S A N F R A N C I S C O B A Y P L A N

S U P P L E M E N T

San Francisco Bay Conservation and Development Commission

January, 1969

FOREWORD

This supplement contains in one volume all of the summary background reports that are the foundation for the San Francisco Bay Plan.

As directed by law, the San Francisco Bay Conservation and Development Commission began its work by making a study of the Bay. The Commission directed its staff and a team of consultants to prepare reports on 25 aspects of the Bay, ranging from the importance of marshlands to port development (the titles of all the reports are given in the table of contents on p. 1).

In most cases, the consultant or the BCDC staff prepared a relatively detailed technical report, and the most important parts of this report with regard to planning for the Bay were summarized for general public distribution. All of the summaries are included in this volume; the more detailed technical reports are available in various public libraries, governmental offices, and in the offices of the BCDC.

The members of the BCDC used each of the 25 reports as the basis for drawing tentative planning conclusions on the different aspects of the Bay. These tentative conclusions, which form the basis of the Bay Plan itself, are also included in this volume.

In a few cases, new information was developed after a report had been printed, and to make these reports as complete as possible, an addendum was prepared to explain the new data.

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TIDAL

MOVEMENT

Part of
a Detailed
Study of
San Francisco
Bay

San Francisco Bay
Conservation and
Development
Commission

San Francisco
California

June 1966

Summary of the report, "The Tides of San Francisco Bay," by Bernard J. Smith, Staff Engineer.

INTRODUCTION

Twice a day, the powerful Pacific tides surge through the Golden Gate to spread out over 400 square miles of Bay surface. Twice a day the tides ebb back toward the ocean. The tides and currents of San Francisco Bay provide an enormous circulation system, almost as important to life in and around the Bay as the blood stream is to a human being.

Viewed from afar, the Bay may appear tranquil and motionless. But the Bay waters are always moving. Even when its surface appears most calm, the serenity of the Bay conceals water movements of great force. The power of rushing water is greatest at the Golden Gate, but decreases rapidly as the tides move farther and farther inland.

The topography of the Bay floor -- in some places a shallow shelf, in others a deep ravine -- and the variations in the Bay shoreline cause the tides to flow faster to some points than to others. Figure 1 illustrates the different speeds of the high water crest in different parts of the Bay.

The tidal crest in the North Bay moves with speeds quite different from those of the tides in the South Bay. As a result, toward the end of the flood tide in the North Bay, the tide will already have begun to ebb in the South Bay. Water from the South Bay will thus flow directly into the North Bay, a tidal flow that is important to circulation of the South Bay waters.

Similarly, toward the end of the ebb tide in the North Bay, the tide will have started to rise in the South Bay and North Bay waters will flow directly into the South Bay. Fresh water from the Sacramento and San Joaquin Rivers flows into the South Bay at this time in the tidal cycle, helping to dilute the relatively stagnant waters of the South Bay.

Tidal currents in the Bay form a complex pattern of swirls, eddies, whirlpools, boils -- and placid backwaters. The varying depths of the Bay, the abrupt change between a shallow area and a deep-water channel, and the configuration of the many straits and inlets -- all these make up the geometry of the Bay bottom and contribute to the pattern of currents. For example, directly west of Angel Island a

clockwise rotation of the surface current occurs. And a slowly swirling current pattern off the Albany shoreline results in the accumulation of debris.

In addition to the wide variation in surface currents, the currents in the deeper parts of the Bay are slowed because of friction with the Bay bottom.

At times in the tidal cycle, the currents may be flowing both upstream and downstream at the same time. Fresh water from the Sacramento and San Joaquin Rivers may be flowing out toward the Golden Gate while a heavier layer of salt water from the ocean flows upstream beneath the fresh water.

IMPORTANCE OF TIDAL ACTION AND RIVER FLOWS

The movement of the tides and the flow of fresh water from the Sacramento and San Joaquin Rivers are of critical importance for the survival of fish and wildlife and for the breakdown and flushing of sewage, industrial wastes, and other pollutants in the Bay. Loss of these functions of the Bay would be costly, both in dollars and in human enjoyment.

The needs of fish and wildlife and of pollution control are met by (1) the oxygen dissolved in the water, (2) the flushing action of the tides, and (3) the variations in the amount of salt in the water.

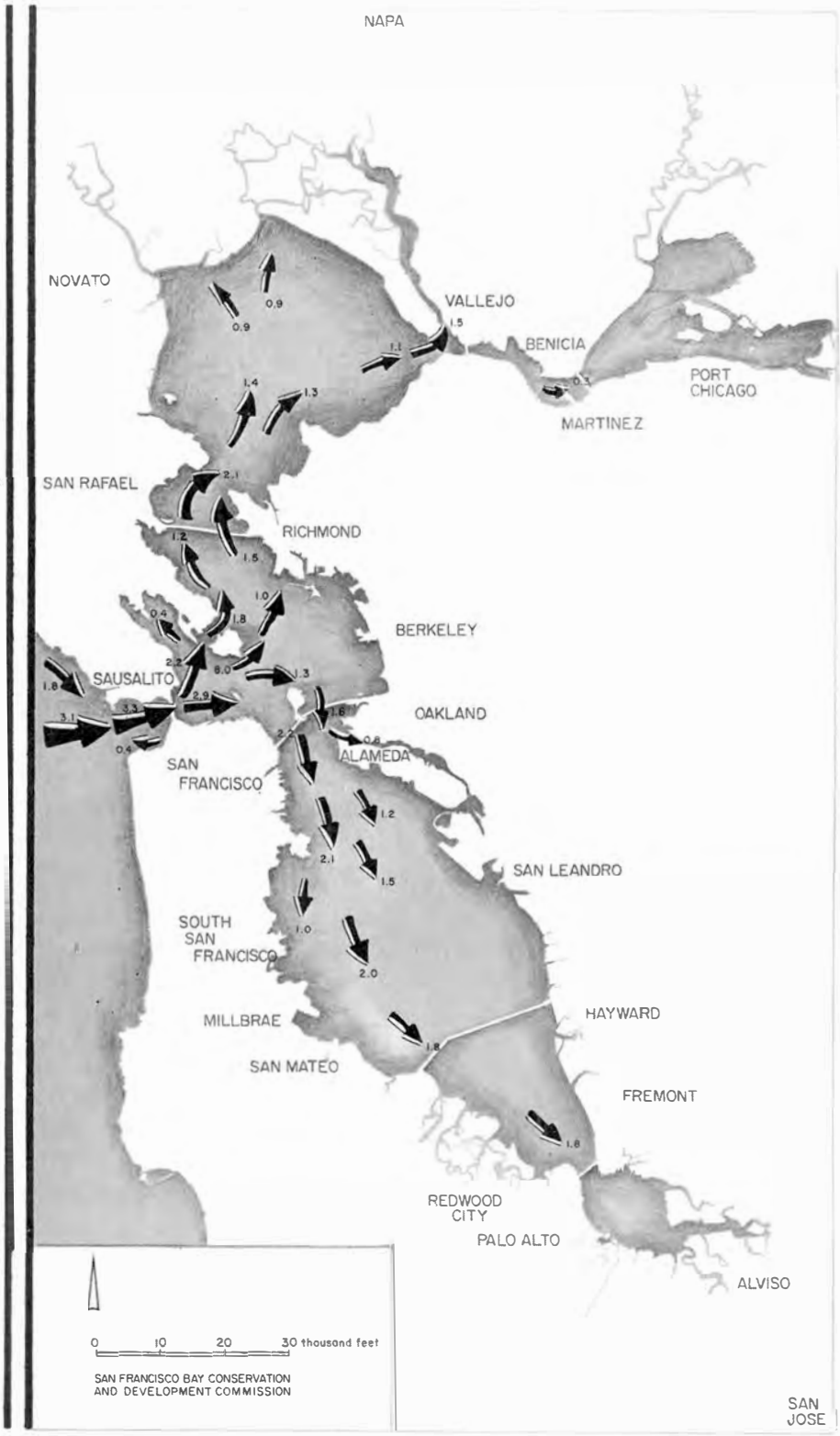
1. Oxygen

Water carries dissolved oxygen, and fresh water carries about 20 to 30 per cent more oxygen than salt water. Fish and other marine life need oxygen in the water to breathe. The oxygen in the water is also essential to decompose the millions of gallons of sewage and other wastes that are dumped into the Bay every day (just as oxygen is necessary for fire to consume wood).

The waters of San Francisco Bay now have an average range of 6.8 to 9.5 parts of oxygen per million parts of water (ppm). Fish and marine life need water with an oxygen supply of at least 4.5 ppm to survive. This leaves only an average range of 2.3 to 5 ppm of oxygen in the Bay waters to break down wastes and prevent the Bay from becoming polluted.

FIGURE 1

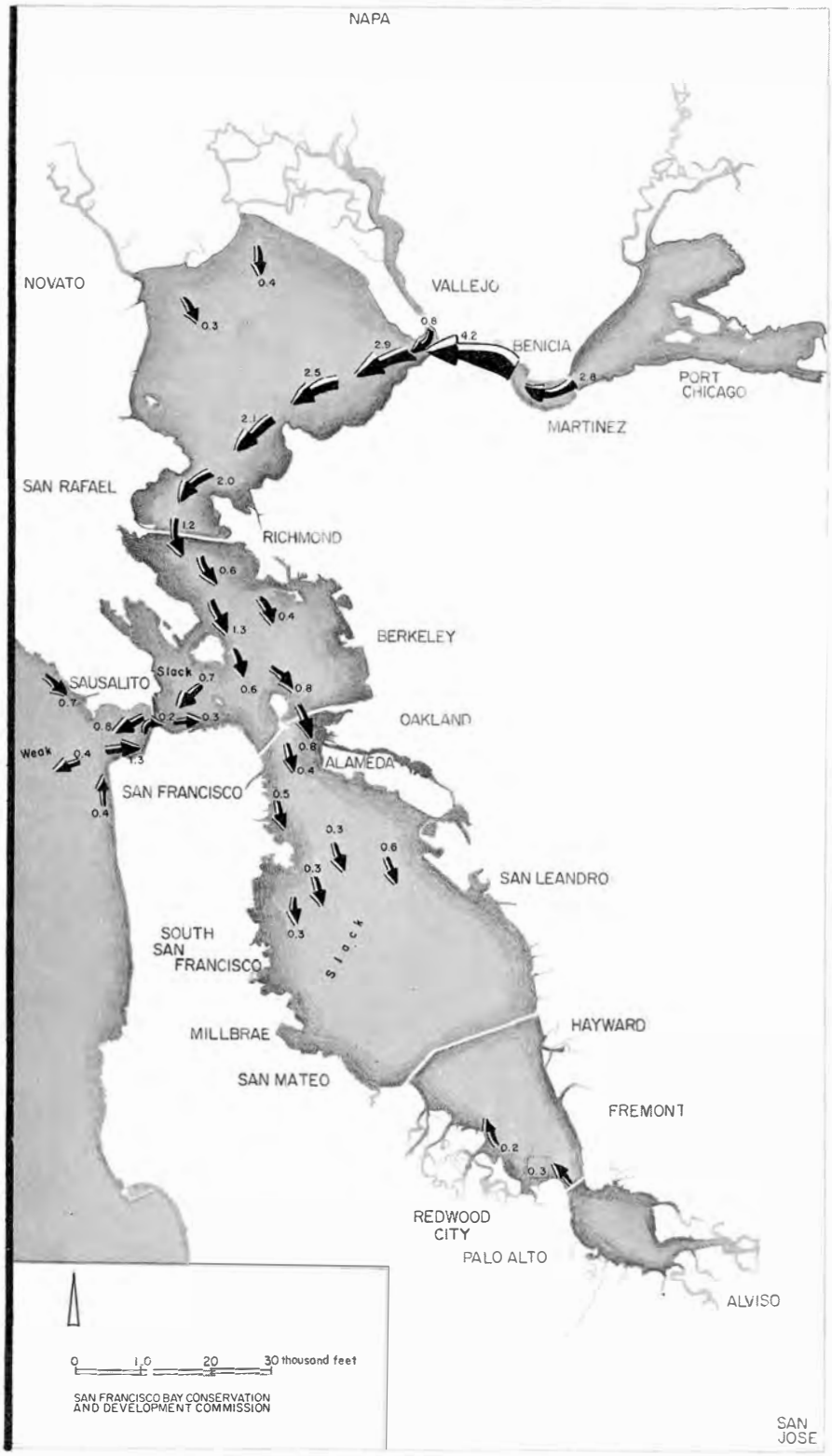
Tidal Currents
San Francisco Bay
Maximum Flood at
Golden Gate



Currents given
in knots:
1 knot = 1.7 ft./sec.
Prepared from
U.S.C.& G.S. charts

FIGURE 2

Tidal Currents
San Francisco Bay
Three Hours After
Maximum Ebb at
Golden Gate



Currents given
in knots:
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Prepared from
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IMPORTANCE OF TIDAL ACTION AND RIVER FLOWS

Already, wastes in the Bay consume a considerable amount of the available oxygen. In the South Bay, for example, during late summer, at the time of greatest recreational use of this part of the Bay, the oxygen supply is at its lowest. One result of this is a demand for increasingly expensive sewage treatment facilities so that less oxygen in Bay waters will be needed to decompose wastes.

The Bay gets some of its oxygen from the fresh water of rivers, particularly the San Joaquin and Sacramento Rivers that flow into the North Bay. But the primary sources of oxygen are these: (1) churning waves trap oxygen from the air; (2) the water surface absorbs oxygen from the air; (3) the exposed mud flats absorb oxygen while the tide is out and transfer it to the water when the tides come in; and (4) aquatic vegetation produces oxygen and exhales it into the Bay waters.

The amount of oxygen in the Bay is thus largely determined by the surface water -- the volume that sweeps in and out with the tides. It is this water that covers and uncovers the valuable mudflats, nourishes the marsh grasses and underwater plants, and takes oxygen from the air.

This top layer of the Bay that moves with the tides is about one-fourth of the total volume of water in the Bay. This one-quarter nourishes the rest of the Bay by mixing with it during the tidal cycles. The mixing is uneven, and the amount of oxygen in the Bay waters is thus unevenly distributed. Everywhere the currents and waves are different, and the extent of mud flats is smaller or greater. Different layers in the water can even prevent the transfer of any oxygen and stifle life in some parts of the Bay bottom.

Increasingly the oxygen supply in Bay waters would be costly. Fresh water could be added to the Bay, but using fresh water for this purpose would be extremely expensive. The Bay could be enlarged, allowing a larger surface to absorb oxygen. In view of the urban development near much of the Bay shoreline, the high costs of dredging (and of disposing of dredged material), and the value of

IMPORTANCE OF TIDAL ACTION AND RIVER FLOWS

shoreline property, any substantial enlargement of the Bay appears unlikely. The best way to restore depleted oxygen supplies is thus to reduce the amount of oxygen-consuming pollutants that are poured into the Bay -- and even this is enormously expensive.

2. Flushing

The Bay disposes of man's wastes by decomposing them and by flushing them away. The flushing is accomplished by the ceaseless flow of the tides and by the flow of fresh water into rivers.

Flushing of the Bay is uneven. It is best in the North Bay, in part as a result of the flow from the Sacramento and San Joaquin Rivers, and worst in the South Bay, partly because no major rivers flow into the South Bay, to provide flushing action.

The flushing action in the South Bay may at first glance appear to be greater than it is, because there is rapid movement of the tides and a tidal range of 8 to 10 feet at Alviso (compared with 4 to 5 feet at the Golden Gate). This does not mean, however, that great quantities of water rush in and out of the South Bay. For the most part, the tides in the South Bay simply cause the water there to rock up and down, like water in a tub, with very little circulation or flushing action.

Tests made on the Army Engineers' Bay model show that if a pollutant is injected into the South Bay in the area of Alviso, ten days of tidal action will be required to carry even a small part of that pollutant as far north as San Francisco International Airport. Twenty days will elapse before tidal action has provided sufficient flushing to carry the pollutant to the Bay Bridge.

The Army Engineers estimate that even if no additional pollutants were to be placed in the South Bay, several years of tidal action would be necessary to flush out the pollutants already there (considering flushing only, and ignoring other action on the pollutants, such as decomposition).

IMPORTANCE OF TIDAL ACTION AND RIVER FLOWS

3. Salt

The waters of the Bay provide a gradual change from the salt of the ocean to the fresh flow of the Sacramento and San Joaquin Rivers. This gradual change appears necessary for the survival of fish such as salmon and bass; an abrupt change from salt to fresh would probably result in a high death rate. In addition, the shrimp, anchovies, and herring upon which the bigger fish feed also adapt to different amounts of salt in the water -- so the salmon have the right diet at the right time as they progress upstream to their spawning grounds. Finally, the fingerlings after spawning need a gradual change in salinity to progress from the fresh water in which they are born to the salt water in which they will spend their adult lives.

EFFECTS OF FILL AND PIERS

In 1850, the total area of San Francisco, San Pablo, and Suisun Bays was almost 700 square miles. By 1958, filling and diking had reduced the area to 435 square miles at mean sea level. Further filling and diking have probably reduced the area to about 400 square miles today.

With 40 per cent of the surface of the original Bay eliminated, the ability of the Bay to absorb oxygen from the air has been reduced by 40 per cent. The amount of water that flows in and out of the Bay with the tides has also been reduced -- by about 14 per cent, since most areas were filled or diked to eliminate probably one foot of previous water cover.

The volume of water that ebbs and flows with the tides is now about 1,250,000 acre-feet (an acre-foot is the volume of water necessary to cover one acre to a depth of one foot). A single square mile of fill only six feet deep would eliminate 1/300 of this tidal volume. If the Bay were filled to a depth of 6 feet below the low tide mark, the volume of tidal water would be reduced by 41 per cent. If the Bay were filled to 12 feet below low tide, this volume would be reduced by 61 per cent.

Fill to the 6 foot mark would reduce the Bay's ability to absorb oxygen by 47 per cent. Fill to the 6 foot depth in the South Bay would reduce the speed

of currents by 75 to 90 per cent, leaving the South Bay still and stagnant.

EFFECTS OF FILL AND PIERS

Small fill projects, and even piers built on pilings, can have important effects on the Bay. Almost any construction in the Bay, whether solid fill or piers, causes adjacent areas upstream and downstream to fill with silt, because the new construction inevitably creates an area of slack water, eddies, and altered current directions. The effects vary, depending on current patterns in the immediate area.

EFFECTS OF FRESH WATER DIVERSION

The volume of fresh water entering the Bay system from the Sacramento and San Joaquin Rivers is about 18 million acre-feet in an average year (ranges from 5 to 52 million per year). Dams built on northern California rivers in the past have already reduced the flow of the Sacramento-San Joaquin River system to about half the original flow into the Bay provided by nature.

The California Water Plan, which will transport water from Northern California to the southern part of the State, may divert as much as 80 per cent of the remaining flow in the Sacramento and San Joaquin Rivers.

The effects of this diversion have been the subject of controversy. Opponents of the diversion argue that it will reduce the oxygen content of Bay waters, severely impair the flushing of Suisun and San Pablo Bays, and harm fish life in the Bay by providing an abrupt change from salt to fresh water.

Proponents of the diversion, including engineers in the Federal Bureau of Reclamation and the State Department of Water Resources, argue that the effects of this diversion have been greatly exaggerated. These proponents argue that the Sacramento and San Joaquin Rivers have relatively little flushing force compared to the tides, contribute relatively little oxygen to Bay waters, and will in any event continue to be released in sufficient quantities to protect the Bay and Delta.

Many studies now under way or planned by Federal and State agencies will deal with the effects of the planned diversion and other aspects of the Bay's oxygen needs and flushing.

SUMMARY

The Bay is a single physical mechanism, in which actions affecting one part may also affect other parts. The tides and currents of the Bay provide an essential flushing and cleansing action, necessary to prevent water pollution. Substantial filling of the Bay would substantially reduce the cleansing force of the tides.

As long as man uses the Bay as a receptacle for sewage and other wastes, and as long as man values the fish and wildlife in the Bay, maintaining oxygen in the Bay waters is essential. Any reduction in the surface of the Bay, and any reduction in the mudflats of the Bay, would reduce the supply of oxygen in the Bay.

SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION
507 Polk St., San Francisco 94102 557-3686

Possible Bay Planning Conclusions Based on the Report on Tidal Movement

1. To conserve fish and wildlife, and to prevent water pollution, San Francisco Bay must have (a) a strong tidal flow that provides mixing and flushing action, and (b) an adequate supply of oxygen. This means that the volume of water flowing in and out with the tides should be kept as large as possible, and that the surface area of the Bay including tidal flats should also be kept as large as possible. Filling and diking, which restrict tidal flow and reduce surface area, should therefore be allowed only for purposes providing substantial public benefits.

2. Any proposed fills, dikes, or piers should be thoroughly evaluated to determine their effects on the Bay, and then modified as necessary to minimize any harmful effects.

3. To conserve the species of fish that depend upon a gradual change in the salt content of the water from stream mouth to open Bay, a continued flow of fresh water from the Sacramento and San Joaquin Rivers into the Bay is necessary. Maintaining an adequate oxygen supply in the Bay, essential for fish and wildlife and for the prevention of water pollution, depends in part on the flow of fresh water into the Bay. The Commission's plans for the Bay should therefore take into account the studies now being made to determine the effects on the Bay of the transfer of fresh water under the State Water Project.

Adopted by the Commission at its meeting of 9/16/66

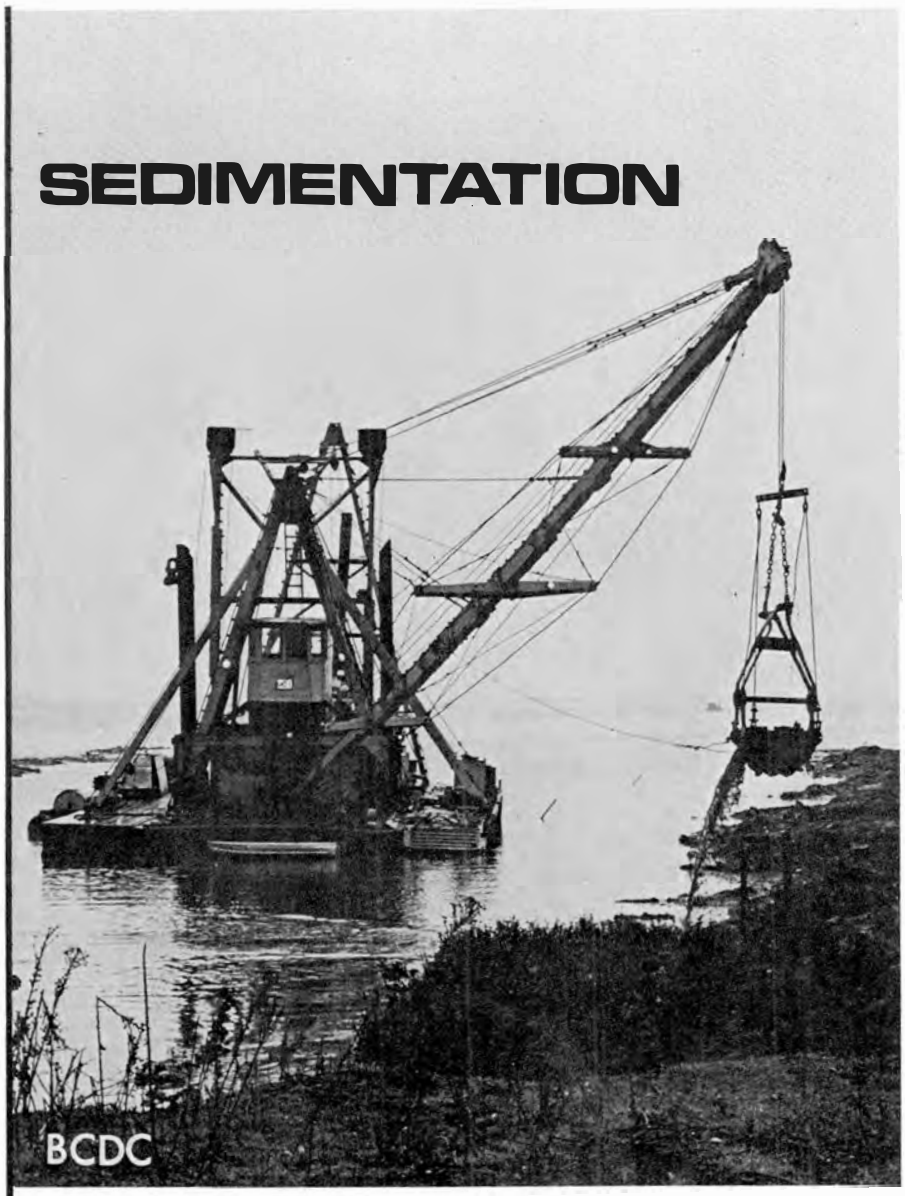
SEDIMENTATION

IN

SAN FRANCISCO

BAY

Part of
a Detailed
Study of
San Francisco
Bay



San Francisco Bay
Conservation and
Development
Commission

San Francisco
California

October 1966

Summary of the report, "Sedimentation Aspects of San Francisco Bay," by Bernard J. Smith, Staff Engineer.

INTRODUCTION

In spring, the waters of the Bay sometimes run a muddy brown.

The spring runoff from the mountains and the Central Valley is reminiscent of the days after the Gold Rush. The 49'ers discovered that a high-pressure hose could eat away a Sierra hillside and expose gold much more quickly than could a pick and shovel. As a result, the rivers became liquid mud and they spread silt, sand, and clay throughout Suisun and San Pablo Bays and the shallower parts of San Francisco Bay.

No longer do gold miners wash soil into the Bay. But the volume of sediment is still heavy enough to pose continuing problems.

WHY SEDIMENTATION SHOULD BE REDUCED

The sediment that is deposited around the Bay is largely washed down from dry land upstream. So, in the first instance, it represents in considerable measure valuable top soil that perhaps could be preserved by additional soil conservation measures.

Many problems result from sedimentation in the Bay. Dredging to remove the silt that continually blocks navigational channels and harbors is expensive. An average of $3 million is spent on Bay dredging annually to maintain 200 miles of deep water channels, 300 miles of shallow water channels, 50 major ports and anchorages, plus smaller harbors, marinas, and private docks. Sometimes the rate of silting can be so rapid as to render a harbor useless, as in the case of the Martinez yacht harbor.

Another problem is that accumulating sediments have filled shallow areas and inlets, reducing the surface area of the water of the Bay and also the volume of water in the Bay, both of which are vital factors in producing sufficient oxygen in the waters for the maintenance of fish and wildlife and for the abatement of pollution.

Finally, sudden accumulations of sediment smother the marine life living on the Bay floor, and also the algae and plants on the floor that provide food

WHY SEDIMENTATION SHOULD BE REDUCED

for fish. The murky water also interferes with feeding since most fish seek their food by sight, not smell or hearing.

Sedimentation is not all bad, however. Excessive algae growth turns the water a slimy green and chokes off marine life; in such cases murky water prevents the penetration of sunlight and helpfully retards algae growth. A recent study also demonstrates that radioactive sediment, which might result from war or nuclear accident, is smothered relatively quickly and rendered harmless by a covering of sediment. And, if sediment is desired to build a new beach or to recreate marshes as suggested by the BCDC report on marshes, a wall or fence can be extended out into the water to direct the shoaling of sediment in the desired location.

Is the Bay filling up with sediment? Theoretically, the Bay could be filled by sediment, but at the present rate it would take about 2,800 years. At the present time, more material is dredged out of channels and harbors each year than comes into the Bay; depositing the dredged materials at sea or on dry land instead of dumping most of them somewhere else in the Bay to flow back into the channels, as at the present time, could neutralize the problem. Moreover, the rate of sedimentation is so slow that many other events upstream may well eventually reduce the amount of sediment washed away and into the Bay.

WHERE THE SEDIMENT COMES FROM

Around 6 million cubic yards of sediment come into the Bay (excluding the Delta) each year. About 85% comes from the Sacramento-San Joaquin Delta and the balance from smaller streams that empty directly into the several bays.

The Sacramento and San Joaquin Rivers and their tributaries have their sources in the high Sierra. Sediment picked up in the rush down the mountains is largely deposited behind dams in the foothills, so most of the sediment that comes into the Bay comes from the Central Valley.

WHERE THE SEDIMENT COMES FROM

Erosion of the land contributes most of the sediment. Deepening of a drainage ditch or a river channel also increases the sediment load because erosion then deepens all of its tributary streams.

The proposed "Big Ditch" plan, which would deepen the navigational channel from the San Francisco Bar to the Port of Stockton another 5 to 10 feet, would increase sedimentation by another 4 million cubic yards a year. The deepened channel would have to be dredged frequently.

WHERE THE SEDIMENT GOES

Only 30% of the sediment that pours into the Bay ever gets out to the ocean. Some of the other 70% is deposited on the mud flats and marshes and some of it goes into the deeper waters of the bays.

Over the centuries, about 670 million cubic yards of sediment have been deposited in Suisun Bay, 4,400 million yards in San Pablo Bay, 4,800 million yards in the Central Bay and 4,700 million in the South Bay south of Candlestick Point.

The Gold Rush accelerated the rate of deposit drastically. About 1,900 million cubic yards of sediment were deposited in the Bay between 1849 and 1949 because of hydraulic mining. One result is that the shore of Southampton Bay, on the north side of Carquinez Strait, has advanced one-half mile from the old shoreline and is now located where the water was 90 feet deep in 1857.

Sediment consists of clay, silt, and sand. When fresh water carrying the sediment meets salt water, much of the material settles to the bottom. The normal location of the salt-fresh water boundary is in the western portion of San Pablo Bay during the winter months of high fresh-water flow and in the eastern portion of San Pablo Bay near Mare Island in the dry summer months, so much of the sediment is deposited in San Pablo Bay.

All of the sediment is not left in San Pablo Bay, however. The back-and-forth sweep of the tides, the turbulent action of the winds, and the seasonal floods and storms constantly stir up the sediment

WHERE THE SEDIMENT GOES

and move it to other locations. Fast water picks up and carries sediment; slow water drops it. While 6 million cubic yards comes into the Bay, the annual dredging operations remove about 11 million cubic yards. Some of the material that is dredged eventually ends up back in the channels and harbors and has to be dredged again and again.

At the present time, no dredged materials are taken out to sea (contractors for the Bay Area Rapid Transit District are considering taking mud from the San Francisco-Oakland tube outside the Golden Gate). Dredged mud is sometimes put behind dikes for fill but is most often dumped in a part of the Bay where it will do the least amount of harm. The best location is near Alcatraz Island where 47% of the silt is carried out to sea by the tides. At Yerba Buena Island only 30% is washed out to sea and in the Carquinez Strait area probably less than 5% ever reaches the ocean. Tests on the Corps of Engineers model indicate that, if all material were dumped at Alcatraz during the peak hour of ebb tide, 70 to 80% of the silt would be carried out to sea.

HOW SEDIMENTATION CAN BE CONTROLLED

The best way to reduce the amount of sedimentation in the Bay is to eliminate sediment at its source. More extensive soil conservation measures over the 50,000 square mile watershed could probably further reduce erosion and resulting sediment flow. This could be accomplished by Soil Conservation Districts and by public works departments at all levels in designing roads and storm drainage systems.

Once sediment is in the Bay system, the major problem is to dump dredged materials in places where they will not find their way back into navigational channels and harbors to be dredged again. The most effective method is disposal at sea but the cost of doing this is not yet known. Such costs would have to be balanced against the current costs of repeatedly dredging the same material. The other "final" method of disposal is behind dikes or on dry land; however, Bay mud is not desirable foundation material and could only be used for such things as parks, where no structures or only very light ones would be anticipated.

HOW SEDIMENTATION CAN BE CONTROLLED

Partial methods of disposing of silt are: (1) constructing fences or dikes in the water to divert the moving sediment to deeper areas of the Bay where it would not interfere with shipping channels, and (2) dumping dredged material in such places as the vicinity of Alcatraz Island where the largest amount of sediment would be carried out to sea.

While the major problem is disposal of accumulating sediment, there is another side to the problem. Water currents pick up sediment and thereby deepen the bottom of the Bay in some locations. Such currents can undercut dikes or even bridge piers; underwater fences or dikes can divert the cutting current away from such facilities and even encourage deposit of sediment there.

While considerable study of the sedimentation problem has been undertaken, much estimating still has to be done. Additional research is necessary to develop more precise criteria for managing sedimentation and particularly for appraising the effects of the California Water Plan on sedimentation in Suisun and San Pablo Bays, as well as the effects of the proposed "Big Ditch" channel deepening project.

THE EFFECTS OF FILLING AND PIERS ON SEDIMENTATION

Any change in the shoreline or bottom of the Bay, whether natural or man-made, alters the flow of water, changing its direction and its speed. Every such change affects the rate at which sediment is either deposited nearby or eroded and carried off elsewhere. In general, a fill or dike that changes the direction of a current to give it a longer straight path would tend to increase sediment pickup in that area and increase deposit of sediment at the end of the straight path. Conversely, a fill or dike or pier that interrupted a current would encourage sediment deposit in the immediate vicinity.

The most apparent shoaling to result from dike construction in the Bay is the long arm of mud that has accumulated behind Dike 12, a 12,800 foot long dike extending westward from Mare Island on the north side of Carquinez Strait.

THE EFFECTS OF FILLING AND PIERS ON SEDIMENTATION

Filling also reduces the amount of water that can come into the Bay with each tide. This reduces the speed of the tidal waters, generally reducing the amount of sediment moved back and forth by the tide.

Reduction of the amount of water that comes into the Bay with each tide may also have significant effect upon the San Francisco Bar, the great arc of sand outside the Golden Gate. Apparently the sand in the Bar comes from up and down the coast outside the Gate and not from sediment from within the Bay. The Bar is held where it is by the tides, the currents along the coast, and the outflow from the Bay. Change in the tidal flow by filling affects the Bar and consequently the maintenance of the channel through the Bar, but extensive research and experimentation will be necessary to determine the probable effect.

EFFECTS OF DIVERSION OF FRESH WATER ON SEDIMENTATION

Diversion of fresh water from the Bay under the California Water Plan will affect the sedimentation process in two ways.

On one hand, the diversion of the sediment-laden waters from the Bay will reduce the amount of sediment flowing into the Bay. If the water diversion to Southern California is increased from the present rate of 3.3 million acre-feet a year to 15 million acre-feet a year, it is estimated the amount of sediment entering the Bay system would be reduced by 2 million cubic yards (this sediment, of course, would tend to accumulate along the canals unless soil conservation and erosion control upstream were substantially improved to reduce sediment flow).

On the other hand, the reduction in the amount of fresh water entering the Bay would move the fresh-salt water boundary closer to the Delta and result in sedimentation in Carquinez Strait and Suisun Bay. This could cause shoaling problems in the harbors and channels from Martinez to Port Chicago and beyond. Even though the total amount of sediment would probably be less due to the reduced water flow, it would then be deposited in more troublesome locations.

SUMMARY

The Bay is a single physical mechanism, in which actions affecting one part may also affect other parts. Sediments in the Bay reduce the surface area and the volume of water in the Bay and clog harbors and shipping channels.

As long as man values the fish and wildlife in the Bay, and uses the Bay as a receptacle for sewage and other wastes, maintaining oxygen in the Bay waters is essential. Any reduction in the surface and volume of the Bay reduces the supply of oxygen in the Bay.

As long as man uses the Bay as a seaport, maintaining the harbors and channels in the Bay waters is essential.

Reduction of sedimentation is possible by more erosion control and by dumping dredged materials outside the waters of the Bay.

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Possible Bay Planning Conclusions Based on the Report on Sedimentation

1. To conserve fish and wildlife, San Francisco Bay must have a strong tidal flow that provides mixing and flushing action and must also have an adequate supply of oxygen. This means that the volume of water flowing in and out with the tides should be kept as large as possible, and that the surface area of the Bay should also be kept as large as possible. Sedimentation, which reduces the tidal volume and reduces the surface area by shoaling at mudflats and inlets, should therefore be reduced as much as possible.

2. To maintain the Bay as a major harbor, adequate docking facilities and navigational channels must be maintained. To reduce dredging costs, sedimentation, which causes filling of the harbors and channels, should therefore be reduced as much as possible.

3. Sedimentation results from (a) upstream erosion that feeds new sediment into the Bay, and (b) redumping of dredged materials back into the Bay and eventually back into channels and harbors. Therefore, to reduce sedimentation, the Commission's plan for the Bay should:

a. Provide means for encouraging increased efforts by Soil Conservation Districts and all public works agencies in the 50,000 square mile tributary area to further reduce erosion.

b. Provide that all dredged materials be placed (1) on dry land or in permitted fills (for which the sediment is adequate foundation), (2) taken out to sea, or (3) dumped in the designated area where the maximum amount of sediment will be washed out to sea.

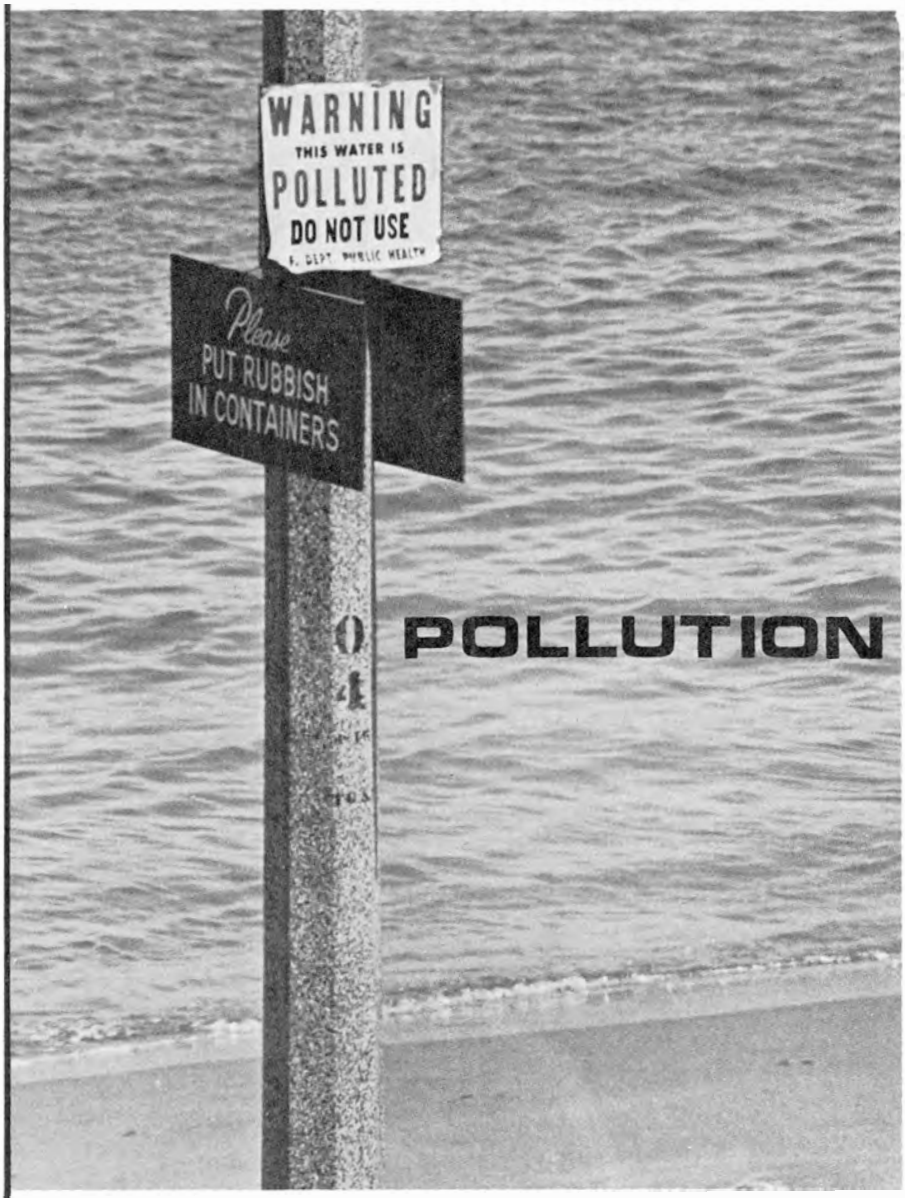
4. Shoaling (accumulation of sediment) in specific locations depends upon the saltiness of the water, the shape of the Bay bottom, the speed and direction of the currents, and the shape of the shore, whether natural or affected by such works of man as fills, dikes, or piers. Therefore, to reduce shoaling in undesirable locations, the Commission's plan for the Bay should:

a. Take into account studies now being made to determine the effects on shoaling patterns in the Bay of the transfer of fresh water from the Delta.

b. Require that any proposed fills, dikes, or piers be thoroughly evaluated to determine their effects on shoaling patterns in the Bay, and then modified as necessary to minimize any harmful effects.

Adopted by the Commission at its meeting of 11/3/66

POLLUTION



San Francisco Bay
Conservation and
Development
Commission

San Francisco
California

July 1967

Summary of the report, "Water Pollution and San Francisco Bay," by the BCDC staff.

INTRODUCTION

Most residents of the San Francisco Bay Area do not ordinarily think of the Bay as part of their waste disposal system. But it is, in fact, just that. Every day, almost 400 million gallons of treated sewage and industrial wastes are poured into the Bay; this daily amount of liquid waste is enough to cover an area the size of San Francisco's Golden Gate Park to a depth of more than one foot.

Compared to rivers and estuaries in other parts of the country, San Francisco Bay is relatively unpolluted. But a rapidly-increasing population around the rim of the Bay will mean a rapidly-increasing volume of wastes to be disposed of. If the Bay shrinks in size through filling, or if methods are not found to substantially reduce the amount of wastes being poured into the Bay, then the Bay Area will be faced with a sharply-increasing problem of water pollution.

WHY CLEAN WATER IS NECESSARY

Ever since men began to live around the shores of the Bay, the Bay has been used as a receptacle for wastes. By 1950, serious pollution problems existed. Many cities were dumping their sewage into the Bay with no treatment whatever. A stench permeated the East Bay shoreline -- caused not by the Bay itself but by the enormous volume of untreated wastes dumped into it. Fishing had almost disappeared. And in the South Bay, which has the least effective circulation system of any part of the Bay, pollution problems were the most serious.

Now, 17 years later, pollution remains an ever-present danger -- but the conditions of 1950 have been vastly improved. The stench that hung over the East Bay shoreline has disappeared. Fishing has greatly improved in the Bay; shrimp have returned to parts of the Bay from which pollution had driven them. And in the South Bay, major efforts toward pollution control have been made.

The first attempts to treat waste waters and prevent water pollution were aimed at halting the spread of disease caused by water-borne contaminants.

WHY CLEAN WATER IS NECESSARY

Prevention of disease remains a major reason for maintaining the waters of the Bay at acceptable levels of purity, but in addition unpolluted waters are necessary to protect fish and wildlife, to permit water sports on the Bay, and to allow esthetic enjoyment of the Bay.

KINDS AND SOURCES OF POLLUTION

San Francisco Bay is a receptacle for waste from municipal (domestic), industrial, and agricultural sources throughout its tributary area.

Domestic sewage contains human excrement, paper, soap, detergents, dirt, food wastes, and numerous other substances. It also contains pathogenic organisms that can cause typhoid, dysentery, and other diseases. A large portion of these wastes is organic and thus decomposible -- which makes the wastes subject to effective treatment and control.

Wastes from factories vary from relatively clean rinse waters to waters heavily laden in some cases with extremely harmful materials, such as lethal chemicals or smothering oils.

Agricultural wastes include large amounts of pesticides and fertilizers. Percolating irrigation water and rain water filter through the soil of farms, and finally reach the Bay through underground water courses. In addition, normal rainfall runoff carries surface soil pollutants to the tributaries of the Bay and thus to the Bay itself.

HOW POLLUTANTS ARE DISPOSED OF

Most pollutants in the water are disposed of by oxygen (oxidized), in approximately the same manner as oxygen is necessary for fire to consume wood. Some pollutants are oxidized in the stream or the Bay where they are dumped; others are flushed out to the ocean and disposed of there.

As the BCDC reports on Tidal Movement and Marshes and Mudflats have explained, the primary sources of oxygen are these: (1) ocean water brought into the Bay by the tides carries oxygen; (2) churning waves trap oxygen from the air; (3) the water surface

HOW POLLUTANTS ARE DISPOSED OF

absorbs oxygen from the air; (4) the exposed mudflats absorb oxygen while the tide is out and transfer it to the water when the tide comes in; (5) aquatic vegetation produces oxygen and exhales it into the Bay waters; and (6) additional oxygen comes from the fresh water of rivers, particularly the San Joaquin and Sacramento Rivers, which flow into the North Bay.

Other wastes, particularly agricultural and some industrial wastes, cannot be broken down by oxygen. These must be diluted in large amounts of water and must be flushed out to sea. Pesticides and fertilizers are the most critical forms of agricultural pollution that affect the Bay. Many pesticides do not decompose easily and can be fatal to many forms of marine life. Fertilizers, on the other hand, spur the growth of slimy green algae that foul beaches and smother marine and plant life.

The flushing of remaining pollutants out to sea is accomplished by relatively fresh water sweeping in from the San Joaquin and Sacramento Rivers, but mostly by the ebb flow of the tide. In general, flushing is quicker in deeper channels and slower in shallow areas; but in many parts of the Bay there is almost no movement in shallow areas and relatively little flushing in the channels. Flushing action is strongest in the North Bays, with their fresh water inflows and better tidal movement, and weakest in the South Bay, where the water tends to rock back and forth with little movement out to sea.

In the absence of good flushing ability, oxygen-consuming wastes will use up most of the oxygen in the water, killing marine life and developing odors and sludge deposits; and any pesticides and nutrients can also become lethally concentrated.

EFFECTIVENESS OF POLLUTION DISPOSAL IN THE BAY

Major efforts to control pollution of the Bay came in 1945, when the State Department of Public Health ordered an end to the discharge of raw sewage into its waters. In 1949, the San Francisco Bay Regional Water Pollution Control Board was created by the Legislature as part of a statewide effort to protect California's waterways (the name was changed in 1966

to Regional Water Quality Control Board). Local governments began an investment of more than $250 million in sewage treatment plants, and industries began to integrate their waste disposal systems with municipal treatment plants or to build their own treatment facilities.

Treatment techniques for domestic sewage have been largely perfected, and treatment through primary, secondary, and tertiary stages can render waste water pure enough for drinking, though each succeeding stage adds to the costs of treatment.

About 60 per cent of the domestic waste flowing into the Bay receives only primary treatment. This process consists of settling raw sewage in concrete tanks until sludge (solid material) is precipitated and floating particles surface. At this point, grease and floating particles are skimmed off and are put into digestion tanks along with the sludge that has been pumped from the tanks. The material decomposes until it becomes innocuous enough to be disposed of elsewhere (e.g., in dumps, land fills, or sometimes in fertilizers). The waste flow that emerges from this primary treatment process has had only about one-third of the oxygen-consuming degradable wastes removed.

Sanitary engineers express one aspect of pollution in terms of Biochemical Oxygen Demand (BOD). This is the amount of oxygen required for bacterial decomposition of wastes over a specified period of time (usually five days). BOD is thus a measure of the amount of oxygen the receiving waters of the Bay must supply to decompose the wastes deposited in the Bay.

A concentration of at least 5 parts per million (ppm) of dissolved oxygen is generally considered necessary to support marine and plant life in a body of water. Water normally has 8 to 9 ppm of dissolved oxygen, leaving a "margin" of 3 to 4 ppm to dispose of wastes without injury to marine life.

Before primary sewage treatment plants were built around the Bay, most of the dissolved oxygen in the Bay waters was needed to decompose raw sewage. When

the dissolved oxygen concentration was reduced, particularly near sewer outfalls, insufficient oxygen remained in the water to support fish -- and much aquatic life perished. Once sewage treatment plants had been built, however, the level of dissolved oxygen in the Bay was restored to the point where fish life began to reappear.

The volume of municipal wastes has continued to maintain -- or, in some cases, even to achieve -- the concentration of 5 ppm of dissolved oxygen in Bay waters.

In secondary treatment, various biological processes are used to further decompose wastes. This treatment removed 80 to 90 per cent of the BOD in wastes. Only about 35 per cent of the municipal waste that enters the Bay receives secondary treatment, however, and about 5 per cent receives intermediate treatment (between primary and secondary).

Tertiary treatment is the last step in achieving almost totally pure water, but it is so expensive that the processes are not widely used. At this stage, the waters may be, for example, passed over sand filters and then over activated charcoal.

It is more difficult to remove the non-degradable chemicals that will not decompose in the digestor tanks or gravel beds, but methods have been designed to remove even these pollutants. Pathogenic bacteria can be killed at any stage of the process by chlorination or by special methods in advanced treatment.

Because there are many small waste treatment plants around the Bay, and because wastes from some disposal sites on dry land -- such as shoreline dumps -- can under some conditions seep into the Bay, an exact count of the number of waste discharges around the Bay is difficult to obtain.

The most up-to-date figures available -- obtained from listings of the San Francisco Bay Regional Water Quality Control Board -- include 203 municipal discharges, 103 industrial discharges, and 60 miscellaneous sources of possible pollution of Bay waters; these miscellaneous sources include dumps.

EFFECTIVENESS OF POLLUTION DISPOSAL IN THE BAY

Along with better treatment, the flushing ability of the Bay system remains an important aspect of pollution prevention. As the BCDC report on Tidal Movement explained, the South Bay has very poor flushing ability. Flushing is better in other parts of San Francisco Bay, but even in the North Bays the pollution moves back and forth within the Bay and only gradually moves out through the Golden Gate. In the North Bays, as well as the South Bay, the greater portion of pollution tends to move to shallow areas where there is little flushing action. Inadequate flushing helps cause recurring quick fish-kills, which indicates that a chronic condition of toxicity exists just below the lethal limits and any sudden increase kills fish.

THE FUTURE PROBLEM

1. Population and Pollution Increases

The population of the Bay Area, the Delta, and the Central Valley areas, whose rivers and streams feed into the Delta and Bay, is expected to increase from about 6 million now to more than 22 million by the year 2020. The 16 million new residents will require tremendous supplies of water -- and they will produce tremendous quantities of wastes. Figure 1 illustrates the annual water demand.

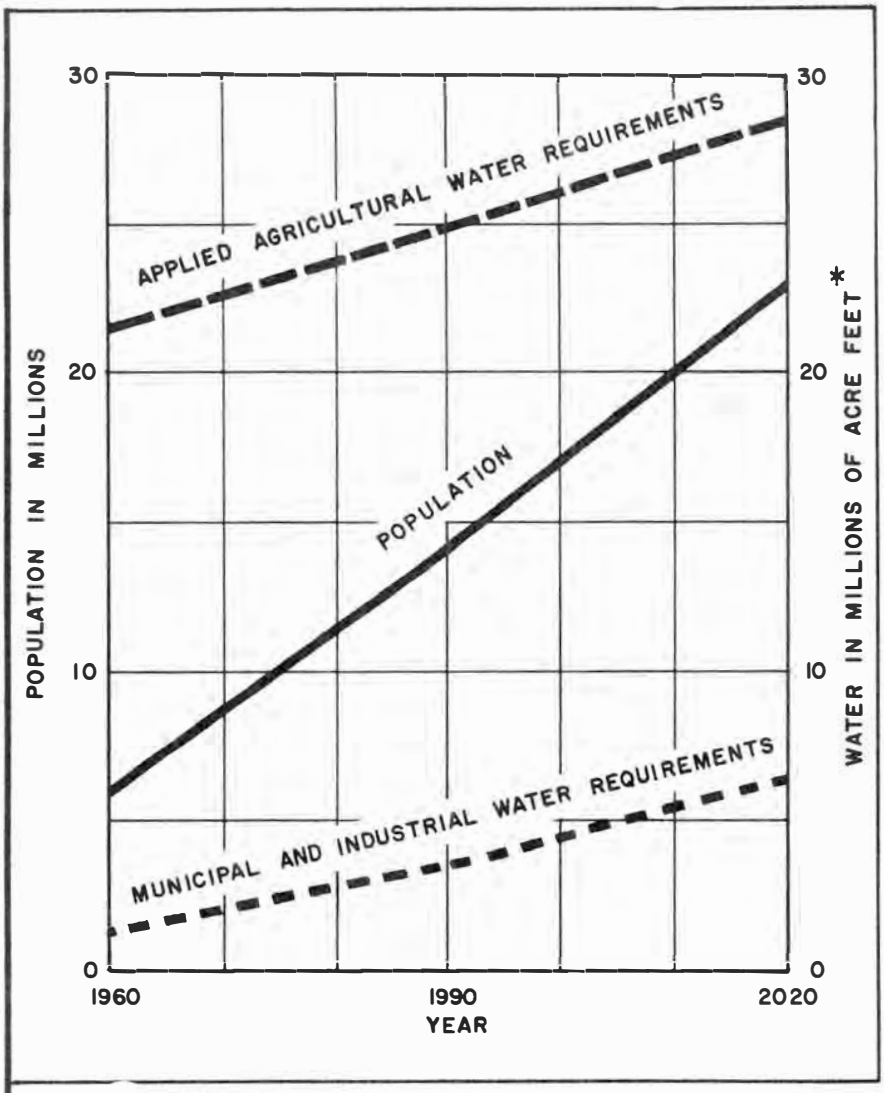
There is as yet no detailed prediction of the expected increase in liquid wastes, but judging from the graphs in Figure 1, the rate of increase will be large. The U. S. Public Health Service indicated in 1963 that the volume of effluent discharged into the Bay would increase to perhaps 1,100 million gallons per day by 1990 and to more than 1,700 million gallons daily by 2015.

2. Reduction of Fresh Water Flows

One element of concern in assessing the future problems of Bay pollution is the planned reduction in the amount of fresh water that will be allowed to flow into the Delta and the Bay. The State Water Project and the Federal Central Valley Project, with extensive systems of dams, reservoirs, and aqueducts, will conserve vast amounts of rain water that fall on Northern

FIGURE 1

Population and Use of Water San Francisco Bay, Delta, and Central Valley Areas 1960-2020



* An acre-foot is the amount of water required to cover one level acre to a depth of one foot, thus 43,560 cubic feet or approximately 327,000 gallons.

Source: San Francisco Bay-Delta Water Quality Control Program, Preliminary Report and Prospectus, State Water Quality Control Board, February, 1966; p. 18 (based on data provided by the State Department of Water Resources).

THE FUTURE PROBLEM

California and will make this water available for various parts of the State.

Under present plans, the fresh water flowing into the Delta will be reduced from the present average of 17.5 million acre-feet a year to about 2.5 million acre-feet in a median year and a little more than 1 million acre-feet in a dry year. The fresh-water outflow is believed to be quite important to the Bay because of the dilution, oxygen, and flushing it provides.

3. Filling Shallow Parts of the Bay

The danger of water pollution will be increased if shallow parts of the Bay are filled. As explained in the BCDC report on Tidal Movement, the surface area of the Bay and the volume of Bay waters both play an important role in determining the ability of the Bay to assimilate wastes. If the surface area is reduced through filling of shallow parts of the Bay, then the dangers of pollution will be increased in two ways: the strength of the tidal flow that flushes wastes from the Bay will be reduced, and the ability of the Bay to maintain an adequate supply of oxygen to neutralize wastes poured into its waters will also be reduced.

GOVERNMENTAL STUDIES OF BAY POLLUTION

No other aspect of the Bay is currently receiving as much study as is the problem of controlling water pollution. The results of some of these studies will be available as the BCDC planning program proceeds; other information will not be developed until after the BCDC plans and recommendations have been submitted to the Governor and the Legislature in January, 1969.

The Federal Water Pollution Control Administration has recently completed a study of the effects of the proposed San Joaquin Master Drain on the Bay. The study concluded that the proposed drain, which would carry agricultural wastes from the Central Valley to an outfall near Antioch, would have a significantly harmful effect on the waters of the Bay and Delta, adversely affecting fishing, recreation, and esthetic values.

GOVERNMENTAL STUDIES OF BAY POLLUTION

This harm would come primarily from nutrients the Drain would deposit in the Bay; the nutrients would stimulate the growth of large quantities of algae and other aquatic plants. The FWPCA study also concluded, however, that these detrimental effects could be minimized by treatment of waste waters; therefore, the FWPCA recommended that no discharge from the Drain be permitted for at least five years, i.e., until 1972, so that pilot treatment facilities can be built and tested.

Interestingly, the FWPCA study also concluded that the Drain, as presently planned, would not increase the present pesticide content of the Bay and Delta, principally because most pesticides are absorbed or decomposed as they pass through the soil of farmlands, while the Drain would collect subsurface waters.

An extremely important aspect of Bay pollution -- the extent to which the Federal Government should help pay for pollution control measures -- is now being studied by the U. S. Army Corps of Engineers. This study will take 5 to 7 years, and, as a first stage, the Army Engineers' Bay Model in Sausalito is being expanded to include the entire Delta area from Sacramento in the north to Vernalis, south of Stockton.

A State-financed water pollution control study is now being conducted by the State Water Quality Control Board. Known as the San Francisco Bay-Delta Water Quality Control Program, this study is dealing with such questions as:

Waste Collection -- Should there be a large, combined system to collect all wastes that drain to the Bay? Or would several smaller systems be preferable?

Waste Treatment -- Should wastes be treated by conventional physical, chemical, and biological processes? By tertiary treatment processes? By other processes that are now being developed?

Waste Disposal -- Should wastes be disposed of in Bay-Delta waters? In the ocean? In underground strata? On land? By evaporation?

GOVERNMENTAL STUDIES OF BAY POLLUTION

Waste Reclamation -- Can waste waters be economically reclaimed for use in recreation, agriculture, industry, etc.?

Governmental Alternatives -- How should a pollution control master plan be administered and financed? By existing State and local agencies? By a multi-county agency? By a new, overriding authority? By some other system? And how should the costs of a pollution control program be apportioned?

The Bay-Delta study must, like the BCDC, submit its plans to the Governor and the Legislature in January, 1969.

The San Francisco Bay Regional Water Quality Control Board, part of the State's water-protection system, has commissioned a five-year pollution study being undertaken by the Sanitary Engineering Research Laboratory at the University of California in Berkeley. This study, now almost completed, is assembling and reviewing all existing information on waste discharges, water quality, and bottom sediments in the Bay, to provide the Regional Board with reliable methods of assessing the general condition of marine life in the Bay.

As a further part of its work, the Regional Board is considering adoption of a set of water quality objectives for the Bay. It is expected that these objectives will be adopted before June 30, 1967. The Regional Board's standards will be of great importance to the planning program of the BCDC, since they will play a major role in determining the uses of Bay waters that can be planned for. Present indications are that the standards will be sufficiently high to permit extensive recreational uses of most areas of the Bay.

A D D E N D U M

EXCERPTS FROM PROPOSED WATER QUALITY CONTROL POLICY OF THE BAY REGIONAL WATER QUALITY CONTROL BOARD

Shortly after the BCDC report on Water Pollution was completed, the San Francisco Bay Regional Water Quality Control Board completed work on its proposed policy for Bay waters, and released a report for public review and hearings. The following statements from the RWQCB policy report concerning water quality problems in San Francisco Bay contain information supplementary to that contained in the BCDC report. As the BCDC report indicates, many concurrent studies are being made of Bay pollution problems, and additional addenda may be issued in the future to update the original BCDC report.

Present Water Quality

Waste dischargers (in their self-monitoring programs), the Regional Board (in its checking program), various water agencies, and tidal water users have collected copious amounts of data on the quality of the waters of the Bay System in the immediate vicinity of waste discharges or at points of water diversion. The Comprehensive Study of San Francisco Bay, initiated by the State Water Quality Control Board at the request of this Regional Board in 1957, has provided the most complete water quality data for the main water mass of the Bay System, but did not collect data on tidal sloughs and streams or in the vicinity of waste discharges. The primary objective of the Comprehensive Study was to gather information and data which would permit quantitative evaluation of the effects of waste discharges upon the beneficial uses of San Francisco Bay and contiguous estuarine waters with particular emphasis on the fishery resource. Following, except as noted, is a brief summary of the water quality data collected by the Comprehensive Study.

Water temperatures vary seasonally from 4.6°C., during the winter in the Suisun Bay area, to 27.1°C., during the summer in the South San Francisco Bay. Mean annual temperatures exhibit a slight tendency to be higher when measured in a landward direction from the Golden Gate. Water temperatures in the shallower portions of the Bay System are much higher than those in the deeper waters during the summer and early fall months.

Transparency as determined by the mean of Secchi disc readings increased seaward from a minimum of 0.9 feet in Suisun Bay and 1.9 feet in South San Francisco Bay to a maximum of 4.6 feet in the Central San Francisco Bay. Variations in transparency do not appear to follow a definite trend although low values are found during periods of maximum rainfall runoff. Maximum transparencies of 9 feet or more were found in the three northern subareas of San Francisco Bay proper.

Mean pH levels increased seaward from 7.65 in the Suisun Bay and 7.60 in the South San Francisco Bay to 7.90 in the Central San Francisco Bay. The lowest pH recorded during the Comprehensive Study was 6.8 observed in South San Francisco Bay and San Pablo Bay and the highest of 8.5 was observed in Suisun Bay.

Mean concentrations of chlorosity ranged from a low of 2.5 g/l in Suisun Bay reflecting fresh water outflows from the Sacramento-San Joaquin Delta to 16.5 g/l in the Central San Francisco Bay and to an extreme of 19.3 g/l in the South San Francisco Bay reflecting the inverse hydrologic characteristics of the South Bay during the summer months.

Mean dissolved oxygen levels were consistently higher than 7.0 mg/l and minimum dissolved oxygen values were 5.7 mg/l or greater in most parts of the Bay System with saturation values generally greater than 85%. South San Francisco Bay was an exception to this where the mean dissolved oxygen level was 4.5 mg/l and complete lack of dissolved oxygen was found in the vicinity of the City of San Jose's waste discharge, then receiving only primary treatment. Special investigations, conducted by the Regional Board's staff in cooperation with waste dischargers, in this area during the summer and fall of 1965, subsequent to the operation of the City of San Jose's activated sludge treatment plant, found the areas of dissolved oxygen depletion reduced in size, but still in violation of waste discharge requirements. Depressed levels of dissolved oxygen have also been measured by other sampling programs in the Upper Petaluma River and in and beyond 27 specific areas delineated by the Regional Board for dilution of wastes. These areas are generally shallow tidal flats or confined bodies of water such as sloughs, creeks or rivers where no samples were collected by the Comprehensive Study. The waters in some of these problem areas and especially South San Francisco Bay at times have measurable levels of dissolved sulfide.

Mean biochemical oxygen demand concentrations were found to be about 1 mg/l throughout the Bay System with the exception of South San Francisco Bay where the mean value was 10 mg/l and the extreme value was 298 mg/l reflecting an effect of the City of San Jose's waste discharge during the canning season. No data are available regarding the decrease in concentration of biochemical oxygen demand after the City of San Jose began operation of its activated sludge treatment plant.

Mean nitrate nitrogen concentrations varied from 0.23 mg/l in the Central and North San Francisco Bays to 0.35 mg/l in the other portions of the Bay System. Nitrate nitrogen concentrations were strongly cyclic with the maxima occurring during the winter and the minima during the mid-summer corresponding to the periods of increased plankton concentrations. Mean concentrations of reactive phosphate in the Bay System varied spatially within a range from 0.2 to 0.5 mg/l with no regular pattern of fluctuations with respect to time. Dissolved silica concentrations were highest at 13.6 mg/l in the Suisun Bay area and 8.7 mg/l in the South San Francisco Bay and decreased seaward to a minimum of 3.6 mg/l in the Central Bay.

The mean concentration of microplankton of 3.6×10^5 cells/l in the Suisun Bay area was on the order of one magnitude greater than all the other subareas of the Bay System. The microplankton concentrations reach a maximum during the months of June and July. Microplankton diversity indices were highest in the Central and North San Francisco Bays and decreased in a landward direction from the Golden Gate.

Coliform concentrations in the Bay System varied widely. Generally the North and Lower San Francisco Bays had the best quality. South San Francisco Bay had the poorest bacteriological quality with 79% of the samples in excess of MPN 1000/100 ml followed by Suisun Bay, San Pablo Bay and the Central Bay. The State Department of Public Health has reported substantial improvement in the bacteriological quality of the Central Bay waters after the initiation of chlorination by the City of San Francisco at its Southeast Plant and East Bay Municipal Utility District in August 1966.

Water Quality Factors

Many communities and industries in the nine-county Bay Area utilize the assimilative capacity of the tidal waters of the Bay System by discharging waste effluents after various degrees of treatment. These waste dischargers are regulated by the Regional Board on a case-by-case basis by the adoption and enforcement of requirements

on the quality and quantity of waste discharged and on receiving water conditions to be maintained. Three hundred and ninety-eight million gallons of treated sewage and industrial wastes are discharged daily during dry weather to the tidal waters of the Bay System from 77 municipal sewerage systems. Approximately 35 per cent of these waste flows receive secondary treatment at 23 sewage treatment plants with the remaining flow receiving primary treatment at 54 sewage treatment plants. No community is discharging waste without treatment in the San Francisco Bay Region. Forty-seven municipal waste discharges are now disinfecting or have facilities capable of disinfecting their waste flow which amounts to 245 million gallons per day, while 32 dischargers with a total waste flow of 153 million gallons per day do not have disinfection facilities.

A total of 269 million gallons per day of industrial wastes is discharged to the Bay System by 47 industries. It is estimated that approximately 94% of this waste flow is cooling water drawn from the Bay System and circulated in closed cooling systems. Most of the industrial waste dischargers are located along the shorelines of Contra Costa County and discharge their wastes to San Pablo Bay or Suisun Bay. These dischargers contribute more than 70 per cent of the biochemical oxygen demand loading in these areas; however, the depletion of dissolved oxygen below 5 mg/l has not been measured immediately beyond industrial waste effluent dilution areas delineated by the Regional Board.

The number, location and degree of treatment of both municipal and industrial waste discharges changes with the continuing implementation of recommendations in studies on sewerage needs and of master plans. The numerous local and county-wide studies and the State Water Quality Control Board's study now under way precludes at this time a definition of future waste loadings on, or future sewerage needs of the Bay System. Over $250,000,000 have been spent by communities in the San Francisco Bay Region for waste treatment and disposal facilities during the past 16 years and there are 29 projects, representing an additional expenditure of $47,000,000, under way or planned for commencement of construction within a year.

There are an undetermined number of untreated waste discharges onto public streets and into waterways in the Bay Area from overloaded sanitary sewer systems during periods of rainfall. Some communities are in the process of separating combined sewer systems and/or studying treatment of combined flows, or are improving sanitary sewerage systems to reduce infiltration or to provide additional capacity to treat the increased flows. However, many other communities have yet to study or provide solutions to the problem. The total magnitude of the effects of these discharges and the costs of solutions to meet the water quality objectives is unknown.

Storm water runoff not containing sewage, discharged from storm sewers, from flood control channels and from tributary streams is a factor with unknown effects on the quality of the waters of the Bay System. These inflows to the Bay System carry significant quantities of silt introduced by land use activities including agricultural practices, residential development, highway construction, and mining of natural resources. The tributary streams and rivers also carry unknown quantities of nutrients, pesticides and organic and inorganic material drained from residential, agricultural and forested lands. The magnitude of the present water quality problem created by these factors is unknown. The discharge of agricultural drainage waters from the San Joaquin Valley may be concentrated in the Bay System if the San Joaquin Master Drain or the San Luis Interceptor Drain are constructed as proposed by the State Department of Water Resources and the U. S. Bureau of Reclamation. These proposals are considered to be a serious threat to the water quality, hence, to the beneficial uses of the waters of the Bay System if they are permitted to discharge

inland from the Golden Gate without adequate treatment or control measures. This Regional Board's Resolution No. 535 prohibits the discharge from the proposed San Luis Interceptor Drain until receipt of evidence and assurances, satisfactory to the Board, that the proposed discharges will not adversely and unreasonably affect the receiving waters for any of the beneficial uses protected by the Board.

Streams tributary to the Bay System, particularly those to the Petaluma River, carry substantial quantities of dairy wastes (manure) containing high concentrations of nutrients which contribute to the excessive planktonic growths and biochemical oxygen demand which contributes to the depletion of dissolved oxygen. The dairy industry in Sonoma County at the request of the Regional Board has initiated a program to eliminate the discharge of dairy wastes which are a source of pollution. This program has reduced the amount of wastes entering tributary streams. The Regional Board adopted requirements prohibiting the discharge of dairy waste to any watercourse within a watershed of the Petaluma River drainage basin. The 10 dairies in the area are under investigation by the staff to determine compliance with requirements.

Maintenance dredging, dredging of new shipping channels, dredging to deepen navigation channels, overflows from hydraulic landfills, mineral extraction, and wind and tide induced currents may create problems of nuisance and pollution by contributing to turbidity and settleable solids. The Regional Board has prescribed requirements for some of these operations on a case-by-case basis to prevent excessive turbidity and other conditions of pollution or nuisance. Maintenance dredging operations, primarily by the U. S. Army Corps of Engineers, remove about 11 million cubic yards annually from navigation channels and harbors. Much of this material is disposed of within the Bay System and some eventually returns to the channels and harbors which must be dredged again. The U. S. Army Corps of Engineers has designated six sites within the Bay System for disposal of dredging spoils. The Flood Control Act of 1965 authorized the "Big Ditch," a project to deepen the existing navigation channels into Suisun Bay to a depth of 45 feet and to Stockton to a depth of 35 feet. Approximately 45,000,000 cubic yards of spoil from this project would be deposited in this Region onto shore lands behind dikes, onto mud flats, in marshlands adjacent to channels, in water areas or in existing disposal areas.

The discharge of oily wastes and sewage from vessels, boats or houseboats is a factor contributing to pollution of the Bay System waters. Oil pollution problems have been generally localized at refinery docks, ports, and marinas and have been attributed to accidental spills, deliberate discharges, and pumping of oily bilge or ballast water. Forty-nine such incidents were investigated by the U. S. Coast Guard during 1966. Complaints received by the Board's staff of oil pollution from vessels are referred to the United States Coast Guard for investigation and corrective action pursuant to an agreement developed by various state and federal agencies. Untreated sewage is discharged to the waters of the Bay System from commercial and military vessels and recreational craft. Little is known about the degree of the effects of these sewage discharges on water quality.

Streams and rivers tributary to the Bay System influence the quality of the tidal waters by transporting pollutants, by repelling the intrusion of saline waters and by flushing of conservative pollutants from the Bay System. Local streams because of their small flow have relatively small effects on the quality of the Bay System compared to the present outflows from the Sacramento-San Joaquin Delta. The present water quality problems of the South San Francisco Bay are, in part, attributed to the limited fresh water inflow which has created a negative estuary. The proposed upstream water development projects for water supply and power

development by the Federal Central Valley Project, by the State Water Project and numerous other projects will drastically reduce the Delta outflow. It has been estimated that the current annual Delta outflows of 17,452,000 acre-feet will be reduced to 5,512,000 and 2,545,000 acre-feet by the years 1990 and 2020, respectively. This reduction of Delta outflows will cause approximately 50% reduction in the sediment load entering the Bay System from the Central Valley; intensify the intrusion of saline waters into the Western Delta impairing the usability of the tidal waters for the municipal, industrial and agricultural water supplies; and reduce the frequency of flushing flows.

Studies have indicated that a very significant transport of pollutants through the San Francisco Bay System is accomplished in one month and flushing is essentially complete in two months with a Delta outflow of 25,000 cubic feet per second. Historically and at present, adequate flushing and removal of accumulated pollutants has occurred almost every winter with Delta outflows which include any of the following: 2,000,000 acre-feet in any one month, 3,000,000 acre-feet total in any two consecutive months, or 4,000,000 acre-feet total in any four consecutive months. It is projected that adequate flushing will be obtained only one year in three by 2020 with the operation of proposed water development projects. The combined effect of the discharge from the San Luis Interceptor Drain or the San Joaquin Master Drain, which would concentrate the points of the disposal of agricultural drainage wastes, together with the reduction of frequency of natural flushing flows through the Bay System is a serious threat to the beneficial uses which the Regional Board has stated its intent to protect unless drain wastes are adequately treated and adequate flushing flows are provided.

Shoreline developments including man-made lagoons, marinas, and boat harbors, piers and land fills influence the quality of waters in the Bay System. These factors may influence the main water mass by interchanging water from the stagnant confined bodies of water; by interfering with the movement and pattern of interchange of tidal waters; by reducing the total water surface area, which is important for reaeration of tidal waters; by creating water quality problems from leachate and floating debris from refuse dumps, and by floating debris from deteriorating water front structures. The problems created by landfills are very complex in nature and are being studied by the State Water Quality Control Board's San Francisco Bay-Delta Water Quality Control Program and by the San Francisco Bay Conservation and Development Commission. The use of tidelands in the Bay Area for solid waste disposal is declining; and, therefore refuse dumps are not expected to cause significant problems in the future. The Regional Board prescribes requirements with respect to water pollution for refuse disposal operations on a case-by-case basis.

Floating debris originates from two major sources: illegal placement of material along the shoreline and in tributary streams, and from new water front construction or water front structures which are falling apart. Floating debris became an acute problem in the Bay Area in the late 1950's following the adoption of an air pollution control regulation which prohibited open burning. Subsequently the Regional Board adopted requirements for a number of established refuse disposal operations and enacted administrative controls. A number of cities and counties in the Region began to enforce existing or new laws designed to eliminate floating debris. A substantial reduction in the amount of floating debris resulted from these actions, but floating debris remains to be a perennial problem requiring expenditures on the order of $2,800,000 annually by the U. S. Army Corps of Engineers for the removal and burning of floating debris from navigable waters and requiring constant surveillance and enforcement of existing local, state and federal laws.

SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION
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Possible Bay Planning Conclusions Based on the Report on Pollution

1. San Francisco Bay receives a variety of municipal, industrial, and agricultural wastes from sources throughout its tributary drainage area. Pollution occurs when waste discharges cause water quality conditions that damage or destroy varied uses of the Bay. Thus, polluted waters may be unsafe for human contact or use, offensive to the senses, damaging or lethal to marine life, and even unsuitable for industrial use. If pollution is to be prevented, wastes must be maintained at suitably low levels by: adequate treatment prior to discharge, dilution, transport to the sea, and through natural breakdown processes using dissolved oxygen. While waste disposal poses a continuing threat to water quality in the Bay, present economic realities indicate that this use of Bay waters will continue into the future.

2. Compared to rivers and estuaries in other parts of the country, San Francisco Bay is relatively unpolluted. In spite of population growth, extensive improvements in industrial and municipal waste treatment have greatly reduced the pollution that once existed in the Bay. But some parts, especially in the South Bay, are still polluted at certain times of the year. As long as the Bay continues to receive wastes from an expanding population and industry, there must be constant improvement in waste management to clean up presently polluted areas and prevent pollution problems in the future.

3. In addition to requiring continuous improvements in waste treatment, the Bay's ability to safely accommodate wastes will require (a) a strong tidal flow and adequate fresh water inflow that provide mixing and flushing action, and (b) an adequate supply of dissolved oxygen. This means that the volume of water flowing in and out with the tide should be kept as large as possible, and that the oxygen-absorbing surface area of the Bay, including tidal flats, should also be kept as large as possible. Filling and diking, which restrict tidal flow and reduce surface area, should therefore be allowed only for purposes providing substantial public benefits.

4. Any proposed fills, dikes, or piers should be thoroughly evaluated to determine their effects on Bay water quality, and then modified as necessary to minimize any harmful effects.

5. Several governmental study programs are now seeking to determine the best methods of controlling water quality and preventing pollution in the Bay. In preparing the Commission's plan for the Bay, it will be assumed that in time actions arising from these studies will result in sufficiently high water quality in all parts of the Bay to permit water contact sports and to provide a suitable habitat for all indigenous and desirable forms of aquatic life.

Adopted by the Commission at its meeting of 8/3/67

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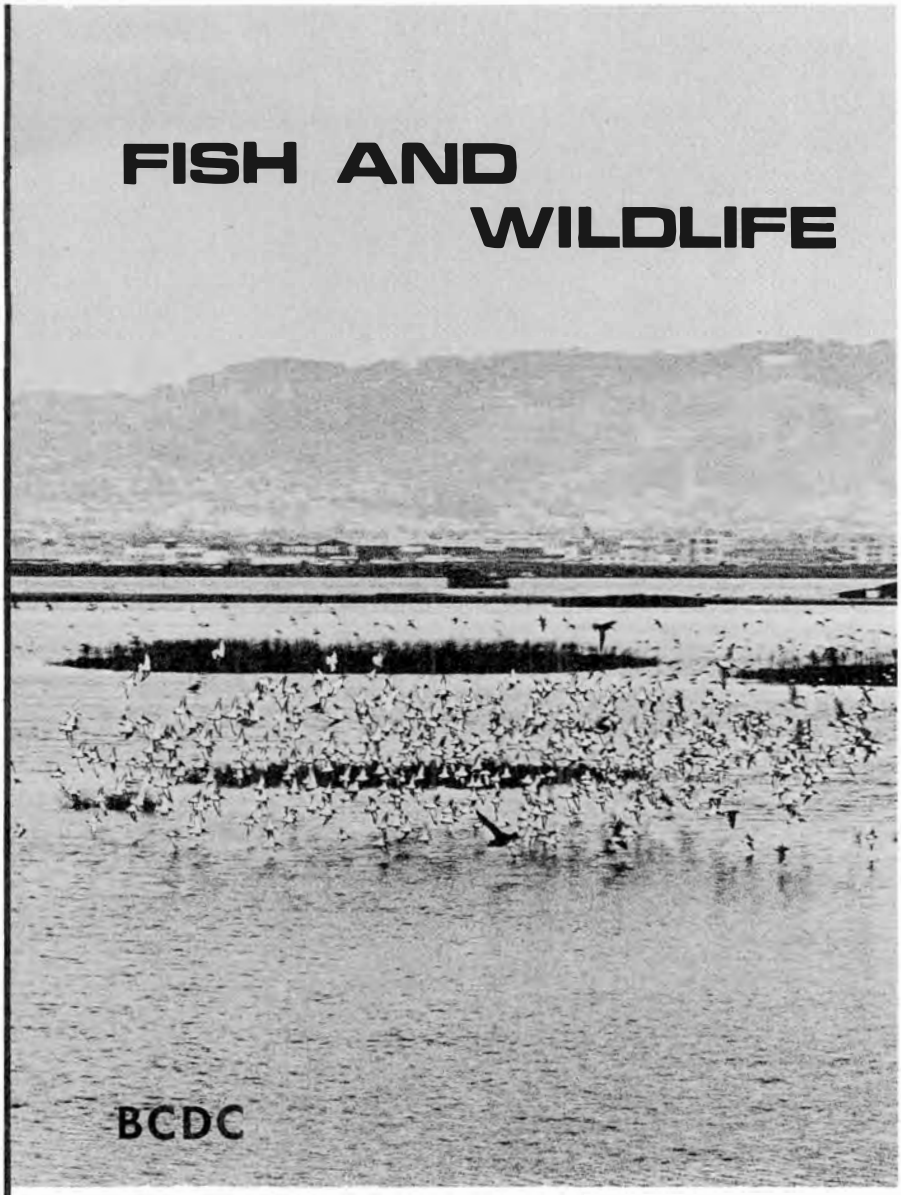
WILDLIFE

IN

SAN FRANCISCO

BAY

Part of
a Detailed
Study of
San Francisco
Bay



San Francisco Bay
Conservation and
Development
Commission

San Francisco,
California

September 1967

Summary of the report, "Preliminary Fish and Wildlife Plan for San Francisco Bay-Estuary," by the State Department of Fish and Game.

INTRODUCTION

Children stop to gaze in wonder at the flocks of birds rising and settling in the marsh and mud. A hunter rises from his blind, leading the duck in his gunsight as it flaps up from the thick cord grass. An old man glows as he reels in a striped bass at the end of the pier.

Many thousands of people fish, hunt, or simply observe the fish and wildlife in San Francisco Bay. Other thousands are pleased to simply know these attractions are available nearby, even if they never get around to enjoying them directly.

As the Bay is so much an integral part of the Bay Area, so also are the Bay's fish and wildlife inhabitants.

WHY FISH AND GAME ARE IMPORTANT

Human benefit from the fish and wildlife of the Bay includes food, economic gain, recreation, science, education, and an environment for living.

For many of these uses, no dollar value can be assigned. For recreation alone, 135,000 man-days were spent hunting around the Bay last year, 370,000 user-days were spent bird watching, photographing, taking part in nature studies, etc., and more than 3,200,000 angler-days were spent behind a fishing pole. All of these numbers are expected to increase at least 60% by 1980 and considerably more thereafter.

Various estimates of the value of the Bay for recreational purposes, made essentially by calculating what hunters and anglers spend to enjoy their sports, range from $9-25 million for last year. By 1980, the estimated value would be $16-43 million.

Recreational fishing far exceeds commercial fishing. In 1963, 500,000 fish valued at $2 million were caught and processed for market. Estimated 1980 catch in the Bay, barring serious losses or appreciable gains in the fishery resource, will be 800,000 fish worth $3.2 million.

The most conservative commercial and recreational value of the fish and wildlife yield from the Bay was therefore approximately $11 million in 1965, and is expected to be $19 million in 1980. These are

WHY FISH AND GAME ARE IMPORTANT

estimates only of how much money is made "from" the fish and wildlife; the actual value of these resources alone in order to produce $11 million of income (at the rate of 4% interest), would be at least $280 million. To produce $19 million a year, an investment of over $471 million is needed. These values would be much higher if public access to the Bay and the quality of the water were both improved.

These are estimates for sport and commercial use of the fish and bird life resources only. No one has attempted to estimate the cash value of the Bay's fish and wildlife for a scientific and educational use, or for maintaining a pleasant and healthy living environment.

Scientific and educational uses range from elementary school classes that go down to the Bay to study the feeding and nesting habits of ducks, to elaborate studies by university researchers probing the mysteries of life. And the birds in the air, together with the fish in the water, are as much a part of the natural environment as is man.

Beyond 1980, all indications are that the rapid growth of the world population will result in much more intensive use of the sea as a source of food. Fish are expected to be herded and managed as cattle are today. The ocean floor is expected to be farmed with marine plants having higher food value than dryland agricultural products. The Bay -- because it is so well protected from storms -- may very well become a prime marine agricultural and herding area within a few decades, adding many times to its estimated 1980 value to man.

KINDS OF HABITAT REQUIRED

1. Fish

The fishery resource of San Francisco Bay includes anadromous fish (which come through the Bay during their life cycle to spawn), native fish that spend their entire lives in the Bay, and crabs, shrimp, and shellfish.

The anadromous fish are the most important. They generally mature in the ocean and enter fresh water to reproduce. Anadromous fish include striped bass, king

KINDS OF HABITAT REQUIRED

salmon, sturgeon, steelhead trout, and shad. Figure 1 shows the migration and feeding areas for salmon and steelhead trout. The shallow waters are probably more important to the survival of young salmon and steelhead than to adults. Young fish actively feed upon insects and plankton (small organisms that drift with the water). A critical avenue is Carquinez Strait, where pollution could easily exterminate runs of salmon and steelhead.

Striped bass use virtually the entire Bay. The striped bass larvae hatch in the Delta and lower Sacramento and San Joaquin Rivers. Very large concentrations of young bass under two inches long are found in Honker, Grizzly, and Suisun Bays in late summer. Water quality and availability of food are considered critical at this time in their life cycle.

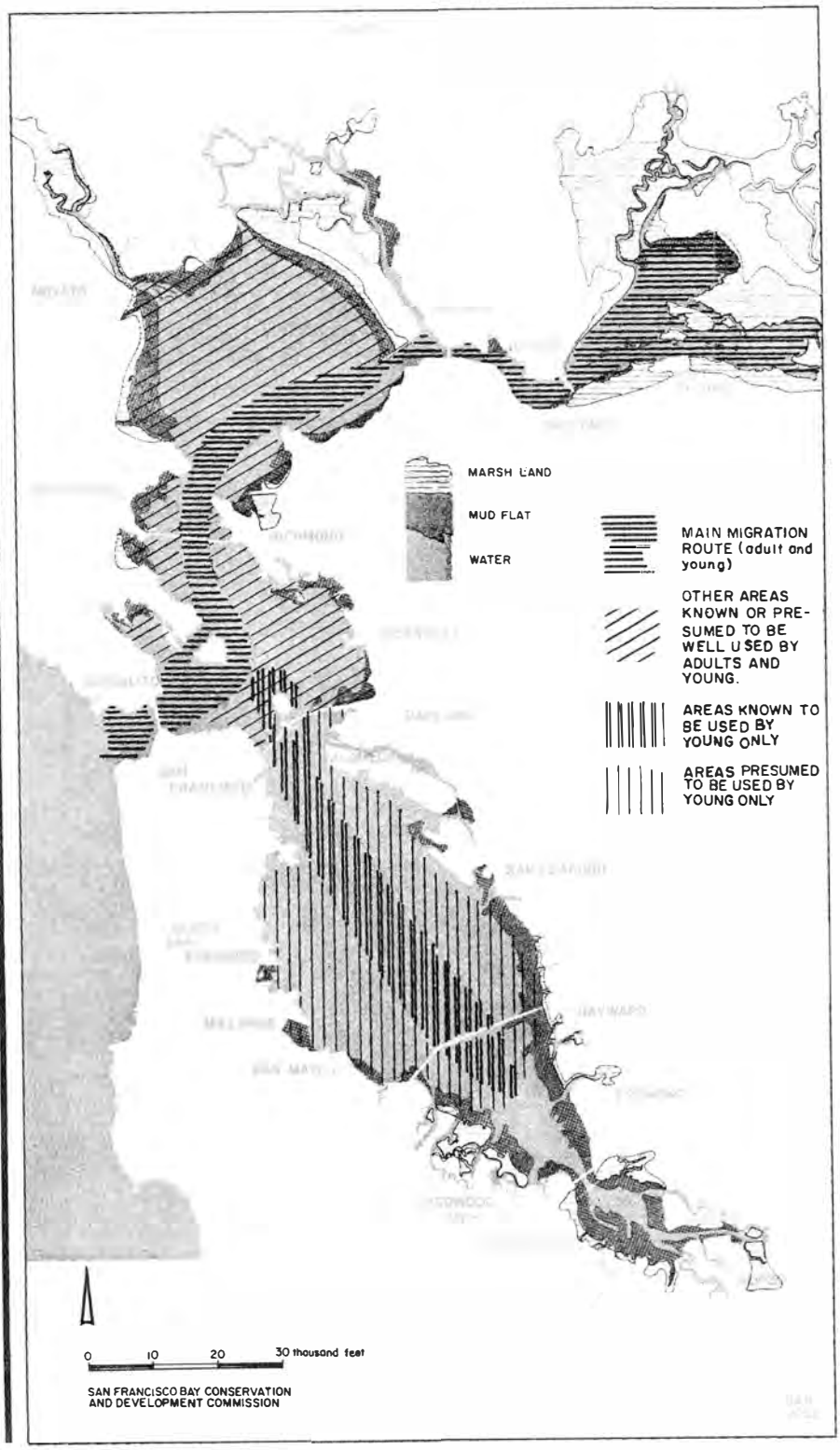
Little is known about the habitat requirements of sturgeon. White sturgeon feed extensively on the San Pablo Bay flats during the summer and fall months. During the winter, sturgeon may have a tendency to seek deeper water. The spawning migration upstream apparently occurs in late winter and early spring. Sturgeon feed on clams, shrimp, barnacles, and small fish.

Shad move from the ocean through the Bay in early spring to spawn upstream. Habitat requirements of young shad are not known. The juveniles migrate out during the fall. The shad migration pattern is similar to the salmon and steelhead pattern shown in Figure 1, except that no shad apparently move into the South Bay.

Bait and forage fish include sardines, anchovies, herring, and smelt. Herring spawning areas in the Bay are limited to the shores of Angel and Alcatraz Islands, part of the west shore of Treasure Island, the Richmond waterfront from San Pablo Point to Point Richmond, and the Marin coast from the Golden Gate through Richardson Bay around to Paradise Cay on Tiburon Peninsula. The herring spawning areas must be protected to insure the survival of the fish.

FIGURE 1

Salmon and Steelhead in San Francisco Bay



KINDS OF HABITAT REQUIRED

Topsmelt inhabit the plankton-rich tidal flats; jacksmelt are in deeper water and are a popular sport fish for dock anglers. Young smelt may be found everywhere in the Bay.

Anchovies are plentiful throughout the Bay. This plankton feeder is an important food for larger fish. Whitebait and sardines are not found in significant numbers in the Bay.

Of the bottom fish, sole enter the Bay nursery ground in tens of thousands and then move out to sea as adults. Flounders are present throughout the Bay, but are not taken in large numbers at the present time. Sharks and rays are fished between the Bay Bridge and Hunters Point. Croakers and perch are found in most of the Bay and are a common sport fish.

Oysters live in almost all of the deeper waters of the Central and South Bays. Their multiplication is limited by the lack of dead shells upon which to attach their young. New dock construction almost anywhere in the Central and South Bays will collect some oysters.

Clams are present in coarse sand or gravel in the middle of the South Bay and at a few coastal points in Marin County and in Richmond. The clam habitat could be greatly expanded by spreading a thin layer of gravel in the tidal zone.

Shrimp are found throughout the Bay. They move into shallow water flats with the incoming tide and return to the deeper channels at low tide. Shrimp feed on decaying marsh plants (detritus) and are the basic diet of almost all fish large enough to eat them.

Young crabs are found in abundance all year in San Francisco and San Pablo Bays, but little is known about adult crabs. Fresh water is fatal to commercially-important species of crabs, so they seasonally migrate in large numbers into the inlets of the Bay as salt water moves in (during periods of low fresh water flow). At one time crabs went upstream as far as Pittsburg, but since controlled fresh water flows have kept fresh water coming into

KINDS OF HABITAT REQUIRED

the Bay during drier periods, their upstream limit has been restricted to the vicinity of Carquinez Strait.

2. Water Birds

San Francisco Bay is the largest river-mouth area along the entire California coast. It is a vitally important resting place, feeding area, and wintering ground for the hundreds of thousands of birds on the Pacific Flyway, which extends from South America to the Arctic Circle.

The Bay provides all the life requirements of a very large number of water birds. Some birds are found in only one habitat. Others depend upon a variety of different habitats. Therefore, the loss of one kind of habitat may result not only in the loss of a few species that depend entirely upon that habitat, but may also interfere with the living requirements of other birds that depend upon a series of different types of habitats.

Four major wildlife habitats exist in and around the Bay; approximately 50 square miles of marshland, 78 square miles of salt production lands, 65 square miles of tidal flats and 400 square miles of open water.

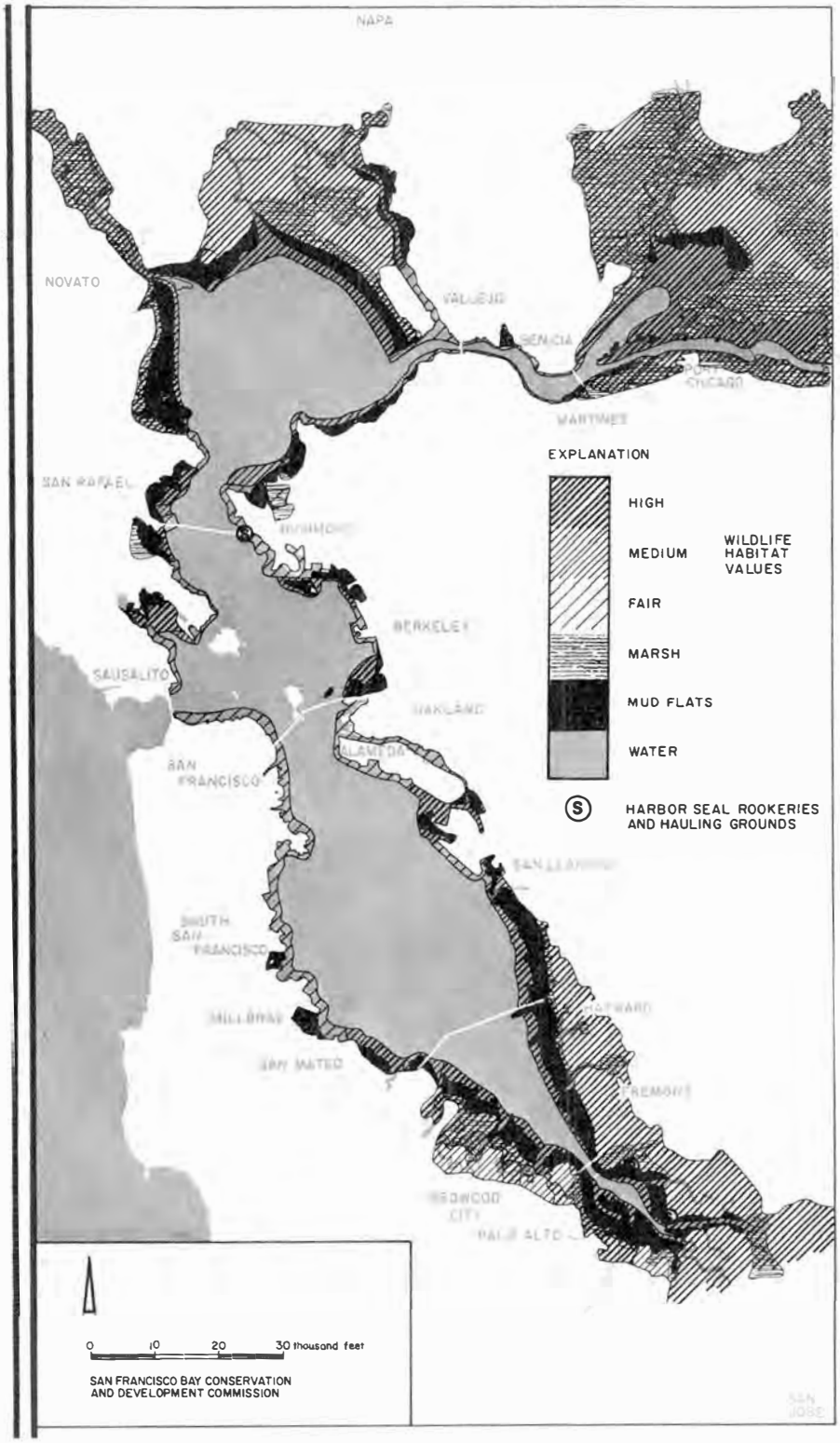
Marsh areas are used for nesting, feeding, and protective grounds for many bird species. Major marshlands are located in Suisun Bay and around the Napa River. Smaller remnants of marshes exist around San Pablo Bay and in South San Francisco Bay.

Salt production lands are important because all species of birds use them for resting and feeding areas. Shorebirds depend upon them for resting areas during high tide.

Exposed mud flats and tidelands occupy major portions of the Bay, except where fill areas extend out to deep water. These tidal flats produce mussels, clams, snails, worms, and insects that shorebirds depend upon for survival. The tidal flats are the food store for shorebirds. The majority of waterfowl and shorebird use in the Bay occurs where water is less

FIGURE 2

Relative Values of Wildlife Habitats



KINDS OF HABITAT REQUIRED

than 18 feet deep at low tide. This generally approaches the normal feeding depth limit for most species of diving ducks. The flats and shoal areas provide a great abundance of invertebrate fauna, which comprise the main diet of many species of diving ducks and shorebirds.

Open water areas are used by ducks, cormorants, geese, and loons for resting, and sometimes for feeding.

In addition to the above principal habitats, Richardson and Corte Madera Bays in Marin County provide a special requirement. These are steep cliffs, which are of great importance during winter storms when very large numbers of sea birds take refuge there from battering winds and waves.

Seventy-five different species of water birds visit the Bay complex, and the water fowl population fluctuates between 600,000 and 800,000. Last January, 652,000 ducks were counted in the Suisun Marsh alone, 20% of all the ducks in California at that time. Up to 20,000 shore birds per mile of shoreline have been estimated at times.

Two-thirds of the canvasback duck population in the state and one-half of the canvasback population of the entire Pacific Flyway winter in San Francisco Bay and depend upon it for their continued existence. Similarly, the bulk of the scaup duck population in the state is observed in San Francisco Bay.

Figure 2 shows the relative value of water bird habitat around the Bay. The values are based on the size of the area, marsh or shallow water environment, availability of food, recreational value, resting sites, refuge, and potential for enhancement. Fifty-eight percent of the shoreline is rated at high value, 12% at medium, and 30% at fair value.

3. Marine Mammals

Marine mammals include harbor seals and occasional harbor porpoises.

KINDS OF HABITAT REQUIRED

Seals require "hauling" grounds where the young pups and adults can leave the water and rest. The three hauling and rookery grounds in the Bay are shown in Figure 2. The Dumbarton Bridge seal population is estimated at 50 to 100, Newark Slough 15, and Richmond 30.

The three hauling grounds cannot now be approached by many people, a fact that is ironically threatening the seals with extermination by vandals -- more public access would probably give vandals less opportunity to shoot the animals.

Harbor porpoises are occasionally seen between Treasure Island and the Golden Gate.

EFFECTS OF FILLS AND PIERS

The worst of many problems affecting fish and water birds are the elimination of three of their four principal habitats (tide flats, marshes, and shallow areas -- leaving only water) through filling. Eighty percent of the marshes that once existed in the Bay have been "reclaimed" through diking and filling for agriculture and industry. In all probability, the original water fowl populations have likewise been reduced by 80%. The effect of fill upon fish life is less clearly understood, but the importance of shallow waters and marshes as "food factories" has been described in the BCDC report on Marshes and Mudflats.

Fill and piers also alter the direction and velocity of water movements created by tides and fresh water inflows. Thus, fill in one part of the Bay can easily result in dangerous environmental changes in other parts of the Bay. The effect of fill in reducing the vital oxygen content of the water has been described in the BCDC report on Tidal Movement, one of the most important problems being the reduction of the total surface area of the water.

Some fish, mammals, and birds appear to accommodate themselves to man-made facilities such as piers, canals, breakwaters, and fills. Fish often concentrate under or near pilings and docks. Water fowl

EFFECTS OF FILLS AND PIERS

are sometimes found in canals. The possible benefits from properly arranged fill projects is a subject that merits further investigation, because it is not yet clear when man-made facilities are beneficial to fish and wildlife.

EFFECTS OF SEDIMENTATION

Another major problem is damage to marine life and plants through smothering or abrasion by deposits of sediment upon them.

The effects of sedimentation upon resources in the Bay have not been adequately studied. However, extensive study of the effects of siltation in fresh waters has demonstrated that it is harmful to fish food, to egg survival, to the young fish, and even to adult fish, which may be injured by having dredged mud dumped on them.

The BCDC report on Sedimentation indicates that large amounts of sediment are deposited by man every year as material dredged from harbors and navigational channels. This material is now largely dumped back into other parts of the Bay. Natural erosion of upstream soils is the other major source of sedimentation.

EFFECTS OF DREDGING

Dredging may be beneficial if it improves tidal flushing or the fish habitat; for example, the excavation site on the east side of Treasure Island (the source of fill for the island) has become a prime fishing area. On the other hand, dredging removes the aquatic life in the bottom, increases turbidity in the area, and causes sedimentation problems. Investigation of the effects of different dredging techniques is needed to determine which causes the least damage to the fish habitat.

EFFECTS OF FRESH WATER DIVERSION

The flow of fresh water into the Bay, particularly through the Delta, is subject to change through construction of dams and diversion of water to the Central Valley agricultural area and to southern California. Changes in the flow of fresh water change the ratio of salt to fresh water in large

areas of the Bay and could alter the habitats to the extent that they could no longer support fish and wildlife in suitable numbers.

EFFECTS OF FRESH WATER DIVERSION

The fresh-water inflow provides a vital element for the myriad plants and fish that thrive best in brackish waters. Recent studies in the Delta indicate that microscopic animals are present in greatest abundance in areas where salts range from 7 to 10 parts per thousand. These microscopic animals (zooplankton) constitute the bulk of the diet of young fish including striped bass, anchovies, smelt, herring, king salmon, and shad. The presence of large numbers of young fish in brackish water areas is no doubt the result of the large amount of food in the same areas.

Fresh water gradually changes to sea water over a 50-mile area from the western edge of the Delta to the middle of San Francisco Bay. The length of the area of mixing of fresh and salt water varies with the amount of water coming into the Bay from the Delta. No study has been made of the possible effects of reduced amounts of fresh water inflow upon the extent of the salt-fresh mixing area and in turn upon the Bay's fish and wildlife resources.

EFFECTS OF WATER POLLUTION

Pollution has resulted in the contamination of shellfish and other marine life, making them unsafe for human consumption. Domestic sewage and wastes from oil refineries are the usual source of such contamination. Ninety percent of the shellfish areas in San Francisco Bay have been declared contaminated and the shellfish from them unsafe for human consumption. The shellfisheries were once a major resource that could be restored with adequate water quality control.

Another major effect of pollution is the elimination of dissolved oxygen in the water. Pollutants consume oxygen as they are decomposed. Excessive pollution eliminates all of the dissolved oxygen in the water and destroys fish life.

EFFECTS OF WATER POLLUTION

In addition to consuming oxygen, some pollutants are poisonous and occasionally large numbers of fish are killed by accidental discharge of untreated poisons (toxic wastes).

Fortunately, pollution can be controlled. Over $200 million has been spent in the Bay Area since 1950 for treatment facilities, restoring some sport fishing areas such as the Albany-Berkeley waterfront, where pollution had previously eliminated fish. But a constantly increasing population around the Bay requires continued expenditures for adequate treatment facilities, and even greater expenditures would be necessary to restore all waters of the Bay to a level conducive to fish life.

SUMMARY

The Bay is a single physical mechanism, in which actions affecting one part may also affect other parts. The fish and wildlife resources of the Bay are dependent upon the food, shelter, and oxygen supplies in the Bay.

As long as man values the fish and wildlife in the Bay, maintenance of their habitat requirements is essential. Any reduction in the surface of the Bay, or in the extent of the marshes and mudflats of the Bay, any increase in the amount of pollution in the Bay, or any drastic change in the fresh water inflow into the Bay interfere with the fish and wildlife habitat. Increases in marsh area and reduction of pollution could result in an increased fish and wildlife population.

SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION
507 Polk Street, San Francisco 94102 557-3686

Possible Bay Planning Conclusions Based on the Report on Fish and Wildlife

1. Human benefit from the fish and wildlife of the Bay includes food, economic gain, recreation, science, education, and an environment for living. No comprehensive estimate of the value of fish and wildlife for these purposes is available, but such value can only increase. In future decades the Bay may become of inestimable additional value as a fish and marine plant "farm," augmenting the nation's and the world's food resources for rapidly growing population.

2. Perpetuation of the fish and wildlife resource depends upon availability of:

   a. sufficient oxygen in the water,
   b. adequate amounts of the proper foods,
   c. sufficient shelter space, and
   d. proper temperature, salt content, and velocity of the water.

Requirements vary according to the specie of fish and wildlife.

3. To insure for present and future generations of Bay Area residents the benefits of fish and wildlife in the Bay, maintenance of their habitat requirements is essential. Action necessary to maintain the required habitats is prescribed in related BCDC reports on Tidal Movement, Marshes and Mud Flats, Pollution, and Sedimentation.

4. In preparing the Commission's plan for the Bay, the ratings assigned to each part of the shoreline of San Francisco Bay by the State Department of Fish and Game (shown in Figure 2, Relative Values of Habitat), will be used to determine shoreline areas of greatest value for shorebirds and waterfowl, but full consideration shall be given to any opportunity for enhancement or improvement of the habitat anywhere around the Bay. Special attention should be given to the habitat needs of those species of birds threatened with extinction and any species whose increase would provide substantial public benefits.

5. In preparing the Commission's plan for the Bay, it will be assumed that all parts of San Francisco Bay are important for the perpetuation of fish and other marine life because any reduction of habitat reduces the marine population in some measure. If, however, assignment of priorities becomes imperative in developing a balanced plan, the highest priority for maintaining fish will be given to (a) those parts of the Bay that are identified as spawning areas for any kind of fish, and (b) those parts of the Bay used as migration routes for anadromous fish. In addition, full consideration will be given to any opportunity for enhancement or improvement of the habitat anywhere in the Bay. Special attention will be given to the habitat needs of those species of fish and other marine life threatened with extinction and any species whose increase would provide substantial public benefits.

Adopted by the Commission at its meeting of 11/18/66

MARSHES AND

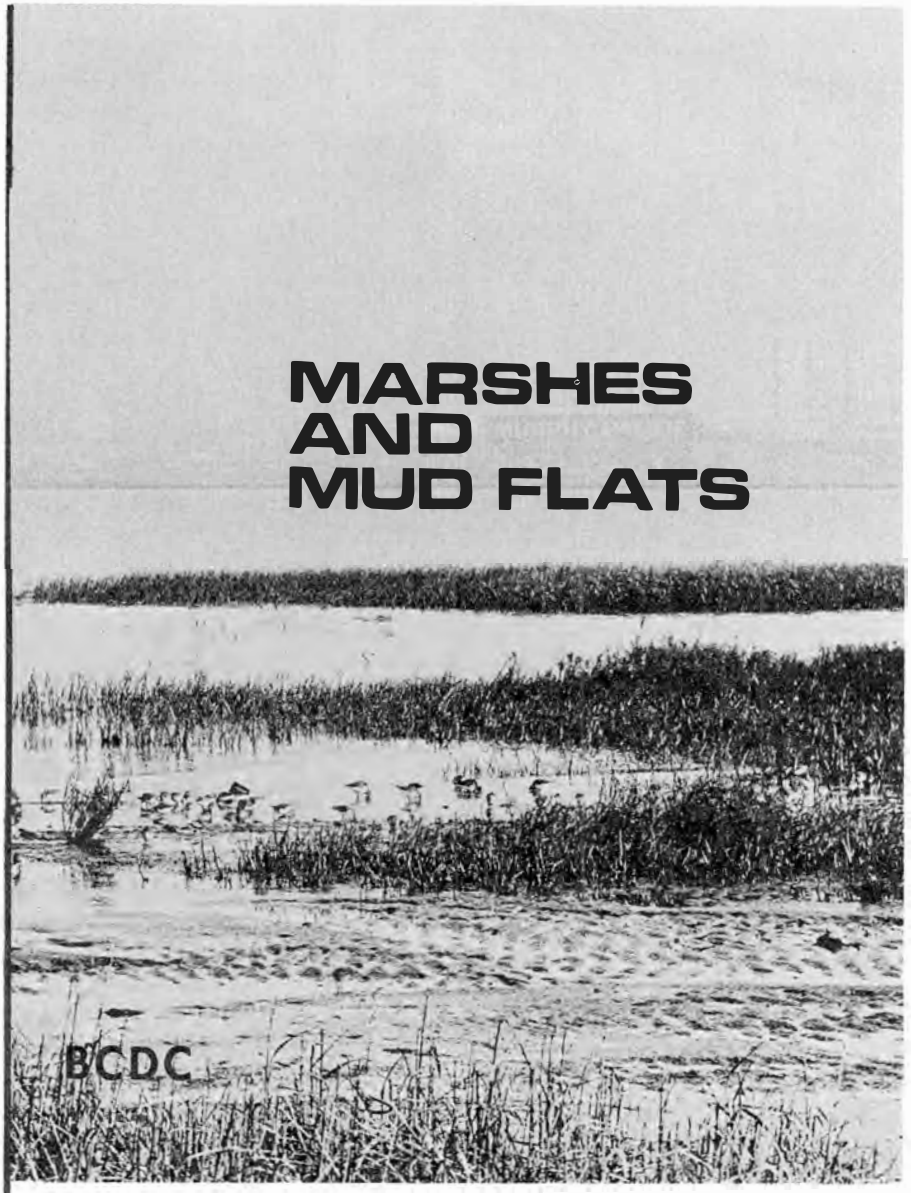
MUD FLATS

OF

SAN FRANCISCO

BAY

Part of
a Detailed
Study of
San Francisco
Bay



San Francisco Bay
Conservation and
Development
Commission

San Francisco
California

October 1966

Summary of the report, "Some Ecological Aspects of San Francisco Bay," by H. Thomas Harvey, Professor of Biology, San Jose State College.

INTRODUCTION

Twice a day, the high tide floods over the muddy shores and creeps into the marshes of San Francisco Bay. Quickly a busy exchange of foods and organisms takes place amid the marsh plants, before the salt water recedes again. For a longer period, the water-covered mud flats are host to schools of fish feeding upon the rich foods washed from the shores or produced on the flats themselves.

As the overflowing waters recede, the exposed marshes and the mud flats enter the next step in the vital cycle of producing food for fish and birds, and thus for man.

The Bay is a complicated system of life and death, every part of the system a link in a chain of events. Figure 1 gives a very brief idea of the linkages.

As a chain is no stronger than its weakest link, so also do changes in one part of the complicated Bay life system affect other parts. Several of this series of BCDC reports concern various links in this chain. This report focuses on the vital role of the marshes and mud flats in the life of the Bay.

KINDS OF MUD FLATS AND MARSHES

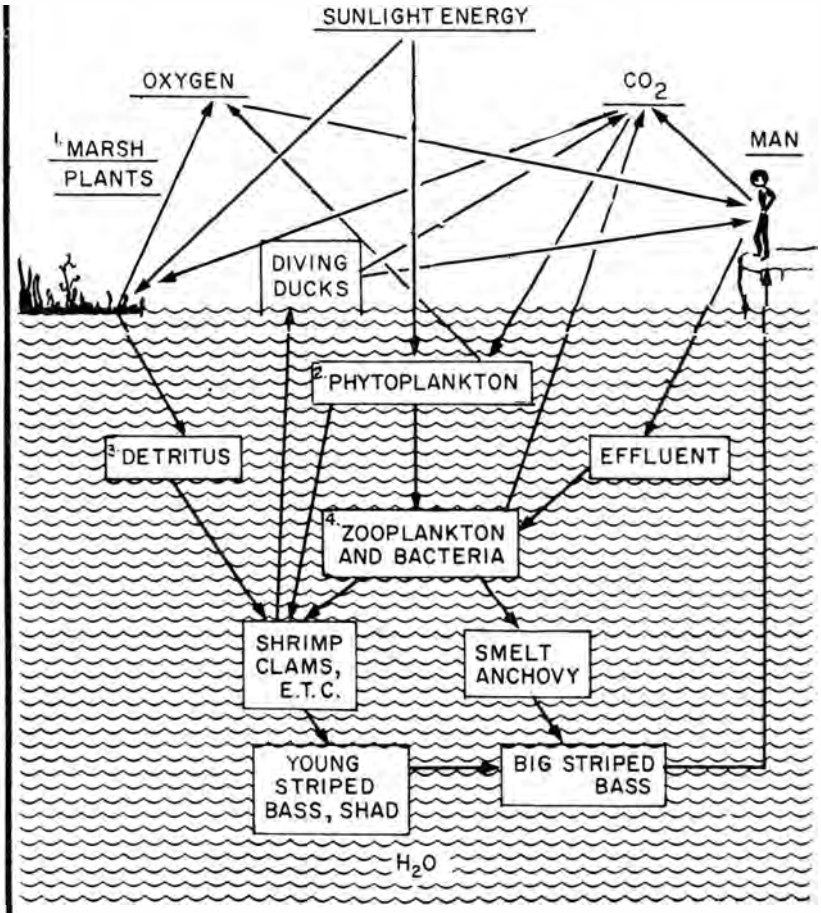
Mud flats lie between the highest tide water mark and the lowest water mark. They generally occur where the shore slopes gently into the Bay waters (see Figure 2). There are now about 45,000 acres of mud flats in the Bay. The mud flats vary in their composition, from soft, soggy areas into which large objects can be pushed by hand, to sand and gravel or even rock.

Marshlands are of two types, salt water and fresh water, but the line between them is often indistinct. Salt marshes, made salty by the rising and falling tides, today occupy only about 75 square miles of Bay shoreline, less than one quarter of that which originally existed. Fresh water marshes extend indefinitely up various tributaries above the high water mark.

Marsh plants can tolerate only a limited depth of water. New marshes are thus created when erosion deposits enough sediment on the mud flats to raise

FIGURE 1

Simplified Bay Ecosystem



1. Marsh plants, e.g., cord grass, are the most productive type of organisms in North America, producing 5-10 times as much food and oxygen per acre as highly cultivated crops, such as wheat.

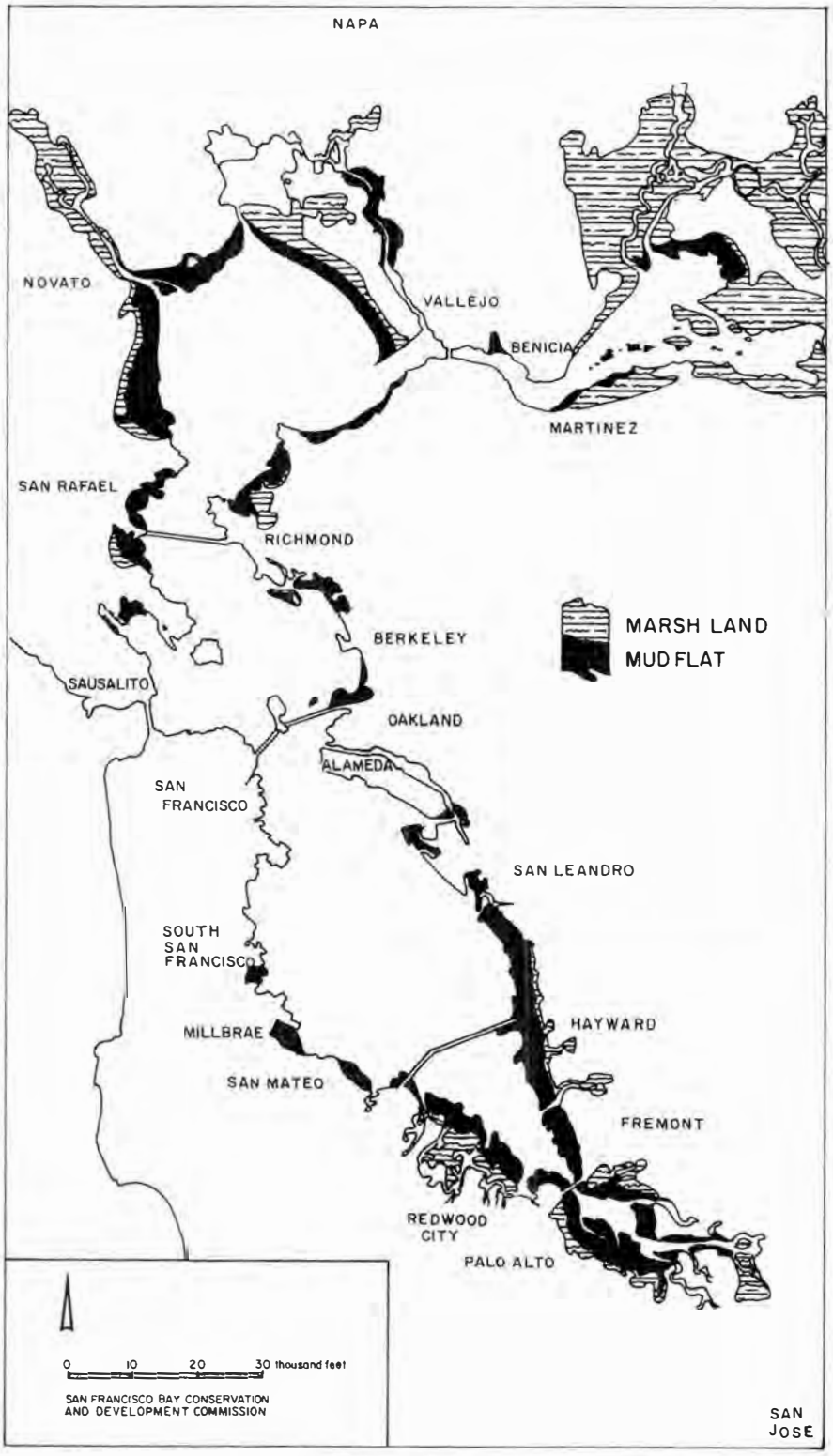
2. Phytoplankton, microscopic plants, with adequate sunlight produce food for minute animals and for filter feeding larger animals, such as mussels and clams.

3. Detritus, minute organic particles from decomposing organisms.

4. Zooplankton, small animals, e.g., protozoans and marine larvae, which drift with current.

FIGURE 4

Map of San Francisco Bay Showing Extent of Mud Flats



Source: U.S. Geodetic & Geological Surveys

KINDS OF MUD FLATS AND MARSHES

their level sufficiently. And marshes have been lost when nearby well-pumping caused the shore to subside, allowing too much water cover.

THE IMPORTANCE OF THE MUD FLATS

Although they may not appear attractive, mud flats are an important link in the Bay's life cycle. They draw foods from marshes and from open water and turn this food into forms upon which many wild birds, fish, and mammals depend.

Microscopic plants (algae) and animals (plankton) occupy the mud surface and float in the water above it; their food value is not known exactly, but is estimated to be very high. The other major foods are decomposing plants and other organisms, together with the bacteria and fungi working upon them (called detritus). Much of this food material comes from decomposing salt marsh grasses.

Clams, mussels, worms, and other mud-dwellers feed on these foods and themselves become food for fish or birds, or they produce larvae upon which the fish or birds may feed.

The importance of these food sources (which will be considered further in the BCDC report on fish and wildlife) is indicated by estimates that over one million shorebirds are supported on the Palo Alto mud flats alone during a winter season, and by estimates that up to 70% of the shorebirds of the Pacific Flyway between Canada and Mexico directly depend upon the San Francisco Bay mud flats for their survival.

The mud flats also play an important role in providing sufficient oxygen in the waters of the Bay for the maintenance of fish and the abatement of pollution. The mud algae, exposed to abundant light alternating with abundant water, produce and expel oxygen into the water and into the air.

THE IMPORTANCE OF THE MARSHES

Salt marshes are extraordinarily fertile -- one of the most productive natural areas in our environment. Situated in well-watered, fairly temperate and sunlit areas, marsh plants are highly

THE IMPORTANCE OF THE MARSHES

productive. One type of marsh plant alone, cord grass, has seven times the food value of an equivalent acreage of wheat.

The food value of the marsh plants is primarily passed to the flooding waters and thence to the mud flats and nearby shallows, thereby supporting a vast marine-life nursery. Also large numbers of birds, including ducks and geese, come to the marshes, especially during the winter, to feed directly on the lush vegetation or on the brackish-water animals that thrive in the marsh.

Marsh plants appear to help in preventing air pollution. Many marsh plants can change a common air pollutant, carbon monoxide, into relatively harmless carbon dioxide and thus reduce the potential hazard of the poisonous gas. Research is needed to determine whether the extraordinarily productive marshes plan a major role in cleansing the air of major pollutants.

THE EFFECTS OF DIKING AND FILLING

Three-quarters of all the marshland that ever existed around San Francisco Bay has been filled or diked off.

Not only should all remaining marshes be considered a valuable resource to be maintained, but new marshes should be created. If existing marshes are filled for necessary public purposes, new marshes should be created to compensate for the loss. Former marshlands could be restored by removing dikes that now separate them from tidal action and by once again allowing Bay waters to cover them (at such places as the diked marshland at Corte Madera and some of the salt ponds of the South Bay). New marshland probably can also be created by placing dredged spoil on mud flats to raise them to an elevation at which vegetation could become established. In either case, the principal cost will probably be the public acquisition of the lands to be made into marshes.

SUMMARY

The Bay is a single physical mechanism, in which actions affecting one part may also affect other parts. The marshes and mud flats of the Bay are the source of food for fish and bird life. Substantial filling of the marshes and mud flats would substantially reduce the amount of food and the amount of fish and bird life the food supports.

As long as man values the fish and wildlife in the Bay, and uses the Bay as a receptacle for sewage and other wastes, maintenance of the marshes and mud flats is essential. Any reduction not only reduces the amount of food available to fish and wildlife, but also reduces the supply of oxygen in the water for the maintenance of marine life and the abatement of pollution.

SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION
507 Polk St., San Francisco 94102 557-3686

Possible Bay Planning Conclusions Based on the Report on Marshes and Mud Flats

1. To conserve fish and wildlife, San Francisco Bay must have an adequate food supply and its waters must have an adequate supply of oxygen. This means that the marshes and mud flats must be maintained to the fullest possible extent. Filling and diking, which eliminate marshes and mud flats, should therefore be allowed only for purposes providing substantial public benefits and for which there are no reasonable alternatives.

2. Any proposed fills, dikes, or piers should be thoroughly evaluated to determine their effects on marshes and mud flats, and then modified as necessary to minimize any harmful effects.

3. To offset possible additional losses of marshes due to filling for purposes providing substantial public benefits, and to augment the present marshes, the Commission's plan for the Bay should consider (a) restoring former marshes through removal of existing dikes, and (b) creating new marshes through carefully placed lifts of dredging spoils.

Adopted by the Commission at its meeting of 10/21/66

FLOOD

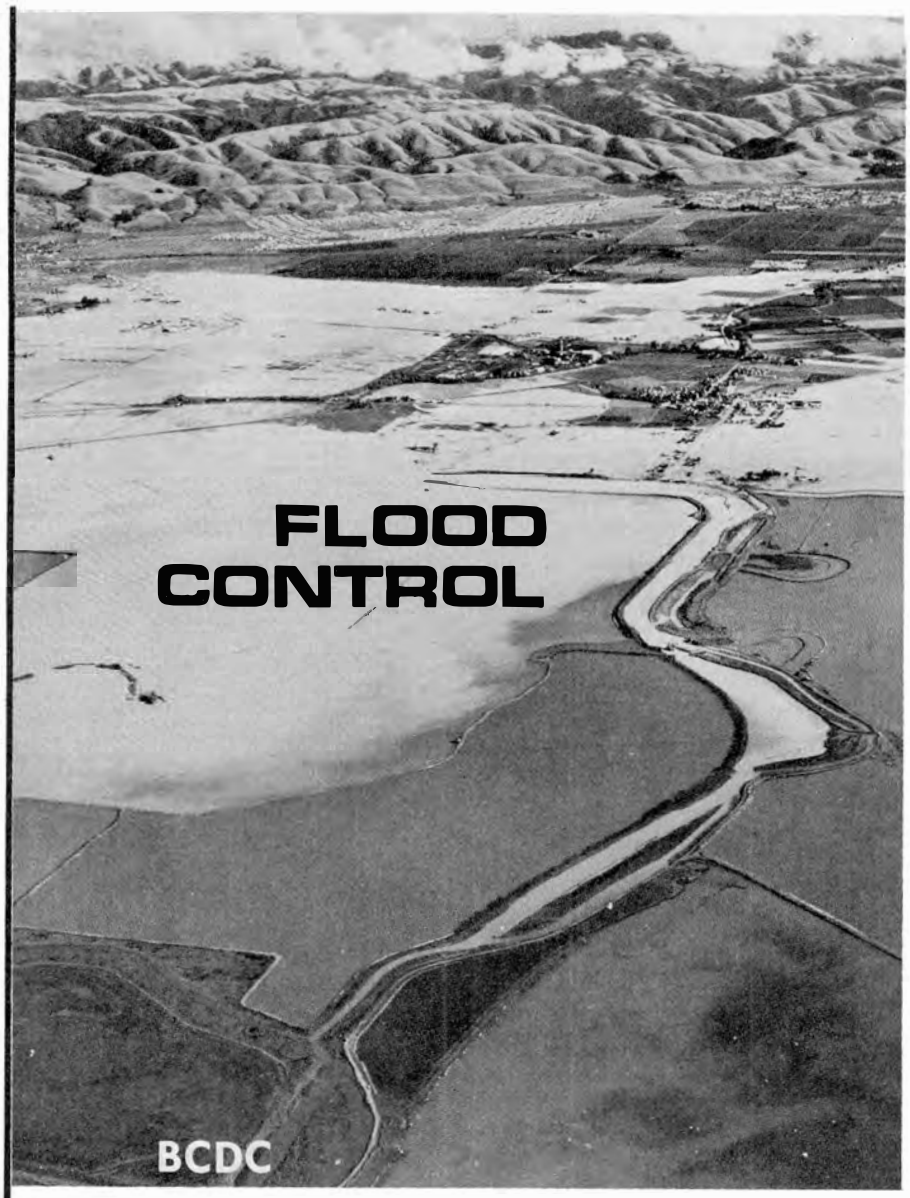
CONTROL

AND

SAN FRANCISCO

BAY

Part of
a Detailed
Study of
San Francisco
Bay



San Francisco Bay
Conservation and
Development
Commission

San Francisco
California

February 1967

Summary of the report, "Flood Control in the San Francisco Bay System Tidal Plain," by Bernard J. Smith, Staff Engineer.

INTRODUCTION

During winter storms, creeks that are normally dry suddenly fill with rushing torrents. Streams nearer the Bay swell with the surge from their many tributaries.

Water that once would have been absorbed by the ground is now deflected off roofs and streets into drainage channels and streams. As urban development spreads, the volume of water thus diverted into streams constantly increases.

At times the rain water rushes down the streams just as storm-swelled tides are coming into them. When the storm waters and tides coincide, the streams frequently overflow their banks, endangering lives and property.

CAN THE BAY OVERFLOW?

1. In Storms

The water level of the Bay has never been recorded at more than two feet above normal high tide. A rise in water level of even this height can occur only when three things happen at the same time -- a high tide, heavy rainfall runoff from tributary streams, and heavy winds that help build up the level of the water.

While a small rise in the water level of the Bay does not threaten most shoreline property, it can cause serious problems at the mouths of streams. A winter storm in the Bay Area tends to be short and intense, with a large amount of rain in a short time. Streams are rapidly filled to capacity and water rushes down them to the Bay. Such heavy runoff sometimes coincides with higher tides caused by the same storm. The high tides can add to the storm runoff near a stream mouth, causing the stream to rise and flood the surrounding lowlands.

The storm runoff that flows into creeks increases constantly as roads and roofs replace vegetation and soil that can absorb rainfall.

2. In Earthquakes

Earthquakes could also cause high water in San Francisco Bay, but there is little concern that much damage would be done. Earthquakes cause three principal effects on water: tidal waves, seiches (waves that slosh back and forth), and waves from landslides.

Most tidal waves (more properly called tsunamis) that might affect San Francisco Bay originate in the Pacific Ocean. These waves appear likely to raise the level of water in the Bay only if the water were already at high tide and the wind were blowing onshore simultaneously, a rare possibility. The tidal wave that badly damaged Crescent City, California, after the 1964 Alaskan earthquake did not raise the level of water in San Francisco Bay, according to official records. However, that tidal wave did cause San Rafael Creek to rise and fall very rapidly, whipping apart the Loch Lomond Yacht Harbor and damaging 310 boats.

A tidal wave could be created in the Bay itself if the earth's crust, during an earthquake, suddenly dropped or rose along a fracture line under the Bay. This is considered a rare possibility because only one or two faults are believed to cross under the Bay (in San Pablo Bay) and there is little recent history of up-and-down motion along faults in the Bay Area (movement tends to be sideways). Any such up-and-down movement would probably be less than two feet and the shallow parts of the Bay would reduce the speed and energy of any resulting tidal wave.

A seiche is a wave that sloshes back and forth in a basin such as a bay. A large earthquake could cause such sloshing in portions of San Francisco Bay, but the rise in water level at the "ends" of the basin would probably be of concern only if the tides were very high and the winds were blowing in the same direction as the waves.

Waves caused by landslides into a bay, or underwater slides on the floor of a bay, have caused considerable damage elsewhere. But no steep areas around San Francisco Bay or on its floor contain large amounts

CAN THE BAY OVERFLOW?

of loose material that could slide in a large block during an earthquake, so this kind of wave is not expected in San Francisco Bay.

WHERE FLOODING IS POSSIBLE

In general, areas less than nine feet above sea level are subject to tidal flooding unless adequately protected by levees (the critical elevation is 10 feet above sea level in the southern part of the South Bay, where the tides run almost a foot higher than in the rest of the Bay). Nine feet is the total height needed because the high tide runs almost three and a half feet above mean sea level, the maximum probable rise in the water level of the Bay is two and a half feet above the high tide, and three more feet of "danger area" must be allowed for waves that slosh up on the dikes.

Figure 1 shows the extent of possible tide flood plains in the Bay Area. Some of these areas, of course, are protected by levees or have been filled above the nine-foot level.

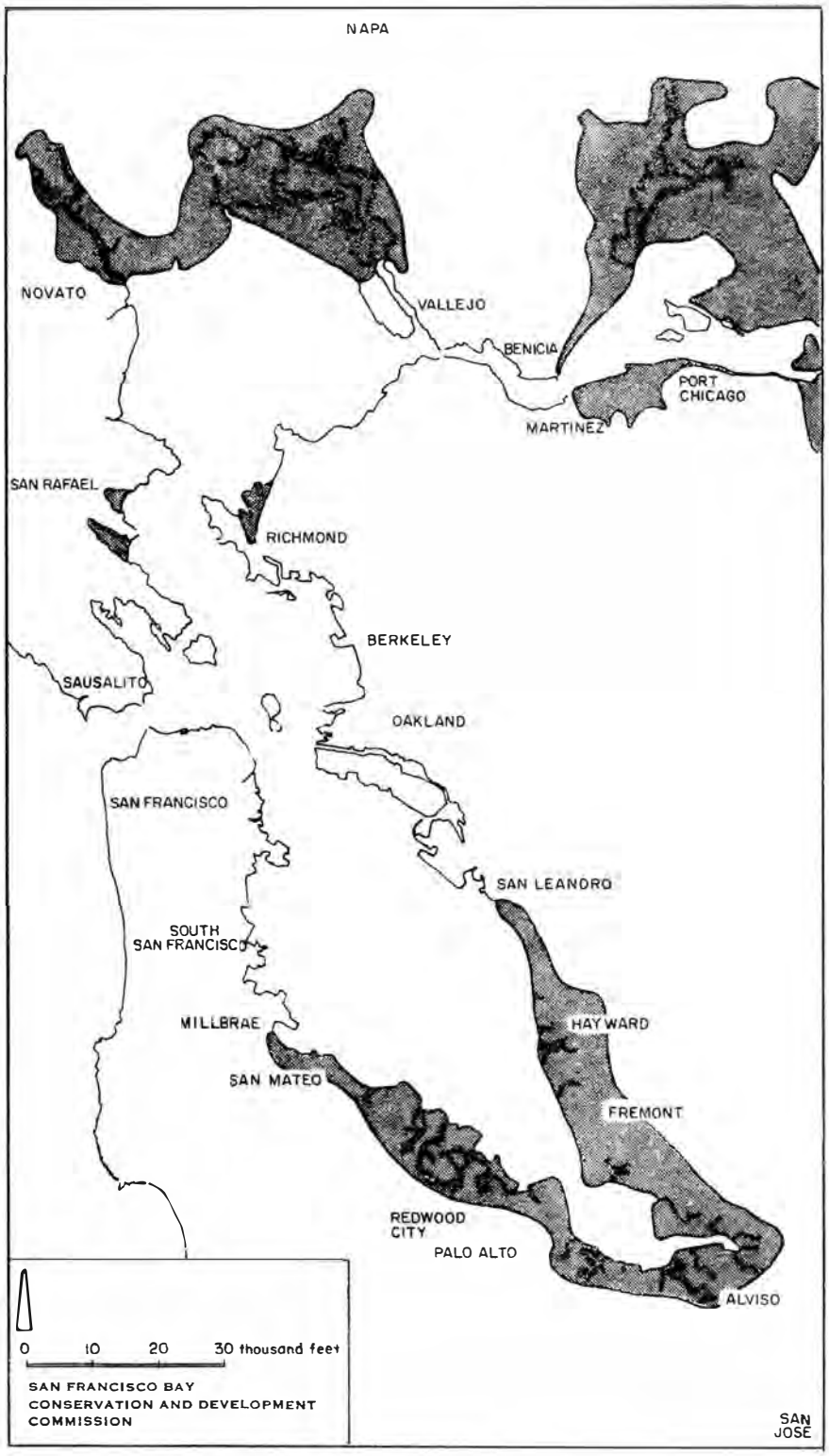
Areas subject to tidal flooding are increased in size when large areas of ground subside. This problem is most serious in the southern portion of the South Bay, which already experiences higher tides than the rest of the Bay. Land at the southern tip of the Bay has been sinking slowly as vast quantities of fresh water are pumped out of the ground (the BCDC report on Geology indicates that if heavy ground water pumping is continued indefinitely in the South Bay area, the shoreline in the Alviso area, which has already subsided about seven feet since 1912, could subside up to seven feet more, requiring heavy protective dikes).

The other major potential flood areas are upstream areas that can be inundated by backed-up stream flows. These areas are likely to increase in size as the volume of storm flows increases with the roofing and paving of more land area.

The highest-value areas that are subject to flooding are those situated in the South Bay tidal plain and those adjacent to streams flowing into other parts of the Bay. No complete tabulation has been made of the amount of urban development in such potential

FIGURE 1

Flood Plains: Areas Subject to Flooding by Tides Or Streams Affected by the Tides, under Storm Conditions, If Not Otherwise Protected



Source: Compiled from U.S. Army Corps of Engineers' Data

WHERE FLOODING IS POSSIBLE

flood areas, but it is apparent there is a very high concentration of value that now must be protected.

METHODS OF PREVENTING FLOOD DAMAGE

There are three main methods of preventing flood damage: (1) building reservoirs for upstream storage; (2) building levees or widening streams, or both; and (3) preventing construction in potential flood areas.

1. Upstream Storage

The soundest method of flood control is impounding the storm runoff upstream from the areas to be protected. In many areas, a system of small earthen dams serves the purpose. Alternately, large dams are built farther downstream if the circumstances permit. In either way, the flood waters can be utilized for power and irrigation, if feasible, thereby getting the maximum benefit from the waters, or can at least be released slowly enough so the lower streams can handle the flow without going over their banks.

Upstream storage for many of the tributary streams flowing into the San Francisco Bay is becoming more and more difficult, however, as urban development spreads into the hills.

A variation of upstream storage is to impound the overflow waters in ponds and other reservoirs at any convenient location along the stream and later release it to percolate into the ground and raise the water table. This is especially useful in areas of water shortage or areas where the water table is being drawn down too much.

2. Levees and Stream-Widening

If not impounded upstream, the growing volumes of flood waters can only be restrained within their banks by increasing the capacity of streams flowing into the Bay. This requires widening streams or diking their sides, or both.

METHODS OF PREVENTING FLOOD DAMAGE

When a stream cannot be widened, a "bypass" is built to divert the waters through another channel to the Bay.

3. Restricting Development in Flood Areas

An obvious way to minimize potential flood damage is to avoid development in potential flood areas. California has laws permitting cities and counties to adopt "flood plain" zoning and subdivision control to restrict the amount of development in flood areas, but few localities have used these tools.

METHODS OF PREVENTING EARTHQUAKE WAVE DAMAGE

No attempt is now being made to protect shoreline areas against waves generated by earthquakes because such waves are rare and it is difficult to predict where they might hit the shore. Possible steps to reduce the potential damage from such waves include (1) designing dikes and piers to withstand the type of sudden falls and rises in water level that occurred in the San Rafael Channel and (2) adding two additional feet to the top of flood-control levees as additional protection against earthquake-generated waves (two feet is the height of the biggest tidal wave recorded along the California coast).

HARMFUL EFFECTS OF LEVEES AND CHANNEL WIDENING

Beneficial though they may be in preventing flood damage, levee construction and channel widening can cause problems themselves.

Flood-control channels are often concrete-lined open ditches that are unsightly in appearance. This problem could be solved by designing part of the flood-control channel for other uses during the large part of the year when there is no rainfall in the Bay Area. For example, the normal water flow could be confined to a relatively small channel and the area for the storm-flow capacity could be maintained as grass usable for parks and recreation. Alternately, if the capacity is provided near the mouth of a stream, it might be feasible to excavate deeply enough to accommodate shallow-draft boating on a seasonal basis.

HARMFUL EFFECTS OF LEVEES AND CHANNEL WIDENING

Another problem has been the construction of flood levees at a stream mouth so that they dike off the coastal marshes, eliminating their water supply and inviting filling to "reclaim" the land. Such levees could be constructed shoreward of the marshes so that these valuable lands can be preserved.

Widening and deepening flood control channels also involves the problem of disposing of dredged mud. Dredged spoil has usually been either dumped on marshes to "reclaim" them or dumped in the Bay, where some of the mud is carried to navigation channels and harbors and is then dredged again. This problem could be overcome, but at additional cost, by disposing of spoils on dry land or by hauling the spoils out to sea, or at least to a location in the Bay where the tides will carry a high proportion out to sea.

EFFECTS OF FILLING ON THE FLOOD CAPACITY OF THE BAY

The deep channels of the Bay have sufficient capacity to carry the largest estimated flood flows without any significant rise in water level. This capacity is further augmented by continued construction of upstream reservoirs to impound storm flows. It has been calculated that even if all shallow areas of the Bay (those 12 feet deep or less at low tide) were to be filled, there would be little effect on the storm flow capacity of the Bay. However, such extensive filling would create other problems, especially in assimilation and dispersal of pollution.

AGENCIES RESPONSIBLE FOR FLOOD CONTROL

The Federal Government, the State of California, counties, flood districts, and cities are all involved in the problem of flood control.

The Federal Government pays for a major portion of flood control construction and projects are usually designed by the Army Corps of Engineers. The State assists counties, flood control districts, and cities in the purchase of rights-of-way and easements. The counties, flood control districts, and cities must initiate the requests for any flood control projects and usually must operate and maintain the projects after they are completed.

PROSPECTS FOR IMPROVED FLOOD CONTROL METHODOLOGY

Under present procedures for evaluating the feasibility of a flood control project, the average annual benefits resulting from the project must at least equal the average annual cost of constructing it. Questions increasingly arise, however, as to whether the "benefits" are calculated adequately. Recreation, for example, is now given a very low dollar value. The criteria for evaluating projects also have generally considered the esthetic and ecological consequences as intangible. Standards are needed to prescribe better design of control projects, provision of multiple use of flood channels during the dry season, and consideration of fish and wildlife habitat needs. While costs would tend to be higher, there would be a corresponding increase in the benefits derived.

As the cost of flood control projects increases, more attention will probably be directed toward reduction of potential damage by restricting land use in potential flood areas.

SUMMARY

The Bay is a single physical mechanism, in which actions affecting one part may also affect other parts. However, the capacity of the Bay to absorb flood flows or to withstand the effects of earthquakes is one aspect that is not much affected by filling or other human manipulations of the Bay.

SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION
507 Polk St., San Francisco 94102 557-3686

Possible Bay Planning Conclusions Based on the Report on Flood Control

1. To help protect lives and property from the damage caused by flooding, San Francisco Bay should continue to serve as a receptacle for rainfall run-off, and communities along the shores of the Bay should be adequately protected from flooding.

2. The Bay is large enough to absorb all foreseeable storm waters without overflowing its shores.

3. Flood damage to shoreline areas can result from a combination of heavy rainfall carried by tributary streams, high tides in the Bay, and winds blowing onshore. To prevent such damage, buildings near the shoreline should have adequate flood protection. The precise design of the buildings in any specific project, or of any specific dikes, should be determined by competent engineers. As a general guideline, however, buildings near the shoreline should be at least nine feet above mean sea level (standard U.S.G.S. datum), or should be protected by dikes of an equivalent height and by any necessary pumping facilities. In the southern half of the South Bay, this height should be at least 10 feet. Exceptions to the general height rule may be made for developments specifically designed to tolerate periodic flooding.

4. Earthquakes in various parts of the Pacific Basin have caused sudden changes in the water level in various parts of San Francisco Bay. But indications are that earthquakes do not cause the water level to rise everywhere in the Bay at the same time. No special provisions can therefore be prescribed at this time to deal with potential flooding caused by earthquakes.

5. The ecology of the Bay and its shallow areas should be considered an important factor in the design of flood control projects. Marshlands should therefore be preserved, except in cases where their filling would provide substantial public benefits in addition to flood control.

6. To enhance the appearance of shoreline areas, and to permit maximum public use of the shores and waters of the Bay, flood control projects should be carefully designed and landscaped and, whenever possible, should provide for recreational uses of stream channels and banks.

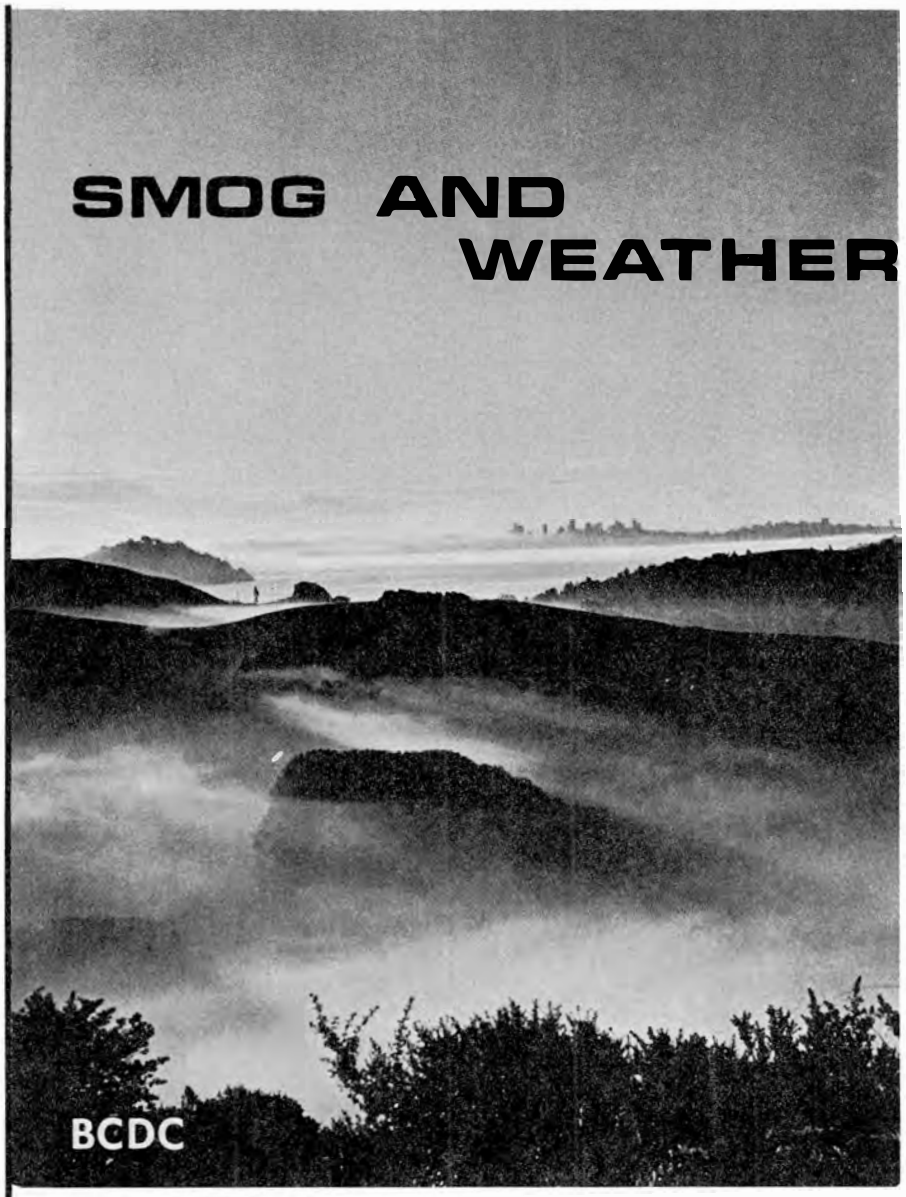
Adopted by the Commission at its meeting of 2/17/67

SMOG

AND

WEATHER

Part of
a Detailed
Study of
San Francisco
Bay



San Francisco Bay
Conservation and
Development
Commission

San Francisco
California

February 1967

Summary of the report, "Smog and Weather: the Effect of San Francisco Bay on the Bay Area Climate," by Albert Miller, Professor of Meteorology at San Jose State College.

INTRODUCTION

Man can sometimes modify the weather dramatically -- for example, by seeding clouds to produce rainfall. But most man-made changes in weather are more complex, and usually unintentional: when man chooses to live in large, industrialized cities he changes the weather in which he lives. A "heat island" is created over cities, resulting in more rainfall, more clouds, and much more air pollution than exists in neighboring rural areas.

As man changes the climate in which he lives, the climate in turn affects man's life. Changing rainfall patterns, for instance, affect plant systems, animals, the soil, human activity, and ultimately human life itself.

Thus the climate of the San Francisco Bay Area is important to the quality of life in the region. San Francisco Bay has a major role in determining the climate. Filling of substantial parts of the Bay would be man-made changes that could significantly affect the climate of the Bay Area.

THE WEATHER IN GENERAL

Climate is a composite of many factors, including temperature, humidity, wind, rain, cloudiness, and the materials of the air. The surface of the earth affects each of these factors; they also affect each other. (For example, the variation of temperature with height above the earth affects the concentration of pollutants in the air but, at the same time, the pollutants alter normal radiative processes and therefore affect air temperature.)

One of the most important determinants of Bay Area weather is the pattern of land and water. There are three essential differences between a land surface and a water surface: (1) a land surface experiences much greater extremes of heat and cold than does a water surface, (2) the frictional drag on the wind is generally much greater over land, and (3) the exchange of dust, smoke, gases, and water between the surface and the air differs over land and water.

The atmosphere is heated and cooled mainly through contact with the earth's surface. Contrasts in temperature over land and water cause air movement

between them (as evidenced by the sea breeze in the Bay Area). Hills reduce the wind at low elevations. Finally, land surfaces produce air pollutants while water surfaces provide much of the atmosphere's water vapor.

1. Heat and Its Effects

The source of practically all energy for the earth and the atmosphere is radiation from the sun. Most of this radiation is able to pass through clear air without being absorbed. It is therefore the surface of the earth that is the most important source of heat for the atmosphere.

When solar radiation strikes the earth's surface, it is largely absorbed. Almost all of the radiant energy is absorbed in the top tenth of an inch of soil, while in pure water, the energy penetrates to depths of over 300 feet. Thus, the absorbed heat is distributed over much more material (mass) in the case of water than in the case of soil. Mixing of the water also helps keep the temperature fairly uniform throughout, making water a much more efficient "heat reservoir" than land. The temperature of water remains fairly constant, even if the water is shallow.

Evaporation of water also requires a great deal of heat (600 calories per gram of water). Since the air over San Francisco Bay is usually already moist from its passage over the Pacific Ocean, this is probably not much of a factor here except perhaps when hot, dry air sweeps down over the Bay Area from the north or northeast.

2. The Effects of Topography

The earth's surface retards air motion through friction. Figure 1 illustrates the change in wind speed with height over a city and over open water. In a city, the wind speed below the tops of the buildings is considerably reduced and even the wind speed above the buildings is slower than it would be over water.

Ranges of hills or mountains substantially affect wind and rainfall patterns.

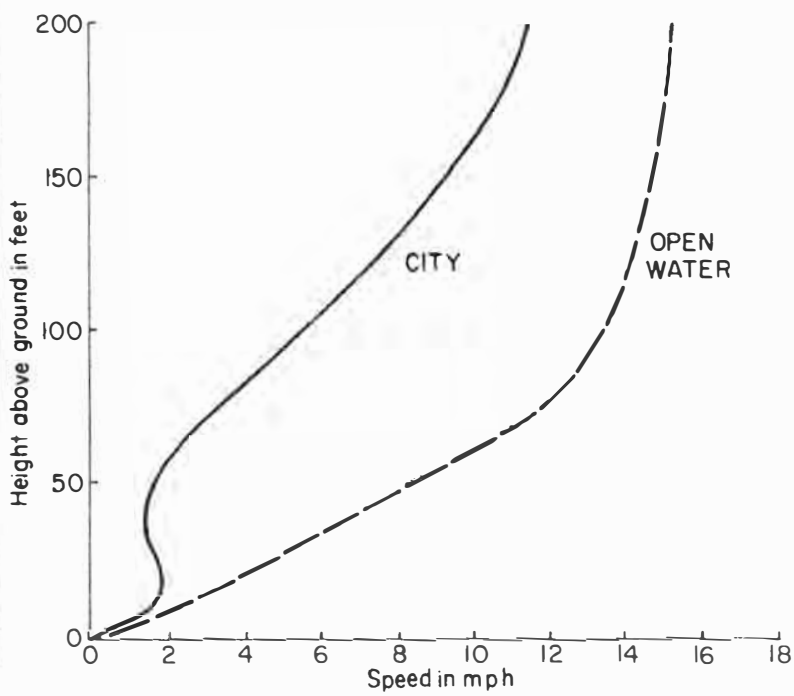
TEMPERATURE

The dominant factor controlling the climate of the San Francisco Bay Area is its proximity to the Pacific Ocean. Air over the Bay almost invariably comes from over the ocean. But the maritime climate of the coast fades quickly as one moved eastward; while San Francisco's mean monthly temperature fluctuates by only 11 degrees throughout the year, Sacramento's range is 31 degrees.

The ocean air that comes into the Bay Area extends upward only about 2,000 feet most of the time. This air usually cannot cross the higher coastal hills and therefore gains access via the passes, principally through the Golden Gate and the northern end of the San Francisco Peninsula (Figure 2). Therefore, the air that reaches Santa Clara County almost invariably must have traversed San Francisco Bay; similarly, the air in the San Pablo and Suisun Bay vicinity must come either from the northwest through Petaluma Valley or from the southwest through the Golden Gate.

FIGURE 1

Typical Wind Speed Distributions in the Vertical



TEMPERATURE

Some idea of the effect of the Bay in preventing rapid change of the temperature of the ocean air as it moves inland can be seen by the temperature pattern illustrated in Figure 3.

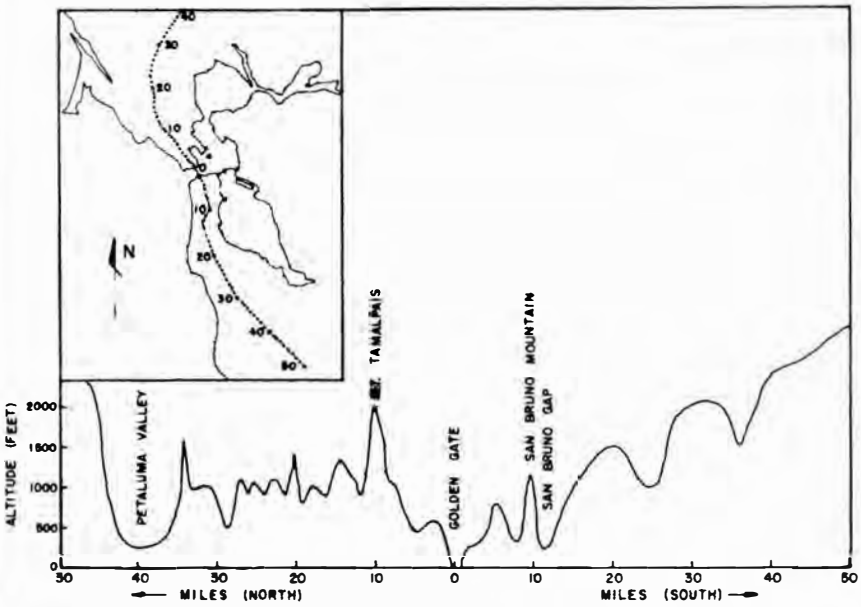
WINDS

The prevailing flow of air over the Bay Area is largely determined by the semi-permanent, high-pressure area over the eastern Pacific Ocean. The high pressure area is so far north and so persistent in the summer that the rain-producing low-pressure areas that sometimes move through in the winter rarely affect the California coast during the summer.

The heating of the ground surface of the interior of California, Nevada, and Arizona causes a low-pressure area to the east of the Bay Area, resulting in strong pressure differences and therefore the strongest average winds during the summer.

FIGURE 2

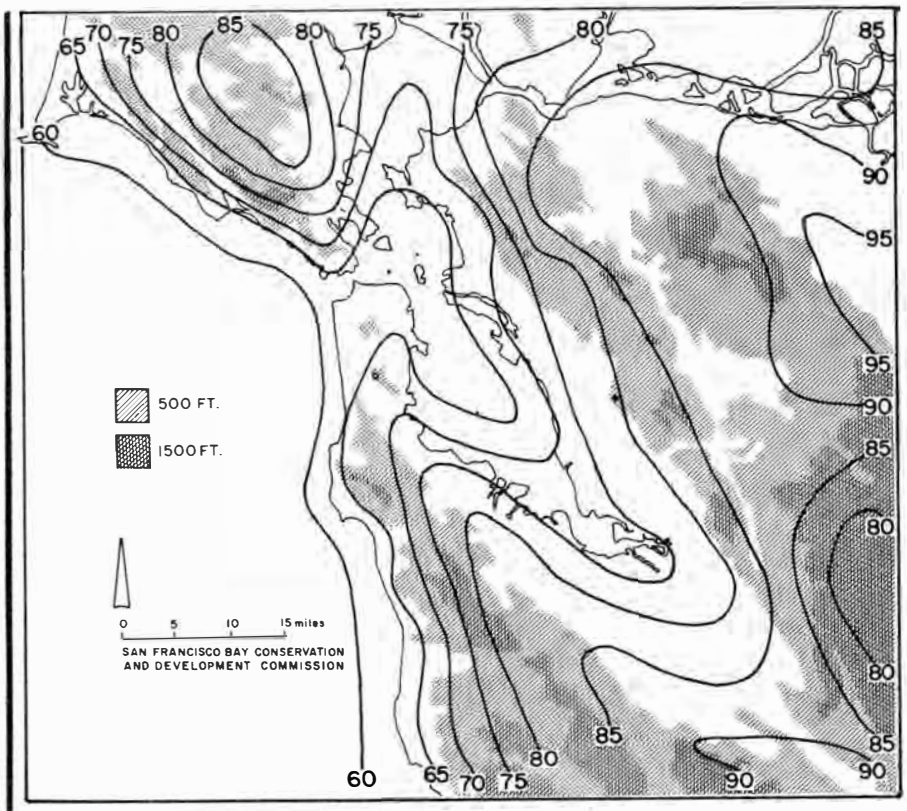
Crestline Profile of the Coastal Mountain Ranges of the Bay Area



Source: Miller, A. Land-Sea Boundary Effects on Small Scale Circulations, Meteorology Department, San Jose State College

FIGURE 3

Daily Mean Maximum Temperature for July 1951-1960 (°F)



Source: Miller, A. Land-Sea Boundary Effects on Small Scale Circulations, Meteorology Department, San Jose State College

WINDS

In the winter, the high-pressure area in the Pacific (Pacific Anticyclone) moves southward, the continent cools, pressure differences along the coast are smaller, and winds are therefore weaker, except during periodic winter storms.

From spring to early fall, the wind comes from the west to north-northwest. The winds are drawn into the Bay Area through the Golden Gate and over the San Francisco Peninsula. Some air peels off toward the northeast, spreading out and diminishing somewhat as it moves across San Pablo Bay and into the Carquinez Strait. Other winds turn southeast after crossing the peninsula, spreading out and diminishing somewhat by the time they reach San Jose.

WINDS

The speed of the daytime wind changes from spring to early fall. This is because of the changes in the temperature difference between the land and water which reaches a maximum in the afternoon. Almost all places in the Bay Area experience the daily wind changes, but there is considerable variation in time and speed from place to place, chiefly because of topography.

Although the average wind speed is lowest in winter, the strongest winds occur then. When the Pacific high-pressure area moves southward in the winter, low-pressure areas can come into the Bay Area causing strong southwest winds and then, after the storm center moves to the east, strong northwest winds. Winter storms occur on the average of about once every two weeks, with above-average winds prevailing for about two days.

PRECIPITATION

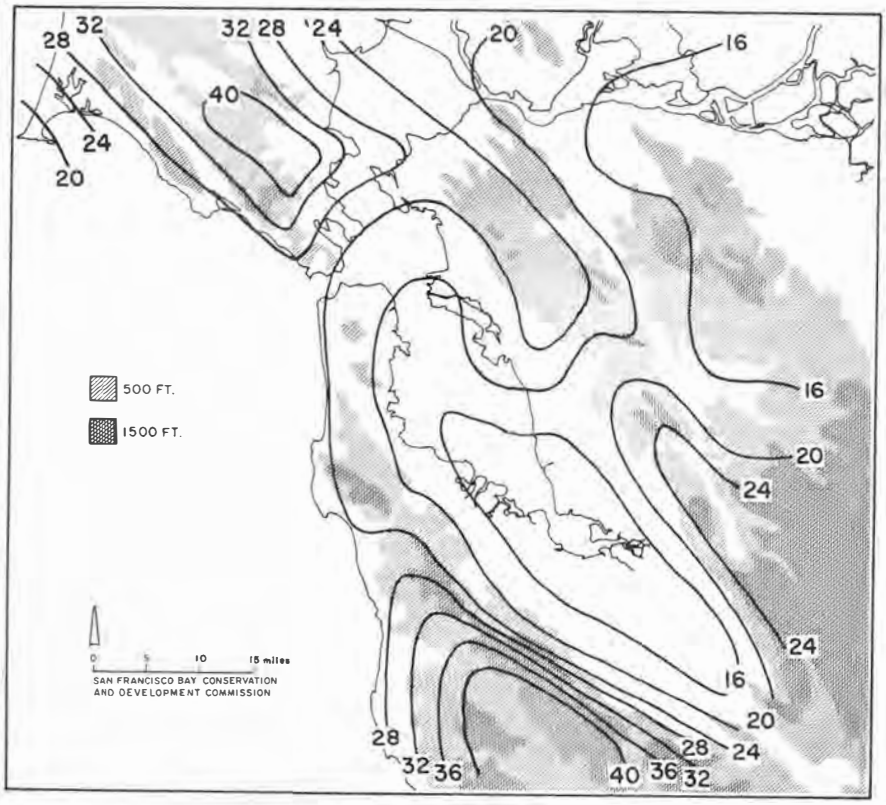
Almost 90% of the annual rainfall in the Bay Area occurs during about 55 days in November through April. Most of the rainfall occurs during the southwest air flow that usually precedes the low-pressure areas as they come in from the Pacific Ocean. As the moisture-laden winds strike the coastal mountain ranges, they are forced to rise; they stop rising or even sink over San Francisco Bay and the Santa Clara Valley and then they are forced upward again when they encounter the Diablo Range to the east. The up-and-down motion is reflected in the amounts of rain that fall. Figure 4 illustrates that there is a maximum over Mt. Tamalpais and the Santa Cruz Mountains, a minimum over the Bay, and then another maximum over the Diablo Range.

AIR POLLUTION

The semi-permanent, high-pressure area over the Pacific Ocean that causes rainless summers also makes the Bay region prone to air contamination. At altitudes above 2-3,000 feet along the eastern edge of the high-pressure area, the air coming toward the California coast is relatively dry and is generally descending. As it descends, this dry air is compressed and warmed. In direct contrast, the air near the ocean's surface is cool and moist (the

FIGURE 4

Normal Annual Total Precipitation (Inches) San Francisco Bay



Source: Constructed from U. S. Weather Bureau climatological data

AIR POLLUTION

ocean surface along the California coast is especially cold, increasing the difference).

The condition of warm, dry air riding above cool, marine air persists along the California coast during the entire summer and during some of the winter. The condition of warm air over cool air is known as a "temperature inversion," illustrated in Figure 5.

The height of the warm air "lid" on the marine layer varies greatly by time and place within the Bay Area; in the vicinity of Oakland, its average height is about 1,400 feet in summer and, when it exists, about 300 feet in winter.

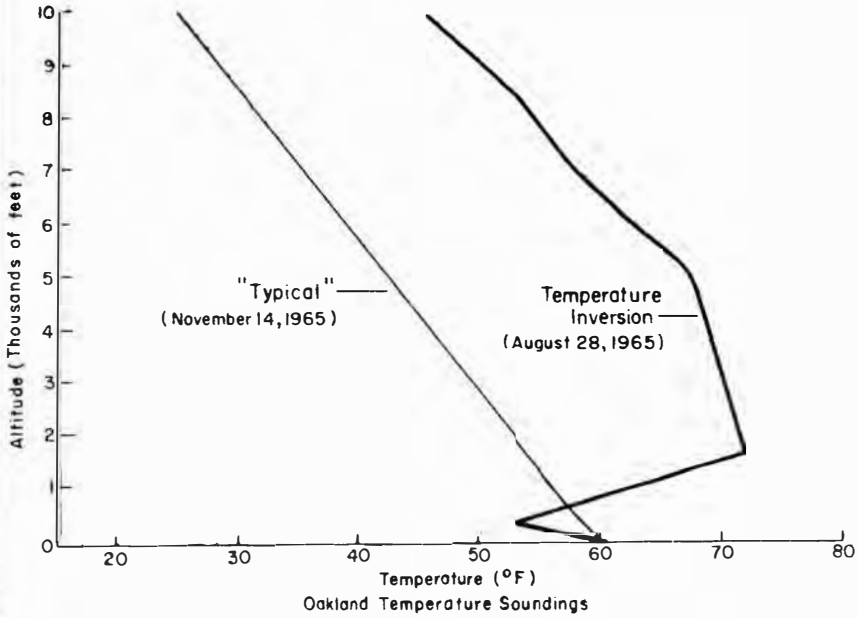
AIR POLLUTION

Since the marine air cannot normally rise above the lid, neither can the pollutants that are injected into the air near the earth's surface. Thus the volume of air into which contaminants can be dispersed is strictly limited. When the wind flow within the lower layer is weak, the total "ventilation" of the area may not equal the rate at which pollution is being emitted, so the concentration of contaminants in the air increases. When this happens, the oxidant concentration (an index of pollution level) will in many places, especially in the South Bay area, exceed the .15 parts per million which is generally considered to cause eye irritation.

Pollutants in the atmosphere injure plants, and property, and health; they also affect the climate. The carbon dioxide that is found in high concentration over cities acts as a blanket, preventing the earth's surface from losing heat as rapidly as it might otherwise. In addition, the smoke and dust in the air over cities can reach a thousand times the concentration of that over the ocean; the smoke

FIGURE 5

Winter and Summer Examples of Atmospheric Stability in the San Francisco Bay Area



Source: Constructed from U. S. Weather Bureau data

AIR POLLUTION

and dust particles reduce the transparency of the air to both the sun's incoming and the earth's outgoing radiation. The dust particles also act as nuclei around which water vapor can adhere and then condense; the larger amount of dust over cities causes more droplets to form and therefore causes more fog. (Fogs are generally denser over cities than over open country.)

In addition to the "lid" imposed by the Pacific high-pressure area, temperature inversions can also result from the loss of heat from the earth's surface during long, clear nights when the air is not too humid (especially in winter). As the earth cools, it cools the air in contact with it and produces a temperature inversion in the atmosphere. Depending on the speed of the wind, the base of this "radiation inversion" can be located at the ground or several hundred feet above it. Once formed, the radiation temperature inversion behaves like any other inversion in capping the air below it.

FOG AND CLOUDS

Marine air approaching the California coast, already cool and moisture-laden from its long trajectory over the Pacific, is further cooled as it flows across the cold ocean current along the coast. This cooling is often sufficient to produce condensation so there is high frequency of fog and stratus clouds ("fog" whose base is above the ground) along the northern California coast during the summer. During the night, as the interior cools, the fog or stratus is able to move over the Bay.

The frequency of fog decreases from west to east (Farallon Islands to Oakland) due to the increasing surface temperatures, which cause the fog to either dissipate or lift off the ground over the land.

Fog is also created <u>within</u> the Bay Area, especially during the winter when the wind is weak and air can stagnate over the Bay Area. During the long nights, fogs are sometimes caused by the cooling of the earth's surface through radiation to the air. For example, the frequency of fog over the Santa Clara Valley is actually about 5 times higher in winter than it is in summer because of such radiational fogs.

EFFECTS OF BAY FILLING ON THE CLIMATE

Typical climatic changes produced by cities in relation to the surrounding countryside include (1) a 1° higher annual temperature and 2° to 3° lower winter minimum, (2) 5 to 10% more rain or snow, (3) 100% more fog in the winter and 30% more in the summer, and (4) 10 times as much dust and 25 times as much carbon monoxide in the air. Since the typical city is not built on surfaces previously covered by water, the changes produced by filling San Francisco Bay for urban development are likely to be greater than these.

Weather occurs on a variety of scales. The local factors that cause small-scale weather phenomena, such as local rainshowers or coastal seabreezes, have little effect on large-scale phenomena, such as the great storms that move in from the west during winter. Thus, a small-scale change in the atmosphere, such as that induced by filling one square mile of Bay, would probably have no noticeable effect on the air circulation and climate of the Bay Area as a whole, although it might be significant in terms of the climate within a few miles of the filled area.

At exactly what stage of Bay filling would a significant change in Bay Area climate occur? It is difficult to answer this question without more research. Based on information presently available, however, it is estimated that significant changes would be observed before 25% of the existing Bay water surface had been eliminated.

If a major portion of San Francisco Bay were to be filled, the following climatic changes could be expected:

1. Wind

The cooling summer sea breezes would not blow as far south and east as they now do, and the strength of the wind would be decreased, particularly in the southern end of the Santa Clara Valley and in the Suisun Bay Area. The summer winds from the ocean come in through the Golden Gate and over the San Francisco Peninsula. They peel off to the northeast over San Pablo Bay and southeast over the South Bay, but slow

down as they come over land at the "ends" of the bays. Filling at the south end of the Bay would move the "end" of the Bay north and therefore slow the winds in that area; filling in the northeast part of the Bay would similarly reduce wind speeds there. In addition, structures built on Bay fill would further diminish wind speeds.

2. Temperatures

Temperatures would rise over the Bay Area. In the summer there would be a significant increase in the mean maximum temperature over the southern half of San Francisco Bay and over the eastern sections of the Bay around Carquinez Strait and Suisun Bay. For example, it is estimated from the climatological records of other valleys open to the ocean that the average maximum temperature at San Jose would increase by at least 5°F (giving San Jose an average July maximum of 86°F). In addition, the average minimum temperature in winter would be decreased by 2° or 3°F. Similar temperature changes could be expected in north Bay communities that are distant from the ocean.

3. Air Pollution

More smog would occur. This is because radiation temperature-inversions, which trap air pollutants, occur more frequently over land surfaces than over water; changing water surface to land through Bay filling would thus increase the frequency and the intensity of radiation inversions in the Bay Area. This increase would occur even if nothing were built on the Bay fill; but there would undoubtedly be automobiles and other sources of air pollution on the filled land. The increase in smog would also be accelerated by the reduction in wind speeds, so that pollutants could not be dispersed as rapidly as at present.

4. Fog and Clouds

Winter fogs would become more frequent and more dense. This is because the increased land surface caused by Bay filling would increase the frequency of nighttime radiation temperature inversions and thus the

EFFECTS OF BAY FILLING ON THE CLIMATE

frequency of fog during long winter nights. These fogs would be increased in density because of the added air pollution resulting from the increase in land surface.

5. Rainfall

The already minimal amount of rainfall in the Santa Clara Valley would probably be reduced even further. Clearly more research is needed on this matter, but information presently available appears to warrant such a conclusion. Most winter rainfall in the Bay Area occurs while the wind is blowing from southwest and west ahead of a low-pressure area moving in from the ocean, but Figure 4 demonstrates the Santa Clara Valley gets the least benefit from that rain. Some rain also falls during the northwest flow of wind that follows the passage of a storm. This rainfall usually comes in squalls (lines of showers) that move with the wind into the south end of the Santa Clara Valley. The Bay may play an important role in helping produce these showers by injecting heat and moisture into the cool northwest winds.

SUMMARY

The Bay is a single physical mechanism in which actions affecting one part may also affect other parts. The waters of the Bay play a significant part in helping to determine the climate of the region: they serve as a "heat reservoir," moderating the extremes of temperature; they help make possible the smooth flow of cooling winds from the ocean; and their existence helps prevent smog.

As long as man values clean air and is not able to adequately control the emission of pollutants into the atmosphere, substantial reduction of the surface area of the Bay should be avoided. Substantial reductions through filling would reduce air circulation and cause more temperature inversions. This would result in higher summer afternoon temperatures, lower winter night-time temperatures, reduced rainfall in some areas, greater frequency and thickness of fog, and in increasingly serious smog conditions, especially in the South Bay area and the Santa Clara Valley and in the Carquinez Strait-Suisun Bay area.

SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION
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Possible Bay Planning Conclusions Based on the Report on Smog and Weather

1. San Francisco Bay plays a significant role in determining the climate of the Bay Area.

2. Filling a substantial part of the Bay -- as much as 25 per cent -- would cause (a) higher summertime temperatures and reduced rainfall in the Santa Clara Valley and the Carquinez Strait-Suisun Bay area; and (b) increases in the frequency and thickness of both fog and smog in the Bay Area.

3. To help prevent such changes in climate, the surface area of the Bay should be kept as large as possible. Filling and diking that would substantially reduce the surface area of the Bay should therefore be allowed only for purposes providing substantial public benefits.

Adopted by the Commission at its meeting of 3/2/67

SALT,

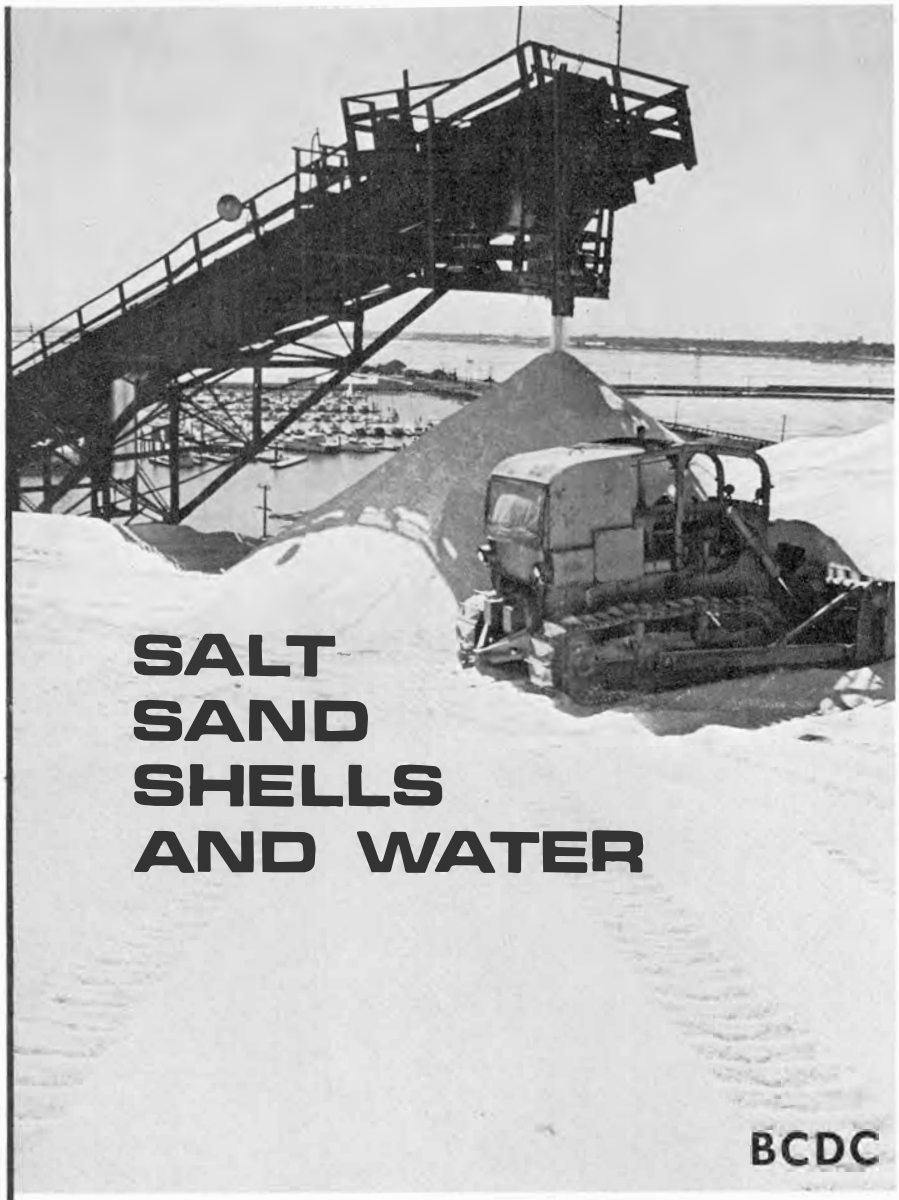
SAND,

SHELLS

AND

WATER

Part of
a Detailed
Study of
San Francisco
Bay



San Francisco Bay
Conservation and
Development
Commission

San Francisco
California

January 1967

Summary of the report, "Salt, Sand & Shells: Mineral Resources of San Francisco Bay," by Harold B. Goldman, Senior Geologist, State Division of Mines and Geology

INTRODUCTION

Sand and shells are pumped from the depths of San Francisco Bay and piled high in waiting barges.

Gigantic reapers harvest raw salt from evaporation ponds along the shores.

Huge pumps draw cold Bay water into the cooling coils of industrial plants.

These uses of the Bay, little known but nevertheless important, are the subject of this report. The Bay contains great quantities of sand, shells, salt, and water, and these resources are used in many ways in the economy of the Bay Area. In addition, the water of the Bay yields a number of chemicals and minerals that are the raw material for industrial plants along the shore.

SAND

Sand deposits in the Bay have served as a basic source of fill for tideland areas, but have been of too poor quality for general industrial use.

Sand is heavy and of low value compared to its weight. Therefore, the cost of sand to a user is mostly the cost of hauling it. So the chief value of sand is its availability nearby.

Sand used as fill costs $1.00 to $1.50 a cubic yard, dredged, transported, and placed. It has been economical to use as fill because it can be pumped from the Bay floor and, being mixed with water, can be pumped onto the fill site. There are no current data on how much sand is used for fills.

Sand for industrial purposes is largely extracted from pits in ancient river beds in Alameda County. Approximately 5 million tons come from these sources each year for building and paving in the Bay Area.

Sand on the Bay bottom is generally of poor quality and must be extensively cleaned and sorted to be of value for industrial purposes. As such, it will only be of value for industrial purposes when better sources of sand have been exhausted.

SAND

The amount of sand available in the Bay Area is not precisely known. Rough estimates suggest that there are about 271 million cubic yards of sand in Bay deposits, the largest of which are shown in Figure 1. This is but a fraction of the 2,000 million cubic yards in the great crescent-shaped sand bar outside the Golden Gate. The rate of use of sand suggests that existing supplies on land near the Bay are adequate for many years. Pending much more extensive analyses of other sources of supply it does not now appear that the sand in the Bay need be conserved for industrial use and it can be used for fill and other purposes as deemed necessary. Constructing new Bay Area beaches would probably require importation of higher-quality sand than is available on the Bay floor.

SHELLS

Oyster shells are dredged from the Bay floor primarily for use as lime in the production of cement. A small portion of the shells are used as soil conditioner, cattle feed, and as poultry grit by local poultry and egg producers. The principal known deposits of shells are indicated in Figure 1.

The shells in the Bay are one of only two principal lime sources in the Bay Area. The other is the limestone quarried at Permanente in Santa Clara County and also in Santa Cruz and San Benito Counties to the south. One of the major cement producers in the Bay Area, the Ideal Cement Company, uses the shell deposits. Cement cannot be transported economically over great distances and the manufacturer using shells is closest to the Bay Area market. Therefore, the shell deposits are an important mineral resource.

Over 30 million tons of shells have been dredged from the Bay since 1924. Remaining deposits are not known but hypothetical calculations suggest they exceed 75 million tons. The Ideal Cement Company dredges the shells from under the Bay mud and uses both the mud (for its clay content) and shells to produce cement. The company has dredged between 1.5 and 2 million cubic yards of shells and mud per year and expects to increase to 2.5 million yards within the next few years.

FIGURE 1

Sand and Shell Deposits and Salt Production Ponds in San Francisco Bay

Source: Compiled from Figure 1 BCDC Report on Geology; U.S.G.S. quadrangles; and Leslie Salt Co. maps

SHELLS

The shell deposits now in use are leased from the State and from cities in which the deposits lie. Lease payments total about $100,000 a year.

The shell deposits in the Bay are important to Bay Area poultry and egg producers, who rely upon the availability of the nearby resources. But the poultry and egg producers use relatively small amounts of shells compared to the amounts used in cement production, and their supply does not appear to be in any jeopardy in the near future.

The BCDC report on Fish and Wildlife states that dredging shells and sand may disturb marine life, but it is not known at this time whether such disturbance is harmful or beneficial. Dredging and washing processes increase the turbidity of the water in the vicinity and improved methods may prove necessary if further research indicates that any harm results from present processes.

SALT

Salt produced from the waters of San Francisco Bay is used not only to make table salt, but also for a wide variety of industrial purposes. More than 1 million tons of salt are produced annually, making the Bay Area one of the great salt-producing regions of the world.

Salt is usually produced by extraction from deposits on dry land or by solar evaporation of sea water. Solar salt production is possible in only a few areas of the world having the required conditions: a dry climate, large areas of land available for salt evaporation ponds, and nearby markets.

The solar evaporation process requires pond areas of 400 to 500 acres each. Over a period of three to four years, the brine is moved from pond to pond as it becomes more concentrated and is finally harvested by large machines. The ponds, red and brown when seen from a high vantage point, are used by water birds in the absence of marshes and mudflats.

The Leslie Salt Company, largest producer in the Bay Area, owns 40,000 acres of salt ponds in San Mateo, Santa Clara, and Alameda counties and 10,000 acres of

SALT

ponds in Napa County (see Figure 1). The local availability of economically priced salt has been a major factor in attracting salt-dependent industries, especially chemical industries. If necessary, salt could be brought into the Bay Area from other sources, but only at a somewhat higher price because of the cost of transporting it.

It now appears that salt will be produced in the Bay Area for many years to come, but only as long as it returns a greater income to the owners of the extensive salt ponds than can be obtained by turning the property to other, more remunerative uses. Already, the Leslie Salt Company is converting some of its ponds to high-value real estate development. Leslie's Redwood Shores project in Redwood City will convert approximately 4,500 acres of former salt ponds into a major urban development housing up to 60,000 people in the next 25 years.

In addition to common salt, several magnesium compounds, artificial gypsum, and bromine are produced from the waters of the Bay. Most of these are by-products of the salt evaporation process but some, particularly high-priced magnesium compounds such as milk of magnesia and magnesium oxide for the pharmaceutical industry, are produced directly from the Bay waters.

WATER 1/

The waters of the Bay are extensively used for industrial purposes, especially cooling. Average annual use (1960-1963) was 655 billion gallons of Bay water. The current water users alone estimate they will eventually need 776 billion gallons per year.

The bulk of the water, 638 billion gallons, is used for industrial cooling purposes. Another 16 billion gallons are used in recovering salts and chemicals,

1/ This section is based on a report of the San Francisco Bay Regional Water Quality Control Board, Beneficial Water Uses to be Protected, December 16, 1965. Page IV-1. No BCDC technical report has been prepared on this subject.

WATER

and one billion gallons are used for treating or diluting wastes in controlled ponds.

The water used for cooling is returned to the Bay, with its temperature increased. The only potential harm to the Bay might be excessive heating of the waters. This is a form of pollution that could adversely affect marine life if extensive enough, but it has not yet been considered a problem.

Using Bay water for industrial purposes relieves the demand for fresh water that must either be brought into the area by aqueduct or must be pumped from underground sources (which are already in short supply). Industrial use of Bay waters will undoubtedly increase as new water-using industries come into the Bay Area.

EFFECT OF FILLING

Filling of the Bay would have little significant effect on the use of the Bay as a sand or industrial water resource.

Filling would affect salt and shells. But the salt ponds would only be filled when it was in the owner's interest to convert the ponds to a more profitable use; total cessation of local salt production is unlikely for so many decades that consequences to the local economy cannot be evaluated, but these would apparently pertain only to the additional cost of transportation. A small portion of the known oyster shell deposits are located close enough to shore to be covered up by filling and shells are valuable enough to the Bay Area economy to justify conservation measures.

SUMMARY

The Bay is a single, physical mechanism, in which actions affecting one part may also affect other parts. The shell resources of the Bay would be adversely affected by filling. The public interest in the sand, salt, and industrial water resources of the Bay, however, would be very little affected by filling or other human manipulation of the Bay.

A D D E N D U M

CAN SAND DREDGED FROM SAN FRANCISCO BAY BE USED FOR BEACHES?

by

Harold B. Goldman
Division of Mines and Geology

Purpose and Scope

The purpose of this study was to determine the suitability of naturally-occurring sand on the floor of San Francisco Bay for use in creating beaches on the margins of the Bay. During the investigation, field visits were made to several natural beaches and some artificially-created beaches within the Bay Area. In addition, discussions were held with the various park and recreation personnel who have jurisdiction over these beaches, to determine their criteria for beach sand.

Specifications of Sand for Use on Beaches

Recreation Requirements. Discussion with various park and recreation personnel reveal that there are no set standards for beach sand. Some of their requirements are aesthetic; others are of a more practical nature, such as cleanliness. Generally speaking, a recreational beach should have clean, uniform, odorless sand that is pleasing in color as well as in personal comfort. The cleanliness of the sand is reflected in the adhesiveness of sand grains to a bather's body. For example, fine sand sticks to the body, and is difficult to remove from clothing. The particle size can also determine the desirability of a sand, e.g., when the sand is very fine, there is the possibility of its being blown away by the wind.

Physical Requirements. Sand that meets the aforementioned recreational requirements reflecting cleanliness, human comfort, and pleasure can be obtained by setting up physical requirements. These specifications determine the particle size distribution (gradation), which in turn determine the cleanliness of the sand. To obtain sand in a certain size distribution, it often is necessary to wash the sand to remove dirt, organic matter, or unwanted silt or clay particles. Specifications also can limit the size range of the sand grains to avoid the problems inherent with fine size sand.

Color can also be specified so that a pleasing white sand can be obtained. The color of any sand is dependent upon the mineral composition. The purest, whitest sands are those composed of quartz, a highly resistant, colorless-to-white silica mineral. The next prominent constituent in sands is feldspar which is also colorless-to-white. Often the mineral grains are coated by a reddish-brown or yellow-brown iron oxide stain, or they contain brown mica flakes that give a buff tone to the sand. Sands that are darker in color ordinarily will contain minute

fragments of rock particles so that for example, it is possible to have a gray-colored beach composed of dark volcanic sands.

Particle shape also has an effect on the recreational aspect of a sand. Ordinarily sand grains on ocean beaches have been subjected to the abrasive actions of waves in the surf zone and the grains become smooth, rounded, and in some instances frosted.

Definition of Terms

To determine the potential use of a sand for a beach, it is necessary to define what is meant by a "beach." The definition of "beach" as given by the American Geological Institute is "the gently sloping shore of a body of water which is washed by waves or tides, especially the parts covered by sand or pebbles." Sand is defined as fragmental material derived from older rocks by disintegration. The sand grains may be an individual mineral grain such as quartz, a composite grain of one or more minerals, or a rock fragment. The sizes of sand grains are determined by a mechanical screening process. To the geologist, fine sand ranges in size from 1/8 to 1/4 of a millimeter; medium sand ranges from a 1/4 to 1/2 millimeter; and coarse sand from 1/2 to 1 millimeter.

Gravel is a term used by the geologist to designate particles larger than 4 millimeters; in the aggregate industry, gravel is a designation for fragments that are larger than 6.35 millimeters (1/4 inch). Gravel-size fragments generally are composed of rock and minor individual mineral fragments.

Silt and clay are terms used to designate particles which are finer in size than 1/16 of a millimeter.

Beaches in San Francisco Bay

Natural Beach. Two of the natural public beaches in the Bay Area are Paradise Beach near Tiburon, a small narrow strip of beach that contains buff-colored, fine-to-medium sands with shell fragments, and Coyote Beach at Coyote Point in San Mateo County. Coyote Beach is approximately 1/4 mile long by 100 feet wide, and consists of brown, fine-to-medium sand overlain by 6 to 12 inches of gray, coarse sand and pebble gravel which contains a high proportion of shell fragments.

Artificial Beaches. As a consequence of dredging for filled lands, beaches have been created at Foster City in San Mateo County and in the City of Alameda. Both of these beaches were created from sand that was put into place in conjunction with filling of mud flats. The Alameda beach is approximately two miles long and 50 feet wide, and contains a buff, fine sand with shell fragments. The Foster City beach areas are composed of a similar sized sand.

As these beaches are essentially fine sands, they are subjected to erosion by tidal action and will need replenishing from time to time.

Sand Used for Recreational Beaches. The East Bay Regional Park District maintains three beaches for which the district imports sand. The sands are purchased from Pacific Cement and Aggregates Company, which excavates from the surf in Monterey Bay near Prattco and provides what is termed Monterey No. 4 sand. This is a clean, coarse sand that is lighter in color than the beaches described in the preceding section.

The San Mateo County Park and Recreation Department maintains the beach at Coyote Point. Because of strong wave action and wind erosion the beach now needs replenishment. The Department calculated that it would need 7,000 cubic yards of clean sand and solicited bids for this material. The bids varied from approximately $3 a ton for sand from Felton (Santa Cruz County) to $5 a ton for Monterey sand. The price differential was due in part to the additional freight haul from Monterey Bay,and in part due to the higher quality of the Monterey sands, i.e., coarser and lighter in color. Felton sand is excavated from bank deposits of a geologically-older marine formation.

San Francisco Bay Bottom Sands

Distribution and Character of Sand. Sand is known to occur on various shoal areas within San Francisco Bay. Three areas have been a source of dredged sand: one is located near Angel and Alcatraz Islands; another is near Bay Farm Island in Alameda County; and the third is San Bruno shoal, where the sand underlies a layer of Bay mud. All of the sands fall into the fine-to-medium size range. There are certain intervals, particularly in the Point Knox shoal, southwest of Angel Island, where coarse sand and gravelly sand may be obtained. These sands contain a very high proportion of shells, while the fine sand also contains a notable proportion of silt and clay. Estimates of the amount of sand that could be obtained from the bottom of the Bay totaled 271 million cubic yards.

Suitability of Sands. Sand on the bottom of San Francisco Bay contains a high proportion of shell fragments that render it unsuitable for use for industrial purposes other than fill. Theoretically, selective dredging could obtain the necessary range of sizes for use, for example, as a sand for use in concrete. However, this would require that the sand be brought ashore, stockpiled, and then processed in a screening and washing plant. In addition, it would be necessary to upgrade the sands by removing as much of the shell fragments as possible. The only method in use today which would upgrade the sands is by means of sink-float equipment whereby liquids are used to separate and float off the shell particles while the heavier sand grains sink. This is a costly process and uneconomical at the present time. Therefore, the highest use under present economic conditions is as a fill sand.

Golden Gate Bar and Ocean Beaches

An estimated two billion cubic yards of sand are available on Golden Gate Bar in the Pacific Ocean directly outside the Golden Gate. This deposit is an excellent source of sand for hydraulic fill and for natural beach replenishment. The sand ranges in size from fine to medium and is quite similar to the sand on the ocean beaches in San Francisco.

The ocean beaches are of higher quality than the beaches within the Bay, primarily because the sand is cleaner. The strong wave action has crushed and floated off the shells which are so ubiquitous in the Bay sands, and washed out the silt and clay. Aside from this difference in cleanliness, the sands are similar in mineralogy and particle shape.

Dredging from Golden Gate Bar is not as favorable as dredging from sand areas within the Bay because of the difficulties of working in rough open water and the added transporting distances. Furthermore, it is not known whether extensive dredging in the Bay would harm nearby beaches. The Army Corps of Engineers has made some studies of the Bar, but has observed that only general conclusions can be reached because of the enormous size of the Bar and the complex forces that have created it and keep it in place. The volume of material in the Bar and on nearby beaches is so great, however, that the Corps is presently of the opinion that no measurable effect could be detected from the amount of dredging likely to be done in the Bar.

Use of Bay Sands for Beaches

Recreational Beach. Broadly speaking, the sands dredged from the bottom of the Bay are unsuitable for use as a recreational beach. To be made suitable, sand would have to be washed and also screened to remove silt, clay, and as many shells as possible and in addition to remove as much as possible of the organic content of the sand. This sand contains a good deal of animal life (called benthic deposits), and when the sand is exposed on the surface of a beach, the majority of the organic forms can be expected to die. As they decompose, they will create an odor that may be offensive.

Lower Quality Beaches. Physically, it is possible to create a beach in the broadest sense of the term as defined previously, using dredged sand from the Bay. The limitations which have been alluded to are such things as unpleasant odor, uncleanliness, and erosive potential from wind and waves.

Presumably a beach could be created by using a dredged Bay sand as a base and placing a top dressing of imported higher quality sand over it. This would be impractical unless a beach of some thickness such as 8 feet were desired. In addition, the problem of erosional stability would still be present.

Indeed, the East Bay Regional Park District in taking over Alameda State Beach, is proposing to place a blanket of at least 18 inches of imported sand over the existing beach which was created by hydraulic fill. Unless some measure is taken to prevent wave erosion such as construction of a breakwater, this beach may continue to erode away.

Quantities of Sand Required for Beaches. Based upon an assumed width of beach of 100 feet and a depth of sand to 2 feet, approximately 40,000 cubic yards of sand are required per mile of beach. The quantity of sand required to improve Coyote Beach is 7,000 cubic yards for an area 1,000-1,200 feet long and 100 feet wide, to a depth of 18 inches.

Thus, even if 100 miles of new beach were to be created, only 40 million cubic yards of sand would be needed, and there are an estimated 271 million cubic yards of sand in the Bay and 2 billion cubic yards of sand outside the Golden Gate.

Conclusion

1. While dredged sands from San Francisco Bay can be used to form beaches, the quality and stability of those beaches may not be satisfactory.

2. Even if dredged sand were used to make lower-quality beaches, the amount necessary would be a small part of the overall sand reserve in the Bay Area.

February, 1967
Addendum to Salt, Sand and Shells
(Mineral Resources of San Francisco Bay)

SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION
507 Polk Street, San Francisco 94102 557-3686

Possible Bay Planning Conclusions Based on the Report on Salt, Sand, Shells and Water

1. The principal resources extracted from San Francisco Bay include salt, shells, sand, and water used for industrial purposes.

2. Salt and sand extractive industries are an important asset to the Bay Area economy, but these minerals are not in short supply and do not need stringent conservation measures. Water for industrial purposes also is an important asset to the economy, tut the supply would not be adversely affected to any significant degree by filling and diking.

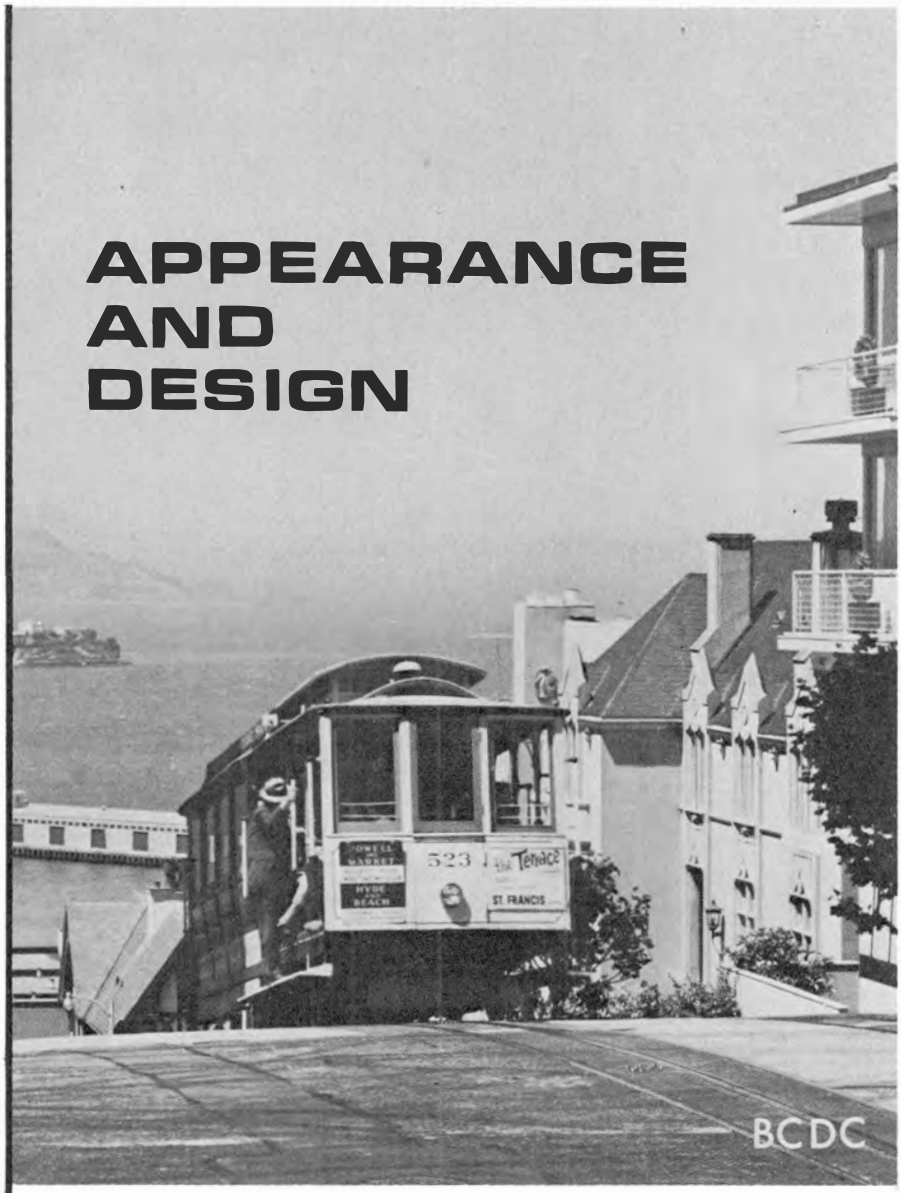
3. Shells are in comparatively short supply. Filling or diking that adversely affects existing shell deposits should therefore be allowed only for purposes providing more public benefit than the availability of the shells.

Adopted by the Commission at its meeting of 2/17/67

APPEARANCE

AND DESIGN

Part of
a Detailed
Study of
San Francisco
Bay



Photograph Courtesy of Redwood Empire Association

San Francisco Bay
Conservation and
Development
Commission

San Francisco,
California

September 1967

Summary of the report, "Appearance and Design: Principles for Design and Development of San Francisco Bay," by Rai Y. Okamoto and William H. Liskamm

INTRODUCTION

"You can climb Twin Peaks and see several hundred square miles of bay spread around you like a glowing tapestry of light and color. More often the bay's impact comes unexpectedly. Rounding a corner in the heart of the city, you come upon it suddenly in the distance between nearby houses, blue in the sun . . . .

"The bay seems always around you. It shines in the distance beyond the long rows of bulging bay-windowed flats. It appears at the bottom of the streets that drop dizzily down from the city's heights . . . .

"It hits you with a quick blow in the innards as you drive over a rise of Russian Hill and see its sudden gleam and sparkle between nearby trees. It comes to you as a series of brief, breathcatching vignettes as you rise on the Powell cable car over Nob Hill and get successive glimpses of it at the ends of the cross streets . . . ."

Harold Gilliam
San Francisco Bay, p. 21

To the viewer, San Francisco Bay and its surrounding hills are things of great beauty. Tourists and residents alike find their lives enriched by the pleasures of viewing the Bay. The many moods of the Bay, and the psychological impact of the Bay on those who view it, have often been written about -- as, for example, in the lines of Harold Gilliam quoted above. These psychological effects and reactions are difficult to identify and measure, but there is no doubt they exist. It has been estimated that a Bay view adds at least 8 to 10 per cent to the value of a home, office, or apartment building in San Francisco; and there is little question the Bay is a major visitor attraction to the tourist industry.

Thus, man's appreciation of the Bay as a major scenic and environmental resource is an extremely important element in planning for the Bay. It is within man's power to deplete the scenic resources of Bay and hills -- or to enhance them.

WHO SEES AND ENJOYS THE BAY

The people who see the most of the Bay and who are able to derive the most pleasurable reaction from observing it are (a) those who are moving on the surface of the Bay, and (b) those at leisure at either the water level or at elevated locations overlooking the water. Next most able to enjoy the Bay are passengers in cars or in aircraft. Perhaps least affected -- but certainly not unaffected -- by the Bay are waterfront workers, regardless whether they are at the water's edge or have a view of the water from above. The concern about maintaining and improving the appearance of the Bay is, therefore, directed at leisure (including tourist) enjoyment of the Bay, and those who glance at the Bay while they are working or commuting.

A VERBAL DESCRIPTION OF THE BAY'S APPEARANCE

While San Francisco Bay is a single body of water, its appearance varies greatly from one part to another:

1. South Bay

Due to the flatness of the land bordering the South Bay, the motion, shape, and even the existence of this part of the Bay are not easily perceived from its rapidly urbanizing edge. Extensive shallows and tidal flats dominate the view. Odors from pollution along both east and west sides retard development near the water, especially in the southeast due to winds from the west. As the water narrows to the south, views of the Bay from hills on the east and west progressively lose sight of, and therefore a significant relationship with, the Bay. South of Mountain View and Fremont, the salt ponds behind dikes are more dominant parts of the view than is the Bay itself; due to the salt evaporators and slow-moving sloughs, the water color ranges from dark yellows and reds through greens to blue.

For the majority of the population living near it, the South Bay (toward its southern end) has neutral or negative implications. Sparsely used for recreation, it is only beginning to develop positive connotations (through Bayshore housing developments, Coyote Point recreation, and boating). South of San Leandro nearly all of the East Bay frontage has primary

A VERBAL DESCRIPTION OF THE BAY'S APPEARANCE

connotations of wasteland, sewage treatment plants, pollution, and smell. Low visual angles almost eliminate any view of the water. South Bay views are generally so distant that activity on the water is barely perceptible; the experience is typically that of a vast space. For the large population of Santa Clara County, "connection" or "association" with the Bay is weak; this could be at least partly overcome, however, with greater public access to the Bay and greater recreational uses of the Bay.

2. Middle Bay and Golden Gate

Water motion is greatest in this area of the Bay due to accelerated currents at and near the Golden Gate and exposure to open sea. With the exception of the eastern flats, the water edge is characterized by steeper slopes and deeper water than in other parts of the Bay. Three major bridges and the East Shore Freeway afford exceptionally strong visual relationships with the water, as do the hills of San Francisco, Marin, Richmond, and the East Bay. Exposure of mud flats by the ebbing tides produces marine scents along the east shore and, less noticeably, in Richardson Bay and along the Corte Madera salt marsh. In addition, pollution odors are also evident in some areas. Well-defined by steeper slopes, the water-land configuration is clearly seen.

Due to its sharply-defined perimeter and the visibility of the water to a large surrounding population, many broad and complex associations with the water itself occur here. Relief from urban intensity is communicated by the expanse of Bay waters, by unbuilt-upon Angel Island, and by the Golden Gate headlands. Dramatized by its surrounding land forms, the Middle Bay's urbanized edge and active uses are perhaps the richest and most memorable "images" distinguishing the Bay Area to visitor and resident alike.

A VERBAL DESCRIPTION OF THE BAY'S APPEARANCE

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3. San Pablo Bay

Any single view of the roughly circular San Pablo Bay, ten to twelve miles across, includes a variety of motions and colors. The extensive northern shallows produce short, choppy, whitecaps in even moderate winds, and cause a blue-brown color as wave and tidal motion disturb the bottom. The minor river and tidal currents in the northern and western parts of the Bay give a motionless appearance to the water on windless days, heightening its vast scale. Waste discharges from industry occur along the Contra Costa County edge; odors there are clearly from factories and refineries, not the Bay. Salt-evaporator and marshland odors characterize the north and western edges, when winds are on-shore. Due to its dimensions, typical views from high or low angles include a vast sky (on clear days) and often strong sun reflections near the horizon.

The size of the Bay subdues the prominence of factories on its southern edge and Hamilton Air Force Base's jet-age facilities. Spots of intense visual interest occur along the industrial Contra Costa shoreline, and the looming form of Mount Tamalpais provides a serene and majestic land form to the southwest.

4. Carquinez Strait

Steep slopes and the confined channel emphasize, by their contrast, the apparent motion and texture of the water. The land form accelerates surface winds and the water's flow. Typical views from surrounding heights clearly display the relationship of land to water. The twin crossing over the strait (the principal northeast "gateway" or "entrance" to the Bay Area) is well-placed for major views, but the design of the bridges interferes badly with these views. Interest in the water is heightened by deep-water shipping in such a narrow channel and by marine activities at Crockett,

Mare Island, Martinez, and Benicia. The water here appears darker than in adjacent Bays, due to steeper visual angles, deeper water and the shimmering surface.

As a symbolic connection between the California central valleys and the Bay, the straits carry many implications of both areas.

5. Suisun Bay

Two-thirds of Suisun Bay's edge can be seen from roads around it, but only from the southern edge is it possible to perceive the motion and texture of the water. From low visual angles, silt-bearing water, seen against hills, reflects earth hues. From higher visual angles with greater sky reflection, water appears dark blue-grey. Shallow water characteristics of short fetch, short chop, and small whitecaps prevail. Although ebb tide exposes slough flats and marsh bottoms, as yet there is little pollution in the northern area, and therefore, little odor. Diked islands appear as part of the marshland waterscape. A wide, general space including water and islands is apparent on clear days, framed by the rolling hills. A few "verticals" in the horizontal landscape are powerful visually because of their uniqueness: Mount Diablo, the ships in "mothballs," and Pacific Gas and Electric Company's power plants.

Lying outside the space formed by the hills of the Bay, Suisun Bay is not well known to the Bay Area population as a whole. The new Interstate Route 680 extension from Concord north to Cordelia and Sacramento exposes Suisun Bay to thousands for the first time. With horizontal rolling hills, shallow water, and adjacent flats, the northern land and water area has a natural, undisturbed appearance. Small tidal and current variations suggest languid qualities. The deep-water ships and industrial activity of the southern shore contrast with the tranquil backdrop to the north.

EXISTING PROBLEMS

Enjoyment of the Bay is adversely affected by:

1. Shoreline developments and roadways that tend to block public access to, and views of, the Bay.

2. Shoreline developments that are of poor quality, or that are inappropriate to a waterfront location.

3. Collections of debris in shoreline marshes, mudflats and sloughs.

4. Deterioration of water quality and reduction of wildlife in the Bay due to poorly-designed filling, insufficient sewage treatment, and litter from pleasure and commercial vessels.

5. Failure to take full advantage of the dramatic view potential from hills surrounding the Bay because of poor road layout and poorly placed buildings or plantings. (There are many notches, passes, and tunnels through the rim of hills around the Bay on which the traveler is suddenly introduced -- or reintroduced -- to views of the Bay.)

GENERAL DEVELOPMENT GUIDE

The basic objective of this General Development Guide is to increase opportunities for people to have pleasurable and leisurely physical and visual contact with the Bay.

Methods of achieving the objective will vary according to (a) the shape of the shoreline in relation to the Bay, and (b) the degree of slope of the land back from the shore. Figure 1 establishes 12 classifications of shoreline configurations and elevations.

Figure 2 shows the distribution of different land-shore configurations around the entire Bay. The map gives a general indication of where each of the classifications can be found around the Bay; in many instances, the detailed topography will be different

FIGURE 1

Basic
Land-Water
Classifications

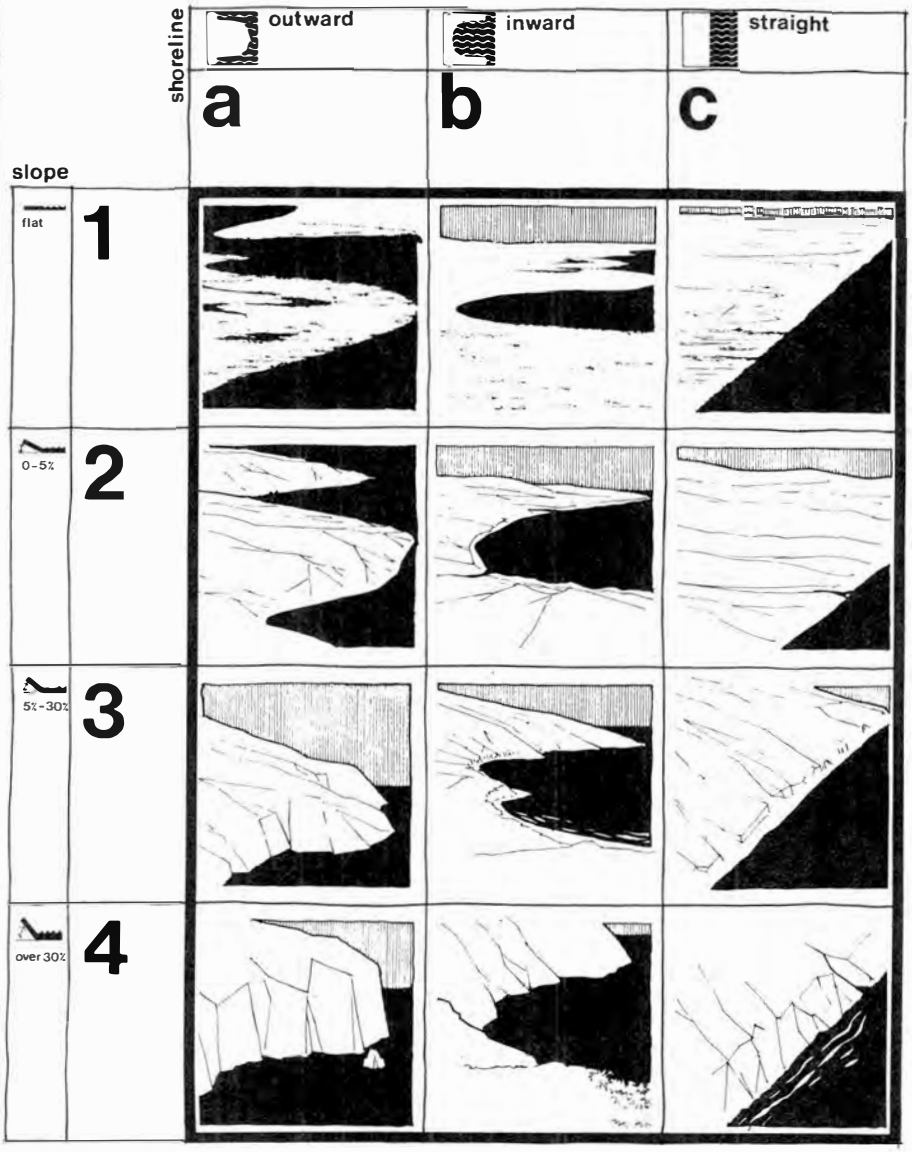
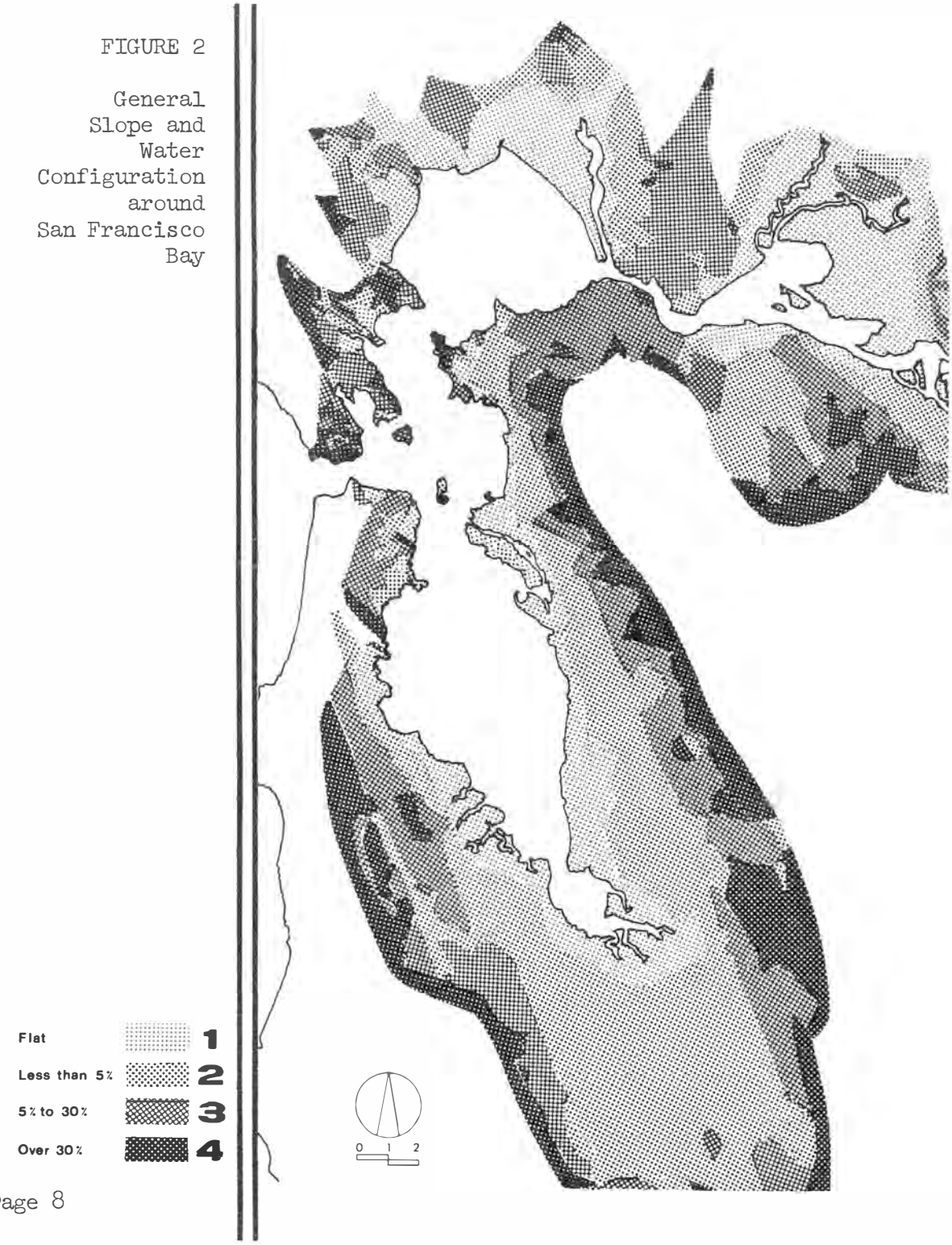


FIGURE 2

General Slope and Water Configuration around San Francisco Bay



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GENERAL DEVELOPMENT GUIDE

shoreline

outward

a

LAND PROJECTING INTO THE BAY PROVIDES RADIAL WATER VIEWS, CUL-DE-SAC CIRCULATION, AND, IN STEEPER SLOPES, DEVELOPS OVERLOOKS AND THE SENSATION OF BEING THRUST INTO SPACE. DEVELOPMENT SHOULD PROTECT AND ENHANCE THESE QUALITIES.

slope

flat — 1

PHYSICAL QUALITIES: THIS LAND USUALLY HAS RELATIVELY NON SUPPORTIVE SOILS, IS SUBJECT TO FLOODING, POOR DRAINAGE, AND OFFERS POOR ORIENTATION. IT HAS LOW ANGLE BAY VIEWS AND INLAND VIEWS ARE EASILY BLOCKED BY LOW CONSTRUCTION. EDGES ARE USUALLY WILD LIFE AREAS.

POTENTIALS: THE EDGE IS EASY TO SHAPE, CANALS AND LAGOONS ARE POSSIBLE. TALL LANDMARK STRUCTURES AT THE EDGE WOULD LOCATE AND SYMBOLIZE THE BAY'S PRESENCE FROM INLAND VIEWING POINTS. SLOUGHS, STREAMS AND WATERSHEDS COULD BE DEVELOPED FOR RECREATION TO FURTHER EMPHASIZE THE WATER THEME, INCREASE LAND VALUES AND STRENGHTEN ORIENTATION. ECOLOGICALLY SENSITIVE RESTORATION IS POSSIBLE IN MARSHLAND.

PROJECTION INTO THE BAY HAS LESS SIGNIFICANCE HERE THAN IN STEEPER SLOPES, SINCE LOW VISUAL ANGLES FROM THE FLATLANDS RENDER ALL SHORELINES ALMOST ALIKE. PROTRUDING POSITION OFFERS WIDEST WATER VIEWS AND SHOULD BE DESIGNED FOR MAXIMUM ENJOYMENT. AN ELEVATED POSITION AT THE REAR CENTER OF THIS LAND FORM ALLOWS A SENSE OF THE PENINSULA AS A UNIT AND, IF SMALL IN AREA, PROVIDES FOREGROUND CONTRAST TO THE BAY. CUL DE SAC CIRCULATION IS IMPLIED BY PENINSULA FORM AND IS MORE EASILY CONTROLLED.

0-5% — 2

PHYSICAL QUALITIES: CHARACTERIZED BY GENTLE SLOPES, GOOD DRAINAGE, EASILY DEVELOPABLE. LOW BAY VIEW ANGLES EASILY BLOCKED BY BUILDINGS. WHERE DEVELOPED, HIGH DENSITIES ARE USUAL, PRODUCING LOSS OF BAY ORIENTATION, SENSE OF THE BAY AND VIEWS.

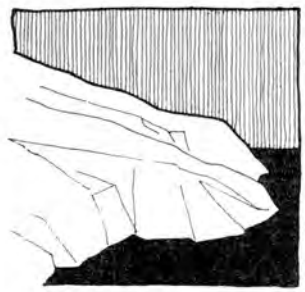
POTENTIALS: LOW SITE DEVELOPMENT COSTS, EASY CIRCULATION; CLUSTER DEVELOPMENT WOULD PRESERVE VIEWS, MAINTAIN SENSE OF BAY AS OPEN SPACE. PUBLIC VISTA POINTS, AND RIGHT-OF-WAY ALIGNMENTS SHOULD BE POSITIONED TO RESTORE VISUAL ACCESS.

THE PROJECTING FORM INCREASES THE WATER EDGE AND BRINGS IT CLOSER TO DEVELOPMENT THAN OTHER PLAN TYPES. SAN FRANCISCO'S DOWNTOWN RADIAL VIEWS ARE EXEMPLARY ALTHOUGH PIERS BLOCK VIEWS ON LAND SLOPES 1 and 2. SWEEPING BAY VIEW POINTS ARE POSSIBLE FOR EXAMPLE ON THE NORTHERN WATERFRONT (FOOT OF FRANKLIN IN FORT MASON), IF PUBLIC ACCESS WERE ALLOWED BEYOND THE PIERS. THIS IS TRUE IN OTHER BAY COMMUNITIES BUILT ON LAND FORM "a".

5%-30% — 3

PHYSICAL QUALITIES: SLOPES ARE LESS SUITABLE FOR INDUSTRIAL AND AGRICULTURAL USES UNLESS TERRACED AND INHIBIT WALKING AND BULK HAULING. WHERE DEVELOPED, STEPPED HOUSING AND UNIFORM BUILDING HEIGHTS HAVE RETAINED VIEWS. UPPER SLOPES PROVIDE GOOD COMPREHENSION OF BAY FORM AND VIEWS TO OPPOSITE SHORE.

POTENTIALS: GOOD FOR RESIDENTIAL, LIGHT COMMERCIAL AND RECREATIONAL USES; HIGHER BUILDINGS ON HIGHER SLOPES INCREASE VIEWER POTENTIAL AND EMPHASIZE SLOPE; HIGH VISTA POINTS SHOULD BE PROVIDED PARTICULARLY ALONG ROADS PARALLEL TO THE CONTOURS. ROUTES AT RIGHT ANGLES TO CONTOURS WOULD PROVIDE FRAMED VIEWS AS IN SAN FRANCISCO.

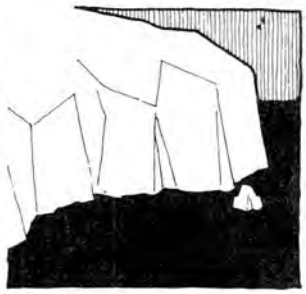


RESIDENTIAL COMMUNITIES, LIKE BRISBANE, BERKELEY, OR SAUSALITO, DEMONSTRATE THE CAPACITY OF THIS LAND TO STACK LOW DENSITY, RESIDENTIAL DEVELOPMENT, WHILE MAINTAINING VIEWS AND A STRONG SENSE OF THE BAY'S PRESENCE. URBAN DENSITIES SUCH AS TELEGRAPH OR POTRERO HILL ARE EQUALLY POSSIBLE, IF HEIGHTS ARE CONTROLLED, ALTHOUGH SPECIALIZED TRANSPORTATION IN THE STEEPER SLOPES IS NEEDED. ALBANY HILL AND THE COYOTE HILLS PRESENT SIMILAR OPPORTUNITIES, ALTHOUGH THEY MAY BE MORE IMPORTANT AS PUBLIC OPEN SPACE.

over 30% — 4

PHYSICAL QUALITIES: VEHICULAR ACCESS DIFFICULT, DEVELOPMENT COSTS HIGH. MANY OF MOST DRAMATIC VIEWS ARE FROM THESE AREAS, ESPECIALLY WHERE ANGLE APPROACHES 90° (GOLDEN GATE, POINT RICHMOND, CARQUINEZ STRAITS). LARGE WATER AREAS ENCOMPASSED BY VIEW EMPHASIZE BAY FORM.

POTENTIALS: PARTICULARLY SUITABLE FOR CONSERVATION AND PUBLIC VIEWING POINTS ESPECIALLY IN PLAN FORM "a". (SEE MAP "PLEASURE DRIVES AND REGIONAL OVERLOOKS WITH SIGNIFICANT BAY VIEWS") USE OF FUNICULARS, AERIAL TRAMWAYS, ETC., RESIDENTIAL ACTIVITY AND SELECTED COMMERICAL USES MAY BE POSSIBLE.

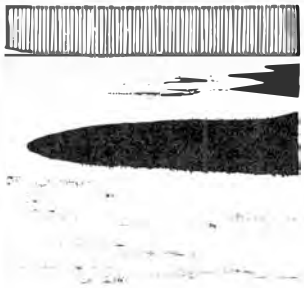


DRAMATIC RELATIONSHIPS WITH THE BAY AND DISTANT SHORE, AND SUBSTANTIALLY BROADER VIEWS THAN ANY OTHER LAND TYPE, TEND TO MAKE THIS TYPE OF SITUATION A PHYSICAL AND PSYCHOLOGICAL PART OF THE WHOLE REGION. VIEW PROMONTORIES SUCH AS WOLFBACK RIDGE, PORTIONS OF POINT RICHMOND, MTS. DIABLO AND TAMALPAIS ARE TYPICAL, AND SHOULD BE PERMANENTLY AVAILABLE TO THE PUBLIC. OFTEN WINDY AND EXPOSED WHERE DEVELOPMENT HAS OCCURED, IT MAY BE INCONSEQUENTIAL IN SCALE OR PRODUCE DISTURBING FORMS ON THE SKYLINE (RADAR DOMES ON GOLDEN GATE HEADLANDS, TRANSMISSION LINES ON SAN BRUNO MOUNTAIN).

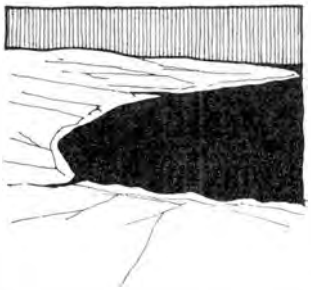
Example: Development guides for sites along a cove, having a 0-5% slope, are found at the intersection of **slope** band **2** and **shoreline** band **b**

inward

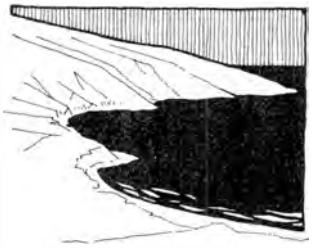
b INWARDLY FOCUSED, THIS PLAN FORM PROVIDES A SECONDARY OR TRANSITIONAL WATER BODY AS A FOREGROUND TO THE BAY. IT PROVIDES USEFUL WIND AND CURRENT PROTECTION IN CERTAIN LOCATIONS. RIDGE LINES OF THE ENCLOSING LAND OFTEN CREATE A BOWL, HENCE AN IDENTIFIABLE GEOGRAPHIC AND DESIGN ENTITY (MARTINEZ; HURRICANE GULCH, SAUSALITO; HOSPITAL COVE, ANGEL ISLAND; PEACOCK GAP, MARIN). AT A COMMUNITY SCALE, THE FORM SUGGESTS A FOCUS FOR COMMUNITY LIFE AT THE BAY'S EDGE WITH CIRCULATION, DEVELOPMENT AND SIGHT LINES DIRECTED TO THE VISUAL CENTER OF THE SPACE.



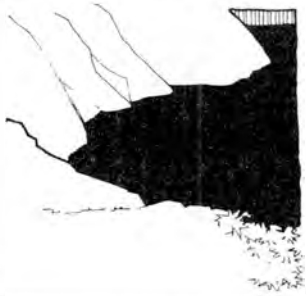
DUE TO PREVAILING WESTERLIES, THIS LAND FORM CAN OFFER NATURAL ANCHORAGE ON THE WEST AND NORTH SIDES OF THE BAY. HOWEVER, SHALLOW WATER USUALLY ADJACENT TO THIS LAND TYPE MAKES DREDGING NECESSARY BEFORE MOST BOATING IS POSSIBLE. THIS PRODUCES A SCARCITY OF BOAT HARBORS, ESPECIALLY IN THE SOUTH BAY WHERE POPULATION PRESSURE AND NEED FOR BOATING FACILITIES IS GREAT. WHERE CONSERVATION IS NOT OF PRIME IMPORTANCE, DEVELOPMENT OF THIS FORM TYPE, IN MARINE HOUSING AND RECREATION, OR EVEN IN CIVIC USES SHOULD BE STUDIED.



THIS IS PERHAPS THE IDEAL SLOPE AND LAND FORM TO PROVIDE A WATER FOCUS FOR DENSE URBAN COMMERCIAL DEVELOPMENT. IT NEEDS ADJOINING LAND AREA BEYOND THE BAY EDGE, AND SUFFICIENT DEPTH FOR SHIPPING. NO SINGLE LOCATION IN THE STUDY QUALIFIES AS AN EXAMPLE, ALTHOUGH PERHAPS MARTINEZ COMES CLOSEST. THERE ARE SMALLER SCALE EXAMPLES ON STEEPER LAND IN 2c BELOW.



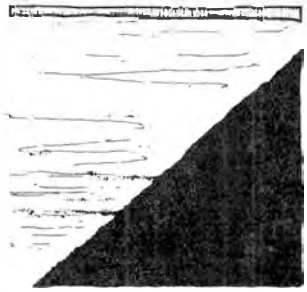
EASY VISIBILITY OF RIDGE LINES AND WATER IN THIS SLOPE RANGE STRENGTHENS THE SENSE OF A COMMUNITY WHEN DEVELOPED. WATER ACTIVITY PROVIDES A SPECTACLE AS IN AN AMPHITHEATER. BAY EDGE FORM ENCLOSING THE FOREGROUND VIEW IS HIGHLY VISIBLE FROM MOST POSITIONS UNLESS LOCAL TOPOGRAPHY IS VERY IRREGULAR. DUE TO THE FOCUS ON THE COVE FORMED, CIRCULATION ALONG THE WATER'S EDGE MUST NOT BECOME A BARRIER BETWEEN LAND AND WATER. HIGH SPEED TRANSPORTATION SHOULD BE FROM ABOVE AND BEHIND TO PRESERVE SMALL SCALE EDGE RELATIONSHIPS.



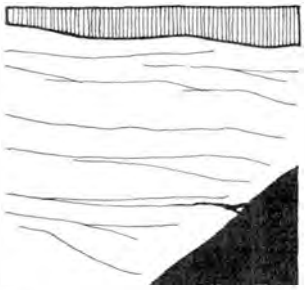
COVE FORM DEVELOPED IN THIS SLOPE CATEGORY IS LESS LIKELY TO PRODUCE BAY VIEW DEVELOPMENT DUE TO THE PRECIPITOUS SLOPE TO THE WATER AND EXPENSIVE SERVICE AND ACCESS PROBLEMS. CONTINUOUS URBAN DEVELOPMENT ALONG THE RIDGE CAN BLOCK ACCESS TO VIEWS FOR LAND BEHIND (AS IN FLATLAND TYPES) DEVELOPS WIND AND CURRENT PROTECTION (AS IN THE EAST SIDE OF PT. BONITA) AND IS USUALLY ACCOMPANIED BY DEEP WATER.

straight

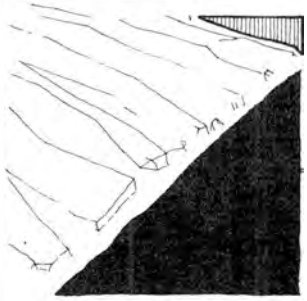
c CLEAR, DIRECTIONAL RELATION TO THE BAY, ESPECIALLY WITH STEEP SLOPES, DIRECTS VIEWS PARALLEL WITH THE WATER'S EDGE. UNLIKE PLAN FORMS "a" AND "b", THE OVERALL EVENNESS OF THE WATER'S EDGE REQUIRES THE INTRODUCTION OF ADDITIONAL ELEMENTS TO ESTABLISH A SENSE OF PLACE, ORIENTATION AND VISUAL FOCUS. PIERS, A YACHT BASIN, A NEARBY ISLAND, ARE TYPICAL FOCUSING ELEMENTS OFFERING THIS SENSE OF POSITION ON THE OTHERWISE UNBROKEN COASTAL FACE. CARE MUST BE TAKEN THAT DEVELOPMENT DOES NOT CREATE BREAKS AT VISUALLY DISTURBING POINTS, OR AT NEW POINTS COMPETITIVE WITH NATURAL BREAKS.



ONE OF THE LEAST PHYSICALLY INTERESTING SHORELINE CONDITIONS - DEVELOPMENT CAN PROVIDE FOCI AND VISUAL STIMULATION; ELEVATED VIEWING POSITIONS AND LANDMARKS COULD AID ORIENTATION. CLUSTER DEVELOPMENT WOULD RETAIN BAY VIEWS FROM INLAND AREAS AND MARSHLAND PRESERVATION WILL HELP MAINTAIN BIOLOGICAL BALANCE. WHEN DIKING IS REQUIRED PROVISION SHOULD BE MADE FOR PEDESTRIAN OVERLOOKS SO THAT THE BAY IS NOT HIDDEN BEHIND DIKES. IN NO OTHER LAND CONDITION ARE HIGH VOLTAGE DISTRIBUTION ROUTES MORE VISUALLY DISTURBING (WEST AND EAST SIDES OF THE SOUTH BAY) DUE TO THE ABSENCE OF OTHER CONSTRUCTION. ALTERNATE ROUTES FOR THESE LINES GROUPED WITH TRANSPORTATION EASEMENTS SHOULD BE CONSIDERED.



THIS LAND-WATER EDGE RELATIONSHIP IS CHARACTERISTIC OF MANY PORTIONS OF THE SOUTH BAY WHERE HEAVY URBANIZATION CONTINUES. BLOCKAGE OF UPHILL VIEWS BY SHORELINE DEVELOPMENT WILL REDUCE THE ABILITY OF THE BAY TO PROVIDE VISUAL EXTENSION OF SPACE. CLUSTER DEVELOPMENT COULD MAINTAIN THIS BAY FUNCTION.



COMMENTS IN 2c ABOVE APPLY IN THIS CATEGORY UP TO 10% SLOPES. SEE ALSO GENERAL NOTES IN "c" ABOVE.

THIS FORM OCCURS RARELY IN THE BAY REGION BUT, WHERE THE BAY PASSES THROUGH THE COASTAL RIDGE LINES (GOLDEN GATE AND CARQUINEZ STRAIGHTS), PARALLEL CLIFFS ACCELERATE CURRENTS AND PRODUCE WIND AND WEATHER EXTREMES. THE STRONGLY-FORMED SPACE PROVIDES WALLS AGAINST WHICH THE APPARENT MOTION OF SHIPS IS HEIGHTENED. THIS LAND IS THEREFORE ASSOCIATED WITH THE MOST DRAMATIC AND DYNAMIC PORTIONS OF THE BAY REGION GEOGRAPHY, AND NEEDS PROTECTION BY WELL PLANNED CONSERVATION PROGRAMS.

GENERAL DEVELOPMENT GUIDE

from the general indication and the appropriate development guide for the actual topography should be employed.

The General Development Guide (fold-out chart) provides methods of achieving the design objectives in each of the 12 land-water classifications. It is intended to serve both the prospective developer and the reviewing governmental body as a summary statement of design principles that can be followed in various parts of the Bay to meet the design objectives.

Figure 3 illustrates methods of carrying out some of the design principles stated in the General Development Guide.

SPECIAL DEVELOPMENT GUIDES

In addition to the General Development Guide principles, the following additional principles are required to achieve the objective of increasing opportunities for people to have pleasurable and leisurely physical and visual contact with the Bay.

1. Build shoreline developments in clusters (leaving more open area around them) to increase the amount of shoreline accessible to the public and to permit more frequent views of the Bay. In addition, grounds and landscaping should be low enough to permit views of the Bay from roads and areas behind the developments.

2. Include in every new development maximum opportunity for pedestrian access to the waterfront.

3. Restrict new waterfront developments that cannot feasibly make room for public access to uses that must of necessity be located on the water (e.g., those using the Bay waters for industrial processing or for shipping).

Open Bay's edge to public access by clustering development

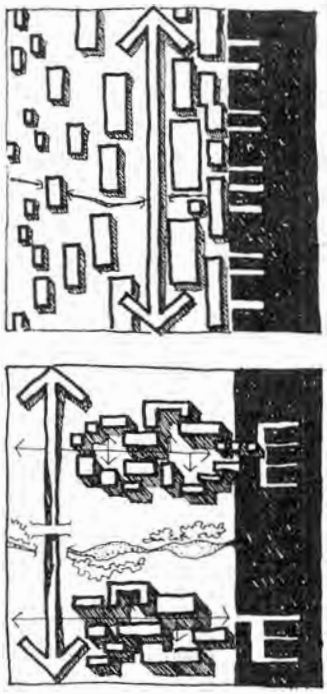
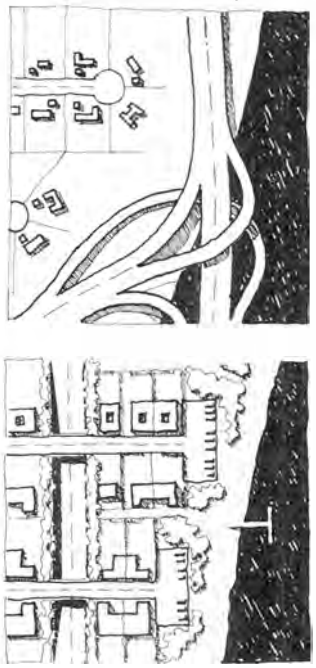


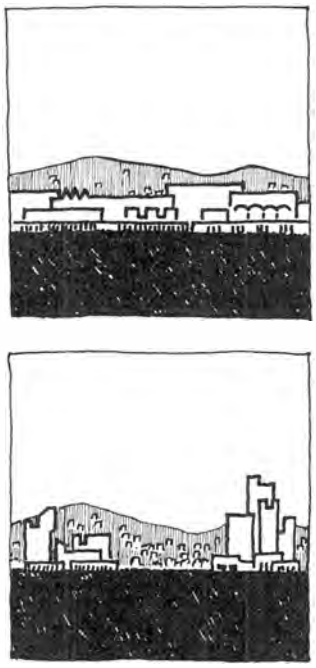
FIGURE 3

Methods of Carrying out Selected Design Principles

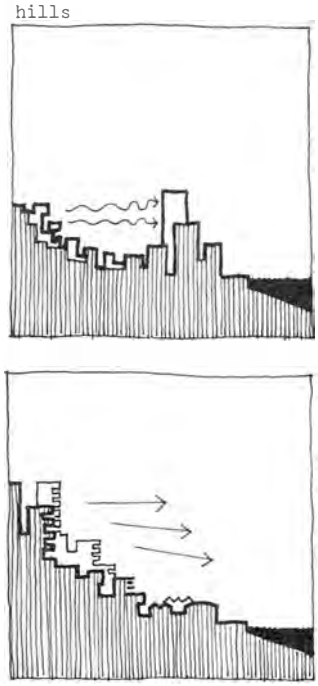
Locate roads so they will not block physical and visual access to Bay.



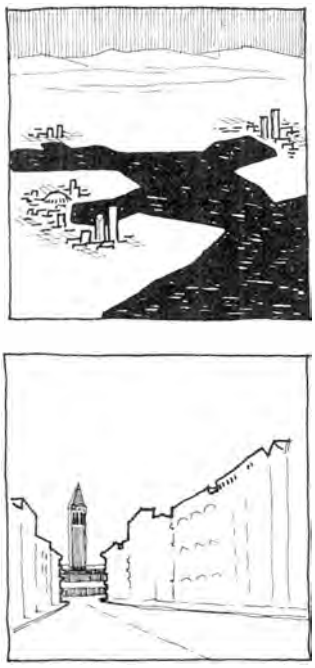
Clustered development at water's edge allows views from inland hills.



Control waterfront development to preserve view from hills



Landmarks at water's edge aid orientation to Bay



SPECIAL
DEVELOPMENT
GUIDES

4. Provide public access into some "natural" areas retained as ecological assets to permit study and enjoyment of these areas (e.g., by catwalks or piers in some sloughs or marshes).

5. Design any permitted fills to produce a net increase in the amount of shoreline, for the purpose of providing additional public access to the Bay.

6. Design roads near the edge of the water as scenic parkways for slow-moving, principally recreational, traffic. The right-of-way design should discourage through traffic and provide for safe pedestrian access to the shore.

7. Design all Bayfront developments to enhance the pleasure of the user or viewer of the Bay. To these ends, planning of all aspects of waterfront development should be guided by professional designers such as landscape architects, urban designers, or architects.

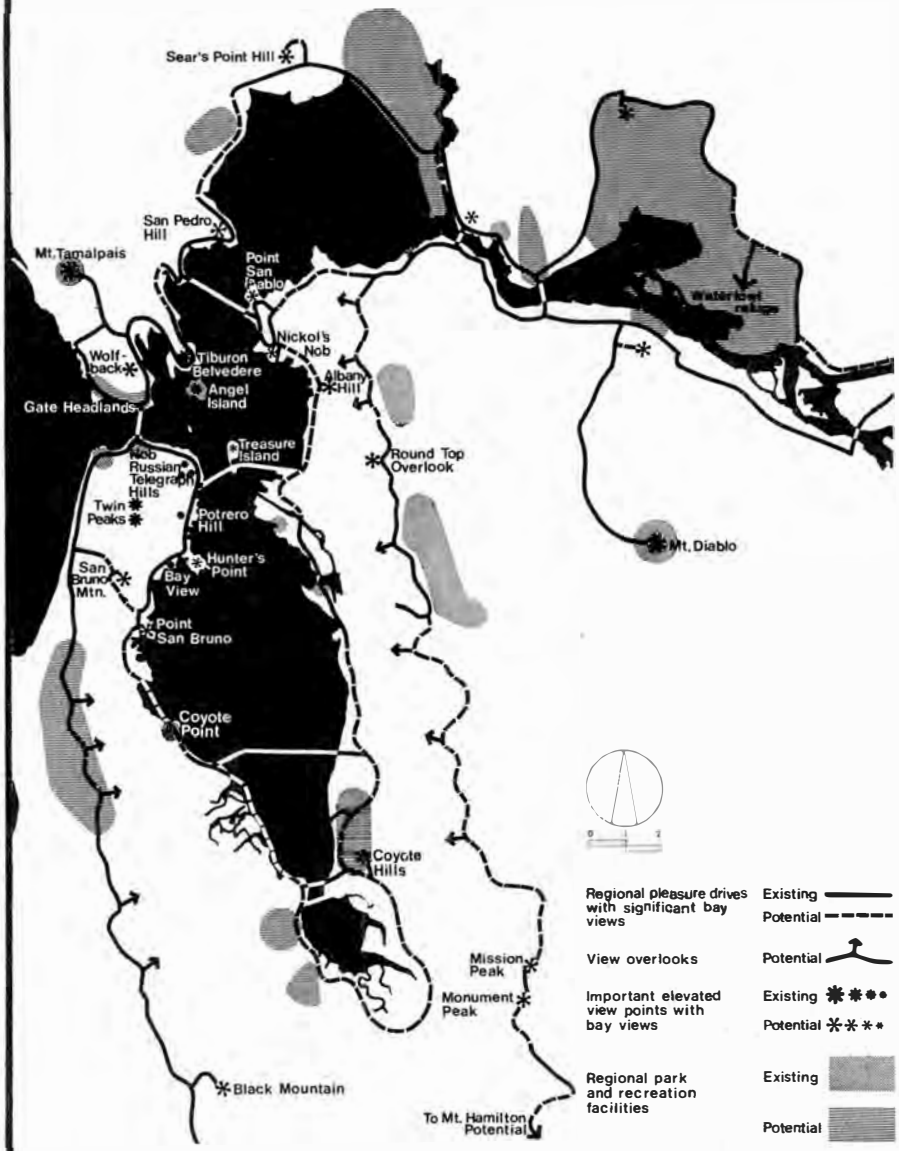
8. Design new or remodeled bridges across the Bay to permit maximum viewing of the Bay and its surroundings by both pedestrians and motorists. Guard rails and bridge supports should be designed with views in mind. Vista turnouts for motor vehicles should be provided at good view locations.

9. Provide Bayshore and high-level scenic parkways approximately as illustrated in Figure 4, with vista points in the general locations indicated.

10. Maintain views of the Bay from further inland or from hills by appropriate arrangements and heights of all developments and landscaping. Design consideration would need to be given to all areas at waterfront locations, and below high-level vista points designated in the preceding paragraph, and the viewpoints

FIGURE 4

Major Existing and Potential Views of Bay

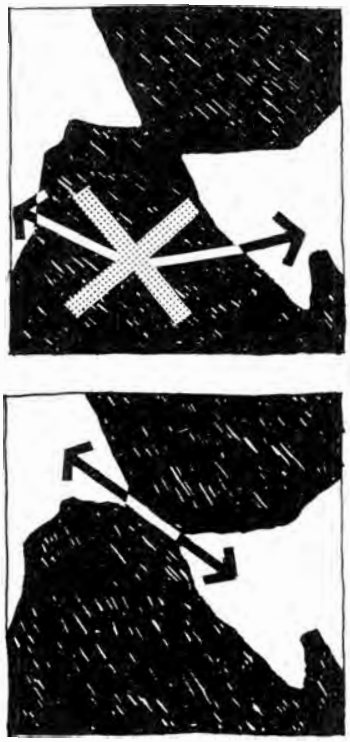


along freeways or "entrance" roads (roads coming over ridges and providing a "first view" of the Bay) shown in Figure 5.

11. Remove debris from sloughs, marshes and mudflats that are to be retained as part of the ecological system, and restore them to their former "natural" state if they have been despoiled by human activities.

12. Design towers, bridges, or other structures near or over the Bay as landmarks that suggest where the waterfront is, to serve as reminders as to the location of the waterfront when it is not visible -- especially in flat areas. But the height of such landmarks should be low enough to assure the continued visual dominance of the hills around the Bay.

Crossings should utilize natural land forms which suggest shore to shore connections

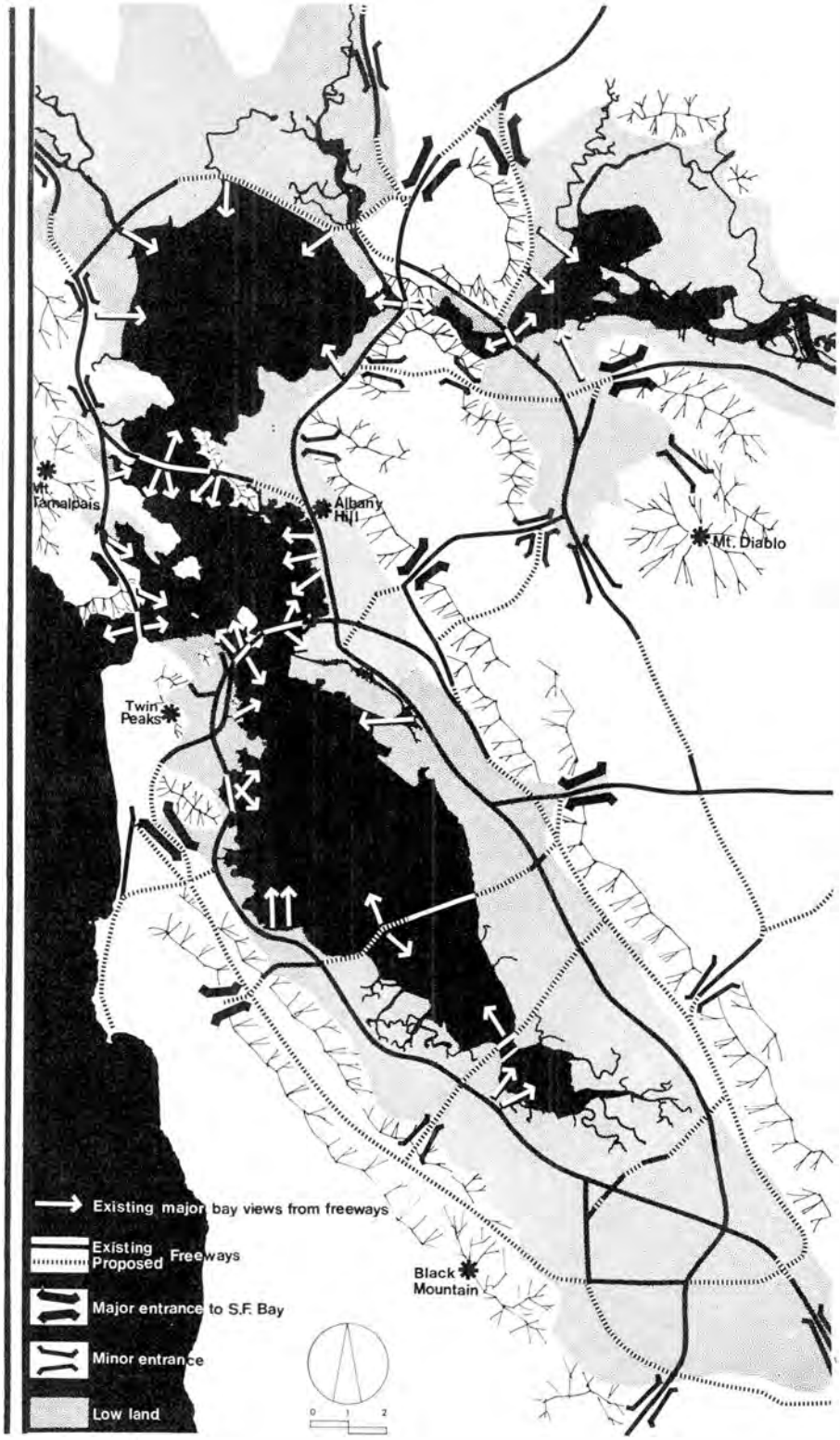


13. Avoid additional surface crossings to the extent possible, to preserve the visual impact of the large expanse of the Bay. The design of new crossings deemed necessary should respect the fact that the Bay consists of a series of natural "bowls," "closed" at each end by a constriction. The crossing should be placed at such "ends" between promontories or other land forms that naturally suggest themselves as connections reaching across the Bay (but without destroying the obvious character of the promontory). To the extent possible, crossings should also be of one "family" of structural types (e.g., all might be suspension bridges).

14. Design access routes to Bay crossings in a manner that orients the traveler to his new direction of movement in relation to the water (as in the main approaches to the Golden Gate Bridge). Similar considerations should be given to the design of highway and mass transit routes paralleling the Bay at any elevation (by providing frequent views

FIGURE 5

Views of Bay from Major Roads



SPECIAL DEVELOPMENT GUIDES

of the Bay or by having turns toward or away from the water made in sight of the water, if possible, so the traveler knows which way he is moving in relation to the Bay).

15. Design developments near the mouths of tributary waterways to preserve the view of the juncture of the tributary with the Bay from as far upstream as the alignment of the waterway will permit, so as to preserve maximum visual contact with the Bay. Developments farther upstream beyond the view of the tributary's mouth should be used for purposes related to the Bay, if at all possible (e.g., marina and boat service facilities or private docks, on navigable tributaries).

ACHIEVING THE DESIGN OBJECTIVES

In addition to the controls and incentives that will be discussed in BCDC planning reports about methods of carrying out the plan for the Bay, a few special, less familiar, "tools" are needed to achieve some of the foregoing design principles.

1. A design review system is needed to evaluate developments that affect the appearance of the Bay. The system must have sufficient control and authority to make it effective. As an example, a twofold approach might involve (a) use by city and county governments, and by all affected regional or state agencies, of a basic design guide for affected developments, and (b) a regional design review board that, by reviewing the proposed design of all projects, could strive for a high level of design quality.

2. The Bay region and the State of California should invoke the national interest in preserving the Bay as a <u>national</u> scenic and ecological resource in every feasible way, such as by establishing the Bay as a national resource comparable to Yosemite or Point Reyes National Parks.

SUMMARY

The Bay is a single physical mechanism, in which actions affecting one part may also affect other parts. The Bay and its surrounding hills are a composition of natural and man-made features. Many man-made features can improve or despoil the appearance of large portions of the Bay scene.

As long as man values the appearance of the Bay, its islands and surrounding hills, special consideration must be given to the design of any development affecting the form and appearance of the Bay, or views of and access to it.

SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION
507 Polk Street, San Francisco 94102 557-3686

Possible Bay Planning Conclusions Based on the Report on Appearance and Design

1. The appearance of the Bay, and man's enjoyment of it as a scenic resource, extensively enhances daily life in the Bay Area.

2. To increase opportunities for people to have pleasurable and leisurely physical and visual contact with the Bay, the General Development Guide (foldout chart) and the Special Development Guides Nos. 1-15 (pages 9 to 15 of the summary) shall be employed as applicable in preparing the Commission's plan for the Bay and shall be incorporated, as applicable, in the Commission's recommendations for carrying out the plan, except as follows:

Substitute for Nos. 2 and 3 (page 9):

> 2. Include in every new development maximum feasible opportunity for pedestrian access to the waterfront. If no such access can be provided, the development should not be allowed on the waterfront unless it must of necessity be there (i.e., unless it is a factory using Bay waters in its processing, a shipping terminal, etc.).

Substitute for No. 7 (page 11):

> 7. Design all Bayfront developments to enhance the pleasure of the user or viewer of the Bay. Planning of all aspects of waterfront development should therefore be guided by esthetic design considerations provided by professionals, such as landscape architects, urban designers or architects, working in conjunction with engineers and professionals in other fields.

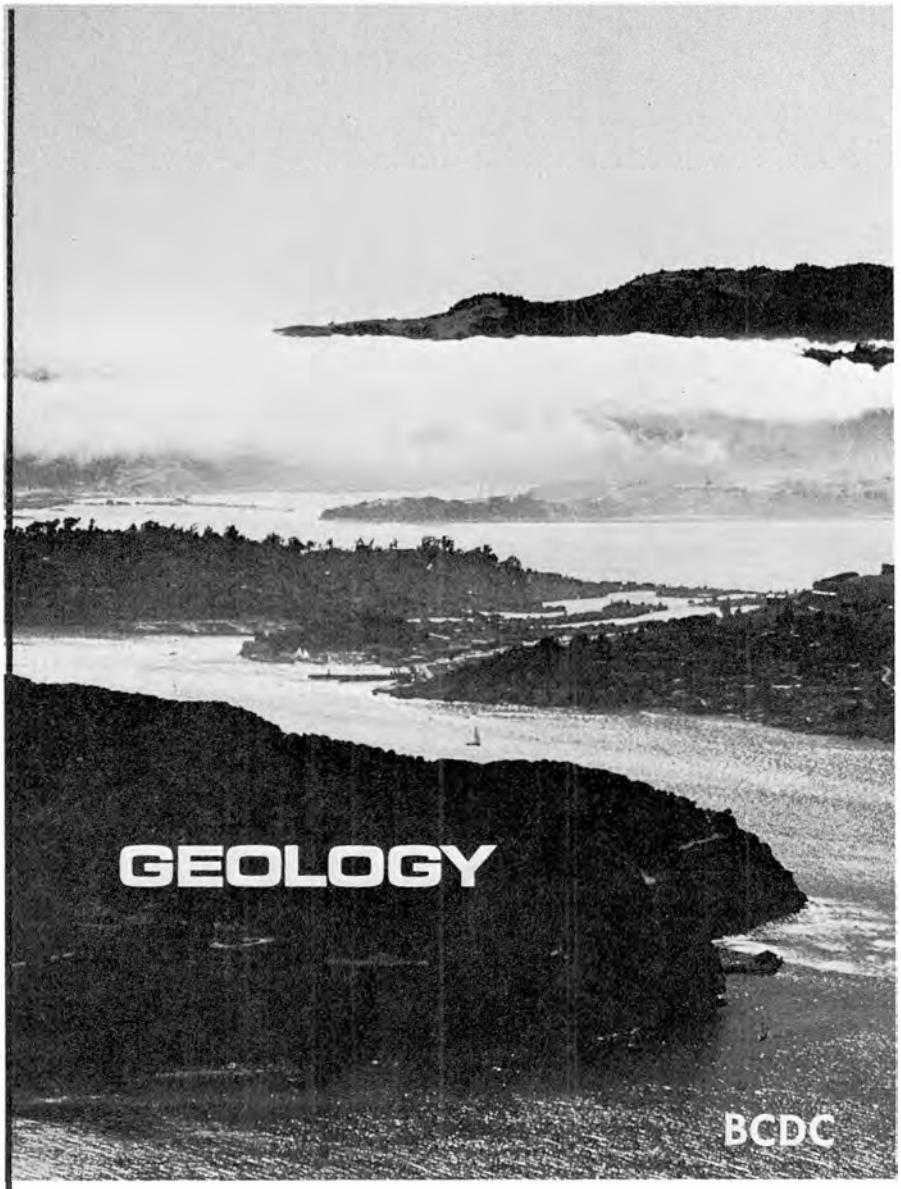
Substitute for No. 11 (page 13):

> 11. Remove "unnatural" debris from sloughs, marshes, and mudflats that are to be retained as part of the ecological system, and restore them to their former "natural" state if they have been despoiled by human activities.

Adopted by the Commission at its meeting of 9/22/67

GEOLOGY OF SAN FRANCISCO BAY

Part of a Detailed Study of San Francisco Bay



San Francisco Bay Conservation and Development Commission

San Francisco, California

February 1967

Summary of the report, "Geology of San Francisco Bay," by Harold Goldman, Senior Geologist, State Division of Mines and Geology.

INTRODUCTION

For millions of years, great forces within the earth's crust gradually created new mountains and new valleys. In the San Francisco Bay region, almost a million years of erosion rounded the mountains down to hills and filled the Bay with millions of tons of mud.

The striking topography of the Bay Area is appreciated for its beauty and its fine harbors. Less obvious are the considerations this geologic legacy imposes upon building and living -- upon the firmness of the ground beneath our buildings, the water reserves in the ground for home and industrial use, and the natural resources and building materials needed for a strong economy.

GEOLOGY, LIFE AND PROPERTY

The Bay Area was born in earthquakes and is still prone to them. But with or without earthquakes to speed settling or collapse, some soils provide a better foundation for building than others. A knowledge of fault zones (where quakes are likely to center) and composition of the ground beneath the surface are key factors in guiding development of the Bay Area with adequate regard for public safety and for secure public and private investment.

Another aspect of considerable importance is the underground supply of fresh water. Some of the Bay Area's water supply comes from deep wells and more may come from that source in the future. On one hand, these wells can be rendered useless by the penetration of salt water into them; on the other hand, extensive pumping may cause the ground above to sink, a potentially serious problem if large subsidence occurs in areas next to water and thus exposes these areas to possible flooding.

HOW SAN FRANCISCO BAY WAS FORMED

The San Francisco Bay trough came into existence less than a million years ago. By then, the Berkeley Hills were already standing, though not yet rounded down. The San Francisco Peninsula-Marin County block of land, then relatively flat, was tilted gradually over thousands of years toward the Berkeley Hills, with the western edge rising to become the San Francisco and Marin hills, and the eastern edge sinking to become the depression in which the Bay now lies.

HOW SAN FRANCISCO BAY WAS FORMED

Simultaneously, the rushing waters from the receding icecaps around the world raised the level of the seas and flooded the trough. In following millenniums, the trough was heavily loaded with sediments from the surrounding hills as the continental icecap and glaciers continued to recede.

THE FOUNDATION OF BEDROCK

Information about the bedrocks beneath the sediments of San Francisco Bay is not complete. Most, however, are believed to belong to the Franciscan Formation, a sequence of sandstones and shale predominantly, with lesser amounts of chert, greenstone, and other rocks. Bedrock comes to the surface in the rock formation of the west Bay, particularly in San Francisco and in Marin County. It drops off sharply from the west side of the Bay and is generally very deep on the east shore; bedrock has been found 300 to 400 feet below the surface near the City of Alameda, with one drill hole having penetrated 1,000 feet before encountering it. Based on sparse information available, bedrock is generally deeper in the southern part of the Bay where depths of 300 to 800 feet are common.

The top of the bedrock is generally very irregular. Much of it was badly weathered when it was once exposed to air, weakening its surface. Ordinarily, building foundations on bedrock are the safest but special consideration must be given to areas underlain by steep rock that has been weakened by weathering.

THE LAYERS OF MUD

Over the millenniums, the rock basin of the Bay has been filled with silt, sand, and clay. "Older Bay mud" describes the earliest materials that lie at the bottom and range in thickness from less than one foot to more than 200 feet. The older Bay mud consists of silty clay, sand, and in places gravel, and the thickness appears to increase toward the central portion of the Bay. Nearer the shores, there may be no older Bay mud.

On top of the older Bay mud there is sometimes a sand layer and usually a layer of "younger Bay mud." The sand unit has not been completely mapped and where known is often cut by mud-filled channels. The layer of younger Bay mud may be as thick as 130 feet

THE LAYERS OF MUD

(see Figure 1). The younger Bay mud ranges from 2,500 to more than 7,000 years old.

The older Bay deposits are substantially different from the younger Bay mud. Because it is more deeply buried, the older Bay mud has been consolidated by the pressure from above and contains less moisture. It is pressed together more tightly than could have resulted merely from the weight of the material above it. As a result, the older Bay deposits provide a good foundation for piles and similar structures and for all except the most heavily concentrated loads.

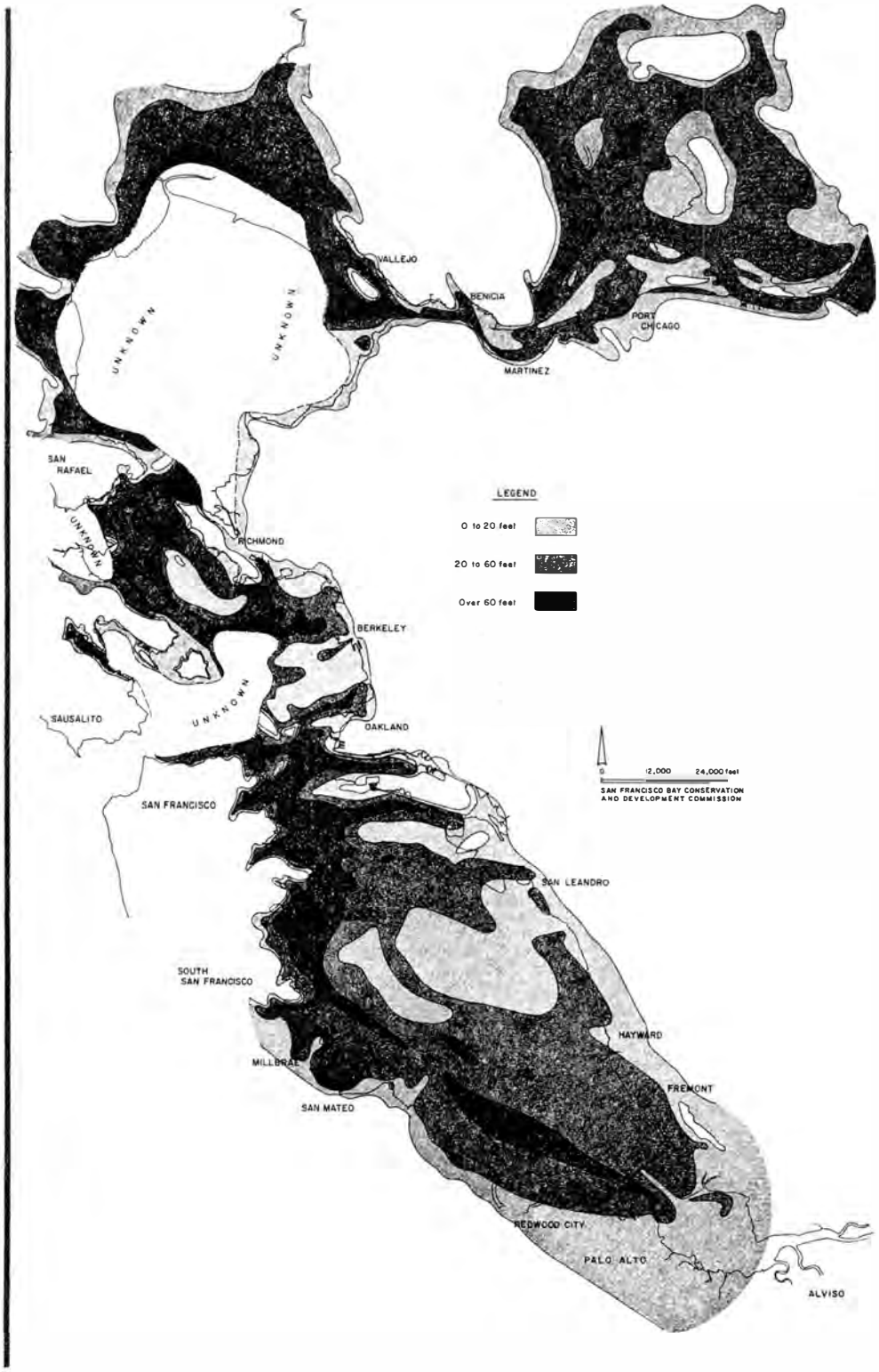
The younger Bay mud has been the most troublesome of the Bay sediments and has caused the most engineering difficulties. This mud, which is primarily a soft silty clay, has a high percentage of water, is pliable and weak, and is highly compressible.

The strength of the younger Bay mud increases with depth as a result of the pressure from above. Like the older Bay mud, the lower levels of the younger Bay mud have been consolidated to a greater degree than the weight above it would prescribe. As a result, younger Bay mud may be a suitable foundation for earth fill that has a broad base.

The top layer of younger Bay mud is highly compressible, and loses considerable strength when it is disturbed. As a result, it creates foundation problems for construction. Special consideration as to design of structures and supporting foundation members must be taken into account when building on this material. When the younger Bay mud is overloaded by fill, it becomes increasingly unstable as the thickness of the fill increases and if the slopes at the edge of the fill are steep, ultimately fails. During construction of the fill on the north side of the toll plaza of the San Francisco-Oakland Bay Bridge in 1947, the mud was overloaded with sand fill and failed. The sand sank 20 feet and the underlying mud was forced sideways for more than 500 feet.

FIGURE 1

Thickness of the Younger Bay Mud



Source: Compiled from Figures 7A-E BCDC Technical Report: Geology of the San Francisco Bay

EARTHQUAKE FREQUENCY AND EFFECTS

Geologic processes that created the dramatically beautiful Bay and hills continue more actively here than in most parts of the United States. The counties around the Bay have experienced 12 damaging earthquakes in the past century. Studies of the strain in the earth's crust in the Bay Area indicate the possibility of a great earthquake (comparable to the San Francisco earthquake of 1906) once each 60 to 100 years.

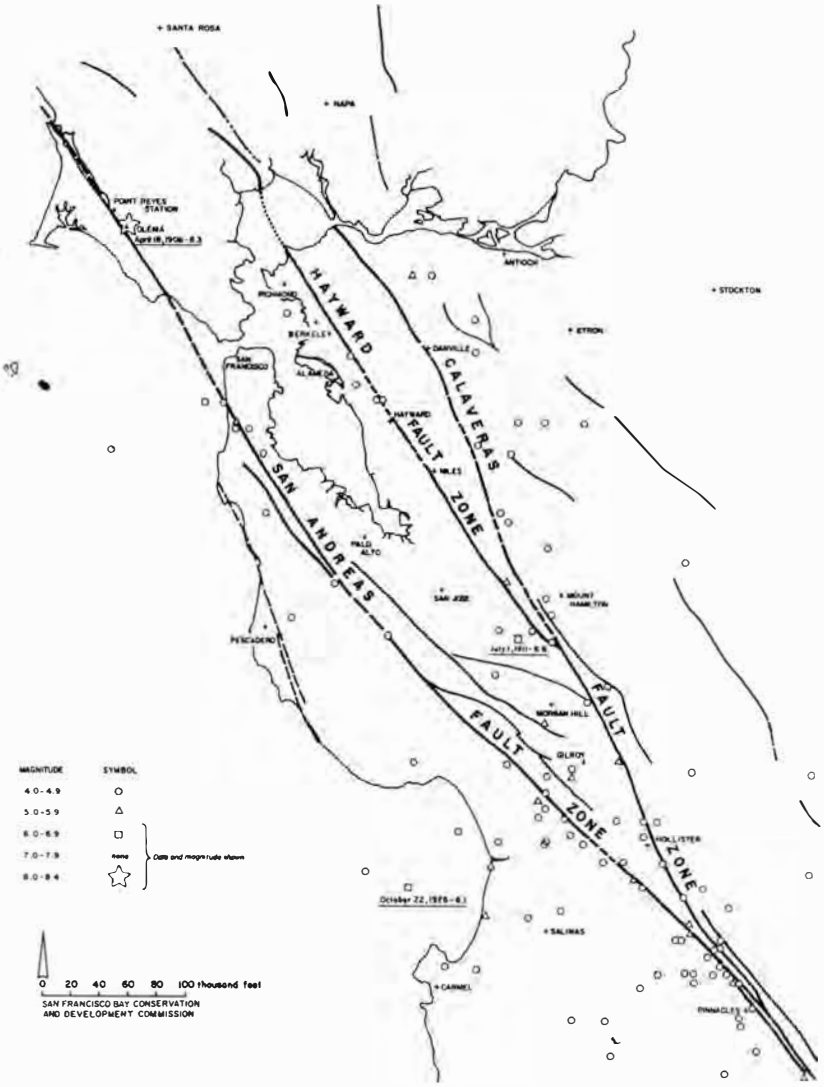
Damaging earthquakes result from movement on faults, which are long, abrupt breaks in the earth's crust. There are major active faults on both sides of the Bay: the San Andreas Fault on the west and the Hayward and Calaveras Faults on the east (see Figure 2). The activity of these faults is indicated by (1) "creep" along the fault (with one side gradually moving north and the other side moving south, distorting buildings, fences, and roads that cross it), and (2) the very fresh and obvious appearance of the fault (not obliterated by time and erosion) such as the long, narrow Tomales Bay, the San Andreas and Crystal Springs Lake on the Peninsula, and the "sag" ponds, notched ridges and displaced drainage channels along the fault.

Recognizing that earthquakes must be "lived with," what may reasonably be expected to happen in a moderate-to-great earthquake?

The earthquake itself consists of vibrations that travel through the earth's crust. The resulting ground motions change in magnitude and frequency as they pass through different earth materials. The violence of ground motion in soft mud materials is significantly greater than in solid rock. For example, in the 1906 San Francisco earthquake, shaking was much more violent in the waterfront areas underlain by Bay mud and fill than Nob Hill and similar areas with more solid rock at or near the surface. Past earthquakes show that such "poor ground" is a greater potential hazard than is nearness to the fault or to the center of the earthquake.

FIGURE 2

Earthquake Epicenters and Magnitudes 1934-65



Source: Data from 1934-1962 from Department of Water Resources. After 1962 from other sources.

EARTHQUAKE FREQUENCY AND EFFECTS

Another aspect of earthquakes is movement along the fault, with one side slipping in a different direction from the other side. The ground on one side of a fault might move vertically or horizontally, or both. Movements on the main faults in the Bay Area have been predominantly horizontal in the recent geologic past, with the east side generally moving southward. Maximum surface slippage in the 1906 earthquake was 20 feet, but there was no observed surface slippage in the 1957 San Francisco earthquake.

Landslides, rock falls, avalanches, and mud and debris flows occur over a wide area as a result of major earthquakes. Slides are especially likely where slopes have been made or have become unduly steep from whatever cause and where the earth has become saturated with water. Even small earthquakes can trigger damaging slides. The steep hills on both sides of the Bay are particularly vulnerable to sliding. Recent studies show that certain types of sediment may liquify and flow during an earthquake; this was the major cause of damage in Anchorage during the 1964 Alaskan earthquake.

All types and sizes of surface cracks and fissures occur in earthquakes that produce significant ground motion. Cracks rarely occur in solid rock, but have their greatest effects on loose soils. Cracking in saturated alluvial deposits is often accompanied by sand boils and mud volcanoes as ground water is squeezed out. Extensive damage results when cracking occurs in loose or soft water-saturated soils; cracking could be a major damage factor in areas of Bay mud and fill in future earthquakes of moderate or large magnitude. Such cracking can occur in water-saturated soils up to 75 miles from the center of the earthquake.

Especially in great earthquakes, but also in moderately large ones, extensive changes in the elevation of the land surface may occur. Broad areas may rise a number of feet above their previous level, or sink just as much. Sinking, or subsidence, would be a major factor of concern along the shores of seas and bays, since shoreline areas could be swamped but, fortunately, movement on the San Andreas system of

EARTHQUAKE FREQUENCY AND EFFECTS

faults has been largely horizontal. Nevertheless, even a small downward movement could be of great concern along a highly developed shoreline, such as along the Bay. Earthquake vibrations can cause loose sandy soils that are water-saturated to contract (as a result of compaction); settling of a few inches to several feet can occur in soft materials.

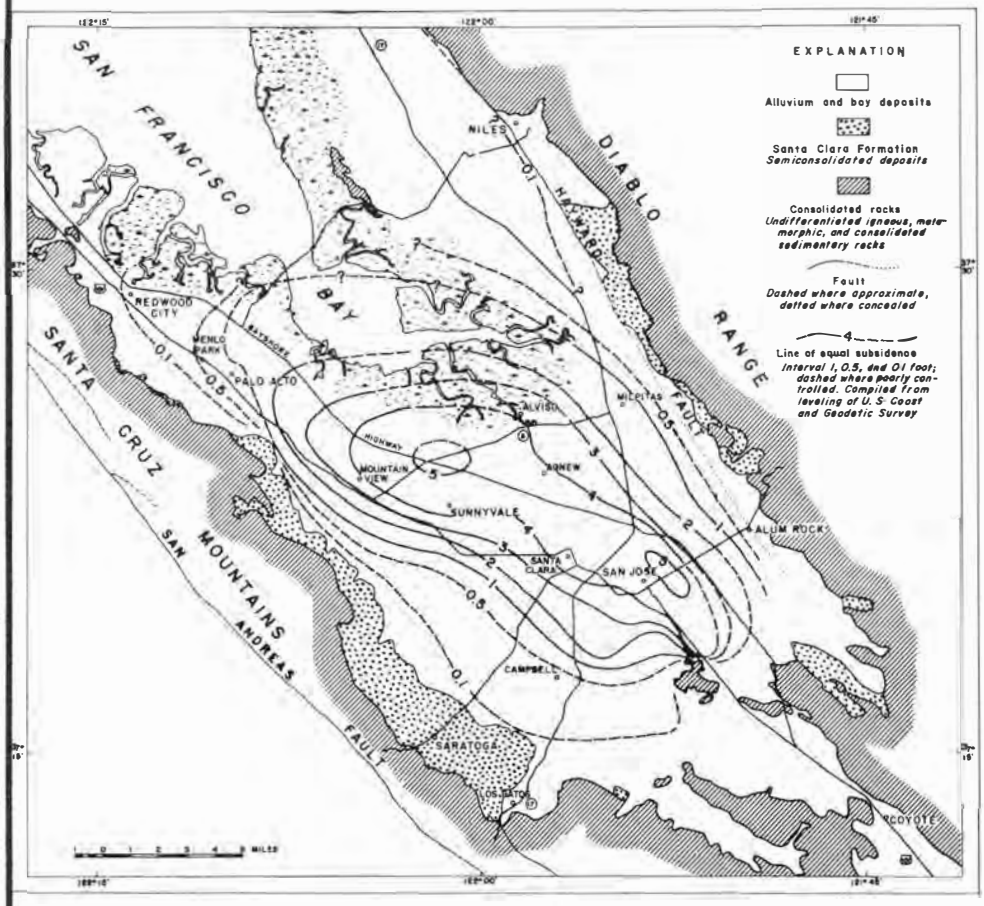
Earthquakes may affect open bodies of water in two ways: by creating seismic sea waves and by creating seiches. Seismic sea waves (often called "tidal waves") are probably caused by abrupt ground movements (usually vertical) on the ocean floor in connection with a major earthquake. A rise of water of even two or three feet in San Francisco Bay due to a seismic sea wave, if coupled with a high tide and onshore wind, could do serious damage to near-to-sea-level developments. A seiche is a sloshing of water in an enclosed basin such as the Bay. It is caused by earthquake motion; the sloshing can occur for a few minutes or several hours. Seiches could only be damaging in San Francisco Bay in the event of a large earthquake combined with a high tide and onshore winds.

GROUND WATER PROTECTION

Underground fresh water supplies are now extensively used by industries around the Bay and by cities in the San Jose area. The underground supply will continue to be an important supplement to surface water now brought into the Bay Area by aqueduct from mountain reservoirs. Underground water is a resource which must be husbanded for several reasons: (1) excessive pumping can cause salt water from the Bay to infiltrate in to the fresh water and contaminate it; (2) excessive pumping can cause the sand layers from which the water is withdrawn, or the overlying layers of clayey soil, to become more tightly compacted and thus allow the ground above to sink considerably; and (3) extensive dredging of Bay mud, or excavation for tunnels or bridge piers, could strip the "cover" from the top of a fresh water reservoir, allowing either the salt water to contaminate the fresh water, or the fresh water (if artesian) to escape in large quantities and thus cause land to sink.

FIGURE 3

Land Subsidence From 1934 to 1960, Santa Clara Valley California



Source: U. S. Geological Survey Open File

GROUND WATER PROTECTION

Contamination of ground water by salt water intrusion has already been a problem in the Fremont and Alviso areas. Also, according to U. S. Geological Survey reports, extensive areas of land have subsided as much as 13 feet in the San Jose area as a result of excessive ground water pumping. Figure 3 shows the general area affected, showing subsidence from 1934 to 1960; actual subsidence has been somewhat greater as indicated by the San Jose figure, which dates from 1913 to 1966.

GROUND WATER PROTECTION

Information is insufficient concerning most of the ground water reservoirs under the Bay. Until more information is available, proposals for extensive penetrations of the Bay bottom by dredging or construction work should be reviewed by the Regional Water Quality Control Board and the State Department of Water Resources; these agencies might require additional geologic data from a prospective developer to evaluate the potential hazard to the ground water reservoir.

The State Department of Water Resources has indicated that little can be done about excessive ground water withdrawal at the present time, but that the plans for the Bay should recognize and anticipate the potential subsidence hazard to Bayside development, particularly in the South Bay area around Alviso, which appears most prone to such subsidence.

FILLS AND PIERS IN THE BAY

The problems of constructing a solid fill on the shores of San Francisco Bay and of erecting earthquake- and settlement-resistant buildings on fill, are the subject of a companion BCDC report. This geologic report points out that piers and fills are safest when constructed upon bedrock or "older Bay mud," but that the "younger Bay mud" is most prevalent around the Bay. "Younger Bay mud" is the most susceptible to failure from earthquakes or overloading; it may sometimes be suitable for earth fills having a broad base, but is less suitable for piles or other construction involving a concentrated loading of weight upon the mud.

SUMMARY

The Bay is a single physical mechanism, in which actions affecting one part may also affect other parts. Much of the Bay floor is covered by a layer of mud, which on one hand is a poor foundation for fills and construction, and on the other hand often protects a fresh water reservoir beneath it.

As long as man values life and property, construction along the shores of the Bay must take due consideration of the underlying geology. Bedrock is generally the best foundation for structures and the "youngest"

SUMMARY

Bay mud is generally the poorest, potentially leading to serious damage or even collapse of the fill or of structures placed upon it, when not properly engineered.

As long as man values natural fresh water supplies, dredging or construction that penetrates the "cover" of an underground fresh water reservoir must be avoided. Penetration can cause depletion of underground fresh water supplies or extensive subsidence, affecting both shoreline areas and inland areas many miles away.

SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION
507 Polk Street, San Francisco 94102 557-3686

Possible Bay Planning Conclusions Based on the Report on Geology

1. San Francisco Bay and the hills surrounding it were created by geological activity in the last million years. The rim of the Pacific Ocean is one of the world's main areas of continued geologic activity as evidenced by major earthquakes. To protect life and property, construction in the Bay Area must anticipate future major earthquakes.

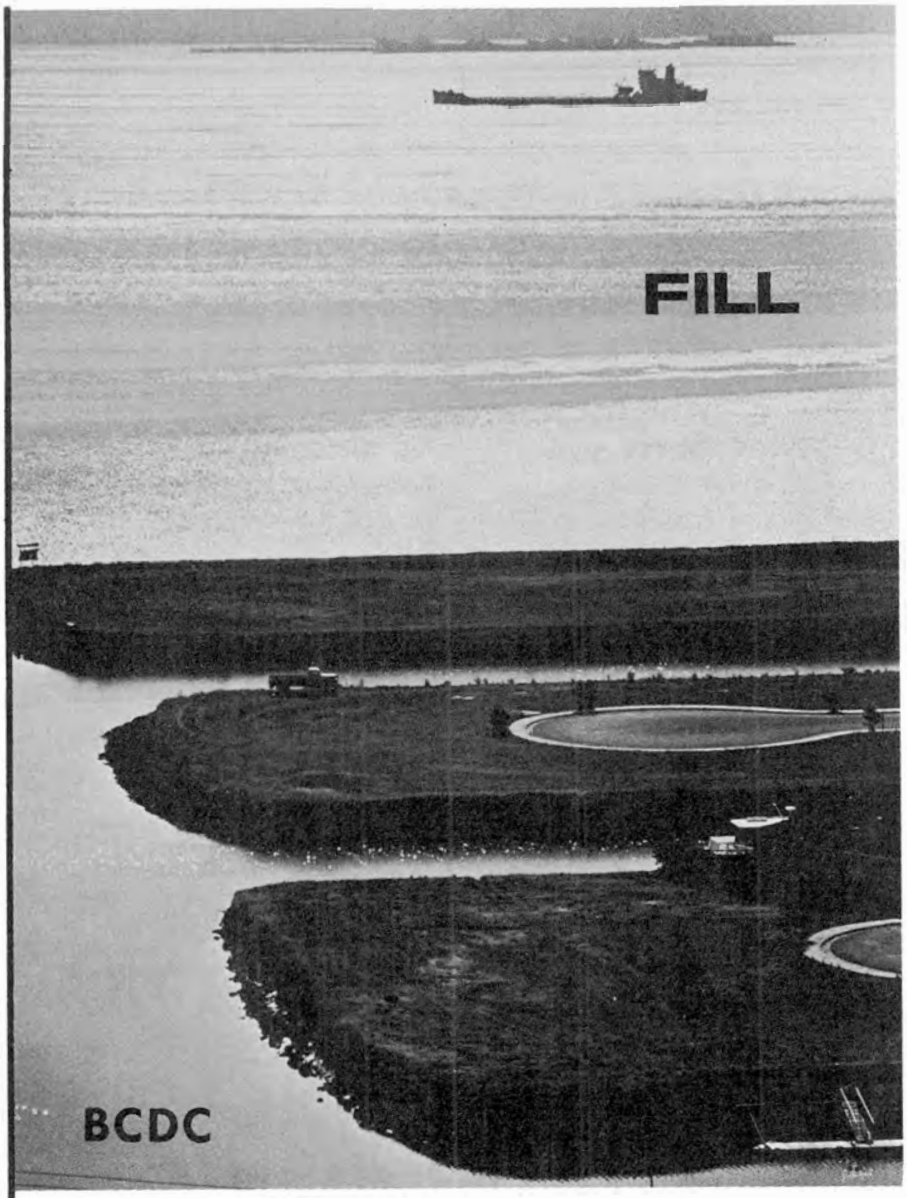
2. To protect underground fresh water reservoirs (aquifers), precautions must be taken against penetrating the "cover" of such a reservoir by dredging or by construction. Since all the natural reservoirs under the Bay have not yet been located and mapped, any proposals for dredging or construction work that might reasonably be expected to penetrate through the younger Bay mud should be reviewed by the State Department of Water Resources, which should be authorized to require provision of additional data on ground water conditions in the area of construction to the extent necessary and reasonable in relation to the proposed project. As one of its recommendations for carrying out its plan for the Bay, the Commission should propose that an appropriate agency have jurisdiction to require provision of data as reasonable and necessary and to prohibit dredging or construction work that might reasonably be expected to penetrate the "cover" of an aquifer.

3. To minimize the potential hazard to Bayside development from subsidence due to ground water withdrawal, the Commission's plan for the Bay should anticipate and take into account the effects of additional subsidence in the area at the lower end of the South Bay, and other areas where subsidence may occur, utilizing the latest information available from the U. S. Geological Survey.

Adopted by the Commission at its meeting of 6/1/67

FILL

Part of
a Detailed
Study of
San Francisco
Bay



San Francisco Bay
Conservation and
Development
Commission

San Francisco
California

May 1967

Summary of the reports, "Seismic Problems in the Use of Fills in San Francisco Bay," by H. Bolton Seed, Professor of Engineering, University of California; "Seismic Risk to Buildings and Structures on Filled Lands in San Francisco Bay," by Karl V. Steinbrugge, Structural Engineer; and "Bay Mud Developments and Related Structural Foundations," by Lee and Praszker, Consulting Engineers.

INTRODUCTION

In many cities around the world, construction of safe buildings requires special engineering, because underlying soils are unstable. Areas near the mouths of rivers have historically been attractive sites for cities, and parts of many of the world's cities are thus built on soft alluvial soils that require special techniques for construction of building foundations that are safe.

In the San Francisco Bay Area, additional soils problems are inherent in construction on (1) steep slopes that may slide in heavy rains or earthquakes, (2) the active earthquake faults that penetrate the Bay Area, (3) areas in which new land has been created by excessive grading of hills and valleys that were previously unsuitable for building, and (4) land created by filling parts of San Francisco Bay.

Great care is needed to insure construction of safe buildings in all these cases. While this report centers on problems arising from construction on filled lands in San Francisco Bay, problems of equal magnitude may be presented by construction in all the areas described above.

Most proposals for the development of Bay lands -- for the construction of airports, parks, homes, industries, etc. -- call for filling. In designing a fill project, an engineer must consider the stability of the Bay bottom upon which the fill is planned and he must also be concerned with potential problems of sinking and settlement within the fill itself. In addition, he must consider the "behavior" of both the fill and the underlying ground over many years of gradual settlement, and in the event of shaking caused by an earthquake.

Knowledge of the factors involved in constructing safe and stable fills around the perimeter of San Francisco Bay is an important element in planning for the Bay and its shoreline.

In preparing this report, the Commission has had the invaluable help of three consultants in highly-specialized engineering disciplines: Professor H. Bolton Seed of the University of California at Berkeley, an internationally-renowned authority on

INTRODUCTION

seismic problems in soils engineering; Karl V. Steinbrugge, a San Francisco consulting engineer and authority on seismic problems in structural engineering; and Michael Praszker, a San Francisco consulting engineer and specialist in soils engineering. In addition, this report has been helped by the work of the State Division of Mines and Geology (which prepared the companion report on Geology) and by the extensive work of members of the Commission's Advisory Committee.

FILL AND ITS USES

Types of fill that are used in the Bay include (1) dredged mud, (2) dredged sand, (3) garbage mixed with sand, (4) imported and compacted fill material from upland excavations, and (5) any combination of the above.

Thus, depending upon the purpose for which the filled land is intended, almost any kind of material can be used for fill except heavy rocks or boulders which tend to settle through the Bay mud to rest on firmer material.

Filled land in the Bay has been used for a large variety of purposes, including parks, housing, airports, port facilities, commercial centers, and industrial development.

THE STABILITY OF FILL UNDER NORMAL SETTLING CONDITIONS

1. What the Mud Consists of

Virtually all fills in San Francisco Bay are placed on top of Bay mud. Under most of the Bay there is a deep, packed layer of old Bay mud. More recent mud deposits, called "younger Bay mud," lie on top of the older muds. The top layer of young mud presents many engineering problems.

The soils that make up the soft young Bay mud consist of fine particles or grains ranging in size from very fine clay to silts and very fine sands. Within the silty clay there are various organic materials such as shells, vegetable matter, and peat. There are also lenses (small incomplete layers) of sand and fine gravel.

THE STABILITY OF FILL UNDER NORMAL SETTLING CONDITIONS

The voids in the younger Bay mud, the space between solid particles, are roughly twice the volume of the solid particles. Thus a cubic foot of younger Bay mud is made up 1/3 of solid particles and 2/3 of intervening space occupied primarily by water. The mud is not tightly packed together. At the top (submerged) it is a semifluid and becomes progressively firmer with increasing depth. Because of the fine grains and the jelly-like character of the young Bay mud, water cannot be easily squeezed out of its voids. Whereas sand will easily give up its water, submerged Bay mud and clay can be dried out only by squeezing out the water over a long period of time. Because the water cannot be readily squeezed out of the younger Bay mud, the mud is weak and unable to support heavy loads.

2. What Happens to the Mud under the Weight of a Fill

When fill is placed upon mud, the water in the voids in the mud is subjected to additional pressure and it tends to be squeezed out. If the fill is applied slowly and is not too heavy, the water will manage to escape through the tiny voids and the solid particles will be forced to come closer together until they can carry some or all of the weight of the fill. This process, called consolidation, allows the mud to gain strength from the gradual pushing together of the grains.

The weight of the fill compresses the mud. How much effect there will be on the mud depends on: (1) how compressible the mud is, (2) how deep the mud is, and (3) how heavy the fill is.

Charts have been prepared by the Army Corps of Engineers showing the average consolidation of Bay mud under a sand fill. These charts indicate that a layer of mud 40 feet thick would achieve half of its total settlement in the first five years and would continue to settle gradually for up to 90 years. But a layer of mud 60 feet thick would require 25 years for the first half of the settlement to take place and would continue to settle for another 400 years.

3. Factors that Affect Settlement

"Normal" settlement that occurs as water is squeezed out of the Bay mud can thus be roughly calculated, but there are many complicating factors:

a. Squeezing out at Edge. A large fill "blanket" pressing down upon the mud applies a fairly constant pressure on each square foot of the mud surface. The pressure downward on each square foot is balanced and confined by the similar pressure on the surrounding square feet of mud surface. Beyond the edge of the fill, however, there is no such downward pressure on the mud.

The relatively heavy pressure on the mud under the fill and the lack of pressure on the mud just beyond the fill can cause the mud to squeeze out from under the edge of the fill "blanket." The outer (or leading) edge of the fill, therefore, may settle more than the main body of the fill as the mud moves out from underneath it. Observations indicate that some heaving of the mud beyond the edge of the fill invariably occurs. The tendency of the mud to squeeze out is greater when the edge of the fill is a steep slope and less when the edge is a gentle slope; it is also greater when the fills have been placed in thick layers progressing out from the shore, rather than in even layers of sand spread over the entire area to be filled.

b. The Thickness of the Mud under the fill is seldom uniform, so one part will settle more than other parts; there will be uneven settlement across the entire fill.

c. Additional Variations in the Thickness of the Mud result when fill is dumped from trucks at the shore and gradually pushed out. As usually practiced, the first dumping of fill creates a heave or "wave" in the mud ahead of the fill and the next section of fill is placed over this wave; the result is additional unevenness in the mud and in the fill thickness, and consequent uneven settling of the fill.

d. Too Rapid Filling or the Application of Too Much Fill at One Time exerts too much pressure on the water in the voids of the mud. In this case the mud, instead of allowing the water to escape from it and thus to consolidate and gain strength, becomes semi-fluid. In this state it is subject to failure upon slight disturbances especially near its edges.

e. Placement of Fills upon a Crust on the Mud tends to keep mud from being squeezed out. Mud above high tide tends to dry out by evaporation and pack together, and over a period of years forms a crust. This crust is fairly strong and if not broken will support light grading equipment.

f. The Material upon Which the Bay Mud Rests may be steeply sloped, especially near the edge of the existing Bay shore. In such a case, the weight of the fill on top of the mud may cause the mud and the fill to slide down the slope.

g. Settlement within the Fill Itself, depending upon the kinds of materials used for the fill, adds to the total amount of subsidence.

While the amount of "normal" subsidence can be generally predicted, the amount of mud that will move out from under a fill cannot easily be calculated. Settling frequently exceeds what was theoretically predicted, because of the flow of mud out from under the fill and because of undetected irregularity of the mud thickness.

4. Results of Settling

Fills that settle uniformly present few problems to the designer of the improvements placed upon them, provided the magnitude of the settlement is anticipated and provided for. Streets and utilities adjacent to pile-supported buildings, for instance, do not settle at the same rates as do the buildings. Provisions must therefore be made to adjust entrances, etc., to the building.

Uneven or differential settlement of fill is not considered detrimental to some types of developments, such as parks or golf courses. Generally, however, differential settlement can be very destructive to buildings, roads, or utilities placed upon fills.

5. Criteria for Building Sound Fills under Normal Settling Conditions

a. The Mud Foundation. Two qualities of a well-designed fill on mud are: (1) mud is prevented from squeezing out from underneath (unless it is done intentionally and under control), and (2) the future pattern of settlement across the top of the fill can be predicted.

(1) The successful construction of a fill usually requires that a uniform base blanket first be placed over the Bay mud. This blanket forms the working surface for compaction equipment and the foundation for additional fill. It must be uniform, compacted, and thick enough to prevent equipment from punching through to the Bay mud and to prevent the Bay mud from squeezing out underneath. The following types of base blanket have been used successfully:

(a) The natural crust that forms on top of mud that has been exposed to the atmosphere for several years.

(b) A uniform layer of about three feet of sand pumped over the entire area to be filled.

(c) Other lightweight material, such as garbage mixed with sand, when uneven settlement will not be harmful.

(2) A fill should always be built up slowly enough so that the mud will not be forced out from under it. In some cases, this may necessitate a rate of filling as low as three feet per year.

(3) The edge of the fill should always be sloped very gently to gradually decrease the pressure on the mud below. Sometimes slopes that extend out 10 feet for each foot of height have proven unsatisfactory. A

well-designed slope at the edge serves to minimize the mud wave around the fill.

(4) Sometimes it is desirable to intentionally squeeze out all the mud from under a fill. If carefully done, this reduces settlement considerably, provided the mud is shallow. Where the mud is deep, the fill cannot be sunk into the mud to create a wave sufficient to constitute a counterbalance. The result is a continuous sinking of the fill at its edges, and a corresponding rise of mud wave. The Bay Bridge Toll Plaza, the Candlestick Causeway, and the parking lot at Candlestick Park are examples of this method of fill construction.

(5) Sometimes a wall or dike is required to contain the mud. Such a structure would need to extend down to the base of the soft layer of mud. Sheet piling can be used for this purpose. Or a trench can be excavated at the edge of the proposed fill and then the trench can be filled with sand. Walls or dikes are expensive and are therefore used principally where deep water is to be maintained at the outside of the fill; examples are the San Francisco Port Authority's Army Street Terminal and the Port of Oakland's new Seventh Street Terminal now under construction.

b. The Fill Itself

(1) When the site to be filled is under water, it must first be brought to a height above mean sea level in a slow and uniform manner, preferably by having fill material pumped in hydraulically.

(2) Tamping of the fill with heavy equipment to compact it should be avoided, until the fill is sufficiently thick to eliminate the possibilities of punching through into the underlying mud.

(3) Once a firm blanket has been established, other select fill material such as decomposed rock may be used to bring the fill area up to the desired grade. It should be emphasized that the uniform placement of fill material is the most crucial factor in the attainment of a successful fill.

THE STABILITY OF FILL UNDER NORMAL SETTLING CONDITIONS

Avoidance of different rates of settling in different parts of a fill (differential settlement) is usually important in all developments other than park and recreational areas, because of the effect of such settling on streets, utilities, and buildings. Deterioration, blight, and loss of economic value sometimes result from differential settlement, particularly in residential areas.

THE STABILITY OF FILL UNDER EARTHQUAKE CONDITIONS

Before discussing the effect of earthquakes on fill, it should be pointed out that present thinking has been considerably influenced by analyses of the earthquakes in Niigata, Japan, in June 1964 and Anchorage, Alaska, in March 1964. These analyses lead to the conclusion that liquefaction of sand was an important cause of soil failures and associated damage.

1. What Happens to Soils in an Earthquake

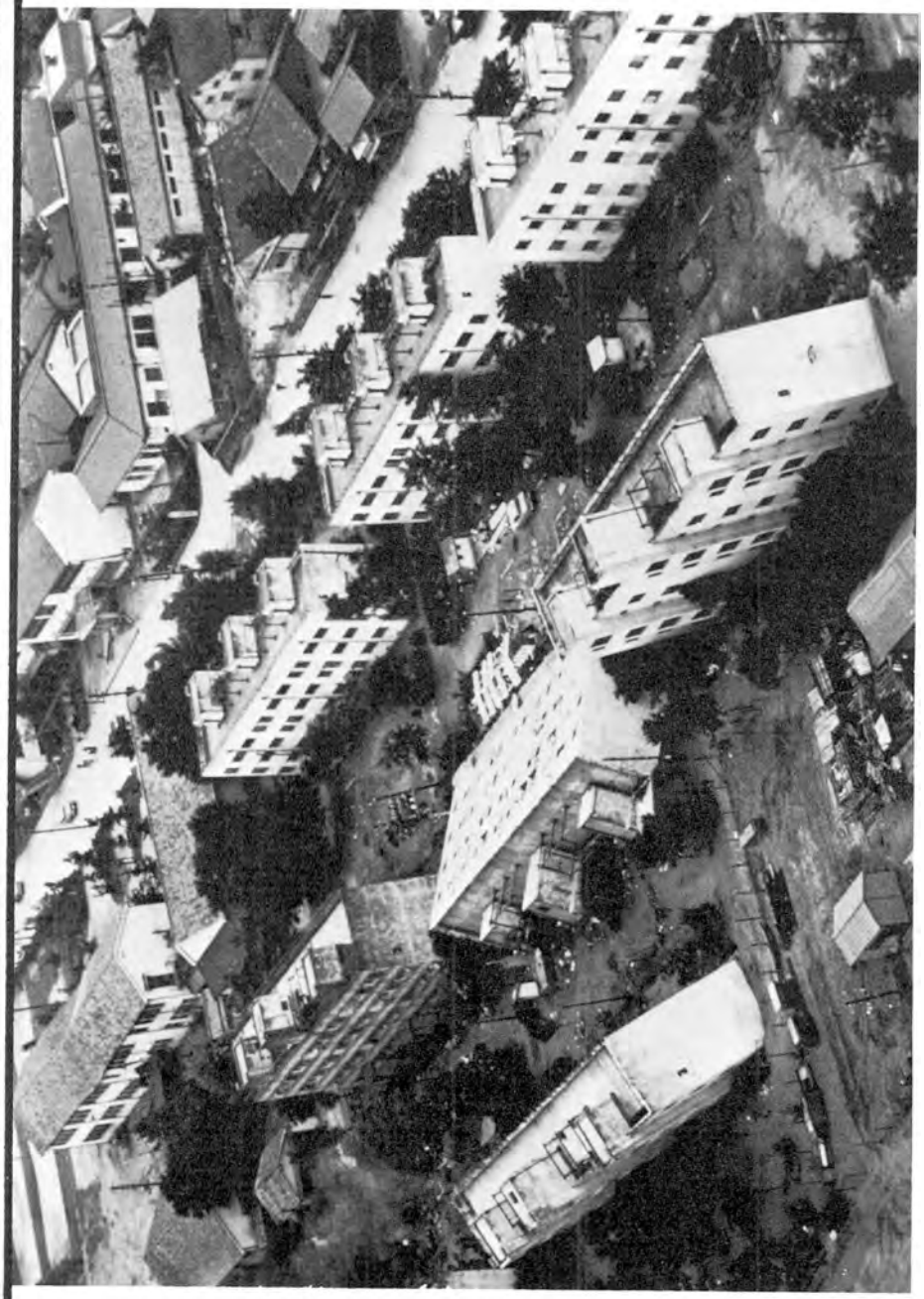
In addition to major shifts in large areas of ground during an earthquake, as described in the BCDC report on geology, the shaking of the ground often causes soil particles to shift and settle in relation to each other. Such shifting and settling is greatest in soils that are least "sticky" or cohesive. Silt, sand, and gravel are the least cohesive, so they settle and become more compact most readily with shaking if they are initially in a loose condition. Particles in clay or mud cannot shift and settle very much, if at all, as a result of shaking because of their stickiness and flexibility.

If the silts and sands that are being shaken are loose and saturated with water, the water in the materials will be forced out as the particles settle together. As the water flows out, it disturbs the sand particles with the result that the entire soil may become fluid.

Under certain seismic conditions, a surface layer of sand may be made fluid either by the water that is in it or by water coming up from sands at lower levels; the sand will then become quicksand. Automobiles and buildings gradually settle into it, and

FIGURE 1

Tilting of Apartment Buildings at Kawagishi-cho, Niigata



buried tanks float to the surface. This happened in Niigata, Japan, in the June 1964 earthquake. If the sandy material is on a slope, it may flow downhill as it becomes liquid. Such flows can be small, causing individual buildings or small slopes to collapse, or whole waterfronts can "flow" as occurred in several places in Alaska in the 1964 earthquake.

If a fluid layer of sand or silt is formed below the surface during an earthquake, the water will escape upward if it can. If it cannot, the ground above the fluid layer will in effect be floating upon water. If the ground surface is sloping and there is nothing in front of the "floating" layer to hold it back, and if the earthquake shaking continues long enough, the section above may slide off much like a ship on ways. This happened in large areas of Anchorage where bluffs 4,000 feet long and as much as 1,200 feet wide slid about 15 feet toward the coast. When the sections of bluff stopped sliding, they left behind a trench (graben) 7 to 10 feet deep and 100 to 250 feet wide at the back of the slide area.

Some kinds of soils behind retaining walls and bulkheads exert much greater pressures against the confining structures when shaken by a major earthquake. The area behind bulkheads at the waterfront often is filled with sand. Since it usually is not possible to compact the sand below the water level and it is, of course, saturated, the sand may liquefy, increasing the pressure against the wall considerably. Under these circumstances the bulkhead may be pushed forward, as happened at Puerto Montt, Chile, in 1961, and at Niigata.

Such "failures" of the soil are the most destructive to buildings and utilities. The other cause of damage in an earthquake is the shaking of the buildings. It is generally believed that buildings on solid rock foundations are shaken less severely than buildings on softer materials.

In small earthquakes, the only ones for which records are available, shaking is much more intense in soft ground than in adjacent rock areas. However,

analyses of the reaction of soils to strong ground motions in the Alaska and Niigata earthquakes indicate that soft-ground shaking in those major earthquakes may actually have been only about 50 per cent stronger than in adjacent rock areas, rather than many times stronger as often anticipated.

Because of the lack of strong motion seismograph records, these analytical results have not yet been substantiated. All experts in the field of seismology deplore the lack of instrumentation and urge that accelerometers be installed on different kinds of natural and artificial ground, including Bay fills.

2. What Happens to Mud and Sand Foundations for Fill During an Earthquake

No matter how good a fill may be, shear failure and lateral displacement of the foundation soils on which it rests will inevitably lead to instability problems. Bay fills are likely to be supported on either San Francisco Bay mud or deposits of sand.

The San Francisco Bay Mud under a fill is not likely to become liquid during an earthquake as some have believed. Intensive study of soil failures following the devastating slides in Alaska in the 1964 earthquake first pointed the finger of blame at subsurface clays which were believed to have become liquid, allowing the mass of soil above to slide off into the sea or a valley. More recently, the fault has been laid to seams of silt and sand in the clay, which are now believed to have far greater possibility of turning liquid than do the relatively sticky and plastic clays and mud. Nevertheless, if a clay soil underlying a fill slope is near the point of failure before an earthquake, it is likely to fail during the earthquake.

If fill slopes on clay foundations are designed to prevent failure during an earthquake, the main cause of damage will be the ground vibrations transmitted through the clay and fill. In this respect, the soft muds and clays transmit fewer shock waves per

minute than do other natural soils and bedrock, and this action is particularly damaging to tall buildings, as will be explained in the following section.

Sand deposits, once thought to be the safest foundation for fills, now must be more carefully examined with regard to their stability during earthquakes. Natural sand deposits in the Bay are likely to be loose to medium dense and therefore potentially vulnerable in a major earthquake to (1) settlement as the sands are shaken and compacted, (2) liquefaction under certain conditions, and (3) sliding of the material under a sloping ground surface in the event the sand below becomes liquid. The possibility of these effects depends upon how loose the sand is; the size, depth, and slope of the sand deposit or seam; the possibilities for drainage; and the violence and duration of the earthquake (much of the devastation in Alaska is believed to have been due to the length of time the shaking continued -- roughly four minutes).

3. What Happens to the Fill Material During an Earthquake

Uncompacted dumped fills of all types of soil are naturally loose and are poor foundations for almost any kind of structure (although over a period of years such fill might settle sufficiently to support houses or other lightweight buildings). In an earthquake, such fill material may (1) settle, (2) become liquid if there is enough sand and water in the material, (3) suffer small and large cracks as one portion settles more than another portion (differential settlement), and (4) slide or slump, especially at the edges of the fill, if the material is wet.

Hydraulic sand fills (sand pumped into a fill site by being mixed with water) are often fairly loose unless mechanically compacted after they are put in place. In a major earthquake, uncompacted sand fills may (1) settle, although not as much as loosely dumped fills and (2) become liquid, depending upon how permeable and loose the sand is, how deep the water table is, and how violent and long

THE STABILITY OF FILL UNDER EARTHQUAKE CONDITIONS

the ground motions are. Experience in the Niigata earthquake indicates that very small differences in depth of water table and looseness of the sand can affect the strength of a sand fill, so all of these factors must be carefully evaluated. If the sand becomes liquid, buildings can settle into it (if they do not have adequate foundations) and the edges of the fill are likely to slide or flow.

Well-compacted fills of select material (material readily compactible) on good foundations can be much sounder than natural earth deposits. In a major earthquake, some settling might occur, but poor natural soils could settle more. The main problems with well-compacted fills are likely to be some sliding or cracking at the edges of the fill if it is very wet, or sliding of the fill due to failure of the mud or sand foundation beneath it. Under sloping surfaces, the fill could slide toward the water, if the "foundation" becomes liquid.

MEETING EARTHQUAKE AND NORMAL SETTLEMENT REQUIREMENTS

Stable fills require (1) proper analysis and design by competent engineers using the latest technical information available, and (2) thorough inspection during construction. Factors affecting the stability of fill are:

1. Avoidance of loose, unconsolidated materials.

2. Careful consideration of relative sand and water heights to avoid the possibility of liquefaction.

3. Uniform placement of fill material during construction.

4. Avoidance of excessive rates of filling.

5. Carefully designed slopes to avoid heaving at the edge of fill.

6. After the mud under a fill has once had the water squeezed out of it and has consolidated, it will remain in that condition even if the fill is subsequently removed. A process called "surcharging" (placing more fill than is needed, then removing the

MEETING EARTHQUAKE AND NORMAL SETTLEMENT REQUIREMENTS

excess after a period of time) sometimes is used to reduce the amount of settlement that the completed fill will experience.

The Army Street Terminal in San Francisco is an example of this process. The site of this terminal was for many years used as a debris dump. The debris fill served to consolidate the Bay mud. Before construction of the terminal was started, the debris was removed to be replaced by compacted sand.

7. Finally, it should be noted that uneven settlement can almost never be totally avoided. The future settlement pattern of a fill should be calculated, and the fill itself and the structures on it should be designed accordingly. For some kinds of developments on fills, it is desirable to observe the completed fill for as long as five years before building structures sensitive to differential settlement.

While building codes control the design and construction of buildings in the interest of public safety, there are few design laws and inspection requirements for the soils engineering beneath the buildings. In the absence of definite knowledge and standards for design of fills, a review board of broad technical composition (including geologists, soils engineers, structural engineers, developers, city planners, and other specialists) is proposed that would be competent to (1) set and then constantly adjust standards as rapidly as new information becomes available, (2) review all fill proposals on the basis of available knowledge, and (3) prescribe an inspection system to assure placement of the fill according to the approved design. Standards could vary according to the intended use of the fill.

"SAFE" CONSTRUCTION ON FILLS

The "safety" of construction may be evaluated from two points of view: hazard to life and hazard to property. The underlying philosophy of the earthquake provisions of building codes is that buildings only need be safe for their occupants. Buildings

must be designed to not collapse in an earthquake, although the building might be so badly damaged as to be prohibitively expensive to repair.

1. "Safe" Construction on Bay Mud under Normal Settlement

If the earth under one part of a building settles more than the earth under other parts of the building, the part of the building above the deepest settlement will tend to sink and to exert more and more stress and strain throughout the structure. Most major structures can accommodate a certain amount of such settlement. Buildings can theoretically be designed to withstand virtually any stress or strain, but the cost of such buildings is prohibitive -- so the structural engineer tries to design only for the probable maximum amount of settlement that can be expected.

While every building on fill must be individually engineered, the following general observations can be made about different types of construction on fill over Bay mud. The observations assume "well-seasoned" fills where the settlement pattern of the surface can be determined and buildings can be designed especially for that "predictable" settlement.

Individual houses are least sensitive to differential settlement but can lose value because of unattractive cracking, sticking doors and windows, etc. The normal foundation (spread footing only a few feet into the ground) is usually satisfactory, but provision should be made (such as installation of jacks) for shimming up when one part settles more than another.

For one- or two-story industrial and commercial buildings, a grid-footing foundation (a series of foundations tied together under the entire floor, not just along the walls) at normal depths into the fill or soils can be adequate. Concrete floor slabs may be laid on the ground, provided they are separated from the footing and divided into small separate sections that can settle individually without

uncontrolled cracking of the slab. Such buildings should not generally exceed two stories in height; even then, piles may be necessary.

All other heavier buildings should generally be built on piles, but even piling can sometimes fail if not properly used. Sound design depends upon (1) thorough evaluation of soil characteristics through a good test boring program, (2) identification of the layers of soil adequate to hold the piles, (3) allowance for a downward drag on the piles as the fill settles on the compressible mud, and (4) surveillance of pile installation by soils engineers.

2. "Safe" Construction under Earthquake Conditions

Damage to buildings in an earthquake is mainly the result of two things: (1) failure of the ground beneath the building and (2) the amount of shaking sustained by the building. Post-quake fire can also cause extensive damage as occurred in the 1906 San Francisco earthquake.

Damage as the result of slides, cracks in the fill, or the fill's becoming "quick" or fluid, can be prevented only by adequate soils engineering as the fill is placed. Aside from these problems, the structural engineer must design the building to accommodate "normal settlement" (because the strains imposed upon a building due to differential settlement could weaken the structure sufficiently so that it would perform more poorly in an earthquake).

The general practice today is to place one- and two-story buildings on a blanket of carefully selected and compacted soil many feet thick over the compressible Bay soils. Except for the edges, a well-built fill acts as a mat and light structures with conventional footings resting on this mat should not ordinarily settle differentially during a major earthquake (although there have been no major quakes since modern Bay fills have been developed).

To withstand the effects of differential settlement, individual footings that are not tied together are the least expensive -- and the least effective.

"SAFE" CONSTRUCTION ON FILLS

Large single mat footings beneath a structure have performed well (the building might tilt but not necessarily sustain irreparable strains). The soundest foundation, as suggested by experience, is piling. Buildings on pilings have sustained earthquakes well throughout the world.

The other cause of damage is the shaking administered to the building by the earthquake. Earthquake waves are longer (and fewer per minute) in soft earth than in hard rock. Tall buildings will quiver when hit by many short earthquake waves on bedrock, but can whip and shake badly if hit by the longer waves experienced on soft grounds.

Theory and experience indicate that risk of damage to structures on fill is least for a one-story wood-frame building. Total collapse rarely occurs even when these buildings are tossed about on slides (unless the ground opens up beneath the building). Bigger structures can be designed to perform equally well, but at additional cost.

One-story industrial and commercial structures often have concrete or masonry exterior walls and wood roofs. To reduce hazard to life, the components of the buildings should be tied together much more thoroughly than is presently required. Building codes do not now require special earthquake design factors for buildings on poor soils.

In addition to buildings, retaining walls and bridge abutments must also be specially designed to withstand increased pressure from soil slumping behind them, as well as the force of the shaking itself.

Fire hazard as the result of an earthquake can readily be minimized. Automatic power and gas shutoff can greatly reduce the possibility of fire, and properly designed water systems provide the second line of protection.

Power, water, and gas systems entering Bay fill should have adequate shutoff devices within sections of the fill and for the entire fill. Water and gas

"SAFE" CONSTRUCTION ON FILLS

lines entering buildings should be designed so they will not be broken if the building settles or rocks.

Water systems needed to fight fires have often been damaged in earthquakes, particularly in poor ground. Damage results from differential settlement and ground cracking; also water surges in the pipelines caused by the earthquakes result in leaks where the pipes have been weakened by corrosion or other causes. These problems can be overcome at little additional cost. Additional protection in the form of a special independent water system, which would use water pumped from the Bay for firefighting, is also desirable in some cases. (San Francisco now has such a system.)

Oil storage tanks are a special cause of concern on Bay fills because, in other areas, they have occasionally sustained spectacular and destructive fires during large earthquakes. Such fires, however, principally resulted from seismic sea waves that destroyed the tanks. Otherwise, oil tanks can be designed to withstand earthquake vibrations as illustrated by tanks in Anchorage and by the thousands of tanks in Kern County that survived the 1952 earthquake. Failure of a tank or breaks in pipes entering the tank can be prevented by design, backed up with the customary diking system around the tanks. Failure of a supporting fill, however, could cause failure of a tank, but even then there would not be a fire unless there were a source of ignition. To reduce risks, tank farms for the storage of any combustible materials on Bay fills should be (1) well isolated from other developments, and (2) so located that escaping oil could not be carried far by the tidal currents or the wind. Probably, only a small part of the Bay would meet these conditions.

MINIMIZING HAZARD TO LIFE AND PROPERTY

Knowledge of how soils behave in earthquakes is rapidly increasing, but judgment still must play a very important part. Pending more definitive information, hazard to life during an earthquake can be minimized either by keeping the number of people living or working in a hazard area as low as possible, or by requiring special design attention to

foundations and superstructures of buildings housing large numbers of people. Special seismic equipment should be installed throughout the Bay Area and on each Bay fill as part of the U. S. Coast and Geodetic Survey network, designed to provide more precise information about the effects of strong-motion earthquakes. Suitable instruments now cost about $5,000 installed and the cost is soon expected to be almost halved.

To prescribe maximum safety in the development of potential Bay fill areas, it is proposed that all such areas be classified according to four risk categories. Because of the lack of definite information about many aspects of the problem, including precise criteria for assigning risk categories, the classification plan should be developed by a professional group including soils engineers, structural engineers, geologists, city planners, and developers. Potential Bay fill areas could be classified as follows:

Minimum Risk Zone: would require that, for all structures more than two stories high, a structural engineer must file a report with the local building department that certifies that all structural engineering aspects of the plans and specifications were complied with during construction.

Moderate Risk Zone: would limit construction to a maximum of two stories and would require that all residential buildings be of wood frame construction. Buildings with concrete, brick, or concrete block walls would generally require design and inspection by a structural engineer. No large places of assembly of people would be permitted.

Substantial Risk Zone: would permit only one-story buildings used as warehouses, storage areas, or other uses requiring a minimum number of employees.

Maximum Risk Zone: would permit only open recreational uses such as parks and golf courses, but no facilities where large numbers of people would collect in one place.

MINIMIZING HAZARD TO LIFE AND PROPERTY

The classification plan and its criteria and requirements should be periodically reviewed to reflect changes resulting from the latest research and experience.

SUMMARY

Rapid increases in population create increasing demands for flat land near urban areas for many purposes -- homes, industries, airports, etc. Since such land can be created by filling parts of the Bay, the safety and stability of filled land will be an increasingly important consideration in planning for the region.

Studies of the behavior of filled land under conditions of normal settling, and under conditions of shaking caused by earthquakes, have provided information as to the safest and most prudent methods of fill construction.

To protect life and property in developments built on filled land, competent engineering design and supervision must be provided to minimize potential settlement or collapse of any filled lands, or of any buildings constructed on fill.

SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION
507 Polk Street, San Francisco 94102 557-3686

Possible Bay Planning Conclusions Based on the Report on Fill

1. To reduce risk to life and damage to property, special consideration must be given to construction on poor soils throughout the Bay Area, including soft natural soils, steep slopes, earthquake fault zones, extensively graded areas, and filled lands in San Francisco Bay. The BCDC is concerned about the safety of construction that might be permitted in its plan for the Bay.

2. The safety of construction on fills depends upon (a) the stability of the ground or Bay bottom on which a fill is placed (i.e., the original mud, sand, rock, etc.), and (b) the manner in which and the material of which the fill is built.

3. In regard to the stability of the ground or Bay bottom, specific analysis must be made in each case by competent specialists, but approximate indications are: (a) building foundations on bedrock are generally the safest; (b) the older Bay mud, which includes firm sediments, generally provides good foundation support for piles and other foundations; and (c) the younger Bay mud is the weakest soil and generally requires special engineering to overcome its deficiencies.

4. In regard to the manner in which a fill is built, construction of a fill or building that will be stable enough for the intended use requires (a) recognition and investigation of all potential hazards, and (b) construction of the fill or building in a manner specifically designed to minimize these hazards. Hazards include (a) settling of a fill or a building over a long period of time, and (b) ground failure caused by the manner of constructing the fill or by shaking in the event of a major earthquake. If these hazards cannot be overcome adequately for the intended use, the fill or building should not be constructed.

5. There are no minimum construction codes regulating construction of lls on Bay mud because of the absence of sufficient data upon which to base such a code. Recognition and investigation of all potential hazards of constructing a fill and the design of the fill and any construction thereon to minimize these hazards therefore requires the highest order of skilled judgment, utilizing the available knowledg of all affected disciplines, in the absence of adequate data or of any minimum codes.

6. In preparing its final plan for the Bay, the Commission shall appoint a Board of Consultants consisting of geologists, civil engineers specializing in soils engineering, structural engineers, and other specialists to review, on the bases of available knowledge, all new fills that might be permitted in its plan so that no fills would be included upon which construction might be unsafe.

7. In the absence of adequate codes or data, public safety in regard to construction of Bay fills requires an instrument such as an adequately-empowered Board of Review competent to (1) set and then constantly adjust standards as rapidly as new information becomes available, (2) review all fill proposals on the basis of available knowledge, and (3) prescribe an inspection system to assure placement of the fill according to the approved design. As one of its recommendations for carrying out the plan for the Bay, the Commission should propose methods of providing such

review and inspection, such as by boards, including all affected disciplines. The Board of Consultants referred to in Conclusion No. 6 will be requested to recommend to the Commission such methods as it deems advisable.

8. The BCDC recommends that cities, counties, and the Association of Bay Area Governments give similar consideration of life and property hazard in other parts of the Bay Area where fault zones, hillsides, excessive grading and general soil conditions may pose special construction problems.

9. To provide vitally needed information on the effects of earthquake on all kinds of soils, the BCDC recommends that installation of strong-motion seismographs be required on all future major land fills, in other developments on problem soils, and in other areas recommended by the U. S. Coast and Geodetic Survey for purposes of data comparison and evaluation.

Adopted by the Commission at its meeting of 6/1/67

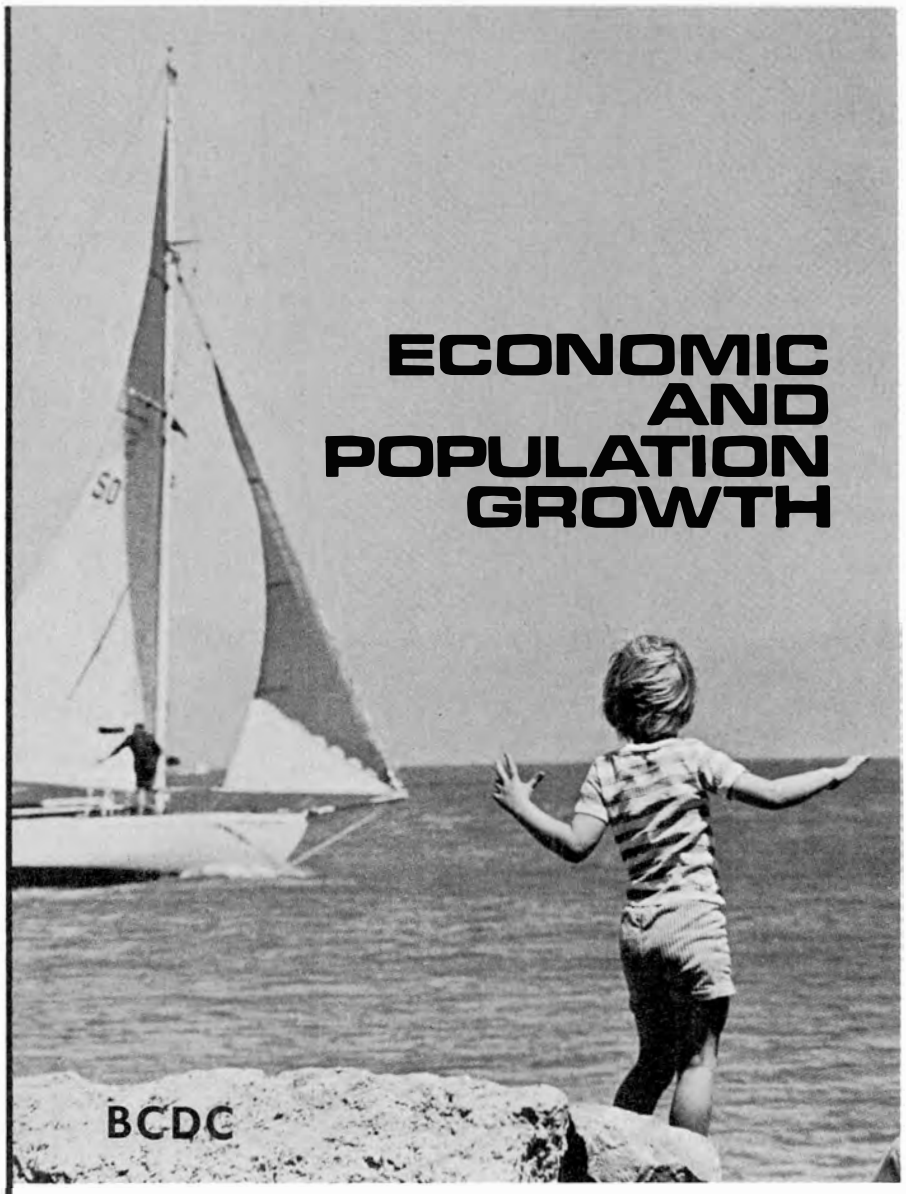
ECONOMIC

AND

POPULATION

GROWTH

Part of
a Detailed
Study of
San Francisco
Bay



San Francisco Bay
Conservation and
Development
Commission

San Francisco
California

February 1967

Summary of the report, "Economic and Population Growth in the San Francisco Bay Area," by Clifford W. Graves, Associate Planner, BCDC.

Planning for the future means planning for people -- many more people.

INTRODUCTION

To plan wisely for future generations in the Bay Area -- and to anticipate future demands upon San Francisco Bay -- it is necessary to know how many people to plan for and the type of economy that will sustain these people. The population will grow but the Bay cannot; this is the heart of the Bay planning problem.

Other BCDC reports deal with the effects of population growth on planning for the Bay -- the increasing numbers of people who will seek outdoor recreation, for example, and the future patterns of industrial growth. This report provides the necessary background projections of the future Bay Area population and economy.

HOW MANY PEOPLE

Table 1 shows the population projections made by the Association of Bay Area Governments, which has undertaken planning for the nine-county Bay Area. Figure 1 charts the past and projected Bay Area population in comparison with past and projected state and national populations. These are preliminary projections that may be succeeded by more refined estimates in time to be reflected in BCDC's planning.

Historically, California and the Bay Area have experienced a much faster rate of population growth than the rest of the nation, because so many people have come here from elsewhere in the country. ABAG projections assume that this migration will gradually decline over the coming decades. The estimates assume that in about 50 years almost as many people will be leaving California every year as will be moving into it; U. S. Census Bureau studies have found that the rate of interstate migration is slowing down and the Bureau expects an eventual "state of equilibrium."

The projections indicate that, for the nine-county Bay Area, a population of 8.2 million should be expected by the turn of the century. This is nearly twice the present population of 4.3 million.

TABLE 1

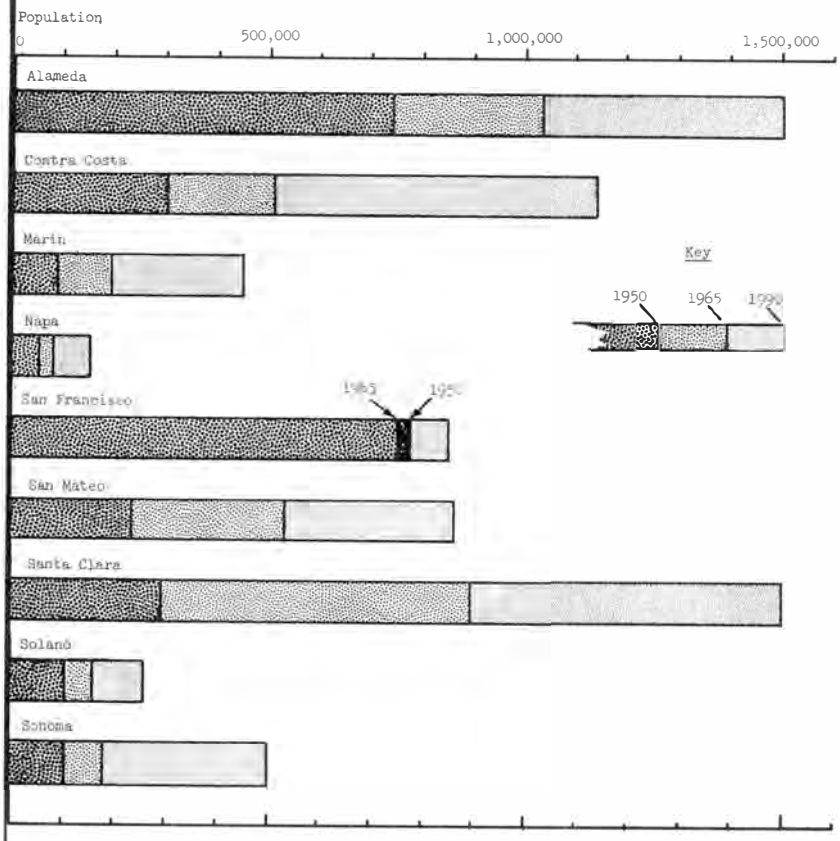
NINE-COUNTY SAN FRANCISCO BAY AREA
POPULATION BY AGE GROUP
1960-1990

AGE GROUP (Years)	1960	1970	1980	1990
	THOUSANDS			
All ages	3,639 (100.0%)	4,869 (100.0%)	6,071 (100.0%)	7,207 (100.0%)
0-14	1,074 (29.9%)	1,337 (27.5%)	1,535 (25.3%)	1,746 (24.2%)
15-24	463 (12.7%)	849 (17.4%)	935 (15.4%)	1,101 (15.3%)
25-44	1,030 (28.3%)	1,244 (25.5%)	1,812 (29.9%)	2,188 (30.4%)
45-59	605 (16.6%)	818 (16.8%)	902 (14.9%)	1,172 (16.3%)
60 and over	466 (12.8%)	621 (12.8%)	887 (14.6%)	1,001 (13.9%)
Median Age (Years)	30.9	28.6	30.5	32.0

Source: Association of Bay Area Governments, November 1966

FIGURE 1

Population of the Bay Area Counties, 1950, 1965, 1990



Source: Association of Bay Area Governments

Page 3

HOW MANY PEOPLE

The average of the future population is expected to be a little "older" by 1990 -- advancing from an average of around 30 today to 32 then. This would reflect a return to a long-established historical trend toward smaller families.

How this larger population will be distributed within the Bay Area depends on many things -- present patterns of land development, topography of the Bay Area, employment opportunities, freeway and rapid transit development, community policy toward housing density, etc. In general, however, the bulk of the Bay Area's population growth during the next 50 years will be in the East Bay and on the San Francisco Peninsula. These areas contain 85 per cent of the nine-county population now, and while this proportion will probably decline, it is expected that they will contain at least 75 per cent of the population by the turn of the century.

HOW THE POPULATION WILL BE EMPLOYED

The Bay Area's share of the national wealth has been increasing for many years. There is good reason to assume that this trend will continue.

The Bay Area's central location on the West Coast, its status as a major ocean port, its established position as a financial, communications, and distribution center, and its attractiveness as a tourist and convention center are all factors encouraging economic growth. In addition, a metropolitan area becomes more self-sufficient as it grows and thus creates its own momentum for continued growth.

Recent trends in Bay Area employment and the ABAG projections to 1990 are shown in Table 2 and Figure 2. According to the ABAG projections, total employment will reach 2.9 million jobs by 1990, an increase of 1.2 million over 1965.

The National Planning Association, a private research organization, estimates that household income in the year 2000 will be $2\frac{1}{2}$ times what it is today -- in other words, will provide $2\frac{1}{2}$ times today's purchasing power. At the same time, the NPA projects a drop in the average work week from 39 hours in 1965 to $32\frac{1}{2}$ in 2000 and anticipates that a considerable portion of

HOW THE POPULATION WILL BE EMPLOYED

the labor force will enjoy one-year "sabbatical leaves" every seven years. More income combined with shorter work weeks, longer vacations, and early retirements, will direct more of the economy toward the service industries.

Following is a brief analysis of each major sector of the Bay Area economy described in Table 2 and Figure 2.

1. Services

Service industries include domestic and personal service, tourist and catering services, repair services, and professional and semi-professional services. This sector had the highest rate of growth between 1960 and 1965 and is expected to continue to expand rapidly as more income becomes available for business, personal, technical, and professional services and as the Bay Area's recreational and scenic assets draw increasing numbers of tourists.

2. Manufacturing

Bay Area manufacturing employment is well-balanced among the major industrial groups. Although manufacturing declined in relative importance from 1960 to 1965, it is expected to increase in importance as a result of (a) the growth of the population to a size adequate to support more manufacturing industries; (b) large expansions of markets throughout the west and probably in the Orient; and (c) the presence in the Bay Area of research and scientific facilities and personnel needed for newer-product industries.

3. Government

Federal, state, and local governmental employment increased sharply in the last five years. The Bay Area is a major center of federal offices and military installations, but the biggest increase has been employment in education. Future growth is expected to be predominantly in state and local governments in response to rapid population growth and increasing demands for public services.

TABLE 2

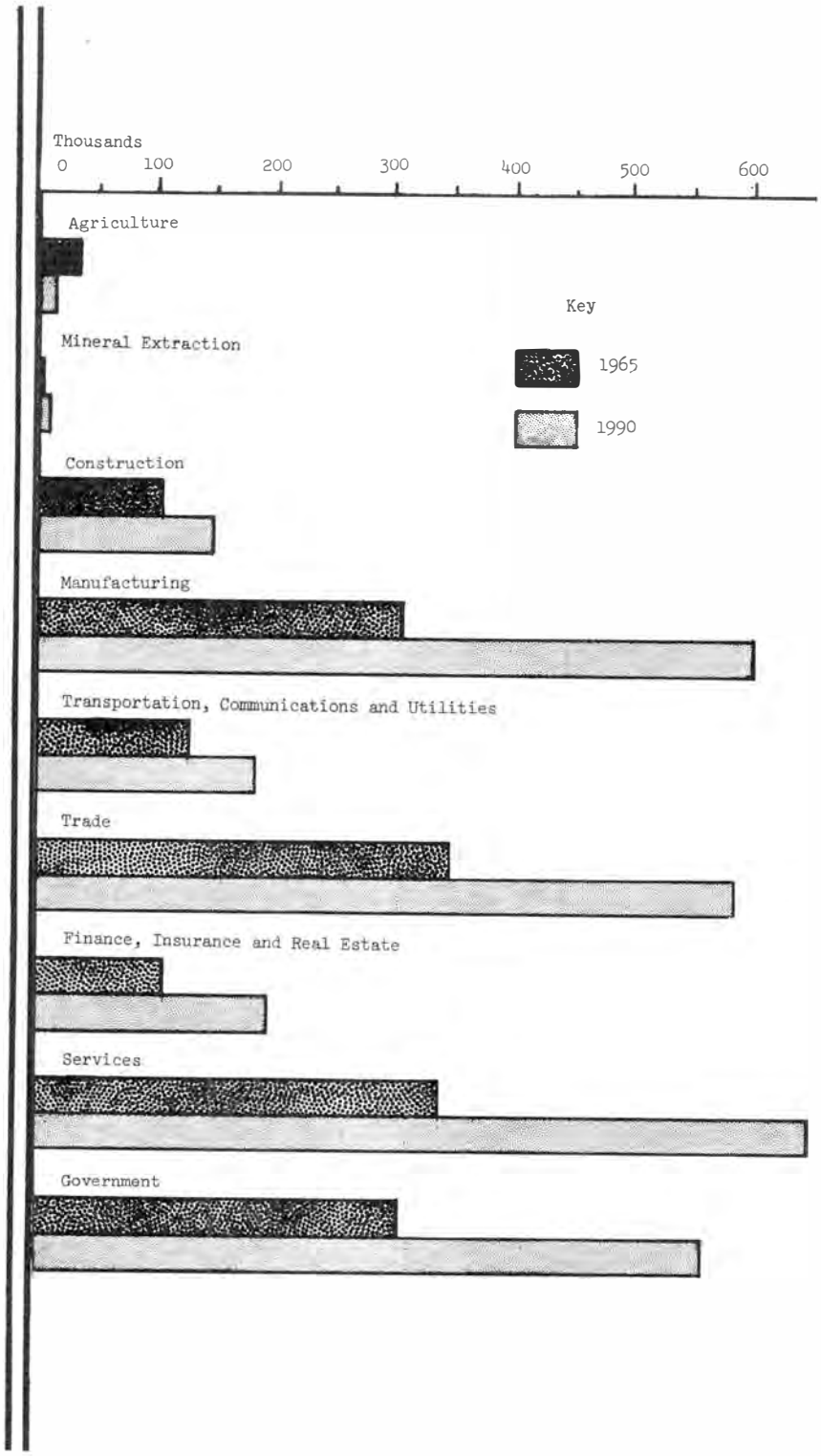
PROJECTED CIVILIAN EMPLOYMENT IN THE NINE-COUNTY BAY AREA
1960-1990

	1960	1965	1970	1980	1990	Average Annual Percent Change 1965-1990
Agriculture	36,000 (2.5%)	31,000 (1.8%)	25,000 (1.3%)	20,000 (0.8%)	15,000 (0.5%)	-2.8
Mineral Extraction	5,000 (0.5%)	6,000 (0.4%)	8,000 (0.4%)	7,000 (0.3%)	9,000 (0.3%)	1.5
Construction	90,000 (6.3%)	102,000 (6.1%)	114,000 (5.9%)	135,000 (5.5%)	149,000 (5.1%)	1.5
Manufacturing	284,000 (19.9%)	306,000 (18.4%)	368,000 (19.1%)	489,000 (19.9%)	591,000 (20.2%)	2.6
Transportation, Communications, and Utilities	120,000 (8.4%)	128,000 (7.7%)	141,000 (7.3%)	162,000 (6.6%)	181,000 (6.2%)	1.4
Wholesale and Retail Trade	305,000 (21.4%)	350,000 (21.1%)	398,000 (20.7%)	496,000 (20.2%)	582,000 (19.9%)	2.0
Finance, Insurance and Real Estate	86,000 (6.0%)	106,000 (6.4%)	127,000 (6.6%)	162,000 (6.6%)	193,000 (6.6%)	2.3
Services	261,000 (18.3%)	331,000 (19.9%)	391,000 (20.3%)	523,000 (21.3%)	649,000 (22.2%)	2.6
Governments	239,000 (16.7%)	301,000 (18.2%)	354,000 (18.4%)	462,000 (18.8%)	556,000 (19.0%)	2.4
TOTAL	1,427,000 (100.0%)	1,659,000 (100.0%)	1,925,000 (100.0%)	2,455,000 (100.0%)	2,925,000 (100.0%)	2.2

Source: Association of Bay Area Governments' Preliminary Regional Plan Projections, November 1966

FIGURE 2

Bay Area Civilian Employment by Industry Group, 1965 and 1990



Source: Association of Bay Area Governments

4. Trade

Wholesale and retail trade have been the chief source of livelihood in the Bay Area for many years. This is because of the region's long-established position as a trading center, exporting agricultural products and distributing goods throughout northern California, western Nevada, and southwestern Oregon. The growth of population will insure large increases in trade employment, but this sector is expected to decline in relative importance as wholesaling operations increase in the Los Angeles area and in the Central Valley. Trade will continue to be a major element in the regional economy, however.

5. Finance, Insurance and Real Estate

Finance, insurance and real estate employ relatively few people, but employment levels in the Bay Area are well above the statewide average because San Francisco has been the leading financial center in the western United States for many years. Rapid growth in this sector is expected to continue as a result of the increasing importance of these services to a rapidly growing population.

6. Agriculture

Agricultural employment in the Bay Area is expected to decline considerably as a result of increased mechanization and the transfer of agricultural land to urban use.

7. Transportation, Communications and Public Utilities

Employment in this sector has been considerably higher than the statewide average, because of the importance of the Bay Area as a transportation and distribution center for a large part of the western United States. Nevertheless, this employment has been declining in relative importance because of (a) the growth of other urban areas and (b) the decline in railroad and local transportation employment, which has not been completely offset by large gains in air and truck transport. Automation and other labor-saving devices are expected to retard the relative rate of growth of transportation, communications, and utilities employment in the future.

HOW THE POPULATION WILL BE EMPLOYED

8. Construction

Employment in construction will increase as the population grows, but technological improvements in construction techniques will keep the rate of employment growth relatively low.

WHERE PEOPLE WILL BE EMPLOYED

Nearly 90 per cent of all Bay Area jobs are now provided in the five counties that border the south and central parts of the Bay -- San Francisco, San Mateo, Santa Clara, Alameda, and Contra Costa. A large proportion of these jobs are in areas near the Bay.

The future distribution of jobs within the Bay Area will be determined by many of the same factors that influence the distribution of population. In addition, changes in the technology of transportation and communication will give many businesses and industries a broadened range of choice as to location.

Further studies are needed to project in any detail the future distribution of employment around the Bay. Work now under way by the staffs of the Association of Bay Area Governments, the Bay Area Transportation Study Commission, and the Bay-Delta Water Quality Control Program will help provide the necessary information.

SUMMARY

The San Francisco Bay Area can expect a doubling of its population within about 40 years. Its economy is well-balanced, and its population growth resources and strategic location are expected to result in continued economic growth in the future.

A D D E N D U M

(to Report on Economic and Population Growth)

REVISED POPULATION AND EMPLOYMENT DATA USED IN THE BAY PLAN

Subsequent to the publication of the original report on Population and Economic Growth in the San Francisco Bay Area, new estimates more appropriate to BCDC purposes became available.

The BCDC Plan uses the projections in three ways: First, the total population and employment estimates are used to illustrate the magnitude of future regional growth with consequent pressures to use and fill the Bay. Second, the population projections are the basis for estimating future recreation facility needs around the Bay. Third, projections of growth in certain manufacturing industries are needed to estimate future water-oriented industrial land needs. Details about the projected distribution of growth within the region or of the overall economic development pattern of the region are not of direct concern to the BCDC.

The Available Projections

Only those projections prepared for or by an agency concerned with regional planning in the Bay Area were considered for use in the Bay Plan because (1) city- and county-wide projections cannot be assembled in any consistent manner and (2) deducing future regional growth directly from statewide or national projections would have been a highly complicated exercise for which the BCDC did not have the resources; also it would have to some extent duplicated the regional projections being prepared by others.

Four sets of projections were available for consideration: The BASS III Model Projections developed for the Bay-Delta Water Quality Control Program; the Bay Area Transportation Study Commission Population and Employment Forecast; the Association of Bay Area Governments' Preliminary Regional Plan Projection; and the U. S. Department of Commerce Projections prepared for the Army Corps of Engineers. The latter two were available when the original BCDC report on Economic and Population Growth was prepared (the ABAG projections were the ones originally selected for use in preparing the Bay Plan). The general nature, purpose and status of each of the sets of projections is described below.

1. BASS III

The University of California Center for Real Estate and Urban Economics prepared employment, population, and land use forecasts for a 13-county area for the San Francisco Bay-Delta Water Quality Control program. The forecasts are contained in a report published in February, 1968. The projections are being used by Bay-Delta to

estimate the volume, composition, and location of future waste loads, and will constitute the basis for the comprehensive waste management plan to be prepared by Bay-Delta.

The forecasts were developed with the aid of a simulation model: The Bay Area Simulation Study (BASS) Model, Version III. This model was originally developed by a group of graduate students at the University of California in 1964 under the supervision of Dr. Paul Wendt, Professor of Business Administration. It was intended as an academic exercise to refine a model developed by Dr. Ira Lowry ("Model of Metropolis") a few years earlier. The BASS I version was intended to forecast growth of the 9-county region by census tracts over a ten-year period. The BASS II version had the same intent, but incorporated many refinements; at one time ABAG considered using the model for its regional planning program and some of the funds for developing BASS II were provided by ABAG.

The BASS III model projects growth with many more categories of activity for a 13-county area by 777 sub-areas, and from 1965 to 2020 by ten-year intervals.

The BASS III forecasts include:

1. Population - total regional and counties.

2. Employment - total regional, county, cities, urban areas by 10 industry groups. Groupings were based on waste loading characteristics of 2-digit S.I.C. (Standard Industrial Classification system) industries.

3. Housing Units - single and multiple family by total region, county, cities, urban areas.

4. Land use in acres - residential, commercial, industrial, public, and vacant by total region, county, cities, and urban areas.

Only 1 and 2 are of interest to BCDC.

2. BATSC Projections

In August 1968, the Bay Area Transportation Study Commission published the regional employment and populations prepared by its staff for the BATSC transportation planning. These forecasts are to be used as inputs to a BATSC simulation model known as PLUM (for Projected Land Use Model); this model will project distribution of people and jobs within the region. Preliminary forecasts were circulated for review and comment in April 1968. The August projections incorporate the results of that review, and are not subject to further revision.

In their present form, there are three alternative sets of employment projections for the region by five-year intervals to 1990. Each of the three is based on a different assumption about

the future overall regional economic growth rate. Employment is projected in 55 2-digit S.I.C. industry groups. Population is derived from the employment projection.

3. ABAG Projections

The ABAG projections used in the BCDC report on Economic and Population Growth include 9-county regional population and employment in nine 1-digit S.I.C. industry groups at ten-year intervals to 1990, and a distribution of population and employment in two industry groups by county. ABAG may revise its regional population estimates based on new data from the State Department of Finance, and its forecasts of population by county may be revised based on comment from local planning agencies. No additional work on employment forecasts is contemplated; ABAG may use the projections developed by BATSC in refining its Preliminary Regional Plan.

4. U. S. Army Corps of Engineers

In 1959 the U. S. Department of Commerce, Office of Area Development, published a set of 9-county regional population, employment and land use projections for the Army Corps of Engineers' Comprehensive Survey of San Francisco Bay and Tributaries. They are used by the Corps as the basis for projecting future navigation improvement needs and for evaluating specific project proposals in the Bay. The Corps' final report is due to be published sometime in 1968.

The projections include regional population, distribution of population by county and township, regional employment by nine 1-digit S.I.C. industry groups, and land use (residential, industrial, and vacant) by region and county at 10-year intervals from 1960 through 2020. Originally prepared a decade ago, they are being revised but are not now available.

Projections Used in Bay Plan

None of the available projections are ideally suited to the needs of BCDC. The employment projections of ABAG, the Corps of Engineers, and BASS III are not sufficiently detailed for use in estimating future waterfront industrial needs. In all three cases, also, there are various problems with the basic information used to prepare the projections. The ABAG and BATSC projections were developed only to the year 1990, while the Bay Plan requires longer-range projections. Despite this problem, the BATSC projections appear best suited to the needs of the Bay Plan.

The BATSC approach considers economic conditions on an industry-by-industry basis. Growth in 55 2-digit S.I.C. industries over the last 15 years was studied. Regional and national trends were analyzed and three overall rates of regional economic growth were projected. Each of the three is based on differing assumptions about the future of the national economy and its effects on regional

growth in the Bay Area. The alternative used for the Bay Plan is the "middle" one. It assumes continued rapid regional economic growth, and emphasizes (relative to the other alternatives) internal regional growth, particularly in trade and service industries. It further assumes that productivity increases and technological innovations will provide expanded output without correspondingly high employment expansion in manufacturing. Of the three alternatives, this one most closely follows current national and regional trends.

The "high" alternative assumes an increasing rate of national economic growth, driven largely by an accelerated pace of Federal defense and aerospace spending with less emphasis on domestic programs. Industries within the region that serve the defense-aerospace program will expand greatly, as they did during the 1950's. While this alternative produces considerably higher total manufacturing employment than the alternative used for the Bay Plan, the difference for specifically water-oriented industries is less marked.

The BATSC employment projections were derived from a series of mathematical formulas for each industry group that could not feasibly be extended to 2020. So, the data was extended by the BCDC staff on the basis of the average rate of change, upwards or downwards, projected by BATSC to 1990. The resulting projections were compared with those from other studies for "reasonableness." In each case, the BCDC projections to 2020 were found to be generally similar and therefore were not further adjusted.

Population is estimated on the basis of projected employment. The projections were carried only to 1990, necessitating extension of the data to 2020 by the BCDC staff.

Tables 1 and 2 record the population and employment projections derived thereby and used in preparing the Bay Plan.

TABLE 1

PROJECTIONS FOR POPULATION, TOTAL EMPLOYMENT & MANUFACTURING EMPLOYMENT IN 9-COUNTY SAN FRANCISCO BAY REGION, 1960-2020

	1960[a]		1965[b]		1980[c]		2000[c]		2020[c]	
	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
	(000)		(000)		(000)		(000)		(000)	
Population	3,639		4,336		6,158		8,785		10,800	
Total Employment	1,427		1,664		2,572		3,728		4,588	
Employment as % of Population		39.2		38.3		41.0		42.4		42.4
Manufacturing	284		314		452		667		900	
Manufacturing as % of Total Employment		19.9		18.8		17.5		17.8		19.6

a/ BCDC Economic and Population Growth
b/ BATSC Baygro Nine County Population Projection
c/ BCDC Extended Forecast from BATSC Baygro Projection

TABLE 2

PROJECTED CIVILIAN EMPLOYMENT IN THE NINE-COUNTY BAY AREA

1965-2020

	1965	1970	1980	1990	2000	2010	2020
Agriculture	30.5 (1.8%)	26.1 (1.3%)	19.6 (.7%)	15.3 (.4%)	11.7 (.3%)	9.1 (.2%)	7.1 (.1%)
Mineral Extraction	2.2 (.1%)	2.4 (.1%)	2.8 (.1%)	3.3 (.1%)	3.7 (.1%)	4.2 (.1%)	4.7 (.1%)
Construction	104.1 (6.2%)	115.3 (6.0%)	148.2 (5.7%)	173.8 (5.4%)	197.5 (5.2%)	215.9 (5.1%)	229.5 (5.0%)
Manufacturing	313.7 (18.8%)	355.9 (18.7%)	452.2 (17.5%)	556.0 (17.5%)	667.2 (17.8%)	782.6 (18.6%)	900.1 (19.6%)
Transportation, Communications, and Utilities	128.1 (7.6%)	135.2 (7.1%)	163.6 (6.3%)	188.3 (5.9%)	206.4 (5.5%)	218.3 (5.1%)	225.8 (4.9%)
Wholesale and Retail Trade	349.5 (21.0%)	384.2 (20.2%)	477.4 (18.5%)	558.3 (17.6%)	635.6 (17.0%)	700.7 (16.6%)	754.2 (16.4%)
Finance, Insurance and Real Estate	105.9 (6.3%)	127.2 (6.6%)	184.9 (7.1%)	234.4 (7.4%)	280.2 (7.5%)	315.7 (7.5%)	342.1 (7.4%)
Services	330.6 (19.8%)	392.7 (20.6%)	575.3 (22.3%)	742.2 (23.4%)	905.4 (24.2%)	1041.4 (24.7%)	1149.2 (25.0%)
Government	299.4 (17.9%)	361.9 (19.0%)	575.3 (21.3%)	692.1 (21.8%)	820.7 (22.0%)	912.6 (21.7%)	975.6 (21.2%)
TOTAL	1664.0 (100.0%)	1900.9 (100.0%)	2572.3 (100.0%)	3163.7 (100.0%)	3728.4 (100.0%)	4200.5 (100.0%)	4588.3 (100.0%)

SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION
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Possible Bay Planning Conclusions Based on the Report on Economic and Population Growth

1. A steadily-increasing population in the Bay Area will create an increasingly intense competition for the Bay. The demand for use of the Bay as a Bay will increase with a rising population; at the same time, more people will mean more pressure to fill parts of the Bay to provide new flat land for a variety of uses. The overriding question to be resolved in the Commission's planning program is the extent to which the Bay should be filled in response to these pressures.

2. Estimates of population and economic growth are important in developing predictions as to future demands on the Bay -- uses of the Bay for recreation, for example, and uses of the waterfront for industry. These estimates should therefore be as precise and reliable as possible.

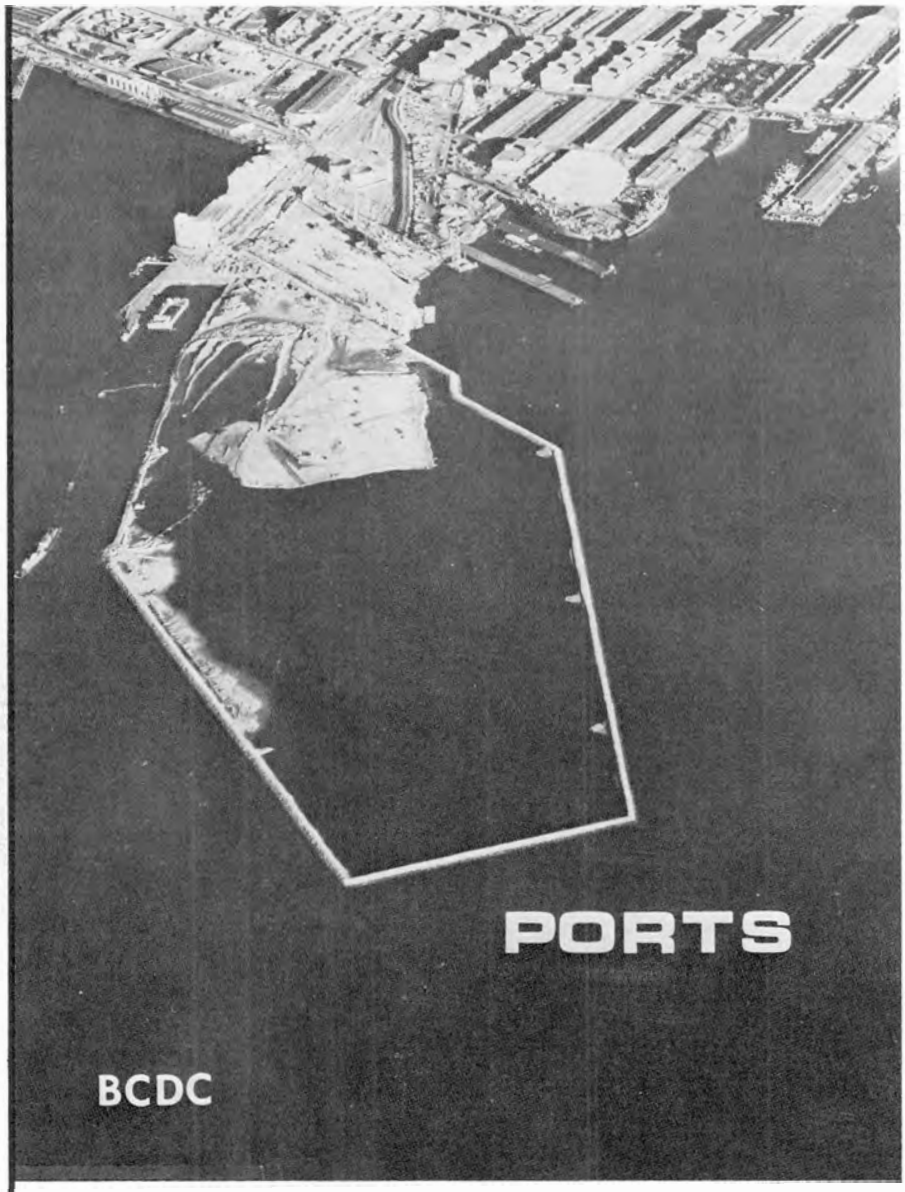
3. For planning purposes, population estimates contained in Table 1 will be used until better estimates are made available to and are approved by the Commission.

4. For planning purposes, employment projections in Table 2 will be used until better estimates are made available to and are approved by the Commission.

Adopted by the Commission at its meeting of 4/21/67

PORTS

Part of
a Detailed
Study of
San Francisco
Bay



Photograph by Sunderland Aerial Photographs, Oakland, California

San Francisco Bay
Conservation and
Development
Commission

San Francisco
California

January, 1968

Summary of the report, "Maritime Commerce in the San Francisco Bay Area," by Clifford W. Graves, Associate Planner.

INTRODUCTION

Every day, a dozen or more ocean-going ships enter the Golden Gate. A troop transport brings American servicemen home from the Far East. A giant tanker carries crude oil from Venezuela. A luxury liner arrives on a world cruise. Freighters bring automobiles from Germany, whisky from Scotland, rattan furniture from Manila, and toys from Hong Kong.

Every day, about a dozen ships steam out the Golden Gate, carrying canned fruits and vegetables from California's fertile farms, machinery made in factories in western states, and petroleum products from Bay Area refineries to many parts of the world.

San Francisco Bay is one of the world's great harbors. San Francisco was founded as a port city, and shipping is still of primary importance to the entire economy of the Bay Area. But shipping means more than money; the presence of ocean-going ships imparts a flavor to life in the Bay Area -- the presence of sailors from around the world, the bustle of the Embarcadero as viewed from Telegraph Hill, a sleek passenger liner at its pier, a giant aircraft carrier passing under the Golden Gate Bridge, a huge tanker at anchor in the Bay.

THE IMPORTANCE OF MARITIME COMMERCE

The strong economy of the Bay Area is tied heavily to shipping. In addition to the jobs and payrolls in the shipping industry itself, there are the many businesses and industries that have established themselves in the Bay Region because they can receive raw materials and can ship finished products by water.

No precise studies have been made of all the economic benefits of shipping to the Bay Area, but the benefits are substantial. One study, made for the Federal Economic Development Administration by Checchi and Company in 1965, estimated that about 50,000 jobs in the Bay Area are attributable to general-cargo shipping and to industries dependent on shipping. These jobs provide a payroll of about $820 million per year. In addition, other jobs and other payrolls are provided by military ports, petroleum refineries, and industrial plants with private docks.

THE IMPORTANCE OF MARITIME COMMERCE

The total tonnage handled by ships in the Bay Area has increased little in recent years. But the value of the tonnage to the Bay Area economy has increased greatly because nearly 45 per cent of the total tonnage is now foreign trade (as opposed to domestic trade), whereas the proportion was only 30 per cent in 1955. A study made by Arthur D. Little, Inc., for the Port of San Francisco concluded that foreign trade is much more beneficial to the Bay Area economy than is domestic trade: foreign and Hawaiian tonnage has almost twice the dollar benefit (in payrolls, etc.) provided by coastwise and intercoastal trade (and nearly 45 times that of inland trade).

Both in the Bay Area and in the nation as a whole, trade with foreign nations is increasing. Further increases are expected, especially on the West Coast, as the Far East, the Indian Ocean area, and Australia become increasingly important markets for exports from the United States.

While foreign trade is expected to grow, domestic shipping will probably decline in the long run. Except for trade with Alaska, Hawaii, and U. S. territories, domestic shipping must compete with -- and is losing ground to -- air, rail, highway, and pipeline transportation.

TYPES OF MARITIME COMMERCE

For purposes of determining port facility requirements, maritime commerce can be divided into four basic types, each requiring different facilities: cargo movement, passenger movement, commercial fishing, and military ship movements.

Of the four, cargo is by far the most important economically, and can be divided into four main categories:

Petroleum -- a high-volume commodity.

Other bulk liquids -- which, like petroleum, are moved in sufficient quantity to be handled in specialized facilities.

TYPES OF MARITIME COMMERCE

Bulk dry cargo -- which also involves large quantities of goods, in this case non-liquid, many of which also are handled in specialized facilities.

General cargo -- all other cargo, liquid and dry, that is packaged and handled in a variety of ways, so it is not easily handled by single-purpose equipment.

HARBOR REQUIREMENTS: PETROLEUM

In tonnage, the principal cargo passing through the Golden Gate is petroleum. Nearly 65 per cent of the total Bay Area shipping tonnage is crude oil and its refined products such as gasoline. With increasing amounts of foreign crude oil being shipped to Bay Area refineries, petroleum traffic will continue to play a major role in Bay Area commerce.

1. Channel Requirements

In recent years there has been a dramatic increase in the size of tankers. The largest tanker afloat in the world in 1949 had a capacity of about 30,000 tons, and had a draft fully loaded of about 32 feet. The largest tanker now afloat has a capacity of 210,000 tons. This ship, the Idemitsu Maru, has a draft of 60 feet (roughly the height of a six-story building) and is more than 1,100 feet long (the length of almost four football fields). Plans are on the drawing board for a 500,000-ton tanker (with an 80-foot draft) and studies have demonstrated the feasibility of a tanker with a capacity of up to 1 million tons.

The rapid increase in tanker size presents the Bay Area -- and other port areas as well -- with a serious problem: How deep should port channels be dredged to accommodate the supertankers?

In other countries, where port control is more centralized and water transportation is even more vital to national economies, channels are already being dredged to considerable depths. Europoort, near Rotterdam, is dredging to 74 feet now and eventually to 98 feet. In Great Britain, the

HARBOR REQUIREMENTS: PETROLEUM

Mersey River is being dredged to a depth of 60 feet from the sea to Liverpool. Gothenberg Harbor in Sweden will be dredged to 59 feet. (The deepest channel in the Bay Area is the 50-foot channel through the San Francisco Bar off the Golden Gate.)

The largest tankers will be employed on the longest routes, carrying crude petroleum to large refining centers. At present, relatively little crude oil comes to Bay Area refineries from far distant sources, although the proportion is increasing. Most of the crude oil refined in the Bay Area comes by pipeline from oil fields in California and the Southwest.

No refinery in the Bay Area expects to have the volume of production necessary to justify the use of tankers carrying more than 150,000 or 200,000 tons, at least for many, many years. So for BCDC planning purposes, it can be assumed that the largest tanker needed to enter the Golden Gate would be a 250,000-ton ship. Such a ship would have a draft of about 65 feet, requiring a channel at least 70 feet deep within protected waters to a point at which some or all of its cargo could be unloaded. The unloading point could be a terminal in the Central Bay, used jointly by several oil companies, or a terminal at the refinery itself.

It appears likely that extensive deepening of Bay channels will be required in the future, though the final determination will probably be made as the result of a study of the nation's overall port needs. In many ports, the costs of deepening channels to even 45 feet are extremely high (the soft bottom of San Francisco Bay reduces initial deepening costs here, but the costs of repeated maintenance dredging in the Bay are high, especially considering possible increases in the costs of spoil disposal). A national policy on supertankers might well designate one or more port areas on each coast to accommodate the largest ships, with lesser dredging in other ports.

2. Terminal Requirements

One reason for the growth in size of tankers is the relative simplicity of docking and unloading the large ships. In contrast to the elaborate wharves, cranes, sheds, and manpower needed for general cargo ships, petroleum terminals can be simple structures. The wharves for Bay Area refineries -- such as the Richmond Long Wharf for the Standard Oil refinery, or the offshore pier at the Sequoia Oil refinery -- illustrate this. A pier may be constructed in the water, with pipelines either extended along a trestle or placed on the bottom of the Bay to connect the ship with the refinery ashore. Offshore terminals can be built in the ocean as well as in the Bay; in some parts of the world, such terminals have been built as far as 10 miles offshore. Petroleum terminals are now in operation along the California coast offshore from Monterey Bay, Morro Bay, and Point Conception.

Ordinarily, a tanker can be unloaded in 24 hours. Increasing the size of tankers will not require more berths at Bay Area refineries, but larger pumping equipment and more storage space may be needed to accommodate the larger vessels. Most of the Bay Area refineries have two docks: one for receiving crude oil, and the other for loading gasoline and other products processed by the refinery.

For very deep draft tankers, a central terminal in the Bay north of Treasure Island is a logical possibility. The terminal could be a simple structure on pilings, and could be connected to refineries and storage facilities by pipeline. The only channel deepening that would be required would be through the San Francisco Bar. Such a terminal would not be needed, however, if Bay channels had to be deepened anyway for dry-cargo ships, or if such a terminal were built outside the Golden Gate (as part of a West Coast system of major offshore terminals).

HARBOR REQUIREMENTS: OTHER BULK LIQUID CARGOES

In addition to petroleum, other liquids, such as molasses, chemicals, and vegetable oils can be shipped in tankers.

Market possibilities for these commodities are much smaller than for petroleum and most of them are therefore carried in relatively small tankers (less than 20,000 tons capacity). However, markets could increase substantially in the long-range future and larger tankers carrying cargoes for more than one destination can be anticipated in planning port facilities. In any event, these tankers will be smaller than petroleum tankers, so channel requirements will be no greater. Docking needs of these ships are essentially the same as for petroleum tankers, and any offshore or central tanker terminal considered for the Bay Area should be capable of handling several different types of liquid and semi-liquid cargoes in addition to petroleum.

HARBOR REQUIREMENTS: BULK DRY CARGO

More and more dry cargo is being handled in bulk form. Large savings can be obtained from mechanized bulk handling that eliminates packaging and from the use of special bulk carrier ships. An increasing proportion of raw materials for industry is expected to be imported into the United States by ship and much of this will be minerals that can be handled in bulk carriers and moved through bulk terminals before processing.

1. Channel Requirements

The growth in size of tankers shows that the size of bulk cargo ships will soon increase, too. The largest bulk cargo ships are now being used to carry ores and combination cargoes -- oil and ores. Some of these ships are as large as 100,000 tons in capacity, and the largest is almost 150,000 tons.

With the possible exception of grain exports, there is no immediate market in the Bay Area requiring giant bulk-cargo ships. But development of a Bethlehem Steel plant at Point Pinole and other industrial development in the Carquinez Strait-Suisun Bay area could change this.

HARBOR REQUIREMENTS: BULK DRY CARGO

Few of the bulk carriers visiting Bay Area ports in the future are expected to be larger than 60,000 tons in capacity, for which a 45-foot channel would be adequate. However, major industries requiring much bigger bulk carriers are a distinct possibility in Contra Costa and Solano Counties, so Bay planning should anticipate the possibility of channel requirements deeper than 45 feet.

2. Terminal Requirements

Handling of bulk cargoes, particularly those that can be handled by conveyors, requires increasing amounts of storage space in which the cargoes may be held before being used or distributed.

HARBOR REQUIREMENTS: GENERAL CARGO

General cargo includes every kind of commodity that can be shipped. Commodities vary greatly in size, weight, method of packaging, and special handling requirements (such as for perishables). For this reason, they are much more expensive to handle on the dock than are bulk commodities that can be handled with special equipment. Whereas savings in bulk cargo movement are obtained by increasing the size of ships (because terminal handling requirements do not increase proportionally), most of the effort toward reducing the cost of general cargo shipment has been toward handling cargo more efficiently and thus reducing the time a ship must spend in port.

1. Terminal Requirements

The quest for more efficient cargo handling has resulted in innovations that drastically alter the requirements for general cargo terminals. The principal innovations are (1) containerization, in which cargo is handled in standard-size containers, and (2) "lighter aboard ship" (LASH), in which cargo can be assembled in lighters or barges at many points and then taken to a central location to be lifted aboard a larger ship. Plans for the Bay must accommodate these changes, but must also provide for the general cargo that will continue to be handled in conventional terminals.

HARBOR REQUIREMENTS: GENERAL CARGO

Containerization. Many types of general cargo can be shipped in large standard-size, weather-tight boxes. These containers can be stored in the open, stacked at least two high, and can be loaded by cranes with relative rapidity. Damage to cargo from mishandling, pilferage, weather, spoilage, or contamination is reduced. Containers can be brought to and from dockside by trucks or railroad cars.

The greatest savings in the use of containers occurs with specially-designed ships and terminals. In effect, the container becomes a type of bulk cargo -- all the shipboard and shoreside handling equipment can be designed to handle a standard container. The SEA-LAND terminal at the Port of Oakland is equipped with cranes and other equipment to operate with specially-designed containerships.

Containerships are generally larger than conventional cargo ships; most of these now being built or planned are 7-800 feet long. Even larger ones -- 1,000 feet long with a 45-foot draft -- are being planned by the Japanese to obtain bulk carrier economies on long routes.

Container terminals need little shed space, but do require large storage lots. A minimum of 20 waterfront acres per berth is required for a ship using the berth once a week. Additional areas are needed for storage, sorting and related activities, but these can be located at an adjacent site not directly on the waterfront. About 100 20-foot containers can be stored per acre, and a full shipload may range as high as 800 containers.

The future of container operations appears quite promising. Kaiser Engineers estimated in a study prepared for the Port of Oakland that from 70 to 90 per cent of all general cargo will be carried in containers by the year 1980. It is possible that by the turn of the century virtually all cargo will be carried in either bulk carriers or container ships.

HARBOR REQUIREMENTS: GENERAL CARGO

In light of the potential growth of trade with Japan and the Far East, using the largest container ships, need for at least a 45-foot channel depth to major container terminals in the Bay Area should be anticipated.

Lighter Aboard Ship. The Lighter Aboard Ship (LASH) method will be put into service about 1970, when 11 special new vessels are completed. Lighters (or barges) will be taken aboard and discharged by cranes on the ship. In effect, the lighter is a floating container that can carry within it many kinds of cargo.

The main advantage of the LASH system is its ability to cut port time to an absolute minimum. Because the ship carries its own cranes, it can simply anchor in midstream to unload its lighters without needing to use wharves. In addition, the ship can serve several piers in one area with only one stop.

Six LASH vessels will be operated by Pacific Far East Lines, which has its headquarters in San Francisco. PFEL officials believe that the six LASH ships will save so much time in port that they will be able to carry more cargo in a year than is carried by the line's 10 conventional ships.

While a LASH ship does not require deep-water berths to operate, some deep-water terminals at principal port areas will be needed. PFEL is considering a number of sites for a terminal in San Francisco Bay. Preliminary plans suggest that a minimum of 30 acres would be required for a two-berth LASH terminal, to provide enough space for storage, sorting, and loading of cargo.

Conventional General Cargo. While trends in bulk shipping and containerization suggest that in 35 or 40 years there will be little conventional shipping, this change will be gradual. In the meantime, the existence of many conventional cargo ships -- and the terminals to serve them -- indicates that a substantial portion of cargo will move in conventional multi-deck cargo ships for many years.

HARBOR REQUIREMENTS: GENERAL CARGO

Since there is no economy in moving conventional general cargo by large ships (the principal costs of conventional shipping are incurred while the ship is in port), no new general cargo vessels are expected to exceed 35 feet in draft. Terminal area requirements are expected to grow somewhat, however, due to increasing mechanization. A prominent example of mechanization efforts is unitization -- the stacking of cargo on uniform-sized pallets for easy handling by forklift trucks and cranes.

HARBOR REQUIREMENTS: PASSENGER TERMINALS

Even with the rapid growth in air travel, the popularity of steamship travel is growing. Steamship companies have taken advantage of the trend toward rising income and longer vacations by making their ships into floating resorts, offering leisurely travel and often brief stops in exotic places.

Only about 2 per cent of the ships passing through the Golden Gate are passenger vessels, but cruise ships contribute to the economy of the Bay Area, and are thus an important part of the maritime industry.

Passenger ships have relatively modest terminal requirements; their principal need is for areas to process luggage. The berthing requirements present no problem; the S.S. Oriana, typical of the larger cruise ships that can be expected to visit the Bay Area in the future, is 804 feet long and has a draft of 31 feet.

A new passenger terminal is needed on the Bay to serve all of the shipping lines. Because the total number of passengers that would be handled is not very large, it would be desirable to design it as a major waterfront commercial-recreation attraction open to the general public. It might include public viewing areas, restaurants, shops and lounges, large parking areas, a heliport and even hotel and office space.

HARBOR REQUIREMENTS: COMMERCIAL FISHING

About 750 commercial fishing boats are headquartered in the Bay, mostly at San Francisco, Oakland, Sausalito, and Richmond.

The era of the small individually-owned fishing boat appears to be giving way to much more productive fleets owned by canneries. (A fleet consists of several small boats and one or two factory ships that process and package the catch so it will be ready for distribution as soon as the ship reaches port.) Meanwhile, commercial fishing vessels in the Bay are being crowded out of harbors by the fast-growing pleasure fleet.

Conversion to fleet operations is not so imminent that better accommodation of the fishing industry in the Bay should be postponed. Deficiencies could be corrected at relatively small cost for the benefit of both the industry and the tourists who are attracted to commercial fishing wharves in increasing numbers. Proposals have been made for such improvements at Fisherman's Wharf in San Francisco and improvements could be made at other Bay harbors. The BCDC plan should encourage such improvement, but it need not provide for major expansion of commercial fishing harbors since the individually-owned fleet is not expected to increase in size.

HARBOR REQUIREMENTS: MILITARY SHIPPING

San Francisco Bay is an important military as well as commercial harbor. At least 13 of the 25 military installations around the Bay make direct use of water transportation.

These installations are: the Oakland Army Terminal, a major passenger and cargo facility; Oakland Naval Supply Center, the Navy's largest supply base in the Bay Region; Alameda Naval Supply Center, which handles perishable supplies; Alameda Naval Air Station, with berths for Navy aircraft carriers; Point Molate Naval Supply Center, a fuel storage area; Concord Naval Weapons Station, a major shipping facility for weapons and explosives; Treasure Island Naval Station, with facilities for some ships and tugboats; Mare Island Naval Shipyard, a major

HARBOR REQUIREMENTS: MILITARY SHIPPING

shipbuilding and repair facility; Fort Mason, which is being discontinued as a shipping point; Hunters Point Naval Shipyard, a major ship construction and repair facility; Government Island, a Coast Guard base in the Oakland Estuary; and Moffett Naval Air Station and Hamilton Air Force Base, both of which have barge channels and docks for fuel shipments.

No major fills appear to be required at any of the military installations except possibly for the Oakland Army Terminal, the Hunters Point Shipyard, and the Alameda Naval Air Station.

No military vessels have greater drafts than commercial cargo ships. Military vessels are not expected to increase substantially in size or draft, so channel depths of up to 45 feet will be adequate for military needs, including aircraft carriers and submarines (the latter, because they lie so low in the water, have draft requirements as great as the large aircraft carriers).

THE BAY AS A HARBOR: PRESENT FACILITIES AND PLANNED IMPROVEMENTS

San Francisco Bay is one of the finest natural harbors in the world, but large public and private investments have been needed to develop it into a port area of worldwide importance. The ability of the Bay to function as a major port area depends primarily on two factors: adequate terminals for loading and unloading cargoes, and adequate channels for large ships.

1. Terminals: Present Facilities

Docks for petroleum tankers have been built at the five operating Bay Area refineries (all situated on the shoreline of Contra Costa County), and will be built for a sixth refinery now under construction at Benicia. Each refinery has berths for at least one tanker and for several barges.

Storage and distribution terminals for petroleum products are located at several places around the Bay: Oakland, Richmond, Ozol (on Carquinez Strait), Martinez, Redwood City, San Francisco, and also at Petaluma and Stockton.

Terminals for molasses, vegetable oils, wines, and chemicals are situated in Oakland, Richmond, and Stockton. Bulk chemicals are also handled at the oil refinery terminals.

Bulk cargoes are stored in the open and handled at terminals in Oakland (scrap metal), Redwood City (salt, gypsum), Richmond (ores, scrap metal, coal), Vallejo (copper ore), Selby (lead), Pittsburg (petroleum and coke, ammonium sulphate), and Stockton (iron ore, petroleum and coke).

Bulk cargoes with enclosed storage are handled at Oakland (magnesite), Redwood City (cement), and Stockton (potash, grains).

Bulk food terminals are in San Francisco, Oakland, Vallejo, Crockett, Stockton, and Sacramento.

The principal terminals for general cargo are in San Francisco, Oakland, Alameda, and Stockton. There are containership terminals in Oakland and Alameda.

2. Terminals: Plans for the Future

Most port agencies around the Bay are planning new terminals to keep pace with the changing technology of shipping. The two new major terminals are the Seventh Street Terminal at the Port of Oakland (still under construction) and the Army Street Terminal in San Francisco.

The new Oakland terminal will be built on 140 acres of diked-off Bay land that is now being filled. This terminal is scheduled to open in 1968; it will provide nine berths for containerships and will be the largest containership terminal on the Pacific Coast. Matson Lines will move its containership operations from Alameda to a portion of the new Oakland terminal.

Plans of the Port of Oakland designate three other areas for new terminals: two are in the Oakland Inner Harbor, along the Oakland Estuary, and are scheduled for eventual redevelopment for either

small containerships or for conventional general cargo ships. The third terminal would be another large port for containerships and would be built by filling a part of the Bay north of the Bay Bridge approach. This area, now marshland and open water, is one of two large undeveloped areas under the Port of Oakland's control that could be developed for major port use; the Port has indicated that major terminals can be provided in San Leandro Bay as an alternative.

In addition to the recently completed Army Street Terminal (which primarily handles conventional general cargo), the Port of San Francisco is considering other major projects: a LASH terminal at Central Basin near the Mission Rock Terminal (Pier 50), a passenger terminal at Pier 35 (the foot of Bay Street), and a major containership terminal on land now being filled south of Islais Creek, near the new Army Street Terminal. (Generally, the Port of San Francisco plans over several years to concentrate its shipping activity in the area south of the Bay Bridge and to gradually replace most of the docks north of the Ferry Building with such things as recreational, commercial, and apartment projects.)

3. Channels: Present Depths

The shipping channels in the Bay extend from the sandbar outside the Golden Gate for 90 waterway miles (via the Bay and San Joaquin River) to Stockton, and for 110 waterway miles to Sacramento.

The central shipping channel through the sandbar is now maintained at a depth of 50 feet below mean lower low water. A water depth about 10 feet below the mean draft of a ship is required for safe passage through this channel. Thus, ships with drafts greater than 45 feet cannot now cross the sandbar, even on a favorable tide. Supertankers with drafts of 40 feet or more must either await favorable tides or unload some of their cargo onto barges before crossing the bar.

The central part of San Francisco Bay has channels with sufficient natural depth to accommodate most deep-draft shipping. Channels across Southampton Shoals in the Central Bay, and San Bruno Shoals in the South Bay, are dredged to 35 and 30 feet, respectively. Access channels are maintained for deep-draft ships to reach the Oakland Outer Harbor, the Oakland-Alameda Estuary, and the Alameda Naval Air Station.

In the relatively-shallow San Pablo Bay, a 35-foot channel is maintained through Pinole Shoal. The Petaluma and Napa Rivers are maintained at depths sufficient to permit barge traffic as far as the cities of Petaluma and Napa.

Carquinez Strait, which connects San Pablo and Suisun Bays, is well over 50 feet deep throughout its length. In Suisun Bay, which is also relatively shallow, shipping channels of 30 feet are maintained.

4. Channels: Proposed Improvements

The principal project planned to accommodate deep-draft ships in the Bay is the Bar-to-Stockton Channel, usually called the "Big Ditch." This $63 million dredging project was authorized by Congress two years ago but is not yet under way because construction funds have not yet been released. The first dredging -- the deepening of the Bay channel -- is expected to begin soon. However, the "Big Ditch" calls for increasing the Bar channel depth from 50 feet now to 55 feet; the main Bay channels will be deepened from 35 feet now to 45 feet; and the channel from Pittsburg to Stockton will be increased from the present 30 feet to 35 feet in depth.

The principal problem posed by the "Big Ditch" is not the dredging itself but the disposal of the 84 million cubic yards of dredged mud that will be taken from the channels. Under the rules established for the Army Engineers' navigation projects, sites for disposing of dredged mud must be provided by

THE BAY AS A HARBOR: PRESENT FACILITIES AND PLANNED IMPROVEMENTS

"local interests," i.e., local governments. Part of the mud -- from the Bar deepening, for example -- can simply be dumped at sea. But as the dredging moves farther inland, the costs of dumping the mud at sea will rise. In the past, mud from channel dredging has often been deposited on the nearest adjacent marshlands and tidelands, "reclaiming" new lands for various purposes.

Congress has appropriated funds to pay for deepening the Oakland Estuary from 30 to 35 feet below MLLW, but the project has not yet been begun because of difficulty in finding a suitable disposal site for the dredged spoil. Other channel improvements may be sought in the future. The Army Engineers have been authorized to study the feasibility of deepening the channel and turning basins at Redwood City from 30 to 35 feet. And if a new deep-water port were to be created in the San Jose-Alviso areas, as has been proposed from time to time, a deep-water channel there would be needed.

Both the Corps of Engineers and private dredging contractors are exploring ways to take spoils from all future dredging projects out to sea, or else to dispose of them on dry land. Present indications are that some method of barging or piping will soon be feasible and BCDC can thus assume that disposal at sea or on dry land (not marshes) will be a reasonable requirement for any major dredging project in the future.

PROPOSALS FOR NEW PORTS

Four new deep-water ports on the Bay -- at Benicia, Antioch, Collinsville, and Alviso-San Jose -- have been proposed by various local groups.

1. Benicia

Benicia Industries, a private corporation that owns a large waterfront area and that leases the former Benicia Arsenal lands, has proposed a four-stage development of a new port. First, a large basin for barges would be created shoreward of the existing 2,400-foot pier. Next, a new pier would be built at the west end of Benicia Industries' property.

This pier would have an automated loader-unloader for bulk cargoes connecting directly with the existing Southern Pacific Railroad line; present plans call for this loader to be the largest on the West Coast. In the third stage, a terminal for both containership and general-cargo vessels would be built on fill. In the final stage, additional piers, container storage areas, and warehouses would be built on fill. The four-stage plan would be carried out over 10 years, would be entirely financed by private capital, and would require up to 200 acres of new fill.

2. Antioch

In its 1965 report on the "Big Ditch" project, the Army Corps of Engineers included a tentative proposal for a deep-water port in the vicinity of Antioch. Also in 1965, a study of the industrial potential of eastern Contra Costa County by consultants to the county's Board of Supervisors proposed that a port be developed in the vicinity of Oakley, east of Antioch. This latter plan, adopted by the Supervisors, is based on expectations of continued industrial development along the San Joaquin River, though sime of this development may be a number of years in coming. Thus, the Antioch-Oakley port would probably not be needed for many years.

3. Collinsville

The 1967 Solano County General Plan proposed industrial development and port facilities at Collinsville, across Carquinez Strait from Antioch. Combined with existing rail connections and a probable freeway crossing from Antioch to Collinsville, deep-water access could open much of the county to industrial development. A port there would probably be used largely for bulk shipping and industrial use, rather than general cargo. Interest in the industrial potential has been heightened by National Steel Company's recent purchase of more than 3,000 acres in this area, making the port more likely.

PROPOSALS FOR NEW PORTS

4. San Jose-Alviso

The Alviso master plan, adopted in 1965, proposes a major port at the mouth of Alviso Slough, with a large industrial area adjacent to it. The San Jose general plan also indicates a deep-water port, but on fill between Jagel and Guadalupe Sloughs, west of the area proposed by Alviso.

HOW MARINE TERMINALS AND WATERWAYS ARE DEVELOPED IN THE BAY AREA

Unlike some other harbors, there is no unified management of port operations in San Francisco Bay. Rather, a multitude of governmental agencies are involved.

1. The Present Situation

Army Corps of Engineers. The Corps exercises the Federal jurisdiction over the nation's navigable waterways, and thus is responsible for maintaining shipping channels. Permits must be obtained from the Corps of Engineers for any construction in the Bay -- such as bridges, tunnels, piers, fill, etc. -- primarily to insure that such work would not interfere with navigation.

In July, 1967, the Corps of Engineers concluded an agreement with the Department of the Interior providing that the Interior Department shall review all applications to the Corps for permits to dredge, fill or excavate in navigable waters. If the Interior Department finds a proposed operation would "unreasonably impair natural resources or the related environment," including fish and wildlife, recreational values, and water quality standards, the Corps will "either deny the permit or include such conditions in the permit" as are needed to protect the public interest.

State Agencies. The State has no direct responsibility for overall port operations in the Bay, but many State agencies influence port work. The Public Utilities Commission, for example, regulates intrastate trucking rates, and thus its decisions can influence the relative attractiveness of various Bay ports. The

State Legislature also makes Bay tidelands available to local agencies for port development. Most important, the State, through its legislative powers, controls the establishment, form and powers of all local port agencies except those exclusively owned and controlled by a single city.

Port of San Francisco. In addition, the State operates the Port of San Francisco through a five-member commission appointed by the Governor. This unusual situation resulted from conditions more than 100 years ago, when San Francisco was the only major port on the Bay and the State Government became concerned with inadequacies in local operation of the port.

Local Port Agencies. Locally-appointed boards of port commissioners operate the ports of Oakland, Redwood City, Stockton, and Sacramento.

Private Terminals. There are three major privately-owned general cargo terminals in the Bay: Howard Terminals, in the Port of Oakland area, Encinal in Alameda, and Parr-Richmond in Richmond. These are old firms whose facilities are modest compared tc the publicly-owned terminals with which they compete. Because they are taxed and cannot use public credit or public loans and grants, the private operators have some difficulty competing with the public ports.

2. Results of Fragmentation

Since no unified port agency is responsible for planning and building terminals around the Bay, each port authority tries to determine the best uses of its own port lands, and to develop them accordingly. The port agencies freely compete with one another. Thus, a major investment by one port can be jeopardized by the competing actions of another. And, of particular importance to the BCDC, parts of the Bay can be filled, and shoreline areas taken, for unnecessarily competing port uses.

Without coordination, the total amount of money spent for ports facilities cannot be invested to the maximum advantage of the region as a whole, e.g., through specialization and through elimination of unnecessary duplication.

REGIONAL PLANNING FOR PORT DEVELOPMENT

The idea of a regional approach to port development in the Bay Area is not new. In 1953, a committee of the State Legislature concluded that two barriers to better port conditions in the Bay Area were "an inherent rivalry between port communities and the lack of a vehicle for concerted action on port problems." As a result of its recommendations, the Northern California Ports and Terminals Bureau was formed, but its principal efforts were limited to comparative rate studies. Within the first year of its existence, Stockton dropped out of the voluntary organization, which continued to lose members until it finally closed its office in mid-1966.

In 1961, the Golden Gate Authority Commission recommended to the Legislature that a single San Francisco Bay authority be established to control seaports, airports, bridges, and land transportation. A bill to create the proposed Golden Gate Transportation Commission was narrowly defeated in the Legislature in 1961, and has been talked about sporadically ever since. The Golden Gate Commission was a major advance over the earlier proposal in that it prescribed the need for the existing ports to transfer significant responsibilities to the central agency, and to be able to spread the costs and benefits among them equitably. The original study commission also recognized the need for the transportation authority to be linked to overall regional planning and to become part of any multi-purpose agency or governmental body that might later be created -- so transportation solutions would not ignore broader regional problems -- but this provision was not included in the actual bill to create the authority.

In the meantime, the Army Corps of Engineers was conducting its Comprehensive Survey of San Francisco Bay and Tributaries. The survey predicted the future development of the Bay Area and anticipated long-range navigation needs. An important feature of the Corps studies is that the forecasts were not based on any regional development objectives or plan -- they were basically projections of present trends without consideration of the changes that could be made in the trends by changes in governmental and economic policies. As a result, the

REGIONAL PLANNING FOR PORT DEVELOPMENT

California Marine Affairs Conference and other groups interested in maritime commerce urged that Congress authorize the Corps to make a much broader study that would examine the economic and governmental forces that influence Bay Area growth and recommend changes that would foster more efficient development of maritime commerce. Congress has authorized a $4.5 million study that will take 6 years to complete, but funds are not expected to be released until late 1968 or in 1969. The very wide scope of the new Corps study will draw increasing attention to the need for effective regional coordination of ports.

Effective regional port planning can best be done by a regional port agency. The BCDC report on Government concludes the Bay Area would be better served by one limited regional government than by several competing agencies. Therefore, regional port planning and coordination -- but not necessarily operation of all ports -- should be considered for inclusion as one of the responsibilities of any limited regional government created for the Bay Area. For the next decade or so, port terminals and channel projects now under way or already planned will be adequate; but beyond that time, regional coordination of ports will be a necessity if the Bay Area is to budget its land and financial resources wisely and to remain a major world port.

A REGIONAL PORT PLAN

How would a regional port agency view the shipping needs of the Bay Area? What priorities would it establish? And what new terminals would it propose?

In the absence of a regional port agency, the BCDC plan for the Bay must attempt to answer these questions. Based on detailed interviews with representatives of all the port agencies around the Bay, with the Army Corps of Engineers, with major shippers, with private consultants on maritime operations, with operators of privately-owned terminals, and with other persons knowledgeable about Bay Area shipping, the following policies are proposed:

A REGIONAL PORT PLAN

1. Shipping and port operations play a vital role in the economy of the Bay Area, but new terminals and improved channels will be needed to keep pace with changes in shipping technology and to maintain the Bay as a world port. The needs of shipping must therefore be given high priority in the BCDC plan for the Bay. This means that some filling and dredging, and some new shoreline areas, will be needed for port use. But this does not mean that all filling planned by a port agency is desirable; future port plans should be evaluated as to their ability to serve regional, not merely local, needs.

2. The present fragmented system of port planning and development may have advantages for a particular community, but it poses serious problems for the region as a whole. In some way, unified port planning and development must be brought about. Only in this manner can sensible regional priorities for investment in new port facilities be established.

3. The BCDC plan for the Bay should assume that the present fragmented system of port planning will not continue indefinitely, but rather will be replaced by some form of regionwide planning and development.

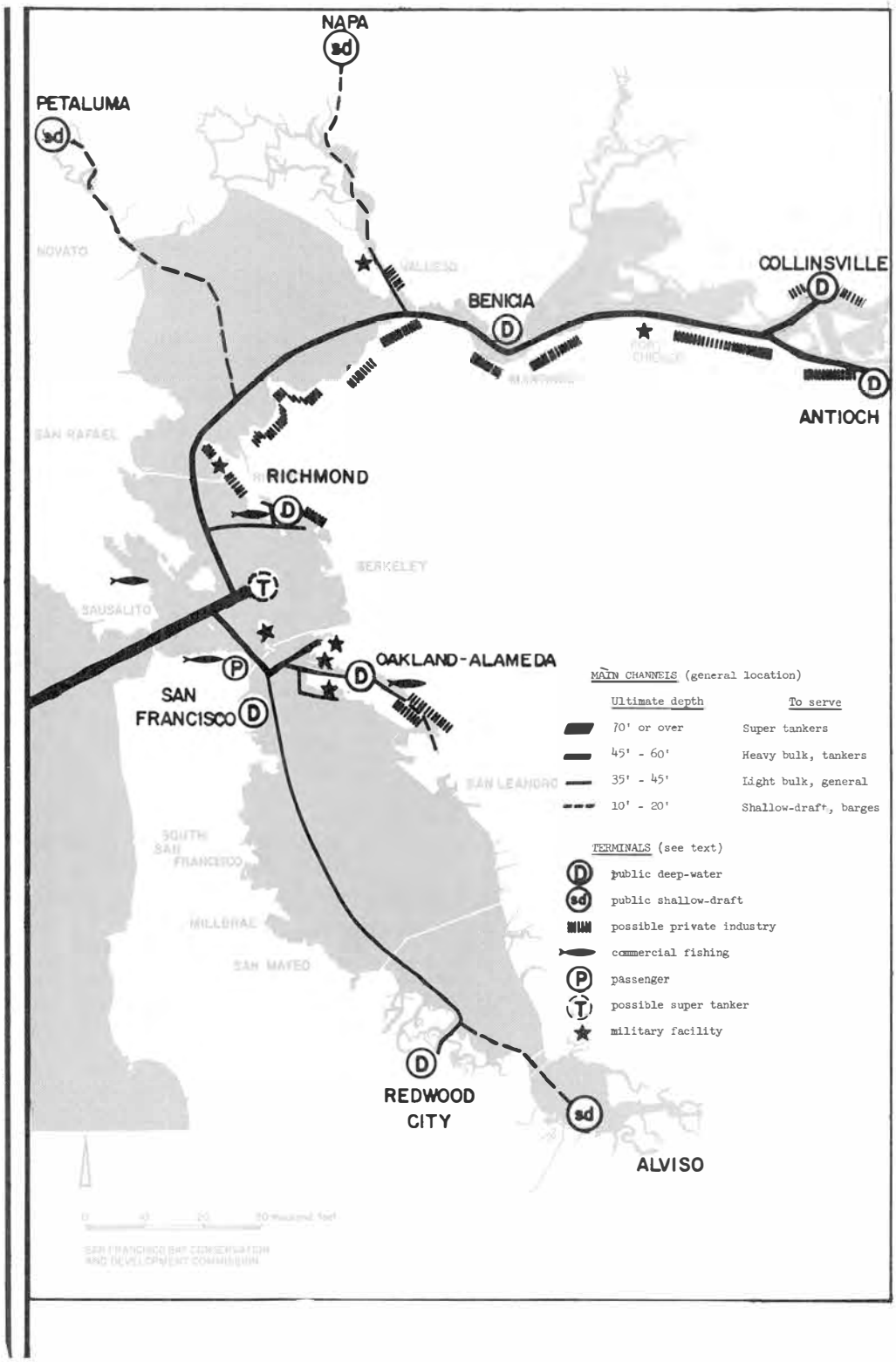
4. In the absence of any later available data, the tonnage projections made by the Army Corps of Engineers in 1963 as part of its Technical Report on Barriers should be used as a basis for estimating future terminal requirements in San Francisco Bay. The estimates assume a larger Bay Area population in 2020 than BCDC has assumed (14 million vs. 10 million), so the resulting port facility estimates should be presumed to be fully adequate, including a good margin of safety to conpensate for any deficiency in the estimates.

5. The BCDC plan should provide for the following port developments (listed counter-clockwise around the Bay):

a. San Francisco. (1) Redevelopment of the waterfront south of the Bay Bridge with modern general cargo terminals and with at least one major terminal for containerships. (2) Gradual shift of most bulk

FIGURE 1

Port Facilities Proposed to Be Included in Plan for the Bay



cargo from San Francisco to Oakland, Redwood City, and North Bay ports. (3) Eventual redevelopment of much of the waterfront north of the Ferry Building for uses not related to shipping. (4) Construction of a new passenger terminal somewhere along the waterfront north of the Ferry Building.

These recommendations are generally in accord with the San Francisco Port Authority's own development plans. San Francisco has neither the industrial land nor the extensive rail facilities to justify large bulk cargo facilities, but it is well located for containerized cargo which can be distributed throughout the region by truck, rail, and barge.

b. Redwood City. (1) Improvement of terminal for bulk cargoes. (2) Dredging of channels to at least 35 feet. (3) Development of the north side of Redwood Creek for public and private terminals.

With deepening of the channel and development of the north side of the creek, Redwood City could absorb some of the bulk shipment now going to San Francisco; it is also a likely site for a container distribution terminal for barge and truck traffic.

c. San Jose. Development of a major barge terminal in the San Jose-Alviso area, but no development of a deep-water ship terminal. The barge terminal could provide important economic benefits for the San Jose-Alviso area, because it could become the nucleus for a major cargo distribution center involving rail, highway, and water transportation. Subsidence problems and the advantages of large concentrated port complexes at other existing ports make a deep-water port unlikely.

d. Alameda. Redevelopment of Encinal Terminals site and the area to the west for container ships and for limited bulk cargo terminals.

e. Oakland. (1) Redevelopment of the Inner Harbor area with modern terminals for general and bulk cargoes. (2) Acquisition for maritime use of any waterfront military property that may become surplus. (3) Gradual redevelopment of industrial

areas south of the Nimitz Freeway and Seventh Street for port-oriented industry, including container storage. (4) Deepening of the Oakland Estuary to 35 feet. (5) Development of a major barge terminal in San Leandro Bay. (6) No filling in the North Harbor area (north of the Bay Bridge approach) for a marine terminal.

The Port of Oakland has sea, air, road, and rail facilities and the necessary space to develop a major regional freight distribution center. Redevelopment of the Inner Harbor for containership use, use of part of the Port of Oakland Industrial Park for container packing and storage, and development of a major barge terminal in San Leandro Bay make such a center possible. A barge terminal in San Leandro Bay would not require large fills and would not preclude recreation uses in the Bay. Port facilities on the Alameda side of the estuary should be expanded. Bay Farm Island should also be studied for possible port development (if it should become available).

No filling is proposed for the Oakland North Harbor (north of the Bay Bridge) because the need for a terminal in this area appears long-range at best. The needed containership berths projected for the Bay Area in 1990 can be provided in Alameda, Benicia, San Francisco, and elsewhere in Oakland. Whether the North Harbor will be needed before 2020 will depend on port expansion in the North Bay area, on the handling rates achieved at other containership terminals, on the feasibility of more intensive use of terminal areas (such as multiple-level container storage), and on other changes in shipping technology that cannot now be predicted with any certainty. Because massive filling would be needed for a North Harbor terminal, the North Harbor should be developed only after a clear regional need for it has been established and after it has been shown that no other suitable alternatives are available.

f. Richmond. (1) Deepening and extension of the Inner Harbor Channel to increase the usable waterfront area. (2) Filling of the barge basin east of the Santa Fe Channel (approximately 100 acres)

and development of the area for containership facilities or industry requiring access to deep-water shipping. (3) Consideration of Point San Pablo as a possible terminal for supertankers if the size of the ships makes them too large to use North Bay channels and no other suitable is available.

The Richmond Inner Harbor could be developed much more intensively for port-related industrial use, especially smaller industries requiring direct water access and perhaps some general cargo traffic. Filling of the barge basin and extending the east-west channel could create nearly a mile of new deep-water frontage with good rail and road access.

Point San Pablo is one of the very few places on the shores of the Bay that has deep-water access immediately adjacent to it; it is a possible supertanker terminal if a Central Bay oil terminal is not feasible.

g. Benicia. Major port development for bulk loading and general cargo berths. This may ultimately require up to 200 acres of fill.

Benicia is the only area around the entire Bay that has the combination of very deep water, road and rail access, and large areas for heavy industry, making it an ideal site for the first large bulk loader-unloader facility on the Bay. Containership facilities would also be appropriate. If properly located and designed, these facilities can be compatible with proposed commercial, recreational and residential uses.

h. Carquinez Strait and Suisun Bay. Development of piers as needed by industry; development should be encouraged along the shoreline east of Martinez. Depending upon the rate of industrial development, Collinsville could be developed as a major port by 1990, but Antioch probably would not be needed until after 1990.

i. Central Bay Oil Terminal. Possible development of deep-water docking facilities for supertankers north of Treasure Island, with pipeline connections to major refineries and storage areas. This may prove to be the most economical and desirable solution to provision of safe harbor for the supertankers without excessive dredging throughout the Bay.

6. These proposals are tentative, and must be reviewed in light of the BCDC report on industry. But the proposals attempt to take into account both the high-priority needs of maritime commerce and other values of the Bay. The proposals would provide the Bay Area with more than adequate shipping terminals to meet future needs, and yet they would require relatively little Bay fill. Furthermore, the proposals would not conflict with existing uses of shoreline land in port areas, and would not require major changes in surface transportation to serve ports. In summary, while the proposals might not provide everything that each port agency or community wishes to have, they do more than meet the needs of the region as a whole, and will keep the Bay Area in the forefront of world maritime trade.

7. Wherever possible, ports should be designed to enable the public to enjoy the "romance of the sea" associated with a major harbor. Too many port areas resemble military installations, with guards and high fences to bar the public from viewing port activities. At present, there are a few places along San Francisco's Embarcadero where some of the older piers are not cut off from the public, and from the Alameda side of the Oakland Estuary it is possible to see ocean-going ships across the narrow channel. But only one terminal -- the Oakland Seventh Street terminal now under construction -- is deliberately setting aside an area for the public to enjoy waterfront views. This is a trend to be encouraged; the maritime atmosphere so important to the Bay Area need not and should not be lost.

SUMMARY

Rapid increases in population mean increasing transportation requirements. Technological developments will yield new forms of transport and demand expanded and continuously modernized support facilities.

San Francisco Bay is the dominant feature of the Bay Area. Among other things, it is a principal transportation corridor among its bordering cities and counties and to the rest of the world.

Transportation facilities -- in this case, maritime -- should be designed to provide the best possible service to the Bay Area with the least possible filling of the Bay.

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A D D E N D U M

PORT PLANNING IMPLICATIONS OF:

1. COLLISION HAZARD
2. CONTAINER UNIT-TRAINS
3. OTHER WEST COAST PORTS

This addendum covers the following subjects which were not included in the original published report on Ports: Maritime Commerce in San Francisco Bay:

1. Environmental Safety Implications of Tankers in San Francisco Bay
2. Implications of Container Unit-Train Possibilities for Port Planning
3. San Francisco Bay Compared to Other West Coast Ports

Safety Implications of Tankers in San Francisco Bay

The Torrey Canyon disaster off the coast of England last year has caused concern over possible consequences of a similar event in San Francisco Bay. However, the sinking of a tanker and the discharge of its oil into the Bay on the scale of the Torrey Canyon disaster are unlikely for four reasons: (1) constantly improving navigation aids, (2) the soft Bay bottom, (3) the slow speed of ships in the Bay, and (4) the ready availability firefighting and other emergency facilities in a harbor as compared to the open seas.

Navigation aids and controls within the Bay are much better than on the open sea and they will be constantly improved. The San Francisco Marine Exchange operates an unofficial but effective "control tower" that keeps track of vessels inside the gate and warns pilots of other vessels in the vicinity. The Coast Guard is considering establishing a "street system" in the Bay much like the air space around an airport, with lanes and directions of traffic clearly identified. Eventually, ships in harbor areas will be controlled much like the Federal Aviation Administration controls aircraft movement. In addition, ship-board electronic guidance systems are being developed to minimize the danger of collision or of running aground. Finally, experienced harbor pilots guide all ships in the Bay.

A major reason for the great damage caused by the Torrey Canyon disaster was the rupture of its hull by the large rocks into which it had steamed. Most of the Bay floor consists of sand and mud, although there are a few areas of sharp rocks in the Golden Gate. In addition, all ships move at sufficiently slow speeds within the Bay to minimize the possibility of major rupture of a tanker either from grounding or from collision with another ship. Finally, in the event of an accident within the Bay, firefighting and other necessary facilities and equipment are relatively close at hand (compared to the open seas), permitting quicker action to prevent an accident from becoming a disaster.

One apparent alternative to a possible accident in the Bay would be to locate a major tanker terminal facility a safe distance outside the Golden Gate. However, it appears that ocean currents buffeting the ships would increase the likelihood of accident, with resulting potential damage to the coastal areas, or even to the Bay through the sweep of the tides into the Bay. There is also a question as to how many vessels could be accommodated at one time at a terminal in the ocean, and how far out or how far away from the Bay market such a facility would have to be because of the shallowness of the continental shelf.

In conclusion, it appears the danger of ship collision in the Bay is small, and constantly decreasing, and that in any event, facilities in the Bay would be potentially less hazardous than facilities outside the Golden Gate.

Implications of Container Unit-Train Possibilities for Port Planning

1. The Unit-Train Concept

The unit-train is essentially a long (80 or more cars), permanently-coupled train that runs as a unit between two points on a regular basis; it may run to different points on different trips, however. The cost per ton of moving cargo in this manner is much less than for a conventional freight train because of the guaranteed utilization of equipment and the elimination of the cost of making up and breaking down trains.

For feasible movement in unit-trains, a commodity must:

1. Be of a single type capable of being loaded and unloaded rapidly.

   Coal, potash, and automobiles are among the few commodities so far proven feasible for unit-train movement.

2. Move in very large volumes continuously.

   The train must move on a regular basis, with no delays, and with a full load. As an example of the volume required, a unit-train to Southern California moves 11,000 tons of coal weekly, 52 weeks a year, from a mine to a power plant.

3. Originate at one fixed point and be destined for another fixed point.

   To be economical, the unit train can have no stops between the two points it serves. Thus, minerals destined for a specific port, mill, or power plant are possible candidates for the system.

2. Unit-Trains and Containerization

As indicated elsewhere in this report, containerization is a rapidly-growing method of moving general cargoes. First used in domestic commerce, containers are now beginning to be used in foreign trade. The Japanese recently decided to use containerization extensively and have formed a consortium of steamship companies to order a fleet of large containerships. Some American lines, notably Matson, SeaLand, and Pacific Far East Lines, are also building containerships for the trans-Pacific trade.

American railroads and the several steamship companies are studying the possibility of moving containers across North America by unit-train instead of by ship passage through the Panama Canal. According to one consultant, A. T. Kearney and Company, Inc., moving the containers by unit-train would cost about as much as moving them by ship but the unit-train would pare five days from the total transportation time between Japan and the east coast of the United States; this would permit a much greater rate of ship utilization. The Kearney Company concluded that sufficient tonnage will be available to support two weekly trains from a single West Coast port to the east.

The railroads studying unit-trains have raised questions about the uncertain volume of foreign trade involved and the unused capacity of the existing trans-continental rail services. Railroaders also indicate that sources and destinations of container cargo are now widely dispersed in the U.S. and are likely to become more so in the future, reducing the advantages of a point-to-point service. However, none preclude the possibility of the unit-train becoming feasible for moving containerized cargo from one port in the west to one in the east.

Meanwhile, however, unit-trains are being explored to move containerized food products from Northern California to eastern markets. The Kearney firm has concluded that sufficient volume exists to support at least two weekly trains; according to Kearney officials, the food industry is enthused about the possibility and probably will embark on the program, perhaps within a year. Kearney points out the steady volume of the food train provides the base to which the now-small, but potentially large, volume of trans-Pacific containers could be added.

3. Facility Requirements

Shippers and railroad men generally agree that unit-train operations for trans-Pacific cargoes would have to be concentrated in a single West Coast terminal. The terminal would have to be extremely large to accommodate the many steamship lines that would use it, and to provide the necessary assembly and storage areas and rail facilities. Because of the probable difficulty of finding and developing one adequate site, a smaller terminal linked to several nearby terminals by barge or other shuttle transport system might have to be considered if at all feasible.

To have the initial volume of containers necessary to begin a unit train operation, the facility is most likely to be established in a port that already has substantial container traffic. The Bay Area has an edge over other high-volume ports (Los Angeles-Long Beach and possibly Seattle) because most U.S. military cargo to the Far East moves through the Bay Area in civilian container-ships, helping to balance the preponderant west-to-east traffic from Japan, and the proposed food train will originate in Northern California. A terminal facility that could accommodate both food shipments and overseas containers would have to be very large; the total requirements have not been computed but 700 to 1,000 acres appears reasonable for a fully-developed operation. Without the food train, a smaller area, perhaps 500 acres, would be needed for the overseas container movement.

4. Possible Sites in the Bay Area

If the containership unit-train concept proves workable, certainly the Bay Area should seek to become the West Coast port for its development. Within the Bay, at least two areas appear well suited for a containership unit-train terminal: the Richmond Inner Harbor and Benicia. Both could develop new unit-train terminals with relative ease, with the relatively small amounts of new Bay fill indicated in the Technical Report.

But neither the Richmond nor the Benicia waterfront is under the jurisdiction of a public port agency, and thus far the only specific proposal for unit-train operations has been made by the Port of Oakland for its North Harbor area (north of the Bay Bridge in Oakland). The Oakland development would probably be more expensive than the other two, and would probably take longer to complete, because the entire site would have to be diked and filled, new channels would have to be dredged, and improved highway and rail facilities would be needed. But the Port of Oakland is clearly capable of developing a new terminal in the North Harbor.

This situation illustrates the need for a regional port agency to plan and coordinate future port expansion in the interest of the Bay Area as a whole. Ideally, such an agency would now be exploring the unit-train concept, evaluating potential sites within the Bay Area, preparing to select the best site, and then planning for construction.

5. Implications for BCDC Planning

A large area would be needed for a unit-train terminal, and successful operations might require enlargement of the area as future containership volume increases. Thus, some Bay filling might be needed for the initial terminal and further filling for later expansion.

There is as yet, however, no certainty as to the feasibility of a containership unit-train operation. Therefore, the BCDC plan for the Bay should not at this time include extensive new filling for a unit-train terminal, but should be sufficiently flexible to accommodate such a terminal if it later appears warranted.

And the unit-train proposals clearly indicate the need for a regional port agency that can evaluate new shipping technology and can make decisions for future port development taking into account the need for surface transportation to serve ports and the effect of Bay filling in the various areas proposed for port expansion.

San Francisco Bay Compared to Other West Coast Ports

There are six principal port areas on the West Coast: San Diego Bay, San Pedro Bay, San Francisco Bay, Portland, Seattle, and Vancouver (British Columbia). Each serves a large hinterland, but each also competes with the others to a degree. A comparison of port facilities and traffic in each area shows the importance of San Francisco Bay as a harbor on the West Coast.

1. Tonnages Handled

The comparitive traffic figures in Tables 1 and 2 show that the Bay Region is a close second to Los Angeles-Long Beach in petroleum movement, and clearly dominates non-petroleum commerce, both domestic and foreign.

These are aggregate statistics for harbor areas. The Bay system includes five public port agencies, and several private facilities. Figures 4 and 5 of the Technical Report show how the traffic is shared among these agencies.

Portland, Seattle, and Vancouver are primarily exporters of bulk products: grains and forest products are their principal commodities. Los Angeles-Long Beach is more diversified, with considerable bulk traffic in metallic ores. The Bay Area is the most diversified of all.

2. Facilities

The 1965 study by Stanford Research Institute, Marine Terminal Requirements in California for 1975, established standards for determining the adequacy of general cargo berths. The standards are listed in Table 4 (page 45) of the Technical Report. Applying the standards to California ports, SRI found that, by 1975, approximately 80 adequate berths with sheds and 14 open wharves would be available in the Bay Region. This is less than the San Pedro Bay harbor but far more than San Diego, as the following table shows.

ADEQUATE GENERAL CARGO BERTHS
ESTIMATED TO BE AVAILABLE IN 1975,
BY PORT

Port	Berths With Sheds	Open Wharves
San Diego Bay	10	5
San Pedro Bay	105	22
San Francisco Bay	80	14

Source: Stanford Research Institute, 1965.

Comparable data is not available for the other West Coast Ports, nor is comparable data available for other types of port facilities such as tanker or other bulk cargo terminals.

The only special facility worthy of note is a new supertanker tanker terminal in Los Angeles Harbor that can accommodate 2 fully loaded 100,000 dwt vessels.

TABLE 1

OCEANBOUND PETROLEUM COMMERCE, 1965
(Thousands of short tons)

Port Area	Domestic		Foreign		Total
	Receipts	Shipments	Imports	Exports	
San Diego Bay	347	13	268	4	659
San Pedro Bay	4,300	7,763	8,468	1,835	22,367
San Francisco Bay	10,172	6,484	4,460	577	21,693
Portland	5,334	621	20	12	5,986
Seattle	4,743	1,051	89	6	5,889

TABLE 2

OCEANBOUND GENERAL CARGO COMMERCE, 1965
(Thousands of short tons)

Port Area	Domestic		Foreign		Total
	Receipts	Shipments	Imports	Exports	
San Diego Bay	6	--	19	134	159
San Pedro Bay	167	121	1,410	2,870	4,002
San Francisco Bay	1,916	1,642	2,448	5,298	11,303
Portland	781	86	38	2,988	3,923
Seattle	155	195	95	1,012	1,458

Source: U. S. Army Corps of Engineers.

SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION
507 Polk Street, San Francisco 94102 557-3686

Possible Bay Planning Conclusions Based on the Report on Ports

1. San Francisco Bay is one of the world's great natural harbors, and maritime commerce is of primary importance to the entire economy of the Bay Area.

2. Because of the large size of the Bay and the numerous existing and potential sites for harbor facilities and to foster appropriate development of the Bay as a natural harbor, future port planning and development -- but not necessarily port operation -- should be made the responsibility of a regional agency.

3. To preserve and enhance the standing of the Bay Area as a major world port, adequate, modern port facilities must be provided. At the same time, unnecessary duplication of port facilities should be avoided, particularly if such duplication would involve unnecessary Bay fill. Also, the development of port facilities should be carefully coordinated with other shoreline uses.

4. Marine terminals and channel-deepening projects now under way or already authorized are generally adequate to meet immediate needs. However, new terminals and further channel improvements will be needed to keep pace with changes in shipping technology. These terminal and channel improvements will provide substantial public benefits for the entire region, and should thus be given high priority in the Commission's plan for the Bay. Some filling and dredging will be necessary to provide for necessary port expansion, and some new shoreline areas will be needed for port use, but any permitted fill or dredging should provide regional, not merely local, benefits.

5. For purposes of BCDC planning, the principal problem with dredging channels in the Bay is the difficulty of disposing of large quantities of dredged mud. The BCDC report on Sedimentation recommended four methods of solving this problem with minimum harmful effect on the Bay: (1) placing the spoil on dry land, (2) using the spoil as the source of fill for approved fill projects, (3) taking the spoil out to sea by barge or pipeline, and (4) dumping the spoil in designated parts of the Bay where the maximum possible amount will be carried out the Golden Gate on the ebb tides. The Commission's plan for the Bay should provide that spoil disposal for future dredging projects must follow one or more of these four alternatives, and that no further tidelands or marshlands in the Bay can be filled solely to provide an area for spoil disposal.

6. To enhance the maritime atmosphere of the Bay Area, ports should be designed, wherever feasible, to permit public viewing of port activities by means of (1) view points, restaurants, etc., that would not interfere with port operations, and (2) openings between buildings and other site designs that permit views from nearby roads.

7. To meet known future requirements, and assuming there will be adequate regional controls to coordinate all future port developments, the Commission's plan for the Bay should assume new port developments as described on pages 22 to 27 and Figure 1 of the Summary, and in addition, the following:

a. In Section five, Richmond (pages 26-27):

Add to the first paragraph: "(4) use of the Kaiser Shipyard No. 3, now held by the Federal government, for containership facilities or industry requiring access to deep water shipping."

Add a new final paragraph: "The Kaiser Shipyard site consists of about 200 acres inside the 'elbow' of the Inner Harbor channel. It is almost entirely flat, and has approximately 7,000 feet of frontage on a 35-foot channel; 5,000 feet of this frontage is a continuous wharf and two narrow finger piers occupy the remaining area. The site is already served by a direct line and spurs of the Santa Fe Railroad and by a good industrial access road. About 72 acres on the north end of the property is vacant and available for development. The balance of the site is under five-year leases that could be phased out as demand for port use expands. Although the entire site may not be available for ten years, up to seven modern containership berths, complete with backup land, could ultimately be developed with little or no fill. When these potential facilities are combined with the Santa Fe lands to the east, where fill and dredging could create as many as ten modern berths, together with other existing facilities, the possibility of a major Bay port complex emerges."

8. A continuing regional agency should periodically revise the plan to meet the needs for port development that may not be foreseen today.

Adopted by the Commission at its meeting of 2/1/68

AIRPORTS

ON THE BAY

Part of
a Detailed
Study of
San Francisco
Bay

San Francisco Bay
Conservation and
Development
Commission

San Francisco
California

September 1966

Summary of the report, "Air Transportation and San Francisco Bay," by Clifford W. Graves, Associate Planner.

INTRODUCTION

Many people in the Bay Area still remember the day in 1929 when Col. Charles A. Lindbergh, about to take off in a "giant" 32-passenger Patrician, swerved from the runway at San Francisco's Mills Field to avoid an incoming plane and got stuck in the mud. That was only 37 years ago.

Times have changed. In 1965 there were nearly 1.4 million aircraft take-offs and landings at the seven principal Bay Area civilian airports. About 1/5 of these were by scheduled airliners carrying more than 10 million passengers. These passengers flew in jet-powered 707's, DC 8's, VC 10's, and other aircraft that only vaguely resemble Lindbergh's tiny plane. The modern air terminals at Oakland and San Francisco likewise only vaguely resemble the ones that greeted Lindbergh, Amelia Earhart, and the many other aviation pioneers who used to call there. Aviation is big business in the Bay Area today, employing more than 35,000 persons, and making jobs for many others in such diverse fields as flower-growing, electronics, and tourism.

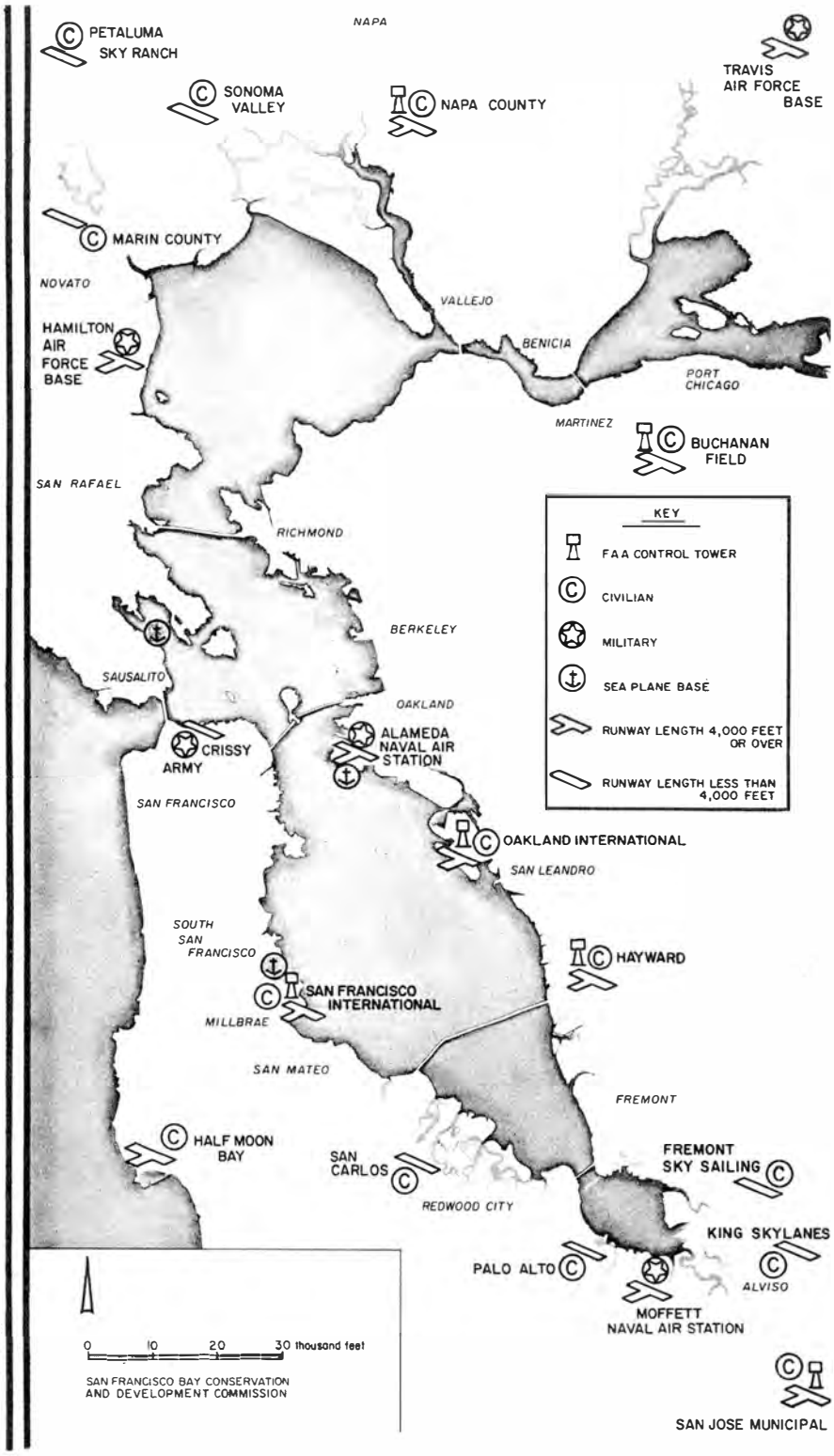
The development of air transportation has already had major effects upon San Francisco Bay and its shoreline. Meanwhile, air transportation is growing rapidly. Machines for moving people through the air have evolved at a dazzling rate -- commercial jets have been flying for only 8 years and already 500-passenger craft are on order, supersonic transports are being planned, and ballistic passenger rockets will certainly be operational by the year 2000. One has only to look back to 1929 and ponder the change in air transportation and rocketry in the last 37 years to appreciate how much change there will be in the next 37 years. Planning for the Bay must reckon with the needs that current and coming generations of aerial vehicles will have for terminals and other facilities on the ground.

WHERE THE AIRPORTS ARE

Figure 1 shows the location of the 20 airports in the immediate area around San Francisco Bay. Seven are located on the shores of the Bay or on fill in the Bay.

FIGURE 1

Bay Area Airports 1966



Page 2

WHERE THE AIRPORTS ARE

The location of a large number of the airports adjacent to and in San Francisco Bay is no accident. Airports require large flat sites, free from surrounding obstructions. They must keep their distance from populated areas for safety and acoustic reasons, but they must be convenient to population centers via good ground transportation service. Land costs must be relatively low.

The topography of the Bay region leaves few large flat sites inside the Bay basin. By the time airports were being developed in the 1920's and 1930's, most suitable sites away from the shore had been developed for other uses. The Bay shore met all the criteria.

Incompatible development has crowded around some airports, but the Bay has proven to be a valuable flight path for aircraft to minimize noise and built-up areas. And the open waters still offer obstruction-free take-off and landing zones.

When located near the heart of a densely developed urban area, open water areas remain one of the few types of locations meeting the needs of high volume passenger and freight airports. However, the spread of population and rapid improvement in surface transportation and helicopter transport make inland sites away from the Bay feasible today and in the future.

EFFECTS OF AIRPORTS ON THE BAY

The two major airports, San Francisco and Oakland, were built by "reclaiming" marshes, mudflats, and shallow waters with extensive amounts of fill. San Francisco has filled 3,400 acres and, under its current long-range plans, would eventually fill about 1,400 more acres. Oakland has filled 1,485 acres and proposes soon to fill 140 more. More than 4,000 acres of fill are included in Oakland's master plan.

Approximately 1,000 acres of fill were required for the Alameda Naval Air Station. No additional fill has been proposed or is anticipated there.

EFFECTS OF AIRPORTS ON THE BAY

Moffett Naval Air Station, Crissy Field in the Presidio of San Francisco, Hamilton Air Force Base, and San Carlos Airport have been wholly or partially built on fills in the Bay, but the aggregate acreage is small compared to the three major facilities.

Definitive information on the effect of these fills on the Bay is not available. The BCDC report on Tidal Movement indicates that most fills, particularly large ones, interfere with tidal currents. Although it has not been demonstrated in tests, it may be supposed that the Alameda Naval Air Station fill, projecting into the narrow gap at the head of the South Bay has interfered with the already-poor water circulation in the South Bay. It is believed that the Oakland Airport fill has caused siltation problems in the San Leandro Marina to its south. In addition to any effects on currents, all fills reduce the volume of water in the Bay and thereby reduce the amount of oxygen available for marine life and pollution abatement.

In addition to their effects on the Bay through filling, airports generate a host of satellite uses which are airport-oriented and thus divert valuable frontage from water-oriented uses.

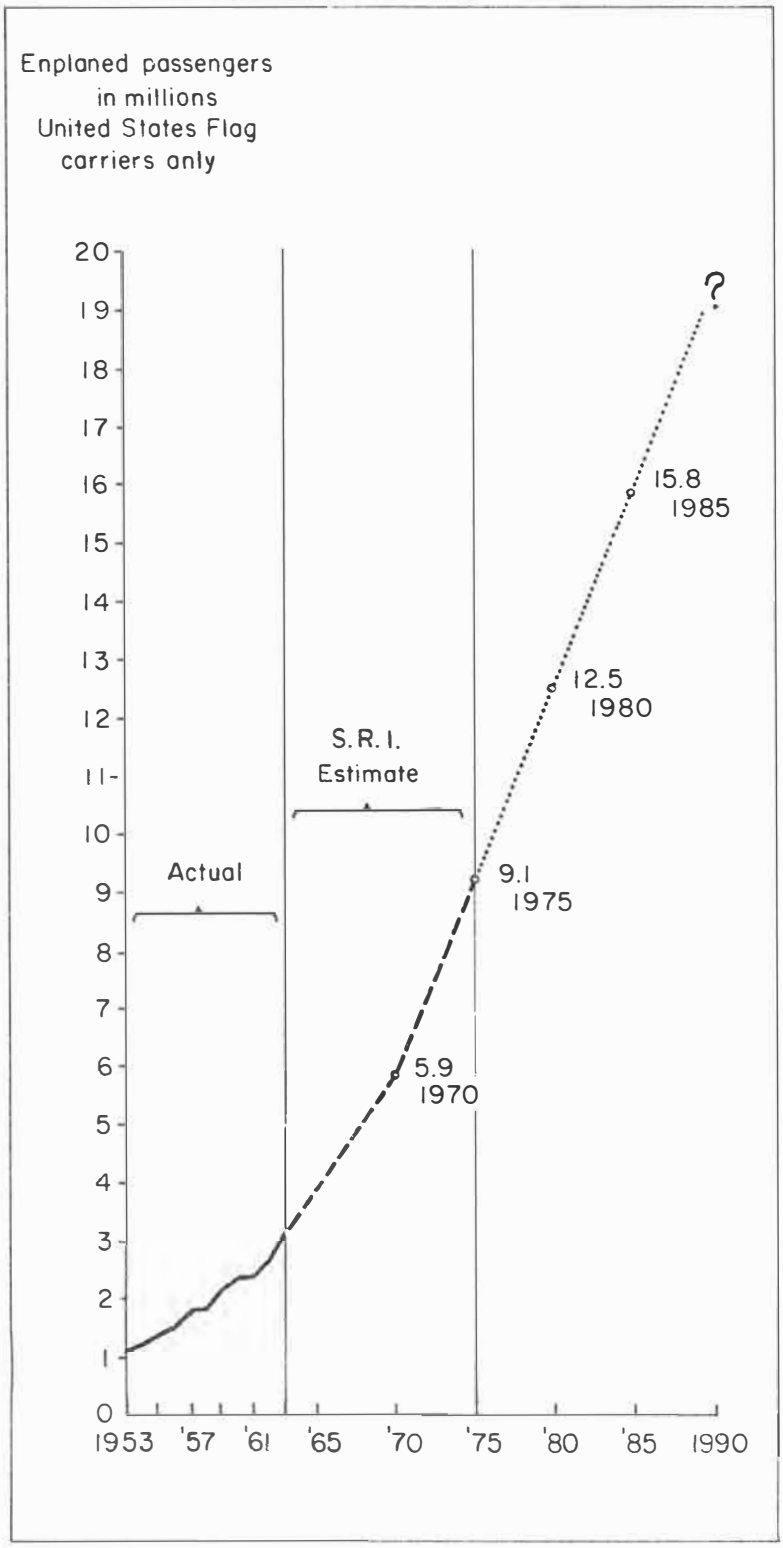
Finally, airports usually have large open areas to reduce encroachment by incompatible uses and to meet future expansion needs. Such areas can often be used for compatible recreational activities that have no major buildings and no concentrations of people. Such multiple use occurs at a few airports in the Bay Area and should be generally encouraged at all airports, especially those fronting upon San Francisco Bay.

THE FUTURE MAJOR AIR FACILITY DEMAND

Airline passenger traffic in the San Francisco region tripled from 1953 to 1963 (Figure 2). Stanford Research Institute projections anticipate it will almost triple again by 1975. No one has predicted beyond that date for the Bay Area, but a simple projection of past trends gives some indication of probable passenger volumes. Population growth and greater general affluence will result in constantly increasing travel demand for the foreseeable future. These figures include both

FIGURE 2

Projected Enplaned Air Passengers for San Francisco Regional Airport Service Area*



Source: 1953-63 data and estimates to 1975 Stanford Research Institute <u>Air Terminal Requirements in California through 1975</u> Prepared for California State Office of Planning January 1966. 1990 projection indicative only.

*San Francisco Regional Airport Service Area includes nine Bay Area counties + Santa Cruz, San Joaquin, & Stanislaus Counties

THE FUTURE MAJOR AIR FACILITY DEMAND

transcontinental and international passengers, as well as most short- and medium-haul passengers.

Airports must be adapted not only to handle increasing numbers of passengers, but also to accommodate the changing types of aircraft used to carry them. San Francisco and Oakland have immediate plans for expansions to accommodate the soon-to-arrive 500-passenger "stretched" jets and the 900-passenger jets, which will be landing here a few years later. Ground support requirements for SST's are only being evaluated (they may be less of a problem than the big jets). But no one has yet given much thought to the ground support requirements of a rocket passenger vehicle.

The biggest aircraft will probably be used in transcontinental and international commerce. Smaller planes will still be needed for shorter hauls (several new short-haul jets will be entering service soon).

Another emerging air service demand is cargo. Air cargo tonnages have increased even more rapidly than passenger traffic in the last three years. Projections indicate that Bay Area tonnage will probably triple in the next four years (from 60,000 tons in 1964 to 180,000 tons in 1968). Almost half of this tonnage moves on regular passenger flights. Development of "quick change" aircraft, capable of passenger transport in the daytime and cargo hauling at night, will permit more effective utilization of expensive aircraft. Combined passenger-cargo use is a feature that will probably be retained in future generations of aircraft.

Thus it appears the major airport of the near future must be able to accommodate both short- and long-haul aircraft and both passenger and air cargo volumes. In the absence of definite airport planning standards to accommodate the rapid emergence of new types of aircraft, plus great increases in volumes, it may at least be presumed that such an airport should be designed to accommodate rapid obsolescence and should have a large enough site to accommodate new ground-support and passenger-cargo handling facilities while obsolete ones are being phased out.

THE FUTURE MAJOR AIR FACILITY DEMAND

The airport site must also be accessible to major surface transportation facilities as it is likely to become the most important single traffic generator in the region.

ALTERNATIVES FOR MEETING NEEDS OF MAJOR AIRPORTS

A regional airport system study should be undertaken at the earliest possible time to determine how best to meet airport needs. Such a study would take at least a year once it is authorized and financed. Authorization, design, and completion of a new major airport would take an additional five to six years. In the absence of such a study, and given the major importance of air transportation in any region's economy, there appears to be no alternative to the current expansion plans of San Francisco and Oakland to meet immediate ground support requirements of increased traffic and larger aircraft.

Until a regional airport system study is completed, immediate assumptions must be made as a guide for both regional and Bay planning. To handle large numbers of aircraft and passengers and to have room to build new facilities while phasing out obsolete ones, the need for a very large site may be presumed (perhaps about 15,000 acres, half again the size of Dulles International Airport). The available locations would be either in the Bay by means of extensive filling or in still-open areas of eastern Alameda, Contra Costa, Solano, or Sonoma Counties. Pending the completion of a regional airport system study some years from now, a location in or away from the Bay will have to be assumed for planning purposes. That assumption however should await completion of the forthcoming BCDC report on surface transportation, which will reflect the work of the Bay Area Transportation Study Commission, and will evaluate probable surface transportation systems that may be available to service an airport in the several possible locations.

Finally, an efficient regional airport system is likely to be achieved only by a single regional agency that can draw needed funds from a regional tax base, control land use around airports, and allocate functions among different airports to minimize costly duplication.

THE FUTURE GENERAL AIR FACILITY DEMAND

In addition to the major regional air carrier facility, there are general aviation airports (some of which also serve short-haul air carriers), military air bases and heliports.

1. General Aviation

Almost 80% of the take-offs and landings at the seven major airports in the Bay Area are made by private business and pleasure flights, which are called general aviation. Four of these airports -- San Francisco, Oakland, San Jose, and Santa Rosa -- also served scheduled air carriers. In addition to the seven airports that have FAA-operated control towers, there are 23 other public and private airports in the Bay Area. Three more are proposed in the FAA's National Airport Plan by 1970 (in Richmond, Fremont, and San Francisco).

Most general aviation airports primarily accommodate small planes with relatively small take-off and landing clear zone requirements. Noise is much less a factor than at a large airport. Depending upon runway layout, hangar and repair service facilities, and airplane storage space requirements, general aviation airport land area requirements range from 100 acres to 400 acres. Small airports are numerous enough to be located as close to their local service area as land costs permit.

In the absence of an overall regional airport system plan, immediate assumptions must be made as a guide for Bay planning. A number of general aviation airports will be needed to augment a regional facility. It may be presumed that the four existing airports serving scheduled air carriers will be sufficient to supplement a major regional facility, unless one or more of them becomes the major large facility of the future. In the event additional supplemental airports are needed, it may be presumed present military airfields will be available for conversion to civilian air carrier use. It may further be presumed that there must be additional smaller private and public general aviation airports to meet the needs of a growing population. Location criteria are sufficiently flexible to ordinarily permit location elsewhere than on the Bay shore; therefore, Bay shore locations

should be discouraged and diking or filling the Bay should not be allowed for a general aviation facility, except possibly for a business aircraft facility near the most built-up area.

2. Military Bases

The principal military air bases around the Bay are Alameda Naval Air Station, Hamilton Air Force Base in Marin County, Moffett Naval Air Station in Santa Clara County, and Travis Air Force Base in Solano County.

No additional military airports are anticipated. On the other hand, in view of the long-range decline in the use of manned aircraft by the military, there is considerable possibility that one or more of the facilities might eventually be released to civilian general aviation use.

3. Heliports

Despite relatively high costs per mile, helicopter service is rapidly emerging to provide fast passenger service between airports and between major city centers. The FAA's National Airport Plan proposes that nine new heliports be built in the Bay Area to meet expected 1970 needs.

Like rapid transit stations, heliports should be located in the heart of the area where they are needed, convenient to other means of transportation. Land requirements are not great and rooftops can often serve landing needs. The biggest single location problem at the present time is the noise generated by helicopters in confined urban spaces.

Because of the noise problem, there may be some pressure to provide heliport sites in waterfront locations. Since landing site requirements are relatively small, and since pilings, or even floats, may provide sufficient platform support, heliports should be allowed on the Bay front if sufficient public necessity is demonstrated. But existing pier facilities should be used to the extent possible, or adequate tests should be made to assure landing platform design that minimizes damaging effects upon the Bay.

THE FUTURE GENERAL AIR FACILITY DEMAND

4. V/STOL Ports

Within about 15 years, V/STOL (Vertical and Short Take-Off and Landing) aircraft are expected to be operational. These are fixed-wing planes that combine the forward speed and handling ability of a conventional aircraft with the ability of a helicopter to take off and land in a very small area.

V/STOL aircraft carry more passengers and cargo than helicopters and could well be providing city-to-city service by 1980. To be competitive with conventional aircraft, V/STOL aircraft will have to be close to city centers to minimize ground travel time.

A STOL airport requires at least a 1,500-foot runway; at least 10 acres would be needed for a small airport. A VTOL port requires three to six acres. A city terminal would require normal airport passenger-processing and equipment maintenance facilities. VTOL ports might be located on rooftops. The noise problem is expected to be serious and waterfront locations will probably be especially desirable to alleviate it.

SUMMARY

Rapid increases in population mean increasing transportation requirements. Mind-staggering technological developments will yield new forms of transport and demand expanded and continuously modernized support facilities.

San Francisco Bay is the dominant feature of the Bay Area. Among other things, it is a principal transportation corridor among its bordering cities and counties.

Transportation facilities, in this case aerial, should be designed to provide the best possible service for the Bay Area with the least possible infringement upon the Bay, which serves the region so well in so many ways.

SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION
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Possible Bay Planning Conclusions Based on the Report on Airports on the Bay

1. For the Bay Area to have adequate but not excessive airport facilities, and to minimize the harmful effects of airport expansion upon the Bay, a regional airport system plan should be prepared at the earliest possible time by a responsible regional agency that has, or will be in a position to cause creation of, authority to carry out the plan by allocating funds from a regional tax base and by controlling surrounding land use.

2. Pending completion of a comprehensive airport system plan, and recognizing that various classes of airports must be included in any plan for the region or the Bay, it shall be assumed that:

a. One major regional airport facility will be needed in the Bay Area to meet future air transport needs caused by very rapid increases in passenger and cargo volumes. Such a facility will ultimately need a very large area (probably in excess of 15,000 acres), protection from incompatible surrounding development, and direct service by the main surface and subsurface transportation system.

b. Existing military and civilian airports will meet supplementary civilian and military air carrier needs. Such facilities should be protected from incompatible surrounding development to permit their continued use for this purpose.

c. Additional general aviation fields for small plane traffic will be needed. Such facilities may be relatively small (100 to 400 acres), and should be convenient to the local market served.

d. V/STOL ports and heliports to serve the airports, intra-regional and short-haul traffic (e.g., Sacramento, Stockton, Monterey), will be needed close to most or all major population and commercial centers. Such facilities need close proximity to the center served, access to the local transportation system and to parking, and special attention in site selection to minimize the noise problem to the immediate surrounding area.

3. In regard to the Bay and its shores, the plan for the Bay should take into account that:

a. A new or expanded regional airport could not be in operation for at least 10 years. A location will be assumed by the Commission for planning purposes upon completion of the Commission's report on surface and subsurface transportation. Regional airport needs in the interval until then should be met by temporary substitute arrangements to the extent determined feasible, and should be met by filling the Bay only as it is demonstrated that no feasible alternative is available. Filling the Bay to provide unnecessary duplication of facilities should be avoided.

b. Expansion or construction of new general aviation facilities should be met in manners not requiring filling or diking in the Bay. New facilities should be located on the Bay shore only as it is demonstrated that no feasible alternative is available.

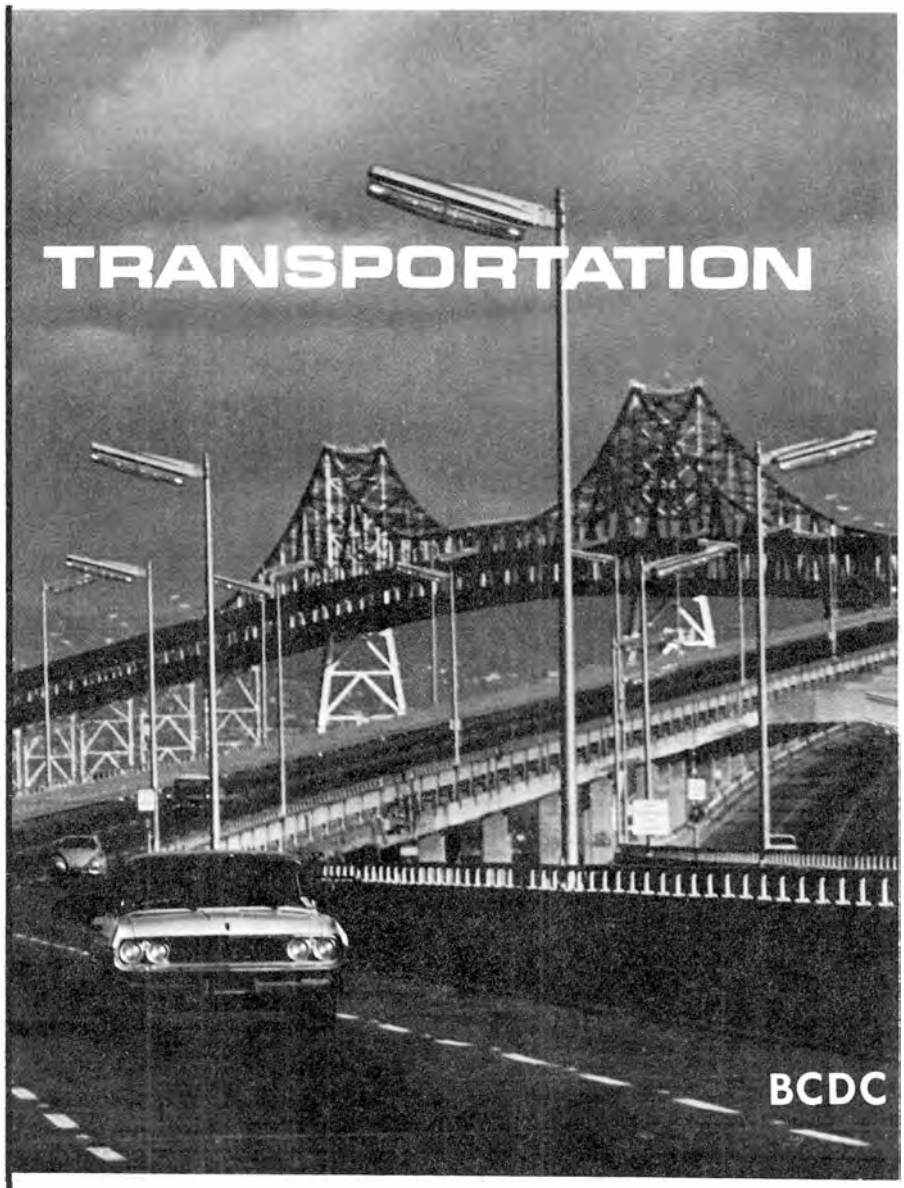
c. Heliports may in some instances need to be located on the shore of the Bay in order to be close to a traffic center with minimum noise interference. In such event, existing pier facilities should be used. New piers, floats, or fill should be permitted only if it is demonstrated that no feasible alternative is available, and then only if designed to minimize potential damage to the Bay.

d. To the extent feasible, all airports on the Bay front should allow compatible water-oriented public uses of the shoreline.

Adopted by the Commission at its meeting of 10/6/66

TRANSPORTATION

Part of
a Detailed
Study of
San Francisco
Bay



San Francisco Bay
Conservation and
Development
Commission

San Francisco,
California

February, 1968

Summary of the report, "Surface Transportation on and Around San Francisco Bay," by George E. Reed, Associate Planner.

INTRODUCTION

Mom to the grocery store, to the hairdresser, the drug store, and home -- and out again to shuttle the kids to music lessons and the library.

Dad to work every day -- sometimes a quick trip to Los Angeles or Chicago.

Families to a weekend in the mountains, a vacation in Mexico.

Short trips, long trips -- by car, bus, plane. Beyond the neighborhood, there's often a switch from one kind of transportation to another.

Parcels and other goods are constantly on the move too: parcel and mail delivery services in the neighborhoods, downtown streets clogged with trucks, traffic tie-ups while a long freight blocks the railroad crossing.

Transportation is part of the tissue and fiber of our communities, like the arteries and veins in our bodies. It is a substantial part of our lives -- a substantial part of the total national and regional economy -- and transportation has a substantial effect on San Francisco Bay.

THE BASIC TRANSPORTATION PROBLEM

Man constantly tinkers, tries to improve on what he currently has. In transportation, this means a continuous evolution now involving new generations of automobiles, planes, even buses and trains.

But most of the tinkering is done with the vehicles; little is done about the total transportation system.

All of the means of transportation -- cars, trucks, buses, trains, planes, pipelines, barges, ferries -- are part of a total system. For example, planes depend on other vehicles to get passengers to airports, railroads become freight haulers as passengers switch to cars and planes. Pipelines cut into the market for tankers and barges.

THE BASIC TRANSPORTATION PROBLEM

Because transportation is seldom developed as a total system, society suffers losses in time (from bad connections, or congestion), money (inefficient use of equipment, unnecessary duplication), and amenity (excessive scarring of city and country living space that is supposed to be served, not overrun, by the means of getting about).

Under the current fragmented approach to transportation throughout the nation, highways too often are planned as separate systems with only incidental concern for connections to transit facilities or railroad terminals. A rapid transit system too often is planned without simultaneous plans for a feeder bus system. Air terminals are planned for speedy service between cities without regard for ground transportation to move very large volumes of people and cargo to and from the airport. Cargo from overseas is speeded across the wharves with increasing efficiency only to be delayed in congestion on the streets. In 1968, the Federal government is spending $4.1 billion on highways, $.9 billion on air transport, $.8 billion on water transport, and only $.1 billion on urban mass transportation.

Under the fragmented approach to transportation, San Francisco Bay may suffer unnecessarily. Too often there is pressure to fill the Bay because there seems to be no other convenient place for freeways (and for airports and ports, which are discussed in other BCDC reports). Previous BCDC reports have described the harmful effects of Bay filling on water quality, fish and wildlife, the Bay Area climate, and the appearance of the Bay. More freeways in the Bay, and even more bridges, would affect large areas of the Bay and must thus be carefully evaluated in BCDC planning. A responsible study of the problem by BCDC requires consideration of the alternatives that might be available.

There is some -- but still much too little -- research, testing, and development aimed at achieving the best total transportation system for the Bay

THE BASIC TRANSPORTATION PROBLEM

Area. With the creation of the Bay Area Transportation Study Commission (BATSC), some attention is being given to the problem in the Bay Area.

FUTURE CHANGES IN THE TRANSPORTATION NETWORK

Fortunately, some transportation research is under way in the United States and abroad. "Breakthroughs" are being explored for improving the "linkages" among various modes of transportation. The "systems approach," born in the defense and space industries, is being employed to examine the transportation problem as a total system.

The principal question is how to move more people and goods in less space per person or per ton, and usually in a shorter time. Somewhat less attention is being given to the problem of transfer from one vehicle or transportation method to another during the course of a single trip.

Examples of efforts to move more people in less space per person that might prove successful are:

*Highway traffic control systems -- electronic devices to monitor traffic and then control it by computer -- are being developed in such widespread locations as London, New York City, Houston, Chicago, Toronto, and San Jose. The San Jose project will use a digital computer to control traffic signals throughout the city.

*Westinghouse Electric Corporation has developed 20-passenger, rubber-tired vehicles that run on a specially-designed "transit expressway." Cars operate singly or in trains, completely under the control of computers. Westinghouse is to install a transit expressway for shuttle service at the new Tampa, Florida, airport. Another transit expressway system is being proposed for a suburb of Pittsburgh.

*The StaRRcar system uses a small vehicle that operates under its own control on local streets, but under automatic control when it enters mainline

"guideways." When the driver enters the guideway, he indicates his desired destination on a small on-board computer. Thereafter, the guideway operates the vehicle, accelerating it to enter the flow of vehicles already on the guideway, controlling the spacing between vehicles, and routing it directly to its destination. The vehicle can then be moved automatically to a central parking location. The StaRRcar concept combines the high speed and small space advantages of mass transportation with the advantages of a single vehicle that can move from door to door without transfers by the passenger.

*Cornell Aeronautical Laboratory has developed a somewhat similar vehicle called the Urbmobile. It operates basically like the StaRRcar except that it has rubber-tired wheels for local streets and uses steel wheels on rails on the automatic guideway system.

*General Motors and RCA have been developing automatic guideway concepts that could be employed on present highways to control vehicles essentially like those in use today.

*Hydrofoils and Hovercraft, two methods of high-speed movement on water, are being actively tested and used in the United States and in many other parts of the world. Such vehicles may some day prove feasible for moving large volumes of people and of cargo back and forth on the Bay.

Elimination of delay caused by transferring between vehicles or methods of transportation is resolved most completely in an approach like the StaRRcar or automated highways where only one vehicle is needed for an entire trip.

Examples of proposed ways to reduce transfer delays might include:

*Speeding up mass transit boarding by streamlining fare collection through use of charge-plates or through complete elimination of fares.

FUTURE CHANGES IN THE TRANSPORTATION NETWORK

*Proposals (not tested) to smooth trans-Bay commuter movements by driving buses from many parts of a community onto special ferries; while en route across the Bay, each bus would be assigned to a specific destination ashore, and passengers could change to the proper bus. Problems with this approach include the relatively large ferries that might be required for the number of people carried and the possible need for large on- and off-ramps.

Project Metran, a study made by faculty and graduate students at the Massachusetts Institute of Technology, is a current example using the systems approach to examine the total transportation problem and to prescribe new kinds of solutions. Taking the Boston metropolitan area as an example, the study demonstrated realistically that the desired elements of a transportation system can be determined from an analysis of the overall regional goals; that needed inventions and breakthroughs can be identified, developed, and tested; and that new systems can be gradually introduced throughout the region upon successful completion of the tests.

The more effective new transportation methods will have to be employed on a regional basis (most of the transportation problems exist between central cities and between the suburbs and the central cities). Therefore, some kind of regional agency is required to finance and administer most major transportation improvements.

EFFECTS OF PRESENT TRANSPORTATION POLICIES UPON SAN FRANCISCO BAY

In the absence of a total-system approach to Bay Area transportation problems, primary emphasis has been placed in the past upon the freeway. One move toward a more balanced approach was approval by the voters of the Bay Area Rapid Transit District system now under construction.

More recently, the State Division of Bay Toll Crossings issued a report emphasizing that the Marin crossing problem is a single transportation

EFFECTS OF PRESENT TRANSPORTATION POLICIES UPON SAN FRANCISCO BAY

problem from Novato to downtown San Francisco, and that improvement must be made in both public transit and auto facilities. The West Bay Rapid Transit District, which is examining the transportation problem on the Peninsula, has indicated it has considered innovations and will strongly consider linkages with other transportation systems.

So a somewhat broader approach, that de-emphasizes freeways, is beginning to be taken. But, as long as the freeway remains a prime solution to transportation problems around the Bay, the Bay remains a possible freeway route. Freeways require large rights-of-way that are not generally available in the densely built-up communities around the Bay, so the open Bay remains an attractive substitute location.

PRESENT BAY TRANSPORTATION SYSTEM AND "PRESSURE POINTS"

The regional surface transportation system around the Bay is illustrated in Figure 1.

The present system is primarily a freeway network and most of the movement of people and goods is by automobile, bus, and truck.

Figure 2 illustrates the gross regional traffic flow and indicates the obvious pressure points. It indicates highway use only; it does not indicate the total number of people or the total amount of cargo being moved around the area.

With BARTD trains not yet operating, only a few carriers are providing elements of mass transit. The Greyhound Company operates commuter buses to the East Bay, the Peninsula, and Marin County. The Southern Pacific Railroad operates commuter trains between San Francisco and San Jose. The Alameda-Contra Costa Transit District operates buses in the East Bay and across the San Francisco-Oakland Bay Bridge to a San Francisco terminal. The San Francisco Municipal Railway operates a complete system of buses and trolleys -- but only within the limits of the city.

FIGURE 1

Existing Major Highways and Railroads Around the Bay

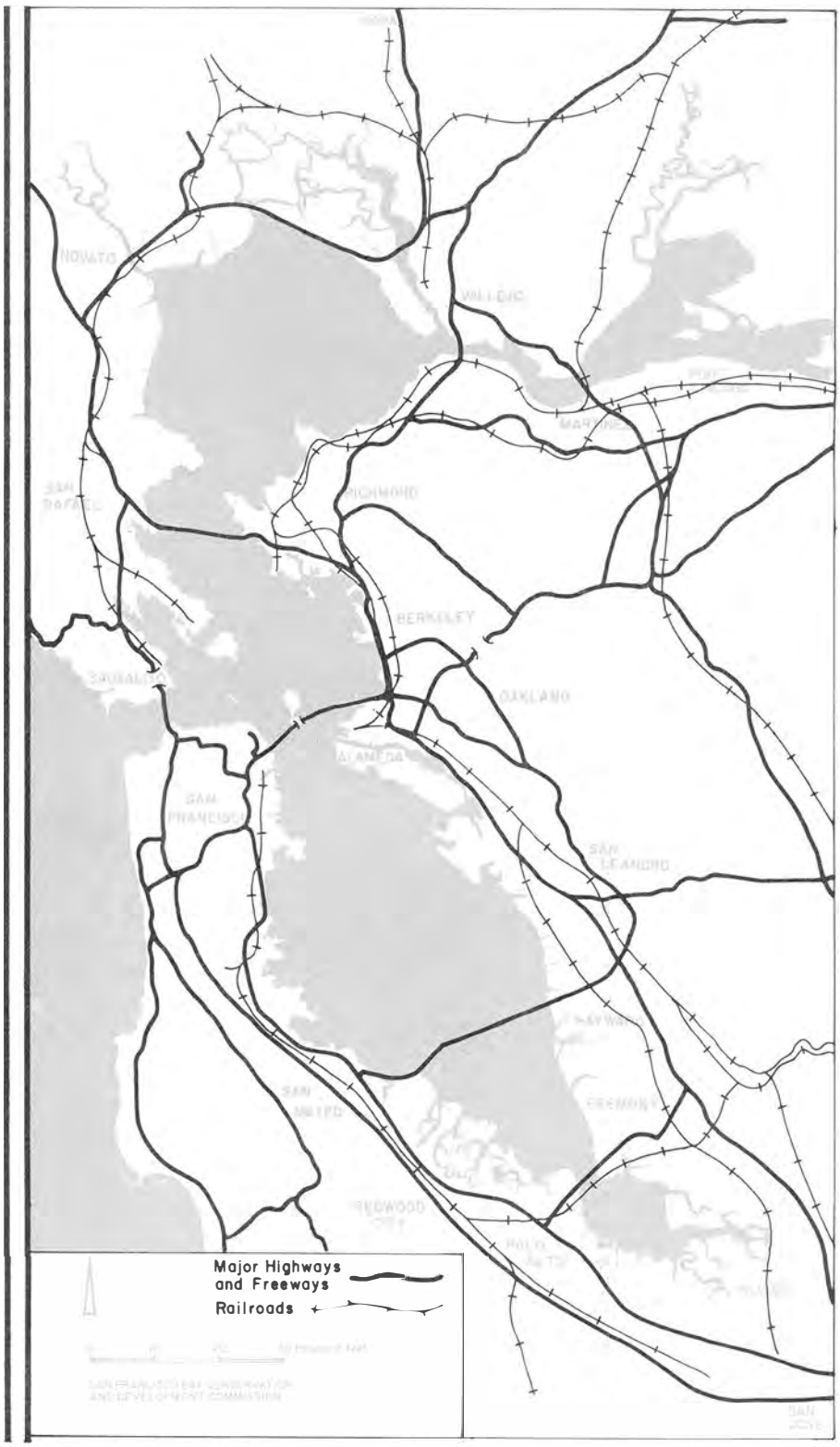
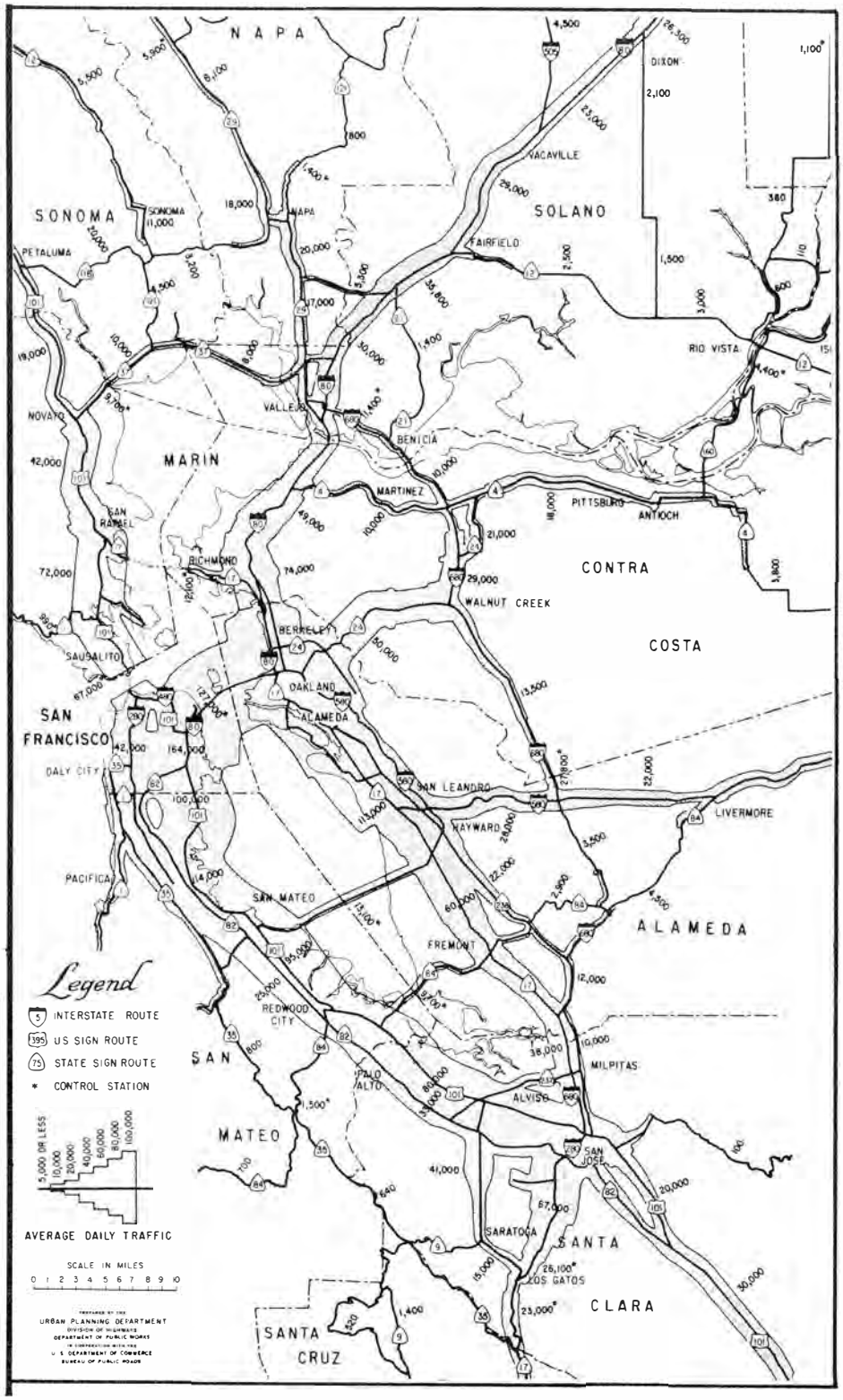


FIGURE 2

Average Daily Traffic on the State Highway System-1964



PRESENT BAY TRANSPORTATION SYSTEM AND "PRESSURE POINTS"

It is not known how much freight is moved on the highway system and how much is moved on railroads, barges, and in pipelines. No one has attempted to collect and corollate the highly disparate data from the many different carriers. This is an important missing element in any attempt to assess the total transportation system and prescribe solutions for it.

CURRENT TRANSPORTATION PROPOSALS AFFECTING SAN FRANCISCO BAY

Current transportation proposals that must be taken into account in preparing a plan for the Bay are shown in Figure 3. These include (1) a new Dumbarton Bridge; (2) a new Southern Crossing; (3) Route 61, on the east shore of the Bay; (4) State Route 37 on the north shore of San Pablo Bay; (5) San Francisco-Marin Crossing; (6) the Bayfront Freeway on the west shore of the Bay; and (7) major airport expansion in the Bay region. All essentially involve automobile transportation.

1. Dumbarton Bridge

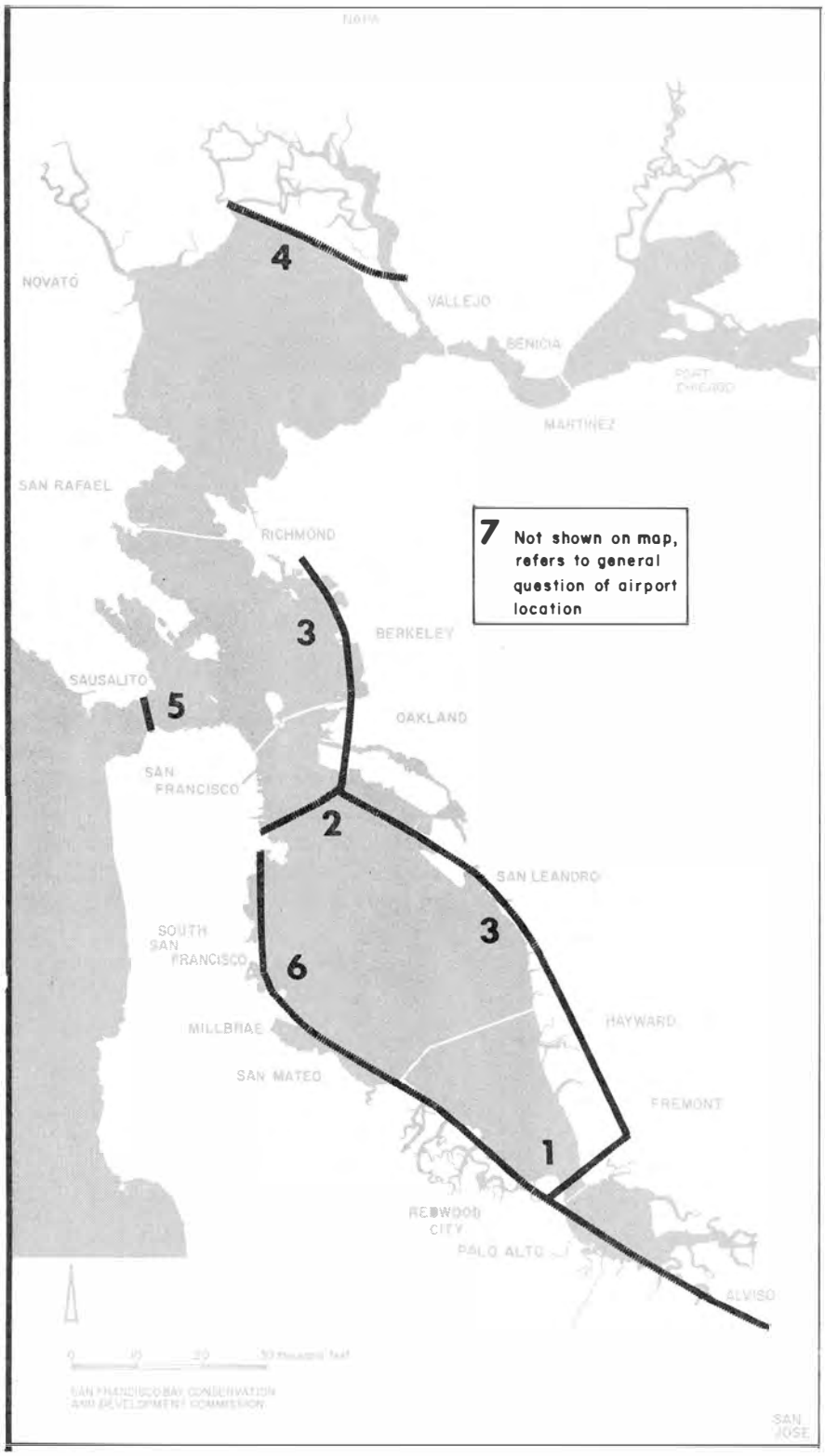
The existing Dumbarton Bridge crosses the South Bay from Fremont and Newark to Palo Alto and Menlo Park. It is two lanes wide, and of substandard construction; the lift portion of the bridge causes lengthy traffic delays. In a 1966 report, the State Division of Bay Toll Crossings recommended a new high-level bridge to replace the present bridge in the same location; the Division also recommended a new toll plaza on the Coyote Hills (conflicting with potential recreation use of the hills). Laws would have to be revised to permit use of Bay Bridge toll revenues to help finance the project.

2. Southern Crossing

To provide relief for the heavily-traveled Bay Bridge, a new crossing from India Basin in San Francisco to Bay Farm Island in Alameda is now being designed. As proposed by the Division of Bay Toll Crossings, the bridge would be linked to a new Hunters Point freeway in San Francisco. In the Bay south of Alameda, the crossing would divide, with

FIGURE 3

Immediate Problem Areas



one branch headed to the north (to connect via a tube under the Oakland Inner Harbor to the Grove-Shafter freeway) and the other to the south (passing through Oakland International Airport to connect to Davis Street in San Leandro).

The Southern Crossing, with its approaches, will cross 12.5 miles of the open Bay. As such, it poses serious esthetic problems. Many miles of the crossing will be low-level trestles over shallow waters; near the San Francisco shore a high-level bridge over the main navigation channel will be needed. At the eastern end, the trestles would have to rise in two places to clear the San Leandro small boat channel. A toll plaza is proposed on fill near the Y in the bridge south of Alameda. Esthetic design of the highest quality -- such as has been used on the San Mateo Bridge and on portions of the Junipero Serra freeway -- will be necessary to make the crossing a visual asset, as well as a transportation asset, to the Bay Area.

3. Route 61

This proposed route parallels the east shore of the Bay from Richmond to the Dumbarton Bridge. Although the Division of Highways has not initiated formal studies on this portion of the route, it has been discussed informally for a number of years and appears on some local public and private plans.

The segment from Richmond to the Bay Bridge would have to be located in the Bay outboard of the existing Eastshore Freeway (U.S. 40-Interstate 80), most of which is itself built on fill.

South of the Bay Bridge, portions of Route 61 are being designed in connection with the proposed Southern Crossing. In general, the route parallels the Nimitz Freeway (State Route 17), with connections to the Bay Bridge, the Southern Crossing, the San Mateo-Hayward Bridge, and the Dumbarton Bridge. In the vicinity of the Southern Crossing, the

proposed freeway would involve extensive over-water construction; south of Davis Street in San Leandro, the route could probably be inland away from the Bay and tidelands.

4. State Route 37

Route 37 skirts the north shore of San Pablo Bay between Vallejo and Novato. More than one-third of the route has been reconstructed from Novato eastward to State Route 121. Preliminary studies have been started on completing the reconstruction eastward into Vallejo. The route will apparently follow the existing alignment through marshland and salt ponds, but will require more right-of-way for additional lanes and interchanges.

5. San Francisco-Marin Crossing

In May, 1967, the Division of Bay Toll Crossings published its report on the Marin Crossing. The report emphasized the necessity of solving the total passenger movement problem between Novato and San Francisco. It emphasized the necessity of the complete cooperation of the many agencies involved, including the City and County of San Francisco, the Golden Gate Bridge and Highway District, the Marin Transit District, and the State Division of Highways.

The Bay Toll Crossings Report analyzed many alternatives, including rail transit, ferries, aircraft, and a gravity vacuum tube. The report made no recommendations, but the alternative apparently most favored provides a two-stage solution to the problem: the addition of a second deck to the Golden Gate Bridge, expansion of highway approaches, and development of an effective bus rapid transit system in the first stage; and a new crossing or rapid transit tube and necessary approaches in a second stage several decades later. The report emphasized that existing highways are inadequate on both sides of the Golden Gate Bridge; the Redwood

Highway north from the bridge would have to be widened in Marin and a freeway connection between the Golden Gate Bridge and the Embarcadero Freeway would be necessary in San Francisco.

Discussion of alternatives is still in progress. The Golden Gate Bridge and Highway District has contracted for engineering study of the proposed second deck. The San Francisco Board of Supervisors has formally opposed the second deck, and supported alternative solutions that would not bring more cars into San Francisco. The Marin County Transit District has endorsed the principle of a Marin County Planning Department report urging serious consideration of many alternatives that would preserve the beauty of Marin, including early action on an effective bus transit system to relieve commuter automobile pressures as soon as possible. The Bay Area Transportation Study Commission (BATSC) has considered the matter, but at this printing (January 10, 1968) has taken no stand. Its study director, however, has strongly supported the proposed second deck on the Golden Gate Bridge and the inauguration of an adequate bus system. As one result of the continuing discussion, the Bridge District in December, 1967, adopted a policy postponing consideration of a second deck until mass transportation solutions have been tested; the current engineering study is to be completed, however.

The ABAG Preliminary Regional Plan, published prior to the Bay Toll Crossings study, recommends construction of the second deck and inauguration of a supplementary high speed ferry system.

6. Bayfront Freeway

The Bayfront Freeway has been so labeled because it is generally proposed to be located on Bay tidelands outboard of the existing Bayshore Freeway in San Mateo County; the route would extend along the Bay from Hunters Point for approximately 27 miles before turning inland in the vicinity of Palo Alto.

The highway was first proposed in local plans, commencing with the "1951 Major Highway Plan" for San Mateo County. It was included in the San Mateo County Master Plan adopted in 1960, and it has been shown on the plans of South San Francisco, Brisbane, San Bruno, and Redwood City. It is also shown in the ABAG Preliminary Regional Plan. It is not shown in the Menlo Park General Plan adopted in 1965. More recently, the Regional Planning Committee of San Mateo County has recommended deletion of the highway from the County Master Plan and proposals have been advanced in most of the affected cities urging similar revision of the city plans.

The Bayfront Freeway was added to the State Freeway and Expressway System by the Legislature in 1959, but the State Division of Highways has made no detailed location studies except for a short section through Foster City (in connection with the rebuilding of the San Mateo-Hayward Bridge).

The present Bayshore Freeway (U.S. 101) is often taxed far beyond its capacity, as evidenced by frequent traffic jams. Early relief is anticipated with completion of the Junipero Serra Freeway along the crest of the Peninsula hills. The new Bayfront Freeway is proposed to meet further demands created by tremendous increases in traffic to the expanding San Francisco International Airport, and completion of the major new developments at Foster City, Marine World Recreation Area, and Redwood Shores, in addition to continued traffic increases throughout the Peninsula.

7. Major Airports on the Bay

The BCDC report on Airports emphasized that aviation terminals are the biggest single traffic generators in the metropolitan region. Every sign points to continued rapid growth in air passenger and cargo traffic. The report urged that a regional airport systems plan be prepared to determine the best sites for major regional airport facilities. In

CURRENT TRANSPORTATION PROPOSALS AFFECTING SAN FRANCISCO BAY

the absence of such a plan, it was concluded that assumptions will have to be made concerning the location of major regional airports, and that such assumptions would depend in part on the findings of this transportation report because of the necessity for adequate ground transportation to serve airports.

Progress in air transportation must be met by new approaches to the ground transportation problem. Travel from central areas and suburbs to airports is already increasingly time-consuming; building more highway capacity to airports adds to the problem of controlling and parking such volumes of vehicles and trucks at the airport. Possible alternatives include rail rapid transit, more extensive shuttle services, helicopters, and helicopter-borne buses.

The Bay Area Rapid Transit System will not directly serve any of the major airports in the Bay Area. The nearest BARTD station to the Oakland International Airport will be nearly three miles from the airport terminal; the present three-county transit district does not include any of the other airports. Helicopter service is provided between the airports and a number of central locations, but the fares are relatively high and not all points are served adequately. An experiment using hovercraft as an over-the-Bay shuttle between the San Francisco and Oakland Airports indicated that a number of problems need to be overcome before such vehicles would be practical as a feeder service.

WHO PLANS TRANSPORTATION IN THE BAY AREA?

Transportation planning for the Bay Area is divided among highway agencies, transit agencies, planning agencies, and regulatory agencies -- with no overall coordination. Most of the planning is for moving people in cars, buses, and trains. No agency systematically plans for improved parcel and cargo movement around the area. No agency plans for intensive use of water transportation or tests other ways of moving people and goods more efficiently around the region.

WHO PLANS TRANSPORTATION IN THE BAY AREA?

Highway planning, particularly for freeways, is accomplished by the State Division of Highways and the Division of Bay Toll Crossings. The Division of Highways controls the Federal highway trust fund allocations from the Federal Highway Administration (formerly the Bureau of Public Roads) and the gasoline sales taxes collected within the state. Local and feeder streets are planned by the cities and counties.

Transit planning is not yet a continuous process. In the 1950's, special study commissions were formed to plan a regional rapid transit system and a sub-regional bus system for the East Bay. These studies spawned the Bay Area Rapid Transit District and the Alameda-Contra Costa Transit District. BARTD is limited at present to building a rail rapid transit system in only the three counties of San Francisco, Contra Costa, and Alameda. The A/C Transit System operates inter-urban and local buses in the East Bay and across the Bay Bridge to a San Francisco terminal. The services of private transit companies such as Southern Pacific and Greyhound, are largely regulated by the State Public Utilities Commission which controls their rates, frequency of service, and areas of service.

The only transit agency empowered to both develop an initial transit plan and then to build the system is the West Bay Rapid Transit Authority (WBRTA) in San Mateo County, which must submit a master transit plan and financing methods to the voters of the county by June 30, 1969; by law, the plan, if it involves a new fixed-rail system, must be compatible with the BARTD system. WBRTA has authority to expand to Santa Clara and other adjacent counties.

In recent years, efforts have been made to coordinate highway, transit, and land use planning. In 1963, the Association of Bay Area Governments launched its regional planning program and in the same year, the Bay Area Transportation Study Commission was created to prepare a regional transportation plan for the nine-county Bay Area.

WHO PLANS TRANSPORTATION IN THE BAY AREA?

In November, 1966, ABAG published its Preliminary Regional Plan. The plan's transportation element places strong emphasis on freeways, proposing a number of new routes including some "super freeways" designed for 80-mile-an-hour speeds with widely spaced interchanges. The plan also proposes extension of the BARTD system into San Mateo, Santa Clara, and eastern Alameda and Contra Costa counties. A high-speed ferry system is proposed between Marin County and San Francisco. The plan also assumes the construction of the Southern Crossing, an additional Bay crossing in the Fremont-Palo Alto area, and a second deck on the Golden Gate Bridge. To augment the regional airport system, the plan tentatively proposes that Travis Air Force Base in Solano County eventually be converted into a major commercial airport.

The ABAG transportation plan is a preliminary proposal for which no supporting background data was published. The plan is proposed to be tested in the BATSC study program. ABAG is primarily a planning agency at the present time, but it can influence transportation developments (including mass transit) through its power of review and comment on an increasing array of Federal grant and loan programs.

The Bay Area Transportation Study Commission was created by the State Legislature and must submit its final report to the Legislature in January, 1969, at the same time the BCDC plan is presented. The $5 million BATSC study program includes (1) data collection, which has been largely completed, (2) sketch planning, in which a 1980 plan is to be developed, (3) testing of the sketch plans and the ABAG plan in computer programs, and (4) the selection of a final regional transportation plan and the procedures required to carry it out. The BATSC program apparently will concentrate on highway planning, although additional attention is now being given to "novel systems" and the study

WHO PLANS TRANSPORTATION IN THE BAY AREA?

director has indicated that transportation planning must anticipate considerable technological innovations in the coming decades. Thus far, the BATSC study primarily concerns movement of persons and vehicles; it does not consider intra-regional cargo movement, nor does it include regional airport planning.

BATSC is a planning agency only. It has no power of decision over current transportation projects in the region. However, as the most comprehensive transportation planning agency in the Bay region, BATSC does have the legal right to review and comment on major surface transportation proposals.

A TRANSPORTATION POLICY FOR THE BAY

A transportation policy for San Francisco Bay should include (1) appropriate use of the Bay for transportation, and (2) prevention of unnecessary filling or other incursion into the Bay for surface transportation, because of the many harmful effects of such filling.

The Bay touches upon all nine counties of the Bay Area and most of the cities. It represents a great but, at present, little-used resource for transportation within the region. The BCDC report on Ports points out that barges may be able to move trucks and freight from point to point within the region at low cost and without adding to surface road congestion. Also, modern ferries (capable of high speeds with minimum noise and waves) are beginning to be seriously discussed. A high-speed ferry system could initially provide service between major traffic generators (e.g., between downtowns and between downtowns and airports) and eventually provide scheduled service from one end of the Bay to the other for both business and pleasure use.

Unfortunately, the bulk of attention in a current Bay transportation policy must be directed at preventing unnecessary further incursion into the Bay by transportation systems. The current fragmentation of transportation planning results in a heavy

concentration on the highway-freeway system. These facilities, which require more land for rights-of-way than do other methods of transportation, are proposed for areas that are already congested, making routes hard to find, expensive to acquire, and increasingly subject to public opposition. These factors result in pressures to shift freeway and highway routes into the Bay, where few such problems exist. Freeways do not have to be in the Bay; they are there for lack of better alternatives. Similarly, continued reliance on automobile transportation causes continued pressures for more Bay bridges.

Since freeways do not have to be in the Bay, a Bay transportation policy should not permit them there. Such a policy would encourage more exhaustive efforts to develop alternatives to more freeways as a means of moving persons and goods within the Bay Area.

Because of the continuing vulnerability of the Bay to being filled for freeways, an important part of a Bay transportation policy should be the creation of more effective research and development systems to test and inaugurate new methods of transportation within the Bay Area. Because an effective transportation system must serve the entire region, not just one city or county, inauguration of an adequate research and development program would have to be undertaken on a regional basis. BATSC, or its successor agency, covering the nine Bay Area counties, is the logical agency to be funded for such a program.

In some cases, new systems may not be feasible soon enough to overcome acute congestion problems. Current methods of transportation may thus continue in use, and a Bay transportation policy must set standards for the design of bridges and freeways for which there is no alternative to a Bay route.

A first requirement -- if a new Bay route is required -- should be that a tunnel beneath the Bay be used if at all feasible.

After adequate proof that no other solution is feasible and that a route must be located over the Bay, steps must be taken to insure that a minimum amount of damage will be done to the Bay and that the maximum amount of benefits will be derived from the facility. This means that the facilities must be designed so as not to disrupt the Bay's ebb and flow and to provide significant visual and esthetic benefits in addition to the transportation service for which they are required.

Some of the desirable design features are incorporated in the criteria for physical design in the BCDC report on Appearance and Design. In addition, the following provisions should be required:

1. Bay crossings and roadways should be placed on bridge-like structures, rather than on fill.

2. Structures should be designed to (a) allow free flow of Bay waters and not cause excessive shoaling, and (b) provide adequate clearances for commercial ships, navy ships, and pleasure boats to have free and uninterrupted passage at all times. In general, horizontal clearances between supports should be as great as structural requirements will permit.

3. The facility should be designed in a manner that does not invite additional filling of the Bay for other purposes (as in the case of the Candlestick Causeway on the Bayshore Freeway, which has resulted in filling on both sides).

4. Toll plazas, service yards, or other ancillary features should be located on existing land, not on new fill.

5. Freeways in the Bay and bridges are the most obvious man-made features that affect the appearance and enjoyment of the Bay. When well designed like the Golden Gate and San Francisco-

A TRANSPORTATION POLICY FOR THE BAY

Oakland Bay Bridges, they can be definite assets. Poorly designed, they can detract from the Bay's appearance, interfere with views, restrict access to the Bay, and even interfere with the natural functioning of the Bay. Therefore, the review of any proposed facility by a design review system was recommended in the BCDC report on Appearance and Design.

6. To provide maximum ultimate capacity on any new major facility that is allowed over the Bay (and thus to minimize the number that might have to be allowed in the Bay), the design of highway bridges and freeway structures should anticipate future mass transit facilities unless they are adequately paralleled by such facilities; in addition, the status of present studies of automated highway controls indicates that the design of all structures to be built from now on should incorporate as much flexibility as possible to permit subsequent installation of automatic vehicle power and guidance elements.

EVALUATION OF CURRENT TRANSPORTATION PROPOSALS

On the following pages, current transportation proposals are evaluated in the light of the Bay transportation policy proposed above.

1. Dumbarton Bridge

From the Division of Bay Toll Crossings analysis, it is apparent that the Dumbarton Bridge should be replaced in its present location. The new bridge should be high-level, with adequate clearances for commercial navigation and recreational boats, as proposed by the Division of Bay Toll Crossings.

The Bay transportation policy would require the following: (1) the toll plaza should be located far enough inland to avoid the necessity of fill and yet not interfere with utilization of the Coyote Hills as a recreation area; and (2) the design of

the bridge should anticipate future mass transit facilities and future accommodation of automated vehicle power and guidance elements (the kind of flexibility for conversion that should be provided should be determined in joint studies with BATSC, the West Bay Rapid Transit Authority, the Santa Clara County Transportation Study, and BARTD).

2. Southern Crossing

It is assumed that plans for the Southern Crossing have passed the point of no return and that the India Basin-Alameda route is definite; the bridge is in the design stage and freeway connections are being planned at both ends.

The Bay transportation policy would require the following: (1) toll plazas, service yards, and offices should not be located on Bay fill as now proposed (alternatives may be to place one-way toll booths at each end of the bridge or to develop new toll collection concepts so that no toll plaza, as such, is required; e.g., by use of special license plates on magnetic signal devices); (2) the design of the Southern Crossing should incorporate sufficient flexibility to permit later adaptation to mass transit and automated highway controls; and (3) because of its prominent location and inherent esthetic problems, careful design will be required to make the sprawling trestle structure a landmark comparable to -- and compatible with -- the bridges to the north and south of it, i.e., the Bay Bridge and the new San Mateo-Hayward Bridge.

3. "Outer Eastshore Freeway" (Route 61-Bay Bridge to Richmond)

No formal route studies have been undertaken by the State Division of Highways for this route. The freeway appears on the Richmond, Albany, and Oakland General Plans, but is not shown on the Berkeley Plan or the ABAG Preliminary Regional Plan.

The BARTD trains that will parallel the freeway are not likely to significantly relieve congestion on the present Eastshore Freeway, because the transit terminates in Richmond and much of the traffic on this sector of the freeway undoubtedly originates beyond the end of the transit system, as indicated by the traffic flow data in Figure 2.

The actual need for this freeway and whether there is any feasible alternative to a route in the Bay are as yet unclear. The Bay transportation policy requires that no commitment be made pending a complete appraisal of alternatives as proposed for the Bayfront Freeway in San Mateo County, below. In the meantime, comprehensive land and water use planning of this section of waterfront should be flexible enough to mesh with any solution finally determined, whether it includes a transportation facility in the Bay or not.

4. Route 61 South of the Bay Bridge

The most important portion of Route 61, insofar as the Bay is concerned, is incorporated in the approaches to the Southern Crossing, so the Bay transportation policy implications concerning the Southern Crossing apply to this route as well.

After connecting to the Southern Crossing, the route will apparently swing inland across Oakland Airport (presumably in a depressed roadway) and connect to an interchange with Davis Street in San Leandro. From that point south, the road will be inland, heading toward Fremont; it should be routed inland of the Coyote Hills, as proposed in the Fremont General Plan.

5. State Route 37

The two-lane portion of Route 37 between the Sonoma County line and the City of Vallejo is to be upgraded to freeway standards.

The Bay transportation policy requires that: (1) Route 37 be improved on the existing alignment, with no intrusion into the Bay, and (2) that access be fully controlled with interchanges only to provide access to public recreation areas. Both of these requirements appear to be in accord with Division of Highway preliminary plans.

6. San Francisco-Marin Crossing

The need for additional transportation capacity in the Marin-San Francisco corridor is obvious and opinion differs only as to the most appropriate means of providing it.

The Presidio area close to the Golden Gate Bridge, the vista points at both ends of the bridge, and the entire San Francisco and Marin approach areas are prime viewing locations that should be preserved or enhanced in accordance with the criteria in the BCDC report on Appearance and Design. The expansion of automobile capacity by enlarging toll plazas, increasing service areas, widening existing ramps and building new ramps would necessarily destroy much of the handsome appearance of each end of the bridge. In addition, increased capacity on the bridge would require increased auto capacity in San Francisco and Marin; this might further disrupt scenic areas on or near the Bay. These considerations apply regardless of whether additional automobile capacity is provided by a second deck on the bridge, a new bridge, or a tube. Since the central Bay is the most widely enjoyed portion of the entire Bay and its shoreline, the highest priority must be given to preservation of the attractiveness of this setting.

All agencies involved have agreed that the solution to the Marin crossing problem should include establishing a fast, modern, comfortable, and complete public bus system that would provide a considerable increase in transportation capacity without any new crossings. Advantages of such a

bus system are that it could be inaugurated relatively quickly, it is most adaptable to serve the low-density residential areas of Marin, and it is most adaptable to amalgamation into other systems (e.g., automated roadway or ferries) that might be developed in the near future. Proposals have been advanced for running the buses on a separate reserved lane and on the right-of-way of the Northwestern Pacific Railroad. The Marin corridor appears to be an excellent laboratory for research and development; for example, automation of a bus system, once it has been inaugurated, might be one of the first experiments.

Other suggested methods of immediate traffic relief are (1) revision of bridge tolls to favor buses over automobiles, and (2) collection of tolls for travel in one direction with travel in the other direction free.

All agencies agree a multi-agency arrangement will be required to carry out transportation improvements in the Marin-San Francisco corridor.

The joint interest of San Francisco and Marin Counties in solving the Marin corridor problem without spoiling the scenic amenity of the area, and the excellent possibilities of imaginative solutions for increasing capacity without adding to the right-of-way, are in accord with the Bay transportation policy. So the BCDC plan for the Bay should encourage all efforts to employ improved methods of transportation, including buses and ferries, and should make no provision for a second deck or an additional vehicular crossing.

7. Bayfront Freeway

There is no question that the existing Bayshore Freeway is badly overcrowded during rush hours; even off-peak traffic is usually heavy and some additional transportation capacity must be provided.

The Junipero Serra Freeway will provide some relief for the Bayshore Freeway as it is completed, but as urban development continues on the Peninsula, the Junipero Serra is also expected to reach peak capacity quickly. Adding urgency to the need for additional capacity in this corridor are the addition of several major traffic generators: Redwood Shores, Marine World, Foster City, the expanding San Francisco Airport, and the additional development of tidelands proposed by West Bay Community Associates (formerly Pacific Air Commerce Corporation).

The Peninsula traffic problem is under intensive study by the West Bay Rapid Transit Authority. It is (1) attempting to encourage techniques for increasing capacity and speeds on the Bayshore Freeway, and (2) developing a plan for a transit system serving San Mateo County, which, if approved by the voters of the county, could then be built by the district.

The Bay transportation policy requires that a Bayfront freeway should not be included in the Commission's plan for the Bay until all alternatives have been exhausted and until the benefits of the Bay route have been clearly established. A minimum evaluation should include:

1. Completion and testing of methods of increasing capacity and speeds on the existing Bayshore Freeway through a traffic management system, perhaps using computers to regulate traffic flow.

2. Completion of an imaginative program to increase the effectiveness of bus service to the San Francisco airport, including reserved bus lanes on the Bayshore Freeway, priority over cars and taxis at passenger pick-up and discharge points within the terminal area, and more frequent and cheaper service (perhaps employing airline subsidies as is now done with SFO helicopters). WBRTA is investigating such a program in cooperation with the airport management.

3. Appraisal of the amount of traffic diverted to the Junipero Serra Freeway from the Bayshore Freeway, and completion and testing of methods of increasing the effective amount of diversion.

4. Estimation of total transportation requirement in the Bayshore corridor, including projected requirements resulting from major proposed land developments and expansion of San Francisco International Airport, and detailed appraisal of all methods of meeting those requirements, taking into account technological innovations that may be available in the foreseeable future.

The evaluations could be made by both the regional transportation agency (BATSC or its successor agency) and the sub-regional agencies (WBRTA and Santa Clara County).

If the Bayfront Freeway is to be built, it should be located on existing fills, or it should be built on structures according to the basic design criteria included in the Bay transportation policy. Also, interchanges with the freeway should be permitted only for existing fill projects or for any major fill project that may be included in the Commission's plan for the Bay.

8. Major Airports on the Bay

The primary requirements for major airports are: (1) large amounts of land for the airport itself, (2) protection of the surrounding area from encroachment by housing, excessively high buildings, or other uses that would interfere with operation of the airport, and (3) a complete and adequate ground transportation system connecting the airport to its major users.

To avoid the necessity for extensive additional filling of San Francisco Bay for major airports, the BCDC report on Airports suggested that serious

consideration be given to an alternative inland site. In attempting to evaluate possible airport sites in eastern Alameda, Contra Costa, Sonoma, or Solano Counties, it is clear that, pending development of a sophisticated total ground transportation system, no existing or potential major airport site currently meets the third criteria above.

In addition, finding sites that can meet the first two criteria is extremely difficult. Either topography or existing urban encroachment rule out virtually every potential close-in site except Travis Air Force Base in Solano County, which is recommended in the ABAG Preliminary Regional Plan as a major airport site. However, Travis is unlikely to be available for civilian use in the foreseeable future because it is a principal base in the worldwide Air Force operations and the Air Force has a major investment in facilities at Travis.

In the meantime, national discussion of the airport planning dilemma has turned toward providing a system of smaller airports throughout a region instead of one or two very large facilities. The concept envisions diversion of the bulk of short-range traffic (500 miles or less, e.g., San Francisco-Los Angeles) to the smaller airports and much better ground and air transportation links among the airports in the system.

Therefore, pending completion of a thorough regional airport study, it appears that major reliance must continue to be placed on San Francisco and Oakland International Airports for long-haul flights, with satellite developments at San Jose and Santa Rosa. It should be assumed for purposes of preparing a plan for the Bay that planning and development -- though not necessarily day-to-day operation -- of all of the major airports will in the future be united under a single agency so that the flight services at each facility can be complementary, not

EVALUATION OF CURRENT TRANSPORTATION PROPOSALS

competitive. All Bay and regional planning should therefore provide for (1) protection of these facilities from any further encroachment by incompatible developments, and (2) the development of a total and sophisticated ground transportation system serving the four airports without necessity of extensive filling.

Because an adequate airport system is expensive to develop, a thorough regional study is required to assure best use of the sizable amount of money that will be required for airport construction and to assure that no more fill will be placed in San Francisco Bay than is absolutely necessary to provide an adequate airport system. It is assumed that it would take three years to complete an adequate regional airport system plan and as many as five to seven years thereafter to build facilities proposed in the plan. Therefore, capital investment in, and any Bay filling for, major airports in the Bay region should be limited to improvements needed before 1978 (10 years from now).

SUMMARY

Rapid increases in population mean constantly increasing transportation requirements. Technological developments will yield new forms of transportation and continuously alter the total ground transportation system.

San Francisco Bay is the dominant feature of the Bay Area. Among other things, it is a principal transportation corridor among its bordering cities and counties.

Transportation facilities, in this case surface facilities, should be designed to provide the best possible service for the Bay Area with the least possible infringement upon the Bay which serves the region so well in so many ways.

SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION
507 Polk Street, San Francisco 94102 557-3686

Possible Bay Planning Conclusions Based on the Report on Transportation

1. San Francisco Bay has been used in the past, and will continue to be used in the future, as a medium of surface transportation. The principal modes of surface transportation than can affect the Bay will be freeways, bridges, underwater tubes, barges, and ferries. (The uses of the Bay and shoreline by airports are discussed in the BCDC report on Airports; the uses of the Bay and shoreline for ports and maritime commerce are discussed in the BCDC report on Ports.)

2. At present, there is no regional coordination of all the means of moving people and goods that make up the total transportation system of the Bay Area. Primary emphasis in the past has been placed on freeways, which in some instances have been built on fill in the Bay because acceptable routes could not be found ashore. Similarly, little attention has been given to using the waters of the Bay for modern boat transportation.

Primary reliance on the automobile for transportation in the Bay Area means further pressures to use the Bay as a route for future freeways. Therefore, the primary goal of Bay transportation planning should be substantial reduction in dependence on the automobile. While the private car will still be needed and used for many types of travel, the goal should be development of new systems of transportation that can carry large numbers of persons without damaging the environment of the Bay Area. Massive use of the automobile during a time of rapid population growth in the Bay Area endangers the environment both because of the air pollutants emitted by automobiles and because of the space required by automobiles for roadways and for parking.

3. To prevent unnecessary Bay filling and to minimize any necessary fillings of the Bay for surface transportation, and to make appropriate use of the waters of the Bay for transportation, the proposed Transportation Policy for the Bay on pp. 18 to 21 of the Summary Report, and the recommendations concerning current transportation proposals on pp. 21 to 29 of the Summary Report, shall be employed in preparing the Commission's plan as follows:

(1) Dumbarton Bridge. Proceed with construction as outlined in the Transportation report.

(2) Southern Crossing. Proceed with construction as outlined in the Transportation report.

(3) "Outer Eastshore Freeway" (Route 61 -- Bay Bridge to Richmond). (a) The "Outer Eastshore Freeway," if routed in the Bay, would be extremely undesirable, and should therefore not be included in the Commission's plan. (b) No route in the Bay should be considered in the future unless all reasonable alternatives to this freeway have been explored and found infeasible. (c) If a route in the Bay is ultimately found to be necessary, it should meet the design criteria in the Transportation report, including the use of bridge-like structures rather than solid fill so as to minimize damage to the Bay.

(4) Route 61 South of the Bay Bridge. Proceed with construction inland, in conjunction with the Southern Crossing, as outlined in the Transportation report.

(5) State Route 37. Proceed with construction as outlined in the Transportation report, with the additional provision that interchanges along the route should provide access to the north as needed but access to the south to serve only one purpose -- to provide access to public recreational areas.

(6) San Francisco-Marin Crossing. Adopt recommendations in the Transportation report, i.e., no new vehicular crossing.

(7) Bayfront Freeway from San Francisco to Palo Alto. (a) The Bayfront Freeway, if routed in the Bay, would be extremely undesirable, and should therefore not be included in the Commission's plan. (b) No route in the Bay should be considered in the future unless all reasonable alternatives to this freeway have been explored and found infeasible. (c) If a route in the Bay is ultimately found to be necessary, it should meet the design criteria in the Transportation report, including the use of bridge-like structures rather than solid fill so as to minimize damage to the Bay.

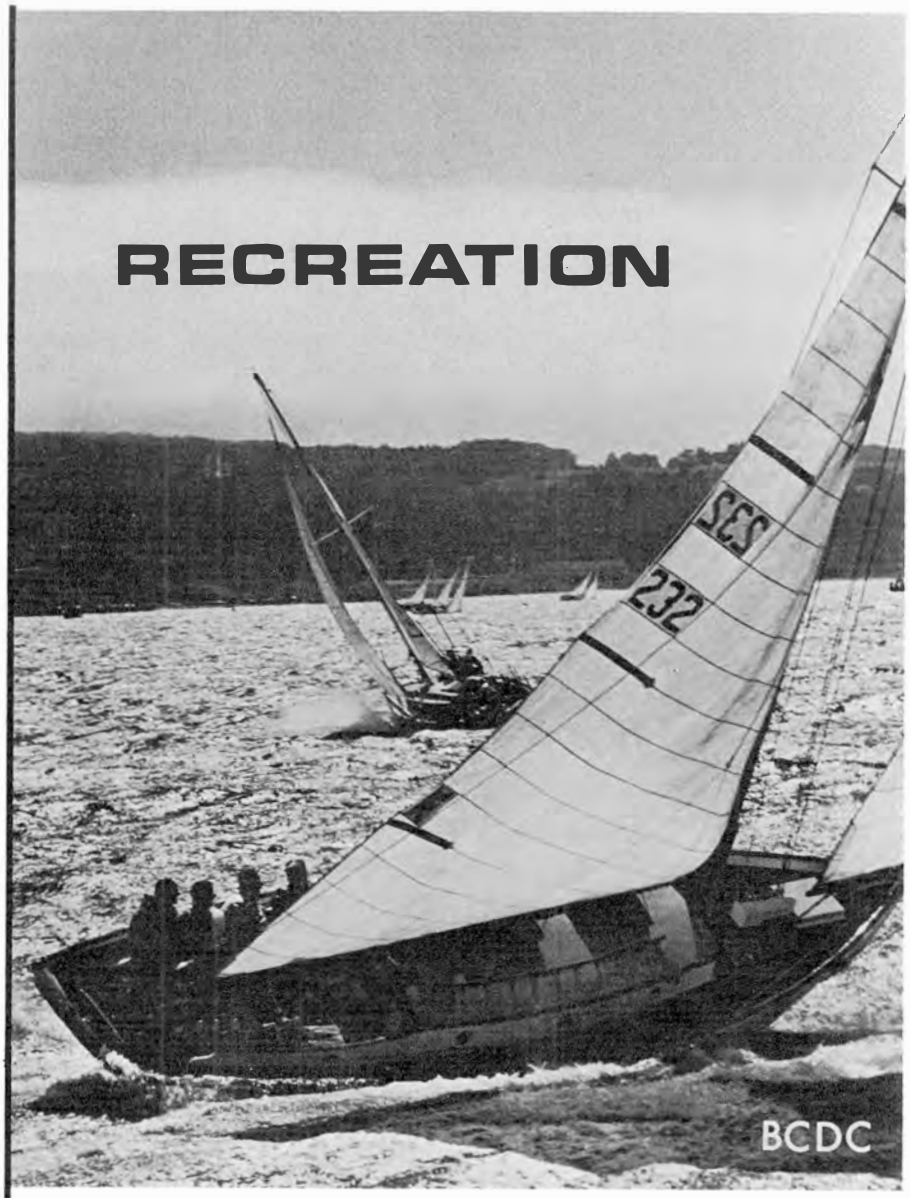
(8) Major Airports on the Bay. Follow recommendations in the Transportation report.

(9) With regard to transportation policy for barge or ferry systems (p. 18 of the Transportation Summary Report), specify that such systems should be developed using feeder transportation systems and, where necessary, multi-level parking structures, so as not to require large parking lots on the shoreline nor to require substantial Bay filling, and so as to minimize delays in transfers between the boats and vehicles ashore.

Adopted by the Commission at its meeting of 2/16/68

RECREATION

Part of
a Detailed
Study of
San Francisco
Bay



San Francisco Bay
Conservation and
Development
Commission

San Francisco,
California

January, 1968

Summary of the report, "Recreation on and Around San Francisco Bay," by the BCDC staff.

INTRODUCTION

A young boy fishing from a pier, a sailboat owner racing on a weekend afternoon, a family picnicking at a shoreside park -- all are enjoying the recreational opportunities provided by San Francisco Bay.

Recreation means different things to different people. To some, recreation is the opposite of work -- "refreshment of strength and spirits after toil," as Webster's dictionary defines it. To others, recreation is simply play. To still others, however, recreation is -- perhaps ironically -- work; recreation is a growing industry in the Bay Area, providing jobs for boat salesmen, marina operators, parking lot attendants, restaurant concessionaires, and many others.

Most planners believe that in the not-too-distant future automation and other time-saving innovations will provide a large increase in the amount of leisure time available to Americans. As the work week declines, time and energy previously devoted to earning a living will be available for recreational activities.

This will mean broad changes in the everyday lives of many Americans -- leisure and recreation will become increasingly important, and vastly expanded opportunities for recreation will be needed.

Fortunately for Bay Area residents, the shores of San Francisco Bay offer great opportunities for recreational development. Four years ago, a study by Mel Scott of the University of California revealed that while the shoreline of the Bay totals some 276 miles, only four miles were then being used for waterfront parks. Perhaps partly as a result of the Scott report, many communities have taken new looks at their waterfronts and have proposed new parks, marinas, and other forms of recreation oriented toward the Bay. But the full recreational potential of the Bay has by no means yet been explored.

GENERAL FACTORS THAT INFLUENCE THE DEMAND FOR RECREATION

Many factors influence the kinds of recreational facilities needed now and in the future: (1) the amount of leisure time people have available, (2) the amount of family income, (3) the accessibility of recreational facilities, (4) the weather, and (5) new kinds of recreational activities.

1. Time

The average work week in the United States is expected to continue to decline. Since 1900 the length of the work week has diminished about one-third -- one extreme prediction is that by the year 2020 (35 years from now) the one-hour work week will be routine for some Americans. While no significant drop in hours of work required to earn a living is expected until after 1980, it is probable that the hours of work required will decline rather sharply once automation and other time-saving processes become more widely used and once society has adjusted to the change and can provide adequate income for less work or even no work.

How much time will then be used for "recreation?" Conservative estimates for the Bay Area are that the annual demand for selected outdoor recreation activities will increase from 240 "participation days" 1/ in 1960 to 460 participation days in 1980. No one has estimated the participation in the decades beyond 1980, but it will probably increase sharply.

2. Income

Surveys report that both the amount of time spent on outdoor recreation and the kind of recreation sought depends in part on the amount of family income. Persons of very low income average 210 hours a year in outdoor recreational activities compared to 375 hours enjoyed by persons in the highest income bracket. In addition, of course, persons of low income choose activities, such as pier and beach fishing, that cost the least, while many other activities, such as yachting, are restricted to those with higher incomes.

1/ Days or parts of days that a participant would engage in a recreational activity.

3. Accessibility

The easier recreation facilities are to get to, the more people will use them. For example, the bulk of a person's free time (50 per cent) occurs in relatively short intervals, such as weekday hours after work, so recreation facilities have to be nearby to get maximum use. At present, two-thirds of the demand for recreation in the Bay Area is satisfied by one-day round trips.

Accessibility can be improved (1) by improving ways of getting to recreational sites (as the freeway system has permitted people to travel greater distances in a short time) and (2) by locating recreation sites closer to the homes of potential users (as would be the case if more of the Bay shore were opened up for recreation use).

4. Weather

The mild weather in the Bay Area not only makes participation in outdoor activities more desirable but also lengthens the season for recreation as compared to other areas of the United States. Attendance at state parks in the Bay Area is spread much more evenly throughout the year than is the case even at comparable valley and mountain parks within California.

On the other hand, there is a wide variation in climatic conditions in the Bay Area. These variations influence the types of activity that are feasible in different parts of the area, particularly those that are sensitive to temperature (such as swimming) and wind (swimming, sun-bathing, and sailing).

5. New Kinds of Recreation

Sports and games enjoy "fads," especially as more time and money becomes available. Snow and water skiing, for instance, have boomed fantastically since World War II. Some forms of recreation,

GENERAL FACTORS THAT INFLUENCE THE DEMAND FOR RECREATION

such as sky diving and scuba diving, may similarly expand in popularity in the future. Or, relatively new forms of recreation may be introduced, such as air boating (air-cushioned vehicles that can travel on land or water).

RECREATIONAL USES OF SAN FRANCISCO BAY

Recreational possibilities on or around San Francisco Bay include boating (sail or motor, in racing, touring, fishing, and water-skiing), fishing (from shore or pier), hunting (for ducks in marshes), swimming, sun-bathing (on a beach as opposed to a lawn), nature exploring (fish, animals, and plants), parks (for walking, sitting, hiking, riding, cycling, and picnicking with the Bay as an essential part of the scene), viewpoints (for sitting and sightseeing), and water-oriented commercial centers.

BOATING

Boating includes both sail and motor driven craft. The vast majority of boats on San Francisco Bay are small enough to be stored out of the water. Most popular use of boats are for fishing, water-skiing and cruising, in that order.

Types of facilities required on the Bay shore for boating include (1) yacht harbors and marinas for storage of boats in the water ("wet storage"), (2) storage sheds and yards for storage of boats on land ("dry storage"), (3) winches and launching lanes for transferring boats from land to water, (4) fueling and repair facilities, (5) water-side campgrounds and boatels for overnight stop-overs, (6) mooring jetties, water-side restaurants, etc., for temporary stops by boaters, and (7) automobile parking facilities, especially at yacht harbors and launching areas.

There are about 13,000 boat slips around the Bay at the present time (Figures 1-7). The projected requirement for 1975 is 25,000 slips. Extremely rough indications are that 67,000 will be required in the year 2020.

There are now 270 boat launching lanes available around the Bay (Figures 1-7). More than 420 lanes will be needed in 1975 and rough projections are

that 1,200 will be needed in 2020. These facilities are more adequate to current needs than are spaces for "dry storage" of trailered boats; because of the availability of garages and yards, there are only 2,100 commercial dry storage spaces now available. This is considerably short of the desired amount, which could be as high as 28,000 spaces by 1975. Table 1 summarizes the area required for parking and for space along the shores of the Bay and adjacent creeks and rivers, assuming present trends in the popularity of boating will continue.

TABLE 1

ESTIMATED SHORELINE REQUIREMENTS FOR BOATING AND SWIMMING, 1975-80 and 2020

	Existing 1/	1975	1980	2020
Miles of shoreline required				
Marina wet storage	5	10		28
Launching ramps	.6	1.0		2.7
Swimming beach	4.0		7.2	16
Total lineal miles	9.6	18.2		46.7
Shoreline acreage required 2/				
Marina 3/	150	310		870
Launching ramps	475	735		2,000
Swimming beach	24		43	76
Total shoreline acreage	649	1,088		2,946

1/ Estimated, not actual. Some data are calculated from standards.
2/ Including parking and ancilary requirements.
3/ Excluding dry storage acreage estimated at 161 acres in 1975 and 452 acres in 2020 -- on basis this acreage need not be provided directly on the waterfront.

BOATING

The location of new yacht harbors and launching lanes must consider the following factors: (1) larger boats need deeper channels than smaller boats but can be maneuvered in and out of marinas where wind and water conditions might be dangerous for smaller boats, (2) access roads to launching lanes should be wide enough and straight enough for vehicles with trailers to negotiate easily, (3) sites that tend to fill up rapidly with silt or mud should be avoided, and (4) launching lanes should be located near prime fishing areas and near calm, clean water suitable for waterskiing.

With increasing affluence and leisure, there will probably be an increasing demand for overnight facilities for persons cruising the Bay and Delta areas. Larger cabin cruisers require temporary docking points where passengers can sleep on their boats overnight with access on land for fuel, food, sewer connections, and perhaps shower facilities. Smaller boats that do not have accommodations on board require picnic grounds in rural areas, all with docking facilities. Camper-boaters are expected to need 870 campsites by 1980 and 2,200 units by the year 2020. No estimates of the demand for private boatel and restaurant complexes are available, but these should be encouraged in urban areas adjacent to public yacht harbors and near commercial ferryboat facilities (to cater to persons taking several-day ferryboat tours in the future).

In addition to permanent shoreside facilities, temporary stopping points providing picnic facilities, a pleasant place to walk about and/or explore, or a convenient waterside store for incidental food and supply needs will be desirable at suitable points between overnight stopping points. Temporary facilities would also cater to day-users able to reach them on a one-day round trip.

In future years, a commercial ferryboat system should augment the fleet of privately-owned boats, greatly expanding the recreation and tourist potential. An expanded fleet could provide frequent service linking recreation sites such as Angel

BOATING

Island, Alcatraz, and Brooks Island and attractive waterfront recreational or commercial areas in the manner of such ferry systems on Swiss lakes and on rivers in London, Paris, and Amsterdam.

FISHING

Fishing from beaches and piers, while not as popular as fishing from boats, requires only that a person have a rod, line, and bait. This type of fishing is therefore particularly attractive to persons having little money to spend for recreation -- and the fish that are caught are welcome additions to the family dinner menu.

Extensive use is made of the seven existing fishing piers in the Bay at Berkeley, Richmond, Paradise Beach in Marin County, San Leandro, Vallejo, Antioch, and at Aquatic Park in San Francisco. Heavy use is also made of the approximately 2,000 linear feet of shoreline that are open to the public for fishing.

Present piers total 6,000 feet in length. Conservative estimates place the 1980 need at 17,800 feet and the 2020 demand at 37,000 feet. No substantial addition in total beach frontage for shore fishing is assumed, but shore fishing is expected to continue wherever the fish will bite and fishermen are allowed access to the shore.

Piers can be built across the tidal flats in marshes to give fishermen access to deeper water. The State Department of Fish and Game considers fishing to be good along virtually the entire length of the Bay shoreline, provided the fishermen can get some distance out over the water on a pier or boat.

Additional fishing piers should be provided between San Francisco and Coyote Point (San Mateo), between Palo Alto Yacht Harbor and San Jose, and between San Jose and San Leandro Harbor, and between the Berkeley Pier and Martinez. These are the major areas where no such facilities are currently available. New piers should be fairly widely distributed, but the largest portion of the facilities should be located near the major population centers, if possible. The principal limitation on fishing piers is that they must not block shipping and boating channels.

HUNTING

Waterfowl hunting in and around San Francisco Bay has decreased since 1950 in all areas except the Suisun Marsh, largely because of the inroads of urban development on wildlife habitat. Assuming adequate measures are taken to retain the remaining waterbird habitat and to increase hunter accessibility to under-utilized areas, it is estimated the number of hunter-days can slowly increase again from 135,000 in 1965 to 190,000 in 1980 and 314,000 in 2020.

Prime bird-hunting areas are illustrated in Figure 12 of the BCDC report on Fish and Wildlife, prepared by the State Department of Fish and Game. Half of the hunting activity is concentrated in the Suisun Marsh, a third is in the remaining marshes of the North Bay, and the final sixth is in the Bayshore marshes south of the San Mateo Bridge.

Hunting has declined in all areas except the 50,000-acre Suisun Marsh that is largely controlled by 200 private duck clubs, and in the Grizzly Island and Joice Island State Waterfowl Management Areas. Hunting is from blinds and from small rowboats.

Much of the attrition in waterbird hunting areas is due to elimination of private duck club holdings because of the increasing value of their land and the resulting higher tax assessment. The retention of the remaining hunting areas depends upon either (1) local government concessions in the form of tax relief or other incentives necessary to keep these marshes open for wildlife, or (2) public purchase of these areas for the purpose of hunting and bird observation. In either case, public boat launching areas should be provided in appropriate locations so that rowboats, despite their limited range, can be used in marsh areas now under-utilized because of lack of access.

SWIMMING AND SUN-BATHING

The demand for swimming in the Bay Area is met in small backyard pools, large public pools, lakes, and salt water beaches. Inseparable from the demand for swimming is the use of the same facilities for sun-bathing.

SWIMMING AND SUN-BATHING

There are no surveys to indicate how much use might be made of beaches around the Bay compared to other sites for swimming and sun-bathing in the Bay Area.

While many people prefer to swim in natural bodies of water or in large reservoirs, swimming and wading in the ocean and in the Bay are severely limited by the coldness of the water. Thus the demand for swimming in the Bay Area is met primarily by pools, reservoirs, and lakes, not by use of the Bay or ocean.

Nevertheless, shoreline beaches and parks are extremely popular -- for sun-bathing primarily but for some swimming as well. Intensive use of Coyote Point Park in San Mateo County and of the Alameda beaches indicates the popularity of Bay beach use, even when other swimming and sun-bathing areas are available in nearby inland locations.

Rough approximations from existing data suggest that about 10 per cent of the current demand for swimming and sun-bathing in the Bay Area is being met on the shores of the Bay, at the present small and widely-spaced beach facilities at Coyote Point, in Alameda, at Aquatic Park in San Francisco, at Paradise Beach in Marin County, and at the new Point Molate Beach and Keller's Beach in Richmond.

If water conditions were improved and if Bayshore parks were increased and improved, it is assumed that their use would increase, to meet perhaps 25 per cent of the total swimming and sun-bathing demand in the future. The 1980 demand for "participation days" of swimming within a one-hour travel zone from the nine Bay Area counties is expected to be 35 million. Of these, about 9 million could be spent on Bayshore beaches.

Present beach frontage on the Bay totals 4.0 miles. Based on present intensities of use, 7.2 miles of beach will be needed in 1980 and 16 miles in 2020, assuming usable beaches are about 50 feet deep. Acreage of beach and accessory requirements are indicated in Table 1.

SWIMMING AND SUN-BATHING

Any new bathing beaches should be located in areas that are as much protected from the wind as possible. While the beaches should be as convenient as possible to major population centers, the desirability of warmth at a beach suggests that the larger proportion of beaches should be in the warmest areas of the Bay shore. One possibility is to locate beaches next to power or other manufacturing plants that actually warm nearby waters through the discharge of water that has been heated in the process of cooling machines or products.

PARKS

Boating, swimming and fishing are direct uses of the Bay and Bay shore. All other recreational uses of the shore are indirect (e.g., walking or driving for pleasure, picnicking, nature walks, sightseeing, bicycling, and horseback riding). Some of these uses of the shore, such as walking or sightseeing, can often be provided in conjunction with other facilities such as housing or ports -- and every effort should be made to do so -- but most of them are provided in parks.

Many parts of the Bay shore are obviously attractive settings for parks. Sites not already reserved for such use need to be acquired or otherwise reserved before they are preempted for other uses that might make future conversion to parks virtually impossible. The most comprehensive assessment of future parks and open space needs in San Francisco Bay Area at the present time is included in the Preliminary Regional Plan of the Association of Bay Area Governments. The plan proposes a total of 100 acres of park and open space for each 1,000 persons. This includes both regional and local parks and open space. One-third of the area should be provided locally for easy accessibility; the balance should be provided within the region but within 30 minutes from centers of population wherever practical.

By these standards, 720,000 acres would be required for the projected 1990 population of 7.2 million and 1 million acres would be required for the 2020 estimated population of 10 million. Adequate and convenient parks and open space will be more and more

PARKS

necessary as population density and the feeling of crowding increases. Much of this space urgently needs to be acquired or reserved before it is developed for other uses.

The entire shoreline of the Bay cannot be used for parks because of existing urban development, future port and waterfront industrial requirements, salt ponds, and wildlife refuge areas. However, because it is a naturally attractive site for parks, as much of the shoreline as possible should be acquired or reserved for parks. Figures 1-7 indicate the relatively few existing park areas and indicate all other areas proposed for parks in city and county general plans and by the Citizens for Regional Recreation and Parks, an organization of Bay Area citizens. These indicate virtually all of the prime park potential remaining on the shores of the Bay (excluding very small parks that might be developed in areas primarily devoted to other uses). The plan for the Bay should include all the proposed park areas unless an overriding public need for another use is demonstrated or unless a proposed park is part of a major fill project that is not allowed to proceed.

Shoreline parks should be developed only for uses that take advantage of the attractiveness of a Bayfront location. These include hiking, bicycling and horseback trails, picnic facilities, and viewpoints. Beach and fishing facilities can also be provided where these are feasible. Boating facilities should generally be restricted to "temporary stop" facilities, permitting boat access to the park, as in the case of Angel Island. Public launching ramps and marina slips should not, as a rule, be located in parks unless there is no other feasible location for such a facility nearby, or unless the park is in a flat area of sloughs that are obviously suitable for boating (as San Mateo County is proposing a system of "inland waterways" by connecting a series of sloughs). As a general rule, immediate Bayfront sites should not be used for recreation facilities, such as golf courses and baseball diamonds, that require special skills (hence not generally usable by the public) and that do not require such frontage;

PARKS

if such facilities are located near the waterfront, they should not block general public access to the shore.

In recent years, many communities have begun to plan and build attractive waterfront parks.

The City of Vallejo has completed the first part of an especially attractive park on Mare Island Strait across from the Mare Island Naval Shipyard. The park includes sculpture, historic plaques and equipment commemorating Navy ships, children's play equipment, large grassy areas, and a long promenade.

The City of San Leandro has also completed the first phase of its well-designed waterfront park, with a restaurant, marina, fishing pier, and small park area. Construction now under way will expand the boating facilities and will provide a large picnic area.

Similarly, the City of Berkeley is now improving its fishing pier, and is developing expanded recreational facilities along its waterfront.

The City of Richmond leased 1,500 feet of beach from the U. S. Navy at Point Molate and 400 feet from Standard Oil Company and opened it to public use in 1966. In 1967 it acquired and developed a small delightful park with 400 feet of beach at Keller's Beach.

In many of these instances, small amounts of Bay fill were necessary to create an attractive shoreline and to provide new public access to the Bay and new opportunities for Bayfront recreation.

VIEWPOINTS

Viewing the Bay is a form of recreation.

There are, of course, no data indicating the demand for viewpoints. A map of existing and proposed viewpoints was published in the BCDC report on Appearance and Design, so all that need be mentioned here is that viewpoints should be provided wherever possible. Special considerations should be given to incorporating

VIEWPOINTS

viewpoints as joint uses with other developments such as airports, ports, or housing developments.

Most viewpoints can be simply adjuncts to roads or trails. In places where large amounts of parking may not be desirable, access might be provided by walkways or any of a variety of other modes, even including an aerial tramway. At a few outlook points, it would also be highly desirable to include exhibits or museums that explain the natural and man-made landscape that can be seen below.

NATURE EXPLORING

In 1965, natural wildlife areas provided an estimated 370,000 user-days of varied recreational experiences, including birdwatching, nature study, and photography. These activities are expected to approach 522,000 user-days by 1980 and 860,000 by 2020. On one hand, the estimates are high because they presume natural areas will be reserved for such study; on the other hand they are conservative because they presume access to the Bay would remain as limited as at the present time.

Many of the best areas for wildlife photography, birdwatching, and educational study are now on private property that is not open to the general public, or are on public lands not open to the public, or are otherwise not accessible. Marshes and mud flats that are preserved in their natural state should have access provided by catwalks to the extent possible without disturbing the plants and animals to be studied. Similarly, access ways could be provided over some of the salt ponds to natural areas among or outboard of the ponds.

Strong encouragement should be offered to "nature exploring," because this recreational use of the Bay shore is generally the least expensive, thereby being available to a large portion of the population. Furthermore, it does not reduce the stock of wildlife (as hunting and fishing do) and it is a desirable means of providing public education about the natural environment.

WATER-ORIENTED COMMERCIAL ESTABLISHMENTS

Commercial enterprises can provide recreation by using a Bayfront environment to create a pleasant setting for shopping or dining. The former ferryboat that now serves as a specialty store in Sausalito, the shops on piers in Tiburon, and the several waterfront restaurants around the Bay are examples of establishments that provide a high degree of enjoyment to their patrons.

Water-oriented commercial establishments are appropriate in intensively urban areas where outdoor recreational uses would be infeasible. A variety of imaginative developments could be created at urban centers around the Bay, on land, on piers, or even on floats (the Sausalito ferry store suggests the possibility of specialty stores on a linked series of boats) to enhance the maritime atmosphere while causing little or no disruption to ecological aspects of the Bay.

Clusters of water-oriented commercial establishments would also be attractive as stops for ferryboats on recreational Bay cruises. Such ferry stops could be developed in San Francisco, Oakland, Sausalito, and Tiburon and perhaps at other locations such as Vallejo. Combined with a fleet of small, pleasant ferries, a system of commercial centers would not only be a delight for residents but also a major new tourist attraction for the Bay Area.

CLUSTERING RECREATIONAL FACILITIES

Whenever several types of recreation can suitably be clustered in a single location, this possibility should be exploited.

Advantages of clustering are: (1) common public facilities, such as parking, toilets, etc., can be shared by those coming to the area for different activities; (2) the use of these public facilities, plus any commercial establishment in the vicinity (restaurants, etc.) can be spread out over more of the year if activities such as swimming (confined to the summer months) and pier fishing (not limited to summer months) take place in the same general area; (3) people visiting the area as a family group are more likely to find activities to interest and

CLUSTERING RECREATIONAL FACILITIES

suit every family member at the same place; (4) such an area would provide most interest to people who merely wish to walk and look, one of the most frequent of recreation activities; and (5) the greater the concentration of publicly sponsored recreation facilities in one place (e.g., yacht harbor, swimming beach, fishing pier, etc.), the greater the likelihood that private investment will develop commercial facilities (e.g., eating and drinking places, bait shops, marine goods shops, sightseeing rides by boat, etc.).

This has already been proven in San Francisco where a northern waterfront area extending for several blocks has become a major attraction for residents and tourists alike, providing a beach, a variety of shops, restaurants, parks, theaters, a maritime museum, a collection of historic sailing ships, a berthing area for fishing boats, and many attractive Bay views.

TOTAL REQUIREMENTS

Estimated requirements for boating and swimming are summarized in Table 1. Almost 50 miles of Bay or slough frontage should be provided for these facilities alone 50 years from now. In addition, most of the parks proposed in Figures 1-7 should be provided. And over and above all of these, every possible opportunity should also be taken to incorporate public access to the Bay in all other developments on the Bay shore.

SUMMARY

Rapid increases in population create a demand for increasing amounts of recreational facilities. More leisure time and greater per capita income will accelerate the demand.

San Francisco Bay is the dominant feature of the Bay Area. Among other things, it is a prime recreational asset that can be used and enjoyed in many ways -- from boating to viewing.

All recreational sites that will be needed in the foreseeable future should be acquired before they are preempted for other less needed uses.

FIGURES 1-7

Existing and Proposed Parks and Open Space

No.	Existing	Proposed (by others than BCDC)	Name (or Location)
1	X		Presidio of San Francisco, U. S. Army
2	X		Marina Green
3	X		Aquatic Park
4		X	Alcatraz Island
5		X	Embarcadero Plaza
6		X	Bay View Park
7		X	Brisbane Regional Parks
8		X	South San Francisco Parks
9		X	South San Francisco Golf Course
10		X	Burlingame City Park
11	X		Coyote Point Park
12		X	Westbay Community Associates
13		X	Foster City
14		X	Marine World
15		X	Redwood Shores
16		X	Greco Island
17		X	Marsh Road Refuse Site
18		X	Cooley Landing Park
19		X	East Palo Alto Park - Ravenswood Point
20		X	Menlo Park Wildlife Preserve
21		X	San Mateo County Shoreline
22		X	Three-Finger Lake, Palo Alto
23		X	Mountain View Regional Park
24		X	Stevens Creek Park Chain
25		X	Guadalupe Park Chain
26		X	Guadalupe Marina
27		X	Sunnyvale Bayland Park
28		X	Alviso Recreation and Wildlife Area
29		X	City of Fremont
30	X		Newark Wildlife Areas
31		X	Alameda Creek-Coyote Hills Regional Park
32	X		San Leandro Waterfront
33		X	San Leandro Bay
34		X	Bay Farm Island
35	X		Alameda Beaches
36		X	Oakland Boat Harbor
37		X	Public Fishing Areas, Oakland, 7th Street
38		X	Town of Emeryville
39	X		Berkeley Waterfront
40		X	City of Albany
41		X	Santa Fe Railroad
42		X	Brooks Island
43		X	Richmond Inner Harbor Basin
44		X	Santa Fe Channel
45		X	Santa Fe Channel
46	X		Keller's Beach
47		X	Brickyard Cove
48		X	Point Molate
49		X	Point San Pablo
50		X	Richmond Sanitary Land Fill
51		X	Wildcat-San Pablo Creek Streamside Preserves
52		X	Point Pinole
53		X	Carquinez Strait Regional Park
54		X	Martinez Waterfront
55		X	Seal Is. and Hastings Seal Crk. Reg. Park
56		X	Mallard Slough Aquatic Park
57		X	Suisun Marshes
58		X	Benicia Waterfront
59	X		Benicia Beach State Park
60		X	Carquinez Strait State Park
61	X		Vallejo Waterfront
62		X	Napa Marshes Game Refuge
63		X	Tolay Creek Conservation Area
64		X	China Camp-Point San Pedro
65		X	West Marin Island
66		X	San Rafael Creek Park
67		X	Corte Madera County Park
68	X		Paradise Beach Park
69		X	Keil Cove and Bluff Point
70	X		Angel Island
71		X	Richardson Bay Greenbelt and Shore Park
72		X	Marina Green
73		X	Manzanita Marina Green
74		X	Sausalito Central Waterfront
75		X	Marin Headlands State Park

FIGURE 1

Boating Facilities and Parks:

Carquinez Strait and Suisun Bay

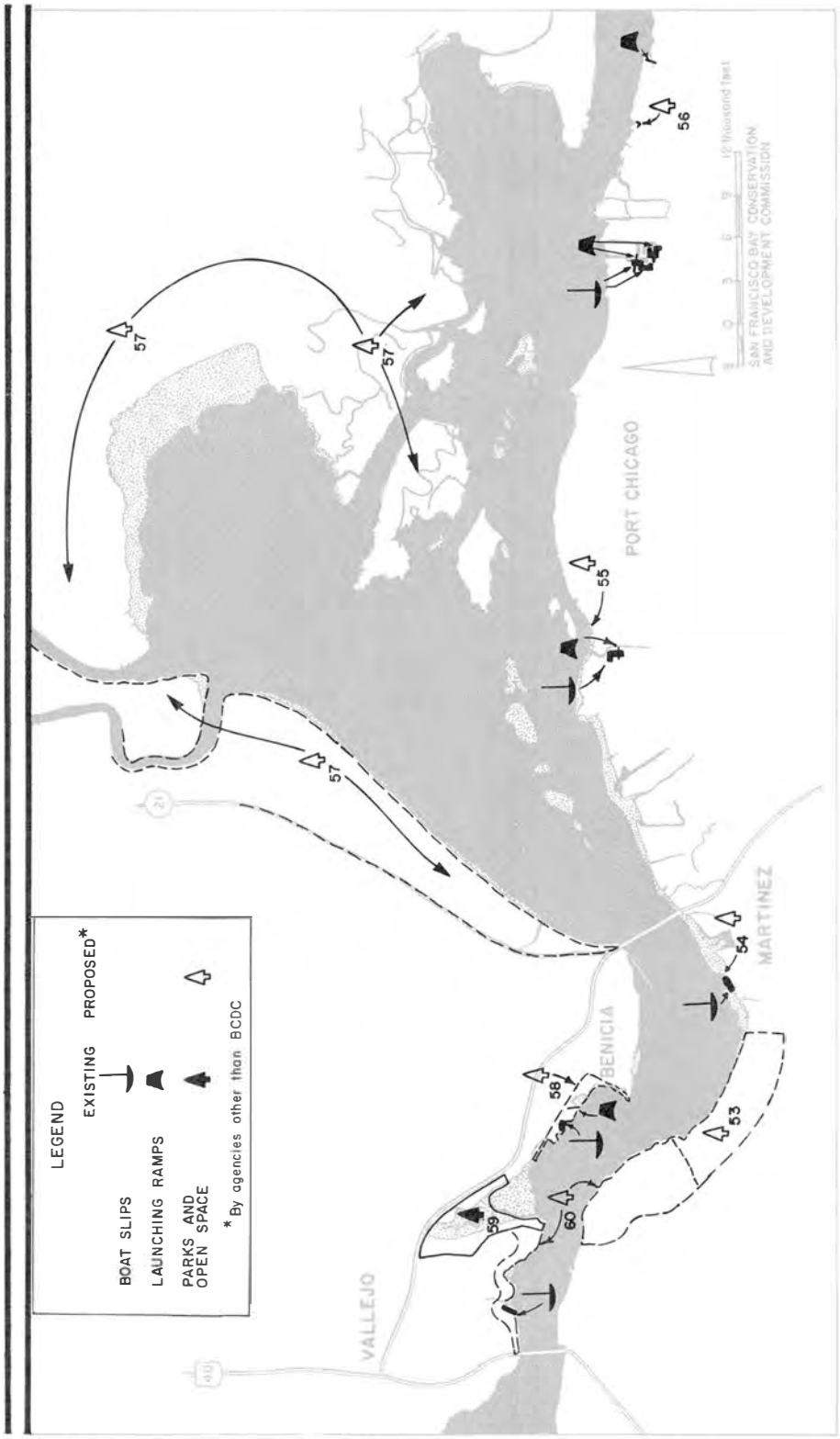


FIGURE 2

Boating Facilities and Parks:

San Pablo Bay (north portion)

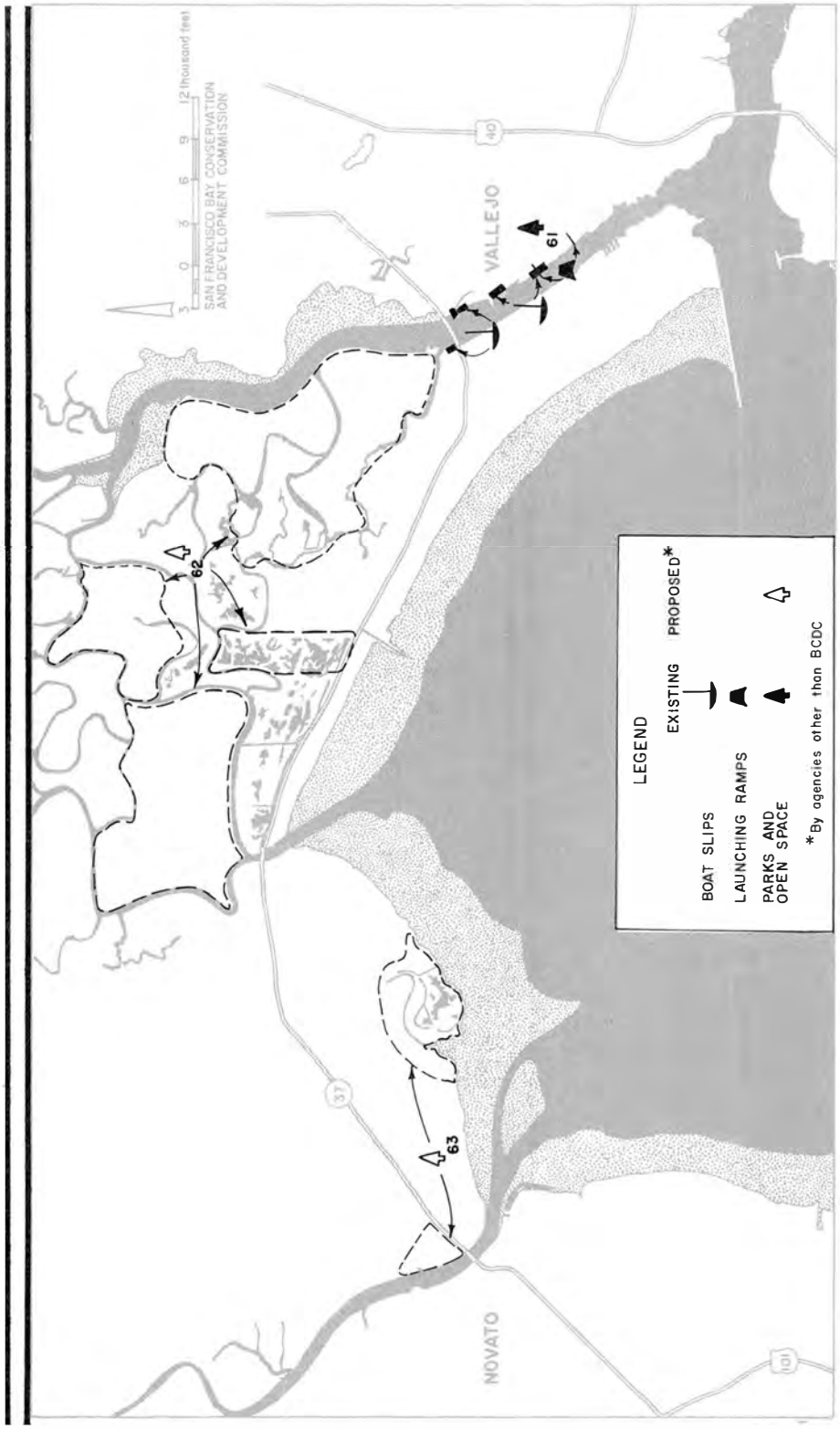


FIGURE 3

Boating Facilities and Parks:

San Pablo Bay (south portion)

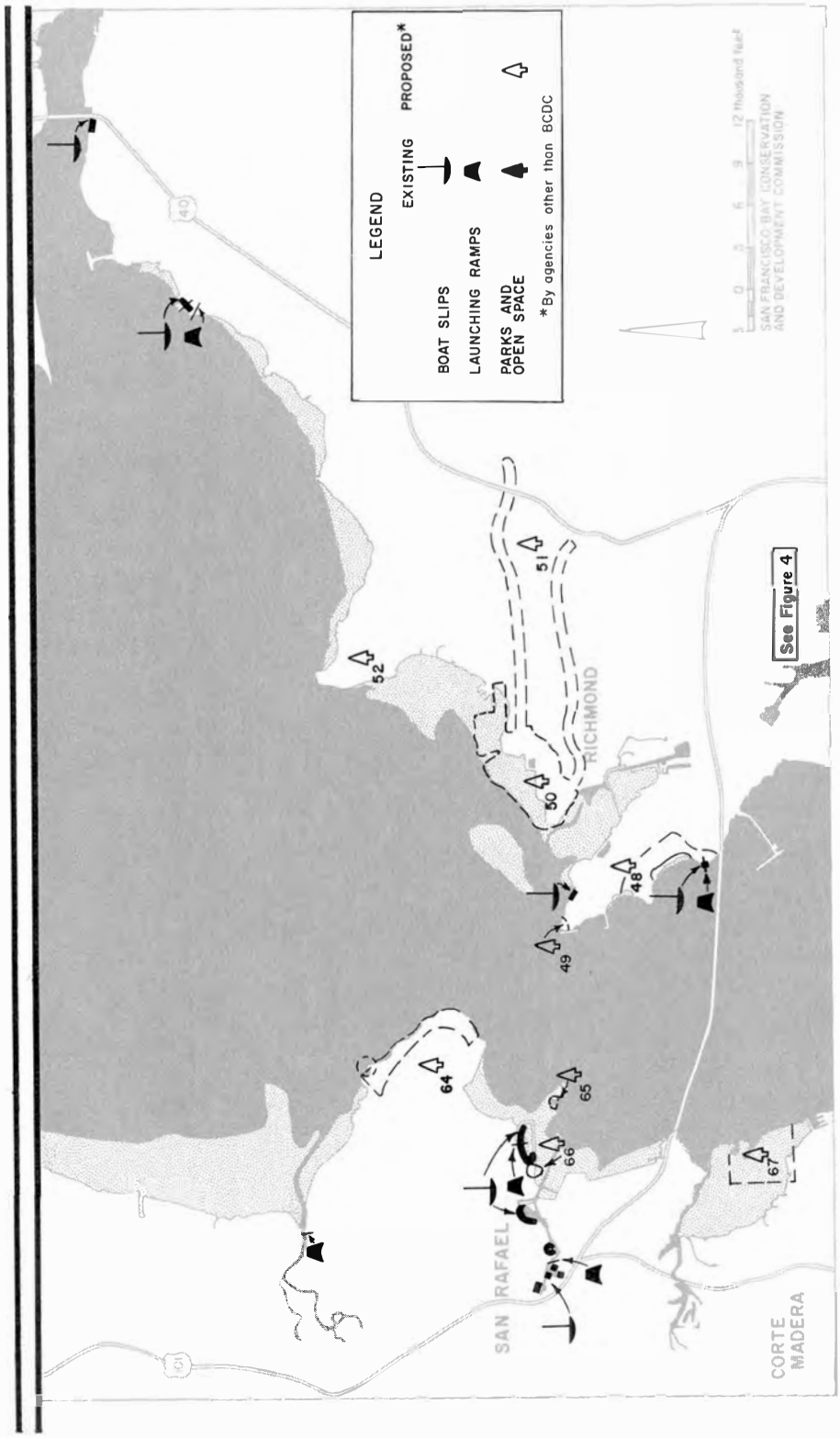


FIGURE 4

Boating Facilities and Parks:

Central Bay

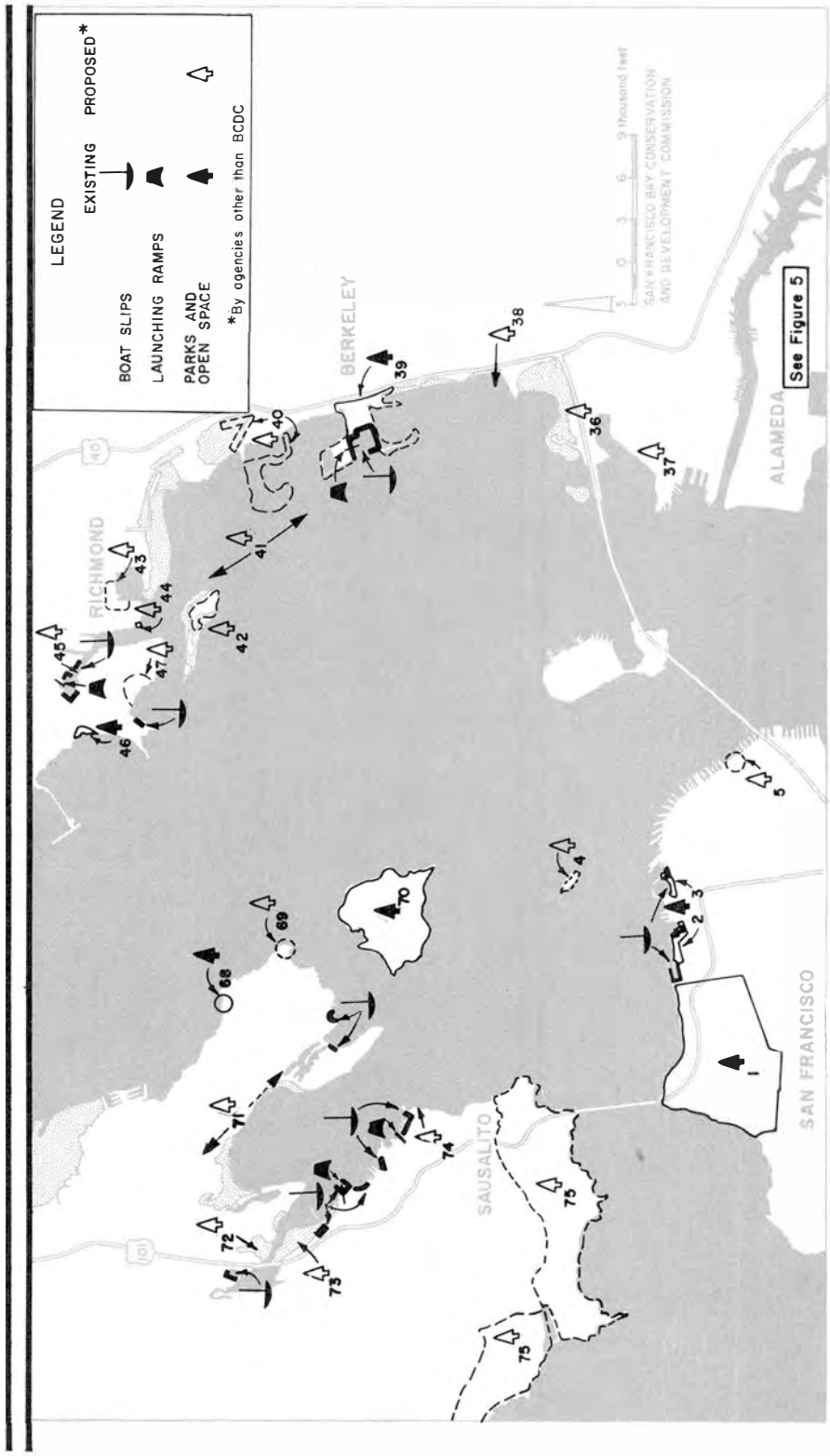


FIGURE 5

Boating Facilities and Parks:

South Bay (north portion)

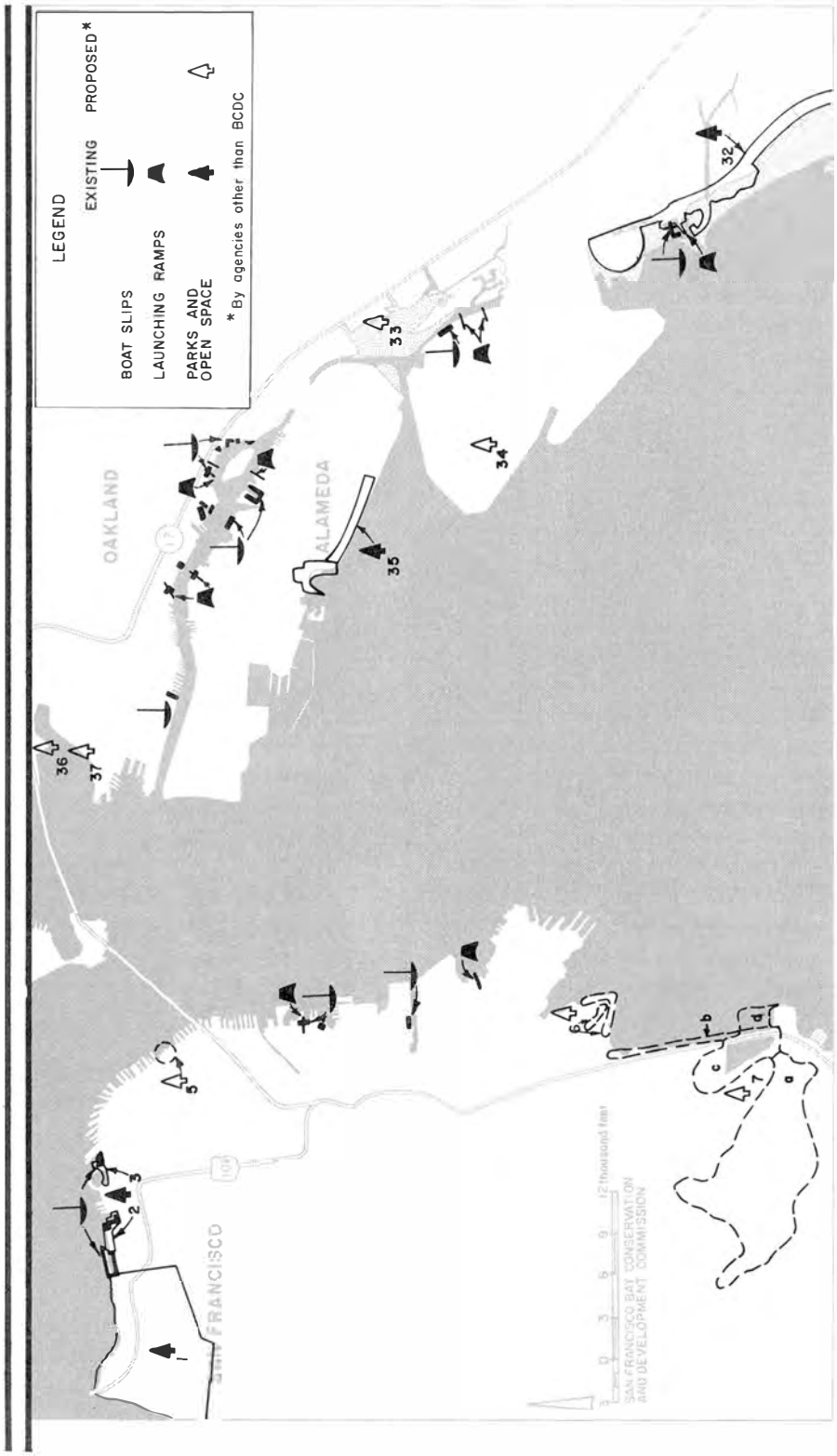


FIGURE 6

Boating Facilities and Parks:

South Bay (center portion)

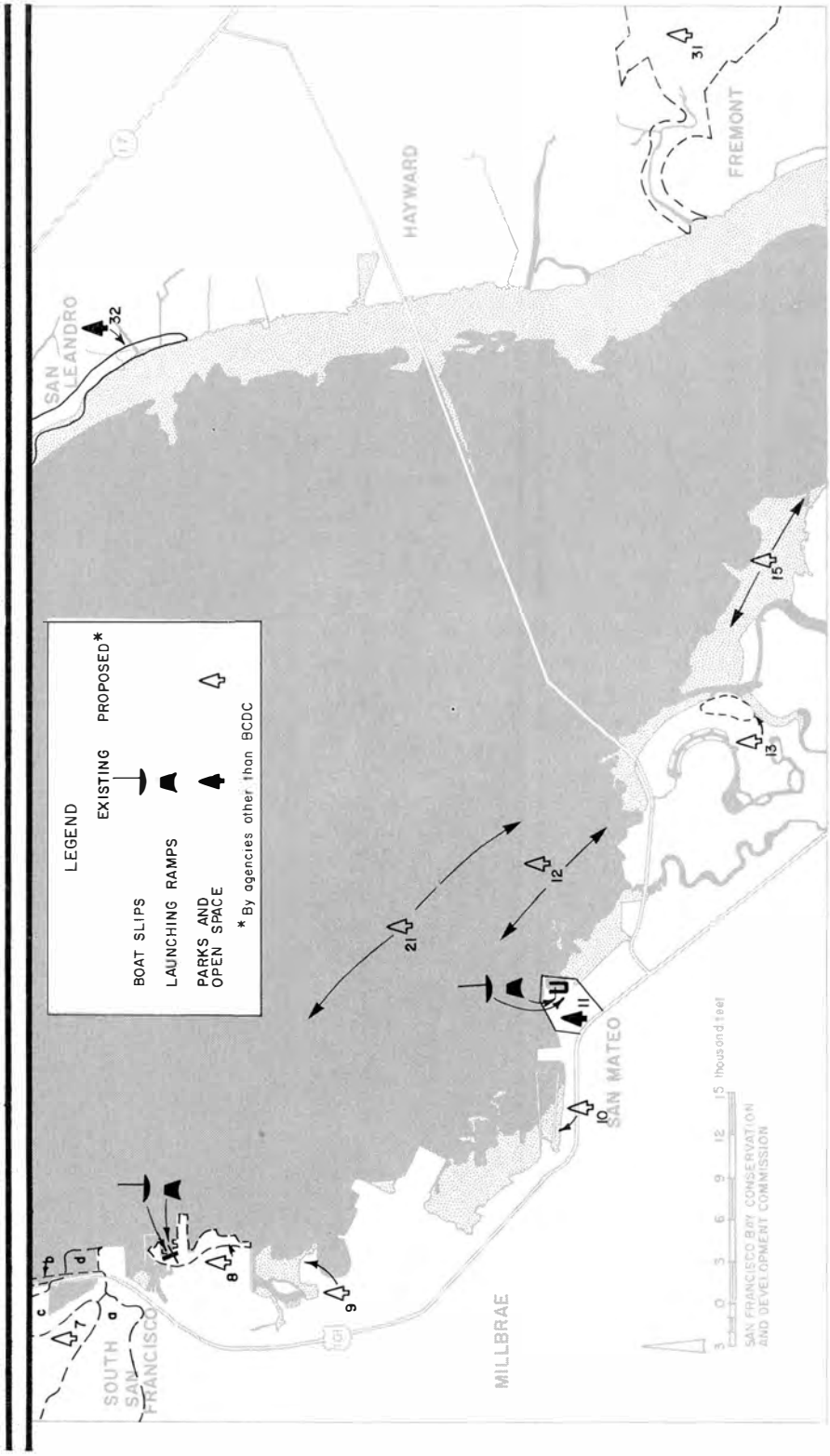
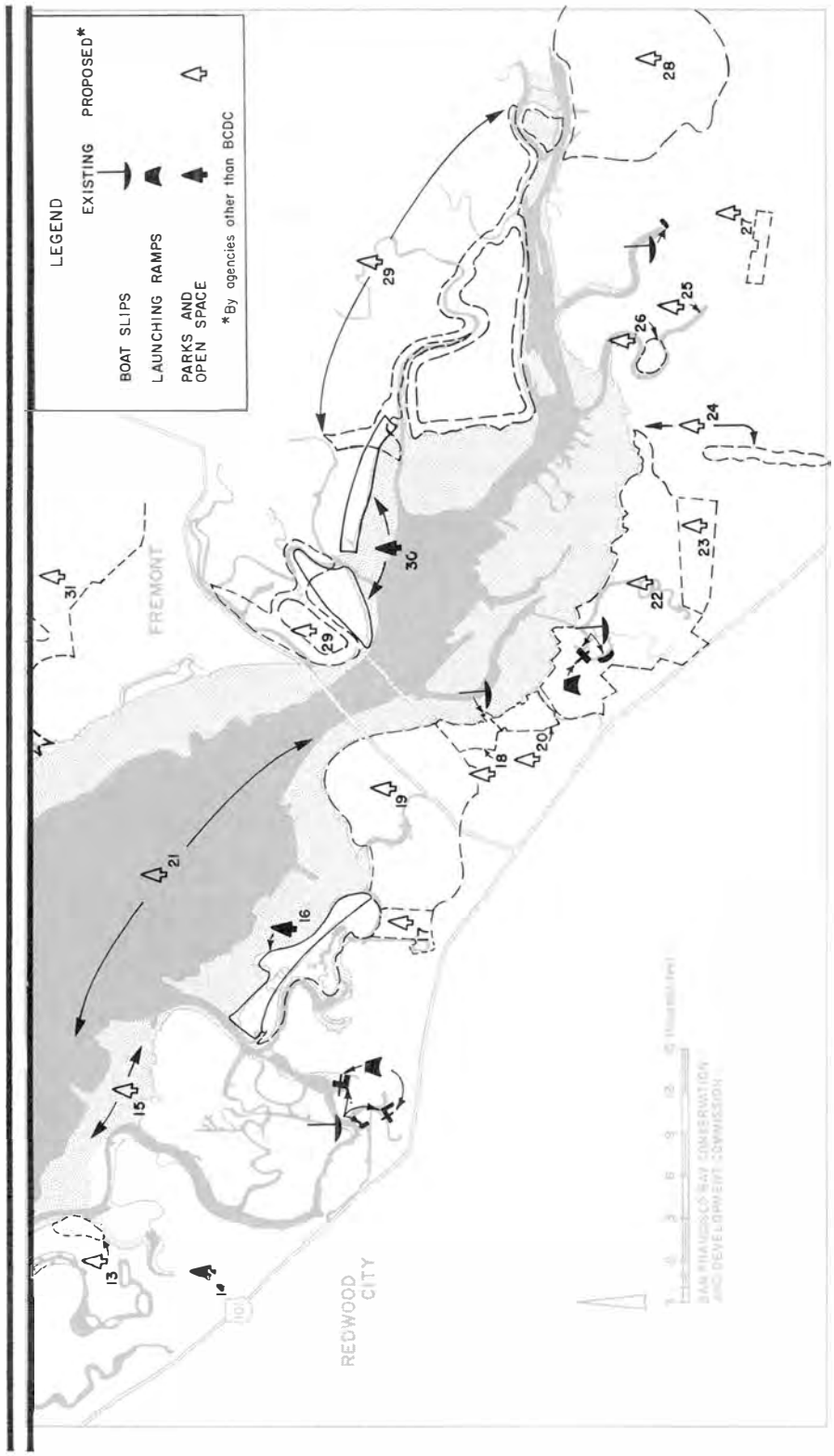


FIGURE 7

Boating Facilities and Parks:

South Bay (south portion)



A D D E N D U M

REVISED MARINA SPACE REQUIREMENTS

Subsequent to the completion of the BCDC reports on Recreation, Commissioner Harry A. Bruno, an architect experienced in marina design, submitted the following proposed revisions in planning standards for wet storage of boats in San Francisco Bay.

"Page 19 of the Technical Report on Recreation on and Around San Francisco Bay establishes a standard of 100 berths per acre of water or 440 square feet per boat for evaluating marina space requirements in the Commission's plan for the Bay.

"The major marinas around the Bay built in the last eight or ten years have from 1,100 to 1,600 square feet per berth. This includes Jack London Square, new Berkeley, new Richmond, San Francisco Yacht Club, and Corinthian at Belvedere, Clipper, Gas House Cove and the new Ballena Bay in Alameda.

"Using a maximum of 44 boats per acre (1,000 square feet):

"Change 1975 requirements from 248 acres to 565.
"Change existing acres from 117 to 265.
"Change increase required for 1975 from 131 to 300.
"Change '220 feet along shore' to 330, and 200 feet to 300.
"Change 55,000 feet to 82,000, and 10 miles to 15-1/2 miles.
"Change 27,000 feet to 40,000, and five miles to 7-1/2 miles.

"And change figures for year 2020 accordingly."

Since Commissioner Bruno's data is drawn from recent Bay Area data, it is more useful in planning for the Bay than is the more general and perhaps older statewide data used in the original report. Therefore, the staff recommends that the substitute data herein be incorporated as the standards to be used in planning for the Bay.

As a result, the summary table, "Estimated Shoreline Requirements for Boating and Swimming, 1975-80 and 2020," (Table 6, page 66 of the technical report and Table 1, page 5 in the summary report) has been revised to read as follows:

ESTIMATED SHORELINE REQUIREMENTS FOR BOATING AND SWIMMING, 1975-80 and 2020

	Existing 1/	1975	1980	2020
Miles of shoreline required				
Marina wet storage	5	15.5		42
Launching ramps	.6	1.0		2.7
Swimming beach	4.0		7.2	16
Total lineal miles	9.6	23.7		60.7
Shoreline acreage required 2/				
Marina 3/	150	310		871
Launching ramps	475	735		2,065
Swimming beach	24		43	76
Total shoreline acreage	649	1,088		3,012

1/ Estimated, not actual. Some data is calculated from standards.
2/ Included parking and ancillary requirements.
3/ Excluding dry storage acreage estimated at 161 acres in 1975 and 452 acres in 2020 -- on basis this acreage need not be provided directly on the waterfront.

SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION
507 Polk Street, San Francisco 94102 557-3686

Possible Bay Planning Conclusions Based on the Report on Recreation

1. San Francisco Bay and its 276 miles of shoreline offer great potential for expanded use to meet the recreational needs of a growing Bay Area population.

2. The demand for recreational facilities in the Bay Area will increase more rapidly than the population increases, and will be accelerated as the work week declines and as the spending power per capita increases. While some recreation facilities exist, many more will be needed.

3. To plan effectively for recreational uses of the Bay and shoreline, the BCDC must consider recreational needs about 50 years into the future -- i.e., in the year 2020. Unless sufficient land is reserved now for recreation, much of it will have been taken for other uses by the year 2020.

4. Amount of Shoreline Required. No precise data exist upon which to base exact calculations of the amount of shoreline that will be needed for formal recreation facilities in the year 2020, but the best available projections will be used for planning. For boating facilities, fishing piers and swimming beaches, the projected requirements are as indicated in Table 1 of the Summary and revised in the Addendum to the Summary. For parks and open space, there is no practical estimate of amount that should be provided on the shoreline of the Bay, but it is assumed the largest possible portion of the total regional requirement should be provided on the shores of the Bay.

5. Location Criteria. In preparing the plan for the Bay, the following general standards shall be used in determining locations for each type of recreational facility:

a. General: Each type of facility should be well distributed around the shores of the Bay to the extent consistent with more specific criteria below. Any concentrations of facilities should generally be as close to major population centers as is feasible. Recreational facilities should not preempt sites determined by the Commission's studies to be needed for ports, waterfront industry, or airports, but efforts should be made to integrate recreation into such facilities to the extent they might be compatible. Different types of compatible recreational facilities should be clustered to the extent feasible to permit joint use of ancillary facilities and provide greater range of choice for users.

b. Marinas and launching lanes: (1) Sites that tend to rapidly fill up with silt or mud should be avoided, (2) launching lanes should not be placed where wind and water conditions might be dangerous for smaller boats, (3) launching lanes should be located near prime fishing areas and near calm, clear water suitable for water-skiing.

c. Fishing piers should not block navigation channels, nor interfere with normal tidal flow.

d. Swimming and sun-bathing beach sites: (1) Beaches should be in areas protected from the wind and in the warmest parts of the shoreline, and where the waters of the Bay are the warmest to the maximum extent feasible, (2) some new beaches could be planned adjacent to power plants or other industrial plants that warm the nearby waters as they discharge heated water that has been used to cool industrial machinery.

e. Viewpoints should be encouraged in every feasible location.

f. Parks and open space: The plan for the Bay should include all parks and open space proposed in Figures 1-7, unless an overriding public need for another use is demonstrated or unless a proposed park is part of a major fill that is not allowed to proceed.

g. Water-oriented commercial-recreational establishments should be encouraged in intensively urban areas adjacent to the Bay.

6. Features to be Included. To assure optimum use of Bay recreational facilities, the Commission's plan for the Bay should encourage:

a. In shoreside parks: (1) Where possible, parks should provide some camp facilities accessible only by boat. Up to 2,200 such campsites will be needed by the year 2020. In addition, docking and picnic facilities should be provided for boaters. (2) To capitalize on the attractiveness of their Bayfront location, parks should emphasize hiking, bicycling, riding trails, picnic facilities, viewpoints, beaches, and fishing facilities. Recreational facilities that do not need a waterfront location, e.g., golf courses and playing fields, should be planned for inland areas. (3) Where shoreline open space includes areas used for hunting waterbirds, public areas for launching rowboats should be provided so long as they do not result in overuse of the hunting area. (4) Where open areas include ecological reserves, access via catwalk or other means should be provided for nature study to the extent that such access does not excessively disturb the natural habitat.

b. In or near yacht harbors or commercial ferryboat facilities: private boatels and restaurants.

c. At viewpoints: (1) access by walkway, tramway, etc., if adjacent parking is not feasible or desirable; (2) exhibits or museums explaining the value or importance of the areas being viewed.

7. The BCDC plan should attempt to reserve all the waterfront land needed for recreation by the year 2020, because delays may mean that needed shoreline will otherwise be preempted for other uses. However, recreational facilities need not be built all at once, but their development can proceed in accordance with recreational demand over the years.

8. Because of the need to increase the recreational opportunities available to Bay Area residents, small amounts of Bay filling could be allowed for shoreline parks and recreational areas that provide substantial public benefits and that cannot be developed without some filling.

9. In addition to the public access to the Bay provided by the recreational facilities to be included in the Commission's plan, every possible opportunity should be taken to provide public access in all other developments along the shoreline, as has been suggested in the Commission's reports on Ports, Airports, Housing, and Appearance and Design.

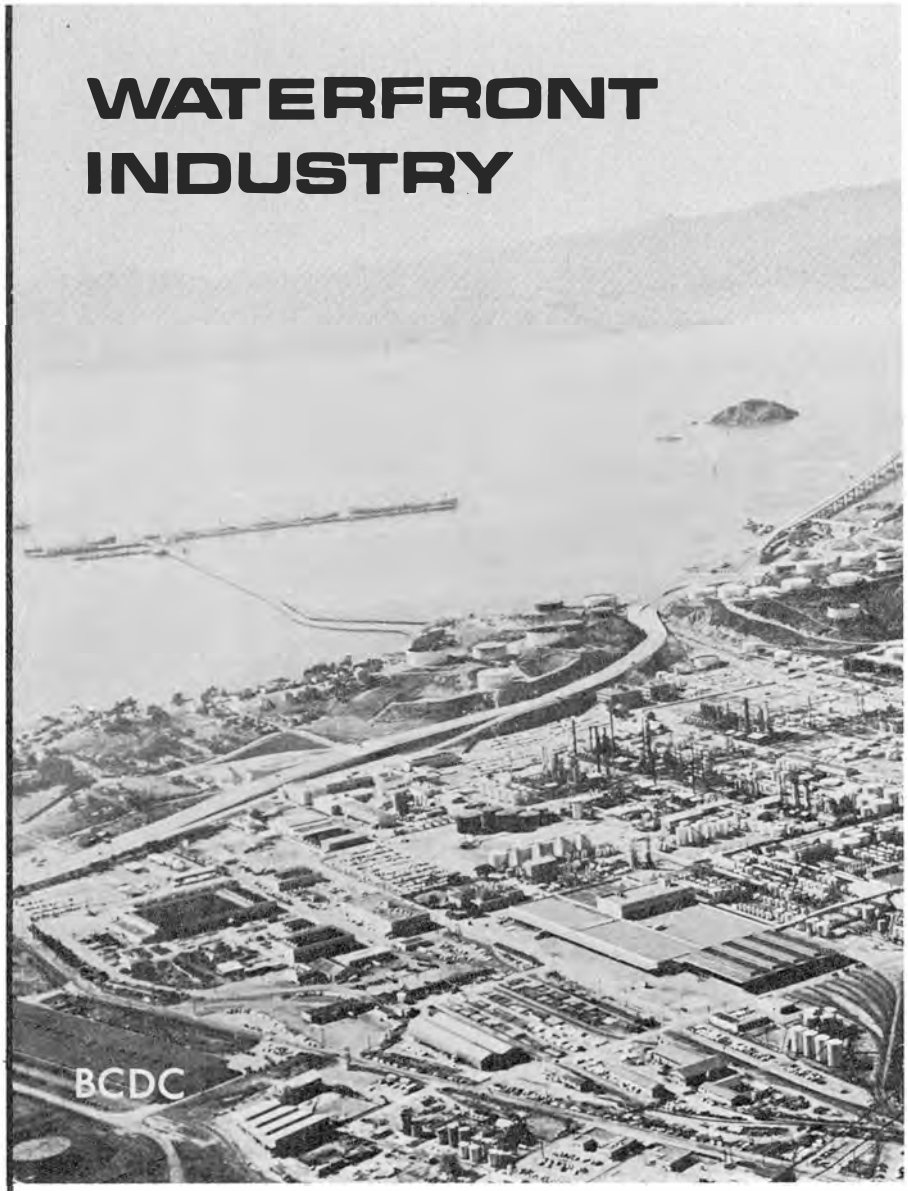
10. The Commission's plan should recommend that the agency carrying out the plan encourage a linking of the entire series of shoreline parks and public access points to the extent feasible without additional Bay filling. Many types of connection can be employed, such as scenic drives, hiking paths, and a system of inland waterways.

Adopted by the Commission at its meeting of 2/1/68

WATERFRONT

INDUSTRY

Part of
a Detailed
Study of
San Francisco
Bay



San Francisco Bay
Conservation and
Development
Commission

San Francisco,
California

February, 1968

Summary of the report, "Waterfront Industry Around San Francisco Bay," by Dr. Dorothy Muncy, Consulting City Planner.

INTRODUCTION

An oil tanker gliding up the Bay.

A barge hauling petroleum products from a refinery to local markets.

The activity of cranes and docks and tracks at industrial plants along the waterfront.

These are but some of the aspects of a vital part of the economy of the Bay Area, and also of California and the West: the heavy industries that, by the nature of their operations, must be located next to protected waterways for shipping purposes, or that need access to large volumes of water for industrial processing purposes.

THE IMPORTANCE OF WATERFRONT INDUSTRY

The kinds of industry that require a waterfront location -- petroleum refining, chemical processing, and steel mills, for example -- are the basic industries upon which other industries -- and the rest of the economy -- depend. These basic industries often transform raw materials into semi-finished materials needed by other manufacturers to make the wide range of goods available to the consumer today. Efficiency and economy usually dictate that the wide variety of industries dependent upon the basic ones locate in the same region.

The United States has only a few protected deep-water harbors. At the same time, the United States is increasingly dependent upon foreign sources for oil, iron ore, and other raw materials that can be processed economically where they are unloaded from ships. As gateways for these materials, ocean ports such as the Bay Area serve the landlocked interior States as well as their own immediate hinterland. This means that the San Francisco Bay Area, with one of the finest deep-water harbors in the world, has a major responsibility for the economy of a large part of the western United States. It must therefore serve more than just its own economic needs.

"TYPICAL" WATERFRONT INDUSTRIES

The kinds of industries that need locations at or near the waterfront may be grouped as (1) those dependent upon deep-water shipping for inbound and outbound materials and products, (2) those closely linked to the foregoing by their dependence upon them for raw materials, (3) those using shallow-draft shipping such as barges, (4) those using large volumes of water in industrial processing, and (5) those attracted to the waterfront for other reasons.

1. Deep-Draft Industries

As already indicated, industries that depend upon large ships are usually the basic processors of raw materials. The large volumes of individual raw materials allow the use of special bulk-carrying ships and special unloading facilities for each material. The increasing size of the ships and the speed of modern unloaders exceed the capacity of barges or railway cars to haul cargoes away, so huge stockpiling areas are required by some industries at the waterfront.

Typical industries requiring access to deep-draft shipping include petroleum refineries; chemical plants; primary metal industries such as blast furnaces, steel works, and rolling and finishing mills; sugar refineries; and shipbuilding and repairing.

2. Linked Industries

Many industries are closely linked to basic processors. For example, petroleum refineries often need such large quantities of electricity that power plants are built nearby. Also, as the size of a basic industry increases, so does the number of linked industries, as in the case of large petrochemical plants. Clustering of linked industries reduces material-handling costs and on-site storage requirements, speeds deliveries, and perhaps most important from the public's point of view, reduces heavy industrial traffic on public roads. For instance, steel plants could deliver within the industrial complex to pipe and sheet

"TYPICAL" WATERFRONT INDUSTRIES

mills, wire-drawing and forging plants, foundries, and large-quantity users of mill products such as structural steel and plate fabricators.

One alternative to immediate juxtaposition of subsidiary industries and basic processors would be a system of pipelines and barges; this would enable product-linked plants to spread out but still to remain linked by the specialized system of transportation. This is an attractive alternative where waterfront sites are scarce; an outstanding example is in the area around the Houston Ship Channel in Texas, where a complex pipeline network connects refineries to petrochemical plants.

3. Shallow-Draft Industries

Industries that can use shallow-draft barges include manufacturers of brick, clay, and concrete products, and food processing industries, such as meat-packing and canneries. The potential for shallow-draft industries greatly exceeds present use on the Bay. Soon to be in operation are ocean-going vessels that carry fully-loaded barges (instead of cargo in holds); this system will permit a wide variety of industries at shallow-draft sites to ship and receive large volumes of overseas products. It could also lead to the development of wholesale and distribution facilities on shallow-draft sites around the Bay.

Another potential development is the use of the Bay to ship large quantities of cargo back and forth within the Bay Area by water, instead of on highways or rail. Faster barges -- or more probably new types of vessels such as surface effect or air cushion vehicles such as Hovercraft -- would make possible the shipment by water of raw materials, finished products, and oversized or hazardous cargoes from one part of the Bay Area to another.

"TYPICAL" WATERFRONT INDUSTRIES

4. Water-Using Industries

Many industries use water in their manufacturing process. Use of water by industry far exceeds household use of water in the United States. However, most industrial use of water does not consume the water: most of it is used to cool industrial equipment and the water is usually returned to its source unpolluted but heated. Typical industries using large volumes of water in the Bay Area are power plants, steel processors, refineries, food processors, and chemical manufacturers. At present, power plants use two-thirds of all the water used for cooling in the Bay Area. A large variety of manufacturing industries use water for processing and waste treatment; most of them can use salt water and most have potential for development in the Bay Area.

5. Other Industries

Other industries that seek waterfront locations are (1) industrial parks seeking the amenities of an attractive waterfront setting, (2) industries linked to airports, such as industries that ship large quantities of air cargo, aircraft service industries, and industries with many service employees who fly to customers' plants, (3) industries needing to be close to freeways and railroads, which in the Bay Area are often located close to the Bay shore, and (4) industries using the waterfront simply because it is the cheapest location available, usually occupying deteriorated buildings or marshy ground to store low-value goods, such as junk and salvage materials.

Except for the industrial park seeking a pleasant site, none of these other industries needs the special advantages of a waterfront location. With the exception of those properly located next to an airport, most of these industries could be located elsewhere if adequate provision were made for them.

HOW INDUSTRIES CAN BE "GOOD NEIGHBORS"

The people of the Bay Area have the opportunity to protect and enhance the Bay's appearance while they plan to utilize the Bay in the service of the region, the state, and the nation. Industry in general is fast trying to become an attractive, as well as economically important, part of the community. Individual industries and associations of industries have found it profitable to be a "good neighbor" and have often exceeded public regulations in combating pollution, etc. But regulations have also been necessary in many instances.

1. The Bay Region is Attractive to Industry

The Bay Area has many characteristics that are attractive to water-oriented industry, more perhaps than any other American metropolitan area: (1) an excellent harbor, (2) a growing population and a high-income consumer market, (3) an established and expanding manufacturing market, (4) a good supply of waterfront land that is not yet committed to other uses, (5) a well-established array of supporting services and facilities, such as city services, industrial supply and repair services, universities of outstanding national reputation, financial facilities and cultural and recreational resources, (6) the outstanding interest of government, business, and civic leaders in a regional analysis of waterfront problems and potentials that is unparalleled in any other port region, and (7) the latent opportunity to use efficient and inexpensive water transportation for distribution of goods and raw materials within the region.

All of these assets combine to give industry extra advantages in the Bay Area that fully justify requirements for industry to achieve high standards as a "good neighbor."

2. Steps Industry Can Take

The desire of industrial managers to have attractive buildings and grounds for public relations purposes has been evident in the last two decades.

HOW INDUSTRIES CAN BE "GOOD NEIGHBORS"

Many consumer-oriented industries, such as auto assembly plants, breweries, soft-drink manufacturers, bakeries and cosmetic and baby products firms have invited the public to visit their production facilities. More recently, heavy industries have been scheduling visits to new plants. There is also a trend toward sharing industrial sites with the public for enjoyment of views, landscape features, and historic buildings. Bay Area examples are Cabot, Cabot and Forbes, which will have a park area open to the public at its waterfront site in San Mateo County and Benicia Industries in Solano County, which has many structures of historic interest open for public visits and also has fine vantage points for viewing the Bay and the Contra Costa County shoreline. These are industrial parks housing several different industries, but similar approaches are possible on large single-industry sites.

A major area of public concern about industry is the need to control air and water pollution. Although many water-oriented industries are "heavy" industries, technological advances have made possible standards of plant operation that do not interfere with the quality of urban life. Installing pollution control equipment is simpler and far less expensive during the construction of a new plant than as an addition to an existing plant; needed pollution control measures should thus be adopted so as to set standards for the design of new plants. At the same time, the region should vigorously continue efforts to improve industrial waste disposal methods. A regional system of piping or barging wastes to the open ocean, or of waste reclamation, could save large amounts of industrial land that would otherwise be needed for individual waste treatment facilities at each plant. A regional plan for waste disposal methods is now being prepared by the State's Bay-Delta Water Quality Control Program.

When Bayfront hills are selected for water-oriented industries, regionwide development regulations should require terracing rather than complete

HOW INDUSTRIES CAN BE "GOOD NEIGHBORS"

leveling of the hills. An example in the Bay Area is the Stanford Industrial Park, in which many plants have been terraced on the hills. Terracing, diking, and landscaping of areas for petroleum and chemical products tanks is also being done in the Bay Area. Long processing lines in steel mills or other fabricating plants will require large level sites for each building, but the complete site need not be level. In rolling terrain, the topography can be utilized to create two or more levels of entrance to buildings.

Overlook points, historic areas and structures, and points of public access to the waterfront can be incorporated in many large industrial sites. Such areas need not be directly accessible by private automobiles and need not require large areas of parking and driveways; where land is too valuable, access can be gained by hiking paths or by imaginative forms of public transit, such as elephant trains or even aerial tramways. Open space and structural density requirements in zoning or industrial subdivision ordinances should be flexible enough to credit public access areas as part of the open space requirements. In addition, if a sizable area is to be obtained for public use in an existing industrial site, a public agency should assist the industry in obtaining suitable adjacent land to replace areas given over to public use.

Most water-oriented industries require large waterfront sites, but many do not need long uninterrupted shorelines for their operations. Industrial shoreline not actually used for shipping facilities and water intakes and outlets could therefore be used for some type of public access or recreation. Some Bay Area waterfront industries have already established recreational uses of parts of their shoreline: Standard Oil Company's shoreline in Richmond includes a yacht harbor and an employee's rod and gun club, and the C&H sugar refinery at Crockett includes a fishing pier and small boat berths along its shoreline.

HOW INDUSTRIES CAN BE "GOOD NEIGHBORS"

Because of topography, the nature of the industrial use, or other reasons, it will not always be possible to provide public access to the waterfront within each industrial site, but provision should be made to achieve these objectives wherever feasible. Regulations, tax arrangements, or other devices should be drawn in a manner that encourages and accommodates industry's increasing desire to be a "good neighbor." Environmental quality now ranks high in management's location decisions, for it contributes to employee satisfaction and reduces operating and administrative costs and personnel turnover. Thus industry, like the public in general, now has a direct stake in seeing that the Bay's beauty is maintained while the economic use of its shoreline is being expanded.

3. The Public's Reciprocal Obligation

The "good neighbor" role to protect public access to the shoreline and the visual appearance of the Bay in industrial areas is reciprocal. Like industry, the public agencies should consider the approval of a development plan an agreement to abide by the conditions. Once industry and public agencies agree on site development and design plans, the industry should be able to proceed with the certainty and confidence that the public agencies will (1) construct the agreed upon improvements such as roads, parks, etc.; (2) enact and enforce the necessary development controls to prevent encroachment of incompatible uses into the industrial area; and (3) refrain from making unreasonable demands on the industry that were not included in the original plan approval.

HOW MUCH LAND IS NEEDED FOR WATER-ORIENTED INDUSTRY?

Estimates of the amount of land that may be needed for water-oriented industry in the future are derived from estimates of the amount of such industry that might come to the Bay region. The most convenient present measure of future industry and its land requirements is the number of persons employed or expected to be employed in such industries.

HOW MUCH LAND IS NEEDED FOR WATER-ORIENTED INDUSTRY?

1. Present and Projected Employment

The growth of basic industry in a region depends upon the market available for its products. Large basic industries, such as steel mills or oil refineries, require a very large market to become economically feasible. The most useful forecasting requires an analysis of the potential of each major industry group and a sophisticated analysis of the growth of each industry group in relation to the growth of other industries and the growth of the region. The effect of technological change must also be evaluated: for example, advances in water transportation technology would increase industrial demand for Bayfront land. The only economic analysis ever made for the Bay Area that approaches this degree of comprehensiveness is the study made more than a decade ago by the U. S. Department of Commerce as part of the Army Corps of Engineers' Comprehensive Report on the Future Development of the San Francisco Bay Area, 1960-2020. More recent studies by other agencies in the Bay Area were expected to be available for use in this study of waterfront industry, but they were not completed in time.

A rough estimate, prepared from the only existing data, suggests that about 125,000 more people will be employed in water-oriented industry in the year 2020 than in 1966. State Department of Employment data for 1964 indicates 55,170 were employed in water-oriented industries at that time.

2. Present and Projected Acreage of Waterfront Industry

With appropriate adjustments, data on current employment in waterfront industries and acreages of land currently used by such industies can be correlated with projected employment estimates to determine the additional amount of land that would be needed in the future. The forecasts must also take into account the changing land needs of different kinds of industries; for example, the advent of giant tankers and bulk-cargo carriers

HOW MUCH LAND IS NEEDED FOR WATER-ORIENTED INDUSTRY?

has made possible much larger, higher volume industries that need considerably more land, e.g., steel mills that can require more than 1,000 acres.

No estimate of the amount of land used for waterfront industry at the present time is available (this also was to be prepared by another agency but was not completed in time). Projections made on the basis of the existing inadequate data suggest that from 27,000 to 44,000 acres of land will be needed for water-oriented industry in the future, in addition to the land now being used for that purpose. These rough estimates should be revised as soon as better data become available, but they give an indication of the large amounts of land that ought to be considered in planning for future waterfront industry.

CRITERIA FOR SELECTING INDUSTRIAL SITES

Four kinds of water-oriented industry have been described above: (1) deep-draft industries, (2) "linked" industries, (3) shallow-draft industries, and (4) water-using industries.

Sites for deep-draft industry require (1) proximity to an existing or potential deep-water channel, (2) proximity to existing or potential railroads and freeways or major roads, (3) large sites (hundreds or even thousands of acres), particularly if new channels must be dredged to the site, (4) relatively gentle grades and high, dry sites, if possible, (5) large tracts of land in single ownership to facilitate purchase, and (6) land that is either vacant or in a type of use that can eventually be phased out economically. Few sites can meet all of these criteria, so in preparing this report, a system of rating points was assigned to these factors; sites were then selected on the basis of their scores on the rating scale.

For shallow-draft industries, the same criteria apply except that somewhat smaller sites are economically feasible. Shallow-draft industrial sites require access to channels at least 12 feet deep.

CRITERIA FOR SELECTING INDUSTRIAL SITES

The same criteria apply for water-using industries except that accessibility of pipelines to the water, in terms of distance and ruggedness of terrain, are substituted for proximity to channel.

The largest and most important "linked industries" are those that are satellite to deep-draft industries; all sites for linked industry should therefore be primarily located adjacent to deep-draft industrial sites or linked to them by a pipeline network or shallow-draft transport route.

All vacant or marginally-used sites on the shores of the Bay were examined in light of the above criteria. The results are indicated in Figures 1 through 7. The locations indicated are merely those that meet the given criteria; these locations are not intended to be included in BCDC plans as waterfront industrial areas until their suitability is confirmed by more careful analysis, including their effects on the ecology of the Bay and the possible priority of other uses.

The sites indicated in the Figures are only those potentially available for future industrial use (they do not include land now being used by waterfront industry). The aggregate acreage of all of the land shown is 49,000 acres. Thus, if the rough acreage requirements suggested above prove to be approximately correct, almost all of the land shown in the Figures would be needed to meet the high estimate while some of the less desirable sites could be eliminated from the inventory if the lower figure were selected.

THE NEED TO RESERVE LAND FOR WATER-ORIENTED INDUSTRY

The above figures indicate that prime sites for water-oriented industry in the Bay Area are in relatively short supply. Because waterfront industry is essential to the economy of the Bay Area, and because the land specifically suitable for that industry is limited, waterfront industrial land must be considered an economic resource to be carefully husbanded and to be used only for industries that specifically require water frontage.

THE NEED TO RESERVE LAND FOR WATER-ORIENTED INDUSTRY

While land suitable for waterfront industry must be conserved, not all of it need be held vacant until needed. Some of the land is now in other uses that can continue in those uses for up to 40 years; also, land now vacant can be used for other temporary purposes until it is needed for the specific industrial use.

OBTAINING THE BEST USE OF THE LIMITED SUPPLY

The following are guidelines -- not rigid standards -- to be used to the extent feasible in designing shoreline industrial facilities.

1. Storage Areas

The shoreline is too scarce and valuable to be given over to non-essential facilities, even within industrial plant sites. Therefore, storage at the shoreline of raw materials, fuel products or wastes -- whether in open piles or in tanks, sheds or other structures -- should not be permitted on a long-term basis.

In general, storage areas should either be at right-angles to the main direction of the shoreline, or if parallel to the shoreline, they should be as far inland as feasible (at least 200 feet is desirable if other use of the shoreline is to be made possible).

2. Sharing of Shoreline

In areas where large acreages are available for industry, site planning should strive to provide access to the shoreline for all future plants that might locate in the same area; in other words, no single plant should usurp all shoreline access to a prime location to the detriment of other waterfront industries that could jointly use the site. The longest dimension of plant sites should therefore generally be at right angles to, rather than parallel with, the shoreline.

Dock or wharf facilities at waterfront industrial concentrations should also be shared as much as possible among industries and also with public agencies, if appropriate. Not only might this save some shoreline for public use or for other industrial use, but also both public and private costs for building shipping facilities and maintaining harbor depths might be reduced. The concept of joint use of berths is not new in port planning.

If the shoreline that is freed by sharing of the shoreline or inboard location of storage areas is put to public use, the industries involved should be compensated for any added costs for longer pipelines and conveyor systems.

3. Waste Disposal

As previously suggested, the use of extensive land areas for waste treatment ponds by waterfront industry should be avoided as much as possible. Regional systems for piping wastes to central treatment facilities or out to sea -- or other methods of treatment that are feasible -- are important to avoid unnecessary Bay fill and unnecessary use of the shoreline for waste disposal purposes.

4. Highway and Railroad Planning in Waterfront Industrial Areas

The shortage of land for water-oriented industry makes highways an undesirable use of the shoreline when these would intrude between dock or wharf facilities and a plant. Therefore, to avoid cutting industry off from the waterfront, new highways in existing or future industrial areas should be located away from the waterfront.

New access roads to waterfront industrial areas should be approximately at right angles to the shoreline, topography permitting.

OBTAINING THE BEST USE OF THE LIMITED SUPPLY

Roads within waterfront industrial areas that must parallel the shoreline should be at least 500 feet inland.

As with the case of highways, any new railroads or rapid transit lines in shoreline areas should avoid unnecessary blocking off of the shoreline.

PROVIDING LAND FOR OTHER INDUSTRIES

Many industries besides those oriented to the water are attracted to waterfront areas because they require freeway and railroad facilities, many of which have been built along the shoreline.

To reduce the pressure that will develop for use of waterfront areas for other industries, freeways in inland locations should be encouraged by the agency responsible for Bay conservation and development. Experience in other areas, such as Boston and Washington, has demonstrated the desire of many industries to move to outlying locations provided that they are well tied to the rest of the region by good radial and circumferential freeways. In the future, when an adequate study has been made of all (not just water-oriented) industrial land needs in the Bay Area, it may well prove necessary for a regional agency to reserve industrial sites on freeways in the same manner as is proposed herein for industrial sites on the waterfront. A corollary policy would be to reserve sites near railroads and freeways in and around the Bay Area for industries that specifically require combined rail and freeway access.

HOW INDUSTRIAL LAND CAN BE RESERVED

The Bay Region can develop its industrial potential while enhancing the appearance and recreational opportunities of the Bay. In order to do this, however, a positive approach to identifying, reserving and planning for prime industrial sites is necessary.

A responsible regional agency should maintain a current detailed inventory of occupied and potential shoreline areas. The agency should

HOW INDUSTRIAL LAND CAN BE RESERVED

be responsible for adding land to or removing it from the inventory (as total estimated requirements might be revised on the basis of then-current studies and analyses).

Reserving potential sites until needed by water-oriented industry is difficult in a growing metropolitan area. Many such sites in the Bay Region have been usurped by uses, such as housing, which have no need for the unique advantages of the water-oriented land; and more sites may be lost in the future. To insure that land in the inventory is available when needed for industrial use owners of land included in the inventory may need to be granted tax concessions or other inventives to offset any discriminatory effect the special controls may have on their land. If not needed immediately, the land could be used for other purposes on an interim basis.

While a regional agency would have to approve additions to and subtractions from the industrial land and inventory, basic administration of the industrial reserves could remain with local governments.

The regional agency could prescribe a detailed priority system for allocating industries to the reserved land and could prepare site development and performance standards for application by the local governments. As long as the industrial reserve is well mapped and all regulations are clearly spelled out, the role of the regional agency in the administration of the reserves would be fairly well in the background. It would need to come into action only when additions or deletions to the inventory were needed or if a violation of the use limitations were attempted.

One problem that often arises when private land is firmly identified for specific high-value uses is that the owners are given a speculative advantage over all other landowners <u>if</u> the allowable supply of land for the use is sharply limited

HOW INDUSTRIAL LAND CAN BE RESERVED

(the owners thereupon tend to defeat the intent of the reserve by pricing the land beyond the feasible limits for the use). Such would not be the case in this instance because a 50-year supply of industrial land is proposed to be reserved. In the initial decades, at least, the owners would have no speculative advantage whatever because of the wide range of choice available to new industries. In the later decades, more sophisticated legal devices will presumably be available to curb land speculation that is not in the public interest.

A converse problem is that the price of appropriate industrial sites is sometimes raised beyond that feasible for industry to pay due to action of government itself in (1) assessing too high taxes (forcing premature development for other uses) or (2) planning and zoning the land for other uses, such as residential or commercial, that command a higher price. Even land that is properly zoned for industry may become too high-priced because the owners hope to have it rezoned for more lucrative uses. This is seldom a problem because the cost of the land for a major water-oriented industry such as an oil refinery or a steel mill is a very small proportion (as low as one per cent in some cases) if the industry's total investment in a new facility. If land price proves to be a problem, government could offset the price to the industrial purchases through appropriate tax incentives or condemnation and resale of the land, etc. In the future, any problem of overpricing could be largely reduced through more appropriate taxation and zoning policies.

SUMMARY

Rapid increases in population create a demand for increasing amounts of waterfront industrial facilities. Increasing incomes in the future and continued growth in all of the western United States will accellerate the demand for waterfront industrial sites.

SUMMARY

San Francisco Bay is the dominant feature of the Bay Area. Among other things, its shores offer an attractive location for industry that requires access to navigable waters or requires the use of large amounts of water in industrial processing.

All waterfront sites that will be needed in the foreseeable future for water-oriented industries should be reserved before they are pre-empted for other, less needed uses or for uses that could locate elsewhere.

FIGURES 1-7

Possible New Sites for Waterfront Industry

	Location	Total Acres
	CONTRA COSTA COUNTY	
CC-1	Richmond	1800-2000
2	San Pablo Point	575-600
3	San Pablo	900-1100
4	Pinole Point	1000-1500
5	Hercules	1650-1880
6	Oleum	
7	Selby	
8	Martinez	
9	Martinez	250-1100
10	Avon	1000
11	Avon	775
12	Nichols	500
13	Pittsburg	1500
14	Pittsburg	350
15	Big Break	450-2200
	MARIN COUNTY	
M-1	San Quentin	125-160
2	Gallinas Creek	500-1000
3	Black John Slough	800-900
	SOLANO COUNTY	
SOL-1	Collinsville	7200-10,800
2	Benicia, vicinity	2300-2700
3	Vallejo	50-100
4	Slaughterhouse Point	500-700
5	Turning Basin, Chipps Island	1000-2000
6	Potrero Hills	2000-4000
	SONOMA COUNTY	
SON-1	Petaluma	500-600
2	Mouth, Petaluma River	500-650
	ALAMEDA COUNTY	
A-1	Dumbarton Point	1100-1600
2	Bay Farms	1500-1600
3	San Leandro Channel	500-650
	SAN MATEO COUNTY	
SM-1	San Bruno Channel	150-175
2	Brewer Island	175-250
3	Redwood Point	2000-2400
4	Ravenswood	2800-3200

FIGURE 1

Possible New Sites for Waterfront Industry: Carquinez Strait and Suisun Bay

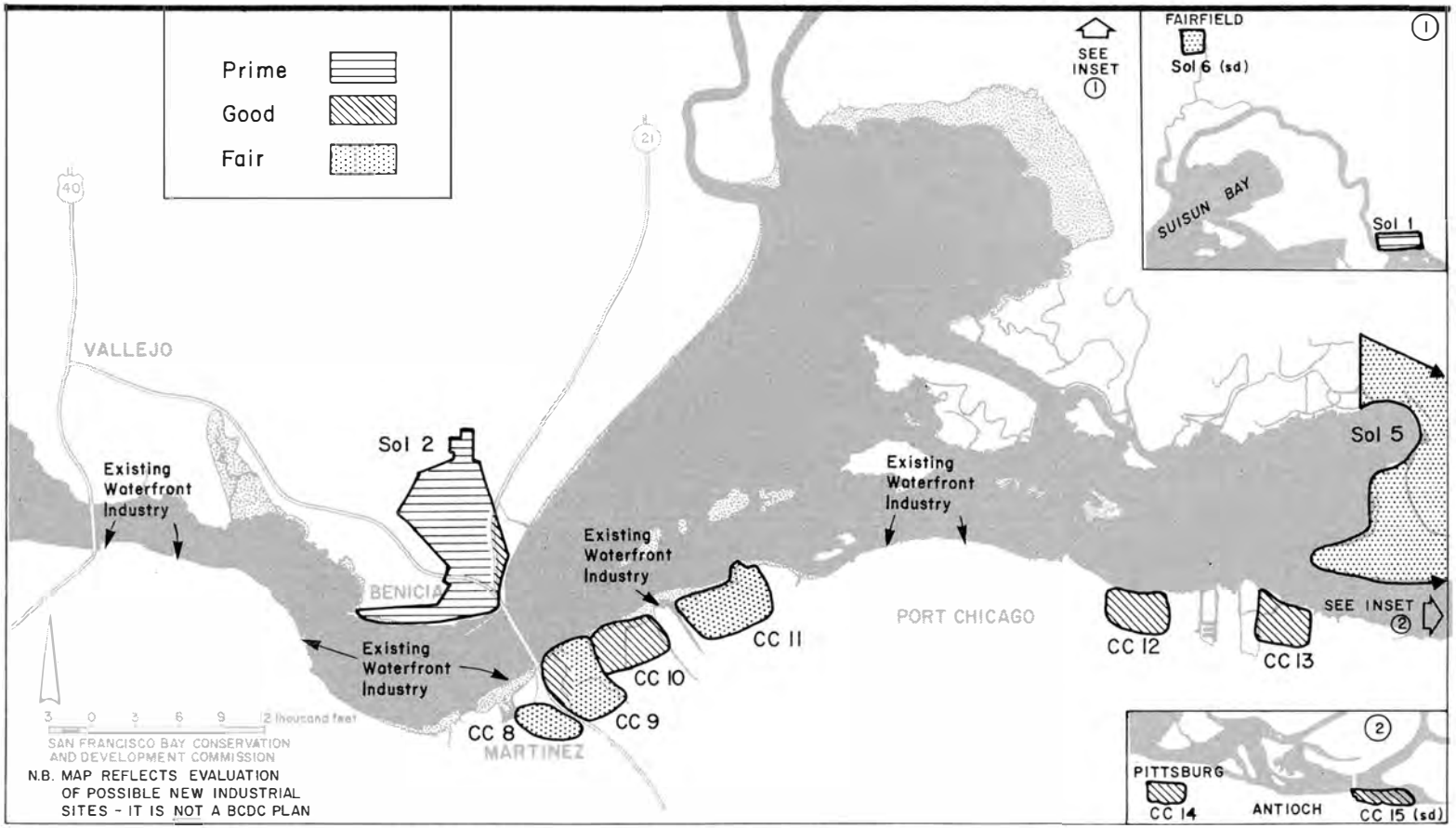


FIGURE 2

Possible
New Sites
for
Waterfront
Industry:

San Pablo Bay
(north portion)

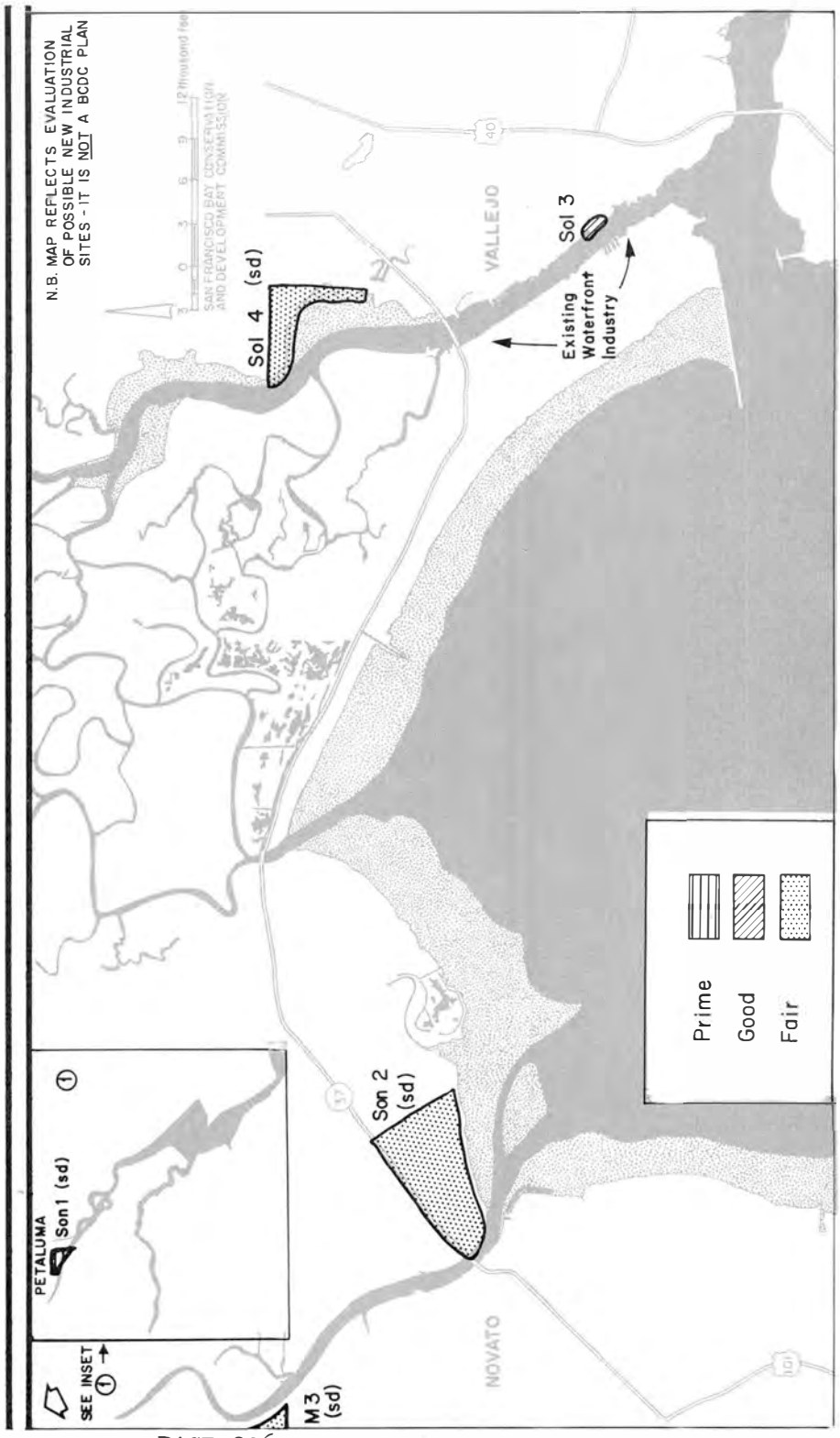


FIGURE 3

Possible New Sites for Waterfront Industry:

San Pablo Bay (south portion)

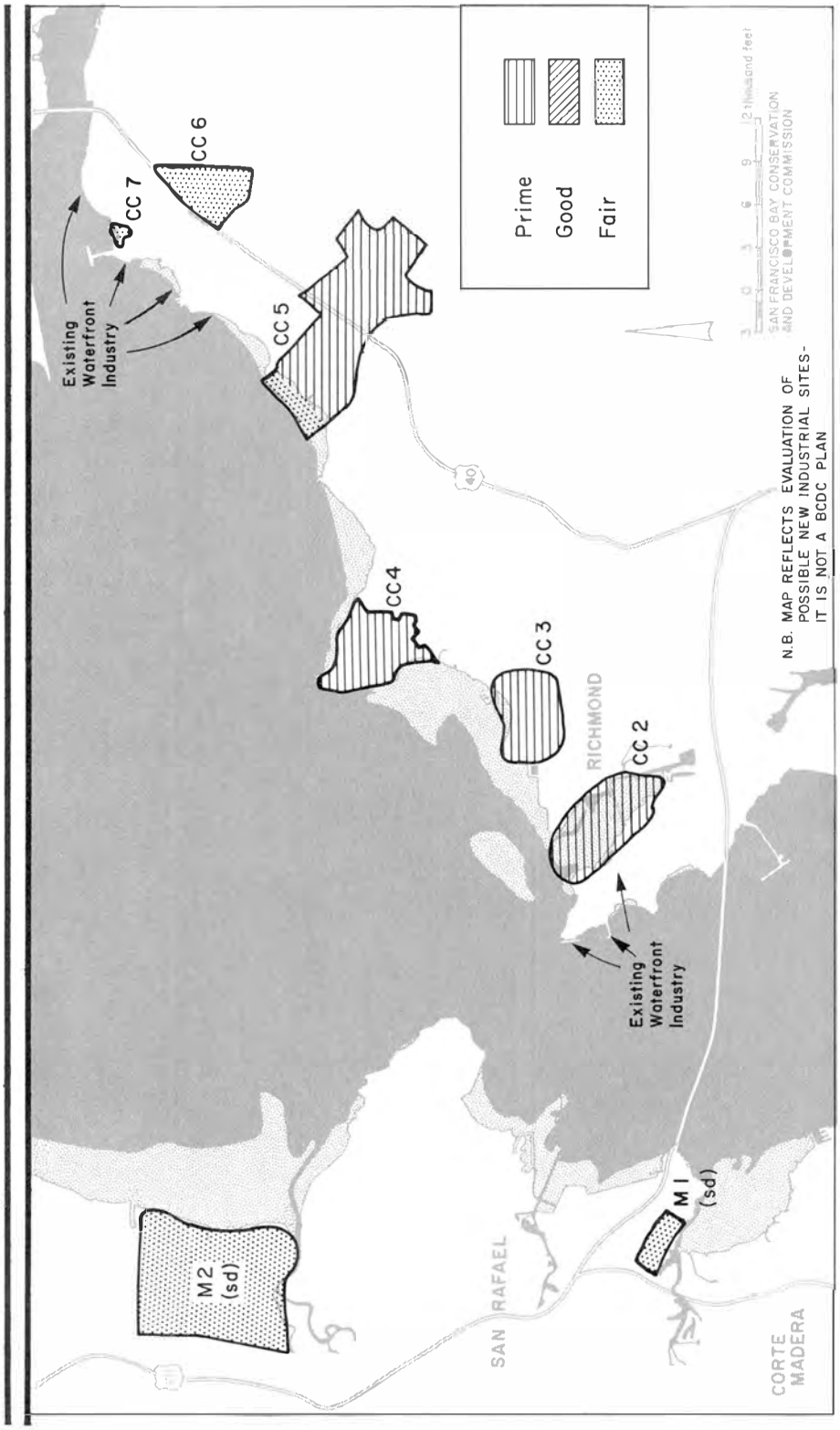


FIGURE 4

Possible New Sites for Waterfront Industry: Central Bay

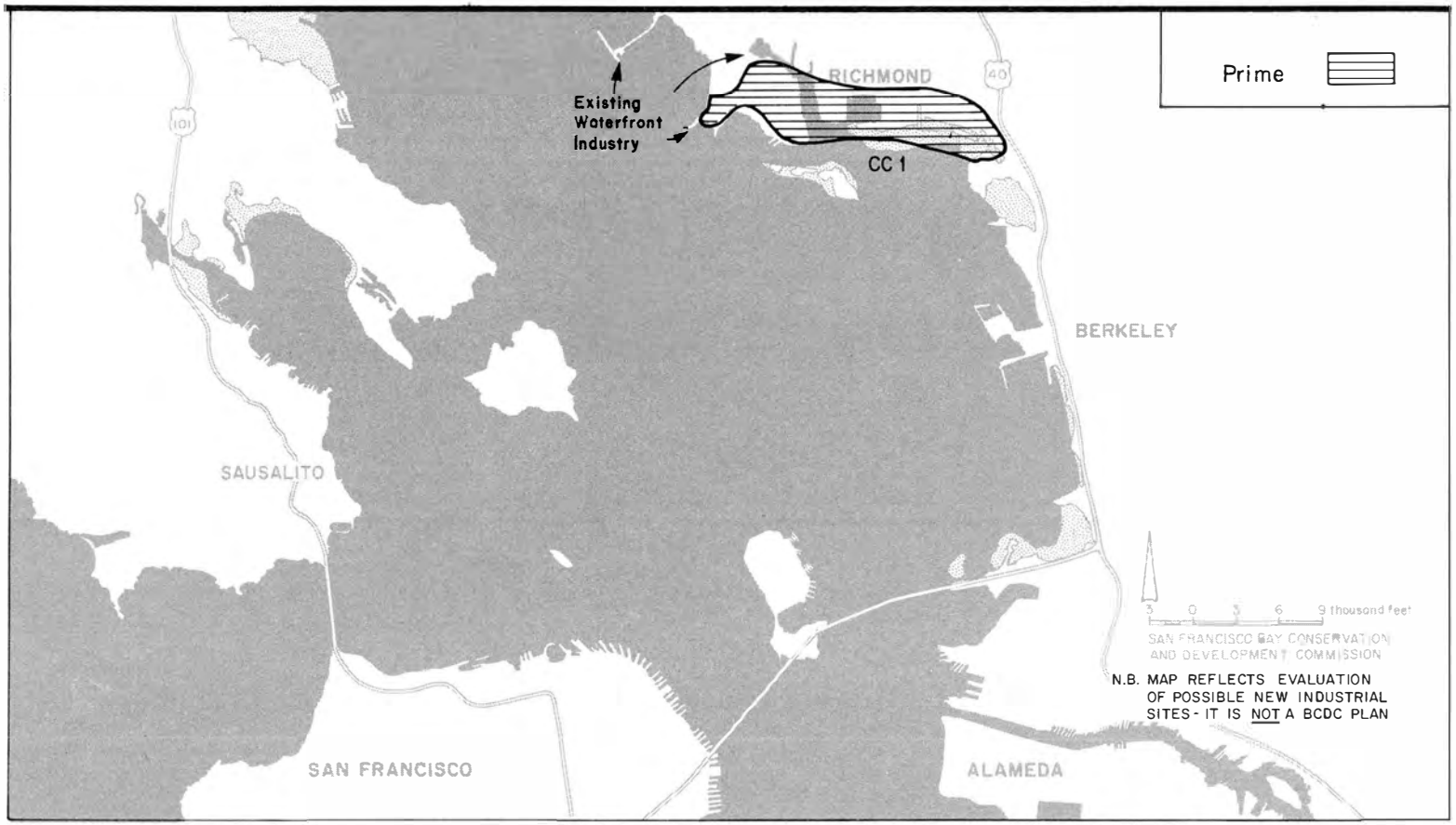


FIGURE 5

Possible New Sites for Waterfront Industry:

South Bay (north portion)

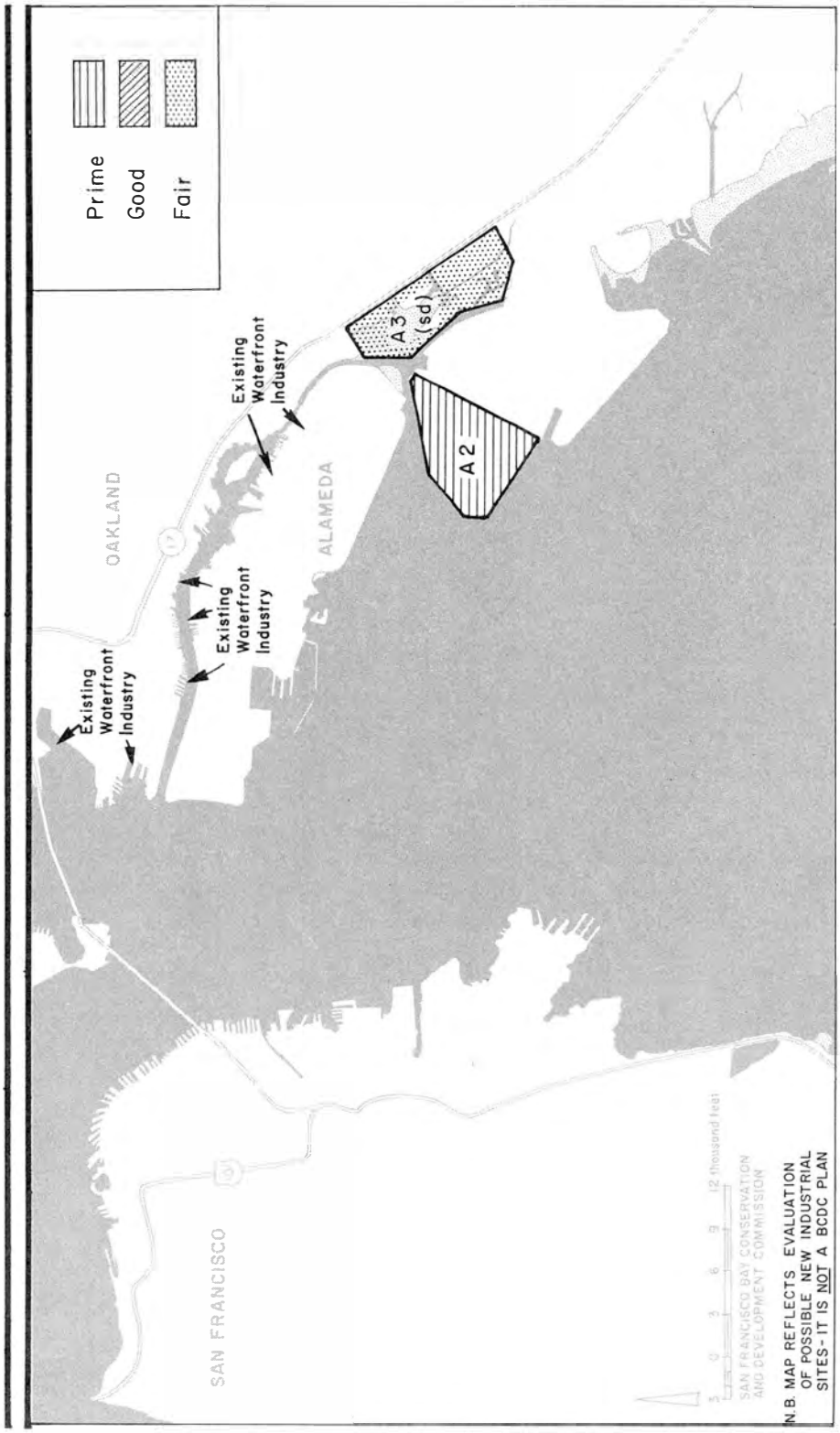


FIGURE 6

Possible New Sites for Waterfront Industry:

South Bay (center portion)

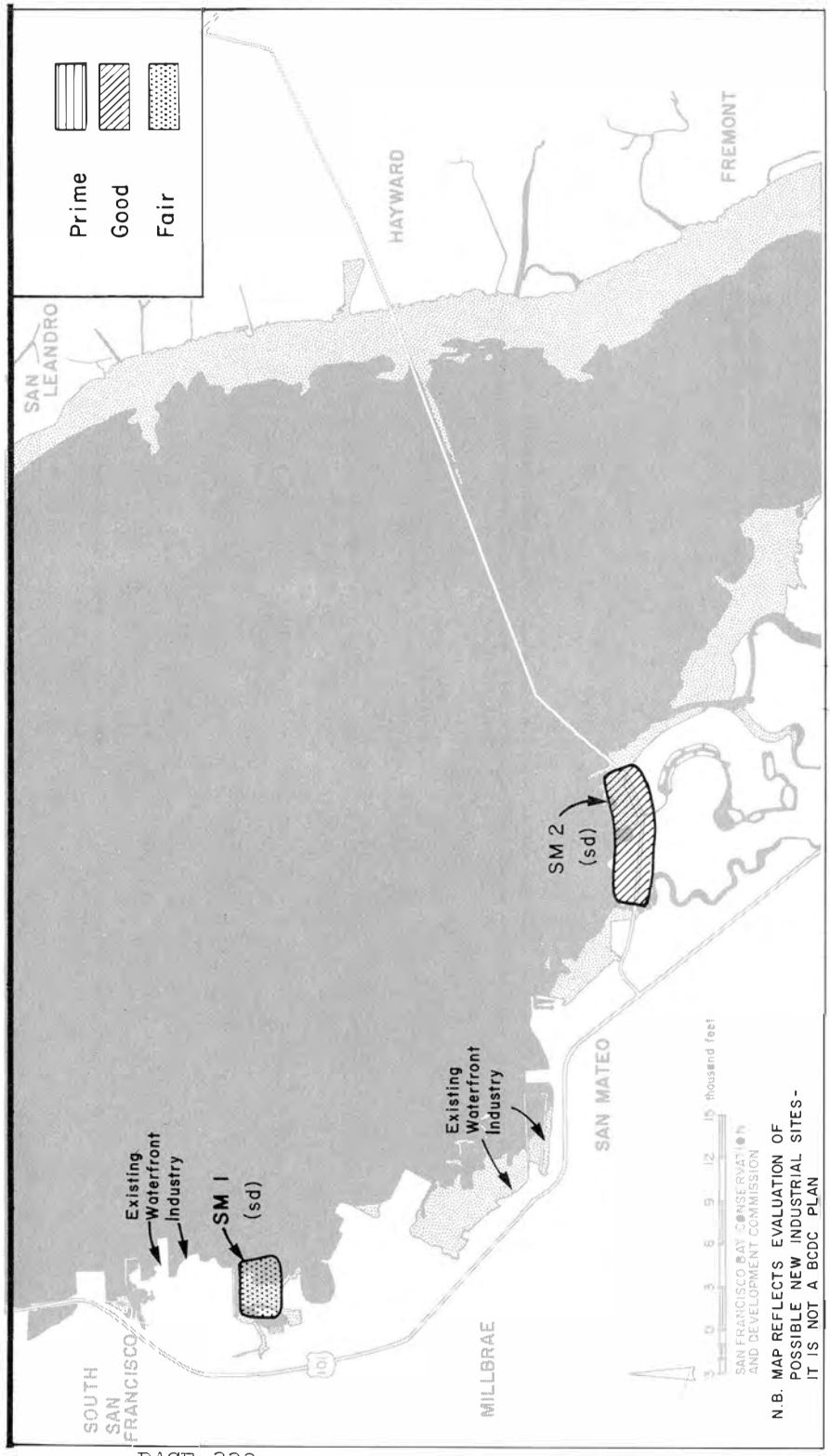
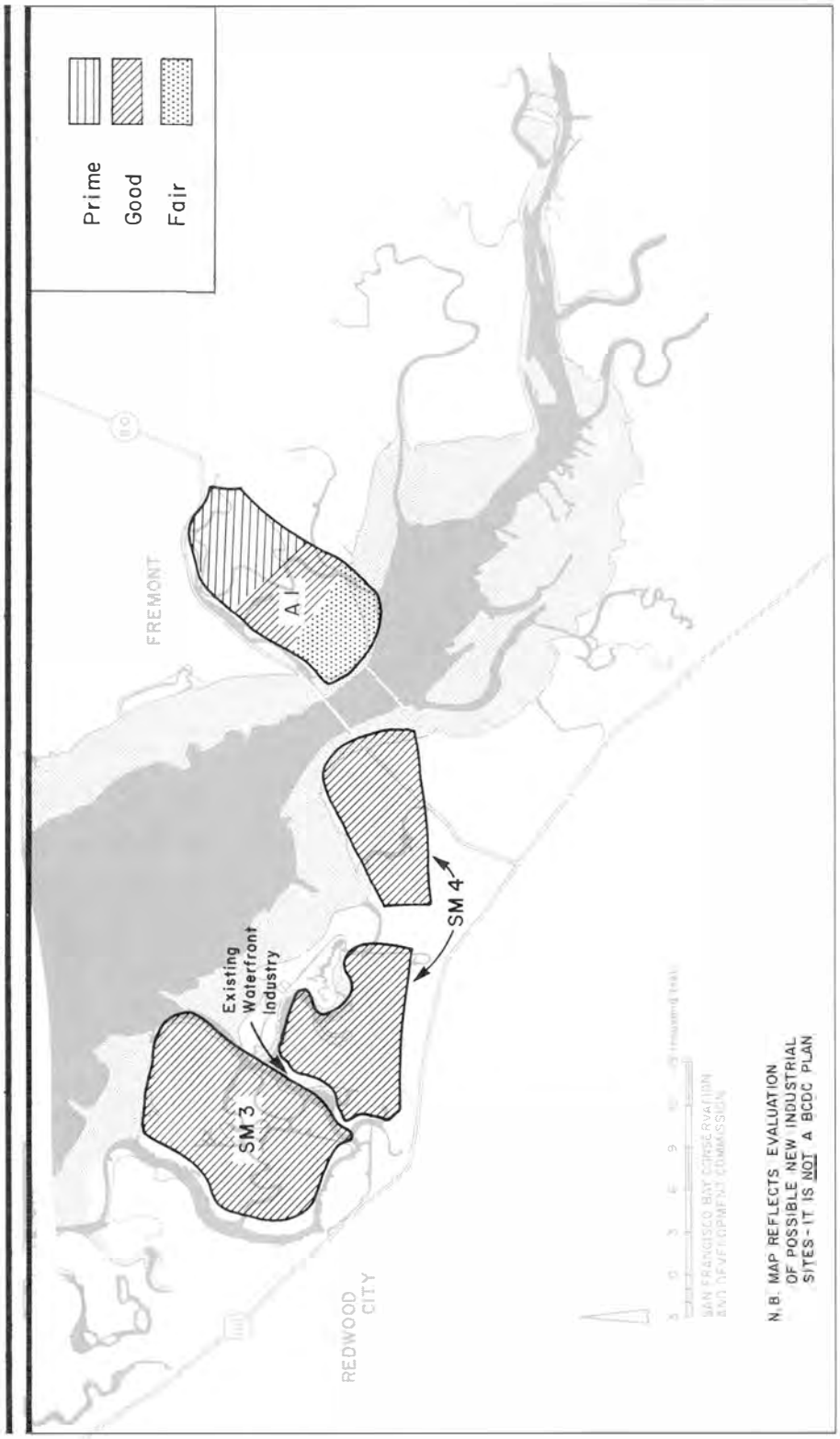


FIGURE 7

Possible New Sites for Waterfront Industry:

South Bay (south portion)



A D D E N D U M

(to Report on Waterfront Industry)

1. HOW MUCH LAND IS NEEDED FOR WATER-ORIENTED INDUSTRY?

2. CRITERIA FOR SELECTING INDUSTRIAL SITES

This addendum revises the industrial land requirement estimates that were included in the original published report on Waterfront Industry Around San Francisco Bay. It also summarizes the basis upon which sites were selected for inclusion in the final San Francisco Bay Plan.

How Much Land is Needed for Water-Oriented Industry?

The original report to the BCDC by Dr. Dorothy Muncy established a procedure by which estimates of land needs for water-oriented industry could be prepared. Data expected from the Bay Area Transportation Study Commission and Bay-Delta Water Quality Control Program were not available in time to be used in Dr. Muncy's report.

To illustrate how this procedure might be applied and to provide an interim guide for BCDC planning, Dr. Muncy used data from several sources and derived an estimated need for 27-44,000 acres of new land for water-oriented industry by 2020. Her primary sources were the BCDC report Economic and Population Growth (which was based on projections in the 1966 ABAG Preliminary Regional Plan), and the U. S. Department of Commerce report Future Development of the San Francisco Bay Area 1960-2020 published in 1959. Dr. Muncy's report emphasized that these figures were highly tentative, and should definitely be reviewed when better employment data became available.

Recent projections developed by several agencies, including the BATSC and Bay-Delta studies, suggest that future Bay Area manufacturing employment will be somewhat lower than the earlier studies showed, while employment in Services, Government and Finance will be considerably higher. The recent studies are based on a detailed analysis of the Bay Area economy, and reflect the nationwide trend toward increased mechanization and productivity per employee in manufacturing industries. Nevertheless, the proportion of Bay Area employment in manufacturing is expected to be slightly higher in 2020 than it is today.

Acreage estimates for the Bay Plan were derived from Bay Area Transportation Study Commission projections described in the Addendum to the Population and Economic Growth Report published in August 1968. Employment projections in the nine major manufacturing industry groups specified by Dr. Muncy were converted to acreage on the basis of formulas she prepared.

On the basis of the revised manufacturing estimates, the acreage that will be required for new water-oriented industrial sites between 1965 and 2020 ranges from 11,000 acres to 19,000 acres, based on different employee-density-per-acre factors.

Effort was made in the Bay Plan to provide as nearly as possible for the higher acreage estimate (19,000 acres) on the assumptions (1) that employee density-per-acre in primary manufacturing will continue to decline as a result of automation and (2) that the urgency of assuring the availability of adequate water-oriented industrial sites requires reservation of the largest acreage the present relatively crude data suggests may be needed.

Therefore, the Bay Plan specifically reserves for water-oriented industrial use approximately 19,000 acres of new land (plus 6,000 acres of prime Bayfront industrial land already in such use). In addition to the acreage so reserved within the area of proposed Bay Agency jurisdiction, there are from 2,000 to 3,700 additional acres available in areas of Sonoma (SON-1) and Contra Costa Counties (CC-14 & 15) just beyond the proposed Bay Agency jurisdiction (since the acreage estimates are derived on the basis of employment forecasts for the entire nine county area, the entire acreage need not be provided exclusively within the smaller Bay Agency area of jurisdiction). Also augmenting the specifically reserved supply of land are three additional possibilities: (1) the acreage that might be added by fills for water-oriented industrial sites in accordance with the plan, (2) sites that might be used by water-oriented industries on unreserved parts of the shoreline, and (3) acreage that is proposed to be made available for industrial use from some military bases (Mare Island and Hunters Point Naval Shipyards, Concord Navy Weapons Station, Alameda Naval Air Station) in the event military use of any of these is discontinued during the 50-year Plan forecast period. Furthermore, substantial areas suitable for water-oriented industry exist along the Sacramento and San Joaquin Rivers upstream from the nine-county Bay Area.

The provision of approximately 19,000 acres of new water-oriented industrial land (including lands in Contra Costa and Solano Counties beyond the jurisdiction of the proposed Bay Agency) appears reasonable considering that (1) it is more than three times the acreage now in use and (2) is supplemented by extensive acreage beyond the proposed Bay Agency jurisdiction and lands now in military ownership.

Furthermore, these projections, while based on the best information now available, should be subject to continuing review by the Bay Agency and revised whenever revision is indicated on the basis of information that may become available in the future.

Criteria for Selecting Industrial Sites

The site selection criteria proposed by Dr. Dorothy Muncy were further refined by the BCDC staff and all possible sites were then reevaluated and assigned total-point ratings accordingly.

Table 1 is a summary list of the sites indicated in the Summary report (plus a few additional sites) with their total-point ratings. In general, the sites with the highest point rating were selected to be included in the San Francisco Bay Plan to be reserved for exclusive

use by water-oriented industries. However, some sites with high ratings (i.e., 70 or more points) were excluded for various reasons (as noted in each case) that were not included in the point-rating system.

TABLE 1

SUMMARY OF POTENTIAL WATER-ORIENTED INDUSTRIAL SITES

	Location	Rating	Not In Plan	Included in Plan In Use	Included in Plan Not In use
			CONTRA COSTA COUNTY		
CC-1	Richmond	78		800 1/	
2	San Pablo Point	64		900	730
3	San Pablo	69	480		
4	Pinole Point	90		600	730
5	Hercules	73		50	910
6	Oleum	73	400 2/		
7	Selby	82		510	60
8	Martinez	83		530	280
9	Martinez	72			
10	Avon	77		1,610	4,220 3/
11	Avon	69			
12	Nichols	72	500 4/		
13	Pittsburg	81	1,500 4/		660
14	Pittsburg	72	350 5/		
15	Big Break	71	450-2,200 5/		
	Crockett			90	

5/ Beyond proposed area of jurisdiction of the successor Bay Agency.
4/ Valuable marsh and unstable shore.
3/ Area included in Plan adds much upland not in original report and eliminates unstable marsh areas.
2/ Site too far removed from waterfront and cut-off by freeway.
1/ Richmond site has 1,650 acres, including some present water area. Estimate assumes ½ of site will be used as a public port area, and the balance as sites for water-oriented industry.

	Location	Rating	Not In Plan	Included In Plan: In Use	Included In Plan: Not In Use
		MARIN COUNTY			
M-1	San Quentin*	63	125-160		
2	Gallinas Creek*	52	500-1,000		
3	Black John Slough*	52	800-900		
		SOLANO COUNTY			
SOL-1	Collinsville	71			6,210 1/
2	Benicia	91		780	950
3	Vallejo	79		40	200
4	Slaughterhouse Point*	57	500-700		
5	Turning Basin, Chipps Is.	40	1,000-2,000		
6	Potrero Hills*	77			3,115
	Morrow Island	78	2,200 3/		
		SONOMA COUNTY			
SON-1	Petaluma*	80	1,120 2/		
2	Mouth, Petaluma River*	71			880
		ALAMEDA COUNTY			
A-1	Dumbarton Point	64	1,100-1,600		
2	Bay Farm Island	64	1,500-1,600		
3	San Leandro Bay	72	500-650		

3/ Preference given to recreation use of drier portions and retention of marshes. Virtually all of possible industry site would be marsh fill.

2/ Beyond proposed area of jurisdiction of the successor Bay Agency.

1/ The use of large acreage to north may be possible either through good linkage apparati to deep water harbor or via shallow draft navigation on Montezuma Slough.

* Shallow-draft potential only

	Location	Rating	Not In Plan	Included In Plan In Use	Included In Plan Not In Use
	SAN MATEO COUNTY				
SM-1	San Bruno Channel*	44	150-175		
2	Brewer Island-Foster City	59	175-250		
3	Redwood Pt.-Bair Island	49	2,000-2,400		
4	Ravenswood	55	2,800-3,200		
	SAN JOAQUIN COUNTY				
	Rough & Ready Island, Stockton	87	1,200-1,400 1/		
	YOLO COUNTY				
	Sac. Deep Water Channel, East Side	80	14,500-15,00 1/		
	Total Now in Use 2/			5,910	
	Total Vacant Reserved				18,945
	Total Reserved in Plan			24,855	

2/ Largely, but not exclusively, in use by water-oriented industries. Any acreage not now used by water-oriented industries should eventually be made available to such industries.

1/ Beyond proposed area of jurisdiction of the successor Bay Agency.

* Shallow-draft potential only

SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION
507 Polk Street, San Francisco 94102 557-3686

Possible Bay Planning Conclusions Based on the Report on Waterfront Industry

1. Industries of many types require frontage on navigable waters to receive raw materials and to distribute processed materials by ship, or need to have large volumes of water available for industrial processes.

2. Waterfront industry, especially that dependent on deep-draft shipping, is basic to the economy of the Bay Area and of the Western United States. Therefore, the needs of waterfront industry must be given high priority in the Commission's plan for the Bay.

3. Land suitable for waterfront industry will probably be in short supply over the next 50 years. Such land is therefore a resource that must be carefully managed and ultimately used only by industries specifically requiring a waterfront site. (All of this industrial land will not be needed at once, however, and other uses can be allowed in the interim.)

4. The amount of additional land to be reserved for waterfront industry should be determined on the basis of the best data available, using a 50-year planning period. The Commission's plan for the Bay should provide for waterfront industry on the basis of the best data available when the plan is being completed. Present data, which is adequate only for general planning, estimates the need for additional waterfront industrial sites at 27,000 to 44,000 acres. For tentative BCDC planning purposes, the higher figure should be chosen as the estimated waterfront industrial need -- 44,000 acres.

5. The determination as to which lands to reserve for waterfront industry should be made on the basis of the location criteria listed on pp. 63-65 of the Technical report and illustrated in Figures 1-7 (these figures are in both the Technical and Summary reports). Preference for industrial use should be given to lands on the basis of these criteria, but with due regard that such sites not unduly interfere with ecological requirements such as recreational and fish and wildlife resources of San Francisco Bay and with the use of these resources.

6. Waterfront industrial sites should be planned so as to avoid wasteful use of the limited supply of waterfront land; the principles on pp. 12-14 of the Summary should therefore be followed to the maximum extent feasible in planning for waterfront industry. While some filling may be necessary at some sites despite the most careful attention to proper site layout, such filling should cause minimum interference with the tidal action and minimum reduction in the waste assimilative capacity of San Francisco Bay.

7. Waterfront industry should be planned so as to make industrial sites attractive as well as economically-important uses of the shoreline, with emphasis on public access to the Bay and recreational use of the shoreline wherever feasible.

The planning principles listed on pp. 5-8 of the Summary should therefore be followed to the maximum extent possible.

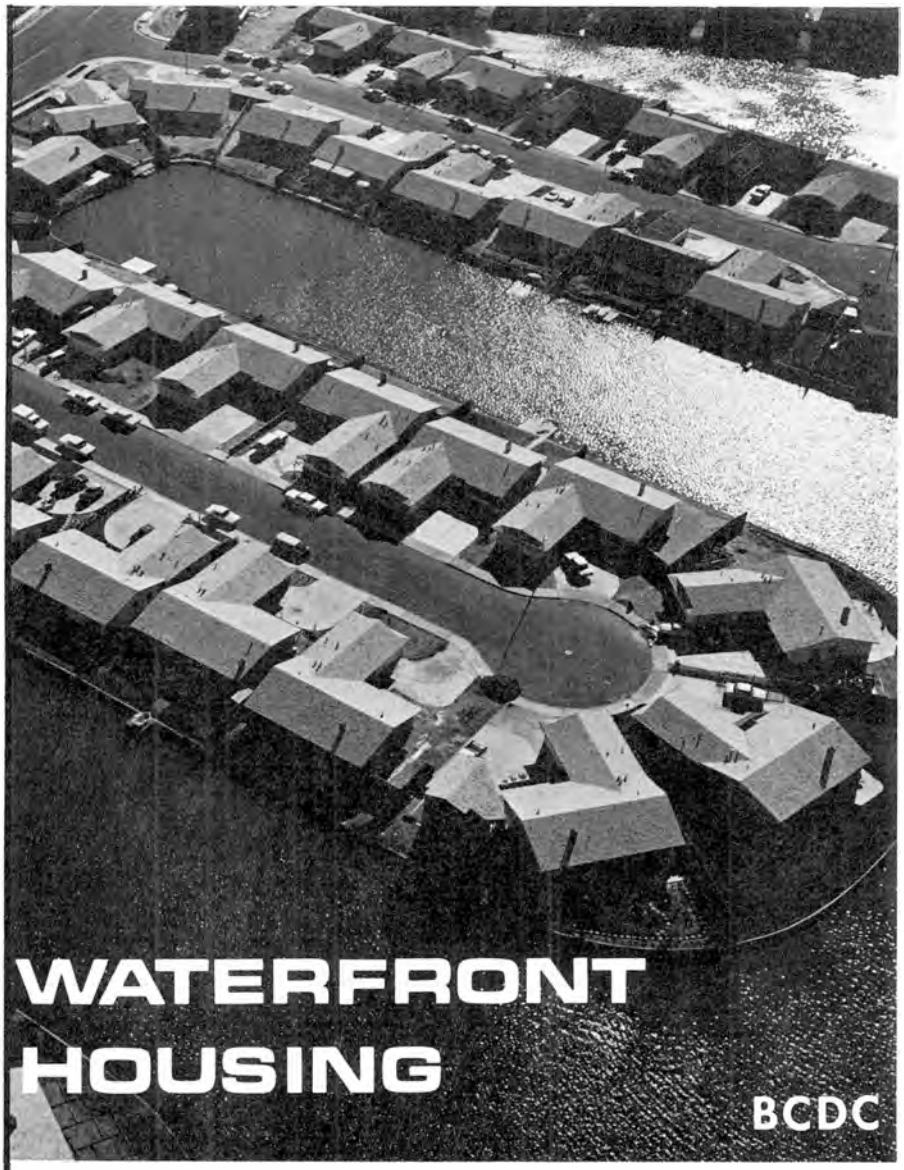
8. Many industries seek waterfront sites not because they require access to the Bay, but rather because they need locations close to freeways and railroads, which are often along the shoreline. To reduce this type of pressure for waterfront sites, the Commission's plan for the Bay should include the policies regarding land for other industries listed on page 14 of the Summary.

Adopted by the Commission at its meeting of 3/7/68

WATERFRONT

HOUSING

Part of
a Detailed
Study of
San Francisco
Bay



San Francisco Bay
Conservation and
Development
Commission

San Francisco
California

December, 1967

Summary of the report, "Residential Development Around San Francisco Bay," by Clifford W. Graves, Associate Planner.

INTRODUCTION

A full moon casting a golden path across the water . . .

A boat creaking against its moorings outside the window . . .

The frequent fog, sometimes drifting, sometimes blowing, close to the Bay . . .

The ever-changing view of the water and the opposite shore . . .

A spectacular sunrise or sunset seen across the Bay . . .

And always the tang of the salt water nearby.

These are but some of the reasons that attract increasing numbers of persons to live in houses and apartments on the shores of San Francisco Bay.

Not only shoreline areas are in demand for housing however (in some parts of the Bay Area). Pressures exist to fill the Bay itself to provide new homesites. Advocates of such projects argue that more persons should be able to enjoy living close to the Bay; opponents argue that the Bay is of such great value as a Bay that it should not be filled merely to house people who could just as easily live elsewhere.

How can the pressures to use the Bay for housing be weighed against the other values of the Bay? To what extent should the shoreline -- and even the Bay itself -- be developed for housing? These questions can best be answered by first analyzing the demand for housing near the Bay. Then this demand can be evaluated along with demands for other uses of the Bay and shoreline.

FACTORS AFFECTING HOUSING DEMAND ON THE BAY

The primary factors affecting demands on the Bay and shoreline for housing are:

1. Until recently, the high costs of filling have tended to restrict use of the Bay for housing developments. But as a growing population uses up the supply of land near the Bay, making the remaining open areas increasingly expensive to buy and develop, the costs of Bay filling for residential development become economically more competitive.

2. Constantly rising incomes enable more people to pay increasingly more money for housing each year, making the development of expensive land continually more attractive.

3. Nearly all parts of the San Francisco Bay shoreline are, or could be, extremely desirable places to live.

4. Interest in shoreline areas for housing has increased (somewhat independent of cost considerations) as the supply of close-in developable land in the Bay Area has diminished.

In the past, Bayside housing has consisted principally of houses or apartments that were built a few at a time and with little or no Bay fill. Now, however, several large-scale residential projects are being built and more are being proposed. Secondary factors affecting housing demand on the Bay are:

1. Large corporations that do not require an immediate return on their investments have entered the housing business. These companies have large amounts of capital that can be invested in filling and other site preparation costs on which no return may be received for many years.

FACTORS AFFECTING HOUSING DEMAND ON THE BAY

2. These large-scale operations make Bayside development competitive with inland sites by their ability to reduce costs per residential unit while at the same time, more and more people are willing to pay higher prices for housing.

3. Under California law, special districts can be formed to issue tax-free bonds that provide capital for large-scale development projects. The Estero Municipal Utility District (Foster City), Redwood City General Improvement District No. 1-64 (Redwood Shores), and the Hunters Point Reclamation District are examples. In addition to being able to raise money through the public bond market, the districts can also obtain significantly lower interest rates. Without these powers, the development of Bay lands would be far less feasible economically and in some cases might be impossible.

Except for the special districts, all of the preceding factors are aspects of national and regional economic trends that do not appear likely to change. Nevertheless, the amount of housing near the Bay can be influenced by two kinds of public control:

1. By their powers of zoning and eminent domain, local governments can direct the location and amount of housing.

2. The State Legislature and to some extent local government, through Local Agency Formation Commissions, can expand or restrict the creation of special districts for Bay-front development.

IS HOUSING A NECESSARY USE OF THE BAY?

With the expected rapid growth of the Bay Area population, is there enough usable land in the region for the necessary housing? Or must parts of the Bay be filled to meet this need?

IS HOUSING A NECESSARY USE OF THE BAY?

Two major regional studies have demonstrated there will be plenty of land available for housing for at least the next fifty years -- the time period for which BCDC is planning. (But, as will be noted shortly, there are varying degrees of demand for the available housing sites.)

The Army Corps of Engineers' massive report, The Future Development of the San Francisco Bay Area, 1960-2020, estimated in 1959 that about half of the 7,000 square miles of land in the nine-county Bay Area was suitable for urban development (in terms of topography, drainage, etc.). The report also estimated that less than 15 per cent of this land was in urban use in 1958. And it was estimated that, even with a high Bay Area population forecast for the year 2020 (14.4 million in the Army Engineers' report, compared to the 10 million figure currently being used by the BCDC) and even with a low estimated population density, less than two-thirds of the potential urban land would be used by 2020.

The more recent Preliminary Regional Plan published in November, 1966, by the Association of Bay Area Governments (ABAG) designated a little more than 1,000 square miles for residential use in 1990. (The figures in the preceding paragraphs included all urban uses, not just residential uses.) And it indicated extensive areas of "land for future urban expansion" after 1990. While ABAG did not make a detailed study of urban land potential, there is no indication that such a study would find any shortage of developable land for housing in the Bay Area for at least the next 50 years.

An adequate supply of land in the region as a whole does not take all the housing pressure off the Bay, however, because the demand for home sites is heavily influenced by (1) accessibility and (2) the attractiveness of the surrounding area.

IS HOUSING A NECESSARY USE OF THE BAY?

Desirable housing sites generally must be conveniently accessible to the breadwinner's place of work. The home-to-work distances that are tolerable depend upon the methods of transportation that are available. Because more than three-quarters of the jobs in the nine-county Bay Area are located within a mile of the shores of the Bay, and because most of the region's principal transportation facilities are located close to the Bay, areas closest to the shoreline are among the most "accessible" in the region.

This pressure to fill the Bay for housing will be relieved in part by the extension of freeways and other transportation systems to inland areas and by the development of an increasing proportion of the Bay Area's jobs at sites more remote from the Bay. Also, as leisure time increases in coming decades, accessibility to recreation and other non-work activities will become more important to Bay Area residents. While the recreational potential of the Bay is an attractive lure, recreational possibilities are also widespread throughout the region and around its periphery so there need not be an overwhelming pressure on the Bay.

The other factor that increasingly influences choice of a home is the attractiveness of the area or the site. The Bayshore, with its natural beauty, interesting maritime activity, and recreational potential, becomes increasingly attractive. As the appearance and attractiveness of the Bay and shoreline improve, the pressure to develop Bay-oriented housing will increase accordingly.

In summary, housing is not a <u>necessary</u> use of the Bay and shoreline due to any regional shortage of residential land but accessibility and physical attractiveness make housing a <u>desired</u> use.

IS HOUSING A PROPER USE OF THE BAY?

Questions of population pressure aside, is housing a proper, or appropriate, use of the Bay and shoreline?

So long as it does not displace other more necessary uses of the shoreline, housing can be of public as well as private benefit if it (1) improves the appearance of the shores of the Bay, and (2) provides public access to the water.

Well-placed buildings can enhance the appearance of many parts of the Bay and shoreline. A residential project, because of the flexibility possible in its design, can be tailored to enhance a shoreline site much more readily than can most other urban uses, as was demonstrated in the BCDC report on Appearance and Design.

Residential developments can include public walkways to the shoreline, access roads, viewpoints, and similar public facilities adjacent to the Bay, without adversely affecting the attractiveness of the residential portion of the development. Also, residential structures, more readily than most other buildings, can be placed on a waterfront site so as to minimize the obstruction of views of the Bay -- views being an important form of public "access" to the Bay and enjoyment of it. Site design incorporating these features is possible because new residential buildings, whether high or low, usually can have enough open space around them to permit necessary shifting around of individual buildings.

Waterfront residence can be considered as a means of providing access to the Bay to more people. So that the maximum number of persons can have such access to the Bay, high priority should be given to multi-family buildings on the shoreline. An exception to this should be made, however, where soil conditions, accessibility, or physical limitations (such as the lack of good fire protection or sewer lines) do not make high-density apartment buildings feasible.

IS HOUSING A PROPER USE OF THE BAY?

While increased residential use of the shoreline is an important objective, no area should be committed to residential use if the area is needed for water-oriented industry, marine terminals, water-related utilities, or water-oriented recreation. But residences on the shoreline should generally have priority over uses that do not require access to the Bay.

THE PUBLIC INTEREST IN HOUSING ON THE BAY

Aspects of Bayfront housing design that are of concern to the general public include: (1) the density of the housing; (2) whether the housing is on fills, piles, or floats; (3) how much public access is provided; (4) compatibility of the housing with neighboring uses; and (5) safety of the site from flooding or ground failure.

1. Density

Density influences building size and, therefore, the visual effect of the project. It also determines the quantity of other facilities needed in an area, such as streets, parking, and open space.

Low-density development (up to four units per gross acre, including streets and neighborhood facilities such as playgrounds) is the most prevalent because of the popularity of the single-family detached house. Advantages of such houses are that, being low, they generally do not block the views of others, and, being small, they can be fitted into difficult topography, such as hillsides near the Bay.

Disadvantages are that extensive grading or filling is usually necessary if a large area is developed, and a single-family lot fronting directly on the Bay uses an excessive amount of such frontage. To obtain as much public access as possible, waterfront houses should either front on new dredged waterways connected to the Bay or be clustered, with public access between groups of houses.

Medium-density housing (five to ten units per gross acre) includes row houses and garden apartments. Their height and bulk can block views, and if spaced too closely together, they can take on a barracks-like appearance. However, since each dwelling unit does not require separate access to a street, apartment buildings can be designed to suit a particular site and can usually be situated to avoid blocking views.

High-density (more than ten units per acre) includes the larger apartment buildings that alter the skyline, can be seen from a very large area, and are likely to block views and create congestion. Problems can be alleviated by locating apartment towers in clusters, separated by open spaces. When properly planned, they can be advantageous in providing drama and orientation to shoreline areas and in providing the advantages of waterfront housing to larger numbers of people.

2. Fills, Piles, and Floats

Residential development along the shoreline can enhance the attractiveness and accessibility of the waterfront, as has been noted above.

But additional questions arise in regard to proposals to fill parts of the Bay for housing.

Fills for any purpose -- housing included -- have been shown by previous reports in the BCDC planning series to reduce the strength of the tides, to reduce the ability of the Bay to assimilate the millions of gallons of treated wastes that are poured into it every day, to reduce the value of the Bay as a habitat for fish and wildlife, and to reduce the influence of the surface of the Bay in helping to prevent air pollution.

The main beneficiaries of housing on the Bay are private -- i.e., the developer and builder of the housing, and the residents who live in it. But the costs of damage to the Bay are borne by the public of the Bay Area as a whole.

THE PUBLIC INTEREST IN HOUSING ON THE BAY

It would therefore appear that large-scale fills for housing are not in the regional public interest and that even small fills for residential use should be permitted only as parts of larger projects that provide substantial public benefits --such as new shoreline parks.

Piles permit a structure to be raised above its site without minimum disturbance of natural conditions. The feasibility of housing on piles (or stilts) is increased by the fact that the cost of a residential unit built on piles is now about the same, and often less, than the same unit on fill at the same site.

The possibilities of large-scale housing developments on piles, instead of fill, are suggested by British plans for a "new town" for about 20,000 persons on marsh and low-lying land in the Thames estuary. Virtually the entire project will be built on piles because fill was found to be both too expensive and unnecessarily disruptive to the environment. The project will consist of a cluster of multi-story buildings surrounded by a peripheral access roadway that will also be built on piles.

Another water-oriented type of housing that causes minimum damage to the environment is the houseboat. Most of the existing houseboats on the Bay are located in Sausalito, along Corte Madera Creek, and in the Oakland estuary. Most of these have been built by the persons who live in them, so their present appeal may be limited. A few professionally-built, year-round houseboats are in use; six of these boats are moored in Sausalito and their owner has had no trouble keeping them rented. Professionally-built houseboats resemble a mobile home in size and convenience; they contain all-electric kitchens, full plumbing, carpeting, etc. Any plans for a large number of persons to live in houseboats on the Bay would require provision of most of the facilities found in a small-boat marina, such as secure moorings and protection from wind and waves, and residents on the boats would need utilities, services, and

easy access to parking and community facilities. No such houseboat facilities exist now in the Bay Area or are being planned.

Houseboat living is an attractive way of life in many water-oriented areas, such as Holland. On San Francisco Bay, individual houseboats might be feasible in some areas where they could be adequately connected to needed services. Or they could be clustered in houseboat "neighborhoods;" such clusters could constitute a complete community, or could be a special part of a new marina, or could even be integrated with more conventional waterfront development. The best place for such types of development would be protected areas such as Richardson Bay, the south end of the South Bay, and the area near the mouth of the Petaluma River.

3. Public Access and General Appearance

As previously described, residential development near the Bay can be designed to increase public access to the Bay and to improve the appearance of the shores. Regardless of whether any fill is used, all Bayshore housing should be designed to achieve these two public objectives.

4. Compatibility with Neighboring Uses

Housing should not be located where it would interfere with uses of the Bay that are more important to the region as a whole.

Particularly sensitive to the intrusion of housing are (1) airports, which have expanded on fill partly to move the noise and hazards of aircraft operations away from surrounding developments, particularly housing; (2) marshes or mudflats being preserved for ecological reasons which might become less desirable habitat for wildlife if housing for large numbers of people were located close by; and (3) waterfront industry and marine terminals, which might be unnecessarily restricted in their activities by adjacent residential development.

THE PUBLIC INTEREST IN HOUSING ON THE BAY

5. Ground Conditions

Areas known to be hazardous or excessively expensive to develop, because of flooding of sites or poor subsurface geological conditions, should not be considered for residential development unless changing technology and construction methods can overcome these problems. The safety of life and property is a matter of public concern, because the public may become involved in helping to pay for dikes, retaining walls, or other expensive protective devices that may turn out to be required long after the project has been in operation.

THE RESIDENTS' INTEREST IN BAY HOUSING DESIGN

In addition to the public interest, there are aspects of design that can make the individual dwelling unit more or less desirable. (Indeed, there might even be said to be some public interest in seeing that each site is developed to its maximum potential.)

1. Fills, Piles, and Floats

Housing on fill can be oriented to the Bay, as at Paradise Cay in Marin County, or it can largely ignore the Bay as an asset as in some fill projects around the shoreline. Waterfront housing should be specifically designed to take maximum advantage of its location on the shore.

Also of concern to the individual property owner is the fact that fills should be carefully designed and allowed to settle for a considerable amount of time before housing is built on them. Otherwise, there is a likelihood of cracked foundations and walls, disrupted drainage and utilities systems, and other related problems.

Dwellings on piles (or stilts) have a water-oriented quality -- the sense of living over the water rather than adjacent to it -- that cannot be found in houses on fill, no matter how close to the water the latter might be.

THE RESIDENTS' INTEREST IN BAY HOUSING DESIGN

Most pile-supported residential projects on the Bay involve only a few buildings. One of the largest projects thus far is the Brickyard Cove development in Richmond; this development uses fill for roadways, but will have all of its houses (perhaps as many as 120) built over the water on piles. Much larger projects appear to be technically feasible.

Houseboats have the additional attraction of being located right on the water surface. The sensation is accented by the daily rise and fall of the house with the tides and the gentle rocking motion in response to the action of the wind and waves, even in well protected areas.

2. Compatibility with Neighboring Uses

As long as housing is not an unwanted neighbor for a more important shoreline development, the combination of housing with other compatible uses adds to the variety and interest within a project. Housing may be attractively located near commercial-recreational facilities such as marinas and specialty shopping areas, and near waterfront parks. Examples of this exist in Sausalito and San Francisco; in addition, waterfront plans for many communities, including Oakland, Berkeley, Vallejo, and San Jose, include residential development tied closely to water-oriented recreation.

Another attractive location for housing is where shipping activity is visible. High-density housing might feasibly be located near marine terminals without interfering with the terminal activity.

3. Water Quality

The water around Bayshore housing should be of the highest quality and should be suitable for intensive recreational uses. Smelly, oily, or trash-laden waters would seriously affect the attractiveness -- and the value -- of any nearby housing.

AREAS ON THE BAY SHORE AVAILABLE FOR HOUSING

Figures 1 through 12 on the following pages illustrate where housing might be located. They also indicate other factors (topography, wildlife habitat, roads, etc.) that should be taken into account in planning specific residential development.

The housing areas indicated on the maps either already exist or have been proposed on the general plans of the local government within whose jurisdiction they lie.

In general, only areas now in private ownership have been considered for residential development. Public lands are assumed to be needed for public purposes, but some residential use might be considered as an attractive mixture with the predominant public uses on such lands.

Figures 1 through 12 are not complete plans. Their only purpose is to illustrate where housing might be located, with due regard to factors that affect its location and site planning.

SUMMARY

Rapid increases in population mean increasing housing requirements for the Bay Area. Increasing incomes in the future will permit more money to be spent for better quality housing in attractive sites.

San Francisco Bay is the dominant feature of the Bay Area. Among other things, its shores offer an attractive location for housing.

Housing on the shores of the Bay should be designed to minimize damage to the public interest in the Bay and to enhance public accessibility to, and the appearance of, the shores of the Bay.

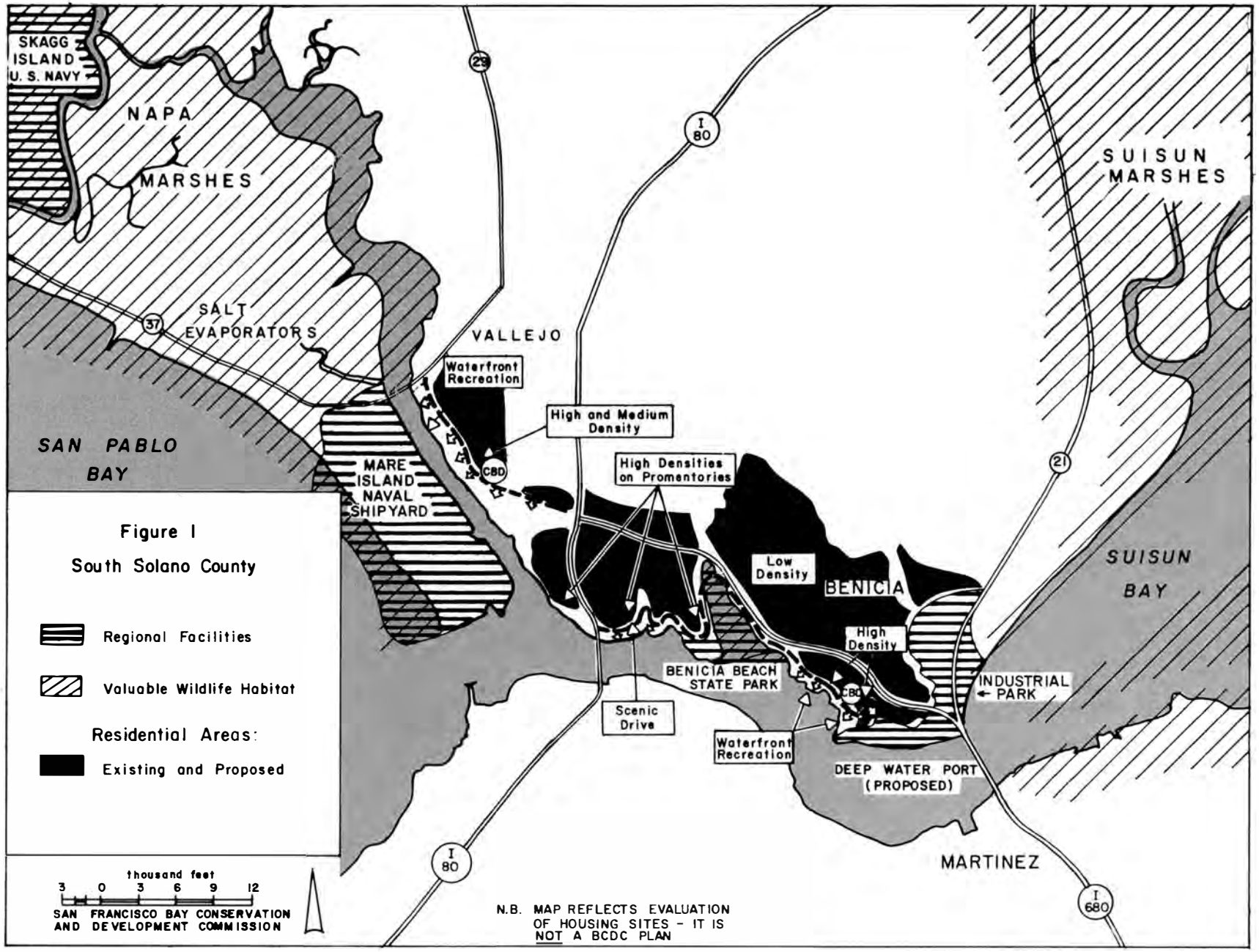


Figure I
South Solano County

Figure 1

SOUTH SOLANO COUNTY

Except for the areas around Benicia and Vallejo, most of the shoreline of Solano and Napa Counties consists of marshes and lowlands having no immediate urban development potential. Local plans for these cities envision much new residential development near the Bay.

A general plan for this area was adopted by the cities and the Solano County Board of Supervisors in March, 1967. The plan proposes residential uses near the shoreline from First Street in Benicia westward along Carquinez and Mare Island Straits, except for the State park at Southampton Bay and a small industrial area in Vallejo.

The plan also emphasizes public access to virtually the entire waterfront. No residential uses are to encroach onto the shoreline itself, which is proposed for permanent public open space and recreation. Most of the housing in Vallejo and around central Benicia will be medium- and high-density; these should be situated so as to provide views of the Bay, but also to avoid blocking the views from other areas.

The plan proposals for residential use are consistent with BCDC objectives and do not conflict with any Bay considerations or regional facility requirements. However, detailed planning for the central Benicia waterfront is essential to insure that the proposed port expansion and the residential-recreation developments are compatible.

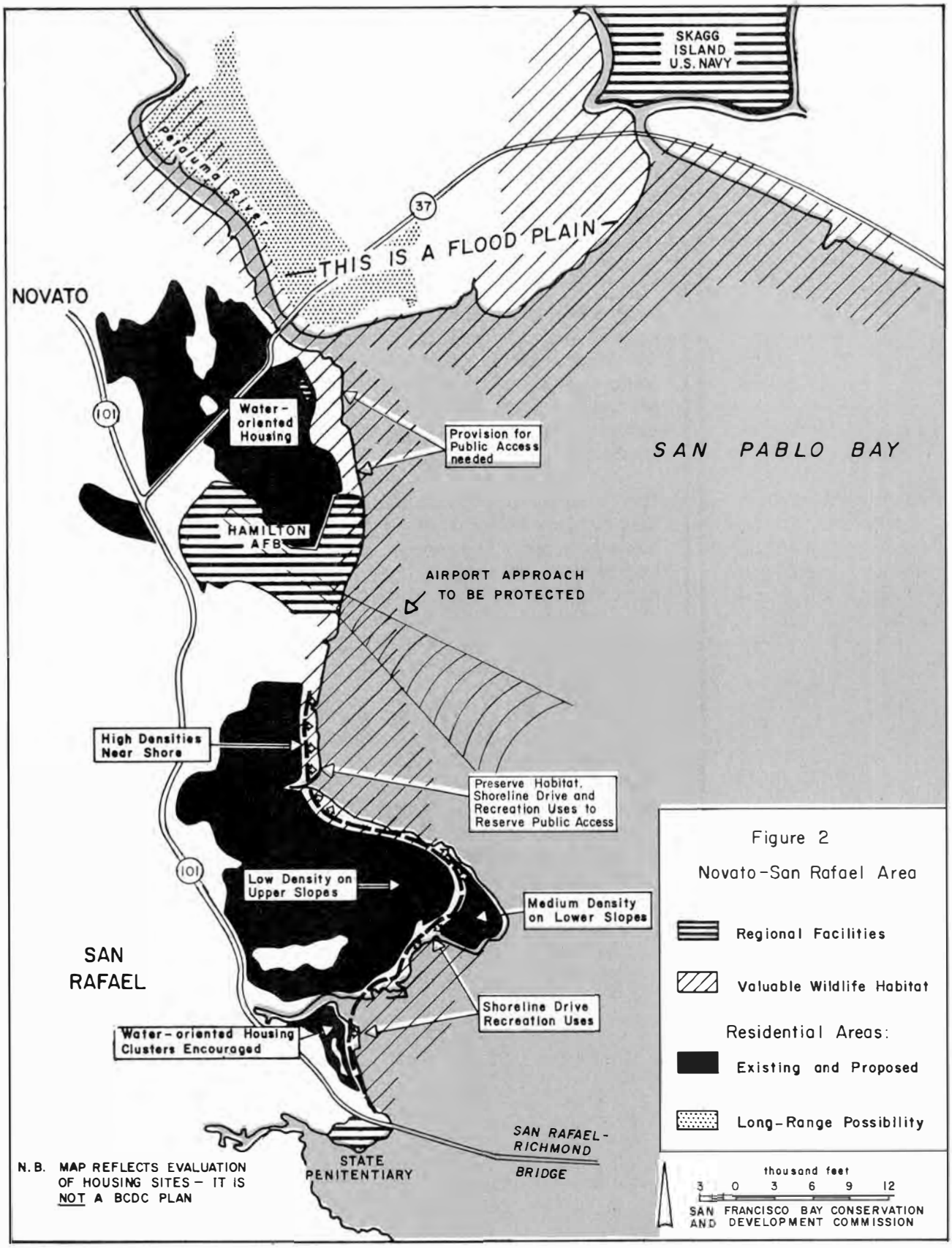

SKAGG ISLAND U.S. NAVY
Petaluma River
37
THIS IS A FLOOD PLAIN
NOVATO
101
Water-oriented Housing
Provision for Public Access needed
SAN PABLO BAY
HAMILTON AFB
AIRPORT APPROACH TO BE PROTECTED
High Densities Near Shore
Preserve Habitat, Shoreline Drive and Recreation Uses to Reserve Public Access
101
Low Density on Upper Slopes
Medium Density on Lower Slopes
SAN RAFAEL
Shoreline Drive Recreation Uses
Water-oriented Housing Clusters Encouraged
SAN RAFAEL-RICHMOND BRIDGE
STATE PENITENTIARY
N.B. MAP REFLECTS EVALUATION OF HOUSING SITES — IT IS NOT A BCDC PLAN
Figure 2
Novato-San Rafael Area
Regional Facilities
Valuable Wildlife Habitat
Residential Areas:
Existing and Proposed
Long-Range Possibility
thousand feet
3 0 3 6 9 12
SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION

Figure 2

NOVATO-SAN RAFAEL AREA

Although most of the waterfront in Sonoma and northern Marin Counties is low-lying and not yet developed, pressures for development there are growing. Housing and recreation are planned to be the principal waterfront uses in this area.

There are no official plans for the Sonoma County shoreline, but a land use plan prepared by the County staff for a proposed Petaluma small-craft harbor suggests a "planned unit development" approach, including housing, for the land along the Petaluma River and Highway 37 to Sears Point. Imaginative site planning is possible, but no design guidelines have been set forth, nor is there any immediate pressure for development there.

The general plan for the Novato area proposes low-density housing for most of the area north of Hamilton Field. Most of the shoreline is still undeveloped. Lagoon-type development is envisioned, utilizing existing creeks and sloughs.

The San Rafael General Plan proposes residential development near the waterfront around Gallinas Creek and Point San Pedro. Housing near the shoreline will generally be at higher densities than inland areas. A "shoreline parkway" is proposed to separate the housing from the shoreline, which is proposed for public use.

Medium-density housing already occupies most of the area around San Rafael Creek. Further south, towards Point San Quentin, lagoon-type residential development is proposed, to be separated from the shoreline by the proposed parkway.

All the plans in their present form are highly generalized. More detailed design and density standards are heeded for this waterfront area. Provisions for public access and wildlife habitat protection should be made more explicit in the Novato and Sonoma County areas before substantial development begins. The Marin County planning staff is studying the idea of water-oriented "activity centers" -- clusters of recreation, commercial and higher-density housing -- that would appear to be applicable at several locations in this area.

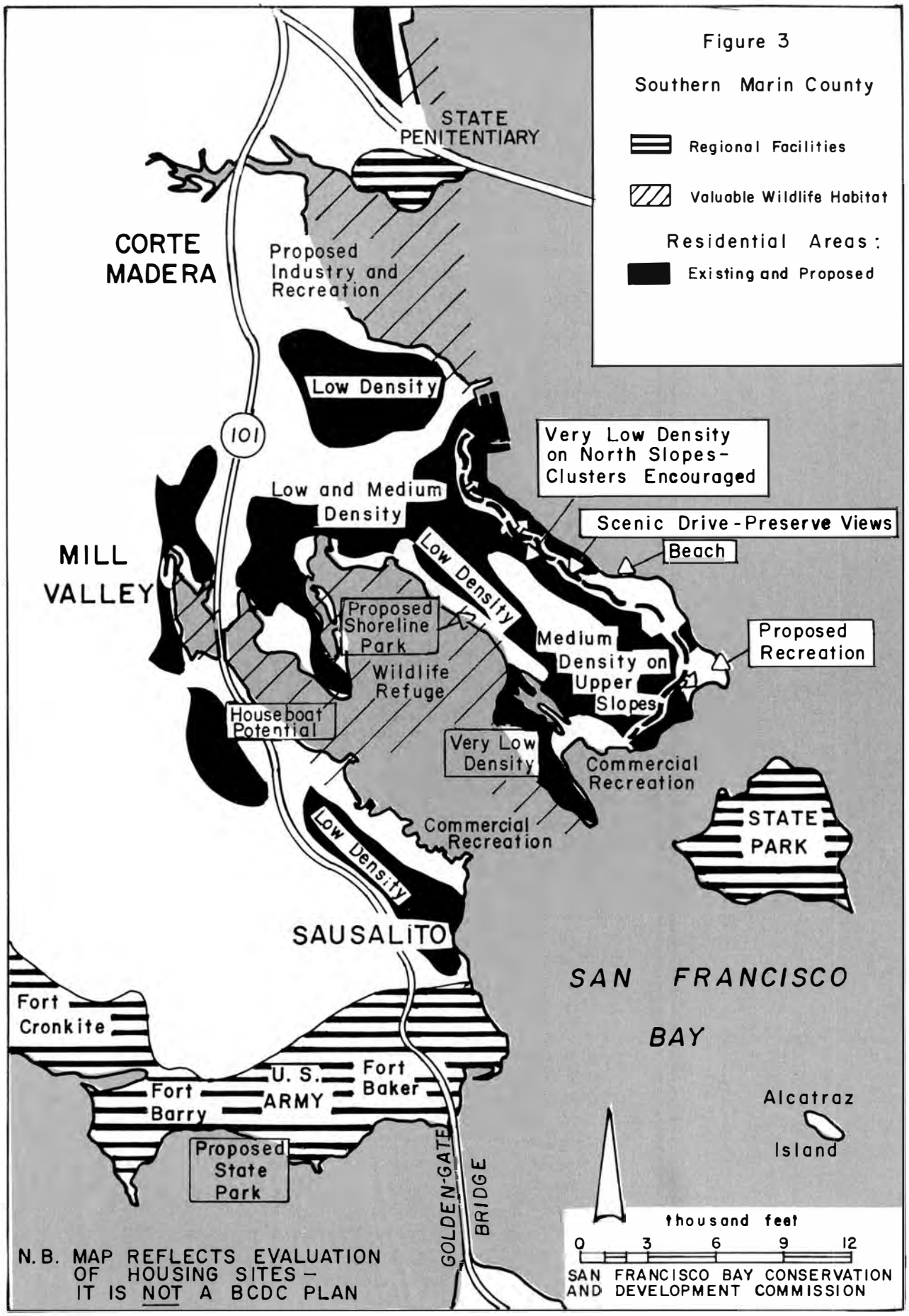


Figure 3
Southern Marin County
Regional Facilities
Valuable Wildlife Habitat
Residential Areas:
Existing and Proposed
STATE PENITENTIARY
CORTE MADERA
Proposed Industry and Recreation
Low Density
101
Very Low Density on North Slopes- Clusters Encouraged
Low and Medium Density
Scenic Drive-Preserve Views
Beach
MILL VALLEY
Low Density
Proposed Shoreline Park
Medium Density on Upper Slopes
Proposed Recreation
Wildlife Refuge
Houseboat Potential
Very Low Density
Commercial Recreation
STATE PARK
Commercial Recreation
Low Density
SAUSALITO
SAN FRANCISCO BAY
Fort Cronkite
U. S. ARMY
Fort Baker
Fort Barry
Alcatraz Island
Proposed State Park
GOLDEN GATE BRIDGE
thousand feet
0 3 6 9 12
N.B. MAP REFLECTS EVALUATION OF HOUSING SITES - IT IS NOT A BCDC PLAN
SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION

Figure 3

SOUTHERN MARIN COUNTY

The scenic attractions of Southern Marin and its proximity to San Francisco have created considerable pressure for housing and recreation uses there.

The Marin County Recreation Plan anticipates near-total urbanization of the shoreline in this zone by 1990. Except for a possible industrial area at Corte Madera and commercial development at Tiburon and Sausalito, the urbanization will be largely residential.

Low- and medium-density development is proposed for most of the Tiburon Peninsula. The Tiburon General Plan indicates very low-density housing on the steep north slopes of the peninsula. Slightly higher densities are proposed for the southern slopes, but a "green belt and shore park" is proposed for most of the shoreline. Belvedere Island is expected to remain a low-density residential area.

The Strawberry Peninsula is proposed for mainly low-density housing with no alteration to the shoreline. The upper reaches of Richardson Bay are expected to develop for low- and medium-density housing oriented to the water. Some fill may be proposed, but pile structures should be used wherever possible. This area lends itself to houseboat development; the county planning staff is examining this potential as part of its Richardson Bay planning study.

Positive action on the recreation proposals is needed to insure that opportunities for public enjoyment of the Bay will increase as the zone becomes intensely developed. Cluster development with a minimum of grading should be encouraged for scenic hillside areas.

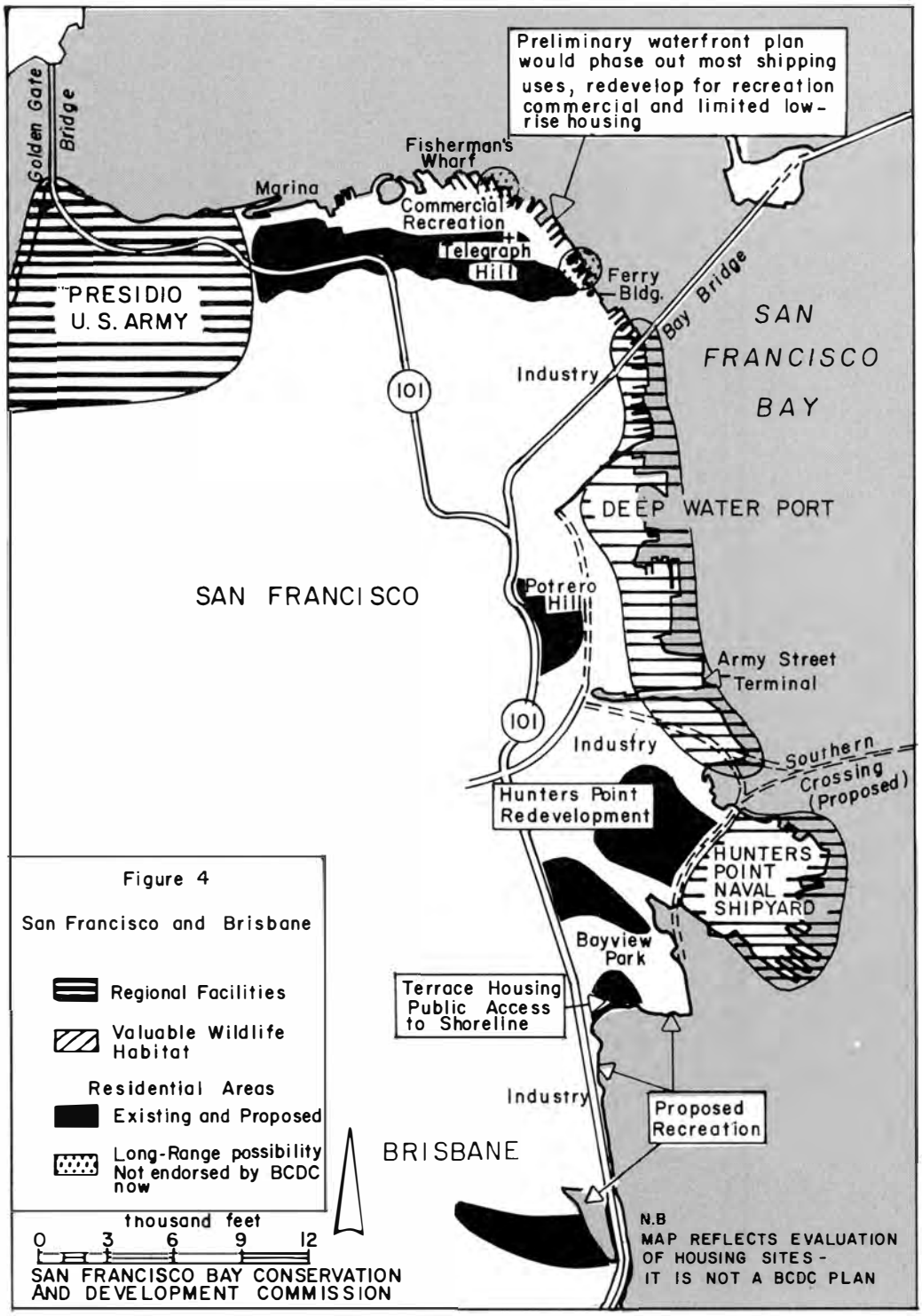

Preliminary waterfront plan would phase out most shipping uses, redevelop for recreation commercial and limited low-rise housing
Golden Gate Bridge
Fisherman's Wharf
Marina
Commercial Recreation
Telegraph Hill
Ferry Bldg.
Bay Bridge
PRESIDIO U. S. ARMY
SAN FRANCISCO BAY
Industry
101
DEEP WATER PORT
SAN FRANCISCO
Potrero Hill
Army Street Terminal
101
Industry
Southern Crossing (Proposed)
Hunters Point Redevelopment
HUNTERS POINT NAVAL SHIPYARD
Bayview Park
Terrace Housing Public Access to Shoreline
Industry
Proposed Recreation
BRISBANE
Figure 4
San Francisco and Brisbane
Regional Facilities
Valuable Wildlife Habitat
Residential Areas
Existing and Proposed
Long-Range possibility Not endorsed by BCDC now
thousand feet
0 3 6 9 12
SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION
N.B
MAP REFLECTS EVALUATION OF HOUSING SITES - IT IS NOT A BCDC PLAN

Figure 4

SAN FRANCISCO AND BRISBANE

Many hillside homes in these cities have excellent views of the Bay, but the shoreline here is developed primarily for nonresidential uses.

Preliminary findings from the San Francisco Northern Waterfront Study, which is jointly sponsored by the City and the San Francisco Port Authority, suggest that much of the present maritime activity north of the Ferry Building area should be gradually relocated, and that the area should be redeveloped for recreation, commercial, and limited residential use. The areas being considered for medium-density housing are the shoreline between Piers 43-1/2 (where the Balclutha is berthed) and 37 (foot of North Point Street); and between Pier 7 (foot of Broadway) and the Ferry Building. According to preliminary designs, the housing would be constructed on finger piers similar to the existing maritime piers.

The Hunters Point redevelopment project, now in the planning stage, is intended to replace the dilapidated public housing on the hill with medium-density housing for low- and moderate-income families. The housing should be designed to take advantage of the fine Bay views from the hill.

A preliminary plan by the City Planning Department for the southern waterfront area proposes terrace-type residential development on the southern slope of Bay View Hill, which has been badly scarred as the result of excavations.

The Brisbane General Plan proposes no residential development near the shoreline.

Provided that the residential proposals do not interfere with necessary maritime use of the waterfront, and that a high degree of public access is included, the proposals would be consistent with BCDC objectives. However, the proposals should be considered in the context of an overall plan for the San Francisco waterfront.

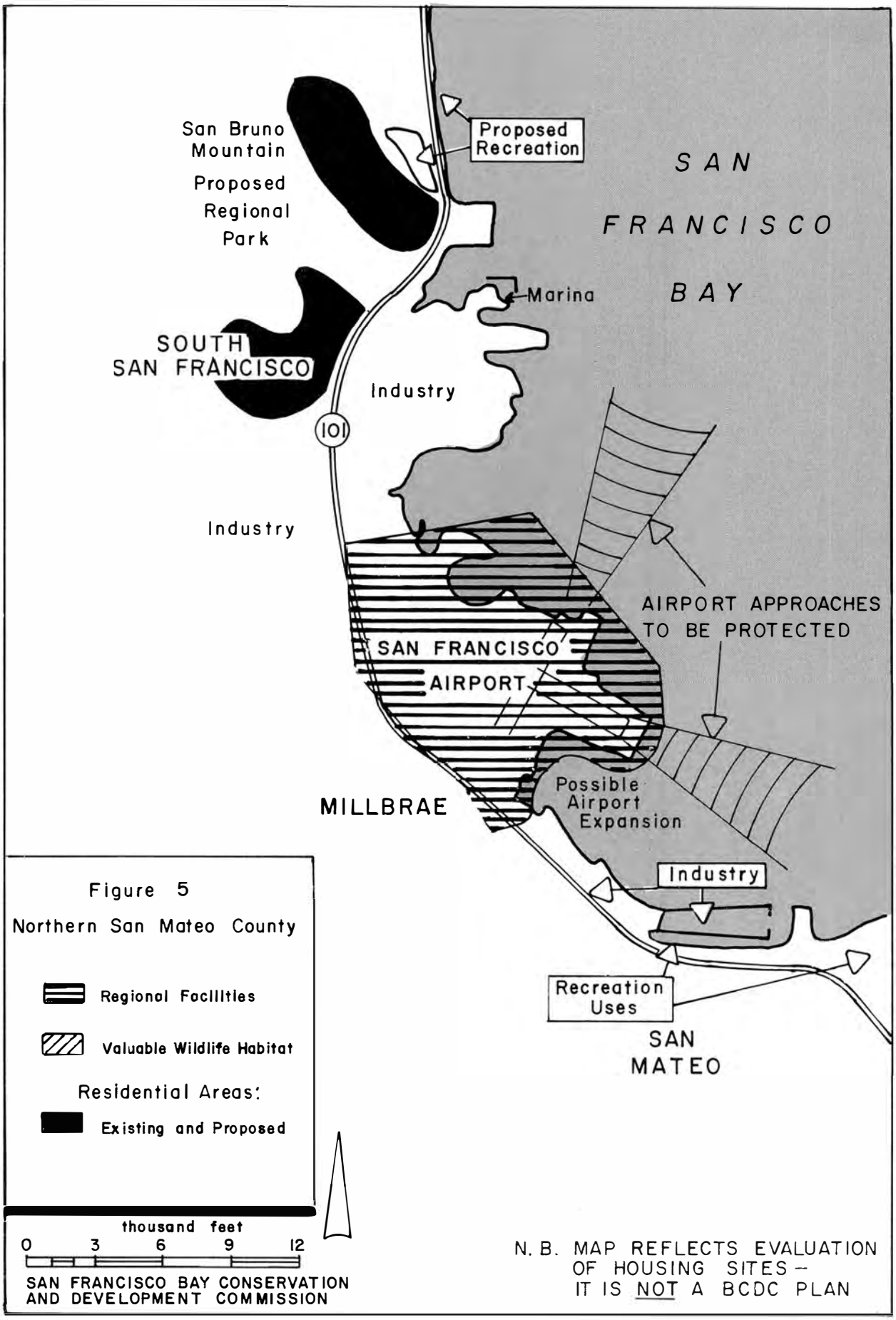


Figure 5
Northern San Mateo County

Figure 5

NORTHERN SAN MATEO COUNTY

The section of the waterfront between Sierra Point and Coyote Point is, and will continue to be, nonresidential.

There are no proposals for shoreline residential use in this zone. Most of the shoreline is already developed for airport and industrial uses. Local plans indicate expansion of these activities, with some new water-oriented recreation facilities in South San Francisco and Burlingame. Residential development would conflict with the operations of San Francisco International Airport.

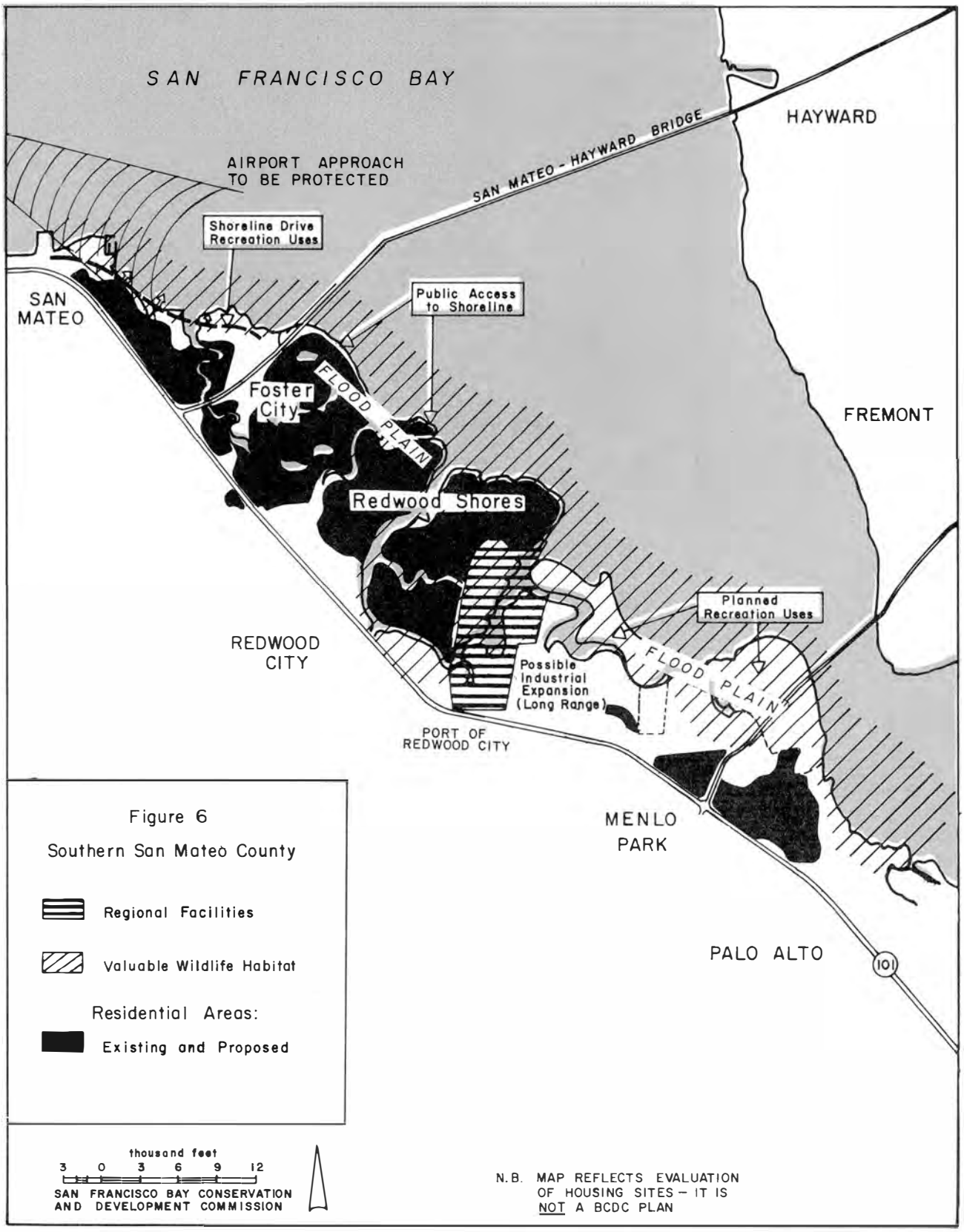


Figure 6
Southern San Mateo County

Figure 6

SOUTHERN SAN MATEO COUNTY

This area between Coyote Point and the San Mateo-Santa Clara County line is a broad flat plain. The waterfront consists mainly of marshes, mud-flats and salt evaporation ponds.

Two large "planned communities" are under construction in this area. Foster City is a 2,600-acre project designed to house about 35,000 persons. It features lagoons usable by small sailboats. Housing is to be primarily low and medium density, but a few high-rise apartment buildings are scheduled for construction in a later stage.

Redwood Shores is a similar but larger (4,500-acre) project designed to house about 60,000 persons by 1985. Most of the housing will be at low and medium densities. Redwood Shores will also have an interior lagoon system, but two waterways will be open to the Bay. Both interior and tidal waterways are being developed from existing sloughs.

Because they are in a flood plain, both projects must be protected from the Bay by dikes. According to the plans, most of the shoreline along the dikes will be open to the public.

Under construction west of Foster City is a 320-acre planned development known as Mariners Island. In addition to planned industrial and commercial uses, 105 acres will be developed for medium-density housing, including town houses and apartments around artificial lagoons.

No residential development is proposed south of the Redwood Shores area. The area south of the Port of Redwood City is proposed for long-range industrial and recreation uses, although limited housing at Menlo Park is a long-range possibility. The County Regional Planning Committee is recommending that most of the waterfront south of Redwood Creek be acquired for permanent open space and recreation uses.

The Mariners Island, Foster City, and Redwood Shores projects are committed projects. They will ultimately house more than 100,000 persons. No need for additional waterfront housing here is foreseen.

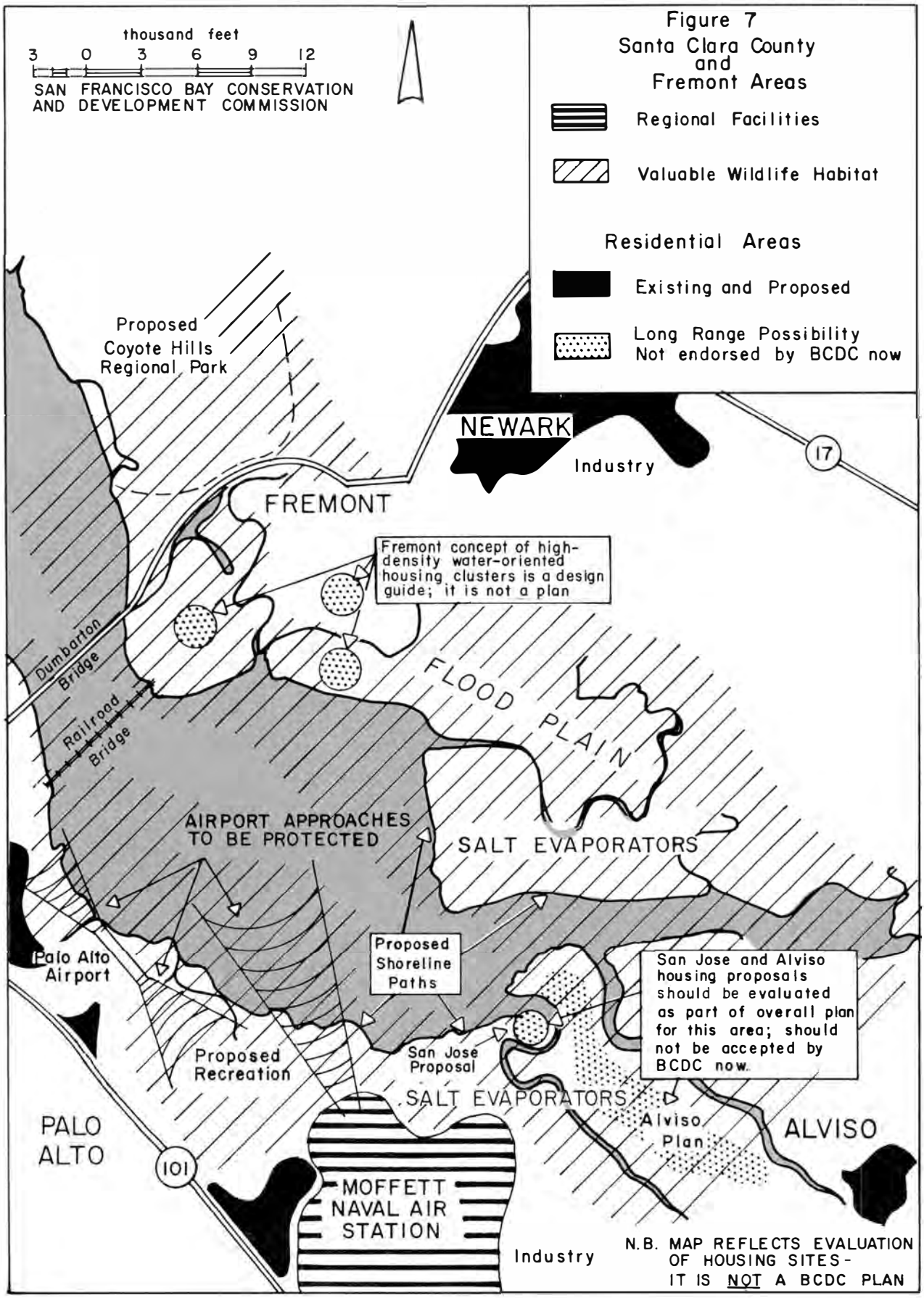

thousand feet
3 0 3 6 9 12
SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION
Figure 7
Santa Clara County and Fremont Areas
Regional Facilities
Valuable Wildlife Habitat
Residential Areas
Existing and Proposed
Long Range Possibility Not endorsed by BCDC now
Proposed Coyote Hills Regional Park
NEWARK
Industry
17
FREMONT
Fremont concept of high-density water-oriented housing clusters is a design guide; it is not a plan
Dumbarton Bridge
Railroad Bridge
FLOOD PLAIN
AIRPORT APPROACHES TO BE PROTECTED
SALT EVAPORATORS
Palo Alto Airport
Proposed Shoreline Paths
San Jose and Alviso housing proposals should be evaluated as part of overall plan for this area; should not be accepted by BCDC now.
Proposed Recreation
San Jose Proposal
SALT EVAPORATORS
Alviso Plan
ALVISO
PALO ALTO
101
MOFFETT NAVAL AIR STATION
Industry
N.B. MAP REFLECTS EVALUATION OF HOUSING SITES - IT IS NOT A BCDC PLAN

Figure 7

SANTA CLARA COUNTY AND FREMONT

The extreme south end of the Bay, from the Santa Clara-San Mateo County line around to Coyote Hills Slough in Alameda County, includes the waterfronts of six cities, but the area is generally uniform in its characteristics and development potential.

All Bayfront lands in Santa Clara County north of Moffett Naval Air Station are proposed by the cities of Palo Alto and Mountain View for major shoreline parks and other public uses.

The City of San Jose recently published a long-range proposal for a major water-oriented commercial-recreation complex to be located on the west side of Guadalupe Slough. The proposal includes some low-, medium-, and high-density housing. Considerable dredging and filling would be involved in the project.

The City of Alviso Master Plan designates nearly three square miles of salt ponds and mudflats on the east side of Guadalupe Slough for low-density, water-oriented residential use. Although very sketchy, the plan would probably include recreation uses as well as housing.

The City of Fremont is presently developing a new general plan. Latest proposals for its waterfront indicate widely-spaced clusters of medium- and high-density residential development south of the proposed Dumbarton Freeway, with the balance of the area to be continued as salt ponds or open space uses. This is not a firm recommendation; it is a development guide to be followed if any urban development of the area is found to be desirable. The Alameda County General Plan designates the major portion of the Fremont shoreline for park and open space uses.

Because of the serious subsidence problems in this part of the Bay, all residential proposals here are long-term possibilities at most. Furthermore, the cities and both counties in this zone are generally committed to the policy that the primary uses of the Bay lands should be recreation and open space. Residential development should not be encouraged here except possibly as an incidental use near major parks.

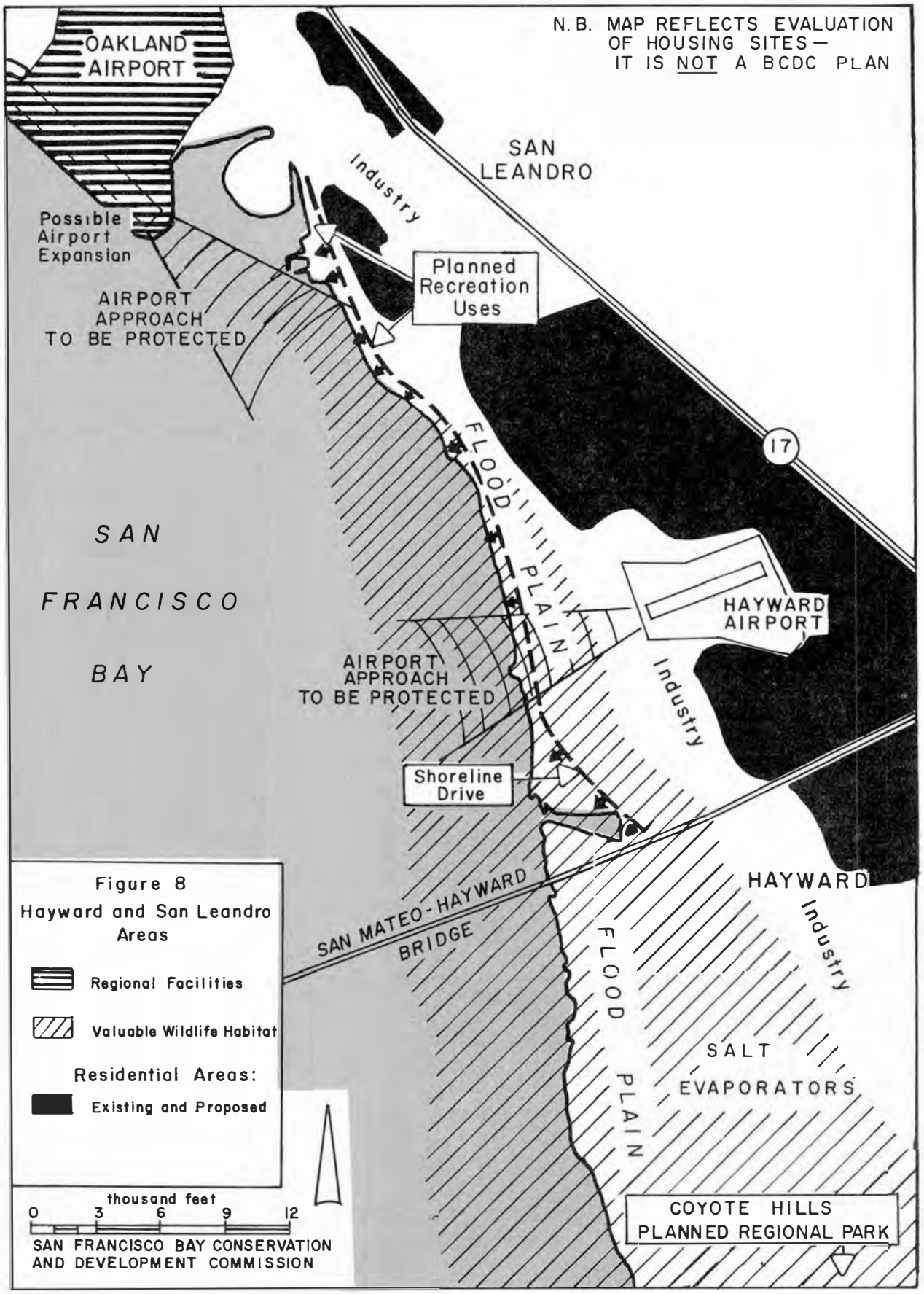

N.B. MAP REFLECTS EVALUATION OF HOUSING SITES — IT IS NOT A BCDC PLAN
OAKLAND AIRPORT
SAN LEANDRO
Industry
Possible Airport Expansion
AIRPORT APPROACH TO BE PROTECTED
Planned Recreation Uses
17
FLOOD PLAIN
SAN FRANCISCO BAY
HAYWARD AIRPORT
AIRPORT APPROACH TO BE PROTECTED
Industry
Shoreline Drive
HAYWARD
SAN MATEO-HAYWARD BRIDGE
Industry
FLOOD PLAIN
SALT EVAPORATORS
COYOTE HILLS PLANNED REGIONAL PARK
Figure 8
Hayward and San Leandro Areas
Regional Facilities
Valuable Wildlife Habitat
Residential Areas:
Existing and Proposed
thousand feet
0 3 6 9 12
SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION

Figure 8

HAYWARD AND SAN LEANDRO AREAS

This area extends from Coyote Hills Slough to the southerly boundary of Oakland International Airport, and San Leandro. The Bay in this zone is extremely shallow for miles offshore and much of the shoreline consists of salt ponds. Except for the City of San Leandro, which is developing its waterfront for recreation use, there has been little detailed shoreline planning within the zone, nor is there much pressure for residential development there now.

Neither Alameda County nor the cities in the zone plan any residential development on the waterfront. The salt ponds are proposed to remain in use for many years and only recreation and open space uses are proposed in local plans. The City of Hayward has designated its waterfront as "tidelands reserve." Adjacent inland areas for Hayward and San Leandro are zoned for industry. There is already considerable existing residential development, primarily low-density, further inland.

There is no apparent need or potential for shoreline housing here, at least until the end of the century. Local plans propose no residential development.

Most of this zone is in a flood plain and is also a valuable wildlife habitat. Ample land is available in the area for housing to satisfy projected demands beyond 1990.

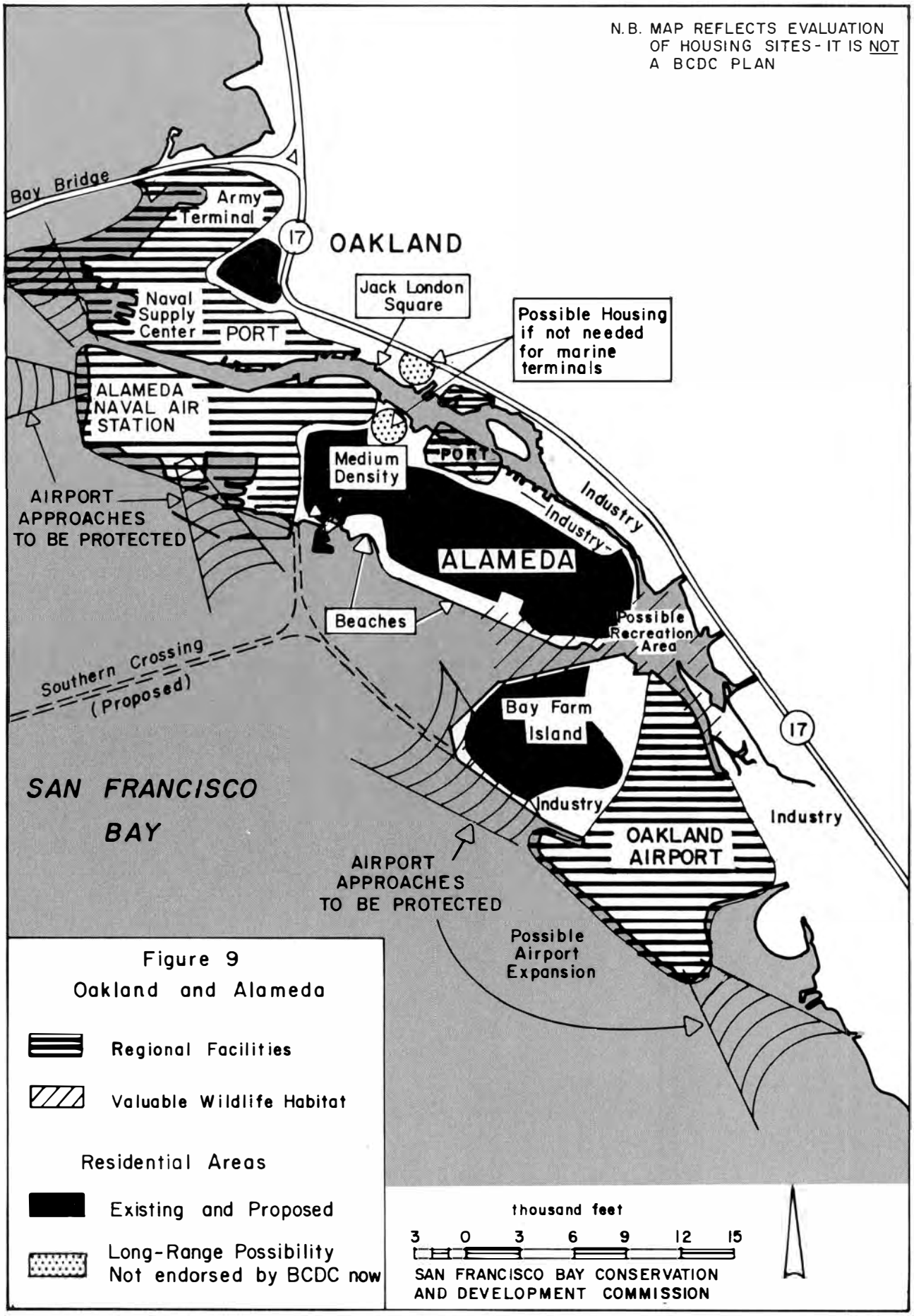


Figure 9
Oakland and Alameda

Figure 9

OAKLAND AND ALAMEDA

This area includes the waterfronts of Alameda and Oakland as far north as the Bay Bridge approach. Two new residential areas are planned for this zone, which contains shipping, airport, and industrial activities of regional importance.

In Alameda, filling is under way adjacent to Bay Farm Island, north of Oakland International Airport, for a 1,000-acre, largely residential community. The City of Alameda approved plans for a low- and medium-density development containing 8-10,000 dwelling units oriented to interior lagoons, similar in concept to Foster City. This was a highly controversial project when it was proposed, due to the amount of Bay fill required and its proximity to the runways of Oakland Airport. A total of 2,000 dwelling units, mostly in medium-density apartments, are planned in three projects near Alameda Memorial State Beach.

In the Port of Oakland area, a high-rise apartment project is planned for a 30-acre site owned by the Santa Fe Railroad along the estuary east of Jack London Square. Preliminary plans also include commercial recreation development along a waterfront promenade from Jack London Square to Lake Merritt Channel. There are no immediate plans to develop the project. The Port of Oakland is planning a small (3-4 story) office-apartment project for a 4-acre site which it owns between the Square and the Santa Fe property.

The projects in Alameda are committed. The Santa Fe proposal is generally consistent with BCDC objectives, but the Commission should not endorse residential proposals on either side of the estuary until the needs of maritime commerce are determined.

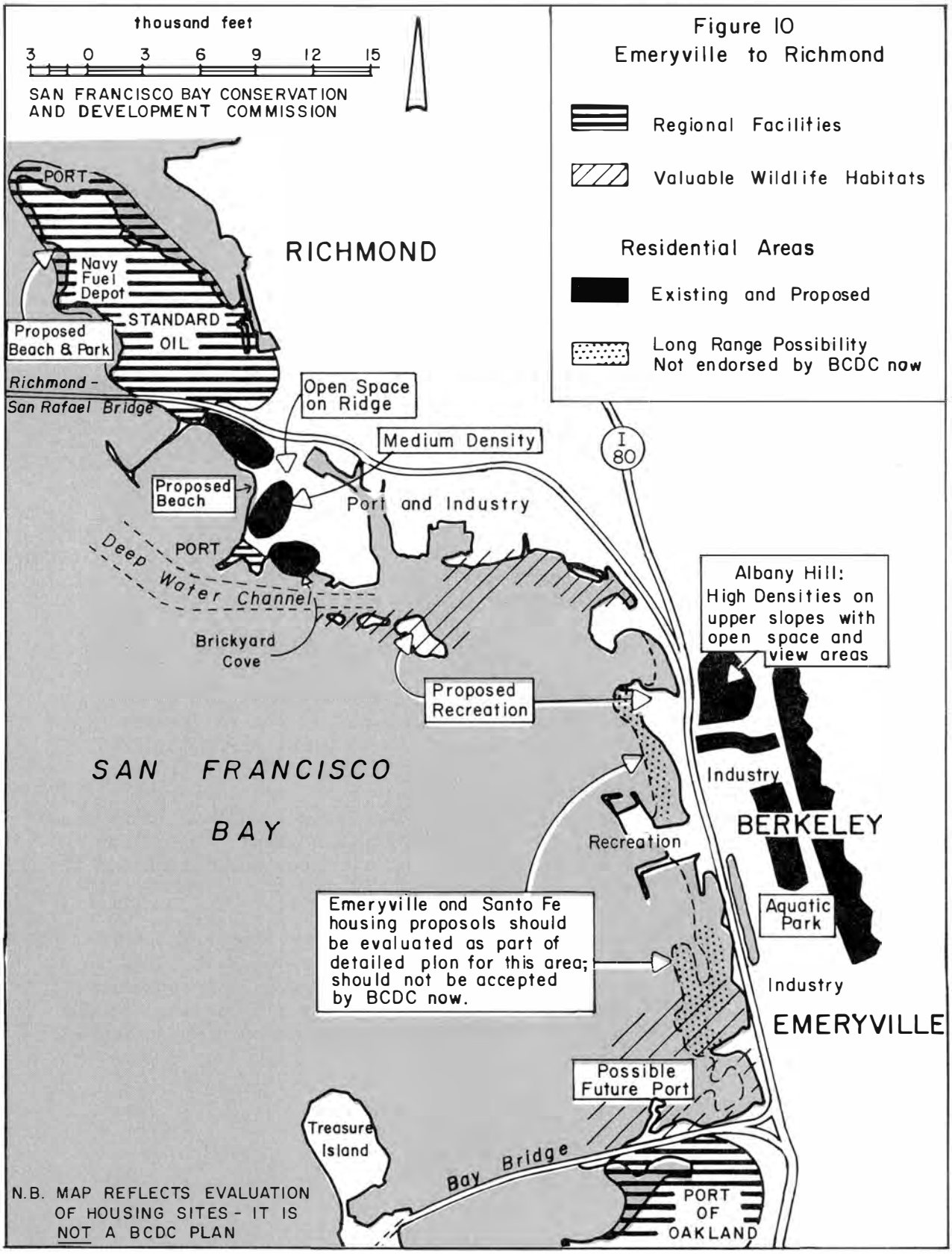

thousand feet
3 0 3 6 9 12 15
SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION
Figure 10
Emeryville to Richmond
Regional Facilities
Valuable Wildlife Habitats
Residential Areas
Existing and Proposed
Long Range Possibility Not endorsed by BCDC now
PORT
RICHMOND
Navy Fuel Depot
STANDARD OIL
Proposed Beach & Park
Richmond - San Rafael Bridge
Open Space on Ridge
Medium Density
I 80
Proposed Beach
Port and Industry
PORT
Deep Water Channel
Brickyard Cove
Albany Hill: High Densities on upper slopes with open space and view areas
Proposed Recreation
SAN FRANCISCO BAY
Industry
BERKELEY
Recreation
Emeryville and Santo Fe housing proposals should be evaluated as part of detailed plan for this area; should not be accepted by BCDC now.
Aquatic Park
Industry
EMERYVILLE
Possible Future Port
Treasure Island
Bay Bridge
PORT OF OAKLAND
N.B. MAP REFLECTS EVALUATION OF HOUSING SITES - IT IS NOT A BCDC PLAN

Figure 10

EMERYVILLE TO RICHMOND

This area includes the East Bay shoreline from the Bay Bridge approach to the San Pablo Canal in Richmond. While inland topography and the East-shore Freeway provide visual access to the Bay for thousands of persons, very few actually have direct access to the water.

The Town of Emeryville proposes filling tidelands to provide sites for high- and medium-density housing as part of a project that would also include industrial and recreational areas.

In Richmond, there is one existing residential area near the shoreline -- a hillside area south of the Standard Oil Long Wharf commonly called Point Richmond. A second area is now being developed in the Bay at nearby Brickyard Cove. Seventy-two units, mostly family homes, on piles and served by roadways constructed on fill are now committed, but about 130 additional units have been proposed by the developer. The Richmond General Plan proposes an additional residential area on the shoreline between these two residential developments, but the existing port uses in the same area are proposed to remain indefinitely.

The Santa Fe Railroad, which owns about 3,400 acres of tidelands along the shoreline between the Bay Bridge approach and Brooks Island in Richmond, has prepared several alternative plans for the East Bay waterfront. The most recent plans show considerable residential development, along with other uses, on fill in Emeryville, Berkeley, Albany, and Richmond. The plans are schematic, and have not been approved by any city or county government.

Whether the Emeryville filling is legally within the Commission's jurisdiction has not been finally determined at this writing. If the Courts decide that the Commission has jurisdiction, any filling and uses should be compatible with plans for the entire waterfront between the Bay Bridge and Richmond, including the Santa Fe lands. Other planning reports, particularly those dealing with port development, uses of the Bay for surface transportation, and methods of carrying out the BCDC plan with regard to privately-owned lands, must be completed before such a plan can be made.

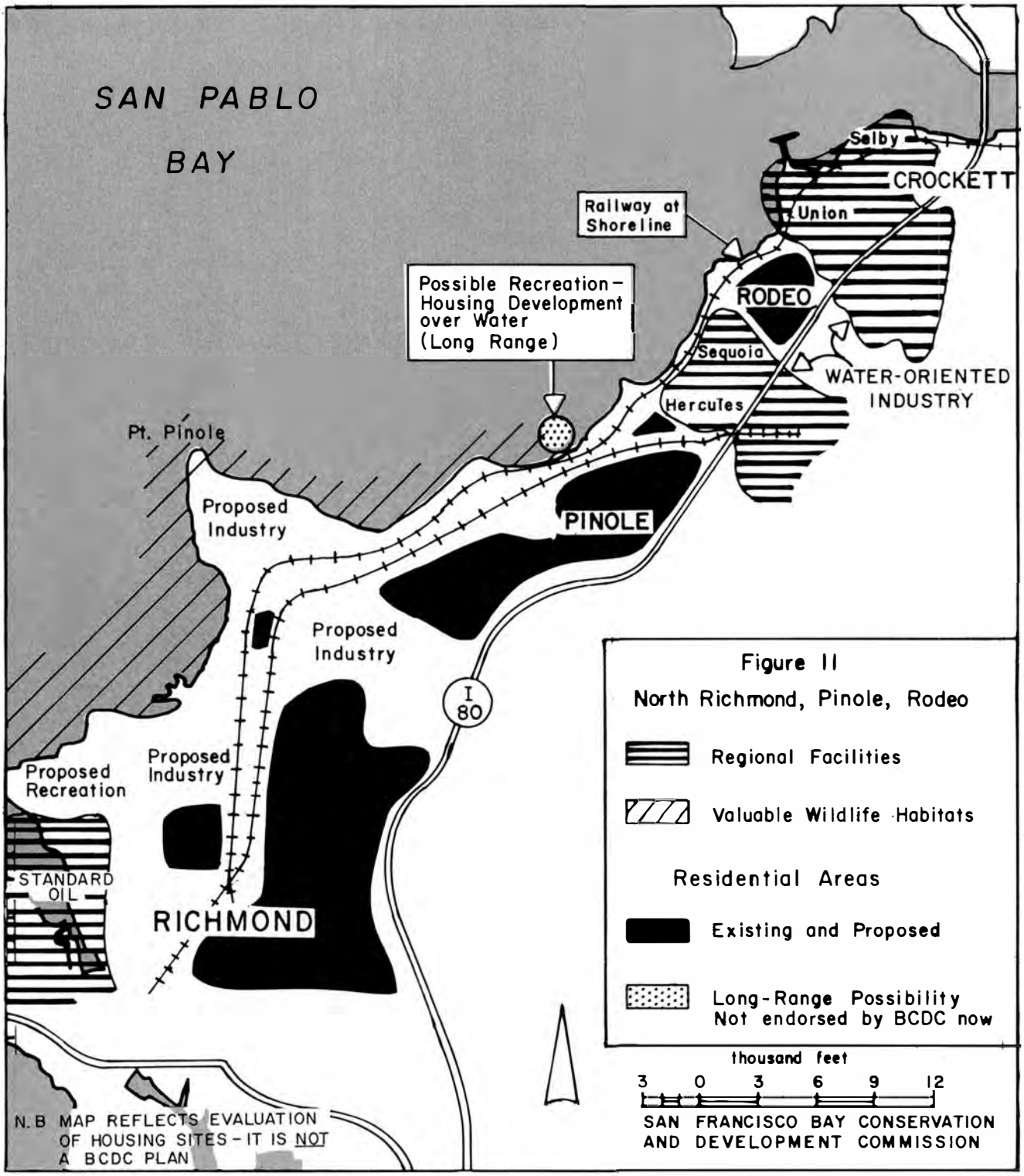

SAN PABLO
BAY
Selby
CROCKETT
Union
Railway at Shoreline
Possible Recreation-Housing Development over Water (Long Range)
RODEO
Sequoia
WATER-ORIENTED INDUSTRY
Hercules
Pt. Pinole
Proposed Industry
PINOLE
Proposed Industry
I 80
Proposed Industry
Proposed Recreation
STANDARD OIL
RICHMOND
N.B MAP REFLECTS EVALUATION OF HOUSING SITES - IT IS NOT A BCDC PLAN
Figure 11
North Richmond, Pinole, Rodeo
Regional Facilities
Valuable Wildlife Habitats
Residential Areas
Existing and Proposed
Long-Range Possibility Not endorsed by BCDC now
thousand feet
3 0 3 6 9 12
SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION

Figure 11

NORTH RICHMOND, PINOLE, RODEO

Because of its proximity to deep water, its isolation from heavily-populated areas and the presence of two major railroads, the waterfront in this area has long been attractive for water-oriented industry. This is one of the most scenic areas around the Bay; despite existing and potential industrial development here, residential development could occur at a few locations.

Existing residential development near the shoreline is limited to two areas: the adjacent communities of Pinole and Hercules, and Rodeo. Limited expansion is planned for both areas, but no additional waterfront housing areas are proposed. The only other waterfront area where housing might be possible is North Richmond, but this is proposed for industry in the Richmond General Plan.

The Southern Pacific Railroad right of way occupies the shoreline north of Point Pinole. No development is possible Bayward of the railroad without Bay fill. Although deep water is fairly close to the shoreline here, there is an area of shallow water at the shore that could be developed.

First priority for shoreline development in this zone should go to industry and recreation. No residential development need be planned for, at least for the next 20 years. Beyond that period, some high-density housing on piles may prove desirable and feasible along the Pinole waterfront, but this should be done only as part of a project to increase public recreation opportunities along the shoreline.

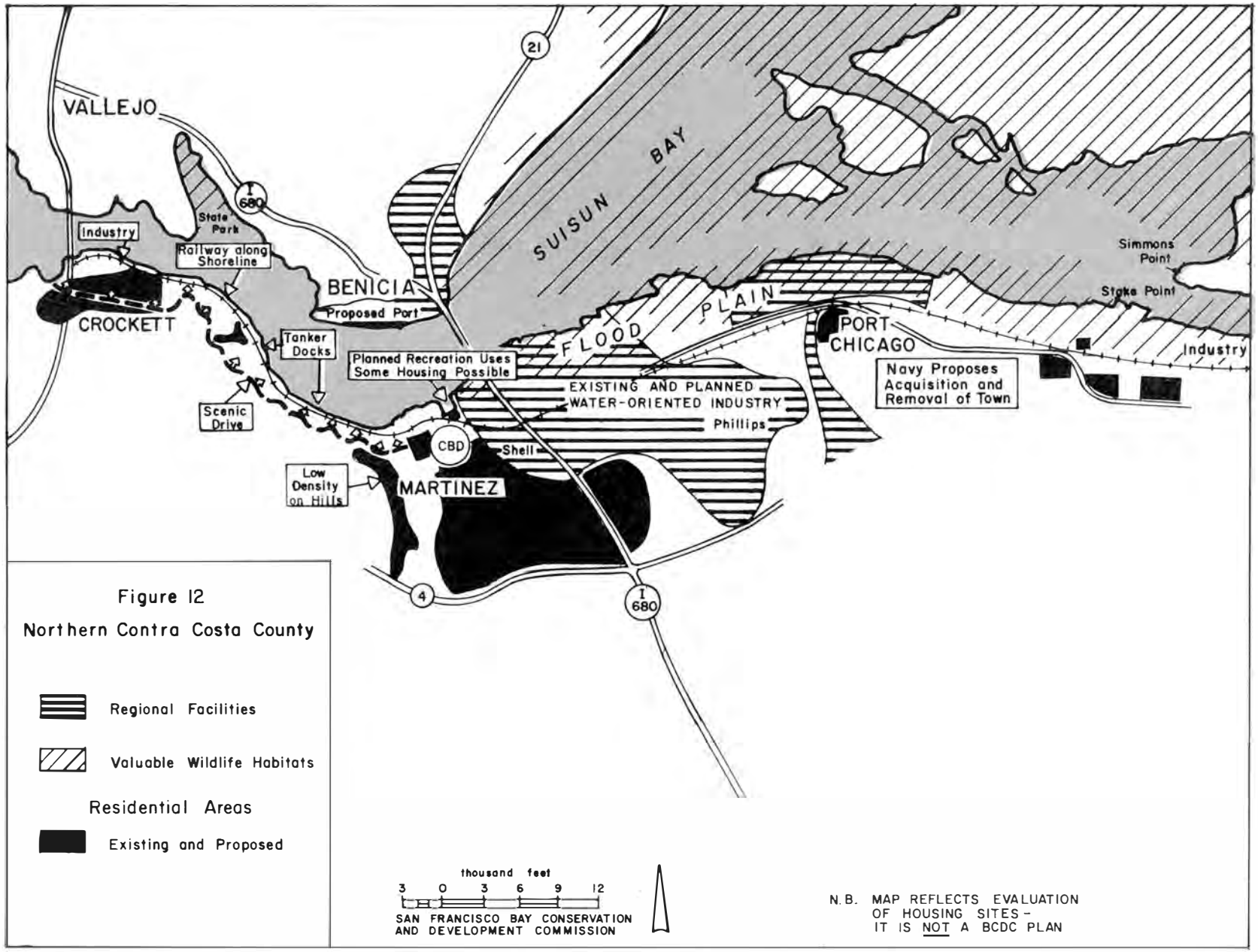


Figure 12
Northern Contra Costa County

Figure 12

NORTHERN CONTRA COSTA COUNTY

The area between the Carquinez Bridge and Pittsburg is also a prime area for water-oriented industry. A railroad occupies the shoreline; however, there are opportunities for housing near the Bay in a few locations.

Three communities have housing near the shoreline: Crockett, Port Costa, and Martinez. None of these communities has any plans for residential use of its waterfront. At Crockett, the water is very deep right at the shoreline and most of the waterfront is occupied by the C&H Sugar plant. Filling up and redevelopment of hillside residential areas could result in some excellent low- and medium-density view housing.

Once an important grain port but now a small residential community, Port Costa is separated from the waterfront by a railroad. The town is undergoing a minor renaissance as an arts and crafts center, but there are no waterfront development plans. The hillsides offer fine views of Carquinez Strait, and some low-density housing can be expected there. Very deep water immediately offshore precludes development across the railway.

The Martinez waterfront is generally planned for industry and recreation use. Detailed waterfront planning could result in proposals for some housing in conjunction with recreation uses. Some low-density housing is planned for the hillsides west of the city.

Various agencies have proposed acquisition of all or parts of the scenic hillside areas between Crockett and Martinez as permanent open space. While increased hillside housing close to the existing communities is possible, no additional housing on these hills is proposed at this time. The possible development of some medium-density housing as well as recreation uses on the Martinez waterfront should be considered only as part of a detailed recreation-oriented waterfront plan for the city.

SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION
507 Polk St., San Francisco 94102 557-3686

Possible Bay Planning Conclusions Based on the Report on Waterfront Housing

1. Because shoreline housing can provide many persons with access to the Bay, it is a permissible use of the shores of San Francisco Bay provided (1) it is so designed as to enhance the appearance of the Bay and so as not to substantially interfere with views of the Bay, and (2) it is designed so as to include access to the water for the general public.

2. But housing is not a necessary use of the shoreline, so it should not be allowed to displace uses that must of necessity be located on the waterfront, such as water-oriented industry, marine terminals, water-related utilities, or water-oriented recreation. Nor should housing be allowed to interfere with other uses of regional importance, such as airports, that may have to be located on the shoreline for lack of other suitable sites.

3. Pending further consideration, when other elements of the Commission's plan for the Bay (including the methods of carrying out the plan) have been assembled, the following criteria shall be an initial guide to the allocation in the plan of shoreline areas for residential development:

a. At the outset, BCDC planning for new residential development should closely follow the adopted plans of the cities and counties around the Bay -- provided these plans meet the other criteria listed below. Initial reliance on local plans is permissible because local governments are usually responsible for providing municipal services (such as roads, fire protection, etc.) to residential areas, and because many local governments have already carefully studied the more detailed problems and possibilities of residential development within their own jurisdictions. Additional areas beyond those shown in local plans may be suggested in the BCDC plan as appearing to be desirable for housing, but they should not be firmly proposed pending more extensive local consideration of such proposals.

b. Residential development should complement, not interfere with, the value of the Bay as a habitat for fish and wildlife, the ability of the Bay to assimilate wastes, and the effect of the Bay in helping to prevent air pollution. Therefore, filling for residential development should be permitted only as part of an overall project that provides substantial public benefits (e.g., by providing new shoreline parks).

c. Only areas now in private ownership should be considered for residential development in the plan; areas in public ownership are assumed to be needed for public purposes.

d. Areas known to be hazardous or expensive to develop because of flooding, subsidence, or other geologic conditions should be excluded from residential development unless there is an important public reason for developing them. All proposals in the BCDC plan involving fill or pilings shall be tentative pending review by the Board of Consultants as provided in the Commission's conclusions from the BCDC report on Fill.

e. Any residential development permitted near the Bay should be designed to increase public access to the Bay and also to increase the amount of shoreline and the surface area of the Bay to the maximum extent feasible by dredging additional channels inland from the Bay.

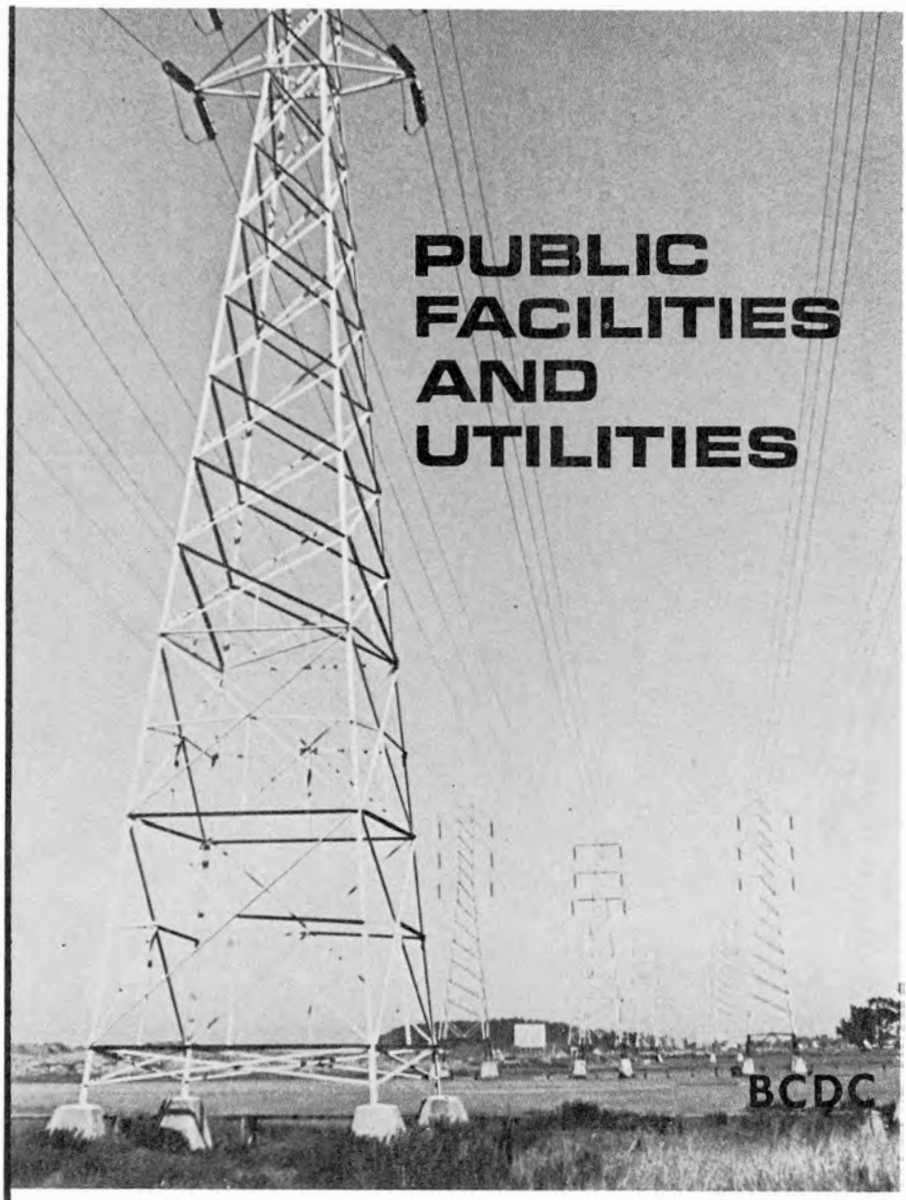
f. Any residential development permitted near the Bay should be designed to enhance the appearance of the Bay and shoreline.

4. Subject to the foregoing criteria, the existing and proposed residential areas indicated in black in Figures 1 through 12 of the Summary -- and the density and design recommendations for new housing in the Figures and the text accompanying the Figures -- shall be tentatively included in the Commission's plan for the Bay. The density and design recommendations are either contained in local plans that are consistent with BCDC objectives or are modifications of local plans based on BCDC planning criteria.

Adopted by the Commission at its meeting of 1/19/68

PUBLIC
FACILITIES
AND
UTILITIES

Part of
a Detailed
Study of
San Francisco
Bay



San Francisco Bay
Conservation and
Development
Commission

San Francisco
California

June 1967

Summary of the report, "Public Facilities and Utilities in and around San Francisco Bay," by Clifford W. Graves, Associate Planner, BCDC.

INTRODUCTION

The ease with which a light can be turned on, a radio tuned, a thermostat adjusted, and a telephone call placed gives no indication of the extensive network of facilities needed to make these services possible. Part of this network crisscrosses the Bay or requires shoreline installations.

In addition to utilities involving power, communications, and sewage disposal, several other public facilities must be considered in planning for the Bay and its shoreline. These include utility pipelines, prisons, and military installations. How do these compete for the limited amount of shoreline available? And how do they affect neighboring uses of the shore or the water?

GENERATION OF ELECTRICITY

The Pacific Gas and Electric Company has six power plants on the shores of San Francisco Bay. These six plants, which occupy about 650 acres of shoreline land in San Francisco, Alameda, and Contra Costa Counties constitute 40 per cent of PG&E's total generating capacity.

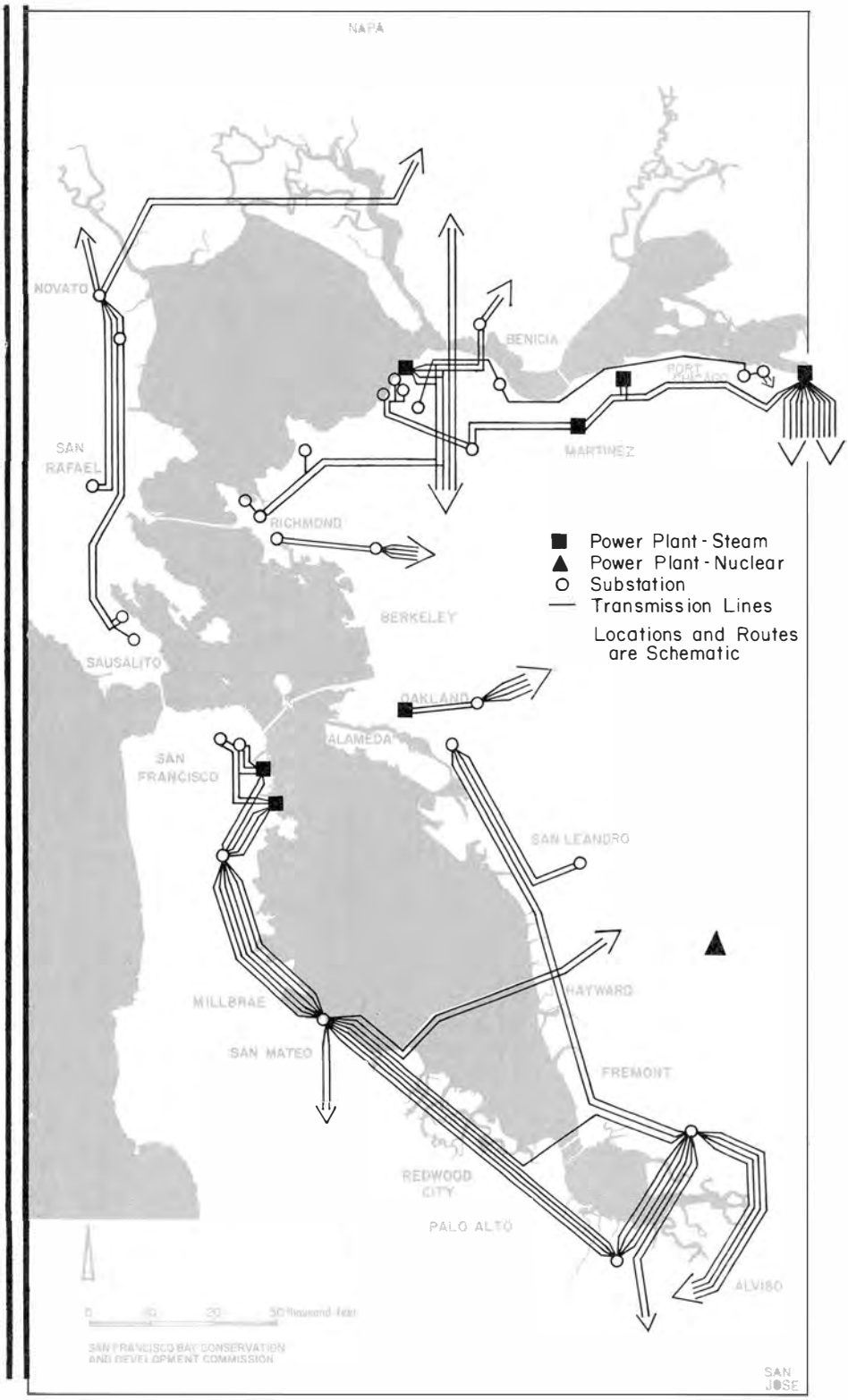
The plants are fueled primarily by natural gas, but they are also designed to use fuel oil during periods of peak gas demand by other users or during emergencies.

The power plants are located adjacent to the Bay because the Bay is both a source of water for cooling and a place to discharge the water after it is used. The Bay provides an economical means of transporting fuel oil to the plants by either barge or tanker, and the flat shoreline, with its absence of development, has been a convenient route for power transmission lines.

The water used to cool condensers in power plants is returned to the Bay unchanged except that its temperature has been increased 10 to 20 degrees. Little is known about the effects of the heated water on marine life nearby; the heating may be beneficial, if the number of fishermen who favor areas around discharge points is any indicator. On the other hand, "thermal pollution" from discharge

FIGURE 1

Electric Power Generating Plants and Transmission Routes Near the Bay



Source: Pacific Gas and Electric Company

of excessive amounts of heated water by many industries could cause problems in the Bay, though it is not a problem now. The temperature increase does not reduce the suitability of the water for recreational purposes and may even improve its attractiveness for swimming and other water contact sports.

One problem with use of Bay waters for cooling is that small fish are often sucked in through the intake pipes; various experiments are under way to reduce or eliminate this problem.

Land near steam-electric plants is ordinarily zoned for industrial use and all of the existing plants are located in industrial areas.

Only one location near the Bay is now being considered by PG&E for a new power plant: a site at Collinsville in Solano County opposite the present PG&E Pittsburg plant. No other Bayshore sites will be needed solely for power generation because of new developments in generating and transmitting electricity. Nuclear power plants produce power at lower fuel cost per kilowatt hour than do steam plants, and nuclear power plants produce no harmful air pollutants. These plants can be located at a distance from the area to be served, because improvements in high voltage transmission lines are permitting more economic transfer of power over long distances. (The only other power generation possibilities that could affect San Francisco Bay are [1] generation through the rise and fall of the tides, which is not feasible here because a tidal range of at least 10 feet is needed, and [2] combination power-desalinization plants, which are discussed in a following section on Water Supply.)

While additional generating units may be added at existing plants, or some of the older units may be replaced with more modern and efficient generating units, PG&E does not expect to add any new generating capacity near the Bay after 1980. Since the useful life of a generating unit is about 35 years, most existing plants around the Bay will probably be phased out by the turn of the century, the exception being plants that may be replaced within the next decade.

ELECTRIC POWER TRANSMISSION AND DISTRIBUTION

Electric power is transmitted from generating stations to major users or to local substations through high voltage transmission lines. Since transmission lines are expensive, PG&E avoids installing them in heavily populated areas where land costs will be high; and the company takes special precautions to minimize future needs to relocate the lines. Transmission lines are usually built on privately-owned land under perpetual easements.

Transmission lines have in the past been located on the shores of the Bay because much of the shore is flat and usually free from urban developments that would require costly shifts in alignment. Most of the lines close to the Bay are located along the west shoreline. There are Bay crossings near the San Mateo and Dumbarton Bridges, Carquinez Strait, and Antioch.

The effect of transmission lines and towers on the Bay is primarily visual. No fill is required for them; the tower footings probably do not significantly affect Bay currents and sedimentation, nor are they harmful to marine life. The lines and towers do not inhibit public access.

The effect on surrounding uses of land is also primarily visual; the scale and appearance of these lines and towers make them "intruders" in almost any urban landscape. The problem is most acute when towers are seen at close range or against a backdrop of small-scale development, such as single-family housing. Where possible, the land near transmission lines should have open-space uses, such as agriculture or recreation, or else have industrial use. New routes should avoid interfering with scenic views.

Because of the cost involved, it is not likely that existing transmission lines along the shores of San Francisco Bay will be removed. According to PG&E, the cost of an underground transmission line is 10 to 20 times the cost of an overhead transmission line, and lines placed under water are even more costly. Underground lines must use heavily insulated cable installed in a steel pipe filled with oil under high pressure; the conductors must also be approximately twice as large as those for overhead lines, because

ELECTRIC POWER TRANSMISSION AND DISTRIBUTION

there is no circulating air to conduct the heat away. Current research does not suggest an early breakthrough to reduce the cost of undergrounding high voltage lines. Research is under way on the transmission of electric power through the air by micro-waves, but the feasibility of this method for transmitting large blocks of power is not known.

Beyond 1980, the expected increase in power demand will require additional transmission lines and some of these may have to be located in or near the Bay. By that time there may be some change in the design of towers to make them less obtrusive than those now used. While it is possible that by the turn of the century new technology will permit the removal of transmission lines, it must be assumed for present planning purposes that they will remain in their present location for decades to come.

Local distribution lines are a much smaller problem. The cost of undergrounding these lines is low enough to make this a generally feasible practice. The electric power industry is also working to improve the appearance of those lines that will remain above ground in the future. Undergrounding, or a combination of underground lines with streamlined overhead facilities, is desirable to improve the appearance of all residential, commercial, public and view areas near the Bay.

COMMUNICATIONS FACILITIES

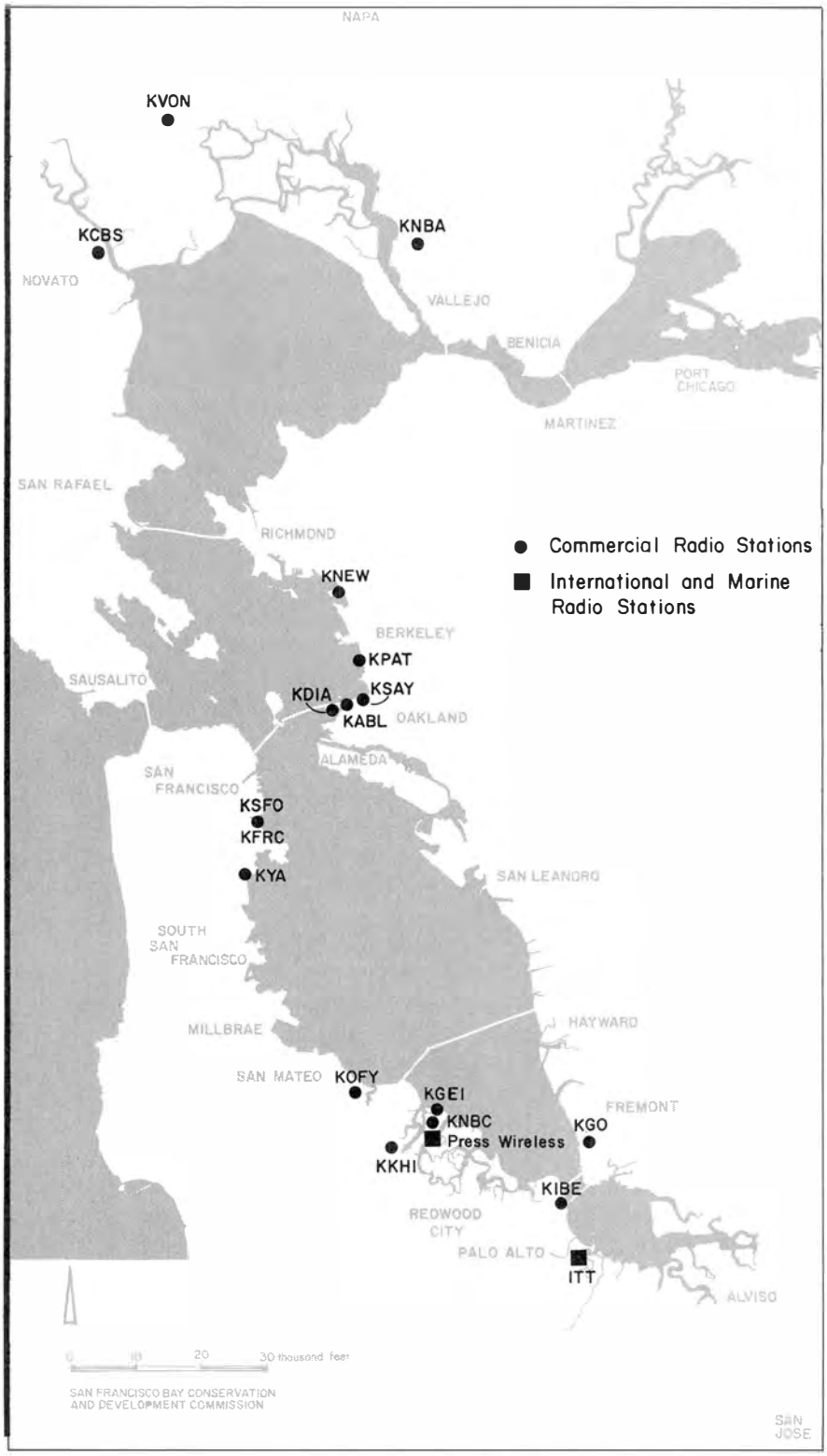
Communications facilities include telephone, telegraph, radio, and television.

The most prevalent communications facilities near the Bay are radio towers. Fifteen AM stations and one short-wave station have a total of 30 towers around the Bay. Two large radio-telegraph fields are situated near the Bay in San Mateo County. These activities chose Bay locations because salt water helps in the transmission of these types of radio waves.

Television and FM stations are not located near the Bay because they rely on direct line-of-sight for the transmission of their signals, and thus prefer hilltop locations.

FIGURE 2

Commercial Radio Towers and Radio-Telegraph Fields Near the Bay



COMMUNICATIONS FACILITIES

The only telephone facilities in the Bay are cable crossings.

Submarine cables and radio towers have no significant effect on the marshes and waters of the Bay. Most of the radio towers are located in areas not presently needed for other uses. Radio and radio-telegraph transmission facilities may, however, interfere with household appliances and these facilities may be moved under the pressures of urban development. The principal effect of the large number of poles that comprise a radio-telegraph field is primarily visual.

In most cases, radio transmitters are located on rented sites, so some of them may be removed for more intensive land uses in the future. Consolidation of several radio stations to use one transmitter tower is possible, but only one such combined facility is now in use. New transmitters could be located without harm in marshes or other natural areas that may be permanently conserved.

Radio-telegraph fields are characterized by forests of poles ranging from 25 to 200 feet in height. One such field occupies a 300-acre site near Palo Alto Airport. The other is on 100 acres in Redwood City. Neither have plans to expand; the larger field may be phased out as the operator, ITT World Communications, expands its cable and satellite facilities. The Redwood City facility will be surrounded by the Redwood Shores development.

WATER SUPPLY

At the present time, the Bay is of no value as a source of fresh water; the only way in which Bay waters could be used for domestic purposes would be through desalinization. Most fresh water used in the Bay Area comes from deep wells or from mountain areas via aqueduct, though some Delta water is diverted for various uses.

The reclamation of waste waters rivals desalinization as a promising supplemental source of fresh water. A number of reclamation projects are already in operation in the Bay Area and in Southern California. Most provide fresh water for pastures, fodder crops, parks, and golf courses. In the more ambitious projects,

WATER SUPPLY

reclaimed waste water is injected directly into an underground aquifer (natural subsurface stratum of sand or gravel in which water collects) from which domestic water is drawn, or is spread over a river basin to percolate down into the ground water. A number of reclamation and desalinization methods are being studied and it appears each will have its utility under different circumstances.

Site requirements for waste water reclamation plants are not yet fully determined; such plants may be integrated with sewage treatment plants. Or partially reclaimed waters could be pumped to plants for further reclamation at another location, perhaps nearer the user of the reclaimed water (for example, in agricultural areas for irrigation purposes).

The site requirements for desalinization plants also will depend upon the particular process used, but, except for savings in water transportation costs, there appears to be no particular advantage to locating a plant on the Bay rather than on the seacoast. A nuclear-powered desalinization plant such as proposed in Southern California thus far requires a buffer zone. Large scale desalinization in the Bay could also upset the ecology of the Bay by increasing local mineral concentration in the Bay waters. The combination of these factors makes it unlikely such a plant would be located on the Bay in the foreseeable future, but the East Bay Municipal Utility District is studying desalinization as a possible supplement to its other water resources.

SEWAGE TREATMENT PLANTS

Nearly 70 municipal sewage treatment plants are located near the Bay.

Shoreline locations permit the convenience of discharging treated wastes into the Bay; in addition, the plants are generally at a lower elevation than the area served so that sewage can flow to them by gravity. Location right at the shoreline is not necessary, however, since the only access to the Bay required by the treatment plants is for the outfall pipes.

Most of the sewage treatment plants are in industrial areas.

SEWAGE TREATMENT PLANTS

The future land requirements for sewage treatment plants will depend on many factors, including future regional organization and technological improvements. It is conceivable that, before the year 2020, the sewage treatment plant as we now know it will be replaced by individual treatment facilities in homes, offices, and factories. In the meantime, however, a growing population, the economies available from large treatment plants as compared to small ones, and increasing treatment standards will all lead to consolidation of some of the smaller plants into larger ones, and some new plants will certainly be built. Any new sites required for new or consolidated plants should be in industrial areas so no sites need to be reserved especially for them elsewhere on the shores of the Bay. Since locations at the water's edge are not necessary, it should not be necessary to fill any parts of the Bay for sewage treatment facilities.

PIPELINES

In the Bay Area, pipelines are now used primarily to carry petroleum products, natural gas, and water. The use of pipelines to carry other commodities, including solid materials, is expected to increase greatly in future years.

For certain commodities, pipelines have definite advantages over other methods of transportation. They take up very little room and commodities flow direct from point to point over a relatively inexpensive right-of-way. They are generally dependable since they can operate without regard to weather or traffic conditions. Most important, they are the cheapest means of transporting large volumes of liquids (a 10-inch pipeline can move large quantities of petroleum for less than the cost of labor alone in rail, highway, or water transportation).

Products such as coal and wood chips are already being transported in water-filled pipelines (slurries), and many other solid products could be transported in the same way. An even wider range of commodities -- including such things as agricultural products, canned goods, and even machine parts -- could be moved through pipelines in sealed capsules. This concept, while still in the experimental stage, has attractive economic possibilities.

FIGURE 4

Major Publicly-Operated Sewage Treatment Plants near the Bay

Alameda County

1. East Bay Municipal Utility District, Special District No. 1
2. City of San Leandro
3. Oro Loma Sanitary District
4. City of Hayward
5. Union Sanitary District -- Alvarado Plant
6. Union Sanitary District -- Newark Plant
7. Union Sanitary District -- Irvington Plant

Santa Clara County

8. Milpitas Sanitary District
9. City of San Jose
10. City of Alviso
11. City of Sunnyvale
12. Moffett Naval Air Station
13. City of Mountain View
14. City of Los Altos
15. City of Palo Alto

San Mateo County

16. Menlo Park Sanitary District
17. City of Redwood City
18. San Carlos - Belmont
19. Estero Municipal Improvement District (Foster City)
20. City of San Mateo
21. City of Burlingame
22. City of Millbrae
23. San Francisco International Airport
24. South San Francisco - San Bruno
25. Guadalupe Valley Municipal Improvement District (Crocker Land Co.)

San Francisco County

26. San Francisco Municipal Sewage System (Southeast Plant)
27. San Francisco Municipal Sewage System (North Point Plant)
28. Treasure Island (United States Navy)

Marin County

29. Sausalito - Marin City Sanitary District
30. City of Mill Valley
31. Richardson Bay Sanitary District
32. Sanitary District No. 5 of Marin County (Paradise Cove Plant)
33. United States Department of Interior, Bureau of Mines
34. Sanitary District No. 1 of Marin County (Tiburon Plant)
35. San Quentin Prison
36. Sanitary District No. 1 of Marin County
37. San Rafael Sanitation District (Main Plant)
38. San Rafael Sanitation District (Marin Bay Plant)
39. Los Gallinos Valley Sanitary District
40. Hamilton Air Force Base
41. Sanitary District No. 6 of Marin County (Ignacio Plant)
42. Sanitary District No. 6 of Marin County (Novato Plant)
43. Sanitary District No. 6 of Marin County (Bahia Plant)

Sonoma County

44. City of Petaluma
45. Sonoma Valley County Sanitation District
46. United States Navy, Skaggs Island Naval Reservation

Napa County

47. Napa Sanitation District

Solano County

48. United States Navy, Mare Island Naval Shipyard
49. Vallejo Sanitation and Flood Control District
50. City of Benicia
51. Fairfield - Suisun Sewer District
52. United States Air Force, Travis Air Force Base

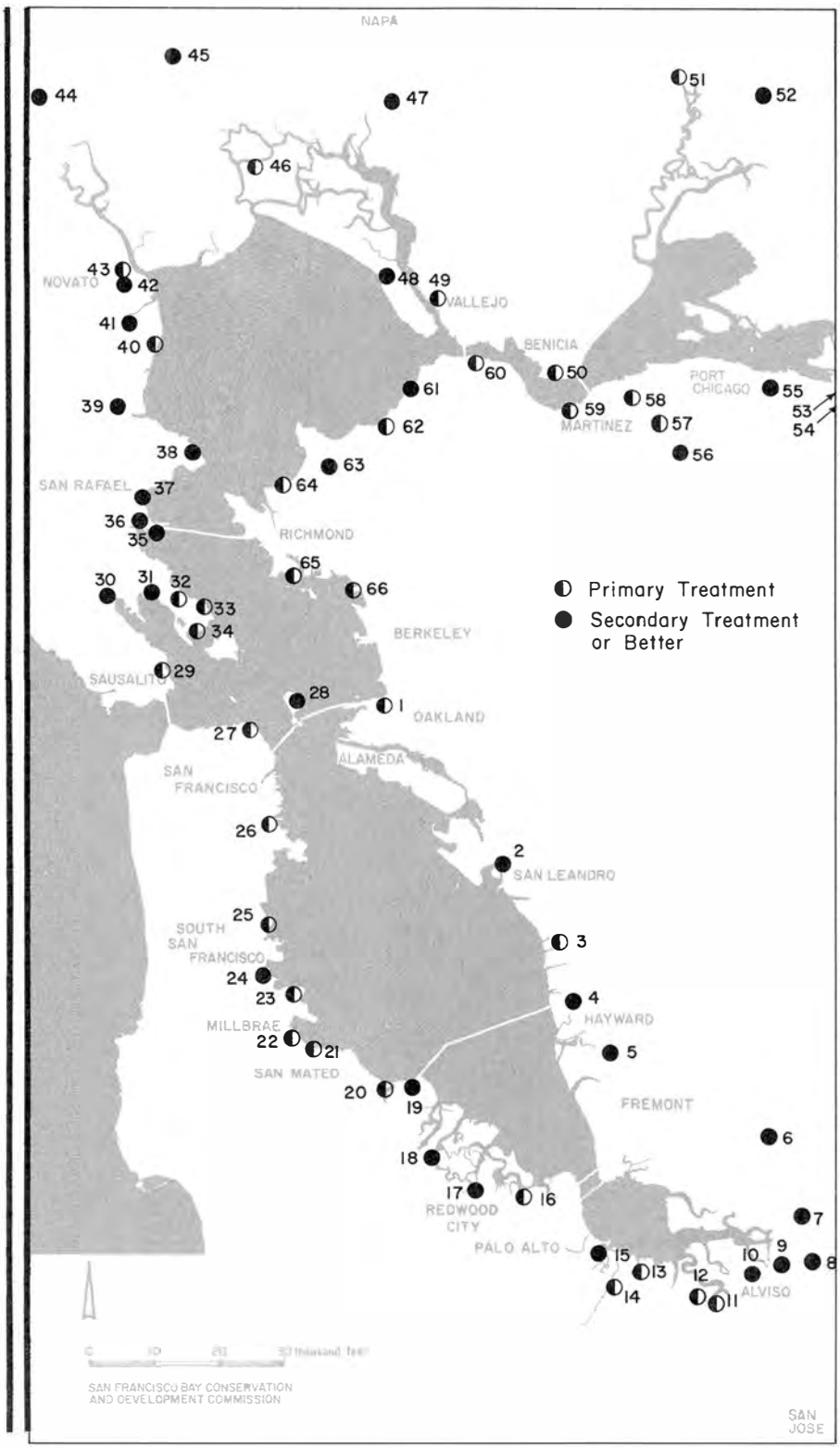
Contra Costa County

53. City of Pittsburg -- Montezuma Street Plant
54. City of Pittsburg -- Camp Stoneman Plant
55. Contra Costa County Special District No. 7A
56. City of Concord
57. Central Contra Costa Sanitary District
58. Mountain View Sanitary District
59. City of Martinez
60. Crockett - Velona Sanitary District
61. Rodeo Sanitary District
62. City of Pinole
63. Contra Costa County Special District No. 3
64. San Pablo Sanitary District
65. City of Richmond
66. Stege Sanitary District

Source: Regional Water Quality Control Board, Sewage Plant Operators

FIGURE 4

Major Publicly-Operated Sewage Treatment Plants Near the Bay



Source: Regional Water Quality Control Board, Sewage Plant Operators

PIPELINES

A few pipelines now cross under the Bay and many more crossings are likely. The lines have little effect on the Bay. Pipelines affect surrounding lands only by requiring terminal facilities such as large gas holders that dominate the landscape around them. These tanks are filled during off-peak periods to supplement peak hour gas demand and to serve as a reserve for emergency shutdowns.

While a substantial increase in the use of pipeline transport is probable, most terminal and distribution facilities will be concentrated in industrial areas and will not need sites immediately on the shoreline of the Bay.

PRISONS

The only penal institution now in use on the shores of the Bay is the California State Prison at San Quentin in Marin County. While the State Department of Corrections intends to gradually redevelop the facility into a special treatment prison, because of its proximity to many special social and professional services in San Francisco, the rebuilding program will not include any Bay filling.

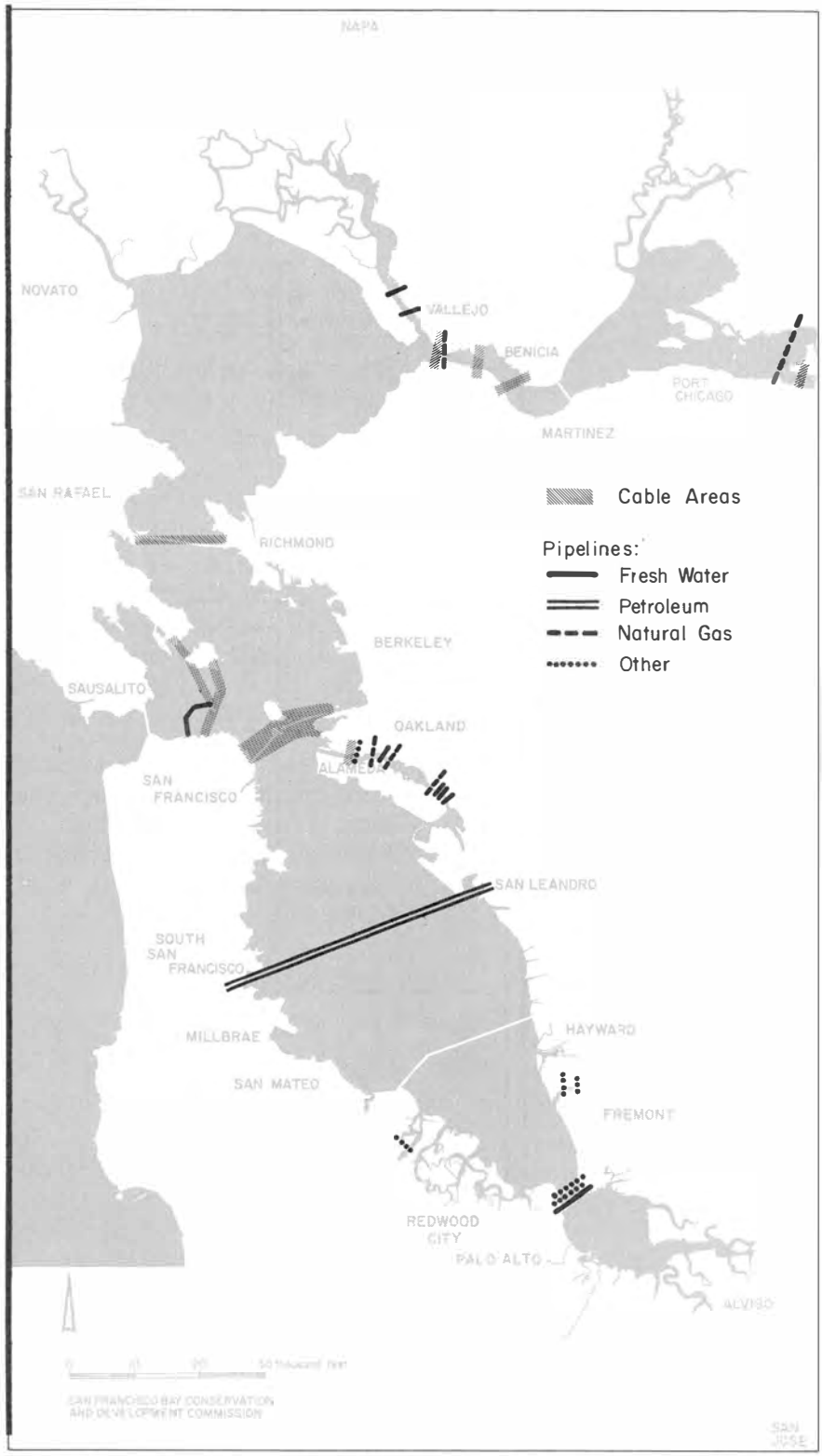
Alcatraz, a 23-acre island in the Bay opposite San Francisco, was a maximum-security Federal prison until recently. The San Francisco Chapter of the American Association for the United Nations offered to build a monument on the island to commemorate the founding of the United Nations in San Francisco and to become a symbol of peace. The design of the monument would be selected through an international architectural competition and the AAUN would finance all of the costs; the monument would then be administered by the National Park Service. An Alcatraz Island Commission created by Congress has unanimously recommended that the Federal Government accept the offer and a bill is now in Congress to create a 7-man United Nations Monument Commission to develop and execute plans for the monument.

MILITARY INSTALLATIONS

Military installations are major users of the Bay waters and shoreline. Activities at the various installations vary widely and the sites range in size from less than one-half acre to more than 6,500 acres.

FIGURE 3

Principal Pipelines and Cable Areas in the Bay



Source: U. S. Army Corps of Engineers

FIGURE 5

Military Installations Near the Bay

Alameda County

1. Oakland Army Terminal
2. Oakland Naval Supply Center
3. Alameda Naval Air Station
4. Alameda Facility, Naval Supply Center
5. Government Island
6. Alameda Naval and Marine Corps Reserve Training Center

Contra Costa County

7. Point Molate Facility, Naval Supply Center
8. Concord Navy Weapons Station

Marin County

9. Fort Baker
10. Fort Berry
11. Fort Cronkhite
12. Point Blunt Light Station, Angel Island
13. Tiburon Navy Net Depot
14. Hamilton Air Force Base

San Francisco County

15. The Presidio of San Francisco
16. Fort Point Coast Guard Station
17. Fort Mason
18. San Francisco Bay Naval Shipyard, Hunters Point
19. Treasure Island Naval Station
20. Yerba Buena Island

San Mateo County

21. California National Guard, Point San Bruno
22. San Francisco Coast Guard Air Station

Santa Clara County

23. Moffett Field Naval Air Station

Solano County

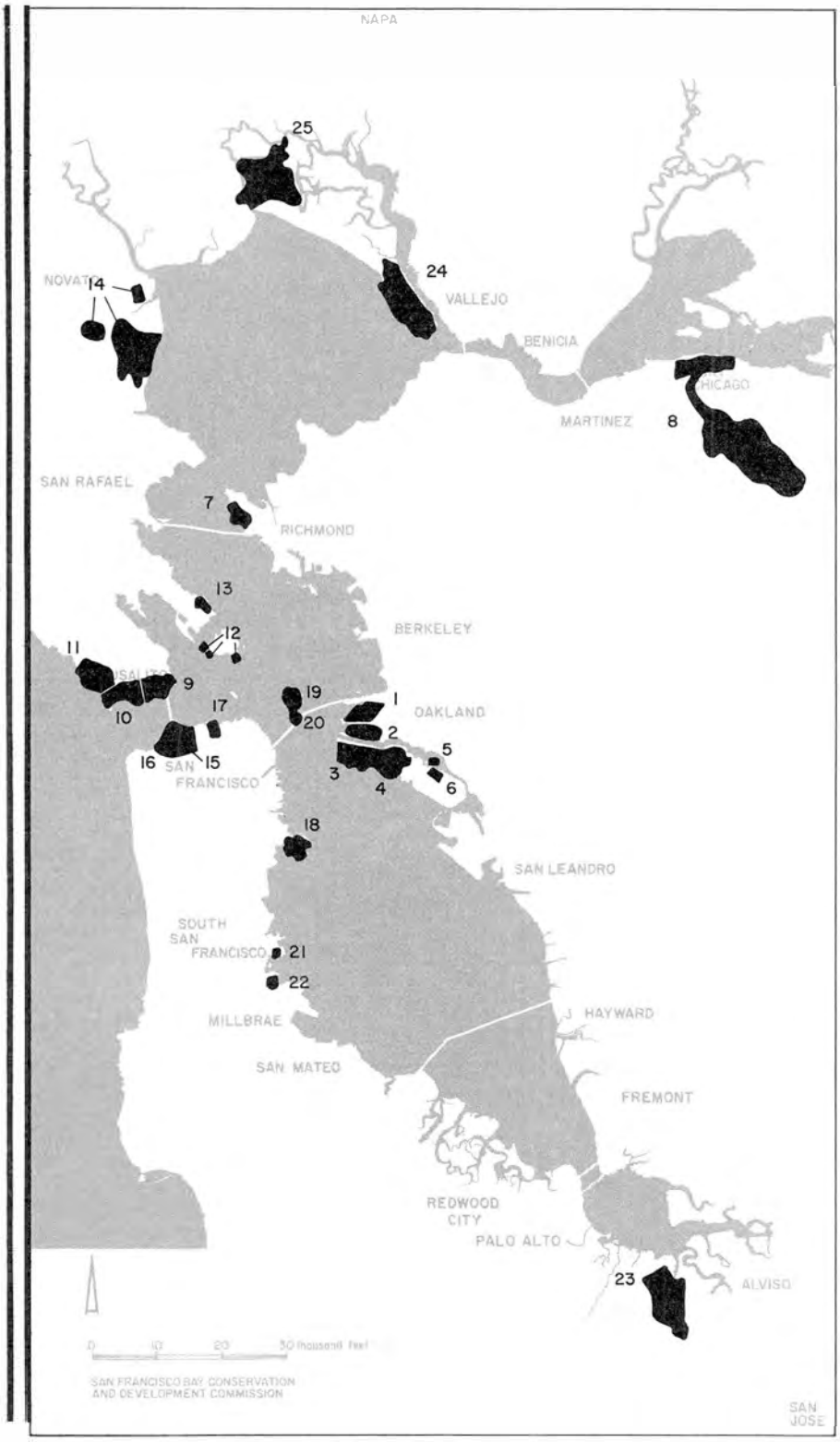
24. San Francisco Bay Naval Shipyard, Mare Island

Sonoma County

25. Skaggs Island Security Group Activity

FIGURE 5

Military Installations Near the Bay



MILITARY INSTALLATIONS

The major supply bases and shipyards are in effect, large industrial complexes. Moffett and Hamilton Fields and the Alameda Naval Air Station are major airports. On the other hand, the Presidio is a valuable open space and scenic asset in San Francisco, as are the three Army forts in Marin County.

Most of the military facilities are considered permanent. Bay fill has been the usual means of enlarging many of the sites. The only installation now known to have any expansion plans is the Oakland Army Terminal, which once intended to fill another 100 acres westward into the Bay; these plans have been suspended, at least temporarily. Minor alterations to the shoreline through pier replacement and small fills are likely at most of the major facilities in the future. The air bases have no expansion plans; runway lengths are considered sufficient for all foreseeable needs. Land requirements for coastal defense installations are decreasing; the State of California has already purchased portions of the three forts in Marin County and intends to purchase all surplus land, as it becomes available, for a Marin Headlands State Park. No new shoreline sites will be needed for military housing or administrative activity.

SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION
507 Polk Street, San Francisco 94102 557-3686

Possible Bay Planning Conclusions Based on the Report on Public Facilities and Utilities

1. A large number of public utilities and public facilities use the Bay and its shores. The requirements and potential of each for future use of the Bay must be considered in the Commission's plan for the Bay.

2. Because of PG&E's planned conversion to nuclear power plants at sites some distance from the Bay Area, no additional Bayshore sites will be needed for electric power plants, except possibly for a new site at Collinsville. Most of the existing power plants around the Bay will probably be eliminated by the year 2000 and the sites made available for expansion of surrounding industrial development. A possible exception to this trend is the development of combination power generation-desalinization plants.

3. Because of the expense involved in removing high voltage transmission lines, and the absence of feasible substitute facilities, existing lines will remain in their present location, and some new lines will have to be installed to meet the demand for power. However, the Commission's plan for the Bay should prescribe that the most pleasing tower and pole design possible be used for any new Bayside facility; that new routes be planned to avoid, to the greatest possible extent, interfering with scenic views; and that undergrounding be used when it becomes technically and economically feasible.

4. Because underground power distribution and telephone lines, and partial underground lines combined with streamlined poles, are now economically feasible and already in use, the Commission's plan for the Bay should prescribe that undergrounding (or an attractive combination of underground lines with streamlined overhead facilities) be required for electric distribution and telephone lines in all new residential, commercial, public, or view areas near the shores of the Bay.

5. Because AM and short-wave radio transmitters function best when located in salt water or salt marsh areas and because the towers required are not unduly objectionable in appearance, the Commission's plan for the Bay should prescribe that the existing towers may remain and that new towers may be permitted in marsh or other natural areas that may be planned for permanent conservation. Wherever possible, however, consolidation of transmitting towers should be encouraged.

6. Because radio-telegraph transmitters function best when located in salt water or salt marsh areas, the Commission's plan for the Bay should prescribe that existing transmitter fields may remain. No new radio-telegraph transmitter fields are anticipated and no provision need be made in the plan for them.

7. New or enlarged sewage treatment plants will be required to meet the needs of a growing population and the requirements for higher treatment standards until disposal of sewage in other ways becomes feasible. The Commission's plan for the Bay should prescribe that any new sewage treatment plants near the Bay may be located in any area where they do not interfere with and are not incompatible with residential, recreational, or other public uses of the Bay and shoreline.

8. The constantly increasing need for fresh water may result eventually in the construction of desalinization plants and waste water reclamation plants. Because desalinization plants are likely to be located at sites remote from the urban areas, and because pollution problems might result from the discharge of large amounts of heated brine into Bay waters, the Commission's plan for the Bay should not include sites for such plants, but this is not to preclude the possibility of such plants on the Bay if such problems can be overcome. Because waste water reclamation plants are more likely to be located in urban areas, the Commission's plan for the Bay should prescribe that any new waste water reclamation plants near the Bay may be located in any area where they do not interfere with and are not incompatible with residential, recreational, or other public uses of the Bay and shoreline.

9. Use of pipelines for transporting many types of commodities is likely to increase substantially in future years. The depth of submarine pipelines in the Bay can be adequately regulated by navigational agencies and the plan for the Bay need not make any special provision for submarine pipelines. The Commission's plan for the Bay should prescribe that any new pipeline terminal and distribution facilities near the Bay should generally be located in industrial areas, but that they may be located elsewhere if they do not interfere with and are not incompatible with residential, recreational, or other public uses of the Bay and shoreline.

10. No additional prisons should be located on the shores of the Bay. The plan for the Bay should provide for the continuation of the existing facility at San Quentin and for the conversion of Alcatraz Island into a national monument.

11. Most military installations on the Bay are permanent. While military requirements may change in the future, only one installation -- the Oakland Army Terminal -- is now known to have plans for additional fill. The Commission's plan for the Bay should assume the continuation of all existing shoreline military installations, except for the eventual conversion of the three Army forts in Marin County into a State park. No substantial fill should be included in the Commission's plan for the Bay for any facility except the Oakland Army Terminal; need for any fill at the Army Terminal should be determined as part of the BCDC report on port facilities in the Bay.

Adopted by the Commission at its meeting of 7/6/67

REFUSE

DISPOSAL

AND

SAN FRANCISCO

BAY

Part of
a Detailed
Study of
San Francisco
Bay

San Francisco Bay
Conservation and
Development
Commission

San Francisco
California

October 1966

Summary of the report, "Solid Waste Disposal and San Francisco Bay," by David M. Stevens, Assistant Planner.

INTRODUCTION

Empty bottles. Rusty cans. Crushed boxes. Junked automobiles. End products of an affluent society.

As long as the piles of debris are out of sight, sound, and smell, no one cares too much about them.

But more people are producing more waste. More people are crowding into once-vacant land. More people are becoming more concerned about population-threatened natural resources.

In the face of more trash to bury, less land to bury it in without neighborhood furor, and more concern about preserving the Bay and the landscape, the refuse disposal problem will become increasingly serious unless new methods of disposal are employed.

Fortunately, some new methods are being tried and there is a growing awareness of the need for extensive improvement of refuse disposal methods in the years ahead.

CURRENT DISPOSAL PRACTICE AROUND THE BAY

While methods of waste disposal may range from discarding bags of trash along a roadside to recovery of high-value metals at considerable expense, this report is mainly concerned with the handling of large amounts of municipal and industrial garbage, trash, and debris.

Virtually all of the refuse disposal in the Bay Area is carried out by private scavenger companies under franchises from the city and county governments. Almost all of the refuse is deposited in dumps, crushed to a more compact size by heavy equipment, and covered with a layer of soil. This process is called "sanitary landfill," sanitary because the layers of soil are intended to reduce the seagull, odor, and rat problem, and "landfill" because the refuse is used to raise the level of or otherwise "reclaim" land that was not previously usable.

Open burning at dumps was eliminated some years ago by the Bay Area Air Pollution Control District. Other methods of refuse disposal such as incineration have not been employed, largely because of the large

CURRENT DISPOSAL PRACTICE AROUND THE BAY

numbers of scavenger companies and the availability of areas where dumps and land fills could be used at considerably less cost.

The most promising innovation employed thus far in the Bay Area is the "transfer" system in Berkeley. Refuse is brought by scavenger companies and the public to the former Berkeley Dump on the tidelands, compacted tightly into much larger trucks (the "transfer" operation), and hauled to more distant dumps. Even with this improved system, trash collection rates are no higher in Berkeley than in surrounding cities.

EFFECTS OF DUMPS ON SAN FRANCISCO BAY

Exact acreage figures are not available, but approximately 38% of the Bay Area's refuse disposal capacity is located in dumpsites on tide, marsh, and submerged lands in the Bay. This is an improvement over the situation only four years ago when 48% of the capacity was on Bay lands; the trend to inland disposal sites is clear.

While dumps are unattractive, most of them have been or can be put to other uses when the site has been filled.

The least apparent effects of the disposal sites has been the elimination of valuable marshland and the reduction of the amount of water in the Bay. Specific information on the effects of these fills on the Bay is not available. However, as shown by the BCDC report on Tidal Movement, most fills interfere with tidal currents. Most important, the reduction of the amount of water in the Bay reduces the amount of oxygen available in the water for marine life and for pollution abatement.

The most apparent effect of some Bayfront dumps has been the water pollution caused by contamination from garbage seeping into the Bay. The San Francisco Bay Regional Water Quality Control Board has worked to eliminate that problem by requiring adequate diking or by prohibiting garbage disposal in Bayfront dumps, but its efforts have not yet been completely successful.

THE FUTURE REFUSE LOAD

Man has always produced wastes. Our rising standard of living increases the amount of waste per person, not only because people can afford to buy more but also because so much of the convenience of modern living is due to "disposable" products and containers, such as paper dresses, tin cans and non-return bottles.

In 1960, the 3,600,000 people of the Bay Area produced about 2.6 million tons of refuse, including garbage, trash, construction and demolition debris, industrial wastes, auto bodies, dead animals, and tree trimmings. About 3,900 acre-feet of dump space (the number of acres required to hold a layer of refuse one foot deep) were required to dispose of that waste accumulation. If the amount of refuse per person were to remain the same (about 4 pounds per day), 10,000 acre-feet of dump space would be needed annually in the Bay Area by the year 2000. But the amount of refuse per person continues to rise so even more space would be needed if no improvements were made.

At present, there are about 110,000 acre-feet of capacity in all of the dumps in the nine-county Bay Area. These existing dumps can handle the total estimated refuse load until around 1978 or 1980, assuming the available capacity can be made available to any community needing it.

ALTERNATIVES FOR MEETING THE FUTURE NEED

To prevent further invasion of the Bay by refuse disposal operations, consideration must be given to the availability of alternate methods of waste disposal. Fortunately, more and more reliance is now being placed upon inland disposal sites. And BCDC surveys indicate that there now is adequate disposal capacity at existing sites to take care of all wastes for the next 10 to 15 years, providing time for development of waste disposal methods that will not involve additional Bay filling.

The only Bay Area cities with urgent disposal problems are San Francisco and Alameda. It appears that Alameda can solve its problem by contracting with scavenger companies that have adequate disposal area. San Francisco has the most serious problem; its scavenger companies are running out of disposal space

and their remaining acreage in San Mateo County is soon to be restricted to waste other than garbage. Disposition of wastes containing garbage might possibly be taken care of by a transfer system such as Berkeley's.

"Transfer" involves emptying refuse collection trucks into much larger vans for the long haul to a dump. Figure 1 illustrates how such a system becomes favorable in terms of overall cost as the distance to the dump increases. One alternative that is sometimes feasible involves a switch to larger trucks for collection and the longer run to the dump; the example of the pick-up truck costs indicates how the cost for a long-haul is higher for a smaller truck.

Recognizing the need to reduce the quantity of waste which must be disposed of in dump sites, the Association of Bay Area Governments has prompted test projects of incineration, composting, and compacting.

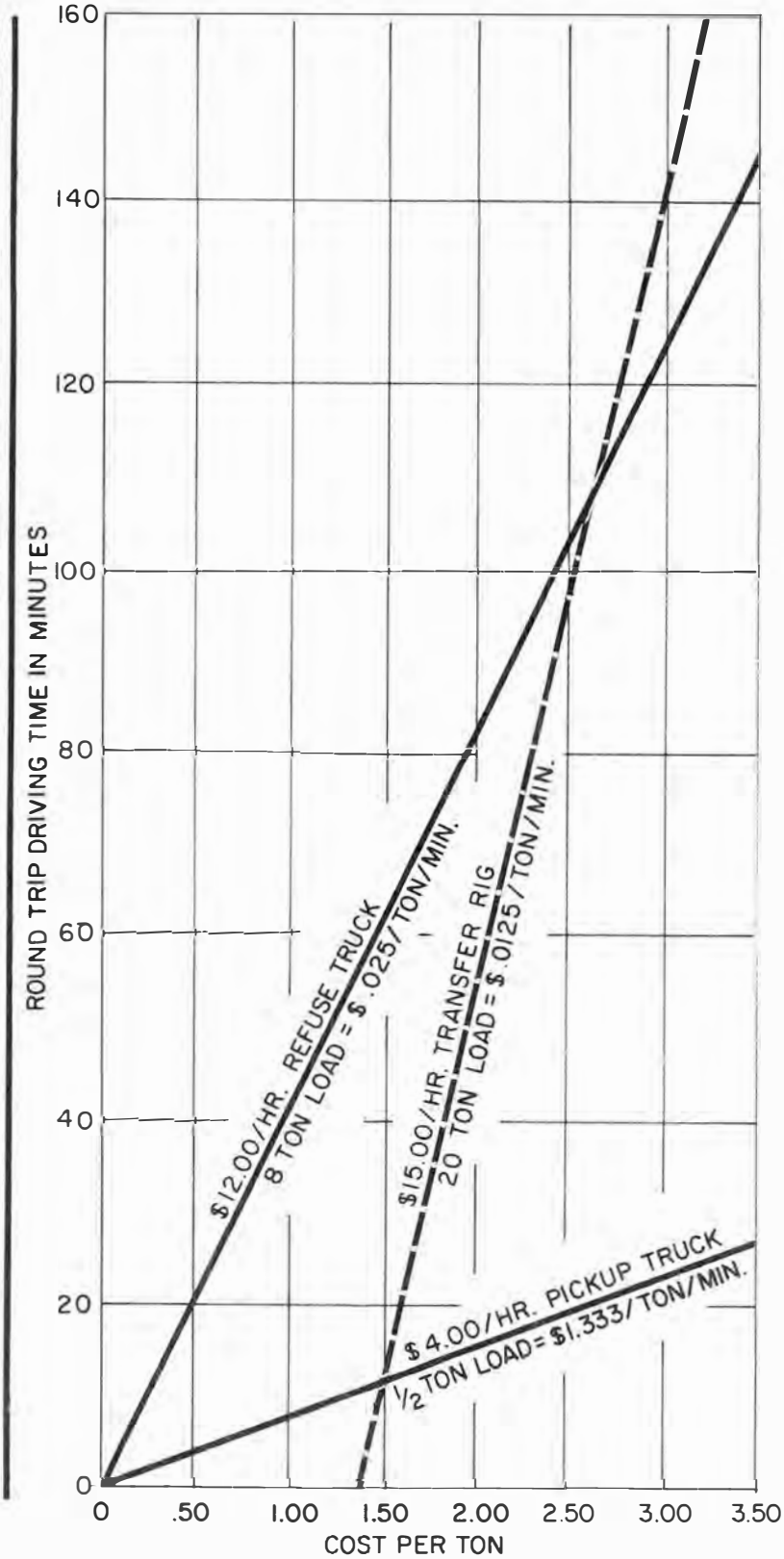
Incineration can be up to four times as expensive as a sanitary landfill. In addition, it poses a considerable problem of air pollution that must be overcome by expensive special equipment. Incineration reduces combustible refuse material to only 10 to 20% of its original volume, requiring that much less area in which to dispose of the residue. But much waste (such as car bodies and much debris from building demolition) cannot be burned and will require the same amount of disposal space; when all wastes are considered, incineration only reduces the volume by about one half.

Composting is a biological decomposition process that reduces refuse into a soil conditioner. Only wastes that can be decomposed by biological action can be composted and there is some question about the adequacy of the market for the large amounts of the conditioner that could be produced.

Compacting involves the use of presses and other devices for reducing the bulk and volume of the waste so it will take less space in a dump, and thereby extend the dump's useful life.

FIGURE 1

Refuse Haul Cost Comparison: Transfer vs. Direct Haul



Source: County Sanitation Districts of Los Angeles County

ALTERNATIVES FOR MEETING THE FUTURE NEED

Other methods of waste disposal include salvage of materials with reuse value, grinding to reduce bulk and permit possible transport by pipeline, and disposal at sea. An entirely different method of attack is to stem the flow of waste materials at the source, for instance by returning to reusable instead of "non-return" bottles.

Waste comes from many sources in many forms with a variety of methods of disposing of each kind. Therefore, the attention of researchers is now being directed towards "systems analysis," a method of analysis that can design a disposal system making the most efficient use of several methods of disposal at the same time. To do this effectively, waste disposal will eventually have to be undertaken on a regional basis for most efficient and economical use of disposal sites and equipment. The San Francisco dilemma shows the need for an approach to waste management that would pool disposal sites to make them more accessible to the communities needing them.

SUMMARY

Rapid increases in population mean increasing waste disposal requirements. Overall, present waste disposal resources in the Bay Area are adequate for the near future. Meanwhile, research and experimentation is being undertaken to use improved methods of waste management within relatively few years.

San Francisco Bay is the dominant feature of the Bay Area. There now appears to be no pressing need to permit any further filling of the Bay for additional refuse disposal sites.

Future refuse disposal systems should be designed to provide the best possible service for the Bay Area with no further infringement upon the Bay.

SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION
507 Polk Street, San Francisco 94102 557-3686

Possible Bay Planning Conclusions Based on the Report on Refuse Disposal

1. To eliminate any necessity of filling San Francisco Bay for solid waste disposal, new waste disposal systems should be developed to combine the most economical disposition with minimum consumption of urban land.

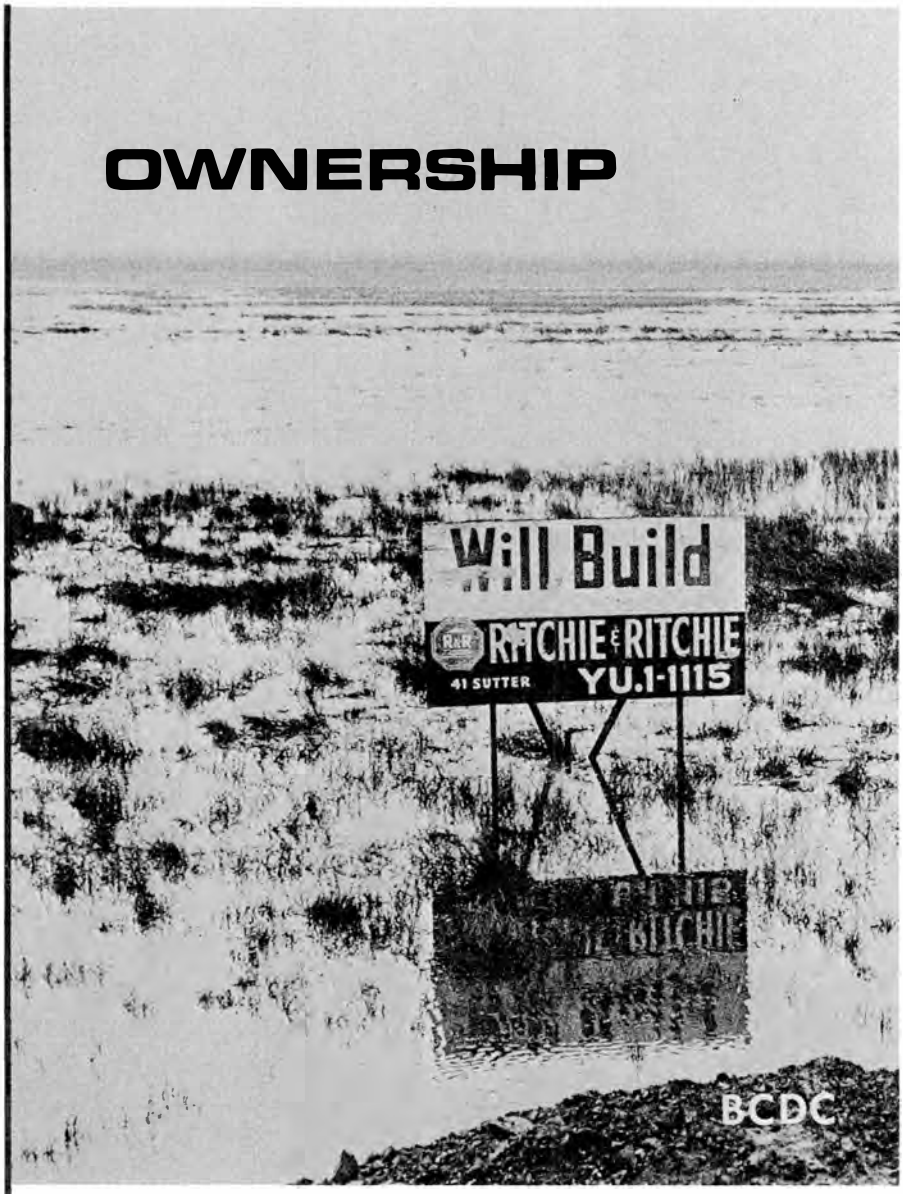
2. Pending the development of new waste disposal systems, sufficient disposal capacity is available throughout the Bay Area to permit solution of any immediate waste disposal problems, through utilization of such sites or at new sites in acceptable inland locations.

3. No refuse, processed or unprocessed, should be used to fill the Bay, except as such refuse may be found to be a suitable foundation for purposes providing substantial public benefit.

Adopted by the Commission at its meeting of 10/21/66

OWNERSHIP

Part of
a Detailed
Study of
San Francisco
Bay



San Francisco Bay
Conservation and
Development
Commission

San Francisco
California

March 1968

This report was prepared by BCDC staff members
under the direction of Alvin H. Baum, Jr.,
Deputy Director

INTRODUCTION

Who owns San Francisco Bay?

Most residents of the San Francisco Bay Area are surprised by the very question, as if someone should ask, "Who owns the sky?" The Bay, they have always assumed, belongs to the federal government, or perhaps to the state government. But why should anyone even ask the question? Surely, the Bay is more than just so much real estate!

Legally speaking, the Bay is a very large amount of real estate, or rather the tidelands along its shores and the drowned valleys beneath its waters have long been treated as real estate in countless statutes and thousands of conveyances. To the man who owns a sailboat the Bay may be an aquatic paradise and to the visitor from New York or Illinois a magnificent scenic attraction, but to attorneys, developers, title insurance companies, land companies, manufacturers of salt and cement, innumerable government officials, members of the State Legislature, and many others it is some of the most valuable real estate in California. Much of it is privately owned and has been sold and resold many times.

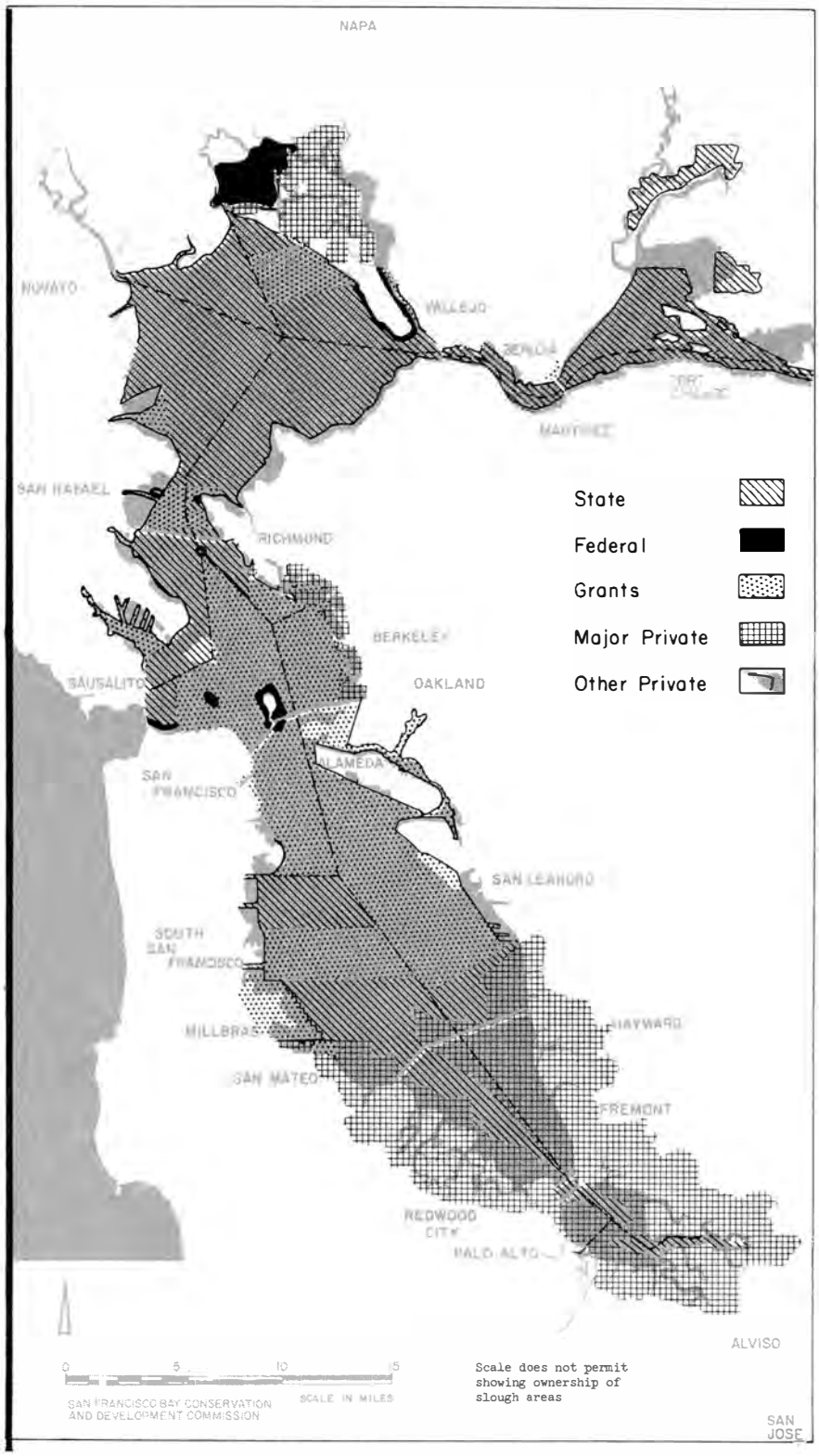
-- Mel Scott
The Future of San Francisco Bay, p. 1 (Institute of Governmental Studies, Berkeley, 1963)

Not only has much of the Bay -- perhaps as much as 22 per cent -- been sold to private buyers, but the remainder of the Bay is also divided in ownership. The State in the past has granted about 23 per cent of the Bay to cities and counties, and now owns outright only about 50 per cent. The remaining 5 per cent is owned by the Federal government. (See Figure 1.)

The privately-claimed parts of the Bay are generally those closest to shore, most shallow, and thus most easily filled. Many of the lands granted to cities

Figure 1

GENERAL PATTERN OF OWNERSHIP IN SAN FRANCISCO BAY



Source: Composite of Figures 3,4 & 5

INTRODUCTION

and counties are just beyond the privately-owned lands, and are thus the next most shallow and easy to fill.

The State sold and granted parts of the Bay in the belief that tidelands and marshlands were virtually worthless in their natural condition and should thus be filled or "reclaimed." In recent years, however, there has been an increasing understanding of the values of the shallow parts of the Bay in maintaining fish and wildlife habitat, in providing scenic beauty and recreational opportunities, and in combating air and water pollution.

OWNERSHIP QUESTIONS THAT AFFECT BAY PLANNING

Many private owners and governmental agencies may want to fill at least parts of their holdings in the Bay; this could result in considerably more filling than is desirable. It is therefore important to determine what rights the holders of Bay lands have to fill them, and what responsibilities they have to the public.

The primary questions of ownership that affect Bay planning are these:

1. What rights does the Federal government have over all the lands in the Bay? (The Federal government has the power and duty to protect the nation's waterways for navigation.)

2. In the case of lands the State has granted to cities and counties, what steps are needed to prevent filling that is not in accord with plans for the Bay as a whole?

3. Do all the private claimants of lands in the Bay have valid titles to their lands, or is some of the privately-claimed land in reality still the property of the State?

4. Do owners having valid titles to their Bay lands have a general right to fill them, or do they hold their lands subject to special rights of the public to use the Bay for fishing and for navigation?

OWNERSHIP QUESTIONS THAT AFFECT BAY PLANNING

(In addition to factors of ownership that may limit rights to fill, holders of Bay lands may of course be subject to ordinary land-use regulations, such as zoning laws. These will be discussed in the forthcoming BCDC report on powers and money needed to carry out a Bay plan.)

TYPES OF "BAY LANDS"

The legal rights deriving from ownership may depend on the extent to which the lands under the Bay are affected by the tides, either now or at some time in the past. In legal terms, there are three types of "Bay lands." (See Figure 2):

-- Submerged lands, which are always covered by water, even at low tide.

-- Tidelands, which are covered and uncovered by the daily tides, and thus lie between mean high tide and mean low tide.*

-- Swamp and overflowed lands, which are above mean high tide but are subject to extreme high tides so that marsh grasses grow on them (and which are thus commonly called marshlands).

PRESENT OWNERSHIP PATTERNS

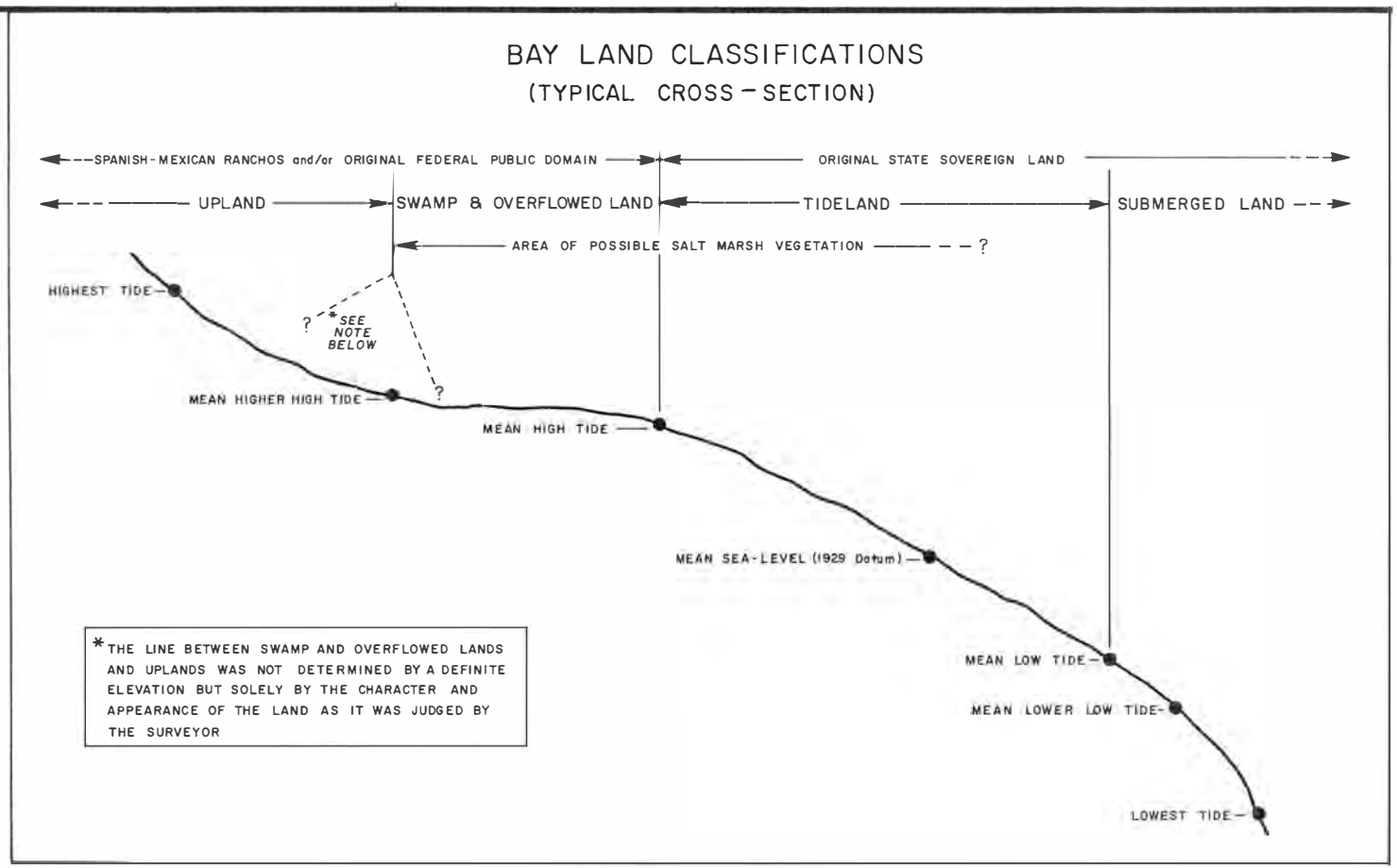
1. Federal

Most of the Federally-owned lands in San Francisco Bay are offshore from military installations. (See Figure 3) For example, in 1859 the State granted to the Federal government all tide and submerged land to 500 yards beyond the low tide line offshore from Forts Baker, Barry, and Cronkhite on the Marin County headlands. In 1897, tide and submerged lands to a line 300 yards beyond the low tide line offshore from the Presidio of San Francisco, Mare Island Naval Shipyard, Yerba Buena Island, Angel

* The word "tidelands" is often used loosely to cover all lands in the Bay -- submerged lands, tidelands, and swamp and overflowed lands.

Figure 2

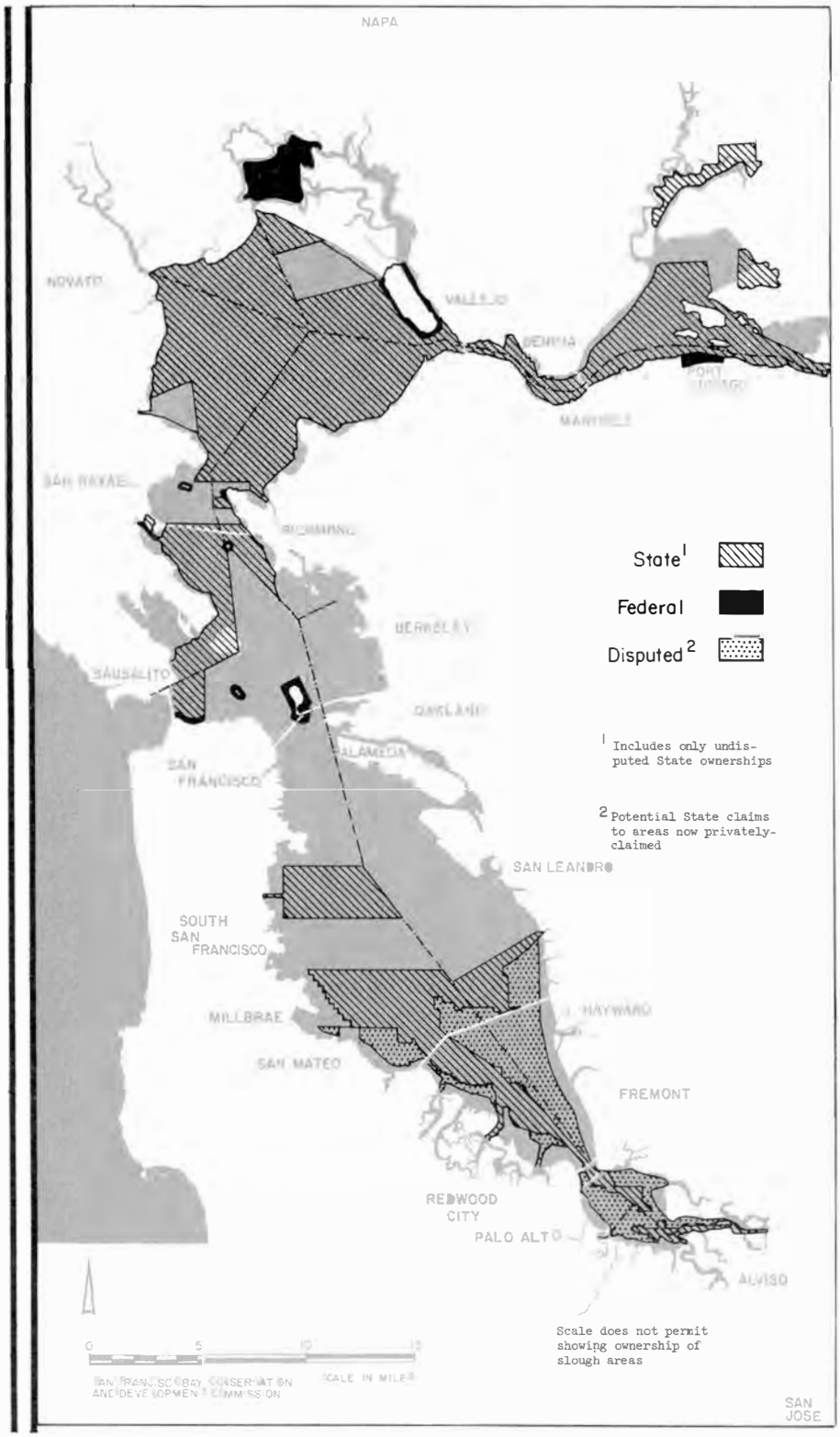
BAY LANDS CLASSIFICATION (TYPICAL CROSS SECTION)



Source: Adapted from chart prepared by State Lands Division, 1966

Figure 3

STATE AND FEDERAL LANDS IN SAN FRANCISCO BAY



Compiled from maps of State Lands Commission and Tax Assessors

PRESENT OWNERSHIP PATTERNS

Island, and the Benicia Arsenal were granted to the Federal government.

Under these grants, the Federal ownership and control lasts only as long as the military installation is maintained; upon abandonment of the military installation, the tide and submerged lands revert automatically to the State. When the Benicia Arsenal was closed by the Federal government in the early 1960's, and when Angel Island was sold to the State for park use, the adjoining tide and submerged land grants expired and ownership of the tidelands reverted to the State. (Part of the Benicia tidelands were later granted to the City of Benicia, however.)

The Federal government also owns some Bay lands in fee and in addition, leases some Bay lands.

It is perhaps surprising that Federally-owned lands in the Bay have been almost entirely military. There are no national parks or seashores around the Bay, though some public use may in the future be made of Alcatraz Island. And Fort Point, under the San Francisco approach to the Golden Gate Bridge, is proposed as a national monument under a bill now pending in Congress.

2. State

Some of the State's Bay lands are administered by operating departments, for a variety of purposes. (See Figure 3) The State Department of Beaches and Parks has jurisdiction over recreational areas such as part of Angel Island, the Marin headlands, Benicia Beach State Park at Benicia, and the Alameda State Beach. In addition, the State Department of Fish and Game administers the Joice Island Wildfowl Refuge in Suisun Bay. And the State Divisions of Highways and of Bay Toll Crossings have jurisdiction over some Bay lands acquired for roadway or bridge construction.

The majority of the Bay lands owned by the State, however, are administered by the State Lands Commission, whose members are the Lieutenant Governor,

the Controller, and the State Director of Finance. The State Lands Commission has extensive powers over State-owned lands throughout California. As to Bay lands within its jurisdiction, the State Lands Commission (and its administrative arm, the State Lands Division within the Department of Finance) issues leases, permits and easements for the use of, or removal of minerals from, State property. Leases cover removal of shells, sand, gravel, mud, and oil and natural gas, and some commercial, industrial, and commercial recreation installations; minor-structure permits are issued for such small structures as private piers and floats; easements authorize crossings under and over the waters of the Bay by pipelines and cables, electric high tension lines, etc.

3. State-Granted Lands

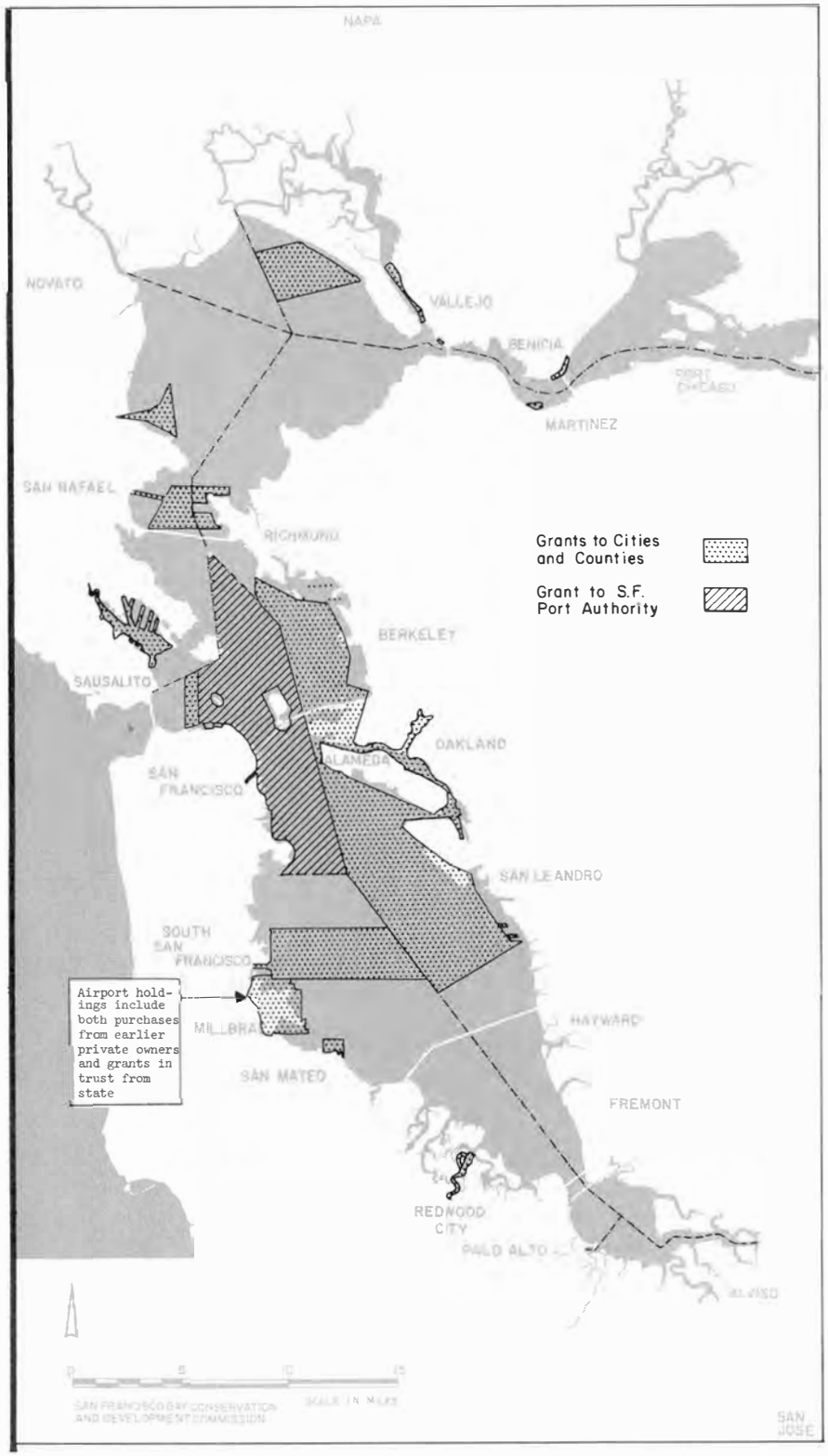
Many cities and counties around the Bay have received grants of Bay lands from the State (see Figure 4. Also shown on Figure 4 are lands that the Legislature has placed under the jurisdiction of the San Francisco Port Authority. The Port Authority is a State agency whose five members are appointed by the Governor, but in practice it operates somewhat like a local port agency.)

The grants to local governments have ranged in size from tiny slivers of tidelands to thousands of acres, and in some cases the grants have covered all the tide and submerged lands within the boundaries of a city except for those previously sold to private owners. In all cases, the cities and counties simply asked the State for lands in the Bay and received them free of charge.

Each grant was made by a separate statute, and thus each grant is unique. In general, however, the grants prohibit sale of the Bay lands but permit their being leased for long periods -- 50 or 66 years. Each grant statute also specifies that the lands are to be held in trust by the city or county for all the people of the State, and are to be used for whatever purposes are specified in the grant.

Figure 4

LANDS IN SAN FRANCISCO BAY GRANTED TO CITIES, COUNTIES AND SAN FRANCISCO PORT AUTHORITY



Source: State Lands Commission

PRESENT OWNERSHIP PATTERNS

All granted lands are also subject to public rights of commerce, navigation, and fishing. From time to time, questions have arisen as to the precise meaning of language in the various grant statutes.

Many of the tideland grants were made between 1911 and 1915 when a shipping boom was expected to result from completion of the Panama Canal. In later years, grant statutes have specifically authorized such uses as airports, small boat harbors, public recreational facilities related to the Bay, highways and streets, commerce and industry, and in a few cases, even "residential purposes in which there is a general statewide interest." Court decisions have held a wide variety of uses of State-granted tidelands to be consistent with the trust for commerce, navigation, and fishing. These have included warehouses, convention halls for use of shipping organizations, and the use of tideland oil revenues to construct a building for use by the YMCA as seamen's accommodations. Many of the uses authorized in the granting statutes have not yet been the subject of court tests, and there are many questions as to the uses of granted Bay lands permitted under the trust for commerce, navigation, and fishing to which the grant lands remain subject.

Just as the grant lands may legally be used only for purposes consistent with the public trust -- broadly as the trust may be defined -- so revenues derived from grant lands may only be used for purposes in keeping with the trust. Where revenues from granted lands are released from the trust, by State statute, they go into the State treasury. This has been done in the case of oil and gas revenues from Long Beach granted lands. Long Beach will retain an estimated 15 per cent of revenues for uses consistent with the trust for commerce, navigation, and fishing (the amounts are so large that Long Beach was able in 1967 to buy the liner Queen Mary for use as a waterfront convention and tourist center); the remainder, an estimated 85 per cent, goes to the State, at present primarily for the benefit of higher education.

PRESENT OWNERSHIP PATTERNS

As the State may legally regain all or a portion of the revenues from tide and submerged lands previously granted to cities and counties, so also may it regain full control over granted tide or submerged lands by revoking a grant, wholly or in part. This has been done occasionally -- most recently when a number of grants to cities on San Diego Bay were revoked and the lands regranted to the San Diego Unified Port District; the City of Coronado challenged the action, but the courts upheld the legality of the revocation. There are still unresolved legal questions as to the effects of grant revocation on persons having a lease or franchise on granted lands from a city or county, but these are the only potential legal barriers to revoking grants of unimproved lands.

As a practical matter, however, revoking grants would be difficult because the cities and counties holding such lands would almost certainly resist giving them up. And, as the policies proposed later in this report make clear, a plan for the Bay can be carried out effectively without revoking the grants.

Of particular concern for BCDC planning is a provision in some recent grants made by the Legislature, beginning in the 1950's. These grants required that the granted lands had to be "substantially improved" within 10 years. Failure to meet this condition sometimes would cause the grant to lapse; sometimes -- when the 10-year provision was included in an amendment to an earlier grant -- failure to meet the 10-year condition would merely cause the amendment to expire. For example, a city might have received a 1919 grant for harbor purposes, with an amendment in 1959 for a variety of other uses, including commercial development, airports, etc.; the amendment might then require substantial improvement within 10 years or the amendment would expire, but the original grant would remain in effect. The State Lands Commission will soon be required to reach a determination as to the meaning of "substantially improved," since the first of the 10-year provisions will soon be expiring.

PRESENT OWNERSHIP PATTERNS

4. Private

As the result of sales and re-sales over the years, there are now over 2,000 parcels of privately-held land in the Bay, with the largest number, about 1,000, in San Francisco south of the Naval Shipyard, where Bay lands were platted in small lots.

While a number of individuals and corporations thus own quite small parcels of land in the Bay, three owners each have very large holdings: (See Figure 5)

Leslie Salt Company claims about 52,000 acres of Bay and adjacent lands; most of the acreage has been diked off for salt ponds and is no longer subject to tidal action. About 36,000 acres of salt ponds have been developed in the South Bay (San Mateo, Santa Clara, and Alameda Counties) and about 10,000 in Napa County. About 4,200 acres of Leslie holdings have been taken out of salt production and are being converted into the Redwood Shores community in Redwood City. Relatively little of Leslie's lands are undiked.

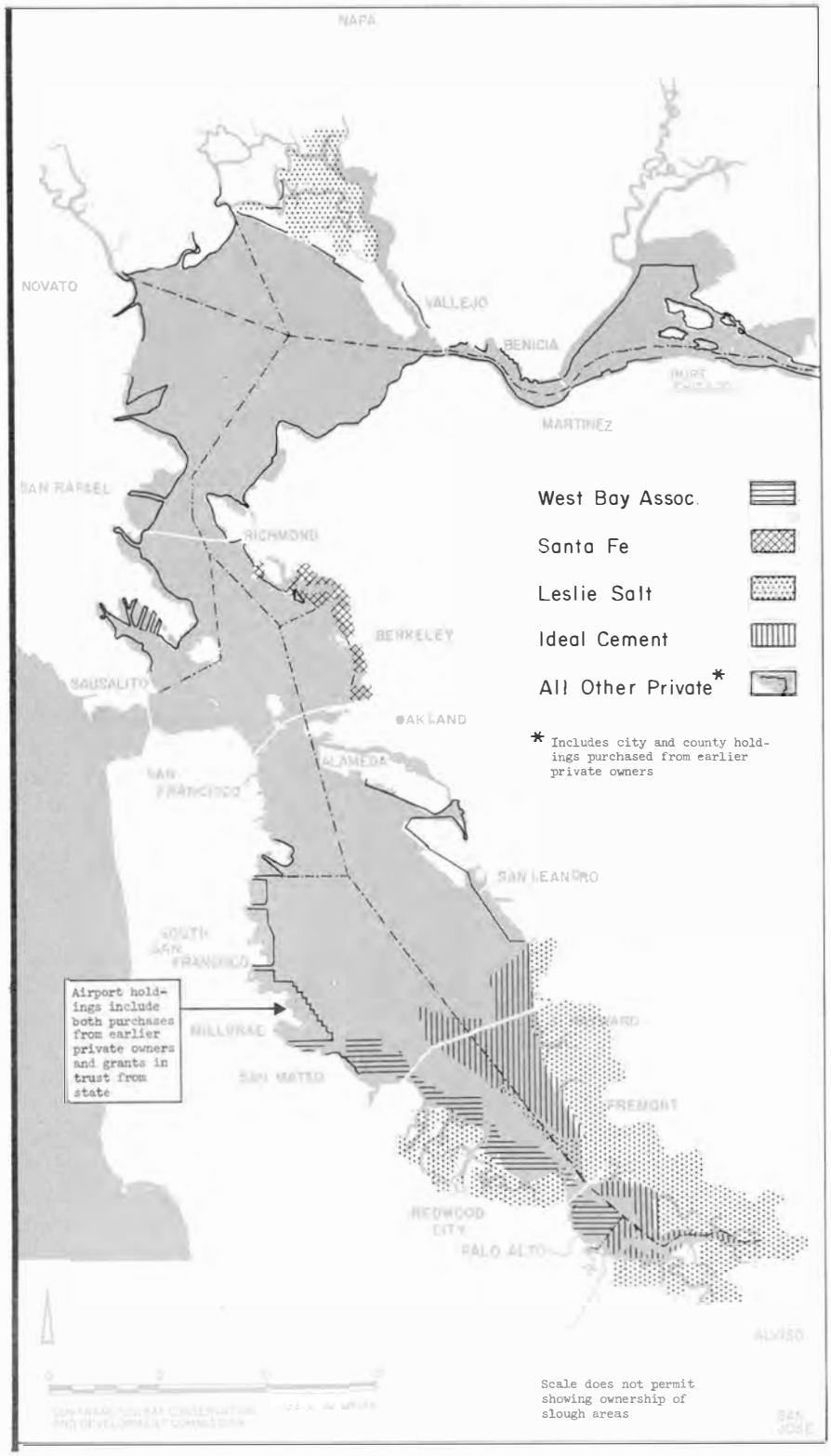
Ideal Cement Company claims a total of some 20,000 acres of Bay lands, virtually all of it under the open waters of the Bay. Ideal acquired its lands to dredge oyster shells and Bay mud for use in making cement at a factory in Redwood City. More recently, however, Ideal has placed about 10,000 acres of its holdings in the joint venture firm of Westbay Community Associates (formerly Pacific Air Commerce Center), which also includes the Crocker Land Company, banker David Rockefeller, and the investment banking firm of Lazard Freres. Westbay Community Associates proposed filling about 60 per cent of its 2,750 acres in the Bay north of the San Mateo Bridge; its initial plans were opposed in late 1967 by various jurisdictions in San Mateo County, and Westbay is re-examining its plans.

The Atchison, Topeka, and Santa Fe Railway claims about 3,400 acres of tide and submerged lands from the Bay Bridge north to Point Richmond. Santa Fe has over the past few years employed planning,

Figure 5

PRIVATELY-CLAIMED* LANDS IN SAN FRANCISCO BAY

*Title to some areas may be defective and areas subject to claim by the State



Compiled from maps of State Lands Commission, Tax Assessors and Individual Owners

PRESENT OWNERSHIP PATTERNS

engineering, and economic consultants to develop proposals to fill part for housing, industry, and waterfront recreation.

Elsewhere around the Bay, a few other owners control sizable parts of the Bay (usually less than 500 acres):

In San Mateo County, these include the Sanitary Fill Company (the refuse disposal company owned jointly by the two scavenger firms in San Francisco); South San Francisco Scavenger Company; Belle Haven Realty Company; U. S. Steel Corporation; and Cabot, Cabot, and Forbes.

In Alameda County, Oakland Scavenger Company and Shoreline Properties, Inc.

In Marin County, Marin Canalways Development Corporation; Peacock Gap, Inc.; Crowley Launch and Tugboat Company; Certosa, Inc.; Golden Gate Baptist Seminary; and Joseph Koret.

In Contra Costa County, Bethlehem Steel Company (at Point Pinole in Richmond); Richmond Sanitary Service; Standard Oil Company; and Hercules Powder Company.

In Solano County, 16 ranchers and duck clubs each own more than 500 acres.

Small parcels of land, divided among many owners, are common in parts of Marin County (Richardson, Corte Madera, and San Rafael Bays) and in parts of Richmond, as well as in the Hunters Point-Candlestick Point area of San Francisco.

Both the current pattern of private ownership in the Bay and the questions of ownership result from a complicated chain of historical events affecting title to Bay lands. Even the following very abbreviated account of that chain indicates why the title history of each parcel of land in the Bay is unique, and why, in case of dispute over title, the processes of research and settlement (by agreement or by litigation) take so long.

PRESENT OWNERSHIP PATTERNS

From the cession of California to the United States by the Treaty of Guadalupe Hidalgo (1848) until statehood in 1850, all land in California not part of a Spanish or Mexican grant was owned by the United States government. (Almost no navigable stream beds or tide or submerged land around the Bay were included in Spanish and Mexican grants.) Most of this land owned by the United States was simply in the public domain, but the tide and submerged lands were held in trust for the future state. By virtue of its admission to the United States on September 9, 1850, California obtained title to all submerged and tide lands within its borders. California received the lands -- in San Francisco Bay and elsewhere -- because the U. S. Supreme Court had ruled in 1845 that each new state would have the same rights to tide and submerged lands within its boundaries as the original 13 states had; the original 13 colonies, when they achieved independence, derived their rights by succession to the rights of the king under the common law of England.

Within a month following statehood, Congress added greatly to the amount of land in San Francisco Bay that the State of California owned and could decide to sell. The Arkansas Swamp Lands Grant Act (the "Arkansas Act"), passed on September 28, 1850, provided that swamplands in the public domain within certain states, including California, would be transferred free to those states. The states could sell these lands and use the proceeds for "reclamation" (diking and filling) of the land sold as necessary for agricultural purposes. California set a price of $1 per acre for the original sales.

The Arkansas Act contemplated that the Federal government would take the lead in surveying swamplands and transferring them to the state for sale, but due to a chronic shortage of Federal surveyors, the system didn't work. California, beginning with the first Act on this subject enacted in 1855, took the lead. Thereafter, upon receipt of an application to purchase, a county surveyor's certification that an area was swamp, and full payment, the State

issued a State Swamp and Overflowed Land (S&O) Patent. (It has been the practice to obtain a Federal patent confirming the swampland character of the tract. In many cases, the Federal patents were not issued until many years after the corresponding State patents; in some cases, no Federal patent may ever have been issued.)

The State's Swampland Act of 1855 was only the first of a number of general sales statutes authorizing the sale of swamp and overflowed and, later, tidelands -- but never of submerged lands* -- under limitations, restrictions, and procedures that changed almost from year to year. The details of the individual acts are too complex and not sufficiently important to be presented here; they are summarized in Table 1.

During the 1850's and 60's, there was considerable confusion and conflict between claimants under the various Federal and State laws. The Federal government in 1866 and the State government in 1868 passed laws attempting to regularize procedures and establish means of settling the questions arising from the years of confusion.

Also in 1868, the Legislature created a Board of Tideland Commissioners to take possession of the unsold marsh, tide and submerged lands in San Francisco, to survey them out to a depth of 24 feet at low tide (the maximum depth engineers thought could be safely filled, or piers built for deep-water access), and then to sell the lands surveyed. The land went briskly at auction and by the middle of 1871 had all been sold.

* The general sales statutes must be distinguished from the special statutes dealing with boards of tideland commissioners which were authorized to sell submerged lands. As explained below, the statutes were quite different, so the legal effect of the "sales" under the different statutes may also be quite different.

TABLE I

PROVISIONS OF "GENERAL SALES STATUTES" AND THE CONSTITUTION OF 1879

Act	Authorized sale of			Except within stated distances from			Acreage limitations
	Sub-merged	Tide	Swamp and overflowed	San Francisco	Oakland	Other towns	
1. Swamp Lands Act of 1855	No	No	Yes	10 mi.	5 mi.	1 mi.incorporated towns	320 acres
2. Amended Swamp Lands Act of 1858	No	No,but if accidentally included,proceeds to be segregated from proceeds of swamp sales	Yes	City limits	Same	Within incorpo-towns	320 acres 640 (as amended 1859)
3. Swamp and Tideland Acts of 1861	No	Yes	Yes	5 mi.	Same	Within $1\frac{1}{2}$ mi.of San Quentin	640 acres (?)
4. Omnibus Act of 1863	No	Yes	Yes	Same	Same	Within 1 mi.of San Quentin	640 acres
5. Sale and Management Act of 1868	No	Yes	Yes	Same	Same	Same (but amended 1870 to forbid sales within 2 mi.of any "town"*	None
6. Constitution of 1879**	N/A	Yes	N/A	2 miles of any incorporated city			N/A

N/A = not applicable

* "Town" was interpreted by the courts to include any small settlement, but in 1872 the provision was changed to "incorporated town."

** The 1879 Constitution, strictly speaking, did not authorize any sales; it prohibited sales near cities.

PRESENT OWNERSHIP PATTERNS

The success of the Board of Tideland Commissioners led the Legislature to expand its jurisdiction in 1870. In that year, the Board was authorized to survey and sell any unsold swamp and overflowed tide and submerged lands to a depth of 9 feet at low tide, outside of San Francisco but within five miles of the boundaries of San Francisco. The land was to be divided into lots of not more than 20 acres, and mooring basins and canals reserved for navigation. The Board of Tideland Commissioners did reserve canals at the mouths of most creeks flowing into the Bay (and at some other locations) and did not subdivide and sell all the frontage out to 9 feet at low tide, instead reserving much of what they were authorized to sell as prospective basins. (See Figure 6, a typical Board of Tideland Commissioners plan from which sales were made.)

The area of the Bay added to the jurisdiction of the Board of Tideland Commissioners in 1870 totaled some 60,000 acres. Because the boundaries of San Francisco extend far into the Bay, this area extended north almost to the present southern boundary of Hamilton Air Force Base in Marin County, south to what is now approximately the northern boundary of San Francisco International Airport in San Mateo County, northeast to a line between Point San Pablo and Pinole Point in Contra Costa County, and southeast to Roberts Landing at the southern boundary of San Leandro. (See Figure 7)

The area that the 1870 statute authorized the Board of Tideland Commissioners to sell was vast, but the Board operated in the same manner as it had under the 1868 statute when the area it was to sell was relatively small and urbanized. Thus many of the lots the Board subdivided and sold after 1870 were quite small, and its instruments of title were called deeds. In comparison, swamp and overflowed and tidelands sold by other agencies of State government were divided into much larger parcels, and conveyed by instruments of title called patents. The contrast in ownership patterns depending on which agency of the State made the original sale (i.e., inside and outside the 5-miles-from-San

Figure 6

PORTION OF
TYPICAL MAP OF
LANDS SOLD BY
BOARDS OF TIDELAND
COMMISSIONERS.
DATED 1871

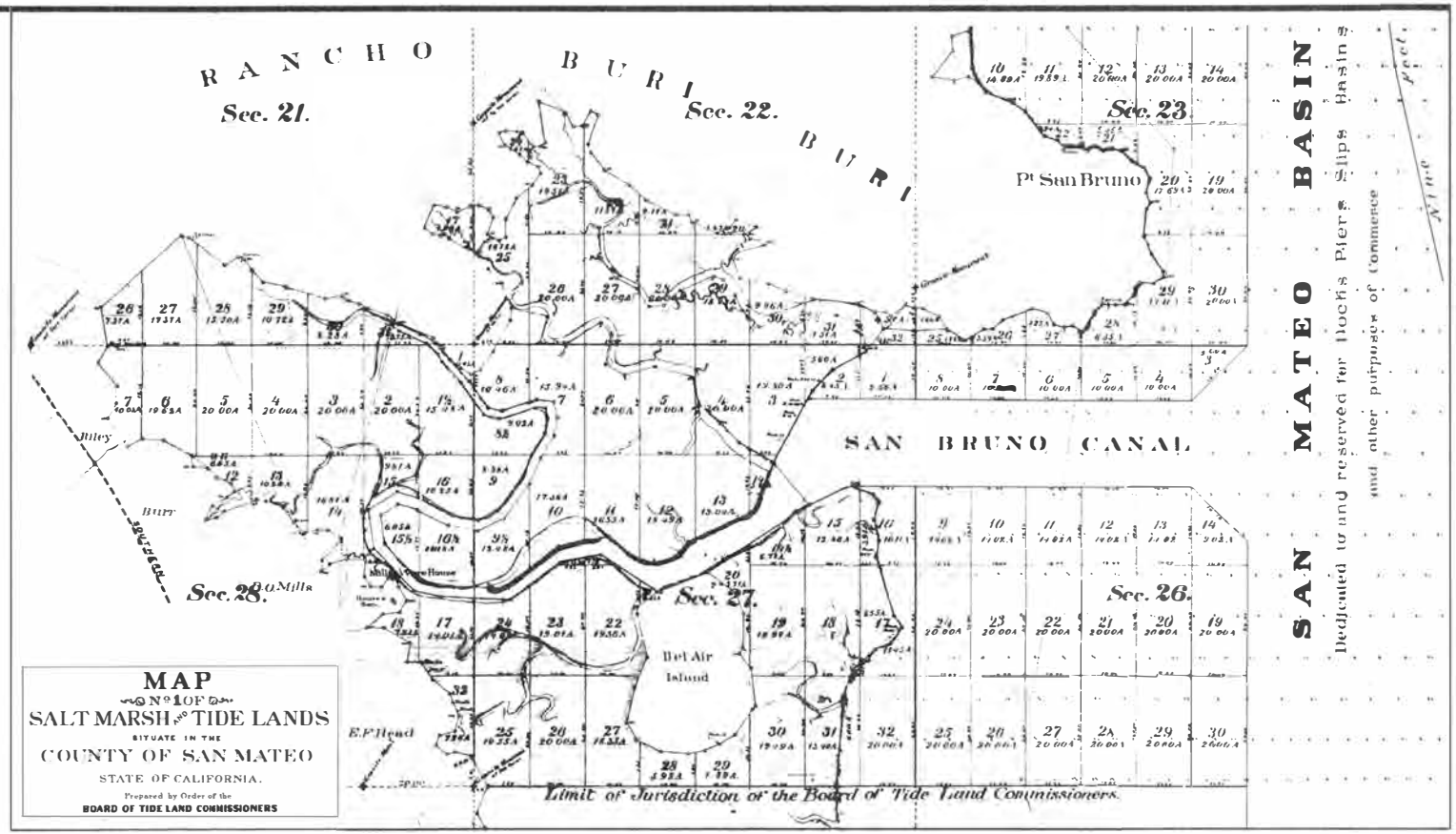
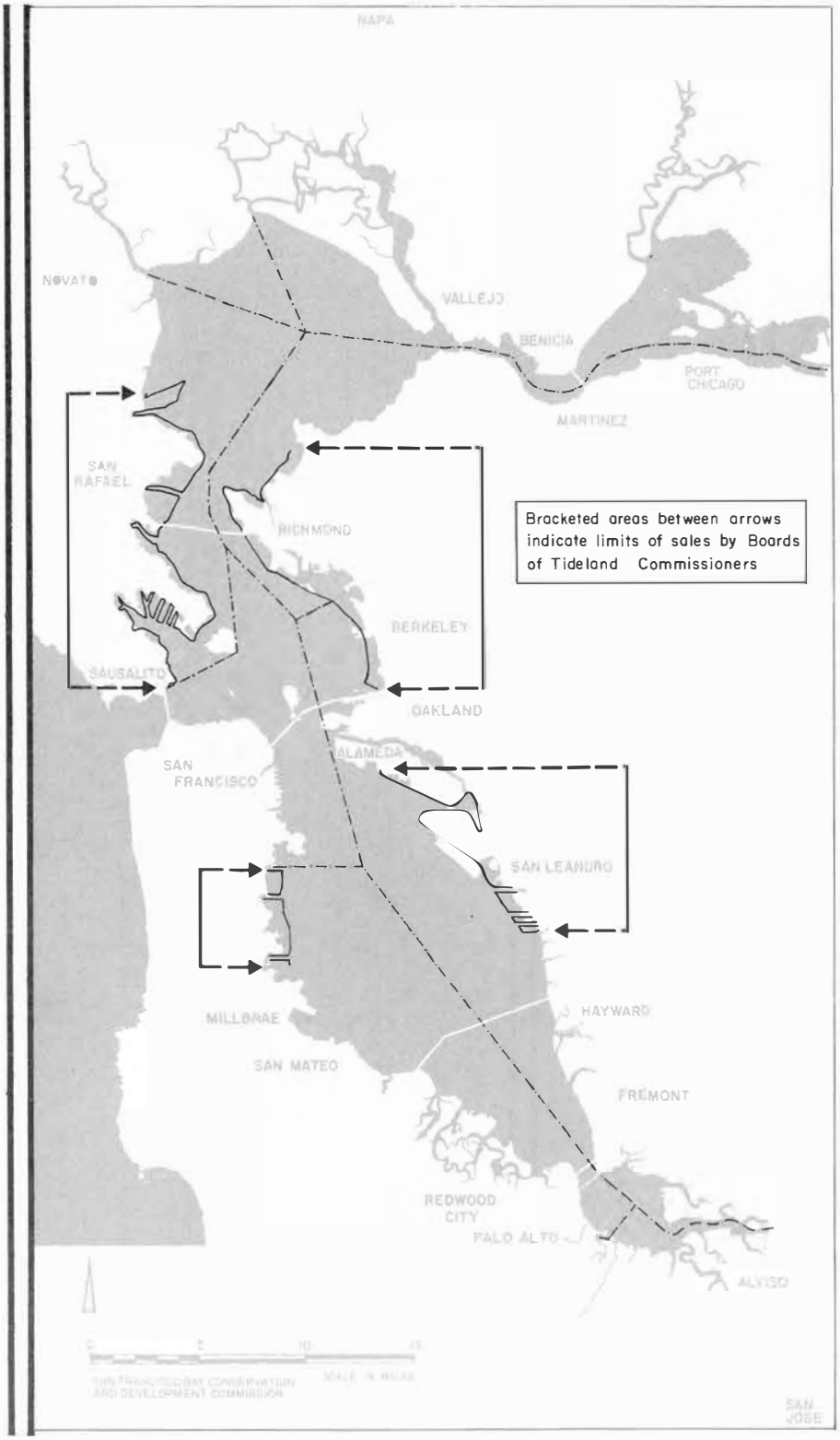


Figure 7

LANDS IN SAN FRANCISCO BAY SOLD BY BOARDS OF TIDELAND COMMISSIONERS



Francisco line) has remained striking through all the years since, and the distinction between (patented) swamp and tidelands and (Board of Tidelands Commissioners) deeded tide and submerged lands may have significant legal importance.

By the time the California Constitutional Convention assembled in 1878, there was widespread concern in the state over the extensive sale of lands not only in San Francisco Bay but also in San Diego Bay, Los Angeles' harbor area, and Humboldt Bay. This concern was not because of a desire to conserve coastal estuaries, but rather because difficulties in navigation and fishing were feared when private owners controlled so much of the access to the shore.

Therefore, Article XV, Section 2, of the California Constitution, which became effective on January 1, 1880, provided that:

> "No individual, partnership, or corporation, claiming or possessing the frontage or tidal lands of a harbor, bay, inlet, estuary, or other navigable water in this State, shall be permitted to exclude the right of way to such water whenever it is required for any public purpose, nor to destroy or obstruct the free navigation of such water; and the Legislature shall enact such laws as will give the most liberal construction to this provision, so that access to the navigable waters of this State shall be always attainable for the people thereof."

And Article XV, Section 3, provided that:

> "All tidelands within two miles of any incorporated city, [city and county, -- added by 1962 amendment] or town in this State, and fronting on the water of any harbor, estuary, bay, or inlet used for the purposes of navigation, shall be withheld from grant or sale to private persons, partnerships, or corporations."

PRESENT OWNERSHIP PATTERNS

Although this language has been hailed in later years as having largely stopped the sale of tidelands, it in fact was no more strict than statutes previously enacted that from time to time afforded some protection against such sales. But the Constitutional limitations could not be as easily changed as statutes, so the Constitutional provision did give some additional protection to a small part of the remaining State-owned lands.

After 1880, some sales of tidelands beyond the two-mile limits were made, but in 1909 the Legislature, by general statute, stopped all tideland sales throughout the state.

TITLE QUESTIONS

In 1850, most of San Francisco Bay was owned by either the State of California or the Federal government. If, therefore, purported transfer of title to any property from the State or Federal government was invalid or defective, the property may actually remain in State or Federal ownership, despite title records showing private ownership.

As noted above, the transfer of Bay lands from the State to private owners took place between 1850 and 1909, and was accomplished by a variety of statutes, repealed statutes, "curative" laws, and administrative procedures, all exceedingly complex. With respect to the questions as to the title to any individual parcel of land, therefore, a specific legal study is necessary.

But all of the laws providing for the sale of Bay lands contained limitations, and these are of special importance in determining the validity of a private title:

1. No submerged lands were ever authorized for sale by the Surveyor General under the general sales statutes and no tidelands were authorized for sale by general statute until 1861.

TITLE QUESTIONS

2. Throughout the period of sales, there were limits on the geographic areas within which lands could be sold.

3. Also, generally, there were limits on the acreage that could be sold to each buyer.

It can be argued that any violation of any one of these provisions made the original sale invalid; if the sale were invalid, the property would remain in State ownership.

By far the most important limitation was that forbidding the sale of submerged lands. Two types of title question have arisen regarding the claims of private owners to submerged lands:

1. Questionable surveys. Sales of State "tidelands" to private owners were based on the surveys and certifications of county surveyors. In some cases, county surveyors allegedly certified that lands in fact submerged were tidelands, and were thus available for sale.

In a report on "Public and Private Ownership of San Francisco Bay," prepared for BCDC by the State Lands Division in December, 1966, the situation was explained as follows: "There are many instances where parcels of so-called 'tidelands' were described as extending as far into the Bay as ten feet or more below the elevation of the mean of all the lower low tides . . . with certifications stating that no portion of the area surveyed was below the low tide. It is undoubtedly on the basis of such certifications that sales were approved for thousands of acres of submerged lands in the Bay."

This casts doubt on the validity of the title to large areas of lands covered by open water now claimed primarily by Ideal Cement Company and also to some areas claimed by Leslie Salt Company. Resolving these title questions would, however, require use of historical soundings, charts, legal papers, and other records, and would be a complex, slow, and expensive process. It is interesting to

TITLE QUESTIONS

note that while the title status of these lands is unclear, Ideal Cement Company entered into a lease with the State Lands Commission for dredging of oyster shells on lands it claims to own. And the State Legislature in 1943 granted to the City and County of San Francisco several thousand acres at the International Airport which San Francisco had previously "bought" from private "owners."

2. Navigable Sloughs. Many navigable sloughs pass through marshland, but their existence was largely ignored by the early county surveyors whose surveys of "swamp and overflowed lands" were the basis for sales of land by the State. Thus, many navigable sloughs, particularly in the South Bay, were included in "swamp and overflowed" areas sold by the State to private owners.

Now, many years later, some of these sloughs are no longer navigable, due in some cases to natural siltation and in others to man's filling. The State Lands Commission asserts that the submerged lands in navigable sloughs -- i.e., the bed of the streams at low tide -- legally could never have been sold, and that while the tideland parts of these sloughs -- i.e., the sloping stream beds and banks covered and uncovered by the tides -- should never have been sold, they could have been. The Lands Commission and Leslie Salt Company recently negotiated an agreement regarding some 2,000 acres of sloughs in the South Bay to all of which Leslie claimed title; under the agreement, Leslie relinquished its claim to about 1,600 acres of sloughs now navigable and the State relinquished its claim to about 400 acres of sloughs formerly navigable.

Other, but probably less significant, title questions arise from possible breaches of the other limitations. For example, some records indicate that tidelands were sold within prohibited areas; in part, however, these sales may have resulted from doubts as to the correct location of the boundaries of the prohibited areas. And while many

TITLE QUESTIONS

of the statutes limited sales to 320 acres for one purchaser, whether by chance or by design, many 320-acre purchases soon were consolidated in single ownerships.

SIGNIFICANCE OF TITLE QUESTIONS

In most cases, the courts have yet to rule on the practical effect of the questionable title activities that took place 75 or 100 years ago.

Many departures from authorized sales may have occurred (and many "curative" laws were passed to try to legalize previous sales) but in addition, many procedural defects might also have occurred to affect title:

-- The sale could have been recorded in the wrong county.

-- The sale price agreed upon with the State might not have been paid on time or might not have been paid at all.

-- Required affidavits might not have been filed, or, if filed, might not have contained the proper information.

-- The State's patent (or deed) might never have been issued, or might not have been issued properly.

But even if a defect in the original purchase of Bay lands can be substantiated, and even if no curative legislation were passed, the present owner might (arguably) still have a perfect title to the Bay lands he claims. He might, in other words, have a valid legal defense to the ownership claims that the State could make.

The private owner of record could rest his claim of such a defense on one or more of the following arguments:

-- The private owners of record have been allowed by the State to occupy the Bay lands without challenge for many years.

SIGNIFICANCE OF TITLE QUESTIONS

-- Some of the lands might have been filled in the past without challenge by the State, and other uses of the lands might have been made without State objection.

-- Various officials of government -- State and local -- could have made statements over the years appearing to relinquish any claim of State ownership.

-- A private owner, having paid real property taxes on Bay lands for years (even though at a low assessed valuation), could argue that this validates his title. (This raises a corollary point: if a private owner is declared not to have valid title to lands for which he has paid property taxes, is he entitled to have his taxes refunded? If so, by whom?)

The State would, of course, reply to such asserted defenses that only a deliberate act by an official agency authorized to sell State lands (or by the Legislature itself) can convey title or excuse defects in original title transactions.

Only court decisions can give final answers to these questions. Pending such determinations, BCDC planning should strongly recommend that ownership issues be settled before any change is made in the open-water status of disputed Bay lands.

RIGHTS OF PRIVATE OWNERS: PUBLIC TRUST FOR FISHING AND NAVIGATION

Even where owners have completely valid titles to lands in the Bay, questions exist as to the extent of these ownership rights. Both the Federal and the State government have rights with regard to Bay lands.

1. Federal

The Federal rights have been long recognized and are rarely in dispute. Under the Constitution of the United States, the Federal government has the power to regulate navigation and commerce between the states; this includes waterborne commerce. As a primary example of this power, the U. S. Army

Corps of Engineers has been designated to protect the navigable waterways of the United States from obstruction or interference. Federal law thus provides that no obstruction may be placed in any navigable water without a permit from the Corps of Engineers. This power has been used primarily to protect navigational channels, though a recent agreement with the U. S. Department of the Interior provides that the Army, in considering future permit requests, will give consideration to the effects of proposed projects on fish and wildlife, water quality, etc.

An owner of lands in San Francisco Bay is therefore ordinarily required to obtain a permit from the Corps of Engineers for development of his lands. The principal exception to this requirement involves lands shoreward of "harbor lines." These lines were established by the Corps of Engineers, often many years ago, to set aside areas for filling and piers without further Corps permission. There are two types of harbor lines -- pierhead and bulkhead lines. Between a pierhead line and the shore, piers and pilings may be placed without a Corps permit; between a bulkhead line and the shore, fill may be placed without a Corps permit.

2. State

The State also has rights over Bay lands. A section of the California Constitution (Article XV, Sec. 2), which became effective on January 1, 1880, provides that:

> "No individual, partnership or corporation, claiming or possessing the frontage or tidal lands of a harbor, bay, inlet, estuary, or other navigable water in this State, shall be permitted to exclude the right of way to such water whenever it is required for any public purpose, nor to destroy or obstruct the free navigation of such water; and the Legislature shall enact such laws as will give the most liberal construction to this provision, so that access to the navigable waters of this State shall always be attainable for the people thereof."

RIGHTS OF PRIVATE OWNERS: PUBLIC TRUST FOR FISHING AND NAVIGATION

Furthermore, Article I, Sec. 25, enacted in 1910, provides in part that:

> ". . . no land owned by the State shall ever be sold or transferred without reserving in the people the absolute right to fish thereupon."

These provisions by themselves have limited practical effect, however, because most of the sales of Bay lands occurred before 1880, and all had occurred before 1910; the Constitutional provisions do not apply to lands sold before these provisions took effect. But all or many private owners tracing their titles back to sales made before 1879 hold their lands subject to rights of the State and of the people regarding commerce, navigation, and fishing.

The existence and scope of those rights today probably depend on the circumstances of each sale long ago. It is clear that, as of 1850 when it acquired the tide and submerged lands at statehood, the State held these lands in trust for all the people with regard to commerce, navigation, and fishing. This trust derived from the English common law, and is completely independent of the State Constitutional provision added 29 years later. But the release of lands from this public trust was permitted in English common law and has long been upheld by Federal and State courts.

Unquestionably, therefore, at least some Bay tide and submerged lands <u>could</u> legally have been sold into private ownership, either free of a trust for commerce, navigation, and fishing, or subject to such a trust. In the case of each sale, certain questions must be asked and answered. These questions, and the general answers given in a recent opinion furnished to BCDC by the Attorney General, are as follows:

a. Did the Legislature, in each statute authorizing the sale of lands in the Bay, intend that the land sold under its provisions be subject to the trust or free of it?

Informal Opinion of Attorney General's Office: The intent is presumed to have been that the lands sold remain subject to the trust unless there is "an express or clearly implied finding" that the lands should properly be sold free of the trust.

State patents to tidelands by the Surveyor-General merely passed title subject to the public trust.

The acts granting power to the several boards of tideland commissioners to sell Bay lands behind a harbor line in San Francisco and Bay lands not reserved as canals or basins (within 5 miles of San Francisco) were generally sufficient to vest authority in these boards to terminate the trust as to such Bay lands.*

b. If the Legislature intended to abandon the trust, was the statute setting forth the abanment valid?

Informal Opinion of Attorney General's Office: The State is empowered to terminate the public interest and leave the lands entirely under the use and control of private parties upon a finding that (1) disposition of the lands should be made for the improvement of the navigation and use of adjacent navigable waters,

* It is important to note that other lawyers do not conclude that lands deeded by the boards of tideland commissioners were conveyed free of the public trust. Their arguments are summarized in a recent comment, "San Francisco Bay: Regional Regulation for Its Protection and Development," Vol. 55, University of California Law Review, pp. 769-778 (August 1967).

or (2) that the parcels are not needed for commerce, navigation, or fishing and could be disposed of without impairment of the public interest in the lands and waters remaining.

Such a finding is conclusive upon the courts in the absence of evidence that the abandonment of the public trust will impair the power of succeeding legislatures to protect, improve, and develop the public interest in commerce, navigation, and fisheries. There appears to be no California decision in which such finding and declaration by the Legislature has been overturned by the courts.

c. If some or all of the Bay land in private ownership remains subject to the public trust for navigation and fishing today, what limitations does the trust impose on the rights of private owners to fill their lands?

Informal Opinion of Attorney General's Office: The owner of lands subject to the public trust may use the property as he sees fit, subject to the power of the State to abate (prevent or remove) any nuisance or illegal obstruction he may create thereon, and to reoccupy the lands in the event such occupation becomes necessary for trust purposes. Such owner may be restrained from interfering with any existing navigational improvement or from filling such lands, if a properly authorized State agency determines that such filling will obstruct the free navigation of a bay, harbor, estuary or other navigable waterway. Whether or not a particular filling project by the private owner constitutes a nuisance or an illegal obstruction depends upon the navigability in fact of the waterway in question, or the effect of flow therefrom upon other navigable waterways.

RIGHTS OF PRIVATE OWNERS: PUBLIC TRUST FOR FISHING AND NAVIGATION

d. Further, with regard to privately-owned Bay lands still subject to the public trust, can the trust be abandoned now? If so, how -- by action of the Legislature? The BCDC? The agency designated to carry out the BCDC plan?

Informal Opinion of Attorney General's Office: The trust can be terminated by an act of the State Legislature; "the Legislature may delegate the power of terminating the public trust to a public agency [i.e., to the agency designated to carry out the BCDC plan] under prescribed standards" for exercising the power.

PROPOSED POLICIES FOR BCDC PLANNING

It appears reasonable for BCDC planning to proceed as follows:

1. As a primary objective, the BCDC enforceable plan should attempt to insure that all publicly-owned lands -- Federal lands, State lands, and grant lands -- are conserved or developed in accordance with the plan for the entire Bay.

   a. Federal lands. The plan for the Bay should treat Federal installations and properties as though they were subject to the jurisdiction of the agency designated to carry out the plan. (Even though not legally subject to the jurisdiction of State and local government, it is Federal policy to conform to State laws, and to local ordinances and plans if they do not interfere unduly with national purposes or objectives.) Federal cooperation should thus be sought in carrying out the Bay plan, and it is reasonable to expect such cooperation except in extraordinary circumstances.

   b. State lands. The plan for the Bay should provide that all State installations and State properties be subject to the power of the agency designated to carry out the plan to regulate filling and dredging in

the interests of the Bay Area as a whole, just as State agencies are now subject to the regulatory power of the BCDC.

c. Grant lands. Cities and counties holding granted lands in the Bay should retain their grants if they wish, but any development of grant lands should first be approved by the agency designated to carry out the BCDC plan as being in accord with the plan for the Bay as a whole.

d. Ten-year provisions. The provisions of recent legislative grants of tide and submerged Bay lands requiring "substantial improvement" within 10 years should be repealed, since the object of those provisions -- filling and building on marsh and tidelands without coordinated planning -- is in direct conflict with both the McAteer-Petris Act and many of BCDC's tentative planning conclusions.

e. New grants. The Legislature should be asked to establish a procedure by which it will not consider requests for new tideland and submerged land grants in San Francisco Bay to local public bodies until such requests have been reviewed and commented upon by the agency designated to carry out the BCDC plan for the Bay as to their effect on the Bay as a whole, and by the State agency having jurisdiction over the State-owned lands in the Bay.

f. Court clarification. Depending on the conclusions of the Attorney General's forthcoming opinion on the uses allowable on granted lands under the typical grant language and the Constitutional-common law trust for commerce, navigation and fishing, clarification should be sought immediately by new State laws and/or court decisions.

PROPOSED POLICIES FOR BCDC PLANNING

2. As a primary objective, the BCDC enforceable plan should attempt to insure that all privately-claimed lands are conserved or developed in accordance with the plan for the entire Bay. Some owners may, however, wish to fill all or part of their lands, while the plan may specify the desirability of keeping them open water. Alternative methods of carrying out the plan as it affects privately-owned lands -- such as acquisition of such lands, regulation, etc. -- are the subject of a forthcoming BCDC report. But as a first step, it is important that the ownership status of privately-claimed lands be clarified, and this is particularly important with regard to lands proposed in the plan for retention as open water.

   a. Conflicting claims. The Attorney General, in cooperation with the State Lands Commission and the agency designated to carry out the BCDC plan, should be asked to try to identify all parcels of Bay lands in private record title which may be subject to conflicting ownership claims by the State, and to determine by investigation, negotiation, and -- if necessary -- litigation, the validity of the conflicting claims; the Legislature should be asked to provide sufficient funds to support this process.

   b. Trust questions. The BCDC or its successor agency should take legal action to definitely answer, at the earliest possible date, all questions concerning the effect of the trust for commerce, navigation and fishing upon Bay lands validly in private ownership. Pending such determination, in any case where the owner of private lands asserts that his property is not subject to the trust for commerce, navigation and fishing, the agency designated to carry out the Bay plan should determine, guided by legal counsel, whether or not the trust

PROPOSED POLICIES FOR BCDC PLANNING

was terminated as to the property in question by act of the Legislature or by action of a public body to which the Legislature had delegated the power to terminate.

c. Future filling. For any privately-owned property subject to the trust for commerce, navigation and fishing, filling should not be allowed unless the agency designated to carry out the Bay plan makes an express finding that:

(1) the filling and uses proposed are consistent with the trust, or

(2) the lands proposed for filling are no longer needed for commerce, navigation, or fishing, and the trust may properly be terminated,

and stating the facts upon which such finding is based.

SUMMARY

The Bay is a single physical mechanism, in which actions affecting one part may also affect other parts. Yet almost one-quarter of the Bay is privately-owned and almost another quarter of the Bay has been granted in trust to cities and counties.

If the Bay is to be conserved and developed as an irreplaceable resource, most privately-owned land and most grant land will have to remain open water. First steps should be (1) clarification of disputed titles and of any commerce, navigation and fishing easements affecting privately-owned Bay lands and (2) legislative action to require that all future development of grant lands be in accordance with the comprehensive plan for the Bay.

SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION
507 Polk St., San Francisco 94102 557-3686

Possible Bay Planning Conclusions Based on the Report on Ownership

1. Effective planning for San Francisco Bay must take into account the divided ownership of the Bay: almost one-quarter is claimed by private owners; almost one-quarter has been granted by the State to cities and counties; about half is owned by the State; and about 5 per cent is owned by the Federal government.

2. The present fragmented pattern of ownership in the Bay has resulted from sales and grants of Bay lands by the State over a period of more than a century. Almost all of these sales and grants were made at a time when the values of marshlands and tidelands were little realized, and when filling and development appeared to be the best use that could be made of the shallow parts of the Bay. Because of the long role of the State government in parceling out Bay lands, the State government has special responsibilities for providing solutions to the problems of divided ownership.

3. As a first step in carrying out the Commission's plan, the policies proposed on pp. 31-34 of the report, under the heading, "Proposed Policies for BCDC Planning," should be followed.

Adopted by the Commission at its meeting of 4/4/68

INTRODUCTION

This is the last -- and in many ways the most important -- in the series of BCDC planning reports. The 22 reports already published have shown the values of the Bay as a Bay, and have also shown the importance of using the shoreline wisely to provide for necessary economic growth in the Bay Area and to provide for greatly expanded recreational opportunities.

But effective planning means more than listing goals to be achieved. Many questions remain: What actions will be needed to resist the inevitable pressures for piecemeal Bay filling? How can a Bay under many ownerships and jurisdictions be maintained as open water? How can necessary parts of the shoreline be reserved for industry? How can large parts of the shoreline be reserved for parks -- and how can the parks be paid for?

Without answers to questions such as these, a plan for the Bay would have limited value -- it could inspire sporadic action, but it would not be a program for concerted, effective action. Recognizing this, the Legislature directed the BCDC to prepare a plan that is not merely advisory but "enforceable."

This report will discuss the money and governmental powers needed to carry out a plan for San Francisco Bay. The report assumes that these powers will be exercised by a governmental entity able to deal effectively with the entire Bay and shoreline. As was discussed in the BCDC report on Government, these powers could be exercised by (1) a limited regional government, or (2) a special agency concerned only with the Bay and shoreline. In general, however, the same money and powers will be needed to carry out a Bay plan regardless of which form of government is chosen.

BAY PLANNING GOALS AND ACTIONS REQUIRED

The tentative conclusions already adopted by the Commission state the principal Bay planning goals for which funds and powers are needed beyond those now available to the region. These can be summarized under two major objectives:

Objective 1: Protect the Bay as a great natural resource for the benefit of present and future generations

The most important resource aspects of the Bay are:

a. The total surface area and water volume of the Bay -- which must be kept as large as possible to maintain the scenic beauty of the Bay, to maintain fish and wildlife in the Bay, to help combat water pollution, to help combat air pollution throughout the Bay Area, and to help maintain the pleasant climate in the Bay Area.

b. The marshes and mudflats around the Bay -- which are necessary to maintain fish and wildlife in the Bay and ocean, to help combat water pollution, and to help combat air pollution.

c. The fresh water aquifers beneath the Bay -- which are a vital part of the total domestic water supply in the Bay Area and must be protected from salt water intrusion that could result from deep dredging.

d. The oyster shell deposits in the South Bay -- which are the raw material for much of the cement used in the Bay Area construction industry.

Objective 2: Develop the Bay and its shoreline to their highest potential with a minimum of Bay filling

The aspects of the Bay and its shoreline of vital importance to the economy of the Bay Area and to the attractiveness of the Bay Area environment are:

BAY PLANNING GOALS AND ACTIONS REQUIRED

a. Maritime ports and channels -- which are necessary for a sound Bay Area economy and which should be developed on a regional basis to take full advantage of the Bay as a natural harbor and to minimize Bay filling.

b. Industries that require water frontage -- which are necessary for a sound Bay Area economy and for which there will be insufficient shoreline if adequate steps are not taken to protect the available supply.

c. The surface transportation system -- which should be developed so as to make maximum use of the Bay by high-speed passenger and cargo vessels and so as to prevent unnecessary filling for roadways and Bay crossings.

d. The airport system -- which should be planned and developed on a regional basis to protect future airport sites throughout the Bay Area and to prevent unnecessary Bay filling for airport facilities.

e. Shoreline parks, fishing piers, and marinas -- which can provide Bayfront recreation at the center of a densely-populated area but for which there will be insufficient shoreline if adequate steps are not taken to protect the available supply.

f. General public access to the waterfront -- which, if incorporated in virtually all waterfront developments, would open up the Bay -- the region's greatest natural resource -- for increased public use and enjoyment.

g. Attractive appearance of the Bay -- which greatly enhances the quality of life in the Bay Area, and which in turn helps attract economic growth.

SHORELINE DEVELOPMENT AFFECTS BAY CONSERVATION

Conservation of the Bay and development of its shoreline are inseparable parts of the same planning challenge. If, for example, the limited shoreline areas suitable for basic industry are allowed to be used for housing, pressures will develop to provide new industrial land by filling the Bay. Clearly, what happens to the shoreline helps determine what happens to the Bay.

Nevertheless, in the interest of clarity, this report will deal separately with Bay conservation and with shoreline development. First, the report will discuss the money and powers needed to carry out the parts of a Bay plan that relate to Bay filling and dredging. Then the report will discuss the money and powers needed to carry out the parts of a Bay plan that relate to shoreline development.

HOW BAY FILLING CAN BE CONTROLLED

As previous BCDC reports have noted, much of the Bay is shallow and relatively easy to fill. About 22 per cent of the Bay is privately owned (this includes many of the most shallow areas) and about 23 per cent has been granted to cities and counties. Pressures for Bay filling to create new, flat land close to the centers of population will grow as the population of the Bay Area continues to grow.

Some filling for purposes that provide substantial public benefits will undoubtedly be included in the BCDC plan. But pressures for additional filling will still exist. Cities, counties and other public agencies may wish to fill their lands to enlarge a property tax base or to provide new land for developments important to them. And the holders of privately-owned lands in the Bay may want to fill because of the many profitable uses that can be made of new land created through filling.

1. Legal Basis of Present Fill Controls

The controls on Bay filling and dredging now exercised by the BCDC are temporary; they cannot be extended indefinitely.

HOW BAY FILLING CAN BE CONTROLLED

The controls -- requiring that anyone who wishes to fill or dredge in the Bay must first obtain a permit from the BCDC -- were established by the Legislature to protect the Bay while the BCDC is preparing its plan. Without such controls, piecemeal Bay filling could have rendered the plan useless before it had even been completed. The courts have frequently upheld the rights of government to prohibit development of lands for a reasonable period of time while a plan is being prepared.

But the present BCDC powers will ultimately expire. What can then be done to control Bay filling in accordance with the rights and needs of the public and in fairness to the owners of lands in the Bay?

2. Future Fill Controls: Shared Jurisdiction

If the BCDC plan is to be carried out effectively, the principle of shared jurisdiction over the Bay should be continued. This principle, involving the cooperative management of the Bay by local government, has worked successfully during the lifetime of the BCDC.

Applying this principle, any public agency or private developer wishing in the future to place fill, pilings, or any other structures in the Bay, or to dredge in the Bay, would be required to obtain a permit from the governmental agency designated to carry out the BCDC plan.

This agency would have, just as BCDC has, considerable jurisdiction over the Bay, but it would nevertheless share jurisdiction, just as BCDC does, with local governments and with other agencies such as the State Lands Commission, the Regional Water Quality Control Board, and the Army Corps of Engineers.

As an example of the way shared jurisdiction would work in practice, an applicant -- either a governmental agency or a private developer -- would first submit his fill or dredging proposal to the city or county having local control over the area in which

HOW BAY FILLING CAN BE CONTROLLED

the work is proposed. The agency carrying out the BCDC plan would not act on the proposal until it had received the views and recommendations of the local government, just as is now the case with BCDC operations under the McAteer-Petris Act. (The only exception would be failure of the local government to provide its comments within a reasonable period of time.)

The principal basis for the Bay agency's determining whether to grant or deny an application would be the extent to which the work proposed complies -- or fails to comply -- with the Bay plan. (As under the present BCDC law, public hearings should be required on permit applications, except that provision should be made for administrative approval of applications for emergency work or for minor repairs or improvements.)

For example, if the Bay plan proposes filling for industrial expansion in a certain area, then presumably an application for industrial fill in this area would be approved, if the application met the other standards of the Bay plan. Even in such cases, however, a permit should still be required; control over filling should not be delegated to other governmental agencies.

This is necessary to prevent confusion and disputes over filling. Why? Because the Bay plan can rarely be specific; the plan will state, for example, that some filling for industrial expansion in a certain area would provide substantial public benefits -- but in few if any cases will the plan be able to specify precisely how many acres should be filled, or how the fill should be designed. Thus, careful review of each fill proposal is necessary. If the agency carrying out the Bay plan is to be truly responsible for the welfare of the Bay and shoreline as a whole, it must be responsible for approval or denial of all fill and dredging applications.

HOW BAY FILLING CAN BE CONTROLLED

This is by no means a new concept, but is similar to the procedures followed in virtually every city or county with regard to land development: a property owner cannot construct a house without a building permit simply because his land is zoned residential; he must first obtain a permit from the city or county to insure that the house he proposes to build is in precise accordance with his community's zoning and building laws.

Therefore, all applications for filling or dredging permits should be reviewed by the agency designated to carry out the Bay plan. The costs of this review should be borne by the applicants, not by the general public; in some cases the costs would be nominal, and in others they might be relatively high, depending on the complexity of the work proposed. This type of sliding fee scale for permit processing is commonly used by city and county departments of building inspection. The review of permit applications should include the following considerations:

a. Safety. Plans for all proposed fill projects should be reviewed -- and approved before construction begins -- by a panel of professionals in the fields of geology, structural engineering, and civil engineering (with specialty in soils engineering). This review is designed to insure that both the fill itself and the structures on the fill are designed -- and built -- in accordance with current standards as to safety, both for normal settling of the fill and for minimizing damage during future great earthquakes that experts say are certain to occur in the Bay Area. Because of the importance of safeguarding life and property, the panel should be given adequate time to review all fill plans.

b. Appearance. Plans for all proposed fill projects should be reviewed by an advisory panel of professionals in the fields of design so that the projects would enhance, and not detract from, the appearance of the Bay and shoreline.

HOW BAY FILLING CAN BE CONTROLLED

c. Public Access to the Bay. Proposed fill projects should increase -- and in no way diminish -- public access to the Bay. Exceptions may be necessary in the case of airport, port, or industrial areas, where public access could not be provided safely, but even in these areas, strong efforts should be made to incorporate public access into the project design. As a general rule, a high percentage of the waterfront created thfough any new filling should be made available to the public in parks, marinas, hiking and riding trails atop dikes, lookout points, etc. Often at little cost to the developer, provision can be made for Bay access that will enhance the development while at the same time benefiting the public at large. Precedents for this are the streets and the parksites that cities and counties customarily require to be dedicated as part of the subdivision process.

This access requirement does not contemplate that extensive parking should be provided at the water's edge, but rather that the public not be fenced off from the Bay, even though a person wishing to use the waterfront might have to hike or walk some distance to reach it.

d. Fill Charge. As previous BCDC reports have demonstrated, filling of the Bay -- even filling for worthwhile purposes -- can damage the Bay in several ways: filling can diminish the scenic beauty of the Bay, can destroy fish and wildlife habitat, and can increase water pollution and air pollution.

These harmful effects of filling are imposed, to some degree, upon all residents of the Bay Area, who lose scenic beauty, who must pay higher costs for waste treatment facilities if the Bay shrinks through filling, and who will suffer the effects of an increase in smog.

It therefore appears reasonable to require that the sponsor of even an acceptable fill project be required to compensate for damage

HOW BAY FILLING CAN BE CONTROLLED

to the Bay. Logically, this compensation could take the form of requiring that one new acre of Bay be provided (presumably by opening up existing dikes) for each acre of the Bay lost through new filling; this would prevent the Bay from shrinking further because of man's filling.

But it would be highly impractical to attempt to enforce such a requirement. It would, however, be practical -- and clearly legal -- to specify another type of compensation: for each acre of the Bay to be filled in an approved project, the sponsor of the project -- whether a public agency or a private developer -- could be required to provide either (a) an acre of new Bay or (b) a fixed dollar amount, perhaps $1-3,000 per acre filled. This money would be used by the agency carrying out the BCDC plan to help compensate for the damage to the Bay caused by filling. The money could be spent in several ways: to buy areas of the Bay that should never be filled because of special importance (e.g., especially valuable wildlife habitat); to buy areas behind existing dikes and open them up to the waters of the Bay; and to improve ecological conditions in some areas, for example, by creating new marshlands.

There is ample precedent for requiring that a fill project providing one type of public benefit, such as industrial or port expansion, not be allowed to completely disregard other public benefits, such as the values of the Bay in alleviating air pollution. If a proposed freeway route requires that school property be taken, nobody would seriously argue that the public benefits of transportation outweigh the public benefits of education; rather, as part of the cost of the freeway, the school would be relocated; the public would thus have both transportation and education. Similarly, the needs of the Bay Area require both economic development and Bay conservation, not one or the other.

It should be emphasized that the fill charge would be imposed only for projects approved as otherwise proposed in this report; under no circumstances would a fill project be allowed simply because its sponsor was willing to pay the fill charge.

3. Proposed Filling Not in Accordance with the Bay Plan

The most difficult questions will not arise as a result of the requirements proposed above. The greatest problems will arise when an owner of private property wishes to fill his lands, although such filling would be specifically opposed in the Bay plan. As noted above, some 22 per cent of the Bay is in private ownership, and certainly the Bay plan will propose that only a very small part of these lands be filled.

To carry out the Bay plan with regard to privately-owned lands, three alternatives are possible:

Alternative 1: Regulation without compensation

For about 40 years there has been no question in the United States that public regulation (such as zoning) can greatly limit the uses of private property without a necessity for the public to compensate the owner.

And one of the oldest legal doctrines, upheld for generations by the courts, is that the public can prevent any use of private property -- and even destroy the property -- if an urgent public need requires it. For example, diseased trees can be destroyed, without payment to the owner, to prevent the spread of a plant epidemic. In San Francisco Bay, these legal precedents might mean that the agency designated to carry out the Bay plan could permanently prevent fill, without compensation to owners, in parts of the Bay where filling would have a particularly harmful effect on water quality, on movement of the tidal currents, or possibly on particularly valuable wildlife habitat. But even if

HOW BAY FILLING CAN BE CONTROLLED

such sensitive areas could be protected under these legal theories, such areas are only a small part of the entire Bay system. The difficult legal questions arise with respect to the remainder of the Bay.

The traditional American rule of law has been that (with the narrow exceptions noted above) regulation so strict as to deprive the owner of any economic use of his land is a "taking" of his property. The owner may bring a lawsuit either to invalidate the regulation or to force the regulating body to compensate him ("inverse condemnation.") But times are changing, and the law has changed with it. According to one of the nation's foremost experts on the law of public land use regulation, the courts would probably uphold a statute declaring that privately-owned lands in San Francisco Bay could not be filled -- and that the owners were not entitled to compensation for being refused permission to fill. Such a ruling by the courts would be based on (1) the dramatic increase in population in California's metropolitan areas, (2) the rapidly diminishing open space in those areas, (3) the skyrocketing prices for acquisition of open space lands now in private ownership, (4) the shortage of funds available for such purchase, (5) the special preparations that have to be made before lands under the Bay are suitable foundations for construction, (6) the legal effects of the public trust for commerce, navigation, and fishing, and (7) the often low prices paid for the Bay lands initially.

For the courts to sustain such a regulation regarding the Bay, two conditions would have to be met:

a. The regulation would have to be based on evidence showing that such stringent restrictions were necessary. Presumably the studies made by the BCDC and other agencies would amply demonstrate the harmful effects of Bay filling.

b. The regulation allowing some property to be filled and prohibiting the filling of other property in the Bay would have to be based on an approved Bay plan that adequately explained the reasons for the differing treatment.

What could an owner do with his Bay lands if he could not fill them? In some cases, profitable use would still be possible -- dredging for oyster shells to use in making cement, commercial fishing piers, perhaps even "fish farming" (use of Bay lands for intensive propagation of fish). But for many property owners, Bay lands would have little value if filling were not allowed.

Possible Arguments for Alternative 1: The Bay is an invaluable resource; it should no longer be treated as underwater real estate. The overwhelming public interest in preserving the Bay for future generations should prevail over any private profit that might be obtained through filling. The owners of Bay lands would still have what they bought -- only their opportunity to fill would be restricted. This is fair because the public does not have any obligation to reward land speculation. In addition, legal precedents exist for such regulation, and all owners would be treated equally before the law. Finally, there may simply not be enough public money available to buy the lands, making total prohibition of filling the only practical method of protecting the Bay as a great natural resource.

Possible Arguments Against Alternative 1: Even if a complete prohibition of filling without compensation is legally permissible, it would be unfair. Parcels of land in the Bay are owned not only by large corporations but also by many individuals. Although the owners may have paid low prices for their lands, they bought their property in good faith (indeed, the original sellers were the Federal and State governments) and have paid taxes on it (albeit usually low taxes) for many years. If the public wishes to prevent the owners from using their lands profitably, the public should follow accepted practices of

buying the lands. Furthermore, either the Legislature or any regional or local legislative body would face strenuous opposition if it sought to enact laws prohibiting fill without some compensation to property owners.

Alternative 2: Purchase of Privately-Owned Lands

Under this alternative, privately-owned lands proposed in the Bay plan as permanent open water would be purchased by one or more public agencies such as the State, counties, cities, special districts, and the agency designated to carry out the Bay plan.

The agency carrying out the Bay plan would thus need the right to buy Bay lands through negotiation if possible, and to purchase them through eminent domain if necessary. In addition, the agency carrying out the Bay plan would have to be able to regulate filling strictly during the time necessary to organize and carry out a program of massive tideland purchasing; otherwise Bay lands could be filled before the public had time to buy them. The length of time necessary to purchase tidelands throughout the Bay is impossible to predict, but an estimate of three to five years for appraisals, negotiations, and necessary legal actions appears reasonable.

How Much Would Alternative 2 Cost? It is extremely difficult to estimate the total value of all the privately-owned lands in the Bay that might have to be acquired under such a program. The value depends to a great extent on the degree of regulation to be imposed by governmental agencies (regional and local). If owners are relatively free to fill and develop their lands, then the value of the privately-held tidelands would be high; if filling is greatly restricted, values would be lower.

One way of estimating the future values of Bay lands is to determine what they have been in the recent past. This is difficult, however, because, even in the several years before BCDC came into existence in September, 1965, there had not been any great number of sales of Bay lands.

HOW BAY FILLING CAN BE CONTROLLED

BCDC surveyed the sales of Bay lands from 1960 through 1967. The survey indicates that values of Bay lands -- as reflected in actual sales during that period -- ranged from as low as $150 an acre to about $22,000 an acre. Per acre prices were highest where the parcels sold were (1) partially upland or adjacent to the shore, (2) near industrial or commercial uses, (3) bought for use by a waste disposal firm, and/or (4) small in size. Per acre prices were lowest when the parcels sold were (1) tide or submerged land cut off from dry land, (2) in an undeveloped or agricultural area, (3) bought for speculation, and/or (4) large in size. Values did not seem to increase with the passage of time during this seven-year period.

It is nevertheless almost impossible to arrive at a meaningful average value, even for 1965. And, with the uncertainties of inflation and of the effect of regulation upon prices of Bay lands, it appears literally impossible to obtain meaningful estimates of prices for the future; only expensive parcel-by-parcel appraisals would have much value, and these would be good only for a brief period after being written.

All that can be done, therefore, is to make a rough estimate. About 57,000 acres of the Bay are in private ownership. At an average price of $500 per acre, about $28.5 million would be required to buy them all. At an average price of $5,000, however, the total price would be some $285 million.

Where Would the Money Come From? Under Alternative 2, large amounts of money would be needed to purchase privately-owned lands in the Bay. And under any of the alternatives discussed in this report, large amounts of money will be needed to buy and develop park lands on the shores of the Bay. (Shoreline recreational development is discussed in more detail on pp. 31-35.) Potential sources of such funds -- and a brief evaluation of each -- are as follows:

HOW BAY FILLING CAN BE CONTROLLED

(1) Federal Sources

(a) Direct Purchase. The Federal government could, by action of Congress and the President, declare all or part of San Francisco Bay to be a National Seashore, Monument, or Wildlife Preserve. Federal funds could then be used directly to purchase privately-owned Bay lands. This is unlikely to happen, however, at least in the immediate future, for two reasons. First, the Federal government is still buying land for the Point Reyes National Seashore, less than 20 miles from the Bay, and it is therefore unlikely to undertake another major project of this type in the Bay Area soon. Second, current competition for Federal funds makes it unlikely that a new purchase program of this sort would be begun soon.

(b) Grants for Conservation and Open Space. Federal funds have been appropriated for purchase and improvement of park, conservation, and open-space areas. The Federal grants usually require, however, matching of each dollar of Federal money by a dollar of local funds. These programs are administered by the Department of the Interior (Land and Water Conservation Fund and outdoor recreation program) and by the Department of Housing and Urban Development (open space program, and land and urban beautification program). Purchase of Bay lands and of shoreline park areas would qualify for such grants, but local matching funds may be difficult to obtain if the local funds have to be raised through property taxes. Moreover, Federal appropriations for these grant programs are presently very limited; more money would be available if Federal offshore oil revenues were earmarked for the Land and Water Conservation Fund, as is proposed in a bill now before Congress.

(c) Shoreline Renewal Grants. Along some parts of the Bay shoreline, urban renewal projects could be undertaken with Federal financial assistance. Waterfront recreation and retention of open water could be planned as part of such redevelopment projects at sites such as the Hunters Point-Candlestick Point area of San Francisco and the shoreline of Richardson Bay north of Sausalito. While the urban renewal program would thus be of assistance in limited areas, it would not serve to provide funds for substantial purchase of Bay lands.

(d) Block Grants. In recent years, hard-pressed State and local governments have increasingly sought Federal financial help. Recent proposals have called for the Federal government to share its income tax revenues with other levels of government. This sharing would take the form of "block grants" -- i.e., the Federal government would return a percentage of its revenues to the States and/or cities and counties, to be spent with little or no Federal control. Many Federal policies encourage regional planning within metropolitan areas, so presumably regional governments would also be eligible to receive block grants. Although considerable support appears to exist for block grants, it is impossible to predict when -- if ever -- such a program will be instituted. And if the Federal government does begin distributing block grants, there will certainly be great competition for these funds -- for programs of education, welfare, urban mass transportation, housing, reduction of local property taxes, etc. But recreation and conservation could expect to benefit to some extent from block grant funds made available to the Bay Area.

(2) State Sources

(a) Direct Acquisition. The State now owns and maintains several parks, recreational areas, and conservation areas on the Bay. The best known of these are Angel Island State Park, the Marin Headlands State Park (formerly Army forts), Alameda State Beach, Benicia State Recreation Area at Southampton Bay, and Joice Island State Game Refuge. Possible sources of funds for additional State acquisitions include:

i. The Wildlife Restoration Fund, which receives $750,000 annually from horse-racing license fees. This money is used by the Wildlife Conservation Board to acquire, restore, and maintain fish and wildlife habitat. Because of limited funds, it does not appear that this source will be able to perform more than a minor role in acquiring habitat in San Francisco Bay, but it should nevertheless be used to maximum advantage.

ii. Tideland Oil Revenues. To many persons, it appears logical to use part of the State's tideland oil income for tideland conservation, i.e., to use this monty to buy back tidelands that the State has sold into private ownership. Logical or not, however, revenues derived from tideland oil in Southern California have been committed by the Legislature to support higher education and the California water project. Certainly any efforts to change this commitment would meet with vigorous opposition from those concerned with State support of the University of California and the State Colleges, and the water project. In the future, however, if additional tideland revenues become

available from these or other sources, it is possible that an appropriate percentage of them could be used for conservation -- but no such revenues are now foreseen.

iii. Revenues from Bridges Over the Bay. Similarly, it may appear logical to use revenues from trans-Bay bridges for the purchase of Bay lands. But revenues from the Bay bridges under control of the Division of Bay Toll Crossings have been committed by the Legislature for many years ahead to help finance the trans-Bay tube of the Bay Area Rapid Transit District and the new Southern Crossing; and revenues from the Golden Gate Bridge are likely to be used to support improved transit between Marin County and San Francisco.

iv. State Appropriations. Annual appropriations of funds for Bay conservation could be made by the Legislature and the Governor. Because of the strong competition for State funds, however, it is most unlikely that any substantial amount of money would become available from direct appropriation.

v. State Bond Funds. Sizable amounts of money for Bay conservation and recreation could be obtained from a State bond issue. Most of the State's recent park and recreation acquisitions in the Bay Area, as elsewhere in California, were financed by the State Beach, Parks, and Recreation bond issue of 1964. Virtually all of the 1964 bond funds have now been spent, however, and there is no indication that another Statewide bond issue for parks and recreation is contemplated in the immediate future.

(b) Aids to Regional and Local Governments.

i. State Grants. Many of the sources of funds discussed above could be used not only for direct State acquisition of land but also for grants to regional and local agencies for programs of conservation and recreation related to the Bay. This was done with the 1964 State Bond Act funds, approximately 27 per cent of which were allocated to cities, counties, and special districts for land acquisition. But, as noted above, no additional bond funds for this purpose are immediately in prospect.

ii. The Harbors and Watercraft Fund, administered by the Department of Harbors and Watercraft in the Resources Agency, makes loans and small grants to publicly-owned small craft harbors throughout California.* Approximately $2.6 million was expended from the fund in the 1966-67 fiscal year, and about twice that amount is budgeted for expenditure during the 1967-68 fiscal year.

(c) Private Sources

i. Grants from Private Foundations. Vigorous efforts can and should be made to secure funds from private charitable foundations for Bay conservation and recreation. National and local foundations have made grants for similar purposes in the past, and might be willing to aid Bay conservation and recreation in the future. Some foundations require that their grants be matched by local funds, however.

* This fund receives the proceeds of taxes levied on gasoline bought for boats within California.

ii. Contributions from Bay Area Residents. It is impossible to estimate the amount of funds that might be raised by a vigorous appeal to residents of the Bay Area to contribute "Bucks for the Bay." While it is difficult to imagine that millions of dollars could be raised by such a method, it is certainly possible that at least some funds could be obtained through a well-planned campaign, perhaps advertising the opportunity to preserve a small portion of the Bay for each $1 contributed.

iii. Dedication of Bay Lands. Owners of Bay lands who dedicate their property for permanent conservation or recreational use are able to take substantial income-tax deductions for their gifts of land to the public. Several gifts of Bay lands have been made in the past to governmental bodies and to conservation organizations; generally, under the terms of these gifts, the donated Bay lands must remain forever open. While it is impossible to predict the number of such gifts that might be expected in the future, certainly vigorous efforts should be made to explain the tax advantages of land donations to the owners of property in the Bay.

(d) Regional Sources

While Federal, State, and private sources of funds may be available to help finance the conservation and recreation aspects of the Bay plan, the amount of these funds is by no means certain. Cities, counties, and special districts will spend some of their own funds on projects relating to the Bay, but once again the total of these funds may not be large.

Therefore, additional sources of funds would be needed within the Bay region. Funds could be raised through a bond issue covering only the nine Bay Area counties. Because of the increasing protest against rising property taxes, however, passage of such a bond issue at an early date would be difficult, especially if a two-thirds majority were required for approval. A region-wide bond issue would appear more promising if the bonds could be repaid from funds other than property taxes, and if -- as with State bond proposals -- a simple majority of the votes cast would be sufficient for approval.

If Alternative 2 is adopted as the preferred means for carrying out the Commission's plan for the Bay, and if a regional bond issue is considered the best means for financing massive purchase of Bay lands, then the Legislature should be asked to maintain rigid controls on Bay filling and dredging for at least three to five years, during which time a region-wide bond election would be held and an acquisition program carried out. The Legislature should also be asked to provide that the regional bonds could be adopted by a simple majority.

Possible Arguments for Alternative 2: Public purchase would be the best form of public control because regulations can be changed, but lands once in public ownership are most likely to be permanently reserved as open water. Purchase would be fair to property owners, who would receive payment for their lands.

Possible Arguments Against Alternative 2: Purchase of Bay lands may be impossibly expensive. Purchase might require the public to buy Bay lands at speculative prices. Because it is not legally necessary to buy private lands to prevent their being filled, such purchases would be an unnecessary expenditure of public funds.

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Alternative 3: Limited Regulation and Limited Purchase

If Alternative 1 (regulation of filling without compensation to property owners) is considered undesirable or unacceptable, and if Alternative 2 (massive public purchase of Bay lands) is considered infeasible, then a third alternative should be considered -- a compromise involving some regulation and some purchase to hold filling to a minimum.

The goal of Alternative 3 would be a careful limiting of fill -- but some filling of Bay lands not in accordance with the Bay plan could still take place.

Under Alternative 3, as under the other two alternatives, the agency carrying out the Bay plan would receive applications for fill permits. In the case of privately-owned tidelands, the agency would determine, after public hearings, whether or not the proposed filling was in accord with the Bay plan. If the project was in accord with the plan, a permit would be issued with conditions as necessary relating to the four general requirements noted previously, i.e., safety, appearance, public access to the Bay, and fill charge. The process would be similar to the consideration of planned unit developments under modern city and county ordinances.

Filling that is in accord with the Bay plan would presumably also be in accord with the public trust for commerce, fishing, and navigation. As explained in the BCDC report on Ownership, this trust, which is descended from English common law, means that the public originally had a right to use all tide and submerged lands in the Bay for commerce, fishing, and navigation, and retains that right even over lands in private ownership unless the right was cut off with legislative approval. The public trust with regard to some parts of the Bay has been terminated by action of the Legislature, but the trust unquestionably still applies to many thousands of privately-owned acres in the

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Bay. In some cases, therefore, filling that is not in accord with the plan might be prevented by the public trust, and all necessary legal steps should be taken to provide a determination in each case.

If a fill project is determined not to be in accord with the Bay plan, and if it is not affected by the public trust, then the agency carrying out the Bay plan could seek funds to buy the lands proposed for filling. Under this Alternative, as well as under Alternative 2, the agency carrying out the plan would need the power to buy Bay lands through negotiation if possible, and through eminent domain if necessary. This would require that funds be made available to buy some Bay lands, but a much smaller amount of money would be needed than under Alternative 2.

If, finally, a fill project is not in accord with the Bay plan, but is not affected by the public trust, and if efforts to prevent the filling by purchasing the lands are not considered feasible (or are tried but fail), then the agency carrying out the Bay plan would have to permit some filling to proceed -- with, however, one extremely important provision:

The fill would be limited to the amount necessary for the owner to receive <u>some</u> economic return on his property.

What would this mean in practice? In the case of an owner who holds both Bay lands and adjacent uplands, and who could derive considerable profit from development of the uplands alone, there might be no need to allow any filling at all. In the case of an owner who holds only Bay lands, but who could derive a sizable profit from intensively using a small fill, only this limited fill would have to be permitted and permanent retention of the balance of his holdings as open water could be assured.

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The court decisions upholding this approach to fill control do not indicate clearly what the legal interpretation of "some economic return" would be. But a survey of court cases shows that laws have generally been upheld if they did not reduce the value of regulated property below one-third of its value before the regulation went into effect. This would be one way of defining "some economic return."

Another would be consideration of a fair return on the owner's investment -- his purchase price plus improvements and taxes paid. In the case of Bay lands, this might be a low figure. And there is already precedent in California law, as well as in an important and recent Massachusetts decision (Commissioner of Natural Resources v. S. Volpe and Co.) for using investment as a basis to determine the required economic return.

A third approach would be to take the words literally -- filling would thus be allowed only to provide some, i.e., very limited, economic return.

Under any of the criteria, some filling would be allowed that is not in accordance with the Bay plan -- but the amount of such filling could clearly be limited. The amount of fill would have to be determined in each case, much as a planning commission for a city or county deals separately with each planned unit development presented to it.

But this method of determining the amount of fill to be permitted appears much more desirable than a rigid standard such as a fixed land-to-water ratio, i.e., a ratio requiring that a certain percentage of an area be left open water if part of it is to be filled. Any such ratio would inevitably be arbitrary, and might be unfair to some owners while permitting others great amounts of fill.

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In short, therefore, under Alternative 3, the agency carrying out the BCDC plan would be required to make one of two specific findings before approving a fill application:

a. The proposed filling is in accordance with the BCDC plan and should therefore be permitted, or

b. The proposed filling is not in accordance with the BCDC plan, but provides only for the amount of filling necessary to enable the property owner to receive some economic return and should therefore be permitted.

Fill applications would be denied if they did not meet either of these two criteria.

Alternative 3 would leave much discretion to the agency carrying out the plan for the Bay, but this seems necessary because of the complexity of the problems involved with each application. Because of the necessity for dealing with each application separately, the success of the Bay plan would depend in large measure on the caliber of the agency that administers it. The Bay agency should thus be designed to attract highly-qualified persons.

An important check on the discretionary power given to the Bay agency would be the right of any citizen, local government, or State agency to appeal to the courts any permit action that was believed to violate the Bay plan and its statutory criteria.

Possible Arguments for Alternative 3: This alternative is a compromise between the desires of the public to prevent fill and of the tideland owners to make a profit from fill. It is also a compromise between total fill prevention (by regulation in Alternative 1 or purchase in Alternative 2) and unrestricted filling.

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Possible Arguments against Alternative 3: It would allow some filling that does not provide substantial public benefits and which, therefore, from the public point of view, should not be allowed. On the other hand, from the point of view of the land owner, it might reduce the profit he expected to receive from filling.

HOW THE SHORELINE (AND THE BAY) CAN BE DEVELOPED TO THEIR HIGHEST POTENTIAL

1. The Bay, Shoreline, and Inland Areas

Planning for the Bay involves proposals to meet two principal objectives: (1) to conserve the Bay as a natural resource and (2) to develop the Bay and shoreline to their highest potential. Necessary economic development -- when coupled with necessary Bay conservation -- requires that an adequate amount of land on the shores of the Bay be provided for industries that must have water frontage, and for ports. Interesting, attractive shoreline development and maximum public access to the Bay for recreation and enjoyment are also important in making the Bay Area a more attractive place to live. (Of course, this in turn helps attract new industry.)

The total amount of shoreline is relatively fixed, and optimum economic development thus requires that sufficient shoreline areas be reserved to meet the long-range needs of each use. Failure to reserve the needed lands will result in either (1) reduction in the amount of waterfront industry, ports, airport facilities, or waterfront recreation that the Bay Area can eventually accommodate, with resulting damage to the overall economy, or (2) pressure to fill the Bay to provide the needed land.

Because economic pressures generally seem to prevail over park and conservation needs, more filling of the Bay appears to be the likely consequence if lands needed for water-related industry, ports, and airports are not reserved in advance. For example, failure to reserve adequate inland space for airports will virtually insure more Bay fills

for airports (e.g., additional filling is likely at the San Francisco or Oakland airports if the growth of passenger and air freight traffic is not directed to other Bay Area airport locations).

2. The Principle of Shared Jurisdiction

While there is thus a strong regional interest in the entire shoreline, there is also a strong local interest in the parts of the shoreline within each city and county bordering the Bay. To serve both the regional and the local interests in the shoreline, the principle of shared jurisdiction should be applied.

Under this principle, the agency designated to carry out the Bay plan would establish general policies and local governments would exercise jurisdiction over their own shoreline areas within these broad policies. The agency carrying out the Bay plan would use the plan to establish the general character of each shoreline area (i.e., port, water-related industry, marina, airport, park, etc.), but would not prepare a precise plan for each area (though it should be prepared to assist and cooperate with local governments in such planning).

Each city or county then would control its own shoreline development so long as the development was in accord with the regional plan. This would permit considerable variety in waterfront development while still insuring that an adequate amount of Bay frontage was reserved for all of the needed uses.

If changes in the general waterfront plan or development criteria were desired for any reason, the change could often be made by mutual agreement. If there were disagreements, however, the regional interest should prevail and thus the agency carrying out the Bay plan should have the deciding voice. But arbitrary or capricious action should be prevented by requiring that

the regional agency state explicitly its reasons for disagreeing with the local government's wishes.

Shared jurisdiction is not a new concept. It is already in limited use in California law: school districts must ordinarily abide by local zoning ordinances but may, through a two-thirds vote of a school board, override these ordinances in selecting school sites; in each case, however, the school board must publicly state its reasons for doing so.

Shared jurisdiction over shoreline areas will almost certainly raise questions with regard to the long-standing power of a city or county to regulate the uses of land within its borders. This power, often called the foundation of "home rule," has been carefully guarded by local governments. But in recent times, cities and counties have shared some of their land-use control with the Federal and State governments and with special-purpose districts. This trend toward sharing of power will almost certainly increase, because many of the problems of modern metropolitan areas cannot be solved satisfactorily within the limited geographic area of a single city or county.

This report has stressed the importance of protecting the regional interest in the shoreline, for necessary economic and recreational development. The agency carrying out the Bay plan must have a voice in decisions affecting waterfront areas to protect the regional interest, but its role should be limited to matters of regional importance, with local governments retaining the greatest possible authority.

3. Regional Uses of the Shore (and the Bay)

The most important aspects in developing the Bay and shoreline to their highest potential are waterfront industry, ports, airports, vista points above the Bay, shoreline parks, marinas

and fishing piers, and salt ponds. The extent of the regional interest to be protected by regulation differs in each case, as indicated below.

Waterfront Industry: Waterfront industry is basic to the economic health of the Bay region -- but land suitable for it will probably be in short supply well before the year 2020.

The BCDC report on Waterfront Industry indicated that, as a minimum, the agency designated to carry out the Bay plan should (1) maintain a current inventory of occupied and potential industrial areas, both shoreline and upland, (2) prescribe a detailed priority system for allowing only industries that specifically require a waterfront site to occupy valuable waterfront land, and (3) prepare site development and performance standards so each parcel is developed in a manner that avoids wasteful use of the available land.

Under the shared jurisdiction principle, local governments would continue their control of shoreline areas within these broad guidelines. But this measure of regional control is the minimum necessary to insure that waterfront areas needed by water-related industry are reserved for that purpose, in the interest of the entire regional economy.

A truly adequate solution -- which could be undertaken immediately -- would require efforts to reduce the pressure for waterfront sites from industries that do not need to be on the shores of the Bay but need only access to freeways or railroads. (Many freeways and railroads have been built close to the shoreline, but industries can, with some effort, be induced to locate on freeways and railroads away from the Bay.) To relieve this pressure on the limited shoreline, adequate inland sites would be needed for industries requiring direct freeway and rail access -- and, of course, adequate freeway and rail service would have to be provided where it is not now available.

Ports: To insure that San Francisco Bay continues as one of the world's great harbors, but to insure also that port expansion takes place without unnecessary Bay filling, the agency carrying out the Bay plan must have as a minimum the power to insure that port planning and development -- but not necessarily day-to-day port operations -- are conducted on a regional basis.

A truly adequate solution, considering the ports as a regional system, must take into account the fact that no major port in the United States is supported solely by revenues from shipping (ports are either subsidized by taxes or else derive lease revenues from housing, industry, restaurants, etc., built on port property). Thus, if individual ports do not have the funds necessary to build facilities needed by the region, some kind of more direct regional management of all ports may well be required. Otherwise, there will be tremendous pressure to allow the ports with the strongest finances to provide all of the regional facilities even though this might result in unnecessary filling of the Bay.

Airports: Airports have been built on the shores of the Bay because the Bay provides an open space for aircraft take-offs and landings away from densely-populated areas. But as the BCDC report on Airports emphasized, no study has ever been made of the Bay region's future needs for an area-wide air transportation system. As a minimum, an airport system plan is needed; the plan should include all forms of air transportation -- commercial, small-plane, and military -- and should consider the ground transportation of passengers and of freight necessary to serve airports. Furthermore, airport planning and development in the Bay Area -- but not necessarily day-to-day operation -- should be conducted by a regional agency to insure against unnecessary Bay filling for airport expansion.

Until now, the cost of building airports has generally been met from revenues generated by users of the airports and by Federal grants; there has been no continuing need for local tax support. The principle of shared jurisdiction may therefore prove adequate in the provision of improved airport facilities by local agencies. Eventually, however, a regional agency may have to become more directly involved if the costs of needed new facilities exceed the financial capabilities of local agencies.

Vista Points above the Bay: Tourists and Bay Area residents alike take great pleasure in viewing the Bay. The popularity of buildings with Bay views, and the crowds that gather at natural vantage points on clear days, illustrate the desirability of developing many more public viewing areas. Many potential sites for new viewpoints were described in the BCDC report on Appearance and Design.

Under the principle of shared jurisdiction, the agency designated to carry out the Bay plan should assist local, State, and Federal governments in acquiring and developing vista points; it should also prepare model ordinances for scenic easements and other methods of protecting the views from being blocked. The agency carrying out the Bay plan might have to be empowered to acquire and develop vista points if this program proves inadequate.

Public Parks, Marinas and Fishing Piers: The BCDC report on Recreation indicated that a growing Bay Area population, expected to have increasing amounts of time and money available for recreation, will need all of the Bayfront recreational land that can possibly be provided. The principal need is to reserve now all of the land that will be needed in the foreseeable future for recreation; otherwise, the land will be developed for other purposes.

Of all the major shoreline uses in the future, recreation will be the most difficult to finance. It is impossible at this time to even estimate

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the total cost of developing shoreline parks, marinas, fishing piers, and beaches. The cost of shoreline land varies widely and the cost of developing a variety of recreation facilities over a period of time cannot be accurately predicted. One current guide has been provided by the Army Corps of Engineers, which estimates that when the population of the Bay Area reaches 10 million, the region as a whole will need more than 100,000 acres of recreational land at an estimated cost of about $1 billion dollars. The Corps also estimates that the cost of needed recreational facilities will equal the cost of the land. All of this recreational land will not be provided on the shores of the Bay, of course, but a large amount of it should be located on the waterfront.

Private investment in Bay and shoreline recreation -- such as pleasure boat service, boatels, and restaurants -- should be encouraged wherever possible.

Recreational facilities can often be provided as by-products of other public projects. For example, necessary investment in flood control projects can often be used to provide improved recreational opportunities -- as in the "Three Finger Lakes" proposal in Palo Alto, Sunnyvale, and Mountain View, and the Alameda Creek-Coyote Hills Aquatic Park in southern Alameda County.

Under shared jurisdiction, some of the necessary money for shoreline recreational development would be provided by local governments. One desirable step to increase the amount of money available to local governments for recreational projects would be to relieve their reliance upon the heavily overburdened property tax. This could be done by (1) shifting major industrial and commercial properties to a regional tax roll, with the proceeds to be distributed to local governments on an equitable basis, or (2) developing new region-wide taxes to relieve

dependence on the property tax; these new taxes could include an income tax, sales tax, or real estate transfer tax.

All the shoreline lands needed for recreation cannot be bought immediately. Major attention should therefore be given to reserving lands needed for shoreline recreation and open space, and to keeping the price of such lands from inflating.

Two methods of doing this are:

a. Acquisition of easements or "development rights." The public could buy from a property owner an easement, such as the right to use privately-owned land for a beach, or the right to cross private property to reach a shoreline park. The public has the legal right to buy easements, and to acquire them by eminent domain if necessary.

   In addition, the public could buy from an owner the "development rights" to his property. The public would thus be paying an owner to keep his land in its present condition; the owner would be selling his right to erect buildings, or make other major changes in his land. Under present California law, the public is authorized to buy "development rights," but a change in law would be needed to give public agencies the power to condemn them.

   Purchase or condemnation of development rights would be most apt to succeed when a landowner has a profitable use of his property now (i.e., agricultural production) and when it is desired to retain the land in this use rather than have it developed in other ways (i.e., housing subdivision). Areas around the Bay for which "development rights" might be acquired include the salt ponds, the duck clubs in Suisun Bay, and some shoreline areas proposed for parks.

b. Permit favorable tax treatment. Under this method, an owner would pay taxes based on the open space use of his land, not on its potential value for other uses. Safeguards would have to be provided, however, to insure that the owner paid back taxes if in the future he converted his land to more profitable uses.

The "Open Space Taxation" amendment to the California Constitution (Section XXVIII, adopted in November, 1966) empowers the Legislature to establish procedures for assuring that tax assessments recognize any "enforceable restrictions" for open space use. A special Joint Legislative Committee under the chairmanship of Assemblyman John Knox is studying methods of carrying out this amendment and is due to report in 1969.

The Williamson Act of 1965 was an attempt to prevent rising property taxes from forcing conversion of open space lands to "higher" uses. But the Williamson Act had the effect of excusing taxes, rather than deferring them for only so long as the lands were not developed; presumably the Williamson Act would be superseded by any new legislation based on the Constitutional amendment.

Special tax treatment can aid preservation of open space, but it may also have severe disadvantages. Cities, counties, school districts, and other units of government are heavily dependent on the property tax and are thus apt to fight any attempts to stabilize or lower assessments on lands within their boundaries. In addition, they may expect to gain substantial tax revenues from development of lands being proposed for retention as open space; in some cases, however, the municipal expenses of providing streets, schools, and other urban services may offset all or part of the gain in revenues from development.

In any case, the extent of any fiscal burdens caused by special tax treatment of open space lands can be determined only on a case-by-case basis. In some cases, the effects might be slight, because preservation of open space in a community may add to the assessed value of nearby land that is already developed or is scheduled to be developed for urban uses. In other cases, however, the effects may be substantial so that alternate sources of tax revenues would be needed to finance local governmental services at the desired level.

Clearly, the heavy dependence of local governments on the property tax limits the use of tax policy as a method of protecting open space. This problem can best be resolved by substantially reducing the dependence of local governments on the property tax.

This is not, of course, an exhaustive list of possibilities, but rather an indication of some of the methods of holding open space and potential park lands in the face of increasing pressures for urban development.

Salt Ponds: The salt ponds of the Leslie Salt Co., totaling some 36,000 acres in the South Bay and some 10,000 acres in the North Bay, represent a special shoreline use. The future of the salt ponds is a matter of considerable concern. While Leslie has said it has no specific long-range plans for its holdings, urban development of some or all of the ponds is likely to receive increasing consideration. Already, ponds totaling some 4,200 acres have been removed from salt production and are now being converted into the Redwood Shores community, which will ultimately house some 60,000 persons.

What is the regional interest in the salt ponds? First, the ponds represent an economically important and productive use of the waters of the Bay (for extracting salt) and the salt is an important raw material for the Bay Area chemical industry.

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Second, the ponds provide some of the open space character of the Bay. Third, the shallow ponds are used as habitat by shorebirds. And fourth, the ponds provide an extensive area of water surface that helps to combat smog and maintain the climate in the Bay Area; filling the ponds (i.e., turning a water surface into a land surface, and then developing the land into housing, factories, roads, etc.) would tend to increase the amount of smog and also tend to raise summertime temperatures in parts of the Bay Area.

Thus, although the salt ponds are diked off from the tides of the Bay and therefore are not under the permit jurisdiction of the BCDC, the ponds are of major importance in any plan for the Bay.

The primary regional goal should be maintenance of the ponds in salt production. To do this, some form of special tax treatment may be needed so that rising property taxes are not allowed to force conversion of the ponds to urban development. Furthermore, this means that the integrity of the salt production system must be respected; Leslie cannot be asked to surrender its ponds at random for various purposes, because this would jeopardize the production system (in which brine is pumped from one pond to another during the salt-production cycle, with the ponds functioning in clusters of 4-5,000 acres).

Maintaining the salt ponds need not prevent greater public access to the South Bay. Park and marina development can be planned for sloughs in the South Bay, and, as has been demonstrated by the plans for the Alameda Creek-Coyote Hills Park in southern Alameda County, major recreational development can be achieved without seriously jeopardizing the salt ponds.

If, despite favorable tax treatment, Leslie desires in the future to withdraw any of its ponds from salt production, then full consideration should be given to opening up some or all of the Leslie dikes. This would represent the last substantial

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opportunity for man to enlarge -- rather than shrink -- the Bay. Opening the Leslie dikes might require some construction of new dikes on the landward side of the ponds if the present dikes have been serving to protect an inland area in addition to salt ponds.

Public purchase of the salt ponds for this purpose might be expensive, but one possible source of funds would be the fill charge discussed elsewhere in this report. Moreover, the possibility of converting salt ponds to urban uses could be avoided through public purchase soon of "development rights" -- the rights to use the ponds for anything but salt production. (Thus, as noted above, the agency designated to carry out the Bay plan should have the power to purchase development rights or possibly to condemn them.) If the public acquired these rights, Leslie would retain ownership of the ponds, and would retain unlimited rights to continue using them for salt production; Leslie would have given up only the possibility of filling the ponds for urban development.

Other Shoreline Uses: Uses of particular regional importance, i.e., ports, airports, waterfront industry or recreation, will not require the entire shoreline. But clearly there is a general regional interest in having the remainder of the shoreline limited to purposes that make a positive use of the Bay, and do not in any way adversely affect it.

It is proposed that the Bay plan limit uses of the shore to those meeting this criterion. Such uses include residential development, recreation making no use of the Bay, and special commercial, educational and cultural facilities and industrial parks (all of which can be made more enjoyable to the user by incorporation of the waterfront asset into the site design), plus sand and shell processing, and certain public utility installations (e.g., AM radio stations, sewage treatment plants, etc.).

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Activities that do not make positive use of the Bay or that would adversely affect it would be specifically prohibited. Such uses include refuse disposal or dredged spoils disposal (unless part of an approved shoreline development project), disposal of untreated wastes, and industrial uses that make no use of the waterfront, e.g., junk yards and industries located on the waterfront simply to obtain low rent.

Existing shoreline uses that meet the criterion would be accepted by the Bay plan (e.g., housing on Tiburon Peninsula). Those that do not meet the criterion would generally be proposed to be phased out over time and replaced by more appropriate activities.

4. Appearance and Access

Two aspects of all shoreline development directly affect the economy of the Bay Area and the attractiveness of the Bay Area environment. These are the design of each development and the incorporation in each, to the maximum extent feasible, of some kind of public access to the Bay.

Attractive appearance. Attractive development, particularly on a large scale, generates significant economic return. This is amply indicated by the large tourist and convention income derived in part from the attractiveness of the Bay Area today. A regional design review system is desirable to evaluate all developments that affect the appearance of the Bay and shoreline. The BCDC report on Appearance and Design suggests that the agency designated to carry out the Bay plan establish a Design Review Board composed of design professionals. The Board could refine the design criteria proposed in the plan for the Bay and publish them in a form usable by developers and local governments.

Under the shared jurisdiction principle, design control should remain with local government. But all proposed development should be required to be

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submitted to the Regional Review Board for comments that might serve to improve the overall quality of design.

General public access to the waterfront. In addition to the waterfront access that can be provided in public parks, marinas, and fishing piers, openings to the Bay should be provided wherever feasible in all waterfront developments. The goal should be making as much of the shoreline as possible accessible to the public; access to the Bay should thus be included in residential and industrial sites, and in port and airport areas to the extent that it can be safely provided.

The agency designated to carry out the Bay plan should model regulations involving waterfront zoning, subdivisions, tax arrangements, etc., so as to encourage the maximum amount of public access to the Bay.

Under the principle of shared jurisdiction, local governments would adopt and administer the access requirements. If this proved insufficient, however, the agency carrying out the plan should be empowered to enforce the public access provisions.

These provisions would generally suffice to insure public access in new Bayfront developments. But increased access should also be provided wherever feasible in existing developments, for example, through purchase of vacant lots; the agency designated to carry out the Bay plan may therefore need sufficient powers and funds to provide for such access points to supplement the efforts of cities and counties.

5. Extent of Bay Agency Jurisdiction on the Shore

If the Bay and its shoreline are to be developed to their highest potential, and if pressures for filling are to be minimized, then the agency carrying out the Bay plan will need the kinds of jurisdiction over the waterfront that have been described in the preceding sections.

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How far inland should the shared jurisdiction extend? There are two alternatives:

a. The shared jurisdiction could apply to a strip of land extending inland a fixed width from the shoreline, perhaps 100 feet, perhaps 500 feet, perhaps 1,000 feet, or perhaps half a mile. (The shoreline would be as defined by the McAteer-Petris Act, i.e., the line of tidal action up to five feet above mean sea level. In salt pond areas, the shoreline would be the Bayward boundary of the dikes.) Or

b. The shared jurisdiction could apply to a strip of land extending inland a varying width from the shoreline, encompassing each parcel of land on the shoreline and also contiguous inland parcels in the same ownership as shoreline properties.

At first glance, the shoreline band of fixed width may appear more understandable, easier to administer, and therefore better than the area of varying width. But a shoreline band of a fixed width would inevitably include some shoreline areas that need not be the concern of the agency carrying out the Bay plan, and would inevitably exclude other areas that definitely should be subject to the principle of shared jurisdiction. Furthermore, a band of fixed width measured from the line of tidal action would require extensive surveys to determine the precise limits of jurisdiction.

On the other hand, the shoreline band of varying width would help assure that Bayfront properties in common ownership, and thus likely to be used or developed as a unit, were treated as a unit by the Bay agency and local government. In some cases, these properties might extend inland a relatively short distance (i.e., the properties Bayward of the Eastshore Freeway in Emeryville or Berkeley). In other cases, the properties might extend inland a greater distance (i.e., properties owned by a port, an airport, or a large waterfront industry).

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If the alternative of varying width is chosen, the boundaries should be fixed as of a specific date, perhaps September 17, 1965 (the date on which the BCDC came into existence), or perhaps April 19, 1968 (the publication date of this report). In this way, the band of shared jurisdiction would be established without regard to future sales or subdivision of property within the band, and both buyers and sellers of property would be aware of whether their lands were included or excluded. A map showing boundary lines could be prepared from the records of county assessors; no surveys would be needed.

Within the shoreline band, the Bay agency would help insure provision of public access to the Bay, would work to insure attractive shoreline development, and, of perhaps greatest importance, would insure use of the shoreline by activities that make a positive use of the Bay and do not in any way adversely affect it.

Shared jurisdiction within the shoreline band as described above would not, however, guarantee an adequate supply of land for specific purposes that are of regional importance and that require access to the Bay. These include waterfront industry, ports, airports, and waterfront recreation. Therefore, as indicated on preceding pages, the shoreline band should extend sufficiently far inland to encompass all areas planned for these specific uses, which are directly related to the Bay. The extent of jurisdiction in these areas would have to be mapped in detail.

It is important to emphasize that within the shoreline area of shared jurisdiction, the agency carrying out the Bay plan would have a limited role: it would determine only general character and development standards and local governments could continue to exercise all their present powers within regional guidelines.

HOW THE SHORELINE (AND THE BAY) CAN BE DEVELOPED TO THEIR HIGHEST POTENTIAL

Sharing jurisdiction over the shoreline band in this way would help to reduce much of the pressure for filling the Bay. But as the previous discussion of waterfront industry and airports made clear, there will still be strong and increasing pressure for Bay fill until a broader regional agency begins to take steps such as reserving prime industrial sites in inland areas and developing new inland airports or expanding existing ones. In the meantime, the Bay agency should attempt to point out, on a continuing basis, those measures that can be undertaken in inland areas to relieve development pressures on the Bay.

AMOUNT OF MONEY NEEDED

1. Conservation and Development Costs

The McAteer-Petris Act requires that the BCDC estimate "the approximate amount of money that will be necessary to maintain and carry out the comprehensive plan, including, but not limited to, the Commission's estimate of the approximate amount of money that will be necessary to purchase real property which the Commission may recommend be purchased for public use."

The preceding pages have indicated the difficulty of providing reliable estimates of the costs of carrying out a Bay plan, partly because it is impossible to determine the total value of all Bay tidelands in anything more than general terms, and partly because it is virtually impossible to develop an orderly and precise program for raising funds to purchase Bay lands.

Nevertheless, as this report has indicated, it is clearly possible to develop a workable program for carrying out a Bay and shoreline plan.

The first -- and indispensable -- step in carrying out a plan is the designation of a governmental agency to which this responsibility would be assigned. Such an agency would have as one of its primary duties the raising of funds necessary for carrying out the Bay plan; as shown in this

AMOUNT OF MONEY NEEDED

report, many sources may be available to provide funds both for Bay conservation and for shoreline development; the agency designated to carry out the Bay plan should seek funds from as many (or all) of these sources as may be necessary.

2. Administrative Costs

In addition to the costs of acquiring and developing properties to carry out the Bay plan, the Bay agency will have some administrative costs.

Carrying out the Bay plan will require, as a minimum, (a) a planning staff to revise the plan as necessary and keep it up-to-date, and to assist cities and counties in detailed planning of shoreline areas, (b) a staff to process applications for permits, (c) consultant help -- primarily in the fields of engineering, economic analysis, and ecology -- to help with future planning and with the processing of permits, (d) engineering inspectors to insure compliance with permits, particularly as to the safety aspects of any approved fill projects, (e) attorneys, appraisers, and other technical assistance in the acquisition of Bay lands for public ownership, and (f) office rent, printing, postage, and other normal administrative expenses.

The costs of carrying out the plan would differ somewhat depending upon whether the agency responsible for this work is (1) an independent, autonomous district such as the Bay Area Pollution Control District, (2) a State agency such as the BCDC, or (3) a department of a limited regional government. The difference in costs is due primarily to the potential economies available to a general-purpose government; e.g., use of a motor pool, leased telephone lines, personnel and accounting services, etc.

In any case, however, the annual administrative cost of effectively carrying out the BCDC plan would probably be about $4-500,000. This figure is higher than the operating budget of the BCDC

AMOUNT OF MONEY NEEDED

(which has averaged about $225,000 per year) because the BCDC budget has not included funds for engineering inspection of fill projects, for negotiation and other legal steps to acquire Bay lands for public ownership, or for extensive assistance to cities, counties, and other governmental bodies with regard to detailed planning of specific shoreline areas.

Some of the expenses of the new agency will be offset, however, by the fees for permit applicants that are proposed to cover the costs of permit processing (as discussed on p. 7). No processing fees are now required of applicants for BCDC permits.

3. Sources of Administrative Funds

The general costs of the Bay agency could be financed from a number of sources. The sources would vary depending on whether the Bay agency were a special Bay agency or part of a limited regional government.

A special Bay agency, if it were a State agency, would presumably receive State appropriations annually. If it were an independent special district like the Bay Area Air Pollution Control District, it could be empowered to levy a small property tax. If, on the other hand, the Bay agency were part of a limited regional government, it would receive at least most of its support from the regional government. A broader range of taxes might be available to a limited Bay Area regional government than to a separate Bay district, because a multipurpose government would have more chance of obtaining political approval of new kinds of taxes, and because some taxes would return more revenues than needed for a Bay agency's operating budget.

SUMMARY

The Bay is a single physical mechanism, in which actions affecting one part may also affect other parts. Protecting the Bay as a great natural resource, and developing the Bay and shoreline to their highest potential, will require that the Bay plan be carried out by a governmental agency having adequate funds and adequate powers.

SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION
507 Polk St., San Francisco 94102 557-3686

Possible Bay Planning Conclusions Based on the Report on Powers

1. The principal objectives of the BCDC plan -- to safeguard San Francisco Bay as a Bay and to enhance development of the Bay and shoreline to their highest potential -- can be achieved only if the agency designated to carry out the plan is given adequate funds and adequate powers.

2. The powers needed to carry out a Bay plan with regard to the Bay are as follows:

a. Permit. The agency designated to carry out the Bay plan should be empowered to grant or deny permits for all filling or dredging in the Bay. Any public agency or any owner of private lands wishing to fill or dredge in the Bay should be required to first obtain a permit.

b. Permit procedures. Permit procedures are based on the following findings and assumptions:

(1) The primary objectives of the Bay plan are to develop the Bay and its shoreline to provide maximum public benefits with a minimum of Bay filling, and to protect the Bay as a great natural resource for the benefit of present and future generations.

(2) The Bay plan will have as its foundation a statement of policies to guide future conservation and development of the Bay and shoreline. These policies will include the following:

(a) Bay and shoreline development should be directly related to uses of the Bay as a Bay. The Bay should no longer be treated as ordinary real estate, but should be regarded as the single most valuable natural asset of the Bay region.

(b) Some Bay filling may be justified for purposes providing substantial public benefits that are directly related to the Bay if these same benefits could not be achieved equally well in a nearby location without fill. These purposes are: (1) providing adequate port terminals to enable the Bay to continue as one of the world's great harbors; (2) providing adequate land for industry that requires access to deep-water shipping; (3) providing for expanded airport facilities, if regional airport studies demonstrate that there are no feasible sites for airport expansion away from the Bay; and (4) providing greatly expanded public access to the Bay and public recreational areas along the shoreline.

(c) Minor amounts of filling may be permitted if necessary (1) to improve the attractiveness of shoreline developments, (2) to make possible additional public access to the Bay, or (3) to make possible additional recreational use of the waterfront, if these

improvements to shoreline developments could not be achieved without filling.

(d) Bay filling should clearly be limited to these purposes, however, because Bay filling of any sort is harmful to the Bay, and thus to present and future residents of the Bay Area. Bay filling threatens to destroy the habitat of fish and wildlife, threatens to destroy the scenic beauty of the Bay, threatens to increase water pollution, and threatens to increase air pollution.

(e) For purposes of sound Bay and shoreline planning, all Bay and shoreline holdings in a single ownership should be considered as a unit. (This is common in local government, where planning and zoning laws provide for planned unit developments that can cover large areas in a single ownership.)

(3) The policies that are the foundation of the Bay plan will probably be changed infrequently, if at all. Provision should be made for amending the policies, but only after public hearings and only on the basis of new information that justifies change. Application and interpretation of the policies as they would affect particular Bay and shoreline areas may be expected to shift somewhat as times change, however, and this would be reflected in the plan maps.

(4) All of the Bay lands and shoreline areas planned for recreational use, i.e., as parks or marinas, should be bought by the public. While precise estimates are not now available, it appears that purchasing these lands would cost many millions of dollars. It is reasonable to expect that some, but not all, of these lands will be bought by cities, counties, and other units of local government. If the public were to purchase all the remaining Bay lands that are now in private ownership, the cost could be as great as $285 million or more. A program of public purchases of this magnitude does not appear to be within the realm of economic possibility.

Permit procedures would operate as follows:

(1) An owner wishing to fill would apply for a permit in the manner described in the Summary report. As part of his application, the owner must show that:

(a) He had a valid title to the property proposed for filling.

(b) Either the public trust for commerce, navigation, and fishing did not apply to the property, or the filling would be consistent with the trust. (In some cases, the public trust would not allow the property to be filled.)

(c) The proposed filling was clearly in accordance with the Bay plan policies, i.e., (1) as to use, and (2) safety, appearance, public access, and fill charge as described on pp. 7-10 of the Summary report.

(2) Each application for a fill permit would be reviewed by the agency designated to carry out the Bay plan. If the proposal were found to be in accordance with the Bay plan policies (i.e., if it were found to provide substantial public benefits as defined in the Bay plan

policies and to meet the standards of safety, appearance, public access and fill charge), a fill permit would be issued.

(3) If the proposal were found not to be in accordance with the Bay plan policies, a fill permit would not be issued. In such cases, an owner might be able to change his proposal to conform to the Bay plan policies, and could then reapply.

3. The powers needed to carry out a Bay plan with regard to the shoreline are those described on pp. 26-41 of the Summary report. These are as follows:

a. Priority shoreline uses. The agency designated to carry out the Bay plan shall have the power to designate, reserve, and, where necessary, establish development standards for, shoreline areas required for priority uses.

(1) Priority shoreline uses (not necessarily in order of priority) are:

(a) Waterfront industry
(b) Ports
(c) Airports
(d) Shoreline recreation -- parks, marinas, piers, etc.
(e) Salt ponds

(2) This power is necessary because the total amount of shoreline is relatively fixed, and optimum development requires that sufficient shoreline area be reserved to meet the long-range needs of each priority use. Failure to reserve the needed shoreline land will result in either (a) reduction in the amount of waterfront industry, ports, airport facilities, or waterfront recreation that the Bay Area can eventually accommodate, with resulting damage to the region's economy, or (b) pressure to fill the Bay to provide more land for these priority uses.

(3) The areas reserved for these priority shoreline uses should extend sufficiently far inland to encompass the entire areas planned for each use (all the uses are, of course, directly related to the Bay).

(4) Local governments should continue to control shoreline development as at present, subject only to the requirement that the development be in accordance with the Bay plan's designation of the general use and development standards for the area.

b. General shoreline improvement. The agency designated to carry out the Bay plan should have the power to insure that all of the Bay shoreline not needed for priority uses is maintained or developed in ways that make a positive use of the Bay and do not affect it adversely.

(1) Plans for all proposed shoreline developments should be submitted to a regional Design Review Board for comments that might serve to improve the overall quality of design.

(2) As much of the shoreline as feasible should be made accessible to the public. Access to the Bay should thus be included in as many shoreline developments as possible, including residential and industrial sites wherever feasible, and in port and airport areas to the extent that it can be provided safely.

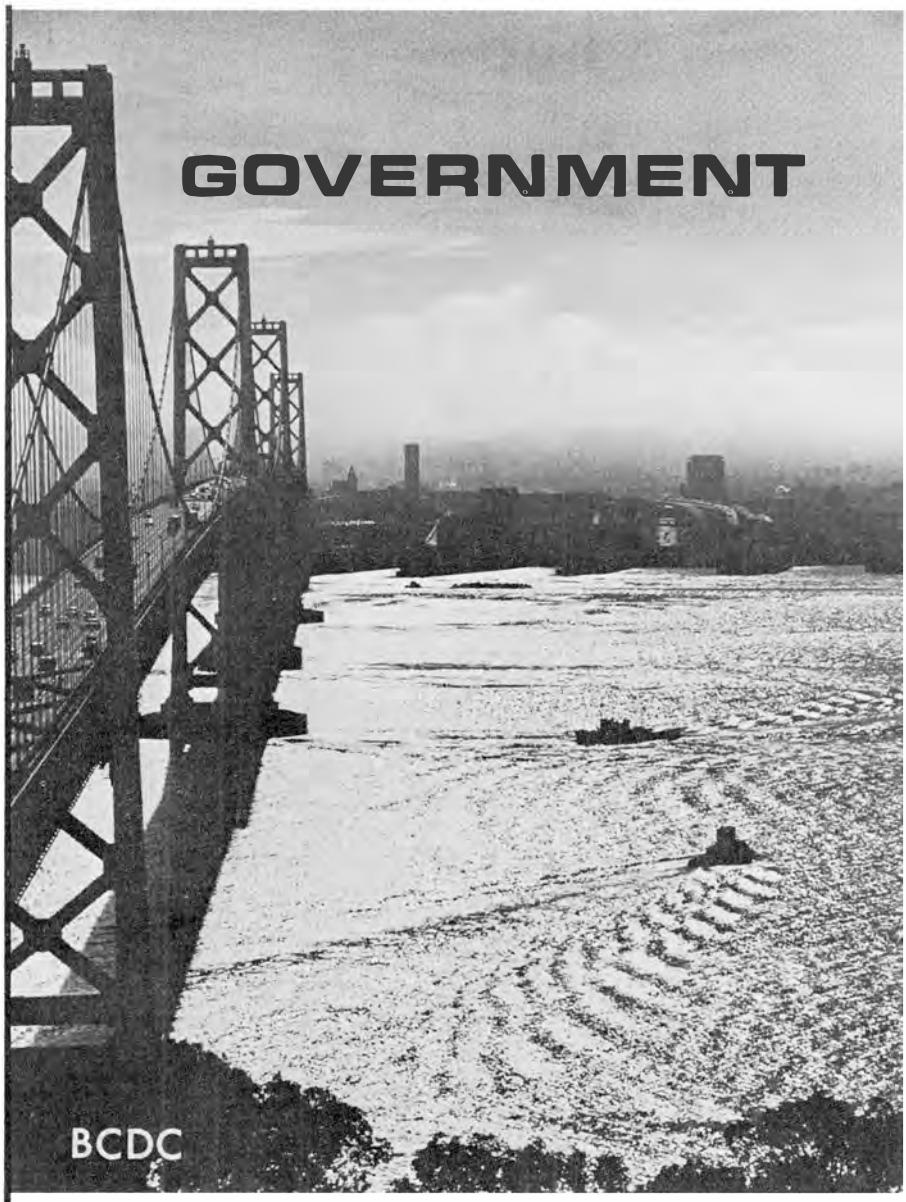
(3) The area of concern for general shoreline improvement should extend inland from the shoreline a varying distance, encompassing each parcel of land on the shoreline and also contiguous inland parcels in the same ownership and use, or 100 feet, whichever is greater.

c. Inland advisory role. The agency designated to carry out the Bay plan should have the power to advise on those measures, such as reserving inland industrial sites and developing new or expanded inland airports, that could relieve pressures for Bay fill. In addition, it should have the power to advise on steps necessary to preserve and enhance scenic views of the Bay from public roads and vista points.

Adopted by the Commission at its meeting of 5/17/68

GOVERNMENT

Part of
a Detailed
Study of
San Francisco
Bay



San Francisco Bay
Conservation and
Development
Commission

San Francisco
California

November 1967

Summary of the report, "Government: Regional Organization for Bay Conservation and Development," by Stanley Scott and John C. Bollens.

WHY SOME KIND OF GOVERNMENTAL AGENCY IS NEEDED

San Francisco Bay is a single, indivisible body of water. But existing governments in the Bay Area have, in the past, used the parts of the Bay under their control as each thought best. Much of the Bay was thus filled or diked off, and little thought was given to the effects of this piecemeal filling on the Bay as a whole.

As the population of the Bay Area grows, and as pressures mount for competing and conflicting uses of the Bay, an effective governmental agency is needed to carry out a plan that will provide for the wise use of the Bay in the best interests of the region as a whole.

The California Legislature, in creating the BCDC, has required it to recommend "the appropriate agency to maintain and carry out" its plan for the Bay.

Past experience has demonstrated that fragmented control by many individual governments is ineffective. And complete control by State or Federal governments would not be acceptable to the residents of the Bay Area. So a regional agency appears to be necessary; but what kind of agency?

A SINGLE-PURPOSE AGENCY?

A special district could be created for the Bay, perhaps along the lines of the Bay Area Air Pollution Control District or the Bay Area Rapid Transit District.

Such a district could be created easily by the Legislature. The district would cause minimum disturbance to existing units of government. It could focus attention on the Bay, and this concern for the Bay would not be diluted by concern with other regional problems.

But such a district would have problems common to all special-purpose governmental agencies: It would be difficult to create a governing body truly responsible to the regional public. It would be difficult to give the district adequate financial powers, particularly if it had to depend on the property tax. And

A SINGLE-PURPOSE AGENCY?

such a district would continue the proliferation of governmental agencies in the Bay Area, bringing further fragmentation of public authority and increasing an unnecessary competition among governments for funds and power. 1/

A MULTI-PURPOSE AGENCY?

Alternatively, a multi-purpose governmental agency could be created that would have responsibility not only for carrying out Bay plans, but also for solving other regional problems, such as solid waste disposal, acquisition and operation of regional parks and open space, control of air and water pollution, and meeting area-wide transportation needs.

A comprehensive agency could weigh the various needs of the region, allocating priorities to the regional programs of the greatest importance and striving for a balance among them. Because most problems affecting the Bay do not stop at the water's edge (e.g., ports, airports, freeway routes, industrial sites), a multi-purpose agency could do a better job of coordinating and accommodating competing uses. A comprehensive agency in place of many competing special districts would have higher political "visibility" -- i.e., as a major governmental agency, there would be greater voter interest in election campaigns or policy proposals concerning it. But such an agency would be more difficult to create than a single-purpose district because it would incur resistance from agencies or units of government that might be modified or absorbed into the comprehensive agency. (However, existing regional districts created by the State Legislature could be combined by the Legislature; and none of the functions of cities and counties would need to be affected except those that were determined to be of regional importance.) Another obstacle is that comprehensive regional agencies are still relatively new in the United States, and therefore feared in some quarters because they are too little understood.

1/ As used in this report, "the Bay Area" means the nine counties bordering the Bay, because any agency formed to carry out plans for the Bay must include all of them. However, suggestions have been made by others that the geographic area included be either smaller or larger.

WHICH KIND OF AGENCY IS BETTER?

Either a single- or multi-purpose approach would be adequate for the purpose of carrying out a plan for the Bay. To be effective, either one would need the following powers as a minimum:

1. Planning - authority to continue the research and planning necessary for informed decision-making.

2. Regulation - continuation of the present power to grant or withhold permits for Bay fill and, in addition, some authority to require that lands adjoining the Bay be used for purposes compatible with the overall Bay plan.

3. Acquisition and eminent domain - authority to buy lands where public ownership is necessary to carry out the plan, and to acquire such lands through condemnation if necessary.

4. Development - authority to provide, either directly or by arrangement with another governmental agency, such public facilities as beaches, marinas, and other waterfront developments, that may be required to carry out the plan for the Bay but may not logically be the responsibility of another agency.

5. Financing - ability to raise enough money to carry out the above activities.

Clearly, these powers could be exercised by a single-purpose Bay district. And it may be, even if a more comprehensive governmental agency were to be created, that a single-purpose district will prove to be an essential temporary expedient until the comprehensive agency comes into existence. The governing body of such a single-purpose district could be like the current Bay Commission, consisting of appointees from cities, counties, State agencies, and the public, or the governing body could be chosen by direct election.

Many of the decisions that affect the Bay are now being made by a wide variety of local and State agencies that build bridges, freeways, ports, airports, sewage treatment plants, etc. A multi-purpose government that embraces all or a substantial share

WHICH KIND OF AGENCY IS BETTER?

of such development activities probably would be desirable, to obtain the best use of limited natural resources and funds (this is the reason for the Federal requirement that an increasingly wide variety of Federal grants be reviewed by a single regional agency).

The continuation of a wide variety of "independent" agencies would also be confusing to both voters and policy-makers. The multitude of independent policies and programs would be extremely difficult to coordinate successfully. Therefore, a comprehensive multi-purpose agency should be an early objective for the good of the Bay and the Bay region.

BASIC OBJECTIVES FOR A REGIONAL AGENCY

A satisfactory comprehensive agency is more difficult to construct that a single-purpose agency, because so many more factors are involved. The following are basic objectives for either a single-purpose or a multi-purpose agency:

1. Limited Government - a regional agency should deal only with problems requiring area-wide solutions. Local governments should continue to control local matters.

2. Responsive Governing Body - a regional agency should have a governing body that is responsive to the regional interests and needs of the Bay Area public.

3. Effective Leadership and Performance - a regional agency should be organized in a manner that encourages effective leadership and performance. This requires that the agency have (1) a governing body that can attract highly qualified members and can operate efficiently, (2) a strong chief executive, and (3) an efficient staff.

4. Sufficient Money and Powers - a regional agency should be granted enough, but no more than enough, money and powers to do the jobs assigned to it.

WHAT HAS BEEN DONE ELSEWHERE?

Various kinds of regional governmental organization have been considered or established elsewhere in the United States and Canada. Some of these experiences shed light on how a comprehensive agency could be fashioned for the Bay Area.

1. City-County Consolidation

City-county consolidations merge one or more major cities in a metropolitan area with the county government. Consolidation has been rarely used; the best-known recent example is Nashville-Davidson County, Tennessee, approved in 1962 by the voters of Nashville and the rest of the county.

This form of government has little relevance to the Bay Area. A complete consolidation of all 91 city and 9 county governments of the Bay Area into a single entity is exceedingly unlikely. Even if it were possible politically, it would be undesirable. A single government encompassing 7,000 square miles and a growing population already totaling 4.5 million, would actually be the "super government" that is frequently raised as a specter in discussions of regional problems.

2. Comprehensive Urban County

Under the urban county approach, an existing county government is converted into a multi-purpose regional agency through the transfer of functions from city governments -- but the city governments are not eliminated as in the case of the city-county consolidation.

The only comprehensive urban county system in the United States is Dade County (Miami), Florida, where it went into effect in 1957, covering an area of over 2,000 square miles and 26 cities. The county governing body, chosen by direct election, was given many area-wide powers. Effective operation of the county government was crippled, however, by the lack of an elected leader (putting great political pressure on the appointed county manager instead of on political candidates) and by numerous referenda and legal challenges.

WHAT HAS BEEN DONE ELSEWHERE?

Dade County experiences relevant to the Bay Area include: (1) cities can delegate some powers to a regional agency and still retain many others; (2) direct election of a regional governing body is workable; (3) effective leadership for a regional government suggests that the chief executive should be elected by and be responsible to the voters of the entire region; and (4) a new government should have some protection from excessively-debilitating legal harassment, at least during its initial period of operation.

3. Federation

In federation, local governments are linked in an overall government, roughly comparable to the United States government and its federal system of states. Powers are allocated between the regional and the local levels of government. The members of the regional governing body are chosen from local areas (not necessarily cities). Federation plans have been considered in many areas of the United States -- including a plan to link San Francisco and San Mateo counties in the late 1920's. However, two legal obstacles have generally been fatal: (1) necessary amendments of a state constitution could not be obtained, and (2) often a majority vote of approval in each city was required and could not be obtained.

The major North American example of metropolitan federation is Toronto, Canada, established in 1953. The Toronto federation was recommended by a provincial (state) commission and enacted by the Provincial Legislature without local referendum, but after extensive local hearings. The new government embraced all 13 cities in the metropolitan area and was assigned those functions judged to be essential for the entire area; the central city of Toronto and its 12 suburbs continued to deal with matters not delegated to the metropolitan government. Each city was represented in the metropolitan governing body. In response to demonstrated needs, the powers of the metropolitan government were increased in 1957. In 1967 several of the member municipalities were consolidated, and the metropolitan governing body was reapportioned to conform closely to changed population

WHAT HAS BEEN DONE ELSEWHERE?

distribution. The governing council was enlarged from 24 to 32 members. The powerful executive committee -- which was enlarged from 7 to 11 members -- prepares the annual budget, awards all contracts, nominates department heads and initiates policy. A two-thirds vote of the whole council is needed to overrule the executive committee.

Toronto experiences of relevance to the Bay Area are: (1) metropolitan reform can be accomplished through federation by direct action of the provincial (state) legislature without a popular referendum; (2) a strong executive committee is essential if the governing body is so constituted as to be unwieldy; (3) periodic review of the organization plus the ability to reorganize it in the light of changing circumstances are necessary to keep the regional government up-to-date; and (4) local functions can be sorted out from areawide responsibilities, enabling local governments to continue providing those services best dealt with at their level.

4. Regional Special-Purpose Districts

Regional special-purpose districts, sometimes called "commissions" and "authorities," are common in metropolitan areas throughout the United States. They operate ports, airports, sewage disposal facilities, mass transit, regional parks, public housing, water supply systems, bridges, and engage in many other activities. Two Bay Area examples are the air pollution control and rapid transit districts. The reason for the popularity of special districts has already been described: they are the easiest to create and the type of regional agency least resisted by existing units of government. In most instances, members of a district's governing board are selected by appointment rather than through direct election by the voters. The appointment method has been criticized because powerful districts so constituted may be insufficiently accountable to the public.

Of obvious relevance to the Bay Area is the demonstrated fact that regional special-purpose districts have proven to be the "easiest" solution to various Bay Area problems (though not every attempt to create

WHAT HAS BEEN DONE ELSEWHERE?

a district has been successful). Formation of districts by the State Legislature, without a popular referendum, eases their birth, but a basic problem remains, because the several district governing bodies are neither coordinated nor effectively accountable to the metropolitan public.

5. Councils of Governments

Metropolitan or regional "councils of governments" are associations of existing city and county governments. Unlike the preceding alternatives, a council of governments (COG) has no power, providing only for voluntary cooperation of its member cities and counties. A COG is a "continuing forum" for the discussion of regional problems, and thus has no authority to enforce its decisions.

Although the COG approach attempts to build on the existing situation without disturbing the legal status of cities and counties, until recently it has been slow to catch hold in the United States. The Association of Bay Area Governments (ABAG), formed in 1961, was one of the first. By 1964, only nine metropolitan areas had COGs. Now, however, the COG idea is being widely adopted because new federal legislation requires some such regional organization to screen a wide variety of applications for federal grants and loans throughout the region, thus using "local" regional agencies, instead of state or federal bureaus, to coordinate the flow of grants in the hope of preventing duplication and waste.

The governing bodies of councils of governments are usually composed of city councilmen and county supervisors. Each city and county, regardless of size, has one vote. Because the COG governing body is often large, a small executive committee has proven necessary to propose policy and to perform the review functions required under the federal legislation. One criticism of councilmen and supervisor "representatives" is that they often tend to reflect and defend their individual local interests. On the other hand, exposure to regional problems tends to help broaden their understanding of such problems, even though their primary loyalty and responsibility is to their home cities and counties.

WHAT HAS BEEN DONE ELSEWHERE?

The council of governments approach is relevant to the Bay Area because of the existence of ABAG. Recognizing the need for a multi-purpose regional agency to undertake new responsibilities, and to reduce the number of special districts in the Bay Area, ABAG has recently initiated an effort to transform itself from a voluntary association into a limited-function regional government.

6. The Tahoe Regional Planning Agency

The most recently established regional organization in North America is the Tahoe Regional Planning Agency, created by the 1967 California state legislature.

The Tahoe agency is to prepare and adopt, then review and maintain, a comprehensive, long-term general plan for the Tahoe region. The plan is to include land use, transportation, recreation, and public services and facilities. To carry out the adopted plan, the agency has power to adopt ordinances, regulations, and policies containing general regional standards for (among other things) zoning, solid waste disposal, sewage disposal, shoreline development, and flood plain protection. In addition, the agency has power to insure compliance with the regional plan and its ordinances, regulations, and policies by legal action if the agency finds that its decisions are not being enforced by a local jurisdiction.

The agency is to have a five-member governing body consisting of one representative of each of the two California counties in the Tahoe region and one from the region's single incorporated city (South Lake Tahoe), plus the Administrator of the California Resources Agency, and an appointee of the Governor representing the public at large.

Upon approval by the State of Nevada and the U. S. Congress, an interstate compact would come into effect expanding the jurisdiction of the Tahoe regional agency to the Nevada portion of the Tahoe Basin, and adding five Nevada residents (selected in roughly the same method as the California members) to the agency.

WHAT HAS BEEN DONE ELSEWHERE?

The workings of the Tahoe Regional Planning Agency will be watched with great interest in the Bay Area, since the Agency was formed specifically to regulate man's use of an irreplaceable resource similar to the Bay. The initial experiences of the Agency in attempting to coordinate development throughout the Tahoe region may be particularly relevant to the Bay Area, which must deal with many of the same kinds of problems. At the same time, however, there are a number of complex problems involved in determining the future of the Bay that do not exist with regard to Lake Tahoe -- use of the Bay as a world port, for example, or airport expansion into the Bay -- so that the concept of the Tahoe Regional Planning Agency might not be precisely applicable to the Bay.

RECENT DEVELOPMENTS IN THE BAY AREA

1. Study Commission Reports on Bay Government

Three of the current regional study programs created by the State Legislature for the Bay Area are required to recommend the kind of regional agency or agencies needed to carry out their plans. (In addition to this requirement in the BCDC legislation, the Bay Area Transportation Study Commission (BATSC), which is preparing an overall transportation plan for the region, and the Bay-Delta Water Quality Control Program, which is preparing a comprehensive plan to control pollution of the waters of San Francisco Bay and the Delta, are both required to make such proposals.) Implicit in the creation of the study commissions is the likelihood that some solutions to the vast regional problems each is studying may be beyond the power of any existing local governments or regional districts.

2. ABAG Proposal for Regional Government

As noted above, the Association of Bay Area Governments has proposed that it be converted into a formal regional government for the Bay Area. If this were done, ABAG would continue to perform advisory regional planning, and would, in addition, assume responsibility for three functions not now adequately dealt with on a regional basis: solid waste disposal, parks and open space, and airports. ABAG proposes eventually

to assume the responsibility for Bay conservation and development, regional transportation, and other regional programs.

A 34-member Executive Committee (giving the larger cities and counties additional votes roughly proportional to their population) would in effect determine ABAG policy, although its decisions on planning, finance, and property acquisition would be subject to the approval of the ABAG General Assembly, in which each city and county, regardless of size, would continue to have a single vote. A president and vice-president would be elected for two-year terms by secret ballot of all city councilmen and supervisors; the president and vice-president would not have to be councilmen or supervisors.

The ABAG proposal is a significant step forward toward solving Bay Area regional problems. It recognizes that a limited-function, multi-purpose regional government is needed. It recognizes that the most feasible method of formation is through direct legislative action. It would restructure the ABAG Executive Committee (but not the General Assembly) to adjust voting power in proportion to the populations of the member cities and counties. And, it has raised the need for a comprehensive regional agency to a higher level of public awareness than has ever been achieved before.

Weaknesses of the ABAG proposal are that the new government would (1) lack regulatory power to carry out ABAG's own preliminary regional plan, (2) have its proposed authority of eminent domain so restricted by veto provisions as to render the power almost useless for major projects, (3) have severely limited revenues, depending primarily on a property tax of one cent per $100 of assessed valuation plus general obligation bond financing, (4) establish a governing body needing further adjustment to comply with the "one man, one vote" principle of equal representation, and (5) fail to provide for direct election of members of the governing body.

RECENT DEVELOPMENTS IN THE BAY AREA

3. Joint Committee on Bay Area Regional Organization

In anticipation of separate governmental proposals from ABAG and the three study groups, the State Legislature has embarked upon its own study of regional governmental problems in the Bay Area through passage of Senate Concurrent Resolution No. 41. The study, to be completed with recommendations to the full Legislature in March, 1969, is being conducted by a joint legislative committee consisting of four state senators and four assemblymen, under the chairmanship of Assemblyman John Knox. The committee is assisted by an advisory group including representatives of cities and counties, the general public, and the major regional agencies in the Bay Area (e.g., BCDC, BARTD, BATSC, etc.).

DETERMINING THE MOST DESIRABLE APPROACH TO BAY GOVERNMENT

Having recognized that an adequate governmental agency is necessary to carry out a plan for the Bay, the next question is: how should it be constructed?

There are many complicated alternatives and possible variations. The most important considerations are explored briefly under the four major objectives: Limited Government, Responsive Governing Body, Effective Leadership and Performance, and Sufficient Money and Powers.

1. Limited Government

A regional agency should deal only with problems requiring area-wide solutions. Local governments should continue to control local matters.

As a general rule, those things that can be handled well by local governments, should be, because local political decisions can be more sensitive to the wishes of the people of individual areas.

Which problems should then be solved regionally? The questions to be asked in determining the answers are: (1) How well is the function now being carried out? and (2) Are important regional problems being ignored at the present time?

DETERMINING THE MOST DESIRABLE APPROACH TO BAY GOVERNMENT

To help determine which functions should be administered regionally, the Joint Legislative Committee on Bay Area Regional Organization (created by SCR 41) is specifically required to study the following: regional planning, air and water pollution, solid waste disposal, regional parks and open space, and regional transportation (including rapid transit, ports, airports, and bridges).

Obviously, few of these problems are exclusively regional or local. Most can and should be separated into logical local and regional components. BCDC has been operating as a regional agency with some of the powers that a permanent agency for Bay conservation and development must have. Yet the cities and counties and the State and Federal Governments have retained their respective roles concerning the Bay. This is true also of other regional agencies, such as the air pollution control district, which regulates emissions from incinerators and industrial plants, while local jurisdictions retain power to approve the location of such activities and the State government polices safety and other regulations.

While "limited function" government means minimum disruption of the present powers of local governments, consideration must also be given to the activities of State and Federal Governments that an effective regional agency might assume. Many decisions of State and Federal agencies directly affect the region, and many of these decisions could be assumed by the regional agency, giving the region greater control over its own future development.

Operate or Coordinate? A multi-purpose regional agency could be established to operate or simply to coordinate or to do both. In any case, the new agency would have jurisdiction only over matters decided to be of regional importance.

An operating agency would be similar to a city or county government; each regional function (pollution control, Bay regulation, transportation, planning, for instance) would be established as a department of the regional agency, with a department chief reporting

to the head of the agency staff. If the regional agency were to absorb existing governmental units, such as the smog-control district, or the rapid transit district, this absorption would probably have to be phased over a period of several years to insure an orderly transition.

A coordinating agency (sometimes called an "umbrella" agency) would coordinate the policies of, but not fully absorb, existing regional units. This would enable the Bay Area to benefit from the experience and expertise of the regional districts, while insuring that their actions were fully compatible with the overall regional policies. To be effective, the coordinating agency would need significant powers: it might appoint some or all of the members of the governing board of the subsidiary agencies, and it would need authority to disapprove any of their proposals that threatened to conflict with adopted regional goals or plans. The coordinating agency could be greatly strengthened by making it the distributor of Federal and State funds made available in the region.

A regional agency could also readily be a combination of both an operating and a coordinating agency, thus minimizing disruption of existing agencies and programs, yet enabling it to initiate new services and programs without the establishment of more single-purpose agencies.

If it should prove impossible or undesirable to create a single comprehensive regional agency for the Bay Area, and if, therefore, one or more additional regional districts are to be established, such districts should at least be made as nearly parallel in structure as possible, to encourage coordination among them and facilitate the possibility of eventual merger.

2. Responsive Governing Body

The regional agency should have a governing body that is responsive to the regional interests and needs of the Bay Area public.

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The degree of "responsiveness" of the governing body depends in turn upon how much the public is aware of and concerned about the policies of the agency. Both the awareness of the voting public and the responsiveness of a governing body are affected by:

a. Whether many single-purpose districts or one comprehensive government is involved, and

b. How the members are selected (appointed or elected),

   1. If appointed, who appoints them,

   2. If elected, how big the voting districts or wards are, and whether partisan politics are involved, and

c. How "special interests" are represented.

Comprehensive Government vs. Many Districts. A pivotal question is whether the voter must be aware of and know about many different special-purpose districts or only a single comprehensive government. Experience in the Bay Area has shown that direct election of members of the governing boards of single-purpose districts rarely arouses much voter interest. Few such elections involve spirited contests or draw the sustained popular attention necessary if the governing body is to know, and to respond to, the wishes of the voting public.

Thus, comprehensive government is much more likely to achieve the necessary popular awareness and concern. It is possible, however, that a single-purpose agency, dealing with a controversial matter such as conservation and development of the Bay, could generate a relatively high degree of voter interest.

Appointed or Elected? As a general rule, the governing bodies of regional single-purpose agencies have been appointed (or elected by a small group, such as a council of mayors), while the governing bodies of comprehensive governments (cities, counties, states, and national) have been elected directly by the people. Appointment appears desirable when there is difficulty achieving a high level of voter interest. On the other hand, direct election is desirable when high voter interest is likely, as in the case of a comprehensive agency

or possibly a controversial single-purpose board with high political visibility.

Another factor in choosing between election and appointment for the governing body is the need for a regional agency to work closely with city and county governments in the Bay Area. This might make it desirable to have the regional governing body composed of both appointees of cities and counties and directly-elected representatives (if this method of liaison is chosen over less formal means). The appointees could be city councilmen or supervisors -- though the responsibilities of a multi-purpose regional agency would require so much of their time as to make this difficult -- or they could be laymen chosen by city and county governments. In any event, various combinations of directly-elected and appointed representatives are possible in designing a governing body.

Appointments: Who Should Make Them? In the Bay Area, appointments to regional boards are generally made by the Governor or by local governments. In addition, the legislation creating special-purpose districts often requires that some members of the governing body be representatives of specific government agencies. Appointment of a whole board by the Governor is not desirable because the appointees would have no direct responsibility to the public of the region and could be too independent and "unresponsive." But a combination of Governor's appointees and locally-appointed members may be satisfactory because several points of view may thus be represented. In the Bay Area, one governing board is entirely appointed by the Governor (San Francisco Bay Regional Water Quality Control Board), while two other governing boards are appointed by local governments (Bay Area Air Pollution Control District and Bay Area Rapid Transit District). Larger governing boards in the Bay Area tend to have a combination of Governor's appointees and local appointees (BCDC and Bay Area Transportation Study Commission).

Election: How Big the Voting Districts? The size of electoral districts -- in either square miles or population -- influences elections. Large districts

tend to (1) reduce the voter's ability to "know" the candidates, (2) increase the influence of mass news media, (3) increase the effort and expense required in political campaigns, thus permitting more influence by well-financed interests, (4) dilute the influence of minority-group voters, and (5) encourage candidates to give greater attention to regional matters as opposed to local interests.

Conversely, small election districts may (1) increase the ability of voters to know the candidates, (2) increase the influence of smaller community newspapers and community pressure groups, (3) encourage excessive local selfishness to the detriment of broader regional interests, (4) reduce the effort and expense required in campaigns, and (5) increase the likelihood that concentrations of minority-group voters will have an effective voice.

With minor adjustments in boundaries, either State Senate or Assembly districts could form the basis for electing a regional governing body. Such districts would meet "one man, one vote" standards and would be reapportioned automatically. The major difference between the two sets of districts is size, Assembly districts generally having half as many voters as Senate districts. Because of the differences in size, Assembly district campaigns cost roughly half the expense and effort of Senate campaigns and make it easier for a minority-group to be represented. (The Bay Area's nine Senators are all Caucasian, while the 18-member Assembly delegation contains three non-Caucasians.)

As an alternative, electoral districts could be created especially for balloting to choose members of the regional governing body. Drawing the lines for such a district might be time-consuming and controversial. Nevertheless, special electoral districts for the regional agency would avoid the confusion that might result if the voters had to choose legislators for both the regional agency and the State Legislature from the same districts.

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Election: Partisan vs. Non-Partisan. Tradition, as well as what appears to be the majority view of California leaders -- both partisan and non-partisan -- holds that partisan elections are undesirable for local and regional government. This stems in part from the scandals of the political machines that controlled local and State politics in the late 19th and early 20th centuries. But as local and regional governmental agencies have become more deeply involved with some of the most fundamental issues confronting American society, the number of proposals for bringing political parties into local elections in California has increased. Parties can, and often do, play an important role in stimulating voter interest and awareness, increasing voter turnout, and providing citizens with full discussion of opposing points of view. Partisan election would therefore be desirable for the regional government, but it is not so important an issue that it should be pursued initially and thus add to the difficulties of getting the agency created.

Representation of "Special Interests." Legislation creating appointed governing bodies has often required that specific government agencies or specific interest groups (e.g., irrigated agriculture, industries producing industrial wastes, recreation and wildlife, cities, etc.) be represented on the board. This may be desirable in some cases, as it gives guidance to those who make the appointments to the boards. On the other hand, it does not appear that elected governing bodies should be deliberately designed to contain representatives of special interests since these can be represented at public hearings or through membership on advisory councils.

The Federal and State governments have intersts in the Bay Area, partly because they invest large sums of money on various programs in the region every year. But this does not mean they should be represented in an appointed or elected governing body. The State's interest can be protected by the State's legislative authority to review the operations of the regional government and to restructure it if necessary. Federal interests can be protected by control of various financial aid programs and by exercise of the Federal Government's legal power.

3. Effective Leadership and Performance

A regional agency should be organized in a manner that encourages effective leadership and performance. This requires that the agency have (1) a governing body that can attract highly qualified members and can operate efficiently, (2) a strong chief executive, and (3) an efficient staff.

An important factor affecting the efficiency of a governing body is its size. The quality of members it will attract is affected by the scope of its power and responsibilities, the length of term of office, and the salary.

Size of Legislature. There is no precise formula for determining how large the governing body should be -- one of almost any size can be made to work. The U. S. House of Representatives, with 435 members, does work, even though creakily on occasion, through an elaborate committee system. California's Assembly has 80 members and its Senate 40. Except for San Francisco,[2] California counties have 5-member Boards of Supervisors regardless of the size of the county (Los Angeles County, with 7 million residents is thus governed by a 5-member legislative body). It appears that a legislative body of between 20 and 40 members would be effective, efficient and at the same time large enough to represent the wide spectrum of regional interests in the nine-county Bay Area, but the optimum size can best be determined when an actual agency is being designed.

Legislator: Scope of Power. It is readily apparent that a regional government having many powers and embracing nine counties would generate more interest and thus, presumably, would attract more qualified candidates than a smaller or single-purpose agency.

Legislator: Term of Office. The standard term of office for most elected officials in California is 4 years, and this would be appropriate for a regional

2/ San Francisco has a combined city-and-county government with an 11-member Board of Supervisors.

agency. Terms should continue to be staggered, to provide the continuity desirable for efficient government.

Legislator: Salary. Legislators, responsible for governing a multi-purpose regional agency, should receive an adequate salary. Candidacy should not be limited to those who have other incomes or to those who may be obligated to special interests. The salary of $16,000 per year now paid to State Legislators appears appropriate for members of a multi-purpose regional legislative body with major powers and responsibilities.

Strong Chief Executive. If the regional government is to be effective, it must have effective leadership. One means of providing this would be direct at-large election of the chief executive. Candidates contending throughout the nine-county Bay Area for this top regional office would go to the electorate with alternative programs. At its best, the campaign for this office would offer voters reasonably clear choices concerning regional policies. The victorious executive would have a popular mandate to work for adoption of his program and to devise new policies as needs arise. On the other hand, an election campaign throughout the entire nine-county region would be both expensive and time-consuming, which would tend to reduce the number of candidates willing to make the race.

As an alternative to direct election, the chief executive could be chosen by vote of the regional governing body. He could be chosen from among the membership of the regional body, but he would not have to be. The chief executive should, however, be appointed for a specified term -- probably four years -- and should not be subject to removal by the governing body (except for cause); this would give him sufficient tenure and independence for effective leadership. A chief executive either directly elected or thus selected by the regional governing body would have a much stronger base of power from which to lead than would one appointed on an annual-rotation, "musical chairs" basis, as is done in many governmental agencies.

Efficient Staff. Much of the ultimate effectiveness of either an efficient legislature or a strong chief executive would depend upon the quality and efficient organization of the agency's staff. Precautions should be taken to insure clear lines of authority to the head of the staff.

4. Sufficient Money and Powers

A regional agency should be granted enough, but no more than enough, money and powers to do the jobs assigned to it.

The powers needed to carry out a plan for the Bay -- or to carry out broader regional programs -- have already been described (page 3). Of these, planning, acquisition and eminent domain, and development require no further explanation; regulation covers a wide array of possibilities and is treated in a separate BCDC report on methods of carrying out Bay plans; but the question of adequate financing needs further discussion.

The financial needs of a regional agency obviously depend on the responsibilities assigned to it. If a small single-purpose agency is only to carry out a plan for the Bay through some kind of shoreline use control and a system of fill permits, an annual budget of a few hundred thousand dollars would probably suffice. But if the plan requires purchase of Bay lands, or development of shoreline areas by the regional agency -- or if the plan is being carried out by a multi-purpose regional government -- then major financial resources would be essential.

Inadequacies and inequities in the property tax, both real and imagined, do not make this long-established source of public funds a likely candidate for raising large new sums of money. Furthermore, heavy reliance on the property tax exerts a pressure for filling parts of the Bay. Local governments, hard pressed to meet their financial needs, may find it attractive to fill tideland areas in the belief they will benefit from property tax revenues produced by new industries, businesses, and apartment housing on the fill.

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While a new governmental agency for the Bay Area could be authorized to add a few more cents to the property tax rate, other sources of financing should be found, especially if large sums of money will be needed. Many possibilities should be explored:

a. A regional addition to the income tax, perhaps computed as a flat percentage of the State or Federal income tax to simplify paperwork.

b. Taxes or charges specifically upon benefits derived from the Bay.

c. A long-term commitment of a portion of tolls from bridges across the Bay.

d. A "property appreciation" tax (similar to the new British "betterment" charge by which a property owner pays a percentage -- in the British case, nearly 50 per cent -- of the increase in the value of his property that has resulted over a period of time from public improvements or planning decisions, as opposed to increased value resulting only from the owner's own efforts).

e. A property transfer tax (levied on property when it changes hands, the amount of the tax being based on the sale price).

f. A regional addition to one or more state taxes, such as the gasoline tax, cigarette tax, alcoholic beverage tax, general sales tax or other state levys.

A regional addition to the income tax is one of the most equitable and attractive possibilities, but if a multi-purpose agency is established, a whole "family" of taxes may have to be considered, perhaps with the income tax as the most important single source.

A new regional governmental agency should be able to obtain referendum approval of its general obligation bonds through a majority vote as is the case

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with state bond issues, instead of having to meet the archaic and excessively restrictive requirement for a two-thirds favorable vote, imposed by the Constitution of 1879 on cities, counties, and school districts.

State and Federal grant and loan programs provide other major sources of funds for regional needs. These funds are likely to be much greater in the future if the Federal Government begins a "tax-sharing" program, returning to state and local governments a portion of Federal income tax revenues.

SUMMARY

The Bay is a single physical mechanism, in which actions affecting one part may also affect other parts. If the Bay is to be conserved and developed as a valuable and irreplaceable resource, its future should be determined by a regional agency with jurisdiction over the entire Bay.

The basic principles for a regional agency are: (1) it should be a limited government dealing with problems requiring area-wide solutions, (2) it should have a governing body that is responsive to the regional interests and needs of the Bay Area public, (3) it should be organized in a manner that encourages effective leadership and performance, and (4) it should have sufficient money and powers to do the jobs assigned to it.

SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION
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Possible Bay Planning Conclusions Based on the Report on Government

(These conclusions from the report on Government, as well as all conclusions thus far adopted by the Commission, are tentative and are subject to revision as the Commission considers and adopts its final plan for the Bay.)

1. The Legislature has directed the BCDC to prepare a "comprehensive and enforceable" plan for the Bay and its shoreline, and, as part of the Commission's final report, to recommend to the Legislature "the appropriate agency to maintain and carry out the plan."

2. To carry out the Bay plan effectively, the successor to BCDC must be a regional agency that has the power to plan, analyze, and regulate the entire Bay and shoreline as a unit. This is necessary because the Commission's plan will reflect the fact that the Bay is a single body of water in which actions affecting one part may also affect other parts. The governmental agency carrying out the BCDC plan must thus include the nine counties that border on the Bay.

3. The powers needed to carry out the BCDC plan for the Bay will be discussed in a forthcoming report, but a tentative listing of responsibilities is necessary to evaluate the most appropriate means of carrying out the plan. For purposes of these conclusions, therefore, it is assumed that any governmental agency carrying out the Commission's plan for the Bay would have the following responsibilities: (a) to keep the Bay plan current, reflecting future changes in the Bay Area and relating the needs of the Bay to other regional needs, (b) to regulate the uses of the Bay and shoreline in accordance with the plan, (c) to see that lands shown by the plan as being needed for public purposes were acquired through negotiated purchase or by eminent domain if necessary, and (d) to insure that necessary shoreline developments such as parks, marinas, and water-related industrial sites were being provided in accordance with the plan.

4. The Commission's plan for the Bay can be carried out by either of two types of governmental agency: (1) a single-purpose agency, concerned only with the Bay, or (2) a multi-purpose, limited regional government, concerned with other regional matters in addition to the Bay. (Carrying out a plan for the Bay would be an appropriate task for a regional government that was also concerned with such matters as air and water pollution, waste disposal, airport development, and regional surface transportation, because they are all directly related to the Bay.)

5. The advantages of a limited regional government are that it would (a) avoid further fragmentation of regional responsibility by forestalling the proliferation of additional special-purpose districts, (b) be able to consider the overall needs of the region as a whole and thus minimize wasteful duplication in regional development, (c) attract broad public attention and thus help to insure public awareness of regional problems and needs, and (d) provide the necessary regional review of a wide range of Federally-financed projects, such as airport, hospital, and sewer construction, and open-space grants.

Therefore, the 1969 Legislature -- and the current Joint Committee on Bay Area Regional Organization -- should be asked to create a limited regional government for the Bay Area. As one of its principal assignments, limited regional government should be required to carry out the BCDC plan for the Bay and shoreline.

If, however, for any reason a limited regional government is not created, the 1969 Legislature -- and the Joint Committee -- should be asked to authorize a special agency to carry out the plan for the Bay. To the maximum extent feasible, the special Bay agency should be structured so as to fit easily into a limited regional government that might be created in the future.

6. Because the structure of a government helps determine its actions, either a special Bay agency or a limited regional government that would carry out the Bay plan should be authorized in accordance with four major objectives:

a. Limited Function Government. Any regional agency should deal only with problems requiring area-wide solutions. Local governments should continue to control local matters.

A step toward achieving this objective would be that the agency carrying out the BCDC plan might discharge part of its responsibilities by delegation to cities, counties, special districts, etc. (for example, some proposals that are adequately detailed in the Bay plan might be administered locally). A forthcoming BCDC report will explore these possibilities.

b. Responsive Governing Body. Any regional agency should have a governing body that is responsive to the people of the Bay Area in regard to their regional interests and needs.

Steps toward achieving this objective would be that:

(1) Members of the agency's governing body should serve staggered 4-year terms to provide continuity.

(2) The agency should have only as many members as are necessary to insure effective representation, probably 20-40 members.

(3) If a limited regional government is to be authorized, its governing body should be chosen by a combination of direct election (i.e., in the same manner that the legislative bodies of cities, counties, states, and the Federal government are chosen) and appointment by boards of supervisors and city councils, perhaps with some of the members appointed and some directly elected, or with a two-house governing body, one house elected and the other appointed.

(4) If a special Bay agency is to be created or authorized, the Commission should, in its final report to the Governor and Legislature, recommend a means of selecting the governing body.

c. Effective Leadership and Performance. Any regional agency should be organized in a manner that encourages effective leadership and performance. This requires that the agency have (1) a governing body that has sufficient responsibilities to attract highly qualified members, and that is organized to operate efficiently, (2) a strong chief executive to provide regional leadership, and (3) an efficient staff.

A step toward achieving this objective would be that if a limited regional government is chosen, its chief executive should have a 4-year term, and should be chosen either (1) by election at large in the Bay Area, or (2) by vote of the regional governing body.

d. Sufficient Money and Powers. Any regional agency should have adequate money and powers to do the jobs assigned to it.

Steps toward achieving this objective would be that:

(1) To finance the day-to-day administrative costs of carrying out a Bay plan (i.e., office rent, costs of keeping the plan up-to-date, etc.), a relatively small State appropriation or property tax would be adequate.

(2) To finance the long-term needs to acquire lands for Bay conservation and to develop shoreline facilities, the over-burdened property tax would be inadequate. While the expenditures of local, State, and Federal agencies will help to carry out the Bay plan, funds over and above those available through all existing sources may be needed for adequate conservation of the Bay and development of its shoreline. A preliminary study of possible sources of funds will be prepared as part of a forthcoming BCDC report.

Adopted by the Commission at its meeting of 1/11/68

REVIEW OF BARRIER PROPOSALS

FOR SAN FRANCISCO BAY

BY

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APRIL 1968

A SPECIAL REPORT

PREPARED FOR

SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION

REVIEW OF BARRIER PROPOSALS

for
San Francisco Bay

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This is a Special Report providing important information about San Francisco Bay that is not covered in the Commission's basic series of 23 planning reports. Tentative planning conclusions based on this report are listed on a separate mimeographed page, in the same manner as in the basic series of planning reports.

Prepared for the

San Francisco Bay Conservation and Development Commission

April, 1968

Introduction

The concept of constructing barriers to control the ebb and flood of tidal waters in San Francisco Bay has been the subject of discussion and study since the 1860's. Proposals have included solid earth fills and other impervious materials, all with the intention of creating a dam to alter the natural flow of water for the benefit of man. Many of the early plans were proposed to prevent the high tides from pushing saline waters into the fresh waters of the Sacramento-San Joaquin Delta. Other plans were to separate the salt water coming in from the Golden Gate from fresh water pools in the north and south portions of San Francisco Bay. The most recent group of barrier proposals have been conceived with the purpose of modifying the existing course of the river and tidal currents, either to prevent salinity intrusion or to increase the circulation of water.

The first investigation of barriers was made in 1880 by State Engineer W. H. Hall on the Carquinez Strait Barrier. The most recent and comprehensive report was prepared by the U. S. Army Engineer District, San Francisco in July 1963 and entitled "Technical Report on Barriers." Among the barrier plans investigated by the Corps of Engineers were the Reber Plan, the Savage Plan and the Modified Nishkian Tidal Barrier.

It is the purpose of this report to the San Francisco Bay Conservation and Development Commission to set forth the status of some of the proposals that have been suggested recently. It is also the purpose to recommend whether the Commission should include barriers in its planning for San Francisco Bay.

Recent Proposals

In most cases where barrier proposals are made for the main body of San Francisco Bay, they are proposed as multiple purpose projects, which when completed would solve a wide range of problems. The primary purpose is generally the solution of the pollution and saline water intrusion problems. Solving the basic pollution problem will also solve the myriad other problems that result from pollution of the Bay waters. However, major secondary benefits that are assigned to various barrier plans include solutions to problems of transportation, recreation, flood control, fish and game, and many others.

An analysis of these benefits and an appraisal of their economic worth is not the purpose of this brief report. Such an analysis would require a more comprehensive investigation and considerably more time. As will be reported herein, there are some agencies that are undertaking more detailed investigations and are planning additional work in this area.

To approach the task of summarizing the status of barrier proposals, contacts were first made with the U. S. Army Corps of Engineers, which has made the most extensive barrier investigation and has the hydraulic model of San Francisco Bay in Sausalito. In addition, the Bay-Delta Water Quality Control Program, the State Division of Highways, the Contra Costa County Water Agency, and several others involved in various barrier proposals were contacted. This report is the result of these contacts.

Upper Bay Barriers

Several basic barrier plans have been proposed in recent years. Not all of these proposals are within the limits of San Francisco Bay as defined in the McAteer-Petris Act of 1965. The first to be discussed is proposed by Contra Costa County and is actually outside of the jurisdiction of the BCDC and has been designated as the Parallel Barrier. Basically it is proposed to construct a barrier along the southern bank of the Sacramento River adjacent to Sherman Island to the western terminus of New York Slough. Studies by the County indicate that this Parallel Barrier, when used in conjunction with the proposed Peripheral Canal and the San Joaquin Master Drain, would improve the water quality of the Western Delta. Since this barrier is located totally upstream from Stake Point, it is outside the area of jurisdiction of the BCDC, but it is briefly discussed here since it would affect San Francisco Bay. When the Corps of Engineers has completed its expansion of the hydraulic model to include the Delta, it is probable that this plan will be one that will be studied early.

The second barrier plan is one proposed by Don Hebert of the United States Bureau of Reclamation. It is to be located parallel to the navigation channel in Suisun Bay. The purpose of the barrier is to regularize the channel and reduce salinity intrusion in the upper Bay system. According to the Corps of Engineers, this proposal is planned for testing in the hydraulic model.

South Bay Barriers

A proposal for construction of diagonal baffles in the South Bay has been suggested for consideration by the City of San Jose. This plan involves the construction of several baffles at approximately 45 degrees to the axis of the South Bay. The purpose would be to deflect the incoming tidal currents to the outside or edges of the Bay and to deflect the outgoing tidal currents to the center of the Bay. In this manner it is hoped that new current directions can be induced which would increase the circulation of water in the South Bay and thus improve the quality of South Bay water. The plan does not expect to cause the South Bay waters to be moved out of the Bay, but it is hoped that it will provide better mixing and elimination of some of the dead ends where very poor quality waters accumulated. This particular plan could readily be tested in the Army's Bay Model, since the baffles could be easily added to the existing model and the circulation compared to the existing conditions.

By far the most elaborate barrier plan for San Francisco Bay is one proposed by Walter Josephs and Dr. Joel Gustafson. Basically this plan involves the construction of two channels on each side of the South Bay with inlet and outlet gates at the ends of the channels and at intermediate points. Between the channels and the main body of the Bay, earth barriers would be constructed to separate the waters. The basic purpose is to conduct the incoming tidal currents through the main center body of the South Bay and

exclude incoming flows from the side channels. When the tide changes and begins to ebb, the flow would be conducted not only through the center body of the Bay but also through the channels on each side of the Bay. The result would be that flow through the side channels would always be in a northern direction. By taking advantage of the tidal cycles and the significant difference in the elevations of the high tides at the Golden Gate and at the south end of the Bay (3.4 feet at mean higher high water), it is hoped that the circulation of water in the South Bay can be improved. In addition to the primary benefit of better circulation and the attendant benefits created by decreased pollution, many other benefits are claimed. Among them are the use of one bank of each channel for a freeway, development of marsh lands and other wildlife sanctuaries, and the establishment of a firm shoreline for South San Francisco Bay with complete public ownership of that shoreline. The plan also includes the development of a smaller scale circulatory system offshore from Emeryville, Berkeley, Albany and Richmond which is independent of the South Bay proposal.

In addition to the above-mentioned plan, additional concepts for constructing barriers or channels to improve circulation in the South Bay have been discussed or tested. The most recent is a concept involving a channel down the east side of the Bay that is physically separated from the main body of the Bay by a longitudinal barrier that runs in a general north-south direction parallel to the shoreline and the axis of the Bay. This plan has

been tested by Water Resources Engineers Inc. for Kaiser Engineers as a part of the State's Bay-Delta Water Quality Control Program. At either end of the channel are tide gates which allow the water to travel in only one direction through the channel: north from the south end. Water Resources Engineers have tested four specific sizes of channels on their mathematical model of the Bay, and while they have not completed their studies or report, it appears that the plan can result in better circulation of South Bay waters, and, therefore, better overall water quality. (See Figure 1)

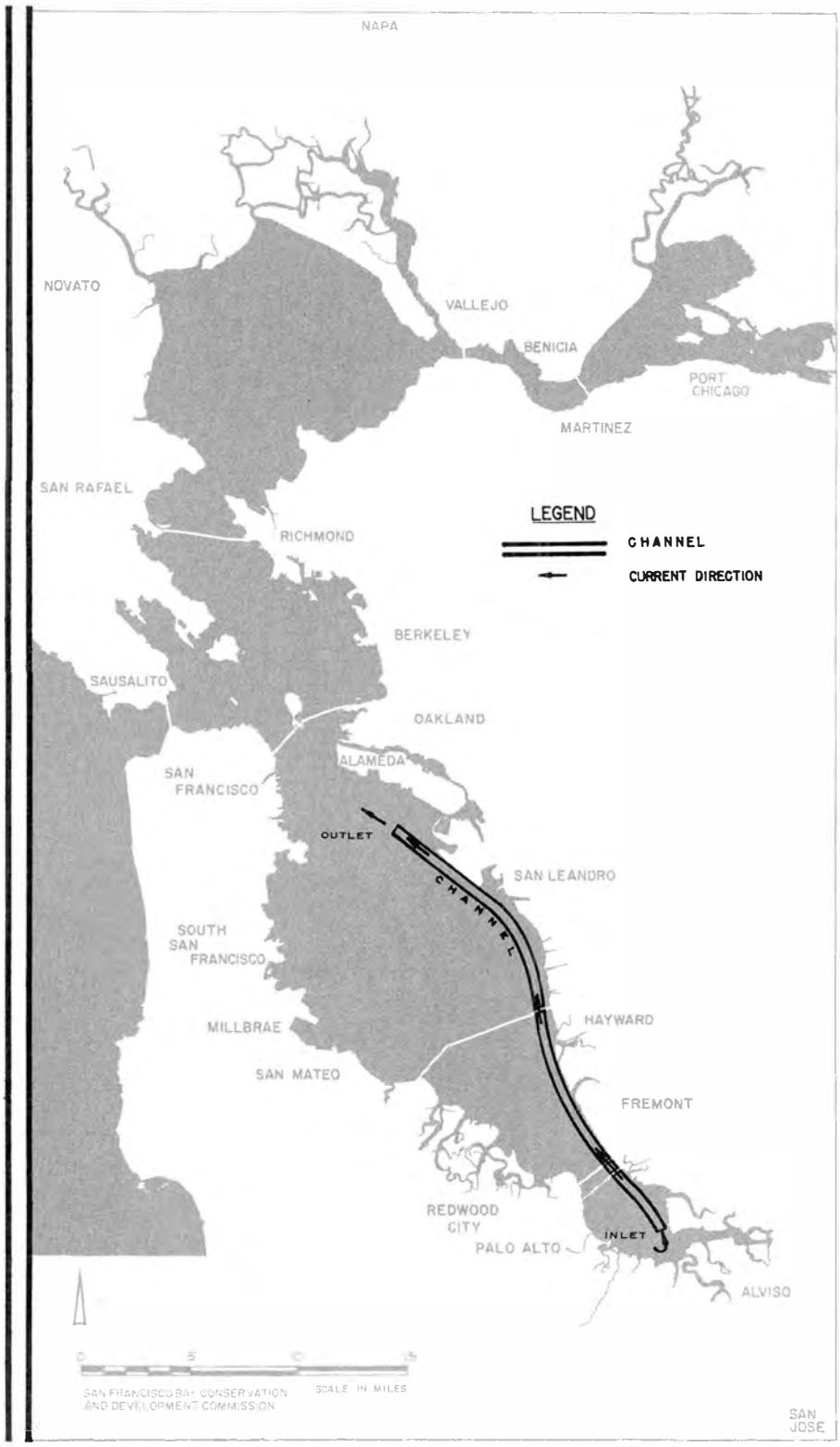
During the course of studying the Sierra Point-Roberts Landing Barrier, the Corps of Engineers tested a longitudinal barrier extending southward beyond the San Mateo-Hayward Bridge. The basic plan was to place batteries of conduits with tide gates on either side of the longitudinal barrier and conduct the flood tide through the eastern conduits and the ebb tide through the western conduits. The Corps' tests indicated that improved circulation patterns appeared to extend about 15,000 feet southerly of the longitudinal barrier. Circulation was not improved south of the Dumbarton Bridge. (See Figure 2)

Barrier Analysis

Of the barrier plans proposed, the most critical to the BCDC are those in the South Bay. The others, while important in their effect upon water quality, will not have a major effect upon the basic planning of San Francisco Bay. Those proposed for the South Bay have not been adequately tested to determine a complete

FIGURE 1

Longitudinal Barrier and Channel along East Shore

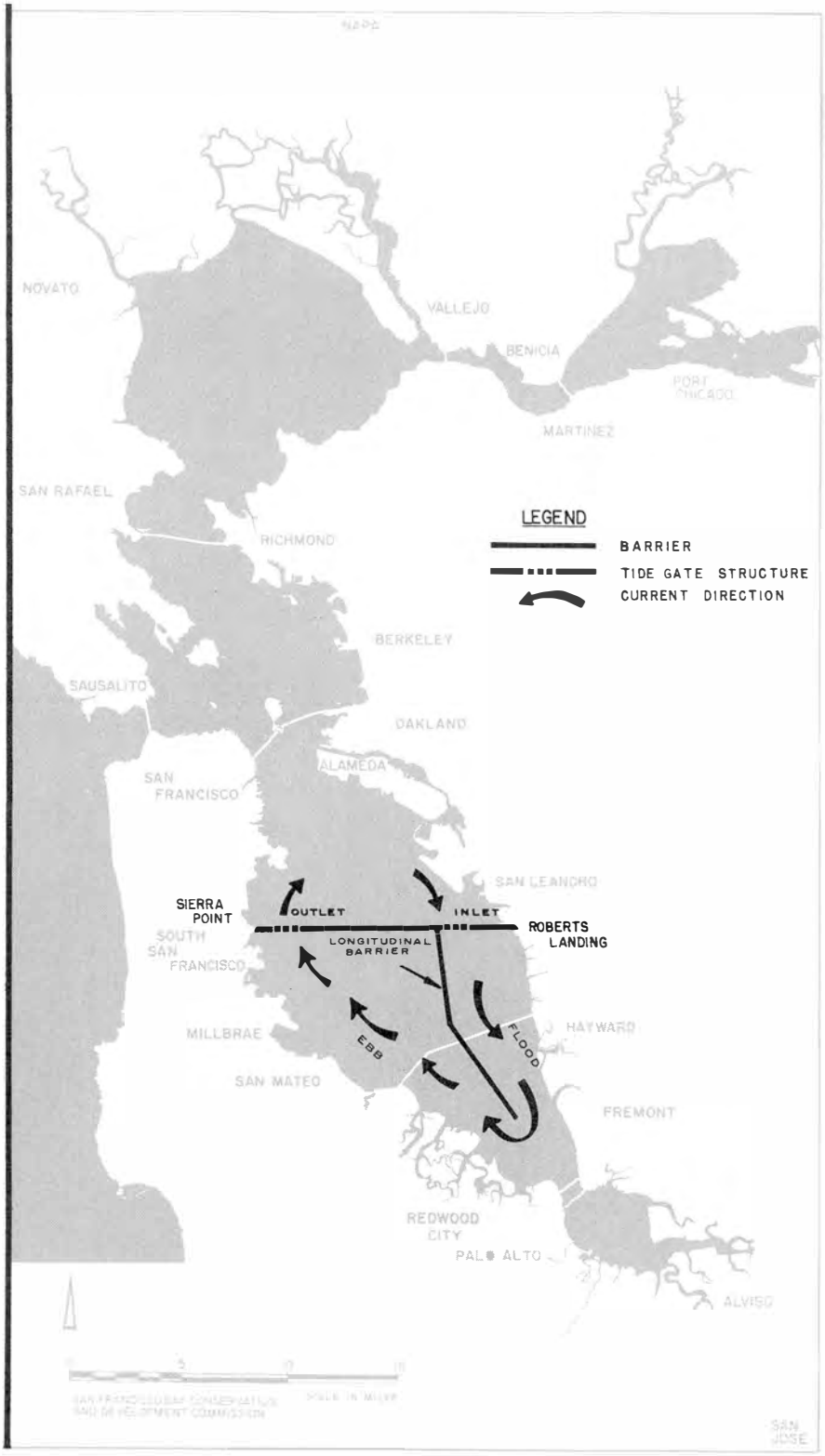


Source: Water Resources Engineers, Inc.

Prepared by: Bissell & Karn, Inc.

FIGURE 2

Sierra Point-Roberts Landing Barrier with Inlet and Outlet Floodways and Longitudinal Barrier



Source: Technical Report on Barriers, Appendix "H" Hydraulic Model Studies, U.S. Army Corps of Engineers

Prepared by: Bissell & Karn, Inc.

analysis of their benefits or their relationship with other problems of the South Bay.

If, as it has been tentatively established, the longitudinal barrier in the South Bay can improve the water quality of the South Bay, then it should be given serious consideration in planning for the future of the South Bay and the cities bordering it. However, there are other problems that may result from the construction of such a barrier which should be studied thoroughly before such a proposal can be accepted completely.

Sedimentation

The construction of a longitudinal barrier of earth in the South Bay would result in considerable modification of the shape of the Bay. The barrier would represent a large obstruction to tidal currents and wind. The effect of these major modifications upon sedimentation in the South Bay is presently unknown. From a hydraulic standpoint, it appears that the presence of the barrier would increase water circulation and would, therefore, also increase the velocity of flow. However, the barrier would reduce the fetch of winds along the surface of the Bay and affect the wave action. Since both of these are factors affecting the rate and location of sediment deposition in the Bay, it is reasonable to assume that the existing patterns of sedimentation would be affected. The extent of the effect has not been determined and should be subject to further investigation. High sedimentation rates would cause high maintenance costs and would affect the economic balance of a proposal.

Flood Control

Some of the plans claim benefits for flood control on the basis that the receiving waters of the channel into which the streams drain could be artificially controlled to maintain lower levels and, subsequently, steeper hydraulic gradients in the stream channels. Exactly what benefit may accrue to flood control is dependent upon the physical features of the individual plan. Since the amount of flood flows expected is substantial (Standard Project Flood for Alameda Creek is 52,000 c.f.s.) any plan must provide that the water level in the receiving waters must be maintained at the existing levels or lower. The critical nature of this problem can be realized when it is considered that in Union City, five miles inland from the present shore of San Francisco Bay, the elevation of the top of street curbs is set on a hydraulic slope that is only 11 inches above the estimated highest tide of record at the shoreline. In addition, the problems of land subsidence in the Santa Clara Valley pose difficulties in providing proper land drainage and flood control without the further complications of higher water levels in the Bay. If a barrier plan is adopted, it must be thoroughly checked to evaluate its effect on flood control and to determine if it can be developed in a manner that would improve the existing situation or at least not further complicate it.

Traffic

One of the major potential benefits that could be derived from a longitudinal barrier is the use of such a barrier as a freeway to

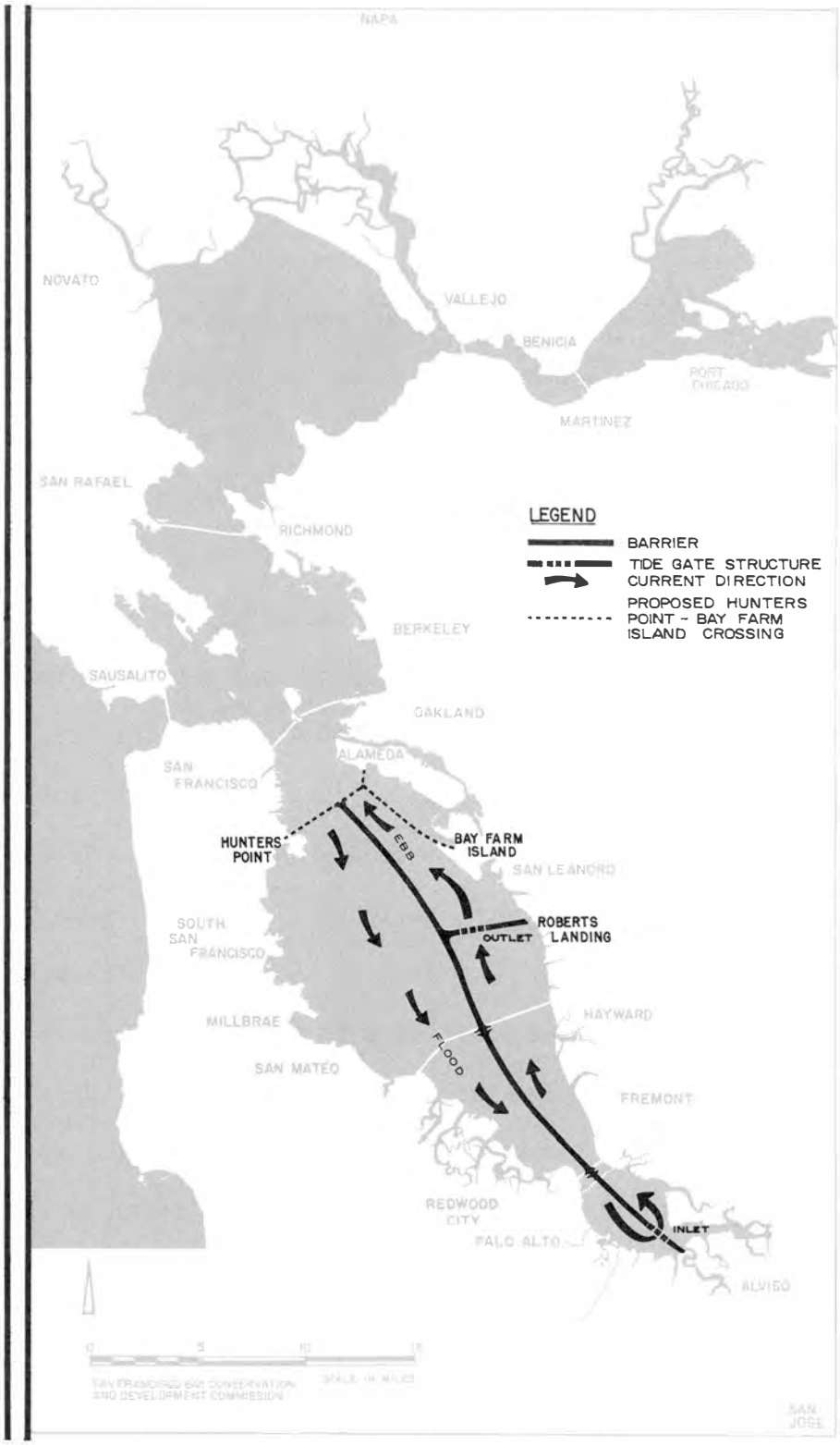
carry traffic in a north-south direction. If such a use can be justified, it may be possible to use funds from the highway programs to bear a portion of the total cost of the barrier. The Legislature has adopted a statewide master plan that includes freeways bayward of the existing freeways located on each side of the South Bay. If one of the freeways could be shifted out into the Bay, it could serve as the backbone of a longitudinal barrier. (See Figure 3)

The San Francisco office of the State Division of Highways indicated that it has not considered such a proposal. Furthermore, it indicates that a freeway located within San Francisco Bay would have limited access and thus would not serve the major expressway function that freeways on land serve, i.e. it cannot be used by drivers that only want to travel a few miles on the freeway between close points. Therefore, the highway engineers feel that the use of a freeway in the Bay would be seriously restricted. However, they point out that a traffic study would determine if such a freeway would serve a justifiable purpose. Such a study could be undertaken by the Division of Highways if authorization were received.

Consideration should be given to the possibility of using such a freeway in the network of the Bay Toll Crossings by making connecting interchanges with the existing San Mateo and Dumbarton Bridges and the proposed Hunters Point-Bay Farm Island crossing. With this network, a motorist or commercial vehicle could enter the system at Alameda, for example, and travel to any one of the terminals of the interconnected bridges. The advantages of such a

FIGURE 3

Longitudinal Barrier Connecting South Bay Crossings



Prepared by: Bissell & Karn, Inc.

high speed interconnecting South Bay highway system may offset some of the disadvantages in handling local traffic by relieving the existing inland freeways of the through traffic, including large trucks, that wishes to travel directly from one city to another.

Water Quality

The major benefit from a longitudinal barrier that improved circulation in the South Bay would be the improved quality of the waters within the Bay. It has been demonstrated by model tests and by actual field observations that the waters in the Bay south of Dumbarton Highway Bridge do not circulate readily and just move back and forth with the ebbing and flooding tides. At the present time water quality problems in this area are apparent and as the area surrounding the Bay continues to develop the problems will increase.

One solution that has been proposed is to increase the degree of treatment given to sewage wastes from these areas and, if necessary, construct a conduit to convey the treated wastes to a portion of the Bay where the tidal currents will circulate them and eventually carry them out the Golden Gate. The outfall for such a conduit could also be into the Pacific Ocean, completely by-passing San Francisco Bay. These solutions would relieve the basic sewage disposal problem, but do not solve the continuing problem of lack of circulation in large portions of the South Bay. During storm periods, the existing sewerage systems become completely overloaded

by infiltration of storm waters and it becomes virtually impossible to properly treat the large quantities of water that enter the system. Consequently, the treatment facilities are by-passed or the sewerage facilities overflow and raw sewage mixed with storm drainage flows directly into the Bay. In addition, the drainage from the lands that are developed for urban uses contains wastes such as oil and chemicals which drain to the Bay and are trapped in the static condition of the South Bay.

Therefore, it appears that better treatment and disposal of sanitary sewage from the South Bay areas will not completely solve the problems of poor water quality in the South Bay. In order to create a more healthful environment for fish and wildlife and permit maximum recreational use of the waters, all forms of pollution should be removed.

Other Considerations

In addition to the other matters discussed above, consideration should be given to the effect of a barrier upon the existing land and shoreline uses. Within the areas to be enclosed by some of the barrier proposals, there are located port facilities and marinas. The effect of a barrier upon these facilities should be thoroughly analyzed. Access can be provided through the barrier separating two bodies of water by means of locks. However, the effect of these locks upon the barrier operation, the maritime traffic and the economic balance should be included in such an analysis.

Consideration should also be given to the esthetic appeal of a barrier proposal. Since this is largely a subjective matter, it may become difficult to analyze accurately. One of the major advantages stated by barrier proponents is that in a barrier project, the shorelines of the Bay would be required to be fixed based upon hydraulic requirements. Most of these shorelines could be held in public ownership and the criteria for development of the edges of the Bay could be established with consideration of esthetics.

Conclusions and Recommendations

1. It is apparent, at this time, that the investigations of potential barriers in San Francisco have not progressed to the point where it can be concluded that the construction of a barrier will represent the complete solution to the problems of pollution that plague the South Bay. It appears that some of the barrier proposals may have merit, but there are many potential problems that should be completely studied and evaluated before a decision can be reached.
2. Investigations are currently underway by several public agencies. Completion of the current investigations should resolve some of the problems and will probably raise additional questions and problems.
3. If the current investigations reveal that the development of a barrier in San Francisco Bay has potential, additional study should be undertaken to determine its hydraulic feasibility.

The Corps of Engineers has authorization and intends to model test all significant water quality developments proposed if preliminary analysis shows merit and justification. Water Resources Engineers, Inc. has indicated a willingness to test proposals if authorization for additional studies is received.

4. If it is determined that a barrier plan is hydraulically feasible and will improve water quality in the South Bay, experts in the fields of biology, traffic, sedimentation, health, recreation, navigation and economics should analyze the plan from the standpoint of their expertise.

5. BCDC is facing a rapidly approaching deadline in its planning for San Francisco Bay. Because the investigations of the use of barriers in the Bay have not progressed to the point where conclusive answers are available, BCDC should proceed with its planning without consideration of barriers. If BCDC cannot develop a plan flexible enough for modification, portions of the Bay and shoreline will require replanning if subsequent investigations prove that a barrier in South San Francisco Bay is not only technically feasible, but economically and esthetically desirable.

Appendix A

Possible Bay Planning Conclusions Based on the Special Report on Barriers

1. Over the years, several proposals have been made for barriers in San Francisco Bay to prevent salt water from intruding into upstream areas or to improve the circulation of Bay waters. Every barrier proposal has disadvantages as well as advantages however; these include the effects of barriers on the ecology of the Bay, effects on the appearance of the Bay, potential flood control problems, potential sedimentation problems, and the relatively high costs of construction.

2. Because further study is needed before any barrier proposal can be considered acceptable, the Commission's plan should not include any barrier anywhere in the Bay. If any serious consideration is given to a barrier in the future, the agency carrying out the BCDC plan will be required to replan all of the affected shoreline and water area.

OIL AND GAS PRODUCTION

IN SAN FRANCISCO BAY

BY

PETER A. STROMBERG
ASSISTANT PLANNER

APRIL 1968

A SPECIAL REPORT

PREPARED FOR

SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION

O I L A N D G A S P R O D U C T I O N

In and Around
San Francisco Bay

by

Peter A. Stromberg
Assistant Planner

This is a Special Report providing important information about San Francisco Bay that is not covered in the Commission's basic series of 23 planning reports. Tentative planning conclusions based on this report are listed on a separate mimeographed page, in the same manner as in the basic series of planning reports.

Prepared for the

San Francisco Bay Conservation and Development Commission

April, 1968

Introduction

This report describes the possible effects of oil and gas exploration and production on San Francisco Bay; and recommends policies to help the Commission in reviewing exploration proposals and in preparing its Bay plan. Interest in the oil and gas resources of the Bay Area, including possible reservoirs beneath the Bay floor, is growing; whether the present interest will result in large-scale production cannot be predicted at this time.

The report briefly discusses the factors leading to the growing interest in oil and gas resources under the Bay; the exploration and drilling process and its possible effects on the Bay and shoreline; present controls on this activity; and gaps in these controls from a Bay conservation standpoint. No attempt is made to evaluate oil and gas resources, nor to calculate potential regional economic effects of exploration and production.

Interest in Local Oil and Gas Resources

Past exploration indicates that a major oil or gas field may yet be located in the Bay Area. Geologic conditions favorable for reservoirs of natural gas and petroleum exist in rocks of sandstone and shale that lie above the Franciscan formation. The Franciscan formation itself apparently is barren of any traces of natural gas or petroleum. The fact that the rock underlying most of San Francisco Bay is the Franciscan formation, with no potentially-oil

bearing sandstone or shale above it, makes it very unlikely there are natural gas or petroleum reservoirs under the Bay.

Surface oil seeps were discovered during the early settlement of the Bay Area and exploitation began early: the first oil wells were drilling in San Mateo County in 1867. Since that time a few wells have been located in Santa Clara, San Mateo, and Sonoma Counties. However, most of these produced sporadically and eventually became unproductive. A few of these older wells, particularly in southern San Mateo County, still produce small amounts of petroleum. There have been recent discoveries of oil in eastern Alameda and Contra Costa Counties, which suggests that it may be possible to develop an oil field of commercial importance in some parts of the San Francisco Bay Area (but probably not near the Bay.)

1. Natural Gas

The consumption of gas in the Bay Area far exceeds local production.

According to the Pacific Gas and Electric Company, about 70 per cent of the natural gas consumed in California is imported from Texas and Canada. The remaining 30 per cent is drawn from local sources. With a local gas shortage and the possibility that abundant gas is present, exploration and wildcat drilling should increase. (Wildcat drilling is any well drilled for oil or gas in territory which is not known to be productive).

The principal local source of natural gas in the Bay region is the Rio Vista Gas Field located in the Sacramento-San Joaquin delta. This field has been producing natural gas for more than thirty years. Its success has stimulated exploration of adjacent areas. At present, several areas near the Rio Vista field have producing wells and exploration continues through wildcat drilling methods.

Although past exploration and drilling activities have been conducted on land, studies by the petroleum companies have concluded that gas reservoirs or "pockets" may extend or exist beneath the northern parts of San Francisco Bay and its tributaries. Several companies are now planning to explore by drilling in some of these areas, including Suisun Bay, Grizzly Bay, Honker Bay, and parts of the Carquinez Straits northeast of the Benicia-Martinez bridge. Exploration for gas and oil is presently concentrated in the Suisun Bay area for two reasons. First, the area is close to a proven production field. Second, geologic investigations have shown that rock units associated with successful gas exploration in northern Contra Costa County extend beneath Suisun Bay. The favorable rock conditions may extend into the eastern half of San Pablo Bay, before the apparently unfavorable Franciscan rock formation that underlies most of the rest of the Bay is encountered.

2. Petroleum

Oil may be located during the exploration for natural gas. Possible reservoir rocks are widely distributed in the San Francisco Bay region and, as mentioned previously, surface seeps of oil have been known since the early 1850's. However, in spite of these apparent favorable conditions, exploration for oil met with little success until recently. Discoveries in Brentwood in Contra Costa County (1963) and in the Livermore area in Alameda County (1967) may lead to a more expansive oil exploration program.

The possibility of oil being present beneath San Francisco Bay below the east half of San Pablo Bay is highly remote; as previously noted the "younger" oil and gas bearing rocks found beneath Suisun Bay do not appear to be present in these other areas.

Exploration and Production of Oil and Gas

The exploration and drilling for oil and gas wells are very precise operations. With the technology now available, the drilling technique has become cleaner, less complicated and more sophisticated as well as a much faster operation than in the past. Exploration for the most part consists of an in-office study of available geologic and geophysical data, past production of the surrounding area, and then weighing the possibility of the presence of an oil or gas reservoir. If warranted, additional geologic mapping is conducted and test borings made to supplement available geological data.

There are several ways of drilling underwater prospects. In one method, a barge specially designed for very shallow water offshore drilling is floated to the site. The barge, approximately 110 feet long x 80 feet wide, is equipped with an assembled derrick which may measure over 130 feet in height. The barge also contains some cabin space for offices, a maintenance and repair shop, a hoist, generators, and space for the equipment used during the drilling process. The derrick rests upon a platform which is mounted on several large pontoons or tanks. Once the barge is over the drill site, the pontoons are slowly flooded so that the bottom of the pontoons eventually rest on the Bay floor. Submerging the barge in this manner can only be accomplished in shallow water of not more than ten feet. For water depths of more than ten feet drilling platforms on stilts are used.

Drilling commences when the barge is in place. Well drilling today is a very rapid procedure. The amount of drilling time required depends on the depth of the suspected oil or gas reservoir. In the Bay Area the average well produces at about 4500 feet. Barring complications, a 5000-foot well can be drilled in less than 20 days.

If the well proves productive, it is equipped with the necessary pipelines, valves, and gauges to regulate the flow of gas or oil. This apparatus is called the "christmas tree." The barge is then refloated by expelling the water from the pontoons and the drilling rig is taken away. With the "christmas tree" installed, the well is almost ready for production. Other equipment necessary for

production is then located near the "christmas tree" and connected to the well: a choke to reduce the pressure of the gas to a production level, a heater to prevent blockage of pipes by hydrates,[1] a tank to separate waste water drawn up with the gas, and a condensing tank for collecting certain liquid hydro-carbons for storing and transport. The gas is then transported by pipeline to a central collection point on land.

A well that has been drilled at an off-shore shallow water site requires that equipment be installed above the water level at the well-site on a "production platform" supported by pilings driven into the Bay mud. While it is possible to transport the "dried" gas long distances after it has been heated and liquids removed, the heating and liquid separation must be accomplished as near to the well aperture as possible because of the aforementioned high pressure blockage. For this reason, it is not possible to transport high-pressure unheated gas through a pipeline to a liquid separation area on land.

Standard Oil Company recently proposed the construction of three production platforms in Suisun Bay. Each platform will support a two-well operation, and measures about 65x87 feet and rises about 20 feet above the surface of the water. This is the minimum size

1/ Hydrates are water-hydrocarbon "ice" which form near the well aperture due to pressure reduction. Heating must be accomplished near the well aperture to prevent blockage in the flowline.

platform for a two-well operation (a one-well operation would be smaller), but up to six other wells drilled from the same site can utilize the same platform.

Drilling methods that take place on land are identical to offshore operations, except that a portable drilling rig is used. If the well is productive, the entire complex of equipment for production can be installed below ground level in a covered concrete enclosure where it will not be seen.

The Effects on the Bay of Oil and Gas Exploration and Production

The exploring and drilling of oil and gas wells can affect several aspects of San Francisco Bay: its ecology; its appearance; and other activities that it supports, such as navigation and water-oriented sports.

1. Ecology

The effects on Bay ecology are relatively minor, consisting of temporary increases in turbidity, possible attraction of marine life, and possible increases in shoaling.

After the drilling barge is floated to the selected site, anchors are positioned to maintain the position of the barge as the pontoons are flooded. When the pontoons are submerged and the anchors are dropped there is a slight compaction of the bottom mud. Also, there is some disturbance of mud around the sides of the barge, resulting in cloudy water for several hours.

Neither the Bay floor nor waters are adversely affected during the drilling process. To prevent possible siltation and pollution

problems, spoils brought up by the drill are placed on a barge and taken to a land disposal site. Some Bay water is used for cooling and lubricating, but it is removed with the spoils.

The preceding indicates that exploration and drilling probably does not affect the natural ecology of the Bay. However, a structure built for an indefinite duration on pilings, such as a production platform, may cause minor changes on the Bay floor in the immediate area. Also, certain marine animals may be affected.

Structures built on pilings may provide shelter and feeding areas for various types of marine life. According to BCDC report on Fish and Wildlife, surface dwelling ocean species concentrate around offshore oil platforms positioned on the continental shelf. Some fish in the Bay also cluster around wharves and piers: fine catches of striped bass and perch by anglers from the Berkeley fishing pier attest to this fact.

Pilings also provide suitable habitat for barnacles upon which various fish feed, especially the California sturgeon. An increase of such a food supply would probably increase the population of these fishes. There is a scarcity of suitable firm substrata for developing artificial reefs in the Bay to provide feeding and shelter areas for marine species, as mentioned in the BCDC Fish and Wildlife report. Clusters of pilings such as those under a production platform may serve a similar function.

According to the BCDC report on Sedimentation, if the platform is built in an area where Bay currents are interrupted, the pilings

can reduce the velocity of the current and thereby induce sediment deposition (shoaling). Where waters are shallow and currents are slow, a structure on pilings would probably have little effect on shoaling. Where currents are weak and shoaling is already a problem it is unlikely that a group of pilings would further aggravate the situation.

2. Bay Appearance

The exploration for and the production of oil and gas wells may adversely affect the appearance of the Bay. An ungainly-looking derrick on a drilling rig or barge could be an eyesore for persons viewing the Bay from the hills and shoreline. Also, persons living near the shore might experience noises both day and night if drilling is within hearing range. (Sound carries long distances over water).

The BCDC report on Appearance and Design notes that the Bay's value as a scenic resource is due in large measure to its openness, and recommends that structures, such as bridges and towers, in broad expanses of open water be avoided whenever possible. This recommendation would also apply to oil and gas platforms.

Although a derrick would be temporary, a production platform would be a fairly permanent fixture on the Bay. Painting and screening can partly subdue its presence, but the platform would be an intrusion on the surface of the Bay. Because of this, drilling off Santa Barbara County is now required to be five miles offshore.

3. Other Bay Activities

If present in large numbers, production platforms might interfere with the use of a water area for recreation. However, the degree of interference depends on the location and spacing of the platforms. The three platforms proposed by Standard Oil in Suisun Bay would have no significant effect on recreation activities there.

Although wells may be located near major shipping channels, it is unlikely that they would be a serious navigation hazard. If a gas well or oil reservoir is suspected below a channel, the actual drilling can be accomplished 1,000 to 1,500 feet away from the channel by slant drilling at an angle. If a production platform is built near a channel, the Coast Guard regulates and enforces the lighting requirements necessary for navigation.

4. Conclusions Concerning Effects on the Bay

For BCDC planning purposes, the major problem of oil and gas resource development is the effect on the Bay's appearance. With the controls already in effect on such development, there appears to be little damage to the ecology of the Bay and some possibility of enhancing it.

By their very nature, the appearance of the drilling and production equipment sharply contrasts with the natural environment. Efforts to minimize adverse effects by screening and other devices have been somewhat successful. In Los Angeles, for example, zoning laws require screening of derricks and other structures, both on land and offshore. The resulting "artificial islands"

and other disguises have not met with unanimous praise, but they represent the most comprehensive attempt so far to make the structures compatible with their surroundings. Fortunately, the prospects for oil and gas production in the Bay Area indicate the Los Angeles situation will not be repeated here.

Existing Controls Over Gas and Oil Operations

Several agencies at all levels of government regulate exploration and production activities, for purposes ranging from resource conservation to esthetics. The regulations most relevant to BCDC planning are described in this section.

1. Federal Regulations

If a drilling operation is not on Federally-owned lands, the U. S. government imposes very few restrictions. As mentioned above, the Coast Guard regulates the necessary lighting of platforms to protect navigation. Also, all proposed platforms to be located outside of established harbor lines must secure a permit from the U. S. Army Corps of Engineers. Where no harbor lines exist (as is the case in much of the Bay Area) Corps jurisdiction extends to the higher high water line including water navigable by the smallest boats. However, there are still large areas of the Bay that are not under Corps control.

Under terms of a recent policy agreement with the Department of the Interior, the Corps of Engineers may now more fully consider the effects of proposed filling, dredging or placing of structures, on the esthetic and ecological value of the environment. For example,

the Corps may require screening and painting of structures. The geographic area of jurisdiction is not extended, however.

2. State Agencies

The California State agencies that have control over oil and gas operations are the State Lands Commission and the Division of Oil and Gas.

If the potential oil or gas producing site is on land under the jurisdiction of the State Lands Commission, the site must be leased from the Commission. As a matter of law and Commission policy the Lands Commission ascertains the requirements of the affected local political subdivisions as well as of State and Federal agencies and incorporates such requirements, insofar as possible, into the operating conditions of the lease forms in each case. While the lease is pending, the Commission notifies the Department of Parks and Recreation and requests comment concerning possible interference with recreational uses of shorelines, tidelands and submerged lands. Also, the Department of Fish and Game is asked to comment on possible adverse effects on fish and wildlife. Regional Water Quality Control Boards are notified so that the lessee may be apprised of their requirements. The Regional Water Quality Control Board protects the quality of water in water courses as well as water on privately or publicly owned marshes from the effects of oil and gas well wastes by prescribing and enforcing waste discharge requirements as appropriate in each case. The Regional Water Quality Control Board's jurisdiction is not limited to state-owned lands.

The State Lands Commission may also schedule a public hearing on the affected area if requested to do so. If the Commission decides that issuing the lease would interfere with or destroy the esthetic or scenic value of residential, recreational, or scenic areas or otherwise be contrary to the public interest, the lease will be denied. If local restrictions can adequately overcome these problems, they are written into the lease and exploration and development is permitted.

The Division of Oil and Gas is primarily concerned with the conservation of natural resources. The division supervises all drilling operations, maintenance, and abandonment of oil and gas wells whether on publicly-or privately-owned land. This supervision is concerned only with the subsurface: the protection of fresh water aquifers and the oil and gas bearing strata. If fresh water aquifers are encountered during the drilling process, the petroleum company is required by law to seal with cement the stratum in which the water is flowing in order to protect the quality of the aquifer. The Division of Oil and Gas reports that the sealing is done as a matter of procedure by the petroleum companies, because water in a gas or oil well is not desirable from an economic standpoint. If the petroleum company can eliminate the water at its source, it will not have to remove it from the petroleum product after it comes from the well, which is a far more costly process.

There are no provisions in the law that allow the Division of Oil and Gas to enforce esthetic and ecological controls at the well site.

3. Local Controls

Some counties do not have specific regulations governing oil and gas wells. If a petroleum company wants to explore for gas and oil they must secure a conditional use permit from the local government having jurisdiction. Communities not having specific regulations are covered under provisions already written in the oil and gas lease of the State Lands Commission. These provisions which are often as stringent as many local regulations, cover most of the necessary site requirements including well spacing, esthetics, spoils dumping, and pollution control.

4. Conclusions

The principal conclusions that can be drawn from this review are:

a. Existing State, Federal, and local agencies have the authority to regulate the location, appearance, and operation of oil and gas facilities. Although none of these is primarily concerned with San Francisco as a Bay, there is no need for additional controls to supplement the authority of these agencies although there may be a need to focus authority on the Bay.

b. Some parts of the Bay are not under the jurisdiction of all agencies. The State Lands Commission, for example, has no control over activities on privately-owned marshes and tidelands which comprise a substantial part of the Bay. The Corps of Engineers' control includes only "navigable" waters. Local governments have zoning power over the other areas, but not all of them have policies pertaining to oil and gas exploration and drilling.

Therefore, if an agency such as BCDC chooses to adopt policies regarding these activities, it should be done with the intention of (a) extending the control into areas of the Bay not presently under the jurisdiction of other State or Federal agencies, and (b) focusing attention on Bay conservation.

Recommendations

The principal conclusions from the preceding analysis concerned the appearance of oil and gas structures and the extension of adequate controls to areas of the Bay where they are now lacking.

1. Appearance of Structures

The following conditions are proposed to guide the design of oil and gas structures in and near the Bay:

a. For onshore sites near the Bay, production and pumping equipment should be fully enclosed by either a building or natural screening that is appropriate to the area in which it is located. But prime scenic areas should not be intruded upon; instead, drilling equipment should either be placed underground or else installed outside the scenic area.

b. The value of San Francisco Bay as a regional scenic resource outweighs the potential public benefits that might result from oil and gas exploration. Therefore, no drilling or production platforms should be permitted to adversely affect the scenic values of the Bay. In areas where drilling or production platforms are

permitted, only the minimum number of platforms necessary to recover the oil or gas should be permitted. The platforms and structures on them should be no larger than necessary.

c. All production platforms permitted in any part of the Bay, and all equipment on such platforms, should be painted or screened so as to be compatible with the surrounding open water, mudflat, marsh, or shore area. (The Los Angeles "South Sea Island" motif complete with palm trees is not considered to be the solution for the Bay Area).

d. Under no circumstances should fill be used for the foundation of drilling or production sites on the Bayshore marshes, mudflats, or in the water.

e. No sign should be constructed or erected, maintained or placed on the premises except those required by law or ordinance to be displayed in connection with the drilling or maintenance of the well.

f. Oil or gas should be transported through underground or underwater pipelines.

2. Extension of Controls

To implement the foregoing design proposals and to extend necessary controls to areas now lacking them, the following steps are proposed:

a. For exploration and development on State-owned lands, the Bay conservation controls could be incorporated into State Lands Commission leases.

b. For all exploration and development, the agency designated to carry out the BCDC plan could develop model policies concerning location, design, and other precautions, for possible adoption by cities and counties.

c. In areas outside the control of the State Lands Commission and within cities and counties that do not implement the model design policies, the BCDC and its successor agency could enforce the regulations as part of its conditions upon the issuance of the necessary pile drilling permits.

SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION
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Possible Bay Planning Conclusions Based on the Report on Oil and Gas

1. Although some gas exploration is now under way in Suisun Bay, and although some drilling for oil and gas is theoretically possible in any part of the Bay, the best geological evidence currently available indicates that such drilling will be confined to Suisun Bay and the eastern part of San Pablo Bay.

2. The principal Bay planning concerns about exploration and production are its effects upon the ecology and appearance of the Bay. Ecological considerations are now adequately provided for by existing regulatory agencies, but aesthetic considerations are not. Therefore, each proposed exploration or development in or on the shores of the Bay should be reviewed as regards its effect upon the scenic values of the Bay and modified to the extent that may be necessary and feasible to minimize adverse effects.

Adopted by the Commission at its meeting of 5/17/68

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