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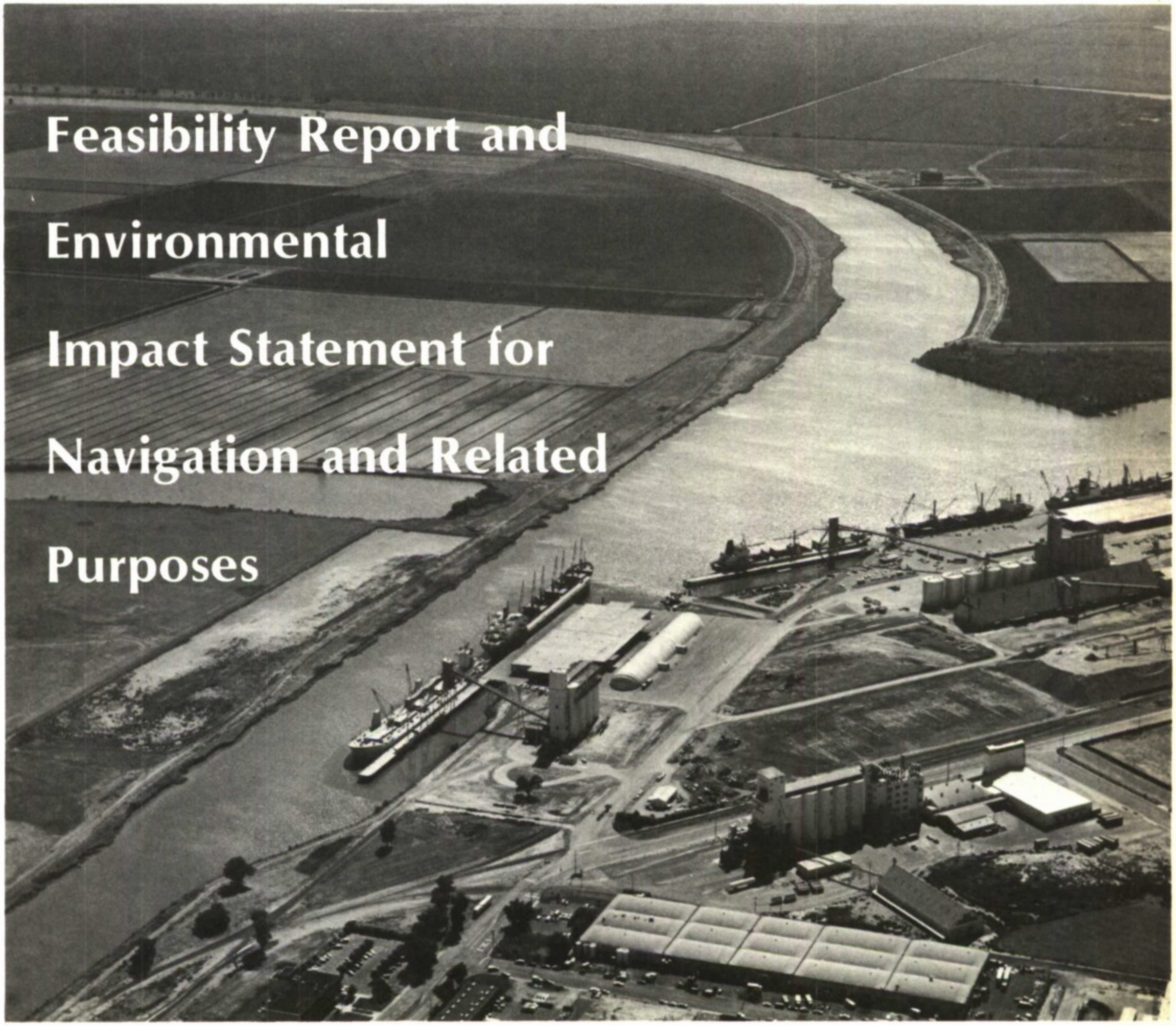
SACRAMENTO RIVER DEEP WATER SHIP CHANNEL, CALIFORNIA



Feasibility Report and Environmental Impact Statement for Navigation and Related Purposes

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SYLLABUS

The purpose of this study was to investigate the need for deeper draft channels to the Port of Sacramento, California, to improve the transportation of commodities to and from the Port of Sacramento; to improve the safety and usefulness of existing channels; and to enhance existing environmental and recreational conditions in the study area.

The study area consists primarily of the Sacramento River Deep Water Ship Channel from the mouth of New York Slough to the Port of Sacramento, and the Suisun Bay Channel from Avon to the mouth of New York Slough.

The problems associated with waterborne transportation in the Sacramento River Deep Water Ship Channel study area result from waterways which are inadequate to efficiently accommodate vessels currently using the channel, thus causing transportation inefficiencies and unsafe conditions. The need for greater transportation efficiency and safety may be fulfilled through existing national transportation policies including channel improvements. Since the existing channel was completed in 1963, tonnages have steadily increased as a result of increased productivity of the agricultural industry in the northern and central portions of California, increased exports of forest products from this region, and due to foreign demand for agricultural and forest products. Imports, including nitrogeneous fertilizers, bulk commodities, and general cargo have also increased during this period. In addition, the channel has provided deepwater access for industries in the service area.

Development and change in waterborne commerce have been rapid and revolutionary in recent years. New shipping techniques and modern terminal development have been necessary to accommodate this increased commerce. Economic growth in the Orient is generally expanding at a higher rate than in the rest of the world, and new or prospective trade policies point to the expansion of United States trade in these countries. This trade is significant to the Port of Sacramento since the port's service area produces large quantities of rice, other grains, wood chips, and other dry bulk products required in the economy of the Orient. The volume of those commodities moved through the Port already exceeds predictions made during feasibility studies of initial channel construction.

The four alternatives considered which might satisfy the need for more efficient and safe commodity import and export for the Port of Sacramento service area were as follows: increased use of LASH barges; intermodal transportation of cargo to alternative ports; deepening the channel; and no action (no further navigation improvements).

The selected plan provides for deepening the Suisun Bay and the Sacramento River Deep Water Channels from New York Slough to the Port of Sacramento, from the existing 30-foot channel to 35 feet. In addition, the channel would be widened as necessary to maintain navigation safety. The selected plan also provides for a water quality monitoring program, authority to construct a submerged sill, 45 acres of land for establishment of wetland habitat, and 156 acres of land for upland habitat to mitigate for losses of such habitat. This portion of the project would have an estimated first cost of $73,100,000 and an average annual cost of $6,154,000. With average annual benefits of $15,202,000, this portion of the project would have a benefit-cost ratio of 2.5 to 1.

The Avon to New York Slough reach of the selected plan is currently authorized for deepening to 35 feet under the San Francisco Bay to Stockton (John F. Baldwin and Stockton Ship Channels) project. In the event that this channel is not deepened to 35 feet under the current authorization, it would be deepened as part of the selected plan. When the Avon to New York Slough reach is included in the selected plan of improvement the project would have an estimated first cost of $81,500,000 and an average annual cost of $7,063,000. With average annual benefits of $15,202,000, the benefit-cost ratio would be 2.2 to 1.

It is recommended that, subject to certain conditions of non-Federal cooperation as outlined in this report, the selected plan be authorized for construction. Estimated first and annual costs to the United States are $56,579,000 and $4,702,000, respectively. Estimated non-Federal first and annual costs are $16,521,000 and $1,452,000, respectively. These costs are based upon the President's recently proposed cost-sharing methods. Cost-sharing based upon traditional cost-sharing policy is also included in this report for comparative purposes.

SACRAMENTO RIVER DEEP WATER SHIP CHANNEL, CALIFORNIA

FEASIBILITY REPORT AND ENVIRONMENTAL IMPACT STATEMENT FOR NAVIGATION AND RELATED PURPOSES

The Study and Report

Purpose and Authority

The purpose of this study was to investigate the need for deeper draft channels to the Port of Sacramento, California, to improve the transportation of commodities to and from the Port of Sacramento; improve the safety and usefulness of the existing channels; and enhance existing environmental and recreational conditions in the study area.

The report was prepared in response to resolutions by the Committee on Public Works, House of Representatives, dated 10 July 1968 and 11 December 1969, requesting the Board of Engineers for Rivers and Harbors to review reports on the Sacramento River, California, and other pertinent reports to determine whether any modification of the existing navigation project is advisable at the present time, particularly to the channel from New York Slough to the Port of Sacramento.

Scope of the Study

The study area, as shown on plate 1, consists primarily of the Sacramento River Deep Water Ship Channel from Collinsville to the Port of Sacramento, California, and the Suisun Bay Channel from Avon to Collinsville.

Alternatives other than deepening the channel were also addressed, including their economic feasibility and economic, social, and environmental impacts and implications. Engineering analyses were limited to determining the feasibility of providing a deeper channel to the Port of Sacramento and the effects such deepening may have on hydraulics, water quality, and the environment.

Study Participants and Coordination

Study participants included concerned Federal, State, and local agencies. Agencies having primary responsibilities in specific problem areas provided information, advice, and comments. These agencies include the U.S. Fish and Wildlife Service; Environmental Protection Agency; Heritage Conservation and Recreation Service; the California Department of Boating and Waterways; California Department of Parks and Recreation; the California Department of Fish and Game; Sacramento, Solano, and Yolo Counties; the Port of Sacramento; and other local agencies, organizations, and individuals.

An initial public meeting was held 3 March 1971 in Sacramento to give Federal, State, and local interests an opportunity to express their views regarding navigation and related water resources and environmental aspects of the investigation. A "formulation stage" public meeting, sponsored by the Port of Sacramento, was held 19 July 1976, also in Sacramento, to present the results of studies, including advantages and disadvantages of the various alternatives investigated. A public information brochure was published in July 1976 summarizing commercial navigation problems in the study area, alternatives considered, advantages and disadvantages of each alternative, and the status of the investigation.

A final public meeting was held 13 November 1979 in Sacramento to present the selected plan to deepen the Sacramento River Deep Water Ship Channel and to receive comments.

The Report

This report is arranged into a main report and six appendixes, one of which is a Technical Report. The main report essentially summarizes the Technical Report but also contains material on plan implementation, coordination, and recommendations. The Technical Report, Appendix 1, presents more detailed aspects of the study for the technical reviewer.

Appendix 2 contains pertinent correspondence and reports from others received during the course of the investigation other than that obtained as a direct result of coordination of the draft feasibility report and Environmental Impact Statement (EIS).

Appendix 3 is the Environmental Impact Statement (EIS), which, in accordance with guidance from the Council on Environmental Quality, has been limited to a concise analysis and evaluation of the significant impacts of the proposed plan and alternatives to the proposed plan so that the document will be more readable and more useful to the public and decision makers.

Appendix 4 is the Section 404 Evalution, prepared in accordance with the Clean Water Act of 1977, as amended (33 USC 1344). This report is required when dredged or fill material is placed into waters of the United States or their associated wetlands.

Appendix 5 is an office study which presents results of an extensive model testing program which determined the impact of deepening the Stockton and Sacramento Ship Channels on salinity distributions in the Bay-Delta estuary.

Appendix 6 contains correspondence received as a result of coordination of the draft feasibility report and EIS, and also contains responses to comments received on the draft EIS.

Prior Studies and Reports

The feasibility report on the existing Sacramento River Deep Water Ship Channel, dated 1 June 1945 (Senate Document 142), resulted in authorization of this channel by the River and Harbor Act of 24 July 1946. Similarly, a feasibility report on the navigation channels between San Francisco and Stockton, dated 15 November 1963 (House Document 208), resulted in authorization of deepening the Suisun Bay Channel to 35 feet, along with other improvements, by the River and Harbor Act of 27 October 1965.

As part of the investigation of the feasibility of deepening the Sacramento River Deep Water Ship Channel, studies have been conducted which include an environmental inventory, an office report on recreation opportunities, an office report on salinity conditions in the turning basin, a sedimentation study for Junction Point, a bottom sediment sampling program, a water quality monitoring program, a cultural resources reconnaissance, a hydraulic model testing program, and an assessment of the effects of a submerged sill. In addition, the Sacramento-Yolo Port District completed an assessment of the recreation potential at the Port of Sacramento as well as a port plan.

Resources and Economy of the Study Area

Environmental Setting and Natural Resources

The study area extends from Avon, in Suisun Bay, to the Port of Sacramento and includes portions of Contra Costa, Sacramento, Solano, and Yolo Counties. As shown on the General Map (plate 1), the study may be divided into three reaches, for a total distance of 58 miles, as follows:

Avon to the mouth of New York Slough near Pittsburg, the westernmost reach, is 11.5 miles long and is known as the Suisun Bay Channel. Currently, this channel is maintained to a depth of -30 feet mean lower low water (mllw) with a bottom width of 300 feet between Avon and Middle Point and 450 feet between Middle Point and New York Slough. The northern side of Suisun Bay is composed of brackish water marshes. The southern side consists of scattered industrial development including the Concord Naval Weapons Station and Pacific Gas and Electric Company powerplant, while the remaining area is undeveloped uplands and wetlands.

Port of Sacramento with Sacramento Metropolitan Area in Background

The 13.5-mile reach from the mouth of New York Slough to the northern end of the Collinsville-Montezuma Hills area (channel mile 11.0) closely follows the Solano-Contra Costa County line from New York Slough to Collinsville, as does the previously described reach, and the Solano-Sacramento County line from Collinsville to mile 11.0. The navigation channel is currently 30 feet deep at mllw and 300 feet wide.

Extending northeast for 33 miles, the reach from channel mile 11.0 near Collinsville-Montezuma Hills area to the Port of Sacramento is 30 feet deep at mllw and 300 feet wide from mile 11.0 to the mouth of the manmade channel (mile 18.6) and 200 feet wide from mile 18.6 to the Port of Sacramento. This reach is bounded by agricultural lands except near the city of Rio Vista.

Most of the study area is within the Sacramento-San Joaquin Delta, which consists of about 1,100 square miles of land and over 700 miles of meandering waterways, and is located at the confluence of the Sacramento and San Joaquin Rivers. The Delta is roughly triangular, bounded by Sacramento on the north, Stockton on the south, and Antioch on the west. The Sacramento and San Joaquin Rivers enter the Delta from northern and southern corners and flow out through the western corner into Suisun Bay and subsequently into San Pablo Bay, San Francisco Bay, and the Pacific Ocean. During the last century, levees have been constructed along the waterways to divide the Delta into about 60 separate parcels which have been drained to form islands. The waterways provide habitat for a varied fishery and are used for both recreational boating and commercial navigation.

Most of the water from the 64,000-square mile Central Valley watershed, or roughly one-third of the entire State of California, drains through the Delta, and most of this water originates as runoff from winter rains in the valley and foothills and from spring snowmelt in the Sierra Nevada. The Sacramento River, the main tributary to the Delta, produces 80 percent of the total runoff. Large-scale diversions and Federal, State, and local water projects constructed within the watershed have cut the mean annual outflow from the Delta from more than 30 million acre-feet to about 16 million acre-feet per year. Additional water is removed from the Delta by agricultural pumping, vegetative transpiration, and by the Contra Costa Canal, South Bay Aqueduct, California Aqueduct, and Delta-Mendota Canal.

The climate of the study area is characterized by hot, dry summers and cool, moist winters. Annual precipitation varies from 7 to 24 inches, averaging approximately 15 inches, and major rainfall occurs from October through April. The prevailing winds in Suisun Bay and the Delta are from the south and southwest and are created by the cool ocean air moving through the Carquinez Strait. The wind and waves are a significant navigational hazard for small craft and can also increase bank erosion.

Water levels in the Delta are influenced by tributary inflow and by tidal action. Flood stages may be caused by a combination of heavy runoff and high tide. Water surface elevations in each of the three reaches within the study area are predominantly influenced by tidal action. The tidal range normally is between 5 and 6 feet in the study area.

During periods of high runoff, floodflows from the Yolo Bypass, Steamboat Slough, and the Sacramento River carry a high sediment load. As the flow recedes, the sediment-carrying capacity diminishes and the sediment is deposited, resulting in shoaling. Shoaling is particularly evident at locations of enlarged cross section such as the junction of Cache Slough, Sacramento River, and Steamboat Slough (Junction Point). Near this location, approximately 200,000 cubic yards of material is dredged annually.

The waters of the ship channel are used for commercial navigation, water supply, fishing, recreation, and disposal of irrigation return flows. These uses have different quality requirements. In 1975, the Central Valley Regional Water Control Board adopted a Basin Plan which included water quality objectives for the deep water channel. Intermittent water quality data collected between 1963 and 1972 indicated that, except for salinity, the water quality in the channel meets or exceeds the objectives. Salinity measurements indicate that total dissolved solids generally exceed the 500 parts per million (ppm) objective between mile 35 and the Port of Sacramento. This increase is due primarily to saltwater ballast discharge from ships at the port. During the course of the current investigation, it was determined that the control of discharge of salt water ballast by oceangoing vessels was a matter of enforcement of existing regulations under the jurisdiction of the State Water Resources Control Board and the Environmental Protection Agency.

The study area is primarily within the boundaries of the Sacramento Valley Air Basin. Major pollution problems within the basin are photochemical smog (oxidents) and particulate matter. Most of the directly emitted particulate matter is the result of stationary sources including agricultural burning. Mobile sources, including motor vehicles, ships, boats, and airplanes, emit most of the oxidents. The city of Sacramento exceeded the national standard for oxidents 28 times in 1975, primarily during periods of atmospheric inversions.

Almost the entire length of the ship channel is bordered by agricultural lands, including row crops and orchards. The vegetation on the channel levees and berms consists primarily of annual grasses, although some brackish water marsh, freshwater marsh, trees, and brush do occur. Remnants of freshwater marsh occur in the Collinsville area. Some brackish water marsh also occurs in the inlets upstream of Collinsville and bordering Montezuma Slough. Across the river, the Lower Sherman Island Wildlife Area is a partially flooded island with freshwater marshes. The manmade channel, from its downstream end to approximately mile 35, has shorelines of bulrush, a few cottonwoods, and small willows. The berms of this portion of the channel are used for dry farm agriculture and grazing.

Phytoplankton are the microscopic, drifting, often unicellular plants that comprise the base of the aquatic food chain. They exist in very high concentrations in the Delta. Zooplankton are tiny free-swimming or drifting animals that feed primarily on phytoplankton and detritus. Their distribution is controlled largely by tides, currents, and wind. Zooplankton are consumed by other organisms such as shrimp and small fish. The mysid shrimp is an abundant and extremely important zooplankton species in the Delta, for it is the principal food of young fish, notably striped bass.

Zoobenthos are either sedentary or mobile animals that live upon or within the bottom substrate. There are many factors that act individually or in combination to determine the distribution of benthic organisms, including salinity, temperature, depth, substrate, and dissolved oxygen. Zoobenthic organisms are important sources of food for fish, waterfowl, and shore birds.

The study area is considered to be one of the most important areas for fisheries in California. It is used by anadromous as well as by resident species. Anadromous fish using the study area as a spawning and nursery ground include striped bass, king salmon, American shad, steelhead, and white and green sturgeon.

Wildlife species inhabiting the study area are diverse and abundant. Important avian species include wading birds, shore birds, waterfowl, upland game birds, and over 150 nongame species. Mammalian species include beaver, mink, muskrat, river otter, skunks, raccoon, and other small rodents. Upland game species such as pheasant, quail, dove, and cottontail rabbit are abundant in the study area. The Suisun Marsh provides habitat for the majority of the wildlife found throughout the Delta, but the marsh is particularly attractive to wintering waterfowl of the Pacific Flyway. The manmade channel also winters numerous waterfowl in years when the adjacent agricultural lands in the Yolo Bypass are not flooded.

At the present time, there are 10 animals and 2 plants in the study area which are listed as threatened, rare, or endangered on the Federal and State threatened, endangered, and rare species lists. Of the 10 animal species, one is an insect, one a reptile, one a fish, five are birds, and two are mammals. This is not to indicate that these species are present in the study area but rather acknowledges their possible presence based on the distributional characteristics and habitat requirements of each species. The two plant species, the Contra Costa wallflower and the Antioch Dunes evening primrose however, are known to exist in the study area and the Antioch Dunes has been declared critical habitat by the Fish and Wildlife Service for both plants. An additional 10 plants (6 species observed in the study area and 4 species with range distributions which include the study area) have been identified as threatened. endangered, or rare by the California Native Plant Society and/or the Smithsonian Institution. Included among these additional plants are the California Hibiscus and a Lilaeopsis that have been found adjacent to the ship channel. Also, the Anthicid Beetle is a proposed species and its proposed critical habitat includes two dredged material disposal sites used for maintaining the channel.

The area from the Port of Sacramento southwest along the ship channel was part of the territories of two aboriginal groups which used the river area. Both were hunters and gatherers, since in prehistoric times the Delta offered a variety of animal, plant, and aquatic foods as well as other material necessary for their livelihoods. Many prehistoric cultural remains in the Delta have been destroyed or buried by past agricultural improvement and land reclamation activities. One aboriginal cultural resource site west of Lake Washington was found as part of this investigation.

No National Register of Historic Places properties or natural landmarks lie within the project area. Two towns of historical interest, Rio Vista and Collinsville are within the region; however, these will not be impacted by the project (see Plate 2 for project location). Rio Vista was established in 1857 near the junction of Cache Slough and the Sacramento River. Collinsville, a former salmon fishing village built on pilings was the site of a cannery established in 1873. Only a few of the houses built on stilts still remain. In the vicinity of Collinsville, the Hastings Adobe is listed on the National Register of Historic Places. A privately-owned steamboat built in 1926 is also listed in the National Register. It is described as being docked at Rio Vista; however, it is no longer at that location. Neither of these properties would be impacted by project construction. In 1976, archeologists conducted an on-the-ground cultural resources reconnaissance survey over a 15 percent sample of the project area. The reconnaissance report was coordinated with the California State Historic Preservation Officer and the Interagency Archeological Services, Heritage Conservation and Recreation Service. An intensive examination of cultural resources will be undertaken during advanced engineering and design studies.

Human Resources

As of mid-1979, the population in Sacramento, Yolo, and Solano counties was estimated at 1,084,700 by the California Department of Finance. This represents an increase of over 20 percent since 1970 and 51 percent since 1960. The State of California's population by comparison increased by 43 percent during this period. The most populous cities in the three counties are Sacramento, Vallejo, Fairfield, Davis, Vacaville, and Woodland. Demographically, the age distribution for the three counties closely mirrors that of the State as a whole. Of the total population of the three counties, 6.1 percent is black and 8.4 percent is Spanish-speaking.

Over the last 5 years, employment in the study area has grown at a rate of about 4.25 percent per year. Employment in finance, insurance, and real estate, as well as services, has increased dramatically in response to specific regional needs. The single most important employment category in the study area is government. Approximately 40.4 percent of all wage and salary workers belonged to this classification in 1977. Clerical workers, with approximately 23 percent of the total jobs, composed the largest occupational group in the three counties. Professional and technical workers and craftsmen and foremen were the second and third largest occupational groups, comprising about 18 and 14 percent of the employees, respectively. Service workers were the only other occupational group in the three counties with more than 10 percent of total civilian employment.

Personal income in the three counties increased at an annual rate of 11.3 percent between 1972 and 1977, compared with 11.0 percent for the State as a whole. The largest source of personal income is wages and salaries. Per capita income in the area was about 10 percent below the State average in 1977.

Development and Economy

The economy of the study area is comprised of a wide range of industries that are sensitive to the changes in supply and demand for locally produced goods and services which are consumed both in local markets as well as in markets outside the regional economy. Agriculture in the Sacramento Valley is known for its high productivity and for the quality of commodities produced. Although not as significant as in other parts of the State, manufacturing in the three counties constitutes an important source of employment and output.

In 1972, manufacturers in Sacramento, Yolo, and Solano Counties accounted for $600 million of California's $31.3 billion value added by manufacturers. Government dominates the economic scene in the study area. With the State Capitol and two major military installations located in the Sacramento area and two major military installations located in Solano County, government is a major source of economic activity.

The Port of Sacramento occupies a significant position in the economic and commercial affairs of the markets in which it operates. Because it provides access to world markets for both import and export for both finished goods and raw materials, the port has given major impetus to economic activities in the study area and has helped to broaden and diversify the industrial base of the regional economy. The economic significance of the port is enhanced by the fact that it enjoys some of the most modern and efficient cargo handling facilities for bulk cargo on the west coast. In addition to modern bulk cargo handling facilities, the port's economic significance is buttressed by the availability of large tracts of land along the deep water ship channel which have been zoned for industrial use and potential port expansion. The port provides a base for an important number of jobs and a sizeable amount of income in the north central California area.

Because of its locational advantages in relation to other areas in the western United States, Sacramento is in the unique position to provide multi-modal transportation facilities capable of handling shipments by surface, air, or water. These transportation facilities, combined with Sacramento's location near the center of California's great Central Valley, make Sacramento an ideal base for certain industrial activities including manufacturing, processing, warehousing, and marketing. The transportation advantage also improves Sacramento's important role as a regional distribution point to other shipping centers of the Pacific Basin as well as to other parts of the United States.

Projected Population, Employment, and Income

The California Department of Finance has developed demographic projections for Sacramento, Yolo, and Solano Counties which estimate that the population of this area will increase from 1.08 million in 1979 to 1.86 million in 2020. This growth represents a compound annual rate of 1.3 percent, which is substantially less than the historic growth rate of 2.2 percent per year obtained since 1950.

Since government has been the largest employer in recent years, it is anticipated that employment in this sector will continue at a relatively high level in the future, although at a somewhat reduced level from what has been experienced in recent times. There is every indication that the employment base will continue to broaden and diversify in the future in response to greater needs for various goods and services. Total personal income for the three counties is expected to increase from about $7.3 billion in 1977 to over $41 billion by 2020. Per capita income is anticipated to rise from $7,121 in 1977 to $22,444 in 2020, or at an annual rate of 2.7 percent.

Waterway Commerce

The commercial significance of the Port of Sacramento is indicated by the enormous increases in tonnages handled at the port in recent years. The total cargo has increased from 545,000 tons in 1966 to over 2.1 million tons in 1979. The four most important commodities handled at the port in 1979 were rice, wood chips, other grains and oilseeds, and fertilizer. The total tonnage for these cargoes accounted for 91 percent of the port's activity in 1979. About 80 percent of the commodity movement through the port is designated for foreign markets. Japan and other Pacific Basin nations account for about 88 percent of the foreign exports.

Prospective Waterway Commerce

The Port of Sacramento enjoys an excellent reputation among shippers and is in a strategic position to benefit in the future from increased shipments to the Pacific. Those commodities which appear to be the most promising to the port's future are rice, other grains and oilseeds, logs, wood chips, fertilizers and fertilizer materials, and other bulk commodities. In addition, commodities would be transported on the ship channel as a result of future industrialization along the channel and as a result of cargo induced by channel deepening.

Since initiation of activities at the port in 1963, rice shipments have consistently been one of the most important export commodities. In 1979, 586,000 tons of rice were exported. World population is projected to increase by 1 to 2 billion people between 1985 and 2000. On that basis, long-term world rice supplies are likely to remain short as demand continues to expand. The shipments of rice are therefore projected to increase to 680,000 tons per year by 1987 and to 1,250,000 tons per year by the year 2037.

Grains (except rice) and oilseeds moving to offshore markets through the Port of Sacramento have been destined primarily for Japan, the Soviet Union, People's Republic of China, Iraq, South Korea, India, Chile, Mexico, and Hawaii. These shipments have included milo, safflower, wheat, barley, and corn. From 65 to 75 percent of the wheat grown in the Sacramento Valley is bound for foreign markets. Grain movements (especially corn and wheat) will continue to increase in the future and become more important to the port's overall activities. There is every indication that the number of unit train movements of corn from Midwest points through port facilities will increase in the future. By 1987, grain shipments are expected to account for 600,000 tons of cargo that will pass through the port, and this tonnage is expected to increase to 1,200,000 tons a year in 2037.

Logs are also shipped in large quantities from the port. These logs originate in the mountains around the Sacramento Valley and are shipped to Japan and South Korea. Substantial increases are not expected in the export of logs in the future and, barring restrictive legislation, current exports will remain fairly constant. Therefore, the 1976-79 average level of log exports (approximately 135,000 tons) was assumed to be the most probable level of log exports throughout the 50-year projection period.

Wood chips are shipped in large quantities from the Port of Sacramento, amounting to 31 percent of the total 1979 shipments. Wood chips are expected to remain one of the major cargoes moving through the Port of Sacramento during the projection period. In the future, wood chips exported through the port are expected to increase to approximately 1.1 million tons by the mid-1980's and to remain at about that level over the projection period.

The Port of Sacramento is the receiving point for large quantities of nitrogenous fertilizer used in Central Valley agricultural production. Ferilizer receipts have increased dramatically in recent years, accounting for about 360,000 tons during 1979. The increasing scarcity of natural gas supplies in California for the manufacture of nitrogenous fertilizer will require greatly increased imports of fertilizer from Alaskan and foreign sources in the future. Fertilizer receipts are expected to increase to about 700,000 tons per year by 1987 and to approximately 1.85 million tons per year by 2037.

Other bulk commodities such as potash, scrap steel, phosphate rock, and others have moved through the port in the past, and prospects are favorable for future shipments of these types of commodities. The port has also recently signed agreements to ship large quantities of petroleum coke and feed commodities over the next 5 years. The potential exists for large future movements of such items as soda ash, steam coal, cement, Nevada-mined ores, and various bulk liquids. By 1987 the port is expected to be handling a minimum 180,000 tons of other bulk commodities, and movements should increase to 690,000 tons by 2037.

The area surrounding the port is attractive for future industrial development that is oriented towards water transportation. The economic advantages in transportation provided by the ship channel and the port influence the location of industries since many industries find that easy access to the waterway affords specific cost savings. Large quantities of land on both sides of the channel near the Port of Sacramento are currently zoned for industrial development. By 1987, industrial development is expected to be responsible for 680,000 tons of cargo shipped annually on the channel. This activity is projected to increase to 1,955,000 tons per year by 2037.

Deepening the channel is expected to induce traffic which would not move without the channel improvements, due to the greater efficiency of the deeper channel and the elimination of the need for topping off vessels which cannot fully load at the port. It is estimated that by 1987 the deepening of the channel to 35 feet will produce 300,000 tons of additional cargo shipments and that this tonnage would increase to 355,000 and 440,000 with channel depths of 37 and 40 feet, respectively. The increases in shipments are expected to reach almost 2.7 million tons by 2037 with a 35-foot channel and 3.5 and 4.6 million tons with a further deepening of the channel to 37 and 40 feet, respectively.

The Collinsville-Montezuma Hills area, located approximately 45 nautical miles inland from the Golden Gate Bridge, encompasses a large expanse of potential water-oriented industrial acreage which is now primarily in low-intensity agricultural use. The only industrial activity in the area is the natural gasfields in the eastern portion. A number of proposals have been made in recent years to develop large-scale industrial facilities along the waterfront in this area. Although most of these proposals have subsequently been withdrawn, the area must be viewed as one of the last opportunities in the Bay region for the development of large-scale, water-oriented industry on a deep-draft ship channel.

The recent availability of large quantities of Alaskan oil and its products on the west coast and the size and growth of the consumer market have encouraged producers of petrochemicals to consider locating facilities in the area. The west coast is currently being supplied with petrochemicals from facilities that are located primarily in the Gulf and Eastern states. Two petrochemical companies have considered the construction of large plants in the Collinsville-Montezuma Hills area for the production of plastic raw materials to supply the west coast industries. Both plant sites were selected because of their strategic location contiguous to the Sacramento River Deep Water Ship Channel and the availability of land for storage tank area. Although both proposals have recently been withdrawn, discussions with industry sources indicate that there is a good potential for the petrochemical industry locating in the Collinsville-Montezuma Hills area.

Other industries which may develop facilities in the Collinsville-Montezuma Hills area include the energy production and storage industry, which consists of electrical generating facilities and liquid petroleum gas suppliers; steel production industry; and the mineral refining industry.

The prospective growth and development of any region is difficult to assess and evaluate. This is particularly true of an area such as Collinsville-Montezuma Hills which is now predominantly in low intensity agricultural use and yet has an enormous potential for future industrial growth. Without channel improvements, approximately 1.5 million tons of cargo are expected to be handled at the Collinsville-Montezuma Hills area by 1987. Industrialization would continue throughout the projection period so that by 2037 approximately 5.5 million tons would be handled. With a 35-foot or deeper channel, the area would attract industries which would not otherwise locate there. This induced development would produce additional cargo for the various depths considered as follows:

PROJECTIONS OF PROJECT INDUCED TONNAGES
FOR THE COLLINSVILLE-MONTEZUMA HILLS AREA
(tons)

Year	35-ft.	37-ft.	40-ft.	45-ft.
1987	300,000	400,000	500,000	600,000
2037	2,500,000	3,200,000	4,300,000	5,000,000

Most rice, wheat, fertilizer, logs and other bulk commodities are shipped through the Port of Sacramento in dry bulk vessels. These vessels range in size from about 15,000 to 60,000 dwt with design drafts from 29 to 42 feet. Shippers prefer to use vessels in the 18,000 to 20,000 dwt range due to the limited depth of the existing channel. However, it is becoming increasingly difficult to charter ships in this size range since most vessels have been replaced by larger ships. Shippers must therefore charter larger vessels which must be operated at less than their design drafts on the channel thus increasing shipping costs.

Bulk wood chip vessels were built specifically to supply wood chips to the paper and fiberboard industry in Japan. Because of the low density of wood chips in bulk form, the industry requires large volumes to be transported in each shipload. Wood chip vessels are voluminous, with hold capacities ranging from 1.4 to 4.2 million cubic feet, sizes ranging between 22,000 and 58,000 deadweight tons (dwt) and design drafts ranging from 32 to 44.5 feet. Vessels calling at the Port of Sacramento are limited to approximately 43,000 dwt by existing channel dimensions.

Since the opening of the port, 2,118 deep draft vessels have moved through the channel carrying 21.5 million tons of cargo. Traffic is primarily comprised of bulk vessels carrying bulk wood chips, rice, wheat, fertilizers, and other bulk materials. The majority of vessels calling at the port in 1977 had design drafts of 30 to 31 feet. If the existing channel is deepened, larger vessels, which carry cargo more efficiently, will be used. In the future most of the vessels used for bulk cargo trades will probably be in the 20,000 to 40,000-ton range since medium sized vessels have more route flexibility and trade opportunities than their larger counterparts.

Recreation

Recreation use of the ship channel and the Delta is almost totally water-dependent, with the principal activities being swimming, fishing, sightseeing, boating, and waterskiing. Fishing is the most popular activity, followed by pleasure boating, but recreation opportunities for nonboaters are very limited. There are few public roads, and those that do exist are generally built on narrow levee crowns which offer few places for autos to stop and park. Additionally, attempting to gain access to the waterway from the public road often involves trespass on private land.

The Sacramento-San Joaquin Delta has over 50,000 acres of protected water surface and over 700 miles of scenic waterways. It is a unique recreation resource providing a superlative sport fishery and opportunity for diverse water-oriented recreation activities such as sailing and waterskiing. Because of the temperate climate, the Delta area receives significant recreation use from March through October. The Resources Agency of the State of California projects that 40 million recreation days of use could occur annually in the Delta by the year 2000, if adequate facilities to support that use were provided.

Problems and Needs

The problems associated with waterborne transportation in the Sacramento River Deep Water Ship Channel study area result from waterways which are inadequate to accommodate vessels currently using the channel, thus causing transportation inefficiencies and unsafe conditions. The need for greater transportation efficiency and safety may be fulfilled through existing national transportation policies including channel improvements. Since the existing channel was completed in 1963, tonnages have steadily increased as a result of increased productivity of the agricultural industry in the northern and central portions of California, increased exports of forest products from this region, and due to foreign demand for agricultural and forest products. In addition, the channel has provided deepwater access for industries in the service area.

Development and change in waterborne commerce have been rapid and revolutionary in recent years. New shipping techniques and modern terminal development have been necessary to accommodate this increased commerce. Economic growth in the Orient is generally expanding at a higher rate than in the rest of the world, and new or prospective trade policies point to the expansion of United States trade in these countries. This trade is significant to the Port of Sacramento since the port's service area produces large quantities of rice, other grains, wood chips, and other dry bulk products required in the economy of the Orient.

Status of Existing Plans and Improvements

Construction of the existing Sacramento River Deep Water Ship Channel was authorized in 1946. Construction of the 30-foot channel was initiated in 1949, and the channel was completed and became operational for oceangoing vessels in June 1963. The Sacramento-Yolo Port District provided the local cooperation requirements for the existing project. These requirements included providing adequate public terminal facilities. In compliance with this requirement, the Port District provided basic terminal facilities costing $31.3 million; the State of California reconstructed the Rio Vista Bridge at a cost of $3.2 million; and other local interests have constructed and placed in operation facilities in the vicinity of the port which make use of the project.

The existing 30-foot channel in Suisun Bay between Avon and Pittsburg was authorized in January 1927 and was completed in 1934. This channel has been authorized for further deepening as part of the San Francisco Bay to Stockton Project, authorized in 1965; however, only limited construction has been accomplished on this project pending completion of evaluation of the effects of deepening the Stockton Ship Channel.

The waterway between Pittsburg and Collinsville has a natural depth of at least 30 feet mllw; hence, no improvements have been made in this reach.

Need for Channel Modification

The characteristics of deep-draft dry-bulk vessels in the world fleet are undergoing rapid changes to meet the competitive demand for efficient transportation. Ship sizes, especially bulk carriers, have increased at a rate which was unforseen just a few years ago. Research on the design of channels for navigation indicates that sufficient depth is the primary requirement for safe and efficient navigation in the waterway. The existing channel was designed to accommodate a loaded Victory class ship with characteristics of 10,800 deadweight tons (dwt), 455 feet 3 inches length overall, 62 foot breadth, and 28 feet 7 inches loaded draft. However, in recent years more and more of the vessels arriving at the port have beams of 80 to 100 feet, lengths from 550 to 700 feet, and design drafts of 33 to 38 feet. In 1977, 48 of the 118 vessels calling at the port had to be light-loaded because of channel depth limitations. This trend can also be observed from the size characteristics of the world bulk carrier fleet. The average size for the total bulk fleet increased from 24,300 dwt in 1967 to 33,700 dwt in 1977. During this same period, the percentage of the world bulk carrier fleet of "18,000 dwt or less", which can use the channel when fully loaded, decreased from 37.0 percent in 1967 to only 19.7 percent in 1977. In excess of half of all bulk carriers fall into the class of 18-40,000 dwt. Modification of the existing channel would be required to provide for safe and efficient navigation of these larger vessels.

As previously indicated, the existing 30-foot channel between Avon and the Port of Sacramento does not provide sufficient depth and width to efficiently accommodate the newer deeper-draft vessels presently in operation and planned for the future. Therefore, ship operators are forced to carry less than capacity loads or to await favorable tides, thus reducing the ship's efficiency and increasing the unit cost of transportation. As ship size increases, navigation in channels with restricted clearances becomes more hazardous. Wind stress on slowly moving ships impairs maneuverability. Fog creates a strong dependency on radar equipment. For larger ships with little keel or beam clearance, navigation is difficult. Particular locations where groundings may be expected for the newer, larger vessels include Cache Slough, the entrance to the manmade portion of the Sacramento Channel, and the area near the Concord Naval Weapons Station in the Suisun Bay region.

When the existing Sacramento River Deep Water Ship Channel was constructed, industrial development along the lower portion of the manmade channel was anticipated, and the west levee of the channel at mile 31.9 was set back for future construction of a turning basin. A turning basin at this location would allow ships to enter the channel to load or unload cargo at a terminal facility south of the turning basin and turn around without proceeding to the turning basin at the Port of Sacramento.

Another navigation problem in the Sacramento River Deep Water Ship Channel is the continuous and rapid shoaling of the channel between Rio Vista (mile 5) and Junction Point (mile 15). Approximately 200,000 cubic yards of sediment is removed from this portion of the channel annually. This shoaling presents a hazard to navigation by reducing the channel depth to below the authorized depth, thus reducing under-keel clearance and maneuverability.

Without channel modification, the effectiveness and efficiency of the Port of Sacramento would be impaired, and the economy of the region would be adversely affected. The port occupies a significant position in the economic and commercial affairs of the market area in which it operates and provides the base for a significant number of jobs and revenue in the north central California area. During 1977 an average of 251 persons were employed at the port each working day, and several times this number of jobs exist throughout the area because of business that relates to products and shipping activities at the port.

Need for Recreation Facilities

The major recreation problems in the study area are similar to those throughout the Delta and stem from inadequate public access and facilities for public recreation. With the exception of a few county facilities, the Brannan Island State Recreation Area, and some public launching ramps, there is a lack of public recreation facilities along navigable waterways in the study area. Riding, hiking, and bicycle trails are few because of the lack of public lands, the high cost of building bridges between islands, the narrow levees, and the scarcity of paved roads. Access for bank fishing is also limited, and most of the shore fishing involves trespassing.

The major recreation season is from June through August with peak use occurring on weekends and holidays, often resulting in a substantial number of persons being turned away. Potential demand is considerably greater than current use because use is constrained by poor access and few facilities. The available evidence indicates that there is a significant latent demand for recreation use of the Delta. It is therefore anticipated that any facilities that could be provided in connection with a deepened channel would be used to capacity soon after completion.

Improvements Desired

At the initial public meeting for the investigation, local interests requested the enlargement of the Sacramento River Deep Water Ship Channel and construction of the turning basin at mile 31.9. The Federal Government was requested to assume responsibility for repair or restoration of works for wave wash protection along the channel. State and Federal fish and wildlife agencies, as well as local conservation groups, requested that careful consideration be given to the environment of the area before recommending any plan of improvement. Subsequent to this meeting, recreation interests have, through informal meetings and correspondence, requested additional public access to the ship channel for boating, fishing, and hunting. Public boat launching ramps in the vicinity of the turning basin at the Port of Sacramento and public park facilities in the vicinity of Rio Vista have been requested.

At the intermediate public meeting, almost all the comments received supported the need for a deeper channel to the port. However, others expressed concern about possible salinity intrusion, its effect on fish and wildlife and vegetation, and general water quality degradation and requested that problems associated with potential salinity and other impacts resulting from deepening be studied and resolved.

Plan Formulation

The evaluation of alternatives is accomplished by weighing the economic, environmental, and social benefits and costs, both tangible and intangible, of each alternative. The formulation of a comprehensive plan of action, which fulfills the study objectives, involves screening of numerous possible solutions. The most viable plan may include concepts from one or more alternative measures considered.

Formulation and Evaluation Criteria

Plans for the use of the water and land resources of the study area for navigation purposes are directed toward improving the quality of life in the Sacramento Valley of California through contributions to the national economic development and environmental quality objectives. Certain technical, economic, and environmental criteria were used to develop and select a plan which best responds to the problems and needs identified by affected parties in accordance with the Water Resources Council's "Principles and Standards for Planning Water and Related Land Resources."

Two broad objectives regarding Federal participation in water resources planning have been established by the Water Resources Council:

a. Enhance national economic development (NED) by increasing the value of the Nation's output of goods and services and improving national economic efficiency.

b. Enhance the quality of the environment (EQ) by the management, conservation, preservation, creation, restoration, or improvement of the quality of certain natural and cultural resources and ecological systems.

The additional considerations of Regional Development (RD) and Social Well-Being (SWB) are also considered as part of the plan formulation process. Because of the broad nature of these objectives, they have been redefined in terms of criteria relating to the problems, needs, and conditions being investigated. In such a form, these criteria provide for orderly and consistent evaluation of all alternatives.

TECHNICAL CRITERIA

The following technical criteria were utilized in developing the plans:

a. All plans should be consistent with Federal laws, policies, and standards and be cognizant of State and local ordinances and county and city land-use zoning. Existing transportation improvements should be preserved and utilized to the maximum extent, consistent with economic criteria.

b. Navigation improvements should be designed to safely accommodate expected vessel traffic.

c. Disposal sites should be constructed with retention dikes, spill boxes, and proper drainage pond systems to assure that water quality standards set by the State Water Resources Control Board are met.

ECONOMIC CRITERIA

The economic criteria for plan formulation and evaluation are as follows:

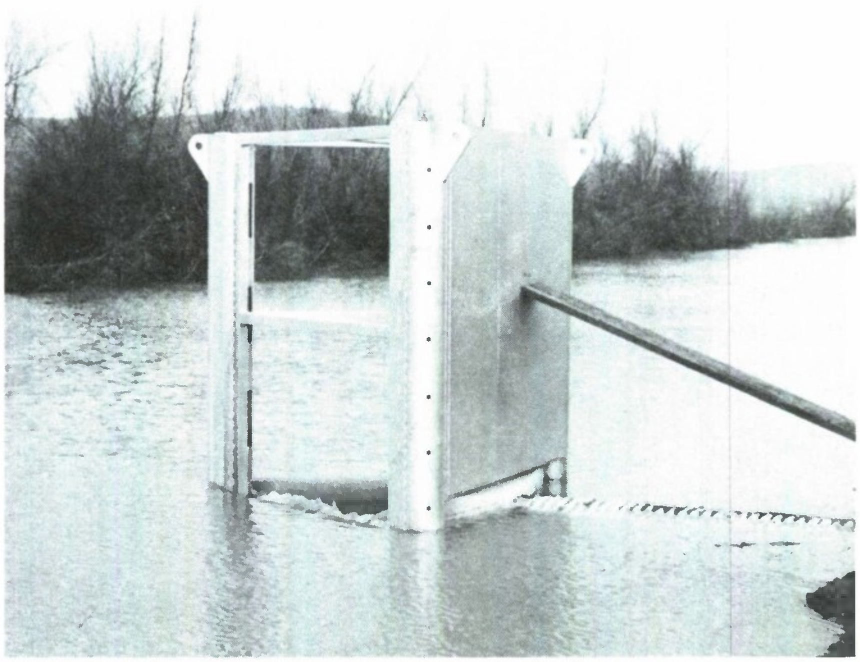
a. A plan must have set national economic development benefits unless the deficiency in net benefits for the national economic development objective is the result of benefits foregone or additional costs incurred to serve environmental quality.

b. Each separable unit of a plan should provide benefits at least equal to cost.

c. Benefits and costs should be expressed in comparable terms to the fullest extent possible.

d. There is no more economic means, evaluated on a comparable basis, of accomplishing the same purpose or purposes which would be precluded from development if the plan were undertaken. This limitation refers only to those alternative possibilities, such as other west coast ports, etc., that would be physically displaced or economically precluded from development if the project were undertaken.

Dredged material entering disposal area south of Rio Vista



Effluent leaving disposal area through spill box at disposal area south of Rio Vista

ENVIRONMENTAL AND OTHER CRITERIA

Preservation or enhancement of area environmental resources is given equal consideration with economic efficiency in developing and evaluating alternatives. Navigation or other improvements should be designed so that existing natural and cultural resources would be disturbed as little as possible, and mitigation for unavoidable losses should be provided to the maximum extent practicable and justified. Other criteria considered in formulating a plan were as follows:

a. The irreversible or long-term commitment of natural resources to effect implementation of a plan should be minimized.

b. Measures should be incorporated in the selected plan which protect, preserve, or enhance environmental quality in the project area. The selected plan should be consistent with local, regional, and State goals for port and industrial growth.

c. Interested Federal and non-Federal agencies, local groups, and individuals should be consulted through cooperative efforts, conferences, public meetings, and other procedures to achieve public acceptance.

d. Public acceptability of the proposed improvements and ability and willingness to meet local cooperation requirements are essential considerations.

INSTITUTIONAL CONSTRAINTS

The State of California has established standards for salinity concentrations at various locations in Suisun Bay and the Sacramento-San Joaquin Delta estuary. These standards are contained in Water Resources Control Board Decision 1485 and are maintained by freshwater releases from State and Federal reservoirs upstream from the Delta. The State Department of Water Resources and Water and Power Resources Service operate these reservoirs and have stated that any project which increases salinity intrusion into the Delta would decrease the yield of the State Water Project and Central Valley Project and thus would make future water requirements of the State more difficult to meet. In addition, the Contra Costa County Water District obtains most of its municipal and industrial water from the Delta. The County therefore strongly opposes all actions which would increase Delta salinities.

It is evident that increases in salinity levels resulting from navigation improvements would not be acceptable to the State of California, the Department of the Interior, and to water users in the Delta. It has therefore been concluded that salinities must not be increased by any plan for navigation improvement.

Possible Solutions

The four alternatives considered which might satisfy the need for more efficient and safe commodity import and export for the Port of Sacramento service area were as follows:

a. Increased use of LASH barges.

b. Intermodal transportation of cargo to alternative ports.

c. Deepening the channel.

d. No action (no further navigation improvements).

Each of the above alternatives was evaluated on the basis of the formulation and evaluation criteria presented previously.

INCREASED USE OF LASH

LASH, an acronym for "Lighter Aboard Ship," is a versatile transportation system which provides for carrying cargo aboard ship in lighters (barges). The lighters, which may be loaded at any port facility, are then transported to the LASH "mother" ship and loaded aboard by a heavy-duty shipboard gantry crane. LASH vessels are particularly suited for situations where there are inland shallow draft navigation systems at both origin and destination locations, where there is congestion in the port areas, or where port facilities are not available, as in underdeveloped nations. LASH service to the Port of Sacramento has been provided in the past from the LASH container terminal at the Port of San Francisco. However, during 1977 the operator of LASH vessels on the west coast serving the Orient converted its vessels to container ships. This conversion eliminated LASH service at the Port of Sacramento and has demonstrated that LASH service to the Orient is currently not feasible.

LASH vessels engaged in Far East trade were operated essentially for general cargo service (primarily eastbound); however, bulk commodities were frequently carried as "back haul" traffic (westbound) to the Far East when space was available. If the number of LASH vessels serving the bay area increases in the future, it would be in response to demand for future general cargo developments rather than to bulk cargo movements. Another restriction of the LASH system to most bulk cargo is that available space is rarely offered more than 30 days in advance of sailing. Exporters of bulk cargo find it difficult to conduct trade on this basis because most contracts are negotiated from 1 month to 1 year in advance of shipment. In addition, the large quantities of logs, wood chips, and liquid gas cargoes handled at the Port of Sacramento could not be efficiently transported via LASH barges.

The above analysis indicates that this alternative would not substantially contribute to the overall NED objective because of the inability of LASH to efficiently handle the existing or projected future cargo movements.

This alternative would have little effect on the environment. Overall, there would be a slight reduction in the amount of particulates and gases emitted to the atmosphere, and aquatic life and wildlife would not be affected by increased LASH traffic. However, the LASH alternative offers no potential for tangible contributions to environmental enhancement.

The LASH alternative would suppress real income due to the inefficiencies of the LASH operation and would also adversely affect employment and regional income. It is also apparent that the LASH alternative would have minimal positive effect on or contribution to regional income, employment, population, and other components of the Regional Development account.

INTERMODAL TRANSPORTATION

This alternative would promote the use of terminal facilities at bay area and other west coast ports to handle the oceangoing cargo that cannot be moved efficiently in the existing 30-foot channel. This alternative is being used to a limited extent at the present time to top-off some of the larger bulk grain vessels that must depart from the Port of Sacramento partially loaded. Under the intermodal transportation alternative, the deeper water ports would be used both for topping-off and lightening operations and for stockpiling and processing large volumes of bulk commodities moving to and from the tributary area served by the Sacramento River Deep Water Ship Channel.

Implementation of this alternative would require construction of new marine terminal and bulk storage facilities at deeper water ports. This new construction would take place only at ports where the channel depth exceeds 30 feet, such as in the bay area. Ports outside northern California are generally too far away to provide logical alternatives. Some of the problems associated with this alternative include limited space availability in the bay area to accommodate the required bulk storage and handling facilities and high overland transportation costs to move bulk commodities from the Port of Sacramento to the bay area. This is also true of moving commodities from the Port of Sacramento service area to the Port of Stockton. Transporting commodities to either the bay area or the Port of Stockton would increase transportation and handling costs by at least $5.00 per ton. Since bulk cargoes tend to provide narrow profit margins, any savings that can be incurred by shippers, buyers, and growers are vital in maintaining a competitive position in the marketplace. Increased use of overland modes of transport to carry bulk cargoes to deeper water ports would eventually limit production from local industries relying on ocean transportation. This alternative would have a negative impact on the NED objectives of increasing the value of the nation's output of goods and services and improving national economic efficiency.

Increasing truck and train traffic would have an adverse effect on air quality due to the increased amount of particulates and gases emitted into the atmosphere. In view of the EQ objective, this alternative has no potential for making a positive contribution to environmental quality of the area. Implementation of this alternative would result in curtailing of future industrial development along the channel; however, this loss would be partially offset by increased payroll in the trucking and railroad industries. This alternative would have a positive effect on job security for trucking and railroad workers, but jobs at the Port of Sacramento would decline, resulting in a net negative impact on real income in the Sacramento area. Further, increases in consumption of our scarce energy sources, gasoline, and diesel fuel, would occur.

DEEPENING THE CHANNEL

This alternative involves enlarging the existing project channels between deeper water in Suisun Bay and the Port of Sacramento to facilitate navigation by deeper draft vessels. Channel depths considered under this alternative include 35, 37, and 40 feet to the Port of Sacramento and 35, 37, 40, and 45 feet to the Collinsville-Montezuma Hills area (channel mile 11.0). The deepened channel would follow the alignment of the existing deep water ship channel. Sufficient dredged material disposal areas have been located to accommodate the dredged material resulting from the maximum depth channel considered. This alternative also has the potential to meet the need for additional recreation facilities. Such facilities could be constructed at dredged material disposal sites in cooperation with a non-Federal recreation sponsor.

Under this alternative, larger, more efficient vessels would be able to call at the Port of Sacramento and to traverse the channel when fully loaded, resulting in transportation savings due to (1) the movement of cargo via larger oceangoing vessels, (2) elimination or reduction in delays due to tides, (3) reduction of present light-loading and topping-off practices, and (4) movement of project induced tonnage. This alternative offers the greatest potential for achieving the NED objectives.

Deepening the channel also has the potential to improve the overall environmental quality of the study area; however, deepening could adversely affect individual aspects of the environment. Possible enhancement measures include construction of salinity control structures which would improve salinity conditions in Suisun Bay, creation of wildlife management areas, provision of recreation facilities, and preservation of existing unique ecological systems and wildlife habitats along the channel by acquiring such areas in public ownership. Adverse effects include possible local increases in salinity concentrations in the Delta. Generally, the deeper the channel the more significant the impacts on Delta salinity. Other detrimental environmental impacts include destruction of some benthic organisms, shoreline vegetation, and wildlife habitat due to channel construction. In addition, secondary effects on air and water quality could occur due to induced industrialization.

Implementation of this alternative would cause immediate short-term negative impacts including noise pollution and other inconveniences associated with dredging and construction operations. Upon completion of construction, these conditions would return to a more natural state. Long-term impacts would include balanced economic development and positive contributions to the social well-being account, assuming that current air, water, and other environmental standards will continue to be enforced. The deepening alternative would strengthen the regional economy by providing for greater employment opportunity through increased agricultural and industrial activity, resulting in substantial regional growth. Channel deepening would not affect maintenance dredging requirements, and this activity would continue at the present rate.

NO ACTION

This alternative course could be taken, although it would not solve the identified problems. It would provide for a continuation of present shipping practices with no improvements other than normal channel maintenance. Present shipping practices would continue to be used to partially offset existing channel depth constraints but would significantly increase the unit cost of moving oceangoing cargoes. Some limitations of future commodity flow in the study area could be expected with the alternative.

There would be no initial cost associated with this alternative since it is essentially the "no development" alternative. As more of the smaller ships are replaced by intermediate-sized vessels, the cost of transporting bulk and other cargo to and from the study area would increase. This increased transportation cost would impact unfavorably on the economy of the study area by discouraging development of the deep-draft navigation-related industries in the study area and possibly inducing relocation of some industries to more economically favorable locations.

As more of the larger ships service the port, more lightering equipment (truck and rail) would be needed for "topping-off" cargoes in the deeper waters of the San Francisco Bay. This would increase the quantity of particulates emitted into the air by trucks and trains. As the economic efficiency of the deep-draft navigation channel decreased, some industrial development would be discouraged, thus reducing the potential for future air and water quality problems associated with this development.

With this alternative, the regional economy would be virtually unaffected for about the next decade, at which time regional growth associated with water-related industries would level off. Regional growth would be much lower under this alternative than under the deepening alternative; however, it is not expected that the overall economy of the region would decline as a result of the no action alternative.

ADDITIONAL SOLUTIONS CONSIDERED

Construct Turning Basin

When the existing Sacramento River Deep Water Ship Channel was constructed, the west levee at mile 31.9 was set back to allow for construction of a future turning basin. Such a basin would accommodate future industrial development along the ship channel south of the basin. However, both Yolo and Solano Counties indicate that no industrialization is anticipated south of the turning basin during the period of analysis. The turning basin site was also considered as a possible passing basin but was found not to be suitably located for this purpose. Considering the potential benefits and costs associated with the construction of the turning basin, it was concluded that the basin is not needed or justified at this time, and it was therefore eliminated from further consideration. However, constructing the turning basin could be considered in the future if the need develops.

Construct Sediment Trap or Channel Construction

As indicated in the discussion of problems and needs, an average of about 200,000 cubic yards of sediment are removed annually from the ship channel between miles 5.0 and 15.0 (see Plate 2). To reduce the maintenance dredging requirements in the ship channel, sediment traps could be constructed in the Sacramento River and Steamboat Slough upstream of their junction with the ship channel. Analysis of such a sediment trap indicated that the flow velocities would not be reduced enough to allow sediment deposition in the trap; hence no substantial reduction in maintenance dredging would result from this construction. A plan to constrict the cross section in the Sacramento River sufficiently to produce scouring velocities was also considered. Analysis of this plan showed that such a constriction would raise the design water surface elevation by 6 feet at Rio Vista. Consequently, consideration of this plan was discontinued. It appears that there is no practical alternative solution to the shoaling problems in the ship channel, and maintenance dredging will therefore be continued on a regular basis to maintain the authorized depth in the channel.

SUMMARY OF POSSIBLE SOLUTIONS

Improvements in waterborne commodity transportation are made necessary by changes in the world fleet of bulk carriers and by the need to improve the national economic efficiency, to enhance the quality of the environment, and to maintain the regional economy and social well-being of the area. Of the alternatives considered, only the channel deepening alternative would substantially meet the needs. The other alternatives would continue to hinder the efficient transportation of bulk commodities to and from the study area. The other alternatives would also result in the slowing of the economic growth of the study area and in a decline in the social well-being of its inhabitants. Although the environmental impacts of these alternatives are slight, they have no potential for enhancing the quality of the environment. On the other hand, although the deepening alternative may have some short-term environmental impacts, it has the potential for providing long-term environmental enhancement to the study area. Table 1 presents a summary of the effects of the alternatives. Based on technical, economic, and environmental criteria, the best means to provide transportation savings to the Port of Sacramento service area is to deepen the existing Sacramento River Deep Water Ship Channel.

Channel Deepening Considered Further

In considering the deepening alternative, the channel was divided into two reaches: (1) from Avon to the northern end Collinsville-Montezuma Hills area (mile 11) and (2) from mile 11 to the Port of Sacramento. The following alternative depths were developed for these reaches:

Alternative Depths

Reach	**Alternative Depths Considered**
Avon to northern end Collinsville-Montezuma Hills Area (mile 11.0)	35, 37, 40, 45
Mile 11.0 to Sacramento	35, 37, 40

A portion of the first reach, from Avon to New York Slough (Pittsburg), is included in the San Francisco Bay to Stockton Ship Channel and is authorized to be deepened to 35 feet. The San Francisco Bay to Stockton project is considered a preproject condition to deepening the Sacramento River Deep Water Ship Channel. In the event that the Stockton project is not constructed, the Avon to New York Slough reach will be included in the selected plan for the present investigation.

Depths greater than 45 feet between Avon and Collinsville-Montezuma Hills (mile 11.0) were not considered since this is the greatest depth authorized under the San Francisco Bay to Stockton project.

The above range of depths allows for determining the optimum economic channel depth or combination of depths. It also facilitates the comparison of environmental effects over a range of channel conditions. By emphasizing various plan components, it is possible to develop National Economic Development (NED), Environmental Quality (EQ), and "mixed" plans from which the "best" plan can be formulated.

THE DESIGN VESSEL

The design vessel, for the purpose of this analysis, is the hypothetical vessel which represents the size range of vessels that would most commonly use the waterway. The channel is designed to assure safe and economical passage for this vessel. Both standard dry-bulk and wood chip vessel dimensions were used in developing the design vessel because the newer type wood chip vessels have broader beams than do dry-bulk vessels, whereas dry-bulk vessels generally have greater drafts. The beam of the design vessel has therefore been increased in recognition of the wider beams of wood chip vessels, while the draft was based on consideration of dry-bulk vessels. The design vessels for various channel depths is shown in the following tabulation.

Design Vessel Characteristics for Various Channel Depths

Channel Depths	Vessel Size (dwt)	Draft (feet)	Beam (feet)	Length (feet)
35-foot	20,000	32	83	520
37-foot	25,000	34	88	586
40-foot	35,000	37	99	645
45-foot	50,000	42	105	707

The characteristics of vessels visiting the port are indicated in Appendix 1 Section B. The average dimensions of dry bulk cargo vessels and wood chip vessels are tabulated in Appendix 1 Section D.

CHANNEL DIMENSION

Channel depths considered were based on providing a minimum of 3 feet of keel clearance (when measured from the static draft line) for the design vessels indicated above. Evaluation of the channel width to accommodate the design vessels required consideration of several factors in addition to the vessel dimensions. These factors include the manueverability of the vessel, current velocities and direction, wind speed and direction, and the characteristics of the channel bottom and banks. Due to the variability of conditions in the study area, channel widths were evaluated in reaches of fairly constant characteristics. Selection of channel widths for individual reaches was based on Report Number 3 of the Corps' Committee on Tidal Hydraulics, May 1965. In no case was the channel width designed less than the minimum widths recommended in Report Number 3 for ideal conditions. In some cases however, the channel width was kept near minimum recommended widths due to special conditions. An example is the reach between mile 18.6 and the Port of Sacramento, which is the manmade portion of the channel. This reach is straight and uniform, is in slack water, and has no winds perpendicular to the direction of travel. Ship speeds are controlled in this reach to prevent erosion due to wavewash and wide beam vessels traverse the channel during daylight hours only. For these reasons the width of this reach was kept near the minimum recommended by the design criteria. In some cases the channel was designed wider than recommended by the design criteria. An example is the Avon to Middle Point reach in which the ammunition loading docks of the Naval Weapons Station are located. The following tabulation summarizes the channel dimensions needed for safe navigation in the study area. These dimensions were used in this investigation to determine costs for alternative channel depths.

SUMMARY OF CHANNEL DIMENSIONS

Reach	Existing		Alternative Width (feet)			
	Depth (feet, mllw)	Minimum Width (feet)	35	37	40	45
1. Avon to Middle Point	30/35(a)	300/600(a)	600	600	600	600
2. Middle Point to New York Slough	30/35(a)	300	450	500	580	600
3. New York Slough to Collinsville-Montezuma Hills	30	300	400	450	500	600
4. Collinsville-Montezuma Hills to Sacramento						
a. Mile 11.0 to Mile 15.0	30	200-300	400	450	500	
b. Mile 15.0 to Mile 18.6	30	200-300	300	300	300	
c. Mile 18.6 to Sacramento	30	200-250	250	280	300	

(a) Estimates were based on two conditions of preproject study depth in Reaches 1 and 2 only, considering that this reach might be deepened to 35 feet as a part of the authorized San Francisco Bay to Stockton project prior to authorization of any deepening of the Sacramento River Deep Water Ship Channel.

DREDGING AND DREDGED MATERIAL DISPOSAL

Deepening of the ship channel would be accomplished by hydraulic suction dredges, and the dredged material would be placed on land disposal sites. Sufficient dredged material disposal areas were identified to accommodate the material from any alternative. The greater the channel depth, the more dredging and dredged material disposal areas would be required. Hence, all disposal areas identified would not be used for channel depths less than the maximum considered. The locations of proposed disposal areas are indicated on Plate 2. The quantity of dredged material and acreage of dredged material disposal areas are tabulated according to channel reach in Section D of Appendix 1 to this report. Maintenance dredging activities would continue and would not be increased as a result of deepening the channel.

ALTERNATIVE RECREATION DEVELOPMENTS

Dredged material disposal sites, a byproduct of dredging, create recreation potential. An analysis of the desires and the needs of the potential recreationist, both boaters and land-based users, and the suitability of the plans to accommodate various activities resulted in the identification of a maximum of 11 potential recreation sites with facilities ranging from fishing access to extensive day-use and camping accommodations including boat launching ramps, picnic, and campsites, swimming beaches, restrooms, parking, and marinas. Since public recreation facilities in the vicinity of the ship channel are extremely limited, it is anticipated that the maximum use of the 11 sites would occur soon after facilities were provided. Preliminary plans for potential recreation development were discussed and closely coordinated with several non-Federal agencies as potential recreation sponsors. The 11 areas considered were Washington Lake, Prospect Island, Grand Island, Decker Island, Sandy Beach south of Rio Vista, and fishing access at six sites. This plan represents the maximum level of recreation development considered. The location of these areas is shown in Appendix 1.

COSTS AND BENEFITS

Costs for the alternative depths considered were estimated based on 1 October 1979 price levels. The estimates of first cost include Federal cost of dredging the channels and relocating navigation aids and non-Federal costs of providing lands, easements, rights-of-way, and relocations and retention dikes. Annual cost estimates were based on a 50-year economic life and 7⅛ percent discount rate. Transportation savings (benefits) were based on the latest available vessel operating costs, assuming a 50-year economic life and a 7⅛ percent discount rate. The following tabulation presents a summary of costs and benefits for the alternative depths.

SUMMARY OF
COSTS AND BENEFITS FOR NAVIGATION IMPROVEMENTS
AVON TO SACRAMENTO

Depth (feet) Avon to Mile 11.0	Depth (feet) Mile 11.0 to Sacramento	First* Cost ($1,000)	Average* Annual Cost ($1,000)	Average Annual Benefits ($1,000)	Benefit-Cost Ratio
35	35	71,100**	5,922	14,899	2.5
37	37	97,900	9,205	18,577	2.0
40	35	93,200	8,289	18,847	2.3
40	40	158,400	13,936	22,238	1.6
45	40	204,700	17,463	24,214	1.4

*Assumes Stockton Ship Channel to be a preproject condition. That is, the Avon to New York Slough (Mile 11.0) reach is considered to be 35' deep.
**Cost of salinity mitigation measure (submerged sill) is included only for channel depth of 35 feet which is the depth at which the sill was model tested.

Cost estimates for the alternative recreation plans previously described were also based on 1 October 1979 price levels. Annual costs were based on a 50-year economic life and a 7⅛ percent discount rate and include operation and maintenance costs. Recreation benefits were based on recreation use of 500,000 recreation days at the beginning of the project, increasing to 750,000 recreation days at year 50, recreation day use value of $2.25 per day, and a 7⅛ percent discount rate. The following tabulation summarizes recreation costs and benefits:

SUMMARY OF RECREATION COST AND BENEFITS

First Cost	Annual Cost	Annual Benefits	Benefit-Cost Ratio
$8,140,000	$894,000	$1,280,000	1.4 to 1

ENVIRONMENTAL EFFECTS

The alternative channel depths would have varying impacts on the environment. In general, the greater depths would cause greater adverse impacts than would the lesser depths. The major areas of concern are vegetation, wildlife habitat, water quality, fisheries, and air quality. A complete discussion of the environmental impacts is provided in Section E of Appendix 1, and Appendix 3 to this report.

The widening of the manmade portion of the Sacramento Channel will destroy vegetation and wildlife habitat along the channel. This loss would be mitigated as described in the next section. Disposal of dredged material would also temporarily destroy vegetation and wildlife habitat at disposal areas. These losses would be temporary, however, since the disposal areas would naturally revegetate within 2 to 3 years. Maintenance dredging would also cause a temporary loss of benthic productivity and the temporary loss of upland habitat at the disposal sites. The impacts of channel widening on vegetation and fish and wildlife habitat are discussed in Section E of Appendix 1, and Appendix 3.

Salinity intrusion as it affects agriculture, domestic water supplies, and fisheries is a major water quality concern associated with channel deepening. Results of preliminary model tests conducted at the San Francisco Bay-Delta Model in Sausalito of the 35 foot channel using 1968 hydrology which is representative of a moderately dry year show no measurable change in salinities. Tests for depths greater than 35 feet were not conducted. Other water quality constituents, such as dissolved oxygen, turbidity, heavy metals, etc., and ground water quality, would not be affected by any of the deepening plans. Impacts on salinity distribution and effects on water quality are described in Section E of Appendix 1 and Appendixes 4 and 5 to this report.

A reduction in pollutants entering the air can be expected when cargo is transported via a deepened channel because of the greater efficiency of larger ships per ton-mile over smaller ships and other alternative modes of transportation. However, this initial decrease in pollutants could be offset by increased industrial activity along the ship channel. The actual effects would depend on the type of industries located in the area and regulations adopted by the Air Resources Board. Impacts on air quality are described in Section E of Appendix 1 and Appendix 3 to this report.

ALTERNATIVE FISH AND WILDLIFE MITIGATION MEASURES

Evaluation of the above environmental impacts and coordination with concerned Federal, State, and local agencies and groups indicate a need for mitigation of significant impacts. The Fish and Wildlife Service, in cooperation with the California Department of Fish and Game, compiled and evaluated environmental data on existing wetlands habitat in the Sacramento River Deep Water Ship channel area (Appendix 2). Their recommendation for mitigating habitat losses due to deepening, required replacement of 45 acres of lost wetland habitat with an equal or greater area of higher quality habitat. They also explained that this mitigation alternative could be accomplished by creating new wetland habitat at dredged material disposal areas or at low-lying islands. The Fish and Wildlife Service also recommended that 156 acres of upland habitat be established to compensate for upland habitat losses due to the disposal of dredged material at the designated disposal sites. They indicated this recommendation could be satisfied by the development and preservation of upland habitat in small tracts on the disposal areas.

ALTERNATIVE MEASURES TO CONTROL SALINITY INTRUSION

Several possible measures have been suggested to offset any increased salinity intrusion, including increasing Delta outflow, constructing a submerged sill, building channel constrictions, or closing western Delta channels. Analyses have been made on increasing Delta outflow and on the submerged sill concept. These analyses indicate that increasing Delta outflow is not a viable alternative due to the present lack of available water for such purpose and the high cost to develop future water supplies. For example, current estimates indicate the cost of developing additional upstream storage, such as the Cottonwood Creek project in northern California is about $200 per acre-foot of annual water supply. If it is assumed that only 5 cfs or 3,600 acre-feet would be required annually, costs would equal $720,000. In contrast the annual cost of a submerged sill would be about $680,000. Therefore, from an economic viewpoint, the use of restoration flows rather than a submerged sill would not be justified. Furthermore, the release of water to the Pacific Ocean during a critically dry year to alleviate salinity increases caused by navigation projects would also have significant social and political implications. Water deliveries from the State and Federal water projects would be reduced during such a critically dry period while the Delta outflow would be increased. This would cause hardships to agricultural users in the San Joaquin Valley and to M&I users in southern California. As demonstrated by the 1976-77 drought, there is far from unanimous agreement that such action is a wise use of resources.

Hydraulic model tests predict the submerged sill concept to be capable of reducing salinities in Suisun Bay below preproject conditions. Mathematical model studies and computer simulation also indicate that the submerged sill would have no adverse effect on phytoplankton populations and dissolved oxygen levels in Suisun Bay. Other concepts such as channel constrictions or channel closures, in combination with the sill, may further reduce salinity intrusion; however, this has not been evaluated. Of the alternative mitigation measures considered, the submerged sill appears to be most effective. By using various combinations of channel closures, channel constrictions, and a submerged sill, it may be possible to fully mitigate any adverse affects for channels deeper than 35 feet should migitation be necessary.

SOCIOECONOMIC EFFECTS

The 35-foot channel would induce a small increase in industrial development in the Sacramento area and a moderate increase in the Collinsville-Montezuma Hills area. The 40- and 45-foot channels, on the other hand, would induce a substantial increase in industrial activity in the Collinsville-Montezuma Hill area and a moderate increase in the Sacramento area.

National Economic Development (NED) Plan

The NED plan addresses the planning objectives while maximizing net economic benefits to the national economy. After evaluating the net benefits and the costs of each alternative, it was determined that maximum net benefits occur with a channel 40 feet deep to the northern end of the Collinsville-Montezuma Hills area and 35 feet from this area to the Port of Sacramento. Thus, the NED plan would consist of a 40-foot channel, 500 to 600 feet wide from Avon to the Collinsville-Montezuma Hills area and a 35-foot channel, ranging from 400 feet to 250 feet wide from the northern end of the Collinsville-Montezuma Hills area to Sacramento. In addition to channel deepening, the NED plan would include recreation development at the 11 sites previously described, and mitigation measures which are justified. These mitigation measures would include a submerged sill in Carquinez Strait or an acceptable alternative to offset salinity intrusion in the event salinity levels are found to increase, 45 acres of wetland mitigation at a former dredged material disposal area on Prospect Island, and up to 156 acres of upland habitat mitigation in small tracts on the dredged material disposal areas sited along the channel.

The first cost of the NED plan including channel deepening and recreation would be $101.3 million and annual costs would be $9.2 million. Average annual benefits associated with this plan are $20.1 million and include both navigation and recreation benefits. This results in national net economic benefits of $10.9 million annually which is the maximum net benefits of all the alternatives considered.

The major environmental effects of the NED plan would be the possibility of increased salinity intrusion with a 40 foot channel to Collinsville, which would make maintaining water quality standards in the western Delta more difficult. In view of the current policy of the State of California that any project-induced increase in salinity in the Delta is unacceptable, mitigation would be necessary for any increase in salinity intrusion. It may be possible to provide this mitigation by constructing channel constrictions, channel closures, or a submerged sill. A submerged sill has been included in the plan: however, this feature may not completely offset salinity intrusion associated with the NED plan. Additional water would therefore be required from upstream reservoirs to maintain Delta water quality. Construction of this alternative would result in the loss of approximately 45 acres of wetland habitat along the manmade portion of the channel; however, any adverse impacts would be compensated for by creating wetlands nearby. Secondary adverse environmental impacts on water quality, air quality, wildlife habitat, land use, and esthetics could occur due to industrialization induced by channel deepening. To compensate for the loss of upland habitat, approximately 156 acres of dredged material disposal areas would be permanently set aside for the development of upland habitat.

The NED alternative would have a significant impact on the economy of the study area by making the Collinsville-Montezuma Hills area more competitive with deepwater locations in the San Francisco Bay Area. This would result in a substantial increase in employment, population, and income for this area. At the Port of Sacramento, there would be a similar increase in industrial growth, but the increase would be less dramatic than that in the Collinsville area. This would result in moderate increases in employment, population, and housing in the Sacramento Metropolitan area.

Environmental Quality (EQ) Plan

The objective of the Environmental Quality (EQ) plan is the management, conservation, preservation, creation, or improvement of natural and cultural resources and ecological systems while meeting the other objectives of the investigation to the greatest extent practical. The following are Environmental Quality objectives considered:

a. Management, protection, enhancement, or creation of areas of natural beauty and human enjoyment.

b. Management, preservation, or enhancement of especially valuable or outstanding archeological, historical, biological, and geologic resources.

c. Enhancement of the quality aspects of water, land, and air by control of pollution or prevention of erosion of eroded areas.

d. Avoiding irreversible commitment of resources to future uses.

Specific actions to be taken to meet EQ objectives include construction of a 35-foot deep channel; purchase of land; acquisition of environmental easements; manipulation of habitat; establishment of recreation and public access sites; and specific management procedures. Included in these measures would be construction of an underwater sill in the Carquinez Strait or acceptable alternative for salinity intrusion control in the event salinity levels are found to increase; prohibiting grazing and farming on channel berms; controlling burning on levees and berms; and utilizing dredged material for mixing with peat soils to counteract subsidence on selected Delta farmlands.

Preliminary estimates of the total first cost of the EQ plan is approximately $82,600,000. This includes approximately $71,100,000 associated with deepening the channel to 35 feet and $11,500,000 for the EQ plan elements. The average annual cost for this plan is $6,920,000 which includes $5,922,000 for navigation improvements and $998,000 for EQ features.

Both monetary and nonmonetary benefits are attributable to the elements of the EQ plan. The average annual monetary benefits of the EQ plan are $15,345,000 per year which includes navigation benefits of $14,899,000 and EQ benefits of $446,000. The increase in fish and wildlife populations associated with habitat established as part of this plan and the protection of existing natural areas under this plan would provide substantial nonmonetary benefits. The fish and wildlife species benefited would contribute to the overall quality of recreation use of the Delta and ship channel area. The following tabulation summarizes the costs and benefits for the EQ plan.

EQ PLAN COSTS AND BENEFITS

	First Cost	Annual Cost	Benefits	Excess Benefits	B/C
Deepening	$71,100,000	$5,922,000	$14,899,000	$8,977,000	2.5
EQ Element	11,500,000	998,000	446,000	-552,000	0.4
Total	$82,600,000	$6,920,000	$15,345,000	$8,425,000	2.2

The economic effects of the EQ plan are presented relative to the NED plan, which was discussed previously. There would be a beneficial impact on national economic development, but the effect would be less than that for the NED plan. Industrial expansion would be restricted, and substantially more area would be provided for public access and recreation opportunity than in the NED plan.

Construction noise and the impact on esthetics would be less under the EQ plan than with the NED plan. Other social effects would be similar to that anticipated for the NED plan. Public appreciation and knowledge of the additional resources available in the region would contribute to social well-being in addition to more direct values to environmental effects of the EQ plan. The EQ plan would directly benefit fish and wildlife habitat by increasing the quantity of upland habitat, riparian vegetation, and wetlands. Those lands which presently possess significant areas of vegetation would be protected. Also, habitat would be improved on the channel berms and levees by prohibiting farming, grazing, and burning on these areas. Deepening the ship channel would decrease truck and rail traffic and result in an initial increase in air quality. However, this improvement in air quality may eventually be offset by the adverse effects of additional industrial development and ship traffic that would be induced by the channel deepening. Such deepening would temporarily disrupt the benthic population and reduce this food source to many fish. This is a relatively short-term impact in that the bottom should be recolonized within 1 to 2 years.

Selecting a Plan

Selection of a plan required careful consideration of the economic and environmental effects, the assumptions upon which the evaluations were based, and the desires of local interests.

Economic considerations indicate that the channel should be deepened to 35 feet to Sacramento and 40 feet to Collinsville-Montezuma Hills, whereas environmental considerations indicate that the minimum amount of deepening would have the least impact on ambient conditions. The primary assumption made regarding the alternative depths was that the authorized John F. Baldwin Channel (Golden Gate to Avon) portion of the San Francisco Bay to Stockton project would be constructed prior to deepening the Sacramento Ship Channel to depths greater than 35 feet. Studies are continuing on this authorized deepening; however, concerns with dredged material disposal, increased salinity intrusion, and mitigative measures are expected to require additional Congressional authorization which will preclude additional construction at this time. The sponsor for this investigation, the Sacramento-Yolo Port District, has consistently expressed the opinion that a channel as deep as 40 feet is needed to Sacramento. The potential sponsor for the channel to the northern end of the Collinsville-Montezuma Hills area, the Solano County Board of Supervisors, has not taken a position on channel deepening.

After considering the economic effects of the various deepening alternatives, the downstream channel constraints, and the desires of local interests, a 35-foot channel from Avon to the Port of Sacramento is the best and most viable solution to the problems and needs of the study area. Of the depths considered, this plan would have the least environmental impact and would provide net benefits almost equivalent to the NED plan.

The preliminary plans for recreation development were coordinated with potential recreation sponsors. After these intensive coordination efforts, non-Federal government entities expressed a willingness and capability to cost-share in the construction of recreation facilities and to accept operation and maintenance responsibilities for recreation facilities at one location, Sandy Beach in Solano County.

The Selected Plan

This section describes the plan which was selected through the plan formulation process. Also described are the accomplishments, environmental and other effects, design, construction, and operation and maintenance aspects of the plan.

Plan Description

NEW YORK SLOUGH (PITTSBURG) TO SACRAMENTO

The selected plan in this reach provides for enlarging the Suisun Bay and Sacramento River Deep Water Channels from New York Slough to the Port of Sacramento. The selected plan also provides for a water quality monitoring program, authority to construct a submerged sill or alternative features in the Delta if needed, for 45 acres of land for establishment of wetland habitat, and for up to 156 acres of land for establishment of upland habitat to mitigate for losses of such habitat elsewhere. Plate 2, sheets 3 through 6, show the general plan of improvement for the channel.

The channel enlargement would consist of deepening the existing 30-foot channel between New York Slough and the Port of Sacramento to 35 feet. In addition, the channel would be widened as necessary to maintain navigation safety. The following tabulation summarizes the existing and selected channel dimensions.

EXISTING AND SELECTED CHANNEL DIMENSIONS IN FEET

Reach	Existing		Selected Plan	
	Width	Depth	Width	Depth
New York Slough to Junction Point (Channel mi. 15.0)	300	30	400	35
Junction Point to Entrance of Manmade Channel (Channel mi. 18.6)	300	30	300	35
Channel mi. 18.6 to Port of Sacamento	200	30	250	35

Approximately 30.3 million cubic yards of material would be excavated and disposed of on approximately 3,500 acres of land. Dredged material disposal sites required for construction of the selected plan are shown on Plate 2. All of this land has been used for disposal of dredged material in the past. Construction of dredged material retention dikes or bulkheads would be the responsibility of the local navigation sponsor. All disposal sites will be partitioned to eliminate rapid return of effluent and thereby maintain water quality standards established by the Environmental Protection Agency (EPA) and State Water Resources Control Board (SWRCB).

Recreation facilities will be constructed at one dredged material disposal area where a potential recreation sponsor has expressed a willingness and capability to cost-share in the development and accept operation and maintenance responsibility. This site is the Sandy Beach area in Solano County. Recreation facilities to be provided at the site would include day-use and camping accommodations. Day-use facilities would include picnic sites, parking areas, a swimming beach, and restroom facilities. Camping accommodations would include restrooms and other support facilities. A boat launching area and support facilities would also be provided. Since the project area has a record of moderate seismic activity, the design and siting of recreation facilities will consider the potential liquefaction of dredged materials subjected to seismic motion.

AVON TO NEW YORK SLOUGH (PITTSBURG)

This portion of the selected plan is currently authorized for deepening to 35 feet under the San Francisco Bay to Stockton (John F. Baldwin and Stockton Ship Channels) project. In the event that this channel is not deepened to 35 feet under the current authorization, it would be deepened as part of the selected plan. This portion of the channel is shown on Sheets 1 and 2 of Plate 2.

The plan for channel modification in this reach consists of deepening the channel along the existing alignment from 30 to 35 feet. The channel bottom would be widened from 300 to 600 feet between Avon and Middle Point and from 300 feet to 450 feet between Middle Point and Pittsburg (mouth of New York Slough). Approximately 3.3 million cubic yards of material would be removed and placed on land disposal areas shown on Plate 2. As with the previous reach, local interests must acquire the rights-of-way for the disposal areas and must construct retention dikes adequate to maintain effluent quality at or above EPA and SWRCB criteria.

PERTINENT DATA ON PLAN

A summary of information relating to the selected plan is presented in the following tabulation.

PERTINENT DATA ON SELECTED PLAN

ITEM	DATA
Navigation Channel — New York Slough (Pittsburg) to Sacramento	
Length	46.5 miles
Depth, below mllw	35 feet
Bottom Width	
Pittsburg to Channel mile 15.0	400 feet
Channel mile 15 to 18.6	300 feet
Channel mile 18.6 to Port of Sacramento	250 feet
Overdepth	1 foot
Side slopes	
Pittsburg to Channel mile 18.6	1V on 4H
Channel mile 18.6 to Port of Sacramento	1V on 3H
Dredging Quantity	30,300,000 cu. yds.
Disposal Areas	3,500 acres
Navigation Channel — Avon to New York Slough (Pittsburg)*	
Length	11.5 miles
Depth, below mllw	35 feet
Bottom Width	
Avon to Middle Point	600 feet
Middle Point to New York Slough (Pittsburg)	450 feet
Overdepth	1 foot
Side Slopes	1V on 4H
Dredging Quantity	3,300,000 cu. yds.
Disposal Area	480 acres

*This reach is currently authorized for deepening under the San Francisco Bay to Stockton (John F. Baldwin and Stockton Ship Channels) project. If this reach is not deepened under the current authorization, it would be deepened as part of the selected plan.

MITIGATION FEATURES

Without mitigation, the selected plan would adversely affect wetland and upland habitat along the manmade portion of the channel and may affect salinity intrusion in the Sacramento-San Joaquin Delta. To offset the loss of wetland habitat, 45 acres of a former dredged material disposal area on Prospect Island would be converted to wetland habitat as recommended by the Fish and Wildlife Service. The location of this site is shown on Plate 2, Sheet 4. To compensate for the loss of upland habitat, a maximum of 156 acres on dredged material disposal areas would be developed for upland habitat. The upland habitat would be created by seeding the disposal areas and dedicating them to wildlife conservation. The location of the upland habitat sites would be determined during post-authorization studies. Increased salinity intrusion which might occur from channel deepening is a major environmental concern. Model tests indicate that there will be no measurable changes in the salinity distribution in the Delta as a result of the proposed channel deepening. In other words, any changes that might occur in the salinity distribution are smaller than the model can accurately predict. However, because of the seriousness of the issue, the effects of channel deepening on salinity distributions in the Sacramento-San Joaquin Delta and Suisun Bay would be monitored before, during, and after the channel deepening. Monitoring would be accomplished by adding high-quality, well-maintained salinity measuring stations to the existing water quality monitoring network. The location of the additional stations would be coordinated with the Fish and Wildlife Service, Water and Power Resources Service, the California Department of Water Resources, and the California Water Resources Control Board. If salinity distributions increase to unacceptable levels above preproject conditions as a result of channel deepening, a submerged sill or acceptable alternative would be constructed in Carquinez Strait to restrict the landward flow of more saline bottom currents. Hydraulic model tests have shown that a submerged sill could reduce salinity levels in Suisun Bay to below base (preproject) conditions.

The mitigation plan would also include authorization for a submerged sill or alternative features in the Delta to control potential salinity intrusion, the construction of which would be predicated upon results of post-authorization model tests. These tests would be conducted by the Corps of Engineers on the San Francisco Bay-Delta Model in cooperation with the California Department of Water Resources and other concerned State and Federal agencies. These tests would be conducted to reevaluate and more exactly determine the effect of channel deepening on salinity intrusion. If these tests indicate a measurable increase in salinity levels would occur as a result of channel deepening, special studies of a submerged sill or alternatives would be conducted. Such studies would probably include evaluation of distorted and undistorted structures in a laboratory flume using saline stratified flows. These studies would be for the purpose of determining the mechanics of how such structures restrict salinity intrusion, suggesting optimum designs for structures found effective, and determining similitude relationships for a distorted model as well as its accuracy in predicting results. The testing program would be reviewed by the Bay-Delta Model Technical Committee, the Bay-Delta Model Advisory Committee, the State Department of Fish and Game, the Fish and Wildlife Service, and the Water and Power Resources Service. The Corps of Engineers would give full consideration to the recommendations of these agencies with respect to formulating and conducting the model tests and at arriving at a decision regarding the advisability of constructing a submerged sill or other mitigative device, if needed. If the proposed plan of improvement is authorized by Congress, appropriate environmental studies would be conducted during post-authorization studies to address all potential impacts of the project.

POTENTIAL FISH AND WILDLIFE ENHANCEMENT

The disposal of dredged material on lands which are below mean sea level elevation provides the opportunity for enhancement of the fish and wildlife resources of the study area by providing wetland habitat for wildlife species and by creating nurseries and food production areas for fish. The Fish and Wildlife Service has recommended that wetlands be developed on Donlon Island in conjunction with the authorized deepening of the Stockton Ship Channel. If the Stockton Ship Channel is not deepened, Donlon Island could be acquired and converted to wetland habitat as a part of the Sacramento River Deep Water Ship Channel project. The potential for this development would be studied in more detail during advanced engineering and design studies.

Coordination with the Federal and State fish and wildlife agencies to date has not revealed a suggested site or sites on which additional enhancement wetlands should be established through the use of dredged materials. Establishment of such wetlands at Federal expense (up to $400,000—and benefits are deemed to be at least equal to costs) was authorized by Section 150 of the 1976 Water Resources Development Act. It is understood that recently the fish and wildlife agencies and interested organizations have placed a high priority on providing additional wetlands in the Sacramento-San Joaquin Delta area to benefit waterfowl and other fish and wildlife resources. If a project is authorized by Congress, additional investigation and coordination will be undertaken with the interested agencies and organizations to determine if there are suitable locations where dredged material should be beneficially utilized to establish additional wetlands to further the program initiated by Congress in 1976. If such locations are found, the Federal cost of the project could be increased up to $400,000.

Evaluated Accomplishments

The primary accomplishment of the selected plan is direct savings in transportation costs by existing and future users of the Sacramento River Deep Water Ship Channel. These savings, or benefits, will result from (1) the movement of cargo via larger ocean-going vessels with their inherent economies of scale, (2) the elimination of excessive tidal delays, (3) reduction of present light-loading and topping off practices, and (4) movement of project-induced tonnage. Transportation savings will accrue to shipments of rice, logs, wood chips, steel scrap, fertilizer, and other grains and bulk commodities. Savings will also accrue to cargo transported as a result of future industrialization and to cargo attracted to the area by the deepening.

The recreation facilities provided as a part of the plan will provide new recreation opportunities of about 120,000 recreation days annually. This use is expected to increase to about 180,000 recreation days at the end of the period of analysis.

Effects on the Environment

There would be no adverse effect on geology, soils, or seismicity as a result of deepening the Sacramento River Deep Water Ship Channel to 35 feet. There would be no change in the soil characteristics at the existing dredged material disposal sites except in the Suisun Bay area where fine sand would be placed on top of silty clay in new land disposal areas.

There would be no impact on total Delta outflow as a result of the project. The submerged sill, if constructed, would increase current velocities only in the immediate vicinity of the structure and the sill would have no effect on sediment transport.

Model tests predict that the selected plan would have no effect on salinities in San Pablo Bay, Suisun Bay, and the Delta during an average or critically dry year, with the exception that minor increases may occur on the Upper Sacramento River (upstream of Rio Vista) during a critically dry year. However, even with the increase, there would be no adverse effect on domestic or agricultural water uses. Model tests also predict that the selected plan, with construction of the submerged sill, would have no effect in San Pablo Bay, Suisun Bay, and the Delta during an average dry year and may reduce salinities below preproject conditions in Suisun Bay and some portions of the Delta during a "critically" dry year. Increases in salinity levels occurring upstream of Rio Vista and on Cache Slough along the channel would not entirely be reduced to preproject levels but would be reduced to levels where there would be no adverse effect on domestic or agricultural water uses. Results of a study with the submerged sill show that, under extreme reduction in turbidity, chlorophyll concentration would increase from 8 micrograms to 13 micrograms per liter at 4400 cfs outflow, which is much less than normal fluctuations in this area.

During the review period for the draft feasibility report, other agencies using the Bay-Delta Model reported observing anomalous results on the Sacramento River (upstream of Rio Vista) under certain test conditions. This suggests the possibility that the minor increases in salinity observed in this area during the Corps of Engineers testing program may be attributable to factors not related to the channel enlargement. An explanation of the reported locational increase in salinity would be sought during the post-authorization model testing program to be conducted by the Corps of Engineers in cooperation with the California Department of Water Resources and other concerned State and Federal Agencies.

Other water quality parameters, such as turbidity, dissolved oxygen, heavy metal concentrations, and nutrient concentrations, will not be affected by the dredging. These elements may slightly increase during dredging, but effects will be short-term and the water quality will return to ambience shortly after dredging is completed. The chemical composition of bottom sediments are indicated in Appendix 1 Section E. Post-authorization studies would be conducted to assess the potential for adverse effects on surface water quality that may result from the resuspension of toxic substances in the water column during dredging. Implementation of the selected plan will result in an initial reduction of pollutants entering the air since cargo will be transported by fewer, though larger, ships. However, this improvement may be offset by the adverse effects of the additional industrial development and ship traffic that would be induced by the channel deepening and the increased recreation use in the Delta. Project-induced vehicle emisssions due to increased recreation use would contribute less than one-half of 1 percent of the total emissions in the future.

With the proposed wetland and upland habitat mitigation, the selected plan would have no overall adverse effects on wetland habitat or wildlife. Approximately 3,500 acres of land would be required for dredged material disposal. Most of these sites are in agricultural production which would be lost for 1 to 2 years following disposal operation. Some wildlife may be temporarily displaced from these areas, but since the sites have been used for disposal in the past, the wildlife would be expected to return in a short time. Other sites which are now used for maintenance dredging and contain natural riparian vegetation will lose some vegetation for a period of 2 to 3 years. These disposal areas would be seeded to help restore natural grassland. The growth-inducing impact associated with the channel deepening would cause a loss of upland grassland vegetation in the Collinsville-Montezuma Hills area and in the vicinity of the Port of Sacramento.

Most benthic organisms would be removed from the manmade portions of the channel during dredging and subsequently from those areas subjected to maintenance dredging. However, studies have shown that the remaining organisms plus natural mitigation would quickly repopulate the channel. Dredging downstream of the manmade portion of the channel would remove only a small portion of the benthic organisms, and the remaining community would supply the needed organism for repopulation.

The selected plan would have little overall impact on fisheries. The removal of benthic organisms, which are a part of the food chain of fish, could have a slight effect on fish populations; however, this impact would be localized to the most recently dredged areas.

In 1976, archeologists conducted an on-the-ground cultural resources reconnaissance survey over a 15 percent sample of the project area. Cache Slough, all spoil sites, and the turning basin were examined completely. A prehistoric site was located near the turning basin at a disposal site. The site could be impacted by the placement of dredged material. The reconnaissance report was coordinated with the California State Historic Preservation Officer and the Interagency Archeological Services, Heritage Conservation and Recreation Service. An intensive survey with all remaining areas examined for cultural resources, will be undertaken during advanced engineering and design studies. At that time, the prehistoric site and any other cultural resources discovered will be evaluated for significance under the National Register of Historic Places criteria. Mitigation and/or preservation of significant cultural resources which may be impacted by project construction, will be coordinated with appropriate parties in accordance with 36 CFR 805 regulations, Corps of Engineers Identification and Administration of Cultural Resources.

A biological assessment of endangered species affected by the project would be made during advanced engineering and design studies and additional coordination would be carried out with concerned agencies as needed.

Other Effects

The proposed channel deepening and associated industrial development would be socially and economically beneficial for the study area and the region. The project would facilitate continued expansion of the Port of Sacramento and expansion and diversification of industry in the area served by the channel. Substantial socioeconomic benefits would accrue to the region in the form of additional employment, higher personal income, strengthened agricultural and increased property values.

Design

The major design considerations in navigation channel improvement are related to the geometry of the channel. The design depth must be sufficient for safe and efficient vessel operation. Factors such as loaded drafts, squat, trim, and maneuverability of vessels were considered in selecting minimum keel clearances of 5 feet for tankers and 3 feet for dry bulk carriers (when measured from the static draft line) for all channels. Channel widths were based on consideration of the need for a passing situation, current velocity and direction, wind velocity and direction, the characteristics of the channel banks, and the controllability of vessels. To assure that the design depth is obtained during construction, 1 foot of overdraft dredging has been included on the design to compensate for the inherent inaccuracies in the dredging operation.

Construction

Following completion and approval of advanced engineering and design studies, and assuming adequate funding will be available, it is estimated that the Sacramento River Deep Water Ship Channel from New York Slough (Pittsburg) to Sacramento could be deepened to -35 feet mean lower low water in 5 years. Deepening of the Suisun Bay channel from Avon to New York Slough (Pittsburg) to 35 feet, if necessary as part of this project, would require approximately 1 year to complete. Retention dikes at dredged material diaposal areas, a responsibility of the local navigation sponsor, must be constructed prior to initiating dredging in any reach. Relocations would also have to be completed prior to dredging in the vicinity of these facilities.

Construction of recreation facilities would be initiated approximately 2 years after disposal of dredged material to allow time for material to drain and consolidate. Construction of the recreation facilities would then be expected to take approximately 2 years. Construction of fish and wildlife mitigation facilities would be initiated concurrently with dredging operations and would be scheduled for completion prior to completion of the channel deepening. Monitoring of salinity distributions would commence before channel deepening to establish base salinity conditions and would continue after completion of the channel to determine the effects of the deepening on salinity distributions in the Delta. A precise timetable for salinity monitoring will be determined after coordination with the Fish and Wildlife Service, the Water and Power Resources Service, the California Department of Water Resources, and the California Water Resources Control Board.

Maintenance and Operation

Maintenance dredging of the ship channel would continue to be a Federal responsibility. No additional maintenance dredging would be required between New York Slough and Sacramento as a result of deepening the channel. Maintenance dredging is performed nearly on an annual basis producing approximately 400,000 cubic yards of material annually for disposal. Water quality certification for the existing maintenance dredging has been obtained from the State of California pursuant to Section 404(c) of the Clean Water Act (33 USC 1344). Maintenance and operation of the recreation development would be the responsibility of the local recreation sponsor.

The operation and maintenance of the fish and wildlife mitigation facilities would consist of annual surveillance of the facilities to insure that encroachment has not occurred and habitat has not been destroyed. An annual report verifying the surveillance would also be prepared. The annual cost to operate and maintain the fish and wildlife facilities has been determined to be negligible.

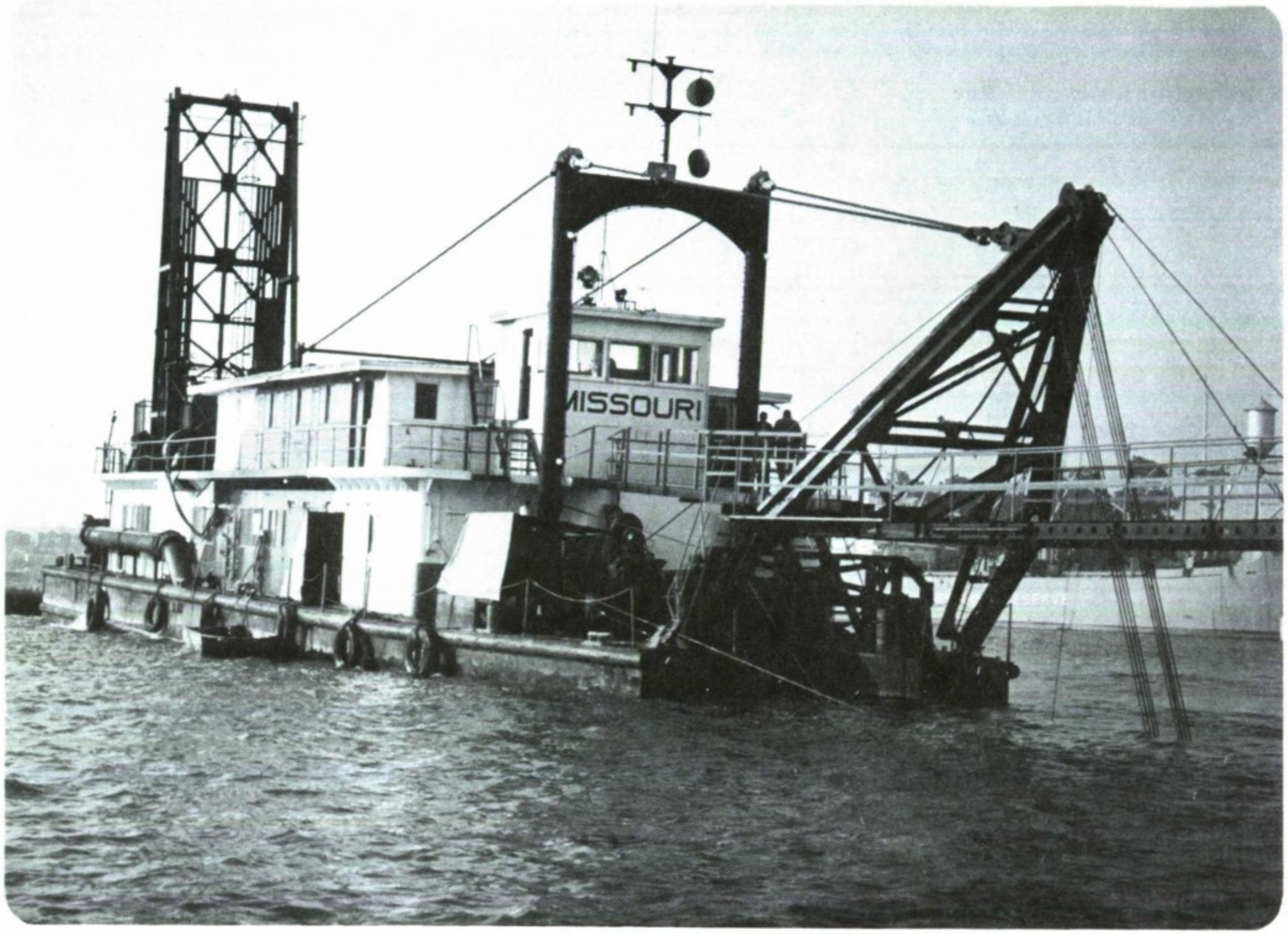
Economics of the Selected Plan

Methodology

Economic justification of the selected plan was established by comparing the equivalent average annual charges with the equivalent average annual benefits which would be realized over the 50-year period of analysis. Annual benefits and costs were compared as a means of demonstrating the project feasibility by relating average annual benefits to average annual costs. The value of benefits and costs at the time of their accrual were made comparable by conversion to an equivalent time basis using an interest rate of 7⅛ percent.

Project Costs

The estimated first and annual costs of the selected plan are summarized in the following tabulation. These costs are based on 1 October 1979 price levels and annual costs are based on 7⅛ percent interest rate and a 50-year amortization period. The cost of a salinity control structure includes the cost of constructing a submerged sill in Carquinez Strait. The cost of the submerged sill is included in the cost estimates to show the impact of the structure on the economic feasibility of the selected plan should a monitoring program or future model tests demonstrate that a control structure is needed. The salinity control structure would be included in the selected plan if salinity levels in the Delta are found to increase above preproject conditions after the channels are deepened. Annual charges include operation and maintenance costs and are based on cost experience in the Sacramento District.



Pipeline dredge "Missouri" maintaining the channel
near Rio Vista.

SACRAMENTO RIVER DEEP WATER SHIP CHANNEL
SUMMARY OF FIRST COSTS

ITEM	AVON TO NEW YORK SLOUGH (PITTSBURG)	NEW YORK SLOUGH (PITTSBURG) TO COLLINSVILLE-MONTEZUMA HILLS AREA	COLLINSVILLE-MONTEZUMA HILLS AREA TO SACRAMENTO
	FEDERAL COST ($)		
Channel Dredging and Disposal	5,300,000	6,480,000	37,100,000
Engineering and Design	350,000	400,000	2,400,000
Supervision and Administration	400,000	490,000	2,800,000
Subtotal	6,050,000	7,370,000	42,300,000
Salinity Control Structure**	—	8,100,000	—
Engineering and Design	—	500,000	—
Supervision and Administration	—	600,000	—
Subtotal	—	9,200,000	—
Recreation*	—	—	1,070,000
Engineering and Design	—	—	130,000
Supervision and Administration	—	—	100,000
Subtotal			1,300,000
Fish and Wildlife Facilities*	—	—	250,000
Engineering and Design	—	—	25,000
Supervision and Inspection	—	—	25,000
Subtotal			300,000
Navigation Aids	50,000	30,000	100,000
TOTAL (FEDERAL)	6,100,000	16,600,000	44,000,000
TOTAL FEDERAL FIRST COST: 66,700,000			
	NON-FEDERAL COST ($)		
Land and Damages			
Dredged Mat'l Disposal	1,610,000	370,000	3,100,000
Recreation Area*	—	—	50,000
Fish and Wildlife Facilities*	—	—	400,000
Subtotal	1,610,000	370,000	3,550,000
Retention Dikes	400,000	1,140,000	5,590,000
Relocations	190,000	—	610,000
Engineering and Design	60,000	110,000	590,000
Supervision and Administration	40,000	80,000	460,000
TOTAL (NON-FEDERAL)	2,300,000	1,700,000	10,800,000
TOTAL COST	8,400,000	18,300,000	54,800,000
TOTAL PROJECT FIRST COST: 81,500,000			

* See section on cost-sharing apportionment in this report.

** Salinity control structure is located downstream from Avon.

SACRAMENTO RIVER DEEP WATER SHIP CHANNEL
SUMMARY OF ANNUAL COSTS
(Dollars)

ITEM	AVON TO NEW YORK SLOUGH (PITTSBURG)	NEW YORK SLOUGH (PITTSBURG) TO COLLINSVILLE-MONTEZUMA HILLS AREA	COLLINSVILLE-MONTEZUMA HILLS AREA TO SACRAMENTO	TOTAL
FEDERAL INVESTMENT COST				
First Cost*	5,680,000	15,685,000	40,894,000	62,259,000
Interest During Construction	—	—	7,285,000	7,285,000
Gross Investment	5,680,000	15,685,000	48,179,000	69,544,000
ANNUAL COST				
Interest and Amortization	418,000	1,155,000	3,547,000	5,120,000
Operation and Maintenance				
Maintenance Dredging	291,000	—	—	291,000
TOTAL (FEDERAL)	709,000	1,155,000	3,547,000	5,411,000
NON-FEDERAL INVESTMENT COST				
First Cost*	2,720,000	2,615,000	13,906,000	19,241,000
Interest During Construction	—	—	2,476,000	2,476,000
Gross Investment	2,720,000	2,615,000	16,382,000	21,717,000
ANNUAL COST				
Interest and Amortization	200,000	192,000	1,205,000	1,597,000
Operation and Maintenance Recreation Facilities	—	—	55,000	55,000
Fish and Wildlife Facilities	—	—	0	—
TOTAL (NON-FEDERAL)	200,000	192,000	1,260,000	1,652,000
TOTAL PROJECT ANNUAL COST:	909,000	1,347,000	4,807,000	7,063,000

* First costs were adjusted in accordance with cost-sharing criteria for recreation and fish and wildlife facilities as described in Appendix 1 Section G. The adjusted first costs were also adjusted in accordance with the President's proposed cost-sharing criteria as described in Appendix 1 Section H.

Vessel Transportation Costs

The estimates of vessel operating costs which serve as a basis for establishing the navigation benefits were prepared by the United States Maritime Administration from information obtained through conferences with ship operators and shipbuilders and from data contained in maritime publications. In this report bulk carrier costs are limited to foreign flag vessels because very few U.S. flagships are presently operating in the world bulk trades due to the higher cost of U.S. shipbuilding and crew wages.

For estimating navigation benefits that will result from the proposed channel deepening, it was necessary to compute voyage transportation costs and corresponding unit cargo costs for several sizes of vessels operating on the major trade routes. With the existing 30-foot channel, an operator of a 25,000 dwt vessel transporting grain to Japan would partially fill the vessel at the Port of Sacramento and depart for the Islais Creek grain terminal at the Port of San Francisco to top-off the vessel. The cost of transporting a ton of grain from the Port of Sacramento to Japan using this method of operation was calculated at $12.82. If the channel were deepened to 35 feet, the operator could load the vessel almost to capacity at the Port of Sacramento and would then sail directly to Japan. The unit transportation cost for this trip would be $11.56 per ton. The unit savings creditable to deepening the channel is the difference between these two costs, or $1.26 per ton. Similar computations were made for different sizes and types of vessels, cargoes, and trade routes.

Estimate of Benefits

The following paragraphs present estimates of navigation benefits that would be provided by deepening the Sacramento River Deep Water Channel by an additional 5 feet. The benefits are directly attributed to increased economic efficiency associated with deep-draft vessel transportation. Benefits from general recreation have also been estimated.

The primary accomplishment of the selected plan is the savings in ocean transportation costs. Most ocean vessels when fully loaded cannot negotiate the existing channel without incurring costly tidal delays, and many vessels sail with less than full cargo loads, resulting in higher transportation costs than if the vessel were fully loaded at one port. Estimates of transportation savings were derived by comparing transportation costs on the improved channel with costs on the existing project channel. The average annual benefits for the Port of Sacramento and the Collinsville-Montezuma Hills area are summarized in the following tabulation.

ESTIMATED AVERAGE ANNUAL NAVIGATION BENEFITS

Item	Average Annual Benefits
PORT OF SACRAMENTO	
Wood chips	$ 1,528,700
Rice	1,510,400
Fertilizers and fertilizer material	1,608,500
Other grains and oilseeds	1,752,400
Other bulk commodities	757,300
Logs	342,300
Future industrializations	1,464,000
Project-induced tonnage	1,488,200
SUBTOTAL	10,451,800
COLLINSVILLE-MONTEZUMA HILLS AREA	
Future industrialization	2,463,900
Project-induced tonnage	1,983,400
SUBTOTAL	4,447,300
TOTAL	$14,899,100

Recreation benefit analysis included projecting recreation demands in the area, inventorying existing recreation facilities, estimating recreation opportunities associated with the project, and applying a unit monetary value to the project-related recreation activites. Recreation use was estimated to be 120,000 recreation days annually at the beginning of the project life, increasing to 180,000 recreation days at the end of 50 years. Based on this use estimate and a unit value of $2.25 per recreation day, benefits were computed to be $303,000 on an average annual basis.

National economic development (NED) benefits from unemployed or underemployed labor resources during project construction have not been included in this analysis. No project features are located within areas having "substantial and persistent unemployment" as defined by the Economic Development Administration (EDA).

The following tabulation shows a summary of average annual benefits associated with navigation and related improvements to the Sacramento River Deep Water Ship Channel.

SUMMARY OF BENEFITS

Navigation	
Collinsville-Montezuma Hills Area	$ 4,447,000
Port of Sacramento	10,452,000
Total Navigation	14,899,000
Recreation	303,000
Fish & Wildlife	0
Total Project	$15,202,000

Justification

Average annual benefits are compared with average annual costs for the selected plan in the following tabulation. Although intangible benefits and tangible secondary benefits may accrue to the national economy, only tangible primary benefits are included in the tabulation.

AVERAGE ANNUAL COSTS AND BENEFITS
NEW YORK SLOUGH TO SACRAMENTO

	Costs	Benefits	Excess Benefits	Benefit to Cost Ratio
Navigation				
New York Slough to Collinsville-Montezuma Hills	$(1,347,000)	$(4,447,000)	$(3,100,000)	3.3
Collinsville-Montezuma Hills Area to Sacramento	(4,575,000)	(10,452,000)	(5,877,000)	2.3
Total Navigation	5,922,000	14,899,000	8,977,000	2.5
Recreation	171,000	303,000	132,000	1.8
Fish & Wildlife Mitigation	61,000	0	-61,000	0
TOTAL	$ 6,154,000	$ 15,202,000	$ 9,048,000	2.5

In the preparation of this tabulation, it was assumed that the Suisun Bay Channel would be deepened to 35 feet under the authorized Stockton Ship Channel project. If this is not the case, the cost of deepening the Suisun Bay Channel would be included in the selection plan. This would increase average annual costs of the project by $909,000, and decrease the benefit to cost ratio to 2.2 to 1.

Maximization

Maximizing net tangible benefits is an economic concept used in sizing facilities to produce the greatest excess of benefits over cost. Under this concept, the last increment in channel depth produces an incremental benefit-cost ratio equal to 1.0 to 1, and further increases in size would be uneconomical. As explained previously, downstream channel contraints prohibit implementation of the National Economic Development plan which provides maximum net benefits. However, the NED plan will be considered further during advanced engineering and design studies.

Division of Plan Responsibilities

Apportionment of costs between Federal and non-Federal interests is based on Federal legislation and administrative policies governing navigation improvement projects. A basis for apportioning costs for the project functions is described in the following paragraphs.

Cost Apportionment

Federal and non-Federal costs associated with the improvement of the Sacramento River Deep Water Ship Channel are based on Federal policy for navigation improvements. The following tabulation shows the apportionment of costs.

COST APPORTIONMENT

35-ft. Channel — New York Slough to Sacramento

	FEDERAL			NON-FEDERAL			
	Navigation ($)	Recreation ($)	Fish & Wildlife Mitigation ($)	Navigation ($)	Recreation ($)	Fish & Wildlife Mitigation ($)	TOTAL
FIRST COST							
New York Slough to Mile 11.0	16,600,000	—	—	1,700,000	—	—	18,300,000
Mile 11.0 to Sacramento	42,400,000	1,300,000	300,000	10,350,000	50,000	400,000	54,800,000
Total	59,000,000	1,300,000	300,000	12,050,000	50,000	400,000	73,100,000
Adjustment for Recreation Cost-Sharing	—	-625,000	—	—	+625,000	—	0
Adjusted Subtotals	59,000,000	675,000	300,000	12,050,000	675,000	400,000	73,100,000
Adjustment for Fish & Wildlife Cost-Sharing	—	—	+260,000	—	—	-260,000	0
Adjusted First Cost	59,000,000	675,000	560,000	12,050,000	675,000	140,000	73,100,000
Total First Cost		60,235,000			12,865,000		
INVESTMENT							
Adjusted First Cost	59,000,000	675,000	560,000	12,050,000	675,000	140,000	73,100,000
Interest During Construction (Mile 11.0 to Sacramento only)	7,552,000	120,000	100,000	1,844,000	120,000	25,000	9,761,000
Gross Investment	66,552,000	795,000	660,000	13,894,000	795,000	165,000	82,861,000
Total Gross Investment		68,007,000			14,854,000		
ANNUAL COST							
Interest and Amortization							
New York Slough to Mile 11.0	1,222,000	—	—	125,000	—	—	1,347,000
Mile 11.0 to Sacramento	3,677,000	58,000	49,000	898,000	58,000	12,000	4,752,000
Subtotal	4,899,000	58,000	49,000	1,023,000	58,000	12,000	6,099,000
O.M.&R.							
New York Slough to Mile 11.0	—	—	—	—	—	—	—
Mile 11.0 to Sacramento	—	—	—	—	55,000	0	55,000
Total	4,899,000	58,000	49,000	1,023,000	113,000	12,000	6,154,000
Total Annual Cost		5,006,000			1,148,000		

FEDERAL RESPONSIBILITIES

Sharing of costs between Federal and non-Federal interests including costs for mitigation, is based upon traditional requirements established as Federal policy for navigation projects, except as noted under "Non-Federal Responsibilities."

Responsibility for construction, operation, and maintenance associated with the recreation area would conform to the requirements of Public Law 89-72, as amended. All of the costs for lands, facilities, and construction would be divided between the Federal Government and the local recreation sponsor. Operation and maintenance of completed facilities would be the responsibility of the non-Federal recreation sponsor.

All of the costs for lands, facilities, and construction of the fish and wildlife mitigation areas would be divided between the Federal Government and the non-Federal navigation sponsor in the same proportion as the project navigation costs. The operation and maintenance of these facilities would consist of annual surveillance of the facilities to insure that encroachment has not occurred and habitat has not been destroyed. An annual report verifying the surveillance would also be prepared. The annual cost to operate and maintain the fish and wildlife facilities has been determined to be negligible.

NON-FEDERAL RESPONSIBILITIES

The following are the specific non-Federal requirements for the navigation improvements and fish and wildlife mitigation facilities:

- Provide without cost to the United States all lands, easements, and rights-of-way required for construction and subsequent maintenance of the project and for aids to navigation, including suitable areas determined by the Chief of Engineers to be required in the general public interest for initial and subsequent disposal of dredged material;

- Provide without cost to the United States all dredged material retention dikes, bulkheads, and embankments necessary for project construction, or the costs of such retaining works, except for additions required solely for development of the recreational area;

- Hold and save the United States free from all claims for damages due to deposition of dredged material, and due to the construction of new levees or reconstruction of existing levees along the Sacramento River Deep Water Ship Channel, including damages to such levees or damages due to failure of such levees, except damages due to the fault or negligence of the United States or its contractors;

- Hold and save the United States free from damages to wharves, bridge piers and other marine and submarine structures, and agricultural lands, due to initial dredging work and subsequent maintenance dredging, except damages due to the fault or negligence of the United States or its contractors;

- Accomplish without cost to the United States all utility modifications and relocations required for construction of the project works, including new bridges or bridge alterations (except for railroad bridges), and absorb any increased annual maintenance and operation costs that might result from such modifications and relocations;

- Provide, maintain, and operate at local expense adequate public terminal and transfer facilities open to all on equal terms, in accordance with plans approved by the Chief of Engineers; and

- Provide and maintain without cost to the United States all public berthing areas, at depths commensurate with project depths, at all public terminals and wharves to be served by the deepened channels.

- Provide without cost to the United States the lands, easements, rights-of-way or other proprietary interest in lands necessary for the development of the fish and wildlife facilities;

- Share the cost of fish and wildlife mitigation features including lands in the same ratio as the remaining costs of the navigation feature; and

- Hold and save the United States free from all claims for damages due to construction of fish and wildlife facilities, except damages due to the fault of negligence of the United States or its contractors.

In addition, non-Federal requirements for the recreation improvements are as follows:

- Provide without cost to the United States the lands, easements, rights-of-way or other proprietary interest in lands necessary for the development of public recreation facilities;

- Pay, contribute in kind, or repay (which may be through user fees) with interest, a portion of cost of recreation facilities which when added to the cost of recreation lands would amount to 50 percent of the total first cost of the recreation lands and recreation facilities;

- Maintain and operate at non-Federal expense public recreation, including access thereto, at the dredged material disposal area designated by the District Engineer; and

- Hold and save the United States free from all claims for damages due to construction of recreation facilities, except damages due to the fault or negligence of the United States or its contractors.

Proposed Revised Cost-Sharing Responsibilities

Pertinent information regarding possible cost apportionment between Federal and non-Federal interests based on future adoption and implementation of the President's water policy message is contained in the following paragraphs.

The President's Proposed Policy

The President's May 1978 message proposing revised sharing of costs of Federal water projects is to involve States more extensively in water project decisions and to eliminate many of the conflicting rules governing cost-sharing for water resource development projects. As applied to this project, the President's new cost-sharing policy requires that States provide a legally binding commitment to contribute a 5 percent cash share of the total first cost of construction of the project. The State's cash contribution is to be paid concurrently and proportionately with the Federal contractual obligation for project construction.

Cost Apportionment

The accompanying tabulations "Cost Apportionment — 35-ft. channel — New York Slough to Sacramento" shows the apportionment of the first and annual costs. Federal and non-Federal responsibilities based on possible future implementation of the President's water policy are described below.

FEDERAL RESPONSIBILITIES

Sharing of costs between Federal and non-Federal interests including costs for mitigation is based upon traditional requirements established as Federal policy for navigation projects, except as noted under "non-Federal Responsibilities."

Responsibility for construction, operation, and maintenance associated with the recreation area would be as provided by Public Law 89-72, as amended. All of the costs for additional interest in recreation lands, and for recreation facilities, would be divided between the Federal Government and local recreation sponsor. Operation and maintenance of completed facilities would be the responsibility of the non-Federal recreation sponsor.

All of the costs for lands, facilities, and construction of the fish and wildlife mitigation areas would be divided between the Federal Government and the non-Federal navigation sponsor in the same proportion as the project navigation costs. The operation and maintenance of these facilities would consist of annual surveillance of the facilities to insure that encroachment has not occurred and habitat has not been destroyed. An annual report verifying the surveillance would also be prepared. The annual cost to operate and maintain the fish and wildlife facilities has been determined to be negligible.

NON-FEDERAL RESPONSIBILITIES

Under the President's proposed cost-sharing policy, non-Federal interests would be required to contribute a 5 percent cash share of the total first cost of construction, to be paid concurrently and proportionately with the Federal contractual obligation for project construction. In addition, non-Federal interests would be responsible for the following requirements under both traditional and proposed cost-sharing requirements:

- Provide without cost to the United States all lands, easements, and rights-of-way required for construction and subsequent maintenance of the navigation improvements and for aids to navigation, including suitable areas determined by the Chief of Engineers to be required in the general public interest for initial and subsequent disposal of dredged material;

- Provide without cost to the United States all dredged material retention dikes, bulkheads, and embankments necessary for project construction, or the costs of such retaining works, except for additions required solely for development of the recreation area.

- Hold and save the United States free from all claims for damages due to deposition of dredged material, and due to the construction of new levees or reconstruction of existing levees along the Sacramento River Deep Water Ship Channel, including damages to such levees or damages due to the failure of such levees, except damages due to the fault or negligence of the United States or its contractors;

- Hold and save the United States free from damages to wharves, bridge piers and other marine and submarine structures, and agricultural lands, due to initial dredging work and subsequent maintenance dredging, except damages due to the fault or negligence of the United States or its contractors;

- Accomplish without cost to the United States all utility modifications and relocations required for construction of the project works, including new bridges or bridge alterations (except for railroad bridges), and absorb any increased annual maintenance and operation costs that might result from such modifications and relocations;

- Provide, maintain, and operate at local expense adequate public terminal and transfer facilities open to all on equal terms, in accordance with plans approved by the Chief of Engineers;

- Provide and maintain without cost to the United States all public berthing areas, at depths commensurate with project depths, at all public terminals and wharves to be served by the deepened channels;

- Provide without cost to the United States the lands, easements, rights-of-way or other proprietary interest in lands necessary for the development of the fish and wildlife mitigation facilities;

- Share the cost of fish and wildlife mitigation features including lands in the same ratio as the remaining costs of the navigation feature; and

- Hold and save the United States free from all claims for damages due to construction of the fish and wildlife facilities, except damages due to the fault of negligence of the United States or its contractors.

In addition, the non-Federal recreation interest would be required to:

- Provide without cost to the United States the lands, easements, rights-of-way or other proprietary interest in lands necessary for the development of public recreation facilities;

- Pay, contribute in kind, or repay (which may be through user fees) with interest, a portion of cost of recreation facilities which when added to the cost of recreation lands would amount to 50 percent of the total first cost of the recreation lands and recreation facilities;

- Maintain and operate at non-Federal expense the public recreation area, including access thereto, at the dredged material disposal area designated by the District Engineer; and

- Hold and save the United States free from all claims for damages due to construction of recreation facilities, except damages due to the fault or negligence of the United States or its contractors.

COST APPORTIONMENT

35-ft. Channel — New York Slough to Sacramento

	FEDERAL			NON-FEDERAL			
	Navigation ($)	Recreation ($)	Fish & Wildlife Mitigation ($)	Navigation ($)	Recreation ($)	Fish & Wildlife Mitigation ($)	TOTAL
FIRST COSTS							
Traditional Cost-Sharing							
New York Slough to Mile 11.0	16,600,000	—	—	1,700,000	—	—	18,300,000
Mile 11.0 to Sacramento	42,400,000	675,000	560,000	10,350,000	675,000	140,000	54,800,000
Total	59,000,000	675,000	560,000	12,050,000	675,000	140,000	73,100,000
Adjustment for 5 Percent Non-Federal Share of Total Cost							
New York Slough to Mile 11.0	-915,000	—	—	+915,000	—	—	0
Mile 11.0 to Sacramento	-2,638,000	-68,000	-35,000	+2,638,000	+68,000	+35,000	0
Total	-3,553,000	-68,000	-35,000	+3,553,000	+68,000	+35,000	0
Adjusted First Costs							
New York Slough to Mile 11.0	15,685,000	—	—	2,615,000	—	—	18,300,000
Mile 11.0 to Sacramento	39,762,000	607,000	525,000	12,988,000	743,000	175,000	54,800,000
Adjusted Subtotal	55,447,000	607,000	525,000	15,603,000	743,000	175,000	73,100,000
Total		56,579,000			16,521,000		
INVESTMENT							
Interest During Construction (Mile 11.0 to Sacramento only)	7,083,000	108,000	94,000	2,313,000	132,000	31,000	9,761,000
Gross Investment							
New York Slough to Mile 11.0	15,685,000	—	—	2,615,000	—	—	18,300,000
Mile 11.0 to Sacramento	46,845,000	715,000	619,000	15,301,000	875,000	206,000	64,561,000
Gross Investment	62,530,000	715,000	619,000	17,916,000	875,000	206,000	82,861,000
Total		63,864,000			18,997,000		
ANNUAL COST							
Interest and Amortization							
New York Slough to Mile 11.0	1,155,000	—	—	192,000	—	—	1,347,000
Mile 11.0 to Sacramento	3,448,000	53,000	46,000	1,126,000	64,000	15,000	4,752,000
Total	4,603,000	53,000	46,000	1,318,000	64,000	15,000	6,099,000
O.M.&R.	—	—	—	—	55,000	—	55,000
Total Annual Cost	4,603,000	53,000	46,000	1,318,000	119,000	15,000	6,154,000
Total		4,702,000			1,452,000		

SUMMARY

The following tabulation illustrates the comparative cost-sharing that would be applicable for both current policy and for the President's proposed policy:

	CURRENT POLICY	**PROPOSED POLICY**
FEDERAL FIRST COST	$60,235,000	$56,579,000
NON-FEDERAL FIRST COST	12,865,000	16,521,000
TOTALS	$73,100,000	$73,100,000

Plan Implementation

The steps necessary for authorization and construction of the proposed plan of improvement are summarized as follows:

a. The completed Feasibility Report would be reviewed by higher Corps of Engineers authorities including the South Pacific Division, the Board of Engineers for Rivers and Harbors, and the Office of the Chief of Engineers.

b. The Chief of Engineers would seek formal review and comments by the Governor of California and interested Federal agencies.

c. The report along with comments of the other Federal agencies and the State, as well as the Secretary of the Army's proposed letter of transmittal to Congress, would be submitted to the Office of Management and Budget (OMB) to determine the relationship of the project to the program of the President.

d. The Secretary of the Army would also submit the report to the Water Resources Council (WRC) for a technical review to insure the proposed plan is in consonance with the WRC Principles and Standards, the President's Water Resources Policy initiatives, and the WRC planning procedures manual.

e. Following the OMB and WRC review, the Secretary of the Army would then forward the final report of the Chief of Engineers to the Congress.

f. Congressional authorization of the project.

g. After authorization of the project, budget requests would be initiated for advanced engineering and design of the project.

h. Upon receipt of funds, advanced engineering and design studies would be initiated.

i. Following advanced engineering and design studies, budget requests would be initiated for construction funds.

j. Surveys, materials investigations, and preparation of design criteria, plans, specifications, and an engineering estimate of costs would be accomplished upon receipt of construction funds. Formal assurances of local cooperation would be requested from non-Federal interests. Bids for construction of the project would be invited and contract awarded.

Following completion of construction, local interests would be responsible for operation and maintenance of recreation facilities in Solano County. Maintenance of the navigation channel will continue to be a Federal responsibility.

Executive Order 11990

The objective of Executive Order 11990, Protection of Wetlands, is to avoid to the extent possible the long and short term adverse impacts associated with the destruction or modification of wetlands and to avoid direct or indirect support of new construction in wetlands wherever there is a practicable alternative. Federal agencies are required to provide leadership and take action to minimize the destruction, loss or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands. The following considerations relate the recommended plan for the Sacramento River Deep Water Ship Channel to the requirements of Executive Order 11990:

- No action (no further navigation improvements), intermodal transportation to alternative ports, increased use of LASH barges, and channel deepening were the alternatives considered during the plan formulation process. Channel deepening was determined to be the only practicable alternative to meeting the needs of the study area.

- Avoidance of wetland losses was carefully considered utilizing advice from the fish and wildlife agencies. Sites for disposal of dredged material were found that will not impact wetlands. However, approximately 45 acres of marsh and riparian vegetation will be lost as a result of widening the manmade portion of the channel. To compensate for this loss, 45 acres of tidal wetlands will be developed on a dredged material disposal site.

- To determine if there are suitable locations where dredged material may be beneficially used to establish additional wetlands under the program authorized by Section 150 of the 1976 Water Resources Development Act, additional investigation and coordination will be undertaken with fish and wildlife agencies and interested organizations during advanced engineering and design studies.

- An evaluation of water quality considerations associated with the selected plan of improvement has been conducted in accordance with Section 404 of the Clean Water Act of 1977, Public Law 92-500, as amended (33 USC 1344), and other pertinent laws and regulations and is presented in Appendix 4 of this report.

These are considered to be all the practicable measures that are available to minimize harm to wetlands and to enhance them taking into account pertinent economic, environmental and other factors.

Executive Order 11988

The objective of Executive Order 11988, Flood Plain Management, is to avoid to the extent possible the adverse impacts associated with the occupancy and modification of flood plains and to avoid direct and indirect support of flood plain development wherever there is a practicable alternative. Federal agencies are required to provide leadership and take action toward the fulfillment of that objective. The following considerations relate the recommended plan for the Sacramento River Deep Water Ship channel to the requirements of Executive Order 11988:

- The flood plain directly affected by the recommended plan of improvement is that portion of the Sacramento River flood plain located between Sacramento and Suisun Bay. Agricultural lands border almost the entire length of this segment of the flood plain. Federal project levees provide greater than 100-year flood protection to much of this reach of the river. The recommended plan of improvement would not affect the flood frequency in the flood plain.

- The selected plan would induce development along the navigation channel. However, development would either be flood-proofed above the level of the 100-year flood plain, occur outside the 100-year flood plain, or in areas afforded greater than 100-year flood protection.

- Sacramento, Yolo, Solano, and Contra Costa counties are participating in the National Flood Insurance Program which requires all future development to be built at or above the 100-year flood plain.

- No action (no further navigation improvements), intermodal transportation to alternative ports, and increased use of LASH barges were the alternatives considered in addition to channel deepening. While these alternatives would probably not induce development in the flood plain, neither would they promote efficient transportation of bulk commodities to and from the project area. Channel deepening was determined to be the only practicable alternative to meeting the needs of the study area.

- The natural values of the flood plain have been altered historically by development.

- Others involved in this study include the State of California, U.S. Fish and Wildlife Service, Port of Sacramento, California Wildlife Federation, navigation interests, local residents of the flood plain, and environmental groups.

Views of Non-Federal Interests

Non-Federal views concerning the draft feasibility report and EIS are contained in Appendix 6 and are summarized below.

RESOURCES AGENCY OF CALIFORNIA

By letter dated 4 January 1980, the Resources Agency of California provided the following comments on the proposed plan of improvement.

Comment — The cumulative impact of deepening the Sacramento, Baldwin, and Stockton Channels should be discussed in one environmental document since the Delta system would be subjected to their combined effects.

Response — An evaluation of the effects of deepening the Avon to Stockton portion of the San Francisco Bay to Stockton Ship Channel has been completed. The results of this evaluation were presented at a public meeting held in Stockton in March 1980. A General Design Memorandum and EIS describing studies conducted on deepening the Stockton channel are scheduled to be completed and made available to the public later in 1980. The current investigation of deepening the Sacramento River Deep Water Ship Channel is a feasibility investigation. Deepening of the Sacramento Channel is not iminent. Congressional authorization of construction and detailed post authorization studies would have to be accomplished before construction could be initiated. Post-authorization studies of the Sacramento Channel would include the deepened Stockton Channel as a preproject condition, and would address the cumulative impact of deepening both channels. The cumulative impact on Delta salinity levels of deepening the Sacramento and Stockton Channels is presented in Appendix 5. Appendix 5 summarizes the results of model studies that consider the Stockton Channel deepened to 35 feet, and the Stockton and Sacramento Channel combined, each deepened to 35 feet. No measurable impacts on salinity were found. Additional response to the cumulative impact issue is provided in Appendix 6.

Comment — The report concludes that deepening the Stockton Ship Channel would not affect salinity distributions or concentrations in the estuary and that subsequent deepening of the Sacramento Ship Channel would also have no measurable impact on salinities. A Department of Water Resources (DWR) analysis of the data in the report and meetings with the Corps and its Bay-Delta Model Advisory Committee, however, indicate that the model is not able to measure relatively small increases in salinity which could require as much as 400 cubic feet per second of additional Delta outflow to counteract. The State Water Project (SWP) and the Central Valley Project (CVP) would be obligated to release this additional amount of water from upstream storage to meet the water quality standards of State Water Resources Control Board Decision 1485. An increase in salinity could have an adverse impact on agricultural, municipal, and industrial uses and on wildlife habitat.

Response — Because of the concerns expressed by DWR regarding the ability of the Bay-Delta Model to detect small changes in salinity levels, the Corps of Engineers has agreed to conduct additional tests during advanced studies to further define the effects of deepening the channel on salinity intrusion. Additional model tests would be conducted in cooperation with DWR and other concerned State and Federal Agencies. The scope of the future testing program is summarized in the Recommendations portion of this report.

The main report and Appendix 1 Section D were amended to indicate the use of additional outflow is not an economical or practical approach to preventing salinity intrusion.

Comment — The Corps proposal to delay the implementation of mitigation measures until an adverse impact is discovered by monitoring water quality is unacceptable. The monitoring program, as proposed by the Corps, would be ineffective in measuring small salinity increases. We believe there is a real possibility of an adverse impact. Mitigation for this impact must become part of the authorization, design, and construction of the channel-deepening projects and must be implemented.

Response — Subsequent to the receipt of the Resources Agency's comments, the Corps of Engineers and DWR have conducted negotiations to define the scope of additional model tests required to resolve the salinity intrusion issue to the mutual satisfaction of both agencies. As a result of these negotiations both agencies have agreed that the Corps' Bay-Delta Model is the best scientific tool available to evaluate changes in salinity that may result from deepening the ship channel. The report has been revised to indicate the decision to provide mitigation for salinity intrusion would be predicated on the results of post-authorization model studies conducted at the Bay-Delta Model in cooperation with DWR and other State and Federal agencies. An acceptable mitigative measure would be implemented concurrent with the channel deepening activities if the model studies conducted during post-authorization studies indicate such a measure is warranted. The mitigative measure would be completed at the same time as the ship channel.

Comment — If a sill or similar device to induce additional turbulence in Carquinez Strait is specified as the mitigation device, we must then be reasonably assured that it will, in fact, reduce salinity intrusion and be environmentally acceptable. As part of its activities to complete its feasibility report on the Sacramento Deep Water Ship Channel, the Corps should implement the undistorted scale model tests, using saline stratified flow as recommended by its Advisory Committee. At the Carquinez Strait and Chipps Island channel constrictions, sand dunes move along the bottom during low flow periods. The effect of the proposed sill on these dunes and the resultant effects on inorganic particulate transport must be investigated further and discussed in the final document.

Response — During advanced engineering and design studies the Corps of Engineers will conduct special studies of a sill and alternative devices if the additional San Francisco Bay-Delta Model tests indicate a measurable increase in salinity incursion would occur as a result of channel deepening.

Such studies would probably include evaluation of distorted and undistorted structures in a laboratory flume using saline stratified flows. These studies would be for the purpose of determining the mechanics of how such structures restrict salinity incursion, suggesting optimum designs for structures found effective, and determining similitude relationships for a distorted model as well as its accuracy in predicting results. The Sacramento District and Department of Water Resources will cooperate in development of specifications for the proposed tests. DFG and USFWS would be invited to present concerns they may have about the sill proposal and to suggest parameters to be observed to infer the effects of the sill on fish life and the nutrient entrapment (null) zone.

In regard to sediment transport, Dr. Ray Krone, consultant on estuarial sediments, conducted tests for the Corps on this topic in 1977. Dr. Krone used the Corps' Bay-Delta Model in Sausalito to assist in his analysis. Dr. Krone concluded " . . . that the sill will have very little effect on sediment transport. Any change resulting from the presence of the sill would be far smaller than normal daily, seasonal, or annual changes in suspended sediment transport in the estuary landward of the sill." Should additional studies of a sill or other potential salinity mitigative feature be conducted during advanced engineering and design studies, consideration will be given to expanding those studies already completed on sediment transport.

Comment — The State uses a design flood of 700,000 cfs in evaluating the effect of a sill, while the Corps uses a 410,000 cfs value. The reasons for this difference and the probable effects of higher flows, if they can be expected, should be addressed by the Corps.

Response — Design floodflows used to evaluate the impact of the sill on water surface elevations would be determined in accordance with the guidelines of future cooperative studies between the Corps of Engineers and DWR. The flow of 410,000 cfs represents a more critical flood condition than that produced by the short term peak flow of 500,000 cfs, which occurred in December 1955. The December 1955 flood condition is considered the flood of record in the Delta. It is expected that Delta water surface elevations incurred with a 700,000 net Delta outflow would be in excess of those incurred with 410,000 cfs.

Comment — Because of the uncertainties related to the sill, the Corps should study other mitigation measures, including development of locks in the Sacramento River Deep Water Channel at the lower end of Prospect Island and through flow increases from purchase or additional water development.

Response — Post-authorization studies would investigate the effectiveness of a submerged sill and alternative mitigation measures. Refer to earlier response on the use of flow increases or additional water development to prevent salinity intrusion.

Comment — The report appears to consider the impact of this project on fish and wildlife adequately, but the final report should more fully describe possible mitigation measures. For example, the Corps has not defined the measures planned for the unavoidable loss of upland habitat caused by widening the channel and at spoil disposal sites. We suggest that the final report specifically indicate the upland mitigation site, with an environmental easement or other dedication provided to assure its continued availability for wildlife.

Response — A maximum of 156 acres of designated disposal areas would be permanently dedicated to the development of upland habitat. The location of the upland habitat areas and final acreage requirements would be determined during later studies. Cost estimates for these areas are currently based on land costs in the vicinity of the manmade reach of the channel. This report, Appendix 1 Section E, and the EIS have been revised to provide for compensation of the loss of upland habitat.

Comment — Wetlands enhancement at Donlon Island should be included in the project authorization.

Response — Wetlands would be developed on Donlon Island as an element of the Stockton Ship Channel project which has been authorized by Congress. If the Stockton project is delayed or not constructed, the potential for creating wetlands at Donlon Island as part of the Sacramento River Deep Water Ship Channel project would be considered in more detail during advanced studies. Refer to this report, Appendix 1 Section B and Appendix 3.

Comment — The report does not mention the presence of Younger Bay Mud which is present in the proposed channel area and underlying adjacent fill areas. The potential lateral spreading of this (and other) materials toward the excavated channel would result in subsidence of adjacent areas.

Response — A detailed description and basis of design for the submerged sill was added to Appendix 1 Section E. The presence of Younger Bay Mud is noted in that description. Subsurface explorations would be conducted during advanced studies to determine the composition of subsurface materials. In the manmade portion of the channel, excavation side slopes would be 1 vertical on 3 horizontal. Side slopes in the remainder of the channel would be 1 vertical on 4 horizontal. It is believed the soils in these reaches are capable of sustaining these slopes. The below water location of the excavation lessens the likelihood of slope failure. This would be verified during future studies.

Comment — The effect of increased ship traffic and an increase in water level on levee maintenance in the Suisun Marsh should be considered in more detail. If the increased traffic and larger ships—coupled with even a small rise in the water level—increases the maintenance problems with the levees, some program to rectify that situation should be included in the project.

Response — It is not anticipated increased ship traffic would affect levee maintenance in the Suisun Marsh since ship traffic would be confined to the ship channel and would not ply the channels of the marsh. Model tests of the submerged sill showed the sill, if needed and eventually constructed, would have virtually no effect on water surface elevations throughout the system during average flow conditions. Water surface elevations would increase minimally under extreme flood conditions. Under extreme flood conditions, the sill would increase water surface elevations in Suisun Bay by a maximum of 0.4 feet.

Comment — The report should also present a more detailed discussion of the economic impacts of the project. The economic analysis, as described in the draft report, is too narrow in scope. From that description, it appears that insufficient consideration was given to the options of using other west coast port facilities, existing or proposed, as alternatives to the further development of the Port of Sacramento.

This is particularly true for the facilities serving shipping that passes through the Golden Gate. For example, the Sacramento and Stockton ports are competitors, both specializing in bulk commodity shipping. If only one of the channels is deepened, the other port could suffer severe economic consequences. The report should show the projected changes in shipping at the two ports if one or both channels are deepened. Other potentially competing developments are proposed for Oakland, Richmond, and Los Angeles.

Response — The report should clearly show that the Sacramento channel proposal is part of a comprehensive plan for the coordinated development of west coast shipping. The relationship of the Port of Sacramento development to regional shipping needs should be discussed.

Response — In developing the cargo projections for Sacramento, detailed studies were conducted of bulk shipping through Pacific ports; bulk storage and handling facilities available at other west coast ports; and economic advantages that the Port of Sacramento has over other west coast ports for various cargo movements.

Other west coast ports are not suitable alternatives to further development at Sacramento. The Port of Sacramento is one of the most modern and efficient cargo handling facilities for bulk cargo on the west coast, relying primarily on bulk cargoes which support or are derived from the economic base of the area. The port has a land transportation cost advantage over other competing ports for certain cargoes such as rice, wheat, wood chips, and fertilizer, and continued shipment of these cargoes on the existing channel would be more economical than overload transportation to and from other ports where deeper draft ships can be accommodated. Also, Sacramento is able to compete effectively against Pacific Northwest ports for cargo, as shown by the current movements of petroleum coke transported to Sacramento from the ARCO refinery at Cherry Point, Washington (Puget Sound).

Additionally, the economic significance of the port is strengthened by the availability along the deep water channel of large tracts of land which have been zoned for industrial use and potential expansion of the port, enhancing the prospects for water-oriented industrial development. Underdeveloped deep-draft waterfront industrial sites on the west coast are extremely scarce, and anticipated demands for such sites are expected to be intense in the future.

Comment — The report does not adequately account for the risk and uncertainty involved in projecting benefits to 50 years in the future. With the rapidly evolving variety of transportation routes and modes, as well as the many variables that affect foreign trade, it appears that either the period of analysis should be shortened or the projected benefits should be weighed against the risk and uncertainty involved. This is particularly important in determining the optimum channel depth.

Response — Tonnages handled at the Port of Sacramento have increased dramatically in recent years, and potential is enormous for continued growth in bulk cargo movements.

The Corps projections presented in this report were developed through detailed studies of the factors underlying patterns of trade. To avoid projection errors, we considered the unique, nonrecurring factors that have affected past trends; the likelihood that present supply-demand relationships will change, as is occurring in receipts of waterborne nitrogen fertilizer; and boundary conditions that might exist. Also, the opinions of commodity experts were also incorporated into the cargo projections.

Projections are "best estimate" of future cargo movements in the channel and form a valid basis for establishing navigation benefits to be derived from the channel deepening. Although actual tonnage of projected individual commodities may well vary from that projected, total tonnage is expected to be achieved.

In every case, a conservative approach was used to establish the estimates of transportation savings for individual commodity movements, and we believe that shortening the period of analysis to less than 50 years is not justified.

Comment — The industrial development that the selected plan induces will be likely to generate substantial additional highway traffic, particularly in the vicinity of the industrial area near the Port of Sacramento and near Collinsville. The adequacy of existing roadway facilities should be an integral part of any decision to approve a growth-inducing project such as the one proposed. The Environmental Impact Statement should include a projection of trips to be generated and an analysis of impacts on existing transportation facilities.

Response — See response to comment by the Department of Transportation.

Intermodal transportation of commodities from the Port of Sacramento to the bay area using existing highway and rail systems would decrease if the channel was deepened. Therefore, channel deepening would reduce the impact on existing transportation systems.

The induced industrial development along the channel would be heavily water- and rail-oriented for material transport, a factor which would tend to minimize impacts on existing roadway facilities. These impacts cannot be adequately addressed until specific development proposals are made; however, they would be subject to specific project EIRs.

DEPARTMENT OF TRANSPORTATION

Comment — By letter dated 21 November 1979, the Department of Transportation indicated the discussion of the intermodal transportation alternative should include impacts and implications due to the facilities attracting and perhaps concentrating vehicular support traffic.

Response — As indicated in Appendix 1 Section D the intermodal transportation alternative would promote the use of terminal facilities at bay area and other west coast ports to handle the oceangoing cargo that cannot be moved efficiently in the existing 30-foot deep channel. The impacts of the intermodal transportation alternative would not be singularly focused on vehicular support traffic since rail and pipeline modes of transport would also be used to haul cargo to and from the deeper water ports. The increased use of the intermodal alternative for hauling ocean cargo to and from deeper water ports would require construction of new marine terminal and bulk storage facilities. Additional facilities to handle the increased truck, train, and pipeline traffic would also be required. With this alternative there would be a concentration of vehicular support traffic at port facilities. The intermodal transportation alternative is however not considered to be viable due to the lack of bulk storage facilities at bay area ports and the high costs of utilizing rail and truck transportation to move large quantities of bulk commodities to and from the tributary area served by the Port of Sacramento. For these reasons a detailed assessment of the impacts of this alternative has not been presented.

Comment — By letter dated 29 November 1979, the Department of Transportation commented that induced industrial development near Collinsville attributable to the proposed project would adversely affect State highways by increasing congestion and deteriorating structural sections. Improvements to State highways would have to be paid for by the State unless Federal matching funds were available. As indicated in the report, the Corps would not participate in financing highway improvements.

Response — The Solano County Planning Commission has adopted a plan for the Collinsville-Montezuma Hills area which designates a band along the ship channel for future industrial development. This plan would permit development at Collinsville regardless of implementation of the proposed plan of improvement. The plan provides for the development of roadways both within the area and along major approach routes with sufficient capacity to accommodate the level of industrialization permitted by the plan. It also outlines alternative approaches for financing major road improvements. The impacts of the industrial zoning designation were addressed in the 16 May 1977 EIR entitled "Collinsville-Montezuma Hills Preliminary Plan and Program, Environmental Impacts." It is anticipated that the industries that would locate in this area would primarily utilize rail and water transportation rather than highways for the movement of raw materials and finished products.

Comment — By letter dated 10 December 1979, the Office of Planning and Design of the Department of Transportation indicated the proposed plan included deepening the ship channel to 38 feet at the Rio Vista Bridge, lowering the submarine cable at the bridge, and providing scour protecting for footings of the bridge which would be exposed by deepening the channel.

Response — The channel would be deepened to 35 feet below mean lower-low water. An additional foot of overdepth would also be provided. Four submerged cables cross the channel immediately downstream of the Rio Vista Bridge. Costs are included in the estimate for lowering these cables. The cost estimate does not provide for scour protection for the bridge footings. The width of the proposed channel would be sufficiently narrowed at the bridge to prevent exposure of the bridge footings and to maintain the stability of the fender piling protecting the piers.

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD

Comment — By letter dated 28 January 1980, the California Regional Water Quality Control Board, San Francisco Region provided coments on the draft EIS.

Response — Responses to these comments appear in Appendix 6.

CALIFORNIA DEPARTMENT OF ECONOMIC AND BUSINESS DEVELOPMENT

Comment — By letter dated 20 November 1979, the California Department of Economic and Business Development expressed support for the proposed project.

SOLANO COUNTY MOSQUITO ABATEMENT DISTRICT

Comment — By letter dated 28 November 1979, the Solano County Mosquito Abatement District expressed concern over the proposed establishment of a 45 acre wetland habitat on Prospect Island in Solano County. The letter cited criteria for mosquito prevention in Dredge Material Disposal sites and requested that the criteria be utilized to prevent the production of mosquitoes on the proposed wetland site.

Response — Response is provided in Appendix 6.

CONTRA COSTA COUNTY

Comment — By letter dated 17 December 1979, the Contra Costa County Planning Department indicated that two DMD sites at Avon are needed for deposition of material from the Walnut Creek flood control channel and for the County's solid waste management program. The County also noted a Pacific Gas and Electric Company Power Plant is proposed for the DMD site located at Pittsburg. The County stated that the maintenance of Delta water quality was a precondition for its support of the project.

Response — Current cost estimates for the Avon to New York Slough reach do not reflect the need to dispose dredged material at the two Avon sites. However, the capacity of the most northwesterly site would be computed during future studies to determine if the site could jointly satisfy the needs of the County and Corps of Engineers. The DMD site near Pittsburg is identified in Appendix 1 Section D as a potential disposal site for the various alternative plans considered during the investigation. That site is not required for the selected plan.

CITY AND COUNTY OF SAN FRANCISCO

Comment — By letter dated 26 December 1979, the Department of City Planning cited many detailed concerns pertaining to almost all aspects of the report. Concerns were expressed about the lack of information on mercury and heavy metals in dredged materials, the effect of dredging on methylation of mercury in sediments, the resuspension of toxic materials as a result of dredging, and the effects of dredging on fishery resources. It was also recommended that the EIS discuss impacts of increased ship traffic, saltwater ballast discharge, industrial development in the Collinsville-Montezuma Hills area, the economic impact on the Port of San Francisco, and describe the transportation facilities at other west coast ports.

Response — Responses to specific comments are as follows:

Comment — The results of the bottom sediment sampling program completed in January 1975 should be indicated.

Response — The results of the bottom sediment sampling program have been included in Appendix 1 Séction E.

Comment — Larger and probably less manuverable ships would use the proposed channel. What effect would this have on the mix of ships on San Francisco Bay? Would there be an increase in the probability of accidents? Would increased ship traffic result in increased saltwater ballast discharge at the Port of Sacramento?

Response — Navigation safety will be improved by the proposed project. The channel improvements will permit the use of larger vessels to carry cargo and will reduce the need to light-load at Sacramento and sail to another port to complete the loading. Light-loading requires trips in and out of two or more ports instead of one, increasing the congestion in these ports (and the probability of accidents).

A large number of vessels between 25,000 and 60,000 dwt traverse the existing channel each year, many with little beam or keel clearance. Nevertheless, the channel has an excellent safety record. Vessels in the 20-40,000 dwt range are expected to comprise most of the future traffic on the deepened channel. The additional clearances to be provided (depth and width) will improve the controllability of these vessels and benefit navigation safety. Also, the one-way channel will be maintained and this will continue to reduce the probability of groundings and collisions in the channel as ship traffic increases.

Ballast discharges at the Port of Sacramento will increase in the future both with and without the channel improvements. Ballast discharges can be controlled through the enforcement of existing regulations.

Comment — The report indicates there is a good potential for the petrochemical industry locating in the Collinsville-Montezuma Hills area. The impacts of such development should be discussed if the deepening of the channel is a prerequisite for development.

Response — A deeper channel is not considered a prerequisite for the location of the petrochemical industry in the Collinsville-Montezuma Hills area. Previous proposals for the location of petrochemical plants in the area by Dow and ARCO were not contingent on the availability of a deeper channel to the port sites. However, both companies indicated that deepening the channel would have increased the efficiency of their transport and, therefore, permitted lower operating costs.

Comment — The lack of depth of analysis of the alternatives precludes meaningful comparison to the proposed plan. Inadequate information is given about the assumptions used in the economic analysis and it appears that the economic analysis of alternatives considered only the Sacramento area rather than the entire Bay Area. A description of transportation facilities available at the San Francisco and Oakland ports should be provided.

Response — Refer to responses to similar comments by the Resources Agency of California and ABAG.

Comment — With respect to the Intermodal Alternative, some of the larger bulk grain vessels would top-off at the Islais Creek grain terminal at the Port of San Francisco. What would be the effect on the Port of San Francisco of the loss of this trade due to deepening the Sacramento River Channel?

Response — Deepening the channel will allow a substantial reduction in the amount of grain that must be moved to San Francisco to "top-off" the larger bulk grain vessels. Because of insufficient channel depths, these vessels now must sail light-loaded from the Port of Sacramento, incurring considerable additional costs because grains must be moved overland to the Bay Area and the higher price of ocean freight for two-port loads. In several years in which shipping has been especially heavy, up to 100,000 tons of grain has had to be moved overland to San Francisco for "topping-off."

The grain terminal at the Port of San Francisco (60,000 ton storage capacity) is best suited to handle out-of-state shipments of corn and grain sorghum moving primarily to Asian destinations. In the last 2 to 3 years, corn shipments from Nebraska and western Iowa have increased dramatically through Pacific ports. Because it can accommodate the vessel sizes required by many Asian buyers (30-50,000 dwt), the Islais Creek grain terminal has been effective in competing for some of this business. Future increases in these out-of-state grain shipments should more than offset the tonnage losses to the terminal from reduced topping-off operations due to the channel deepening.

Comment — What would be the economic effects on the Port of San Francisco of increased trade due to adoption of the Intermodal Alternative?

Response — The intermodal alternative is not considered to be viable due to the lack of bulk storage and handling facilities at bay area ports and the high cost of utilizing rail and truck transportation to move large quantities of bulk commodities to and from the tributary area served by the Port of Sacramento. It is more economical to use the existing channel for most shipments than overland transportation to and from bay area ports where deeper draft vessels can be accommodated.

Comment — Energy consumption of the alternative plans should be provided so the conclusion stated in Appendix 1 Section D can be evaluated.

Response — There will substantial fuel savings as a result of the channel deepening due to the reduction in both the overland transport of ocean cargoes for topping-off operations and two-port loadings. In addition, the larger vessels that will be able to traverse the 35-foot channel when fully loaded are much more fuel efficient per ton-mile than the smaller vessels that are able to operate efficiently on the existing channel. For example, a 25,000 dwt vessel consumes only 17 percent more bunker fuel on a typical voyage between Sacramento and Japan than a vessel of 18,000 dwt — despite having 45 percent more cargo capacity.

ASSOCIATION OF BAY AREA GOVERNMENTS (ABAG)

Comment — By letter dated 25 January 1980, ABAG relayed comments on two major issues: economic development and water quality. Specifically, the letter commented that the economic analysis should be supplemented with documentation of economic impacts on other regional port facilities in the Bay Region, and the analysis should include information as to whether NED benefits would accrue to other locations in the Bay Area if the project were not implemented.

Response — Deepening the channel is not expected to have any significant economic impact on ports in the Bay Area. These ports primarily handle containerized and break-bulk cargoes, whereas the Port of Sacramento handles dry bulk cargo; therefore, little competition exists between bay area ports and the Port of Sacramento. Channel deepening would, however, allow a reduction in the amount of grain that must be moved to the grain terminal at the Port of San Francisco to "top-off" the larger grain vessels that now must sail light-loaded from the Port of Sacramento because channel depths are inadequate (see response to comment by the City and County of San Francisco). If the project is not implemented, NED benefits will be lost due to transportation inefficiencies and the higher cost of moving oceangoing cargoes.

Comment — Pertaining to water quality, ABAG expressed two major concerns: the vulnerability of spoil sites to wind and wave erosion and the possible transportation of this material to environmentally sensitive habitats nearby, and the environmental problems associated with the submerged sill and mercury and lead contamination resulting from dredging activities.

Response — With the exception of the potential Ryer Island disposal site and a portion of the Prospect Island disposal site, dredged material would be placed above sea level and would not be exposed to wave erosion. Dredged material placed at Ryer Island would be partially below sea level but would be protected from wave erosion by the perimeter of the island. Dredged material would be placed at Prospect Island to create wetland habitat. Although the dredged material would be placed at or below sea level, erosion would be minimized since the site would not be exposed to currents or long fetches. Nearly all the disposal areas would be susceptable to wind erosion. The use of vegetative cover to control wind erosion as recommended by ABAG would be considered during advanced studies. Up to 156 acres of the disposal areas would be seeded to provide permanent upland habitat.

Refer to the comments of the Resources Agency of California for response to the environmental impact of the submerged sill. Possible mercury and lead contamination resulting from dredging activities are addressed in Appendix 1 Section E, the EIS, and Appendix 6.

Responses to ABAG comments on the EIS appear in Appendix 6.

YOLO COUNTY

By letter dated 6 November 1979, the Yolo County Planning Department indicated the feasibility report and EIS adequately responded to issues directly affecting Yolo County. The following comments were provided.

Comment — The statement in Appendix 1 Section D indicating that no industrialization is anticipated on the east side of the channel below channel mile 37 should indicate that in Yolo County, no industrialization is anticipated on the west side south of the existing industrially zoned property.

Response — Appendix 1 Section D was revised in accordance with the above comment.

Comment — Disposal of dredged material on sites indicated in Appendix 1 Section D for the alternative depths would result in significant impacts on prime farmlands. What will be the new use of DMD areas not used for recreation or wetland habitat?

Response — All disposal sites required for the selected plan have been used in the past either for the original construction of the channel or for maintenance dredging. Those sites not used for recreation, upland, or wetland habitat mitigation facilities would return to their former use following deposition of dredged material.

CALIFORNIA WATERFOWL ASSOCIATION

By letter dated 14 February 1980, the California Waterfowl Association provided the following comments.

Comment — Page 10, last full paragraph — the specific basis for the projected increase in rice tonnage exported needs to be explained.

Response — The basis for the projected increases in rice exports is presented in Appendix 1 Section B.

Comment — Page 12, first paragraph — clarification would be desirable as to whether the projected increase in shipment tonnage is all at the Port of Sacramento.

Response — These projected increases in shipments would be handled both at the Port of Sacramento and by new industries that are expected to locate along the upper portion of the channel in the future (if the channel is deepened).

Comment — Page 48 — the table presenting the Estimated Average Annual Navigation Benefits should include the tonnage estimate on which the dollar benefits are based.

Response — The tonnage estimates used in computing navigation benefits are presented in Appendix 1 Section B.

Comment — Appendix 1, page D-38, Section 67 — the current habitat at the disposal sites should be described.

Response — Existing habitat at disposal sites is indicated in Table B-3 of Appendix 1 Section B.

Comment — Appendix 1, page D-38, Section 68 — the narrative should make it clear whether or not the cumulative effects of the Stockton and Sacramento Channels are being discussed.

Response — Paragraph 68 refers the reader to Appendix 5 for the results of model tests of salinity intrusion. Model test results indicated in Appendix 5 for deepening the Sacramento Channel are based on test conditions which consider the Stockton Channel to be deepened to 35 feet. In other words, the cumulative impact of deepening both channels is indicated.

Comment — Appendix 1, page E-15, Section 26 — the apparent conflict between the language of this section and various other places where the draft claims that there would be no increase in Suisun Marsh salinities needs to be resolved.

Response — Appendix 1 Section E, and the EIS were revised to indicate the proposed plan would have no effect on salinity levels in Suisun Marsh and hence would not adversely affect the seed production of waterfowl plants.

Comment — The effect (or lack of it) on the high tide salinity levels in the Suisun Marsh needs to be discussed. In particular, the report should describe the project effects (if any) on the quality of the water at Collinsville which would be used to implement the U.S. Water and Power Resource Service's Suisun Marsh water supply plan.

Response — The following tabulation was developed from salinity data observed at Bay-Delta Model Station 21 which is located on the Sacramento River near Collinsville. These test results are based on 1977 hydrology or critically dry hydrologic conditions. As can be determined from these results, the proposed plan would have no effect on high tide salinity levels in the vicinity of Collinsville.

STATION 21 SACRAMENTO RIVER AT COLLINSVILLE[1]

Month	Higher-High Water Base	Higher-High Water Plan	Lower-Low Water Base	Lower-Low Water Plan
Jan	6.60	6.40	4.47	2.79
Feb	6.69	6.39	4.95	2.68
Mar	6.56	6.46	4.17	2.76
Apr	7.01	6.81	4.75	3.20
May	7.64	7.44	5.64	3.83
Jun	7.93	7.80	5.88	4.47
Jul	7.99	7.76	5.87	4.18
Aug	8.32	8.08	6.51	4.30
Sep	8.24	8.03	5.41	4.79
Oct	8.08	7.74	5.96	4.33
Nov	7.60	7.46	5.56	3.70
Dec	5.79	6.01	3.39	2.46

[1]Values indicated are in units of parts per thousand and represent the average of surface and bottom salinity measurements.

Review By Other Federal Agencies

Comments and letters received from other Federal agencies expressing views and recommendations on the draft feasibility report and EIS are contained in Appendix 6 and are summarized below.

DEPARTMENT OF AGRICULTURE, SOIL CONSERVATION SERVICE (SCS)

Comment — By letter dated 20 November 1979, SCS expressed concern about the loss of agricultural production and possible adverse impact on prime agricultural land. SCS recommended that the soil class and land capability of the DMD areas be discussed. SCS indicated that the creation of 45 acres of wetland habitat on Prospect Island would compensate for the removal of native vegetation elsewhere.

Response — All the DMD areas required for the selected plan of improvement have been used in the past, either for original construction of the channel or for subsequent maintenance dredging activities. Consequently, the overburden soils at these sites consist of sands and silts. As indicated in the EIS, agricultural lands on which dredged material is disposed would be out of production for 2 to 3 years. The only potential permanent loss of agricultural lands would be those areas that would be designated for the development of upland habitat, currently estimated at a maximum of 156 acres on yet-to-be designated areas, the 45 acre parcel designated for wetland habitat development, and the 30 acre recreation area near Rio Vista.

DEPARTMENT OF THE INTERIOR, BUREAU OF MINES

Comment — By letter dated 26 November 1979, the Bureau of Mines indicated the channel deepening would have no impact on local or regional mineral resources. The Bureau of Mines recommended that the mineral compensation of the sand fraction of the dredged materials be determined.

Response — An analysis of bottom sediments in the channel reach from Avon to the mouth of New York Slough was made in conjunction with post-authorization studies of the Stockton Ship Channel. The results of that analysis are indicated in Appendix 1 Section E. The results of the bottom sediment sampling program conducted between New York Slough and the Port of Sacramento for the current investigation are also included in Appendix 1 Section E.

Comment — The Bureau of Mines also indicated that recreation facilities sited on dredged material disposal areas could be affected by seismic activity.

Response — As indicated in the main report and Appendix 1 Section E, the design and siting of recreation facilities will consider the potential liquefaction of the dredged materials.

UNITED STATES NAVAL WEAPONS STATION, CONCORD, CALIFORNIA

Comment — By letter dated 11 December 1979, the Naval Weapons Station stated that two dredged material disposal sites within the station's boundary were no longer available. It was also indicated that known endangered species of wildlife resident within the station were not addressed in the EIS.

Response — Alternate DMD sites at the Naval Weapons Station have been located as indicated on Sheet 1 of Plate 2. The salt marsh harvest mouse which is resident within the station is included in the list of rare and endangered species found in the study area as indicated in Appendix 1 Section B.

NATIONAL OCEAN SURVEY (NOS)

Comment — By letter dated 30 November 1979, the National Ocean Survey indicated that tidal hydraulic considerations were accurate and adequate. NOS indicated geodetic control survey monuments may be located in the proposed project area and requested advance notice before the commencement of any activity that would disturb or destroy these monuments.

Response — Coordination will be established with NOS to prevent the disturbance or destruction of geodetic control monuments.

NATIONAL MARINE FISHERIES SERVICE (NMFS)

Comment — By letter dated 10 December 1979, the National Marine Fisheries Service indicated that deepening and widening the existing channel would jeopardize fishery resources of San Francisco Bay and its tributaries and could adversely affect programs aimed at preserving and restoring such resources. NMFS recommended that project construction be deferred until the evaluation of the effects of deepening the Stockton Ship Channel could be completed. NMFS also recommended that the cumulative impact of deepening the Stockton and Sacramento Channels on the San Francisco Bay and tributary fishery resources be evaluated.

Response — The evaluation of the effects of deepening the Avon to Stockton portion of the San Francisco Bay to Stockton project has been completed. The results of advanced studies of the Avon to Stockton channel were presented at the public meeting held in Stockton in March 1980. A General Design Memorandum and EIS is scheduled to be released later in 1980. Construction of the Sacramento River Deep Water Ship Channel is not imminent. Congressional authorization of construction and detailed post-authorization studies would have to be accomplished before construction could be initiated. Post-authorization studies of the Sacramento Channel would include the deepened Stockton Channel as a preproject condition. An additional response to the cumulative impact issue is provided in Appendix 6.

Specific comments on the report were provided as follows:

Comment — Deepening and widening the channel would physically alter important fish habitat.

Response — Dredging would temporarily alter some habitat; however, studies indicate benthic habitat is quickly reestablished following dredging. Furthermore, in the case of benthic habitat, the widening of the man-made portion of the channel would actually create additional habitat.

Comment — The adverse impacts of the proposed project would be increased if the current practice of aquatic disposal of spoil material is continued in Suisun Bay.

Response — Aquatic disposal of dredged material in the New York Slough to Sacramento reach is not anticipated. All dredged material will be placed at designated DMD areas. The dredged material is confined at these areas by dikes.

Comment — Habitat alterations would occur from changes in salinity distributions.

Response — Model studies indicate there would be no measurable change in salinity distributions as a result of deepening and widening the channel.

Comment — Reduction of Delta outflow, possible discharge of agricultural drain waters from the San Joaquin Valley into Suisun Bay, and the reclamation of waste water in the San Francisco Bay Area must be considered in speculating about changes in salinity.

Response — None of these actions are associated with the Sacramento River Deep Water Ship Channel. Those who propose such actions would have to identify the impacts of the Delta and provide necessary mitigation.

Comment — The project would encourage industrial development in the Collinsville-Montezuma Hills area. This development would alter aquatic habitat and result in increased demand for high quality domestic water. Waste products from such development would increase the pollution burden of the area.

Response — It is true that the project could inspire industrialization at the Collinsville-Montezuma Hills area. In fact, the project is partially justified on the basis of induced commodity movements at this location. However, since this area has been zoned for industrialization, development would occur with or without the channel improvements. The impacts of the zoning were addressed in the May 1977 Collinsville-Montezuma Hills Preliminary Plan and Program Environmental Impacts. Furthermore, recent experience indicates the State of California will closely scrutinize proposals for industrial development along the channel.

Comment — Project implementation would increase the risk of major accidents.

Response — This comment is addressed earlier in the response to a similar comment made by the City and County of San Francisco.

DEPARTMENT OF THE INTERIOR (DOI)

Comment — By letter dated 4 January 1980, the Department of the Interior stated that their principal concern was related to the effect of channel deepening on salinity distribution in the Sacramento-San Joaquin Delta. DOI estimated corrective flows of 300 to 500 cfs would be required to return salinity levels to preproject conditions. The DOI agreed that a submerged sill or other mitigative device was acceptable if project authorization required a complete study of the effects of such a measure on fish and wildlife resources as well as salinity distribution.

Response — Subsequent to issuance of the draft feasibility report, the Corps of Engineers Waterways Experiment Station (WES) further evaluated the results of salinity tests conducted in the Bay-Delta Model. WES addressed the following matters: adequacy of model verification; the repeatability of both dynamic and steady state salinity tests; and the accuracy with which the model can be expected to predict changes in prototype salinities for physical changes in channel dimensions of the type proposed for the Stockton and Sacramento Ship Channels. Appendix 5 has been amended to include the results of the recent WES analysis. WES concluded that the capability of the model to predict changes effected by changes in channel widths or depths is well within the reliability of prototype measurements that might be made during a post construction study. In other words, the predictive capability of the model is essentially equal to the repeatability of the model and is much more reliable than any information that could be developed by studies in the prototype. The Water and Power Resources Service will be invited to participate in post-authorization model studies of salinity intrusion. Future studies would also address the effects of a sill or other mitigative device, if needed, on fish and wildlife resources.

Comment — DOI requested that project authorization should require specifically that, in the event installation of a submerged sill (or functionally equivalent device) is contemplated subsequent to channel deepening, the Corps of Engineers shall: (1) fund a special study by the Fish and Wildlife Service to ascertain the probable impacts of a submerged sill on fish and wildlife resources; (2) give full and equal consideration to the recommendations of the Service, based on such study, in arriving at a decision concerning the advisability of constructing a submerged sill; and (3) prepare a supplemental environmental impact statement solely addressing the construction of the sill and incorporating all information obtained in the studies conducted under (1) above. The supplemental EIS shall receive full public review as specified under provisions of the National Environmental Policy Act and the regulations promulgated by the Council on Environmental Quality.

Response — Project authorizations are normally general in scope; however, the USFWS would be consulted with respect to post-authorization studies of the submerged sill or alternative devices, if needed, that will be conducted by the Corps of Engineers in cooperation with the California Department of Water Resources and other concerned State and Federal agencies. A separate EIS addressing construction of the sill is not warranted since the impacts of that or any other measure required to control salinity intrusion would be fully discussed in the EIS prepared during post-authorization studies.

Comment — The project does not compensate for losses of upland habitat that will occur at dredged material disposal areas.

Response — The main report and Appendix 1 Section E have been modified to provide for the development of a maximum of 156 acres of permanent upland habitat.

Comment — By letter dated 31 October 1979, the Interagency Archeological Service (IAS) requested further information on the impact of the proposed project on cultural resources.

Response — The requested information was furnished by SPKED-D letter dated 11 December 1979.

Comment — The report and EIS does not contain enough substantive information to determine the impacts on cultural resources in the study area. The areas surveyed for cultural resources and intensity of the investigation should be covered.

Response — The main report, Appendix 1 Section E, and the EIS have been revised to include the requested information.

Comment — Compliance with Title 36 CFR 800 should be documented.

Response — Documentation has been presented in the main report and Appendix 1 Section E.

Comment — Chemical and biological characteristics of channel sediments should be indicated.

Response — The composition of bottom sediments have been included in Appendix 1 Section E.

Comment — A historical archeologist should evaluate any areas of Rio Vista or Collinsville that may be affected by the proposed project.

Response — The main report was amended to indicate the towns of Rio Vista and Collinsville would not be impacted by the project.

Comment — The quantity of additional Delta outflow required to offset increases salinity intrusion should be indicated.

Response — There would be no measurable salinity intrusion caused by the selected plan. Information was provided in the main report and Appendix 1 Section D to indicate increasing Delta outflow would be economically less viable and much more impractical that other mitigative measures.

Comment — Eliminate the words "fish and" from the title paragraph "Potential Fish and Wildlife Enhancement" in the main report since it is not clear that disposal of dredged materials on lands will enhance fishery resources.

Response — Main report was modified to indicate the disposal of dredged materials would create nurseries and food production areas for fish.

Comment — A qualified archeologist should be retained to intensively survey all of the project area and conduct subsurface testing in areas where the ground surface is disturbed.

Response — The main report, Appendix 1 Section E, and the EIS were modified to indicate that an intensive survey of all cultural resources would be conducted during advanced engineering and design studies.

Comment — DOI indicated that protecting the prehistoric site located near the turning basin with dredged material may not be the most effective means of mitigating adverse impacts.

Response — The main report was revised to indicate that the significance of the historic site would be evaluated during advanced studies under the National Register of Historic Places criteria. Mitigation and/or preservation would be coordinated with appropriate parties in with 36 CFR 800, Advisory Council on Historic Preservation procedures and 33 CFR 805 regulations.

Comment — What would the submerged sill do to the salinity caused seasonal shift of marine benthic organisms from San Pablo Bay to Suisun Bay and back again?

Response — Further studies of the impact of the sill or other mitigative devices which may be required on benthic organism movement will be further addressed during advanced studies. Studies to date indicate construction of the sill would not affect biological parameters in the study area.

Comment — The average annual Delta outflow of 16 million acre-feet appears to be in error.

Response — The September 1979 edition of the Sacramento-San Joaquin Delta Summary of Facts developed by the State Water Project Agencies indicates that Delta outflow index ranged from 2.4 to 32.1 million acre-feet per year and averaged 16.7 million acre-feet during the period 1969 to 1978. This data has been included in Appendix 1 Section B.

Comment — The mean 95 percent confidence limit for average monthly salinities for the Chipps Island Station (11A) is 0.41 parts per thousand (ppt) total dissolved solids. DOI's experience with the Bay-Delta Model indicates this salinity variation is equal to a restoration of 200 to 300 cfs. DOI, therefore, concluded the "noise" in the model could mask a significant change between base and project model tests.

Response — DOI's concern that the Bay-Delta Model cannot detect small changes in salinity which may require significant restoration flows to maintain Delta salinity levels is similar to that of DWR. To resolve this issue, the Corps of Engineers will conduct additional model studies during post-authorization studies in cooperation with DWR and other State and Federal agencies. The WPRS will be invited to review the proposed testing program and present any concerns they may have with respect to observing hydraulic and salinity variations.

Comment — Base and Plan steady state tests are not comparable since model equilibrium was not established for each condition.

Response — It is recognized that if the model failed to reach stability during the steady state tests, significant variability in salinity measurements which may not be related to channel improvements may be observed. In response to this comment, the Corps of Engineers would agree to conduct additional model tests during advanced engineering and design studies to further evaluate the salinity incursion effects of channel deepening. The procedures and aspects of the testing would be accomplished in consultation with the Bay-Delta Model Technical and Advisory Committees. It should be noted that the Bay-Delta Model Advisory Committee, based on tests conducted to date, stated " . . . model test results do not predict changes due to channel deepening."

Comment — The proposed salinity monitoring network would probably not have the sensitivity to distinguish the impact of the project if the impacts cannot be detected by the model.

Response — It is agreed that the sensitivity of the model would exceed that of the proposed prototype monitoring network. The wide variation of salinities in the Delta under present and future conditions limits the probability of determining from field data any changes in salinities attributable to the proposed plan. For these reasons the determination of the need to provide a mitigative measure for salinity incursion would be based on the results of future model tests as well as pre- and post-construction prototype monitoring studies. The monitoring program would serve to confirm model results within the sensitivity of those instruments. Furthermore, the monitoring program would provide high quality salinity data for eastern Delta channels which is not currently available.

Comment — The use of model results on other than a comparative basis between Plan and Base conditions is questionable.

Response — The assertion that the increase in salinity at Cache Slough would not exceed drinking water standards, which was based on an absolute rather than comparative interpretation of model results, was deleted from Appendix 5 of this report.

Comment — The discussion on threatened, rare, and endangered plants and animals indicates that preliminary information on such species has been assembled by the Corps of Engineers. Compliance with the Endangered Species Act requires that the District Engineer officially request the Regional Director of the Fish and Wildlife Service, Portland, Oregon, for a list of endangered and threatened species, or species that have been proposed for listing, that may be present in the area affected by the proposed action.

Response — Amendments to the Endangered Species Act of 1973 were enacted into law in 1978 and 1979 during final stages of this planning study, and implementing regulations by the lead agencies have not been promulgated. A list of endangered and threatened species was developed by the Corps of Engineers and coordinated with the Office of the Secretary of the Interior. An assessment of the impacts on known endangered species in the project area was conducted by the Corps of Engineers with the finding that no significant impacts are expected. No adverse comments on the impact finding were received during coordination of the report and draft Environmental Impact Statement. Consultation will be initiated after authorization.

Additional responses to comments made on the EIS are included in Appendix 6.

DEPARTMENT OF THE INTERIOR, GEOLOGICAL SURVEY

By letter dated 1 February 1980, the Department of Interior provided additional comments from the Geological Survey. These comments generally concerned the ecological consequences associated with channel deepening and the impact of the submerged sill on hydraulic conditions. Responses to comments on the EIS are located in Appendix 6. Comments on the main report are indicated below.

Comment — How will the submerged sill affect gravitational circulation in Suisun Bay? What happens to transport properties other than salinity intrusion? Since there is a great difference in mixing characteristics between the Bay-Delta Model, stratified flumes, and the Bay system, how can the effects of deepening be properly evaluated? While the sill can control salinity intrusion, how can one be assured that costly mitigation for undesirable side effects will not be required?

Response — The detailed concerns of the Geological Survey will be answered during advanced engineering and design studies. The Corps of Engineers typically relies on expert consultants to study highly technical problems such as those identified above. Current model studies have been guided by the Bay-Delta Model Advisory Committee which is composed of acknowledged experts in estaurine studies and modeling techniques. Advanced engineering and design studies will be conducted by the Corps of Engineers in cooperation with DWR. Guidance of model studies will be provided by the Bay-Delta Model Advisory Committee, the Bay-Delta Model Technical Committee, DWR, WPRS, and USFWS.

In response to the Geological Survey's concern about a valid evaluation of the effects of deepening the channel, the Bay-Delta Model Advisory Committee has indicated that the Bay-Delta Model is the best scientific tool available to make such a determination. DWR concurs with the Advisory Committee's conclusion.

A submerged sill would only be implemented if it is determined to be needed for mitigation, and is a feasible mitigative measure from the standpoints of water quality effects, economic considerations, and environmental factors. The Corps of Engineers will recommend implementation of another form of mitigation to Congress prior to deepening of the Sacramento Channel if the submerged sill proves unacceptable.

Comment — What are the explicit criteria that will be used to determine whether a mitigation measure would be necessary?

Response — Additional model tests would be conducted during advanced planning to reevaluate the salinity incursion effects of channel deepening. The procedures and other aspects of the testing will be conducted in accordance with recommendations of the Bay-Delta Model Advisory and Technical Committees. If these tests confirm that one or both projects would measurably increase the rate of salinity incursion, a mitigative measure would be implemented.

The implementation of a mitigative measure would also be predicated on the results of pre- and post-construction monitoring of salinity distributions. If the recommended salinity monitoring network indicates an increase in Delta salinity levels as a result of channel deepening, in addition to model test results, mitigation would be provided.

Comment — Since the submerged sill is largely unproved on a scientific basis when applied to tidal reaches, what technical criterion would be used to establish the degree of mitigation necessary and the type of measure to use?

Response — If mitigation is indeed required, the degree and type of mitigation would be determined by post authorization hydraulic model studies. The Corps of Engineers with DWR concurrence believes the Bay-Delta Model provides the best available scientific basis for studying all the aspects of the salinity intrusion issue. Undistorted hydraulic flume tests would supplement Bay-Delta Model studies and test different configurations of the submerged sill using saline stratified flows. It is also believed that if mitigation for salinity incursion is indeed needed, other type devices may suffice to reduce salinity without the potential adverse side effects that some believe will accompany a submerged barrier. It is contemplated that additional tests to address this aspect will be conducted.

Comment — Because of the uncertainties in the models, the use of 1968 and 1977 hydrologic conditions as prototype conditions, the apparent failure to account for increased water export, and the failure to consider possible discharges of agricultural waste water into Suisun Bay, NMFS recommended that additional studies be conducted prior to drawing conclusions on potential project effects.

Response — Subsequent to Congressional authorization, additional studies would be conducted as a part of the normal project planning effort. Refer to Recommendations portion in this report for information on the scope of post-authorization model studies.

Detailed responses to comments made on the EIS are addressed in Appendix 6.

ENVIRONMENTAL PROTECTION AGENCY (EPA)

By letter dated 7 January 1980, the EPA voiced the following concerns.

Comment — The cumulative impacts of deepening the Stockton and Sacramento Channels on salinity incursion should be addressed.

Response — Refer to response provided for a similar comment by the Resources Agency of California.

Comment — Would the submerged sill accommodate the increased salinity attributable to deepening both channels?

Response — Model tests indicate there would be no increase in salinity as a result of deepening both channels. The model tests also show that the submerged sill would reduce salinity levels below preproject conditions in many locations in Suisun Bay and the Delta. Model tests of salinity incursion and the need for mitigation will be reevaluated during post-authorization studies that will be conducted in cooperation with DWR and other concerned State and Federal agencies.

Comment — How much additional Delta outflow would be required to maintain Delta water quality standards with both channels deepened?

Response — As discussed above, model tests indicate there would be no increase in salinity as a result of deepening both channels. Therefore, no additional Delta outflow would be required. The impracticality of increasing Delta outflow to maintain Delta water quality standards is discussed in the main report and Appendix 1 Section D.

Comment — How would the deepened ship channels with the proposed cross Delta facility affect water quality in the Bay and the Delta?

Response — The proposed Peripheral Canal was included to a limited extent in the model testing program of the Stockton and Sacramento Channels, which is described in Appendix 5. Those additional tests of the Peripheral Canal, which were conducted at the request of DWR, basically showed that the effects of the Canal on water quality would not change with construction of the Stockton and Sacramento Ship Channels. We did not do extensive testing of the proposed Peripheral Canal since it is viewed as a concept at this time, and is not considered a pre-project condition to navigation channel deepening.

Comment — EPA recommended that the California Water Resources Control Board be included as one of the coordinating agencies in determining the locations of salinity monitoring stations to be included in the proposed monitoring network.

Response — The main report and Appendix 1 Section E have been amended to include this recommendation.

Comment — The current amount of salt water ballast discharge in the turning basin, estimates of future discharge, and average flow rate in the area should be provided.

Response — Appendix 1 Section B was amended to discuss present and anticipated ballast discharge. The entire manmade reach of the channel is in slack water and no sustained flows are maintained in the turning basin. Fresh water is occasionally introduced into the channel from the Sacramento River via operation of the shallow draft navigation lock which connects the upper terminus of the ship channel to the Sacramento River.

Comments on the EIS are addressed in Appendix 6.

DEPARTMENT OF THE INTERIOR; HERITAGE, CONSERVATION, AND RECREATION SERVICE (HCRS)

Comment — By letter dated 31 October 1979, HCRS requested copies of the cultural resources reconnaissance report and other cultural resources studies relevant to the project.

Response — The requested information was sent to HCRS by letter dated 11 December 1979.

Fish and Wildlife Service recommendations as contained in their detailed report prepared under the authority and in accordance with the provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. et seq.) and forwarded by letter dated 20 March 1980 have been fully considered and adopted for this project as discussed in Appendix 2.

Summary

In response to House of Representatives Public Works Committee Resolutions dated 10 July 1968 and 11 December 1969, the Sacramento District Corps of Engineers has investigated the need: (1) to deepen the Sacramento River Deep Water Channel to 40 feet below mean lower low water or such lesser depths as may be practical; (2) to construct a vessel turning basin at mile 31.9; and (3) to alleviate the shoaling problem at Junction Point, mile 14.1. In addition, the District Engineer has evaluated the need for water project-related recreation (pursuant to Public Law 89-72) and the opportunity for wetland enhancement (pursuant to Section 150 of Public Law 94-587) in the area along the deep water ship channel.

The need for more efficient dry-bulk commodity transport is evidenced by the current light-loading practices at the Port of Sacramento with the associated inefficient practice of topping-off light-loaded vessels at other west coast ports; the trend in the maritime industry to construct an increasing percentage of the dry-bulk carriers with design drafts exceeding existing depths in the Sacramento River Deep Water Ship Channel; and the potential for increased industrialization along the ship channel. Studies by the State of California affirm the need for more water-related recreation facilities on the Sacramento-San Joaquin Delta, which includes a major portion of the ship channel. The lack of potential user or users of a turning basin at mile 31.9 indicates there is no need for construction of a turning basin at this time. Also, there is no more effective solution available to control or reduce sediment deposition at Junction Point than the current practice of periodic maintenance dredging.

The disposal of dredged material on lands which are below mean sea level elevation provides the opportunity for enhancement of the fish and wildlife resources of the study area by providing wetland habitat for wildlife species and by creating nurseries and food production areas for fish. The Fish and Wildlife Service has recommended that wetlands be developed on Donlon Island in conjunction with the authorized deepening of the Stockton Ship Channel. If the Stockton Ship Channel is not deepened, Donlon Island could be acquired and converted to wetland habitat as a part of the Sacramento River Deep Water Ship Channel project. The potential for this development would be studied in more detail during advanced engineering and design studies.

Coordination with the Federal and State fish and wildlife agencies to date has not revealed a suggested site or sites on which additional enhancement wetlands should be established through the use of dredged materials. Establishment of such wetlands at Federal expense (up to $400,000—and benefits are deemed to be at least equal to costs) was authorized by Section 150 of the 1976 Water Resources Development Act. It is understood that recently the fish and wildlife agencies and interested organizations have placed a high priority on providing additional wetlands in the Sacramento-San Joaquin Delta area to benefit waterfowl and other fish and wildlife resources. If a project is authorized by Congress, additional investigation and coordination will be undertaken with the interested agencies and organizations to determine if there are suitable locations where dredged material should be beneficially utilized to establish additional wetlands to further the program initiated by Congress in 1976. If such locations are found, the Federal cost of the project could be increased up to $400,000.

In consideration of the remaining problems and needs, the Sacramento District Engineer investigated four alternative solutions: (1) increased use of LASH barges, (2) increased use of intermodal transportation, (3) deepening the ship channel, and (4) do nothing. Even though the alternative for deepening the channel has the greatest potential for adverse environmental impact, it is the only alternative that can make positive contributions to the National Economic Development, Environmental Quality, Regional Development, and Social Well-Being accounts. The primary adverse effect associated with channel deepening without mitigation features is loss of some existing marshland along the channel and upland habitat at dredged material disposal areas. It has been determined that these adverse effects can be ameliorated — by development of new marsh areas and upland habitat.

Model tests indicate that even though a submerged rock sill in Carquinez Strait at 50 feet below mean lower low water (Corps of Engineers Datum) would not significantly disturb the estuarine environment, it might not completely mitigate increased salinity intrusion for channel depths exceeding 35 feet, and since the existing channel oceanward from the Sacramento River Deep Water Ship Channel is limited to 35 feet in some reaches and will probably not be deepened in the foreseeable future, 35 feet is the current maximum practicable depth for the Sacramento River Deep Water Ship Channel. Accordingly, the selected plan consists of deepening the Sacramento River Deep Water Ship Channel from 30 to 35 feet between New York Slough (Pittsburg) and the Port of Sacramento and deepening the Suisun Bay Channel to 35 feet if it is not previously deepened by the authorized San Francisco Bay to Stockton project; widening the channel as necessary for safe navigation; and constructing recreation facilities at a dredged material disposal site south of Rio Vista. The existing water quality monitoring network in the Delta would be modified to include high quality salinity monitoring stations to measure the effects of channel deepening on Delta salinity levels. Mitigation measures would consist of the development of 45 acres of marshland at Prospect Island and up to 156 acres of upland habitat at dredged material disposal areas along the channel. A submerged sill would be constructed at Dillon Point in Carquinez Strait or an alternative mitigative measure would be implemented if the water quality monitoring network indicates an unacceptable increase in salinity levels in the Delta after the channels are deepened. The installation of a submerged sill or other acceptable alternative measure would also be predicated on the results of model tests conducted during advanced engineering and design studies. If the Stockton Ship Channel deepening to 35 feet is constructed prior to the proposed action, the selected plan would produce annual National Economic Development benefits of $15,202,000 as compared to annual economic costs of $6,154,000, yielding net economic benefits of $9,048,000 and a benefit-cost ratio of 2.5 to 1. If the Stockton Channel deepening is not constructed, the average annual benefits would remain $15,202,000, but the average annual cost would increase to $7,063,000, yielding net economic benefits of $8,139,000 and a benefit-cost ratio of 2.2 to 1. These benefits would accrue to the economy in the form of savings to shippers due to reduced light-loading and topping-off practices; increased use of larger, more efficient vessels; reduction of vessel delays due to tides; and movement of project induced tonnages. Benefits from increased recreation use along the channel and use of unemployed or underemployed workers are also included.

The proposed mitigation measures would ameliorate the potential adverse environmental effects associated with channel deepening. In general, the selected plan would improve the quality of life and development of the region through additional job opportunities, a more stable economic base, and improved transportation safety. An evaluation of the selected plan pursuant to the Clean Water Act of

1977, as amended (33 USC 1344), indicates that there would be no significant adverse environmental effect due to disposal of dredged or fill material in navigable waters of the United States. A summary of this evaluation is contained in the environmental statement, and a Section 404 Evaluation Report is included in this report as Appendix 4.

Pending authorization and funding for construction, advanced engineering and design studies could be initiated by the Corps of Engineers. Engineering and construction costs for the navigation features would be a Federal responsibility, and the costs of lands, easements, rights-of-way, relocations and retention dikes for dredged material disposal sites would be the responsibility of the non-Federal sponsor. The Port of Sacramento had indicated it will accept these responsibilities. Separable first costs for recreation will be shared 50 percent Federal and 50 percent non-Federal with the recreation sponsor. Operation and maintenance of recreation facilities would be a non-Federal responsibility. Separable first costs for the fish and wildlife mitigation facilities will be shared 80 percent Federal and 20 percent non-Federal with the navigation sponsor. This cost-sharing percentage is determined by including both project navigation first costs and the capitalized present value of the operation and maintenance cost of navigation features. Federal and non-Federal first costs for navigation improvements, exclusive of fish and wildlife mitigation features, are $59,000,000 and $12,050,000 respectively. There is no increased maintenance attributable to the navigation improvements, hence the capitalized present value of the operation and maintenance cost of navigation facilities is equal to zero. The Federal portion accounts for 80 percent of the total cost of navigation improvements exclusive of mitigation features. The non-Federal portion accounts for the remaining 20 percent. In accordance with current policy, mitigation costs of $700,000 shared in the same proportion as the project navigation features would therefore be $560,000 (80 percent) Federal and $140,000 (20 percent) non-Federal. The cost of operating and maintaining the fish and wildlife mitigation facilities has been determined to be negligible.

The non-Federal navigation interest has also indicated a willingness to provide a 5 percent cash share of the total first cost of construction of the project as required under the President's proposed revised cost-sharing criteria.

Conclusions

The District Engineer, Sacramento District Corps of Engineers, has reviewed and evaluated, in light of the overall public interest, the information contained in the environmental statement, and views of other agencies, organizations, and individuals on environmental and other impacts of the plans for improvement of the Sacramento River Deep Water Ship Channel. In addition, the District Engineer has personally inspected the project area and has participated in meeting with local Government officials, representatives of other agencies and organizations, and other concerned members of the public.

The possible consequences of deepening and widening the Sacramento River Deep Water Ship Channel were studied and evaluated for economic factors, social well-being, engineering considerations, and environmental effects. Specific attention was given to improving navigation access to the Port of Sacramento, providing recreation opportunities, and preventing adverse environmental effects. The District Engineer has also reviewed the combined beneficial and adverse EQ and NED effects of the alternatives studied and finds that these combined positive NED and EQ impacts outweigh the negative impacts for the recommended plan.

In conclusion, it has been found that the action proposed is based on a thorough evaluation of all viable alternatives. The project is in consonance with national policy, existing statutes, and administrative directives. Further, construction of the proposed project is supported by Sacramento, Yolo, and Solano Counties and the Sacramento-Yolo Port District. The environmental statement meets the requirements of the National Environmental Policy Act. The project will assist in promoting a productive economy and improving the quality of life in the region.

Recommendations

It is recommended that the modification to the Sacramento River Deep Water Ship Channel, described as the selected plan in this report, be authorized for Federal construction, with such modifications as in the discretion of the Chief of Engineers may be advisable, at a currently estimated Federal first cost of $56,579,000, provided non-Federal interests:

- Contribute a 5 percent cash share of the total first cost of construction, to be paid concurrently and proportionately with the Federal contractual obligation for project construction;

- Provide without cost to the United States all lands, easements, and rights-of-way required for construction and subsequent maintenance of the project and for aids to navigation, including suitable areas determined by the Chief of Engineers to be required in the general public interest for initial and subsequent disposal of dredged material:

- Provide without cost to the United States all dredged material retention dikes, bulkheads, and embankments necessary for project construction, or the costs of such retaining works, except for additions required solely for development of the recreation area;

- Hold and save the United States free from all claims for damages due to deposition of dredged material, and due to the construction of new levees or reconstruction of existing levees along the Sacramento River Deep Water Ship Channel, including damages to such levees or damages due to the failure of such levees, except damages due to the fault or negligence of the United States or its contractors;

• Hold and save the United States free from damages to wharves, bridge piers and other marine and submarine structures, and agricultural lands, due to initial dredging work and subsequent maintenance dredging, except damages due to the fault or negligence of the United States or its contactors.

• Accomplish without cost to the United States all utility modifications and relocations required for construction of the project works, including new bridges or bridge alterations (except for railroad bridges), and absorb any increased annual maintenance and operation costs that might result from such modifications and relocations;

• Provide, maintain, and operate at local expense adequate public terminal and transfer facilities open to all on equal terms, in accordance with plans approved by the Chief of Engineers; and

• Provide and maintain without cost to the United States all public berthing areas, at depths commensurate with project depths, at all public terminals and wharves to be served by the deepened channels;

• Provide without cost to the United States the lands, easements, rights-of-way or other proprietary interest in lands necessary for the development of the fish and wildlife mitigation facilities;

• Share the cost of fish and wildlife mitigation features including lands in the same ratio as the remaining costs of the navigation features; and

• Hold and save the United States free from all claims for damages due to construction of the fish and wildlife mitigation facilities, except damages due to the fault or negligence of the United States or its contractors;

and further provided that the non-Federal recreation interest will:

• Provide without cost to the United States the lands, easements, rights-of-way or other propriety interest in lands necessary for the development of public recreation facilities;

• Pay, contribute in kind, or repay (which may be through user fees) with interest, a portion of the cost of recreation facilities which when added to the cost of recreation lands would amount to 50 percent of the total first cost of the recreation lands and recreation facilities;

• Maintain and operate at non-Federal expense a public recreation area, including access thereto, at the dredged material disposal area designated by the District Engineer; and

• Hold and save the United States free from all claims for damages due to construction of recreation facilities, except damages due to the fault or negligence of the United States or its contractors.

Paul F. Kavanaugh

PAUL F. KAVANAUGH
Colonel, CE
District Engineer

TABLE I

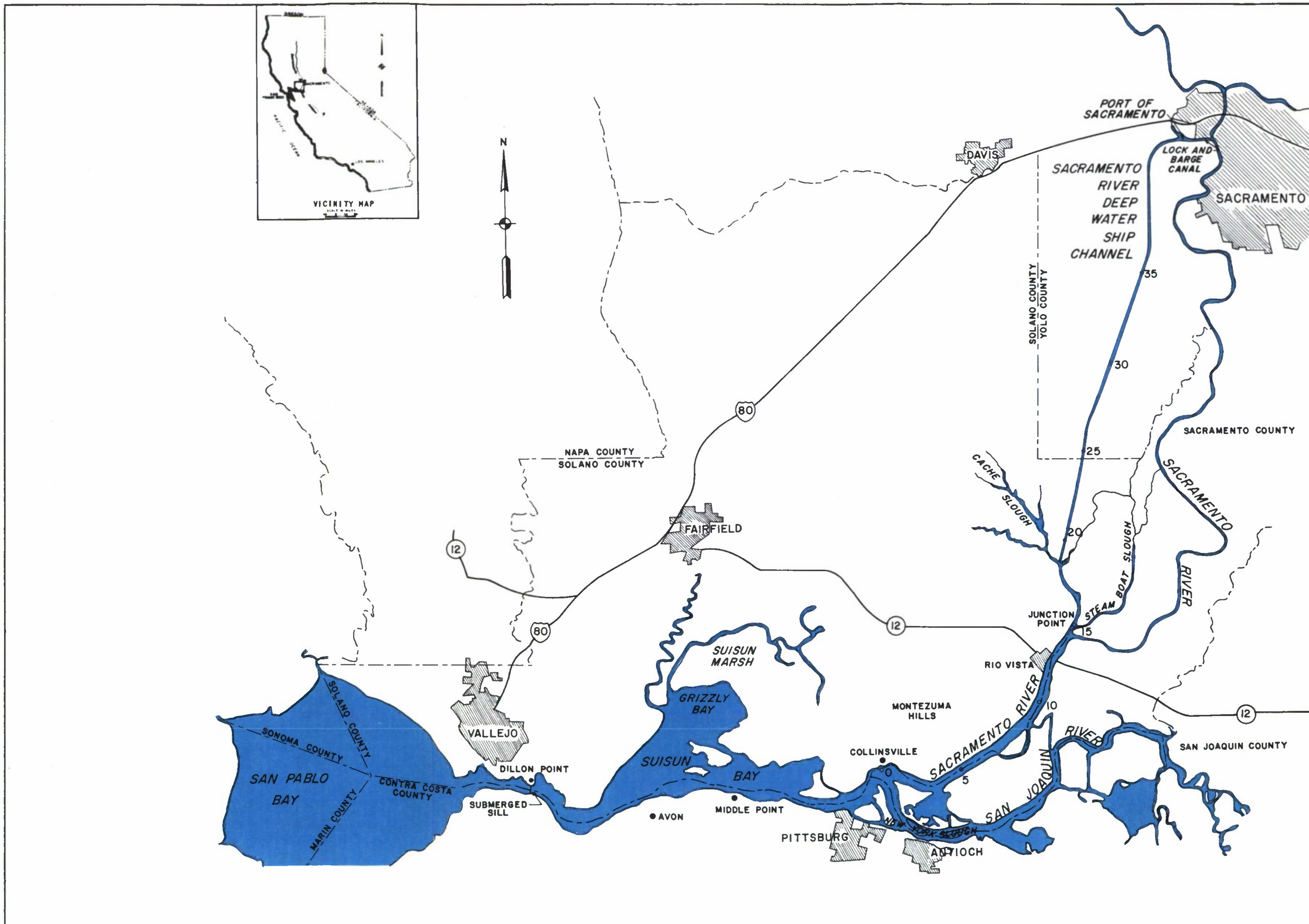
SUMMARY OF ECONOMIC-ENVIRONMENTAL-SOCIAL EFFECTS

	LASH	INTERMODAL TRANSPORTATION	DEEPENING THE CHANNEL 35 FEET			37 FEET			35/40 FEET			40/45 FEET			NO ACTION
ALTERNATIVE DESCRIPTION	Use LASH to handle additional tonnages expected at the Port.	Increase the use of truck and rail traffic to handle additional tonnages at the Port.	Dredge the channel from Sacramento to New York Slough to a depth of 35 feet.			Dredge the channel from Sacramento to Avon with a depth of 37 feet.			Dredge the channel from Sacramento to Collinsville-Montezuma Hills to 35 feet and from Collinsville-Montezuma Hills to Avon to 40 feet.			Dredge the channel from Sacramento to Collinsville-Montezuma Hills to 40 feet and from Collinsville-Montezuma Hills to Avon to 45 feet.			Maintain the existing channel at its current depth.
			SACRAMENTO TO COLLINSVILLE-MONTEZUMA HILLS	COLLINSVILLE-MONTEZUMA HILLS TO NEW YORK SLOUGH	TOTAL	SACRAMENTO TO COLLINSVILLE-MONTEZUMA HILLS	COLLINSVILLE-MONTEZUMA HILLS TO AVON	TOTAL	SACRAMENTO TO COLLINSVILLE-MONTEZUMA HILLS	COLLINSVILLE-MONTEZUMA HILLS TO AVON	TOTAL	SACRAMENTO TO COLLINSVILLE-MONTEZUMA HILLS	COLLINSVILLE-MONTEZUMA HILLS TO AVON	TOTAL	
NATIONAL ECONOMIC DEVELOPMENT (x1,000)	Large Federal subsidies would be required to expand the LASH fleet.	(No Federal Cost)													(No Federal Cost)
Annual Costs		0	4,575*	1,347	5,922	6,943	2,262	9,205	4,575	3,714	8,289	10,222	7,241	17,463	0
Annual Benefits		0	10,452	4,447	14,899	12,226	6,351	18,577	10,452	8,395	18,847	13,843	10,371	24,214	0
Net Annual Benefits		0	5,877	3,100	8,977	5,283	4,089	9,372	5,877	4,681	10,558	3,621	3,130	6,751	0
Benefit/Cost Ratio		0	2.3	3.3	2.5	1.8	2.8	2.0	2.3	2.3	2.3	1.4	1.4	1.4	—
ENVIRONMENTAL QUALITY															
(a) Salinity	No Impact	No Impact	See Appendix 5 for detailed discussion.			See Appendix 5 for detailed discussion.			See Appendix 5 for detailed discussion.			See Appendix 5 for detailed discussion.			None
(b) Vegetation	Insignificant	No Impact	A temporary loss of vegetation will occur at disposal areas. Most of these sites are currently grassy type areas. Approximately 45 acres of vegetation will be permanently lost due to widening the existing channel 50 feet.			Same as 35 except 218 acres of land would be permanently lost due to widening the channel 75 feet.			Same as the 35-foot.			Same as the 37 but 290 acres would be permanently lost due to widening the channel 100 feet.			No Impact
(c) Wildlife	Insignificant	No Impact	Wildlife habitats will be destroyed where dredged material is deposited but should reestablish over a short period of time. 156 acres will be developed to compensate for this loss.			Same as the 35-foot.			Same as the 35-foot.			Same as the 35-foot.			No Impact
(d) Water Quality	Insignificant	May improve existing conditions due to fewer vessels being used in channel.	Minor change.			Same as the 35-foot.			A slight degradation could occur from industrial run-off and increased ship traffic.			Same as 35/40-foot.			As more ships begin using the channel water quality may be degraded.
(e) Air Quality	Slight increase in pollutants.	Greater increase in pollutants than with LASH.	Use of larger, newer and more efficient vessels would slightly improve air quality. However, induced industrialization and cargo movements would eventually result in a slight increase in pollution.			More effect than the 35-foot.			More effect than the 35-foot.			Slightly worse than the 35/40-foot.			As more larger ships service the port, more intermodal lightening equipment would be needed for "topping off" cargoes in the deeper waters of San Francisco Bay.
(f) Dredging	None	None	30.3 million CY of material would be dredged and deposited on 3,500 acres of land.			53 million CY of material would be dredged and deposited on 4,380 acres of land.			48.3 million CY of material would be dredged and deposited on 5,230 acres of land.			97.5 million CY of material would be dredged and deposited on 8,745 acres of land.			None
(g) Fisheries	Insignificant	No Impact	See Appendices 1 and 3 for detailed discussion.			See Appendices 1 and 3 for detailed discussion.			See Appendices 1 and 3 for detailed discussion.			See Appendices 1 and 3 for detailed discussion.			None
(h) Land Use	No Impact	Additional bulk handling or storage facilities would need to be constructed in Bay Area.	45 acres of a DMD site will be converted to a tidal marsh. A 30-acre portion of the sandy beach DMD site south of Rio Vista will be converted to recreation uses. 156 acres of DMD sites will be converted to upland habitat.			Same as the 35-foot.			Same as the 35-foot.			Same as the 35-foot.			None
(1) Marine Organisms	No Impact	No Impact	Benthic communities will be temporarily destroyed in area of dredging. Widening the channel will create additional benthic area over the project life.			A wider channel will destroy more organisms than 35-foot channel.			More effect than the 35-foot.			More effect than the 35/40-foot.			No Impact
REGIONAL DEVELOPMENT															
(a) Land Use	No additional land would be required to increase the use of LASH at the Port of Sacramento.	Some land at the Port area would need to be developed for new facilities.	Some induced development would require that land presently used for agricultural purposes be converted to industrial sites.			Slightly more effect than the 35-foot.			More effect than the 35-foot.			More effect than the 35/40-foot.			No Change

*Cost of salinity mitigation measure (submerged sill) is included only for channel depth of 35 feet which is the depth at which the sill was model tested.

TABLE I
SUMMARY OF ECONOMIC ENVIRONMENTAL SOCIAL EFFECTS
(Continued)

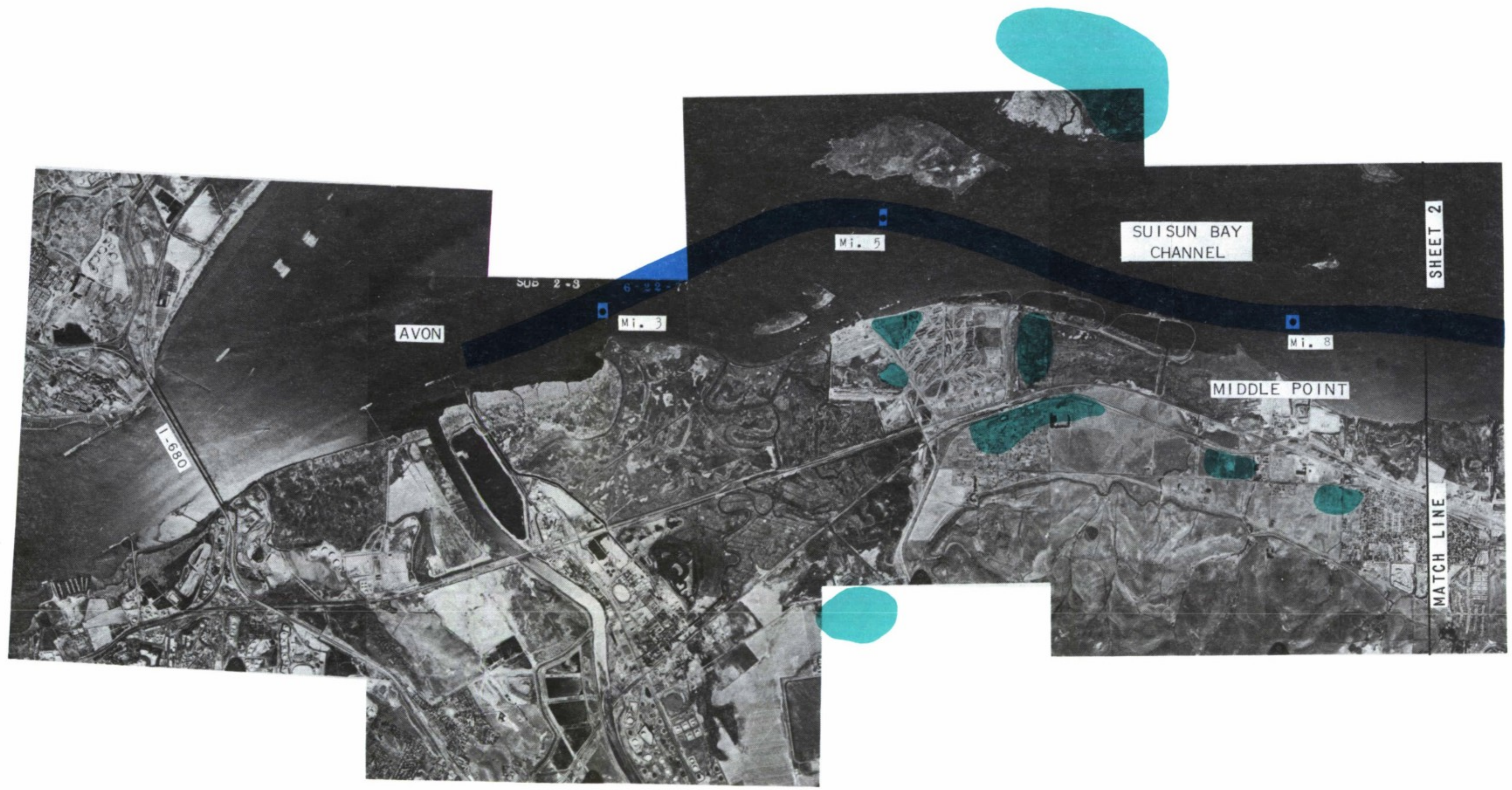
	LASH	INTERMODAL TRANSPORTATION	DEEPENING THE CHANNEL 35 FEET	37 FEET	35/40 FEET	40/45 FEET	NO ACTION
(b) Employment/Labor Force	Some new jobs would probably be generated over a period of time from a conservative amount of new development.	Same as for LASH.	A positive effect would occur. During construction, 130 new construction jobs and 35 support jobs would be generated in the local area. A total of 3,550 new jobs in operation and maintenance of recreation facilities and in port and deepwater dependent industrial development would be generated directly by the deepening (over 50 years). Also, 5,680 new jobs would be generated indirectly by above increase in direct employment.	More effect than 35-foot.	More effect than 35-foot.	More effect than 35/40-foot.	Same as for LASH.
(c) Business, Industrial, Agricultural Activities	A minor increase in industrial activity.	Same as for LASH.	A positive effect would occur. Deepening the channel to 35 feet would produce 600,000 tons of additional cargo shipments (from new industries and port activities), and this increase in shipments would reach almost 5.2 million tons by 2037. Substantial socioeconomic benefits would accrue to the region in the form of additional employment, higher personal incomes, strengthened agricultural and industrial base and increased property values.	More effect than 35-foot.	More effect than 35-foot.	More effect than 35/40-foot.	Some new activity will occur with or without channel improvements.
SOCIAL WELL-BEING							
(a) Noise	No Significant Impact	More trucks and rail traffic will add to the present noise level around the Port.	Some noise will be generated during the dredging operation but will be in relatively remote locations. Moderate increase along the improved channel as land is converted from agricultural to industrial use.	Same as the 35-foot.	Same as the 35-foot.	Same as the 35-foot.	No Impact
(b) Population/Housing	No Significant Impact	No Impact	New jobs will bring new people to the area which will result in increased housing development.	More effect than 35-foot.	More effect than 35-foot.	More effect than 35/40-foot.	No Significant Impact
(c) Esthetics	No Significant Impact	The sight of increased numbers of trucks and facilities may be displeasing to some people.	Disposal areas may be esthetically displeasing until new growth and development take place.	Same as the 35-foot.	Same as the 35-foot.	Same as the 35-foot.	No Impact
(d) Transportation	No Significant Impact	Will add significant traffic to the highways.	Improved transportation efficiency would greatly improve competitive position of Northern California importers/exports.	More effect than 35-foot.	More effect than 35-foot.	More effect than 35/40-foot.	No Improvements
(e) Recreation	No Contribution	No Contribution	Estimated initial use at Sandy Beach Recreation Area is 120,000 recreation days annually.	Same as the 35-foot.	Same as the 35-foot.	Same as the 35-foot.	No Contribution
(f) Health/Safety	More vessels using the channel with the existing dimensions could create a safety problem.	More truck traffic would lower the existing level of safety on the highways.	Safety would increase due to fewer vessels and wider channel. Future increase in traffic may then decrease the level of safety slightly.	Same as the 35-foot.	Same as the 35-foot.	Same as the 35-foot.	An adverse impact would eventually occur due to channel congestion.
(g) Historical/Archeological	No Effect	No Effect	Any discoveries would be reported to the proper agencies.	Same as the 35-foot.	Same as the 35-foot.	Same as the 35-foot.	No Impact



GENERAL MAP
OF STUDY AREA

SACRAMENTO RIVER DEEP WATER
SHIP CHANNEL INVESTIGATION
CALIFORNIA

PLATE I



SACRAMENTO RIVER DEEP WATER SHIP CHANNEL, CALIFORNIA

SELECTED PLAN ALIGNMENT AND PROPOSED DISPOSAL AREAS

SACRAMENTO DISTRICT, CORPS OF ENGINEERS

SEPTEMBER 1978

SCALE IN MILES

1 0 1

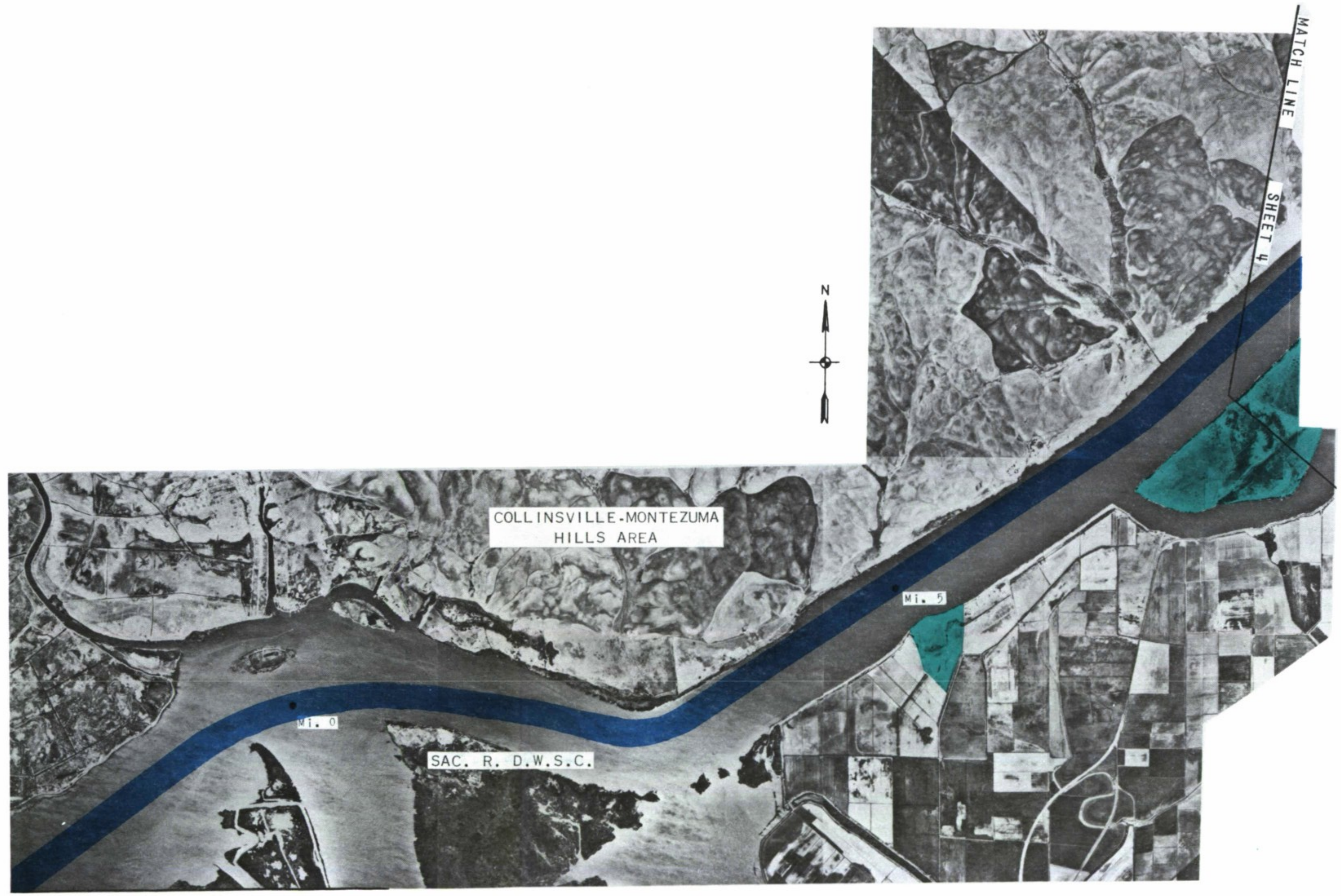
LEGEND

Proposed Disposal Areas

SACRAMENTO RIVER DEEP WATER SHIP
CHANNEL, CALIFORNIA

SELECTED PLAN ALIGNMENT AND
PROPOSED DISPOSAL AREAS

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SEPTEMBER 1978



SACRAMENTO RIVER DEEP WATER SHIP
CHANNEL, CALIFORNIA

SELECTED PLAN ALIGNMENT AND
PROPOSED DISPOSAL AREAS

SACRAMENTO DISTRICT, CORPS OF ENGINEERS

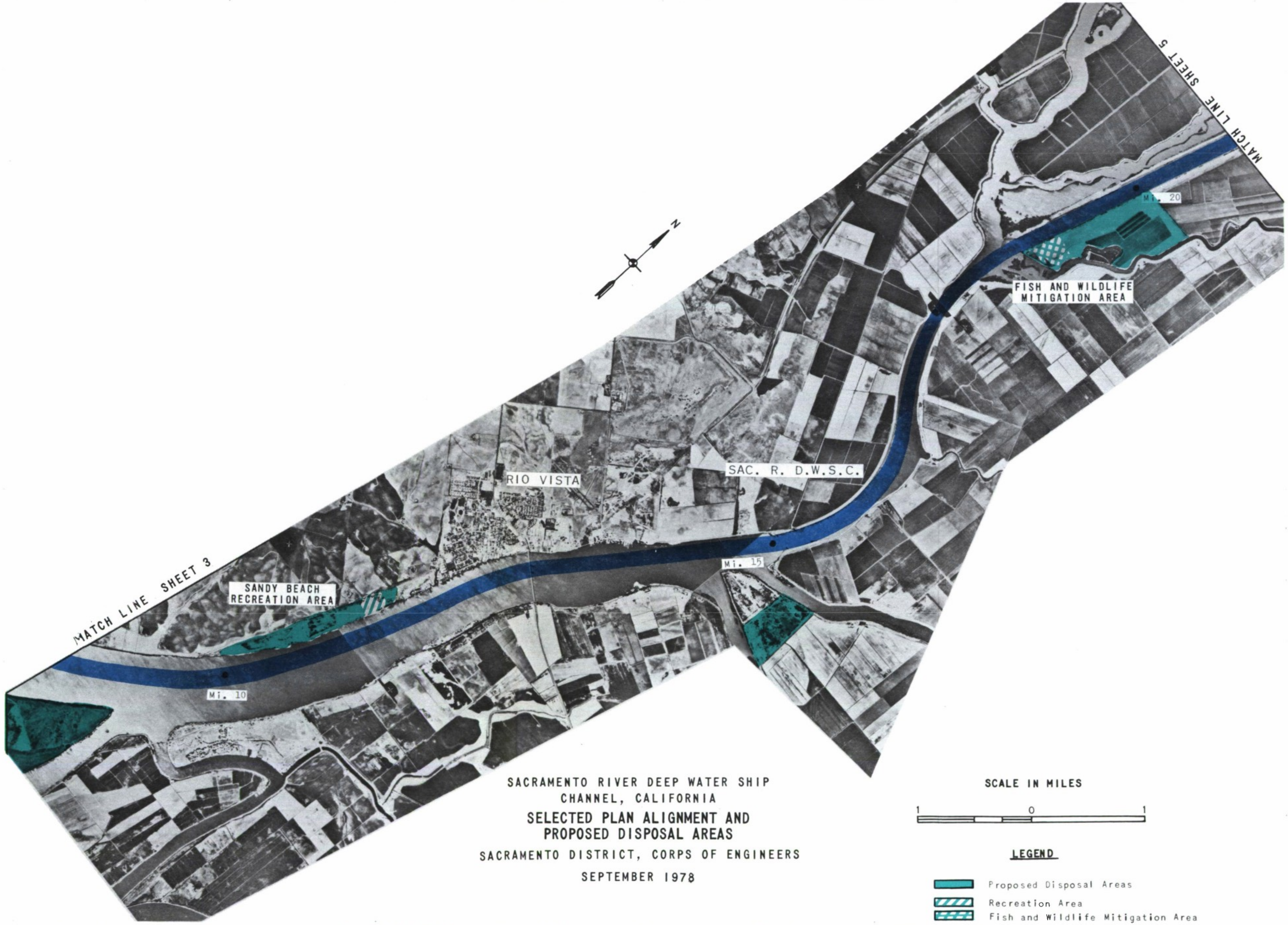
SEPTEMBER 1978

SCALE IN MILES

1 0 1

LEGEND

Proposed Disposal Areas



SACRAMENTO RIVER DEEP WATER SHIP CHANNEL, CALIFORNIA

SELECTED PLAN ALIGNMENT AND PROPOSED DISPOSAL AREAS

SACRAMENTO DISTRICT, CORPS OF ENGINEERS

SEPTEMBER 1978

SCALE IN MILES

1 0 1

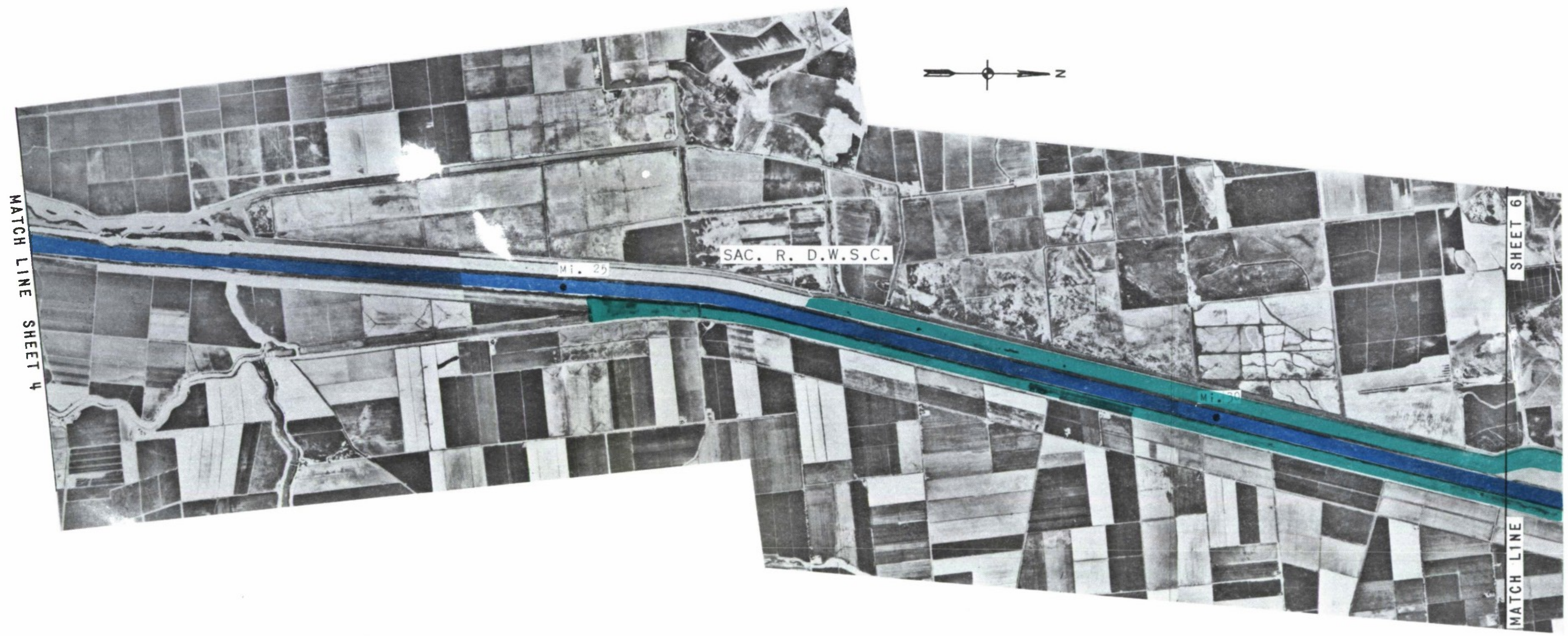
LEGEND

Proposed Disposal Areas

Recreation Area

Fish and Wildlife Mitigation Area

PLATE 2 SHEET 4 OF 6



SACRAMENTO RIVER DEEP WATER SHIP CHANNEL, CALIFORNIA

SELECTED PLAN ALIGNMENT AND PROPOSED DISPOSAL AREAS

SACRAMENTO DISTRICT, CORPS OF ENGINEERS

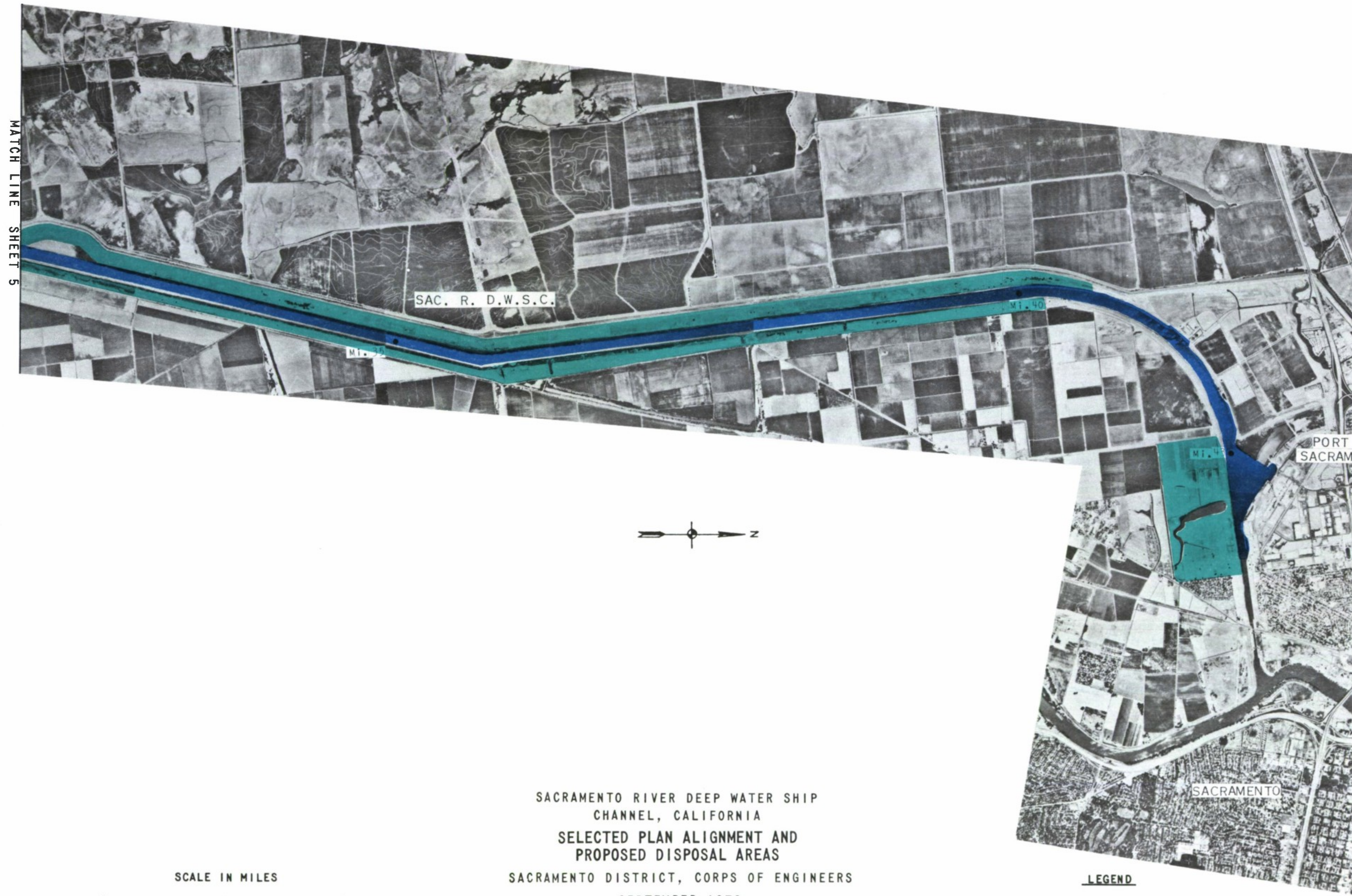
SEPTEMBER 1978

SCALE IN MILES

1 0 1

LEGEND

Proposed Disposal Areas



SACRAMENTO RIVER DEEP WATER SHIP
CHANNEL, CALIFORNIA

**SELECTED PLAN ALIGNMENT AND
PROPOSED DISPOSAL AREAS**

SACRAMENTO DISTRICT, CORPS OF ENGINEERS

SEPTEMBER 1978

SCALE IN MILES

1 0 1

LEGEND

Proposed Disposal Areas

JULY 1980

A P P E N D I X E S

Sacramento River Deep Water Ship Channel California

FEASIBILITY REPORT AND ENVIRONMENTAL IMPACT STATEMENT FOR NAVIGATION AND RELATED PURPOSES

SACRAMENTO RIVER DEEP WATER SHIP CHANNEL, CALIFORNIA FEASIBILITY REPORT AND ENVIRONMENTAL IMPACT STATEMENT FOR NAVIGATION AND RELATED PURPOSES

Technical Report

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SECTION B	RESOURCES AND ECONOMY OF THE STUDY AREA
SECTION C	PROBLEMS AND NEEDS
SECTION D	PLAN FORMULATION
SECTION E	THE SELECTED PLAN
SECTION F	ECONOMICS OF THE SELECTED PLAN
SECTION G	DIVISION OF PLAN RESPONSIBILITIES
SECTION H	PROPOSED REVISED COST-SHARING RESPONSIBILITIES

APPENDIX 1

PREPARED BY THE
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
DEPARTMENT OF THE ARMY

SECTION A

THE STUDY AND REPORT

SECTION A

THE STUDY AND REPORT

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SECTION A

THE STUDY AND REPORT

Purpose and Authority

1. The organization and content of this report are described in this section. Background information concerning the study, including authorization, scope, participants and coordination, and prior studies and reports, is also included in this section.

2. Deep-draft navigation access to the Port of Sacramento has been a significant factor in stimulating commercial and industrial development in the Port of Sacramento service area. However, largely because of concern for the impact of the world-wide trend towards larger and deeper draft ships on future economic conditions for the port and surrounding area, the Committee on Public Works, House of Representatives, at the request of local interests made through their representatives in Congress, adopted the following resolutions on 10 July 1968 and 11 December 1969, respectively:

> "Resolved by the Committee on Public Works of the House of Representatives, United States, that the Board of Engineers for Rivers and Harbors is hereby requested to review the reports of the Chief of Engineers on Sacramento River, California, published as Senate Document No. 142, Seventy-ninth Congress, 2nd Session, with a view to determining whether any modification of the existing navigation project is advisable at this time, particularly with respect to the reach in Suisun Bay from New York Slough to Collinsville, California."

> "Resolved by the Committee on Public Works of the House of Representatives, United States, that the Board of Engineers for Rivers and Harbors is hereby requested to review the reports on Sacramento River, California, published as Senate Document No. 142, Seventy-ninth Congress, 2nd Session, and other pertinent reports, with a view to determining whether any modification of the existing navigation project is advisable at the present time, with particular reference to the channel from New York Slough to the Port of Sacramento, California, specifically including the deepening of the ship channel and suitable portions of the harbor to a depth of 40 feet at MLLW or such lesser depth as may prove to be economically feasible, the dredging of the planned turning basin at channel mile 31.9, as well as alternate solutions to the shoaling problem at Junction Point, channel mile 14.1."

Scope of the Study

3. This report addresses the need for deeper draft channels to the Port of Sacramento, California; the economic feasibility of alternatives for deepening the channels; alternatives other than deepening; the need for public recreation developments; and the economic, social, and environmental impacts and implications of all alternatives. The primary study area consists of the Sacramento River Deep Water Ship Channel from Collinsville to the Port of Sacramento and the Suisun Bay Channel from Avon to Collinsville. However, the study area is extended as necessary to include far-reaching social, environmental, and economic factors. Figure B-1 shows the location of the study area. Engineering analysis is limited to determining the feasibility of providing a deeper channel to the Port of Sacramento and what effects this may have on hydraulics, water quality, and the environment.

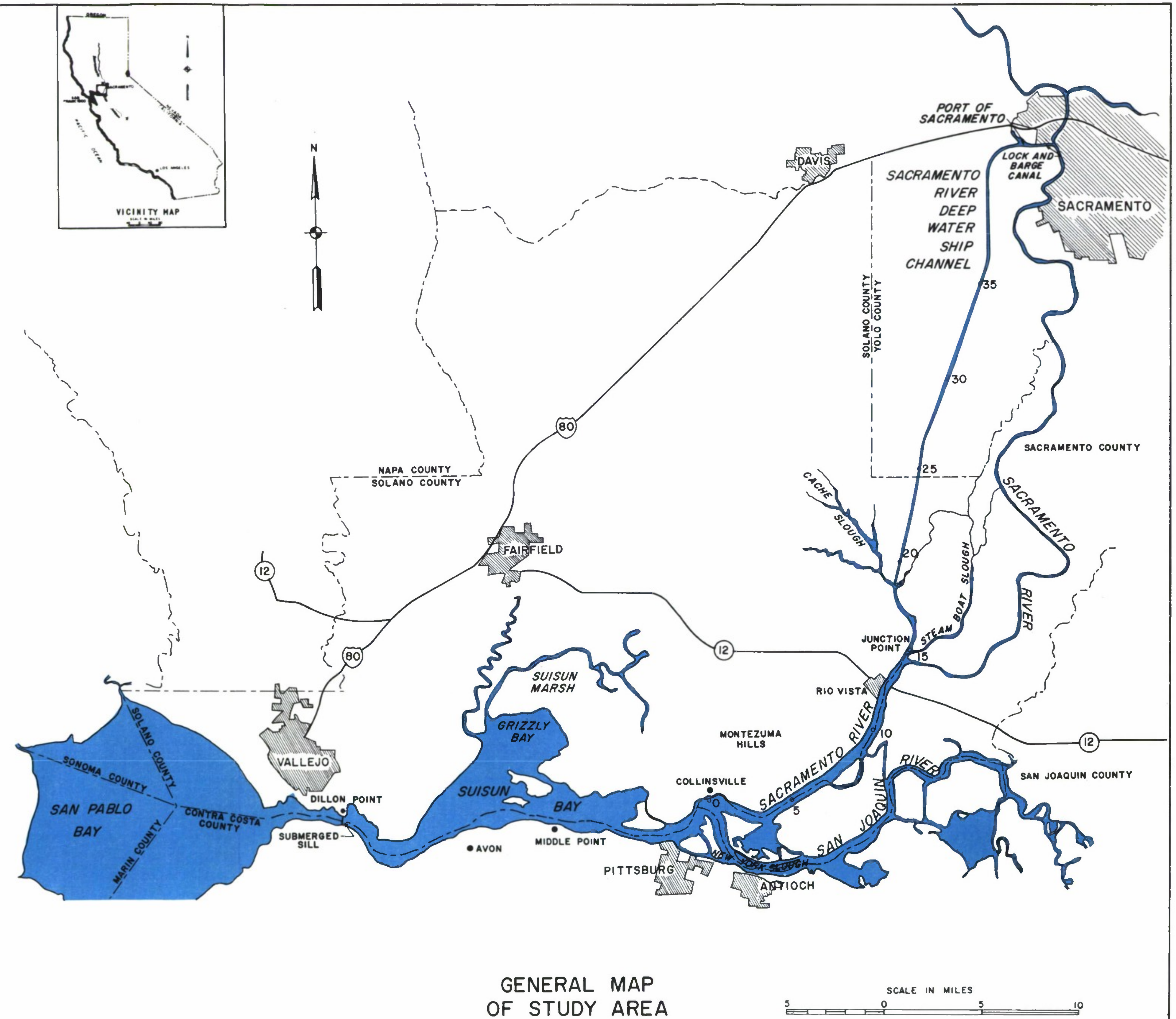
Study Objectives

4. Pursuant to the authorizing resolutions for this investigation and based on an appraisal of the existing and expected conditions in the study area, the following objectives were established as guidelines for the formulation and evaluation of alternative plans:

a. Determine the need for deeper draft channels to the Port of Sacramento and the Collinsville-Montezuma Hills area to improve the transportation of commodities to and from the northern California service area.

b. Improve the safety and usefulness of the existing channels.

c. Enhance existing environmental and recreation conditions in the study area.



GENERAL MAP
OF STUDY AREA

SACRAMENTO RIVER DEEP WATER
SHIP CHANNEL INVESTIGATION
CALIFORNIA

FIGURE B-1

10. The following studies have been conducted and reports prepared as part of this investigation on the feasibility of deepening the Sacramento River Deep Water Ship Channel. The results of these studies to date are incorporated in this report.

a. An environmental inventory was completed in August 1972. The purpose of this report was to inventory the components of the natural and cultural environment within the study area. This information was limited to available existing sources.

b. An Office Report on Salinity Conditions in the harbor and ship channel was completed in December 1972. This report presented the results of an investigation of salinity conditions in the channel and turning basin including data on salinity observations, sources of salt input, and a discussion of the associated salinity conditions.

c. An assessment of the recreation potential at the Port of Sacramento was completed by the Port Director in July 1974. This report recommended that the Port District Commission express its willingness to cooperate with other local agencies in the fostering of planning for recreation activites on Port District property, consistent with long-term plans for the property.

d. A Sedimentation Study for Junction Point was completed by the Hydrologic Engineering Center in June 1974. The purpose of this study was to determine both the effects of channel deepening on sediment load distribution and to determine whether channel modifications could reduce the sediment deposits at Junction Point.

e. A Port Plan was adopted by the Sacramento-Yolo Port District Commission in January 1974. This report presented a master plan for the port.

f. A Bottom Sediment Sampling Program, completed in January 1975, was conducted to determine the soil classification, rate of settling, and pollutant content of the bottom material in the existing channel.

g. A water quality monitoring program was conducted from February 1976 through May 1977 to determine the water quality characteristics of the Sacramento River Deep Water Ship Channel.

h. A cultural resources reconnaissance was conducted of the study area by contract with J.S. Seldomridge & C. Smith-Madsen to determine what effect, if any, the deepening of the channel and disposal of dredged material would have on archeological and historical resources of the area.

i. Hydraulic model tests have been conducted at the San Francisco Bay-Delta hydraulic model to determine what effects the alternatives for deepening the existing channel might have on salinity intrusion, salinity concentrations, and the hydrologic characteristics of the waterways.

j. An assessment of the effects of a submerged sill on sediment transport and the water quality of western Delta — Suisun Bay was conducted under contracts with Dr. Ray Krone and Hydroscience, Inc., to determine the effect of the submerged sill on phytoplankton and dissolved oxygen concentrations.

SECTION B

RESOURCES AND ECONOMY OF THE STUDY AREA

SECTION B

RESOURCES AND ECONOMY OF THE STUDY AREA

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SECTION B

RESOURCES AND ECONOMY OF THE STUDY AREA

Environmental Setting And Natural Resources

Study Area

1. The study area extends from Avon, in Suisun Bay, to the Port of Sacramento, a distance of 58 miles. As shown on the General Map, Figure B-1, the study area can be divided into three reaches: Avon to the mouth of New York Slough (Pittsburg), the mouth of New York Slough (Pittsburg) to the northern end Collinsville-Montezuma Hills area, and Collinsville-Montezuma Hills area to the Port of Sacramento. A general description of each reach is given below.

a. Avon to the mouth of New York Slough near Pittsburg — This westernmost reach is 11.5 miles long and is known as the Suisun Bay channel. This channel is currently maintained to a depth of -30 feet mean lower low water (mllw) with a bottom width of 300 feet between Avon and Middle Point and 450 feet between Middle Point and New York Slough. The northern side of Suisun Bay is composed of brackish-water marshes. The southern side consists of scattered industrial development including the Concord Naval Weapons Station and PG&E powerplant, while the remaining area is undeveloped uplands and wetlands.

b. Mouth of New York Slough to northern end Collinsville-Montezuma Hills area (Channel mile 11.0) — This 13.5-mile reach closely follows the Solano-Contra Costa County line from New York Slough to Collinsville, as does the previously described reach, and the Solano-Sacramento County line from Collinsville to mile 11.0. The navigation channel is currently 30 feet deep at mllw and 300 feet wide. The reach turns north where the brackish marshes end and agricultural lands begin.

c. Channel mile 11.0 to the Port of Sacramento — This reach extends northeast for 33 miles. The existing navigation channel has a depth of 30 feet at mllw and a width of 300 feet from Collinsville-Montezuma Hills area (Channel mile 11.0) to the mouth of the manmade channel (mile 18.6) and 200 feet from mile 18.6 to the Port of Sacramento. With the exception of the city of Rio Vista, this reach is bounded by agricultural lands. The Yolo Bypass borders the west side of the upper portion of the ship channel. The upper 24-mile portion is manmade and is connected to the Sacramento River at Sacramento via a lock at the upstream end. Most of the study area is within the Sacramento-San Joaquin Delta, which consists of about 1,100 square miles of land and over 700 miles of meandering waterways, and is located at the confluence of the Sacramento and San Joaquin Rivers. The Delta is roughly triangular, bounded by Sacramento on the north, Stockton on the south, and Antioch on the west. The Sacramento and San Joaquin Rivers enter the Delta from northern and southern corners and flow out through the western corner into Suisun Bay and subsequently into San Pablo Bay, San Francisco Bay, and the Pacific Ocean. During the last century, levees have been constructed along the waterways to divide the Delta into about 50 separate parcels which have been dewatered and drained to form islands. The waterways provide habitat for a varied fishery and are used for both recreational boating and commercial navigation.

Geology

2. The region from the eastern tip of Suisun Bay to Sacramento is a synclinal depression. Various sedimentary deposits have covered this region since the Jurassic Period (136 to 195 million years ago). From the Jurassic Period to the Miocene Epoch (12 to 26 million years ago) marine sediments were deposited in the syncline. These materials are primarily siltstone, claystone, and sandstone. Since the Miocene Epoch, layers of sedimentary deposits were left by rivers which carried eroded materials from the Klamath and Sierra Nevada Mountains. These later deposits are sandy to silty. The total depth of all deposits is as great as 5 miles. The alluvial layers have been topped off with a layer composed mainly of muck, peat, or organic clay. These deposits were formed from the accumulation of organic matter (2, 21, 48).[1]

Soils and Sedimentation

3. The soils of the Delta can be separated into two types, organic and mineral. The organic soils are dark colored mucks and peaty mucks, formed from the decomposition of water-saturated layers of tules and other vegetation. Peat soils occur along the ship channel from Avon to Prospect Island. This soil becomes saturated from seasonally high water tables but then dries out and is subject to wind erosion. Underlying this peat is a light gray mineral sediment. Many of the islands in the Delta are subsiding with subsidence reaching as much as 3.0 inches per year in some areas. This is caused mainly by oxidation of peat, withdrawal of ground water, and withdrawal of natural gas. North of Prospect Island, naturally occurring mineral soils are present. Their color ranges from brown to dark gray and they are subject to poor drainage and concentration of salts. Mineral soils are also found in fill areas and natural levee deposits between Collinsville and the mouth of Cache Slough (2, 17, 48, 58).

[1]Indicates references in paragraph 52, References.

4. It has been known for many years that the peatlands of the Delta have resulted from the decomposition of marsh flora. Early studies reported that these peats were composed primarily of tules (*Scirpus spp.*) overlying a thick accumulation of fibrous reeds (*Phragmites communis*)(15). It was apparent that the accumulation of the peat soils had taken considerable time, but the duration, and even the depth of the peats, was unknown. Recent studies of borings have demonstrated that peat soils reach a depth of nearly 60 feet on Sherman Island and become progressively shallower eastwardly across the Delta. Radiocarbon dating of the bottom levels of the borings indicate that the buildup began about 11,000 years ago on Lower Sherman Island and began progressively later to the east (43). Recent tests of samples from these borings by the California Department of Parks and Recreation have shown that they contain abundant fossil pollen. This should make it possible to determine the composition of the prehistoric flora and to study factors such as climatic fluctuations and saltwater intrusions.

5. Although investigations have thus far been limited, these natural deposits contain the potential for yielding a detailed and closely dated record of climatic, floral, and hydraulic changes throughout the post-Pleistocene. Attempts to obtain similar information from local archeological deposits have been unsuccessful (22).

6. Within the existing Sacramento River Deep Water Ship Channel there are a few locations which, because of geological formations and/or hydraulic conditions, are shoaling areas. During periods of high runoff, floodflows in the Yolo Bypass, Steamboat Slough, and the Sacramento River carry a high total sediment load due to the natural upstream erosion. As the flows recede, the sediment-carrying capacity of the flows diminishes and sediment is deposited, resulting in shoaling. This is particularly true for locations of enlarged cross section such as the junction of Cache Slough, Sacramento River, and Steamboat Slough (Junction Point), and just below Rio Vista near mile 11. Approximately 200,000 cubic yards are dredged annually from Junction Point, and about the same amount is dredged below Rio Vista. In the manmade portion of the ship channel, maintenance dredging is done about once every 5 years. This material is fine sand as opposed to the coarser sand deposited at Junction Point and below Rio Vista. Most of the sediment in the manmade channel is eroded from the channel banks by "prop-wash" from ship traffic and from the levees by ship waves. Significant sediment-related phenomenon is also exhibited in the Suisun Bay portion of the ship channel. In this area shoaling occurs from time to time, but during high flow periods scouring occurs, reducing the need for maintenance dredging of the nagivation channels.

7. The disposal sites for maintenance dredging in the study area are generally located on land along the ship channel. There are three disposal sites near Junction Point. The primary site is on the western tip of Grand Island. The other two are on the west side of the channel north and south of Rio Vista. For the manmade portion of the ship channel, the material is deposited along the berm immediately adjacent to the area of dredging. When dredging is required in Suisun Bay, the material is generally deposited in approved water disposal sites along the channel.

Seismicity

8. The ship channel traverses a seismically active area. The Midland fault zone is roughly parallel to the study area in the Cache Slough region and then crosses the Sacramento River at the tip of Grand Island. The last major earthquake along this fault was the Winters earthquake which occurred in April 1892. Its magnitude was between 6.0 and 6.9 on the Richter scale. The Calaveras and Hayward fault zones are also in the general region of the ship channel. Any major seismic activity along these faults could be felt in the area. The National Earthquake Information Center has placed the Sacramento area in Seismic Risk Zone 3 (major risk and damage) and the channel area beginning near Rio Vista in Seismic Risk Zone 4 (major risk and damage and near major fault systems). The Risk Zone scale ranges from 0 (no risk and damage) to 4.(2)

Climate

9. The climate of the area is characterized by hot, dry summers and cool, moist winters. Annual precipitation varies between 7 and 24 inches with a yearly average of approximately 15 inches. The major rainfall occurs from October through April. The first fall frost occurs about 1 December and the last spring frost about 7 February. The lowest recorded temperature is 11°F. The highest is 114°F. Relative humidities show a large variation both diurnally and annually. Relative humidity averages about 90 percent during December through February, dropping to an average of about 30 percent during June through August. Dry, light to moderate winds from the north and northeast may produce humidities of less than 10 percent. Conversely, winter radiant cooling will sometimes cause relative humidities to approach 100 percent, producing a fog layer which can persist for several days.

10. Winds in the Suisun Bay and Delta area may blow from any direction; however, the prevailing winds are from the south and southwest. These prevailing winds are created by the cool ocean air moving through the Carquinez Strait. Figure B-2 displays wind roses which show the prevailing winds for two stations near the project area. The winds and waves are a significant navigational hazard for small craft. In addition, they can increase bank erosion processes. As would be expected, the potential for bank erosion and navigational hazard due to wave generation does not become significant until the channel is aligned with the wind. For the prevailing winds there is a significant reach aligned with the wind between Rio Vista and Sacramento. However, the larger waves in the channel do not appreciably affect commercial vessels, and erosion problems are minimal because the energy components of the waves are not directed toward the shoreline. Bank erosion can be expected to occur in those sections of the waterway which lie perpendicular to the wind. These shorelines are exposed to small waves over long periods of time with most of the wave energy dissipating against the bank or levee. Waves generated by moving vessels may be the largest waves the levees and shorelines experience. At extreme high tides, in areas where levees have limited freeboard, waves from ship, tug, and barge traffic have, on occasion, broken over the levee.

Hydrology

GENERAL

11. Most of the water from the 64,000-square-mile Central Valley watershed, or roughly one-third of the entire State of California, drains through the Sacramento-San Joaquin Delta. Most of the water originates as runoff from winter rains in the valley and foothills and from the spring snowmelt in the Sierra. Three-quarters of the total annual flow occurs between January and May with January and February the peak months. The main rivers tributary to the Delta include; the Sacramento, which produces 80 percent of the total runoff; the San Joaquin (12 percent); and other minor tributaries (3 percent). Before large-scale diversions began, the mean annual outflow from the Delta was more than 30 million acre-feet. Many Federal, State, and local water projects constructed within the watershed have cut the flow significantly. The Water and Power Resources Service has estimated that annual Delta outflow index has ranged between 2.4 million and 32.1 million acre-feet for the years 1969-1978 (3). The average outflow index during this period which includes the severe drought years of 1976-1977 was approximately 16.7 million acre-feet.

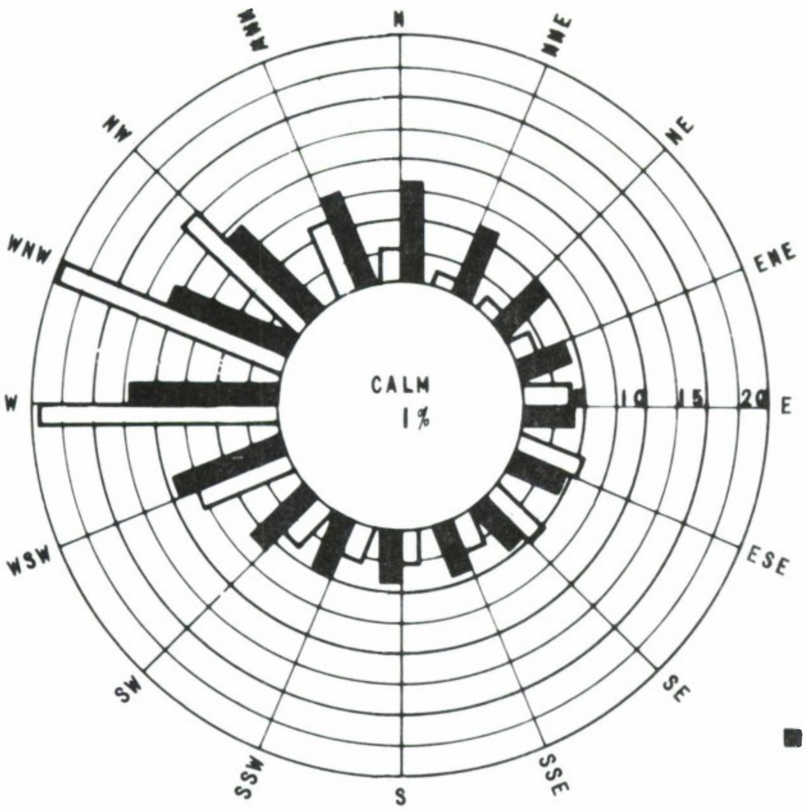
12. Besides diversion by upstream facilities, water is also removed from the Delta. Agricultural pumping and vegetative transpiration take up around 1.8 million acre-feet, and the Contra Costa Canal, South Bay Aqueduct, California Aqueduct, and Delta-Mendota Canal divert about 5 million acre-feet per year, although their design capacities could produce much larger diversions.

WATER SURFACE ELEVATION

13. Water elevations in the study area are influenced by hydrological and geological phenomena. Rapid melting of snowpacks and rains in the tributary areas may greatly increase the water levels of the waterways in the study area. Another significant factor which influences the water levels is tidal action. The combination of heavy runoff and tidal action may produce flood stages. Historic water levels are described below for individual reaches within the project area:

a. Avon to Collinsville-Montezuma Hills area — The water elevations in this reach are predominantly influenced by tidal action. Records indicate that the highest stage at Avon was approximately 5.9 feet above mean sea level (m.s.l.), and at Collinsville, 15 miles inland from Avon, the maximum reading was 5.8 feet above m.s.l. The width of the waterway at Collinsville is roughly 4,800 feet, while at Avon the width is approximately 6 miles. Though the water levels are influenced by tidal action, the difference in high stages at these two points is also significantly affected by the large quantity of water flowing through the more constricted Collinsville area. The actual tidal height difference for Avon and Collinsville is quite small, in the order of 0.1 to 0.2 feet.

b. Collinsville to Junction Point — Tidal action is also a significant determinant of water surface elevations in this 14.5-mile reach. High stage readings are 6.1 feet for Collinsville and approximately 6.8 feet m.s.l. for Junction Point. The tidal height (amplitude) difference between these two points (Collinsville and Junction Point) varies up to 0.45 feet at high tide. Comparison of the tidal amplitude difference in this reach and the previous reach shows that tidal amplitudes are increasing upstream.



PITTSBURG

OATA SOURCE: DOW CHEMICAL CO.

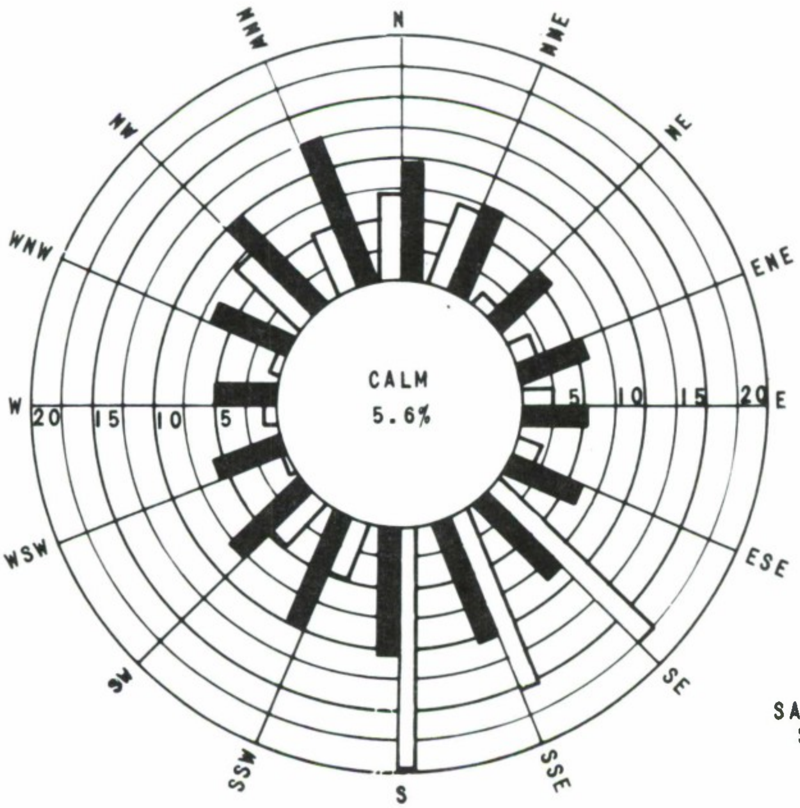
PERIOO OF RECORD: 1956-65

TYPE: RECORDING

LEGEND

■ Wind Speed in miles per hour

□ Wind Direction in percent



SACRAMENTO, McCLELLAN AFB

DATA SOURCE: U.S.W.B.

PERIOD OF RECORO: UNKNOWN

TYPE: HOURLY

SACRAMENTO RIVER DEEP WATER SHIP CHANNEL, CALIFORNIA

WIND ROSES

US ARMY ENGINEER DISTRICT
SACRAMENTO, CALIFORNIA
APRIL 1977 L.K.K.

FIGURE B-2

c. Junction Point to the Port of Sacramento — The water surface elevation for this reach is predominantly influenced by tidal action. The maximum elevations recorded are 6.8 feet m.s.l. at Junction Point and 13.0 feet m.s.l. for the channel side of the W.G. Stone Lock. The hydraulic conditions are complicated in this reach and are discussed below in the paragraph on tidal hydraulics. It would appear from the above tidal elevations that the fall between these two points would be towards the downstream location of Junction Point. However, this is not always the case. Floodflows at the junction of the Sacramento River, Steamboat Slough, and Cache Slough can cause a backwater effect in the ship channel depending on both tidal condition and flood runoff. Water surface elevations in the ship channel are usually directly related to tidal action.

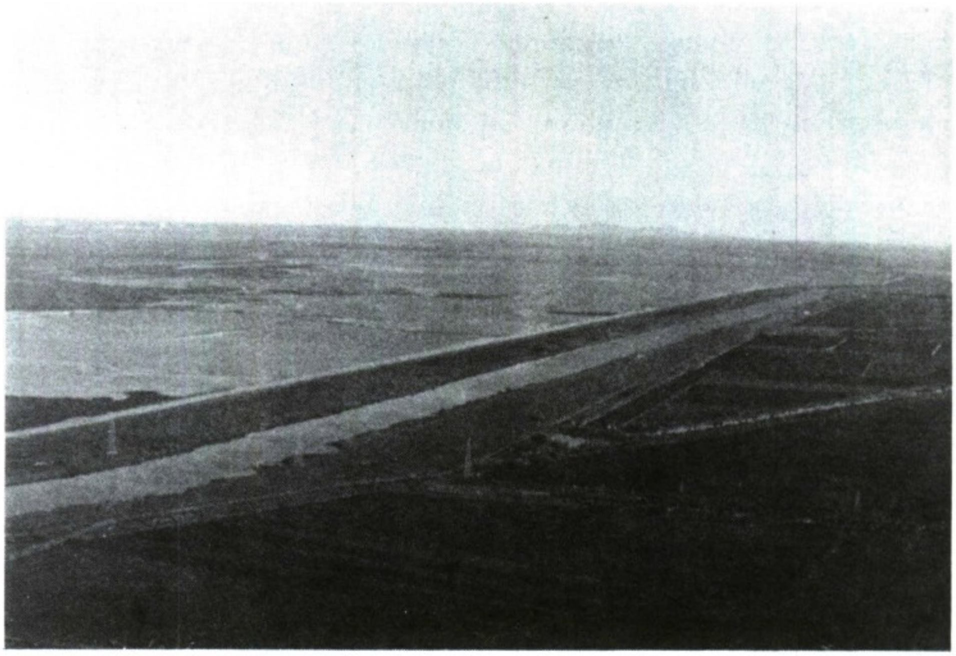
TIDAL HYDRAULICS

14. Tidal action is an important factor in the development of any plan to improve the navigability of waterways in the study area. Tidal ranges for an average tide and low advective outflow are 5.1 feet at Avon, 4.5 feet at Collinsville, 4.75 feet at Junction Point, and 6.0 feet at the Port of Sacramento. These values will vary from tide to tide, but for this same average tide, water surface elevation range for the Golden Gate gage was 6.4 feet. Measurements taken in the estuary show that during the normal flooding tide the average inward velocity at Avon is 3 feet per second (fps) and 3.75 fps for maximum ebb; for Collinsville the velocity is 1.8 fps flood and 2.3 fps ebb; and at Junction Point the velocities are .75 fps flood to 1.4 fps ebb.

15. The closed end of the Sacramento River Deep Water Ship Channel and the constrictive geometry of the channel complicate the tidal hydraulics of the ship channel between Junction Point and the Port of Sacramento. The tidal amplitude increases as a result of a harmonic oscillation created by the closed end of the channel. The constrictive geometry serves to increase the tidal effect, causing the average tidal range at the port (6.0 ft.) to be similar to that at the Golden Gate. As a contrast, the average tide range for the riverside of the locks is approximately 2.5 feet during periods of low flow. Velocities associated with this tide are 1.8 fps flood, 2 fps ebb at Junction pont, and in the Sacramento Ship Channel at channel light "84" 2.1 fps flood and 2.9 fps ebb.

Ground Water

16. The ground water underlying Suisun Bay and the surrounding marshland has not been exploited to a great extent, but a number of deep wells in the reclaimed marshlands yield small quantities of freshwater at depths of several hundred feet. To the south of Suisun Bay, layered deposits of sand and gravel separated by thick layers of silt and clay form an aquifer having a base depth of less than 100 feet and a general dip towards San Francisco Bay. The Tehama formation is an important aquifer possibly extending under Suisun Bay below the existing ship channel. The general movement of ground water in this region is bayward with the aquifers being recharged by upland percolation of precipitation. In a few localized areas near Suisun Bay, overdrafts have reversed the normal pattern of the past. For example, in the Pittsburg area excessive industrial and municipal ground water overdrafts have induced infiltration of lesser quality water. The source of this saltwater may be the bay or connate water in sedimentary strata that border the bay (1, 52).



Sacramento River Deep Water Ship Channel, Mile 36 to 40,
with Yolo Bypass in the background.

Sacramento River at Mile 13 showing Rio Vista Bridge
with the City of Rio Vista in the background.

17. A report by the U.S. Geological Survey for the San Francisco Bay to Stockton (John F. Baldwin and Stockton Ship Channels) project found that channel bottom surveys in 1850, 1934, and 1971 and test drillings in 1972 indicate a large part of the channel between the Benecia — Martinez Bridge and New York Slough already has been, at one time or another, deeper than 47 feet. Hydraulic mining debris deposited in the area from 1853 to 1884 raised the natural riverbed as much as 13 feet. Thus, most of the permeable strata that immediately underlie this portion of the alignment of the proposed deeper channel probably are saline (1, 49, 59).

18. Much of the area along the manmade portion of the Sacramento River Deep Water Ship Channel consists of impervious surface layers underlain by sandy layers. These sandy layers usually appear between 10 and 30 feet beneath the surface and are frequently intersected by the channel. The shallow ground water level varies between 5 and 32 feet below the surface. The State of California has operated a monitoring program on a number of wells in the Sacramento-San Joaquin Delta. Data from those wells near the channel indicate that the existing ship channel has not produced any change in the quality of adjacent ground water.

Water Quality

19. The uses of the waters of the ship channel include commercial navigation, water supply, fishing, recreation, and disposal of agricultural waste water. These uses, some of which compete with each other, have different water quality requirements. In 1975, the Central Valley Regional Water Quality Control Board adopted a Basin Plan which included water quality objectives for the deep water channel and in August 1978 adopted a similar plan for the Delta. The deep water channel, however, has not been monitored regularly in the past, and therefore existing water quality data are sketchy at best. Intermittent water quality data collected by the Central Valley Regional Water Quality Control Board from 1963 to 1972 indicate that, except for salinity, the water quality in the channel meets or exceeds the objectives. Salinity measurements taken by the Sacramento District between March 1968 and October 1972 indicate the total dissolved solids generally exceed the 500 ppm objective between mile 35 and the turning basin (51). This increase is due primarily to saltwater ballast discharge in the turning basin. The number of tons of ballast discharge by months for the period from October 1969 through August 1972 is tabulated below along with the computed excess of export cargo tonnage over import tonnage. It is recognized that there is not a fixed relationship between these two factors; however, there is a definite correlation which indicates that ballast discharge averages about 20 percent of the excess of export over import tonnage. This relationship can be used to approximate ballast discharge for the period during which no record was made of ballast discharge and for future traffic conditions.

The relatively high TDS concentration observed in December 1968 indicated the desirability of attempting to use Sacramento River water to flush some of the accumulated solids into Cache Slough. The relatively high Sacramento River flows during the 1968-69 winter period provided a good opportunity to flush the channel. During the period from 12 December 1968 to 19 March 1969 an estimated 35,600 acre-feet of water was discharged into the ship channel through the lock. This was supplemented by an additional 15,000 acre-feet of water from precipitation falling on project waters and from seepage and drainage water pumped from the reclamation districts. As a result of this flushing

Salt Water Ballast and Net Export From Project (Long Tons)

	1969		1970		1971		1972	
	Salt Water Ballast	Net Export	Salt Water Ballast	Net Export	Salt Water Ballast	Net Export	Salt Water Ballast	Net Export
January			7,840	81,800	11,760	93,100	7,000	50,700
February			12,320	72,900	5,600	54,300	11,000	67,200
March			0	36,800	39,000	165,800	6,000	58,900
April			14,560	83,000	35,000	159,600	11,000	87,200
May			6,160	88,900	35,000	145,600	13,000	83,800
June			45,360	205,600	48,400	237,000	5,000	23,900
July			25,760	149,200	0	0	19,000	162,700
August			25,200	105,700	0	0	18,000	145,100
September			13,440	115,400	0	0		
October	5,600	82,300	31,360	115,800	27,000	171,400		
November	28,560	29,400	40,880	106,100	26,000	127,200		
December	11,760	118,300	39,200	88,200	16,000	84,500		
Total	45,920	230,000	262,080	1,249,400	243,760	1,238,500	90,000	679,500

action, there was a net reduction of dissolved solids in the project of about 6,500 tons. The excess of export over import cargo for the flushing period was used with the established correlation of ballast discharge to net export tonnage to estimate ballast discharge of about 90,000 tons or about 3,100 tons of additional dissolved solids were flushed from the system. The TDS gradually built up during the ensuing months to near the pre-flushing level.

20. A firm quantity of water from the Sacramento River would not be available for flushing flows. Furthermore, the flushing action may only relocate the problem downstream. A more expedient means of solving this problem would be the prevention and control of the discharge of the salt water ballast by enforcing existing water quality standards. Enforcement of water quality standards in the ship channel is the responsibility of the Environmental Protection Agency and the Regional Water Quality Control Board (60).

21. Specific water quality parameters are described in the following subparagraphs.

a. Temperature. — Water temperatures during the winter months generally range between 45°F and 55°F. During the remainder of the year, temperatures rise to between 60°F and 80°F. In the lower reaches of the channel, current reversals due to tidal action cause local increases in temperature (2).

b. pH. — The waters of the deep water channel are slightly alkaline in the pH range of 7.1 to 9.2. Biologic activity causes pH values to be highest during the daylight hours (2).

c. Turbidity. — The turbidity or suspended solids of the deep water channel shows marked seasonality. Generally, the highest turbidities occur during periods of high runoff. Turbidities during the summer range between 15 and 170 Jackson Turbidity Units (JTU) with the higher readings occuring in the lower reaches of the channel (2).

d. Dissolved oxygen. — Data on dissolved oxygen are collected by the Central Valley Regional Water Quality Control Board in the upper reaches of the channel and by the Department of Water Resources in the lower reaches. The dissolved oxygen concentrations, in general, are above 5.0 parts per million (ppm), which is the minimum concentration desirable for anadromous fish. However, some DO readings taken on the bottom of the channel in the loading dock area during August of 1965 showed concentrations of 4.7 ppm. Very little sampling has been done at night to determine the extent of diurnal fluctuations in dissolved oxygen. Concentrations lower than 5.0 ppm probably occur at night during the warm season in areas of extensive algal growth (2). Further investigations into the DO problems will be made during advanced engineering and design studies.

e. Salinity. — The salinity of the ship channel is measured regularly by the Central Valley Regional Water Quality Control Board, California Department of Water Resources, and Water and Power Resources Service. Salinity is measured in terms of specific conductance, which varies annually and seasonally. Annual variations are caused by changes in Delta inflow which is related to annual precipitation. Seasonal changes are caused by variations of streamflow and agricultural and domestic waste discharge practices in the area. The specific conductance in the upper reaches of the ship channel, near the port, ranges between 200 and 900 micromhos. The specific conductance generally decreases downstream until the influence of saline water is evident. The specific conductance of the ship channel near Cache Slough ranges between 100 and 250 micromhos. Between 1952 and 1977, the zone of salinity intrusion did not reach upstream to Rio Vista. However, less than 8 miles downstream from Rio Vista, specific conductance readings in excess of 1,500 micromhos have been observed. These high readings occur during the driest part of the year (July through October). The corresponding readings at Rio Vista during the same period were below 200 micromhos (2).

f. Nutrients. — Detailed data on nutrient levels in the upper reaches of the ship channel are lacking. However, continuous monitoring in the lower reaches of the channel (below Cache Slough) has yielded excellent nutrient profiles. The nitrogen series (organic, ammonia, nitrite, and nitrate nitrogen) are monitored in Cache Slough and the Sacramento River downstream to Collinsville. The results of the monitoring show that the dominant nitrogen form is nitrate-nitrogen which accounts for more than 80 percent of the total nitrogen. The nitrate-nitrogen concentration ranges between 0.1 an 1.9 milligram per liter (mg/l). The organic nitrogen concentration ranges between 0.0 and 0.8 mg/l, and ammonia and nitrite-nitrogen concentrations are consistently below 0.2 mg/l. Sources of these nitrogen elements include agriculture, domestic sewage, industrial wastes, siltation, urban runoff, rainfall, and ground water. Average concentrations of ortho- and total phosphate for the reach mentioned above range between 0.1 and 0.8 mg/l. The concentrations of the nutrients nitrogen and phosphorus in the lower reaches of the ship channel are sufficient to support extensive algal growth. Although little information is available concerning the nutrient levels in the upper reaches of the channel, algal blooms of nuisance proportion have been observed on numerous occasions in the channel during the last several years (2).

g. Heavy metals. — An analysis of sediments from four sites in the channel near Pittsburg, Middle Point and Point Edith tested as part of the Stockton Ship Channel studies (52) included chemical oxygen demand, total Kjeldahl nitrogen, pH, heavy metals, total phosphorus, chlorinated pesticides and sulfides. Based on EPA maximum limits, mercury was well below the limits as were all other heavy metals with the exception of zinc which exceeded the limits at all sites tested. In addition, sediments from six sites, spaced out along the Sacramento Ship Channel from near Collinsville to the turning basin, were also tested as part of this investigation (62). Again, based on EPA maximum limits, mercury was well below the limits as was lead. Zinc was found to exceed the limits at three of the six sites. One site was located near Collinsville, one near mile 33 in the manmade channel and one in the turning basin. Tests for zinc elsewhere in the region indicates that natural levels of this metal exceed the EPA standards. It is suspected that most of the zinc in the sediments originated from Central Valley soils which are relatively rich in zinc concentrations (52). There is no information available indicating any zinc related problems in Delta biota. Further testing of sediments in the Sacramento Deep Water Ship Channel will be undertaken during the advanced engineering and design stage. The chemical composition of bottom sediments is tabulated in Appendix 1 Section E.

h. Bacteriological quality. — Some discontinuous information regarding bacteriological quality of the ship channel is available. Although these data are sketchy, they give some indication as to the bacteriological quality of the channel. A limited bacteriological study by the Central Valley Regional Water Quality Control Board in conjunction with the State Department of Public Health indicated that total coliform concentrations (most probably number [MPN] per 100 ml) ranged between 23 MPN to greater than 24,000 MPN. The fecal coliform concentration varied from 6 MPN to 7,000 MPN. It should be noted that both the high concentrations occurred near a sewer treatment plant discharge at one location in the channel (the east side of the canal lock) and are not indicative of the entire channel. The study concluded that the State should perform additional bacteriological sampling to arrive at the statistical distribution of contamination for correlation with the Sacramento River.

Air Quality

22. The study area is primarily within the boundaries of the Sacramento Valley Air Basin. Major pollution problems in the basin are oxidants (photochemical smog) and particulate matter. Ambient air quality standards are listed in Table B-1. Table B-2 is a summary of 1975 oxidant emissions data for the Sacramento Valley Air Basin. Most of the directly emitted particulate matter (83 percent) is the result of stationary sources including agriculture (stubble burning, etc.).

TABLE B-1
CALIFORNIA AND NATIONAL AMBIENT AIR QUALITY STANDARDS (48)

	California Standards		National Standards	
Pollutants	Averaging Time	Concentration	Primary[1]	Secondary[2]
Oxidants	1 hour	0.10 ppm	0.08 ppm	Same as Primary Standards
Carbon Monoxide	12 hours	10ppm	—	Same as
	8 hours	—	9 ppm	Primary
	1 hour	40 ppm	35 ppm	Standards
Sulfur Dioxide	Annual Average	—	0.03	—
	24 hours	0.04	0.14	—
	3 hours	—	—	0.05 ppm
	1 hour	0.05 ppm (1310 ug/m³)	—	—
Nitrogen	Annual Average	—	0.05 ppm	Same as
Dioxide	1 hour	0.25 ppm	—	Primary Standards
Suspended Particulate	Annual Geometric Mean	60 ug/m³	7575 ug/m³	60 ug/m³
Matter	24 hours	100 ug/m³	260 ug/m³	150 ug/m³

[1]National Primary Standards: The levels of air quality necessary, with an adequate margin of safety, to protect the public health. Each state must attain the primary standards no later than 3 years after the State's implementation plan is approved by the Environmental Protection Agency (EPA).
[2]National Secondary Standards: The levels of air quality necessary to protect the public welfare from any known or anticipated adverse effects of a pollutant. Each State must attain the secondary standards within a "reasonable" time after implementation plan is approved by EPA.

Table B-2
Summary of Emissions for 1975
Sacramento Valley Air Basin
(Tons per Average Day)

	Organic Gas	Oxides of Nitrogen	Carbon Monoxide
Stationary Sources	198	28	400
Mobile Sources			
Motor Vehicles	139	119	983
Aircraft	20	4	78
Railroads	4	12	5
Ships	0	1	1
Total, Mobile Sources	163	136	1070
Total, All sources	361	164	1470

23. Mobile sources, including motor vehicles, ships, boats, and airplanes, emitted 87 percent of the oxides of nitrogen, 90 percent of the carbon monoxide, 76 percent of the sulphur dioxide, and 68 percent of the total organic gases. About 5 million tons of agricultural debris are burned each year in the Sacramento Air Basin. Excessive burning of accumulated waste occasionally results in a decrease of visibility lasting for several hours. Particulate matter is also introduced into the air of the region as a result of the handling of agricultural products at various break-bulk points, which are locations where agricultural products (especially grains) are transferred from one mode of transportation to another. However, all transfer points are equipped with air pollution control equipment and the amount of particulate matter entering the atmosphere is probably insignificant on a regional level. Studies have shown that motor vehicles produce the majority of emissions measured, except particulate matter.

24. Temperature inversions in the study area increase the severity of air pollution by trapping pollutants close to the earth. These inversions are caused by warm air aloft holding the cooler air close to the ground, thereby not allowing dispersion of pollutants (48). The dispersion capacity of the atmosphere in the study area generally varies with the time of year. During the spring and summer, sea breezes often develop through the Carquinez Straits. Part of this flow continues up the Sacramento Valley, past Sacramento (51). In mid-fall, these winds weaken. Local drainage winds become increasingly important in late fall and winter when storm winds are not present. Low level atmospheric inversions are most common during the winter months. Thus, the winds are much lighter and atmospheric diffusion is less in the late fall and winter than in the spring and summer. This stagnation tends to decrease the general air quality of the region (2). The city of Sacramento exceeded the State Standard for oxidants 13 times and the National Standard for oxidants 28 times in 1975.

Vegetation

25. Almost the entire length of the Sacramento River Deep Water Ship Channel is bordered by agricultural lands on the landsides of the levees. The agricultural vegetation includes row crops and orchards. The vegetation on the channel levees and berms consists of disjunct stands of brackish water marsh, freshwater marsh, riparian trees and brush, and grass. Extensive farming occurs on the berms along the manmade portion of the channel. On the northern side of the Suisun Bay Channel brackish water marsh covers 54,000 acres and is managed by the State (Grizzly Island and Joyce Island Wildlife Areas) and many private hunting clubs for waterfowl. Dominant plants in this marsh include saltgrass *(Distichlis spicata)*, pickleweed *(Salicornia virginica)*, and alkali bulrush *(Scirpus robustus)*. Important waterfowl forage plants are alkali bulrush, brass buttons *(Cotula coronopifolia)*, and fat hen *(Atriplex patula)*. Management for waterfowl food production consists of regulation of submergence time and soil salinities. Favorable salinity levels are obtained by leaching soil salts with fresh to brackish waters from the channels dissecting the marsh. If soil salinities remain too high during seed production season, significantly fewer seeds will develop. A Suisun Marsh Protection Plan for preservation of the area was adopted and enacted into law by the State of California in 1974 (55).

26. Remnants of freshwater marsh occur in the Collinsville area. Chain and Montezuma Islands are mostly marsh vegetation. Some brackish water marsh also occurs in the inlets upstream of Collinsville and bordering Montezuma Slough. Across the river, the Lower Sherman Island Wildlife Area is a 3,100-acre partially flooded island with freshwater marshes. Small stands of riparian trees occur within the freshwater marsh areas where higher ground elevations preclude the marsh. A narrow, intermittent band of riparian vegetation and marsh occurs on the right bank of the Sacramento River from Marshall Cut to just downstream of Rio Vista. The riparian vegetation consists mostly of willow *(Salix spp.)* with scattered western sycamore *(Platanus racemosa)*, oak *(Querus spp.)*, and Fremont cottonwood *(Populus fremontii)*. The marsh is composed basically of bulrush and cattails *(Typha spp.)*. Prior to 1945 the California hibiscus *(Hibiscus californicus)* had been collected immediately downstream of Rio Vista; however, the California Native Plant Society states that the California hibiscus has not been collected since and lists the species as rare and endangered (10)(see additional discussion in paragraph 38). The left bank of this reach is leveed and vegetated with grasses and scattered trees. Vegetation in the Brannan Island State Recreation Area includes eucalyptus *(Ecalyptus spp.)*, willow, cottonwood, oak, pine *(Pinus spp.)*, alder *(Alnus spp.)*, bush lupine *(Lupinus spp.)*, tree tobacco *(Nicotiana bigelovii)*, sweet fennel *(Foeniculum vulgare)*, tumbleweed *(Salsola kali)*, milk thistle *(Silybum marianum)*, California poppy *(Eschscholzia californica)*, and various grasses.

27. Decker Island supports a small amount of riparian trees, mostly cottonwoods. A narrow bank of marsh composed of bulrushes occurs along the southeastern shore. The southern and eastern part of the island is farmed, and the rest of the upland consists of scattered willow, wild rose *(Rosa spp.)*, elderberry *(Sambucus spp.)*, grasses, and forbs. Further upstream, the tip of Grand Island is surrounded by mature riparian vegetation of willow, white alder *(Alnus tenuifolia)*, Oregon ash *(Fraxinus latifolia)*, and oak. The upland area has stands of large shrubs (willow, wild rose, elderberry), wild grape, plus patches of grass. The mouths of Miner and Prospect Sloughs are lined with bulrush and riparian trees. Prospect Slough, which is adjacent to the lower 3 miles of the manmade portion of the channel, is a combination of open water, marsh, and riparian trees and brush (2,55). The manmade channel from its downstream end to approximately mile 35 has shorelines of bulrush, a few cottonwoods, and bush-sized willows, which have resulted from construction of the channel. The berms of this part of the channel are used for both agriculture and grazing. Lists of common plant species are available from the Sacramento District. The California Natural Areas Coordinating Council has designated several locations in the study area as "Natural Areas." They are Suisun Marsh, Browns and Winter Islands, and five remnant marshes in the Yolo Bypass (11).

28. Table B-3 lists the habitat types found on the potential dredged material disposal sites. The numbers in the table do not necessarily reflect acres impacted, since many of the sites will not be used for the selected plan and some only partially used, allowing avoidance of wetlands and riparian lands.

TABLE B-3
SUMMARY OF HABITAT TYPES AT DREDGED MATERIAL DISPOSAL SITES

Site	Location	Usable Area (AC)	Woodland	Grassland	Marshland	Agricultural Land	Riparian
S-1	Port of Sacramento	360		57		303	
S-2	Manmade Channel	75				75	
S-3	Manmade Channel	125				125	
S-4	Manmade Channel	150		20		130	
S-5	Manmade Channel	200				200	
S-6	Manmade Channel	185				185	
S-7	Manmade Channel	260				260	
S-8	Manmade Channel	85				85	
S-9	Manmade Channel	185				185	
S-10	Manmade Channel	215				215	
S-11	Little Holland Tract	355				355	
S-12	Prospect Island	400		137	35	228	
S-13	Rio Vista	500		460			40
S-14	Grand Island	230		197	33		
S-15	Brannan Island	590	40	40		510	40
S-16	Sandy Beach	85		85			
S-17	Collinsville-Montezuma Hills	180				180	
S-18	Collinsville-Montezuma Hills	625				625	
S-19	Decker Island	600		410	70	120	
S-20	Sherman Island	100		95	5		
S-21	Collinsville-Montezuma Hills	376	9	264	56	47	
S-22	Sherman Island	260		50	210		
S-23	West Pittsburg	230		230			
S-24	Port Chicago	20		20			
S-25	Port Chicago	90		90			
S-26	Port Chicago	30			30		
S-26A	Port Chicago	16			16		
S-26B	Port Chicago	65			65		
S-26C	Ryer Island	580			580		
S-26D	Port Chicago	40		40			
S-27	Martinez	120		120			
S-28	Martinez	360		360			
S-29	Martinez	80		80			
S-30	Martinez	80		80			
S-31	Manmade Channel	500		500			
S-32	Manmade Channel	350		350			
S-33	Collinsville-Montezuma Hills	167	21	84	58	4	
S-34	Collinsville-Montezuma Hills	33		3		30	
S-35	Collinsville-Montezuma Hills	88	8	50	28	2	

Planktonic Organisms

29. Phytoplankton are the microscopic, drifting, often unicellular plants that comprise the base of the aquatic food chain. They exist in very high concentrations in the Delta. During summer months diatoms constitute about 80 to 95 percent of the phytoplankton population, while during the winter and spring months green algae and flagellates make up about 60 to 70 percent of the population. Blue-green algae generally constitutes less than 5 percent of the phytoplankton population in the Delta. Significant blue-green algae populations are usually associated with polluted waters.

30. Zooplankton are tiny free-swimming or drifting animals that feed primarily on phytoplankton and detritus. Their distribution is controlled largely by tides, currents, and winds. Zooplankton are consumed by other organisms such as shrimp and small fish. Two groups of zooplankton — cladocerans and copepods — are roughly equal in abundance throughout the freshwater part of the Delta. In saltwater, cladocerans become relatively less abundant than copepods. Copepods occur in high populations where saltwater and freshwater mix in the Suisun Bay. The mysid shrimp *(Neomysis mercedis)* is an abundant and extremely important zooplankton species in the Delta, for it is the principal food of young fish, notably striped bass. The food of the shrimp are the phytoplankton. The abundance of phytoplankton and the salinity seem to be the most important variables determining the shrimp populations. The phytoplankton and shrimp densities are highest in the entrapment zone. The entrapment zone occurs generally between Honker Bay and Antioch and is closely associated with the mixing area of the freshwater outflow and the saltwaters of the bay. In this zone suspended organics and nutrients tend to accumulate, creating a highly biologically productive area. Downstream of the entrapment zone densities of both groups decrease. Upstream of the entrapment zone phytoplankton density increases and shrimp density decreases. The exact reasons for this are unknown but it is suspected that agricultural pumping may contribute to the shrimp decline or the habitat in the river may not be as suitable as in Suisun Bay where the entrapment zone usually occurs (27). One of the habitat features affecting shrimp distribution may be net water velocity; the concentration of shrimp decreases as the net flow rises above 0.3 feet per second (27). The California Department of Fish and Game has noted a general decrease of shrimp populations in Suisun Bay from 1972 to 1976 as a result of decreased food supplies (32).

31. Federal, State, and local water developments have resulted in the decrease in all aquatic organisms over the last 30 years (61). Although the Central Valley Project and the State Water Project increased average flows in July, August, and September, total annual flows have been reduced substantially. The result of these reduced flows and accompanying increased salinities has been altered distributions of nearly all aquatic organisms. Other factors which contributed to the decrease include flow reversal in many Delta channels, higher than normal net velocities in Delta channels and the loss of individuals through diversions.

Benthic Organisms

32. Zoobenthos are either sedentary or mobile animals that live upon or within the bottom substrate. More than 138 species of benthic animals have been identified in the Bay-Delta system. There are many factors, both biological and environmental, that act individually or in combination to determine the distribution of benthic organisms, including salinity, temperature, depth, substrate, and dissolved oxygen. Since certain of these animals are not mobile, rates of change in salinity may affect the benthos more than the actual salinity content of the water. There are areas of high productivity in both freshwater and saltwater environments and a minimum number of species can be expected in that part of the estuary where variance in salinity and tides is the greatest. Zoobenthic organisms are important sources of food for fish (discussed in paragraphs 33-40), waterfowl, and shorebirds (52). Benthic animals are disturbed in the ship channel by prop wash from 120 to 130 ships per year. The bottom community has adapted to the disturbance and thus is maintaining a stable productivity in the aquatic ecosystem. Maintenance dredging also disturbs the benthic community. Such dredging occurs about once every 5 years, except between Junction Point and Rio Vista where shoaling areas are dredged annually.

Fish

33. The study area is considered to be one of the most important areas for fisheries resources in California. It is used by anadromous sport species such as king salmon *(Oncorhynchus tshawytscha)*, striped bass *(Morone saxatilis)*, steelhead *(Salmo gairdneri)*, American shad *(Alosa sapidissima)*, and white and green sturgeon *(Acipenser transmontanus and A. medirostris)*. The sport and commercial salmon fishery that exists off the California coast emanates largely from the Sacramento-San Joaquin system. Species resident in the project area include white and channel catfish *(Ictalurus catus and I. punctatus)*, brown bullhead *(I. nebulosus)*, and a variety of sunfish — notably largemouth bass *(Micropterus salmoides)*, black crappie *(Pomoxis nigromaculatus)*, and bluegill *(Lepomis macrochirus)*. A crayfish *(Pacifastacus leniusculus)* fishery has developed during the last few years in the Delta. Numerous other species such as threadfin shad *(Dorosoma petenense)*, tule perch *(Hysterocarpus traski)*, Delta smelt *(Hypomesus transpacificus)*, longfin smelt *(Spirinchus thaleichthys)*, splittail *(Pogonichthys macrolepidotus)*, golden shiner *(Notemigonus crysoleucas)*, carp *(Cyprinus carpio)*, blackfish *(Orthodon microlepidotus)*, sculpin *(Leptocotus armatus)*, Mississippi silversides *(Menidia audens)*, and the young of the previously named species make up the food supply for many of the fish. The young of many species and some of the adults depend on zooplankton and benthic organisms for food.

34. Water projects and related developments in the San Francisco Bay and tributaries system have caused or contributed to major declines in anadromous fish populations by eliminating important spawning and rearing habitat and altering habitat in downstream areas through changing flow regimes and salinity distributions.

35. Striped bass utilize the study area more than any of the other anadromous fish. Adults move upstream from the bay and spawn in the San Joaquin River portion of the central Delta and in the Sacramento River above Sacramento. Fertilized eggs drift with the current and hatch in 2 or 3 days. The

newly hatched larvae drift for several days, living off their yolks, until they reach the tidal area where an external food supply exists. The center of this nursery area for young striped bass normally extends from western Suisun Bay to the central Delta. The greatest concentration of bass and food occurs in the entrapment zone. The Fish and Wildlife Service sampled monthly for a year in the manmade channel and in the turning basin and found that the basin and upper channel sustain a population of young striped bass. They feed on the abundant supply of zooplankton which includes the mysid shrimp (56). Although striped bass and shrimp populations fluctuate together, there may not be a direct cause and effect relationship; both may be affected by other factors, such as salinity and velocity (27).

36. About 90 percent of the Central Valley's king salmon run traverses the lower portion of the study area to the junction of the manmade channel. The adult salmon population (which is composed of fall, winter, and spring runs in descending order of abundance) spawns in the upper Sacramento River and its tributaries. Although the bulk of the Sacramento River run proceeds up the river and through Steamboat and Miner Sloughs, Fish and Wildlife Service sampling catches showed that a small part of the run migrates up the manmade channel. Young salmon enter the study area on their seaward migration. When many of them reach the Rio Vista-Collinsville area they are still of sub-smolt size and are not physiologically and/or behaviorally ready to enter the saltwater environment of Suisun and San Francisco Bays. These small salmon linger in the Delta nursery area until they attain smolt size, at which time they proceed in their migration to the ocean. King salmon are harvested in the ocean by both commercial and sport fishermen, although some sport catches are made in the bay. The average annual commercial catch of salmon from the Sacramento River is 500,000 fish with a present day value of about $7.5 million. The ocean sport catch averages 100,000 annually and, with the inland sport catch, had a combined value in 1970 of $1.3 million (1965 dollars). The inland sport catch occurs primarily upstream from the project area (56).

37. American shad is another important sport fish which spends considerable time in the study area. The adults travel through the Delta in the spring during the upstream migration. Most shad entering the Central Valley system spawn in tributaries of the Sacramento River. As with striped bass and salmon, most go up the river, but some proceed up the manmade channel, as revealed by gill net catches. As with striped bass, the eggs of shad drift downstream until hatching occurs. The habitats of young shad are not nearly as well understood as those of young striped bass, but it is known that larval shad are carried downstream and use the study area as a nursery ground. In late summer, a large portion of the juvenile shad travel through the study area during the downstream migration phase. Shad support an intensive sport fishery from about April through July in the Sacramento River and tributaries. Although catch statistics and angler efforts are not documented as they are for striped bass and salmon, a significant amount of recreation is provided as shad are easily caught at times. The Department of Fish and Game is intensifying research on shad due to the increasing recreation importance of the resource (56).

38. Steelhead also migrate through the study area and some use the manmade channel. Spawning takes place primarily in tributaries of the Sacramento River. Natural spawning is augumented by artificial means at three hatcheries operated primarily for salmon. Young steelhead, unlike king salmon, spend a year or more in the home stream prior to migration to the sea. They evidently migrate directly through the study area and do not use it as a nursery area as do salmon. Steelhead provide considerable recreation

for the inland fishermen because steelhead, unlike fall run salmon, continue to feed after entering freshwater. About 20,000 steelhead are caught each year in the Sacramento system, but no ocean fishery occurs for steelhead (56).

39. White and green sturgeon migrate through the study area on spawning runs up the Sacramento River. Spawning, at least for white sturgeon, takes place in the Sacramento River below Red Bluff. The young drift downstream at a very small size and travel through the Delta enroute to San Francisco Bay. On their way to the Bay they probably use the lower project area as a nursery. Department of Fish and Game capture of sturgeon ranging from about 8 to 20 inches (200 to 500 mm) in the manmade channel indicates the sturgeon use the channel for migration and nursery purposes. Spawning habitats of green sturgeon in the Sacramento-San Joaquin system are not known. Collections of green sturgeon have never been made above the Delta, but it has been hypothesized that they do spawn upstream. Larval specimens are found in the Delta. The Fish and Wildlife Service collected one 18-inch (455 mm) specimen at the Port of Sacramento which suggests that some migrate upstream. Sturgeon are not caught in large numbers in the river system, but considerable effort is expended by anglers seeking trophy specimens weighing several hundred pounds. In San Francisco Bay where sturgeon spend a considerable portion of their life cycle, they are pursued with greater success (56).

40. Anchovy *(Engraulis mordax)* and herring *(Clupea harengus)* spawn in San Pablo Bay, Carquinez Strait, and Suisun Bay. They utilize Suisun Bay as a limited spawning and nursery area because of low salinities. Both fish are important commercially. Many nonmigratory or resident fish utilize the study area and other parts of the Delta. Within the manmade ship channel, 15 species were collected during a 1-year sampling program. Resident species support considerable fishing, probal equivalent to that for striped bass. The thicktail chub historically inhabited the Delta and is presently ssified as endangered by the California Fish and Game Commission. It has not been collected or otherwise observed in the Delta for many years (56). A list of the major fish species in the study area is available from the Sacramento District.

Wildlife

41. Wildlife species inhabiting the study area are diverse and abundant. Important avian species include wading birds such as great blue heron *(Ardea herodias)*, black-crowned night heron *(Nycticorax nycticorax)*, great egret *(Casmerodius albus)*, and American bittern *(Botaurus lentiginosus)*; shorebirds such as snipe *(Capella gallinago)*, killdeer *(Charadrius vociferus)*, least sandpiper *(Calidris minutilla)*, and long-billed curlew *(Numenius americanus)*; waterfowl such as mallard *(Anas platyrhynchos)*, pintail *(Anas acuta)*, Canada goose *(Branta canadensis)*, and snow goose *(Chen albifrons)*; upland game birds such as pheasant *(Phasianus colchicus)*, California valley quail *(Lophortyx californicus)*, and mourning dove *(Zenaida macroura)*, and over 150 nongame species. Mammalian species include beaver *(Castor canadensis)*, mink *(Mustela vison)*, muskrat *(Ondatra zibethica)*, river otter *(Lutra canadensis)*, striped and spotted skunks *(Mephitis mephitis and Spilogale putorius)*, racoon *(Procyon lotor)*, black-tailed hare *(Lepus californicus)*, Audubon cottontail *(Sylvilagus auduboni)*, fox *(Urocyon cincereoargenteus)*, oppossum *(Didelphis marsupialis)*, California ground squirrel *(Otospermophilus beechyi)*, and other small rodents (56).

42. The Suisun Marsh provides habitat for the majority of species of birds, mammals, reptiles, and amphibians found throughout the Delta, but the marsh is particularly attractive to wintering waterfowl of the Pacific Flyway. As much as 20 percent of birds using the flyway, or about 1,000,000 birds, utilize the marsh's abundant water and food supply. It has been recently discovered that the endangered Aleutian Canada goose winters in Suisun Marsh. With recently improved management techniques the nesting birds have been increasing in number (9, 56). Waterfowl utilize the Delta at all times of the year. Open water is used by dabbling ducks for resting and by diving ducks for feeding. Marshes and flooded agricultural lands provide the main source of food and cover for dabbling ducks. Ducks feed in the marshes between the channel and the levee when they become flooded by rising tides. The manmade channel probably winters numerous waterfowl in years when the adjacent agricultural lands in the Yolo Bypass are not flooded. A very small amount of nesting may also occur along the manmade portion of the channel.

43. Despite the barrenness of some levees and berms, upland game species such as pheasant, California valley quail, mourning dove, and cottontail rabbit are abundant in the project area because of the favorable habitat provided by the interspersion of crop fields, fallow land, and woody cover bordering Delta channels and along the manmade channel. Furbearers such as muskrat, mink, river otter, skunk, fox, beaver, and weasel are found in the area. Several beaver lodges are located adjacent to stands of willows along the manmade channel (56).

44. Nongame birdlife of the Delta encompasses in excess of 150 species. The herons and egrets are dependent upon a variety of habitats to meet their nesting and foraging needs. Active heron rookeries are located at Stone Lake, Lower Sherman Island, Joyce Island, and Montezuma Slough (2). Agricultural fields, riparian vegetation, and marshes are all utilized by the herons for foraging small rodents, lizards, and fish. The raptors — owls, hawks, and falcons — are an important part of the Delta ecosystem as they feed on fish, birds, mammals, and reptiles. Passerine birds are dependent upon the variety of habitats in the Delta. The value of the passerines extends beyond ecological and esthetic considerations because passerines provide a service of direct economic importance by consuming insects and weed seeds (2, 56). The Department of Fish and Game transplanted tule elk (*Cervus nannodes*) to Grizzly Island in February 1977. There are now 10 free roaming elk in the State wildlife area (23).

Threatened, Rare, and Endangered Plants and Animals

45. The Federal Endangered Species Act of 1973 and the California Endangered Species Act list those species which are endangered, threatened, or rare.

a. Plants. — Twelve species appearing on Federal, State, California Native Plant Society (CNPS), and Smithsonian Institution threatened, endangered, and rare species lists have range distributions which include the Sacramento River Deep Water Ship Channel area (see Table B-4). Two plants listed as endangered on the State lists, the Contra Costa wallflower and the Antioch Dunes evening primrose, occur at the 60-acre remnant of the Antioch Dunes. The Dunes have been declared critical habitat by the Fish and Wildlife Service for both plants (see Figure B-3). The Antioch Dunes evening primrose has also been recently sighted in Brannan Island State Recreation Area. One plant, the California hibiscus, is proposed for endangered status by the Fish and Wildlife Service (53). In addition, the California hibiscus and five other plants observed in the project area are listed as rare and endangered by CNPS. These six plants and their respective range distributions in the Sacramento River Deep Water Ship Channel area are: California hibiscus — Rio Vista vicinity; Lilaeopsis — Montezuma Hills, Sherman Island, and Brannan Island; and Suisun aster, Delta tule pea, Bolander water hemlock, and gum plant — Browns Island. CNPS considers these plants threatened with extinction and not likely to survive "if causal factors now at work continue to operate" and to exist in "only one or a very few restricted localities" and to occur only on a type of habitat that could disappear or change. Other plants listed by the CNPS which have not been observed in the project area but which have range distributions including the Sacramento-San Joaquin Delta are: fragrant fritillary, bearded allocarya, and Balsamorhiza macrolepis. The range distribution of the Northern California black walnut and the bearded allocarya both have been placed on a petition prepared by the Smithsonian Institution for inclusion as endangered and threatened species, respectively, on the Federal threatened and endangered species list.

b. Animals. — Ten species appearing on Federal and State threatened, endangered, and rare species lists (7, 55) have ranges which include distribution in the Sacramento River Deep Water Ship Channel area. Table B-4 lists these species by name and status. Each species has been placed in one or two of the rare and endangered categories. The status of endangered and rare is assigned by the Department of Fish and Game. A species considered endangered is one in which prospects for survival and reproduction are in immediate jeopardy. Its peril may result from one or many causes: mortality rate exceeding birth rate; inability to adapt to disturbance; predation, competition, or disease caused by the introduction of a new species; or environmental pollution. Without help and protection an endangered species would most probably become extinct. A rare species is one that, although not presently threatened with extinction, exists in such small numbers throughout range that it may become endangered if its environment worsens. The status of those species deemed endangered by the Fish and Wildlife Service (53) is essentially the same as that assigned endangered status by the State (7). There are no species classified as threatened (roughly equivalent to State's rare status) by the Fish and Wildlife Service within the study area.

46. Of the 22 species whose distribution includes the study area, 12 are plants, 1 is an insect, 1 a reptile, 1 a fish, 5 are birds, and 2 are mammals. Inclusion of these species in Table B-4 does not confirm the presence of each species within the study area but rather acknowledges their possible presence based upon the distributional characteristics and habitat requirements of each species. The Lange's metalmark butterfly once occurred near Oakley and Antioch, but because of industrial and agricultural development it has been restricted to a few acres near Antioch. Figure B-3 shows the designated critical habitat for the Contra Costa wallflower and Antioch Dunes evening primrose as identified by the FWS (54). The giant garter snake is one of the largest (to 4-1/2 feet) and most aquatic of garter snakes. Although its original range included the southeastern Delta, its current known distribution extends from near Lodi to near Modesto. The thicktail chub was last reported in Steamboat Slough in 1957. It may be extinct now due to draining of riparian marshes, diking, channelization, and other actions (31). Predation by introduced fish may also have contributed to its decline. The Aleutian Canada goose winters in the area and utilizes the marsh and wetlands for resting and feeding. The southern bald eagle ranges over most of California, but nesting is primarily centered in the coastal and interior mountain ranges around large lakes, rivers, and reservoirs from Fresno County north. Use of the Sacramento-San Joaquin Delta

TABLE B-4
RARE AND ENDANGERED SPECIES

Common Name	Status[1] California[2]	U.S.[3]	CNPS[5]	Smithsonian[6] Institution
Mammals				
Salt marsh harvest mouse	E	E	—	—
San Joaquin kit fox	R	E	—	—
Birds				
Aleutian Canada goose	—	E	—	—
Southern bald eagle	E	E	—	—
American peregrine falcon	E	E	—	—
California black rail	R	—	—	—
California yellow-billed cuckoo	R	—	—	—
Reptile				
Giant garter snake	R	—	—	—
Fish				
Thicktail chub	E	—	—	—
Insect				
Lange's metalmark butterfly	—	E	—	—
Plants				
Contra Costa wallflower[4]	E	E	E	—
Antioch Dunes evening primrose[4]	E	E	E	—
California hibiscus	—	—	E	E
Lilaeopsis	—	—	E	—
Suisun aster	—	—	E	—
Delta tule pea	—	—	E	—
Bolander water hemlock	—	—	E	—
Gum plant	—	—	E	—
Fragrant fritillary	—	—	R	—
Bearded allocarya	—	—	E	T
Balsamorhiza macrolepis	—	—	R	—
Northern California black walnut	—	—	—	E

[1]This status is current as of Mar 79. R-Rare; E-Endangered; T-Threatened.
[2]Listed in Animals of California Declared to be Rare or Endangered as published in the California Administrative Code, Title 14, Section 670.5.
[3]Listed in the United States List of Endangered Fauna, as amended in the Federal Register.
[4]Critical habitat has been designated within the study area.
[5]Inventory of Rare and Endangered Vascular Plants of California, California Native Plant Society.
[6]Petitioned by the Smithsonian Institution and submitted to the Fish & Wildlife Service for inclusion on the Endangered and Threatened List.

area by the bald eagle is probably restricted to feeding in grassland areas by those birds migrating during winter months. The California black rail winters in salt marshes bordering San Francisco Bay and has recently been observed in the marsh area east of Pittsburg. Although the yellow-billed cuckoo has not been identified within the Delta, sufficient habitat for it does exist, and the species has been reported both north and south of the study area. The American peregrine falcon visits this area only during a migration movement by an individual falcon. It is not known to utilize the area for either feeding or nesting. Although suitable habitat exists in the southern Delta, the San Joaquin kit fox is generally restricted to areas of natural vegetation found in the coastal foothill areas bordering the San Joaquin Valley further south. Formerly found throughout the extensive brackish and salt marshes once bordering San Francisco Bay, the salt marsh harvest mouse is now restricted to scattered colonies within its original range, including Van Sickle Island and the Montezuma Hills area near Collinsville.

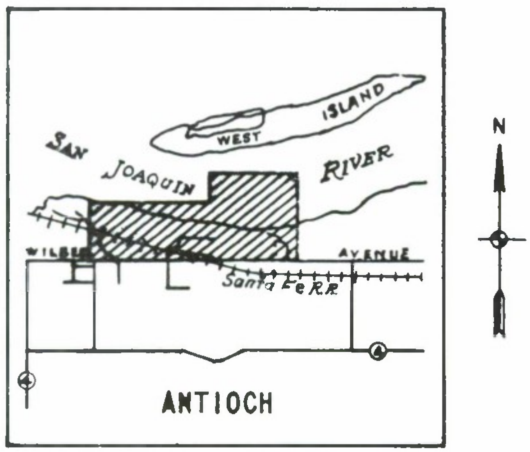


FIGURE B-3

Designated Critical Habitat for Contra Costa Wallflower and Antioch Dunes Evening Primrose

Prehistoric Cultures

47. The area from the Port of Sacramento southwest along the ship channel was part of the ethnographic territories of two aboriginal groups belonging to the Penutian language family. These two groups, the Plains Miwok and the Poo-e-win, made seasonal use of this river area. The Plains Miwok utilized an area extending from the foothills of the Sierra Nevada west to the lower Sacramento Valley. The Poo-e-win occupied the area from Knights Landing and Verona on the Sacramento River south to the north shore of Suisun and San Pablo Bays. Both groups were hunters and gatherers. In prehistoric times, the Delta offered a variety of animal, plant, and aquatic food types, as well as other material necessary for their livelihoods.

48. Much of the prehistoric cultural record has been altered or destroyed by past improvement and land reclamation activities such as dredging, leveeing, and disposal of dredged material. During the cultural resources reconnaissance performed by Corps contractors, one prehistoric site was found west of Lake Washington near the Port of Sacramento. The reconnaissance report recommends preservation of this site (42). It is predicted that little else will be found on the remainder of project lands during the intensive cultural resources survey phase because of previous extensive alteration of the area.

History

49. The Central Valley was first explored in the late 1700's. One of the first explorers was Pedro Fages, a Spanish lieutenant who, in March of 1772, began expeditions from San Francisco Bay during which he explored the rivers and sloughs. In 1776 Anza and Font reexplored the same territory. In 1805 the Spanish Army entered the Delta to track down and return Indians who had escaped the mission system. Ensign Gabriel Moraga led his third exploratory expedition in 1808 up the Sacramento River to perhaps as far as Butte City. The first Americans to explore the area were trappers, one of them being Jedediah Smith, who trapped up the Sacramento River and its tributaries in 1827 and 1828. Alexander Roderick McLeod of the Hudson's Bay Company trapped the same area in 1828 and 1829. During these early days of the activities of the Hudson's Bay Company in the Sacramento Valley, a malaria epidemic swept the aboriginal populations. This epidemic curtailed the Indian's resistance against foreign encroachment more effectively than foreign armies. The Hudson's Bay Company withdrew by the end of 1845 when the area had been depleted of desirable fur species.

50. In the early 1840's, Americans acquired Mexican land grants. One land grant which occupied the greatest portion of the study area was awarded to John Bidwell in November 1844. The grant, located on the north side of the Sacramento River, stretched from the confluence of Cache Slough and the Sacramento River southwest to Sherman Island. After gold was discovered in 1848, many people ascended the Delta rivers on their way to the Mother Lode. With this influx of people the California Indians became so culturally and physically disrupted that they vanished as a race. By 1850 many discouraged miners settled in the Delta and began farming (42). Protection of the farms and towns from flooding began with the private construction of levees. The Corps of Engineers began construction of a comprehensive system of flood control works under the authority provided by the Flood Control Act of 1917 and has continued these actions with the Sacramento River Bank Protection Project authorized by the Flood Control Acts of 1960 and 1974. The first dredging of the Sacramento River for navigation occurred under the authority of the River and Harbor Act of 1899. The River and Harbor Act of 1946 authorized the present 30-foot navigation channel.

51. There are no National Historic properties or Natural Landmarks within the project area. Hastings Adobe, on the National Register of Historic Places, is adjacent to the project area near Collinsville and about a half mile from the river. Two towns are of historical interest. Rio Vista, originally named Brazos del Rio, was laid out in 1857 by Colonel N. H. Davis near the Junction of Cache Slough and the Sacramento River. In 1862 the town was renamed Rio Vista and was owned by the Steam Navigation Company. Floods destroyed the town and it was moved to its present location. Collinsville was a former salmon fishing village built on pilings. The F.E. Booth and Company cannery was established there in 1873. Only a few of the houses built on stilts remain (20).

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Human Resources

53. Detailed information concerning human resources for Sacramento, Yolo, and Solano Counties (the area immediately affected by the ship channel) is presented in this portion of the report. For analytical purposes, "human resources" have been defined to encompass certain demographic variables, including selected population characteristics, employment data, major skills and occupations of the labor force, as well as historical personal income. The data and information presented is largely predicated on empirical data compiled by the U.S. Census, other Federal agencies, and from State of California sources.

Population Characteristics

54. As of mid-1979, total population in the three-county area is estimated at 1,084,700 by the California Department of Finance as shown in Table B-5. This represents an increase of over 20 percent since 1970 and 51 percent since 1960. The State of California population, by comparison, increased by 43 percent during this 19-year period. Since 1960, increases in Sacramento County's midyear population

TABLE B-5
POPULATION TRENDS IN SACRAMENTO, YOLO, AND SOLANO COUNTIES
1960-79
(Midyear Estimates)

Year	Sacramento	Yolo	Solano	Total
1960	510,300	66,400	137,100	713,800
1970	636,600	92,700	172,400	901,700
1971	651,500	93,500	179,000	924,000
1972	661,900	95,500	181,700	939,100
1973	671,400	96,500	180,500	948,400
1974	683,000	98,700	182,400	964,100
1975	691,600	101,700	188,000	981,300
1976	704,100	105,400	193,300	1,002,800
1977	721,100	106,600	200,100	1,027,800
1978	736,600	108,000	207,000	1,051,600
1979	756,700	109,500	218,500	1,084,700

Source: California Department of Finance.

have averaged more than 12,900 persons per year. Within the past 9 years, Sacramento County's most rapid population growth (2.7 percent) occurred in 1979, while the county registered its slowest population growth in 1975 (1.3 percent). Sacramento County has averaged a population increase of 1.9 percent per year during the 1970-79 period.

55. Since 1960, Yolo County's population has been expanding at an average rate of 2.7 percent per year. The County gained an estimated 43,100 persons during this period. Solano County, too, has been one of the fastest growing counties in Northern California since 1960. Population gains during the last 19 years have averaged 2.5 percent per year. In terms of absolute numbers, Solano County has added 81,400 people during this time.

56. The largest cities in the three-county area (in terms of their January 1, 1980 populations) were the city of Sacramento (274,400), Vallejo (75,400), Fairfield (58,100), Davis (37,800), Vacaville (42,450), and Woodland (28,250).

57. Selected demographic and social characteristics of the population of Sacramento, Yolo, and Solano Counties are presented in Table B-6. From a demographic point of view, the age distribution for the three counties closely mirrors that of the State as a whole; the percent distribution of those in the most productive age group (ages 20-64) is identical, 54.0 percent. The only significant difference between the two areas is in the age group of those "65 and over." California has a higher percentage in this category which is also reflected in the median age, 28.1 years for California (not shown) as opposed to 26.3 for the three counties. The median age for Yolo County is only 24.5 and Solano County 24.8, and the median age for the three-county area would be even lower were it not for the fact that Sacramento County had registered a median age of 26.9 in 1970.

58. Of the total population of the three counties, 6.1 percent is black and 8.4 percent is Spanish-speaking. The majority of the black population (67.2 percent) lives in Sacramento County; essentially all of the remainder (30.7 percent) reside in Solano County. The Spanish-speaking population is more evenly distributed, but high concentrations exist in Yolo County, especially in and near the city of Woodland. According to the 1970 Census, 19 percent (169,900 out of 893,200) of the population was classified as "foreign stock" (foreign born and native born of foreign or mixed parentage). The median school years completed by the population 25 years of age and over in 1970 was 12.4 years. This level of educational attainment was the same as for the State as a whole.

TABLE B-6
SELECTED DEMOGRAPHIC AND SOCIAL CHARACTERISTICS
OF SACRAMENTO, YOLO, AND SOLANO COUNTIES, 1970

ITEM	SACRAMENTO	YOLO	SOLANO	TOTAL
Population	631,498	91,788	169,941	893,227
Age distribution				
Under 5	50,790	7,299	15,396	73,485
5-19	195,768	28,057	50,679	274,504
20-64	340,199	49,996	92,452	482,647
65 and over	44,741	6,436	11,414	62,591
Median age	26.9	24.5	24.8	26.3
Racial distribution				
White	566,332	86,786	144,864	797,982
Negro	36,418	1,145	16,656	54,219
Number foreign born	30,580	6,647	8,625	45,852
Foreign stock:[1]				
Total	117,832	20,833	31,284	169,949
Number of Mexicans	15,495	6,217	3,567	25,279
Number with Spanish language	47,368	13,611	14,093	75,072
Median school years completed	12.4	12.4	12.3	12.4
Percent high school graduates	65.8	61.6	62.7	64.9
Percent Negro	5.8	1.2	9.8	6.1
Percent foreign born	4.8	7.2	5.1	5.1
Percent foreign stock:				
Total	18.7	22.7	18.4	19.0
Mexicans	2.5	6.8	2.1	2.8
Percent with Spanish language	7.5	14.8	8.3	8.4

[1]Foreign stock comprises the foreign born and native born of foreign or mixed parentage (i.e., 1st and 2nd generations).

Source: U.S. Bureau of the Census, Census of Population: 1970

Employment

59. Employment trends over the last 5 years for the study area are shown in Table B-7. Nonagricultural wage and salary workers have increased from 311,600 to 384,000 which represents a growth rate of about 4.25 percent per year. Certain employment categories have registered particularly strong gains during this period. Employment in finance, insurance, and real estate, as well as services, has increased dramatically, not only as part of a broader national trend but in response to specific regional needs. Construction activities, as measured by employment opportunities, have also expanded rapidly during the last 5 years. Wholesale and retail trade employment increased 25.6 percent during this time, to 84,000 persons. The single most important employment category in the study area is government; 40.4 percent of all nonagricultural wage and salary workers belonged to this classification in 1977. As subsequently noted, much of government employment in the three-county area is centered in Sacramento, the State Capital. Several major military installations also provide employment opportunities to civilians in the area.

60. Although not significant in terms of present employment levels, much of the manufacturing activity in the area is closely related to agriculture with the dairy industry, food packers, and canners all being important employers. Over 9,400 persons are employed on a permanent annual basis in agriculturally related manufacturing activities, and almost double this number work at the peak of the packing and canning season. The agricultural work force has remained at a relatively stable level during recent years.

Major Skills and Occupations

61. Data on employed civilian workers by occupational group are available from the 1970 Census of Population. Table B-8 is a summary tabulation of the detailed census breakdown of the employed labor force by occupational group for Sacramento, Yolo, and Solano Counties. The table shows that the largest group of workers (both male and female) in the three-county area were clerical and kindred workers; about 69,900 or 23 percent out of a total of 310,900 were so classified in 1970. Professional, technical, and kindred workers and craftsmen, foremen, and kindred workers were the second and third largest occupational groups, comprising about 18 and 14 percent of the employees, respectively. Service workers were the only other occupational group in the three-county area with more than 10 percent of total civilian employment. Among female workers (not shown in Table B-8), the largest occupational category in the three-county area was clerical workers (52,900 out of 120,600), and the second and third largest categories were professional, technical, and kindred workers (21,500) and service workers (18,300). About 77 percent of all employed female workers in Sacramento, Yolo, and Solano Counties were employed in these three occupational groups in 1970.

TABLE B-7
RECENT EMPLOYMENT TRENDS BY INDUSTRY DIVISION FOR SACRAMENTO, YOLO, AND SOLANO COUNTIES 1972-1977[1]
(Thousands)

INDUSTRY	1972	1973	1974	1975	1976	1977
Agriculture	11.4	11.7	12.3	12.8	12.4	11.6
Nonagricultural wage and salary workers	311.6	323.0	336.7	348.1	363.8	384.0
Mineral extraction	.3	.3	.5	.4	.5	.5
Construction	14.6	15.0	15.0	14.6	15.6	18.4
Manufacturing	24.5	25.3	24.5	24.3	25.9	27.8
Food processing	9.0	9.1	9.2	8.8	8.9	9.4
Other nondurable goods	5.3	5.4	5.5	5.5	5.5	5.8
Durable goods	10.2	10.8	9.8	10.0	11.5	12.6
Transportation, communications, and utilities	16.3	16.5	16.8	16.0	17.2	17.8
Wholesale and retail trade	66.9	70.0	72.3	74.9	79.5	84.0
Finance, insurance, and real estate	12.4	13.0	13.7	14.3	15.5	17.1
Services	46.4	49.5	52.4	55.9	59.7	63.3
Government	130.2	133.4	141.5	147.7	149.9	155.1
Federal	39.8	38.2	40.0	40.6	39.6	39.0
State and local	90.4	95.2	101.5	107.1	110.3	116.1

[1]Does not include self-employed, unpaid family or private household workers.
Source: California Employment Development Department.

Personal Income

62. As employment and population have expanded in Sacramento, Yolo and Solano Counties, so too has personal income. From about $4.3 billion in 1972, personal income in the three-county area rose to an estimated $7.3 billion in 1977. This represents an annual growth rate of 11.3 percent, compared to about 11.0 percent for the State as a whole during the same period. Total personal income data for Sacramento, Yolo, and Solano Counties by source are presented in Table B-9 for the years 1972 and 1977.

63. From these data presented, it is evident the largest source of personal income in Sacramento, Yolo, and Solano Counties is wage and salary disbursements which accounted for 62.7 percent of the total income in 1977. Growth in this category was 60.7 percent during 1972-77, 10 percent below the overall growth of total personal income. A related category is "other labor income" which was estimated at $308.8 million in 1977. Although other labor income represents only 4.0 percent of the total income, it was the fastest growing source of income during the 1972-77 period with a gain of 142 percent. The second fastest growing component of income was transfer payments which showed a twofold increase

TABLE B-8

DISTRIBUTION OF EMPLOYED PERSONS BY OCCUPATIONAL GROUP IN THE STUDY AREA, BY COUNTY, 1970

OCCUPATIONAL GROUP	SACRAMENTO COUNTY	YOLO COUNTY	SOLANO COUNTY	TOTAL	% DISTRIBUTION
Professional, technical, and kindred workers	40,649	7,503	7,431	55,583	17.9
Managers and administrators, except farm	20,995	2,534	3,770	27,299	8.8
Sales workers	19,841	1,734	3,086	24,661	7.9
Clerical and kindred workers	54,218	6,354	9,294	69,866	22.5
Craftsmen, foremen and kindred workers	29,693	3,667	8,559	41,919	13.5
Operatives, except transport	13,427	2,089	4,069	19,585	6.3
Transport equipment operatives	7,557	1,559	1,684	10,800	3.5
Laborers, except farm	9,184	1,503	2,400	13,087	4.2
Farm workers	3,085	2,113	1,503	6,701	2.1
Service workers	25,587	4,068	7,480	37,135	11.9
Private household workers	2,777	662	852	4,291	1.4
Total employed, 16 years and over	227,013	33,786	50,128	310,927	100.0

Source: U.S. Bureau of the Census, Census of Population: 1970.

during the period. The total amount of transfer payments came to $995.9 million (16.2 percent) in 1977 compared to $603.7 million in 1972. This growth reflects the increases in social security, welfare, and unemployment benefits. Proprietor's income and property income accounted for the remaining 17.1 percent of total income in 1977, with $496.9 million and $808.5 million, respectively.

64. Per capita income (total personal income divided by total population) in the three-county area has also risen. In 1977, residents of the area had a per capita income of $7,121, way ahead of the 1972 figure of $4,563. However, because the area is less industrialized and more heavily dependent on government and agricultural activities than the rest of the State, its 1977 per capita income figure of $7,121 was about 10 percent below the State average.

65. While it is difficult to adjust income figures over a decade because of inflation, a comparison of median family income provides a basis for determining if a relative improvement in the financial condition of the population has occurred. As Table B-10 indicates, the median income of families in Sacramento, Yolo, and Solano Counties increased about 51 percent during the 1959-69 period. Inflation has generally been calculated at 21 to 26 percent over the same period. Thus, the finances of the population of the three-county area significantly increased between 1959 and 1969. A comparison of income distribution by category provides some insight into income distribution around the median figures. The 1969 data for the three-county area, for example, indicate that the majority of families (61 percent) earned from $8,000 to $24,999 in 1969. There were fewer low income wage earners in 1969 than in 1959, and the number of families making over $25,000 increased significantly during the decade.

TABLE B-9
TOTAL PERSONAL INCOME BY SOURCE OF INCOME
FOR SACRAMENTO, YOLO, AND SOLANO COUNTIES
1972 and 1977
(millions of dollars)

Source	1972	1977	Percent Increase 1972-77
Wage and salary disbursements	2,977.4	4,784.4	60.7
Other labor income	127.5	308.8	142.2
Proprietor's income	350.5	496.9	41.8
Property income	420.6	808.5	92.2
Transfer payments	603.7	1,235.5	104.7
Less: Personal contributions for social insurance	194.2	315.6	62.5
Total personal income	4,285.5	7,318.5	70.8

Source: Bureau of Economic Analysis, U.S. Department of Commerce.

TABLE B-10
DISTRIBUTION OF FAMILIES BY INCOME CLASSES AND MEDIAN FAMILY INCOME IN SACRAMENTO, YOLO, AND SOLANO COUNTIES, 1959 AND 1969

	1959	1969	Percent Distribution 1969	Percent Change
All Families	176,033	226,323	100.0	+ 28.6
Less than $2,000	10,893	10,212	4.5	- 6.3
$ 2,000 - $ 3,999	22,412	17,840	7.9	- 20.4
$ 4,000 - $ 5,999	36,767	22,149	9.8	- 39.8
$ 6,000 - $ 7,999	40,374	27,376	12.1	- 32.2
$ 8,000 - $ 9,999	28,276	30,777	13.6	+ 8.8
$10,000 - $14,999	28,264	64,658	28.6	+128.8
$15,000 - $24,999	7,043	43,474	19.2	+517.3
$25,000 or more	2,014	9,837	4.3	+388.4
Median Income	$6,889	$10,372		+ 50.6

Source: U.S. Bureau of the Census, Census of Population: 1960 and 1970.

Development and Economy

66. Following are pertinent data and information concerning the regional economy, agricultural and industrial development, transportation facilities and services, as well as demographic projections for major social and economic variables. Specific information relating to existing and prospective waterway commerce and vessel traffic is included. A separate analysis is provided for each commodity grouping to serve as a basis for subsequent benefit evaluation.

Agricultural and Industrial Development

67. The study area's economy is comprised of a wide range of industries that are sensitive to the changes in the supply and demand for locally produced goods and services which are consumed both in local markets as well as in markets outside the regional economy. For instance, agriculture in the

TABLE B-11
AGRICULTURAL PRODUCTION IN THE SACRAMENTO VALLEY
(thousands of dollars)

Commodity	1972	1973	1974	1975	1976
Field & seed crops	290,297	490,927	642,731	582,779	483,439
Livestock & poultry	111,301	139,462	128,663	121,583	130,173
Fruit & nut crops	127,757	215,289	187,975	174,214	200,504
Vegetable crops	72,834	106,757	168,759	180,595	125,545
Nursery & cut flowers	6,795	10,494	11,008	13,243	14,794
Apiary products	2,230	3,749	5,252	6,111	5,122
Total	611,214	966,678	1,144,388	1,078,525	959,577

Source: County Agricultural Commissioners.

Sacramento Valley is known for its generally high productivity and for the quality of commodities produced. For many years now, the nine Sacramento Valley counties (Butte, Colusa, Glenn, Sacramento, Solano, Sutter, Tehama, Yolo, and Yuba) have contributed to achieving a high level of agricultural production in the region. Since 1973, the value of agricultural production in the Valley has accounted for about $1 billion a year. As Table B-11 shows, field and seed crops have consistently contributed about half the value of total agricultural output due, mainly, to the abundant rice production in the region. Other important field crops in addition to rice are barley, wheat, alfalfa hay, grain sorghum, corn, and sugar beets. Fruit and nut crops, livestock and poultry, as well as vegetable crops, are also important in terms of agricultural production. The major orchard crops are prunes, almonds peaches, walnuts, pears, and apples.

68. Although not as significant as in other parts of the State, manufacturing activities in Sacramento, Yolo, and Solano Counties nevertheless constitute an important source of employment and output. According to the California Employment Development Department, 27,800 people were employed in manufacturing in 1977. The most significant categories within manufacturing employment are in durable goods and food processing. Almost 80 percent of all manufacturing employment is in durable goods and in food processing categories. Employment in food processing, no doubt, reflects the importance of agriculture to the entire region.

69. Value added by manufacture is considered to be the best measure of relative economic importance of output among industries and geographic areas because it, rather than gross sales, measures the contribution to the economy. This measure of manufacturing activity is derived by subtracting the costs of materials, supplies, containers, fuel, electricity, and contract work from the value of shipments and other receipts. In 1972, the latest year for which data for the three-county area are available, manufacturers in Sacramento, Yolo, and Solano Counties accounted for $0.6 billion of California's $31.3 billion value added by manufacture. Some of the largest manufacturing firms in the three-county area are listed in the following tabulation.

Name of Company	Employment	Type of Business
Aerojet Liquid Rocket Company	2,000	Propulsion systems
Aerojet Solid Propulsion Company	1,200	Aerospace research
Campbell Soup Company	1,750-2,100	Food processing
Del Monte Corporation	300-1,300	Food processing
Libby, McNeil & Libby	260- 900	Food processing
Sacramento Food (Div. of Borden)	300-1,500	Food processing
Rice Growers Assn. of California	380	Milled rice
American Crystal Sugar Co.	280	Sugar beet refining
Exxon Co.	380	Petroleum refinery
Anheuser-Busch, Inc.	400	Brewery
Ball Metal Container Corp.	200	Metal Containers
Carnation Co. (Contadina Div.)	1,000	Canned vegetables, fruit
Spreckels Sugar Co. (AMSTAR)	410	Beet sugar
Mobil Chemical	350	Plastics (polyethlene)
Hunt-Wesson Foods, Inc.	150-1,200	Tomato canning

70. The dominant force on the economic scene in the three-county area is government. It brings more people, more business, and more money to the area than any other single sector. With the State capital and two major military installations (Mather and McClellan Air Force Bases) located in the Sacramento area as well as Travis Air Force Base and Mare Island Naval Shipyard in adjacent Solano County, government continues to be a major source of economic activity. Some idea as to the extent and magnitude of government services within the study area can be obtained from the accompanying tabulation on nonmanufacturing employment.

Name of Employer	Employment	Type of Business
Mather Air Force Base	6,140	A.F. training base
McClellan Air Force Base	16,500	A.F. logistics depot
State of California	48,900	Government
Port of Sacramento	250	Seaport & terminal
Mare Island Naval Shipyard	10,600	Shipbuilding & repair
Travis Air Force Base	2,980 (civilian)	National Security
University of California	6,800 (full-time)	Education & Research

Economic Significance of the Port of Sacramento

71. Since the initiation of activities 17 years ago, the Port of Sacramento has progressively advanced its sphere of economic influence to the point where the port now occupies a significant position in the economic and commercial affairs of the markets in which it operates. Increasingly, it brings to the area access to world markets for both import and export, for both finished goods and raw materials. All of this is accomplished at ocean freight rates that equal those of all other terminal ports on the west coast. This has given major impetus to economic activity in the study area and has helped to broaden and diversify the industrial base of the regional economy. The vast agricultural and forest resources of the Sacramento and Sierra regions, added to the variety of other raw material, make the Port of Sacramento an ideal distribution center and a choice location for industrial development.

72. The economic significance of the Port of Sacramento is enhanced by the fact that the port enjoys some of the most modern and efficient cargo handling facilities for bulk cargo on the west coast. The advantages of the bulk handling facilities of the port are its large, open paved storage areas; large capacity grain elevators; bulk storage warehouses; and extensive bulk conveyor equipment. In 1979, the port handled 2,176,569 tons of cargo with 129 ocean vessels making calls. A very large portion of these movements was bulk commodities such as wood chips, logs, rice, wheat, corn, and fertilizer. Of the 1979 commodity movements, 83 percent were bound for foreign markets. This emphasis on handling foreign exports is important because the port contributes in this way toward a more favorable balance of trade position.

73. In addition to the modern bulk cargo handling facilities, the port's economic significance is buttressed by the availability of large tracts of land along the deep water channel which have been zoned for industrial use and potential port expansion. One area designated for future port expansion is located adjacent to the south side of the turning basin as indicated in the aerial photograph of the Port of Sacramento and Adjacent Areas on page B-44. As indicated on Plate E-5 in Section E of Appendix 1 , this area has also been proposed as a site for dredged material disposal. The use of this site for the disposal of dredged material has been coordinated with port authorities and it has been concluded that this would not be incompatible with port expansion plans. The prospects for additional water-oriented industrial development are strengthened by the fact that undeveloped deep-draft waterfront industrial sites are extremely scarce on the west coast relative to anticipated future demand.

74. Developing at a rate far more rapid than was originally expected, the port provides a base for an important number of jobs and a sizeable amount of income in the north central California area. During 1977, a total of 624,000 manhours were worked by people at the port. Based upon a 40-hour week, this means that an average of 251 people were employed at the port each working day. Several times this number of jobs exist throughout the area because of business that relates to the products and shipping activities at the port.

75. A study in 1976 showed that more than 1,650 people work directly for the port, its major export firms, and servicing companies. For each of these "direct" jobs, there are an additional two jobs indirectly

dependent on the port's economic activities. The total of about 5,000 jobs in the Sacramento area attributable to port business generate basic new dollar income to the area of approximately $60 million per year. These payroll dollars circulate many times throughout the retail market area in purchases of food, housing, transportation and myriad of other uses.

Transportation Facilities and Services

76. Because of its locational advantages in relation to other areas in the western United States, Sacramento is in the unique position to provide multi-modal transportation facilities capable of handling shipments by surface, air, or water. These transportation facilities, combined with the fact that Sacramento is located near the center of California's great Central Valley, make it an ideal base for certain industrial activities including manufacturing, processing, warehousing, and marketing. Sacramento's transportation advantage is also improved by its important role as a regional distribution point to other shipping centers of the Pacific Basin as well as to other parts of the United States.

77. The Sacramento area is located at the junction of two mainline transcontinental railroads, the Southern Pacific and Western Pacific, and is connected to the transcontinental Atchison, Topeka and Santa Fe via the Central California Traction Company. The Sacramento Northern, a short-line carrier, offers rail service to Sacramento Valley markets. The Southern Pacific and Western Pacific have rail yards with total capacity of 1,570 cars. The largest switching and marshalling yard west of Chicago is also located in the Sacramento area and is operated by the Southern Pacific. The yard has a daily capacity of 9,000 cars. The Port of Sacramento has a 200-car holding yard.

78. Four major freeway systems bisect the area. Interstate 80 and U.S. 50 are major east-west directional arterial highways. Interstate 5 and U.S. 99 are major north-south highways. These routes, together with other converging freeways, lend ready access to markets throughout the 11 western states. Interstates 80 and 5 are immediately adjacent to the Port of Sacramento. Forty-one regularly scheduled truck lines and some 500 contract carriers service the Sacramento area.

79. The Sacramento Metropolitan Airport is located 12 miles north of the downtown core area and is surrounded by agricultural land. The airport is a modern facility with up-to-date navigation and safety equipment. The land area encompasses 3,700 acres, 600 of which are utilized for structural improvements. Six major carriers (United, PSA, Western, Air California, Hughes Air West, Frontier) and four commuter carriers serve the airport. In 1977, a total of 2.5 million passengers passed through the Metro Airport, compared with 1.3 million in 1970. There are also several smaller public and private airports within the study area and numerous unpaved airstrips. In addition, there are three major military airfields in the area: Travis at Fairfield and McClellan and Mather at Sacramento.

80. Deep draft navigation improvements in the study area include the existing Sacramento River and Suisun Bay deep water ship channels. These channels currently provide deep water access to the Port of Sacramento for fully loaded ships up to about 18,000 deadweight tons (dwt). Larger ships must be partially loaded and/or await higher tides before using the channels. Between 120 and 130 deep-draft vessels use these channels annually to transport primarily bulk commodities to and from the Sacramento Valley

Port of Sacramento and Adjacent Areas

region. Also, within the study area is a shallow draft channel in the Sacramento River which provides a 10-foot depth at mllw between deep water at Junction Point (mile 14.1) and Sacramento. This channel is currently used mostly by small craft with drafts less than 10 feet. Due to lack of use by commercial vessels, the shallow draft channel has not been maintained since 1973.

Projected Population, Employment, and Income

81. The following paragraphs contain a summary of some of the more important economic variables of the three-county area, and a projection of future growth and development in terms of population, employment, and income.

Population Projections

82. The California Department of Finance has developed demographic projections for the three-county area which incorporate recent data on fertility levels, migration patterns, and mortality rates. The baseline analysis assumes that the "E" level of fertility, or the replacement level of 2.1 births per woman on the average in her lifetime, will characterize United States birth behavior. The difference between the fertility level of each county and that of the United States is diminished gradually to one-half its 1975 value by the year 2015, thus assuming that the individual county fertility characteristics will approach but not reach the United States level in that 40-year period. The mortality pattern, starting from recorded data for 1975, assumes a moderate decline to the end of the projection period. Future net migration to the State will be at an annual average level of approximately 150,000. Based on these assumptions as well as others, the Department of Finance has estimated that population of the three-county area will increase from 1,084,700 in 1979 to 1,857,000 in 2020. This growth represents a compound annual rate of about 1.3 percent which is substantially less than the historical growth rate of 2.2 percent per year obtained since 1950. The annual rate of increase between 1979 and 2020 for Sacramento County is projected at 1.0 percent, 1.1 percent for Yolo County, and for Solano County at about 2.2 percent. Solano County because of its close proximity to the bay area and availability of land for residential construction is expected to grow significantly in future years. The Department of Finance population projections are shown on the following page.

PROJECTED POPULATION FOR SACRAMENTO, YOLO AND SOLANO COUNTIES 1979-2020

	Sacramento	Yolo	Solano	Total
1979	756,700	109,500	218,500	1,084,700
1990	876,700	128,500	286,100	1,291,300
2000	975,600	144,000	365,400	1,485,000
2010	1,064,400	159,400	452,000	1,675,800
2020	1,146,100	171,100	540,200	1,857,400

Source: Population Projections for California Counties, 1975-2020, Series E-150, California Department of Finance, December 1977.

Employment

83. Projected employment by major industry division for Sacramento, Yolo, and Solano Counties is shown in Table B-12. As stated previously, the largest employment category in recent years has been the government sector. In 1977, employment in this category accounted for 155,100 jobs, or about 40 percent of all enumerated positions. It is anticipated that the government sector will continue to remain at a relatively high level in future years, though at a somewhat reduced level from what has been experienced in recent times. There is every indication that the employment base will continue to broaden and diversify in the future in response to greater anticipated needs for various goods and services. Most important and significant will be the sustained proportional increase in the level of employment in service-related jobs. This sector accounted for 63,300 individuals in 1977 and is expected to grow to 177,100 by year 2020. By this time, services will constitute the second largest employment category in the three-county area. The other major employment category is wholesale and retail trade which comprises a large and stable portion of the employment base. The level of employment in the trade industry is expected to grow at approximately the same rate as the population of the area. Manuafacturing employment will gain in relative terms as a result of increased industrial diversification. Food processing will continue to play a major role as growth occurs and as the economic base expands. Employment within transportation, communication, and utilities is expected to correspond closely to future population levels established for the three-county area by the California Department of Finance. The employment picture for the finance, insurance, and real estate category appears to be rather favorable on a long-term basis. Only employment in agriculture and mineral extraction in the three-county area is projected to decline in relative as well as in absolute terms, mirroring a broader-based national trend.

TABLE B-12
PROJECTED EMPLOYMENT BY INDUSTRY DIVISION
FOR SACRAMENTO, YOLO AND SOLANO COUNTIES, 1977-2020
(in thousands)

Industry Division	1977	1990	2000	2020
Agriculture	11.6	11.0	10.0	8.0
Mineral Extraction	.5	.5	.4	.3
Construction	18.4	24.3	29.3	36.7
Manufacturing	27.8	39.3	50.5	66.3
Transportation, Communications and Utilities	17.8	23.2	28.1	35.1
Wholesale and Retail Trade	84.0	111.0	134.1	167.7
Finance, Insurance and Real Estate	17.1	24.8	32.4	46.8
Services	63.3	95.0	132.8	177.1
Government	155.1	187.4	206.1	242.1

Sources: 1977 data from California Employment Development Department; projections by U.S. Army Corps of Engineers, Sacramento District.

Income

84. Projections of total and per capita personal income for the three-county area are shown in the tabulation below. The per capita income estimates are based on rates of increase developed by "OBERS" (U.S. Department of Commerce) for the BEA Economic Area 168, Sacramento. Total personal income, by definition, is a function of per capita income and population. The population projections for the three-county area prepared by the California Department of Finance serve as a basis for the population estimates. As indicated in the tabulation, total personal income for the counties is expected to increase, on a constant (1977) dollar basis, from about $7.3 billion in 1977 to over $41 billion by 2020. Per capita income is anticipated to rise from $7,121 in 1977 to $22,444 in 2020, or at an annual rate of 2.7 percent.

Total Personal Income for Sacramento,
Yolo, and Solano Counties
(in millions of 1975 dollars)

Year	Per Capita Income	Population	Total Personal Income
1977	7,121	1,027,800	7,318.5
1990	10,073	1,291,300	13,007.3
2000	13,431	1,485,000	19,945.0
2020	22,444	1,857,400	41,687.5

Sources: Per capita income estimates based on projected rates of increase by OBERS for BEA Economic Area 168, Sacramento, California; population projections by the California Department of Finance.

Waterway Commerce

85. The commercial significance of the Port of Sacramento is indicated by the enormous increases in tonnages handled at the Port for both outbound as well as inbound commodities in recent years. The Port's first year of operation was 1963, but during the ensuing years the activities at the Port of Sacramento have increased dramatically. As Table B-13 indicates, the total cargo has increased from 545,000 tons in 1966 to over 2.1 million tons in 1979. Even more significant is the increase in tonnage recorded by certain commodities. For example, no wood chips, logs, or fertilizer were moving out of or into Sacramento in 1966. Today, wood chips are one of the most important commodities moving through the Port. More than one-fourth of the Port's total activity for 1979 was based on export of wood chips to the Far East. In excess of 124,000 tons of logs were exported from Sacramento in 1979, and over 359,000 tons of fertilizer material were imported during the most recent full year. The four most important commodities (or commodity groups) in 1979 were as follows: rice (585,456 tons), wood chips (550,791 tons), other grains and oilseeds (487,417 tons), and fertilizer (359,380 tons). The tonnage for these cargoes accounted for approximately 91 percent of the Port's total activity in 1979. Each of these cargoes is discussed in more detail in subsequent paragraphs.

86. Data on the origin-destination of commodity movements through the Port of Sacramento for the 1976-79 period are presented in Tables B-14 and B-15. It is evident that most cargo — about 80 percent in both 1978 and 1979 — is designated for foreign markets and only a small portion is for domestic consumption. Japan and other Pacific Basin countries accounted for 88 percent of the foreign exports at the Port in 1979. The only significant import item is fertilizer imported from Alaska, Norway, and Belgium. The major outbound commodities are wood chips exported to Japan and bulk rice and bagged rice shipped to such places as Puerto Rico, South Korea, Italy, Syria, Peru, Portugal, Bangladesh, and Indonesia. Another important outbound commodity for the Port of Sacramento is logs destined for Japan and South Korea. Wheat and corn shipments are also significant outbound commodities for the Port. The major countries of destination for these wheat and corn shipments in recent years have been Japan, People's Republic of China, Soviet Union, Iraq, South Korea, Mexico, and Chile. Tables B-14 and B-15 demonstrate the far-flung international trade activities at the Port of Sacramento.

TABLE B-13
Tonnages Handled at the Port of Sacramento
1966-1979
(Short Tons)

Commodity	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
OUTBOUND														
Rice	277,515	504,240	502,075	509,435	426,248	428,321	356,328	383,152	374,848	568,747	483,451	548,014	481,656	585,456
Other grains and oilseeds	93,277	290,042	175,257	79,896	56,702	26,403	16,686	189,551	169,512	471,018	425,891	315,483	455,247	487,417
Prepared animal feeds	101,345	84,199	125,249	125,769	105,136	149,005	146,942	62,311	52,200	11,244	43,790	28,226	7,163	15,411
Wood chips	—	41,469	191,757	277,321	267,347	490,842	470,361	662,636	506,115	603,783	452,916	635,336	534,137	550,791
Logs	—	10,080	211,327	329,277	369,521	177,113	24,326	63,102	63,459	106,724	119,748	180,369	122,657	124,698
Other bulk commodities	11,421	13,093	10,015	9,284	47,633	—	58,165	121,451	106,554	116,350	25,331	38,665	25,604	29,508
General cargo	52,164	116,892	44,107	17,202	10,738	12,122	3,052	18,191	15,354	11,416	2,508	2,855	8,097	5,385
INBOUND														
Fertilizer	—	—	—	3,793	19,765	19,549	35,884	72,437	96,215	63,414	101,357	53,080	279,267	359,380
Other bulk commodities	—	—	—	—	—	—	—	—	—	—	—	3,878	—	—
General cargo	9,484	8,057	10,387	6,250	13,841	25,519	24,221	11,780	5,767	1,756	1,320	7,279	5,230	18,523
Total Cargo	545,156	1,068,072	1,270,174	1,358,227	1,316,931	1,328,874	1,135,965	1,584,611	1,390,024	1,954,452	1,656,312	1,813,185	1,919,058	2,176,569

Source: Port of Sacramento

TABLE B - 14

COMMODITY MOVEMENTS THROUGH THE PORT OF SACRAMENTO 1976 AND 1977

(Short Tons)

COMMODITY	1976 TONNAGE	1976 TO/FROM	1977 TONNAGE	1977 TO/FROM
OUTBOUND				
Bulk rice	288,412	Puerto Rico (109,681), South Korea (123,865), Japan (23,677), Italy (14,753), Spain (16,436)	343,298	Puerto Rico (134,403), Italy (120,261), Indonesia (19,359), South Korea (61,355), Syria (7,920)
Bagged rice	195,039	Portugal (58,992), Syria (45,294), Bangladesh (56,345), Indonesia (34,408)	204,716	Portugal (67,680), Syria (31,677), Bangladesh (60,012), Indonesia (44,760), India (587)
Wheat	365,961	Japan (47,578), Ecuador (18,045), Russia (207,307), Peru (8,144), Chile (16,017), India (47,926), Brazil (20,944)	170,064	Japan (98,044), South Korea (13,920), Bangladesh (32,911), Portugal (10,003), Mexico (7,650), Hawaii (7,536)
Corn	40,592	Hawaii (15,238), Taiwan (25,354)	66,131	Hawaii (10,189), Japan (55,942)
Safflower	4,610	Japan	10,482	Japan
Milo	14,728	Hawaii	2,038	Hawaii
Barley	--	--	66,768	Japan (58,636), South Korea (7,220), Hawaii (912)
Alfalfa pellets	24,781	Japan (22,568), Hawaii (2,213)	15,219	Japan (14,446), Hawaii (773)
Cottonseed pellets	1,746	Hawaii	3,991	Hawaii
Beet pulp pellets	15,014	Japan	8,285	Japan
Soybean meal	2,249	Hawaii	731	Hawaii
Wood chips	452,916	Japan (426,200), Italy (26,716)	635,336	Japan
Logs	119,748	Japan (105,851), South Korea (13,897)	180,369	Japan (165,618), South Korea (14,751)
Scrap steel	20,966	Taiwan (10,771), Japan (10,195)	17,714	Japan
Bulk clay	4,365	Taiwan	--	--
Potash	--	--	20,951	Taiwan
General cargo	2,508	Alaska (2,339), Bay Area ports (169)	2,855	Algeria (945), Chile (1,201), Saudi Arabia (626), Puerto Rico (50), India (33)
INBOUND				
Bulk fertilizer	101,357	Norway-Belgium	53,080	Norway-Belgium
Wood chips	--	--	3,878	Inland waterway movement
General cargo	1,320	Gulf ports (468), Japan (852)	7,279	British Columbia (6,714), Japan (565)
Total Cargo	1,656,312		1,813,185	

SOURCE: Port of Sacramento

TABLE B-15
Commodity Movements Through the Port of Sacramento
1978 and 1979
(Short Tons)

Commodity	1978 Tonnage	1978 To/From	1979 Tonnage	1979 To/From
Outbound				
Bulk rice	362,561	Italy (146,168), Puerto Rico (120,913), Indonesia (95,480)	337,576	South Korea (180,640), Puerto Rico (56,061), Portugal (38,029), Italy (27,918), Spain (21,140), Peru (13,788)
Bagged rice	119,095	Indonesia (70,693), Peru (26,106), Portugal (16,966), India (2,954), South Africa (1,210), Bangladesh (1,166)	247,880	Indonesia (191,008), Peru (22,036), Portugal (16,583), Syria (16,098), Bangladesh (2,155)
Wheat	354,075	Iraq (107,046), Japan (89,341), Europe (63,593), Indonesia (31,878), India (24,024), Mexico (20,832), Chile (17,361)	278,127	People's Republic of China (224,460), Chile (31,964), Mexico (21,703)
Corn	97,474	Japan (66,089), South Korea (22,136), Hawaii (9,249)	202,779	People's Republic of China (97,087), South Korea (82,269), Soviet Union (23,423)
Milo	2,874	Hawaii	—	—
Safflower	—	—	6,511	Japan (4,273), Indonesia (2,238)
Soybean meal	824	Hawaii	—	—
Alfalfa pellets	4,382	Japan	—	—
Cottonseed hulls and cake	2,490	Hawaii	—	—
Beet pulp pellets	—	—	15,411	Japan
Almond hulls	291	Hawaii	—	—
Wood chips	534,137	Japan	550,791	Japan
Logs	122,657	Japan (121,786), South Korea (871)	124,698	Japan (111,189), South Korea (13,509)
Scrap Steel	25,604	Japan	16,758	Japan
Bulk clay	—	—	6,978	Japan (4,693), Norway (2,285)
Zinc sulphate	—	—	412	Australia
Magnesite	—	—	5,360	Australia
General cargo	8,097	Europe (4,200), India (2,526), Yemen (1,371)	5,385	Saudi Arabia (2,834), Philippines (1,122), Venezuela (629), Indonesia (583), Finland (217)
Inbound				
Bulk fertilizer	279,267	Norway-Belgium (126,454), Alaska (152,813)	359,380	Norway-Belgium (124,469), Alaska (234,911)
General cargo	5,230	Canada (2,596), Japan (1,556), Johnston Island (1,056), Norway (22)	18,523	Finland (8,685), Greece (4,959), Canada (4,407), Coast Ports (233), South Korea (145), Norway (56), Indonesia (38)
Total Cargo	1,919,058		2,176,569	

SOURCE: Port of Sacramento.

Prospective Waterway Commerce

87. Data and information were obtained from various sources to assess and evaluate prospective waterway commerce. Historical and current tonnage and vessel data were taken from official records of the Port of Sacramento. Interviews were conducted with large-volume shippers and receivers of the principal commodities moving on the ship channel and with carriers, trade associations, port officials, and others in a position to supply data on present and future waterborne tonnage movements. Future tonnages were estimated to the year 2037, with the assumption of a 50-year project amortization period beginning in 1987. The modal and trade route allocation of the projected cargoes was developed after examination of historical data, average size of shipment, cost of movement by alternative modes, and using information obtained from major shippers.

88. Inevitably there are great uncertainties associated with waterborne tonnage projections extending into the future. Insofar as possible an attempt was made to take into account current developments and changing relationships in commodity movements and to adopt those assumptions and judgments as to future trends which at this time appear most reasonable. The projections presented draw on numerous analyses and appraisals. Generally, the projections were developed using both formal statistical techniques and the judgment of experienced people in the trade field, a combination expected to yield better results than either component used alone.

Port of Sacramento

89. Since initiation of activities at the port in 1963, cargo movements have increased dramatically. The port enjoys an excellent reputation among shippers and is in a strategic position to benefit from increased shipments to the Pacific in the future. Those commodities which appear to be the most promising to the port in the future are discussed in the following paragraphs.

90. **Rice.** — Rice is one of the major cargoes moving through the Port of Sacramento, amounting to 586,000 tons or 27 percent of total 1979 movements. Of the 586,000 tons of rice shipped during that year, 338,000 tons were in bulk shipments and 248,000 tons were in bags. The choice between movement in bulk or bags depends most frequently upon the handling facilities available at the distant port. The port here has the only west coast elevator used exclusively for bulk rice. Its storage capacity is 22,000 tons. Most of the rice is shipped by the Rice Growers Association of California (RGA) and Farmers Rice Co-op which operate rice milling and processing plants near the port.

a. Rice in World Export Markets.

(1) Although rice is the staple grain of nearly half the world's population, less than 5 percent of the total rice production enters international trade. The level of world rice trade is only about 10 percent of world wheat trade. The United States and Thailand are the world's major rice exporters. These two countries, plus Pakistan, Burma, and the People's Republic of China, accounted for about 70 percent of the world's 10.6 million tons of average annual rice exports in the 1977-79 period.

(2) The United States, with only 1 percent of the world's rice growing area and 2 percent of total world production, accounts for approximately 22 percent of the rice trade. About two-thirds of its production is generally available for export. U.S. rice exports are divided roughly one-third and two-thirds between Government-financed shipments and cash markets, respectively. The volume of U.S. rice exports averaged 2.33 million metric tons annually in 1977-79 and 2.15 million metric tons annually in 1975-77.

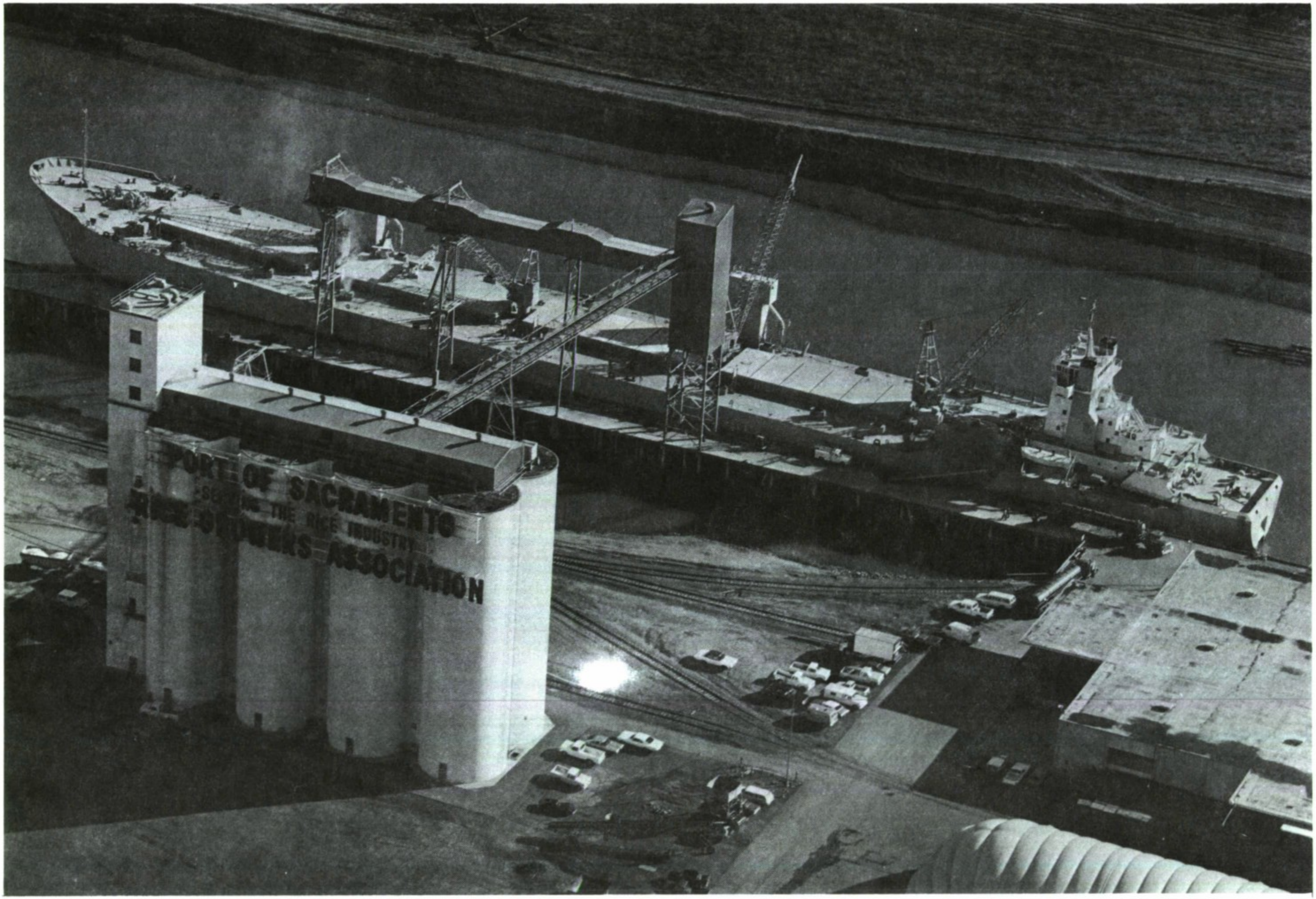
b. Rice in California

(1) Rice is one of California's major crops and has ranked from 10th to 15th in gross value among the leading commodities in recent years. California produces about 20 percent of all rough rice harvested in the United States. Texas, Arkansas, Louisiana, and Mississippi are the only other major rice-producing states. The majority of California rice is produced in the Sacramento Valley with five-sixths of the state's acreage located north of Sacramento. Rice is the number one agricultural crop in Colusa, Butte, Sutter, and Glenn Counties. Other counties in the Sacramento Valley where rice is important are Yolo, Yuba, Sacramento, and Placer. Rice varieties grown in California are grouped into two market grain types — pearl, or short grain and medium grain. The southern states grow principally long and medium grain rice. Within the rice producing districts there are four major milling centers. These are Stuttgart, Arkansas; Sacramento, California; Crowley, Louisiana; and Houston, Texas.

(2) Total yearly production, acreage, and yield of rice for California are presented in the accompanying tabulation for the years 1960 through 1979. During this 20-year period, rice production has grown from 13.8 million hundredweight in 1960 to 33.7 million hundredweight in 1979. In 1979 there were 522,000 acres of rice harvested with an average yield of 6,450 pounds per acre. Rice yields per harvested acre in California have been steadily increasing, and the State average of 6,450 pounds per acre in 1979 represented an increase of 35 percent since 1960 and over 13 percent since 1970. Farm yields of 8,000 pounds per acre of dry, rough rice are obtainable in California under favorable conditions.

c. Markets and Shipments

(1) California grown rice has been shipped through the Port of Sacramento to destinations throughout the world. Since the port began operations, Puerto Rico has been one of the largest and most stable rice export markets. Large shipments of rice are also made to markets in Indonesia, Italy, South Korea, Portugal and Bangladesh. The recent large shipments of rice to Italy (294,347 tons in the 1977-79 period) through the port are a result of crop failures in that country. These shipments consisted entirely of unmilled paddy rice and represented the first time such shipments have been handled by the port.



Bulk Rice Loading and Storage Facilities at the Port of Sacramento

Crop Year	Acreage Harvested	Yield Per Acre	Production	Crop Year	Acreage Harvested	Yield Per Acre	Production
	(1,000 acres)	(pounds)	(1,000 cwt)		(1,000 acres)	(pounds)	(1,000 cwt)
1960	288	4,775	13,752	1970	331	5,700	18,867
1961	290	4,800	13,920	1971	331	5,200	17,212
1962	323	4,950	15,988	1972	331	5,700	18,868
1963	324	4,325	14,013	1973	401	5,616	22,521
1964	327	5,050	16,514	1974	467	5,380	25,110
1965	327	4,900	16,023	1975	525	5,750	30,179
1966	327	5,500	19,800	1976	399	5,520	22,017[1]
1967	360	4,900	17,640	1977	308	5,810	17,913[1]
1968	432	5,325	23,004	1978	490	5,220	25,578
1969	389	5,525	21,492	1979	522	6,450	33,669

[1]The level of rice production in California was adversely affected by the serious drought experienced in 1976 and 1977.
Source: California Crop and Livestock Reporting Service.

Rice is also exported in smaller quantities to many other countries. Since 1975 shipments have been made to Japan, Spain, Syria, Peru, South Africa, and India. The destinations of rice shipments through the Port of Sacramento during the period 1966-79 are presented in Table B-16. In some years, a large portion of the rice shipments through the port move into world markets under Public Law 480 (Food For Peace) and other concessional sales programs.

(2) In the future, the Puerto Rican market is expected to remain a major destination of the rice shipments through the Port of Sacramento. The Rice Growers Association (RGA) and Farmers Rice Co-op have receiving and packaging facilities located near San Juan and presently account for approximately 80 percent of the Puerto Rican rice import trade. The trend in rice exports from the Port of Sacramento to markets in Europe, South Korea, and Indonesia is expected to continue to develop and expand in the future. Large potential markets for California rice also exist in many of the developing countries of the world and are expected to develop further in future years.

(3) The major factor contributing to the continuing demand for California rice is its growing foreign export market. Over the years the domestic markets and Puerto Rico have had a relatively stable demand for California rice. The growth in California rice production is a direct result of the growth in the foreign demand. This growth in foreign demand is illustrated in Table B-17 which presents historical rice shipments by the California mills.

d. Projections

(1) World population is projected to increase by another 1 to 2 billion people from 1985 to 2000; by the year 2000 the world population will be at least 50 percent greater than it is today. A large portion of this increased population is expected to be concentrated in the already over-populated, food-deficient

TABLE B-16
Port of Sacramento Rice Shipments by Destination
1966-1979
(Short Tons)

Year	Puerto Rico	South Korea	Japan	Bangladesh	Europe	Syria	Indonesia	Okinawa	Southeast Asia	Hawaii	India	Africa	South America	TOTAL
1966	106,605	—	72,290	—	—	—	—	51,794	46,401	425	—	—	—	277,515
1967	114,680	81,865	83,183	—	—	—	—	46,434	178,078	—	—	—	—	504,240
1968	106,018	315,969	—	—	—	—	—	66,564	13,524	—	—	—	—	502,075
1969	116,095	332,438	—	—	—	—	—	60,902	—	—	—	—	—	509,435
1970	121,482	228,481	40,863	—	—	—	—	35,422	—	—	—	—	—	426,248
1971	85,859	313,214	10,109	—	—	—	—	19,139	—	—	—	—	—	428,321
1972	128,877	227,451	—	—	—	—	—	—	—	—	—	—	—	356,328
1973	103,860	242,432	—	—	20,130	—	—	—	16,730	—	—	—	—	383,152
1974	117,943	138,067	7,262	—	33,133	—	45,615	—	32,828	—	—	—	—	374,848
1975	131,207	386,297	—	51,243	—	—	—	—	—	—	—	—	—	568,747
1976	109,681	123,865	23,677	56,345	90,181	45,294	34,408	—	—	—	—	—	—	483,451
1977	134,403	61,355	—	60,012	187,941	39,597	64,119	—	—	—	587	—	—	548,014
1978	120,913	—	—	1,166	163,134	—	166,173	—	—	—	2,954	1,210	26,106	481,656
1979	56,061	180,640	—	2,155	103,670	16,098	186,588	—	4,420	—	—	—	35,824	585,456

SOURCE: Port of Sacramento

TABLE B-17
RICE SHIPMENTS BY CALIFORNIA MILLS TO VARIOUS OUTLETS
1955-1975
(short tons)

Crop Year	Puerto Rico	Hawaii	Guam	Foreign Exports	Domestic Markets	Government Agencies	Total
1955	85,810	28,068	6,301	4,191	41,705	4,543	170,618
1956	102,823	30,636	7,596	147,133	52,388	4,891	345,467
1957	106,522	28,812	6,788	26,541	45,429	61,638	275,729
1958	120,209	28,962	7,006	66,031	84,072	4,045	310,325
1959	114,579	29,097	6,563	88,898	64,637	1,705	305,479
1960	101,210	31,763	5,149	107,740	81,136	40,100	367,198
1961	120,917	22,603	3,044	179,106	80,390	100,614	506,674
1962	112,975	27,969	3,100	223,542	82,993	22,944	473,523
1963	123,137	27,257	3,906	259,130	67,214	5,872	486,516
1964	121,100	25,427	3,936	219,737	77,362	3,993	451,555
1965	127,470	25,260	4,815	202,612	62,527	3,860	426,544
1966	140,895	25,677	4,231	424,304	77,727	4,831	677,665
1967	115,807	26,373	4,125	342,046	79,217	1,661	569,229
1968	140,956	27,742	7,505	512,893	91,836	5,629	786,561
1969	138,910	27,423	7,555	354,535	101,941	4,429	634,793
1970	130,575	28,858	3,670	310,605	109,122	7,468	590,298
1971	135,280	30,326	6,374	346,419	131,902	8,221	658,522
1972	126,088	27,974	8,076	303,664	161,855	7,761	635,418
1973	114,069	29,103	12,590	354,226	169,341	7,835	687,164
1974	143,082	30,354	6,446	488,180	101,494	4,847	774,403
1975	132,030	28,893	6,443	496,625	97,731	8,557	770,279

Source: U.S.D.A., A.M.S., "Rice Market News" February 23, 1977.

developing Asia. On that basis, long-term world rice supplies are likely to remain short as demand continues to expand. The U.S. will likely continue to hold its position as one of the world's leading rice exporters. Rice shipments from the Port of Sacramento averaged 538,000 tons annually in the 1977-79 period and 371,000 tons annually in the 1972-74 period. These shipments are projected to increase to 680,000 tons by 1987 and to 1,250,000 tons by the year 2037.

(2) The rice projections were developed following a careful review of recent studies of future trends in rice production and trade made by the Food and Agriculture Organization (FAO) of the United Nations and the U.S. Department of Agriculture. The U.S. will export about 2.8 million metric tons of milled rice in 1985 by recent FAO estimates, up from an annual average of 2.33 million tons in 1977-79 and 2.15 million tons in 1975-77. U.S. shipments of rice in 1985 will account for about 28 percent of overall world exports under the FAO projections, an increase of nearly 6 percent from 1977-79. Indonesia is expected to remain the largest importer of rice during the projection period, reaching 2.45 million metric tons by 1985, or one-fourth of total projected world imports. FAO's study points out that there will be a projected global "deficit" of 3 million tons of paddy rice by 1985. Rice production in the United States for

1985 is projected at 6.25 million metric tons by the FAO, up from 5.27 million tons in 1977-79. The rice projections contained in the recent grain-oilseed-livestock (GOL) model developed by the Foreign Demand and Competition Division, U.S. Department of Agriculture, also show increases in U.S. rice exports; by the year 1985 exports will have increased from 1.9 million metric tons in 1973-74 to 1975-76 to between 3.0 and 4.0 million metric tons, depending on the alternative projection level considered.

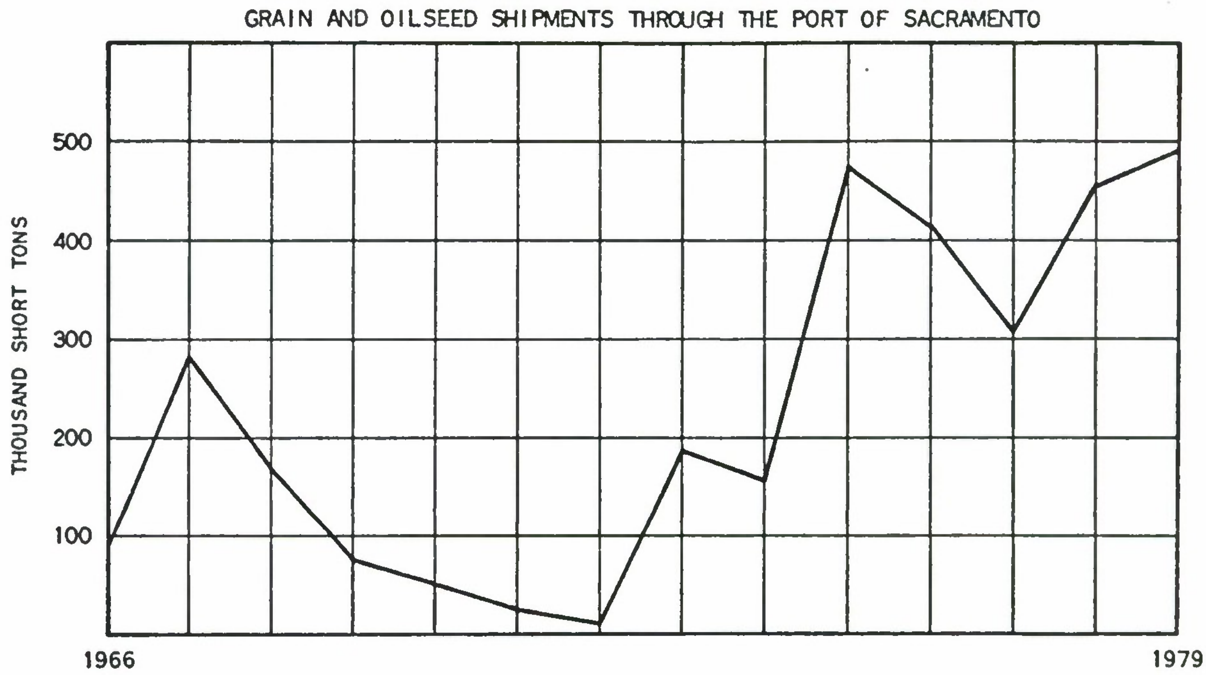
(3) The amount of rice that will be available for export through the Port of Sacramento in the future was correlated to the rice yield projections for California contained in the OBERS projection series. It was assumed that the amount of acreage devoted to rice production in the future will remain relatively constant at its current level. Presently, there are about 500,000 acres in rice production. It is believed that this level represents the maximum area in California that is economically feasible for long-term rice production. A listing of the projected rice shipments developed for the Port of Sacramento by destination is contained in the following tabulation.

Port of Sacramento Rice Shipment Projections
(1987-2037)

Year	Puerto Rico	East Asia	Europe, Africa, South and Southeast Asia, And Western Asia	Total Tonnage
1987	145,000	200,000	335,000	680,000
1997	160,000	245,000	400,000	805,000
2007	172,000	300,000	478,000	950,000
2037	195,000	410,000	645,000	1,250,000

91. **Other Grains and Oilseeds** — Grains (except rice) and oilseeds moving to offshore markets through the Port of Sacramento have been destined primarily for Japan, the Soviet Union, People's Republic of China, Iraq, South Korea, India, Chile, Mexico, and Hawaii. These shipments have included milo, safflower, wheat, barley, and corn. The following figure illustrates the trend in these shipments since 1966. As indicated, these grains comprised only 93,000 tons of cargo at the port in 1966. The tonnages have increased sharply in recent years to a high of 487,417 tons in 1979.[1] The major component of these shipments is wheat. In the 1978-79 period, there were 632,202 tons of wheat exported through the Port of Sacramento to markets in the People's Republic of China, Iraq, Japan, Europe, Chile, Mexico, Indonesia, and India. The wheat that is exported through the port is grown primarily in the Sacramento Valley and the northern portion of the San Joaquin Valley. From 65 to 75 percent of the wheat grown in the Sacramento Valley is bound for foreign markets. The predominant variety of wheat grown in the Sacramento Valley is Anza, a low-protein variety. Anza averages a 9 percent protein value in the Sacramento Valley, about 2 percent less than that sought by most exporters. This may require shippers to import more high-protein wheat from out-of-state sources in the future. This high-protein wheat could then be blended with the lower protein, but higher yielding, Anza variety grown in California to produce a quality of wheat more acceptable to exporters. Some high-protein wheat from Colorado has moved through the port in recent years.

[1]Tonnages in 1977 were down significantly due to the drought that prevailed throughout California.



92. Cargill, Incorporated leases and operates the export grain terminal at the Port of Sacramento. In 1978, Cargill began receiving corn shipments by unit trains (50 to 75 cars) from Nebraska and Western Iowa, for export through the port. The transportation costs of these shipments are economically competitive because of new unit train export rates from the Midwest to west coast ports. The new export rates apply to unit train shipments of corn, milo, and soybeans. These out-of-state shipments should substantially increase the amount of corn shipped through the Port of Sacramento in future years. The competitiveness of these unit train shipments from the Midwest can be seen in the following tabulation showing recent increases in corn exports through California ports. Most of the unit train shipments have been handled at the Ports of Long Beach and San Francisco where vessels in the 30-50,000 dwt range can be fully loaded on existing channels.

Corn Exports Through California Ports, 1976-79
(metric tons)

Ports	1976	1977	1978	1979
Sacramento	22,988	64,494	80,057	215,907
Stockton	53,469	66,780	76,702	41,806
San Francisco	17,425	32,412	198,172	288,025
Long Beach	44,782	224,879	1,011,241	1,447,883
San Diego	—	—	—	10,748
Total	138,664	388,565	1,366,172	2,004,369

Source: Grain Cargoes Inspected for Export, 1976-79, U.S. Department of Agriculture.

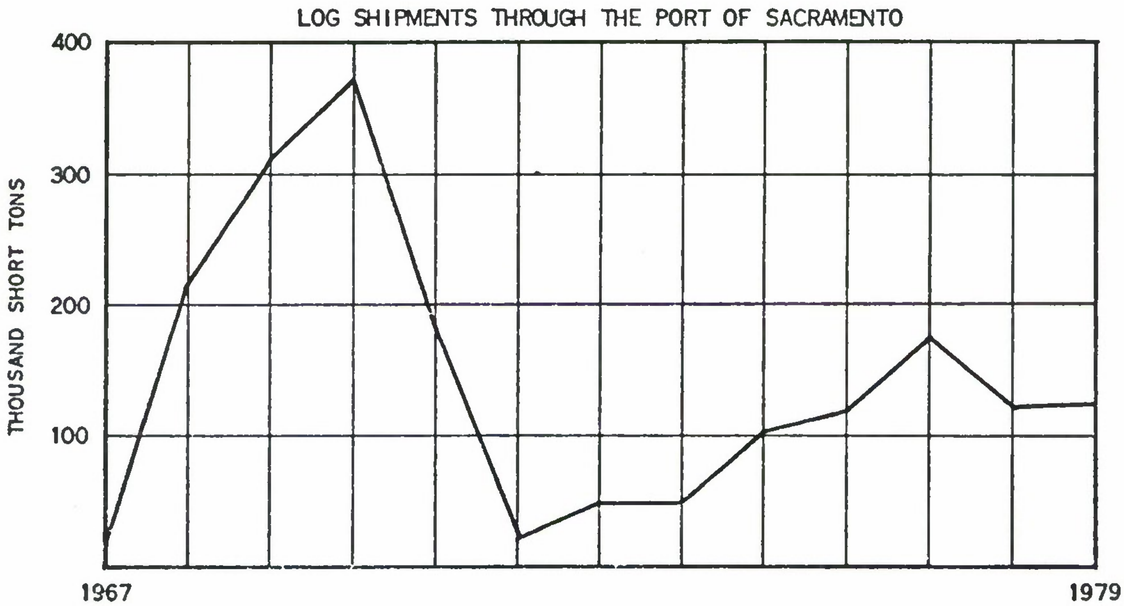
93. The economic relationships established in this analysis suggest that grain movements (especially corn and wheat) will continue to increase in the future and become more important to the port's overall activities. There are several factors which warrant this conclusion. First, in line with marketing forecasts, grain production in California is expected to expand in the future. This is largely predicated on past trends and likely future supply and demand relationships for export grain. Second, there is every indication that the number of unit train movements of corn from Midwest points through port facilities will increase in the future (corn exports increased from 88,225 tons in 1978 to 202,779 tons in 1979). However, it is clear that these movements will not reach their full market potential unless a deeper channel is provided. Sacramento is at a disadvantage compared to other west coast ports in competing for this business since it cannot handle the vessel sizes required by many Asian buyers. Informed sources in the trade indicate that the port needs to be able to accommodate vessels in the 30-35,000 dwt range in order to attract large increases in this traffic. Third, expanding markets overseas, especially in the People's Republic of China, Japan, the Soviet Union, and many of the less developed countries, will require substantially increased grain exports in the immediate future. Finally, there are specific indications that the People's Republic of China, Japan, and other countries in the Far East will move larger quantities of grain through the west coast in order to take advantage of the faster turnaround time for their vessels (compared to Gulf ports) and to avoid the rising cost of transporting grain through the Panama Canal. Recent increases in bunker fuel prices have resulted in a substantial widening of the ocean freight advantage enjoyed by west coast ports to Asian destinations. This development has been and will continue to be good for west coast business. Between 1977-78 and 1978-79, west coast feed grain exports more than doubled, moving from 88 million bushels to 178 million bushels. The projections presented below incorporate these assumptions. By 1987, grain shipments are expected to account for 600,000 tons of cargo that will pass through the port. As indicated, most of this will be shipped to East Asia. This tonnage is expected to increase to 1,200,000 tons per year in 2037.

**Other Grains and Oilseeds Projections
for the Port of Sacramento**

Year	East Asia	Hawaii	Other	Total Tonnage
1987	425,000	25,000	150,000	600,000
1997	510,000	30,000	180,000	720,000
2007	605,000	35,000	215,000	855,000
2037	850,000	45,000	305,000	1,200,000

94. **Logs** — Logs are also shipped in large quantities from the Port of Sacramento, totaling 124,698 tons in 1979. These shipments originate in the mountain areas around the Sacramento Valley and are shipped to Japan and South Korea, with Japan being the major customer. The principal receiving ports in Japan for the logs are Tanabe, Kisarazu, Oita, Hosajima, Tagonoura, and Kagoshima. Export log species include white fir, Douglas fir, and pines. Most of the logs are exported by Nippi International and Fibrex Shipping companies.

95. As illustrated in the following figure, log exports through the port have fluctuated greatly in recent years, between a high of 370,000 tons in 1970 and a low of 10,000 tons in 1967. This was due to irregular market conditions and some shifts in the cutting areas. In addition, Northern California logs find acceptance in Japan and other parts of the Orient only after there is considerable pressure on the large Washington-Oregon market. Log exports from the port have exceeded 100,000 tons annually in the last 5 years, and 1980 shipments will be close to 135,000 tons.

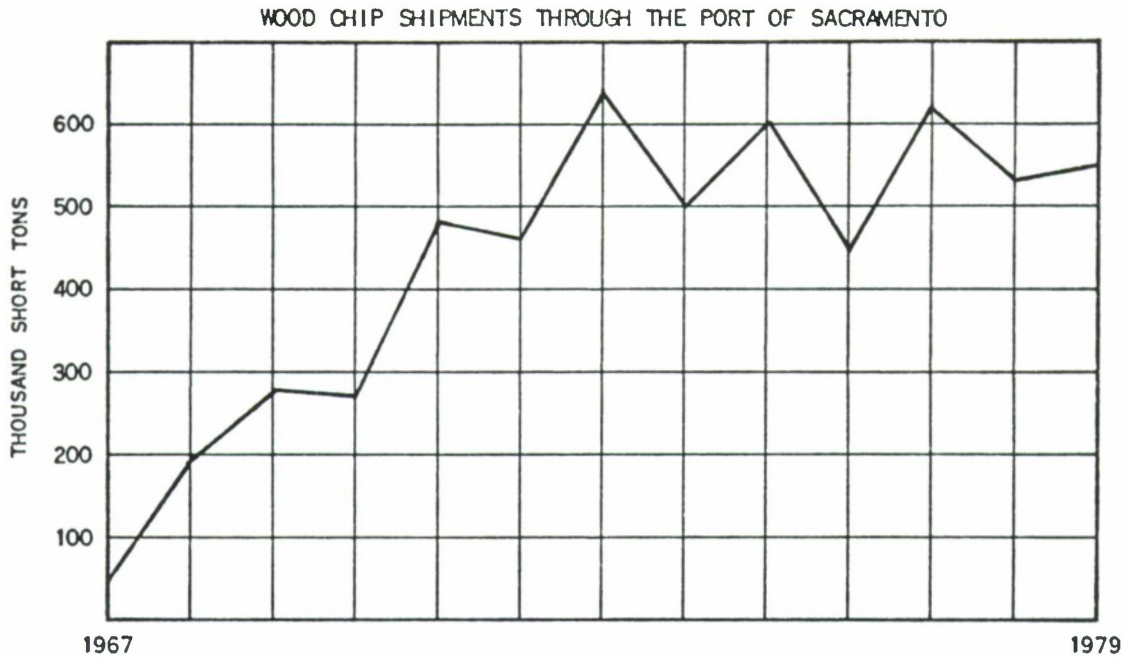


96. Contacts with the major companies selling and buying export logs in California indicate that substantial increases in export volumes are not likely in the future and that, barring restrictive legislation, export volumes will remain fairly constant at the current level. For purposes of this study it was assumed that the 1977-79 average level of log exports (approximately 135,000 tons) is the most probable level of log exports throughout the 50-year projection period.

97. **Wood Chips** — Wood chips are shipped in large quantities from the Port of Sacramento, amounting to 551,000 tons or 31 percent of total 1979 shipments. The wood chips are produced from the residue of sawmills, veneer mills, and other wood-using plants and sent exclusively to Japan where they are used to manufacture paper and paper products.[1] Most of the wood chips are currently being shipped to pulp mills in Toyama and Kushiro, Japan. Three companies purchase the wood chips for the mills in Japan-Louisiana Pacific, Mitsui & Company, and Marubini & Company. The wood chips are brought to the port by rail and truck from northern California, southern Oregon, and western Nevada.

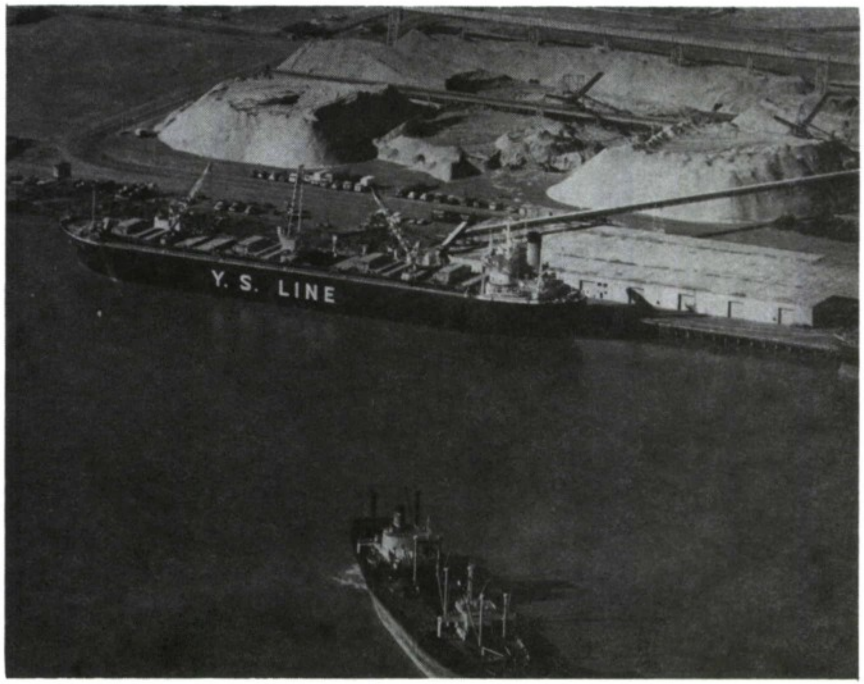
98. The following figure shows the tonnages of wood chips from the beginning of shipments in 1967 through 1979. Tonnages in 1976 were down significantly due to a major fire in June that destroyed most of the wood chips stockpiled at the Port and most of the conveyor belts associated with chip handling. All of the chip facilities that were destroyed in the fire have since been replaced and are currently in full operation.

[1]In 1976, Louisiana Pacific had a trial shipment to Italy of approximately 27,000 tons of wood chips which was loaded at the Port of Sacramento.



99. Japan's pulp and paper industry depends on wood chip imports for about 50 percent of its pulp requirements. Table B-18 shows Japan's wood pulp imports by country for the 1969-75 period. The data indicate that about 65 percent of Japan's pulp import needs are currently being supplied by wood chips from the United States. Australia, Malaysia, the Soviet Union, and New Zealand are also major suppliers to the Japanese market. Seven woodchip handling facilities along the west coast are currently shipping about 3.5 million bone dry units of wood chips (1bdu=2,400 pounds of bone dry wood equivalent) to Japan each year. These facilities are listed in the following tabulation.

	Bone Dry Units
Coos Bay	1,560,000
Longview	400,000
Portland	570,000
Humboldt Harbor	300,000
Greys Harbor	100,000
Tacoma	260,000
Sacramento	300,000
	3,490,000



42,124 dwt Tonami Maru loading
wood chips at the Port

37,300 dwt Valentina berthing at
Port of Sacramento to load wood chips

TABLE B-18

JAPAN'S WOOD PULP IMPORTS, BY COUNTRY 1969-1975

(Cubic Meters)

YEAR	ITEM	USSR	USA	AUSTRALIA	MALAYSIA	NEW ZEALAND	INDONESIA	NEW GUINEA	OTHER	TOTAL
1969	Pulpwood	140,528	--	318	69,127	--	5,307	--	116,952	332,232
	Wood chips	--	3,221,582	4,957	130,672	15,975	--	--	7,827	3,381,013
	Total	140,528	3,221,582	5,275	199,799	15,975	5,307	--	124,779	3,713,245
1970	Pulpwood	276,269	--	--	84,964	6,237	24,937	--	168,686	561,093
	Wood chips	--	4,281,820	--	486,557	152,252	--	--	3,570	4,924,199
	Total	276,269	4,281,820	--	571,521	158,489	24,937	--	172,256	5,485,292
1971	Pulpwood	173,540	10,020	4,622	89,374	1,880	56,651	--	209,745	545,832
	Wood chips	--	4,504,669	304,210	514,399	173,898	--	--	9,221	5,506,397
	Total	173,540	4,514,689	308,832	603,773	175,778	56,651	--	218,966	6,052,229
1972	Pulpwood	164,973	--	--	70,934	--	46,047	--	82,298	364,252
	Wood chips	30,894	5,733,036	883,086	553,096	228,976	11,041	--	23,332	7,463,461
	Total	195,867	5,733,036	883,086	624,030	228,976	57,088	--	105,630	7,827,713
1973	Pulpwood	361,794	24,511	15,234	58,597	3,327	193,657	--	29,883	687,003
	Wood chips	84,802	7,565,313	2,033,114	605,535	297,758	--	--	34,541	10,621,063
	Total	446,596	7,589,824	2,048,348	664,132	301,085	193,657	--	64,424	11,308,066
1974	Pulpwood	349,687	171,412	89,296	171,312	60,315	373,681	25,459	9,245	1,250,407
	Wood chips	250,040	8,681,257	2,584,537	849,102	323,141	--	78,289	29,661	12,796,027
	Total	599,727	8,852,669	2,673,833	1,020,414	383,456	373,681	103,748	38,906	14,046,434
1975	Pulpwood	304,673	82,244	69,884	15,057	36,542	87,573	8,337	--	604,310
	Wood chips	390,978	7,701,283	1,962,947	687,249	358,257	--	161,066	1,840	11,263,620
	Total	695,651	7,783,527	2,032,831	702,306	394,799	87,573	169,403	1,840	11,867,930

SOURCE: Japan Paper Association

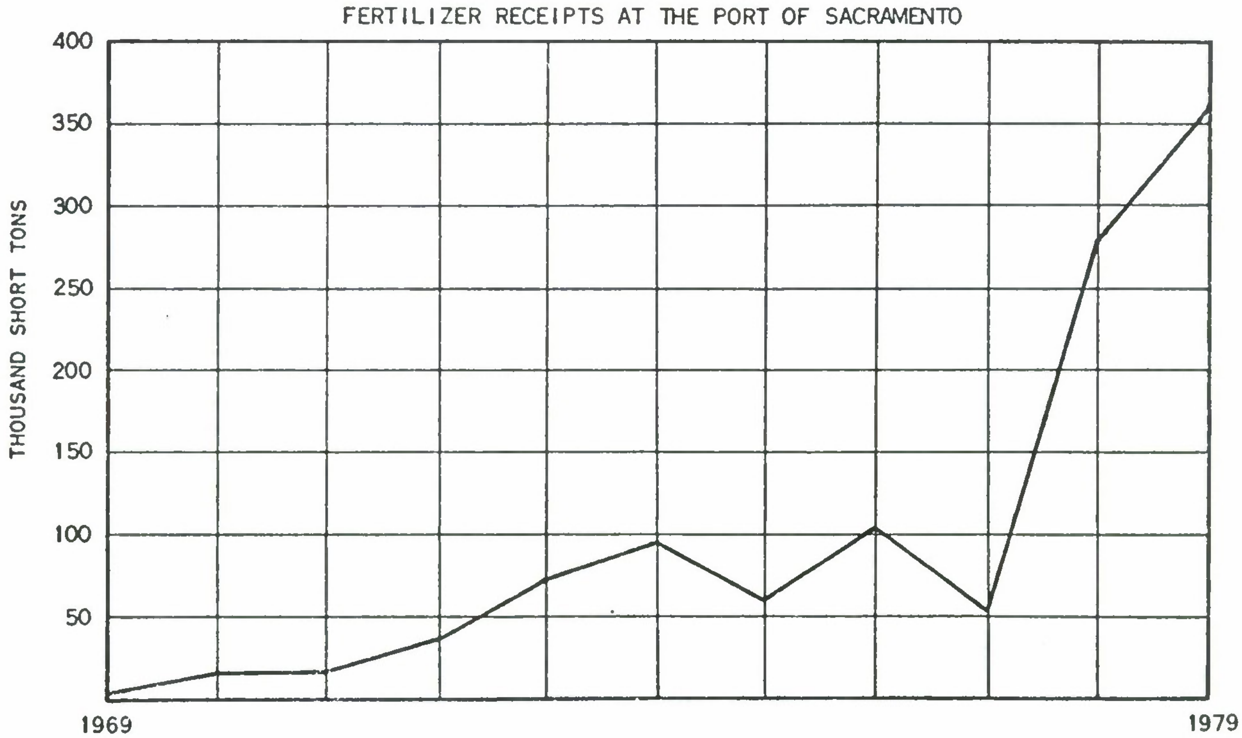
100. Wood chips are expected to remain one of the major cargoes moving through the Port of Sacramento during the projection period. The recent world recession significantly affected the Japanese economy and in turn the demand for paper in Japan. This resulted in a slowdown in wood chip exports. With a resurgence in Japan's paper industry beginning in 1979, the port is now experiencing a larger volume of wood chips through its facility. The port has also recently signed two new wood chip shipping contracts with Diashowa and Kanematsu Gagoshu paper companies in Japan which add to existing agreements for Japanese wood chip movements. The most recent projections by the Japan Paper Association show imports of wood chips from North America increasing from 8.1 million cubic meters in 1976 to 14.3 million cubic meters in 1985. Wood chips exported through the Port may also be going to Taiwan and South Korea, and possibly the People's Republic of China in future years.

101. Estimates of projected tonnage of wood chips through the Port were based on data collected during interviews with both shippers and private companies in the timber industry. Recent survey data from the U.S. Forest Service showing current levels of mill residue, logging residue, and cull material available for chipping and export were reviewed and used in the analysis. Future wood chip exports through the Port are expected to increase to approximately 1.1 million tons by the mid-1980's and remain at about that level over the remainder of the projection period. This projection recognizes that there will be an increasing domestic demand for mill and logging residue in the future to meet energy and raw material needs in northern California.

102. **Fertilizers and Fertilizer Materials** — The Port of Sacramento is the receiving point for large quantities of nitrogenous fertilizer used in Central Valley agricultural production. Supplies come from Porsgrunn, Norway, and Antwerp, Belgium, in bulk and are bagged at the Port. The receipts include calcium nitrate, urea, ammonia sulfate, and complex fertilizers (NPK). Norsk Hydro of Oslo, Norway, is the producer of the fertilizer and it is being distributed in the United States by the Wilson and George Meyer and Company of South San Francisco.

103. Additional nitrogen supplies began arriving at Sacramento in May 1978. Union Oil's Chemicals Division has recently constructed a bulk fertilizer storage facility on the deep water channel to handle anhydrous ammonia and prilled urea. The facility consists of two 20,000-ton refrigerated storage tanks for ammonia, complete with docking facilities on the channel for receiving ammonia tankers. Dry bulk storage is also provided at the facility for approximately 20,000 tons of urea. A photograph of this facility is shown on page B-78. Products received at the new terminal are produced at Union's ammonia-urea fertilizer complex on the Kenai Peninsula southwest of Anchorage, Alaska. The raw material feedstock for the operation is natural gas from the Kenai gasfields on Cook Inlet. The Kenai facility has a daily output capacity of 3,000 tons of ammonia and 2,000 tons of prilled urea. The ammonia is delivered to Sacramento by tanker and the urea by ocean barge.

104. Fertilizer receipts at Sacramento have increased dramatically in recent years, accounting for about 360,000 tons during 1979. The following figure shows tonnages from the beginning of receipts in 1969 through 1979. Nitrogen fertilizers are being imported into California in larger quantities each year because natural gas shortages and high gas costs have forced shutdowns in the California nitrogen industry.



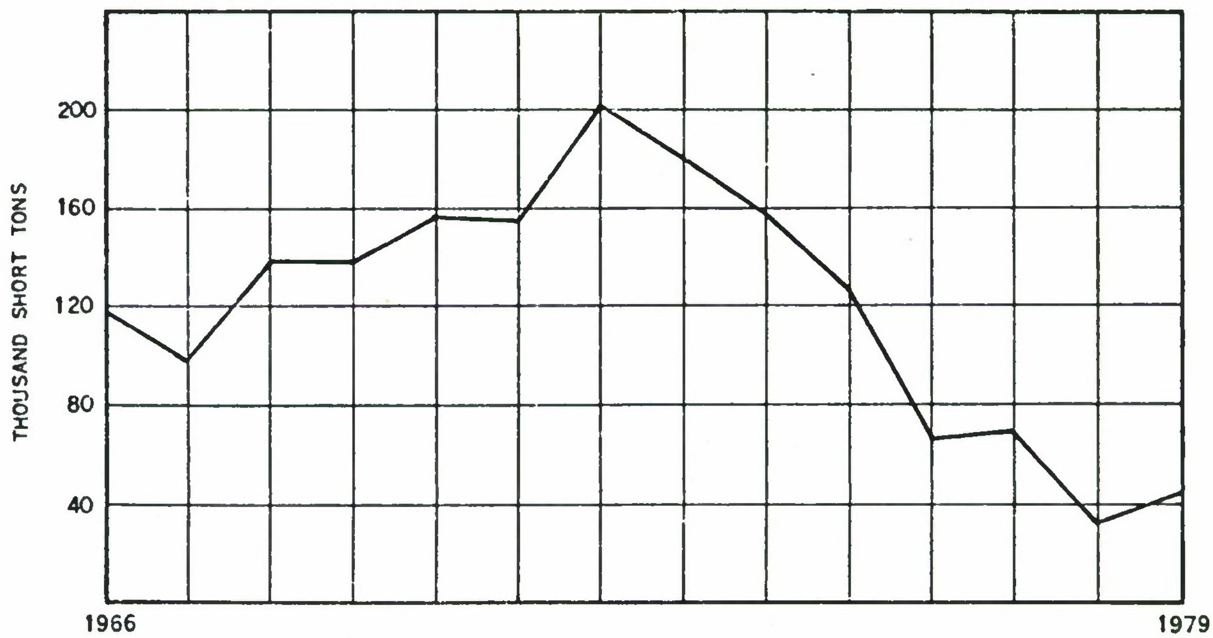
105. The increasing scarcity of natural gas supplies in California for the manufacture of nitrogen fertilizer will require greatly increased imports from Alaskan and foreign sources in the future. Sacramento is expected to handle a major portion of these increased supplies. The Port of Stockton is also currently expanding their bulk fertilizer storage facilities and is expected to handle most of the remaining increases in fertilizer imports. Fertilizer receipts at Sacramento are expected to nearly double by the year 1987; i.e., from about 360,000 tons in 1979 to 700,000 tons per year. By 2037 they are expected to be approximately 1.85 million tons per year. The projected trends are shown in the following tabulation. These projections were developed usihg historical trends in California fertilizer consumption and information and data received from shippers and industry experts concerning future import needs.[1]

Year	Domestic Receipts	Foreign Imports	Tonnage
1987	500,000	200,000	700,000
1997	700,000	300,000	1,000,000
2007	1,000,000	360,000	1,360,000
2037	1,350,000	500,000	1,850,000

[1]In the last 10 years, California fertilizer consumption has increased at an average annual rate of 4.3 percent and currently amounts fo 2.6 million tons per year.

106. **Other Bulk Commodities** — In addition to the significant bulk commodities discussed previously, other bulk commodities of lesser significance also use the port. These include potash, scrap steel, prepared animal feeds, phosphate rock, tri sodium phosphate (TSP), di-ammonia phosphate (DAP), clay pellets, magesite, and diatomaceous earth. The following figure shows the tonnages of these commodities handled at the port during the period 1966 through 1979. As shown, tonnages have decreased sharply in recent years from a high of 205,000 tons in 1972 to about 45,000 tons at the present time. The reason for the decrease in other bulk commodities is largely attributable to the reduction in shipments of prepared animal feeds to Japan brought about by recent competition from Canadian, Pacific Northwest, and Australian feed producers.

OTHER BULK COMMODITIES SHIPPED THROUGH THE PORT OF SACRAMENTO



107. The prospects for future shipments of various other bulk commodities are favorable based upon past trends and information supplied by port officials and several private companies. The port has recently signed an agreement with the Atlantic Richfield Petroleum Products Company which calls for the shipment of a minimum of 250,000 metric tons of petroleum coke over the next 3 years. ARCO's investigations revealed that among all ports on the west coast, Sacramento was uniquely suited to handle and store their dry bulk cargo. The coke originates at the new ARCO refinery at Cherry Point, Washington, and is moved by rail to Sacramento for worldwide shipment and ultimate use in the processing of bauxite into aluminum. In April 1980, the first shipment of petroleum coke was loaded at the port bound for Italy. The port has also recently signed agreements with Newhall Land and Farming Company — Heringer Ranches, Inc., Pelleting Division, and Toyomenka Company to ship a minimum of 450,000 tons of feed comodities, primarily alfalfa pellets and beet pulp pellets, to Japan over the next 5 years. The potential also exists for large future movements of such items as soda ash, steam coal, Nevada-mined ores, cement and other building materials, various bulk liquids, and a number of neo-bulk cargoes such as automobiles. By 1987 the port is expected to be handling a minimum of 180,000 tons of other bulk commodities, and movements should increase to 690,000 tons by 2037. The following tabulation presents the projected tonnages that will be handled by the port between 1987 and 2037.

Year	Tonnage
1987	180,000
1997	275,000
2007	390,000
2037	690,000

108. **Future Industrialization** — The area surrounding the port is attractive for future industrial development that is oriented towards water transportation. In anticipation of such change, local zoning ordinances have been enacted to assure the orderly development of both light and heavy industries by setting aside sufficient land for the industrial (M-2) category. Just northeast of the port is the West Sacramento Port Center which is already substantially developed. This center is characterized by light industry and warehousing. A new development northwest of the harbor, the Port Sacramento Industrial Park, is aimed at providing an area for water transportation-oriented heavy industries. A photograph showing the location of this park is presented on the following page. The park is a 600-acre site with 7,800 feet of frontage on the ship channel. This type of development with its channel access is unique as there is a shortage of water-oriented sites on the west coast. Already there is development occurring along the channel. Union Oil's Channel Division has recently completed a bulk fertilizer terminal that stores ammonia fertilizer shipped from their manufacturing plant in Alaska. In the same area, Levin Metals Corporation has proposed a metal processing plant, similar to its other plants in Redwood City and Richmond, on a 36-acre site, complete with dockage. Next to this site, the Best Pipe Company has a 14-acre storage facility. Best Pipe imports various kinds ot pipe, and is presently using the Port of Sacramento to handle its shipments. ASC Pacific Inc., a structual steel fabricator, is located on a 6.5.-acre site and receives shipments of rolled sheet from its parent company, an Australian steel manufacturer. Although these shipments are currently moving through the Port of Long Beach, they could be handled at the Port of Sacramento in the future. The economic advantages in transportation provided by the ship channel and port also influence the location of other industries near the port since these industries find specific cost savings afforded by near and easy access to the port facilities. Such an example is the decision of Nissan, USA, to locate its Pacific Northwest Datsun parts warehouse in Sacramento. This new facility replaces two outmoded warehouses in Portland and South San Francisco.

109. On the south side of the ship channel near the harbor there are 2,000 acres which are currently zoned Agricultural General (A-1) and are designated in the East Yolo County General Plan for Agricultural — 1st Phase/Industrial — 2nd Phase. This area is shown in the photograph on page B-70. The Port of Sacramento owns 357 acres of land in this area. This land is intended to be used for the future expansion of the Port. The Davis-Walker Cooperation is also presently considering the construction of a mini-steel mill in this area for the production of wire related products. The proposed facility would include a rod mill, electric arc melting furnace, continuous billet castor, and a rolling mill. Billets and iron ore pellets would be shipped to the plant by oceangoing vessels. The following tabulation shows tonnages associated with new industries that are expected to locate along the channel in the future. These projections are predicted on upper information obtained from industry sources familiar with the local area. It is assumed that similar industries will locate in the port area and that these industries will locate there even if the channel is not deepened. Industries that are likely to consider the area adjoining the port as a future site for new industrial plants and facilities include cement and mineral processing,

Year	Tonnage
1987	680,000
1997	1,030,000
2007	1,275,000
2037	1,955,000

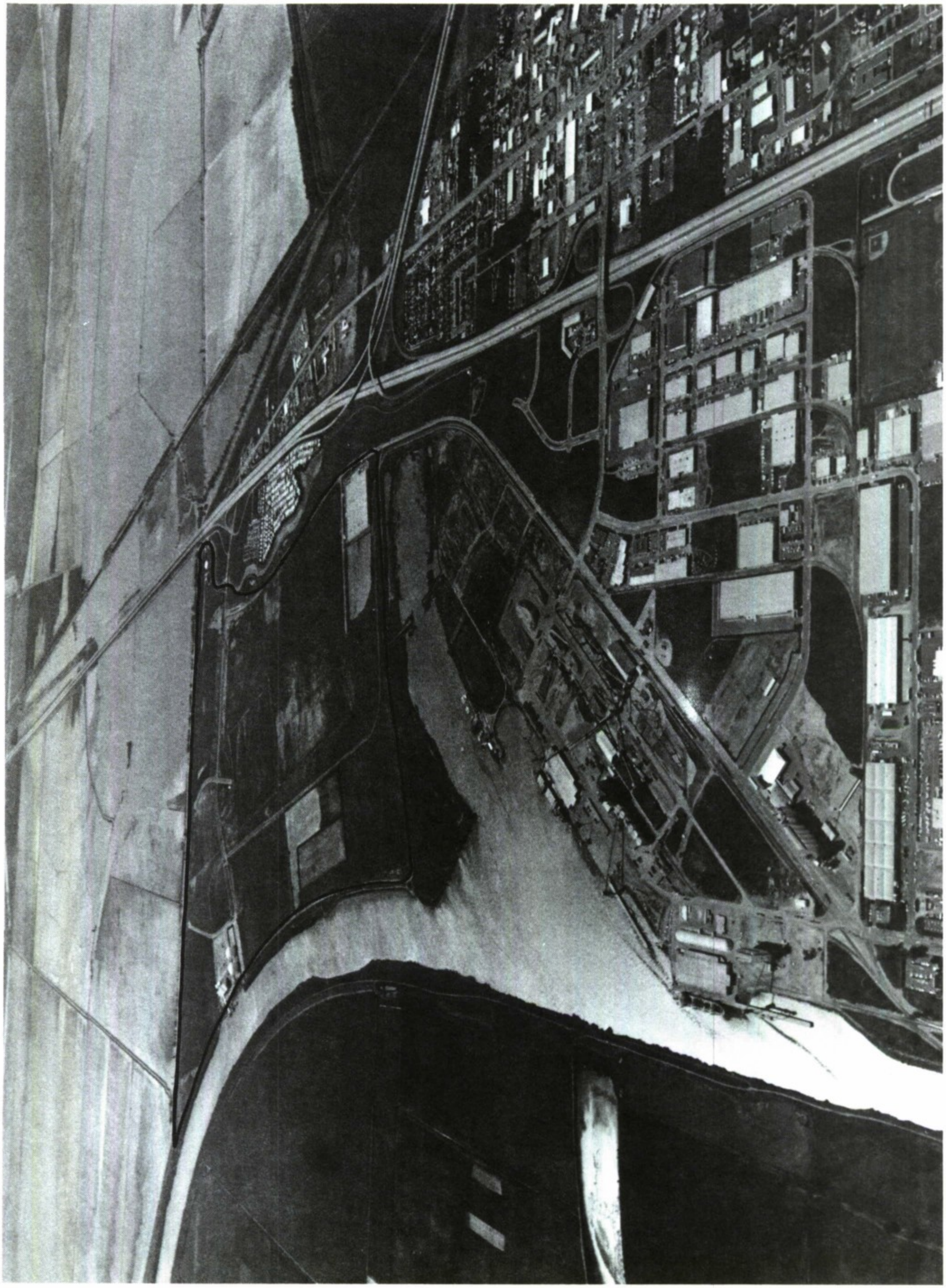
agricultural processing and storage, automobile assembly, chemical industries of various kinds, manufacturers of wallboard and other building materials, scrap metal shredding facility, and marine construction. By 1987, industrial development is expected to be responsible for 680,000 tons of cargo shipped annually on the channel. This activity is projected to increase to 1,955,000 tons per year by 2037.

110. **Project-Induced Tonnage** — At present the Port of Sacramento has an effective draft limitation of about 30.5 feet (9.3 meters). This limits the port to ships with an average deadweight tonnage of between 15,000 to 20,000, depending on the ship's construction. Any larger ships which call at the port have to partially load and then stop at other ports and "top-off" or sail light-loaded to their destinations. This draft limitation imposes a significant physical constraint on bulk cargo movements and is causing the port to lose some cargoes. In the future, this problem will be accentuated and will also affect future industrialization as there are many companies that will not locate along a channel which cannot accommodate the more "optimal" size ships (i.e., ships which minimize water transportation cost) because of draft limitations. Deepening the channel will reduce the need to send grain to San Francisco to top-off the larger bulk grain ships that must depart from the Port of Sacramento partially loaded due to limited channel depths. Also, this will have a beneficial effect upon future industrial activity and should place the port in a more competitive position, as well as enable it to attract additional out-of-state grain shipments.

111. Projections of project-induced tonnages for various alternative channel depths are presented in the accompanying tabulation. As indicated, it is estimated that by 1987 the deepening of the channel to 35 feet will produce 300,000 tons of additional cargo shipments and that this tonnage would increase to 355,000 and 440,000 with channel depths of 37 and 40 feet, respectively. The increases in shipments are expected to reach almost 2.7 million tons by 2037 with a 35-foot channel and 3.5 and 4.6 million tons with a further deepening of the channel to 37 and 40 feet, respectively. These projections are based upon discussions with port officials and various major shippers and take into account a detailed analysis of shipping costs at the alternative channel depths. The induced grain movements through the port resulting from reduced topping-off operations were computed by comparing the amount of cargo that will have to be light-loaded from grain ships departing Sacramento in the future, both with and without a deeper channel.

Projections of Project-Induced Tonnages for the Port of Sacramento by Channel Depth (1987-2037)

Year	35-ft.	37-ft.	40-ft.
1987	300,000	355,000	440,000
1997	900,000	1,100,000	1,400,000
2007	1,500,000	1,850,000	2,400,000
2037	2,675,000	3,450,000	4,640,000



Port Sacramento Industrial Park

Future Industrial Land at the Port of Sacramento

Collinsville-Montezuma Hills

112. This area is located in southeast Solano County, roughly about 45 nautical miles inland from the Golden Gate Bridge. This large expanse of potential water-oriented industrial acreage is now primarily in low-intensity agricultural use. The present agricultural activities consist chiefly of rotational grain growing and some sheep grazing. The only industrial activity in the Collinsville-Montezuma Hills area at the present time is the natural gasfields in the eastern portion. The area is bordered on the south and east by the Sacramento River Deep Water Ship Channel from Rio Vista to the small settlement of Collinsville, on the west by the Montezuma Slough, on the north by Highway 12, and on the northeast by the city limits of Rio Vista. Much of the area is distinguished by the gently rolling terrain of the Montezuma Hills. This area is shown in the photographs on page B-73.

113. The area is isolated from major Bay region urban concentrations and from the larger Solano County cities, and is immediately upstream from the Suisun Marsh. The marsh is an expanse of approximately 85,000 acres of tidal marsh, managed wetlands, and waterways, and is the largest remaining wetland in the San Francisco Bay area and a wildlife habitat of nationwide importance.

114. A number of proposals have been made in recent years to develop large-scale industrial facilities along the waterfront in the Collinsville-Montezuma Hills area including plans for a steel production plant, a fossil fuel electric generating plant, and two large petrochemical complexes. Although three of these proposals have subsequently been withdrawn (the steel plant and both of the petrochemical facilities) the area has to be viewed as one of the last opportunities in the Bay region for the development of large-scale, water-oriented industry on a deep-draft ship channel. Descriptions of the types of industries which may be attracted to the area over the next 10- to 20-year period are presented in the following paragraphs.

115. **Petrochemical Production** — The recent availability of large quantities of Alaskan oil and its products on the West Coast and the size and growth of the consumer market have encouraged producers of petrochemicals to consider locating facilities in the area. The specific attraction to the petrochemical producers is the potential for realizing substantial transportation economies by locating facilities on the west coast to serve this market area. The west coast market is currently being supplied with petrochemicals from facilities that are located primarily in the Gulf and Eastern states.

116. Two petrochemical companies have each considered the construction of large petrochemical plants in the Collinsville-Montezuma Hills area for the production of plastic raw materials to supply the West Coast industries. Both plant sites were selected because of their strategic location contiguous to the Sacramento River Deep Water Ship Channel and the availability of land for the storage tank area necessary for a petrochemical facility. Although the majority of plastic product fabricators are currently located in southern California, suitable additional plant sites are no longer available there. A brief description of the two original proposals is presented in the following paragraphs.

117. In 1974, The Dow Chemical Company proposed to build a plant on its 2,700-acre site east of Collinsville as part of the company's planned expansion of its existing chemical complex, near Pittsburg, in Contra Costa County. This facility was to be constructed in conjunction with a second new plant

Future Industrial Land in the
Collinsville-Montezuma Hills Area

Future Industrial Land in the
Collinsville-Montezuma Hills Area

adjoining the existing Dow facilities on the south side of the San Joaquin River near Pittsburg. Four pipelines, crossing lower Sherman Island, would have connected the two plant sites and transported gaseous materials (ethylene, propylene, and hydrogen) between Montezuma and Pittsburg.

118. Plant feedstocks would have consisted primarily of petroleum naphtha shipped by barge from San Francisco Bay area suppliers or from refineries in Alaska, Washington, or Los Angeles by oceangoing tankers. The plant was to produce primarily liquid products to be transported by ship, rail, and pipeline. Products would have included ethylene, prophylene, benzene, ethylbenzene, styrene, cumene, phenol, acetone, pentane, and butane. The naphtha requirement was projected at 1.75 million tons (12.6 million barrels) per year.

119. In January 1977, Dow announced indefinite postponement of its plans for development of the Montezuma Hills plant site. The company reported that the process of obtaining necessary governmental permits had proved to be so cumbersome and expensive that continuation of the project for the time being had become impractical. The company, however, has retained its ownership of the 2,700-acre plant site.

120. The ARCO Chemical Company, a division of Atlantic Richfield, also proposed to build a similar plant in the area. It was to be constructed on a 4,000-acre site located immediately adjacent to the Dow property. The proposed facility would have required approximately 50,000 barrels of naphtha feedstock per day, shipped by tanker from Los Angeles and Puget Sound refineries. Output anticipated from this unit included cumene, caustic, butane, styrene, acetone, phenol, polyethylene, polyvinyl chloride, and polypropylene. The facility was expected to employ between 1,400 to 1,500 full-time operating, maintenance, and technical personnel. Investment in plant and equipment was projected at roughly $1.5 billion.

121. In January 1978, ARCO announced that construction of the plant had been indefinitely postponed because projections now seem to indicate an insufficient demand for the facility's output through the early 1980's.

122. Although both proposals have recently been withdrawn, discussions with industry sources indicate that there is a good potential for industrial development in the Collinsville-Montezuma Hills area. Because of certain inherent locational advantages and expected improvements in future demand and supply conditions, the petrochemical industry at some point should find the area attractive for development. Since there are no remaining suitable sites for petrochemical plants in southern California and as consumer markets expand in the State, it is likely that petrochemical producers will exercise their locational choice in favor of the Collinsville-Montezuma Hills area.

123. Air quality impacts will be an important consideration in any decision to allow petrochemical plants to locate in the Collinsville-Montezuma Hills area because emissions associated with these plants are in categories which already exceed federal and/or state ambient air quality standards in the area vicinity. Therefore, the petrochemical producers would have to either reduce their emissions in the area to zero or, perhaps more realistically, control their emissions to the greatest degree possible and arrange to reduce the pollutants from nearby sources more than enough to make up for emissions from new plants.

124. **Energy Production and Storage** — Pacific Gas and Electric Company owns 1,120 acres of undeveloped land near Collinsville, contiguous to the Sacramento River and directly across from Montezuma Island. The Collinsville site is under active consideration for a large coal-fired powerplant, the first unit to be operational in the 1985-90 period. The plant, as proposed, would consist of two 800-megawatt generating units and would cost more than $2 billion. Coal for the plant is expected to be imported by unit train from eastern Utah. The possibility also exists that, in the future, PG&E might find it attractive to import low sulphur coal or methacoal (synthetic fuel) by ship or barge from the Alaskan coalfields near Anchorage or from other sources of supply.

125. A high technology energy industry that might foreseeably be attracted to the Collinsville-Montezuma Hills area is that of liquid petroleum gas suppliers. Liquid petroleum gas, otherwise known as LP gas or simply LPG, is the term used by the oil industry for a mixture of petroleum hydrocarbons consisting mainly of propane and butane. It can be shipped from a petroleum refinery or gasfield to a supply facility site as liquid under fairly normal pressure, discharged into refrigerated storage tanks, then transported by truck or rail to industries as a substitute for increasingly scarce and expensive natural gas.

126. There are currently two LPG marine terminals serving the west coast, one in Los Angeles Harbor, the other at Ferndale, Washington. The Ferndale facility is operated by the California Liquid Gas Corporation (Cal-Gas), a wholly owned subsidiary of the Dillingham Corporation. It has the capacity to receive and store seaborne shipments of LPG which approximate 15 million gallons per shipload. A similar facility was proposed recently by Cal-Gas for a vacant deep-draft site along the Carquinez Strait at Selby, but plans for development have been withdrawn due to problems in obtaining the necessary permits to develop the site.

127. It is likely that additional marine receiving facilities will be needed on the west coast in the future to handle expected increases in LPG imports. Future supplies are expected to come mainly from Alaska, Indonesia, Mexico, and the Middle East. It is conceivable that the Collinsville-Montezuma Hills area will at some point attract an LPG supplier, especially if petrochemical producers and other energy-intensive industries locate facilities in the area. The location of such a facility in the area may also depend on whether or not a deeper draft channel is eventually provided.[1] Assuming an LPG facility were constructed in the area, it is unlikely that it would come into operation prior to the 1985-90 period.

128. **Steel Production** — Some years ago, National Steel Corporation announced plans to construct a fully integrated still mill on a 4,000-acre site at Collinsville that they and Southern Pacific Transportation Company jointly owned. The plans were dormant for some time, only to be withdrawn fairly recently. Conditions in the steel market were mostly responsible for the failure to develop the mill. West coast steel production over the past decade has been subjected to strong foreign competition, most notably from Japan. As much as 40 percent of the west coast demand for steel has been satisfied in recent years by foreign producers. This competitive situation may change in the future, however. Legislative steps are already underway to restrict the further importation of steel mill products which are being sold in this country at less than the cost of production by establishing a "trigger pricing system." The trigger price is

[1] Most of the LPG coming from foreign sources of supply in the future will probably be transported in ships of 50,000 to 75,000 cubic meters. These vessels will have inbound drafts to west coast terminals of between 34 and 37 feet. Future domestic ocean shipments of LPG will probably be transported in much smaller vessels or possibly even in barges. An example is the 32,000-cubic-meter tanker S.S. Cornucopia which was recently placed into service carrying refrigerated liquid ammonia from Kenai, Alaska, to terminals in Portland, Oregon, and Sacramento, California. This vessel is also capable of transporting LPG cargoes and has a maximum loaded draft of 31.8 feet.

determined by the Japanese cost and production (Japan is the world's lowest-cost producer). The system was partially successful in reducing imports in 1979 below those of the two previous years. In addition, the recent dollar devaluations in relation to the yen should lessen competition from Japan in the future, allowing domestic producers to compete more effectively. Coupled with an expected general growth in demand, a need for additional steel production capacity on the west coast could result.

129. The bay area supports a few steel scrap mills such as Judson Steel in Emeryville. This type of facility usually produces some sort of basic form, such as a billet from scrap steel, and is frequently combined with a finishing mill to minimize a variety of costs including tranportation. Such a facility by itself is not highly waterfront dependent. A larger steel facility which produces steel billets from ore or iron ore pellets would be highly waterfront dependent for receiving raw materials by ship or barge. There are currently no such facilities in the bay area. Only two facilities currently exist in the Western States to serve west coast markets — one in southern California, the other in Utah.

130. With projected changes in competitive and demand situations as described, pressures for development of one or more steel production facilities can be expected in the future to serve west coast markets. Since suitable waterfront-oriented sites are scarce in southern California, pressures may be focused on the bay area and the Collinsville-Montezuma Hills area to accommodate such a facility.

131. Mineral Refining — Certain locational advantages and unique site characteristics make the area potentially attractive for the introduction of facilities associated with future ocean mineral refining.

132. The ongoing development of ocean mineral recovery and refining technologies and the need for a waterway linkage between the ocean source and the refinery facility have resulted in increasing interest by this industry in the area. Extensive copper and other metallic minerals are found in deposits of manganese nodules located on an area of the ocean floor between California and Hawaii. Hawaii is closest to these deposits, but the market for related metals is on the mainland, making the west coast a more optimum location for a refining facility. Los Angeles is also closer to the deposits than the Collinsville-Montezuma Hills area, but there are probably no suitable sites remaining there for this use. It is unlikely, however, that a refinery facility to process the nodules would locate in the area much before 1990. The reason is that copper and nickel prices are currently sharply depressed by worldwide overproduction from land mines and will have to increase significantly before ocean floor mining becomes attractive. There is also considerable uncertainty at the present time over who will be able legally to mine the ocean floor and under what national or international constraints and taxation they will operate.

133. **Development Potential and Prospective Cargo** — The prospective growth and development of any region is difficult to assess and evaluate. This is particularly true of an area such as Collinsville-Montezuma Hills which is now predominantly in low intensity agricultural use and, yet, has enormous potential for future industrial growth. This potential is due to a scarcity of deep draft industrial sites in California and the area's direct access to the Sacramento River Deep Water Ship Channel. The Collinsville-Montezuma Hills area is a probable site for significant industrial expansion.[1]

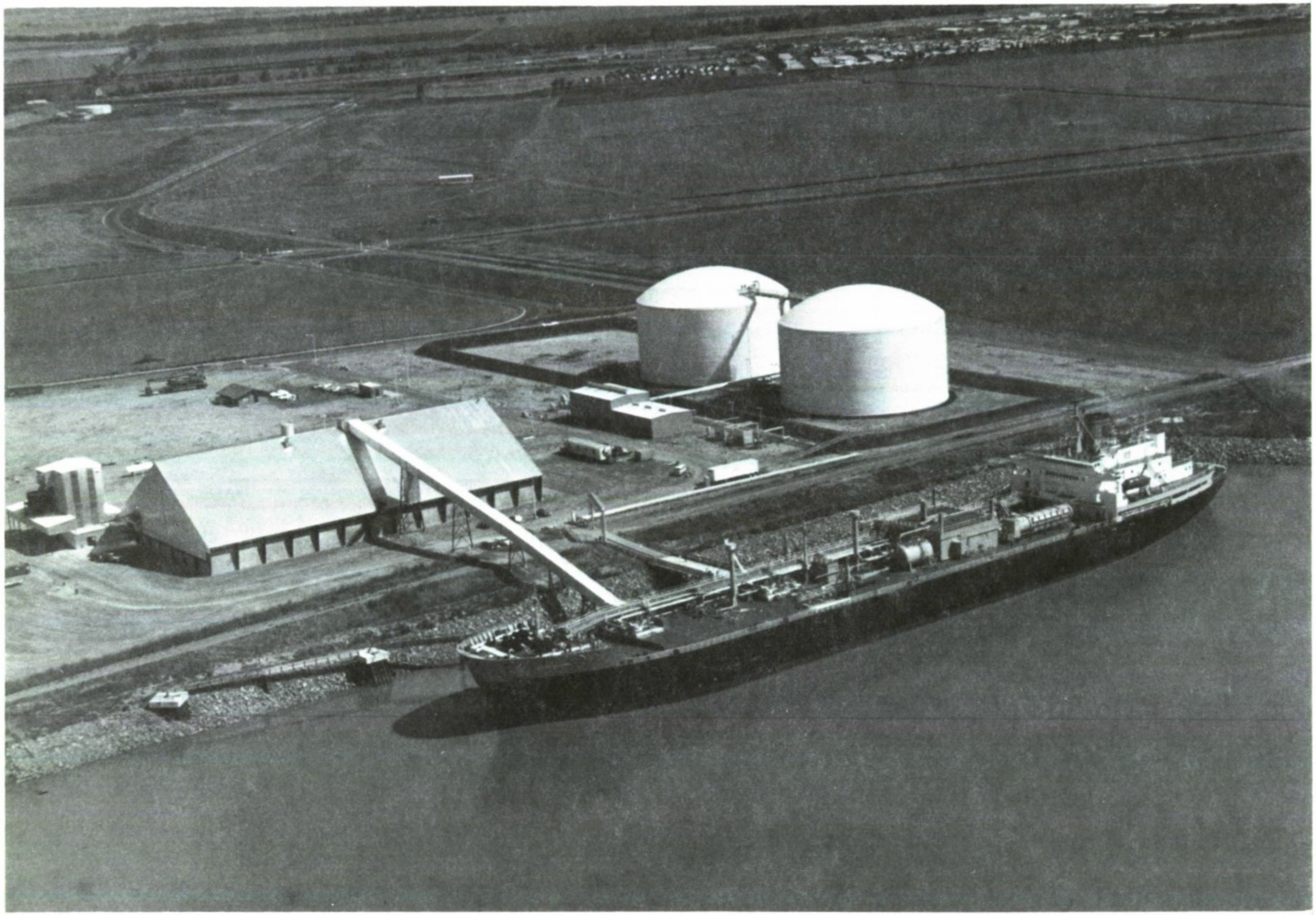
[1]The Solano County Planning Commission has recently adopted a plan for the Collinsville-Montezuma Hills area which designates a waterfront band along the Sacramento River Deep Water Ship Channel for future industrial development. The total area included within Water-Dependent Industrial designations is roughly 9,680 acres or approximately 15 square miles.

134. As previously mentioned, the inherent advantages of water transportation over other modes make the area desirable for future industrialization. Some types of developments which might locate in this area are petrochemical plants, an LPG terminal, electrical generating facilities, a steel production mill, mineral refining plant, or other water-related industry. Companies whose production or marketing facilities require a deep-draft site should be prime beneficiaries of an improved channel.

135. Without channel improvements, approximately 1.5 million tons of cargo are expected to be handled at the Collinsville-Montezuma Hills area by 1987. Industrialization of the area would continue throughout the projection period so that by 2037 approximately 5.5 million tons would be handled. With a 35-foot or deeper channel, the area would attract industries which would not otherwise locate there. This induced development would add approximately 300,000 tons of cargo for the 35-foot channel in 1987 and approximately 2.5 million tons to the 2037 projection. Progressively higher tonnages would be achieved with further deepening of the channel to 37, 40, and 45 feet. The induced tonnages for these alternative depths are presented below. The cargo projections for the Collinsville-Montezuma Hills area were developed by assessing the developmental potentials for water-related industries and associated cargo movements under existing channel conditions and with the alternative channel depths considered in this analysis.

Tonnage Projections for the Collinsville-Montezuma Hills Area
(1987-2037)

	Future	Induced Tonnages			
Year	**Industrialization**	**35 ft.**	**37 ft.**	**40 ft.**	**45 ft.**
1987	1,500,000	300,000	400,000	500,000	600,000
1997	2,800,000	900,000	1,100,000	1,400,000	1,800,000
2007	3,800,000	1,500,000	1,800,000	2,300,000	2,700,000
2037	5,500,000	2,500,000	3,200,000	4,300,000	5,000,000



37,500 dwt S.S. Cornucopia unloading ammonia at Union Chemical Terminal, channel mile 42. Land for future industrial expansion is shown in background.

Vessel Traffic

136. During the period since the opening of the Port of Sacramento (1963-1979), 2,118 deep draft vessels moved through the port carrying over 21.5 million tons of cargo. In considering the deepening of the existing channel to Sacramento, the characteristics of the existing vessel fleet utilizing the channel must be reviewed.

137. Dry Bulk Carriers — Bulk carriers calling at the Port of Sacramento range in size from about 15,000 to 60,000 dwt with design drafts from 29 to 42 feet. However, shippers prefer to use vessels in the 18-20,000 dwt range due to the limited depth of the existing channel. These vessels can be fully loaded at the port and can then proceed directly to their destination. It is becoming increasingly difficult to charter ships in this size range since most of these vessels have been replaced by larger ships. Shippers are therefore forced to charter larger vessels (20-60,000 dwt) which must be "topped-off" at other west coast ports or operated at less than their design drafts, thus increasing shipping costs. Table B-19 shows the principal characteristics of typical dry bulk carriers which loaded grain at the Port of Sacramento during the 1976-79 period. Most of the grain loaded at the port is backhaul traffic for bulk vessels which haul steel products and automobiles to the west coast. The bulk vessel which calls at the Port of Sacramento on a regular basis to load rice for Puerto Rico is the integrated tug-barge (ITB) California Rice Transport. This vessel is 656 feet long, has a beam of 85 feet and a maximum loaded draft of 31.5 feet. It has a cargo capacity of about 32,500 short tons and makes seven trips per year between Sacramento and San Juan, Puerto Rico. The ITB normally loads about 18,000 tons of milled rice at Sacramento and then proceeds to the Pacific Northwest to top-off with aluminum and lumber destined for east coast markets. On the return voyage to the west coast the vessel carries about 30,000 tons of phosphate rock from Jacksonville, Florida, to the Port of Stockton. This vessel is shown in the photograph on page B-54.

138. Dry bulk fertilizer arriving at the Port of Sacramento from Norway and Belgium is transported in medium-size bulk vessels between 24,000 and 30,000 dwt. These vessels have design drafts from 34 to 35.5 feet and must stop at the Port of San Diego to discharge cargo before calling at Sacramento. The vessels shown in the following tabulation are typical of the specially strengthened bulk carriers used in this trade. A special requirement of these vessels is that they must be able to sail with two holds empty since cargo is discharged at more than one west coast port. These vessels carry lumber and other forest products from the Pacific Northwest on their return trips to Europe. The anhydrous ammonia which began arriving at Union Chemical's fertilizer terminal located on the channel in May 1978 is being transported in the first U.S. flag liquid ammonia carrier, the S.S. Cornucopia. This vessel is 623 feet long with a beam of 90 feet and has a maximum draft of 31.8 feet. Cargo capacity is 23,000 short tons (32,000 cubic meters) with a full load displacement of 37,500 long tons. Cargo gear includes four independent insulated tanks which can carry the liquid ammonia at -28°F. A photograph of this vessel is shown on page B-78.

TABLE B-19
SAMPLE OF VESSELS LOADING GRAIN AT THE PORT OF SACRAMENTO
1976-79

Vessel	Year Built	DWT	Length	Beam	Design Draft	Sailing Draft	Cargo	Tons Loaded	Destination
Pan Pacific	1966	25,040	585′ 8″	75′ 1″	34′ 1″	30′ 6″	rice	20,235	South Korea
Pacglory	1974	22,593	539′ 2″	75′ 2″	32′ 4″	30′ 6″	corn	21,041	Japan
On Lee	1970	35,657	655′ 5″	91′ 5″	36′ 10″	31′ 5″	wheat	30,166	People's Republic of China
Ace Pioneer	1976	16,588	557′ 10″	86′ 0″	29′ 10″	30′ 6″	wheat	16,421	Japan
Pan Western	1967	52,225	700′ 0″	96′ 2″	41′ 10″	30′ 0″	rice	33,075	South Korea
Asia Prosperity	1974	26,900	581′ 4″	75′ 0″	34′ 3″	31′ 0″	rice	23,681	Bangladesh
Sheaf Royal	1972	38,711	656′ 0″	88′ 9″	36′ 7″	28′ 0″	rice	27,305	Syria
Sunny Pioneer	1975	20,203	518′ 4″	76′ 11″	31′ 3″	30′ 4″	wheat	18,682	Japan
Lynton Grange	1976	26,600	600′ 6″	74′ 8″	34′ 5″	30′ 6″	wheat	23,422	Bangladesh
Causeway	1976	60,740	736′ 3″	106′ 0″	41′ 4″	29′ 2″	rice	39,225	Bangladesh
Amazonas	1975	25,604	591′ 7″	75′ 1″	33′ 6″	29′ 10″	wheat	20,944	Brazil
Kate N.L.	1965	34,602	604′ 9″	85′ 9″	36′ 3″	28′ 9″	wheat	24,182	India
Kyrakatingo	1967	52,733	716′ 9″	102′ 2″	39′ 5″	30′ 10″	wheat	37,449	People's Republic of China
Andros City	1967	39,796	623′ 4″	90′ 9″	37′ 3″	29′ 8″	rice	29,848	Italy
Hasselt	1974	30,668	623′ 4″	75′ 6″	35′ 1″	30′ 0″	wheat	24,556	Soviet Union
Alkaios	1975	19,030	506′ 0″	74′ 10″	30′ 2″	30′ 4″	corn	19,711	Japan
Atlantic Heritage	1969	29,168	593′ 2″	91′ 3″	35′ 1″	28′ 9″	rice	22,046	Italy
Santa Catalina Maru	1972	22,697	544′ 5″	75′ 1″	34′ 0″	30′ 4″	wheat	16,204	Japan
Lago Maihue	1970	16,061	474′ 6″	67′ 10″	30′ 4″	31′ 0″	wheat	16,017	Chile
Pacific Defender	1968	20,520	520′ 0″	74′ 3″	30′ 1″	31′ 2″	rice	19,996	Indonesia
Kavo Alkyon	1961	16,230	534′ 4″	66′ 7″	30′ 10″	30′ 4″	rice	16,436	Spain
Kavo Xifias	1961	40,347	669′ 11″	90′ 7″	38′ 7″	30′ 5″	rice	29,423	Italy
Larry L	1970	27,306	597′ 1″	75′ 2″	34′ 11″	30′ 5″	wheat	21,600	Soviet Union
Kyuko Maru	1978	51,658	655′ 11″	105′ 8″	40′ 9″	30′ 10″	wheat	36,904	People's Republic of China
Maria Voyazides	1971	29,202	593′ 2″	75′ 11″	35′ 0″	30′ 3″	rice	24,595	Bangladesh
Georgina Glory	1962	27,593	577′ 0″	75′ 0″	36′ 1″	31′ 0″	wheat	21,934	Soviet Union
Pavel Rybin	1975	23,625	555′ 11″	80′ 10″	32′ 6″	31′ 2″	wheat	21,197	Soviet Union
Gospic	1977	37,836	615′ 9″	93′ 2″	35′ 2″	30′ 6″	rice	32,554	Indonesia
Maritime Investor	1976	41,035	602′ 3″	90′ 8″	39′ 4″	29′ 7″	rice	29,994	Italy

VESSEL	DWT	LENGTH	BEAM	DESIGN DRAFT	INBOUND DRAFT
Star Daranger	27,890	564′ 0″	85′ 2″	34′ 2″	30′ 4″
Star Atlantic	29,709	564′ 0″	85′ 2″	35′ 4″	31′ 0″
Star Columbia	27,890	564′ 0″	85′ 2″	34′ 2″	29′ 6″
Star Heranger	27,890	564′ 0″	85′ 2″	34′ 2″	29′ 6″
N.R. Crump	28,939	593′ 10″	95′ 11″	34′ 4″	27′ 8″
Temple Inn	24,090	534′ 4″	75′ 2″	34′ 2″	29′ 6″

139. Bulk vessels carrying full loads of logs from the Port of Sacramento range in size from about 16,000 to 20,000 dwt with loaded departure drafts of 29 to 31.8 feet. Larger vessels between 20,000 and 30,000 dwt are also used for log shipments but must be partially loaded because of draft limitations. Most of the log vessels calling at the port transport a considerable amount of cargo on deck to achieve sufficient volume. To facilitate this, the heavy-lift cranes on board the vessels are mounted on pillars to provide space for deck cargo and to swing clear of a full deck load. Ballast from 2,000 to 4,000 long tons is common on log carrying vessels to balance the logs stowed on deck. The largest log vessel to call at the Port of Sacramento has been the Natasha (February 1978) with a deadweight capacity of 29,623 tons. This vessel came to the port in ballast from the Canal Zone and loaded 3.8 million board feet of logs (20,609 tons) before departing light for Tomakonai, Japan. The principal characteristics of typical vessels being used to transport logs from the Port of Sacramento are outlined in the following tabulation.

VESSEL	DWT	LENGTH	BEAM	DESIGN DRAFT	SAILING DRAFT	TONS LOADED
Natasha	29,623	574′ 7″	85′ 5″	33′ 9″	30′ 8″	20,609
Eastern Cherry	19,418	512′ 4″	74′ 4″	31′ 3″	30′ 5″	15,064
Asia Botan	18,820	508′ 8″	75′ 0″	29′ 4″	30′ 6″	14,512
Shinyu Maru	20,009	502′ 0″	77′ 6″	30′ 11″	30′ 6″	15,804
Sunny Wealth	18,546	469′ 10″	75′ 0″	30′ 0″	29′ 2″	13,244
Toshin Maru	16,549	465′ 9″	71′ 7″	29′ 10″	30′ 2″	13,769
Maritime Queen	19,297	512′ 4″	74′ 4″	31′ 3″	31′ 0″	14,603
Asia Beauty	25,401	576′ 11″	83′ 5″	31′ 2″	31′ 6″	20,684
Pacific Trader	20,000	555′ 10″	75′ 0″	33′ 8″	31′ 1″	17,236

140. Wood Chip Vessels — Bulk wood chip vessels were built specifically to supply the paper and fiberboard industry in Japan with pulpwood in the form of wood chips. The vessels are unique from conventional bulk vessels because of the low density of the cargo carried. Wood chips stow at one-half to one-third the density of other bulk commodities such as grain and phosphate rock. Wood chip vessels are therefore considerably deeper and slightly wider beamed than conventional vessels. Even at that, a typical wood chip vessel does not have sufficient volumetric capacity to stow more than about 70 percent of its deadweight capacity. Growth of the wood chip trade has resulted in the construction of 76 wood chip vessels aggregating over 2.5-million dwt. Table B-20 shows the wood chip vessels which called at the Port of Sacramento during the 1976-79 period. Most of the wood chips moving through the port are being transported by vessels in the 41-43,000 dwt range. These vessels have hold capacities of 2.9-3.0 million cubic feet and carry between 27,500 and 32,000 tons of wood chips (stowage factors on the wood

TABLE B-20
VESSELS LOADING WOOD CHIPS AT THE PORT OF SACRAMENTO
1976-79

Vessel	Year Built	DWT	Hold Capacity (1,000 Cubic Feet)	Length	Beam	Design Draft
Chuetsusan Maru	1967	28,209	1,642	577′ 5″	84′ 2″	35′ 1″
Dai Honshu Maru	1974	43,272	2,114	599′ 1″	91′ 5″	42′ 0″
Ehime Maru	1970	28,991	2,750	642′ 11″	96′ 6″	29′ 8″
Golden Grampus	1975	37,300	2,704	643′ 0″	96′ 7″	35′ 6″
Grand Zodiac	1975	31,304	2,114	570′ 10″	91′ 3″	32′ 9″
Honshu Gloria	1975	41,962	2,880	639′ 9″	98′ 6″	37′ 8″
Honshu Maru	1967	22,109	1,420	534′ 10″	77′ 11″	31′ 11″
Jugo Maru	1968	22,194	1,420	534′ 8″	77′ 10″	31′ 10″
Kasugai Maru	1970	42,623	2,896	646′ 4″	98′ 7″	36′ 0″
Kathryn Maru	1968	26,597	1,726	578′ 0″	82′ 2″	32′ 10″
Kenjyu Maru	1974	42,187	2,903	650′ 10″	100′ 6″	36′ 3″
Madang	1973	23,804	1,775	564′ 4″	82′ 0″	30′ 9″
Oji Gloria	1976	41,901	2,880	639′ 10″	98′ 5″	36′ 1″
Oji Maru	1967	26,611	1,726	578′ 1″	82′ 1″	32′ 10″
Oji Maru No. 1	1972	41,875	2,950	638′ 9″	99′ 11″	36′ 2″
Pacific Venture	1976	41,000	2,900	643′ 1″	100′ 0″	36′ 1″
Papyrus Maru	1972	24,318	1,644	577′ 5″	77′ 11″	31′ 10″
Prince of Tokyo	1974	41,515	2,950	638′ 10″	99′ 11″	36′ 1″
Sendai	1975	40,999	2,954	643′ 0″	100′ 2″	36′ 2″
Taikai Maru	1971	28,848	2,704	643′ 2″	97′ 7″	39′ 8″
Tonami Maru	1969	42,124	2,882	646′ 4″	99′ 0″	36′ 1″
Valentina	1976	37,300	2,700	643′ 1″	96′ 7″	35′ 1″

chips loaded in Sacramento are generally 90 to 105 cubic feet per ton depending on the moisture content of the chips). The sailing drafts of these vessels range from 29 to 30 feet, and they represent the maximum size wood chip vessels that can presently load at the port with the existing channel dimensions.[1]

141. The largest wood chip vessels in the world fleet are used to transport wood chips from Australia, South Africa, and the Pacific Northwest to Japan. Therefore, vessel dimensions, especially beam, are not limited by the Panama Canal. The dimensions of these vessels are presented in Table B-21. The largest existing wood chip vessel is the 57,897 dwt Eden Maru, with a 4.2 million cubic foot hold capacity, a length of 736.5 feet, and a beam of 115 feet. It is primarily used to transport eucalyptus chips from Australia to Japan but has also called at Coos Bay, Oregon, and Longview, Washington, for loading. It is expected that wood chip vessels in the 46-58,000 dwt range will call at the Port of Sacramento in the future if a deeper channel is provided. Based on a detailed review of actual loadings of the large wood chip vessels at ports in the Pacific Northwest and information provided by vessel operators, it is estimated that wood chip vessels in the 46-58,000 dwt range could fully load at the Port of Sacramento without requiring drafts greater than about 32 feet. A channel depth of 35 feet below mllw would carry all vessels with few tidal delays.

Traffic Densities

142. Table B-22 presents a summary of vessel calls at the Port of Sacramento since initiation of activities in 1963. While it is evident that the number of calls have moderated somewhat in recent years since achieving historical heights in 1973, it will be recalled from statistics already presented that the total tonnage of cargo has continued to increase dramatically at the Port of Sacramento during the last decade and a half. Table B-23 presents a summary of vessel calls by design draft at the port in 1977. The loaded drafts of the vessels at the port may have been less than the design draft, meaning that they were light (less than fully loaded). The majority of vessels calling at the Port of Sacramento in 1977 had design drafts of 30 to 31 feet. As indicated, an equal number had design drafts of 28 to 29 feet and 32 to 33 feet. Fifteen percent of the vessels had drafts of 34 to 35 feet, and 18 percent had design drafts of 36 to 37 feet. Only 13 percent of the vessels had design drafts of less than 28 feet, and 5 percent had design drafts of 38 feet or greater.

143. If the existing channel is deepened, larger vessels will be used — particularly on the longer trade routes — as they carry cargo more efficiently. The greatest gains in the scale economies of the larger ocean bulk carriers are to be obtained in sizes up to about 35,000 DWT. Above this size, the gains tend to become progressively less. Most of the vessels used in future bulk cargo trades will probably be in the 20,000 to 40,000-ton range, since medium sized vessels have more flexibility of route and trade

[1]Because of their light density cargo, wood chip vessels operate at about 80-85 percent of their design draft when fully loaded with softwood chips.

TABLE B-21

LARGEST WOOD CHIP CARRIERS IN THE EXISTING WORLD FLEET

VESSEL	YEAR BUILT	DWT	HOLD CAPACITY (1,000 cubic feet)	LENGTH	BEAM	DESIGN DRAFT	PRINCIPAL TRADE ROUTE
Oriental Taio	1974	46,595	3,140	675′ 9″	100′ 2″	37′ 3″	Pacific N.W. — Japan
Mimosa Africana	1975	50,077	3,600	687′ 7″	110′ 10″	37′ 10″	Durban, S.A. — Japan
Eden Maru	1971	57,897	4,156	736′ 6″	115′ 0″	37′ 9″	Australia — Japan
Oriental Soveign	1975	47,152	3,500	685′ 8″	104′ 11″	36′ 1″	Pacific N.W. — Japan
Meridian	1975	46,242	3,100	649′ 7″	105′ 8″	36′ 9″	Pacific N.W. — Japan
World Wood	1974	47,347	3,142	674′ 0″	100′ 1″	37′ 1″	Pacific N.W. — Japan
Empress of Eden	1975	58,028	4,110	791′ 4″	108′ 4″	37′ 10″	Australia — Japan
Hokuetsu Venture	1976	46,439	3,100	649′ 7″	105′ 9″	36′ 8″	——
Pacific Taio	1974	57,172	4,128	736′ 6″	115′ 0″	37′ 9″	Australia — Japan
Kengo Maru	1972	47,948	3,314	712′ 0″	105′ 10″	35′ 0″	——
Southern Cross	1973	47,909	3,314	712′0″	105′ 9″	35′ 1″	Pacific N.W. — Japan
Hachinohe Maru	1972	54,187	3,422	754′ 5″	110′ 5″	44′ 6″	Australia — Japan

opportunities than their larger counterparts. Exceptions will undoubtedly occur for certain specific cargo trades where the length of haul and volume of annual movement justify using the larger carriers. Generally, the economics of moving dry bulk cargoes such as rice, grain, fertilizers, etc., is such that these cargoes must move in medium-size volumes on more frequent schedules to meet the consumption patterns at the distant ports. This is due to the high interest costs to the cargo owner of carrying the inventory which tend to offset the savings in transportation provided by the larger vessels.

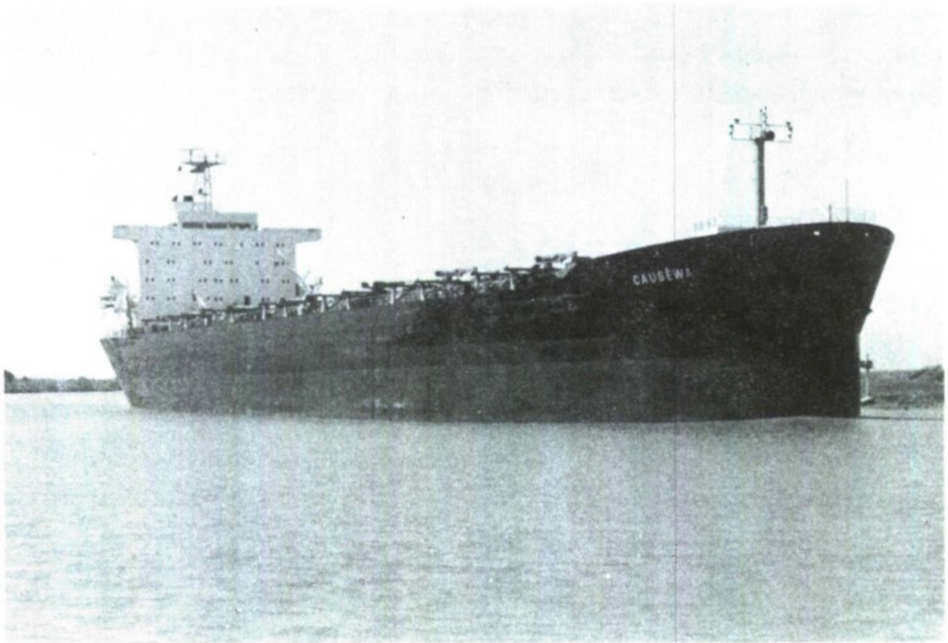
TABLE B-22
HISTORICAL VESSEL CALLS
PORT OF SACRAMENTO

YEAR	CALLS	YEAR	CALLS
1963	14	1971	137
1964	66	1972	124
1965	108	1973	173
1966	109	1974	149
1967	168	1975	145
1968	167	1976	127
1969	132	1977	118
1970	129	1978	123
		1979	129

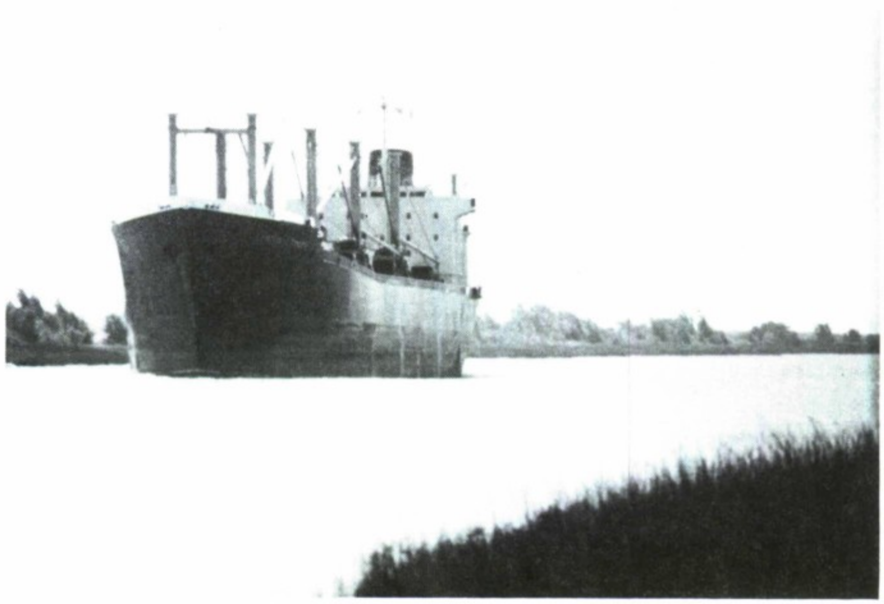
TABLE B-23
VESSEL CALLS BY DESIGN DRAFT
PORT OF SACRAMENTO

1977

DRAFT	CALLS	PERCENT
x 28	15	13
28-29	17	14
30-31	25	21
32-33	17	14
34-35	18	15
36-37	21	18
b 38	5	5



60,740 dwt M/V Causeway of British registry, entering the Port of Sacramento



British M/V Lynton Grange (26,541 dwt) inbound to the Port of Sacramento to load 23,000 tons of wheat and rice for Bangladesh.

Recreation

144. Existing Recreation Use — Recreation use of the ship channel and the Delta is almost totally water-dependent, with principal activities being swimming, fishing, sightseeing, boating, and water skiing. Picnicking and overnight boat use are closely associated with these activities. Fishing is the most popular activity, comprising an estimated 66 percent of the total use. Pleasure boating is the second most popular activity, comprising an estimated 21 percent of total use. The heavy boating use of the Delta is reflected in the number of vessels registered in the market area (over one-third of the total number for the State of California in 1965). The number of boats registered per thousand persons in the market area in 1965 was 19 compared with 17 for the remainder of the State.

145. Recreation opportunities for nonboaters are very limited. There are few public roads in the Delta and those that do exist are generally built on narrow levee crowns which offer few places for autos to park. Additionally, attempting to gain access to the waterway from the public road often involves trespass on private land. Brannan Island State Recreation Area is the only public facility with camping accommodations; however, a number of private resorts offer camping facilities, including electrical hookups for recreation vehicles and trailers.

Existing Recreation Facilities

146. There are six facilities located on the ship channel at or in the vicinity of Rio Vista which provide recreation opportunities. The six facilities include a resort which provides a wide variety of services including camping, picnicking, and boat launching facilities; two marinas; a state recreation area that offers picnicking, camping, and a boat launching ramp; and two public launch ramps. Solano County is developing a recreation area on an existing Corps of Engineers dredged material disposal area with Federal assistance (Land and Water Conservation Funds administered by the Heritage Conservation and Recreation Service) to provide picnicking, camping, swimming, and boat launching facilities. The Collinsville-Montezuma Hills Area Plan identifies the following sites for potential future marina development (1) Collinsville Inlet, (2) Collinsville Point, and (3) Montezuma Island area. There are no other known recreation developments planned along the ship channel.

Alternative Water-Oriented Recreation Areas

147. Since the ship channel is part of the Delta, the recreation use occurring on the channel is often only part of a total outing which extends to other waterways within the Delta. Because the Delta has a unique physiographic and ecologic composition that is not duplicated in the western United States, there are no similar alternative recreation areas which could be utilized. Although there are alternative water-oriented recreation opportunities nearby such as the lower reaches of tributary streams as well as several reservoirs, recreation users are attracted to the Delta because of its unique character and are not likely to consider lake and river recreation as alternatives.

SECTION C

PROBLEMS AND NEEDS

SECTION C

PROBLEMS AND NEEDS

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Section C

PROBLEMS AND NEEDS

1. Problems and needs associated with waterborne transportation in the Sacramento River Deep Water Ship Channel study area result from waterways and related facilities which are inadequate to accommodate vessels currently using the channel, thus causing transportation inefficiencies and unsafe conditions. The need for greater transportation efficiencies and safety may be fulfilled through existing national transportation policies which include providing channel improvements.

2. Since the Port of Sacramento became operational in 1963 it has become an integral part of the agricultural industry of northern and central California. Growth of the port has resulted from increases in productivity of the agricultural industry, increased exports of forest products, and increased foreign demand for agricultural and forest products from California's Central Valley. In addition, a number of industries requiring access to deep water have located or are planning to locate along the deep water ship channel because of the availability of relatively low-cost vacant land along the channel.

3. Development and change in waterborne commerce have been rapid and revolutionary in recent years. High levels of world economic growth have been directly reflected in this commerce. New shipping techniques and modern terminal development have been necessary to accommodate this increased commerce. Economic growth in the Orient is generally expanding at a higher rate than the rest of the world, and new or prospective trade policies point to the expansion of the United States trade in these countries. This trade is significant to the Port of Sacramento since its service area produces large quantities of the rice, other grains, wood chips, and other bulk commodities required in the economy of the Orient.

Existing Plans and Improvements

4. Construction of the existing Sacramento River Deep Water Ship Channel was authorized by the River and Harbor Act of 24 July 1946. Construction of the 30-foot channel was initiated in 1949 and suspended in 1950 because of the Korean conflict, but was resumed in Fiscal Year 1956. The project has been in operation for oceangoing vessels since June 1963. Local interests were required to furnish all lands, easements, right-of-way, and dredged material disposal areas for the initial work and for subsequent maintenance; make all necessary utility changes; and construct, operate, and maintain an adequate public terminal with necessary utilities and rail and highway connections at the harbor. The Sacramento-Yolo Port District, formed under State of California laws in April 1947, provided the required local cooperation.

5. In compliance with the requirement for adequate public terminal facilities, the Port District has spent $31.3 million for basic terminal facilities. The State of California reconstructed the Rio Vista Bridge at a cost of about $3,200,000 to permit passage of oceangoing vessels. State and local interests have constructed and placed in operation facilities in the vicinity of the port which make use of the project, including a rice grower's cooperative mill and storage facilities, a highway overpass entrance to the port terminal area, 600 acre port industrial park, bulk fertilizer storage facility, and miscellaneous facilities. In February 1974, the Port District distributed a Port Plan which called for continued growth of cargo volume and related expansion of port facilities.

6. Construction of the Suisun Bay Channel between Avon and Pittsburg was originally authorized for improvement by the River and Harbor Act of 2 March 1919. The existing 30-foot channel was authorized by the River and Harbor Act of 21 January 1927, as modified by the Acts of 3 July 1930 and 30 August 1935. Work on this channel was initiated under the public works program of 1933 and was completed during 1934. This project has been authorized for further deepening to 35 feet as a part of the San Francisco Bay to Stockton (John F. Baldwin and Stockton Ship Channels) project. This modification was authorized by the River and Harbor Act of 1965, but only limited construction has been initiated pending completion of evaluation of the effects of deepening the Stockton Ship Channel.

7. The waterway between Pittsburg and Collinsville is naturally deep with depths exceeding 30 feet below mllw. Therefore, no improvements have been made in this reach.

Sacramento River Deep Water Ship Channel
and Turning Basin looking northeast across
the Port and Sacramento metropolitan area.

Port of Sacramento, Turning Basin, and Deep Water Channel
looking southwesterly. Future industrial
area is in the background.

Need for Channel Modification

8. The characteristics of the deep-draft dry-bulk vessels of the world fleet are undergoing rapid changes to meet the competitive demand for efficiency in cargo carrying. Ship sizes, especially for bulk carriers, have increased at a rate which was unforeseen just a few years ago. While not every port would expect to accommodate all vessels, current Federal policy indicates that sufficient channel widths and depths should be provided for safe and efficient navigation for the vessels that are expected to call.

9. The previous section on vessel traffic shows a trend toward larger vessels at the Port of Sacramento. The existing channel was designed to accommodate a loaded Victory class ship with characteristics of 10,800 deadweight tons (dwt), 455 ft. 3 in. length overall, 62 ft. breadth, and 28 ft. 7 in. loaded draft. However, in recent years more and more of the vessels arriving at the port have beams of 80 to 100 feet, lengths of from 550 to 700 feet, and design drafts of 33 to 38 feet. In 1977, 48 of the 118 vessels calling at the port had to be light-loaded because of channel depth limitations. This trend can also be observed from the size characteristics of the world bulk carrier fleet presented in Tables C-1 and C-2. As indicated in Table C-1, the average size for the total bulk fleet has increased from 24,300 dwt in 1967 to 33,700 dwt in 1977. What is even more revealing is the percent distribution by class of size for world bulk carriers during this time. Table C-2 shows that the bulk fleet of "18,000 dwt or less" decreased from 37.0 percent in 1967 to only 19.7 percent in 1977. In excess of half of all bulk carriers fall into the class of 18-40,000 dwt. This percentage has remained fairly constant during this period but, nevertheless, exhibits a slight upward trend. The most dramatic increase has been in vessels of over 40,000 dwt. This percentage has increased from only 8.7 percent in 1967 to 22.8 percent in 1977.

10. The existing 30-foot channel between Avon and the Port of Sacramento does not provide sufficient depth and width to efficiently accommodate the newer deeper-draft vessels presently in operation and planned for the future. The inability of this channel to accommodate the newer deep-draft vessels at their full capacity requires ship operators to carry less than capacity loads or to await favorable tides, thus reducing the ship's efficiency and increasing the unit cost of transportation. As ship size increases, navigation in channels with restricted clearances becomes more hazardous. Wind stress on slowly moving ships makes it difficult to maintain steerage. Fog conditions create a strong dependency on radar equipment, and for the larger ships with little keel or beam clearance, navigation is difficult. Particular areas or locations where groundings may be expected for the newer larger vessels (including colliding with banks) include Cache Slough, the entrance into the manmade portion of the Sacramento channel, and near the Concord Naval Weapons Station in the Suisun Bay region. The latter location is related to the Sacramento River project in that deepening and widening the Sacramento channel would only be practical if the channel from Avon to New York Slough were appropriately deepened and widened either as a part of the San Francisco Bay to Stockton project or as part of an improved Sacramento channel.

TABLE C-1
DEVELOPMENT OF THE WORLD BULK CARRIER FLEET
1967-77

YEAR	NUMBER OF VESSELS	TOTAL DEADWEIGHT TONNAGE	AVERAGE SIZE (DWT)
1967	1,271	30,942,000	24,300
1968	1,498	39,280,000	26,200
1969	1,761	48,152,000	27,300
1970	1,964	55,101,000	28,100
1971	2,131	61,720,000	29,000
1972	2,345	70,417,000	30,000
1973	2,580	79,881,000	31,000
1974	2,781	89,393,000	32,100
1975	2,992	97,812,000	32,700
1976	3,197	105,749,000	33,100
1977	3,464	116,586,000	33,700

Source: Fearnley & Egers Chartering Co. Ltd.

11. In anticipation of industrial development along the lower portion of the manmade channel when the existing Sacramento River Deep Water Ship Channel was constructed, the west levee of the channel at mile 31.9 (Collinsville is mile 0.0) was set back for future construction of a turning basin. A turning basin at this location would allow ships to enter the channel, load or unload cargo at future terminal facilities south of the turning basin, and turn around without proceeding to the turning basin at the Port of Sacramento. The turning basin could also be used as an emergency maneuvering area, if ships must pass in the channel.

12. Another navigation problem in the Sacramento River Deep Water Ship Channel is the continuous and rapid shoaling of the channel from below Rio Vista (mile 5) to Junction Point (mile 15). Maintenance dredging records indicate that approximately 200,000 cubic yards of sediment is removed from this portion of the channel annually. This shoaling presents a hazard to navigation when it reduces the channel depth to below the authorized depth, thus reducing under-keel clearance and maneuverability.

13. Without channel modification, the effectiveness and efficiency of the Port of Sacramento would be impaired, and the economy of the region would be disadvantaged. The port occupies a significant position in the economic and commercial affairs of the market area in which it operates. As discussed in the previous section, the port provides the base for a significant number of jobs and revenue in the north central California area. During 1977, a total of 624,000 manhours were worked at the Port of Sacramento, or based on a 40-hour week, an average of 251 persons were employed at the port each working day. Several times this number of jobs exist throughout the area because of business that relates to the products and shipping activities at the port.

TABLE C-2
SIZE DISTRIBUTION OF WORLD BULK CARRIERS
(percent of total vessels)

DWT	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977
Less than 18,000	37.0	33.6	31.6	30.1	27.5	25.8	24.3	22.2	21.8	20.4	19.7
18,000-40,000	54.3	52.9	52.1	52.2	54.1	55.1	56.4	57.5	57.0	57.6	57.5
40,000-60,000	7.1	10.9	12.7	13.6	13.5	13.1	12.3	12.3	12.5	12.6	12.9
60,000-80,000	1.6	2.3	3.1	3.5	3.7	4.0	4.3	4.8	5.5	5.6	5.9
80,000-100,000	—	0.2	0.4	0.3	0.4	0.5	0.6	0.5	0.4	0.8	0.7
100,000-150,000	—	0.1	0.1	0.3	0.7	1.4	1.8	2.4	2.5	2.7	3.0
More than 150,000	—	—	—	—	0.1	0.1	0.3	0.3	0.3	0.3	0.3
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Fearnley & Egers Chartering Co. Ltd.

Need for Recreation Facilities

14. The major recreation problems in the study area are similar to those throughout the Delta and stem from inadequate public access and facilities for public recreation. With the exception of the few county facilities, the Brannan Island State Recreation Area, and some public launching ramps, there is a lack of public recreation facilities along the navigable public waterways in the study area. Riding, hiking, and bicycle trails are few in number because of the lack of public lands, the high cost of building bridges between islands, the narrow levees, and the scarcity of paved roads. Access for bank fishing is limited. Much of the shore fishing involves trespassing, and most of the bank fishing areas now used by the public could be closed at the option of the private landowner or reclamation district.

15. The major recreation season is from June through August with peak use occurring on weekends and holidays, often resulting in a substantial number of persons being turned away. Potential demand is considerably greater than current use because use is constrained by poor access and few facilities. The California Department of Parks and Recreation estimates that its parks at Brannan Island and Franks Tract, if fully developed, would be able to accommodate only an estimated 9 percent of the total annual use in the Delta project for 1990. The available evidence indicates that there is significant latent demand for recreation use of the Delta. It is therefore anticipated that any facilities that could be provided in connection with a deepened channel would be used to capacity.

16. Estimates of future recreation demand for the Delta are presented in Table C-3. These estimates represent the potential (latent) recreation demand if facilities were available.

TABLE C-3
Annual Recreation Demand[1]
(in millions of recreation days)

Year	Water dependent activities	Land dependent activities	Total
1975	5.6	13.5	19.1
1980	6.3	15.4	21.7
1990	8.3	20.5	28.8
2000	11.3	28.5	39.8

[1]Source: Delta Master Recreation Plan (Draft), Resources Agency of California, 1976.

Improvements Desired

17. The initial public meeting for this study was held on 3 March 1971 in Sacramento, California, to ascertain the desires of the local interests and to obtain other information pertinent to the study. At that meeting local interests requested the enlargement of the Sacramento River Deep Water Ship Channel and construction of the turning basin at mile 31.9. It was also requested that the Federal Government assume responsibility for repair or restoration of works for wave wash protection along the channel. State and Federal fish and wildlife agencies, as well as local conservation groups, requested that careful consideration be given to the environment of the area before recommending any plan of improvement.

18. Subsequent to the initial public meeting recreation interests have requested, through informal meetings and correspondence, additional public access to the ship channel for boating, fishing and hunting. Public boat launching ramps in the vicinity of the turning basin at the Port of Sacramento and public park facilities in the vicinity of Rio Vista have been requested.

19. At the intermediate public meeting held on 19 July 1976 almost all the comments received supported the need for a deeper channel into the port. However, others expressed concern about possible salinity intrusion, its effects on fish and wildlife and vegetation, and general water quality degradation. They requested that problems associated with potential salinity and other impacts resulting from deepening be studied and resolved.

SECTION D

PLAN FORMULATION

SECTION D

PLAN FORMULATION

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SECTION D

PLAN FORMULATION

1. The evaluation of alternatives and their components is accomplished by weighing the benefits and costs, both tangible and intangible, in the economic, environmental, and social categories. The formulation of a comprehensive plan of action which fulfills the study objectives involves the screening of numerous possible solutions. The most viable plan may include concepts from one or more alternative measures or plans.

Formulation and Evaluation Criteria

2. Plans for the use of the study area's water and land resources for navigation purposes are directed toward improving the quality of life in the Sacramento Valley of California through contributions to the objectives of national economic development and environmental quality. Formulation of a specific plan must be within the context of an appropriate set of evaluation criteria so as to provide reliable estimates of consequences and feasibility of each alternative. Certain technical, economic, and environmental criteria were used to develop and select a plan which best responds to the problems and needs identified by affected parties in accordance with the Water Resources Council's "Principles, Standards, and Procedures for Water and Related Land Resources," 25 October 1973.

3. Two broad objectives regarding Federal participation in water resources planning have been established by the Water Resources Council:

a. Enhance national economic development (NED) by increasing the value of the Nation's output of goods and services and improving national economic efficiency.

b. Enhance the quality of the environment (EQ) by the management, conservation, preservation, creation, restoration, or improvement of the quality of certain natural and cultural resources and ecological systems.

4. The additional consideration of Regional Development (RD) and Social Well-Being (SWB) is also specified in the "Principles and Standards." The contributions to the RD account are determined by establishing the effect of a proposal on the regional aspects of income, employment, population distribution, economic base, environment, social development, and other factors. Contributions to the SWB account are determined by establishing the beneficial effects of a proposal on real income, security of life, health and safety, education, cultural and recreational opportunities, and emergency preparedness.

5. Because of the broad nature of these objectives, they have been redefined in terms of criteria relating to the problems, needs, and conditions being investigated. In such a form, these criteria provide for orderly and consistent evaluation of all alternatives.

Technical Criteria

6. The following technical criteria were utilized in developing the plans:

a. All plans should be consistent with Federal laws, policies, and standards and be cognizant of State and local ordinances and county and city land use zoning. Existing transportation improvements should be preserved and utilized to the maximum extent, consistent with economic criteria.

b. Navigation improvements should be designed to safely accommodate the vessel traffic expected to use them.

c. Disposal sites should be constructed with retention dikes, spill boxes, and proper drainage pond systems to assure that water quality standards set by the State Water Resources Control Board are met.

Economic Criteria

7. The economic criteria for plan formulation and evaluation are as follows:

a. A plan must have net national economic development benefits unless the deficiency in net benefits for the national economic development objective is the result of benefits foregone or additional costs incurred to serve environmental quality.

b. Each separable unit of a plan should provide benefits at least equal to cost.

c. Benefits and costs should be expressed in comparable terms to the fullest extent possible.

d. There is no more economical means, evaluated on a comparable basis, of accomplishing the same purpose or purposes which would be precluded from development if the plan were undertaken. This limitation refers only to those alternative possibilities such as other west coast ports, etc., that would be physically displaced or economically precluded from development if the project were undertaken.

Environmental and Other Criteria

8. As provided by "Principles and Standards," preservation or enhancement of area environmental resources is given equal consideration with economic efficiency in developing and evaluating alternatives. Navigation or other improvements should be designed so that existing natural and cultural resources will be disturbed as little as possible, and mitigation for unavoidable losses should be provided to the maximum extent practicable and justified. Other criteria considered in formulating a plan were as follows:

a. The irreversible or long-term commitment of natural resources to effect implementation of a plan should be minimized.

b. Measures should be incorporated in the selected plan which protect, preserve, or enhance environmental quality in the project area.

c. The selected plan should be consistent with local, regional, and State goals for port and industrial growth.

d. Interested Federal and non-Federal agencies, local groups, and individuals should be consulted through cooperative efforts, conferences, public meetings, and other procedures to achieve public acceptance.

e. Public acceptability of proposed improvements and ability and willingness to meet local cooperation requirements are essential considerations.

Institutional Constraints

9. The State of California has established standards for salinity concentrations at various locations in Suisun Bay and the Sacramento-San Joaquin Delta estuary. These standards are contained in Water Resources Control Board Decision 1485 and are maintained by freshwater releases from State and Federal reservoirs upstream from the Delta. The State Department of Water Resources and Water and Power Resources Service operate these reservoirs and have stated that any project which increases salinity intrusion into the Delta would decrease the yield of the State Water Project and Central Valley Project and thus would make future water requirements of the State more difficult to meet. In addition, the Contra Costa County Water District obtains most of its municipal and industrial water from the Delta. The County therefore strongly opposes all actions which would increase Delta salinities.

10. It is evident that increases in salinity levels resulting from navigation improvements would not be acceptable to the State of California, the Department of the Interior, and to water users in the Delta. It has therefore been concluded that salinities must not be increased by any plan for navigation improvement.

Possible Solutions

11. Of the alternatives considered which might satisfy the need for more efficient and safe commodity import and export for the Port of Sacramento service area, only three could provide tangible resolution of the need. A fourth alternative is no Federal involvement or the "No Action" alternative. The four alternatives studied are:

a. Increased use of LASH barges.

b. Intermodal transportation of cargo to alternative ports.

c. Deepening the channel.

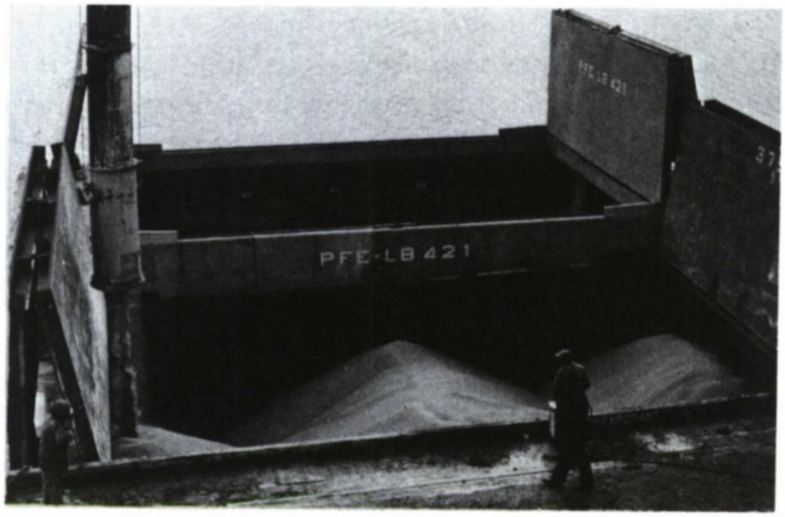
d. No action (no further navigation improvements).

12. In this section, each of the above alternatives were evaluated on the basis of the formulation and evaluation criteria previously presented.

Increased Use of LASH

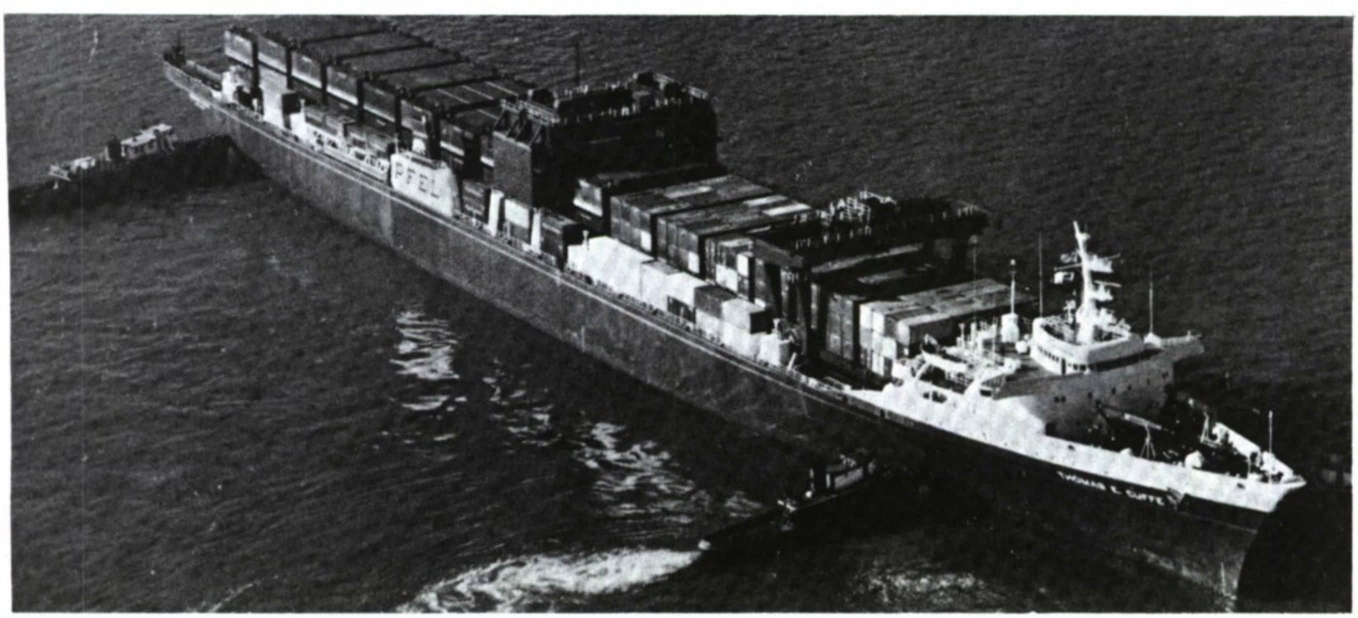
13. LASH is the acronym for "Lighter Aboard Ship," a versatile transportation system which provides for carrying cargo aboard ship in lighters (barges). The lighters may be loaded with cargo at either shallow-draft or deep-draft shoreside or inland waterway locations and then loaded aboard and unloaded from the LASH "mother" vessel by a heavy-duty shipboard gantry crane. The lighters have a capacity of 415 short tons and are capable of transporting odd-sized lots of general cargo, bulk commodities, machinery, baled goods, etc., plus standard containers. LASH vessels have a definite place in foreign cargo movements, particularly where there is congestion in overseas ports or where highly developed container port facilities are not available, as in underdeveloped nations.

14. LASH service to the Port of Sacramento has been provided in the past from the LASH container terminal at the Port of San Francisco. Tugboats towed the lighters to Sacramento for loading and back to the home port area to await arrival of the LASH carrier vessel. However, during 1977, one of the major operators of LASH vessels on the west coast, Pacific Far East Lines (PFEL), began converting its four LASH vessels to container ships. This expensive conversion was made necessary by unfavorable economic conditions and labor problems in the Far East. Past movements of LASH cargo through the Port of Sacramento amounted to 100,108 short tons in 1975, 86,317 short tons in 1976, and 8,000 short tons in 1977. Most of this tonnage consisted of bulk rice, moving to South Korea under Public Law 480 (Food for Peace Program).



Lighter (LASH barge) loading rice at the Port.

Lighter being maneuvered to "mother" ship.



Fully loaded LASH "mother" ship ready for departure.

15. U.S. Pacific Coast LASH vessels provide only liner service as regulated by the U.S. Maritime Administration (MarAd). MarAd regulations presently limit the Pacific Coast LASH vessels to U.S.-trans-Pacific trade routes 27 (Australia-New Zealand) and 29 (the Far East). However, service is currently offered only to trade route 27 due to the withdrawal of PFEL from LASH service. Farrell Lines, Inc. has two LASH vessels which sail from Vancouver, Tacoma Portland, San Francisco, and Los Angeles to Australia, New Zealand, Tahiti, Samoa, and Papua, New Guinea.

ECONOMIC CONSIDERATIONS

16. LASH vessels engaged in Far East trade were operated essentially for general cargo service (primarily eastbound). However, bulk commodities were frequently carried as "back haul" traffic (westbound) to the Far East when space was available and service provided. Westbound bulk rates on available LASH barges were generally offered at competitive prices, even though LASH vessels are more expensive to build and operate per cargo ton than conventional bulk carriers, because there was limited westbound general cargo trade using LASH. Recent developments indicate that LASH service between the Pacific Coast and Far East is currently not profitable. Even if the number of LASH vessels serving the bay area increases in the future, the demand for conventional bulk carriers at the Port of Sacramento would not be lessened because the size of the LASH fleet would respond primarily to future general cargo developments rather than the growth in bulk cargo movements.

17. Another restriction of the LASH system to most bulk cargo is that available space is rarely offered more than 15 to 30 days in advance of sailings in order to accommodate any military cargo or government aid cargo that may become available for shipment at much higher, more profitable rates. Exporters of bulk cargo find it difficult to conduct trade on this basis because most contracts are negotiated from 1 month to 1 year in advance of shipments. Therefore, they must rely, in most cases, on conventional bulk carriers in the bulk market. It should also be noted that the large quantities of logs, wood chips, and liquid gas cargoes handled at the Port of Sacramento could not be efficiently transported via LASH barges.

18. LASH is a sophisticated, expensive transportation system; therefore, steaming time must be maximized and port time minimized in order to ensure profitable operation. This tends to limit the LASH "mother" vessels to long-haul foreign cargo movements. Coastwise commerce, such as the existing movements of large quantities of bulk fertilizer materials from Alaska to the Port of Sacramento area, could not be accommodated by this alternative. There is also no LASH service between the Pacific Coast and Puerto Rico, Europe, India, Africa, Russia, Mexico, and South America.

19. The above analysis indicates that this alternative would not substantially contribute to the overall NED objectives because of the inability of LASH to efficiently handle the existing or projected future cargo movements. This is because the LASH system is primarily in service to handle general cargo, of which relatively little originates in the port service area, and what bulk cargo capacity is available could easily be displaced by increased utilization of LASH for general cargo. Therefore, economically, LASH is not a feasible solution to the draft problems confronting bulk cargo shippers at the Port of Sacramento.

ENVIRONMENTAL CONSIDERATIONS

20. The impact by LASH on the environment would be slight. It is expected that an increase in the usage of LASH would decrease the usage of deep draft vessel, truck, and rail transportation but increase tug (towboat)/barge traffic. Overall, there would be a slight reduction in the amount of particulates and gases emitted to the atmosphere. Neither aquatic life nor wildlife would be affected by LASH traffic increases. However, the LASH alternative offers no potential for tangible contribution to environmental enhancement.

SOCIOECONOMIC CONSIDERATIONS

21. The LASH alternative would adversely affect some of the SWB account components. Real income, for example, would be suppressed since the inefficiencies of the LASH operation would inhibit increases in employment and regional income. Recreational opportunities and health and safety conditions would be essentially unaffected. It is also apparent that the LASH alternative would have minimal positive effect on or contribution to regional income, employment, population and the other components of the Regional Development account.

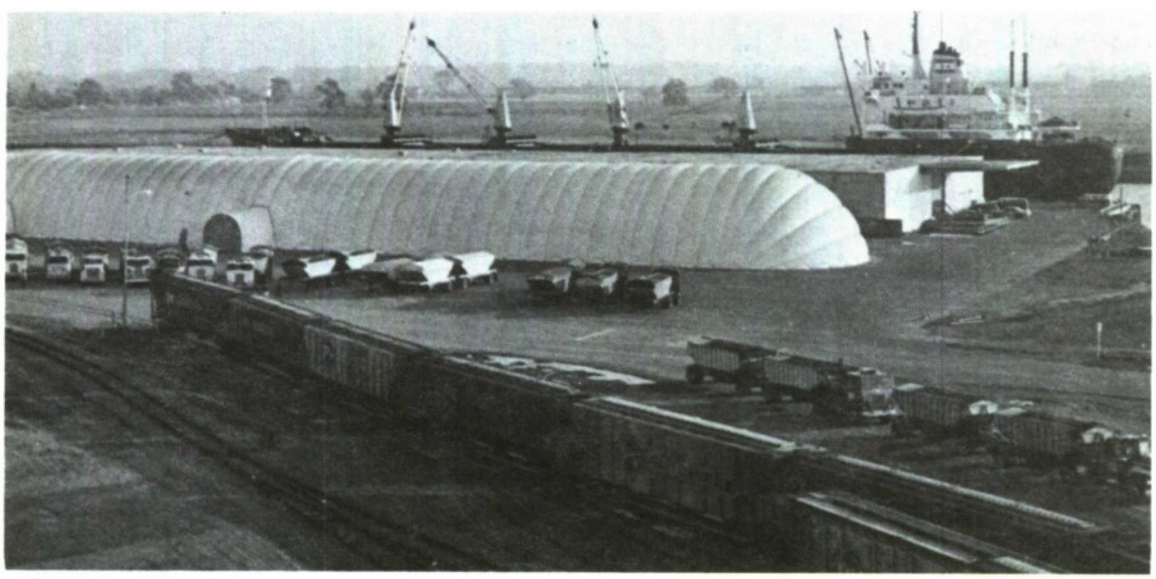
Intermodal Transportation

22. This alternative would promote the use of terminal facilities at bay area and other west coast ports to handle the oceangoing cargo that cannot be moved efficiently in the existing 30-foot channel. Motor carrier, rail, and pipeline modes of transport would be used to haul this cargo to and from the deeper water ports. This procedure is being used to a limited extent at the present time to top-off some of the larger bulk grain vessels that must depart from the Port of Sacramento partially loaded due to limited channel depth. Bulk rice, corn, and wheat are shipped by truck or rail from various parts of the Sacramento and San Joaquin Valleys to the Islais Creek grain terminal at the Port of San Francisco to top-off these partially loaded vessels. Under the intermodal transportation alternative, the deeper draft ports would be used both for topping-off and lightening operations and for stockpiling and processing large volumes of bulk commodities moving to and from the tributary area served by the Sacramento River Deep Water Ship Channel.

ECONOMIC CONSIDERATIONS

23. Increasing the use of other modes of transport for hauling ocean cargo to and from deeper water ports would require construction of new marine terminal and bulk storage facilities. Additional facilities to handle the increased truck, train, and pipeline traffic would also be required. This new construction would take place only at ports where channel depths exceed the existing Sacramento channel depth of 30 feet. The bay area is the only location in northern California where this is presently the case. Congress has authorized deepening the Stockton Ship Channel to 35 feet, but construction has not yet started. Ports outside of northern California are generally too far away to provide logical alternatives.

Rail traffic at the Port of Sacramento.



The intermodal transportation alternative would require greater use of rail and truck.

24. One of the problems associated with this alternative is that limited space is available in bay area ports to accommodate the required bulk storage and handling facilities. Land costs around these ports are so high that expansion at most ports would be prohibitively expensive. However, assuming the required facilities could be provided, the unit cost of moving ocean cargo would rise by approximately $5 to $6 per ton. Similarly, to ship many of the bulk cargoes originating in or for the Port of Sacramento service area through the Port of Stockton, would increase overland transportation and handling costs by at least $5 per ton. Also, additional investment would be required at the Port of Stockton for new terminal and storage facilities to accommodate the cargo from the Sacramento Valley region. For example, most of the rice, wood chips, wheat, and logs currently shipped from the Port of Sacramento originate from the Sacramento Valley, generally north of Sacramento. To ship these commodities from Stockton (assuming construction of the authorized 35-foot Stockton Ship Channel), additional overland transportation and handling costs of at least $5 per ton would be incurred while ocean transportation savings of less than $2 per ton would be realized by utilizing the deeper channel to Stockton as compared to using the existing 30-foot channel to Sacramento. Since bulk cargoes tend to provide narrow profit margins, any savings that can be incurred by shippers, buyers, and growers are vital in maintaining a competitive position in the market place. Increased use of overland modes of transport to carry bulk cargoes to deeper ports would eventually limit production from local industries relying on ocean transportation.

25. This alternative would result in a loss of economic efficiency in handling existing and future cargo movements to and from the Sacramento Valley Region. The lack of bulk storage facilities in the deeper ports of the San Francisco Bay area, in addition to the higher costs of utilizing rail and truck transportation, would inflate the cost of bulk goods entering or leaving the port service area. This would have a negative impact on the NED objectives of increasing the value of the Nation's output of goods and services and improving national economic efficiency.

ENVIRONMENTAL CONSIDERATIONS

26. Increasing truck and train traffic would have an adverse effect on air quality due to the increased amount of particulates and gases emitted into the atmosphere. In view of the EQ objective, this alternative has no potential for making a positive contribution to the environmental quality of the area.

SOCIOECONOMIC CONSIDERATIONS

27. Implementation of this alternative would have relatively minor effects on the Sacramento region. Future industrial development along the channel would be curtailed; however, this loss would be partially offset by increased payrolls in the trucking and railroad industries and at ports in the bay area. Overall, this alternative would have a slightly negative effect on Regional Development in the Sacramento region.

28. This alternative would make both positive and negative contributions to the Social Well-Being (SWB) account. The positive effects include additional job security for trucking and railroad workers. However, cargo movement through the port would decline and jobs at the port would be lost, resulting in a net negative impact on real income in the Sacramento area. Other negative SWB effects include increased pollution emissions into the atmosphere and increased highway traffic, both of which

adversely affect health and safety conditions. Furthermore, increases in consumption of our scarce energy resources, gasoline and diesel fuel, would occur. Other SWB characteristics such as recreation opportunities, education, and emergency preparedness would be virtually unaffected by this alternative.

Deepening The Channel

29. This alternative would involve enlarging the existing project channel between deeper water in Suisun Bay and the Port of Sacramento to facilitate navigation by deeper draft vessels. It is noted that depths greater than 35 feet would not be practical without deepening the downstream waterways between Suisun Bay and the Golden Gate Bridge. This downstream deepening is authorized by the John F. Baldwin portion of the San Francisco Bay to Stockton project; however, the future of this portion of the project is uncertain due to problems related to salinity intrusion, dredged material disposal and economic justification.

30. Channel depths considered under this alternative include 35, 37, and 40 feet to the Port of Sacramento and 35, 37, 40, and 45 feet to the Collinsville-Montezuma Hills area (Channel Mile 11.0). Dredging quantities and areas required for dredged material disposal for the various depths are shown in the following tabulation:

Excavation Quantities and Disposal

	Plan	Excavation Quantity (cubic yards)	Disposal Area (acres)
a.*	35-foot channel from Avon to New York Slough	3,300,000	480
b.	35-foot channel from New York Slough to Mile 11.0	4,500,000	530
c.	35-foot channel from Mile 11.0 to Port of Sacramento	25,800,000	2,970
d.**	37-foot channel from Avon to New York Slough	2,000,000	330
e.	37-foot channel from New York Slough to Mile 11.0	8,100,000	740
f.	37-foot channel from Mile 11.0 to Port of Sacramento	39,600,000	2,830
g.**	40-foot channel from Avon to New York Slough	5,200,000	650
h.	40-foot channel from New York Slough to Mile 11.0	14,000,000	1,130
i.	40-foot channel from Mile 11.0 to Port of Sacramento	55,400,000	3,830
j.**	45-foot channel from Avon to New York Slough	11,800,000	1,085
k.	45-foot channel from New York Slough to Mile 11.0	27,000,000	3,350

* Authorized under San Francisco Bay to Stockton Project (Stockton Channel).

** Assumes Stockton Channel at 35-foot depth.

Plates D-1 through D-5 show the alignment and typical sections of the channels and possible dredged material disposal areas. Sufficient disposal areas are shown to accommodate the dredged material resulting from the maximum depth channel. Not all disposal areas shown would be used for depths less than the maximum considered.

31. This alternative also has the potential to meet the need for additional recreation facilities. Such facilities could be constructed at dredged material disposal sites in cooperation with non-Federal recreation sponsors.

ECONOMIC CONSIDERATIONS

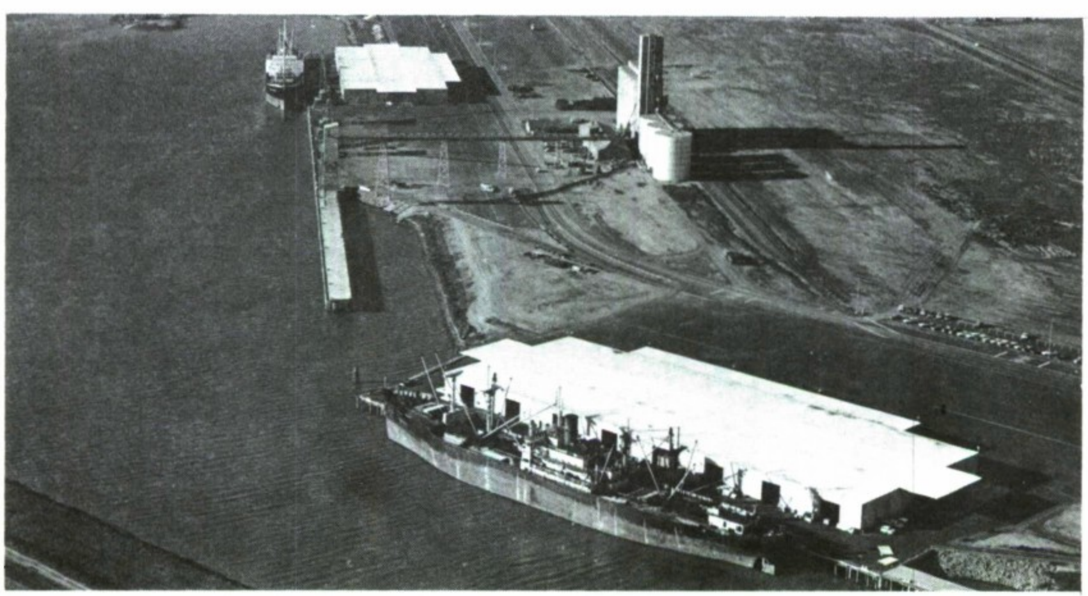
32. Under this alternative larger, more efficient vessels would be able to call at the Port of Sacramento and to traverse the channel when fully loaded. Currently, only about 20 percent of the bulk carriers in the world fleet can operate efficiently in the channel. With this alternative, 60-65 percent of the world bulk carriers could traverse the channel fully loaded. This improvement is reflected in transportation savings which result from: (1) the movement of cargo via larger oceangoing vessels with their inherent economies of scale, (2) elimination or reduction in delays due to tide, (3) reduction of present light-loading and topping-off practices, and (4) movement of induced cargo (cargo that would not move without deepening). This alternative offers the greatest potential for achieving the NED objectives. NED benefits would result from the utilization of larger ships with lower unit transportation costs which would also induce greater cargo movements through the channel both to and from the Port of Sacramento and to and from new industrial developments.

ENVIRONMENTAL CONSIDERATIONS

33. This alternative has the potential for improving the overall environmental quality of the study area and for contributing significantly to the Environmental Quality objectives. However, it could also adversely affect individual aspects of the environment. Possible enhancement measures include construction of salinity control structures which would improve salinity conditions in Suisun Bay, creation of wildlife management areas, provision of recreation facilities, and the preservation of existing unique ecological systems and wildlife habitats along the channel by acquiring such areas in public ownership.

34. Adverse effects include possible local increases in salinity concentrations in the Delta which could be adverse for aquatic life, fauna and flora, and agricultural, industrial, and municipal water supply. Generally, the deeper the channel, the more significant are the potential impacts on Delta salinity. Other detrimental environmental impacts include destruction of some benthic organisms, shoreline vegetation, and wildlife habitats due to channel construction and temporary destruction of vegetation at dredged material disposal sites. However, these impacts would be alleviated within 1 to 3 years by natural regrowth. Also, secondary effects on air and water quality could occur due to induced industrialization; however, local controls should be effective in maintaining existing standards.

The Port and Navigation Lock soon after completion in 1963.



The Port in the early 1960's.

SOCIOECONOMIC CONSIDERATIONS

35. Channel deepening would make both positive and negative contributions to the Social Well-Being (SWB) account. Immediate short-term negative impacts include noise pollution and other inconveniences from dredging and other construction operations. In addition, the esthetic value at the disposal sites would be temporarily reduced. Upon completion of construction, these conditions would improve and return to a more natural state. With regard to long-term impacts, the most likely future assumes that current air, water, and other environmental standards will continue to be enforced, thus resulting in balanced economic development which would result in positive contributions to the SWB account. Channel deepening and related development would result in increased real income, health and safety, recreational opportunities, and emergency preparedness.

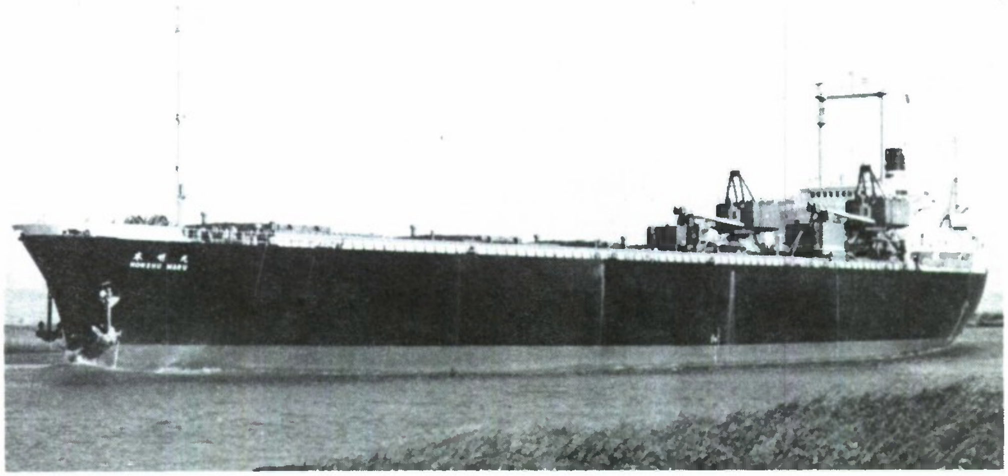
36. Regional development benefits for the deepening alternative would parallel the National Economic Development (NED) benefits since a large portion of the NED benefits would enter the regional economy. The deepening alternative would strengthen the regional economy by providing for greater employment opportunity through increased agricultural and industrial activity. This would result in substantial regional growth.

No Action

37. This alternative course could be taken, although it would not solve the identified problems. It would essentially provide for a continuation of present shipping practices with no improvements other than normal channel maintenance. Present shipping practices used to partially offset existing channel depth constraints include the use of smaller vessels, partial loading (light loading) of larger vessels, and use of rail and truck modes to transport cargoes needed to top-off vessels that cannot operate in the existing channels with full loads. These practices significantly increase the unit cost of moving oceangoing cargoes. Some limitation of future commodity flows in the study area could be expected with this alternative.

ECONOMIC CONSIDERATIONS

38. There would be no initial cost associated with this alternative since it is essentially the "no development" alternative. Any increase in commodity flow would be handled by smaller ships, intermodal transportation, and light-loaded intermediate-sized ships. As more of the smaller ships are replaced by intermediate-sized and larger vessels, the costs of transporting bulk and other cargo to and from the study area would increase. Although increased use of intermodal transportation would occur, the increased transportation costs would impact unfavorably on the economy of the study area by discouraging development of deep-draft navigation-related industries in the study area and possibly inducing relocation of some industries to more economically favorable locations. This alternative has no potential for providing positive contributions to the National Economic Development objective.



Large ships will continue to leave the Port partially loaded if "No Action" is taken.

Congestion will continue and intensify with "No Action."

ENVIRONMENTAL CONSIDERATIONS

39. This alternative is the "without development" condition and provides a baseline for evaluation of other alternatives. As more of the large ships service the port, more intermodal lightering equipment would be needed for "topping off" cargoes in the deeper water of the San Francisco Bay. As compared to existing conditions, this would increase the quantity of particulates emitted into the air by trucks and trains. Other air pollution would result from the continued use of older, less efficient smaller ships. Eventually, the economic efficiency of deep-draft vessels using the channel will drop to a level low enough to discourage development of deep-draft navigation related industries and probably result in relocation of some industries to more economically favorable areas. This would eventually reduce the potential for air and water quality and land use problems associated with industrial development.

SOCIOECONOMIC CONSIDERATIONS

40. With no action (no development), the regional economy would be virtually unaffected for about the next decade or so until the declining economic efficiency of deep-draft vessel transportation limits commodity flow. Regional growth associated with those industries transporting cargo by oceangoing vessels would level off. Although there would be a significant difference between the regional development associated with no action as compared to regional development associated with deepening the channels, it is not expected that the overall economy and development of the region would decline as a result of the no action alternative.

41. It is also anticipated that future adverse effects would develop regarding health and safety. This would be due to the increased truck and rail traffic hauling cargo to and from the deeper water ports. At the same time, higher costs of handling commodities would likely discourage any significant growth at the port. This would eventually result in an increase in port-related unemployment and net loss in real income for the Sacramento region.

Additional Solutions Considered

CONSTRUCT TURNING BASIN

42. When the existing Sacramento River Deep Water Ship Channel was constructed, the west levee at mile 31.9 was set back to allow for construction of a future turning basin. Such a basin would accommodate future industrial development along the east side of the ship channel. The levee setbacks provide for a basin approximately 1,500 feet in length with 1,000-foot transitions at each end and a width of 830 feet from the edge of the existing channel. At this time Yolo and Solano Counties land use plans indicate that no industrialization is anticipated on the east side of the channel below channel mile 37. Furthermore, no industrialization is anticipated in Yolo County on the west side of the channel below the existing industrial zoned property. Economic benefits could be derived from construction of a passing basin in the channel since this could reduce ship delay time when entering or leaving the Port of Sacramento. However, after considering the dimensions and location of the basin, it was concluded that the basin is too small to allow a vessel to enter and stop without tug assistance and that the basin is located too near the Port of Sacramento to be effectively utilized as a passing basin. The Port District's operations office indicated that a passing basin is not needed at this time and that if such a basin were constructed in the future it should be located in Cache Slough near the mouth of the manmade channel.

43. Considering the potential benefits and costs associated with construction of the turning basin, it is concluded that the basin is not needed or justified at this time. The basin has therefore been eliminated from further consideration at this time. However, constructing the turning basin could be considered in the future if the need develops.

CONSTRUCT SEDIMENT TRAP OR CHANNEL CONSTRICTION

44. As indicated in Section C, "Problems and Needs," approximately 200,000 cubic yards of sediment are removed annually from the ship channel between miles 5.0 and 15.0 (see Plates D-2 & D-3). To reduce the maintenance dredging requirements in the ship channel, sediment traps 2 miles long and 5 feet deep located in the Sacramento River and Steamboat Slough upstream of their junction with the ship channel were considered. The effectiveness of the sediment traps were analyzed by the Hydrologic Engineering Center (HEC), using their computer program "Scour and Deposition in Rivers and Reservoirs." The results indicated that the flow velocities would not be reduced enough to allow sediment deposition in the traps; hence, no substantial reduction in maintenance dredging would result from construction of such sediment traps.

45. A plan to constrict the cross section of the Sacramento River sufficiently to produce scouring velocities was also considered. Such a plan would keep shoaling material in suspension, thus reducing maintenance dredging. However, analysis of this plan by HEC showed that such a constriction would raise the design water surface elevation by 6 feet at Rio Vista. Consequently, consideration of this plan was discontinued.

46. It appears that there is no practical alternative solution to the shoaling problem in the ship channel between miles 5 and 15. Maintenance dredging will therefore be continued on a regular basis to maintain the authorized depth in the ship channel.

Summary of Possible Solutions

47. The discussion of alternatives, thus far, has been based on the need for improving waterborne commodity transportation between the study area and world markets. Improvements are made necessary by changes in the world fleet of bulk carriers and by the need to improve national economic efficiency, to enhance the quality of the environment, and to maintain the regional economy and the social well-being of the area. Of the alternatives considered, only the channel deepening alternative would substantially meet the above needs. The other alternatives such as increased use of LASH, intermodal transportation, and no action would continue to hinder the efficient transportation of bulk commodities to and from the study area. These alternatives would also result in the slowing of the economic growth of the study area and a decline in the social well-being of its inhabitants. Even though the major adverse environmental impact of these alternatives is a slight decrease in air quality and an increase in energy consumption (diesel fuel), they have no potential for enhancing the quality of the environment. On the other hand, although the deepening alternative may have some significant short-term environmental impacts, it has the potential for providing long-term environmental enhancement for the study area. Table D-1 presents a summary of the effects of the alternatives.

TABLE D-1

SUMMARY OF ECONOMIC-ENVIRONMENTAL-SOCIAL EFFECTS

	LASH	INTERMODAL TRANSPORTATION	DEEPENING THE CHANNEL: 35 FEET	DEEPENING THE CHANNEL: 37 FEET	DEEPENING THE CHANNEL: 35/40 FEET	DEEPENING THE CHANNEL: 40/45 FEET	NO ACTION
ALTERNATIVE DESCRIPTION	Use LASH to handle additional tonnages expected at the Port.	Increase the use of truck and rail traffic to handle additional tonnages at the Port.	Dredge the channel from Sacramento to New York Slough to a depth of 35 feet.	Dredge the channel from Sacramento to Avon with a depth of 37 feet.	Dredge the channel from Sacramento to Collinsville—Montezuma Hills to 35 feet and from Collinsville—Montezuma Hills to Avon to 40 feet.	Dredge the channel from Sacramento to Collinsville—Montezuma Hills to 40 feet and from Collinsville—Montezuma Hills to Avon to 45 feet.	Maintain the existing channel at its current depth.

NATIONAL ECONOMIC DEVELOPMENT (x1,000)	LASH	INTERMODAL TRANSPORTATION	35 FEET: SACRAMENTO TO COLLINSVILLE-MONTEZUMA HILLS	35 FEET: COLLINSVILLE-MONTEZUMA HILLS TO NEW YORK SLOUGH	35 FEET: TOTAL	37 FEET: SACRAMENTO TO COLLINSVILLE-MONTEZUMA HILLS	37 FEET: COLLINSVILLE-MONTEZUMA HILLS TO AVON	37 FEET: TOTAL	35/40 FEET: SACRAMENTO TO COLLINSVILLE-MONTEZUMA HILLS	35/40 FEET: COLLINSVILLE-MONTEZUMA HILLS TO AVON	35/40 FEET: TOTAL	40/45 FEET: SACRAMENTO TO COLLINSVILLE-MONTEZUMA HILLS	40/45 FEET: COLLINSVILLE-MONTEZUMA HILLS TO AVON	40/45 FEET: TOTAL	NO ACTION
	Large Federal subsidies would be required to expand the LASH fleet.	(No Federal Cost)													(No Federal Cost)
Annual Costs		0	4,575*	1,347	5,922	6,943	2,262	9,205	4,575	3,714	8,289	10,222	7,241	17,463	0
Annual Benefits		0	10,452	4,447	14,899	12,226	6,351	18,577	10,452	8,395	18,847	13,843	10,371	24,214	0
Net Annual Benefits		0	5,877	3,100	8,977	5,283	4,089	9,372	5,877	4,681	10,558	3,621	3,130	6,751	0
Benefit/Cost Ratio		0	2.3	3.3	2.5	1.8	2.8	2.0	2.3	2.3	2.3	1.4	1.4	1.4	—

	LASH	INTERMODAL TRANSPORTATION	35 FEET	37 FEET	35/40 FEET	40/45 FEET	NO ACTION
ENVIRONMENTAL QUALITY							
(a) Salinity	No Impact	No Impact	See Appendix 5 for detailed discussion.	See Appendix 5 for detailed discussion.	See Appendix 5 for detailed discussion.	See Appendix 5 for detailed discussion.	None
(b) Vegetation	Insignificant	No Impact	A temporary loss of vegetation will occur at disposal areas. Most of these sites are currently grassy type areas. Approximately 45 acres of vegetation will be permanently lost due to widening the existing channel 50 feet.	Same as 35 except 218 acres of land would be permanently lost due to widening the channel 75 feet.	Same as the 35-foot.	Same as the 37 but 290 acres would be permanently lost due to widening the channel 100 feet.	No Impact
(c) Wildlife	Insignificant	No Impact	Wildlife habitats will be destroyed where dredged material is deposited but should reestablish over a short period of time. 156 acres will be developed to compensate for this loss.	Same as the 35-foot.	Same as the 35-foot.	Same as the 35-foot.	No Impact
(d) Water Quality	Insignificant	May improve existing conditions due to fewer vessels being used in channel.	Minor change.	Same as the 35-foot.	A slight degradation could occur from industrial run-off and increased ship traffic.	Same as 35/40-foot.	As more ships begin using the channel water quality may be degraded.
(e) Air Quality	Slight increase in pollutants.	Greater increase in pollutants than with LASH.	Use of larger, newer and more efficient vessels would slightly improve air quality. However, induced industrialization and cargo movements would eventually result in a slight increase in pollution.	More effect than the 35-foot.	More effect than the 35-foot.	Slightly worse than the 35/40-foot.	As more larger ships service the port, more intermodal lightening equipment would be needed for "topping off" cargoes in the deeper waters of San Francisco Bay.
(f) Dredging	None	None	30.3 million CY of material would be dredged and deposited on 3,500 acres of land.	53 million CY of material would be dredged and deposited on 4,380 acres of land.	48.3 million CY of material would be dredged and deposited on 5,230 acres of land.	97.5 million CY of material would be dredged and deposited on 8,745 acres of land.	None
(g) Fisheries	Insignificant	No Impact	See Appendices 1 and 3 for detailed discussion.	See Appendices 1 and 3 for detailed discussion.	See Appendices 1 and 3 for detailed discussion.	See Appendices 1 and 3 for detailed discussion.	None
(h) Land Use	No Impact	Additional bulk handling or storage facilities would need to be constructed in Bay Area.	45 acres of a DMD site will be converted to a tidal marsh. A 30-acre portion of the sandy beach DMD site south of Rio Vista will be converted to recreation uses. 156 acres of DMD sites will be converted to upland habitat.	Same as the 35-foot.	Same as the 35-foot.	Same as the 35-foot.	None
(1) Marine Organisms	No Impact	No Impact	Benthic communities will be temporarily destroyed in area of dredging. Widening the channel will create additional benthic area over the project life.	A wider channel will destroy more organisms than 35-foot channel.	More effect than the 35-foot.	More effect than the 35/40-foot.	No Impact
REGIONAL DEVELOPMENT							
(a) Land Use	No additional land would be required to increase the use of LASH at the Port of Sacramento.	Some land at the Port area would need to be developed for new facilities.	Some induced development would require that land presently used for agricultural purposes be converted to industrial sites.	Slightly more effect than the 35-foot.	More effect than the 35-foot.	More effect than the 35/40-foot.	No Change

*Cost of salinity mitigation measure (submerged sill) is included only for channel depth of 35 feet which is the depth at which the sill was model tested.

TABLE D-1
SUMMARY OF ECONOMIC ENVIRONMENTAL SOCIAL EFFECTS
(Continued)

	LASH	INTERMODAL TRANSPORTATION	DEEPENING THE CHANNEL 35 FEET	37 FEET	35/40 FEET	40/45 FEET	NO ACTION
(b) Employment/Labor Force	Some new jobs would probably be generated over a period of time from a conservative amount of new development.	Same as for LASH.	A positive effect would occur. During construction, 130 new construction jobs and 35 support jobs would be generated in the local area. A total of 3,550 new jobs in operation and maintenance of recreation facilities and in port and deepwater dependent industrial development would be generated directly by the deepening (over 50 years). Also, 5,680 new jobs would be generated indirectly by above increase in direct employment.	More effect than 35-foot.	More effect than 35-foot.	More effect than 35/40-foot.	Same as for LASH.
(c) Business, Industrial, Agricultural Activities	A minor increase in industrial activity.	Same as for LASH.	A positive effect would occur. Deepening the channel to 35 feet would produce 600,000 tons of additional cargo shipments (from new industries and port activities), and this increase in shipments would reach almost 5.2 million tons by 2037. Substantial socioeconomic benefits would accrue to the region in the form of additional employment, higher personal incomes, strengthened agricultural and industrial base and increased property values.	More effect than 35-foot.	More effect than 35-foot.	More effect than 35/40-foot.	Some new activity will occur with or without channel improvements.
SOCIAL WELL-BEING							
(a) Noise	No Significant Impact	More trucks and rail traffic will add to the present noise level around the Port.	Some noise will be generated during the dredging operation but will be in relatively remote locations. Moderate increase along the improved channel as land is converted from agricultural to industrial use.	Same as the 35-foot.	Same as the 35-foot.	Same as the 35-foot.	No Impact
(b) Population/Housing	No Significant Impact	No Impact	New jobs will bring new people to the area which will result in increased housing development.	More effect than 35-foot.	More effect than 35-foot.	More effect than 35/40-foot.	No Significant Impact
(c) Esthetics	No Significant Impact	The sight of increased numbers of trucks and facilities may be displeasing to some people.	Disposal areas may be esthetically displeasing until new growth and development take place.	Same as the 35-foot.	Same as the 35-foot.	Same as the 35-foot.	No Impact
(d) Transportation	No Significant Impact	Will add significant traffic to the highways.	Improved transportation efficiency would greatly improve competitive position of Northern California importers/exports.	More effect than 35-foot.	More effect than 35-foot.	More effect than 35/40-foot.	No Improvements
(e) Recreation	No Contribution	No Contribution	Estimated initial use at Sandy Beach Recreation Area is 120,000 recreation days annually.	Same as the 35-foot.	Same as the 35-foot.	Same as the 35-foot.	No Contribution
(f) Health/Safety	More vessels using the channel with the existing dimensions could create a safety problem.	More truck traffic would lower the existing level of safety on the highways.	Safety would increase due to fewer vessels and wider channel. Future increase in traffic may then decrease the level of safety slightly.	Same as the 35-foot.	Same as the 35-foot.	Same as the 35-foot.	An adverse impact would eventually occur due to channel congestion.
(g) Historical/Archeological	No Effect	No Effect	Any discoveries would be reported to the proper agencies.	Same as the 35-foot.	Same as the 35-foot.	Same as the 35-foot.	No Impact

48. Improving the Sacramento River Deep Water Ship Channel would meet the needs of waterborne commerce and provide transportation savings that exceed improvement costs. The alternatives to channel improvements, such as LASH, intermodal transportation, and no action, are not practical alternatives because they do not provide an efficient means of transportation and do not meet the needs of waterborne commerce. Therefore, based on technical, economic, and environmental criteria, the best means to provide transportation savings to the Port of Sacramento service area is to deepen the existing Sacramento River Deep Water Ship Channel.

Channel Deepening Considered Further

49. In considering the deepening alternative, the channel was divided into two reaches: from Avon to the Collinsville-Montezuma Hills area (mile 11) and mile 11.0 to the Port of Sacramento. These reaches can be considered separately since commodity movements in the two reaches are largely independent of each other, as long as the downstream reach is at least as deep as the upstream reach. The following array of alternative depths was therefore developed:

ALTERNATIVE DEPTHS

Reach	Alternative Depths Considered
Avon to Collinsville-Montezuma Hills	35, 37, 40, 45
Collinsville-Montezuma Hills to Sacramento	35, 37, 40

Depths greater than 45 feet between Avon and Collinsville-Montezuma Hills were not considered since this is the greatest depth authorized under the San Francisco Bay to Stockton project.

50. The above range of depths allows for determining the optimum economic channel depth or combination of depths. It also facilitates the comparison of environmental effects over a range of channel conditions. By emphasizing various plan components, it is possible to develop National Economic Development (NED), Environmental Quality (EQ), and "mixed" plans from which the "best" plan can be formulated.

The Design Vessel

51. The design vessel, for the purposes of this analysis, is the hypothetical vessel which represents the size range of vessels that would most commonly use the waterway. The channel or waterway is then designed to assure safe and economical passage for the design vessel. For the Sacramento channel, the design vessel is developed by determining the commodities handled and the types and sizes of vessels in use, both now and in the future, which handle those commodities and are likely to use the channel under current and future conditions. The following tabulation presents the average dimensions of various size vessels currently in use in transporting the commodities that move or might move in the area served by the channel.

AVERAGE VESSEL DIMENSIONS

Dry Bulk Cargo Vessels

DWT	Design Draft (feet)	Beam (feet)	Length (feet)
15,000	29.6	70.2	454.0
25,000	33.4	75.3	585.5
35,000	36.6	79.4	643.0
50,000	41.2	91.9	706.5
60,000	40.9	105.6	736.5
80,000	46.6	106.1	839.0

Wood Chip Vessels

DWT	Design Draft (feet)	Fully Loaded Draft (feet)*	Beam (feet)	Length (feet)
30,000	31	25.7	86	580
42,000	36	30.5	100	640
50,000	38	32.0	110	690

*Fully loaded draft is less than design draft because of the low density of the softwood chips.

Both standard dry-bulk and wood chip vessel dimensions are presented because of the difference in their proportions. The newer type wood chip vessels have broader beams than do dry-bulk cargo vessels. Generally, however, dry-bulk vessels have greater drafts. Therefore, the design vessel's beam widths will primarily consider wood chip vessels, and their drafts will be based on consideration of the dry-bulk vessels.

52. To accurately evaluate the potential range of depths, design vessels must be determined for channel depths of 35, 37, 40, and 45 feet. A 3-foot bottom clearance (when measured from the static draft line) for the vessels in freshwater is considered adequate to account for sinkage (squat), trim, and to provide adequate safety clearance over the sandy channel bottom. Figure D-1 illustrates the factors which affect channel depth. Based on the preceding tabulation and criteria, the design vessels can be developed as shown in the following tabulation.

Design Vessel Characteristics for Various Channel Depths[1]

Channel Depths	DWT (tons)	Draft[2] (feet)	Beam (feet)	Length (feet)
35-foot	20,000	32	83	520
37-foot	25,000	34	88	586
40-foot	35,000	37	99	643
45-foot	50,000	42	105	707

[1]Channel depth = Draft + clearance + squat for economic speed.
[2]Draft = Design vessel static draft (summer seawater) + freshwater sinkage.

The beam of the design vessels has been assumed larger than normal for dry-bulk carriers to account for the wide beamed wood chip vessels which use the channel.

Channel Dimensions

53. Factors affecting channel dimensions include the size and maneuverability of the vessel, current velocities and direction, tidal stages, wind speed and direction, vessel speed, characteristics of the channel bottom and banks, and in the case of an existing channel such as the Sacramento River Deep Water Ship Channel, any specific considerations necessary as a result of experience gained in use of the channel. The following paragraphs include a discussion of these interrelated factors as they apply to design channel width, design channel width in bends, and design channel depth.

54. Shown on page D-29 is an extensive list of references which were used in determining appropriate channel dimensions. In some cases, the channel was designed wider than recommended in the various references. An example is the Avon to Middle Point reach in which the ammunition loading docks of the Concord Naval Weapons Station are located. In no case was the channel width designed less than the minimum recommended in the the references. In some cases, however, the channel width was kept to a minimum due to special considerations. An example is the reach between mile 18.6 and the Port of Sacramento, which is the manmade portion of the channel. This reach is straight and uniform, is in slack water, and has no winds perpendicular to the direction of travel. To prevent erosion due to wavewash, ship speeds are controlled by imposition of speed limits. Wide beam vessels traverse the channel during daylight hours only, further decreasing the possibility of pilot error. Over 4,000 deep-

draft vessel trips have been made through the channel with only one significant grounding. These facts indicate that serious consideration should be given to decreasing channel design widths in this reach where practicable.

55. Channel Width — Channel width is premised on the beam and steering characteristics of the design vessel, the traffic density, and the characteristics of (1) the banks, (2) other vessels encountered in the channel, and (3) the waves likely to be experienced in the several reaches. While acknowledging no formulas for evaluating these characteristics and their complex relationships, EM 1110-2-1607 does reference, as a general guide, Chapter 10 of the Committee on Tidal Hydraulics Report No. 3. Studying other waterways similar to the one under study is another means of determining the appropriate balance between safe, efficient operation and economical construction. The EM cautions that accident-free operation of another waterway may be reflective of an overdesigned, uneconomical project as well as an appropriately designed project. Guidance provided in the EM and the Committee on Tidal Hydraulics Report No. 3 indicates a range of channel widths that should be considered on the basis of user vessel characteristics and physical and hydraulic conditions in the channel area. These "guides" suggest ranges to be considered for vessel maneuvering lanes and bank clearances, and in cases where two-way traffic is involved, a vessel clearance lane as well as width in bends. These allowances are discussed below.

> "The maneuvering lane is that portion of the channel required for a vessel to maneuver in, in an effort to navigate a straight course. This lane should provide adequate width for the vessel to avoid encroaching on its safe bank clearance or approaching another ship so closely that dangerous interference between ships will occur."

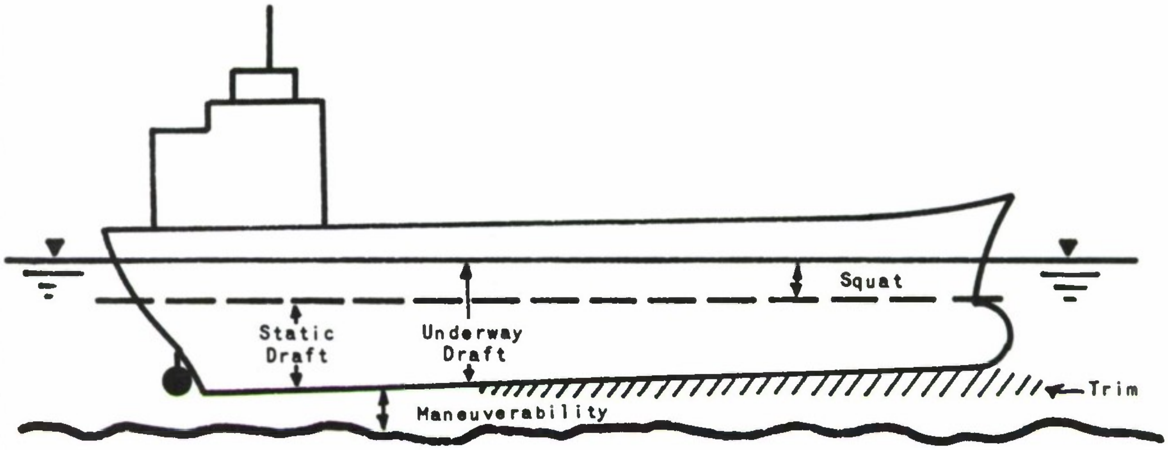
• Model tests and vessel observations outlined in Tidal Hydraulics Report No. 3 indicated that maneuvering requirements for various vessels are mainly related to the vessels controllability. These tests indicated that the maneuvering lane may be as little as 160 to 180 percent of the vessel beam for those with good to average controllability where there are no currents at an angle to the channel, or winds or waves that cause vessel yaw. When vessels have poor controllability and yawing forces are likely to be experienced, 200 percent of the vessel beam is suggested for the maneuvering lane. In general, the controllability of various vessels was defined as follows:

a. Very good for naval fighting vessels and freighters of the Victory ship class.

b. Good for naval transports and tenders, T-2 tankers, new ore ships and freighters of the Liberty ship class.

c. Poor for old ore ships and damaged vessels.

> "Bank clearances are required to compensate for the positive pressures against the bow of a vessel and the negative pressures against its stern as it moves in proximity to a channel bank. Pressures are created by the hydraulic compression of the water as it is "squeezed" between the vessel and the bank at its bow and the rapid evacuation of the water at the stern by the vessel's propellers. With adequate clearances this phenomenon can be compensated and equilibrium established through application of some degree of rudder. Again, the bank clearance required by a vessel is dependent



Static draft refers to the flotation of a ship in freshwater.

Squat is a term describing a reduction in the water level immediately surrounding a vessel resulting in an increase in its draft as opposed to static draft.

Trim is the adjusting of the bow or stern to obtain the most efficient cruising plane. Usually the stern is lower than the bow.

Maneuverability is the bottom clearance needed for safe navigation.

FACTORS AFFECTING CHANNEL DEPTH

SACRAMENTO RIVER DEEP WATER
SHIP CHANNEL INVESTIGATION
CALIFORNIA

Figure D-1

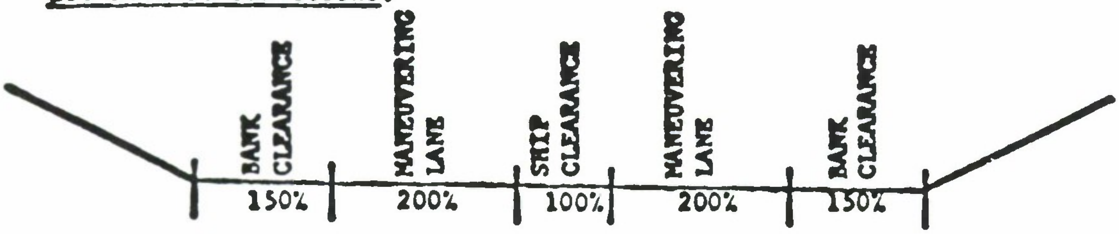
Figure D-2

Limitations for Channel Width Design

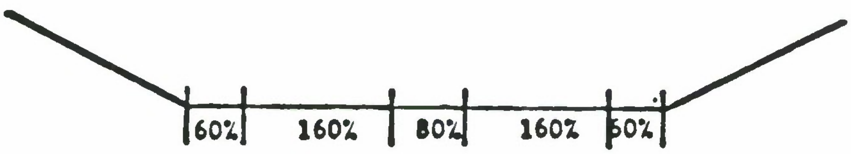
(Given in % of Vessel Beam)

Two-way traffic:

Maximum allowances
for adverse conditions.

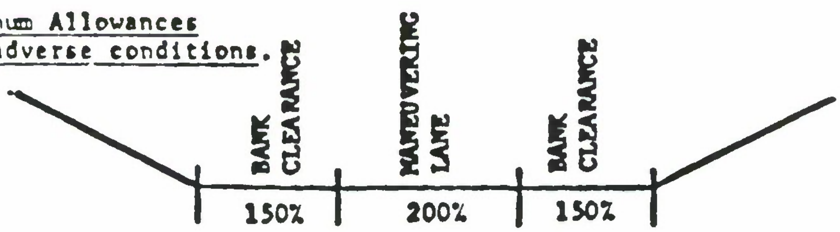


Minimum Allowances
for Ideal Conditions.

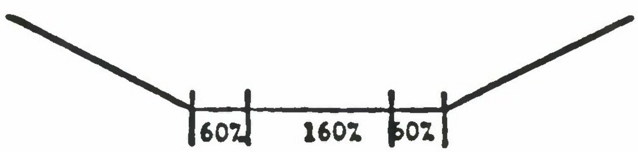


One-way traffic:

Maximum Allowances
for adverse conditions.



Minimum Allowances
for Ideal Conditions.



upon the vessel's controllability, its speed, the nature of the bank material, its shoaling characteristics, the width and depth of the channel, and wind and hydraulic forces. Studies indicate that where favorable conditions exist, the bank clearance could be as little as 60 percent of the beam of the vessels if they are known to handle well that close to the edge of the channel. Conversely, if strong currents, winds, and waves are known to occur frequently at an angle to the channel and the banks are composed of hard materials, as much as 150 percent of the vessel beam may be advisable.

"In cases where a channel is required to accommodate two-way traffic, a width allowance is necessary between the vessels to avoid adverse hydraulic interactions when passing. The conclusion of tests outlined in Tidal Hydraulics Report No. 3 indicates that in wide waterways that are well buoyed and not subject to strong currents or other yawing forces, a minimal ship clearance of as little as 80 percent of the beam of the larger vessel may be satisfactory. However, a clearance of 100 percent of the beam is recommended for less ideal conditions."

56. The Sacramento River Deep Water Ship Channel can be separated into five reaches based on conditions in the existing channel that must be considered when determining appropriate channel widths. These reaches are Avon to Middle Point, Middle Point to New York Slough, New York Slough to Junction Point (mile 15.0), mile 15.0 to mile 18.6, and mile 18.6 to Port of Sacramento.

a. Avon to Middle Point — The existing 300 to 600-foot wide channel in this reach lies within a naturally wide waterway and handles vessels from Sacramento, Stockton, Pittsburg, and Port Chicago. Due to this high usage, and the wide waterway, the design channel is expected to provide for two-way traffic. According to river pilots, controllability is not a problem in this reach, although waves and wind perpendicular to the direction of travel do exist. Extra bank clearance, however, is necessary in this reach due to the Naval Weapons Station's ammunition loading docks at Port Chicago. Also, due to the possibility of yawing forces, a value of 180 percent of the design vessel's beam should be used to compute the width of the maneuvering lane. Experience has shown that a greater bank clearance is needed for the wider channels that experience potential yawing conditions. The bank clearance lane should have a width of at least 100 percent of the beam of the design vessel. The ship clearance lane for two-way traffic should have a width equal to 100 percent of the beam width of the design vessel. The bottom and bank materials are generally fine sand and silts along the entire reach.

b. Middle Point to New York Slough — This reach is similar to the previous reach, except that traffic from Port Chicago and the hazard associated with ammunition loading at Port Chicago are not present. Potential yawing forces are also not as great in this reach as in the previous reach. Therefore, it is practical to decrease the channel width in this reach to less than that in the previous reach. Also, sufficient traffic uses this reach to justify a two-way channel. A value of 160 percent of the design vessel's beam should be used to compute the width of the manuevering lane. The bank clearance lane should have a width of 70 percent of the beam width of the design vessel. The ship clearance lane for two-way traffic should have a width equal to 80 percent of the beam width of the design vessel.

c. New York Slough (Pittsburg) to Junction Point (Mile 15.0) — In this reach, the channel is within the Sacramento River, which is narrower and subject to higher current velocities than the previous reaches. Only vessels bound for or departing from the Port of Sacramento use this channel, and based on future traffic projections, a one-way channel is considered adequate in this reach. To prevent collisions in the channel, the port's operations office uses two-way radio communication to control vessel movements between New York Slough and the Port of Sacramento. Wind and currents are generally parallel to the channel in this reach and are not a problem. Bottom sediment consists of medium to fine sand which poses no hazard to navigation provided the channel is adequately maintained. Due to the higher current velocities in this reach, a value of 180 percent of the vessel's beam was used for the maneuvering lane, and a value of 150 percent of the vessel's beam should be used for bank clearance.

d. Junction Point to Mile 18.6 — This reach lies in Cache Slough between the Sacramento River and the manmade portion of the channel and is the narrowest portion of the natural waterway. This channel carries high winter flows from the Yolo Bypass and is hence subject to high current velocities. This reach also need only provide for one-way traffic. Due to the lack of wind and waves in this portion of the channel, the bank clearance can be decreased. By use of a bank clearance of 90 percent of the design vessel beam width and 180 percent for the maneuvering lane, a 300-foot-wide channel is provided. This 300-foot width would provide an orderly 3.6-mile-long transition from the 400-foot-wide channel downstream of Junction Point (mile 15.0) to the narrower 250-foot-wide manmade channel starting at mile 18.6.

e. Mile 18.6 to Port of Sacramento — This reach comprises the manmade portion of the channel and is hence straight and uniform. This reach is in slack water and is not subject to winds perpendicular to the direction of travel. The bottom material consists of silty clays and silty sands. A one-way channel is adequate due to control of traffic by the port. A value of 160 percent of the vessel's beam was used for the maneuvering lane, and a value of 70 percent of the beam was used for bank clearance.

57. Channel Width in Bends — In examining the design criteria for ship channel bends, it is apparent that channel bends ultimately should be designed based on judgment, actual ship maneuvering experience, and empirical equations, as well as ship beams and lengths. To investigate possible required increases in channel widths in bends of the Sacramento River Deep Water Ship Channel, various computations were made using the empirical equations and rules-of-thumb contained in the Tidal Hydraulics Report No. 3, P.I.A.N.C., and other publications.

58. Four bends in the ship channel should be considered for additional channel widening. Two of these bends are in the reach between Junction Point and mile 18.6, which is the narrowest portion of the natural waterway. The two bends are located at channel miles 16.0 and 17.0. The other two bends warranting further consideration are in the manmade portion at channel miles 36.0 and 41.0. Following is a detailed discussion of each of these bends:

a. Bend at Mile 16.0 — The radius of this bend is 6,500 feet. DeMiranda, Kray, and Navy D.M. No. 6 (see list of references on page D-29) recommended bend radii of 5,800, 7,000, and 3,000 feet, respectively, for the 35-foot depth design vessel (83-foot beam, 580-foot-long ship). Several of the references recommend a slight increase in channel width (10 to 20 feet), based on the above information. However, many of these same references call for a 300-foot-wide channel in this bend, based on the 35-foot depth design vessel. Without widening at his bend, the channel is already designed for a 300-foot width. Since (1) the bend radius is more than adequate; (2) the references, for the most part, indicate the need for only a minor widening; and (3) the fact that the channel is already designed for a 300-foot width (the width recommended by many of the references), it was decided that widening at mile 16.0 due to the bend was not necessary.

b. Bend at Mile 17.0 — The radius here is 9,000 feet. DeMiranda, Kray, and Navy D.M. No. 6 recommended bend radii of 1,740, 7,000, and 3,000 feet, respectively, for this bend. Some of the references recommended no increase in channel width, others recommend a slight increase (up to 10 feet). However, many of these same references call for a 300-foot-wide channel in the bend, which is the design width for the channel at this location. For the reasons enumerated above, it was decided that additional widening at mile 17.0 due to the bend was not necessary.

c. Bend at Mile 36.0 — The radius of this bend is 5,000 feet. DeMiranda, Kray, and Navy D.M. No. 6 recommend bend radii of 1,740, 7,000, and 3,000 feet, respectively. Some of the references recommend slight increases in channel width at this bend (17 to 35 feet); correspondingly, these references call for a channel width of from 250 to 300 feet. The channel (35 feet in depth) is currently designed for a 250-foot width in this reach. For the following reasons, it is not necessary to widen the channel at mile 36.0 due to the bend: (1) The existing bend radius exceeds that which is necessary for the design vessel; (2) the proposed design width (250 feet) is within the range of recommended widths (250 to 300 feet); (3) this bend is located in slack water and has a 15-mile straight, uniform channel just down-channel from it. Vessel speeds are strictly controlled (reduced) in this reach, and wide beam vessels traverse the channel only during daylight hours. Also, over 4,000 deep-draft vessel trips have been made through this bend (currently 200 feet wide), with no serious problems encountered. Many of these trips were by ships as long as or longer than ships expected to call at the port with a deepened channel.

d. Bend at Mile 41.0 — The radius of this bend is 8,000 feet. DeMiranda, Kray, and Navy D.M. No. 6 recommend bend radii of 5,800, 7,000, and 3,000 feet, respectively. Some of the references recommend slight increases in channel width at this bend (5 to 11 feet). These same references call for a channel width in the bends of 250 feet, which is the width already designed for this reach of channel. Ships arrive at the Port of Sacramento immediately upon leaving this bend and thus travel very slowly through it. For these reasons, plus the additional safety considerations associated with the manmade portion of the channel (discussed in paragraph c above), it is not considered necessary to widen the channel an additional amount due to the bend.

59. Channel Depth (Keel Clearance) — The references shown on page D-29 were also used in designing proper keel clearance. For the most part, references on this topic are general and leave the ultimate decision to the reader. For instance, ETL 1110-2-209 says, "Criteria for safety clearance for intakes is not available and clearances are, to a considerable extent, a matter of judgment." EM 1110-2-1607 " . . . has been designed to serve as a guide to the Corps of Engineers personnel . . . " Several of the references do recommend, however, that " . . . a nominal clearance of at least 2 feet under the keel of a vessel is needed."

60. The design channel is made up of the sum of the draft, the keel (safety or maneuverability) clearance, the squat, and trim necessary for economic speed of travel. In design of the Sacramento River

Deep Water Ship Channel, a total of 3 feet for squat, trim, and keel clearance was added to the draft of dry bulk vessels to compute the necessary channel depth. In addition to that, the drafts of the vessels were increased one-fourth of an inch per foot of design draft when going from salt to fresh water. Justification for the 3-foot increment is as follows:

a. Maneuverability or safety clearance accounts for most of the 3-foot additional depth. Several references state that at least 2 feet is needed. However, others state that 2 feet is in excess of what is needed. For instance, in a P.I.A.N.C. paper, Mr. T.F.D. Sewell, Director, Maunsell Consultants Ltd., London, indicated that in the sheltered waterway of the Suez Canal, an under keel clearance of 5 percent of the draft was adequate. For a draft of 32 feet, this would amount to a design keel clearance of 1.6 feet. A major portion of the Sacramento River Deep Water Ship Channel is in slack water with no external effects such as wind and currents affecting navigability. The channel bottom is made up predominantly of sands, with no rock formations. Obviously, a design keel clearance of from 1.5 to 2 feet is adequate.

b. Trim, which is adjustment of the bow or stern of a vessel to obtain the most efficient crusing plane, is a factor to be considered in design of the Sacramento River Deep Water Ship Channel. However, for several reasons unique to this channel, trim is not a major consideration. As previously mentioned, vessel speeds are strictly controlled in the channel, and thus, if a ship were to trim to allow increased speed, it may be to no avail due to imposed speed limits. Steaming time from the Golden Gate Bridge to the port is about 9 hours with existing speed limits. Obviously, not much time would be gained in trimming for efficient speed even if the speed limit permitted it. Vessels calling at the port from Japan often traverse the channel even keel and then trim for efficient speed when they reach the deeper water. This is a practical decision which is expected to continue in the future, with or without a deepened channel.

c. Squat is a term describing the increase in draft which a vessel creates by the fact that it is underway, as opposed to vessel draft under static conditions. Squat is a function of many things, including the vessel speed, vessel trim, and the characteristics of the ship. As applied to operation of the Sacramento River Deep Water Ship Channel, squat is a more important consideration than trim but is less important than keel clearance. If the vessel is traveling at a reduced speed, which is the case in the ship channel, squat is reduced. As mentioned in paragraph b above, little trim is currently used or expected in the future in the ship channel. Little literature is available on the effect of even versus uneven trim on vessel squat. However, Chapter X of the May 1965 Report No. 3 by the Tidal Hydraulic Commisssion states, "It seems likely that a vessel down at the stern while at rest might have a greater squat at the stern than would be experienced if the static bow and stern drafts were the same, other things being equal, but no quantitive data on this matter is (sic) available." This indicates that it is "likely" that a vessel traveling with even keel, the predominant case in the ship channel, will have less squat than if it were traveling with trim. Furthermore, many of the wood chip vessels visiting the Port of Sacramento are the newer type broad beam vessels which would have less squat than the narrower beam dry-bulk vessels.

d. Summarizing, it is evident that given the type of vessels which are expected to use the ship channel and the special operating procedures which the channel utilizes, a total design of 3 feet for squat, trim, and keel clearance is sufficient to allow safe and efficient operation of dry bulk vessels. Additional justification for this figure is that the 3 foot clearance (static draftline) closely approximates actual operating procedures in the channel. Furthermore, use of the 3-foot figure insures a conservative analysis of navigation benefits. By increasing the 3-foot increment, navigation benefits would increase since an increased increment would affect preproject conditions more than project conditions.

61. Following is a list of references used in design of the channel dimensions:

a. EM 1110-2-1607, Tidal Hydraulics, dated 2 August 1965.

b. Chapter X, Design of Channels for Navigation, Tidal Hydraulic Commission Report No. 3, dated May 1965.

c. Waugh, R.G., "Planning and Designing Deep Draft Navigation Channels," a paper presented at Waterways Experiment Station Deep Draft Navigation Channel Design Conference, Vicksburg, Mississippi, 16 May 1978.

d. Bulletin No. 16, page 88-93; Permanent International Association of Navigation Congresses publication dated 1973.

e. "Proposed Procedures for Determining Ship Controllability Requirements and Capabilities," a paper presented at the First Ship Technology and Research (STAR) Symposium, Washington, D.C., August 26-29, 1975.

f. Eda, H., "Directional Stability and Control of Ships in Restricted Channels," a paper presented at the Annual Meeting, New York, N.Y. November 11 and 12, 1971, of The Society of Naval Architects and Marine Engineers.

g. 24th International Navigation Congress, Section 1, Inland Navigation, Subject 3.

h. U.S. Navy Dept. Design Manual, Harbor and Coastal Facilities, Navdocks DM-26 Facilities Engrg. Command, Washington D.C., July 1968.

i. DeMiranda, C.F.V. XIV Congress, Permanent International Association of Navigation Congresses, 2nd Section, 1st Communication, Cairo, 1926.

j. Kray, J.C., Layout and Design of Channels and Maneuvering Areas, Permanent International Association of Navigation Congress, Volume II 1975.

k. Sewell, T.F.D., "Factors Involved in Developing the Suez Canal," P.I.A.N.C., 1978.

l. Mobile Harbor Channel Design Summary Report as presented by Mr. Jim Baxter, Mobile District at the Deep Draft Channel Design Conference, 16-18 May 1978, U.S. Army Engineers Waterways Experiment Station, Vicksburg, Mississippi.

m. ETL 1110-2-209, Engineering and Design — Navigation Channels and Channel Depths, dated 23 February 1976.

TABLE D-2

DETAILED ANALYSIS OF CHANNEL WIDTHS

ALTERNATIVE DEPTHS
(Feet)

REACH	35 FEET				37 FEET				40 FEET				45 FEET			
	MANEUVERING LANE	BANK CLEARANCE LANE	SHIP CLEARANCE LANE	CHANNEL WIDTH	MANEUVERING LANE	BANK CLEARANCE LANE	SHIP CLEARANCE LANE	CHANNEL WIDTH	MANEUVERING LANE	BANK CLEARANCE LANE	SHIP CLEARANCE LANE	CHANNEL WIDTH	MANEUVERING LANE	BANK CLEARANCE LANE	SHIP CLEARANCE LANE	CHANNEL WIDTH
1. Avon to Middle Point	150	105	80	600	160	95	80	600	180	70	100	600	190	60	100	600
2. Middle Point to New York Slough	130	60	70	450	160	50	80	500	160	80	100	580	190	60	100	600
3. New York Slough to Collinsville-Montezume Hills	150	125	*	400	160	145	*	450	180	160	*	500	190	205	*	600
4. Collinsville-Montezume Hills to Sacramento																
a. Mile 11.0 to 15.0	150	125	*	400	160	145	*	450	180	160	*	500				
b. Mile 15.0 to 18.8	150	75	*	300	160	70	*	300	180	60	*	300				
c. Mile 18.6 to Sacramento	130	60	*	250	160	60	*	280	160	60	*	300				

*One-way traffic.

TABLE D-3

SUMMARY OF CHANNEL DIMENSIONS

Reach	Existing Depth (feet, mllw)	Existing Minimum Width (feet)	Alternative Width (feet) 35	37	40	45
1. Avon to Middle Point	30/35(a)	300/600(a)	600	600	600	600
2. Middle Point to New York Slough	30/35(a)	300	450	500	580	600
3. New York Slough to Collinsville-Montezuma Hills	30	300	400	450	500	600
4. Collinsville-Montezuma Hills to Sacramento						
a. Mile 11.0 to Mile 15.0	30	200-300	400	450	500	
b. Mile 15.0 to Mile 18.6	30	200-300	300	300	300	
c. Mile 18.6 to Sacramento	30	200-250	250	280	300	

(a) Estimates were based on two conditions of preproject study depth in Reaches 1 and 2 only. considering that this reach might be deepened to 35 feet as a part of the authorized San Francisco Bay to Stockton project prior to authorization of any deepening of the Sacramento River Deep Water Ship Channel.

Dredging and Dredged Material Disposal

62. Deepening of the ship channel would be accomplished by hydraulic suction dredges with the dredged material placed on land disposal sites. As indicted in the section on "Possible Solutions," Plates D-1 through D-5 show sufficient dredged material disposal areas to accommodate the material from any alternative. The greater the channel depth, the more dredging and dredged material disposal areas would be required. Hence, all disposal areas shown would not be used for channel depths less than the maximum considered.

Alternative Recreation Developments

63. Dredged material disposal sites are a byproduct of dredging that create recreation potential. An analysis of the desires and the needs of the potential recreationist, both boaters and land-based users, and the suitability of the plans to accommodate various activities resulted in the identification of a maximum of 11 potential alternative recreation sites with facilities ranging from fishing access to extensive day-use and camping accommodations. The following subparagraphs contain descriptions of the various preliminary concepts potential recreation developments that were discussed and closely coordinated with several non-Federal agencies as potential recreation sponsors. This coordination led to inclusion of the Sandy Beach area in the selected plan as discussed in Section E. The locations of all potential recreation areas are shown on Plates D-3 through D-5.

a. Washington Lake — This area is adjacent to the Port of Sacramento. Approximately 20 acres could be developed for recreation use. Access would be by auto and boat with only day use facilities provided. Grading and contouring of the dredged material would be required as part of the recreation development. Facilities would include 20 picnic sites, a boat-launching ramp with 4 lanes, restrooms with potable water, paved roads and parking, and related support facilities.

b. Prospect Island — Access would be by boat only. No land-based development was planned, but moorage for 24 houseboats or cruisers and 10 small boats and a boat sanitary dump station would be provided.

c. Grand Island — Approximately 60 acres of the Grand Island disposal site could be developed with day-use and overnight camping facilities. Access would be by auto and boat. Grading and contouring of the dredged material would be required as part of the recreation development. Facilities to be provided would include 25 picnic sites, a swimming beach, 100 campsites, 25 boat-access campsites, a boat-launching ramp with three lanes, restrooms with potable water and showers, paved roads and parking, and support facilities such as administrative office, entry control station, and water, sewage, and electrical facilities.

d. Decker Island — Approximately 60 acres of the Decker Island disposal site could be developed with day-use and overnight facilities. Access would be by boat only. Grading and contouring of dredged material would be required as part of the recreation development. Recreation facilities would include 25 picnic sites, a swimming beach, 100 campsites, 25 docks for on-board boat camping, restrooms with showers and potable water, and support facilities such as water supply, sewage disposal, and electrical power distribution.

e. Fishing Access — Three fishing access areas could be provided along the deep water ship channel and three areas on the dredged material disposal site south of Rio Vista. Chemical toilets and a graveled parking area for 25 autos could also be provided at each site. In addition, the Rio Vista sites would require approximately 1.5 miles of two-lane graveled access road.

f. Sandy Beach — This area could provide for expansion of a proposed 30-acre recreation area immediately south of Rio Vista. The site would be developed with day-use and camping facilities including 30 picnic sites, a swimming beach, a two-lane boat-launching ramp, 40 campsites, restrooms with showers and potable water, and related support facilities.

Costs and Benefits

64. Costs for the alternative depths considered were estimated based on 1 October 1979 price levels. The estimates of first cost include Federal costs of dredging the channels and relocating navigation aids and non-Federal costs of providing lands, easements, rights-of-way, relocations and retention dikes. Annual cost estimates were based on a 50-year economic life and 7⅛ percent rate of interest. Transportation savings (benefits) were based on the latest available vessel operating costs, assuming a 50-year economic life and a 7⅛ percent rate of interest. The benefits are directly attributable to increased economic efficiency associated with deep-draft vessel transportation. Commodity projections used in

determining benefits were those presented in Section B, "Resources and Economy of the Study Area." Table D-4 summarizes the first and annual cost estimates and the estimates of average annual benefits for various combinations of channel depths.

65. Preliminary cost estimates for the alternative recreation plans described in paragraph 63 were based on 1 October 1979 price levels. The estimate of first cost includes construction of all facilities necessary to complete the recreation developments. Non-Federal recreation sponsors would be required to pay 50 percent of the first cost as a required local cooperation requirement. Annual costs were based on a 50-year economic life and a 7⅛ percent rate of interest and include costs for operation and maintenance which would be a non-Federal responsibility. Recreation benefits were derived using standard methodology which includes estimating the quantity and quality of recreation use. Benefits were based on recreation use of 500,000 recreation days at the beginning of the project, increasing to 750,000 recreation days at year 50 and a recreation day use value of $2.25 per day. The following tabulation summarizes recreation costs and benefits.

SUMMARY OF RECREATION COST AND BENEFITS

First Cost	Annual Cost	Annual Benefits	Benefit-Cost Ratio
$8,140,000	$894,000	$1,280,000	1.4 to 1

Environmental Effects

66. The alternate channel depths would have varying impacts on the environment. In general, the greater depths would cause greater adverse impacts than would the lesser depths. The major areas of concern are vegetation and wildlife habitat, water quality, fisheries, and air quality.

67. The widening of the manmade portion of the Sacramento Channel will destroy vegetation and wildlife habitat along the channel. The total acreage, however, would amount to a maximum of approximately 200 acres (for the 40-foot channel plan) and a minimum of 45 acres (for the 35-foot channel plan). Disposal of dredged material would also temporarily destroy vegetation and wildlife habitat at the disposal areas. Approximately 8,745 acres of land would be used for dredged material disposal for a channel 45 feet in depth between Avon and Mile 11.0 and 40 feet in depth between Mile 11.0 and Sacramento. This compares with 3980 acres required for a channel 35 feet in depth between Avon and Sacramento. Losses at the disposal areas would be temporary since the disposal areas would naturally revegetate within 2 to 3 years. With the exception of those sites identified for recreation, wetland development, or upland habitat development along the channel, all other disposal areas would be returned to preproject use.

68. Salinity intrusion is the major water quality concern associated with channel deepening. Other concerns include increased turbidity, decreased dissolved oxygen concentrations, increased concentrations of heavy metals in the water column, and contamination of ground water. Physical model tests of the various channel depths were conducted at the San Francisco Bay-Delta model in Sausalito, California,

to determine the impact of the alternatives on salinity intrusion. Dynamic and steady state tests were conducted using historical 1968 hydrology, which is considered to be a "dry," but not a "critically dry" condition, and 1977 hydrology which represents a critically dry condition. Results of these tests, for a depth of 35 feet, are described in detail in Appendix 5 to this feasibility report. No model tests have been conducted for depths greater than 35 feet. Results, for a depth of 35 feet, are best summarized by conclusions of the Bay-Delta Model Advisory Committee. The Committee, whose recommendations are also included in Appendix 5, concluded that " . . . any changes that might occur in the salinity distribution as a result of the proposed project are smaller than the model can accurately predict." Water quality constituents such as dissolved oxygen, turbidity, heavy metals and ground water quality would not suffer long-term effects by any of the deepening plans. There may be some short-term local increases in turbidity and decreases in dissolved oxygen near the discharge from the dredged material disposal areas. However, this relatively minor effect would occur only during construction and would be similar for all depths. Any increase in turbidity and possible resuspension of toxic materials as a result of dredging would not be expected to have an adverse effect on fish, fish eggs, and fish larvae. Suction dredging would not cause any detectable increase in turbidity.

69. A net reduction in pollutants entering the air can be expected while transporting cargo via a deepened channel over the short-term. This is due to the greater efficiency of ships per ton-mile over alternative modes of transportation. Since larger ships are more efficient per ton-mile than smaller ones, the greater the channel depth, the less pollutants entering the air. However, this incremental decrease would probably be offset by an increase in industrial activity along the ship channel so that there would probably be a net decrease in air quality in the area as a result of the deepening alternative. The actual effects would depend on the type of industries which are located in the area and regulations adopted by the Air Quality Control Board.

Alternative Fish & Wildlife Mitigation Measures

70. Evaluation of the above environmental impacts and coordination with concerned Federal, State, and local agencies and groups indicate a need for mitigation of significant impacts. The Fish and Wildlife Service has indicated a need to create one acre of new wetland habitat for every acre of such habitat lost due to widening the ship channel. This can be accomplished by breaching the dikes at former dredged material disposal areas to allow the area to be periodically inundated by tidal fluctuations. It could also be accomplished by acquiring low-lying island land and managing the water level for optimum marsh habitat production. The method of wetland mitigation would depend on the amount of land required. Small amounts of wetland can be created at former dredged material disposal areas, while larger quantities would require managing low interior island land for wetland habitat.

Alternative Measures To Control Salinity Intrusion

71. Several possible measures have been suggested to offset any increased salinity intrusion. These measures include increasing Delta outflow, contructing a submerged sill, building a channel constriction, or closing western Delta channels. Increasing the net Delta outflow would repel increased salinity intrusion by maintaining the current location of the hydraulic barrier in the western Delta.

TABLE D-4*

SACRAMENTO RIVER DEEP WATER SHIP CHANNEL INVESTIGATION
COSTS AND BENEFITS FOR NAVIGATION IMPROVEMENTS
(7-1/8% Discount Rate, 50-Year Economic Life, 1 October 1979 Price Level)

($1,000)

CHANNEL DEPTH (Feet, M.L.L.W.)		FIRST AND ANNUAL COSTS						AVERAGE ANNUAL BENEFITS			NET BENEFITS AND B/C RATIO					
AVON TO COLLINSVILLE-MONTEZUMA HILLS	COLLINSVILLE-MONTEZUMA HILLS TO SACRAMENTO	AVON TO COLLINSVILLE		COLLINSVILLE-MONTEZUMA HILLS TO SACRAMENTO		TOTAL		AVON TO COLLINSVILLE-MONTEZUMA HILLS	COLLINSVILLE-MONTEZUMA HILLS TO SACRAMENTO	TOTAL	AVON TO COLLINSVILLE		COLLINSVILLE-MONTEZUMA HILLS TO SACRAMENTO		COMBINED	
		FIRST	ANNUAL	FIRST	ANNUAL	FIRST	ANNUAL				NET BENEFITS	B/C	NET BENEFITS	B/C	NET BENEFITS	B/C
35	35	18,300	1,347	52,800	4,575	71,100	5,922	4,447	10,452	14,899	3,100	3.3	5,877	2.3	8,977	2.5
37	37	23,000	2,262	74,900	6,943	97,900	9,205	6,351	12,226	18,577	4,089	2.8	5,283	1.8	9,372	2.0
40	40	40,400	3,714	118,000	10,222	158,400	13,936	8,395	13,843	22,238	4,681	2.3	3,621	1.4	8,302	1.6
40	35	40,400	3,714	52,800	4,575	93,200	8,289	8,395	10,452	18,847	4,681	2.3	5,877	2.3	10,558	2.3
45	35	86,700	7,241	52,800	4,575	139,500	11,816	10,371	10,452	20,823	3,130	1.4	5,877	2.3	9,007	1.8
45	37	86,700	7,241	74,900	6,943	161,600	14,184	10,371	12,226	22,597	3,130	1.4	5,283	1.8	8,413	1.6
45	40	86,700	7,241	118,000	10,222	204,700	17,463	10,371	13,843	24,214	3,130	1.4	3,621	1.4	6,751	1.4

*Cost of potential mitigation measure (submerged sill) is included only for a channel depth of 35 feet which is the depth the sill was model tested.
Assumes Stockton Ship Channel to be a preproject condition; that is, the Avon to New York Slough reach is considered to be 35 feet deep.

72. The submerged sill concept would include constructing an underwater barrier in a deep portion of the estuary, which would partially block the upstream movement of the more dense saltwater. Since the Carquinez Strait near Dillon Point is the deepest part of the estuary, studies of the sill have concentrated on this location.

73. A channel constriction could be constructed in a narrow portion of the estuary, such as at Chipps Island. Such a constriction would impede the tidal flow and reduce the amount of salt transported upstream. This concept would require construction of a bypass so that floodflows could be transported around the constriction.

74. During the 1976-77 drought, the California Department of Water Resources closed one Delta channel and proposed closing two others as an emergency measure to reduce salinity intrusion into the Delta. It may be possible to construct permanent dams at certain locations which would have the same effect. Small craft navigation locks would be required adjacent to these dams to permit recreational navigation to continue in the closed channels.

75. It is not practicable to thoroughly evaluate the effect of all these alternatives within such a complex system as the Delta during feasibility studies. Preliminary analyses have been made on increasing Delta outflow and on the submerged sill concept. These analyses indicate that increasing Delta outflow is not a viable alternative due to the present lack of available water for such purpose and the high costs to develop future water supplies.

76. The referenced analyses of the economic and social impacts of increasing Delta outflow to mitigate project effects on salinity were limited to the effects of deepening the Stockton Ship Channel on the Suisun Bay-Delta area, the primary area of impact. However, conclusions are considered to also be generally applicable for the use of restoration flows from upstream reservoirs to mitigate salinity effects associated with any project. It should be explained that at the time these analyses were conducted, the Stockton Ship Channel included the False River Cutoff alignment. An unacceptable amount of salinity intrusion was found to occur with that alignment, and the Stockton Ship Channel has since been revised to eliminate the False River Cutoff.

77. Model tests were conducted using 1968 and 1931 hydrologic conditions. The 1968 hydrology was chosen primarily because prototype salinity data were available for that year and were used to verify the model; also, 1968 is considered a "low flow" year, but not an extreme condition. The 1931 hydrologic conditions with estimated 1980 development level were used to determine the project induced effects which would result from an extremely dry year with substantial pumping demand, an extreme condition with probability of occurrence of less than one percent in any one year.

78. Model tests at the Bay-Delta model simulated restoration flows needed for 1968 hydrologic conditions with the selected plan by adding flows of 300 cfs to the Sacramento River during the time of maximum seasonal salinity (9-28 April, 29 May-1 July, 13-27 September). Total releases approximated 40,000 acre-feet.

The limitations of these tests were as follows:

(1) Restoration flows were applied to the Delta from the Sacramento River only. Other schemes of distributing the water among the various inflow points to the Delta, which may result in more or less efficient use, were not tested.

(2) The temporal distribution of restoration flows was determined by real time monitoring of salinities at key stations and adjustment of restoration flow to keep those salinities near base values. Various other operational schemes were not attempted.

79. The quantity of restoration flow needed for critically dry (1931) conditions was approximated by calculating the increased flow-salinity reduction relationship from the 1968 tests and applying this relationship to the results of tests using 1931 hydrologic conditions. This computation indicated that more than 300,000 acre-feet would be required to mitigate for project effects under 1931 conditions. This quantity of water would require the firm water supply yield of a major reservoir or a series of reservoirs. Current estimates indicate the cost of developing additional upstream storage, such as the Cottonwood Creek project, is about equal to $200 per acre-foot of annual water supply. If it is assumed that only 5 cfs or 3600 acre-feet would be required annually, costs would equal $720,000. In contrast, the annual cost of a submerged sill would be about $680,000. Therefore, from an economic viewpoint, the use of restoration flows rather than a submerged sill would not be justified.

80. The release of up to 200,000 or 300,000 acre-feet of water to the Pacific Ocean during a critically dry year to alleviate salinity increases caused by navigation projects would also have significant social and political implications. Water deliveries from the State and Federal water projects would be reduced during such a critically dry period while the Delta outflow would be increased. This would cause hardships to agricultural users in the San Joaquin Valley and to M&I users in southern California. Also, as demonstrated by the 1976-77 drought, there is far from unanimous agreement that such action is a wise use of resources.

81. Hydraulic model tests predict the submerged sill would be capable of reducing salinities in Suisun Bay. Mathematical model studies and computer simulation also indicate that such factors as phytoplankton population and dissolved oxygen level in the western Delta would not be adversely affected by the sill. Other concepts, such as channel constrictions or channel closures in combination with the sill, may further reduce salinity intrusion; however, these have not been evaluated.

82. Of the alternative measures considered, the submerged sill appears to be the most effective. By using various combinations of channel closures, channel constrictions, and the submerged sill, it may be possible to fully offset any adverse effect of channels deeper than 35 feet, should it be necessary.

Socioeconomic Effects

83. The various channel depths under consideration would produce varying socioeconomic effects. The greater the channel depth, the greater the impact. The 35-foot channel would induce a small increase in industrial development in the Sacramento area and a moderate increase in the Collinsville-

Montezuma Hills area. The 40- and 45-foot channels, on the other hand, would induce a substantial increase in industrial activity in the Collinsville-Montezuma Hills area and a moderate increase in the Sacramento area.

National Economic Development (NED) Plan

84. The NED plan is the plan that addresses planning objectives while maximizing net economic benefits to the national economy. These net benefits are the difference between total annual costs and total annual benefits. Plan benefits are determined by analyzing and measuring the net values of increased economic output or, in this case, primarily the savings in ocean transportation costs. Each channel depth considered was evaluated to determine its contribution to the national income account versus the associated cost incurred in achieving this contribution. The results of evaluating the benefits and costs of various depth channels to the Port of Sacramento and to the Collinsville-Montezuma Hills area are shown in the following tabulation:

Summary of Average Annual Benefits and Costs
for Navigation Improvements
7-1/8 Percent Interest, 50-Year Project Life
(1 October 1979 Price Levels)
(in $1,000)

Channel Depth	Average Annual Benefits	Average Annual Costs	Net Benefits
Collinsville-Montezuma Hills to Port of Sacramento			
35	10,452	4,575	5,877
37	12,226	6,943	5,283
40	13,843	10,222	3,621
Avon to Collinsville-Montezuma Hills Area			
35	4,447	1,347*	3,100
37	6,351	2,262	4,089
40	8,395	3,714	4,681
45	10,371	7,241	3,130

*Cost of potential salinity control measure (submerged sill) is included only for channel depth of 35 feet which is the depth at which the sill was model tested.

For this evaluation, it was assumed that the authorized John F. Baldwin Ship Channel would be constructed prior to dredging the Sacramento channel to depths greater than 35 feet.

85. It can be seen from the above tabulation that maximum net benefits occur with a channel 40 feet deep from Avon to the Collinsville-Montezuma Hills area and 35 feet from this area to the Port of Sacramento. Thus, the NED plan would consist of a 40-foot channel, 500 to 600 feet wide, from Avon to Collinsville-Montezuma Hills and a 35-foot channel, ranging from 400 feet to 250 feet wide, from Collinsville-Montezuma Hills to Sacramento.

86. In addition to channel deepening, the NED plan would include recreation development at the 11 sites described in paragraph 63, thus increasing the total net benefits of the plan. Also, mitigation measures which are justified would be included. The first cost for the NED plan would be $101.3 million which includes costs for navigation and recreation improvements. Based on a 50-year project life and 7⅛ percent interest rate, the average annual costs and benefits would be $9.2 million and $20.1 million, respectively. This results in national net economic benefits of $10.9 million annually.

87. The lower transportation costs resulting from the NED plan would encourage industrial development along the channel. The proposed industrial areas near Collinsville and the Port of Sacramento would therefore be expected to develop at an early date under this plan. Other effects of the plan are described in the following discussion on economic, environmental, and socioeconomic effects.

Economic Effects

88. This plan was selected as the NED plan because, of all the alternatives considered, it has the maximum net economic benefits. This plan would produce national net benefits of approximately $10.5 million annually for navigation improvements. In addition, net benefits of $0.4 would result from recreation development. These benefits would primarily be due to transportation savings resulting from use of larger, more efficient vessels; reduction in light-loading and topping-off practices; movement of project-induced tonnage; and use of recreation facilities.

Environmental Effects

89. The major environmental effects of the NED plan alternative would be the possibility of increased salinity intrusion with a 40-foot deep channel to Collinsville. Increases in salinity would make maintaining water quality standards in the western Delta more difficult. In view of the current policy of the State of California that any man-induced increase in salinity in the Delta is unacceptable, control measures would be necessary for any increased salinity intrusion. It may be possible to control this by constructing channel constrictions, channel closures, or a submerged sill, as described previously.

90. Construction of this alternative would result in the loss of approximately 45 acres of wetland habitat along the manmade portion of the channel. This loss would primarily be the result of the channel widening necessary for safe navigation. Mitigation for this loss would be provided by creating wetland elsewhere, as described previously, thus providing adequate compensation for any adverse impact.

Secondary effects on air and water quality could occur due to industrialization induced by channel deepening. The environmental impact on other aspects of the physical environment would be minimal. There should be no impacts on cultural resources, ground water, or fisheries. There may be a minor short-term impact on local water quality in the vicinity of the dredging and disposal operations, including a slight increase in turbidity and decrease in dissolved oxygen. A loss of upland habitat would also accrue from the disposal of dredged material on the designated disposal areas. Compensation for this loss could be achieved by permanently dedicating portions of the disposal areas to the development of upland habitat.

Socioeconomic Effects

91. Deepening the channel to the Collinsville-Montezuma Hills area to 40 feet would have a significant impact on the economy of the study area. This alternative would make the Collinsville-Montezuma Hills area more competitive with deepwater locations in the San Francisco Bay area. However, land costs are much lower in the Collinsville area than in the bay area; hence, rapid industrial development could be expected in the Collinsville area. This would result in a substantial increase in employment, population, and income from this area. This alternative would also create a demand for additional utilities and transportation facilities in the Collinsville-Montezuma Hills area. More schools and other public facilities would be required due to the increased population. Costs for these facilities would be offset by increased tax base and tax revenue resulting from industrial expansion.

92. Construction of a 35-foot channel to the Port of Sacramento would result in some industrial growth along the channel west of the port. Industries requiring deep-draft access for import of raw materials or for export of finished products would locate there. This would result in moderate increases in employment, population, and housing in the Sacramento Metropolitan Area. There would also be a moderate increase in the tax base and tax revenue in Yolo County where the development would occur. This increased revenue would make possible additional high quality public facilities, such as schools, roads, and utilities.

Environmental Quality (EQ) Plan

93. The objective of the Environmental Quality (EQ) plan is the management, conservation, preservation, creation, restoration, or improvement of natural and cultural resources and ecological systems while meeting the other objectives of the investigation to the greatest extent practical. Although plans formulated to maximize Environmental Quality are not necessarily constrained by monetary or cost-sharing requirements, they should be reasonable and viable plans and should assist other Federal, State, or local environmental objectives. The following are Environmental Quality objectives considered:

a. Management, protection, enhancement, or creation of areas of natural beauty and human enjoyment.

b. Management, preservation, or enhancement of especially valuable or outstanding archeological, historical, biological, and geological resources.

c. Enhancement of quality aspects of water, land, and air by control of pollution or prevention of erosion and restoration of eroded area.

d. Avoiding irreversible commitment of resources to future uses.

Plan Elements

94. Specific actions to be taken to meet EQ objectives include; construction of a 35-foot-deep channel, purchase of land, acquisition of environmental easements, manipulation of habitat, establishment of recreation and public access sites, and specific management procedures. Land would be purchased at various locations along and adjacent to the ship channel to provide public access for fishing and to provide sites for picnicking, camping, and wildlife habitat. Permanent environmental easements would be acquired at various locations along the ship channel, limiting land uses to those compatible with wildlife habitat perservation and enhancement. Areas along the channel already in public ownership would be retained to protect their recreational, biological, and historical values. Environmental management and improvement measures include; establishing of wetlands, including construction of ponds and marshes with plantings of marsh, riparian, and upland vegetation; prohibiting grazing and farming on channel berms; controlling burning on levees and berms; and utilizing dredge material for mixing with peat soils to counteract subsidence on selected Delta farmlands. The EQ plan would also include supplementing the existing water quality monitoring network in the Delta to include high-quality, well maintained salinity measuring stations. These stations would observe salinity distributions before and after the channels are deepened. If salinity levels are found to increase to an unacceptable level subsequent to deepening the channels, a submerged sill or acceptable alternative would be constructed in the Carquinez Strait to prevent salinity intrusion. The location of the high-quality monitoring stations and evaluation of results would be coordinated with concerned agencies such as; the Fish and Wildlife Service, Water and Power Resources Service, and the State of California.

Costs

95. Preliminary estimate of total first cost for the EQ plan is $82,600,000. This includes $71,100,000 associated with deepening the channel to 35 feet and $11,500,000, largely land costs for the EQ plan elements. Annual cost for the EQ plan would be $6,920,000, using a discount rate of 7⅛ percent and a 50-year project life. The first and annual costs and benefits for the plan are tabulated below.

EQ PLAN COSTS AND BENEFITS

	First Cost	Annual Cost	Benefits	Excess Benefits	B/C
Deepening	$71,100,000	$5,922,000	$14,899,000	$8,977,000	2.5
EQ Element	11,500,000	998,000	446,000	-552,000	0.4
Total	$82,600,000	$6,920,000	$15,345,000	$8,425,000	2.2

Benefits

96. Both monetary and nonmonetary benefits are attributable to the elements of the EQ plan. Monetary benefits are calculated on the basis of recreation use of facilities provided as a part of the plan and from the establishment of wetlands. Nonmonetary benefits are those derived from the establishment of new habitat and the protection of existing habitat and accrue directly to wildlife and indirectly to man.

MONETARY BENEFITS

97. The average annual benefits attributed to the recreation features of the EQ plan are calculated by multiplying the average annual net increase in use by the appropriate unit value for recreation. Average annual benefits attributed to establishment of wetlands by dredged material placement are at least equal to the cost of establishing such areas (Section 150 of Public Law 94-587). Average annual monetary benefits of the EQ plan elements are $446,000 and are summarized below:

Site	Activity	Benefits
Lake Washington	Picnicking, fishing	$ 34,000
Levees and berms along ship channel	Picnicking, fishing, boat ramp	113,000
Mouth of Miner Slough	Picnicking, fishing, boat ramp	38,000
Sand spit at Cliff House	Fishing	38,000
Decker Island	Camping	53,000
Sacramento River right bank	Picnicking, fishing, camping	151,000
Marshes along ship channel	Wildlife	0
Marsh at Lake Washington	Wildlife	19,000

The annual benefits for the EQ plan total $15,345,000 million, which includes navigation benefits of $14,899,000 and EQ benefits of $446,000.

NONMONETARY BENEFITS

98. Construction of ponds and establishment of marshes and upland habitat would benefit fish and wildlife. The ponds would provide habitat for warmwater game fish, which in turn would provide food for birds such as kingfishers, egrets, and bitterns. In addition, the ponds would provide resting and feeding areas for waterfowl. Marsh habitat, very limited in California, would provide breeding and nursery areas for many game fish, nesting and feeding habitat for many birds, and valuable habitat for many small mammals. Establishment of upland habitat on the channel berms and levees would provide undisturbed areas which would be used for breeding, resting, and feeding by many mammals and birds, including fox, coyote, pheasant, and dove.

99. The increase in fish and wildlife species associated with the newly established habitat and the protection of existing natural areas would provide unmeasurable benefits to recreation. The fish and wildlife species benefited would contribute to the overall quality of recreation use of the Delta and Sacramento Ship Channel area. In addition, the quality of wildlife related recreation activities such as bird watching, photography, nature study, fishing, and hunting would be improved.

Economic Effects

100. The economic effects of the EQ plan are presented relative to the NED plan, which was discussed beginning within paragraph 84. There would be a beneficial impact on local finances, but the effect would be slightly less than for the NED Plan. Dedication of land to environmental uses would restrict land use for industrial expansion. The EQ plan would provide substantially more areas for public access and recreation opportunity but would result in less opportunity for regional, industrial, and economic growth than does the NED plan. However, alternative locations for such growth could be selected and, thus, such growth would not be totally needed. More land would be required to implement the EQ plan, but much of this land is presently nonproductive. Consequently, there would be little difference between the economic effects of the NED and EQ plans.

Social Effects

101. The social effects of the EQ plan are also presented relative to the NED plan. Construction noise would be less since there would be a shorter time required to construct a shallower channel. Esthetic impact during construction would be similar to the NED plan, but the extensive planting for establishment of wildlife habitat would eventually improve the esthetics. Other social effects would be similar to that anticipated in the NED plan, i.e., demand for expansion of other modes of transportation reduced because of increased use of oceangoing vessels; vessel safety improved because of improved navigability; and transportation safety in other modes improved due to decreased demand on those modes. Public appreciation and knowledge of the additional EQ resources available in the region would contribute to social well-being separate from and in addition to more direct values to environmental effects of the EQ plan.

Environmental Effects

102. Fish and wildlife habitat improvement includes development of upland habitat and riparian vegetation, including the establishment of ponds and associated wetlands, on lands to be used as dredged material disposal sites or lands presently lacking in vegetation. Those lands which presently possess significant areas of vegetation would be protected by an environmental easement which places strict regulations on the use of those lands. This would directly benefit wildlife by providing important habitat for feeding, nesting, and cover.

103. Improvements in water quality due to the EQ Plan would primarily result from decisions to prohibit grazing and burning along the berm areas of the channel. These practices would reduce erosion which would decrease sedimentation and turbidity within the ship channel. Vegetation established on the dredged material disposal sites would also reduce the erosion of soils into the ship channel. Deepening the ship channel would allow for increased transportation of goods by ship from the Port of Sacramento service area; therefore, decreasing truck and rail traffic which would initially result in an increase in air quality. However, this improvement in air quality may eventually be offset by adverse effects of additional industrial development and ship traffic that would be induced by the channel deepening.

104. Dredging of the channel would result in a disruption of benthic organism production, reducing this food source important to many fish. This impact is relatively short term, as the channel bottom should be recolonized within 1 to 2 years. During dredging, there would also be a slight short-term increase in turbidity, which should return to ambient levels in a matter of days after dredging ceases.

Selecting a Plan

105. As noted previously, the channel deepening alternative is the only alternative which would meet the needs of the study area. The deepening alternative was therefore further considered in two reaches with seven combinations of channel depths, ranging from 35 feet to 45 feet below mllw. As a result of this analysis, it was possible to develop the NED and EQ plans to meet the specific objectives of economic development and environmental quality, respectively. Selection of a plan requires careful consideration of economic and environmental effects, the assumptions upon which the evaluation was based, and the desires of the local interests.

106. Economic considerations indicate that the channel should be deepened to 35 feet to Sacramento and 40 feet to the Collinsville-Montezuma Hills area, whereas environmental considerations indicate that the minimum amount of deepening would have the least impact on ambient conditions. Model tests indicate that any changes that might occur in the salinity distribution as a result of the proposed project are smaller than the model can accurately predict. However, a high quality, well maintained water quality monitoring effort will be instituted as part of the plan to insure whether or not a salinity reduction measure is needed (submerged sill) because of the channel deepening. If the sill is needed and eventually constructed, the monitoring program would continue to further evaluate the effectiveness of the sill.

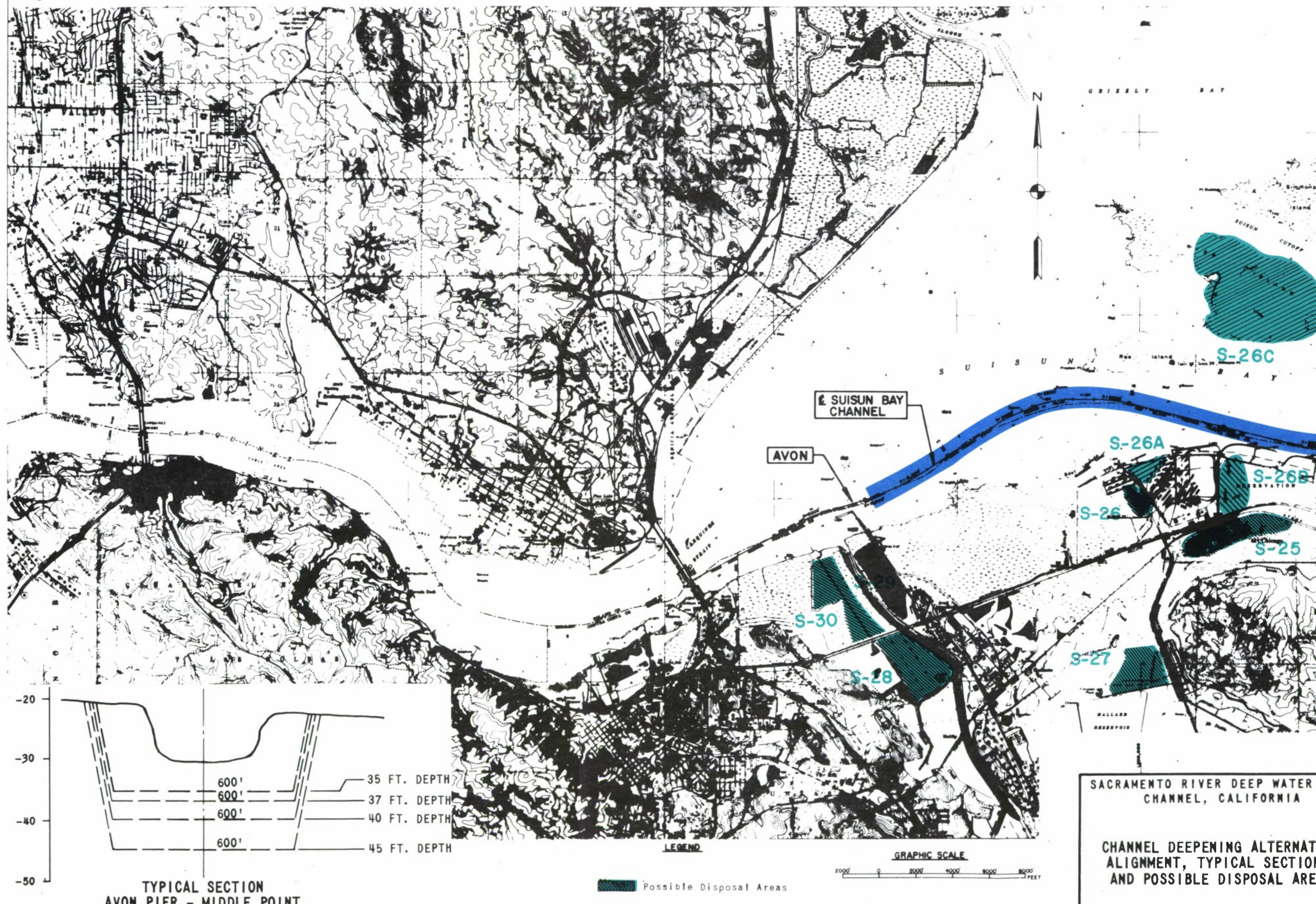
107. The primary assumption made regarding the alternate depths considered was that the authorized John F. Baldwin Channel (Golden Gate to Avon) portion of the San Francisco Bay to Stockton Project would be constructed prior to deepening the Sacramento Ship Channel to depths greater than 35 feet. The existing channel between the Golden Gate and Avon is 35 feet deep and is authorized for deepening to 45 feet. Studies are continuing on this authorized deepening; however, there are concerns with dredged material disposal and increased salinity intrusion for the John F. Baldwin Channel which may preclude its implementation.

108. The sponsor for the Sacramento River Deep Water Ship Channel, the Sacramento-Yolo Port District, has consistently expressed the opinion that a deeper channel is needed to Sacramento. The Solano County Board of Supervisors, a potential sponsor for the channel to the Collinsville-Montezuma

Hills area, has not taken a position on channel deepening. Deepening of this portion of the channel to a depth greater than the depth of the channel to Sacramento would require a separate non-Federal sponsor.

109. After considering the economic and environmental effects of the various deepening alternatives, the downstream channel constraints, and the desires of the local interests, a 35-foot channel from Avon to the Port of Sacramento is the best and most viable solution to the problems and needs of the study area. Of the depths considered, this depth would have the least environmental impact and would provide net positive benefits almost equivalent to the NED plan. Also, the existing downstream channel currently constrains the Sacramento River Deep Water Ship Channel to 35 feet, and there is no indication that this constraint will be removed in the near future. The Director of the Port of Sacramento has recently indicated that the Port District will support construction of a 35-foot channel in light of the downstream channel constraints.

110. The preliminary plans for recreation development were coordinted with potential recreation sponsors, including the State of California, Sacramento County, Yolo County, Solano County, East Yolo Community Services District, and the city of Rio Vista. After these intensive coordination efforts, non-Federal governmental entities expressed a willingness and capability to cost-share in the construction of recreation facilities and to accept operation and maintenance responsibilities for only 1 of the 11 facilities. Accordingly, the recommended plan is limited to recreation development at one site which is located at the dredged material disposal area immediately south of Rio Vista (Sandy Beach).



SACRAMENTO RIVER DEEP WATER SHIP CHANNEL, CALIFORNIA

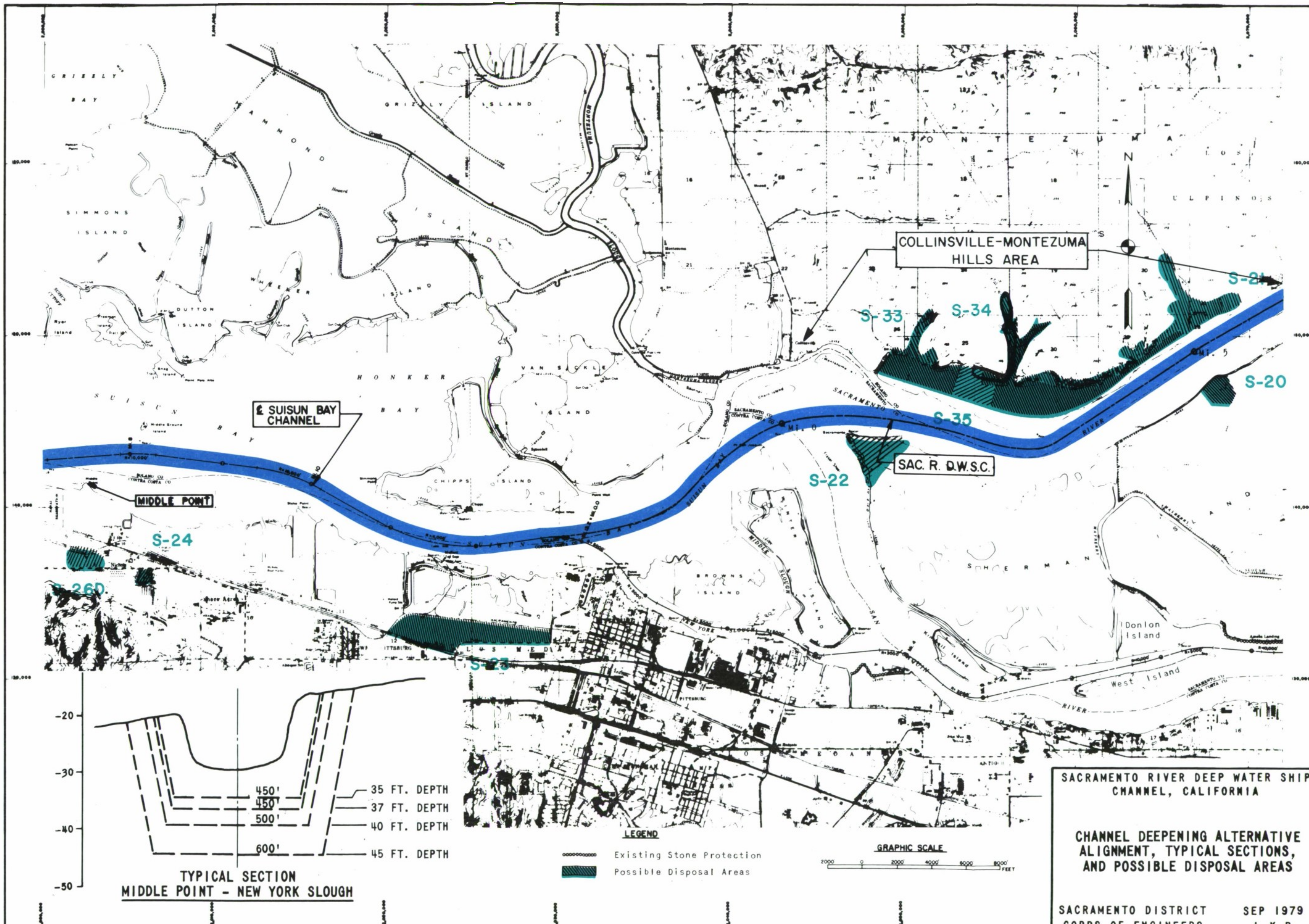
CHANNEL DEEPENING ALTERNATIVE ALIGNMENT, TYPICAL SECTIONS, AND POSSIBLE DISPOSAL AREAS

SACRAMENTO DISTRICT, CORPS OF ENGINEERS

SEP 1979

L.K.R.

PLATE D-1



SACRAMENTO RIVER DEEP WATER SHIP CHANNEL, CALIFORNIA

CHANNEL DEEPENING ALTERNATIVE ALIGNMENT, TYPICAL SECTIONS, AND POSSIBLE DISPOSAL AREAS

SACRAMENTO DISTRICT
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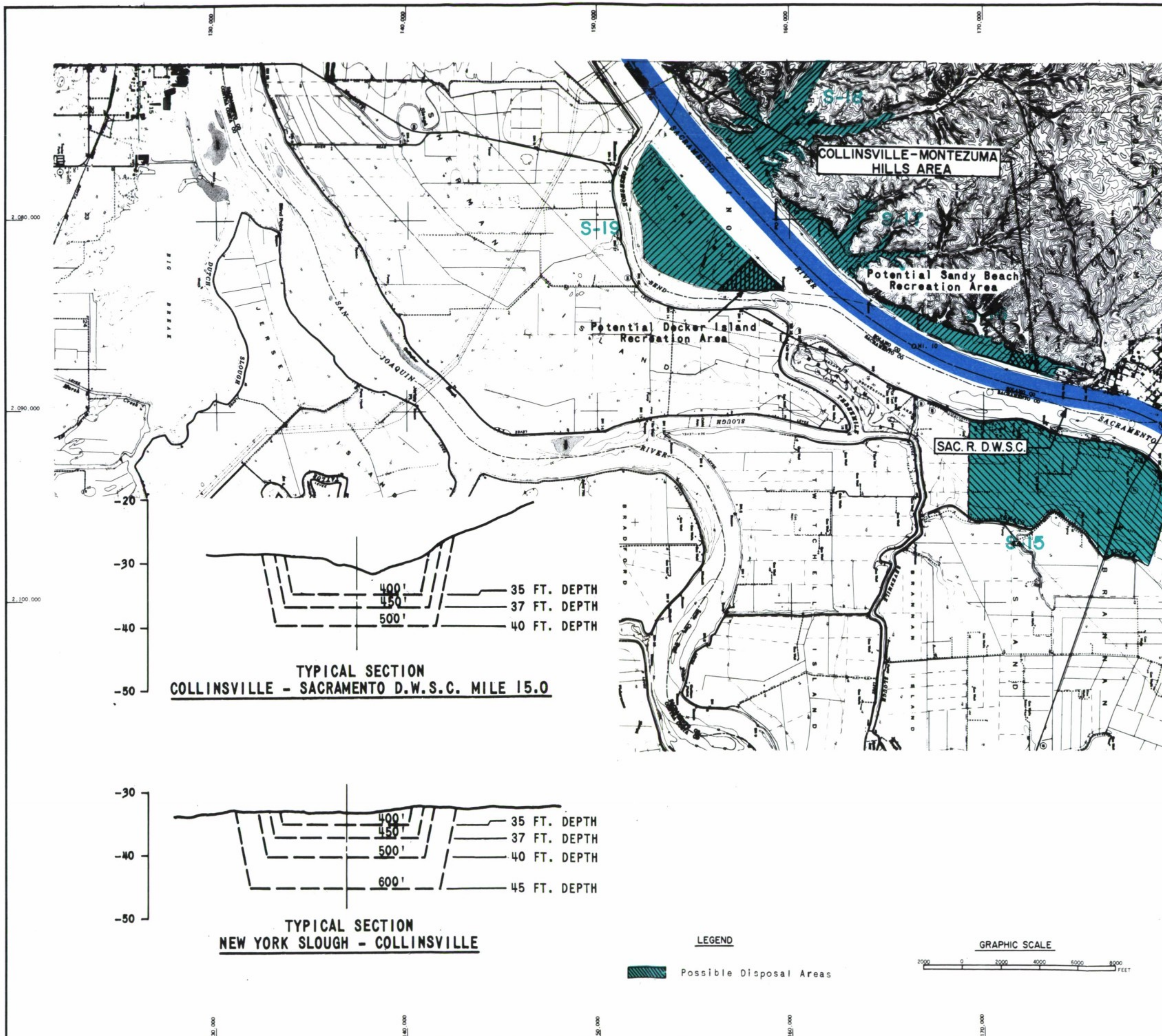
PLATE D-2



SACRAMENTO RIVER DEEP WATER SHIP CHANNEL, CALIFORNIA

CHANNEL DEEPENING ALTERNATIVE ALIGNMENT, TYPICAL SECTIONS, AND POSSIBLE DISPOSAL AREAS

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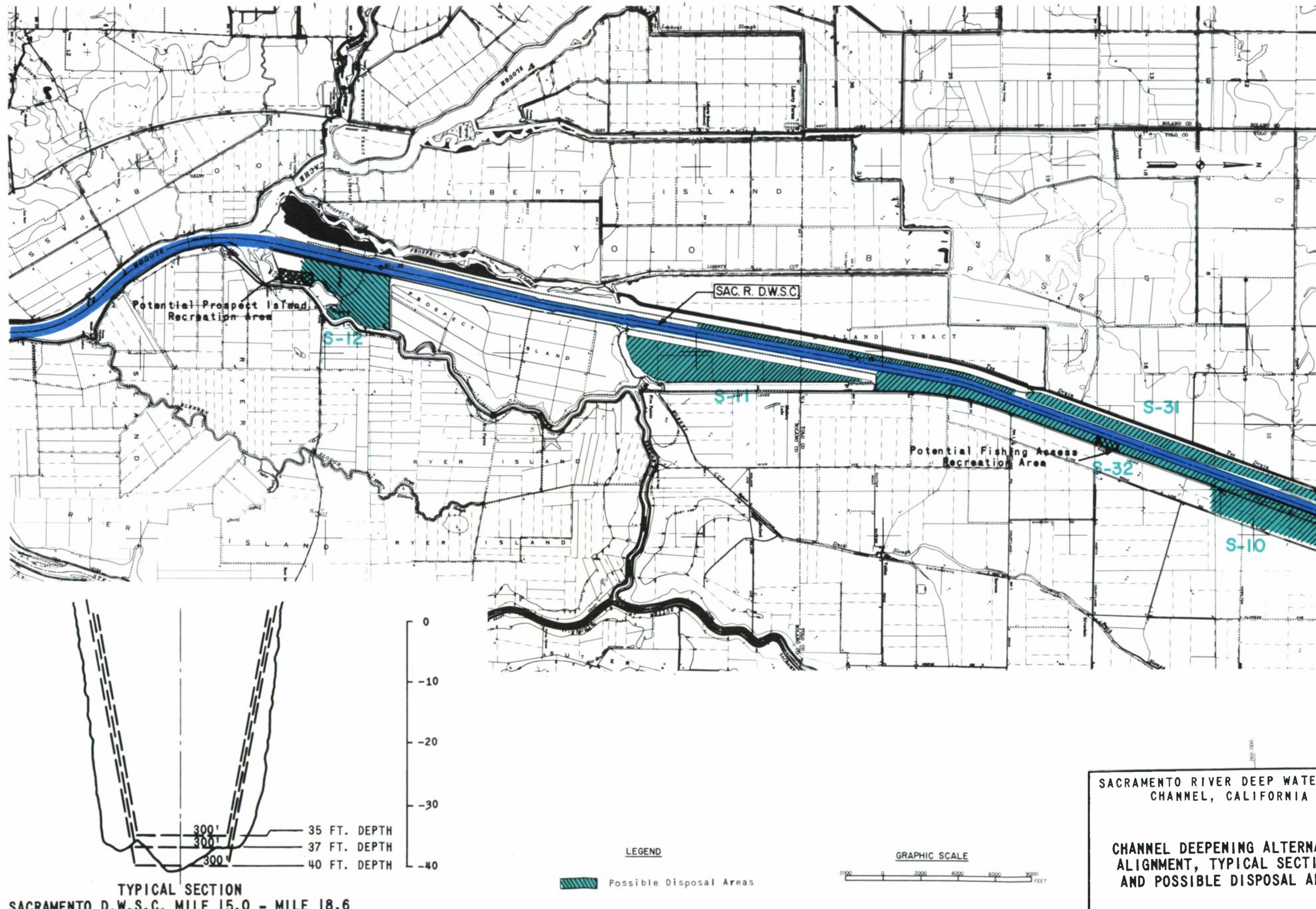
PLATE D-3



SACRAMENTO RIVER DEEP WATER SHIP CHANNEL, CALIFORNIA

CHANNEL DEEPENING ALTERNATIVE ALIGNMENT, TYPICAL SECTIONS, AND POSSIBLE DISPOSAL AREAS

SACRAMENTO DISTRICT, CORPS OF ENGINEERS

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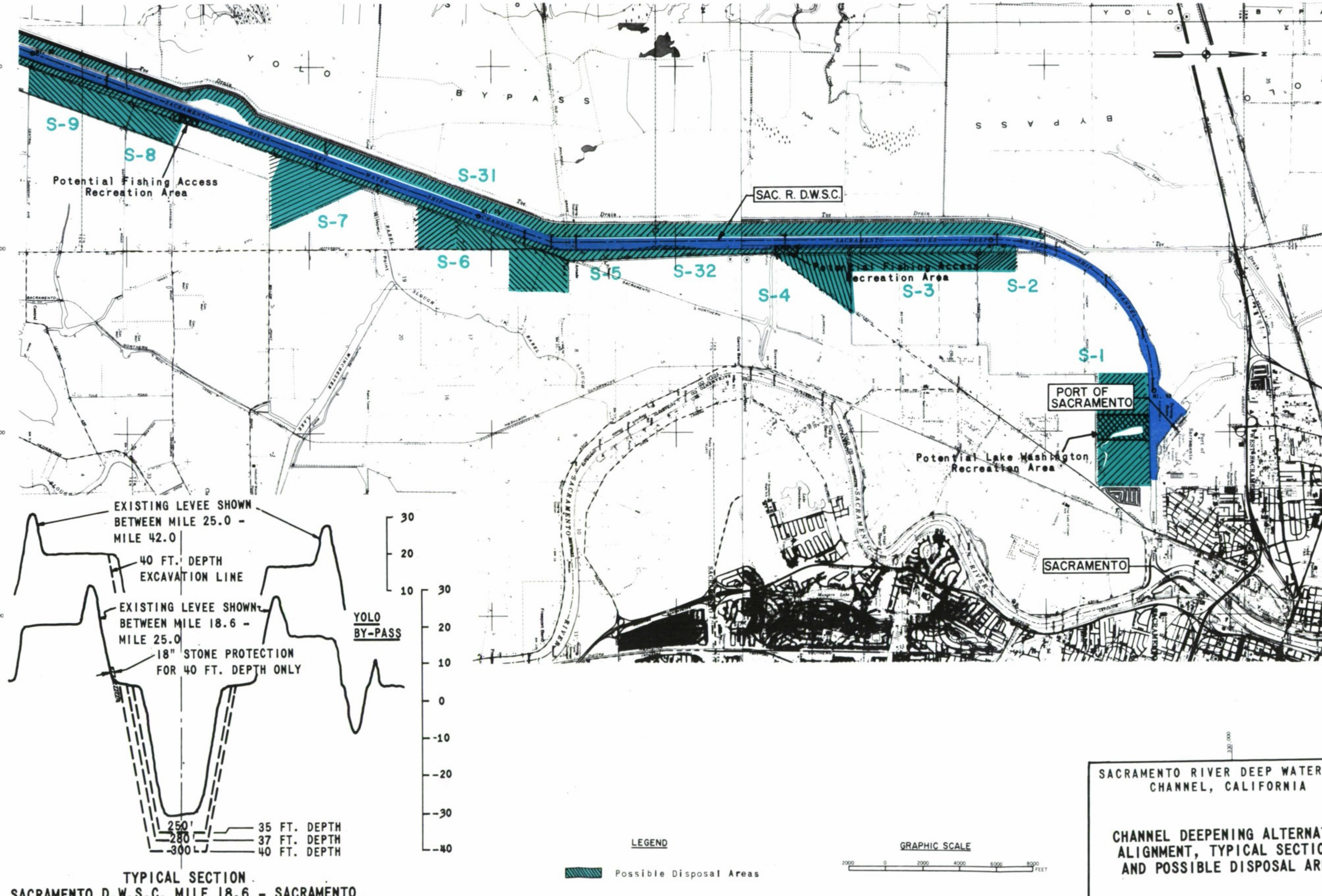
PLATE D-4



SACRAMENTO RIVER DEEP WATER SHIP CHANNEL, CALIFORNIA

CHANNEL DEEPENING ALTERNATIVE ALIGNMENT, TYPICAL SECTIONS, AND POSSIBLE DISPOSAL AREAS

SACRAMENTO DISTRICT, CORPS OF ENGINEERS — SEP 1979 — L.K.R.

PLATE D-5

SECTION E

THE SELECTED PLAN

SECTION E

THE SELECTED PLAN

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SECTION E

THE SELECTED PLAN

1. This section broadly describes the plan selected through the plan formulation process previously discussed. Also described are the accomplishments, environmental and other effects, design, construction, and operation and maintenance aspects of the plan. The plan is described in two reaches, New York Slough (Pittsburg) to the Port of Sacramento and Avon to New York Slough (Pittsburg). The Avon to New York Slough reach is currently authorized for deepening to 35 feet under the San Francisco Bay to Stockton (John F. Baldwin and Stockton Ship Channels) project but has not been constructed.

Plan Description

New York Slough (Pittsburg) to Sacramento

2. The selected plan in this reach provides for enlarging the Suisun Bay and Sacramento River Deep Water Ship Channels from New York Slough to the Port of Sacramento. Also included in the selected plan are 45 acres of land for establishment of wetland habitat and up to 156 acres of upland habitat to mitigate for losses of such habitat elsewhere. The selected plan also provides for supplementing as necessary the existing water quality monitoring network in the Sacramento-San Joaquin Delta to include high quality salinity monitoring stations. These stations would measure salinity levels in the Delta before, during, and after deepening and widening of the channel. If model studies conducted during advanced engineering and design studies or the salinity monitoring program determine that salinity levels increase to unacceptable levels above preproject conditions subsequent to channel deepening, a submerged sill or acceptable alternative measure would be constructed in Carquinez Strait to mitigate for the increased salinity. The monitoring program would then continue to further document the effectiveness of the sill or alternative mitigative measure. Plates E-2 through E-5 show the general plan of improvement for the channels.

CHANNEL

3. Deep-draft navigation improvements would consist of enlarging the existing channels from New York Slough to the Port of Sacramento as shown in Table E-1. Channel side slopes would be 1 vertical on 4 horizontal in the reach between Pittsburg and Sacramento Ship Channel mile 18.6 and 1 vertical on 3 horizontal from ship channel mile 18.6 to the port. Approximately 30.3 million cubic yards of dredged material would be excavated. Dredging would be accomplished with hydraulic suction dredges equipped with cutterheads. The dredged material would be pumped a maximum of 10,000 linear feet to land disposal area. Approximately 3,500 acres of land would be required for disposal.

4. Relocations made necessary by channel deepening include six high pressure gaslines, four underground cables, and other miscellaneous items. The local navigation sponsor would be responsible for these relocations.

TABLE E-1
Existing and Selected Channel Dimensions in Feet

Reach	Existing Width	Existing Depth	Selected Plan Width	Selected Plan Depth
New York Slough to Junction Pt. (Channel mi. 15.0)	300	30	400	35
Junction Point to Entrance of Manmade Channel (Channel mi. 18.6)	300	30	300	35
Channel mi. 18.6 to Port of Sacramento	200	30	250	35

DREDGED MATERIAL DISPOSAL

5. Selection of sites for disposal of dredged material is based on accessibility for the hydraulic dredge discharge and effluent pipelines, the capacity of each site without causing detrimental effects, and the potential for acquisition of the site. Plates E-2 through E-5 show the sites needed to handle the material excavated for the selected plan.

6. All the sites shown have been used for disposal of dredged material in the past, either during original construction of the channel or during maintenance operations. Construction of dredged material retention dikes or bulkheads will be the responsibility of the local navigation sponsor. In general, dikes will be constructed to a height which is twice the depth of dredged material to be placed in the area. This will provide sufficient detention time to allow essentially all solids to settle out. All land sites will be partitioned to eliminate rapid return of effluent and thereby maintain effluent water quality above standards established by the Environmental Protection Agency (EPA) and State Water Resources Control Board (SWRCB).

7. Rights-of-way for dredged material including maintenance dredged material disposal areas will be provided by the local navigation sponsor. All of the disposal areas required for this plan are currently owned either by the Port of Sacramento or by a government agency. The Corps of Engineers and State of California own or have permanent easements on several disposal areas between Collinsville and Junction Point (channel mile 0.0 to 15.0). The remainder of the areas are owned by the Port of Sacramento.

RECREATION PLAN

8. Since dredged material disposal sites provide excellent opportunities to satisfy recreation needs, recreation facilities will be constructed at one dredged material disposal area where a potential recreation sponsor has expressed a willingness and capability to cost-share in the development and accept operation and maintenance responsibilities. Because of the significant latent demand for Delta recreation opportunities, it is expected that the recreation area developed in conjunction with the project would be utilized to capacity on peak use days by its third year of operation. It is planned to construct initially all facilities suitable for implementing the recreation potential of the dredged material disposal site that the recreation sponsor is willing to support and which is economically justified.

9. The following is a description of the concept for development of recreation facilities. The proposed development is the result of continuing coordination with the potential sponsor.

The Sandy Beach area would be developed jointly with Solano County and would utilize approximately 30 acres of the dredged material disposal site immediately south of Rio Vista. The site would be developed with day-use and camping facilities designed to expand planned recreation facilities which will be owned and operated by the county. Grading and contouring of dredged material will be required as part of the recreation development. The following facilities are proposed.

a. Day-use facilities: 30 picnic sites, 5 acres of swimming beach, an 8-fixture restroom with change shelter, and parking for 100 automobiles.

b. Boat launch facilities: two-lane boat launch ramp, courtesy pier, and parking for 50 auto-boat trailers.

c. Auto access: 40-unit campground and two 6-fixture restrooms with showers.

d. Support facilities: Administration building, entry control station, fenced maintenance yard, maintenance/storage building, electrical power distribution, and connection to municipal water supply and sewerage systems.

e. Roads and landscaping: 0.5 mile of two-lane paved road, 0.5 mile of one-lane paved road, 25 acres of landscaping including 5 acres of irrigated turf.

Since the project area has a record of moderate seismic activity, the design and siting of recreation facilities would take into consideration the potential liquefaction of dredged materials subjected to seismic motion.

SALINITY CONTROL MEASURES

10. If salinity levels in the Delta increase to unacceptable levels as a result of the proposed project, a submerged rock embankment (sill) or acceptable alternative would be constructed in the Carquinez Strait to restrict the landward flow of more saline bottom currents. This would satisfy the institutional contraint that salinity levels must not increase as a result of the project. The location of the proposed submerged sill is shown on Plates E-1 and E-6, and a typical section and centerline profile of the structure are shown on Plate E-7. A complete description of the submerged sill is presented in paragraph "Submerged Sill" in this section of the report. Extensive model tests have been conducted to determine the need for a sill and its effectiveness. The model testing procedure and results as well as results of related water quality and sediment transport studies are presented in the paragraph "Effects on the Environment" in this section. Detailed information on these is presented in Appendix 5, Impacts on Salinity Distribution. To further determine the need for a sill and measure its effectiveness if needed, a monitoring program, as described on page E-1, and recommended by the Fish and Wildlife Service, would be implemented during advanced engineering and design studies.

If the recommended plan of improvement is authorized for construction by the Congress, detailed model studies would be conducted by the Corps of Engineers in cooperation with the California Department of Water Resources and other concerned State and Federal agencies. The salinity intrusion associated with channel deepening would be reviewed during advanced studies. During these studies, the effectiveness of a submerged sill or other mitigative measure to control salinity intrusion, if needed, would be evaluated in the Corps of Engineers Bay-Delta Model and in undistorted hydraulic flume tests using saline stratified flows.

Avon to New York Slough (Pittsburg)

11. This portion of the selected plan is currently authorized for deepening to 35 feet under the San Francisco Bay to Stockton (John F. Baldwin and Stockton Ship Channels) project. In the event that this channel is not deepened to 35 feet under the current authorization, it would be deepened as part of the selected plan. This portion of the channel is shown on Plates E-1 and E-2.

CHANNEL

12. The plan for channel modification of the Suisun Bay Channel consists of deepening the channel along the existing alignment from 30 feet to 35 feet mllw. The channel bottom will be widened from 300 feet to 600 feet from Avon to Middle Point and from 300 to 450 feet from Middle Point to Pittsburg (mouth of New York Slough). Channel side slopes would be 1V on 4H. Approximately 3.3 million cubic yards of material will be removed by suction dredge, and the material will be placed on land disposal areas. Only miscellaneous relocations are required in conjunction with channel deepening in this reach, and these would be the responsibility of the local sponsor.

DREDGED MATERIAL DISPOSAL

13. Dredged material disposal sites would be located along the south shore of Suisun Bay above the mean higher high water elevation and potentially at Ryer Island. The locations of these areas are shown on Plates E-1 and E-2. The sites shown include sufficient area to accommodate all the dredged material from construction of the 35-foot channel. As with the previous reach, local interests must acquire the rights-of-way for the disposal areas and must construct retention dikes adequate to maintain effluent quality at or above EPA and SWRCB criteria. Most of the areas shown are on Concord Naval Weapons Station property. The remainder of the areas are in private ownership, and disposal easements would have to be acquired before they could be used. These sites would also be used for disposal of future maintenance dredged material.

The disposal area on Ryer Island was designated subsequent to coordination of the draft feasibility report. The island is owned by the Concord Naval Weapons Station which indicated a preference for disposal on the island in lieu of some areas previously designated on the Weapons Station proper. The use of Ryer Island for dredged material disposal has been coordinated with the Fish and Wildlife Service and the California Department of Fish and Game. They have indicated that portions of the island may be acceptable for disposal but additional information would be required before they could give final approval. The required information would be developed during advanced studies.

PERTINENT DATA ON SELECTED PLAN

14. A summary of information relating to the selected plan is presented in Table E-2.

Fish & Wildlife Mitigation Features

15. Without mitigation, the selected plan would adversely affect wetland and upland habitat along the manmade portion of the channel. To offset the loss of wetland habitat, 45 acres of a former dredged material disposal area on Prospect Island would be converted to wetland habitat as recommended by the Fish and Wildlife Service. This would be accomplished by constructing a new levee to protect the remainder of the island and then grading the interior of the disposal area to approximately mean sea level elevation. The exterior levees would then be breached, subjecting the interior of the area to tidal action. Wetland plant species would be established in the area. The location of this site is shown on Plate E-4. To compensate for the loss of upland habitat, a maximum of 156 acres of dredged material disposal areas

TABLE E-2
PERTINENT DATA ON SELECTED PLAN

ITEM	DATA
Navigation Channel — New York Slough (Pittsburg) to Sacramento	
Length	46.5 miles
Depth, below mllw	35 feet
Bottom Width	
Pittsburg to Channel mile 15.0	400 feet
Channel mile 15 to 18.6	300 feet
Channel mile 18.6 to Port of Sacramento	250 feet
Overdepth	1 foot
Side slopes	
Pittsburg to Channel mile 18.6	1V on 4H
Channel mile 18.6 to Port of Sacramento	1V on 3H
Dredging Quantity	30,300,000 cu. yds.
Disposal Areas	3,500 acres
Navigation Channel — Avon to New York Slough (Pittsburg)*	
Length	11.5 miles
Depth, below mllw	35 feet
Bottom Width	
Avon to Middle Point	600 feet
Middle Point to Pittsburg	450 feet
Overdepth	1 foot
Side Slopes	1V on 4H
Dredging Quantity	3,300,000 cu. yds.
Disposal Areas	480 acres

*This reach is currently authorized for deepening under the San Francisco Bay to Stockton (John F. Baldwin and Stockton Ship Channels) Project. If this reach is not deepened under the current authorization, it would be deepened as part of the selected plan.

would be developed for upland habitat. The upland habitat would be created by seeding the disposal areas and dedicating them to wildlife conservation. The specific location of the upland habitat sites would be determined during post-authorization studies.

Potential Fish and Wildlife Enhancement

16. The disposal of dredged material on lands which are below mean sea level elevation provides the opportunity for enhancement of the fish and wildlife resources of the study area. Section 150 of the Water Resources Development Act of 1976 (PL 94-587) directs the Corps of Engineers to consider establishment of wetland areas, where appropriate, in connection with dredging required for water resource development projects, with all costs borne by the United States. As a part of this investigation, establishment of wetland areas was considered for several locations, as discussed under the EQ plan. However, officials of the Port District objected to creating wetlands in the Lake Washington area and along the ship channel due to future port expansion and industrial development needs. The Fish and Wildlife Service has recommended that wetlands be developed on Donlon Island in conjunction with the

SCALE 1" = 500'

LEGEND:

MARSHLAND

UPLAND

ISLAND

POSSIBLE FISH AND WILDLIFE
ENHANCEMENT AREA ON DONLON ISLAND

SACRAMENTO RIVER
DEEP WATER SHIP CHANNEL
INVESTIGATION, CALIFORNIA
SEP 1979

FIGURE E-1

authorized deepening of the Stockton Ship Channel. The Corps of Engineers will be responsible for construction of the enhancement area. The Port of Stockton will be responsible for providing the land and reasonable evidence that the wetlands area will not be substantially altered or destroyed by natural or manmade causes. If the Stockton Ship Channel is not deepened, Donlon Island, which is currently submerged, could be acquired and converted to wetland habitat as part of the Sacramento River Deep Water Ship Channel project. Wetlands could be developed by closing the breaks or discontinuities in the existing levees and filling the interior of the island to elevations varying from slightly below to 5 or 6 feet above mean sea level. This would create a variety of habitat ranging from marsh plants to upland riparian vegetation. Figure E-1 shows a conceptual plan of vegetative cover types and patterns for this area. Although this feature is not a part of the selected plan, it does have potential for development and would be studied in more detail during advanced engineering and design studies if the Stockton Channel is not constructed.

Evaluated Accomplishments

17. The primary accomplishment of the selected plan is direct savings of transportation costs by existing and future users of the Sacramento River Deep Water Ship Channel. These savings, or benefits, will result from (1) the movement of cargo via larger oceangoing vessels with their inherent economies of scale, (2) elimination of excessive tidal delays, (3) reduction of present light-loading and topping-off practices, and (4) movement of project-induced tonnage. Without channel deepening, commodities shipped from the Port of Sacramento service area would continue to have to be transported to deeper water ports for either topping-off of ships loaded at Sacramento or for direct shipment from the alternative ports. Also, without channel deepening, vessels which carry bulk cargoes out of Sacramento will continue to have to stop at ports in San Francisco Bay, or at other west coast locations to complete their loads before sailing for their final destinations. As more of the larger vessels are put into service, the restrictions of the present channel will become more acute. With a deeper channel, transportation savings will accrue to shipments of rice, logs, wood chips, steel scrap, fertilizer, and other grains and bulk commodities. Savings will also accrue to cargo transported as a result of future industrialization and to cargo attracted to the area by the deepening.

18. The recreation facilities provided as part of the plan will provide new recreation opportunities in the study area. It is estimated that approximately 120,000 recreation days would be accommodated annually by this development at the beginning of the project life. This is expected to increase to 180,000 recreation days at the end of the 50-year period of analysis. This recreation development will provide an average annual equivalent benefit of approximately $303,000. The proposed facilities would provide for camping, picnicking, boat launching, swimming, and other related recreation opportunities.

Effects on the Environment

Geology, Soils, and Seismicity

19. There would be no effect on geology, soils, or seismicity as a result of deepening the channel to 35 feet between New York Slough and Sacramento. This deepening would require the removal of approximately 30.3 million cubic yards of material from the channel. This material would be mostly sand, silty sand, and sandy clays which are similar to materials deposited at existing dredged material disposal sites. The chemical and biological composition of channel bottom sediments are summarized in Tables E-7 to E-14. Post-authorization studies would be conducted to assess the potential for adverse effects on surface water quality that may result from the resuspension of toxic substances in the water column during dredging activities. There would be no change in the soil characteristics at the dredged material disposal sites since all of the sites have been used in the past. Ground elevations at the sites would be raised to about 6 feet, msl. Between Avon and New York Slough, approximately 3.3 million cubic yards of fine sand would be dredged and placed on land disposal areas. This would change the soil characteristics from silty clay to fine sand at these sites.

Hydrology

20. There would be no impact on total Delta outflow as a result of the project. Studies by the Waterways Experiment Station (WES) and Dr. Ray Krone[1], under contract to the Corps, have shown that the submerged sill would increase current velocities only in the immediate vicinity of the structure and that the sill would have no effect on sediment transport. Even though Dr. Krone's study showed that sediment would not collect at the sill, normal operation of the project would include periodic depth soundings in the vicinity of the sill to determine the condition of the structure. If these soundings show major changes in the contours of the structure or bottom, maintenance would be performed to return the structure to "as constructed" condition. The following two paragraphs describe the studies of the effects of the submerged sill on velocities and water surface elevations.

a. Effects of submerged sill on flow velocities. — Undistorted model tests were conducted of the submerged sill by the Waterways Experiment Station in Vicksburg, Mississippi. The primary purpose of these tests was to design the distorted shape of the sill for use in the Bay-Delta model; however, velocity measurements were also taken on four lines upstream and four lines downstream, and at the centerline of the sill. These locations are shown on Figure 1 of Appendix 5. Results of tests with and without the sill are shown on Figures 2 and 3 of Appendix 5 for flood and ebb flows, respectively. As can be seen from those figures, the sill has no effect on velocities up current of the sill, and velocities return to essentially base conditions within 2,000 feet down current of the sill, except for the crest of the sill and along the south side of the strait where velocities are increased by 1.0 to 2.5 feet per second (total of about 5.5 feet per second) for a tidal flow of 500,000 cfs, flood and ebb tides, for about 4,000 feet down current of the sill. This increase in flow velocities on the south side is offset by a velocity decrease of about 1.0 foot per second on the north side, such that the average cross-sectional velocity remains essentially unchanged. Since the sill has little effect on current velocities except in the immediate vicinity of the structure, it would not affect long-term sedimentation and erosion patterns except at the base of the sill, due to development of an eddy at the down current toe. Also, the velocity changes would not create a boating hazard. Furthermore, increases and decreases in flow velocities are a natural day-to-day occurrence due to varying channel geography, ebb and flood tidal action, and varying release rates from upstream reservoirs.

b. Effects of submerged sill on water surface elevations. — Tests were conducted at the Bay-Delta model in Sausalito to determine the effect of the submerged sill on water surface elevations. Test results showed that the sill had virtually no effect on water surface elevations throughout the system during average flow conditions. To further test the effect under critical flow conditions, steady flow tests were conducted with and without the sill using a 410,000cfs total Delta outflow for about 15 tidal cycles. During these tests, measurements of water surface elevation were taken at various locations throughout the system. These results are shown on Chart 20 of Appendix 5 and indicate that under extreme flood conditions the sill would increase the water surface elevations by a maximum of 0.4 foot at certain locations in Suisun Bay and by less than 0.2 foot in the remainder of the Delta.

Water Quality

21. The major concern regarding water quality impacts of the proposed project is the possibility of salinity intrusion into the Delta. Any increase in salinity intrusion could affect agricultural, industrial, municipal, and fish and wildlife uses of the water. The State of California has established standards for salinity concentrations in the Delta and has stated that any project which increases salinity and thus makes meeting these standards more difficult would not be acceptable. Studies were therefore conducted on the effect of channel deepening on salinity intrusion and on measures to mitigate for any increase in salinity. Studies were also conducted to deterimine whether future construction of a Peripheral Canal would change the conclusions drawn from studies done without the Peripheral Canal. A summary of the results of these studies is presented in subparagraph a below. In addition, studies were done to determine the effect of the submerged sill on the biological aspects of water quality. The results of these studies, which were conducted under contract to the Corps by Hydroscience, Inc., are presented in subparagraph b below.

a. Salinity Intrusion Studies. — The following paragraphs present the results of model studies conducted of the selected plan at the Corp's San Francisco Bay-Delta model in Sausalito, California. A complete description of the test procedure and results of all tests are presented in Appendix 5. All tests of the 35-foot channel to Sacramento included the Congressionally authorized 35-foot channel to Stockton and were compared with the existing (base) conditions.

Model tests of the selected plan (35-foot channel to Sacramento) using 1968 hydrologic conditions, an average dry year, show that the plan would not affect salinities in the Bay-Delta estuary. Chart 15 of Appendix 5 shows these results for six locations in the estuary. Using 1977 hydrologic conditions, a "critically" dry year, model tests show that the plan would not affect salinity distributions in the Bay-Delta estuary or Suisun Marsh, with the exception of the upper Sacramento River (upstream of Rio Vista), where an increase in salinity averaging 0.13 parts per thousand would occur. Chart 13 of Appendix 5 shows these results for six locations in the estuary. Chart 16 of Appendix 5 shows that addition of the submerged sill to the system will not entirely reduce salinity to preproject conditions at this location (Cache Slough area). As previously discussed, a salinity monitoring program in addition to additional studies of the sill will be implemented beginning with advanced engineering and design studies to further determine the need for a sill and its effectiveness if eventually constructed.

Chart 18 of Appendix 5 summarizes these results at six locations in the system. A comparison of model tests of the selected plan including a submerged sill and the Peripheral Canal with preproject (base) conditions including the Peripheral indicates the addition of the Peripheral Canal has no effect on salinity distributions.

b. Water Quality Studies. — Hydroscience, Inc.[1], conducted studies under contract with the Corps to determine the effect of the submerged sill on water quality parameters other than salinity. The following is a summary of the approach used and the conclusions reached by Hydroscience. The effects of the submerged sill or other mitigative structures, if needed, on water quality parameters will be investigated in greater detail during advanced engineering and design studies.

The study focused on several key areas related to the water quality assessment.

The first element of the study, that of determining the transport characteristics in Western Delta-Suisun Bay, was completed through a detailed analysis of salinity and dye dispersion measurements and a reproduction of the available velocity data. The second element of the study constructed and calibrated a suspended solids model to calculate the distribution of suspended solids concentration under existing conditions.

Prediction of light extinction characteristics due to the suspended particles in the water column followed, using a model which relates light extinction properties to the nature and concentration of suspended solids present. The next element of this study was to project the changes in transport, suspended solids, and phytoplankton biomass due to the proposed construction. Alternative transport and light extinction coefficient scenarios which reflect various combinations of changes in physical and environmental conditions, were constructed. The phytoplankton model developed for the Interagency Ecological Study Program was then used to calculate trends in phytoplankton biomass and dissolved oxygen levels under each of these scenarios.

The principal conclusion drawn from the model simulation in this study is that the proposed channel deepening and sill placement would have minimum effect on phytoplankton population and dissolved oxygen level in the Western Delta-Suisun Bay area. The calculated increases of phytoplankton biomass and dissolved oxygen levels are relatively small under alternative transport and light extinction scenarios associated with the proposed project conditions. They are not considered to provide any serious threat to the water quality in the study area. The following are the pertinent technical factors which are relevant with respect to this conclusion.

[1]Hydroscience, Inc., "Assessment of The Effects of Proposed Submerged Sill on the Water Quality of Western Delta-Suisun Bay" prepared for Sacramento District, U.S. Army Corps of Engineers, May 1978.

(1). Comparison of the hydraulic model data and the prototype salinity measurements indicates that the hydraulic model does represent the prototype conditions quite adequately. The transport calculation reproduces the dye and salinity data from the model simultaneously.

(2). The effect of the proposed project with the sill on phytoplankton growth and dissolved oxygen level under a series of alternative conditions was simulated using the phytoplankton model. The results show that under an extreme reduction of light extinction coefficient assuming trapping of the sediment input from downstream in the bottom layer of water, the most significant increase in chlorophyll concentration is calculated in the bays. However, they only represent a measurable increase in the phytoplankton chlorophyll level (from 8 μg/l to 13 μg/l) at 4,400 cfs outflow. The calculated increase of chlorophyll concentration at the 10,000 cfs conditions is even smaller and is considered insignificant compared with the observed range of concentration.

(3). Another simulation was conducted to examine phytoplankton growth under the proposed project conditions and with the proposed San Luis Drain in operation, recognizing the potential impact of the agricultural return of water. A critical period with maximum phytoplankton growth and peak nutrient loading provided by the drain was considered. When the drain is present, the increase in phytoplankton chlorophyll concentration, due to the proposed project with the sill, is so small that it will not present a serious threat to the quality in the study area.

A potentially critical condition considering a drought flow of 2,500 cfs was also investigated. The results indicate that the salinity intrusion associated with this flow is so significant that the reduction of light extinction coefficient becomes less important. As a result, the proposed construction would not affect the phytoplankton growth during drought flow conditions.

(4). The final projection was designed to examine the effect of the proposed project under a time-variable input conditions in 1974. The calculation shows that the levels of phytoplankton biomass and dissolved oxygen are not affected by the project with the sill under time-variable conditions. It is concluded that the proposed construction essentially would have no dynamic effect on water quality in the Western Delta-Suisun Bay area. However, additional studies will be conducted prior to project construction to further determine the environmental effects of the sill.

22. Studies by the Waterways Experiment Station have shown that pesticides and heavy metals which are absorbed to the sediment particles are not usually released into the water during dredging. In many cases, dredging actually reduces the amount of these toxic substances by removing them with the bottom sediment.

23. Other water quality parameters such as turbidity, dissolved oxygen, and nutrient concentrations will not be significantly affected by the dredging. These parameters may experience slight increases during actual dredging operations, but these effects will be short-term and the water quality will return to ambient conditions shortly after dredging is completed.

Ground Water

24. Deepening the channel is not expected to cause detrimental impacts to ground water quality. A U.S. Geological Survey report on conditions in Suisun Bay states that most of the channel through Suisun Bay has at one time or another been deeper than the proposed 35-foot depth. Upstream of Suisun Bay, wells adjacent to the channel vary from approximately 100 to 600 feet in depth, indicating that the major water-bearing strata are considerably below the channel bottom. Additionally, the waters of Cache Slough and the manmade portion of the channel contain water of high enough quality that ground water would not be degraded.

Air Quality

25. Increased quantities of cargo will be transported by fewer, though larger ships. Ships are more efficient than alternate modes of transportation, and larger ships are generally more efficient than smaller ones. Consequently, a net reduction of pollutants entering the air can be expected over the short term. However, this improvement in air quality will probably be offset by the adverse effects of additional industrial development around the Port of Sacramento and increased recreation use in the Delta area. Project-induced vehicle emissions would contribute approximately 0.43 percent of the total nitrogen oxides (NOx), 0.06 percent of the carbon monoxide (CO), and 0.03 percent of the total hydrocarbon emissions in 1980 for the three-county area. For the 1990 projections, the project condition emissions are 0.02 percent of total NOx, 0.04 percent of total CO, and 0.02 percent of the total HC emissions for the basin.

Vegetation

26. Without mitigation, the widening of the manmade portion of the channel would result in a loss of approximately 45 acres of marsh and riparian vegetation which has become established as a result of the construction of the original channel. Approximately 3,500 acres of land is needed for dredged material disposal between New York Slough and Sacramento. All of this land has been used for dredged material disposal in the past and is currently in agricultural production or is used for disposal of material from maintenance dredging. The agricultural land would be out of production for 1 or 2 seasons after receiving dredged material. Other sites which are now used for maintenance dredging will lose their native vegetation for a period of 2 to 3 years. Under existing preproject conditions the seed production of waterfowl food plants in Suisun Marsh is impacted by salinity intrusion during low flow years. During these years leaching of soil salts would be hampered by high salinity levels. Since the proposed plan would not have any measurable effects on Delta salinities, the seed production of waterfowl plants would continue to be affected under low flow conditions with the plan in place. However, the effect would not be caused by the project. The construction of the submerged sill or other measures would eliminate this potential problem. The growth-inducing impact associated with the channel deepening would cause loss of upland grassland vegetation in the Collinsville-Montezuma Hills area and in the vicinity of the Port of Sacramento. The California hibiscus and a Lilaeopsis species, identified as rare and endangered species by the California Native Plant Society, are the only threatened, endangered, or rare plant species that have been previously collected or observed in the area of the proposed channel deepening operations. An

investigation of all potential disposal sites in the Rio Vista area will be made during advanced engineering and design, and appropriate measures will be taken to protect any remnant populations discovered. Approximately 100 acres would be required annually for disposal of material resulting from maintenance dredging. This represents land required for current maintenance practices as these practices are not expected to change with the project.

27. Losses of vegetation due to channel deepening would be offset by specific management actions. A 45-acre dredged material disposal site on the south end of Prospect Island would be converted to wetland habitat to mitigate for losses of such habitat elsewhere. In addition, the dredged material disposal areas would be seeded to help reestablish natural grassland on these areas. 156 acres of dredged material disposal areas would be dedicated for the development of upland habitat and wildlife conservation.

Planktonic and Benthic Organisms

28. As indicated in paragraph 21, mathematical and physical model studies conducted by Hydroscience Inc., indicate that the proposed project would increase phytoplankton concentrations by 5 micrograms per liter, assuming that all sediment returning from San Pablo Bay in the bottom layer of water would be trapped by the sill during low Delta outflow periods. Under this extreme assumption, there would be a reduction in light extinction (increased light) which would produce additional phytoplankton growth.

29. Most benthic organisms would be removed from the manmade portion of the channel during dredging operations. However, tests by the Waterways Experiment Station show that not all benthic organisms are removed by suction dredges and that the remaining organisms plus natural migration would quickly repopulate the channel. Dredging downstream of the manmade portion of the channel would remove only a portion of the benthic organisms in the waterway. The remaining benthic community between the channel and the levees would supply the organisms for repopulation. Studies have shown that where 75 percent of the organisms have been removed from the channel, repopulation to predredged levels occurred within 14 days. However, complete recovery of the benthic ecosystem may take as long as 2 years. Because dredging would progress from one end of the channel to the other over a 5-year period, these impacts would occur only in the portions of the channel which had been most recently dredged. Similar impacts can be expected during maintenance dredging which is expected to occur annually. The maintenance dredging is expected to continue at the present rate.

Fish

30. Deepening the ship channel is expected to have little overall impact on fisheries in the study area. Minor impacts on fish could occur from turbid effluent waters released from dredge material disposal sites. However, this potential localized impact can be avoided by proper operation of disposal areas. The removal of benthic organisms which are part of the food chain of fish could have a slight effect on fish population. However, this impact would also be localized to the most recently dredged area.

Wildlife

31. The proposed deepening combined with construction of the fish and wildlife mitigation areas should have essentially no net impact on wildlife. There may be a shift, however, in wildlife populations from along the manmade portion of the channel to the fish and wildlife mitigation areas. Disposal of dredged material on upland grasslands would temporarily eliminate wildlife habitat in these areas. However, all of the disposal sites proposed for use have been used previously and, as shown by current conditions at these sites, both vegetation and wildlife would return shortly after disposal is completed. Furthermore, 156 acres of selected disposal areas would be seeded following construction and set aside to create permanent upland habitat. Induced industrial development associated with the channel deepening would eliminate some wildlife habitat in the vicinity of the Port of Sacramento, along the ship channel, and in the Collinsville-Montezuma Hills area.

Endangered Species

32. Although the ranges of several species of rare and endangered wildlife encompass the project area, only the salt marsh harvest mouse is resident. Suitable habitat for the mouse does not occur on any of the DMD sites although the mouse has been sighted in Collinsville-Montezuma Hills area and may be affected by future industrial development. The anthicid beetle is a proposed endangered species and its proposed critical habitat includes two dredged material disposal sites used for maintaining the Sacramento River Deep Water Ship Channel — Grand Island and Sandy Beach. A biological assessment of the effects of the project on endangered species of plants and animals would be conducted during advance engineering and design if a project is authorized by the Congress. If the assessment indicates there would be adverse impacts, the U.S. Fish and Wildlife Service would be consulted and a biological opinion obtained. It is anticipated that the extent of dredged material disposal areas and alternative areas provides sufficient flexibility to insure that a plan to avoid or mitigate damage to or perhaps to enhance endangered species in the project area could be developed if needed.

Paleontology, Archeology, and History

33. In 1976, archeologists conducted an on-the-ground cultural resources reconnaissance survey over 15 percent of the project area. Cache Slough, all spoil sites, and the turning basin were examined completely. A prehistoric site was located near the turning basin at a disposal site. The site could be impacted by the placement of spoil. The reconnaissance report was coordinated with the California State Historic Preservation Officer and the Interagency Archeological Services, Heritage Conservation and Recreation Service. An intensive survey with all remaining areas examined for cultural resources, will be undertaken during future engineering and design studies. At that time, the prehistoric site and any other cultural resources discovered will be evaluated for significance under the National Register of Historic Places criteria. Mitigation and/or preservation of significant cultural resources which may be impacted by project construction, will be coordinated with appropriate parties in accordance with 36 CFR 800, Advisory Council on Historic Preservation procedures and 33 CFR 805 regulations, Corps of Engineers Identification and Administration of Cultural Resources.

Other Effects

34. The proposed channel deepening and the associated industrial development would be socially and economically beneficial for the study area and the region. The project would facilitate continued expansion of the Port of Sacramento and expansion and diversification of industry in the area served by the channel. Substantial socioeconomic benefits would accrue to the region in the form of additional employment, higher personal incomes, strengthened agricultural and industrial base, and increased property values. Table E-3 summarizes those effects. Most of these benefits can be credited to the Social Well-Being and Regional Development Accounts; however, some carry over into the National Development account.

Design

35. The major design consideration in navigation channel improvements is that relating to the geometry (width and depth) of the channel. An analysis of channel dimensions is presented in Section D, Plan Formulation, but will be summarized here. The design depth, or water under the keel, must be sufficient for safe and efficient operation. Factors such as loaded drafts, squat, trim, and maneuverability of vessels were considered in selecting keel clearances of 5 feet for tankers and 3 feet for dry bulk carriers (when measured from the static draft line) for all channels. Channel widths were based on consideration of the need for a passing situation, current velocity and direction, wind velocity and direction, the characteristics of the channel banks, and the controllability of vessels. Proposed channel dimensions are summarized in Table E-1.

36. The design of channel side slopes was based on the soil characteristics of the bank material. The materials in Suisun Bay, the Sacramento River, and Cache Slough are generally fine sands, silty sands, and sandy silts. These materials are capable of sustaining a side slope of 1 vertical (V) on 4 horizontal (H), hence, the channel from Avon to the beginning of the manmade channel, mile 18.6, was designed with this side slope. In the manmade portion of the channel the soils are sandy silts, clayey silts, and silty clays and are capable of sustaining the designed side slopes of 1V on 3H. Post-authorization subsurface explorations would be conducted to confirm the type and location of materials to be excavated. The potential lateral spreading of excavated materials would be studied at this time.

TABLE E-3

SOCIOECONOMIC EFFECTS OF SELECTED PLAN

Item	During Construction	After Construction
Employment	Average of 130 new jobs directly related to project construction; 35 new support jobs generated indirectly in the local area.	A total of 3,550 new jobs in operation and maintenance of recreation facilities and in port and deepwater dependent industrial development; 5,680 new jobs generated indirectly by above increase in direct employment during the 50 year period of analysis.
Population	No significant effect since most new jobs would be filled by local residents.	Small but permanent increase of less than one percent above baseline growth conditions.
Tax Base	Slight decrease since some agricultural land will be taken out of production for 2 to 3 years for dredge material disposal.	Slight increase in Yolo and Solano Counties as induced industrial development occurs.
Tax Revenue	Slight increase due to increased payroll and disposable income. Impact on annual property tax revenues would be minimal.	Moderate increase due to increased payroll and increased tax base in Yolo and Solano Counties.
Noise	Noise levels of 68 to 72 decibels. This is above background levels for agricultural areas; however, few people would be affected.	Moderate increase along the improved channel as land is converted from agriculture to industrial use.
Safety	Hazard to boating and navigation due to presence of waterborne construction equipment would be minimized by use of warning signs and lights.	Improved safety to commercial navigation due to widened and deepened channel.
Transportation	Slight disruptions of roads and traffic where dredge discharge pipe crosses roads.	Localized increase in rail, truck, and ship traffic due to induced industrial development and cargo movements; however, increases are not expected to be significant.

37. To assure that the design depth is obtained during construction, 1 foot of overdepth (over-35 feet mllw) dredging has been included in the design and accounted for in the cost estimate. This overdepth is sufficient to compensate for the inaccuracies inherent in the dredging operation considering the wave heights and tidal variation in the study area.

Construction

38. Following completion and approval of advanced engineering design studies, and assuming adequate funding will be available, it is estimated that the Sacramento River Deep Water Ship Channel from New York Slough (Pittsburg) to Sacramento could be deepened to -35 feet mllw in 5 years. Approximately 6 million cubic yards of material would be dredged yearly during this construction period. Deepening of the Suisun Bay Channel from Avon to New York Slough (Pittsburg) to -35 feet mllw, if necessary as part of this project, would require approximately 1 year to complete. Approximately 3.3 million cubic yards of material would be dredged during this period.

39. Construction of retention dikes at dredged material disposal areas, a responsibility of the local navigation sponsor, must be completed prior to initiating dredging in any reach. Construction of these dikes would, therefore, have to be initiated at least 6 months prior to beginning of dredging operations. Relocation of gaslines and underground cables, also a non-Federal responsibility, would have to be completed prior to dredging in the vicinity of these facilities. Design and construction of these relocations would take approximately 1 year, hence this work should be initiated by non-Federal interests at least 1 year prior to dredging. However, at the request of the local sponsor, this work could be included in a Federal construction contract on a cost reimburseable basis.

40. Construction of recreation facilities would be initiated approximately 2 years after disposal of dredged material on the proposed recreation site. This would allow time for the material to drain and consolidate. After initiation, construction of the recreation facilities would be expected to take approximately 2 years.

41. Construction of the fish and wildlife area at Prospect Island would be initiated concurrently with dredging operations and would be scheduled for completion prior to completion of channel deepening. Seeding of disposal areas to create upland habitat would be accomplished after the material has been allowed to drain and consolidate.

42. Construction of the submerged sill would be predicated on the results of advanced engineering and design model studies or the results of post-construction salinity monitoring of field conditions. If the post-authorization model studies indicate Delta salinity levels would increase as a result of channel deepening, the submerged sill or other mitigative measure would be scheduled for construction so that it would be completed at the same time as the channel deepening. If the salinity monitoring network indicates an increase in Delta salinity levels following completion of channel deepening, construction of the submerged sill would commence at that time. Construction of the sill would take approximately 2 years.

Maintenance and Operation

43. Maintenance dredging of the ship channel would continue to be a Federal responsibility. Studies have shown that deepening the channel to 35 feet would have no effect on current maintenance dredging requirements between New York Slough and Sacramento. The current practice of taking periodic condition surveys would continue to determine the location and extent of shoaling. Material dredged during maintenance operations would continue to be placed in the existing disposal areas, as shown on plates E-2 through E-5. In addition, the 100-acre existing site on the tip of Grand Island would not be used during construction to allow sufficient capacity for material dredged during maintenance operations from this rapid shoaling area. Water quality certification for the existing maintenance dredging has been obtained from the State of California pursuant to Section 404(t) of the Clean Water Act (33 USC 1344).

44. Maintenance and operation of the recreation development which would be constructed as part of the project would be the responsibility of the local recreation sponsor. This is consistent with the provisions of Public Law 89-72.

45. Studies have shown that the submerged sill, if eventually constructed, would have no effect on either suspended sediment or bedload sediment transport. Maintenance of the structure due to sediment deposition would therefore not be required. However, normal operating procedures would include obtaining periodic condition surveys of the sill. If the surveys show unexpected sedimentation, the sediment would be removed to insure proper performance of the sill.

46. During advanced studies the Corps of Engineers will determine if a Federal or State fish and game agency will accept management and associated funding responsibility for operation and maintenance of the fish and wildlife mitigation features. The non-Federal navigation sponsor would be asked to assume the maintenance and operation obligations if a Federal or State agency is unable to accept the task. If the non-Federal navigation sponsor subsequently indicates that it does not have the capability to perform the maintenance and operation functions, the Corps of Engineers would then assume this responsibility.

Submerged Sill

Scope

47. If future model tests conducted during advanced engineering and design studies indicate that the channel deepening increases the rate of salinity intrusion into the Delta, a submerged sill or alternative mitigative measure that is feasible from the standpoints of water quality effects, economics, and environmental factors would be constructed in Carquinez Strait and completed at the same time as the Sacramento channel deepening.

Description

48. The submerged sill at Dillon Point would consist of tremied rock fill embankment crossing Carquinez Strait. The embankment would have a maximum height of about 85 feet and crest length of about 2,300 feet with prefabricated concrete sections 10 feet high, 12 feet wide and 4 feet long protecting the top of the embankment. The crest of the concrete sill would be 50 feet below Mean Lower Low Water (MLLW) and crest of the embankment would be 60 feet below MLLW. A general plan, profile and section are shown on Plates E-6 and E-7. Geologic cross-sections and geologic maps are found on Plates E-8 and E-9. Contours of top of bay mud, top of firm clays and sands, and top of bedrock are shown on Plates E-10, E-11, and E-12 respectively. Locations and logs of borings are found on Plates E-13 and E-14 respectively.

Previous Studies

49. Previous investigations have been conducted to determine the feasibility of a barrier at or near the Dillon Point site. The most recent study was done by the U.S. Army Corps of Engineers, San Francisco District. Since the previous work by the State of California and the San Francisco District were comprehensive studies, the Sacramento District's investigation consisted mainly of analyzing these earlier works.

Foundation

50. Soundings and borings indicate that as much as 76 feet of bay mud overlays firm clays and sands on the south abutment. The soft bay mud, if left in place, would not provide an adequate foundation for the embankment. It would produce excessive displacement of the concrete sill and would be subject to erosion. Excavation of the bay mud is therefore required. The excavation would be made from approximately -80 feet MLLW at a point about 700 feet from the south shore back to the shore following the bottom of the soft bay mud (Plate E-8). The bottom of the excavation would be approximately 100 feet wide. Side slopes of 1 vertical on 4 horizontal would be used along the length of the cut. Plate E-19 shows a typical section in the planned excavation area. The remainder of the embankment foundation is competent, being composed of consolidated firm clays and sands or bedrock.

Construction Materials

51. Core Stone — The interior of the embankment will be a core stone composed of waste materials from commercial quarries in the San Francisco Bay area. A typical gradation was obtained from the Basalt Rock Company for their riprap production at McNear quarry at Point San Pedro and is shown on Table E-4. The material is best described as a sandy gravel. It will be pervious with a permeability in the order of 10 to 100 feet per day.

TABLE E-4
Typical Gradation of Core Stone (Quarry Waste Rock*)

MATERIAL SIZE	PERCENT PASSING
6"	100
3"	82
1½"	61
¾"	45
#4 sieve	23

*Provided by Basalt Rock Company for McNear quarry.

Quarry Run Rock — The core stone will be held in place during construction with quarry run rock. This rock will be composed of materials from quarrying operations which are not suitable for riprap. Quarry run rock generally consists of overburden rock, maximum size 5 feet, which is scalped off by a grizzly and not processed through the crushers.

Riprap — Riprap up to 2 feet maximum size will serve as armor protection. Adequate rock in this size range is produced at many quarries in the San Francisco Bay Area including Basalt Rock Company's McNear quarry and Napa quarry at Napa. Table E-5 lists the weight requirements of the riprap.

TABLE E-5
Riprap Gradation

WEIGHT (lbs)	PERCENT LIGHTER
1000	100
	PERCENT HEAVIER
200	50
5	10

Embankment

52. Stability — A stability analysis was made in accordance with EM 1110-2-1902 without the quarry run rock and showed that slopes of 1 on 2 would be safe during the steady seepage condition (Plate E-20). However, with a 0.15 gravitational acceleration the factor of safety was considerably less than 1.0. Furthermore, the core stone may have a liquefaction potential. As a defensive measure, quarry run rock will be provided both on the upstream and downstream faces for greater stability and to lessen the liquefaction potential.

53. Seepage — The embankment materials are pervious. The most pervious materials may have permeabilities as high as 1,000 feet per day. However, very little seepage will occur through the embankment because the hydraulic gradient is nearly zero. The seepage that does occur will be caused by the pressure gradient developed by the difference in fresh water (62.4 lbs/cu. ft.) and saline water (64.0 lbs/cu. ft.) unit weights. A seepage analysis was made based upon this pressure gradient. The calculated total maximum seepage through the embankment is less than 20 cubic feet per second. This seepage would be insignificant when compared with the total flow in the strait, however, if it is necessary to reduce seepage, 10 percent minus 200 sieve size materials could be blended into the core stone at the quarry to reduce the seepage to less than 2 cubic feet per second. Also the quarry run rock below the concrete sill will be grouted to preclude seepage through that layer.

54. Slope protection — The surface of the embankment must be protected from tidal flows and propeller wash. Propeller wash is by far the more critical condition. The upstream and downstream faces of the embankment will be protected with a 3 foot thick layer of 1,000 pound maximum weight riprap. No analytical method has been developed to determine size of riprap required for various types of propeller wash. The Waterways Experiment Station, however, has done model testing that showed a concrete sill 10 feet high, 12 feet wide and precast in 4 foot long sections will provide adequate protection.

Construction

55. The embankment will be built in stages as follows:

a. Quarry run rock will be placed at the upstream and downstream toes to about elevation -120 feet MLLW thru a tremmie. Dredging of the soft bay mud will commence on the south abutment.

b. Construction of the embankment will continue with core stone placed thru a tremmie to -120 feet MLLW, after which the quarry run rock would be placed at the upstream and downstream toes in ten foot stages followed by core stone placements in ten foot stages. Riprap will be placed on the upstream and downstream faces of the embankment with tremmies.

c. The crown of the embankment, quarry run rock, will be placed to the crest, followed by riprap placed on the faces to the crest at -60 feet MLLW.

d. The concrete sill will be installed either by placing the units individually or the units tied together and placed as one flexible unit along the crest. This will be followed by grouting of the cap quarry run rock below the concrete sill through the grout pipes provided in the precast concrete units.

Explorations

56. The following investigations were carried out by the San Francisco District, Corps of Engineers. Borings B-543 and B-544 were angle holes drilled in the rock at Dillon Point north of the barrier site at the locations shown on Plate E-13. The drill rig utilized a core barrel with hard-metal or diamond bits that drilled a 2-5/8 inch diameter core. Logs of the borings are shown on Plate E-14. Borings B-228 and B-229 were drilled on the San Francisco District's proposed barrier axis to determine the character of embankment foundation materials. These borings were vertical. Samples through the soft upper portion of boring B-228 were taken with 2-3/8-inch inside diameter thin walled push tubes. The underlying firmer sands and clays were sampled with a 4-inch core barrel using 2-1/2 inch diameter liners. Boring B-229 was drilled in the deeper portion of the channel using a 4-inch core barrel with liners for sampling. Logs of borings made by other agencies and private concerns were made available to the Corps of Engineers for this investigation. Locations of these borings are shown on Plate E-13.

Testing

57. The following tests were run by the San Francisco District, Corps of Engineers.

a. Dillon Point Testing: Push tube samples were obtained from boring B-228 and three jar samples and two liner samples were obtained from boring B-229. Testing, other than visual classification, was confined to the samples from boring B-228 due to the disturbed condition of the samples obtained from boring B-229. In addition to the undisturbed samples obtained from boring B-228, a companion hole, offset 20 feet, was bored and vane shear tests performed at depths comparable to those of the undisturbed push tube samples. The laboratory testing program consisted of the determination of specific gravity, field dry unit weight, moisture content, triaxial compression shear, consolidation, and visual inspection and classification. Sufficient mechanical analyses and liquid and plastic limits determinations were made to verify the visual classifications. A petrographic analysis was run on sample 34, boring B-228. Borings B-543 and B-544 were drilled, essentially parallel to the channel alignment and roughly normal to the bedding planes of the rock. The effects of weathering extended downward to the water table at approximately Mean Sea Level and were evident principally as iron and manganese coatings along fractures. Generally, the weathered rock was only slightly inferior in quality to that of the fresh rock below the water table. Water stood at about Mean Sea Level and tended to reflect tidal fluctuations. Drilling circulation water was lost in both holes after drilling approximately 30 feet. Although the rock materials were relatively impervious, free circulation of water was affected through fractures. Core samples of shale were in a saturated or near saturated condition when extruded from the core barrel and seldom showed evidence of shaly partings. However, as air drying progressed the samples tended to break along shaly partings into smaller pieces. Six samples from boring B-543 and 16 samples from boring B-544 were field tested to determine the amount of deterioration due to air slaking by immediately sealing some in water, air drying companion samples for varying times, and subjecting others to various numbers of wet, dry cycles. Tests for specific gravity and absorption were made by the South Pacific Division Laboratory on 25 core samples from borings B-543 and B-544. Mineralogical analyses of two shale samples were made by the U.S. Geological Survey to evaluate their possible swelling tendencies.

b. Tests results and design values for bay mud: Vane shear tests indicate that as the vane is rotated, the strength of the bay mud increases to a maximum value and then decreases to a more or less constant value. Laboratory tests show that the bay mud is highly compressible, and while its consistency is very soft at the surface, it increases in stiffness with increasing depth. Natural water contents of the mud range from the liquid limit to 50 percent above the liquid limit, with values particularly high at the surface and decreasing with depth. Atterberg limits are plotted on Plate E-17. It can be seen that the muds lie in the zone of organic clays and inorganic silts of high compressibility. A total of 11 unconsolidated-undrained triaxial compression tests were made on undisturbed samples from boring B-228. The confining pressure for each of these tests was set equal to the overburden pressure on the sample, computed from the submerged unit weight and depth of overlying material. The triaxial data are plotted on Plate E-18 and have a strength envelope with a slope approximately 9.5° and a cohesion of .05 ton/sq. ft. This envelope was used to develop the shear strength vs. depth relationship for submerged bay muds which is shown on Plate E-16.

58. Geomorphology — The Dillon Point submerged sill site lies across Carquinez Strait about 8,200 feet upstream from the Interstate 80 Carquinez Bridge. The strait is bounded by low hills that rise from 175 feet to more than 500 feet above the river on slopes averaging about 1 vertical on 2 horizontal. The left (south) side of the strait has a terrace that is about 100 feet wide and about 15 feet above water level. The terrace carries the main line of the Southern Pacific Railroad with the station of Eckley approximately 1,400 feet downstream from the barrier axis. The strait is 2,700 feet wide at the axis of the sill. Water depth at the south side is shallow with a 10-foot depth out some 550 feet from the shore, which deepens to 88 feet at 1,000 feet, 120 feet at 1,900 feet, and reaches a maximum depth of 136 feet at 2,200 feet. Water depth decreases rapidly from 120 feet at 2,400 feet to 57 feet at 2,620 feet as it approaches the north shore (Plate E-8). Dillon Point at the north side of the strait is a rounded knoll that rises 165 feet above the river. Upstream from the right (north) end of the sill axis, the hills are dissected by Southampton Bay which is about 3,000 feet wide at the strait and extends northerly for about 8,000 feet. Downstream, three small re-entrants dissect the hillside.

Geology

59. Bedrock at the Dillon Point site is the marine Chico Formation of late Cretaceous age consisting of 65 to 70 percent thin-bedded, grayish black clay-shale and 30 to 35 percent hard massive sandstone. The shale is highly consolidated, siliceous, silty to sandy shale and clay-shale that is highly jointed. A variety of shale, called "mudstone" in the logs of drill holes, is massive when wet but develops shaly partings as it dries. The mineralogical composition has been determined by the U.S. Geological Survey and Table E-6 is adapted from their analysis. Sandstone beds are interbedded with shale and generally average from an inch to two feet thick, except for a 50-foot thick bed at the eastern side of Dillon Point. The sandstone is hard, fine to medium grained, gray to tan, highly jointed, and the thinner beds tend to break into blocks that are as wide as the bed is thick. Partings of shaly sandstone are common in the thicker beds. Minor amounts of pebble-conglomerate are locally associated with the sandstone. The weathered rock is only slightly inferior in quality to the fresh rock. The effects of weathering extend downward to the water table at about zero feet MSL and are represented by deposits of iron and manganese oxides along joints and fractures. A soft yellow clay is present along some minor shear zones. The shale is generally saturated and when exposed to air it tends to break into 1/8 to 1/2-inch pieces to a depth of one or two inches beneath the exposed surface. When core samples are taken from the shale and air dried, or particularly when exposed to wet-dry cycles, they break readily into 1/8 to 3-inch pieces with the development of a small amount of non-plastic fines along partings. Overburden consists of soil mixed with 1/8 to 1/2-inch pieces of shale and small blocks of sandstone and ranges from zero to six feet or more in depth. Quaternary to recent sediments overlie portions of the bedrock in Carquinez Strait and Southampton Bay. Generally, the sequence of sediments is sand and gravel at the base, overlain by firm silty to clayey materials that may contain some sand lenses. This unit is referred to as the Older Bay Mud. It is overlain by soft, relatively unconsolidated silty to clayey deposits called Younger Bay Mud. Either or both of the Older and Younger Bay Mud formations may be absent above bedrock. Along the axis and out 500 feet from the south shore is 7 feet of water, 74 feet of Younger Bay Mud and 43 feet of Older Bay Mud which rests on the Chico Formation at about elevation -124 feet. Out 1,000 feet from the south shore is 88 feet of water, 38 feet of Old Bay Mud with bedrock at about elevation -126 feet. Out 500 feet from the north shore the Bay Muds are absent and bedrock is at about elevation -135 feet. In Southampton Bay as much as 120 feet of Younger Bay Mud overlies Older Bay Mud with the Chico Formation at an approximate elevation of -150 feet. The locations of exploration borings are shown on Plate E-13. Contour maps showing the top of Younger Bay Mud, the top of Older Bay Mud, and the top of bedrock are shown on Plates E-10, E-11, and E-12 respectively.

Geologic Structure

60. The shale and sandstone beds of the Chico Formation on the north side of Carquinez Strait at Dillon Point strike about N 20° W, and dip 30° S (see Plates E-8 and E-9). The axis of the sill trends about N 10° E, so the axis makes an angle of about 30° with the strike of the beds. A series of faults that strike approximately parallel to the strike of the beds cut the Dillon Point area. The Southampton fault trends through Southampton Bay but is concealed beneath Younger Bay Mud. A disturbed zone (fault zone ?) about 100 feet wide, parallels the Southampton fault along the eastern edge of Dillon Point. Another disturbed zone (fault zone ?) about 100 feet wide cuts through Dillon Point about 600 feet west of the axis. It is exposed immediately above the water surface, but could not be traced to the northwest due to the

TABLE E-6
Estimated Composition and Free Swell of Shale

CONSTITUENT	BORINGS B-543* (Percent)	BORINGS B-544** (Percent)
Nonclay material in shale[1]	18-25	31-43
Quartz and feldspar	15-20	30-40
Carbonaceous matter	3-5	1-3
Clay material in shale[2]	75-82	57-69
Composition of clay minerals		
Montmorillonite	65	20
Mica	20	40
Chlorite	15	40
Approximate percentage of montmorillonite in shale[3]	50-55	10-15
Free swell[4]	47	13

*B-543 sample is from depth 221 feet.
**B-544 sample is from depth 116 feet.
[1]Estimated visually under microscope.
[2]Calculated as remainder after subtracting nonclay material.
[3]Calculated from estimates of clay material in shale and montmorillonite in clay minerals; unit digit is not significant.
[4]Increase in volume in percent of original volume.

overburden cover. A minor fault trends northwesterly through an embayment about 1,800 feet west of the axis. Several minor faults that trend approximately east-west, offset some of the sandstone beds, particularly the 50-foot thick bed of sandstone east of the axis. Offset of these minor faults varies from a few inches to several feet. Core from drill holes B-543 and B-544 show slickensides and other evidence of minor faulting, and some of these zones are filled with soft yellow clay. Both the shale and the sandstone are jointed extensively and during drilling all circulation water was lost in both holes at a depth of about 30 feet below the collars of the holes. Water stood in the holes at about Mean Sea Level, and tended to reflect tidal fluctuations. These data suggest that water passes readily through the fractures.

Seismology

61. The San Andreas, Hayward, and Sunol (Calaveras) faults are major faults that trend north-northwest through the bay area. They are active, and recorded displacement has occurred along all of them in historic times. The bay is bracketed by two of these faults, the San Andreas and the Hayward faults, and the Hayward fault may continue northward across San Pablo Bay. The net result is that the San Francisco-Suisun Bay area is one of the most seismically active areas in California, if not in the United States. Prior to 1927, earthquake records were assembled from press reports and eye witnesses, and intensities were assigned on the Rossi-Forrel scale (Reference 31). In 1927, the U.S. Coast and Geodetic Survey began recording earthquake statistics and wherever possible located the epicenter of the earthquake by longitude and latitude as well as assigning modified Mercalli intensities or Richter

magnitudes. Records (Reference 31) show that at least 30 earthquakes with Rossi-Forrel intensities of VII or greater — sufficiently strong to damage masonry — occurred between 1850 and 1927. This group includes the famous earthquake originating from movement on the San Andreas fault on 18 April 1906. Since 1927, three similar (but smaller) earthquakes have affected the area. Innumerable earthquakes of intensities that rattle windows and cause slight damage to poorly constructed buildings occur every year. Plate E-21 shows the locations of epicenters for the period 1927-1958 along with the locations of the principal faults. The effects of an earthquake usually are felt over an area adjacent to the epicenter and this "felt area" may extend over hundreds of square miles. Damage to structures within the "felt area" depends on numerous variables, such as the geologic nature of the foundation, design of the structures, and distance from the epicenter. It is probable that any location within the bay area may be subjected to earthquake intensities of VII or greater (modified Mercalli scale).

Data on intensities and location of epicenters are available in the catalog of Townley and Allen (Reference 31), in publications of the U.S. Coast and Geodetic Survey such as the annual "United States Earthquakes" and the quarterly "Abstracts of Earthquake Reports for the Pacific Coast and the Western Mountain Region".

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29.——, Appendix H, "Hydraulic Model Studies, Vol 1", (March 1963).

30. U.S. Army Corps of Engineers Waterways Experiment Station "Adequacy of Submerged Rock Weirs to withstand Propeller Wash, St. Clair River, Michigan, Misc. Paper No. 2-821, (May 1966).

31. Townley, S.D. and Allen, M.W. "Descriptive Catalog of Earthquakes of the Pacific Coast of the United States, 1764-1928, "Seismological Society Am. Bulletin, Vol 29, (January 1939).

Analysis of Bottom Sediments

62. During post-authorization studies of the Stockton Ship Channel, a sampling program was conducted to determine the composition of bottom sediments. 75 samples from 26 test holes were taken along the channel during the period 28 April 1972 to 30 June 1972. Tests on the samples were performed as follows:

a. Volatile solids, chemical oxygen demand (COD), total Kjeldahl nitrogen, oil and grease, lead, zinc, copper, cadmium, chromium and nickel were determined according to "Chemistry Laboratory Manual, Bottom Sediments" compiled by Great Lakes Region Committee on Analytical Methods and published by the Environmental Protection Agency, Federal Water Quality Administration, December 1969.

b. Mercury, Hatch, and Ott Method using a Coleman 50 Mercury Analyzer.

c. Arsenic, Method 104A of "Standard Methods for Examination of Water and Wastewater", 13th Edition 1971, published jointly by American Public Health Association, American Waterworks Association and Water Pollution Control Federation.

d. Nitrate and nitrite nitrogen, Methods 133A and 134 of Standard Methods, 13th Edition 1971.

e. pH, Official and Tentative Methods of Analyses of the Association of Official Agricultural Chemists.

The chemical analyses of samples for holes located in the Avon to New York Slough reach, which is the reach common to the Sacramento and Stockton channels, are presented in Tables E-7 and E-8. The location of the test holes are indicated on Plates E-1 and E-2.

63. A bottom sediment sampling program was also conducted for the Sacramento River Deep Water Ship Channel Investigation. 22 samples were taken from 6 test holes along the channel between the turning basin and Collinsville. Tests on the samples were performed as follows.

a. Biochemical oxygen demand (BOD) tests were run on the fluff samples according to Paragraph 219 of 13th Edition of "Standard Methods for Examination of Water and Wastewater," published by the American Public Health Association.

b. Volatile solids, COD, total Kjeldahl nitrogen, oil and grease, total phosphorous, heavy metals, and pesticides according to "Chemistry Laboratory Manual, Bottom Sediments," compiled by Great Lakes Region Committee on Analytical Methods and published by the Environmental Protection Agency (EPA), Federal Water Quality Administration, December 1969.

c. Mercury, EPA Provisional Method for Mercury in Sediment, Cold Vapor Technique.

d. pH and nitrate according to "Standard Methods for the Examination of Water and Wastewater," 13th edition.

e. Particle size, Atterberg limits, and moisture contents were run in accordance with Engineer Manual, EM-1110-21906, "Laboratory Soils Testing," 30 May 1970.

The chemical analyses of samples for these holes are presented in Tables E-9 to E-15. The locations of the test holes are indicated on Plates E-3 to E-5.

TABLE E-7
ANALYSIS OF BOTTOM SEDIMENTS

Hole No.	20			21				
Field Sample No.	**PS-1**	**PS-2**	**PS-3**	**PS-1**	**PS-2**	**PS-3**	**PS-4**	**EPA**
Laboratory No.	**PC-446**	**PC-447**	**PC-448**	**PC-449**	**PC-450**	**PC-451**	**PC-452**	**Max.**
Depth (feet)	**1.0-2.0**	**5.0-6.0**	**9.0-10.5**	**0.0-1.0**	**1-3**	**5-6**	**6-7**	**Limits**
Moisture Content, % dry wt.	80.4	107.5	108	32.3	33.4	34.3	40.1	
Volatile Solids, % dry wt.	10.0	16.2*	15.7*	1.1	1.3	1.5	3.7	6.0
Chemical oxygen demand, % dry wt.	9.6*	20.0*	19.7*	0.3	0.4	0.4	2.8	5.0
Total Kjeldahl nitrogen, % dry wt.	0.19*	0.35*	0.29*	0.01	0.01	0.01	0.07	0.10
Nitrate nitrogen (N), % dry wt.								
Nitrite, nitrogen (N), % dry wt.								
Oil and grease, % dry wt.	0.07	0.39*	0.13	0.01-	0.01	0.01	0.06	0.15
pH								
Heavy Metals								
Mercury (Hg), 1X10-4, % dry wt.	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Lead (Pb), 1X10-4, % dry wt.	21	21	25	12	10	12	13	50
Zinc (Zn), 1X10-4, % dry wt.	87*	114	174	66*	45	64*	80*	50
Cadmium (Cd), 1X10-4, % dry wt.	1.3	1.3	1.4	0.7	0.6	0.6	0.9	
Copper (Cu), 1X10-4, % dry wt.	108	73	119	17	12	16	39	
Chromium (Cr), 1X10-4, % dry wt.	225	210	285	125	125	145	190	
Arsenic (As), 1X10-4, % dry wt.	6.9	7.9	7.6	2.0	2.6	1.8	5.8	
Nickel (Ni), 1X10-4, % dry wt.	185	185	220	120	115	120	145	
Total Phosphorus (P), 1X10-4, % dry wt.	988	1698	813	622	594	666	867	
Sulfide (as H2S), 1X10-4 % dry wt.	4-	4-	4	3-	3	3	29	
Chlorinated Pesticides	None	None		None	None	None	None	
BHC except y isomer (a), ppb dry wt.			13					
Polychlorinated Biphenyls (PCB)								
aroclor 1254, ppb dry wt.	144	43	256	107	28	78	80	

*Exceeds EPA maximum limit.
(a) — 1, 2, 3, 4, 5, 6 — Hexachlorocyclohexane except gamma isomer.

Note: Where there are blank spaces, no tests were requested.

TABLE E-8
ANALYSIS OF BOTTOM SEDIMENTS

Hole No.	23			24			26			
Field Sample No.	FS-1	FS-2	FS-3	FS-1	FS-2	FS-3	FS-1	FS-2	FS-3	EPA
Laboratory No.	PC-453	PC-454	PC-455	PC-456	PC-457	PC-458	PC-459	PC-460	PC-461	Max.
Depth (feet)	39-41	46-48	49-51	35.0-36.0	40.0-45.0	45.0-46.0	35.0-36.0	36.0-40.0	40.0-50.0	Limits
Moisture Content, % dry wt.	36.4	35.3	34.0	71.0	74.1	64.8	35.1	24.7	28.1	
Volatile Solids, % dry wt.	2.2	2.3	2.1	6.9*	7.2*	6.0	2.1	1.6	1.7	6.0
Chemical oxygen demand, % dry wt.	1.1	1.1	0.8	5.5*	5.6*	5.0	0.6	0.3	0.4	5.0
Total Kjeldahl nitrogen, % dry wt.	0.04	0.04	0.03	0.18*	0.21*	0.17*	0.02	0.01	0.02	0.10
Nitrate nitrogen (N), % dry wt.										
Nitrite, nitrogen (N), % dry wt.										
Oil and grease, % dry wt.	0.02	0.02	0.01	0.03	0.03	0.03	0.01	0.01	0.01	0.15
pH										
Heavy Metals										
Mercury (Hg), 1X10-4, % dry wt.	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	1.0
Lead (Pb), 1X10-4, % dry wt.	13	15	15	22	21	16	15	11	14	50
Zinc (Zn), 1X10-4, % dry wt.	47	74*	53*	85*	85*	81*	45	55*	59*	50
Cadmium (Cd), 1X10-4, % dry wt.										
Copper (Cu), 1X10-4, % dry wt.										
Chromium (Cr), 1X10-4, % dry wt.										
Arsenic (As), 1X10-4, % dry wt.										
Nickel (Ni), 1X10-4, % dry wt.										
Total Phosphorus (P), 1X10-4, % dry wt.										
Sulfide (as H2S), 1X10-4 % dry wt.										

*Exceeds EPA maximum limit.
Note: Where there are blank spaces, no tests were requested.

TABLE E-9
ANALYSIS OF BOTTOM SEDIMENTS

Hole No. 1

Field Sample No. Laboratory No.	PT-1 PC-1925	PT-2 PC-1926	PT-3 PC-1927	PT-4 PC-1928	PT-5 PC-1929
Volatile solids, % of dry wt.	24.9	15.4	20.1	23.1	15.7
Chemical oxygen demand (COD), 10^{-4}% of dry wt.	377,700	232,100	338,100	380,800	187,200
Total Kjeldahl nitrogen (N), 10^{-4}% of dry wt.	6,226	2,737	4,054	4,511	3,094
pH	6.5	6.5	6.1	6.0	6.7
Oil and grease, 10^{-4}% of dry wt.	6,581	2,478	3,456	3,215	4,236
Mercury (Hg), 10^{-4}% of dry wt.	0.2	0.2	0.3	0.2	0.3
Lead (Pb), 10^{-4}% of dry wt.	13	12	9	10	13
Zinc (Zn), 10^{-4}% of dry wt.	72	79	78	77	79
Nitrate (NO_3), 10^{-4}% of dry wt.	15	8	8	4	9
Total phosphorous (P), 10^{-4}% of dry wt.	13	21	30	163	238
Immediate oxygen demand (IOD), ppm	205+	182	200	202	205+
Cadmium (Cd), 10^{-4}% of dry wt.	0.6	0.7	0.7	0.7	0.8
Copper (Cu), 10^{-4}% of dry wt.	54	66	60	71	13
Chromium (Cr), 10^{-4}% of dry wt.	83	87	84	103	81
Arsenic (As), 10^{-4}% of dry wt.	3.1	2.5	3.1	2.3	2.8
Nickel (Ni), 10^{-4}% of dry wt.	92	93	121	101	127
Chlorinated Hydrocarbons (a)					
Aroclor, 10^{-7}% of dry wt.	3	5	7	8	13
BHC, 10^{-7}% of dry wt.	3.8	0.7	0.7	0.3	0.4
pp'DDT, 10^{-7}% of dry wt.	2.5	1.7	3.2	3.6	2.1

(a) Aroclor is a polychlorinated biphenyl (PCB). The others are pesticides.

TABLE E-10
ANALYSIS OF BOTTOM SEDIMENTS

Hole No. 2

Field Sample No. / Laboratory No.	PT-1 PC-1930	PT-2 PC-1931	PT-3 PC-1932	PT-4 PC-1933	PT-5 PC-1934
Volatile solids, % of dry wt.	2.4	1.5	1.9	1.6	1.5
Chemical oxygen demand (COD), 10^{-4}% of dry wt.	9,880	2,880	4,790	4,230	10,460
Total Kjeldahl nitrogen (N), 10^{-4}% of dry wt.	378	263	281	205	244
pH	6.6	5.7	6.4	5.6	4.9
Oil and grease, 10^{-4}% of dry wt.	200	155	206	169	283
Mercury (Hg), 10^{-4}% of dry wt.	0.2	0.2	0.2	0.1	0.1
Lead (Pb), 10^{-4}% of dry wt.	6	4	4	3	4
Zinc (Zn), 10^{-4}% of dry wt.	48	31	38	27	29
Nitrate (NO_3), 10^{-4}% of dry wt.	3	2	2	2	3
Total phosphorous (P), 10^{-4}% of dry wt.	2	93	135	348	182
Immediate oxygen demand (IOD), ppm	194	89	144	119	213+
Cadmium (Cd), 10^{-4}% of dry wt.	0.4	0.2	0.3	0.2	0.1
Chlorinated Hydrocarbons (a)					
Aroclor, 10^{-7}% of dry wt.	4	2	1	33	2
BHC, 10^{-7}% of dry wt.	0.1-	0.4	0.8	0.5	0.1-
pp'DDT, 10^{-7}% of dry wt.	1.5	0.9	0.6	1.0	1.2

(a) Aroclor is a polychlorinated biphenyl (PCB). The others are pesticides.

TABLE E-11
ANALYSIS OF BOTTOM SEDIMENTS

Hole No. 3

Field Sample No. Laboratory No.	PT-1 PC-1935	PT-2 PC-1936	PT-3 PC-1937	PT-4 PC-1938	PT-5 PC-1938A
Volatile solids, % of dry wt.	1.2	1.7	1.6	1.9	1.6
Chemical oxygen demand (COD), 10^{-4}% of dry wt.	3,470	2,620	2,890	3,060	3,770
Total Kjeldahl nitrogen (N), 10^{-4}% of dry wt.	263	240	172	137	569
pH	7.4	7.4	7.2	6.9	6.8
Oil and grease, 10^{-4}% of dry wt.	174	158	298	157	130
Mercury (Hg), 10^{-4}% of dry wt.	0.1	0.1	0.1	0.1	0.1
Lead (Pb), 10^{-4}% of dry wt.	5	6	5	4	3
Zinc (Zn), 10^{-4}% of dry wt.	42	43	34	34	28
Nitrate (NO_3), 10^{-4}% of dry wt.	2	2	2	2	2
Total phosphorous (P), 10^{-4}% of dry wt.	3	96	99	105	5
Immediate oxygen demand (IOD), ppm	126	202	78	211	124
Cadmium (Cd), 10^{-4}% of dry wt.	0.2	0.2	0.1	0.1	0.3
Copper (Cu), 10^{-4}% of dry wt.	13	13	12	11	12
Chromium (Cr), 10^{-4}% of dry wt.	29	34	35	43	44
Arsenic (As), 10^{-4}% of dry wt.	0.4	0.7	0.5	0.7	0.6
Nickel (Ni), 10^{-4}% of dry wt.	46	51	58	49	59
Chlorinated Hydrocarbons (a)					
Aroclor 1254, 10^{-7}% of dry wt.	1	2	6	5	14
BHC, 10^{-7}% of dry wt.	2.1	1.8	1.9	2.3	1.4
pp'DDT, 10^{-7}% of dry wt.	1.2	0.9	1.6	0.9	1.7

(a) Aroclor is a polychlorinated biphenyl (PCB). The others are pesticides.

TABLE E-12
ANALYSIS OF BOTTOM SEDIMENTS

Hole No. 4

Field Sample No. Laboratory No.	PT-1 PC-1939	PT-2 PC-1940
Volatile solids, % of dry wt.	5.7	4.6
Chemical oxygen demand (COD), 10^{-4}% of dry wt.	8,015	4,010
Total Kjeldahl nitrogen (N), 10^{-4}% of dry wt.	462	413
pH	8.0	8.5
Oil and grease, 10^{-4}% of dry wt.	56	42
Mercury (Hg), 10^{-4}% of dry wt.	0.1	0.1
Lead (Pb), 10^{-4}% of dry wt.	11	10
Zinc (Zn), 10^{-4}% of dry wt.	50	49
Nitrate (NO_3), 10^{-4}% of dry wt.	4	5
Total phosphorous (P), 10^{-4}% of dry wt.	7	77
Immediate oxygen demand (IOD), ppm	181	187
Cadmium (Cd), 10^{-4}% of dry wt.	0.1	0.4
Chlorinated Hydrocarbons (a)		
Aroclor 1254, 10^{-7}% of dry wt.	3	6
BHC, 10^{-7}% of dry wt.	1.8	1.8
pp'DDT, 10^{-7}% of dry wt.	1.4	0.9

(a) Aroclor is a polychlorinated biphenyl (PCB). The others are pesticides.

TABLE E-13
ANALYSIS OF BOTTOM SEDIMENTS

Hole No. 5

Field Sample No. **Laboratory No.**	**PT-1** **PC-1941**	**PT-2** **PC-1942**
Volatile solids, % of dry wt.	6.8	4.2
Chemical oxygen demand (COD), 10^{-4}% of dry wt.	28,310	6,490
Total Kjeldahl nitrogen (N), 10^{-4}% of dry wt.	1,109	197
pH	7.2	8.1
Oil and grease, 10^{-4}% of dry wt.	205	181
Mercury (Hg), 10^{-4}% of dry wt.	0.1	0.1
Lead (Pb), 10^{-4}% of dry wt.	10	5
Zinc (Zn), 10^{-4}% of dry wt.	78	60
Nitrate (NO_3), 10^{-4}% of dry wt.	3	1
Total phosphorous (P), 10^{-4}% of dry wt.	287	231
Immediate oxygen demand (IOD), ppm	193	116
Cadmium (Cd), 10^{-4}% of dry wt.	0.8	0.4
Copper (Cu), 10^{-4}% of dry wt.	59	35
Chromium (Cr), 10^{-4}% of dry wt.	82	134
Arsenic (As), 10^{-4}% of dry wt.	1.8	0.4
Nickel (Ni), 10^{-4}% of dry wt.	153	178
Chlorinated Hydrocarbons (a)		
Aroclor 1254, 10^{-7}% of dry wt.	5	2
BHC, 10^{-7}% of dry wt.	0.9	1.6
pp'DDT, 10^{-7}% of dry wt.	0.9	0.7

(a) Aroclor is a polychlorinated biphenyl (PCB). The others are pesticides.

TABLE E-14
ANALYSIS OF BOTTOM SEDIMENTS

Hole No. 6

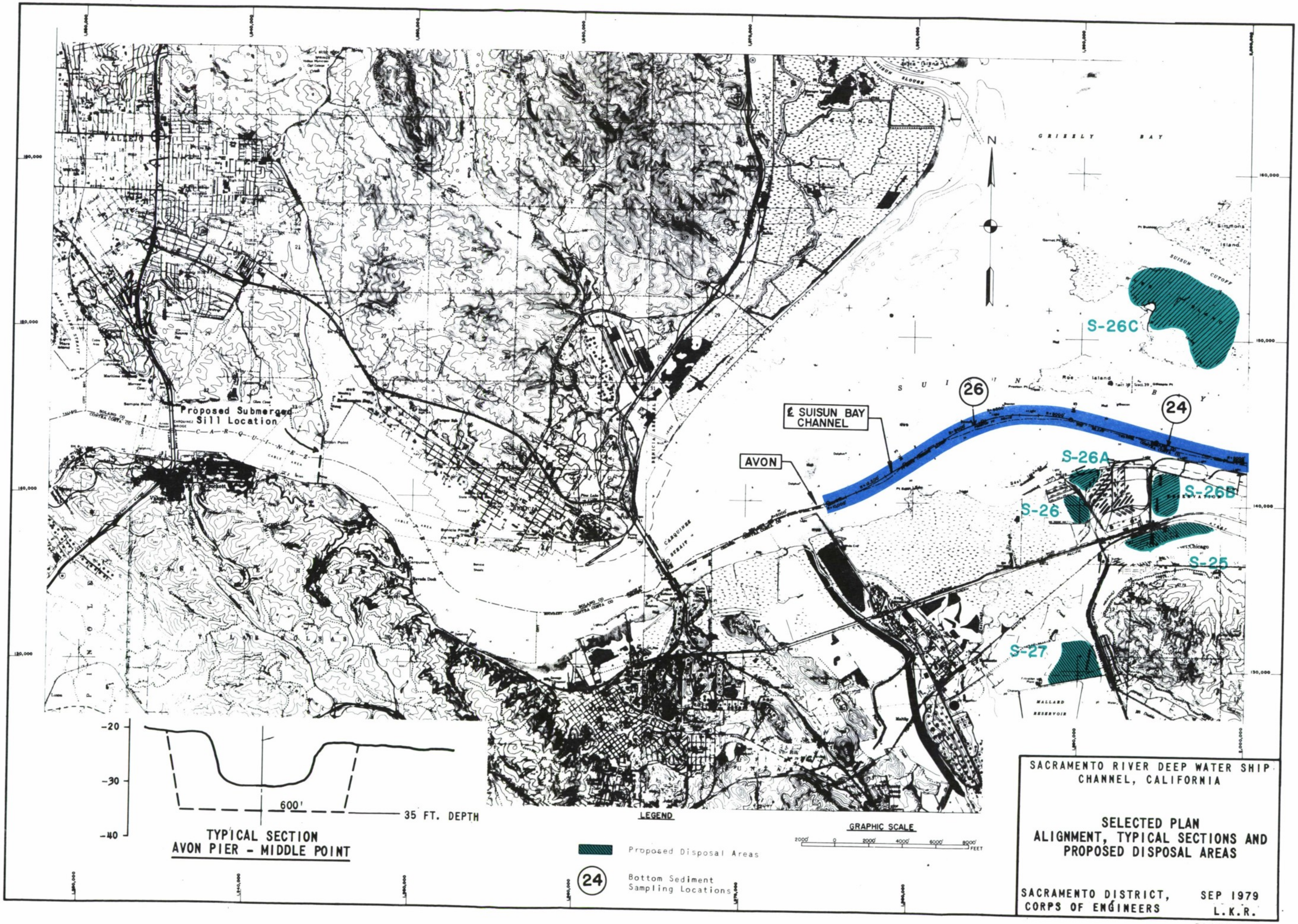
Field Sample No. / Laboratory No.	PT-1 PC-1943	PT-2 PC-1944	PT-3 PC-1945
Volatile solids, % of dry wt.	6.4	4.1	4.8
Chemical oxygen demand (COD), 10^{-4}% of dry wt.	18,290	5,780	4,200
Total Kjeldahl nitrogen (N), 10^{-4}% of dry wt.	1,198	452	467
pH	7.2	7.7	7.8
Oil and grease, 10^{-4}% of dry wt.	92	33	192
Mercury (Hg), 10^{-4}% of dry wt.	0.1	0.1	0.1
Lead (Pb), 10^{-4}% of dry wt.	9	7	9
Zinc (Zn), 10^{-4}% of dry wt.	74	53	59
Nitrate (NO_3), 10^{-4}% of dry wt.	7	3	14
Total phosphorous (P), 10^{-4}% of dry wt.	341	136	243
Immediate oxygen demand (IOD), ppm	138	123	124
Cadmium (Cd), 10^{-4}% of dry wt.	0.7	0.5	0.5
Copper (Cu), 10^{-4}% of dry wt.	55	40	46
Chromium (Cr), 10^{-4}% of dry wt.	66	47	50
Arsenic (As), 10^{-4}% of dry wt.	1.9	0.8	0.6
Nickel (Ni), 10^{-4}% of dry wt.	121	112	1
Chlorinated Hydrocarbons (a)			
Aroclor 1254, 10^{-7}% of dry wt.	-	1	2
BHC, 10^{-7}% of dry wt.	0.9	1.6	0.9
pp'DDT, 10^{-7}% of dry wt.	0.4	0.3	0.5

(a) Aroclor is a polychlorinated biphenyl (PCB). The others are pesticides.

TABLE E-15
BIOCHEMICAL OXYGEN DEMAND TESTS
January 1975

Hole No.	BOD, mg/l
1	5.6
2	9.8
3	7.0
4	7.8
5	4.8
6	1.4

NOTE: Samples were water taken just above the channel bottom at the site of each hole.

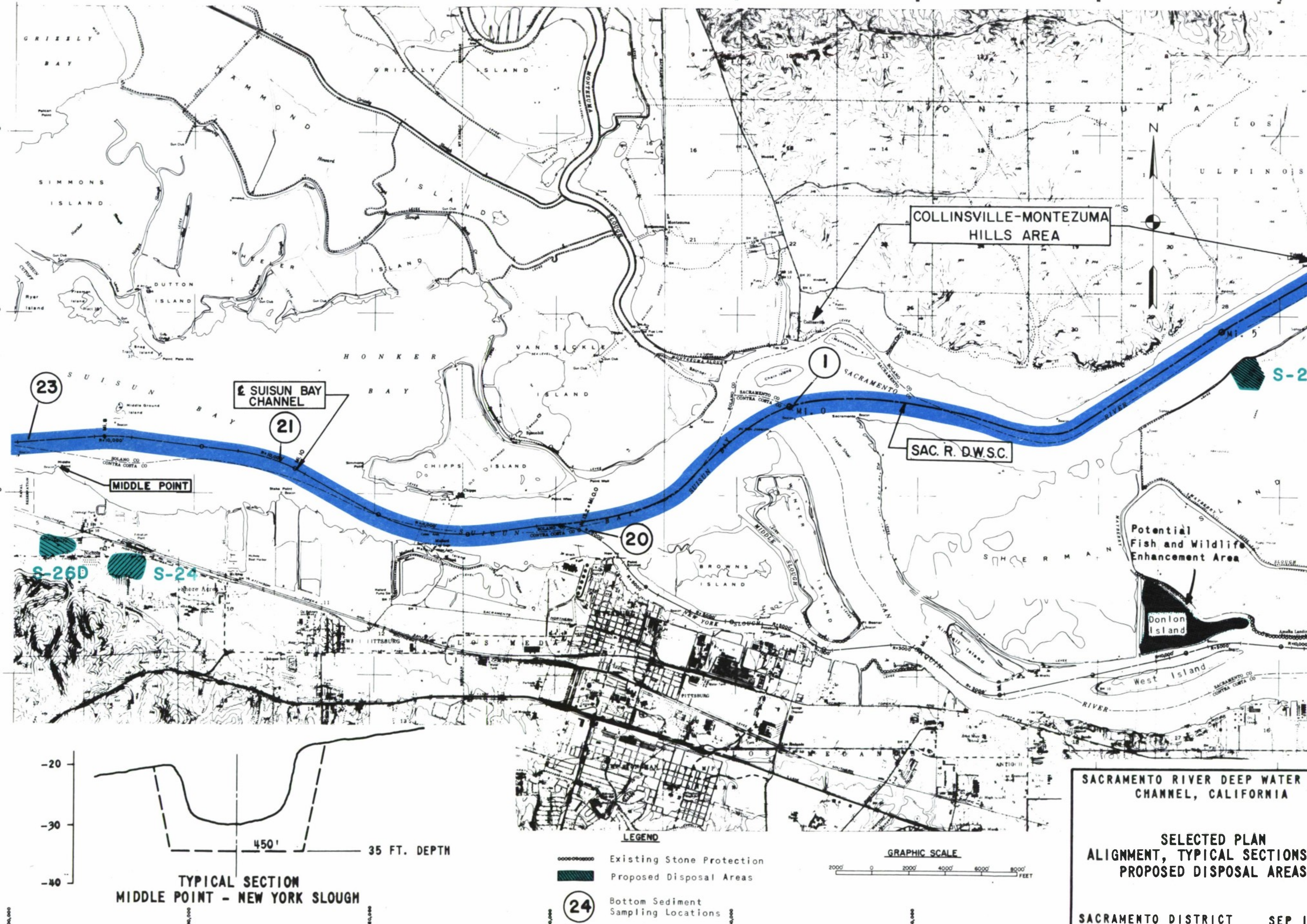


SACRAMENTO RIVER DEEP WATER SHIP CHANNEL, CALIFORNIA

SELECTED PLAN
ALIGNMENT, TYPICAL SECTIONS AND PROPOSED DISPOSAL AREAS

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
SEP 1979
L.K.R.

PLATE E-I

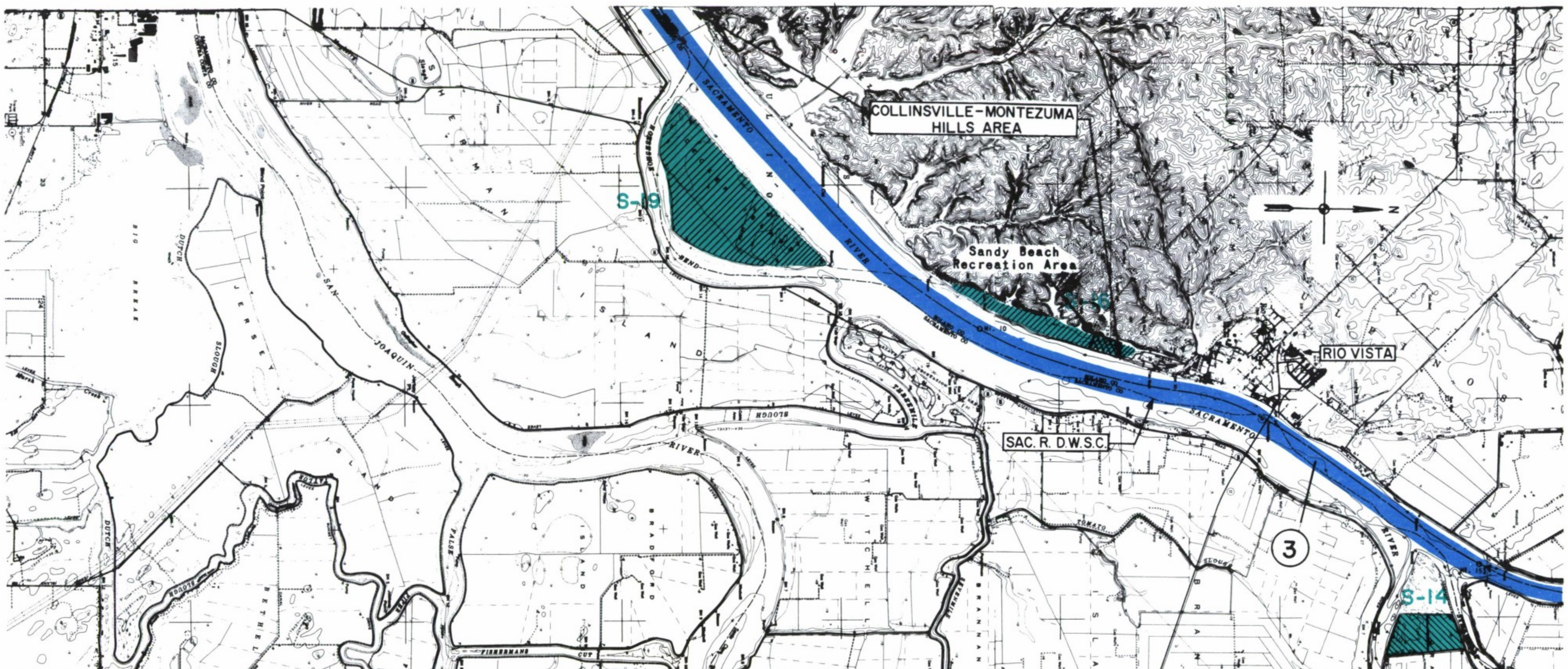


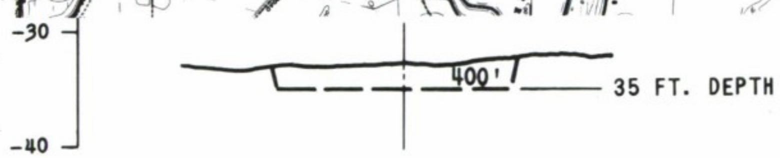
SACRAMENTO RIVER DEEP WATER SHIP CHANNEL, CALIFORNIA

SELECTED PLAN
ALIGNMENT, TYPICAL SECTIONS AND PROPOSED DISPOSAL AREAS

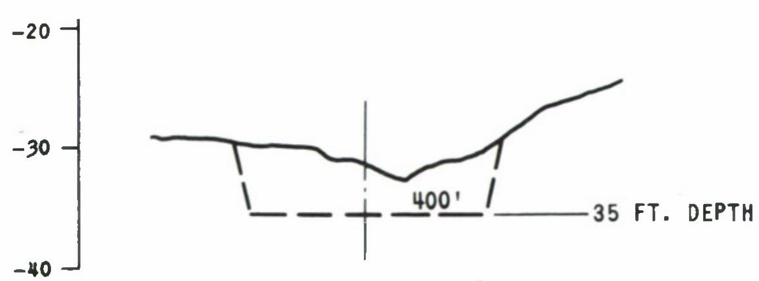
SACRAMENTO DISTRICT CORPS OF ENGINEERS

SEP 1979
L.K.R.





TYPICAL SECTION
NEW YORK SLOUGH - COLLINSVILLE



TYPICAL SECTION
COLLINSVILLE - SACRAMENTO D.W.S.C. MILE 15.0

LEGEND

Proposed Disposal Areas

(24) Bottom Sediment Sampling Locations

GRAPHIC SCALE

2000 0 2000 4000 6000 8000 FEET

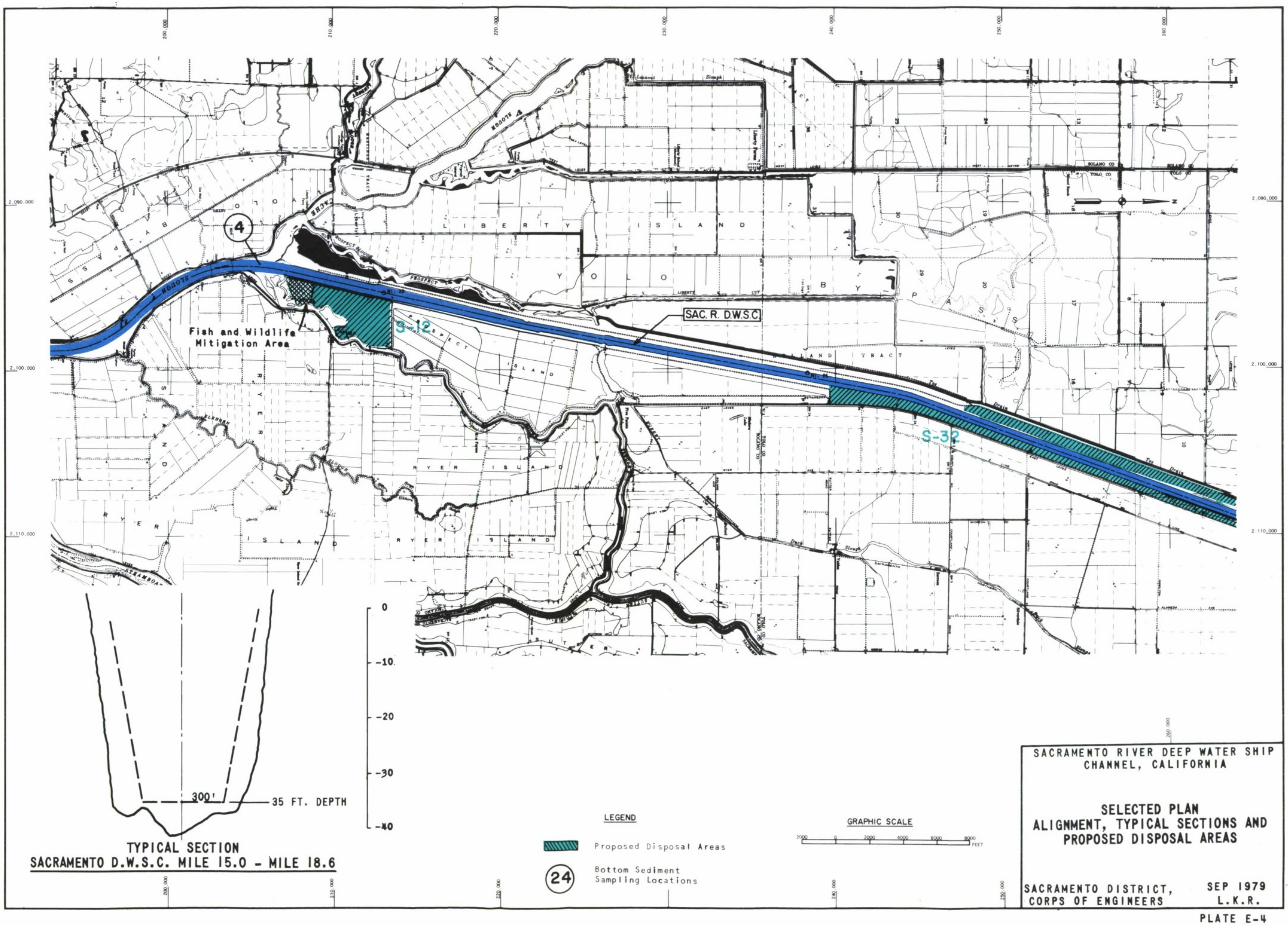
SACRAMENTO RIVER DEEP WATER SHIP CHANNEL, CALIFORNIA

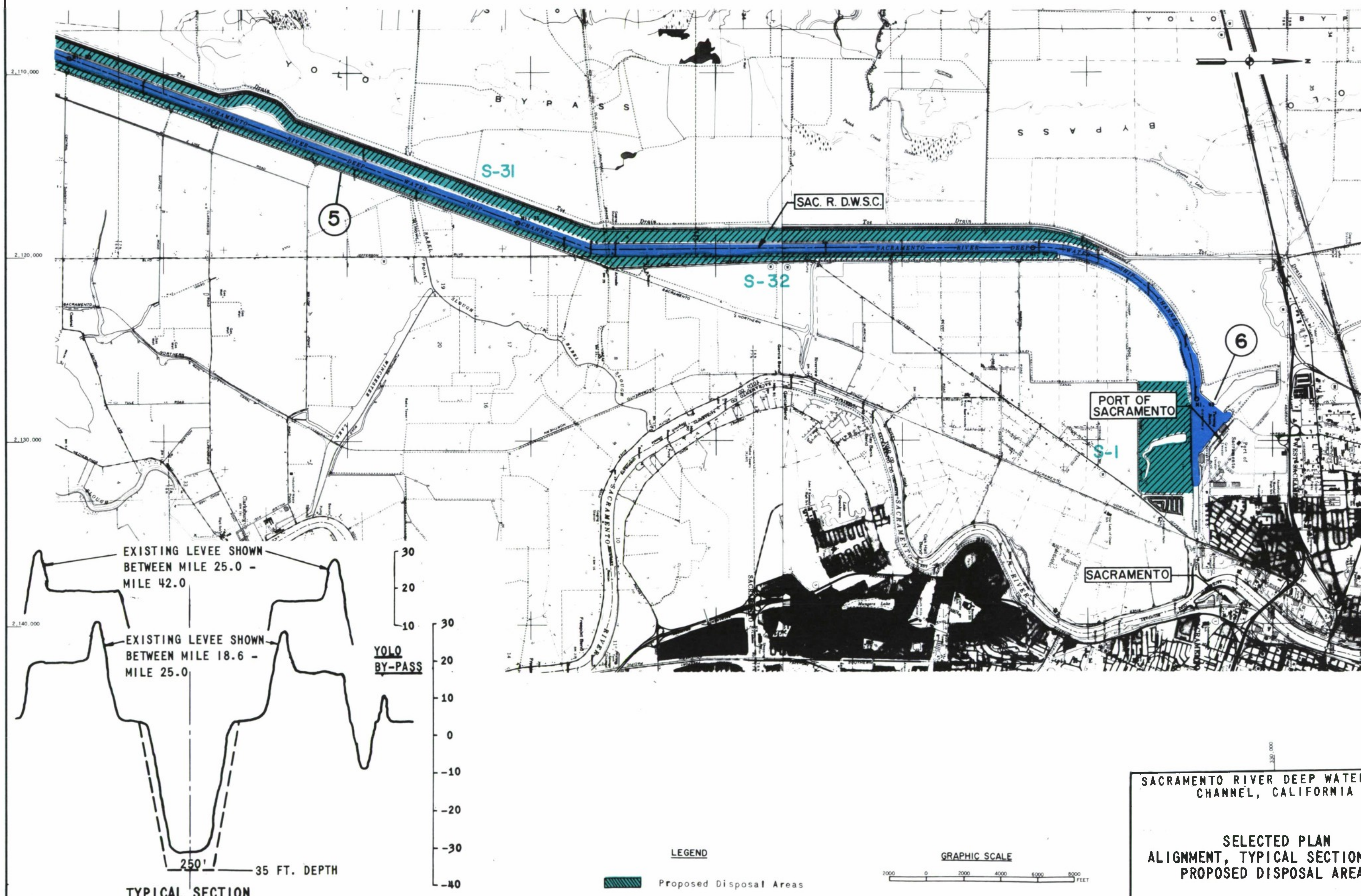
SELECTED PLAN
ALIGNMENT, TYPICAL SECTIONS AND PROPOSED DISPOSAL AREAS

SACRAMENTO DISTRICT, CORPS OF ENGINEERS

SEP 1979
L.K.R.

PLATE E-3


SAC. R. D.W.S.C.
S-12
S-32
Fish and Wildlife
Mitigation Area
4
L I B E R T Y
I S L A N D
Y O L O
B Y
P A S S
P R O S P E C T
I S L A N D
R Y E R
I S L A N D
0
-10
-20
-30
-40
300'
35 FT. DEPTH
TYPICAL SECTION
SACRAMENTO D.W.S.C. MILE 15.0 - MILE 18.6
LEGEND
Proposed Disposal Areas
24
Bottom Sediment
Sampling Locations
GRAPHIC SCALE
2000
0
2000
4000
6000
8000
FEET
SACRAMENTO RIVER DEEP WATER SHIP
CHANNEL, CALIFORNIA
SELECTED PLAN
ALIGNMENT, TYPICAL SECTIONS AND
PROPOSED DISPOSAL AREAS
SACRAMENTO DISTRICT,
CORPS OF ENGINEERS
SEP 1979
L.K.R.
PLATE E-4



TYPICAL SECTION
SACRAMENTO D.W.S.C. MILE 18.6 - SACRAMENTO

LEGEND

Proposed Disposal Areas

(24) Bottom Sediment Sampling Locations

GRAPHIC SCALE

2000 0 2000 4000 6000 8000 FEET

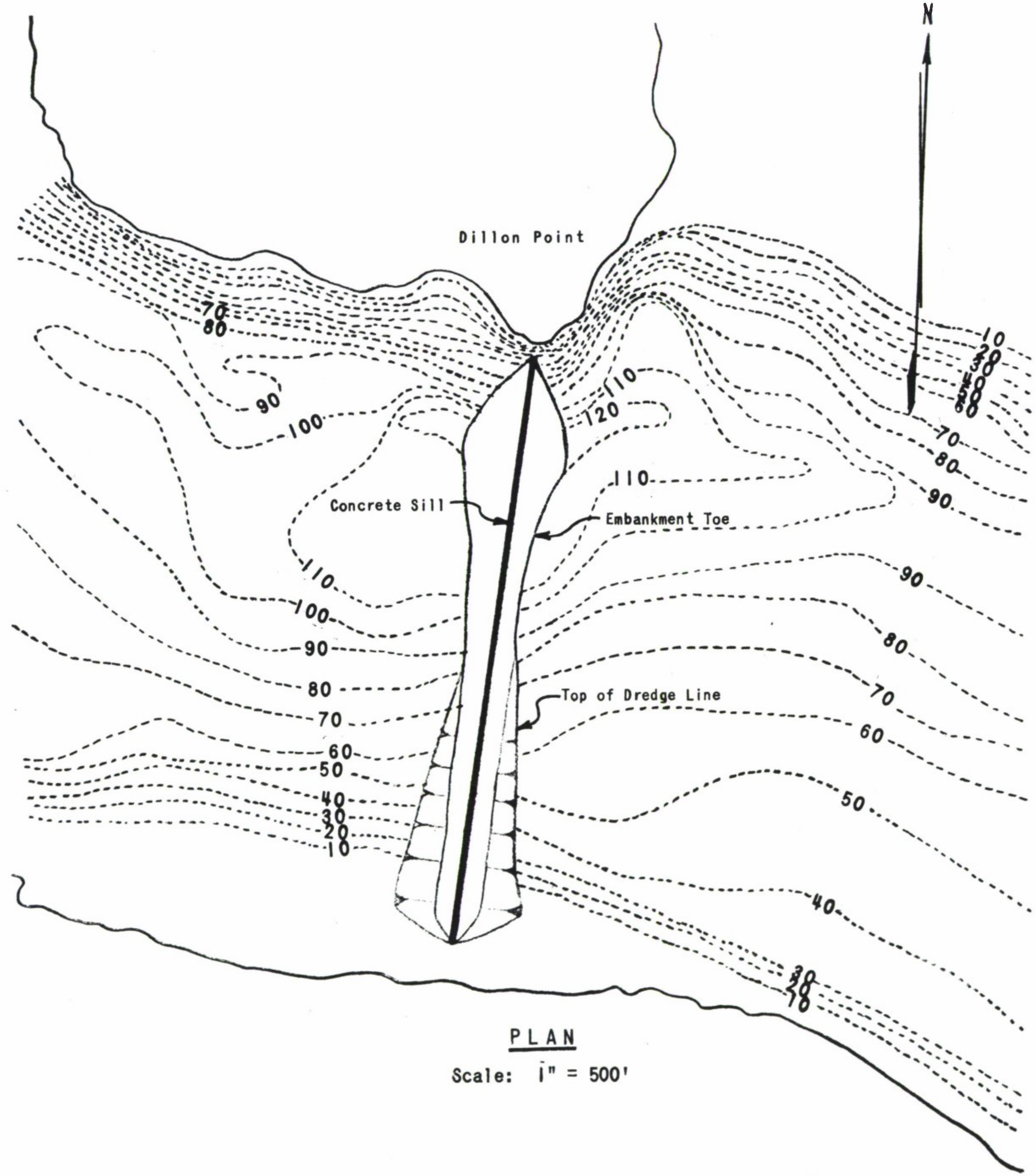
SACRAMENTO RIVER DEEP WATER SHIP CHANNEL, CALIFORNIA

SELECTED PLAN
ALIGNMENT, TYPICAL SECTIONS AND PROPOSED DISPOSAL AREAS

SACRAMENTO DISTRICT, CORPS OF ENGINEERS

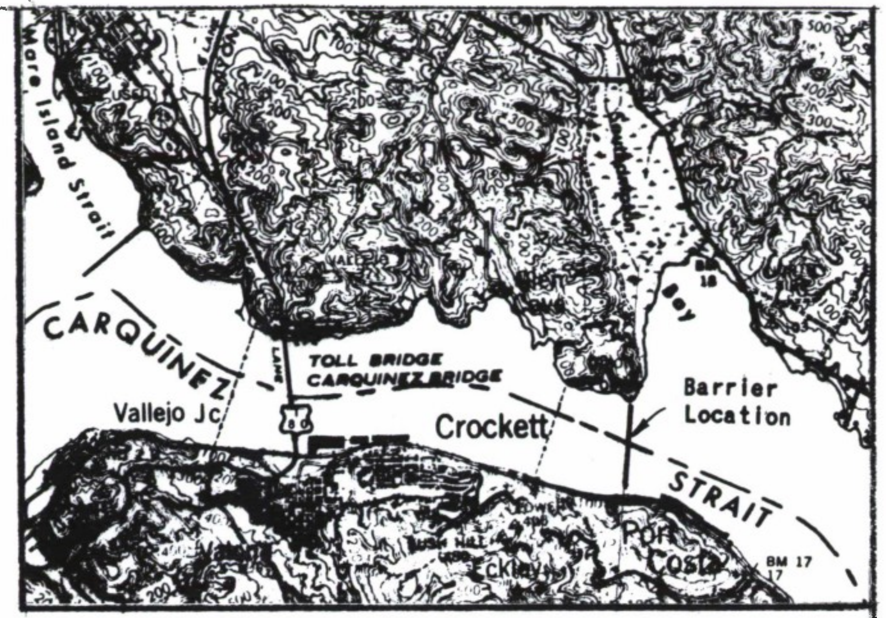
SEP 1979
L.K.R.

PLATE E-5



PLAN

Scale: 1" = 500'



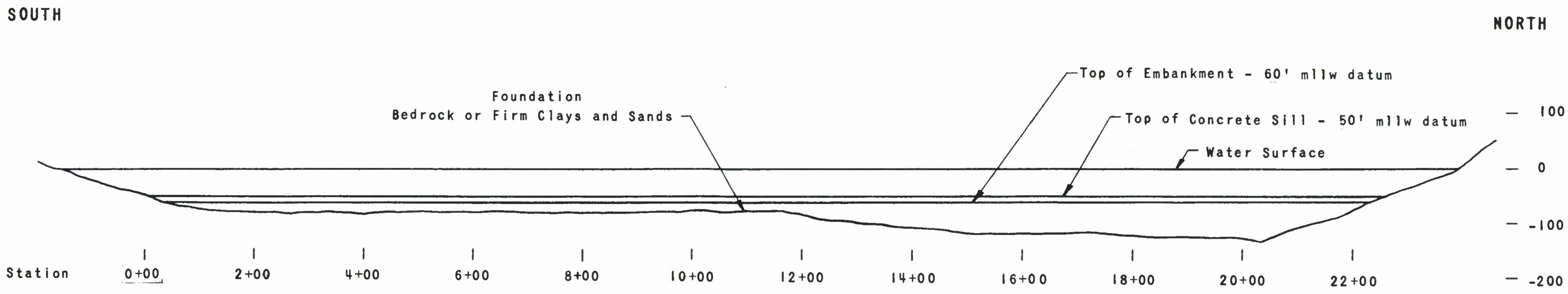
VICINITY MAP

BASIS OF DESIGN
SACRAMENTO DEEP WATER SHIP CHANNEL
CALIFORNIA

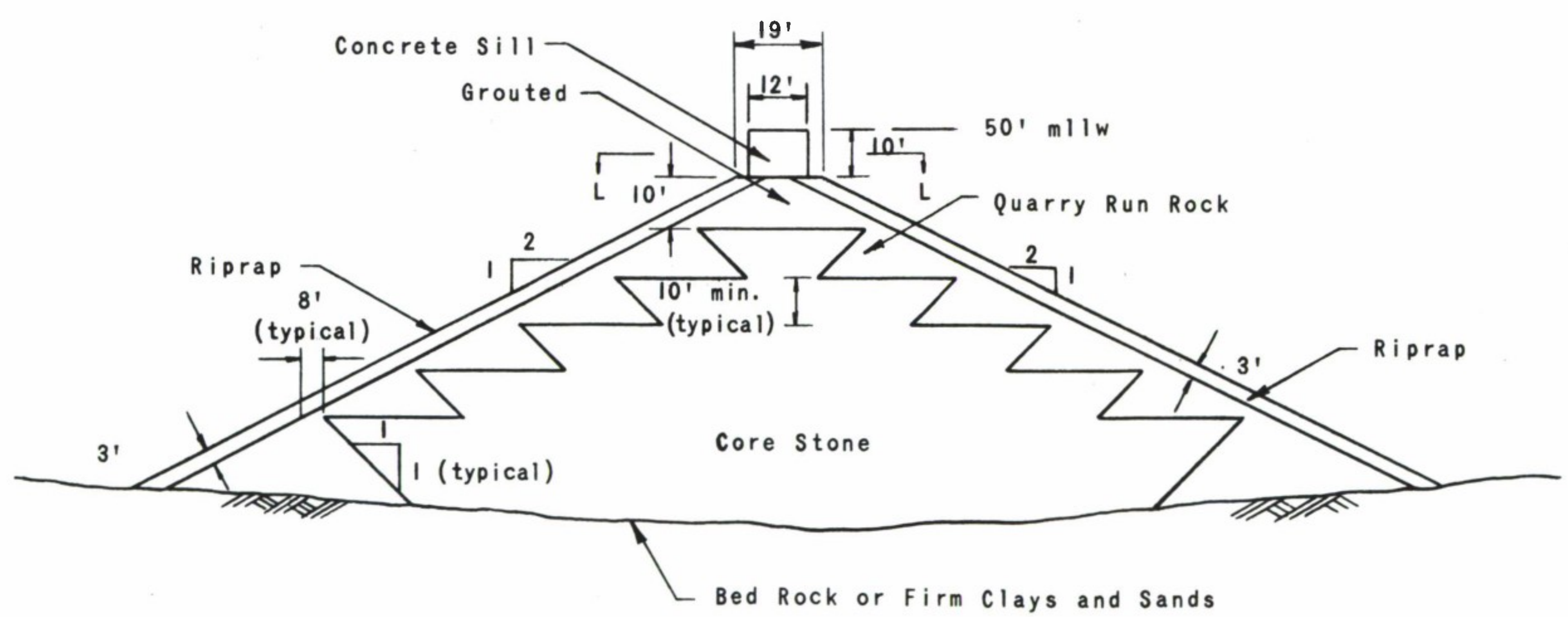
DILLON POINT BARRIER
PLAN

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

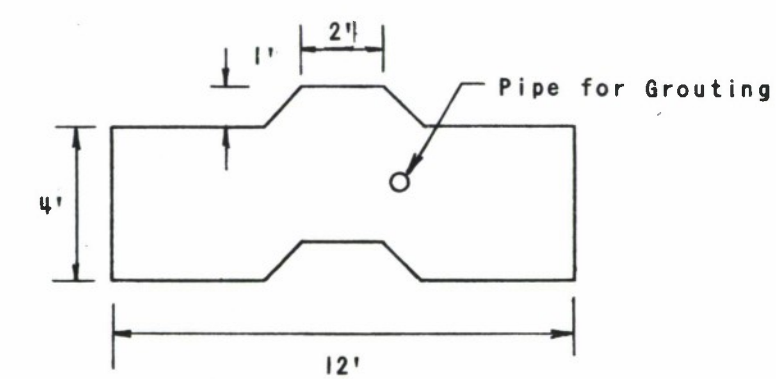
PLATE E-6



PROFILE
Scale: 1" = 200'



TYPICAL SECTION
Scale: 1" = 40'



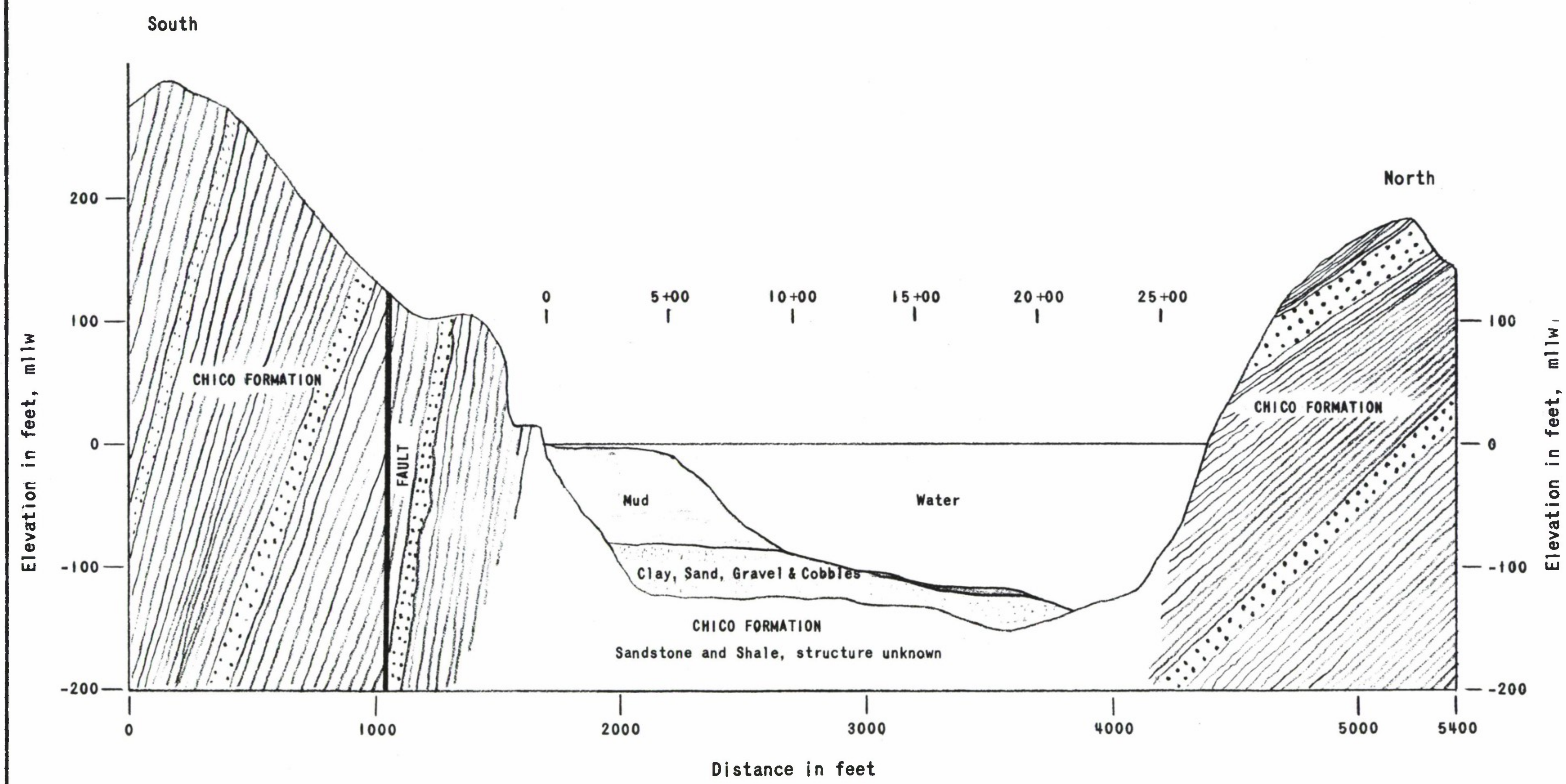
SECTION L-L
CONCRETE SILL
Scale: 1" = 40'

BASIS OF DESIGN
SACRAMENTO DEEP WATER SHIP CHANNEL
CALIFORNIA

PROFILE AND TYPICAL SECTION

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

PLATE E-7



GEOLOGIC CROSS-SECTION

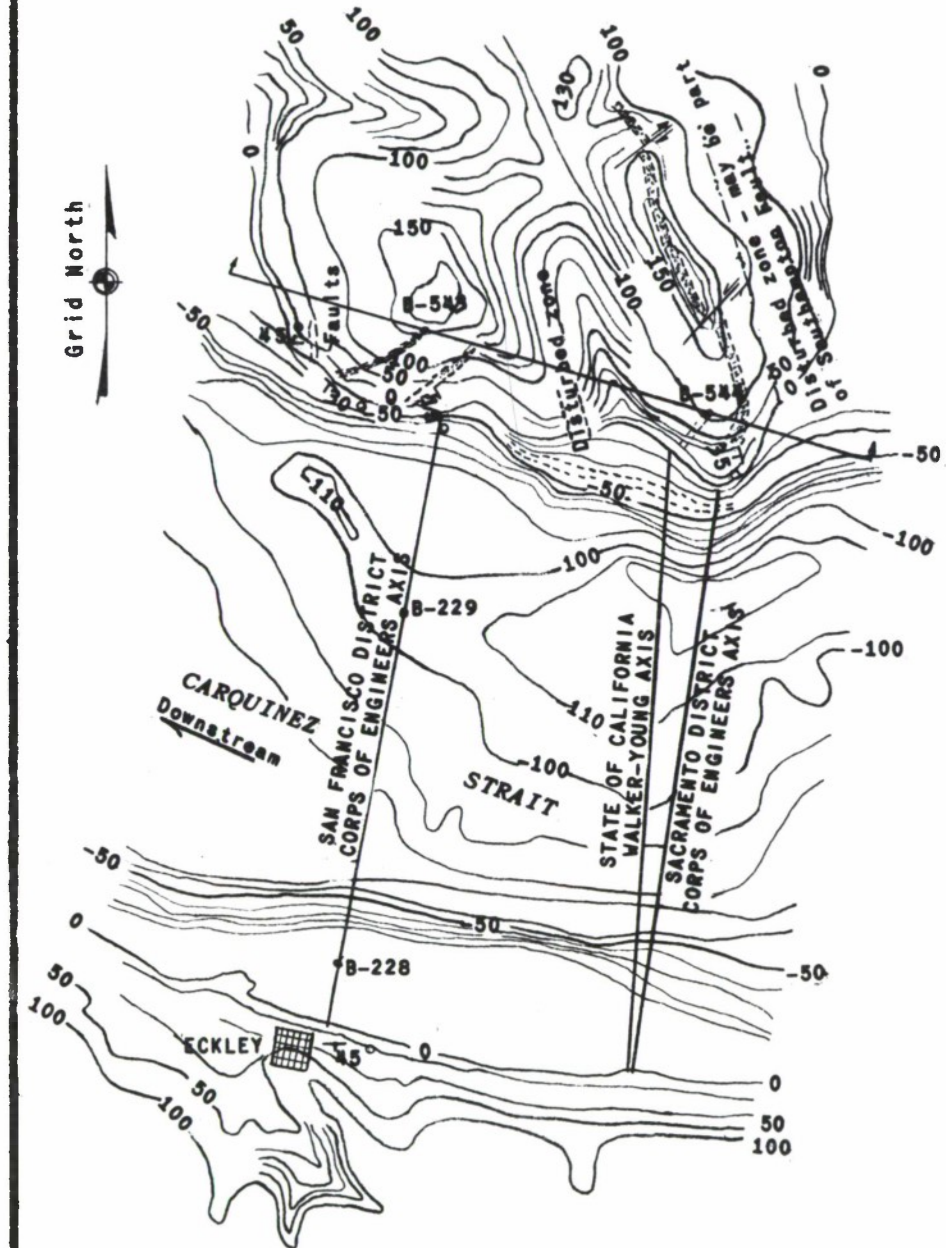
Boring data from
California DWR - 1929.

BASIS OF DESIGN
SACRAMENTO DEEP WATER SHIP CHANNEL
CALIFORNIA

GEOLOGIC CROSS-SECTION

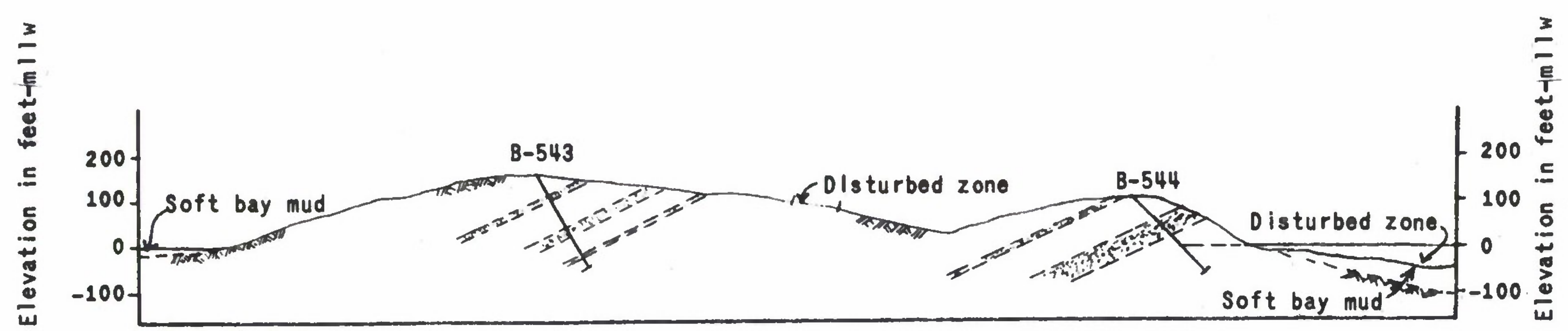
U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

PLATE E-8



GEOLOGIC MAP

400 0 400 800
Scale in feet



CROSS-SECTION I-I

200 0 200 400
Scale in feet

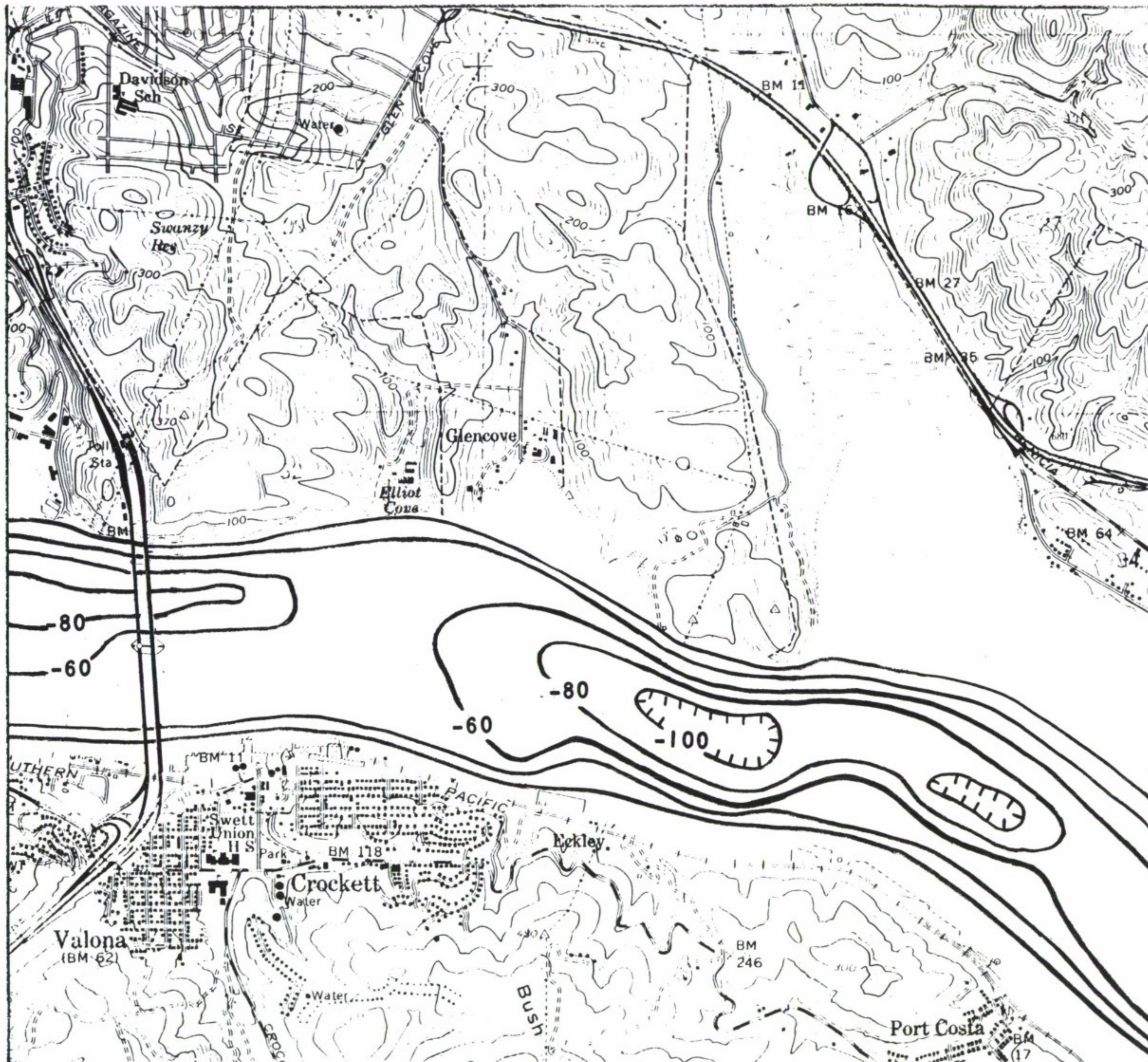
	CLAYEY SHALE,	varies from soft to hard, frequently banded, finer-grained shale is called mudstone, containes sandstone beds from 1 to 24 inches thick, weathers to 1/4 to 1/2 inch cubes, generally strikes N20°W, dips 30°SW.
	SANDSTONE,	hard, generally massive, occasionally has shaley structure, beds from 2 to 50 feet thick, same attitude as the shale.
•	B-228	Exploratory borings, see Plate E-14 for logs.
	45°	Strike and Dip symbol.
		Fault showing relative displacement.

Boring data from San Francisco District, Corps of Engineers, 1958.

BASIS OF DESIGN
SACRAMENTO DEEP WATER SHIP CHANNEL
CALIFORNIA

GEOLOGIC MAP
AND CROSS-SECTION

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT



'As per San Francisco District 1958 Report.

Scale: 1" = 2000'

LEGEND:

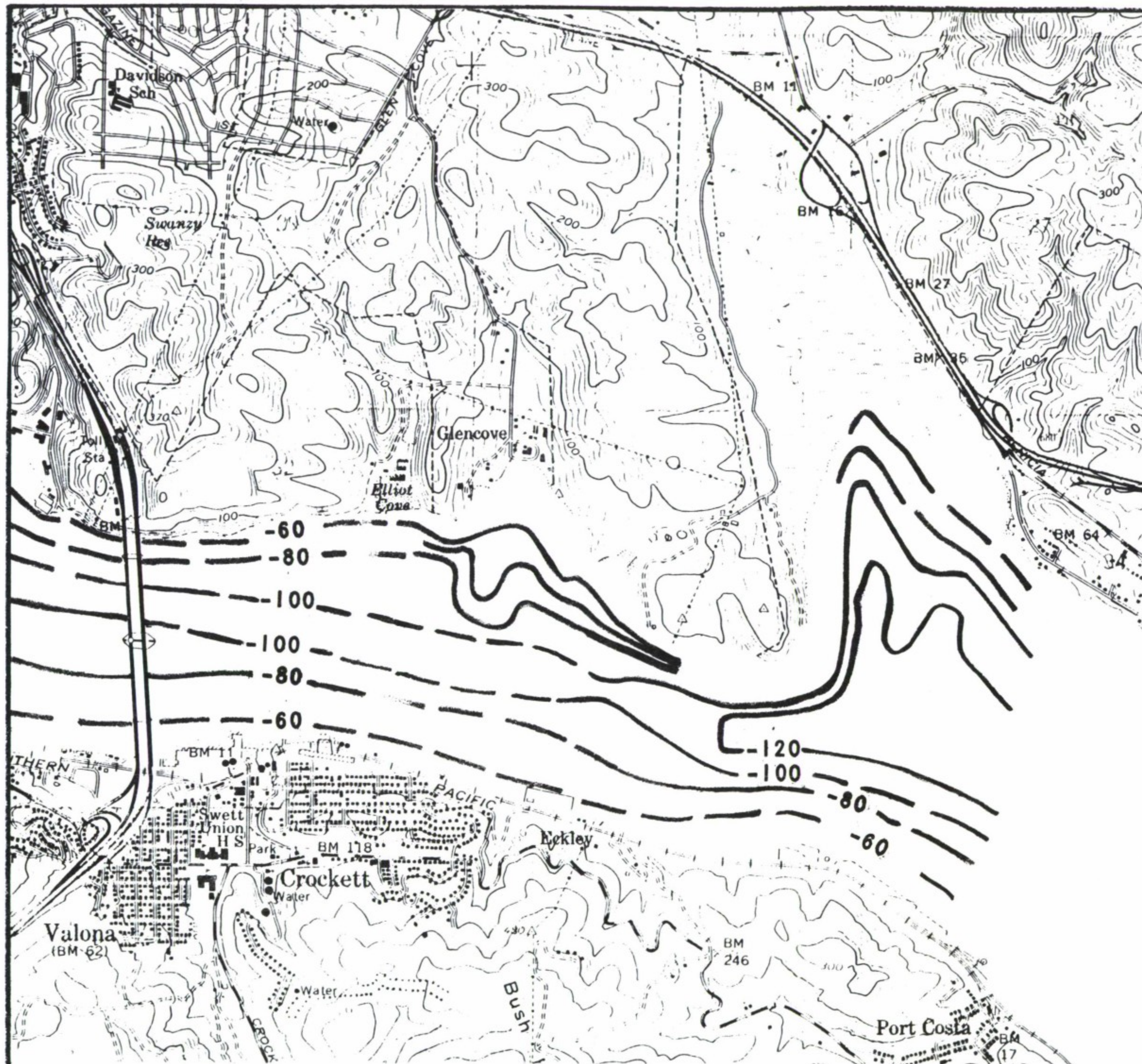
— -60 — 20-Foot Contours Controlled by Explorations.

BASIS OF DESIGN
SACRAMENTO DEEP WATER SHIP CHANNEL
CALIFORNIA

CONTOURS - TOP
OF SOFT BAY MUD

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

PLATE E-10



As per San Francisco District 1958 Report.

Scale: 1" = 2000'

LEGEND:

— -60 — 20-Foot Contours, Controlled by Explorations.

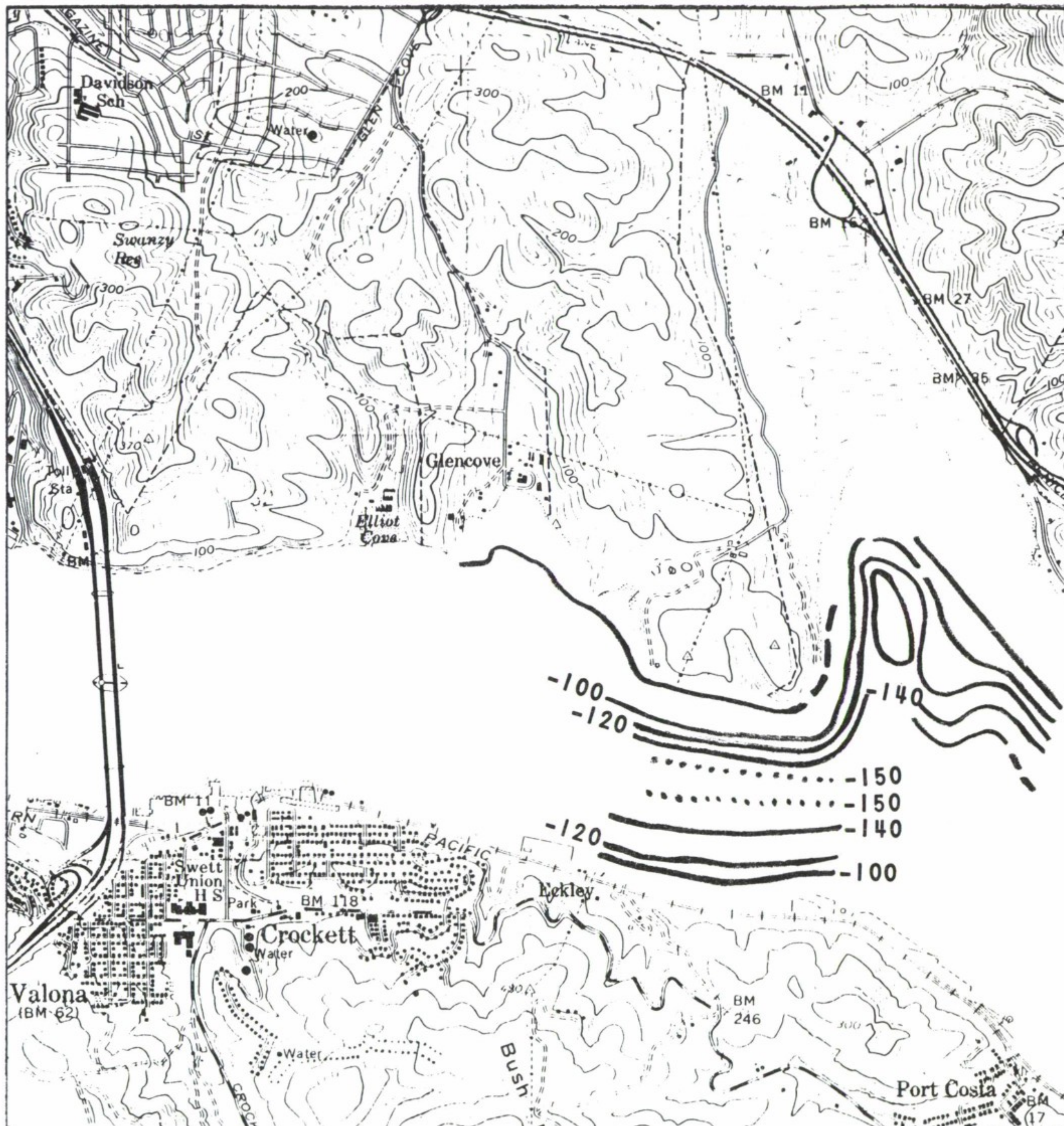
– – -80 – – 20-Foot Contours, Interpolated between Explorations.

BASIS OF DESIGN
SACRAMENTO DEEP WATER SHIP CHANNEL
CALIFORNIA

CONTOURS - TOP OF FIRM CLAYS & SANDS

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

PLATE E-11



LEGEND:

— -60 — 20-Foot Contours, Controlled by Explorations.

– – -80 – – 20-Foot Contours, Interpolated between Explorations.

• • • -50 • • • Intermediate Contours, Controlled by Explorations.

As per San Francisco District 1958 Report.

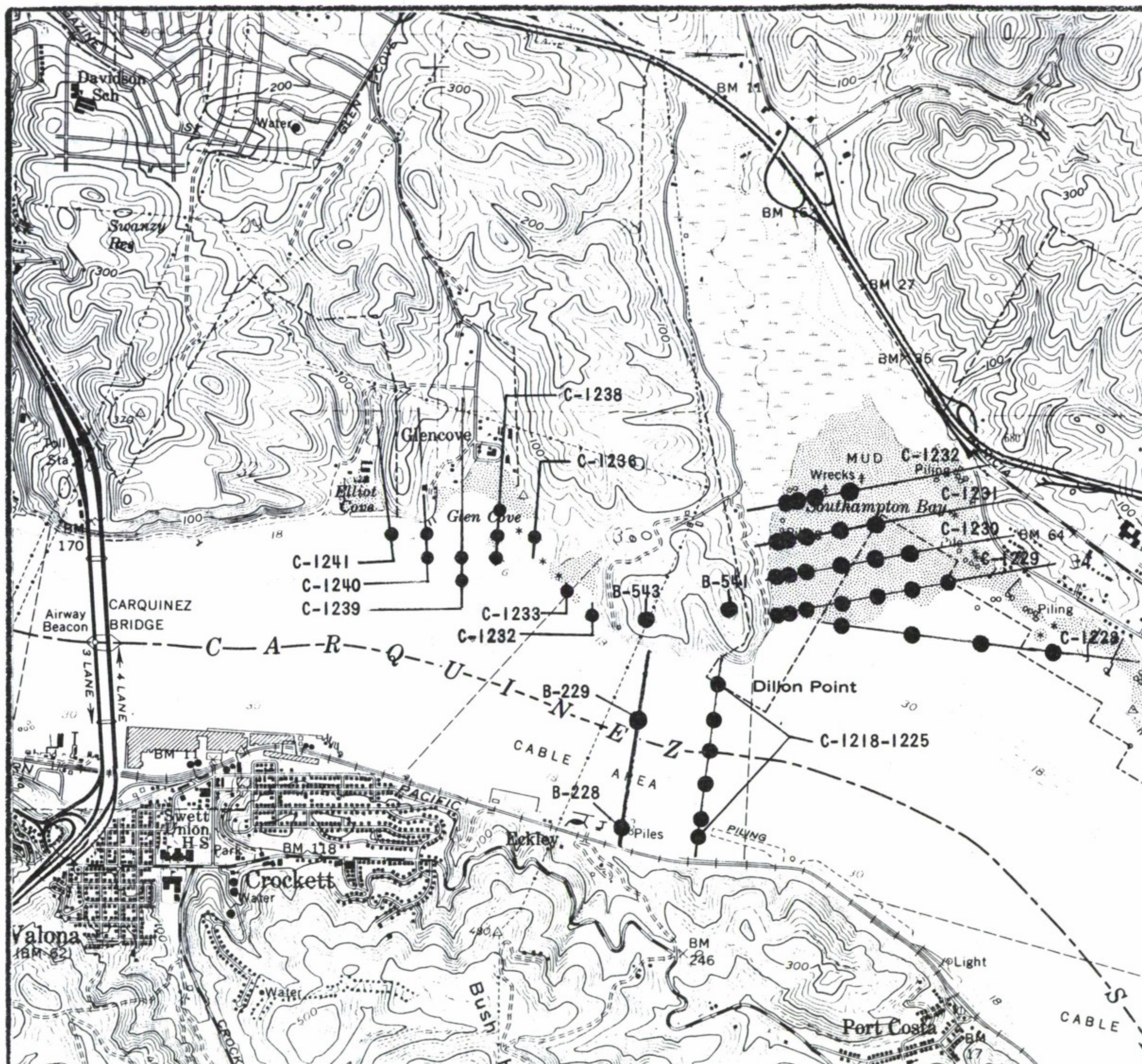
Scale: 1" = 2000'

BASIS OF DESIGN
SACRAMENTO DEEP WATER SHIP CHANNEL
CALIFORNIA

CONTOURS - TOP OF BEDROCK

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

PLATE E-12



As per San Francisco District 1958 Report.

Scale: 1" = 2000'

LEGEND:

● Exploration Boring.

B-228 Boring Designation Letter - Prefix Represents Agency that Drilled the Boring; Number Represents Code Number of Boring.

AGENCY CODE:

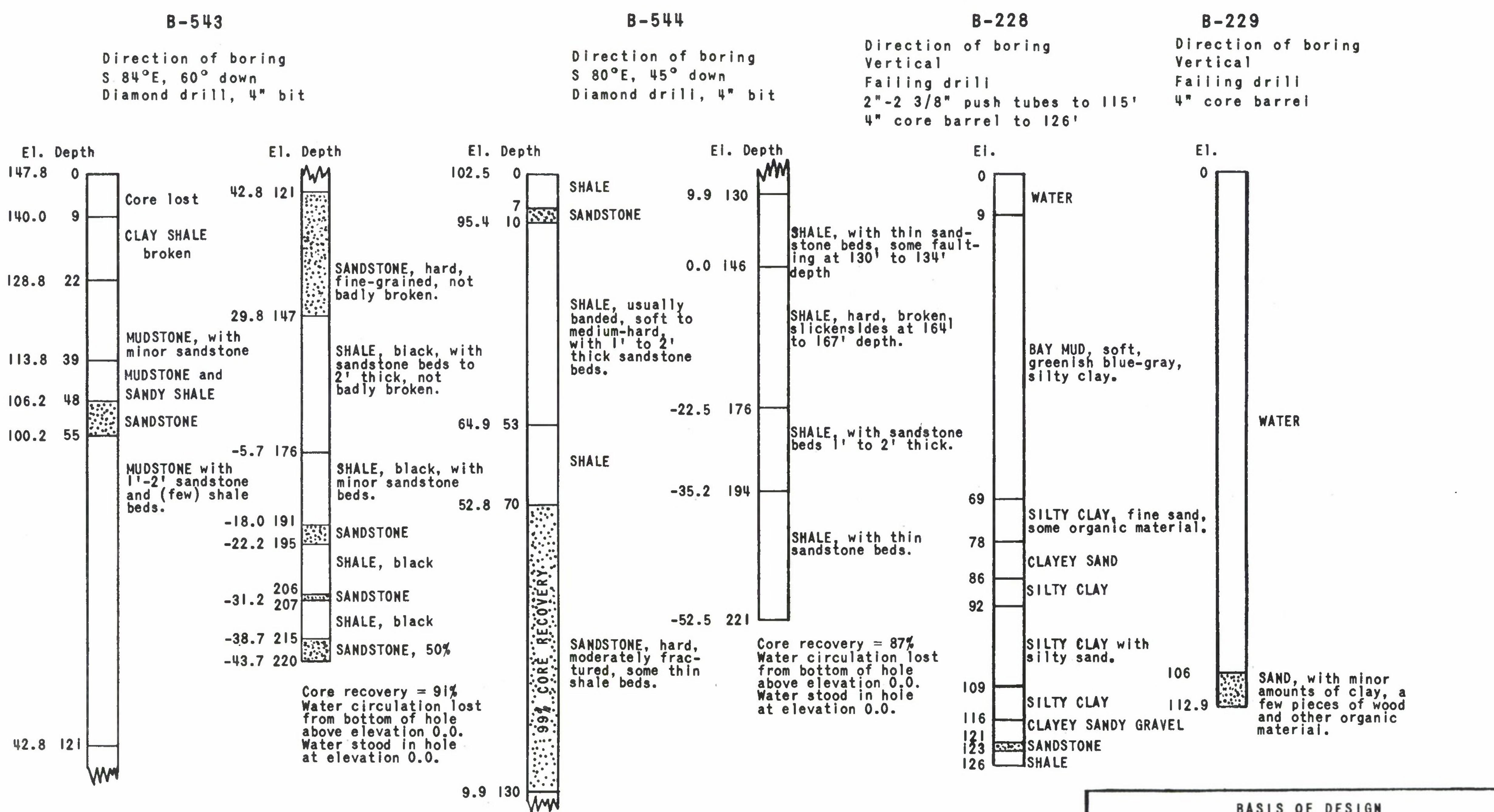
B - Corps of Engineers, San Francisco District.

C - State of California.

BASIS OF DESIGN
SACRAMENTO DEEP WATER SHIP CHANNEL
CALIFORNIA

LOCATION OF EXPLORATIONS

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT



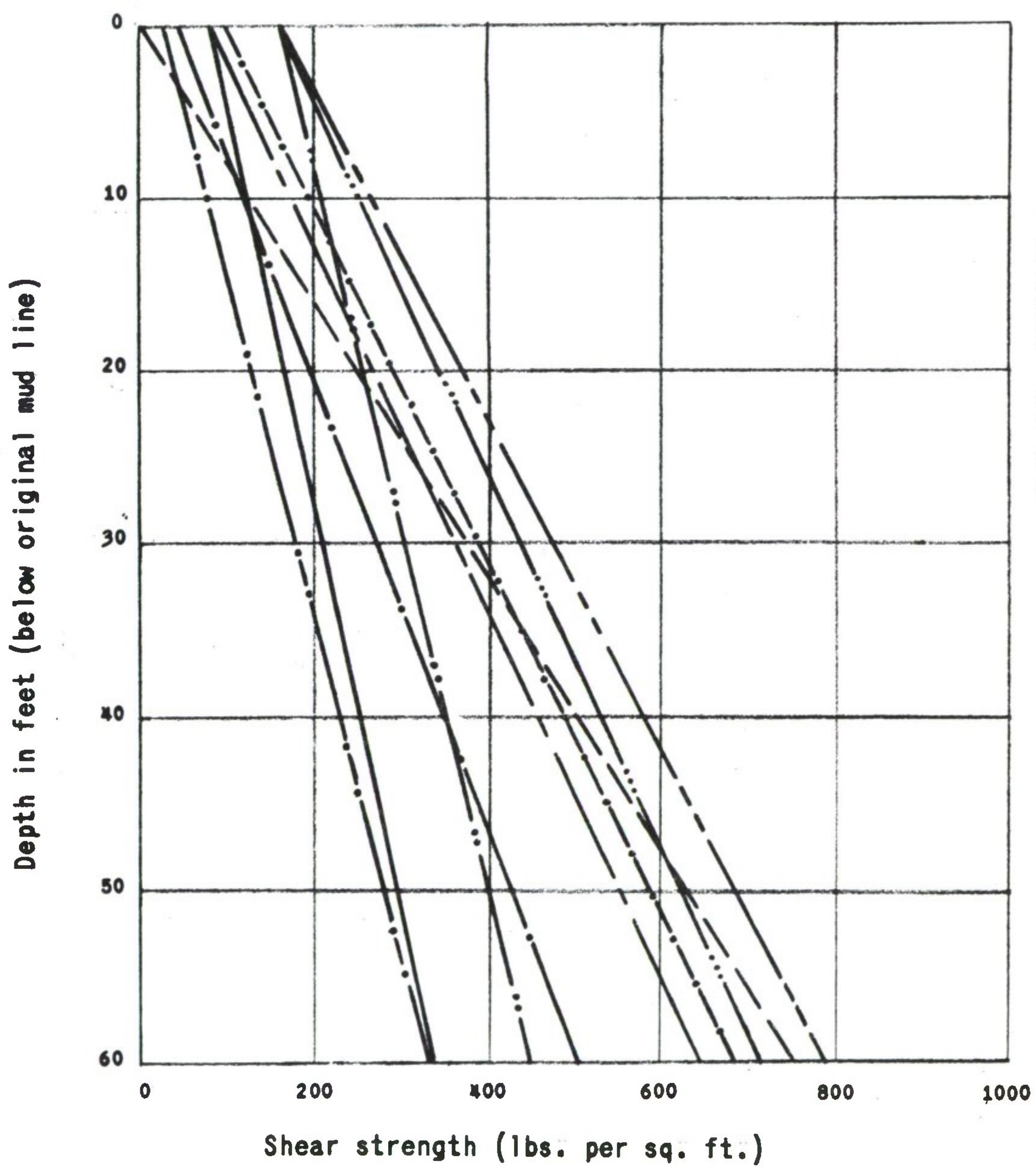
Boring data from San Francisco District Corps of Engineers, 1958.

For location of borings, see Plate 8.

BASIS OF DESIGN
SACRAMENTO DEEP WATER SHIP CHANNEL
CALIFORNIA

LOGS OF BORINGS

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT



1 M and R, Design value, Candlestick Cove, 1952 Study, C = 25 + 5D
2 C of E, Adopted design value, C = 80 + 4.3D
3 C of E, Average of triaxial shear tests, C = 80 + 9.25D
4 M and R, Average value, Candlestick Cove, C = 12.5D
5 Average strength - M and R tests, Holes 21E and 28E, Candlestick Cove, C = 40 + 8.4D
6 Design value for San Francisco Airport, C = 160 +10.4D
7 Design value used in North San Pablo Bay, C = 160 + 9.0D
8 Design value, Richardson Bay at Waldo, C = 160 + 4.8D
9 M and R, average strength deep hole, C = 100 + 9.75D

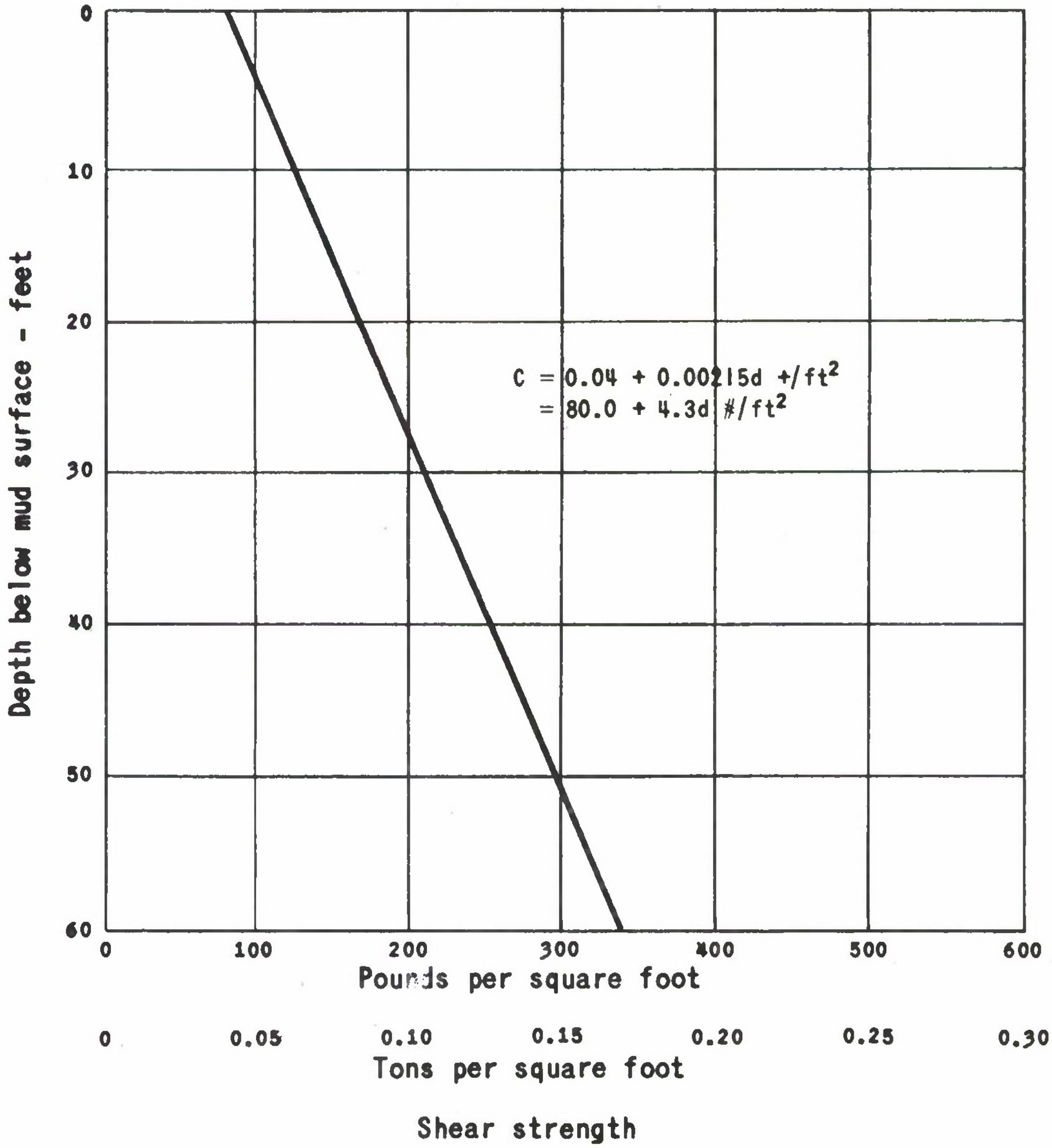
NOTES:

1. C = Strength in pounds per square foot.
2. D = Depth below original mud line.
3. M and R = State Division of Highways, Materials and Research Department.
4. C of E = Corps of Engineers, San Francisco District.
5. All values based on undisturbed strength. 1 and 2 based on minimum test values. 3, 4, 5 and 9 based on average values. Bases for 6, 7 and 8 are unknown.

BASIS OF DESIGN
SACRAMENTO DEEP WATER SHIP CHANNEL
CALIFORNIA

COMPARISON OF
BAY MUD STRENGTHS

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

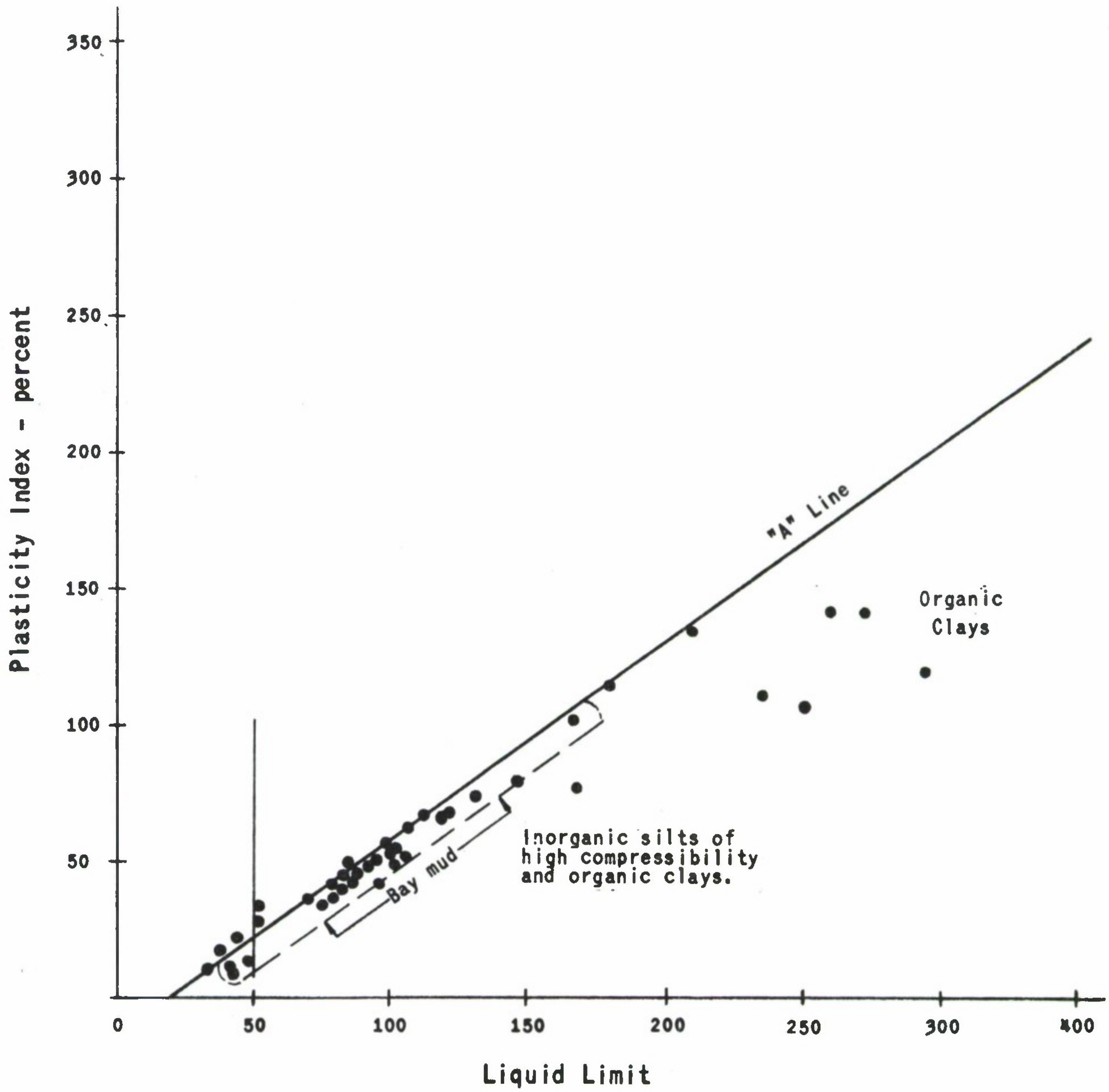


From San Francisco District

BASIS OF DESIGN
SACRAMENTO DEEP WATER SHIP CHANNEL
CALIFORNIA

DESIGN SHEAR STRENGTH
SOFT BAY MUD

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

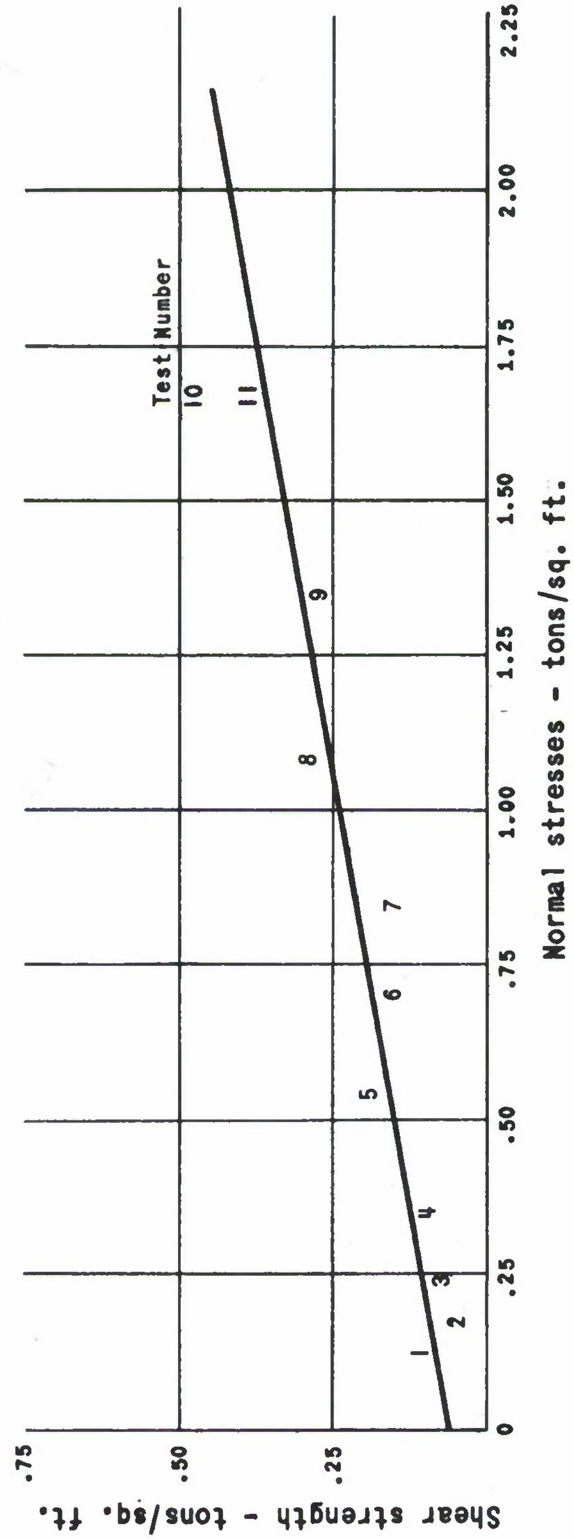


From San Francisco District.

BASIS OF DESIGN
SACRAMENTO DEEP WATER SHIP CHANNEL
CALIFORNIA

PLASTICITY CHART

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT



MOHR CIRCLE STRENGTH ENVELOPE
FOR BAY MUD

NOTES:

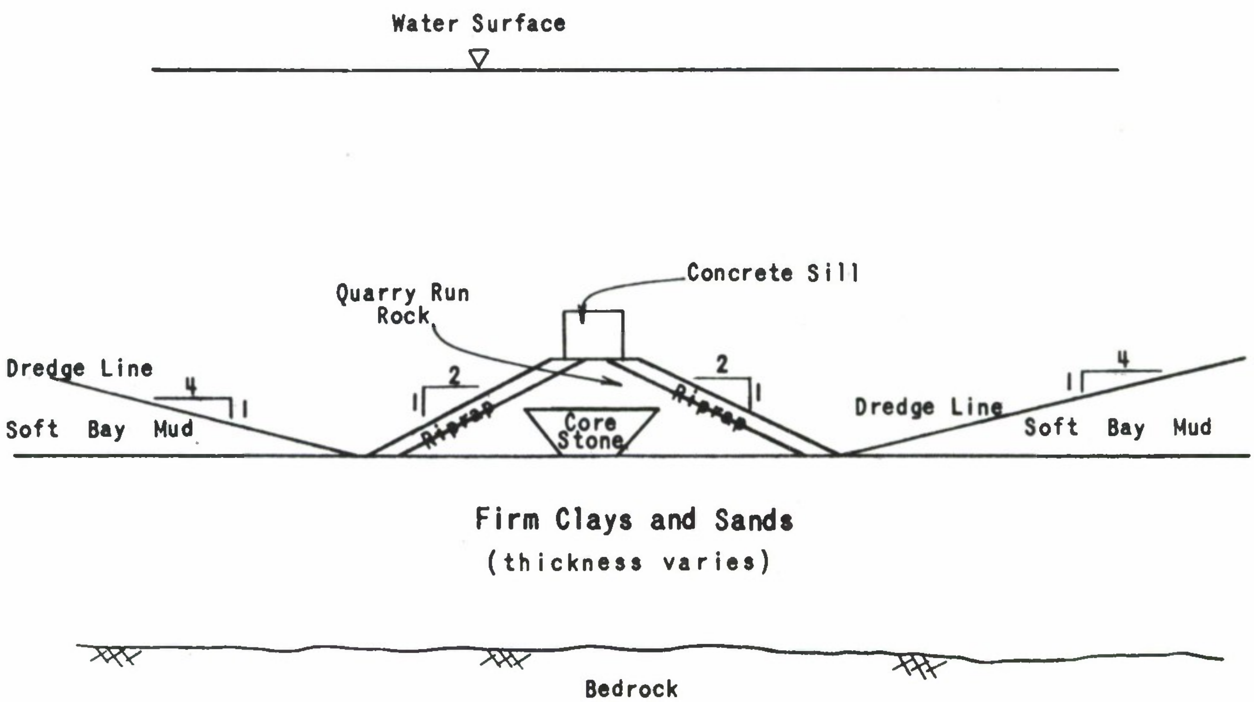
1. Triaxial shear Q tests for boring B-228.
2. Normal stress equal to overburden load on existing soil.

From San Francisco District

BASIS OF DESIGN
SACRAMENTO DEEP WATER SHIP CHANNEL
CALIFORNIA

MOHR STRENGTH ENVELOPE
FOR BAY MUD

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT



Scale: 1" = 40'

BASIS OF DESIGN
SACRAMENTO DEEP WATER SHIP CHANNEL
CALIFORNIA

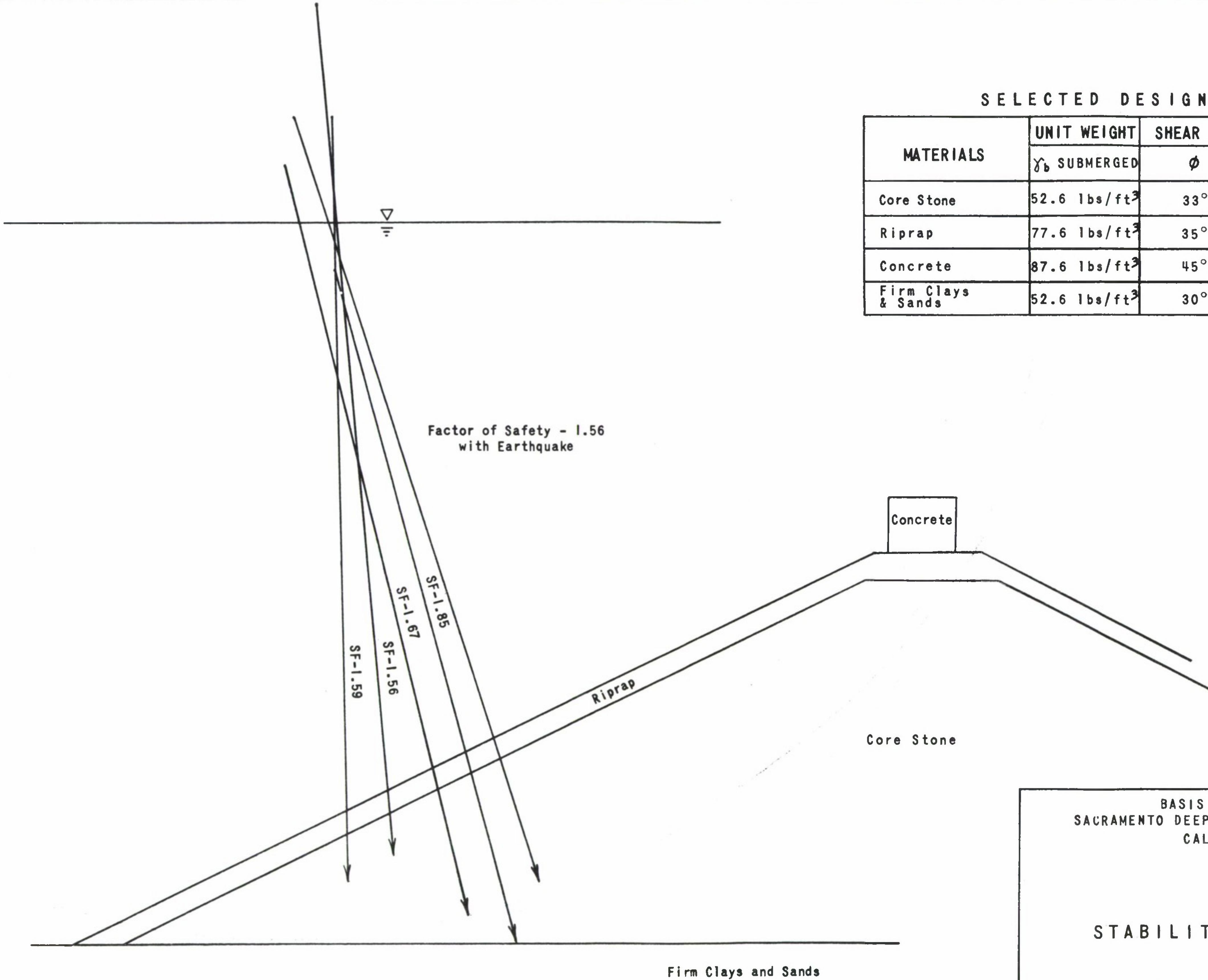
TYPICAL DREDGE AREA SECTION

STATION 0+00 TO 13+00

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

SELECTED DESIGN DATA

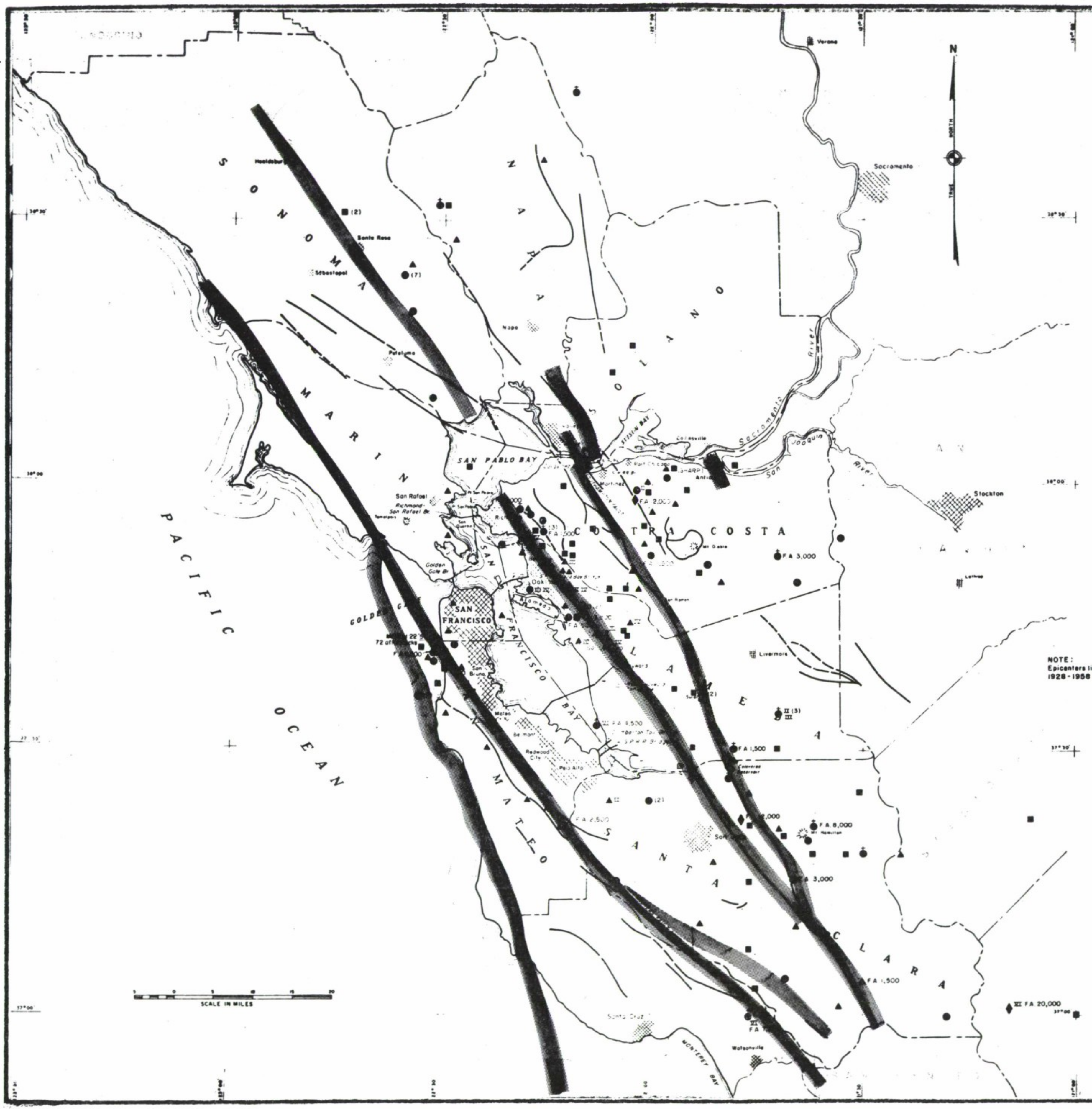
MATERIALS	UNIT WEIGHT	SHEAR STRENGTH VALUES	
	γ_b SUBMERGED	ϕ	C
Core Stone	52.6 lbs/ft^3	33°	0
Riprap	77.6 lbs/ft^3	35°	0
Concrete	87.6 lbs/ft^3	45°	3000 lbs/A^2
Firm Clays & Sands	52.6 lbs/ft^3	30°	0



BASIS OF DESIGN
SACRAMENTO DEEP WATER SHIP CHANNEL
CALIFORNIA

STABILITY ANALYSIS

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT



BASIS OF DESIGN
SACRAMENTO DEEP WATER SHIP CHANNEL
CALIFORNIA

FAULTS AND EPICENTERS
SAN FRANCISCO BAY AREA

U.S. ARMY CORPS OF ENGINEERS
SACRAMENTO DISTRICT

SECTION F

ECONOMICS OF THE SELECTED PLAN

SECTION F

ECONOMICS OF THE SELECTED PLAN

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SECTION F

ECONOMICS OF THE SELECTED PLAN

METHODOLOGY

1. Economic justification of the proposed works was established by comparing the equivalent average annual charges with the estimated equivalent average annual benefits which would be realized over the 50-year period of analysis. Annual charges include interest, amortization, operation and maintenance, and major replacement costs. Navigation benefits are based on the difference in waterborne transportation costs without and with the project. Recreation benefits were derived by applying a unit value to the increased recreation activities as a result of the project. Annual benefits and costs, referred to as the benefit-cost-ratio, were compared as a means of demonstrating the project feasibility by relating average annual benefits to average annual costs.

2. The value of benefits and costs at their time of accrual are made comparable by conversion to an equivalent time basis using an appropriate interest rate. An interest rate of 7⅛ percent applicable to public projects investigated in fiscal year 1980 was used in this report. The net effect of converting benefits and costs in this manner is to develop equivalent average annual values.

3. Estimated costs include the value of material and services used in initially constructing the project, converted into annual amortization and interest values, and estimated increased annual operation, maintenance, and replacement costs. Savings in transportation costs and recreation opportunities afforded by the project are the estimated benefits. Savings in transportation costs are based on waterborne transportation costs for preproject versus project conditions. Waterborne transportation costs are derived from vessel operating costs considering the size of vessel, lay time necessary for cargo operations, delay times, and travel time. Recreation benefits are derived by estimating the recreation opportunities created by the plan and applying a unit value to the increased recreation use. The methodology includes estimating the recreation needs of an area from population growth and participation in various recreation activities and comparing the projected needs with available opportunities to determine the type of project facilities that will aid in meeting the needs of the area.

4. Another consideration is maximizing net tangible benefits. This concept is aimed at including the optimum combination of project functions, the sizing of facilities, and development of the area to obtain the greatest excess of benefits over costs. The improvement which results in maximization of net benefits is the National Economic Development plan. Since maximization of net benefits does not reflect intangible values and considerations, an Environmental Quality plan is required in accordance with Principles and Standards to give comparable consideration to social, economic, and environmental effects.

Project Costs

First Cost

5. The estimated first cost for the selected plan is summarized in Table F-1. The cost is based on October 1979 price levels. The estimated cost of real estate is based on market value of lands as determined by the Real Estate Division of the Sacramento District from recent sales. The unit prices used for construction are based on plant, labor, material breakdown and adjustment of average bid prices received on comparable work. The cost of the salinity control structure was based on construction of a submerged sill in Carquinez Strait with a crest elevation at -50 feet mllw. A 20 percent contingency allowance was applied to all of the construction items. A 35 percent contingency allowance was used for real estate estimates due to the preliminary nature of these estimates. Estimates of cost for engineering and design and supervision and administration are based on cost experienced for similar work throughout the Nation, amounting to 15 percent. Detailed estimates of first cost are presented in Table F-3. Costs of a submerged sill in Carquinez Strait are included in both Table F-1 and F-3, even though, depending on results of a future salinity monitoring effort and model studies, construction of a sill may or may not be required.

Annual Cost

6. The estimate of annual cost for the selected plan is presented in Table F-2 and is based on 7⅛ percent interest rate and a 50-year amortization period. Interest during construction was added to the first cost when the construction period for a reach would require more than 2 years. Such interest was not added to the reaches between Avon and Collinsville-Montezuma Hills since each reach would require approximately 1 year to construct and benefits could accrue upon completion of the reach. Annual charges also include operation and maintenance costs and are based on costs experienced in the Sacramento District. Maintenance and operation costs for recreation facilities are estimated on a recreation day-use basis at the rate of $0.35 per recreation day. Periodic replacement of recreation facilities is considered to be a replacement chargeable to maintenance.

TABLE F-1
SACRAMENTO RIVER DEEP WATER SHIP CHANNEL
SUMMARY OF FIRST COSTS

ITEM	AVON TO NEW YORK SLOUGH (PITTSBURG)	NEW YORK SLOUGH (PITTSBURG) TO COLLINSVILLE-MONTEZUMA HILLS AREA	COLLINSVILLE-MONTEZUMA HILLS AREA TO SACRAMENTO
	FEDERAL COST ($)		
Channel Dredging and Disposal	5,300,000	6,480,000	37,100,000
Engineering and Design	350,000	400,000	2,400,000
Supervision and Administration	400,000	490,000	2,800,000
Subtotal	6,050,000	7,370,000	42,300,000
Salinity Control Structure**	—	8,100,000	—
Engineering and Design	—	500,000	—
Supervision and Administration	—	600,000	—
Subtotal	—	9,200,000	—
Recreation*	—	—	1,070,000
Engineering and Design	—	—	130,000
Supervision and Administration	—	—	100,000
Subtotal			1,300,000
Fish and Wildlife Facilities*	—	—	250,000
Engineering and Design	—	—	25,000
Supervision and Inspection	—	—	25,000
Subtotal			300,000
Navigation Aids	50,000	30,000	100,000
TOTAL (FEDERAL)	6,100,000	16,600,000	44,000,000
TOTAL FEDERAL FIRST COST: 66,700,000			
	NON-FEDERAL COST ($)		
Land and Damages			
Dredged Mat'l Disposal	1,610,000	370,000	3,100,000
Recreation Area*	—	—	50,000
Fish and Wildlife Facilities*	—	—	400,000
Subtotal	1,610,000	370,000	3,550,000
Retention Dikes	400,000	1,140,000	5,590,000

TABLE F-1 (Cont'd)

ITEM	AVON TO NEW YORK SLOUGH (PITTSBURG)	NEW YORK SLOUGH (PITTSBURG) TO COLLINSVILLE-MONTEZUMA HILLS AREA	COLLINSVILLE-MONTEZUMA HILLS AREA TO SACRAMENTO
Relocations	190,000	—	610,000
Engineering and Design	60,000	110,000	590,000
Supervision and Administration	40,000	80,000	460,000
TOTAL (NON-FEDERAL)	2,300,000	1,700,000	10,800,000
TOTAL COST	8,400,000	18,300,000	54,800,000

TOTAL PROJECT FIRST COST: 81,500,000

* See Sections G and H for description of cost-sharing apportionment.

** Salinity control structure is located downstream from Avon.

TABLE F-2
SACRAMENTO RIVER DEEP WATER SHIP CHANNEL
SUMMARY OF ANNUAL COSTS
(Dollars)

ITEM	AVON TO NEW YORK SLOUGH (PITTSBURG)	NEW YORK SLOUGH (PITTSBURG) TO COLLINSVILLE-MONTEZUMA HILLS AREA	COLLINSVILLE-MONTEZUMA HILLS AREA TO SACRAMENTO	TOTAL
	FEDERAL INVESTMENT COST			
First Cost*	5,680,000	15,685,000	40,894,000	62,259,000
Interest During Construction	—	—	7,285,000	7,285,000
Gross Investment	5,680,000	15,685,000	48,179,000	69,544,000
	ANNUAL COST			
Interest and Amortization	418,000	1,155,000	3,547,000	5,120,000
Operation and Maintenance				
Maintenance Dredging	291,000	—	—	291,000
TOTAL (FEDERAL)	709,000	1,155,000	3,547,000	5,411,000
	NON-FEDERAL INVESTMENT COST			
First Cost*	2,720,000	2,615,000	13,906,000	19,241,000
Interest During Construction	—	—	2,476,000	2,476,000
Gross Investment	2,720,000	2,615,000	16,382,000	21,717,000
	ANNUAL COST			
Interest and Amortization	200,000	192,000	1,205,000	1,597,000
Operation and Maintenance Recreation Facilities	—	—	55,000	55,000
Fish and Wildlife Facilities	—	—	negligible	—
TOTAL (NON-FEDERAL)	200,000	192,000	1,260,000	1,652,000
TOTAL PROJECT ANNUAL COST:	909,000	1,347,000	4,807,000	7,063,000

* First costs were adjusted in accordance with cost-sharing criteria for recreation and fish and wildlife facilities as described in Appendix 1 Section G. The adjusted first costs were also adjusted in accordance with the President's proposed cost-sharing criteria as described in Appendix 1 Section H.

TABLE F-3
SACRAMENTO DEEP WATER SHIP CHANNEL
DETAILED ESTIMATE OF FIRST COST
(October 1979 price level)

Cost Acct. No.	Item	Quantity	Unit	Unit Price ($)	Amount ($)
	AVON TO NEW YORK SLOUGH (PITTSBURG)				
	FEDERAL COST				
09.	CHANNELS				
	Excavation-dredging	3,300,000	cy	1.35	4,455,000
	Contingencies				845,000
	TOTAL CHANNELS				5,300,000
30.	ENGINEERING & DESIGN				350,000
31.	SUPERVISION & ADMINISTRATION				400,000
	FIRST COST (C of E)				6,050,000
	NAVIGATION AIDS (USCG)	1	job	LS	50,000
	TOTAL FEDERAL FIRST COST				6,100,000
	NON-FEDERAL COST				
	LANDS AND DAMAGES				
	Disposal Easement (2 yr)	1	job	LS	1,036,800
	Contingencies				363,200
	Acquisition Costs	1		LS	210,000
	TOTAL LANDS AND DAMAGES				1,610,000
	RETENTION DIKES (Non-Rec)	270,000	cy	1.10	(297,000)
	Spillways (4)	1	job	LS	(30,000)
	Subtotal				327,000
	Contingencies				73,000
	TOTAL RETENTION DIKES				400,000
	RELOCATIONS				
	Misc. Items	1	job	LS	160,000
	Contingencies				30,000
	TOTAL RELOCATIONS				190,000
	ENGINEERING & DESIGN				60,000
	SUPERVISION & ADMINISTRATION				40,000
	TOTAL NON-FEDERAL FIRST COST				2,300,000
	TOTAL FED. & NON-FED. COST, AVON TO NEW YORK SLOUGH (PITTSBURG)				8,400,000
	NEW YORK SLOUGH (PITTSBURG) TO COLLINSVILLE-MONTEZUMA HILLS AREA				
	FEDERAL COST				
09.	CHANNELS				
	Excavation (dredging)	4,500,000	cy	1.20	5,400,000
	Contingencies				1,080,000

TABLE F-3 (Cont'd)

Cost Acct. No.	Item	Quantity	Unit	Unit Price ($)	Amount ($)
	TOTAL CHANNELS				6,480,000
30.	ENGINEERING & DESIGN				400,000
31.	SUPERVISION & ADMINISTRATION				490,000
	Navigation Aids (USCG)	1	job	LS	30,000
	TOTAL FEDERAL FIRST COST				7,400,000
	SALINITY CONTROL STRUCTURE				
09.	CHANNELS				
	Excavation	700,000	cy	1.40	980,000
	Graded Riprap	80,000	ton	14.00	1,120,000
	Random Rock	300,000	ton	6.00	1,800,000
	Quarry Run Rock	250,000	ton	7.50	1,875,000
	Prefab. Concrete Sill Block	600	ea	1600.00	960,000
	Subtotal				6,735,000
	Contingencies				1,365,000
	TOTAL CHANNELS				8,100,000
30.	ENGINEERING & DESIGN				500,000
31.	SUPERVISION & ADMINISTRATION				600,000
	TOTAL FEDERAL FIRST COST (SALINITY CONTROL STRUCTURE)				9,200,000
	TOTAL FEDERAL FIRST COST				16,600,000
	NON-FEDERAL COST				
	LANDS & DAMAGES				
	Disposal Easements	1	job	LS	238,500
	Contingencies				81,500
	Acquisition				50,000
	TOTAL LANDS & DAMAGES				370,000
	RETENTION DIKES				
	Embankment	850,000	cy	1.10	935,000
	Spillways (3)	1	job	LS	23,000
	Contingencies				182,000
	TOTAL RETENTION DIKES				1,140,000
	ENGINEERING & DESIGN				110,000
	SUPERVISION & ADMINISTRATION				80,000
	TOTAL NON-FEDERAL COST				1,700,000
	TOTAL FEDERAL & NON-FEDERAL COST NEW YORK SLOUGH TO COLLINSVILLE-MONTEZUMA HILLS AREA				18,300,000

TABLE F-3 (Cont'd)

Cost Acct. No.	Item	Quantity	Unit	Unit Price ($)	Amount ($)
	COLLINSVILLE-MONTEZUMA HILLS AREA TO SACRAMENTO FEDERAL COST				
09.	CHANNELS				
	Excavation (dredging)	25,800,000	cy	1.20	30,960,000
	Contingencies				6,140,000
	TOTAL CHANNELS				37,100,000
30.	ENGINEERING & DESIGN				2,400,000
31.	SUPERVISION & ADMINISTRATION				2,800,000
	NAVIGATION AIDS (USCG)	1	job	LS	100,000
	TOTAL FEDERAL FIRST COST (NAVIGATION)				42,400,000
	NON-FEDERAL COSTS				
	LANDS AND DAMAGES				
	Disposal Easements	1	job	LS	1,989,900
	Contingencies				695,100
	Acquisition	1	job	LS	415,000
	TOTAL LANDS & DAMAGES				3,100,000
	RETENTION DIKES				
	Embankment	4,197,000	cy	1.10	4,616,700
	Spillways (11)	1	job	LS	65,000
	Contingencies				908,300
	TOTAL RETENTION DIKES				5,590,000
	RELOCATIONS				
	2 — 26" 0.0 HP Gas Lines	1	job	LS	160,000
	2 — 12-¾" 0.0 HP Gas Lines	1	job	LS	140,000
	2 — 10-¾" 0.0 HP Gas Lines	1	job	LS	120,000
	4 — Submerged Cables	1	job	LS	90,000
	Contingencies				100,000
	TOTAL RELOCATIONS				610,000
	ENGINEERING & DESIGN				590,000
	SUPERVISION & ADMINISTRATION				460,000
	TOTAL NON-FEDERAL FIRST COST (NAVIGATION)				10,350,000
	TOTAL FEDERAL & NON-FEDERAL FIRST COST (NAVIGATION), COLLINSVILLE-MONTEZUMA HILLS AREA TO SACRAMENTO				52,750,000
	FEDERAL COSTS				
14.	RECREATION FACILITIES				
	SANDY BEACH RECREATION AREA				
	Road — paved, 2 lane	0.5	mi	174,000	87,000

TABLE F-3 (Cont'd)

Cost Acct. No.	Item	Quantity	Unit	Unit Price ($)	Amount ($)
	Road — paved, 1 lane	0.5	mi	140,000	70,000
	Parking — paved, auto	100	ea	300	30,000
	Parking — paved, car-trailer	50	ea	600	30,000
	Parking — paved, car-trailer for campground	40	ea	575	23,000
	Water Facilities	1	job	LS	22,000
	Restroom — 8 fixture flush w/change shelter	1	ea	75,000	75,000
	Restroom — 6 fixture flush w/showers	2	ea	55,000	110,000
	Holding tank dump station	2	ea	9,000	18,000
	Connection to municipal sewer	1	job	6,000	6,000
	Sewer force main	1	job	13,000	13,000
	Electrical facilities	1	job	LS	85,000
	Boat ramp — 2 lane	1,800	SY	55	99,000
	Boarding float (8' x 60')	1	ea	6,000	6,000
	Camp unit, auto access	40	ea	750	30,000
	Picnic unit	30	ea	750	22,500
	Swimming beach	5	ac	16,000	80,000
	Administration bldg. (400 SF)	1	ea	25,000	25,000
	Entrance station	1	ea	10,000	10,000
	Storage & maintenance bldg. (400 SF)	1	ea	23,000	23,000
	Service yard (1,800 SF)	1	ea	5,000	5,000
	Irrigated turf w/75% tree cover	1	ea	8,500	8,500
	General landscaping w/40% tree cover	1	ea	16,000	16,000
	Subtotal (Recreation Facilities)				894,000
	Contingencies				176,000
	TOTAL (RECREATION FACILITIES)				1,070,000
30.	ENGINEERING & DESIGN				130,000
31.	SUPERVISION & ADMINISTRATION				100,000
TOTAL FEDERAL FIRST COST SANDY BEACH RECREATION AREA					1,300,000

NON-FEDERAL COSTS

Cost Acct. No.	Item	Quantity	Unit	Unit Price ($)	Amount ($)
	SANDY BEACH RECREATION AREA				
	LANDS & DAMAGES				
	Fee Acquisition	1	job	LS	33,000
	Contingencies				12,000
	Acquisition				5,000
	TOTAL LANDS & DAMAGES				50,000
	TOTAL NON-FEDERAL COST FOR RECREATION				50,000
	TOTAL COST RECREATION FACILITIES				1,350,000

TABLE F-3 (Cont'd)

Cost Acct. No.	Item	Quantity	Unit	Unit Price ($)	Amount ($)
	FEDERAL COST				
06.	FISH AND WILDLIFE FACILITIES				
	Wetland Habitat	1	job	LS	193,300
	Upland Habitat	1	job	LS	11,700
	Subtotal				205,000
	Contingencies				45,000
	TOTAL (FISH AND WILDLIFE FACILITIES)				250,000
30.	ENGINEERING & DESIGN				25,000
31.	SUPERVISION & ADMINISTRATION				25,000
	TOTAL FEDERAL FIRST COST				300,000
	NON-FEDERAL COST				
	LANDS AND DAMAGES				
	Wetland Habitat	1	job	LS	63,000
	Upland Habitat	1	job	LS	157,000
	Subtotal				220,000
	Contingencies				105,000
	Acquisition	1	job	LS	75,000
	TOTAL LANDS AND DAMAGES				400,000
	TOTAL NON-FEDERAL COST FOR FISH AND WILDLIFE FACILITIES				400,000
	TOTAL COST FISH AND WILDLIFE FACILITIES				700,000

Vessel Transportation Costs

7. The section below presents data and information concerning vessel transportation costs which serve as a basis for establishing the navigation benefits. The analysis makes allowance for differences in operating costs of bulk carriers and tankers at sea and in port and also provides the methodology utilized in determining the ocean shipping costs per ton of cargo for various sizes of vessels at both existing and improved channel depths.

Hourly Operating Costs

8. Estimates of operating costs for representative bulk carriers and tankers were furnished by the Planning Division, Office of the Chief of Engineers. These estimates were prepared by the United States Maritime Administration from information obtained through conferences with ship operators and shipbuilders and from data contained in maritime publications. Basic cost units are vessel hourly operating costs, including components of interest and amortization of the vessel investment, crew wages, fuel, maintenance, repairs, stores, supplies, subsistence, insurance, profit, and miscellaneous expenses. Capital costs were based on vessel deliveries in 1979. Construction differential subsidies were not taken into consideration with regard to U.S. flag vessels. Operating costs were estimated based on information in effect on 1 January 1979. However, fuel cost estimates were updated by the Sacramento District using the posted price for bunker oil on the west coast on 1 January 1980 ($128/ton). These fuel prices are now in a period of rapid increase. The annual operating season for all vessels is assumed to be 350 days, with a 15-day outage for repairs and inspections. Fuel costs were based on estimated consumption rates both at sea and in port for auxiliaries, heating, lighting, and cooling as well as the main engines. Tables F-4 and F-5 present the hourly operating costs for various sizes of bulk carriers and tankers, respectively. Bulk carrier costs are limited to foreign flag vessels because very few U.S. flagships are presently operating in the world bulk trades due to the higher cost of United States shipbuilding and crew wages.[1]

[1] In March 1977, only 16 bulk carriers were operating in the privately owned United States merchant fleet.

TABLE F-4
Estimated Hourly Operating Costs of Oceangoing Tankers With Their Principal Characteristics
January 1980

DWT	Cost Per Hour At Sea	Cost Per Hour In Port	Length *(feet)*	Beam *(feet)*	Draft *(feet)*	Immersion Factor *(L.T./inch)*	Speed *(knots)*	Fuel Consumption *(bbls per day)* At Sea	Fuel Consumption *(bbls per day)* In Port
U.S. Flag									
20,000	$1,093	$ 942	529	77	32′ 0″	80.4	15.5	237	50
25,000	$1,217	$ 977	562	82	32′ 0″	92.4	16.0	372	74
37,000	$1,247	$1,007	711	84	32′ 6″	118.0	16.0	372	74
50,000	$1,359	$1,096	677	96	39′ 6″	130.0	16.0	406	80
Foreign Flag									
20,000	$ 605	$ 452	529	77	32′ 0″	80.4	15.5	240	50
25,000	$ 695	$ 477	562	82	32′ 0″	92.4	15.6	340	70
37,000	$ 684	$ 486	605	92	36′ 0″	109.0	15.5	305	60
50,000	$ 822	$ 564	680	106	41′ 6″	147.0	16.0	400	80

TABLE F-5
Estimated Hourly Operating Costs of Foreign Flag Dry Bulk Vessels With Their Principal Characteristics
January 1980

Item	Vessel Size (DWT) 15,000	25,000	35,000	50,000	60,000	80,000
Cost per hour						
At sea	$584	$644	$693	$775	$857	$1,016
In port	$453	$473	$508	$567	$611	$ 702
Grain capacity (cubic feet)	675,000	1,200,000	1,450,000	2,300,000	2,500,000	3,300,000
Length (feet)	454.0	585.5	643.0	706.5	736.5	839.0
Beam (feet)	70.2	75.3	79.4	91.9	105.6	106.1
Draft (feet)	29.6	33.4	36.6	41.2	40.9	46.6
Immersion factor (long tons/inch)	62.2	87.0	105.0	130.5	157.5	180.0
Speed (knots)	14.5	15.0	15.0	15.0	15.4	15.5
Fuel consumption (bbls/day)						
At sea	187	242	263	295	345	435
In port	25	30	34	37	40	45

Unit Transportation Costs

9. For estimating navigation benefits that result from the proposed channel deepening, it was necessary to compute voyage transportation costs and the corresponding unit cargo costs for several sizes of vessels operating on the major trade routes. An example of the method used to determine these costs is presented below for a foreign-flag bulk carrier of 25,000 DWT transporting grain from the Port of Sacramento to Yokohama, Japan.

Vessel size	25,000 DWT
Distance, Port of Sacramento to Yokohama, Japan	4,617 nautical miles
Cruising time, 4,536 mi. at 15.0 knots and 81 mi. at 8.9 knots	311.5 hours
Cost at sea at $644 per hour	$200,600
Cost in port, 139 hours per trip at $473 per hour	$65,700
Cost per trip, including ballast cost (700 mi.)	$298,800[1]
Fully-loaded vessel draft, summer saltwater	33 feet 5 inches
Freshwater draft	34 feet 1 inch
Maximum cargo capacity, deadweight tonnage x 1.12 minus 500 tons for freshwater and stores	27,500 short tons
Fuel consumption	1.70 tons per hour
Fuel spaces:	
Running fuel, 1.70 tons per hr. x 311.5 hrs.	530 tons
Emergency fuel, 7 days steaming at full power	286 tons
Total fuel spaces	816 tons
Cargo capacity for this trip 27,500 tons — 816 tons for fuel	26,684 tons
Cost per cargo ton, fully-loaded: $298,800/26,684	$11.20
30-foot channel	
Vessel loaded to 29 feet 0 inches	
Average tidal delay to maintain a physical safe clearance under the keel of 3 feet (when measured from the static draft line)	11.5 hours
Tidal delay: $644 per hour x 11.5 hours	$7,400
Fully-loaded immersion factor	97.4 short tons/inch
Immersion factor light-loaded	95.1 short tons/inch

[1]The ballast "leg" of 700 miles to the Port of Sacramento for loading would take about 50.4 hours and cost $32,500.

Cargo required to be light-loaded
61 in. at 95.1 tons per inch .... 5,801 tons

Remaining vessel cargo
26,684-5,801.. 20,883 tons

Cost per cargo ton, light-loaded:
$287,000 + $7,400/20,883 .... $14.10
(includes 25-hr savings in port time)

Unit cargo costs for vessel topping-off at the Port of San Francisco

Cost per trip (Port of Sacramento-Port of San Francisco).................. $69,800

Cruising time, Port of San Francisco to Yokohama, Japan .... 303.4 hours

Cargo capacity:
27,505 — 802 .... 26,703 tons

Cost per trip, Port of San Francisco to Yokohama, Japan................... $253,200

Cost per cargo ton, Port of San Francisco to
Yokohama, Japan $253,200/26,703 .... $9.48

Delivered cost per cargo ton (Port of Sacramento cargo)
20,883 × $9.48 + $69,800/20,883 .... $12.82

35-foot channel

Vessel loaded to 33 feet 8 inches

Average tidal delay to maintain a physical safe clearance under the
keel of 3 feet (when measured from the static draft line) .... 7.8 hours

Tidal delay:
$644 per hour × 7.8 hours $5,000

Cargo required to be light-loaded
5 in. at 97.2 tons per inch .... 486 tons

Remaining vessel cargo
26,684-486 .... 26,198 tons

Cost per cargo ton, light-loaded:
$297,900 + $5,000/26,198 .... $11.56
(includes 2-hr. savings in port time)

10. With the existing 30-foot project channel, the vessel operator would partially fill the vessel at the Port of Sacramento and depart for the Islais Creek grain terminal at the Port of San Francisco to top-off the vessel. In order to maintain a physical safe clearance under the keel of 3 feet (when measured from the static draft line) for vessel squat, trim, and maneuverability, the vessel operator would need to wait an average of 11.5 hours for higher tides before departing Sacramento. The cost of transporting each ton of grain from the Port of Sacramento to Japan is therefore calculated at $12.82 per ton. If the project channel were deepened to 35 feet, the operator could load the vessel almost to capacity at the Port of Sacramento and would then cruise directly to Japan after waiting an average of 7.8 hours for higher tides at the Port. The unit transportation cost for this trip would be $11.56 per ton. The unit savings creditable to deepening the project channel to 35 feet is the difference between these two costs, or $1.26 per ton. Similar computations were made for different sizes and types of vessels, cargoes, and trade routes.

Estimates of Benefits

11. The following paragraphs present estimates of the navigation benefits that would be provided by deepening the Sacramento River Deep Water Ship Channel by an additional 5 feet in order to meet the present and anticipated future requirements for navigation improvements. The benefits are directly attributable to increased economic efficiency associated with deep-draft vessel transportation. Benefits for general recreation have also been established for purposes of this analysis. A thorough discussion of the basis for these benefit values will be presented subsequently. National economic development (NED) benefits from unemployed or underemployed labor resources during project construction have not been included in this analysis. No project features are located within areas having "substantial and persistent unemployment" as defined by the Economic Development Administration (EDA).

12. The navigation benefits were estimated for deepening the existing project channel to 35 feet below mean lower low water (mllw) from the mouth of New York Slough to the Port of Sacramento. This is a distance of approximately 40 nautical miles. The benefits are based on a 50-year project life and a 7⅛ percent rate of interest. The base year used in the analysis is 1987 since it is anticipated that the project could be completed by that time.

13. Benefits derived from the navigation improvements are reflected in transportation savings which result from (1) the movement of cargo via larger oceangoing vessels with their inherent economies of scale, (2) reduction in delays due to tides, (3) reduction of present light-loading practices, and (4) movement of project-induced tonnage. These transportation savings would accrue to companies shipping through the Port of Sacramento and to new industries which will locate adjacent to the channel in the future. In addition to these primary benefits, substantial regional beneficial effects would be realized by the surrounding area.

Transportation Benefits

14. The primary accomplishment of the selected plan is the savings in ocean transportation costs. These savings contribute to national economic development and are considered a project benefit. Most ocean vessels when fully loaded cannot negotiate the existing channel without incurring costly tidal delays, and many vessels sail with less than full cargo loads. This forces vessels to stop at other ports and "top-off" or sail light-loaded to their destination. Economies of scale savings from using larger vessels are lost if total cargo capacity of the vessels is not fully utilized. Whether the vessels top-off or sail light-loaded to their destination port, transportation costs are higher than if the vessel could fully load at one port.

15. Estimates of transportation savings for the proposed channel improvements were derived by comparing transportation costs for the prospective ocean commerce on the improved channel with transportation costs on the existing project channel. The first step in this procedure was to determine probable future changes in the composition of the vessel fleet over the life of the channel improvements and to estimate the share of prospective commerce that would be transported in each size of vessel at both existing and improved channel depths. The primary considerations in developing these estimates were length of the trade route, volume of annual movement, historic and projected trends in vessel construction, and the scale economies provided by the larger oceangoing carriers. Having determined the tonnage to be transported in each size of vessel, by individual commodity and time period, the next step was to compute total transportation costs. This was accomplished by applying the unit cargo costs at the different channel depths to the tonnage to be carried in each size of vessel. Transportation savings were then determined by comparing the total transportation costs on the improved channel with the transportation costs on the existing project channel. An example of this procedure is presented in the accompanying tabulations for potential movements of grain to East Asia from the Port of Sacramento.

16. The foregoing sample computation of navigation benefits is indicative of the approach utilized in this study in determining the average annual navigation benefits for deepening the Sacramento River Deep Water Ship Channel to 35 feet. The benefits expected from future industrialization along the channel were estimated using representative unit savings per ton computed for existing and proposed cargo movements by water-oriented industries on the channel. These unit savings per ton were multiplied by the projected tonnages in each future time frame and discounted over the life of the project. This procedure is illustrated in Table F-6 for industries which are expected to locate facilities in the vicinity of the Port of Sacramento in the future. The annual benefits for the Port of Sacramento and the Collinsville-Montezuma Hills area are summarized on Table F-7. The benefits of $1,464,300 and $2,463,900 shown in Table F-7 for future industrialization are related to new industries expected to locate along the channel in the future even if the channel is not deepened. Benefits to be derived from induced future industrialization are included in the benefit values for project-induced tonnage shown in Table F-7 and will be discussed in detail in subsequent paragraphs.

17. These benefit computations required a significant input of data, and a number of assumptions were necessary to determine the input data and develop the transportation savings. These basic assumptions and input data are as follows:

a. Shippers will alter the sizes of their vessel fleets if the channel is made deeper since the per ton-mile cost of moving cargo by water decreases substantially as the size of the vessel increases. This is due to the fact that the cost of operating a relatively small vessel is about the same as the cost of operating a large vessel.

b. The clearances considered necessary under the keel of deep-draft vessels for sinkage (or squat), trim, and maneuverability were 5 feet for tankers and 3 feet for dry bulk carriers (when measured from the static draft line). Another consideration was that the freshwater of the Delta affords less buoyancy than does sea water. As a result, vessels sink lower in the water than they do at sea or in the bay area. The additional freshwater loading allowance was computed at one-fourth of an inch per foot of summer draft.

SAMPLE COMPUTATION OF AVERAGE ANNUAL NAVIGATION BENEFITS
POTENTIAL MOVEMENTS OF GRAIN TO EAST ASIA

Transportation Costs on Existing 30-Foot Channel
(1987-2037)

	Unit	1987		1997		2007		2017		2027		2037	
DWT	Cost	Tonnage	Total Cost	Tonnage	Total Cost	Tonnage	Total Cost	Tonnage	Total Cost	Tonnage	Total Cost	Tonnage	Total Cost
15,000	$18.05	180,900	$3,265,200	205,800	$3,714,700	225,000	$4,061,300	235,200	$4,245,400	239,500	$ 4,323,000	241,100	$ 4,351,900
25,000	12.82	158,500	2,032,000	204,500	2,621,700	262,700	3,367,800	310,300	3,978,000	344,200	4,412,600	361,100	4,629,300
35,000	10.69	52,800	564,400	62,100	663,800	73,800	788,900	95,500	1,020,900	122,800	1,312,700	161,500	1,726,400
50,000	9.44	32,800	309,600	37,600	354,900	43,500	410,600	54,000	509,800	68,500	646,600	86,300	814,700
Total		425,000	$6,171,200	510,000	$7,355,100	605,000	$8,628,600	695,000	$9,754,100	775,000	$10,694,900	850,000	$11,522,300

SAMPLE COMPUTATION OF AVERAGE ANNUAL NAVIGATION BENEFITS
POTENTIAL MOVEMENTS OF GRAIN TO EAST ASIA

Transportation Costs on 35-Foot Channel
(1987-2037)

		1987		1997		2007		2017		2027		2037	
DWT	Unit Cost	Tonnage	Total Cost	Tonnage	Total Cost	Tonnage	Total Cost	Tonnage	Total Cost	Tonnage	Total Cost	Tonnage	Total Cost
15,000	$16.62	77,900	$1,294,700	77,900	$1,294,700	77,900	$1,294,700	77,900	$1,294,700	77,900	$1,294,700	77,900	$1,294,700
25,000	11.56	238,400	2,755,900	300,500	3,473,800	362,100	4,185,900	409,600	4,735,000	436,700	5,048,300	444,800	5,141,900
35,000	10.10	67,100	677,700	81,800	826,200	103,800	1,048,400	133,200	1,345,300	169,500	1,712,000	218,000	2,201,800
50,000	8.91	41,600	370,700	49,800	443,700	61,200	545,300	74,300	662,000	90,900	809,900	109,300	973,900
Total		425,000	$5,099,000	510,000	$6,038,400	605,000	$7,074,300	695,000	$8,037,000	775,000	$8,864,900	850,000	$9,612,300

SAMPLE COMPUTATION OF AVERAGE ANNUAL NAVIGATION BENEFITS
POTENTIAL MOVEMENTS OF GRAIN TO EAST ASIA

AVERAGE ANNUAL EQUIVALENT SAVINGS FOR 35-FOOT CHANNEL
(1987-2037)

YEAR	TOTAL COSTS 30-FOOT CHANNEL	TOTAL COSTS 35-FOOT CHANNEL	TOTAL SAVINGS	DECADAL DEFERRAL FACTORS	DEFERRED SAVINGS
1987	$ 6,171,200	$5,099,000	$1,072,200	.26027	$ 279,100
1997	7,355,100	6,038,400	1,316,700	.38452	506,300
2007	8,628,600	7,074,300	1,554,300	.19320	300,300
2017	9,754,100	8,037,000	1,717,100	.09707	166,700
2027	10,694,900	8,864,900	1,830,000	.04877	89,200
2037	11,522,300	9,612,300	1,910,000	.01617	30,900
					$1,372,500

TABLE F-6
COMPUTATION OF AVERAGE ANNUAL NAVIGATION BENEFITS
FUTURE INDUSTRIALIZATION IN THE VICINITY OF THE PORT OF SACRAMENTO

AVERAGE ANNUAL EQUIVALENT SAVINGS FOR 35-FOOT CHANNEL
(1987-2037)

YEAR	TONNAGE	TOTAL SAVINGS @ $1.35[1] PER TON	DECADAL DEFERRAL FACTORS	TOTAL DEFERRED SAVINGS
1987	680,000	$ 918,000	.26027	$ 238,900
1997	1,030,000	1,390,500	.38452	534,700
2007	1,275,000	1,721,300	.19320	332,600
2017	1,520,000	2,052,000	.09707	199,200
2027	1,760,000	2,376,000	.04877	115,900
2037	1,955,000	2,639,300	.01617	42,700
				$1,464,000

[1]Estimated savings per ton based on the unit savings computed for Union Oil's Chemical Division bulk fertilizer storage facilities.

TABLE F-7
Estimated Average Annual Navigation Benefits
For Deepening the Sacramento River
Deep Water Ship Channel to 35 Feet[1]

(Thousands of dollars)

Item	Average Annual Benefits
Port of Sacramento	
Rice	$ 1,510.4
Other grains and oilseeds	1,752.4
Logs	342.3
Wood chips	1,528.7
Fertilizers and fertilizer materials	1,608.5
Other bulk commodities	757.3
Future industrialization	1,464.0
Project-induced tonnage	1,488.2
Subtotal	$10,451.8
Collinsville-Montezuma Hills	
Future industrialization	$ 2,463.9
Project-induced tonnage	1,983.4
Subtotal	$ 4,447.3
TOTAL	$14,899.1

[1]Future benefits discounted at 7-⅛ percent interest.

c. Bunker fuel is taken at the end of each voyage "leg' sufficient for the voyage leg in prospect plus 7 days steaming at full power. The same assumption was made with regard to freshwater and stores. The consumption of freshwater and stores was estimated at 25 tons per day.

d. Favorable tides will be used to the maximum extent possible for vessel movements in the channel both with and without the project. Tidal delays were incorporated in all computations of unit cargo costs. The amount of vessel delay was computed from mean tide curves at the Port of Sacramento, Cache Slough, Rio Vista, Benicia and Pinole Shoals. These curves are shown on Chart F-1. Computations for tidal delays were based on the premise that if adequate depths were available, vessels would transit the channel in both directions in a random pattern; i.e., the same number of transits would occur in equal time intervals throughout a 24-hour day. Average delays for different classes of vessels were determined by computing the delays for all vessels of that class transiting the channel in one direction in a 24-hour period and averaging these delays. An example of this procedure is shown in the following tabulation.

Average Tidal Delay for an Outbound Vessel from Sacramento loaded to 33.7 feet on the Proposed 35-foot channel.[1]

Vessel Departure Time	% Vessels Departing	Average Delay (Hours)	% Delay (Hours)
0			
0 to 0.5 hrs. (Ave. 0.25) + 5.0 hrs. delay at Benicia	2.1	5.25	11.03
0.5			
5.5 to 7.8 (Ave. 6.65 hrs.)	9.6	6.65	63.84
2.8			
0 to 13.9 hrs (Ave. 6.95 hrs.)	57.9	6.95	402.41
16.7			
No Delay	0.8	0	0
16.9			
1.7 to 8.8 (Ave. 5.25 hrs.) + 5.0 hrs. at Benicia	29.6	10.25	303.40
24.0	100.0		780.68
	Average hours delay		7.8

[1]Based on a 3-foot keel clearance.

e. A ballast "leg" of 700 miles was included in the calculations of voyage transportation costs for certain bulk cargo shipments. This figure was obtained from a detailed examination of the shipping pattern of trade routes and port calls of vessels loading bulk commodities at the Port of Sacramento in 1976 and 1977. A further check with vessel chartering companies in San Francisco familiar with west coast bulk shipping confirmed the reasonableness of this figure. The principal exception to this was the round trip voyage transportation costs computed for wood chip movements since the wood chip vessels normally return empty to the west coast from Japan.

Benefits from Movement of Project-Induced Tonnages

18. Benefits would also be derived from the projected commodities that will move only if the channel is deepened (induced tonnages). The benefits are primarily savings in transportation costs attributable to induced grain shipments and future industrialization along the improved channel. Estimates of these benefits are presented in the following tabulation and are also summarized in Table F-7.

Estimated Average Annual Benefits from Movement of Project-Induced Tonnages

Item	**Average Annual Equivalent Benefits**
Port of Sacramento	
Grain	$ 532,000
Future industrialization (upper channel area)	956,200
	$1,488,200
Collinsville-Montezuma Hills	
Future industrialization	$1,983,400

19. Analysis of relevant data clearly indicates that the selected plan will bring about a substantial reduction in the amount of grain that must be moved to San Francisco to "top-off" the larger bulk grain vessels which now have to sail light-loaded from the Port of Sacramento because of insufficient channel depths. Shippers estimate that the additional costs to transport and load grain from the Central Valley at San Francisco is between $0.10 and $0.14 per bushel higher than moving it through facilities at the Port of Sacramento. For purposes of this study an average of $0.12 per bushel (or $4.00 per ton) was credited to the channel deepening project as a cost savings that would be realized as a result of the reduced topping-off operations. This savings per ton was multiplied by the projected additional grain movements through the Port in each future time period and discounted over the life of the project. The average annual equivalent benefit for these induced grain shipments is estimated at $532,000 as shown in the above tabulation.

20. As previously discussed in Section B, deepening of the channel will place the Port of Sacramento in a more competitive position to attract additional out-of-state grain shipments, primarily from Nebraska and western Iowa. Benefits for these movements were not estimated because of difficulties in measuring the savings to shippers that would result from moving the grain through facilities at the Port of Sacramento with an improved channel as opposed to utilizing other west coast facilities or the gulf coast ports. These measurement difficulties arise because unit train export rates for grain from Midwest points are equalized to all loading ports along the west coast. Also, ocean freight rates for grain are seldom determined by travel distance because rates from most ports are back-haul and are determined by the amount of inbound tonnage from the Far East.

21. Benefits to be derived from the induced future industrialization were assumed equal to the product of the waterway traffic times one-half of the difference between constructed alternative transportation rates and constructed rates with the improved channel.[1] This procedure is in accordance with ER 1120-2-114. Unit transportation costs per ton developed for representative cargo movements both with and without the project were used to approximate alternative and improved waterway rates for the induced traffic. These costs and the derived unit savings per ton for the induced traffic are shown in the tabulation below. The vessels used in the unit savings computations are approximately the "optimum" sizes that could be used by shippers to move the induced traffic both with and without the project.

[1]This rule-of-thumb approach assumes that rates lower than the constructed alternative rates will be required to move this traffic. Some part of the induced traffic will move at a rate slightly below the constructed alternative rate. Additional increments of traffic will move only at rates further reduced. The last increment will move only at the constructed 35-foot waterway rate. It was assumed that the induced traffic will be evenly distributed between the alternative constructed rate and the 35-foot waterway rate and that the average unit benefit is equal therefore to one-half the difference between these two rates.

	Unit Costs on 30-foot Channel	Unit Costs on 35-foot Channel	Unit Savings	Unit Savings For Induced Traffic ($3.16 × ½)
PORT OF SACRAMENTO				
Unit transportation costs per ton for inbound bulk cargo movements to the Port of Sacramento from foreign sources using vessels of 18,000 dwt on the existing 30-foot channel and 25,000 dwt vessels on the proposed 35-foot channel	$13.17	$10.01	$3.16	$1.58

	Unit Costs on 30-foot Channel	Unit Costs on 35-foot Channel	Unit Savings	Unit Savings For Induced Traffic ($3.74 × ½)
COLLINSVILLE-MONTEZUMA HILLS				
Unit transportation costs per ton for inbound bulk cargo movements to the Collinsville-Montezuma Hills area from foreign sources using vessels of 18,000 dwt on the existing 30-foot channel and 30,000 dwt vessels on the proposed 35-foot channel	$12.65	$ 8.91	$3.74	$1.87

22. Applying the above unit savings per ton to projected tonnages in each future time frame resulted in average annual equivalent benefits from the induced future industrialization of $956,200 and $1,983,400 for the Port of Sacramento and the Collinsville-Montezuma Hills area, respectively, as shown in the following tabulation.

ESTIMATED AVERAGE ANNUAL BENEFITS FROM INDUCED FUTURE INDUSTRIALIZATION

PORT OF SACRAMENTO

Year	Tonnage	Total Savings @ $1.58 Per Ton	Decadal Deferral Factors	Deferred Savings
1987	100,000	$ 158,000	.26027	$ 41,100
1997	500,000	790,000	.38452	303,800
2007	900,000	1,422,000	.19320	274,700
2017	1,200,000	1,896,000	.09707	184,000
2027	1,450,000	2,291,000	.04877	111,700
2037	1,600,000	2,528,000	.01617	40,900
				$956,200

COLLINSVILLE-MONTEZUMA HILLS

Year	Tonnage	Total Savings @ $1.87 Per Ton	Decadal Deferral Factors	Deferred Savings
1987	300,000	$ 561,000	.26027	$ 146,000
1997	900,000	1,683,000	.38452	647,100
2007	1,500,000	2,805,000	.19320	541,900
2017	2,000,000	3,740,000	.09707	363,000
2027	2,300,000	4,301,000	.04877	209,800
2037	2,500,000	4,675,000	.01617	75,600
				$1,983,400

Recreation Benefits

23. Recreation benefit analysis included projecting recreation demands in the area, inventorying recreation resources, estimating recreation opportunities associated with the project, and applying a unit monetary value to the project related recreation activities.

RECREATION MARKET AREA

24. The Sacramento River Deep Water Ship Channel is both hydrologically and geographically an integral part of the Sacramento-San Joaquin Delta. Therefore, it is anticipated that the users of recreation facilities along the ship channel would emanate from the same geographic regions as visitors to other

Delta recreation facilities. Surveys of recreation use in the Delta conducted by the California Departments of Water Resources and Parks and Recreation in 1962-1963 indicated that 93 percent of the recreation users originated from the 13 counties in and adjacent to the Delta. These 13 counties include Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Solano, Sonoma, Sacramento, Santa Clara, San Joaquin, Stanislaus, and Yolo Counties and are considered to be the market area for recreation use in the Delta. Additional surveys conducted at Brannan Island State Recreation Area during the summer of 1970 revealed that 88 percent of the day use and 68 percent of the overnight use originated from the San Francisco Bay area. Sacramento and San Joaquin Counties each contributed 5 percent of the day use and 4 percent of the overnight use.

MARKET AREA POPULATION CHARACTERISTICS

25. The projected population for the 13-county market area is tabulated below. Sacramento, San Joaquin, Yolo, and Solano Counties are expected to have a rapid growth rate with their populations increasing from 1,367,000 in 1978 to 2,379,000 in 2020. The San Francisco Bay complex is expected to continue steady growth with the most rapid expansion in Alameda, Contra Costa, Marin, and Santa Clara Counties. A slight decline in San Francisco County's population is forecast through the year 2000 followed by a gradual increase to slightly above the current population by 2020.

Market Area Population Estimates

Year	Population (millions)
1980	6.5
1990	7.4
2000	8.1
2010	8.8
2020	9.4

[2]Population projections for 1980-2020 prepared by the California Department of Finance, E-150 series, December 1977.

RECREATION DEMAND

26. The Delta, which includes the ship channel, is and will continue to be a major recreation resource in California. Its esthetically pleasing setting, temperate year-around climate, and the close proximity of the major population centers in northern California contribute to the Delta's constantly growing popularity. However, current use of the Delta is significantly constrained by the lack of access for land-based users and insufficient recreation facilities to accommodate both water and land dependent activities. The California Department of Parks and Recreation in its Delta Master Recreation Plan estimates that the latent demand (the amount of use that would occur if facilities were available) for the Delta will be nearly 22 million recreation days by 1980 and nearly 40 million recreation days by 2000. The

department also estimates that there are significant shortages of trails and camping, picnicking, and hunting facilities. Since all available evidence indicates a tremendous unsatisfied demand, it is reasonable to anticipate that the limited increase in the supply of recreation facilities that could be developed in conjunction with the ship channel project would be used to design capacity almost immediately following construction.

PROJECT CAPABILITY

27. The dredged material disposal sites are the principal resources which offer the opportunity to incorporate recreation development with channel deepening. Also, other areas along the ship channel in addition to dredged material disposal areas were examined for project related recreation potential (e.g., a trail system) as well as providing minimum recreation facilities. Eleven potential recreation areas were identified including fishing access sites and extensively developed recreation areas. However, the lack of vehicular access to the ship channel required significant amounts of public access acquisition. Consequently, indications of interest by non-Federal agencies to participate in recreation development costs and operation and maintenance were obtained on only one area. Solano County has expressed interest in participating in recreation developments at a dredged material disposal site located near Rio Vista (Sandy Beach). This recreation developments would provide parking, launching facilities, swimming, picnicking and camping.

PREDICTED RECREATION USE

28. Because of the temperate climate, the Delta receives significant recreation use from March to October with the peak use months being June, July, and August. Recreation use is concentrated on weekends and holidays; however, there is significant weekday use which is attributed to camping and overnight use of boats, particularly houseboats. Estimates of annual recreation use are based on the capacity of the facilities to be provided and current trends in distribution of recreation use at Brannan Island State Recreation Area. Brannan Island is located within the project's market area and is similar to the type of recreation facilities contemplated. This recreation area presently consists of 336 acres of land containing 150 campsites, 110 picnic units, and boat launching facilities. It received an average use of 152,000 recreation days in 1976. The carrying capacity for the proposed recreation site was developed by considering local needs and desires and by calculating the number of individuals that could reasonably be supported by the proposed facilities. Because of the proximity to the city of Rio Vista, it is assumed that proposed facilities would be used to their fullest extent during the average weekend day during the peak month shortly following the completion of facilities. Using these considerations, initial use of Sandy Beach is estimated to be 120,000 recreation days annually. In the future, with increased weekend crowding of available facilities, more diversity in days people have off, and trends toward a 4-day work week, it is anticipated that weekday use of facilities would increase. This more efficient use of facilities would enable greater number of people to utilize the available facilities, resulting in greater annual use in the latter portion of the project life. Capacity use, which would be reached in project year 50, is estimated at 180,000 recreation days annually at Sandy Beach.

RECREATION BENEFITS

29. Economic benefits were based on the recreation use levels discussed in the previous paragraph. Benefits are based on 7⅛ percent interest rate over a 50-year project life and a unit value of $2.25 per recreation day. The unit value was derived using standard methodology which includes consideration of the quality of access and facilities to be provided, variety of recreation activities available, competition, esthetics, and proximity to users. On this basis the average annual equivalent benefits would be $303,000 for Sandy Beach.

Summary of Benefits

30. Table F-8 below shows a summary of average annual benefits associated with navigation and related improvements to the Sacramento River Deep Water Ship Channel.

TABLE F-8
SUMMARY OF BENEFITS

Navigation	
Collinsville-Montezuma Hills Area	$ 4,447,000
Port of Sacramento	10,452,000
Total Navigation	14,899,000
Recreation	303,000
Total Project	$15,202,000

Justification

31. Comparison of average annual benefits with the average annual costs is shown in Table F-9 below. Although intangible benefits and tangible secondary benefits may accrue to the national economy, only tangible primary benefits are included in the table. In the preparation of Table F-9, it was assumed that the Suisun Bay Channel would be deepened to 35 feet under the authorized Stockton Ship Channel project. If this is not the case, the cost of deepening the Suisun Bay Channel would be included in the cost of the selected plan, the average annual costs would increase by $909,000, and the overall project benefit to cost ratio would decrease to 2.1 to 1.

TABLE F-9
AVERAGE ANNUAL COSTS AND BENEFITS
NEW YORK SLOUGH TO SACRAMENTO

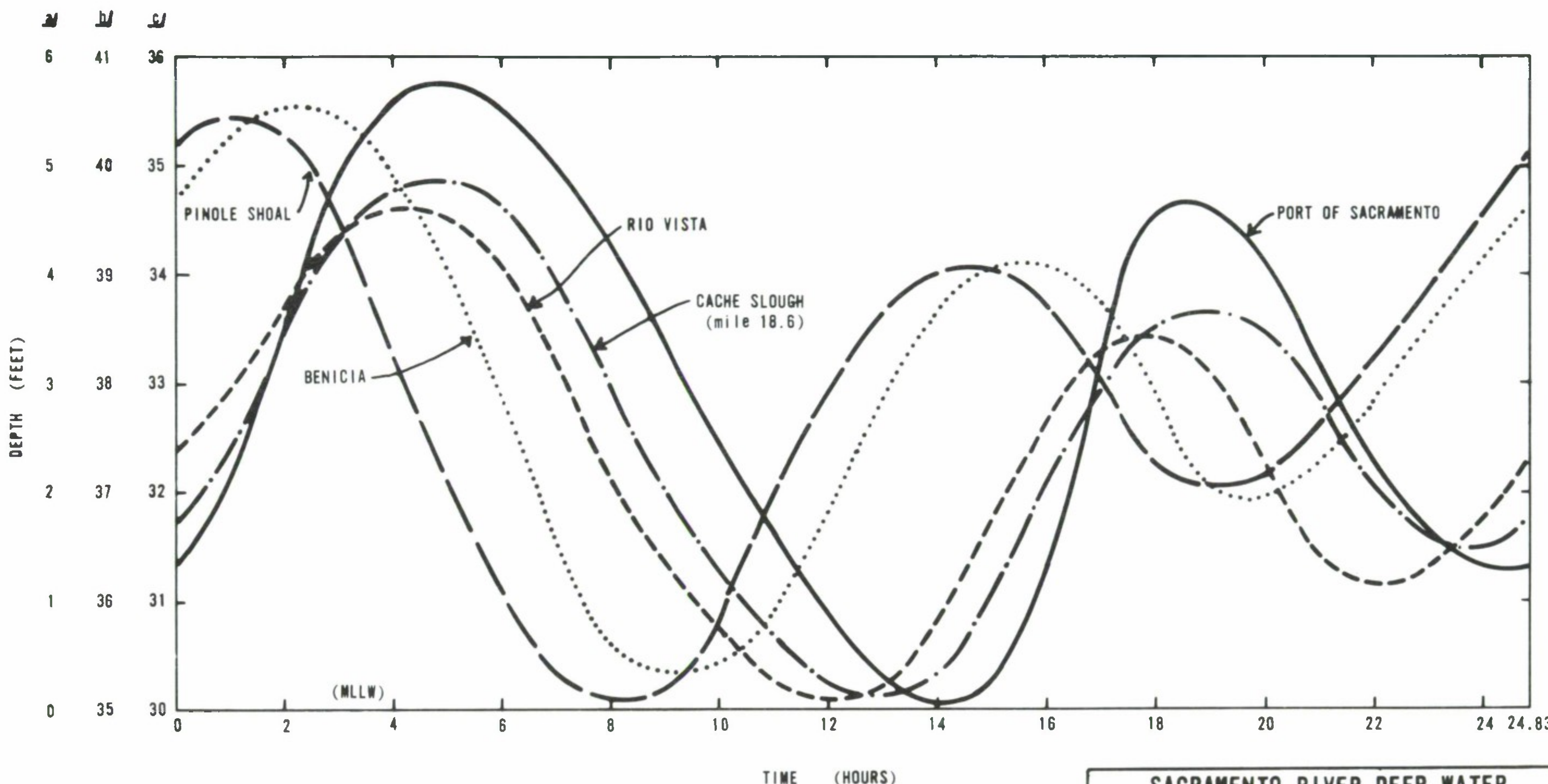
	Costs	Benefits	Excess Benefits	Benefit to Cost Ratio
Navigation				
New York Slough to Collinsville-Montezuma Hills	$(1,347,000)	$(4,447,000)	$(3,100,000)	3.3
Collinsville-Montezuma Hills Area to Sacramento	(4,575,000)	(10,452,000)	(5,877,000)	2.3
Total Navigation	5,922,000	14,899,000	8,977,000	2.5
Recreation	171,000	303,000	132,000	1.28
Fish & Wildlife Mitigation	61,000	0	-61,000	0
TOTAL	$ 6,154,000	$ 15,202,000	$ 9,048,000	2.5

32. As indicated above, deepening the Sacramento River Deep Water Ship Channel to 35 feet is economically justified regardless of prior construction of other navigation projects in the area.

Maximization

33. Maximizing net tangible benefits is an economic concept used in sizing facilities to produce the greatest excess of benefits over cost. Under this concept, the last increment in the channel depth produces an incremental benefit-cost ratio equal to 1.0 to 1, and further increases in size would be uneconomical.

34. Plan formulation studies described in Section D included analyzing costs and benefits of various size alternative channel deepening plans. In the process of this investigation, it was possible to develop the National Economic Development (NED) plan which provided maximum net benefits. Under this plan the channel would be deepened to 40 feet from Avon to the Collinsville-Montezuma Hills area and to 35 feet to the Port of Sacramento. As was explained in Section D, this plan cannot be implemented at this time due to the existence of the 35-foot channel between the Golden Gate and Avon. However, implementing the NED plan will be considered further during advanced engineering and design studies.



a/ Depth of existing condition (add 5-feet to Benicia curve).

b/ Depth with 35-foot channel.

c/ Depth above adjusted MLLW.

SACRAMENTO RIVER DEEP WATER SHIP CHANNEL, CALIFORNIA

ADJUSTED TIDAL CURVES

CORPS OF ENGINEERS SACRAMENTO, CA

PREPARED: LRT
DRAWN: LKK
DATE: OCT 1976

CHART F-1

SECTION G

DIVISION OF PLAN RESPONSIBILITIES

SECTION G

DIVISION OF PLAN RESPONSIBILITIES

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SECTION G

DIVISION OF PLAN RESPONSIBILITIES

1. Apportionment of costs between Federal and non-Federal interests is based on Federal legislation and administrative policies governing navigation improvement projects. A basis for apportioning costs for the project functions is described in the following paragraphs.

Cost Apportionment

2. Federal and non-Federal costs associated with the improvement of the Sacramento River Deep Water Ship Channel are based on Federal policy for navigation improvements. Under this policy, non-Federal interests would be required to furnish all lands, easements, and rights-of-way and damages, including all relocations required by the plan, and in the case of recreation features, any additional amount needed to bring the total non-Federal cost of these features to not less than 50 percent separable costs. Table G-1 shows the apportionment of costs.

3. Of the estimated $1,350,000 in first cost associated with recreation features of the project, $1,300,000 is the estimated first cost for construction work and $50,000 is the estimated first cost for recreation lands. For the project-related recreation facilities, the estimated Federal costs for construction work, including costs for engineering, design, supervision, and administration, exceed the costs for recreation lands, including acquisition costs, by $1,250,000.

4. In accordance with current policy, one-half of this excess must be reimbursed to the Federal Government. Accordingly, $625,000 has been added to the non-Federal cost and subtracted from the Federal cost. The cost of operating and maintaining the recreation features after construction would be a non-Federal responsibility.

5. The Federal first cost shown in Table G-1 includes $300,000 attributable to fish and wildlife mitigation facilities. The non-Federal first cost includes $400,000 for lands for fish and wildlife mitigation. The total development cost of $700,000 for fish and wildlife facilities will be cost-shared in the same proportion as the costs of the navigation facilities. This cost-sharing percentage is determined by including both project navigation first costs and the capitalized present value of the increased operation and maintenance cost of navigation facilities. Federal and non-Federal first costs for navigation improvements, exclusive of fish and wildlife mitigation features are $59,000,000 and $12,050,000, respectively. There is no increased maintenance attributable to the navigation improvements, hence the capitalized present value of the operation and maintenance cost of navigation facilities is equal to zero. The Federal portion accounts for 80 percent of the total cost of navigation improvements exclusive of mitigation features. The non-Federal portion accounts for the remaining 20 percent. In accordance with current policy, mitigation costs of $700,000 shared in the same proportion as the project navigation features would therefore be $560,000 (80 percent) Federal and $140,000 (20 percent) non-Federal. Accordingly, $260,000 has been subtracted from the non-Federal cost and added to the Federal cost to reflect this cost-sharing.

Federal Responsibilities

6. As indicated in Table G-1, the presently estimated Federal share of the project first cost is $60,235,000 in accordance with the criteria previously described. The improved channel would require no additional maintenance dredging. All designs, specifications, and construction subsequent to Congressional authorization would be done by the Federal Government. However, non-Federal interests would have the option of designing and constructing features such as retention dikes and relocations which they are responsible for.

7. All of the costs for lands, facilities, and construction of the fish and wildlife mitigation areas would be divided between the Federal Government and the non-Federal navigation sponsor in the same proportion as the project navigation costs. The operation and maintenance of these facilities would consist of annual surveillance of the facilities to insure that encroachment has not occurred and habitat has not been destroyed. An annual report verifying the surveillance would also be prepared. The annual cost to operate and maintain the fish and wildlife facilities has been determined to be negligible.

TABLE G-1

COST APPORTIONMENT

35-ft. Channel — New York Slough to Sacramento

	FEDERAL			NON-FEDERAL			
	Navigation ($)	Recreation ($)	Fish & Wildlife Mitigation ($)	Navigation ($)	Recreation ($)	Fish & Wildlife Mitigation ($)	TOTAL
FIRST COST							
New York Slough to Mile 11.0	16,600,000	—	—	1,700,000	—	—	18,300,000
Mile 11.0 to Sacramento	42,400,000	1,300,000	300,000	10,350,000	50,000	400,000	54,800,000
Total	59,000,000	1,300,000	300,000	12,050,000	50,000	400,000	73,100,000
Adjustment for Recreation Cost-Sharing	—	-625,000	—	—	+625,000	—	0
Adjusted Subtotals	59,000,000	675,000	300,000	12,050,000	675,000	400,000	73,100.000
Adjustment for Fish & Wildlife Cost-Sharing	—	—	+260,000	—	—	-260,000	0
Adjusted First Cost	59,000,000	675,000	560,000	12,050,000	675,000	140,000	73,100,000
Total First Cost		60,235,000			12,865,000		
INVESTMENT							
Adjusted First Cost	59,000,000	675,000	560,000	12,050,000	675,000	140,000	73,100,000
Interest During Construction (Mile 11.0 to Sacramento only)	7,552,000	120,000	100,000	1,844,000	120,000	25,000	9,761,000
Gross Investment	66,552,000	795,000	660,000	13,894,000	795,000	165,000	82,861,000
Total Gross Investment		68,007,000			14,854,000		
ANNUAL COST							
Interest and Amortization							
New York Slough to Mile 11.0	1,222,000	—	—	125,000	—	—	1,347,000
Mile 11.0 to Sacramento	3,677,000	58,000	49,000	898,000	58,000	12,000	4,752,000
Subtotal	4,899,000	58,000	49,000	1,023,000	58,000	12,000	6,099,000
O.M.&R.							
New York Slough to Mile 11.0	—	—	—	—	—	—	—
Mile 11.0 to Sacramento	—	—	—	—	55,000	0	55,000
Total	4,899,000	58,000	49,000	1,023,000	113,000	12,000	6,154,000
Total Annual Cost		5,006,000			1,148,000		

Non-Federal Responsibilities

8. The presently estimated non-Federal share of the project first cost for navigation improvements is $12,050,000 reflecting cost-sharing criteria. Prior to construction of navigation improvements, local interests would be required to furnish assurances satisfactory to the Secretary of the Army that they will:

- Provide without cost to the United States all lands, easements, and rights-of-way required for construction and subsequent maintenance of the project and for aids to navigation, including suitable areas determined by the Chief of Engineers to be required in the general public interest for initial and subsequent disposal of dredged material;

- Provide without cost to the United States all necessary dredged material retention dikes, bulkheads, and embankments necessary for project construction, or the costs of such retaining works, except for additions required solely for development of the recreation area;

- Hold and save the United States free from all claims for damages due to deposition of dredged material, and due to the construction of new levees or reconstruction of existing levees along the Sacramento River Deep Water Ship Channel, including damages to such levees or damages due to the failure of such levees, except damages due to the fault or negligence of the United States or its contractors;

- Hold and save the United States free from damages to wharves, bridge piers and other marine and submarine structures, and agricultural lands, due to initial dredging work and subsequent maintenance dredging, except damages due to the fault or negligence of the United States or its contractors;

- Accomplish without cost to the United States all utility modifications and relocations required for construction of the project works, including new bridges or bridge alterations (except for railroad bridges), and absorb any increased annual maintenance and operation costs that might result from such modifications and relocations;

- Provide, maintain, and operate at local expense adequate public terminal and transfer facilities open to all on equal terms, in accordance with plans approved by the Chief of Engineers; and

- Provide and maintain without cost to the United States all public berthing areas, at depths commensurate with project depths, at all public terminals and wharves to be served by the deepened channel.

9. The estimated non-Federal share of the project first cost for recreation improvements is $675,000. In addition, non-Federal interests would operate, maintain, and provide replacement for recreation facilities at an estimated annual cost of $55,000. Prior to construction of recreation improvements, local interests would be required to furnish assurances satisfactory to the Secretary of the Army that they will:

- Provide without cost to the United States the lands, easements, rights-of-way or other proprietary interest in lands necessary for the development of public recreation facilities;

- Pay, contribute in kind, or repay (which may be through user fees) with interest, a portion of the cost of recreation facilities which when added to the cost of recreation lands would amount to 50 percent of the total first cost of the recreation lands and recreational facilities;

- Maintain and operate at non-Federal expense public recreation areas, including access thereto, at those dredged material disposal areas designated by the District Engineer; and

- Hold and save the United States free from all claims for damages due to construction of recreation facilities, except damages due to the fault or negligence of the United States or its contractors.

10. The estimated non-Federal share of the project first cost for fish and wildlife mitigation features is $140,000. In addition, non-Federal interests would operate, maintain, and provide replacement for fish and wildlife mitigation facilities at a negligible annual cost. Prior to construction of fish and wildlife mitigation features, local interests would be required to furnish assurances satisfactory to the Secretary of the Army that they will:

- Provide lands, easements, rights-of-way or other proprietary interest in lands necessary for the development of the fish and wildlife mitigation improvements;

- Share the cost of fish and wildlife mitigation features including lands in the same ratio as the first costs of the navigation features; and

- Hold and save the United States free from all claims for damages due to construction of fish and wildlife mitigation facilities, except damages due to the fault or negligence of the United States or its contractors.

SECTION H

PROPOSED REVISED

COST-SHARING RESPONSIBILITIES

SECTION H

PROPOSED REVISED COST-SHARING RESPONSIBILITIES

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SECTION H

PROPOSED REVISED COST-SHARING RESPONSIBILITIES

1. In his Environmental Message of 23 May 1977, the President directed the Office of Management and Budget, the Council on Environmental Quality, and the Water Resources Council " . . . to conduct in consultation with the Congress and the public, a review of the present Federal water policy." In response to that directive, a policy review was undertaken, policy option papers were published in the *Federal Register* for public comment, and public hearings were held in nine cities throughout the Nation. During the policy review, one of the issues identified was inequitable sharing of costs of water resource projects. Subsequent to the policy review, the President made a decision regarding sharing of costs of Federal water projects to accomplish two important goals:

a. to involve States more extensively in water project decisions, and

b. to eliminate many of the conflicting rules governing cost-sharing for flood control projects — especially with regard to structural and nonstructural flood damage reduction measures.

This section presents revised cost-sharing responsibilities which reflect the President's recent decision.

The President's Proposed Policy

2. As applied to the Sacramento River Deep Water Ship Channel project, the President's new cost-sharing policy requires the following:

- States will provide a legally binding commitment to contribute a 5 percent cash share of the total first cost of construction of the project. The State's cash contribution is to be paid concurrently and proportionately with the Federal contractual obligation for project construction.

Cost Apportionment

3. Table H-1 shows the apportionment of costs between Federal and non-Federal interests for the Sacramento River Deep Water Ship Channel project. Responsibilities of Federal and non-Federal interests are described in the paragraphs below.

Federal Responsibilities

4. Under the President's recent policy, sharing of costs between Federal and non-Federal interests is based upon standard requirements established as Federal policy for navigation projects, except as noted under "non-Federal Responsibilities" in paragraph 7. The Federal Government would design, prepare detailed plans for, and construct the project.

5. Responsibility for construction, operation, and maintenance associated with the recreation area would conform to the requirements of Public Law 89-72, as amended. All of the costs for lands, facilities, and construction, would be divided between the Federal Government and the local recreation sponsor. Operation and maintenance of completed facilities would be the responsibility of the non-Federal recreation sponsor.

6. All of the costs for lands, facilities, and construction of the fish and wildlife mitigation areas would be divided between the Federal Government and the non-Federal navigation sponsor in the same ratio as the project navigation costs. The operation and maintenance of these facilities would consist of annual surveillance of the facilities to insure that encroachment has not occurred and habitat has not been destroyed. An annual report verifying the surveillance would also be prepared. The annual cost to operate and maintain the fish and wildlife facilities has been determined to be negligible.

Non-Federal Responsibilities

7. Under the President's revised cost-sharing policy, non-Federal interests would be required to contribute a 5 percent cash share of the total first cost of navigation improvements, to be paid concurrently and proportionately with the Federal contractual obligation for project construction. In addition, non-Federal navigation interests would be responsible for the following requirements under both the traditional and proposed cost-sharing requirements:

- Provide without cost to the United States all lands, easements, and rights-of-way required for construction and subsequent maintenance of the project and for aids to navigation, including suitable areas determined by the Chief of Engineers to be required in the general public interest for initial and subsequent disposal of dredged material;

- Provide without cost to the United States all dredged material retention dikes, bulkheads, and embankments necessary for the project construction, or the costs of such retaining works, except for additions required solely for development of the recreation area;

- Hold and save the United States free from all claims for damages due to deposition of dredged material, and due to the construction of new levees or reconstruction of existing levees along the Sacramento River Deep Water Ship Channel, including damages to such levees or damages due to the failure of such levees, except damages due to the fault or negligence of the United States or its contractors;

- Hold and save the United States free from damages to wharves, bridge piers and other marine and submarine structures, and agricultural lands, due to initial dredging work and subsequent maintenance dredging, except damages due to the fault or negligence of the United States or its contractors;

- Accomplish without cost to the United States all utility modifications and relocations required for construction of the project works, including new bridges or bridge alterations (except for railroad bridges), and absorb any increased annual maintenance and operation costs that might result from such modifications and relocations;

- Provide, maintain, and operate at local expense adequate public terminal and transfer facilities open to all on equal terms, in accordance with plans approved by the Chief of Engineers; and

- Provide and maintain without cost to the United States all public berthing areas, at depths commensurate with project depths, at all public terminals and wharves to be served by the deepened channel.

8. In addition, under the President's proposed cost-sharing policy, the non-Federal interests would be required to contribute a 5 percent cash share of the total first cost of recreation improvements, to be paid concurrently and proportionately with the Federal contractual obligation for project construction. The following would be non-Federal responsibilities under both the traditional and proposed cost-sharing criteria.

- Provide without cost to the United States the lands, easements, rights-of-way or other proprietary interest in lands necessary for the development of public recreation facilities;

- Pay, contribute in kind, or repay (which may be through user fees) with interest, a portion of the cost of recreation facilities which when added to the cost of recreation lands would amount to 50 percent of the total first cost of the recreation lands and recreational facilities;

- Maintain and operate at non-Federal expense public recreational areas, including access thereto, at those dredged material disposal areas designated by the District Engineer; and

- Hold and save the United States free from all claims for damages due to construction of recreation facilities, except damages due to the fault or negligence of the United States or its contractors.

9. In addition, under the President's proposed cost-sharing policy, the non-Federal interests would be required to contribute a 5 percent cash share of the total first cost of fish and wildlife mitigation facilities to be paid concurrently and proportionately with the Federal contractual obligation for project construction. The following would be non-Federal responsibilities under both the traditional and proposed cost-sharing criteria.

- Provide without cost to the United States the lands, easements, right-of-way or other proprietary interest in lands necessary for the development of the fish and wildlife facilities;

- Share the cost of fish and wildlife mitigation features including lands in the same ratio as the first costs of the navigation features and;

- Hold and save the United States free from all claims for damages due to construction of fish and wildlife facilities, except damages due to the fault or negligence of the United States or its contractors.

Table H-1
COST APPORTIONMENT
35-ft. Channel — New York Slough to Sacramento

	FEDERAL			NON-FEDERAL			
	Navigation ($)	Recreation ($)	Fish & Wildlife Mitigation ($)	Navigation ($)	Recreation ($)	Fish & Wildlife Mitigation ($)	TOTAL
FIRST COSTS							
Traditional Cost-Sharing							
New York Slough to Mile 11.0	16,600,000	—	—	1,700,000	—	—	18,300,000
Mile 11.0 to Sacramento	42,400,000	675,000	560,000	10,350,000	675,000	140,000	54,800,000
Total	59,000,000	675,000	560,000	12,050,000	675,000	140,000	73,100,000
Adjustment for 5 Percent Non-Federal Share of Total Cost							
New York Slough to Mile 11.0	-915,000	—	—	+915,000	—	—	0
Mile 11.0 to Sacramento	-2,638,000	-68,000	-35,000	+2,638,000	+68,000	+35,000	0
Total	-3,553,000	-68,000	-35,000	+3,553,000	+68,000	+35,000	0
Adjusted First Costs							
New York Slough to Mile 11.0	15,685,000	—	—	2,615,000	—	—	18,300,000
Mile 11.0 to Sacramento	39,762,000	607,000	525,000	12,988,000	743,000	175,000	54,800,000
Adjusted Subtotal	55,447,000	607,000	525,000	15,603,000	743,000	175,000	73,100,000
Total		56,579,000			16,521,000		
INVESTMENT							
Interest During Construction (Mile 11.0 to Sacramento only)	7,083,000	108,000	94,000	2,313,000	132,000	31,000	9,761,000
Gross Investment							
New York Slough to Mile 11.0	15,685,000	—	—	2,615,000	—	—	18,300,000
Mile 11.0 to Sacramento	46,845,000	715,000	619,000	15,301,000	875,000	206,000	64,561,000
Gross Investment	62,530,000	715,000	619,000	17,916,000	875,000	206,000	82,861,000
Total		63,864,000			18,997,000		
ANNUAL COST							
Interest and Amortization							
New York Slough to Mile 11.0	1,155,000	—	—	192,000	—	—	1,347,000
Mile 11.0 to Sacramento	3,448,000	53,000	46,000	1,126,000	64,000	15,000	4,752,000
Total	4,603,000	53,000	46,000	1,318,000	64,000	15,000	6,099,000
O.M.&R.	—	—	—	—	55,000	—	55,000
Total Annual Cost	4,603,000	53,000	46,000	1,318,000	119,000	15,000	6,154,000
Total		4,702,000			1,452,000		

SUMMARY

The following tabulation illustrates the comparative cost-sharing that would be applicable for both current policy and for the President's proposed policy:

	CURRENT POLICY	PROPOSED POLICY
FEDERAL FIRST COST	$60,235,000	$56,579,000
NON-FEDERAL FIRST COST	12,865,000	16,521,000
TOTALS	$73,100,000	$73,100,000

SACRAMENTO RIVER DEEP WATER
SHIP CHANNEL, CALIFORNIA
FEASIBILITY REPORT AND
ENVIRONMENTAL IMPACT STATEMENT
FOR NAVIGATION AND RELATED PURPOSES

Correspondence/Reports From Others

APPENDIX 2

PREPARED BY THE
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
DEPARTMENT OF THE ARMY

CORRESPONDENCE/REPORTS FROM OTHERS

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U.S. Fish and Wildlife Service letter dated 20 March 1980 and Detailed Report

Responses to Fish and Wildlife Service Recommendations

Solano County Board of Supervisors letter dated 6 February 1979, recreation sponsorship

Sacramento-Yolo Port Commission letter dated 1 July 1980 navigation sponsorship

Resources Agency of California letter dated 26 June 1980, non-Federal cost sharing

California Department of Parks and Recreation letter dated 21 February 1978, coordination with State Historic Preservation Officer

Responses to Fish and Wildlife Service Recommendations

Responses to specific recommendations of the Fish and Wildlife Service summarized in their 20 March 1980 transmittal letter are presented below.

Recommendation — In the event actual construction of a submerged sill (or functionally equivalent device) to repel salinity intrusion is contemplated subsequent to channel deepening, the Corps of Engineers should:

(a) fund a special study by the Fish and Wildlife Service to ascertain the probable impacts of such a structure on fish and wildlife resources;

(b) give full and equal consideration to the recommendations of the Fish and Wildlife Service, based on said study, in arriving at a decision concerning the advisability of constructing the submerged sill; and

(c) prepare a supplemental environmental impact statement addressing construction of the submerged sill and incorporating the information obtained from said study.

Response — The construction of a submerged sill or alternative features in the Delta to control potential salinity intrusion would be predicated on the results of post-authorization model tests. These tests would be conducted by the Corps of Engineers in cooperation with the Department of Water Resources and concerned State and Federal agencies to reevaluate and more exactly determine the effect of channel deepening on salinity intrusion. Special studies of a submerged sill or alternative features would be conducted if the model tests indicate a measurable increase in salinity levels as a result of channel deepening. The testing program would be reviewed by fish and wildlife agencies. The Corps of Engineers would give full consideration to the recommendations of these agencies with respect to formulating and conducting model tests and at arriving at a decision regarding the advisability of constructing a submerged sill or other mitigative feature if required. If the proposed plan of improvement is authorized by Congress, appropriate environmental studies would be conducted during post-authorization studies to address all potential impacts of the project (pages 36, 60, 61, and 76).

Recommendation — The scheduling of channel dredging operations should be coordinated with the California Department of Fish and Game, the National Marine Fisheries Service, and the Fish and Wildlife Service to minimize interference with the migration, spawning, and rearing of fish species.

Response — The timing of channel dredging and construction of a submerged sill or alternative mitigative feature would be coordinated with fish and wildlife agencies to minimize any impact on migrating species to the extent possible (page 3-15).

Recommendation — Losses of marsh-riparian habitat along the artificial reach of the ship channel due to channel enlargement would be offset by the development of 45 acres of marsh-riparian habitat at Prospect Island, as already included in the project plan.

Response — To compensate for the loss of marsh-riparian habitat along the manmade portion of the channel, 45 acres of a former dredged material disposal area on Prospect Island would be converted to wetland habitat as recommended by the Fish and Wildlife Service (pages 36, E-5, E-14).

Recommendation — Losses of upland habitat at the dredged material disposal areas due to placement of dredged materials during channel deepening should be offset by the development and preservation of a total of 156 acres of upland habitat in small tracts on the disposal areas.

Response — To compensate for the loss of upland habitat, a maximum of 156 acres on dredged material disposal areas would be developed for upland habitat (pages 36, 62, 76, E-5, E-14, E-15).

Recommendation — That habitat for fish and wildlife along the artificial reach of the ship channel should be improved by excavating small ponds in the channel berms, prohibiting burning as a levee maintenance practice, excluding cattle from marsh areas, managing as much project land as possible for wildlife, and sloping the new channel edges to promote natural establishment of marsh vegetation.

Response — The actions identified above have been included as elements of the Environmental Quality (EQ) plan. Any or all of these elements could be included in the project. This will be considered during advanced engineering and design studies which provide the opportunity for a complete review of the plan formulation process (pages 31, 32, D-41, D-42, D-43).

Recommendation — Public access for outdoor recreationists should be provided to the artificial channel and to project lands if non-Federal interests are willing to cost-share in accordance with the requirements of the Federal Water Project Recreation Act.

Response — Recreation facilities have been provided to the extent that non-Federal interests have indicated a willingness to share development costs (pages 37, 51, D-31, D-32, E-3).

Recommendation — Dredged material should be used wherever feasible to develop wetland habitat as provided for under Section 150 of the Water Resources Development Act of 1976.

Response — It is understood that recently the fish and wildlife agencies and interested organizations have placed a high priority on providing additional wetlands in the Sacramento-San Joaquin Delta to benefit waterfowl and other fish and wildlife resources. If a project is authorized by the Congress, additional investigation and coordination will be undertaken with the interested agencies and organizations to determine if there are suitable locations where dredged material should be beneficially used to establish additional wetlands as provided by Section 150 of the Water Resources Development Act of 1976 (pages 37, 62, E-6).

STATE OF CALIFORNIA—THE RESOURCES AGENCY

EDMUND G. BROWN JR., Governor

DEPARTMENT OF PARKS AND RECREATION
P.O. BOX 2390
SACRAMENTO 95811
(916) 445-8006

February 21, 1978

Donald M. O'Shei, Colonel, CE
District Engineer - Sacramento District
U.S. Department of the Army - Corps of Engineers
650 Capitol Mall
Sacramento, CA 95814

Dear Colonel O'Shei:

Thank you for the opportunity to comment on your August 12, 1977 letter concerning your cultural resource document, Cultural Resources Reconnaissance: Sacramento Deep Water Ship Channel, Collinsville to Sacramento. My staff and I would like to offer the following preliminary comments:

1. Two questions arise pertaining to the coverage of the study areas:

    a. How were surveyers distributed over the study areas (i.e., traverses a half meter, one meter...)?
    b. Why was a 15% sample utilized? This should be justified.

2. The site located and recorded in the reconnaissance has not been assessed for eligibility for inclusion on the National Register of Historic Places per 36 CFR Part 800. Our review indicates that this site meets National Register Criteria No. 4. I suggest that you comply with the National Historic Preservation Act, as amended, and 36 CFR Part 800.

3. In determining the effect on Native American sites, it is important to establish the value of these sites in the Native American community (36 CFR Part 800.10 and Guidelines for Making "Effect and No Adverse Effect Determinations" Part 1(3a and b)).

Again, thank you for allowing us to comment on your cultural resource document. If we can be of any further assistance, please do not hesitate to contact Mr. William Seidel at (916) 445-8006.

Sincerely yours,

Knox Mellon

Dr. Knox Mellon
State Historic Preservation Officer

B-7/1

cc: Mr. Stephen Rios
Executive Secretary
Native American Heritage Commission
1400 Tenth Street
Sacramento, CA 95814

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

SACRAMENTO RIVER DEEP WATER SHIP CHANNEL

CALIFORNIA

A DETAILED REPORT ON
FISH AND WILDLIFE RESOURCES

REGION 1

United States Department of the Interior

FISH AND WILDLIFE SERVICE

SACRAMENTO AREA OFFICE
2800 Cottage Way, Room E-2740
Sacramento, California 95825

MAR 20 1980

District Engineer
Sacramento District, Corps of Engineers
650 Capitol Mall
Sacramento, California 95814

Dear Sir:

This is our detailed report on the effects that deepening the Sacramento River Deep Water Ship Channel, located in Sacramento, Yolo, Solano, and Contra Costa Counties, California, would have on fish and wildlife resources. It is intended for inclusion in the Corps of Engineers' feasibility report which is being prepared preliminary to the Corps' request for Congressional authorization to proceed with advanced engineering, design, and construction. The analysis of project effects presented herein is based on engineering data provided by the Corps prior to December 15, 1979.

Our report was prepared under the authority, and in accordance with the provisions, of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. et seq.). It was prepared in cooperation with the California Department of Fish and Game and has the Department's full concurrence, except as indicated in the appended letter of March 10, 1980, signed by Deputy Director E.V. Toffoli. The Department of Fish and Game believes that mitigation measures relating to any impacts of channel deepening on salinity distribution must be agreed upon prior to construction. Also, the report was reviewed by the National Marine Fisheries Service.

The project plan under study involves deepening the 46.5-mile-long Sacramento Ship Channel from 30 to 35 feet MLLW and widening it from 300 to 400 feet between New York Slough and Junction Point and from 200 to 250 feet between Cache Slough and the Port of Sacramento. Material dredged from the channel would be placed on previously used, upland disposal sites adjacent to the channel. In recognition of the possibility that channel deepening could increase salinity levels in the Sacramento-San Joaquin Delta--considered by the Corps of Engineers, based on its hydraulic model tests, to be an unlikely consequence--the project plan includes provision for possible future construction of a submerged rock sill in Carquinez Strait. The submerged sill would be constructed if the results of a salinity monitoring program, conducted before, during and after channel deepening, reveal that increasing the depth of the channel has caused an unacceptable increase in Delta salinity levels. The plan also provides for establishment of general recreation facilities at a dredged material disposal area and the conversion of 45 acres of former disposal area to wetland habitat to compensate for losses elsewhere.

Our major concern respecting the proposed channel deepening project is the possibility that its authorization for construction would mean the future installation of a submerged sill in Carquinez Strait without full consideration of the consequences for fish and wildlife resources. Salinity should not be designated as the only criterion on which a decision to construct the submerged sill is based. Given additional information on the probable effects of a submerged sill on such phenomena as the Delta's nutrient entrapment zone and the movements of aquatic organisms, it is conceivable that the disadvantages to fish and wildlife resources assignable to a submerged sill might be judged to outweigh the benefits to be gained by all interests through the restoration of salinity levels to the pre-project condition. The first of the following recommendations addresses this concern.

On the basis of our analysis, we conclude that the Corps of Engineers' proposal to deepen the Sacramento River Deep Water Ship Channel could be accomplished in a manner that would avoid certain fish and wildlife losses and satisfactorily compensate for other losses that would be unavoidable. Additionally, the proposed project offers some opportunity for resource enhancement. Accordingly, the Fish and Wildlife Service recommends:

1. That in the event actual construction of a submerged sill (or functionally equivalent device) to repel salinity intrusion is contemplated subsequent to channel deepening, the Corps of Engineers:

   (a) fund a special study by the Fish and Wildlife Service to ascertain the probable impacts of such a structure on fish and wildlife resources;

   (b) give full and equal consideration to the recommendations of the Fish and Wildlife Service, based on said study, in arriving at a decision concerning the advisability of constructing the submerged sill; and

   (c) prepare a supplemental environmental impact statement addressing construction of the submerged sill and incorporating the information obtained from said study.

2. That scheduling of channel dredging operations be coordinated with the California Department of Fish and Game, the National Marine Fisheries Service, and the Fish and Wildlife Service to minimize interference with the migration, spawning, and rearing of fish species.

3. That losses of marsh-riparian habitat along the artificial reach of the ship channel due to channel enlargement be offset by the development of 45 acres of marsh-riparian habitat at Prospect Island, as already included in the project plan.

4. That losses of upland habitat at the dredged material disposal areas due to placement of dredged materials during channel deepening be offset by the development and preservation of a total of 156 acres of upland habitat in small tracts on the disposal areas.

5. That habitat for fish and wildlife along the artificial reach of the ship channel be improved by excavating small ponds in the channel berms, prohibiting burning as a levee maintenance practice, excluding cattle from marsh areas, managing as much project land as possible for wildlife, and sloping the new channel edges to promote natural establishment of marsh vegetation.

6. That public access for outdoor recreationists be provided to the artificial channel and to project lands if non-Federal interests are willing to cost-share in accordance with the requirements of the Federal Water Project Recreation Act.

7. That dredged material be used wherever feasible to develop wetland habitat as provided for under Section 150 of the Water Resources Development Act of 1976.

Please advise us of your proposed actions concerning our recommendations.

Sincerely yours,

Area Manager

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DESCRIPTION OF THE PROJECT

The Sacramento River Deep Water Ship Channel extends 46.5 miles from New York Slough (Pittsburg) to the Port of Sacramento (see attached map). The ship channel, completed in 1963, has a depth of 30 feet at mean lower low water and varies in bottom width from 200 to 300 feet. The lower half of the ship channel length follows the natural channels of the Sacramento River and Cache Slough; the upper half follows an excavated overland route from Cache Slough to Sacramento. Near Sacramento, the ship channel terminates with a harbor and turning basin having a width of 2,000 feet and a length of 3,000 feet. Just above the harbor, a 13-foot deep navigation lock connects the ship channel with the Sacramento River, thus providing passage for tugs, barges and other shallow-draft vessels.

At its lower end, the Sacramento River Deep Water Ship Channel connects with the Stockton Ship Channel which joins the Baldwin Ship Channel in Suisun Bay near Avon. The Baldwin channel, which extends 24 miles to the ocean, has an existing controlling depth of 35 feet and an authorized depth of 45 feet. Deepening of the Stockton channel from its present depth of 30 feet to 35 feet has been authorized by the Congress.

The proposed project entails deepening the Sacramento Ship Channel to 35 feet, and widening it from 300 to 400 feet between New York Slough and Junction Point (mile 15.0) and from 200 to 250 feet between Cache Slough and the Port of Sacramento. The width of the Cache Slough reach of the channel (mile 15.0 to mile 18.6) would remain at 300 feet.

Approximately 30.3 million cubic yards of material would be removed from the ship channel by hydraulic dredging. The material would be placed on several upland disposal sites, totalling about 3,500 acres, all of which have been previously used for placement of dredged material. Recreation facilities would be constructed at the Sandy Beach disposal area immediately south of Rio Vista for both day use and overnight camping. Development of a 45-acre marsh at Prospect Island, by planned placement of dredged material, is proposed to compensate for project-caused destruction of marsh-riparian habitat along the artificial channel.

Although physical model tests conducted to date indicate that channel deepening would not cause a further intrusion of saline waters into the Delta, the project plan includes provision of: (1) a salinity monitoring program before and after deepening; and (2) construction of a submerged rock sill across Carquinez Strait at Dillon Point, should the monitoring program show that an adverse change in salinity has occurred. The monitoring program would be continued after sill installation until such time as it has been demonstrated that the salinity problem has been satisfactorily resolved. The sill, if constructed, would extend upward from the bottom of the Strait, where elevations range from about -25 to -120 feet mean lower low water, to elevation -50 feet. The sill would be about 1,700 feet long, have a crest width of 12 feet, and side slopes of 1 vertical to 2 horizontal.

ENVIRONMENTAL SETTING

The Sacramento River Deep Water Ship Channel traverses the northwest quadrant of the Sacramento-San Joaquin Delta from Suisun Bay to the Port of Sacramento. The lands of the Sacramento-San Joaquin Delta are of a typically flat floodplain nature with elevations ranging from 18 feet above sea level at Sacramento to nearly 20 feet below sea level at the interior of some leveed Delta islands. The Montezuma Hills border the deep water channel on the west side of the Sacramento River downstream from Rio Vista and are the only lands of the project area exhibiting significant relief. Lands of the Delta are used primarily for agricultural purposes. Corn and small grains are the predominant crops, but considerable land is used for orchards, vegetable production, and grazing. Much of the land is irrigated as insufficient rainfall occurs during the hot summers to support the crops otherwise adapted to the Mediterranean-type climate.

The significant wildlife values associated with the Sacramento-San Joaquin Delta are the result of many factors, most notably vegetative diversity. Approximately 1,000 square miles of fertile Delta land (two-thirds reclaimed lowland) support a variety of crops and are interlaced with about 700 miles of channels and waterways. The channels and waterways, comprising about 40,000 surface acres, are fringed with various types of vegetation on island levees, in contiguous marshes, and on unleveed natural channel islands. The 1,000 square miles of farmland is further diversified by ruderal vegetation along roadways and ditches and in fallow lands, and by isolated groves of trees.

Riparian vegetation is particularly important to wildlife in the Delta because of its interspersion with intensively farmed lands, which alone do not afford all the life requirements for most species. Riparian vegetation is also of importance to the fishery resource because it provides a source of energy in the form of detritus and terrestrial insect life which falls into the river. Five major types of riparian habitat are associated with the levees of the Delta: woodland, woodland-shrub, shrub, shrub-grass, and grass-ruderal. These habitat types are described in the Service's report of October 18, 1979 on the Stockton Ship Channel portion of the San Francisco Bay to Stockton navigation project.

Emergent aquatic vegetation, comprising two wetland types, is also of importance to wildlife in the Delta. One type, marsh, is composed predominantly of hard-stem bulrush with varying amounts of other aquatic species such as cattail, three-square bulrush, water hyacinth, and yellow waterweed. These marshes commonly occur as strands along Delta levees where they serve to buffer wave action and thus reduce levee erosion and resultant loss of terrestrial vegetation. The other wetland type occurs on islands within Delta channels. Some channel islands are terrestrial in character, but many of the smaller ones are tidal wetlands. These island wetlands are often vegetated with both marsh and upland species. Characteristic marsh plants are roundstem, hardstem, and three-square bulrush; cattail; and phragmites. Woody upland plants found on channel islands include willow, buttonwillow, white alder, and creek dogwood.

Suisun Marsh is the most important wetland in the Delta. It is the largest marsh (80,000 acres) of its kind in California and is a major wintering area for migratory birds, at times hosting as many as a million waterfowl. It also produces many thousands of waterfowl during the nesting season. Two-thirds of the area is intensively managed to maximize natural food production for wintering birds by controlling plant composition through regulation of submergence time and soil salinities. Favorable salinity levels are obtained by leaching soil salts with fresh to brackish waters from the leveed channels dissecting the marsh. These channels are also used as a nursery area by shad, striped bass, salmon, and sturgeon. A Suisun Marsh Protection Plan for preservation of the area was enacted into law by the State of California in 1974. Additional protection was given to the marsh in 1978 when the State Water Resources Control Board issued Water Right Decision 1485. Continued preservation of the existing marsh is dependent upon maintaining suitable water quality in Suisun Bay. It is to be noted that salinity requirements differ for fish and wildlife, agriculture, and municipal and industrial uses. Hence, levels acceptable for one use may not be acceptable for others.

The exceptional fishery values of the Delta are a product of the diversity of its aquatic habitats and the highly productive nature of the ecosystem. It supports a variety of both native and introduced anadromous and resident fishes on a year-round basis. The Delta fisheries co-mingle with those of the rivers emptying into the Delta from the Central Valley. Open water habitat in the Delta has been subdivided into the following classifications: mainstem river; high-flow thru channels; low-flow thru channels; deadend sloughs; and special habitat. Each of the various open water habitats of the Delta support somewhat different assemblages of aquatic organisms. The fishery value of all habitat types is enhanced by dense shoreline vegetation which provides cover and a source of invertebrate food and detritus.

The nutrient base supporting fish populations in the Bay-Delta system has its origin in the photosynthesis of phytoplankton, aquatic plants, and terrestrial plants. Nutrients from the latter two sources are not usually available for utilization by aquatic organisms until detritus has been formed. Primary consumers of detritus and phytoplankton are opposum shrimp and other zooplankton, benthic invertebrates, and some species of fish. Secondary consumers, among which are all the fishes, derive their energy mainly by feeding on the above-named primary consumers and on other smaller fishes. Thus, the fisheries of this estuarine system depend on detritus derived from aquatic and terrestrial plants growing in and upstream from the Delta, as well as on phytoplankton production within the estuary.

A very important nutrient trap, or mixing zone, exists where fresh and salt waters meet within the estuary. This highly productive zone moves in response to outflow, shifting downstream with increasing outflow and upstream with decreasing outflow. In recent years during spring, summer, and fall it has usually been located in the shallow and highly productive Suisun Bay area of the estuary.

Bio-production within this hydraulically dynamic zone is high for several reasons. In the upper strata of the zone, flocculation of suspended sediments and detritus occurs, with the result that material settling downward is carried upstream by the more saline bottom waters. At the upper end of the mixing zone where stream currents are dissipated, the organic and inorganic material deflocculates, rises to the surface, and returns downstream where the cycle begins again. There is a continuous loss of nutrient material downstream, but the residence time for incoming nutrients is always greater within the nutrient trap zone than elsewhere. Associated with the high level of nutrients are dense concentrations of phytoplankton and zooplankton (including the important Neomysis shrimp).

The entire reach of the ship channel is affected by tidal flow, but in most years only the portion near Collinsville becomes brackish from intrusion of saltwater. Upstream from that point the water remains relatively fresh due to controlled-flow conditions. Mean tidal amplitude is about 3 feet in the project area, but is more pronounced in the manmade channel where tidal effects are not countered by freshwater inflow. Within the upstream portion of the natural channel there is usually a net downstream flow, but in the broad lower reaches flows are typically reversed during flood tides.

Composition of the manmade channel and river bottom is typically sandy. In other areas of the Delta, benthic composition is predominantly peat. Fine silts and clays suspended in the river do not normally settle out in large quantities until they reach the brackish waters of Suisun and San Pablo Bays where the small material flocculates into larger, heavier particles. Rate of sand deposition within and upstream from the bays varies according to the scouring action of the water flow. Within the manmade portion of the channel, shoreline erosion is evidently responsible for the small amount of sedimentation that occurs there.

The water of the artificial ship channel exhibits different physical and chemical characteristics than that of the natural channel. Insufficient water moves from the river through the lock at the head of the manmade channel to flush the upstream portion of the channel. As a result, the total dissolved solids level of the turning basin usually exceeds 1,000 parts per million (ppm). The downstream portion of the artificial channel is flushed by river water carried up the channel by tidal action so that, at Mile 25, total dissolved solid levels are sometimes as low as 200 ppm. Evidently, other water quality parameters do not differ significantly from the turning basin downstream to Mile 25. During an entire year of sampling, oxygen was determined to be at or near saturation throughout the channel at surface and bottom; most variation within 7-11 ppm range appeared to be the result of temperature change. Alkalinity ranged from 77-154 ppm and hydrogen ion concentration from 8.1-8.7; both parameters remained relatively stable at sampling stations from surface to bottom throughout the year. Anadromous fishes migrating up the artificial channel evidently move through the lock to the river when boats are passed as no evidence of population buildup in the turning basin has been reported.

FISH AND WILDLIFE RESOURCES

Fish Resources

The Sacramento River Deep Water Ship Channel is located within the most important area for fishery resources in California. The area is frequented by high-value anadromous sport species such as king salmon, striped bass, steelhead, American shad, and white and green sturgeon. The significant sport and commercial salmon fishery that exists off the California coast emanates largely from the Sacramento-San Joaquin system. Resident species in the project area of significant sport value include white and channel catfish, brown bullhead, and a variety of sunfish--notably largemouth bass, black crappie, and bluegill. A commercial crayfish fishery has developed in recent years in the Delta. Numerous other species such as threadfin shad, tule perch, delta and longfin smelt, splittail, golden shiner, carp, blackfish, sculpin, Mississippi silversides, and the young of the previously named species make up the food supply for many of the fish of sport and commercial importance. As already noted, the young of many species and some of the adults depend on zooplankton and benthic organisms for food.

Striped bass utilize the project area more intensively than the other anadromous fishes. Adults move upstream from the Bay and spawn in the San Joaquin River portion of the central Delta and in the Sacramento River above Sacramento. Fertilized eggs drift with the current and hatch in 2 or 3 days. The newly hatched larvae drift for several days, living off their yolks, until they reach a tidal area where an external food supply exists. The main nursery area for young striped bass normally extends from western Suisun Bay to the central Delta. Monthly sampling of the artificial channel and the turning basin revealed that the basin and upper channel sustains a population of young striped bass. They probably feed on the abundant supply of zooplankton which includes neomysid shrimp. The Sacramento-San Joaquin system's adult striped bass population, estimated at 1.4 million fish, supports 2 million angler-days of fishing annually. In 1970, the fishery was valued at 7.5 million dollars (1965 dollars). Within the upper artificial channel and turning basin, a significant fishery for striped bass develops every fall. Local anglers say the fishery begins in October, when threadfin shad (a primary striped bass prey) appear in large numbers, and lasts to January. The California Department of Fish and Game estimated angler day-use at 25,700 in 1973 for the upper channel and turning basin.

About 90 percent of the Central Valley's king salmon run enters the Sacramento system by way of the lower project area and proceeds up the mainstem and Steamboat and Miner Sloughs past the artificial channel. Sample catches show, however, that part of the run does migrate up the artificial channel. The adult salmon population (composed of fall, winter, and spring runs) spawns in the upper Sacramento River and its tributaries. Subsequently, the young salmon enter the project area on their seaward migration. When many of them reach the Rio Vista-Collinsville area they are still of subsmolt size and are not physiologically or behaviorally ready to enter the saline waters of Suisun and San Francisco Bays. These small salmon must, therefore, linger in the Delta nursery area until they attain smolt size, at which time they proceed in their migration to the ocean. King salmon are harvested in the ocean by both commercial and sport fishermen, and some sport catches are made in the Bay. The average annual commercial catch of 500,000 fish has an estimated present day, ex-vessel value of about 7.5 million dollars; the National Marine Fisheries Service indicates this value may be a great as 10 million dollars. The ocean sport catch averages 100,000 annually and with the inland sport catch had a combined value in 1970 of 1.3 million dollars (1965 dollars). The inland sport catch occurs primarily upstream from the project area.

American shad is another important sport fish which spends considerable time in the project area. The adults pass through the Delta in the spring during the upstream migration. Most shad entering the Central Valley system spawn in tributaries of the Sacramento River. As with striped bass and salmon, most shad go up the natural channel, but some proceed up the artificial channel as revealed by gill net catches. As with striped bass, the eggs of shad drift downstream until hatching occurs. The habits of young shad are not as well understood as those of young striped bass, but it is known that larval shad are carried downstream and use the project area as a nursery ground. In late summer, a large portion of the juvenile shad population evidently passes through the project area during the downstream migration phase. Shad support an intensive sport fishery from about April through July in the Sacramento River and tributaries. Although catch statistics and fishermen effort have not been documented as for stripers and salmon, a significant amount of recreation is provided as shad are easily caught at times and are very sporting. The California Department of Fish and Game is intensifying research on shad due to the increasing recreational importance of the resource.

Steelhead trout also migrate through the project area and some use the artificial channel. Spawning takes place primarily in tributaries of the Sacramento River. Natural spawning is augmented by artificial means at three hatcheries. Young steelhead, unlike king salmon, spend a year or more in freshwater prior to seaward migration. Unlike salmon, it is thought that young steelhead migrate through the project area without delay. Steelhead provide considerable recreation for the inland fishermen because steelhead, unlike fall-run salmon, continue to feed after entering freshwater. About 20,000 steelhead are caught each year in the Sacramento system; no ocean fishery occurs for steelhead.

White and green sturgeon migrate through the project area on spawning runs up the Sacramento River. Spawning, at least for white sturgeon, takes place in the Sacramento River below Red Bluff. The young drift downstream at a very small size and pass through the Delta en route to San Francisco Bay. On their way to the Bay they probably use the lower project area as a nursery. Capture of sturgeon ranging from about 200 to 500 mm in the artificial channel indicates their use of the channel for migration or nursery purposes. The spawning habits of green sturgeon in the Sacramento-San Joaquin system are not well known. Sturgeon are not caught in large numbers in the river system but considerable effort is expended by anglers seeking trophy specimens weighing a hundred pounds or more. In San Francisco Bay, where sturgeon spend a considerable portion of their life cycle, they are pursued with greater success. A size limit has been imposed to insure recruitment of mature fish for maintenance of a viable population.

About 20 nonmigratory or resident fish utilize the project area and other parts of the Delta. Within the artificial ship channel, 15 species were collected during a one-year sampling program. The resident species support a combined fishery that is probably equivalent to that for striped bass.

The thicktail chub is presently classified as endangered by the California Fish and Game Commission. It has not been collected or otherwise observed in the Delta for many years.

Wildlife Resources

Wildlife species inhabiting the project area are diverse and abundant. Important avian species include wading birds such as great blue heron, black-crowned night heron, great egret, and American bittern; shorebirds such as snipe, killdeer, least sandpiper, and long-billed curlew; waterfowl such as mallard, pintail, Canada geese, and snow geese; upland game birds such as pheasant, California quail, and mourning dove; and over 150 nongame species such as woodpeckers, raptors, and passerines. Mammalian species include beaver, mink, muskrat, river otter, skunk, raccoon, jackrabbit, cottontail rabbit, fox, opossum, and California ground squirrel and other small rodents.

Waterfowl utilize the Delta at all times of the year; as many as a million birds winter in the Bay-Delta system. Open waters are used by dabbling ducks for resting and by diving ducks and grebes for feeding. Marshes and flooded agricultural lands provide the main source of food and cover for dabbling ducks. Few waterfowl nest in the channel area. In 1976, about 25 mergansers wintered at the upper end of the artificial channel and evidently found food with little difficulty. At least six pairs of mallards were observed on the channel in the spring of 1976. Ducks feed in the marshes between the channel and levee when flooded by rising tides. The artificial channel probably winters numerous waterfowl in years when adjacent agricultural lands in Yolo Bypass are flooded. Waterfowl hunting in the Bay-Delta system is considered by some to be the best in the State. Private clubs are located on Suisun Marsh and in the Yolo Bypass; unattached hunters utilize the many channels of the Delta, the bays, and the State-owned marshes in and near the project area, e.g., Sherman and Grizzly Islands. Duck hunting on the artificial channel is light, possibly due to concern over prosecution for trespass.

Upland game species such as pheasant, California quail, mourning dove, and cottontail rabbit are abundant in the project area because of the favorable habitat afforded by the interspersion of crop fields, fallow land, and the woody cover bordering Delta channels and irrigation ditches. Pheasants are common along the artificial channel despite the barrenness of some levees and berms due to grazing and burning. Pheasant is the most popular upland game species in the area, but if weather conditions are favorable large numbers of doves delay their southward migration and thereby provide excellent hunting. Access to project lands bordering the artificial channel is very limited due to posting by adjacent land owners. A few hunters gain access to land on the west side of the channel by means of small boats.

Furbearers such as muskrat, mink, river otter, skunk, fox, beaver, and weasel are found in the area. Several beaver lodges are located adjacent to stands of willows along the artificial channel and no doubt other water-dependent species inhabit the project area as in the rest of the Delta. Trapping is not as important as it once was because of reduced furbearer populations due to man's modification of the Delta. Most of these species are almost totally dependent for their existence on the riparian-marsh-water interspersion of the estuary.

Nongame birdlife of the Delta encompasses in excess of 150 species ranging in size from the tiny hummingbird to the tall and stately sandhill crane. Observing nongame as well as game species is an important recreational activity for many people living in and visiting the rural areas of the Bay-Delta ecosystem. The amount of happiness and contentment derived from the experience of observing wildlife in its natural habitat is as difficult to quantify as the pleasure derived from participating in hunting, trapping, and fishing. The greatest aesthetic value is associated with those species which are large and easily observed, such as the great egret, great blue heron, black-crowned night heron, and American bittern. These species, like waterfowl and shorebirds, are entirely dependent on the aquatic habitat and associated plant species. Raptors such as redtail, red-shouldered and rough-legged hawks, white-tailed kite, and turkey vulture, are commonly seen perched in trees or flying overhead. The ecological role of these predatory birds and their dependency on small fish, birds, and mammals sets them apart from other birds in the minds of many people who, having only a casual interest in birds, stop to watch their conspicuous quest for food. The presence of native species in their historical ranges depends on continued maintenance of a suitable environment. Their value extends beyond aesthetic considerations because they provide a service of direct economic importance by consuming harmful insects and weed seeds.

Endangered and Threatened Species. The American peregrine falcon, southern bald eagle, Aleutian Canada goose, and salt marsh harvest mouse, all classified as endangered by the Secretary of the Interior and the California Fish and Game Commission, are associated with the Sacramento-San Joaquin Delta, as are certain other species classified as rare by the Commission, e.g., Alameda striped racer, giant garter snake, California black rail, and California yellow-billed cuckoo. Critical habitat has been established near Antioch for the protection of two endangered plants: Contra Costa wallflower and Antioch Dunes evening primrose. This critical habitat is also inhabited by the endangered Lang's metalmark butterfly. Compliance with the Endangered Species Act requires that the District Engineer make a written request to the Regional Director of the Fish and Wildlife Service, Portland, Oregon, for a list of endangered and threatened species, or species that have been proposed for listing, that may be present in the area affected by the proposed action. Following receipt of the Service-supplied list, the Corps of Engineers should conduct a biological assessment to ascertain the probable effects that construction of the project would have on endangered and threatened species. The results of the biological assessment form the basis for a determination as to whether formal consultation under Section 402.05 of the Act is required.

PROJECT IMPACTS ON FISH AND WILDLIFE

Deepening the Sacramento River Deep Water Ship Channel would impact fish and wildlife resources in the project area by: (1) disrupting benthic habitats, (2) removing marsh and riparian vegetation, (3) disrupting upland wildlife habitat, and (4) inducing industrial growth. Additionally, it is possible that channel deepening could alter salinity distributions as well as sedimentation rates and patterns.

Physical model studies conducted by the Corps of Engineers indicate that deepening the Stockton Ship Channel alone would have no effect on salinity distributions in the Bay-Delta estuary. However, deepening both the Stockton Ship Channel and the Sacramento Ship Channel would, according to the model studies, cause an increase in salinity levels ranging from 5 to 10 percent in the Sacramento River above Rio Vista and in the central and southern parts of the Delta. There would be no change in salinity levels, due to deepening of the channels, in either Suisun Bay or Suisun Marsh or in the lower San Joaquin and Sacramento Rivers.

Model studies of the proposed project, i.e., a deepened Sacramento Ship Channel (connected to a previously deepened Stockton Ship Channel), plus a submerged sill in Carquinez Strait, indicate that at flows below 15,000 cfs there would be: (1) no measurable change in salinity downstream from the sill, (2) a decrease in salinity upstream from the sill in Suisun Bay of 2 to 8 percent, (3) a decrease in salinity in Suisun Marsh of 3 to 10 percent, (4) a decrease in salinity in the lower Sacramento and San Joaquin Rivers of 3 to 15 percent, and (5) a decrease in salinity in the remainder of the system of 1 to 15 percent, with the exception of the upper Sacramento River (above Rio Vista) where salinities would not be entirely reduced to preproject levels. Above Rio Vista, the salinity concentration would increase by about 75 parts per million.

From the standpoint of salinity it would therefore seem that installation of a submerged sill would be advantageous to fish and wildlife. However, a submerged sill could well affect the dynamics of estuarine phenomena in addition to that of salinity distribution. The possible disruption of the nutrient trap zone by a submerged sill is a matter of concern to biologists studying the Bay-Delta system as is the effect of a sill on the movement of aquatic organisms and the transport of toxic materials and sediments. On balance, the negative impacts of the project on fish and wildlife might be least severe if the modest increase in salinity induced by channel deepening is accepted in lieu of a submerged sill to control salinity intrusion.

Whether the results of the model studies constitute a fully accurate forecast of the effects of channel deepening and a submerged sill on salinity distribution is not certain. In the opinion of a panel of experts retained by the Corps of Engineers to review the results, the differences observed in salinity readings under "with and without conditions" may be no more an indication of actual changes than of "noise" in the model. In any case, the panel concluded that installation of a submerged sill is not warranted on the basis of the model studies. Thus, as previously noted the project plan provides for sill installation only if monitoring studies conducted before and after channel deepening reveal that an adverse alteration of salinity distribution has occurred.

The bottom topography of Suisun Bay would change to some degree following installation of a submerged sill. The net effect would likely be increased sediment deposition upstream from the sill until the bottom topography of the estuarine system adjusted to the new control being exerted. No attempt has been made to assess the long-term changes in sediment dynamics which would follow installation of a submerged sill in Carquinez Strait. Studies conducted thus far have focused on the effect of the sill on transport of sediment upstream--the potential impact of the sill in reducing sediment load carrying capacity above the sill has not been fully addressed.

Changes in sedimentation resulting from sill-induced alteration of estuarine hydraulics could lead to significant changes in fish and wildlife habitat in the estuary over the long term. With reduced current speed in upstream areas, caused by restriction of flow through Carquinez Strait, river-borne sediments would tend to settle out farther upstream than they now do. This could accelerate filling of slack-water areas and alteration of benthic habitat. Without data delineating anticipated changes in bottom topography, we are unable to forecast with any precision the impacts of the sill on the various fish and wildlife species of the estuary.

Destruction of benthic communities occurs when channels are dredged. Dredging to deepen the channel would remove organisms in the annelidan, molluscan, and arthropodous groups from about 1,540 acres of benthic habitat. Reestablishment of benthic communities is, however, normally accomplished within 2 years. Deepening a ship channel within a river or tidal area usually leads to more frequent maintenance dredging because, as the cross-sectional area of the river or channel is increased, current velocity and sediment carrying capacity are reduced. Deepened channels are out of equilibrium with the flow and sedimentation dynamics of the natural system, thus suspended sediments are deposited at an increased rate. A shortened maintenance dredging schedule means more frequent destruction of the benthic community and possible prevention of total recovery.

Some fish life, as well as benthic organisms, would be pumped out of the water onto dredged material disposal areas. The severity of the impact would depend on the time of year when dredging occurs and on the skill of the dredge operators in keeping the suction head in the sediments to minimize the amount of water pumped. Additionally, dredging negatively impacts aquatic life by generating high turbidity levels, reducing dissolved oxygen levels, and resuspending toxic materials.

Destruction of marsh and riparian vegetation--and consequent displacement and ultimate loss of wildlife--along the artificial portion of the ship channel constitutes the most obvious impact that would result from the project. Widening the channel from 200 to 250 feet would mean the loss of 45 acres of vegetation inboard of the levees.

Round-stem bulrush would begin reestablishment in shallow and tidal areas of the modified levee berms the year following construction; however, stands comparable to those previously existing would probably not develop due to reduced area between the water's edge and the levees. Until recovery occurred, use of the levees and berms by waterfowl and upland game for cover, feeding, and nesting would be severely reduced. New growth of willows would also start soon after construction, but development of mature, dense stands favored by beaver would probably take 5 to 10 years. The most apparent adverse impact of the project on a single species would be in connection with beaver since five lodges in the lower half of the artificial channel would be destroyed. The affected beaver would probably be lost unless a suitable transplant habitat was found because nearby Prospect Slough has an established beaver population. Few areas exist in the Central Valley to which beaver could be successfully transplanted.

Reduction in the amount of detritus contributed by marsh and riparian plants to the aquatic ecosystem constitutes another negative aspect of the project. Detritus and its associated bacterial populations are utilized as food by benthic and planktonic organisms as well as by some fishes. The importance of detritus to estuarine production is receiving more and more recognition as studies of estuarine dynamics continue. In the Bay-Delta estuary, detritus was abundant when expansive marshes existed and when riparian vegetation lined the river and its floodplain. Widespread removal of natural vegetation in recent times is an important reason why all remaining marsh and riparian vegetation should be preserved wherever possible.

As now planned, compensation for the marsh and riparian habitat lost along the artificial portion of the channel would be realized through regrowth along the new channel edge and development of a 45-acre marsh at the southern tip of Prospect Island. This "agricultural-disposal" site would be sculptured to create channels, marshes, and upland habitat prior to the restoration of tidal action.

Upland wildlife habitat would be lost at disposal sites along the channel due to placement of dredged materials. The area needed to accommodate the 30.3-million cubic yards of dredged material is 3,500 acres. Within the reach of the artificial channel, dredged materials would be placed along the levee system which was designed for its containment. Within the river channel reach, dredged materials would be placed on adjacent uplands. The simultaneous destruction of riparian and marsh vegetation along the artificial channel and of upland habitat at the disposal sites would constitute a significant loss of wildlife habitat. The development of a recreation area at one of the disposal sites could improve conditions for wildlife if open space for wildlife habitat is provided. If the area is totally developed for recreation, negative impacts to wildlife would result. Adverse impacts would occur, as now, when sand is blown from the disposal sites and deposited in the riparian vegetation along the Sacramento River south of Rio Vista.

Growth-inducing aspects of the project would lead to additional losses of fish and wildlife habitat and to further deterioration of the estuarine system. Deepening the channel would likely foster the establishment of new industries on agricultural lands in the vicinity of Collinsville and at the Port of Sacramento. Expansion at the Port would probably mean destruction of the marsh at Lake Washington. Development could also foreclose use of land now providing access to the turning basin for anglers and other recreationists. Industrial development in the Collinsville area could impact Suisun Marsh in an adverse way, and any oil spill in the Suisun Marsh area would obviously be detrimental to wildlife. Contamination of the aquatic system would undoubtedly increase as a result of industrialization on adjacent lands and the associated vessel traffic.

DISCUSSION

Aside from the uncertainties associated with possible installation of a submerged sill in Carquinez Strait, we believe the channel deepening plan affords opportunities to satisfactorily reduce adverse impacts and to compensate for unavoidable losses. Opportunities exist as well for enhancing fish and wildlife resources and recreational use of the study area. The following paragraphs substantiate our recommendations for loss prevention, compensation, and enhancement.

Hydraulic model studies conducted by the Corps of Engineers have indicated that installation of a submerged sill in Carquinez Strait, with a deepened channel, would have the effect of generally reducing salinity levels in Suisun Bay and in other upstream reaches of the estuary. Were salinity intrusion a sole concern, and assuming reliability of the model studies, it could be concluded that installation of the sill would likely be to the overall advantage of fish and wildlife resources--given the other factors, such as export pumping, that alter the natural hydraulics of the Bay-Delta system. But, as already noted, a submerged sill poses problems for fish and wildlife apart from salinity considerations that have not been subjected to enough study to allay our concerns. A satisfactory assessment of a submerged sill cannot be made until additional information is developed on the impacts of such a structure on the nutrient trap zone, the movements of aquatic organisms, and the transport of toxic materials and sediments.

In the absence of information essential to a more complete understnding of the consequences likely to attend installation of a submerged sill, we would favor a project plan that does not include that feature at all. The relatively small increase in salinity levels in parts of the system that may be anticipated from channel deepening alone, again assuming reliability of the model studies, are not considered great enough to adversely affect fish and wildlife. It is recognized, however, that a submerged sill (or some other means to repel salinity intrusion) may be required following channel deepening to accommodate the interests of the Water and Power Resources Service and the California Department of Water Resources. Those agencies, which must take into account the effects of their project operations on Delta salinity, have indicated that they will not support the channel deepening proposal if an increase in salinity intrusion is predictable.

As proposed by the Corps of Engineers, deepening of the ship channel would be preceded and followed by monitoring studies to determine the effect, if any, of deepening on salinity distribution in the Sacramento-San Joaquin Delta. A submerged sill would be constructed in Carquinez Strait only if that were necessary to restore salinity distribution in the Delta to the preproject condition. In that event, monitoring would be continued until such time as it could be concluded that the salinity problem has been satisfactorily corrected.

This approach is acceptable to the Fish and Wildlife Service provided the authorization for the project requires a full consideration of all factors (not just salinity) affecting the distribution and abundance of fish and wildlife resources in the Delta before arriving at a decision to build the submerged sill. It is very possible that, given additional information, the disadvantage to fish and wildlife resources assignagle to a submerged sill could outweigh the benefits to be gained by all interests through the restoration of salinity distribution to the pattern that prevailed before channel deepening.

The project authorization should require specifically that, in the event installation of a submerged sill (or functionally equivalent device) is contemplated subsequent to channel deepening, the Corps of Engineers shall: (1) fund a special study by the Fish and Wildlife Service to ascertain the probable impacts of a submerged sill on fish and wildlife resources; (2) give full and equal consideration to the recommendations of the Fish and Wildlife Service, based on such study, in arriving at a decision concerning the advisability of constructing a submerged sill; and (3) prepare a supplemental environmental impact statement solely addressing the construction of the sill and incorporating all information obtained in the studies conducted under (1) above.

Losses to the benthic community attributable to dredging, while severe, are temporary and would be offset over the life of the project due to the fact that channel deepening and widening has the effect of creating benthic area. Preliminary calculations indicate that channel enlargement would increase benthic habitat in the project area by about 212 acres (1,537 acres vs. 1,749 acres).

It is difficult to calculate the fish and wildlife values that would be lost over the life of the project due to removal of 45 acres of marsh and riparian vegetation along the artificial channel because some areas newly exposed to the water's edge by channel modification would develop such habitat. For calculation purposes, we have assumed that existing marsh and riparian habitat has a habitat unit value of 10 (on a scale of 0 to 10). Accordingly, 22,500 habitat units would be lost initially (45 acres x 10 habitat units x 50 years). Creating 45 acres of marsh riparian habitat (unit value of 10) from agricultural land (unit value of 5) would restore only one-half the value lost. Full restoration would require that 90 acres of agricultural land be converted to marsh-riparian habitat, assuming that no new habitat developed along the channel. Since it can be anticipated that some habitat would develop naturally on areas newly exposed to tidal action during the life of the project, we have concluded that the proposed 45-acre compensation area would satisfactorily offset marsh and riparian habitat losses along the artificial channel.

Reduction of upland habitat losses at the dredged material disposal areas could be achieved in several ways. Along the artificial channel, well-vegetated portions of the existing disposal strip between the channel levee and the toe drain should be left intact. This would be especially important if most of the vegetation between the channel and the levee was destroyed, as the remaining vegetation would become critically important to the wildlife living along the channel. This same practice should be followed on other large disposal areas. The disposal sites south of Rio Vista should be managed to prevent dried spoils from blowing onto riparian vegetation and back into the river and channel. Erection of snow fences and revegetation might be needed. Also, conditions for wildlife on permanent disposal sites could be optimized by planting annual and perennial species having wildlife food and cover values. It is recognized that some of the areas would have to be reused when maintenance dredging is performed, but significant fish and wildlife benefits could be gained through appropriate management during interim periods. Rotational use of the sites and of areas within the sites would contribute to the reduction of adverse impacts over the life of the project.

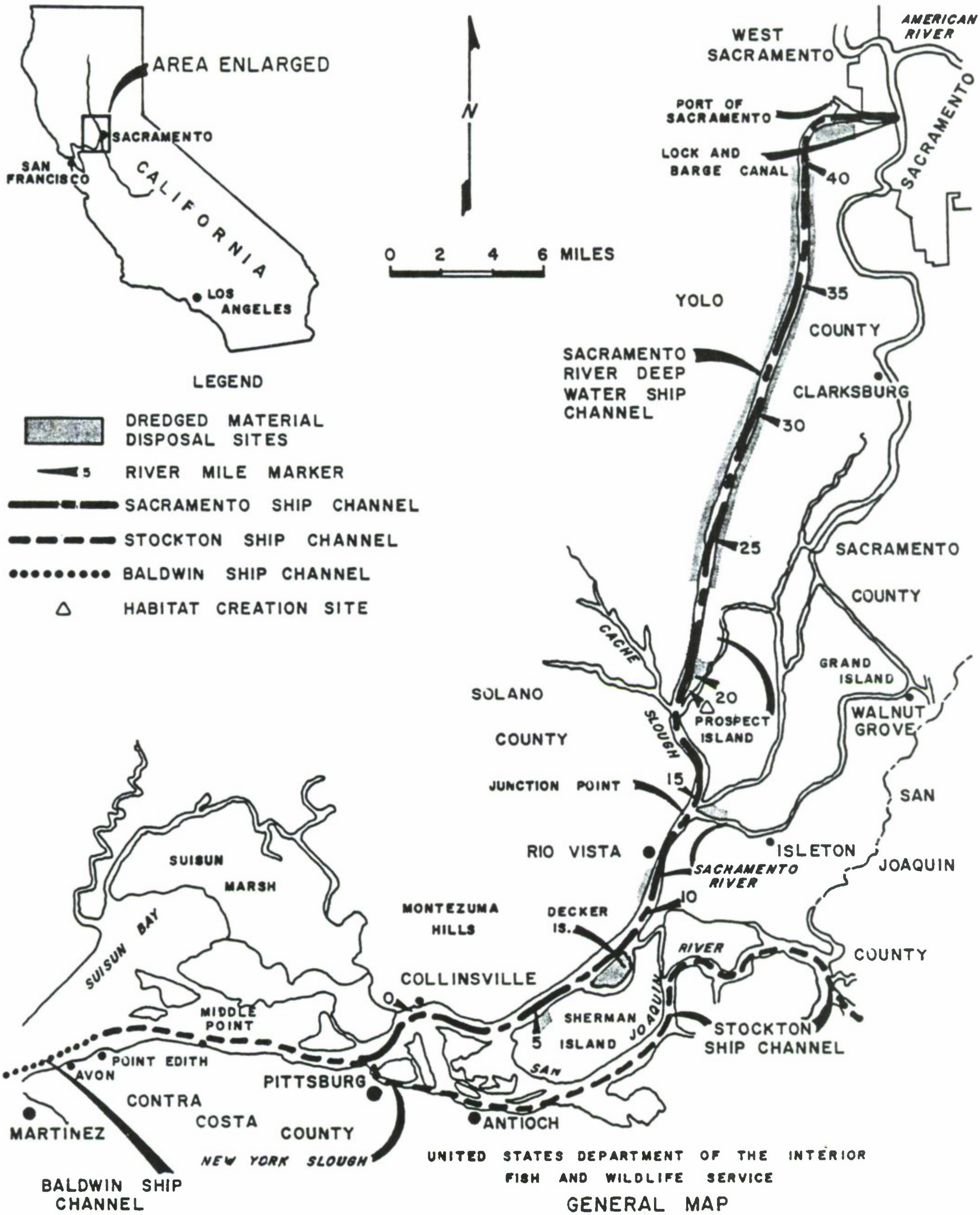
Measures would have to be implemented to offset unavoidable adverse impacts at the disposal sites. To fully compensate for losses resulting from disposal operations, improvement of fish and wildlife habitat should be undertaken. For purposes of calculating the compensation requirement, we have assumed that the 3,500 acres of disposal sites have an average habitat unit value of 5, and that following placement of dredged material the wildlife value of the sites would not be recovered for at least 2 years. Using these parameters, it is calculated that the initial disposal operation would cause a net loss of 35,000 habitat units (3,500 acres x 5 habitat units x 2 years). This loss should be offset over the life of the project (50 years) by developing a portion of the total disposal area into wildlife habitat subsequent to spoil disposal at the time of project construction. The developed habitat, which would have a unit value of 10, should not be used for disposal of dredged material during future project maintenance. If it is assumed that the developed habitat would attain a value of 10 habitat units per acre by year 10 of the project (equivalent to 5 years with no value), then approximately 156 acres should be set aside for wildlife, i.e., 35,000 habitat units = increased habitat unit value of 5 x 45 years x 155.6 acres. Maximum utility to wildlife would be realized if the 156 acres of habitat were developed in several small tracts in the project area.

Enhancement of fish and wildlife resources would be possible on project lands between the edge of the water and the backside of the levees if managed optimally for regrowth of marsh and riparian vegetation. Modification of the levee berms to create small ponds is another possibility. Such ponds should be constructed so that they would contain some water even at low tides. The levees and channel edges could be greatly improved for wildlife through implementation of better land use practices: burning should be eliminated as a levee maintenance practice unless done to promote vegetation of value to wildlife; and cattle should be excluded from marsh areas. Project lands which are leased for agricultural purposes could also be managed for hunting and other compatible recreational uses.

Project authorization should provide for public access to the artificial channel and to project lands. At present, public access to the channel is by means of boat only from either end of the channel and, in the case of the upstream access, to daylight hours when the navigation lock is operated. At least three additional boat access points are needed to allow for full use of this navigable waterway. Neither present use by commercial vessels nor anticipated future use is considered sufficient to preclude use of the channel by recreational boaters. Access to all project disposal sites should be permitted to allow for public enjoyment of fish and wildlife resources and general outdoor recreation. Areas for intensive recreational use should be established as a part of the project, if deemed desirable by the California Department of Parks and Recreation or the County recreation and parks departments. Small picnicking areas and turnouts on levee roads would greatly enhance public enjoyment of the channel.

Implementation of those above-described enhancement measures which would necessitate an expenditure of funds would require cost-sharing in accordance with the provisions of the Federal Water Project Recreation Act (PL 89-72). To date, coordination with non-Federal entities has not revealed an interest in sharing the capital cost of public access facilities and assuming responsibility for annual operation and maintenance.

Opportunities exist to create or improve wetland habitat through the use of dredged material, as authorized under Section 150 of the Water Resources Development Act of 1976 (PL 94-587). Given certain conditions specified in the statute, all costs of establishing a wetland area through the use of dredged material can be allocated to the Federal government. There are areas adjacent to the channel that are suitable for placement of spoils to desired elevations and configurations, with subsequent connection to tidal flow, as is proposed for the Prospect Island compensation area. Additionally, there is an 18-acre diked island in Miner Slough which could be converted into a marsh through placement of spoils and restoration to tidal action. The expansive shallow water area on Prospect Island affords a similar opportunity. To further improve wetland habitat along the artificial channel, the altered levee berms could be rebuilt to a height and slope (relative to the tidal fluctuations) to allow establishment of marsh vegetation.



UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE

GENERAL MAP
CORPS OF ENGINEERS
SACRAMENTO RIVER DEEP WATER SHIP CHANNEL
SACRAMENTO, SOLANO, YOLO COUNTIES, CALIFORNIA
JANUARY 1979 PORTLAND, OREGON

STATE OF CALIFORNIA—RESOURCES AGENCY EDMUND G. BROWN JR., Governor

DEPARTMENT OF FISH AND GAME
1416 NINTH STREET
SACRAMENTO, CALIFORNIA 95814
(916) 445-1383

March 10, 1980

Mr. William Sweeney, Area Manager
U.S. Fish and Wildlife Service
2800 Cottage Way, Room E-2740
Sacramento, California 95825

Dear Bill:

Your letter of February 4, 1980 (ES-S), asks if we wish to withdraw our previous concurrence with your Sacramento River Deepwater Ship Channel report.

Although we do not wish to withdraw concurrence, in light of concerns about the project expressed in our letter to you of February 21, 1980, the recommendation of studying the effects of a submerged sill in Carquinez Strait subsequent to construction of the project is unacceptable. Mitigation measures must be agreed upon prior to construction. With the exception of this single item, we concur in the findings and recommendations of your report.

If the Department can be of further assistance, please contact Robert W. Lassen, Regional Manager, Region 2, 1701 Nimbus Road, Rancho Cordova, California 95670, telephone (916) 355-7020.

Sincerely,

FOR Director

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COURT HOUSE
FAIRFIELD, CALIFORNIA 94533

February 6, 1979

Colonel Donald M. O'Shei
Sacramento District, Corps of Engineers
650 Capitol Mall
Sacramento, California 95814

Dear Colonel O'Shei:

In reply to your recent letter, the Board of Supervisors of the County of Solano this day is expressing the interest and intent of the County of Solano to participate in the recreation function of the Sacramento River Deep Water Ship Channel Investigation as follows:

- Provide without cost to the United States the land, easements, rights-of-way or other proprietary interest in lands necessary for the development of public recreation facilities;

- Pay, contribute in kind, or repay (which may be through user fees) with interest, a portion of the cost of recreation facilities which when added to the cost of recreation lands would amount to 50 percent of the total first cost of the recreation lands and recreation facilities; and

- Maintain and operate the public recreation areas at non-Federal expense.

The County of Solano has an interest in the recreation function of the investigation and by this letter assures that necessary local assurances will be provided by the County of Solano. The Board of Supervisors of the County of Solano understands that a cost-sharing contract will need to be entered into at the appropriate time prior to construction. This is subject to our approval of the final recreation plan, to be developed jointly with the Corps of Engineers, and acceptance of the final cost allocations pertaining to the recreation function.

Sincerely yours,

LARRY L. ASERA, Chairman
Board of Supervisors

LLA:pm

Port of Sacramento

SACRAMENTO-YOLO PORT DISTRICT / WORLD TRADE CENTER / WEST SACRAMENTO, CALIFORNIA 95691 / TWX 910-367-3581 / TEL (916) 371-8000

July 1, 1980

File No. 5030.1

Colonel Paul F. Kavanaugh
District Engineer
U.S. Army Corps of Engineers
650 Capitol Mall
Sacramento, CA 95814

Dear Colonel Kavanaugh:

I am in receipt of your letter of June 23, 1980 requesting a statement of intent to provide assurances of non-Federal cooperation. This is to advise that the Port of Sacramento will be prepared to enter into an agreement of assurances to provide all elements of non-Federal costs that may be required by the Congress in the authorizing document. This assurance will also include the cost sharing referred to in your June 3, 1980 letter to Mr. Huey D. Johnson, Secretary for Resources for the State of California, and covered in his reply to you dated June 26, 1980.

We understand that the local cooperation that you intend to recommend are those referred to in the "Draft Feasibility Report" on the project, dated September, 1979 and was the subject of a public hearing on November 13, 1979. The specific assurances are as listed below:

a. Provide without cost to the United States all lands, easements, and rights-of-way required for construction and subsequent maintenance of the project and for aids to navigation, including suitable areas determined by the Chief of Engineers to be required in the general public interest for initial and subsequent disposal of dredged material;

b. Provide without cost to the United States all dredged material retention dikes, bulkheads, and embankments, necessary for project construction, or the costs of such retaining works, except for additions required solely for

PORT OF SACRAMENTO

development of the recreation area;

c. Hold and save the United States free from all claims for damages due to deposition of dredged material, and due to the construction of new levees or reconstruction of existing levees along the Sacramento River Deep Water Ship Channel, including damages to such levees or damages due to the failure of such levees, except damages due to the fault or negligence of the United States or its contractors;

d. Hold and save the United States free from damages to wharves, bridge piers and other marine and submarine structures, and agricultural lands, due to initial dredging work and subsequent maintenance dredging, except damages due to the fault or negligence of the United States or its contractors;

e. Accomplish without cost to the United States all utility modifications and relocations required for construction of the project works, including new bridges or bridge alterations (except for railroad bridges), and absorb any increased annual maintenance and operation costs that might result from such modifications and relocations;

f. Provide, maintain, and operate at local expense adequate public terminal and transfer facilities open to all on equal terms, in accordance with plans approved by the Chief of Engineers;

g. Provide and maintain without cost to the United States all public berthing areas, at depths commensurate with project depths, at all public terminals and wharves to be served by the deepened channel;

h. Provide without cost to the United States the lands, easements, rights-of-way or other proprietary interest in lands necessary for the development of the fish and wildlife mitigation facilities;

i. Share the cost of the fish and wildlife mitigation features including lands in the same ratio as the remaining costs of the navigation features; and

j. Hold and save the United States free from all claims for damages due to construction of the fish and wildlife mitigation facilities, except damages due to the fault or negligence of the United States or its contractors.

Please be advised that we disagree with the appropriateness of your recommendation in two matters and expect

PORT OF SACRAMENTO

to seek modification thereof through Congress. These matters are:

1. Provision of dredged material retention dikes, bulkheads and embankments. These items, in the past, have been a normal part of the Corps' construction. Obviously, there must be an interface between the Federal and local responsibilities someplace, but we fail to see any logic in this item. Furthermore, it is our contention that this is merely a shifting of traditional Federal costs to the local interests.

2. Cost sharing. This matter at this stage is only an Administration proposal that still requires Congressional action. We have numerous objections to this cost shift but it suffices to say that we do not expect you to implement this until there is Congressional action and so our assurances are contingent on such action.

Very truly yours,

Melvin Shore

Melvin Shore
Port Director

MS/ns

OFFICE OF THE SECRETARY
RESOURCES BUILDING
1416 NINTH STREET
95814

(916) 445-5656

Department of Conservation
Department of Fish and Game
Department of Forestry
Department of Navigation and Ocean Development
Department of Parks and Recreation
Department of Water Resources

EDMUND G. BROWN JR.
GOVERNOR OF
CALIFORNIA

Air Resources Board
California Coastal Commission
California Conservation Corps
Colorado River Board
Energy Resources Conservation and Development Commission
Regional Water Quality Control Boards
San Francisco Bay Conservation and Development Commission
Solid Waste Management Board
State Coastal Conservancy
State Lands Commission
State Reclamation Board
State Water Resources Control Board

THE RESOURCES AGENCY OF CALIFORNIA
SACRAMENTO, CALIFORNIA

JUN 2 6 1980

Colonel Paul F. Kavanaugh
District Engineer
Sacramento District
U. S. Army Corps of Engineers
650 Capitol Mall
Sacramento, CA 95814

Dear Colonel Kavanaugh:

Your letter of June 3, 1980 requested assurances of payment of a five percent "State" share of the total first cost of the proposed Sacramento River Deep Water Ship Channel Project.

We cannot give you the assurances requested. The State of California does not have statutory authority to provide financial assistance for the construction of federal navigation projects and, as you are aware, we have expressed some concerns about the project.

If Congress authorizes this project, and includes a requirement that nonfederal interests pay five percent of the total first cost, then the local sponsors would have to pay it--in addition to the remaining nonfederal costs. We suggest that you contact the Port of Sacramento to determine its willingness to pay these costs.

Sincerely,

Huey D. Johnson

Huey D. Johnson
Secretary for Resources

cc: Mr. Melvin Shore
Port of Sacramento
P. O. Box 815
West Sacramento, CA 95691

SACRAMENTO RIVER DEEP WATER
SHIP CHANNEL, CALIFORNIA
FEASIBILITY REPORT AND
ENVIRONMENTAL IMPACT STATEMENT
FOR NAVIGATION AND RELATED PURPOSES

APPENDIX 3

Environmental Impact Statement

PREPARED BY THE
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
DEPARTMENT OF THE ARMY

SACRAMENTO RIVER DEEP WATER SHIP CHANNEL
ENVIRONMENTAL IMPACT STATEMENT

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SUMMARY

Sacramento River Deep Water Ship Channel, California Environmental Impact Statement

Major Conclusions and Findings. — The navigation problems and needs of the Sacramento River Deep Water Ship Channel were investigated in response to resolutions of the House of Representatives. Four alternative plans were considered: (1) Increased usage of Lighter Aboard Ship (LASH), (2) Intermodal transportation of cargo to alternative ports, (3) Deepening the channel, and (4) No Action. Of the alternatives considered, only the deepening alternative would substantially meet the needs of the study area. The selected plan provides for deepening the existing channel from 30 to 35 feet and widening as necessary and construction of a recreation area at a cost of $73.1 million. Two alternative variations of the selected plan were investigated and utilized to improve it: a National Economic Development (NED) Plan and an Environmental Quality (EQ) Plan. The Sacramento District Engineer has reviewed and evaluated information contained in this environmental impact statement and has concluded that the proposed action is based on a thorough evaluation of all viable alternatives. The project is in consonance with national policy, existing statutes, administrative directives, and is supported by Sacramento, Yolo, and Solano Counties. An evaluation of the selected plan pursuant to the Clean Water Act of 1977, as amended (33 USC 1344), indicates there would be no significant adverse environmental effects due to disposal of dredged or fill material in waters of the United States or adjacent wetlands.

Areas of Controversy. — Several areas of concern were identified during the course of the study. One concern was the loss of 45 acres of marsh and riparian vegetation. This vegetation will be lost as a result of widening the manmade portion of the ship channel. Mitigation consists of a replanting program to convert a 45 acre former dredged material disposal (DMD) site to a tidal marsh. Another concern was the dumping of dredged material on 3,500 acres of land which are presently agricultural and upland habitat. Associated with this disposal would be a reduction in the wildlife associated with this habitat. Habitat improvement on 156 acres of these lands following DMD would mitigate for this loss. The physical effect of dredging the channel would also cause a short-term reduction in the population levels of benthic organisms and the fish which are dependent on these organisms for food; both would be restored to preproject levels following construction. Finally, there was concern that salinities would increase in the Bay-Delta estuary. However, extensive physical and mathematical model tests indicated no adverse changes in salinities would occur with the proposed channel deepening. It is proposed that the effects of channel deepening on salinity distributions in the Sacramento-San Joaquin Delta and Suisun Bay would be monitored before, during, and after the channels are deepened. If an unacceptable increase in salinities is determined to be caused by the deepening, a submerged sill or acceptable alternative in Carquinez Strait would be constructed. Monitoring would then continue after sill construction to further verify its effectiveness. Additional model studies would be conducted by the Corps of Engineers in cooperation with the California Department of Water Resources and other concerned State and Federal agencies during advanced engineering and design stages to further evaluate changes in salinity distributions associated with channel deepening. If these studies reveal measurable salinity increases attributable to channel deepening, a submerged sill or alternative mitigative measure would be implemented at the time of channel deepening and completed concurrent with the deepening.

Unresolved Issues. — There are no unresolved issues at this time for any of the plans discussed.

Addendum

New requirements for EIS. — As a result of regulations published by the Council on Environmental Quality (CEQ) on 29 November 1978 (40 CFR 1500-1508), the Corps of Engineers issued a proposed rule with new requirements for EIS. The proposed rule is a draft Engineer Regulation No. 200-2-2, "Environmental Quality: Policy and Procedures for Implementing NEPA" which will become 33 CFR 230. Additional instructions issued by the Office of the Chief of Engineers provide that draft EIS's scheduled to be filed after 30 July 1979 should be in the new format described in the proposed rule. If the draft EIS is sufficiently advanced to preclude extensive rewrite and scheduled for filing after 30 July 1979, it should simply include revised pages or an addendum to address the additional sections required by the new CEQ format. These sections are: (1) 1502.12 (Summary), (2) 1502.13 (Purpose and Need), (3) 1502.17 (List of Preparers), (4) 1502.24 (Methodology and Scientific Accuracy), (5) 1502.25 (Environmental Review and Counsultation Requirements), and (6) 1502.10 (Index). The Summary preceeds this Addendum, and the other 5 additional sections are presented below in this addendum. Other information, presented in the format previously required, follows this addendum.

Purpose and Need. — The navigation problems and needs are being investigated in response to resolutions of the House of Representatives Committee on Public Works, adopted on 10 July 1968 and 11 December 1969. The proposed project would primarily provide savings in transportation costs by providing passage of larger and deeper-draft ships, in addition to providing some recreation benefits.

Methodology and Scientific Accuracy. — Certain technical, economic, and environmental criteria were used to develop and select a plan which best responds to the problems and needs identified by affected parties in accordance with the Water Resource Council's "Principles, Standards, and Procedures for Water and Related Land Resources," 25 October 1973.

Technical Criteria. —

a. All plans should be consistent with Federal laws, policies, and standards and be cognizant of State and local ordinances and county and city land use zoning. Existing transportation improvements should be preserved and utilized to the maximum extent, consistent with economic criteria.

b. Navigation improvements should be designed to safely accommodate the vessel traffic expected to use them.

c. Disposal sites should be constructed with retention dikes, spill boxes, and proper drainage pond systems to assure that water quality standards set by the State Water Resources Control Board are met.

Economic Criteria. —

a. A plan must have net national economic development benefits unless the deficiency in net benefits for the national economic development objective is the result of benefits foregone or additional costs incurred to serve environmental quality.

b. Each separable unit of a plan should provide benefits at least equal to cost.

c. Benefits and costs should be expressed in comparable terms to the fullest extent possible.

d. There is no more economical means, evaluated on a comparable basis, of accomplishing the same purpose or purposes which would be precluded from development if the plan were undertaken. This limitation refers only to those alternative possibilities such as other west coast ports, etc., that would be physically displaced or economically precluded from development if the project were undertaken.

ENVIRONMENTAL AND OTHER CRITERIA. —

As provided by "Principles and Standards," preservation or enhancement of area environmental resources is given equal consideration with economic efficiency in developing and evaluating alternatives. Navigation or other improvements should be designed so that existing natural and cultural resources will be disturbed as little as possible, and mitigation for unavoidable losses should be provided to the maximum extent practicable and justified. Other criteria considered in formulating a plan were as follows:

a. The irreversible or long-term commitment of natural resources to effect implementation of a plan should be minimized.

b. Measures should be incorporated in the selected plan which protect, preserve, or enhance environmental quality in the project area.

c. The selected plan should be consistent with local, regional, and State goals for port and industrial growth.

d. Interested Federal and non-Federal agencies, local groups, and individuals should be consulted through cooperative efforts, conferences, public meetings, and other procedures to achieve public acceptance.

e. Public acceptability of proposed improvements and ability and willingness to meet local cooperation requirements are essential considerations.

Environmental Review and Consultation Requirements. — The following table presents Federal policies and laws, Executive Orders, State and local policies and the appropriate degree of compliance for each.

RELATIONSHIP OF SELECTED PLAN TO ENVIRONMENTAL REQUIREMENTS
Sacramento River Deep Water Ship Channel, California

Federal Policies	Compliance
Fish and Wildlife Coordination Act of 1965	Full
Federal Water Project Recreation Act	Full
Water Resources Planning Act of 1965	Full
National Historic Preservation Act of 1966	Full
National Environmental Policy Act of 1969	Full
Federal Water Pollution Control Act Amendments, 1972	Full
Endangered Species Act of 1973, as Amended, 1978	Full
Protection of Wetlands (E.O. 11990)	Full
Section 404(r) of the Clean Water Act of 1977	Full
Construction in Floodplains (E.O. 11988)	Full
State and Local Policies	
California Environmental Quality Act	Full
Delta Area Planning Council's Delta Action Plan	Full
State of California's Delta Master Recreation Plan	Full
Sacramento County General Plan	Full
Yolo County General Plan	Full

List of Preparers. — The following people were primarily responsible for preparing this Environmental Impact Statement:

NAME	EXPERTISE	EXPERIENCE	PROFESSIONAL DISCIPLINE
Mr. Mark Capik (Study Manager)	Civil Engineering	6 years civil engineer, Sacramento District	Engineer
Mr. Arthur Champ (former Study Mgr.)	Civil Engineering	6 years civil engineer, Sacramento District	Engineer
Mr. Joseph Holmberg	Forester	9 years, EIS studies, Bureau of Reclamation; 2 years, EIS studies Jones & Stokes Assoc.; 6 years, EIS studies, Sacramento District	Environmental Resources Planner
Mr. Fred Kindel (EIS Coordinator)	Wildlife Management	15 years EIS studies, Sacramento District; 7 years, Wildlife Management, State and Private	Environmental Resources Planner
Mr. Robert Martin	Wildlife Management	6 years EIS and biological studies, U.S. Fish and Wildlife Service and Sacramento District; 4 years Park Ranger and Manager	Environmental Resources Planner
Mr. Dennis Saulque	Recreation Planning	2 years recreation research, Univ. of CA, Davis; 6 years recreation planning, Sacramento District	Outdoor Recreation Planner
Mr. George Redpath	Aquatic Ecology	4 years EIS studies, Private Consultant; 4 years EIS studies, Sacramento District	Environmental Resources Planner

Index. — Presented below is an index of environmental and other data and where it is discussed in the EIS. The discussion throughout the EIS is cross-referenced to more detailed data presented in the main report, other appendixes and other published sources.

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APPENDIX 3

ENVIRONMENTAL IMPACT STATEMENT

This environmental impact statement is prepared as an appendix document to the feasibility report and will be coordinated as outlined in Section IX, "Coordination with Other Agencies." Letters and numbers appearing in parenthesis refer to sections and paragraphs in Appendix 1 where more detailed information appears. References cited appear in paragraph 52, Section B, Appendix 1.

Section I — Project Description

1.01 **Project location.** — The Sacramento River Deep Water Ship Channel is situated in the Sacramento-San Joaquin River Delta of Central California (plate 1). The channel extends from the San Francisco Bay area to Sacramento. The study area includes portions of Yolo, Sacramento, Solano, and Contra Costa Counties and is divided into three reaches: (1) the Suisun Bay Channel from Avon to the mouth of New York Slough, (2) The Sacramento River from New York Slough to Collinsville, and (3) the existing Sacramento River Deep Water Ship Channel from Collinsville to the Port of Sacramento.

1.02 **Authority.** — The navigation problems and needs of the study area are being investigated in response to resolutions of the House of Representatives Committee on Public Works, adopted on 10 July 1968 and 11 December 1969.

1.03 **Project purpose.** — The proposed project would primarily provide savings in ocean transportation costs by providing for larger and deeper draft ships. Some recreation benefits would also be provided. (C 8-13, F 10, 28)

1.04 **Proposed plan.** — The proposed plan provides for deepening and widening existing Suisun Bay and Sacramento River deep water channels from New York Slough to the Port of Sacramento from 30 to 35 feet as shown below. Approximately 30,300,000 cubic yards of dredged material would be excavated between New York Slough and Sacramento requiring a maximum of 3,500 acres of land for disposal. Future maintenance should remain the same as for present conditions: 200,000 cubic yards per year between Junction Point and Rio Vista and 200,000 cubic yards from the remainder of the channel. The Avon to New York Slough reach is authorized for deepening under San Francisco Bay to Stockton project. If this reach is not deepened under the current authorization, it would be deepened as part of the selected plan. Approximately 3,300,000 cubic yards would be excavated in this reach requiring 480 acres of land for disposal.

Reach	Existing Width (feet)	Existing Depth (feet)	Selected Plan Width (feet)	Selected Plan Depth (feet)
New York Slough to Junction Pt. (mi. 15.0)	300	30	400	35
Junction Point to Entrance of Manmade Channel (mi. 18.6)	300	30	300	35
Entrance to Port of Sacramento	200	30	250	35

Recreation facilities would be provided to develop the potential provided by dredged material disposal. Also included in the selected plan is the supplementing, as necessary, of the existing water quality monitoring network in the Delta to include high-quality, well-maintained salinity measuring stations. These stations would observe salinity distributions before, during, and after deepening and widening the channels. If salinity levels increase to unacceptable levels above preproject conditions subsequent to deepening the channels, a submerged sill or acceptable alternative would be constructed in the Carquinez Strait to prevent salinity intrusion. The location of the high-quality monitoring stations and need for a sill would be coordinated with concerned agencies such as the Fish and Wildlife Service, Water and Power Resources Service, State Department of Water Resources, and State Water Resources Control Board. (Section E.)

1.05 **Costs and benefits.** — The costs and benefits for the channel deepening project are summarized below:

	First Cost	Annual Cost	Annual Benefit	Benefit to Cost Ratio
Navigation				
New York Slough to Collinsville-Montezuma Hills	$18,300,000	$1,347,000	$ 4,447,000	3.3
Collinsville-Montezuma Hills to Port of Sacramento	58,750,000	4,575,000	10,452,000	2.3
Recreation	1,350,000	171,000	303,000	1.8
Fish and Wildlife Mitigation	700,000	61,000	0	0
Total	$73,100,000	$6,154,000	$15,202,000	2.5

The overall benefit-cost ratio is 2.5 to 1, and annual benefits would exceed annual costs by $9,048,000. If the Avon to New York Slough reach is included in the selected plan the project first cost would be $81,500,000 and the overall benefit-cost ratio would be 2.2 to 1.

1.06 **Compatibility with existing and proposed projects**. — The primary features of the existing Sacramento River Deep Water Ship Channel, in operation since 1963, are presented in paragraph 1.04. Also completed as a part of this project are a navigation lock and a shallow-draft barge canal connecting the port to the Sacramento River. The Sacramento River Shallow Draft Channel, originally authorized in 1899, provides for navigation on the Sacramento River from Suisun Bay to Red Bluff, a distance of 245 miles. The navigable depths authorized are 10 feet below mean lower low water up to Sacramento and low water depths of 6 feet to Colusa, 5 feet to Chico Landing, and depths as practicable to Red Bluff. Construction was not completed above Colusa due to a lack of commercial navigation. Recreation boating on the Sacramento River has become increasingly popular, involving thousands of small craft, and probably is in excess of 3 million recreation days annually.

Other existing deep-draft channels in the region include the Stockton Deep Water Channel, the Suisun Bay Channel, the Pinole Shoal Channel, and the San Francisco Bar Channel. The Stockton Deep Water Channel provides a 30-foot channel from the mouth of the New York Slough to the Port of Stockton. The Suisun Bay Channel provides a channel through upper Carquinez Strait and lower Suisun Bay with a depth of 35 feet to Avon and 30 feet to the mouth of New York Slough. The Pinole Shoal Channel provides a 35-foot channel through San Pablo Bay to the natural deeper waters in the San Francisco Bay. The Bar Channel at the mouth of the bay provides a 55-foot depth.

The San Francisco Bay to Stockton (John F. Baldwin and Stockton Ship Channels) project was authorized for construction by the River and Harbor Act of 1965. This project provides for modification of the existing Suisun Bay Channel Project by deepening the channel between Avon and New York Slough from 30 feet to 35 feet, and modification of the existing San Joaquin River Navigation Project by deepening the Stockton Deep Water Channel from 30 feet to 35 feet. The authorization also provides for deepening the channels from Avon to the Golden Gate to 45 feet. Except for deepening the San Francisco Bar Channel and placing some bank protection, work has not yet started on this authorized project.

1.07 **Current status**. — Feasibility studies for the Sacramento River Deep Water Ship Channel are scheduled to be completed in 1980. If the improvement is authorized by Congress for construction and adequate funding is provided, engineering and design could begin soon thereafter. Preconstruction planning, engineering, and design prior to construction are estimated to require about 3 years.

Section II — Environmental Setting Without The Project

(The environmental setting is discussed in more detail in the technical appendix, and references to the pertinent section and paragraphs are noted in parentheses).

2.01 **Geology.** — The project area is underlain by thick sedimentary and alluvial deposits which have filled the synclinal depression of the Central Valley since the Jurassic Period. These materials are primarily siltstones, claystones, and sandstones. (B.2)

2.02 **Soils.** — The Delta soils are of two types, organic and mineral. The organic soils are peats which vary in the study area from 0 to 40 feet deep. Mineral soils occur north of Prospect Island. (B.3-7)

2.03 **Seismicity.** — The ship channel passes through a seismically active region. The Midland Fault Zone is roughly parallel to the project in the Cache Slough area and crosses the Sacramento River at the tip of Grand Island. The Calaveras and Hayward Fault Zones are located several miles southwest of Avon. (B.8)

2.04 **Climate.** — The climate of the project area is the mild two-season Mediterranean type typical of California's Central Valley. Temperatures can exceed 100 degrees Fahrenheit in summer and occasionally fall below freezing during the winter months. Approximately 95 percent of the mean annual rainfall of 15 inches occurs from October through April. The prevailing wind is from the south and southwest with a velocity of at least 8 miles per hour (mph) 50 percent of the observed time. In the reach from Avon to Collinsville, the wind velocity is 12 to 14 mph 50 percent of the observed time. Winds of this velocity are a significant navigational hazard to small craft and can cause bank erosion. (B.9-10)

2.05 **Hydrology.** — The Sacramento-San Joaquin Delta drains most of the water from the 64,000-square mile Central Valley watershed. Before large-scale diversion began, the mean annual outflow from the Delta was more than 30 million acre-feet. Presently the mean annual outflow index is about 16.7 million acre-feet and has ranged between 2.4 million and 32.1 million acre-feet for the years 1969-78. (B.11-12)

2.06 **Water Quality.** — Intermittent water quality data collected by the Central Valley Regional Water Quality Control Board in the Sacramento River Deep Water Ship Channel from 1963 to 1972 indicate that except for salinity the quality is equal to or better than the Board's 1975 objectives. Total dissolved solids are often greater than the 500 ppm objective between mile 35 and the turning basin due primarily to saltwater ballast discharge in the turning basin. The problem of saltwater ballast discharge was determined to be one of enforcement of existing water quality standards under the jurisdiction of the Regional Water Quality Control Board and the Environmental Protection Agency. The dissolved oxygen concentrations are generally above 5 ppm (the standard for dissolved oxygen); however, a few dissolved oxygen readings taken on the bottom of the channel in the loading dock area have fallen to 4.7 ppm. Algal blooms of nuisance proportions have been observed in the channel indicating a high nutrient level. (B.19-21)

2.07 **Ground water.** — Ground water has not been explored to any great extent, but a number of deep wells yield small quantities of fresh water. An aquifer extends under Suisun Bay, and part of it is exposed to the Sacramento River. The general movement of ground water is bayward. The ground water level varies between 5 and 32 feet below the surface. (B.16-18)

2.08 **Air quality.** — Major pollution problems in the Sacramento Valley Air Basin are oxidants and particulate matter. Motor vehicles produce the majority of all emissions, except particulate matter. Much of particulate matter is introduced by agricultural burning. Inversion layers cause an accumulation of air pollution. The city of Sacramento exceeded the State standard for oxidants 13 times and the National Standard for oxidants 28 times in 1975. (B.22-24)

2.09 **Vegetation.** — Almost the entire length of the Sacramento River Deep Water Ship Channel is bordered by agricultural lands on the landsides of the levees. The vegetation on the channel levees consists of discontinuous stands of brackish water marsh, riparian trees and brush, and grass. Extensive farming occurs on the berms along the manmade channel. On the northern side of Suisun Bay is Suisun Marsh, a brackish water marsh covering 54,000 acres. In the Collinsville area remnants of freshwater marsh occur in the inlets upstream of Collinsville and bordering Montezuma Slough. Across the river is Lower Sherman Island Wildlife Area, a 3,100-acre partially flooded island with freshwater marshes. Small stands of riparian tress occur on higher ground. A narrow, intermittent bank of riparian vegetation and marsh occurs on the right bank of the Sacramento River from Marshall Cut to Rio Vista. (B.25-28)

2.10 **Planktonic and benthic organisms.** — Phytoplankton and zooplankton, the base of the aquatic food chain, occur in great variety and numbers in the Delta. The mysid shrimp are an extremely important zooplankton species which is the principal food of young fish, notably striped bass. The mysid shrimp population levels seem to be determined by the abundance of phytoplankton and the water salinity.(B.29-32)

2.11 **Fish.** — The Delta is used as a spawning and/or nursery area for a variety of sport fish and as a migration route for both sport and commercial fishes. Salmon, steelhead, striped bass, sturgeon, shad, and catfish, black bass, and sunfish are notable fishes occurring in the study area. Some anadromous fish are known to migrate through the manmade channel and utilize the lock to pass to or from the Sacramento River. (B.33-40)

2.12 **Wildlife.** — Wildlife species inhabiting the study area are diverse and abundant. The varied environments of the channels provide habitat for the variety of species of birds, mammals, reptiles and amphibians found throughout the Delta. As many as one million waterfowl winter in the nearby Suisun Marsh. Common wildlife species found along the ship channel include the Canada goose, several species of ducks, American kestrel, belted kingfisher, white-crowned sparrow, big brown bat, muskrat, raccoon, western pond turtle, common garter snake, and Pacific treefrog. (B.41-44)

2.13 **Threatened, Rare, and Endangered Plants and Animals.** — Studies conducted to date indicate twelve species of plants appearing on Federal, State, California Native Plant Society, and Smithsonian Institution threatened, endangered, and rare species lists have range distributions which include the Sacramento Deep Water Ship Channel area. Ten species of animals appearing on Federal and State threatened, endangered, and rare species lists also have ranges which include the channel area. (B.38-39)

Pursuant to Section 7(c) of the Endangered Species Act, during advanced engineering and design studies, the Fish and Wildlife Service will be requested to furnish a list of endangered or threatened species which have been listed or are proposed to be listed which may be affected by the project. A biological assessment will be prepared and coordinated with the Fish and Wildlife Service and the California Department of Fish and Game. (B.45-46)

2.14 **Archeology and history**. — Much of the prehistoric cultural record in the study area has been altered or destroyed by agricultural operations, industrial and urban developments, and water resources developments such as leveeing and dredged material disposal. A preliminary cultural resources reconnaissance survey of 15 percent of the area was performed for the Corps of Engineers, and coordinated with the State Historic Preservation Officer and Interagency Archeological Services, Heritage Conservation and Recreation Service. One prehistoric site was located west of Lake Washington near the Port of Sacramento. It may be significant according to National Register of Historic Places criteria. There are no archeological or historical sites listed on the National Register of Historic Places within the project area. (B.47-51)

2.15 **Socioeconomics**. — The total population of the three-county study area was 1,084,700 in mid-1979. In 1970, 6.1 percent of the population was black, and 8.4 percent was Spanish-speaking. The median educational level was 12.4 years of schooling. In 1977 the single most important employment category in the study area was government with 40.4 percent of all nonagricultural workers. Much of the manufacturing activity in the area is closely related to agriculture with the dairy industry, food packers, and canners all being important employers. The largest occupational group of workers in the area is clerical and kindred workers (23 percent) followed by professional, technical and kindred workers (18 percent) and craftsmen, foremen, and kindred workers (14 percent). Total personal income in the area was about $7.3 billion in 1977, representing a per capita income of $7,121. (B.53-65)

2.16 **Recreation**. — The Sacramento-San Joaquin Delta has over 50,000 acres of protected water surface and over 700 miles of scenic waterways. It is a unique recreation resource providing a superlative sport fishery and opportunity for diverse water-oriented recreation activities such as sailing and waterskiing. Because of the temperate climate, the Delta area receives significant recreation use from March through October. The Resources Agency of the State of California projects that 40 million recreation days of use could occur annually in the Delta by the year 2000. (B.144-147, C.14-16)

2.17 **Esthetics**. — The project area is located in the level farmland of the lower Sacramento Valley. Industrialization is evident only in the vicinity of the Port of Sacramento and around Rio Vista. The manmade channel is virtually straight with its berm and levees sparsely vegetated with annual grasses. The bulk of the manmade channel is inaccessible to the public. Downstream of Prospect Island the project area resembles a typical Delta channel or slough.

2.18 **Future setting without the project**. — In the absence of the project the following aspects of the study area are not expected to change: geology, soils, ground water, seismicity, climate, paleontology, archeology, and history.

There will be hydrologic changes without the project. Considering projects presently under construction,'planned and authorized, and contractual commitments for future use of water, it has been projected that the required Delta outflow to Suisun Bay and the Pacific Ocean could decrease by as much as 30 to 35 percent by the year 2000 based on a typical dry year, with about a 10 percent reduction for an average year. Ground water conditions in Sacramento County are not expected to change due to direct recharge from the Sacramento River. So little is known about the present ground water conditions in Yolo and Solano Counties that future conditions cannot be predicted.

With decreased Delta outflows, and consequently greater tidally influenced salinity movement, the concentration of planktonic organisms in the entrapment zone will be located further upstream more often than at present, and since there is generally less depth and width to upstream channel areas, this would reduce overall populations. Decreased Delta outflows may, therefore, have detrimental impacts on the fish populations.

Loss of agricultural, upland, marsh and riparian vegetation can be expected from projected industrial development along the existing ship channel. This increased industrialization will also result in decreased wildlife populations. The additional industry will result in more jobs within the study area.

Water quality in the manmade portion of the channel is likely to improve due to continuing upgrading of water pollution control systems and enforcement of regulations concerning sewage effluents. Air quality is likely to be adversely affected due to a greater use of trucks and railroads for commodity transport which would accompany a lesser reliance on the more energy-efficient ships.

Section III — Relationship of the Proposed Action to Land Use Plans

3.01 **General.** — This navigation channel traverses an area that includes several jurisdictions, each with its own land use plans. The jurisdictions include the State of California, Contra Costa County, Solano County, Sacramento County, and Yolo County. Additionally, the Delta Advisory Planning Council was created by a joint powers agreement of these counties and prepared a regional land use plan. The proposed deepening project does not conflict with the plans prepared by these different agencies. The land use plans developed by these local agencies anticipate as future growth, industrial development generated by the channel deepening project, and consequently assure the orderly development of both light and heavy industries by setting aside sufficient land for the industrial (M-2) category.

3.02 **State of California.** — In September 1976 the State of California published the "Delta Master Recreation Plan" to serve as a "comprehensive guide for preserving and developing the Delta's scenic, wildlife, and recreation resources" (The Resources Agency, 1976). One of the major conclusions of this plan was that recreation opportunities and preservation of fish and wildlife values be included in all applicable Federal, State, and local projects. Ship channel deepening plans would not conflict with the guidelines of this plan.

The California Fish and Wildlife Plan lists the general policies of maintaining and enhancing the fish and wildlife of the State and encouraging the recreation, scientific, and commercial uses of these resources (California Department of Fish and Game, 1966). Ship channel deepening plans would not conflict with these policies, provided that dredged material disposal sites are properly located and that impacts on the entrapment zone are minimized.

3.03 **The Delta Advisory Planning Council**. — The Delta Advisory Planning Council prepared the "Delta Conservation and Development Plan" which is intended as a guide for future development in the Delta. The proposed deepening is basically in accord with that plan in that it provides for public recreation areas and increases public access to the waterways. A guideline in the plan requests that future projects ensure that salinity intrusion does not degrade water quality. Preliminary studies of the proposed sill indicate that it would not only prevent adverse impacts from the project on salinity but could also improve water quality over present conditions. Another guideline included in the plan is protection and enhancement of riparian habitat which will be complied with where possible and lost vegetation mitigated for and allowed to return.

3.04 **Sacramento County**. — Sacramento County borders the left bank of the Sacramento River. Deepening the channel would not conflict with the goals of the "General Plan" which apply to this area: That is to maintain the agricultural environment; protect the land, air, and water resources; maintain a balanced ecological system; and provide residents with a full range of recreation opportunities (Sacramento County, 1973).

3.05 **Contra Costa County**. — This county borders the ship channel on its south bank in Suisun Bay. The "Open Space Conservation Plan" recognizes the importance of fish and wildlife preservation and the potential that exists for recreation development. The "East County General Plan Draft" of 1976 includes as permanent open space the publicly owned parks and recreation areas and the Delta waterways open to the public. The "Land Use and Circulation Plan of Contra Costa County, California" states that areas which have desirable natural characteristics, historic significance, or potential for public use should be maintained for such uses. (Contra Costa County, 1973; U.S. Army, Corps of Engineer, May 1976.) The Sacramento River Deep Water Ship Channel would have an impact on Contra Costa County only if the Stockton Ship channel is not constructed. If that is the case, then the Avon to New York Slough reach which borders Contra Costa County would be included in the Sacramento River project. Impacts of channel deepening on land use would be related to the sites used for the disposal of dredged material.

3.06 **Solano County**. — Solano County borders the ship channel on the north and east banks from Suisan Bay to approximately mile 24. The proposed deepening project would be compatible with the goals stated in the "Resource Conservation and Open-Space Plan": to preserve and enhance the quality of living by preventing the degradation of the natural environment; to seek equitable distribution of the full range of benefits derived from natural resource management; and to preserve for subsequent generations the greatest possible freedom of choice in the use and enjoyment of the county's natural resources (Solano County, 1972). The deepening project would be fully compatible with the January 1979 draft Collinsville-Montezuma Hills Area Plan and program which is under consideration as an amendment to the Southeastern Solano County General Plan.

3.07 **Yolo County**. — This county lies on both sides of the ship channel north of approximately mile 24 and includes the Port of Sacramento. Goals stated in the "Conservation Element of the General Plan" include conserving land forms, providing sufficient quality water for agriculture and recreation, maintaining air quality, preserving and rehabilitating vegetation and wildlife resources, and preserving historical heritage. (Yolo County, 1973). These goals would be aided by the project.

Section IV — Probable Impact of The Proposed Action on the Environment

4.01 **Geology**. — No geologic impacts are anticipated.

4.02 **Soils**. — The proposed deepening project would require the removal of 30.3 million cubic yards of material to increase the channel depth by 5 feet. The need for continuing maintenance dredging would remain the same as experienced for present conditions: 200,000 cubic yards per year between Junction Point and Rio Vista and 200,000 cubic yards per year in the remainder of the channel. Dredging to a depth of 35 feet would require 3,500 acres of disposal area. The materials to be dredged are sand, silty sand, and sandy clay which are similar to materials deposited at existing dredged material disposal (DMD) sites. Most DMD sites used for deposition of initially dredged material would not be further disturbed following deposition, allowing previous or similar uses to become reestablished. One DMD site would be developed for recreation use. The stability and physical characteristics of this site will be taken into consideration when designing the recreation area. Sites used for maintenance dredging and sites from which materials are removed by others for use primarily as construction material would be periodically disturbed.

4.03 **Seismicity**. — The impact of earthquakes with or without the project will be the same.

4.04 **Climate**. — Waves generated by wind are the only climatic effect which could be influenced by the proposed channel enlargement particularly if larger fetches for wave runup were created. However, the small increase in fetch with a 50-foot-wider channel in a portion of the project is not expected to significantly increase wave size. Marsh vegetation along the shoreline dampens wave action reaching the shore and assists in decreasing bank erosion.

4.05 **Hydrology**. — There will be no impacts on amount of Delta outflow due to the deepening of the channel. Studies by the Waterways Experiment Station and Dr. Ray Krone (Krone, 1977) have shown that channel deepening with construction of the submerged sill would increase current velocities only in the immediate vicinity of the submerged sill and that the sill would have no effect on sediment transport. The water surface elevations of tidal fluctuations will be slightly altered. Tests conducted at the Bay-Delta model in Sausalito showed that during average flow conditions there was virtually no effect on water surface elevations throughout the system. Additional tests results, however, revealed that under critical flow conditions the sill would increase water surface elevations by a maximum of 0.4 foot at certain locations in Suisun Bay and by less than 0.2 foot in the remainder of the Delta. These differences will cause a corresponding minor change in the emergent vegetation pattern but should not impact the amount of vegetation.

4.06 **Water Quality.** — The major concern regarding water quality impacts of the proposed project is that increased salinity in the Delta may occur as a result of deepening the Sacramento River Deep Water Ship Channel. Impacts from increased salinity may include effects on agricultural, industrial, municipal, and fish and wildlife uses of the water. The State of California has established standards for salinity concentrations in the Delta and has stated that any project which increases salinity and thus makes meeting these standards more difficult would not be acceptable. In recognition of the importance that has been placed upon the water quality of the Delta, the Corps of Engineers conducted physical model tests at the San Francisco Bay-Delta Model in Sausalito, California, to identify the location and magnitude of any changes in salinity distribution associated with the proposed modifications of the channel geometry. The tests consisted of comparing preproject salinity distributions with those resulting from channel deepening. Model tests predict that the selected plan would have no effect on the Bay-Delta estuary during an average or critically dry year, with the exception of minor increases that may occur on the upper Sacramento River (upstream at Rio Vista) during a critically dry year. However, even with the increase, there would be no adverse effect on domestic or agricultural water uses. Model tests also predict that the selected plan, with construction of the submerged sill, would have no effect in San Pablo Bay, Suisun Bay, and the Delta during an average dry year and may reduce salinities below preproject conditions in Suisun Bay and some portions of the Delta during a critically dry year. Increases in salinity levels occurring upstream of Rio Vista and on Cache Slough along the channel would not entirely be reduced to preproject levels but there would be no adverse effect on domestic or agricultural water uses. Further tests of the submerged sill, if needed, will be conducted during advanced engineering and design studies to further determine the environmental effects of the sill and to further adjust the height of the sill so that, within the accuracy of the model, salinities are returned to preproject conditions. Advanced studies will also consider alternative mitigative measures.

Studies by the Waterways Experiment Station show that pesticides and heavy metals which are absorbed to the sediment particles are not usually released into the water during disturbance from dredging. In many cases dredging actually reduces the amount of these toxic substances by removing them with the bottom sediment (Engler, 1977). In studies done by Aderlini, et. al. (1976), an investigation was conducted of the San Francisco Bay System in which nine heavy metals were looked at (silver, arsenic, cadmium, copper, mercury, nickel, lead, selenium, and zinc) and their concentration in five invertebrate species during dredging operations. Changes in metal concentrations in sediments and all invertebrates during the study period were relatively small and these changes could not be directly attributed to dredging activities. The study concluded that if changes in metal concentrations in the water occurred as a result of dredging activities, the changes were either less than the normal small natural fluctuations or were of short duration. Pedicord (1975) conducted tests on several organisms by exposing them to contaminated material similar to San Francisco Bay mud. He found the mussels, shrimp, a polycheate species, an amphipod species, shiner surf perch, striped bass, and a isopod species were tolerant of suspended sediment loads much in excess of the few hundred milligrams per liter generally expected in the water column during major dredging operations in San Francisco Bay. The most sensitive species tested, striped bass, survived only a few hours at levels of .5 mg/l of contaminated sediments, a condition probably representing a worst case of turbidity generation with a dredging operation. Such conditions are very unlikely to occur where mobile organisms may escape turbidity maxima. In reviewing these studies and several others, the Waterways Experiment Station (1978) concluded that "Release of sediment-associated heavy metals and their uptake into organism tissue has been found to be the exception rather than the rule." Sediment analysis conducted in 1975 found that of the heavy metals tested, only zinc exceeded EPA maximum limits. All other heavy metals, including mercury, fell well below the EPA limits. Based on the above studies, it does not appear that heavy metal uptake will be a problem with this project. The results of the bottom sediment sampling program is presented in Appendix 1 Section E. Additional testing of bottom sediments will be conducted during advanced studies to determine impacts to the water column and to determine effluent quality from the leachate from the DMD sites.

A separate water quality evaluation was accomplished pursuant to Section 404 of the Clean Water Act of 1977, as amended (33 USC 1344). That evaluation, Appendix 4, indicates that water quality studies and evaluation accomplished during feasibility level planning determined that the project impact on aquatic systems would be minimal since dredged or fill material would only be placed into waters of the United States during construction of the underwater sill at Dillon Point in Carquinez Strait. The greatest impact would be upon those benthic organisms directly covered by the fill placement. In addition, there is a possibility that the sill could have an overall beneficial or enhancing effect on upstream portions of the estuary by causing a small decrease in salinity over preproject conditions, bringing this parameter closer to conformance with the water quality criteria of the State of California's Regional Water Quality Control Board.

Impacts on Delta water quality resulting from secondary impacts due to project-induced regional growth are expected to be minimal as industrialization and urbanization will be subject to state water quality criteria. New pollution sources will be subject to control under the provisions of the Federal Water Pollution Control Act (PL 92-500), as implemented by the State of California. Discharge permits will regulate new effluent sources, assuring maintenance of the Delta water quality within acceptable State water quality objectives.

4.07 **Ground water.** — Deepening the channel is not expected to cause detrimental impacts to ground water quality. A U.S. Geological Survey report on the San Francisco Bay to Stockton (John F. Baldwin and Stockton Ship Channels) project states that most of the channel has been deeper than the proposed 35-foot depth at one time or another. Hence, permeable materials in the channel already have been exposed and are therefore probably saturated with saltwater (Akers, 1974). Upstream of Suisun Bay the channel presently intersects sandy layers, and thus the ground water has already adjusted to any water intrusions from the channel. Wells adjacent to the channel vary from approximately 100 to 600 feet deep, indicating that the major water bearing strata are considerably below the channel. Additionally, the waters of Cache Slough and the manmade portion of the channel contain high enough water quality so as to not degrade ground water.

4.08 **Air Quality.** — Increased quantities of cargo will be transported by fewer, though larger, ships. Ships are more efficient than alternate modes of transportation, and larger ships are more efficient than smaller ones. Consequently, over the short term, a net reduction in pollutants entering the air can be expected due to transporting cargoes via the deepened channel. However, this improvement in air quality will eventually be offset by the adverse effects of additional industrial development around the Port of Sacramento and increased recreation use in the Delta, both induced by the channel deepening project. While new stationary sources will be regulated and controlled by air emission permits, new mobile sources associated with induced regional growth will not be regulated by a permit program. Manufacturer vehicle emission improvement will reduce the impact of the new mobile sources, but the increased vehicle population with their associated emissions will add to an existing oxidant emission problem in the Sacramento Valley Air Basin. The magnitude of this impact is impossible to estimate at this time. The projected contribution of emissions from project-induced recreation vehicles, however, is possible to estimate. The estimated initial annual use of the project's recreation facilities is estimated to be 120,000 recreation days. Assuming an average of four persons per vehicle and an average round trip of 150 miles, it is estimated that approximately 4,500,000 miles would be driven to and from the recreation areas annually. Table 1 lists the emissions which could be expected from this level of recreation use for 1980 and 1990 and their contribution to the total emissions in Sacramento, Yolo, and Solano Counties. These estimates are based on average emission factors for motor vehicles (assuming improved vehicle emission in the future) and estimates of total emissions for Sacramento, Yolo, and Solano Counties (EPA, 1973, Calif. Air Res. Board, 1978). Table 1 shows that project-induced vehicle emissions would contribute only 0.43 percent of the total nitrogen oxides (NOx), 0.06 percent of the total carbon monoxide (CO), and 0.03 percent of the total hydrocarbon (HC) emissions in 1980 for the three-county area. For 1990 the projection for project-induced emissions are 0.02 of total NOx, 0.04 of total CO, and 0.02 of total HC emissions for the basin.

Additional investigation during advanced engineering and design studies will identify any other project related air quality impacts.

TABLE 1

PROJECTED CONTRIBUTION OF EMISSIONS FROM PROJECT-INDUCED RECREATION VEHICLES TO TOTAL THREE-COUNTY (SACRAMENTO, YOLO, SOLANO) EMISSIONS FOR 1980 AND 1990

	NO_x		CO		HC	
	1980	1990	1980	1990	1980	1990
Project Induced Vehicle Emissions (Tons/Ave. Day)	0.42	0.02	0.31	0.16	0.04	0.02
3-County Emissions — Vehicle Source (Tons/Ave. Day)	64.2	57.6	400.0	215.5	58.7	32.2
% Project Induced Vehicle Emissions	0.66	0.03	0.08	0.07	0.07	0.06
3-County Emissions — All Sources (Tons/Ave. Day)	98.4	98.9	559.8	404.3	130.3	118.4
% Project Induced Vehicle Emissions	0.43	0.02	0.06	0.04	0.03	0.02

4.09 **Vegetation.** — The widening of the manmade portion of the channel would, without mitigation measures, result in a loss of approximately 45 acres of marsh and riparian vegetation which has become established as a result of the construction of the original channel. The agricultural land on dredged material disposal (DMD) sites would be out of production for one or two seasons. Other DMD sites will lose their native upland vegetation for 1 or more years (Fish and Wildlife Service, June 1977). Approximately 3,500 acres of surface area is needed for dredged material disposal and 100 acres for annual maintenance dredging. The water quality evaluation accomplished pursuant to Section 404 of the Clean Water Act (33 USC 1344) (Appendix 4) indicates that dredged or fill material would not be placed on any wetlands. In addition, an undetermined amount of habitat would be lost due to induced development as discussed in paragraph 4.17 Land Use.

The seed production of waterfowl food plants in the Suisun Marsh would not be expected to be impacted by salinity intrusion except during critically dry years. During critically dry years leaching of soil salts would be naturally hampered by high salinity levels (Fish and Wildlife Service, June 1977). However, this would occur with or without the proposed project. This situation will increase in frequency as more water is diverted from the Delta. Deepening the channel will create growth-inducing impacts. New industries in the vicinities of Collinsville and the Port of Sacramento will permanently displace native and agricultural vegetation.

The loss of vegetation as described above would cause a reduction in other members of the ecosystem as described in paragraphs 4.06, 4.08, 4.09, 4.10, 4.11, 4.12, and 4.16. The reestablishment of vegetation lost along the manmade portion of the channel to preproject levels would take, without specific management actions, at least 10 years (Fish and Wildlife Service, June 1977). However, wildlife mitigation and enhancement actions will promote faster reestablishment. The selected plan includes converting 45 acres of a DMD site to tidal marsh to mitigate for lost marsh and riparian habitats along the manmade channel. The reestablishment of emergent vegetation is also desirable to provide protection from wave wash erosion. Wetland areas established under authority provided by Section 150 of the Water Resources Development Act of 1976 (PL 94-587) could be utilized to increase and enhance the amount of marsh and riparian acreage along the channel. If the Stockton Ship Channel project is not constructed, Donlon Island could be acquired and converted to wetland habitat under this authority. If this site is not available, other areas could be acquired. Wetland would be established by filling the submerged island with dredged material to approximately mean sea level elevation and then planting marsh vegetation. Establishment of wetlands would be coordinated with the California Department of Fish and Game and Fish and Wildlife Service, and would follow criteria for development by the California Mosquito and Vector Control Association.

Agricultural land used as DMD sites would return to crop production except for those areas converted to wildlife and recreational development. Those DMD sites in native vegetation would be seeded after use to minimize soil erosion and assist in reestablishing the native vegetation. Where dredge lines cross marsh and riparian vegetation, care will be taken to minimize loss and damage to plants. Where this vegetation must be removed, plantings would be accomplished to assist habitat reestablishment and to minimize erosion. Mitigation for the temporary loss of wildlife values has been evaluated by the Fish and Wildlife Service and they have recommended that 156 acres be improved as compensation. The Corps recommends the 156 acre mitigation lands acquisition be authorized by Congress. The actual amount of lands required will be further evaluated during advanced engineering and design studies and reduced if studies so indicate.

NO !!

The California hibiscus, identified as a rare and endangered species by the California Native Plant Society is the only threatened, endangered, or rare plant species that has been previously collected, or observed in the area expected to be disturbed during the proposed channel deepening operations. The California hibiscus was last collected in 1945 at the DMD site just downstream of Rio Vista. An investigation will be made of all potential DMD sites in the vicinity of Rio Vista during advanced engineering and design, if the project is authorized, to determine whether the hibiscus is present, and appropriate measures would be taken to protect any remnant populations.

4.10 **Planktonic and benthic organisms**. — Model tests show that if salinity intrusion occurs, the entrapment zone and those planktonic organisms associated with it would be moved upstream a short distance as a result of deepening the channel. Depending on flow conditions, this could change the euphotic zone volume due to changes in surface area and average depth, thus changing the total phytoplankton populations (Ball, 1977). This condition could result in a change in the food supply for mysid shrimp and consequently in striped bass juveniles, although other factors are also involved in bass production, as described in paragraph 4.11. If the submerged sill is constructed to mitigate for salinity intrusion, it would move the entrapment zone downstream to near its location under preproject conditions. Hydroscience, Inc., under contract to the Corps, conducted studies to determine the effect of the proposed project with the sill on the biological aspects of water quality. The principal conclusion drawn from the study is that the proposed channel deepening and sill placement would have virtually no effect on phytoplankton population and dissolved oxygen levels in the western Delta-Suisun Bay area.

Most benthic organisms would be removed from the manmade portion of the channel during the dredging operation. However, tests by the Corps Waterways Experiment Station show that not all benthic organisms are picked up by suction dredges (Pedicord, 1977) and that the remaining organisms plus natural migration would repopulate the channel. Dredging downstream of the manmade portion would remove only the center portion of the channel in Cache Slough and the Sacramento River. The remaining benthic community between the channel and the levee would supply the organisms for repopulation of the channel. The speed of movement into the disturbed area is very rapid, as shown by a study on the Coos Bay, Oregon, dredging operation where 75 percent of the organisms had been removed, but most dredge sites had repopulated to predredged levels within 14 days (McCauley, et al, 1976), although complete recovery of the benthic ecosystem could take up to 2 years (Fish and Wildlife Service, June 1977). Because dredging would occur over a 5-year period, these impacts would be occurring only in those portions recently dredged. Maintenance dredging frequency would not increase with the selected 35-foot deep channel (U.S. Army, Corps of Engineers, 1974). Initially ship traffic would decrease, lessening prop wash impact on benthic life; however, project-induced ship traffic would ultimately increase the frequency of this type of benthic zone disturbance. Disturbance of the bottom during dredging would release nutrients (particularly nitrogen) which would tend to stimulate phytoplankton growth. The increased turbidity from DMD site effluent would decrease the euphotic depth and depress photosynthesis. These impacts would be localized and temporary (U.S. Army, Corps of Engineers, May 1976). Construction of the sill in Carquinez Strait would eliminate benthic habitat under the rock structure; however, some benthic organisms would reestablish on the structure. Impacts due to maintenance dredging would be similar and would occur as often as maintenance dredging is undertaken. This represents a continuation of existing maintenance practices which are not expected to change with the project.

4.11 **Fish.** — There are three primary impacts on fish from the proposed work: dredging, removal of vegetation, and possible alteration of the salinity regimen. There are also two minor impacts: temporary increases in turbidity and increases in water pollution brought about by project-induced industrialization.

The dredging operation would remove benthic organisms which are part of the food chain of fish. The impact would be insignificant downstream of the manmade channel because not all of the channel width would be dredged. In addition, present benthic communities are disrupted periodically by prop wash from the larger ships as they clear the bottom of the existing channel by only one and a half feet when loaded. Benthic organisms would immediately begin to reestablish in the deepened channel, coming from the sides of the river and tributaries flowing into the channel. The impact would be localized during the 5 years necessary to dredge the entire channel. There will be no increase in maintenance dredging with the 35 foot channel. Without the specific management actions described in paragraph 4.09, natural reestablishment of vegetation would provide the same preproject habitats in approximately 10 years. Implementation of mitigation as described in paragraph 4.07 and wetland enhancement features under Section 150 of P.L. 94-587 could significantly assist reestablishment of the aquatic ecosystem and result in more habitat than presently occurs. The loss of 45 acres of marsh and riparian vegetation along the manmade channel would cause a loss of fish spawning, cover, and foraging habitats. Associated with the loss of vegetation would be a loss of detritus utilized as food by some fish and by benthic and planktonic organisms. This loss would be completely mitigated by conversion of 45 acres of a dredged material disposal site to tidal marsh, as described in paragraph 4.09.

If widening and deepening the Sacramento Deep Water Ship Channel causes the salinity of Suisun Bay and the lower reaches of the Sacramento River to increase above preproject conditions the entrapment zone would move upstream and would affect the fisheries since juvenile striped bass are concentrated in the vicinity of the entrapment zone where they feed on the mysid shrimp. The Fish and Wildlife Service believes that upstream movement of the zone would place the shrimp and juvenile striped bass in an area of reduced euphotic zone volume which would decrease the food supply (phytoplankton) of the shrimp (Fish and Wildlife Service, June 1977). This situation would compound an already poor condition (low flows) for juvenile striped bass survival. However, a study conducted by Hydroscience, Inc., showed the effect of the project with the sill on phytoplankton biomass is practically zero. Tests predict the sill would decrease salinities below preproject conditions during a critically dry year in Suisun Bay and parts of the Delta and thus affect total bass survival. On the other hand, the decrease in salinities to below preproject levels would allow greater phytoplankton populations throughout Suisun Bay and Honker Bay which could mean more striped bass food. Suisun Bay, Carquinez Strait, and San Pablo Bay are part of the nursery areas of anchovies and herring. Presently, they move into Suisun Bay when salinities are higher in the summer. The degree of impact of channel deepening with the sill on the commercial fisheries cannot be determined at this time due to lack of knowledge of the salinity requirements and the percentage that this nursery area supplies to the catch (Ganssle, 1966; Sprat, 1977; Petrovich, 1977; Chadwick, 1977). Timing of construction of the sill or alternative mitigative measure and channel dredging would be coordinated with the California Department of Fish and Game and the Fish and Wildlife Service to minimize the impact on migrating species to the extent possible.

Measures would be taken to minimize release of turbid effluent and to meet all water quality standards. Induced industrial development along the channel would mean greater pollution of the channel during rain runoff. The "shock loadings" of pollutants (early runoff from rainstorms contain higher concentrations of pollutants removed from streets and other areas), although brief, can seriously disrupt the aquatic environment. These disruptions can cause direct fish kills. This problem is being examined by a current 208 Planning Project funded by the Environmental Protection Agency (Daneker, 1977). The project would have no discernable effect on the status of the thick-tail chub which has not been reported since 1957 and is now thought to be extinct.

4.12 **Wildlife.** — Without mitigation measures, widening and deepening the ship channel would have a primary impact on marsh, upland, and agricultural wildlife habitats because of removal of vegetation. If the project induces changes in the salinity gradient there would also be a primary impact on waterfowl food production in Suisun Marsh. Minor, short-term impact caused by construction activity would affect wildlife populations, and industrialization of portions of the channel area would eliminate wildlife habitat.

The loss of marsh and riparian habitats along the banks of the manmade channel would result in loss of the animals utilizing these habitats. Some of the species receiving adverse impacts include beaver, muskrat, mallard, red-winged blackbird, brown towhee, blue grosbeak, western toad, and western pond turtle. The losses would be localized to the manmade portion of the channel, and these losses would be insignificant compared to populations of these species in the Delta as a whole. Because of extensive agricultural use, there is little upland habitat in the Delta. Use of the natural upland habitat for dredged material disposal would temporarily eliminate wildlife use and reduce wildlife populations in the immediate vicinity. Species affected include pheasant, quail, mourning dove, Audubon cottontail, and songbirds such as Bewick's wren, house finch, and song sparrow. Both habitat and wildlife use would return after disposal. There would be a less significant wildlife habitat loss on agricultural lands used for material disposal, but the lands would be able to be brought back to preproject condition much sooner (1 to 2 years) than the upland habitat would return to native growth. Of the 3,500 acres required for dredged material disposal, the amount in upland and the amount in agricultural habitat is indicated in Appendix 1 Section B. Permanent wildlife habitat losses would be sustained at the Sandy Beach recreation site. Mitigation measures described in paragraph 4.09, including conversion of 45 acres of DMD site to tidal marsh and reestablishment of vegetation, and the development of up to 156 acres of upland habitat at DMD areas along the channel would return wildlife habitat to preproject levels.

Widening and deepening the ship channel would not cause salinity intrusion to penetrate the Suisun Marsh to such an extent during years of low outflow that effective leaching would be prevented. (See paragraph 4.09.) However, an exceptionally dry year such as 1977 could result in significantly reduced seed production (Michny, 1977). This would occur with or without the proposed project. This in turn would result in significantly fewer waterfowl surviving the winter to return to breeding grounds in the spring. Since Suisun Marsh supports about 20 percent of the wintering population of the Pacific Flyway and is by far the largest brackish marsh in California, any reduction in the productivity of the marsh would be considered significant. The problems with marsh management would be mitigated by a submerged sill or alternative measure in the Carquinez Strait. Model tests indicate the selected plan without a sill would have no effect on salinities in Suisun Bay during average dry or critically dry years. However, tests predict that the selected plan with a sill would lower salinities in Suisun Bay and some portions of the Delta below preproject conditions in a critically dry year. The lower salinities would be beneficial to marsh management and probably result in greater waterfowl food production. Some temporary disturbance of wildlife in riparian areas, such as the Grand Island DMD site, would occur when dredging operations are in progress, but the disturbance would be minimized. As noted in paragraph 4.09, where vegetation must be removed, planting will assist recovery of wildlife populations. Industry associated with the Port of Sacramento and the ship channel would eliminate wildlife habitat. However, most of the industry would be placed on existing agricultural land currently zoned for industry and the impact is considered minor. Although the ranges of several species of rare and endangered wildlife encompass the project area (California Department of Fish and Game, Jan. 1976), only the salt marsh harvest mouse is resident. Since no dredged material will be disposed on Van Sickle Island or on wetland areas in the Collinsville-Montezuma Hills vicinity, the only known colonies of the mouse near the project, there is no discernable impact anticipated. Several other species of wildlife notably the Aleutian Canada goose, southern bald eagle, California black rail, and American peregrine falcon migrate through the area but would be unaffected by the widening and deepening of the ship channel.

4.13 **Archeology and history**. — Few impacts are expected since most project construction sites have been previously disturbed and the findings of the reconnaissance survey predict a low potential for discovering cultural remains. The reconnaissance survey of the study area would be updated with an intensive survey during advanced planning if the project is authorized. Those archeologic and historic sites determined significant may be protected or mitigated. Such determinations would be coordinated with appropriate agencies in accordance with 36 CFR 800 and 33 CFR 805 cultural resources regulations.

4.14 **Socioeconomics**. — The proposed channel deepening and the associated industrial development would be socially and economically beneficial for the study area and the region. The project would facilitate continued expansion of the Port of Sacramento and expansion and diversification of industry in the area served by the channel. Substantial socioeconomic benefits would accrue to the region in the form of additional employment, higher personal incomes, strengthened agricultural and industrial base, and increased property values. For example, an average of 130 new jobs would be created during project construction, and 3,550 new jobs would result directly from port and deep water dependent industrial development. Also, there would be an increase in the tax base and tax revenue due to increased payrolls, disposable income, and induced industrial development. Population would increase by less than 1 percent as a result of project construction. There would be an increase in noise level in the construction area; however, few people would be affected. Also, there would be a hazard to boating during construction, but this would be minimized by use of warning signs and lights. Upon completion of construction, there would be a minor increase in noise levels in the port area, and there would be a minor increase in the Collinsville-Montezuma Hills area as land is converted from agricultural to industrial use. The completed project would improve navigation safety due to widened and deepened channels.

4.15 **Recreation**. — Implementation of the recreation element associated with the proposed plan for widening and deepening the Sacramento River Deep Water Ship Channel presents an opportunity to develop the recreation resource of the Sandy Beach area near Rio Vista. This recreation feature would help achieve a better future balance between surrounding metropolitan populations and other recreation facilities in the Delta. An estimated 180,000 recreation days annually could be sustained at the recreation site without detriment to environmental resources or to the quality of the recreation experience. About 30 acres of an existing DMD site at Rio Vista's Sandy Beach would be converted to recreation facilities. Roads, parking, campsites, picnic tables, sanitary facilities, launch lanes, equipment yards, and administrative facilities would occupy areas presently occupied by upland habitat. Extensive landscaping is planned.

4.16 **Esthetics.** — Since there is little public access to the manmade portion of the ship channel, there would be little esthetic impact on the general public. During construction of the proposed project, there would be some loss to esthetics due to construction activity, but this would be temporary. All dredged material disposal would be done so as to blend with the natural setting, and the DMD sites would be returned to preproject visual character by means of plantings and landscaping. Potential growth induced development in the Collinsville-Montezuma Hills area and the Port of Sacramento area could assist in eventual removal of the visual esthetics associated with at most 12,700 acres of native and agricultural vegetation. A portion of the development can be attributed to the project while other areas (i.e., P.G.&E. site) will be developed with or without the project.

4.17 **Land use.** — Widening and deepening the existing channel would remove 45 acres of freshwater marsh and an undetermined amount of barren mudflat between the channel and the dredged material retention dike. New dredged material will be placed on 3,500 acres of DMD sites along the ship channel. The impact of using 3,500 acres for dredged material disposal would be mitigated by promptly replanting the area to its previous habitat or returning to previous use. A total of 30 acres at one dredged material disposal site would be permanently converted to recreation use. The loss of marshland would be mitigated as described in paragraph 4.09. Approximately 9,700 acres of native and agricultural vegetation in the Collinsville-Montezuma Hills area and approximately 3,000 additional acres in the vicinity of the Port of Sacramento are zoned for industrial use. Some of this is going to be developed with or without the channel deepening plan (e.g., the P.G.&E. site). The channel deepening will induce some additional development. Some of the industrial sites in the Collinsville area are as large as 4,000 acres so only portions of the sites will actually be developed. There are 2,000 acres south of the Port of Sacramento that are currently zoned Agricultural General (A-1) and are designated on the East Yolo General Plan for Agricultural — 1st Phase/Industrial — 2nd Phase. Some of this will be developed with or without the channel deepening. The 600-acre Port of Sacramento Industrial Park is being developed at the present time.

Section V — Probable Adverse Environmental Effects Which Cannot Be Avoided

5.01 Approximately 45 acres of marsh and riparian vegetation will be lost as a result of widening the manmade portion of the ship channel. In addition, approximately 3,500 acres of land will be covered by dredged material between New York Slough and Sacramento. All of these DMD sites are presently in agricultural and upland habitat. Associated with this loss in habitat will be a resulting loss in wildlife dependent upon that habitat. However, through a replanting program and the conversion of 45 acres of a

DMD site to tidal marsh, and the dedication of up to 156 acres of DMD areas to upland habitat development the losses would be mitigated. Additional and as yet unknown losses of natural and agricultural vegetation, water quality, air quality, fish and wildlife, and esthetics would occur as a result of new industries attracted to the area by the deepened channel. However, the lands projected for industrial development are currently zoned industrial in the local land use plans. The physical effects of dredging the channel would also include a short-term reduction in benthic organisms and fish which depend on these organisms for food. Model tests predict no adverse changes in salinities for the selected plan or the selected plan with construction of the submerged sill with one exception. Minor increases may occur at Rio Vista and Cache Slough along the Ship Channel during a critically dry year. However, even with the increase the salinity levels in Cache Slough there would be no adverse effect on domestic or agricultural water uses. Model tests predict no increases in salinities during an average dry year.

Section VI — Alternatives

6.01 **General.** — As discussed in Section D of Appendix 1, four alternative plans were considered in developing the selected plan. The four alternatives considered are: (1) increased usage of Lighter Aboard Ship (LASH), (2) intermodal transportation of cargo to alternative ports, (3) deepening the channel, and, (4) no action (no navigation improvement). The following paragraphs discuss the environmental impact of the alternatives.

6.02 **Increased use of LASH.** — There would be no need to deepen the existing channel, and the impact by LASH on the environment would be slight. It is expected that an increase in the usage of LASH would decrease the usage of deep draft vessel, truck, and rail transportation but increase tug (towboat) barge traffic. Overall, there would be a slight reduction in the amount of particulates and gases emitted to the atmosphere. Neither vegetation, aquatic life, nor wildlife would be affected by LASH traffic increase. However, at the present time the LASH vessels serving the Far East from the San Francisco Bay area have been taken out of service and converted to container vessels due to unfavorable economic conditions and labor problems in the Far East. Even if the number of LASH vessels increases in the future, these vessels would not meet the increasing demand for conventional bulk carriers at the port and at expected industrial facilities along the channel. (D.13-21)

6.03 **Intermodal transportation.** — Increasing truck and train traffic would have an adverse effect on air quality due to the increased amount of particulates and gases emitted into the atmosphere. Additional marine and truck terminals and lands necessary for stockpiling commodities would need to be constructed in the San Francisco Bay area. This alternative also results in a loss of economic efficiency in handling existing and future cargo movements at the port. The lack of bulk storage facilities in the deeper water ports of the San Francisco Bay area, in addition to the higher costs of utilizing rail and truck transportation, would inflate the cost of goods leaving the port's service area. (D.22-28)

6.04 **Deepening the Channel.** — Deepening the channel has the potential to improve the overall environmental quality of the study area; however, deepening could adversely affect individual aspects of the environment. Possible enhancement measures include construction of salinity control structures which would improve salinity conditions in Suisun Bay, creation of wildlife management areas, provision of recreation facilities, and preservation of existing unique ecological systems and wildlife habitats along the channel by acquiring such areas in public ownership. Adverse effects include possible local increases in salinity concentrations in the Delta. Generally, the deeper the channel the more significant the impacts on Delta salinity. Other detrimental environmental impacts include destruction of some benthic organisms, shoreline vegetation, and wildlife habitat due to channel construction. In addition, secondary effects on air and water quality could occur due to induced industrialization.

Implementation of this alternative would cause immediate short-term negative impacts including noise pollution and other inconveniences associated with dredging and construction operations. Upon completion of construction, these conditions would return to a more natural state. Long-term impacts would include balanced economic development and positive contributions to the social well-being account, assuming that current air, water, and other environmental standards will continue to be enforced. The deepening alternative would strengthen the regional economy by providing for greater employment opportunity through increased agricultural and industrial activity, resulting in substantial regional growth. (D.31-34)

Two variations on this alternative are the National Economic Development plan (NED) and the Environmental Quality plan (EQ). The NED plan addresses the planning objectives while maximizing net economic benefits. The plan which would maximize net benefits would include a 40-foot-deep channel, 500 to 600 feet wide, from Avon to the Collinsville-Montezuma Hills area, and a 35-foot channel ranging from 250 to 400 feet wide, from the Collinsville-Montezuma Hills area to Sacramento. In addition to channel deepening, the NED plan would include recreation developments. (D79-87) The lower transportation costs resulting from the NED plan would encourage industrial development along the channel. These lower transportation costs would produce national net benefits of approximately $12.0 million annually. Environmental impacts of the NED plan would include possible increased salinity intrusion, loss of wetland habitat, and short-term local impacts on water quality during construction. Possible mitigation measures for salinity intrusion could include the construction of a submerged sill in Carquinez Strait, channel closures or channel constrictions. Mitigation for the loss of wetlands would be accomplished by creating additional wetlands elsewhere. (D79-87) The EQ plan is intended to emphasize the management, conservation, preservation, creation, restoration, and/or improvement of natural and cultural resources and ecological systems while meeting the objectives of the investigation to the greatest extent practical. Specific plan elements for the EQ plan include the construction of a 35-foot-deep channel; purchase of land for habitat improvement, recreation development, and public access; acquisition of environmental easements; and creation of new habitat areas including wetlands. Benefits attributed to the EQ plan include monetary benefits calculated on the basis of recreation use of facilities provided and the establishment of wetlands, and nonmonetary benefits derived from the establishment of new habitat and the protection of existing habitats accrued directly to fish and wildlife. The economic effects of the EQ plan would include restricted land use for industrial expansion in the vicinity of the Port of Sacramento, while providing some opportunity for regional, industrial, and economic growth. In addition the net economic benefits would be less than the net economic benefits of the NED plan.(D93-104)

6.05 **No Action.** — As more of the larger ships service the port, more lightering equipment (intermodal, etc.) would be needed for "topping off" cargos in the deeper water of the San Francisco Bay. As compared to existing conditions, this would increase the quantity of particulates emitted into the air by trucks and trains. Other air pollution would result from the continued use of older, less efficient smaller ships. Eventually the economic efficiency of deep-draft vessels using the channel will drop to a level low enough to discourage development of deep-draft navigation-related industries and probably result in relocation of some industries to more economically favorable areas. Loss of vegetation and wildlife could also occur at these other locations. (D.37-41)

Section VII — The Relationship Between Local Short-Term Uses Of Man's Environment And The Maintenance And Enhancement Of Long-Term Productivity

7.01 **General.** — The selected plan described would result in the temporary loss of production on approximately 3,500 acres of land to be used for DMD sites. Vegetation, benthic life, and fish and wildlife would experience short-term losses during and for several years after construction. However, the mitigation and enhancement features of the selected plan would have the long-term effect of increasing vegetation and fish and wildlife resources above the present level. The selected plan would also benefit the economy of the area by improving present and assuring future world trade and by inducing industrial development providing for increased jobs and tax base. Without the selected plan the continued light-loading of vessels and inefficiencies and hazards to navigation would, in the long-term, result in financial losses to shippers and shipping interests, unfavorable competitive positions for the products of northern California's economy, and increased hazards as vessel traffic increases. Without the project there would continue to be a serious shortage in recreation in the Delta, causing unregulated recreation use which would result in a deteriorated recreation experience in the Delta. The selected plan contains recreation improvement measures to help accommodate the long-term rise in recreation demand.

The short-term expenditure of funds and resources for deepening the Sacramento River Deep Water Ship Channel including the associated environmental effects is justified by the long-term gains in economic development and in man's total environment.

Section VIII — Irreversible And Irretrievable Commitments Of Resources Which Would Be Involved In The Proposed Action Should It Be Implemented

8.01 Improving the Sacramento River Deep Water Ship Channel for navigation and recreation will irreversibly commit resources including capital funds and some lands. Approximately 30.3 million cubic yards of sediment will be dredged and either deposited on land or used for beneficial purposes. Construction of the project will require the expenditure of nonrenewable energy resources. Conversion of existing lands to waterways, deposition of dredged material to create marshlands and conversion of land uses for recreation and other beneficial uses are considered irreversible changes. Additional lands will be converted to industrial development.

Section IX — Coordination With Other Agencies

9.01 **Public participation.** — The most recent public coordination efforts were public meetings held on 3 March 1971, attended by over 80 persons, 19 July 1976, attended by approximately 60 persons, at which alternatives were discussed and the interests and concerns of the public were noted, and 13 November 1979, attended by 100 persons. The selected plan of improvement was presented at the 1979 meeting and the opinions of government agencies and the public were received. In July 1976, a public information brochure was prepared and made available to the public, summarizing the navigation problems in the study area, alternatives considered, advantages and disadvantages of each alternative, and the status of the investigation. The draft feasibility report and environmental statement was distributed to Federal, State, and local agencies in October 1979. Also, in October 1979 an information summary of the selected plan of improvement was mailed to over 900 political leaders, individuals, and interested organizations.

9.02 **Coordination with other agencies.** — In the course of this investigation, advice and comments have been requested and received from agencies having primary responsibilities for information in specific problem areas. These agencies included the Fish and Wildlife Service, California Department of Boating and Waterways, and California Department of Fish and Game. In addition to providing advice and comments, the Fish and Wildlife Service has conducted a study for the Corps of Engineers of the environmental effects of the proposed action.

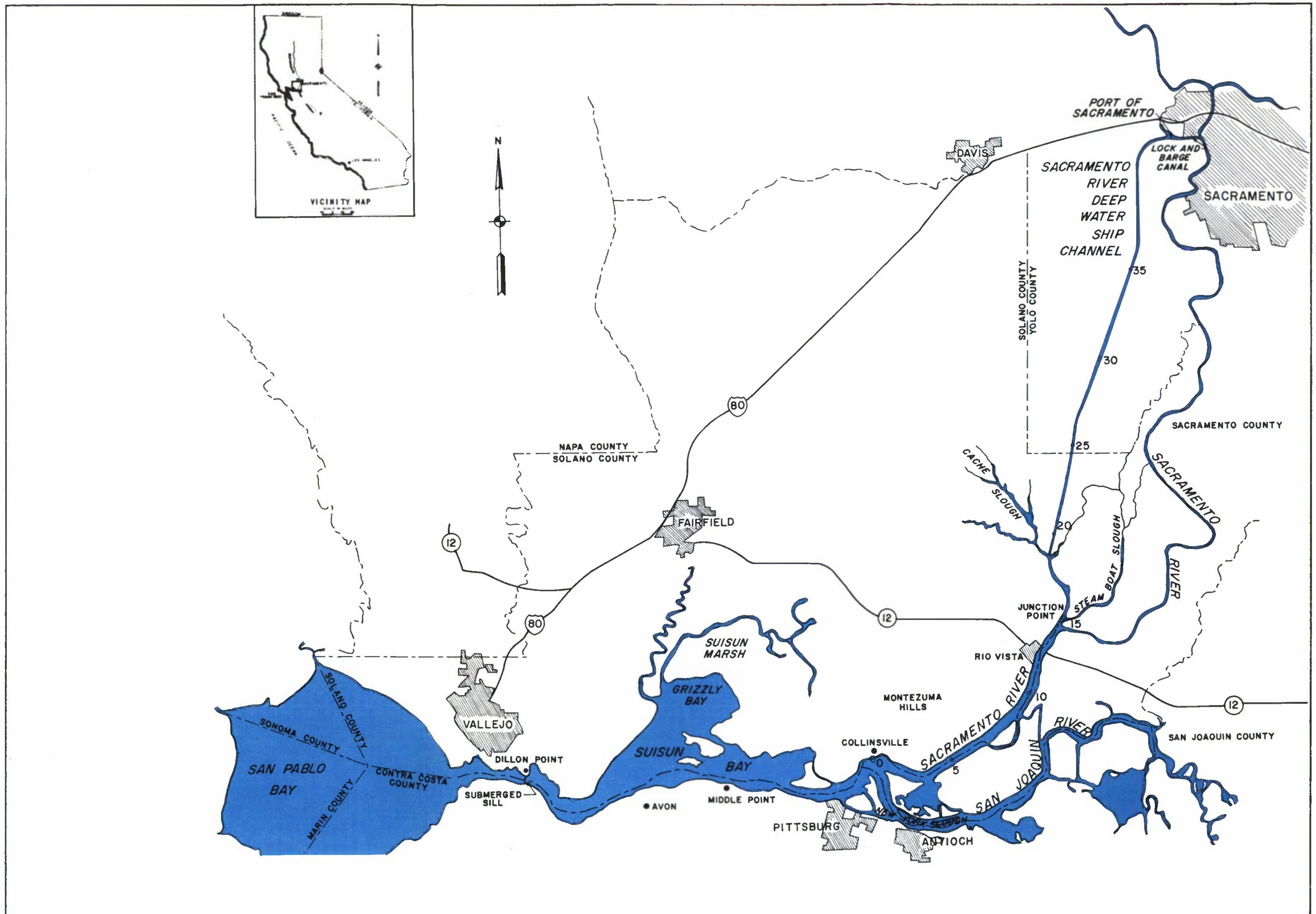
9.03 **Solicitation of comments.** — This draft environmental statement was coordinated with various levels of Federal, State, and local agencies and with interested citizens' groups and individuals. Their comments were evaluated and have been included in the final report. These groups include but are not limited to those listed below:

Federal Agencies
- Department of the Interior
- Department of Agriculture
- Department of Commerce
- Environmental Protection Agency
- Federal Energy Administration
- Coast Guard
- Advisory Council on Historic Preservation

State Agencies
- State Clearinghouse
- Department of Fish and Game
- Department of Parks and Recreation
- Department of Boating and Waterways
- Air Resources Board
- Water Resources Control Board
- Resources Agency
- State Historic Preservation Officer

Local Agencies
- Sacramento Regional Area Planning Commission
- Yolo County
- Solano County
- Sacramento County
- Contra Costa County
- East Yolo Community Services District
- Sacramento-Yolo Port District

Local Organizations
- Audubon Society
- Sierra Club
- National Wildlife Federation
- California Natural Resources Federation
- Riverlands Council
- California Wildlife Federation



GENERAL MAP
OF STUDY AREA

SACRAMENTO RIVER DEEP WATER
SHIP CHANNEL INVESTIGATION
CALIFORNIA

PLATE I (EIS)

SACRAMENTO RIVER DEEP WATER
SHIP CHANNEL, CALIFORNIA
FEASIBILITY REPORT AND
ENVIRONMENTAL IMPACT STATEMENT
FOR NAVIGATION AND RELATED PURPOSES

Section 404 Evaluation

APPENDIX 4

PREPARED BY THE
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
DEPARTMENT OF THE ARMY

SACRAMENTO RIVER DEEP WATER SHIP CHANNEL

SECTION 404 EVALUATION

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SECTION I

INTRODUCTION

In accordance with Section 404 of the Clean Water Act of 1977, Public Law 92-500, as amended (33 USC 1344), and other pertinent laws and regulations, the placement of dredged or fill material into the waters of the United States or their associated wetlands requires an evaluation of water quality considerations associated with the action. The Sacramento River Deep Water Ship Channel investigation indicates a need for deepening and widening the existing Suisun Bay and Sacramento River Deep Water Channels from New York Slough to the Port of Sacramento from 30 to 35 feet. No dredged material will be deposited within the waterway or upon an associated wetland. Fill material may be deposited within the waterway to construct a submerged sill at Dillon Point. The purpose of the sill, to be constructed if needed, is to control and prevent any increased salinity intrusion into the Delta due to the deeper channel. Prior to deepening and widening the channels the existing water quality monitoring network in the Delta will be supplemented with high-quality, well maintained salinity measuring stations. Salinity distributions will be observed prior, during, and subsequent to construction of the channels. The location of the high quality monitoring stations as well as the need for the sill will be determined after consultation with the Fish and Wildlife Service, Water and Power Resources Service, State Water Resources Control Board, and State Department of Water Resources, as well as other interested agencies.

The need to construct a sill or alternative measure will be determined on the basis of the results of model tests conducted by the Corps of Engineers in cooperation with California Department of Water Resources and other concerned State and Federal agencies during post-authorization studies. If a measurable increase in salinity is found, mitigation will be provided. Similarly, if post construction monitoring of salinity levels in the prototype indicates an increase in salinity distributions attributable to channel deepening mitigation will be provided.

SECTION II

PROJECT DESCRIPTION

2.01 Project features — Deep-draft navigation improvements would consist of enlarging the existing channel from Avon to the Port of Sacramento as shown in Plates E-1 through E-5. Approximately 30.3 million cubic yards of dredged material would be excavated. Dredging would be accomplished with hydraulic suction dredges equipped with cutterheads. The dredged material would be pumped a maximum of 10,000 linear feet to upland disposal sites. Approximately 3,980 acres of land would be required for disposal for the entire reach from Avon to Sacramento, with only 3,500 acres needed for the reach from New York Slough to Sacramento. The sites needed to handle the material excavated are shown on Plates E-1 through E-5. These sites have been used for disposal of dredged material in the past, either during the original construction of the channel or during subsequent maintenance dredging.

2.02 Mitigation features — The existing water quality monitoring network in the Delta will be supplemented with high-quality, well maintained stations to measure salinity distributions before, during and after the channels are deepened. If the results of post-authorization model tests of salinity intrusion or the results of post-construction monitoring of salinity distributions in the prototype indicate a measurable increase in salinity levels as a result of channel deepening, a submerged rock mound (sill) or alternative measure would be constructed in the Carquinez Strait (Plate E-1) to restrict and prevent any increased landward flow of more saline bottom currents which might be made possible because of the 5-foot deeper channel in the upstream portion of the estuary. Construction of the sill would require the open water deposition of approximately 225,000 tons of quarry and derrick stone. The stone would be barged to the construction site and would be offloaded and deposited by clamshell crane. Plate E-6 shows the cross section of the proposed site indicating sill height.

SECTION III

PHYSICAL EFFECTS

3.01 Potential destruction of wetlands — There will be no wetlands destroyed as a result of dredged material or fill material disposal. There will be, however, approximately 45 acres of marsh and riparian vegetation removed during the widening of the manmade portion of the ship channel. Mitigation for this habitat loss includes the development of 45 acres of tidal wetland on a dredged material disposal site.

3.02 Impact on the water column — The type of material used to construct the underwater sill (quarry and derrick stone) will not increase turbidity appreciably and what small increase would occur would be very short term in nature having no effect on light transmission, esthetics, or nektonic and planktonic populations.

3.03 Covering of benthic communities — The sill in Carquinez Strait will cover benthic habitat under the rock structure. Although benthic organisms would recolonize the rock structure, the community in the sill area would shift from presumably mud dwelling species to species adapted to life on relatively clean rock.

3.04 Other effects.

a. Changes in bottom geometry and substrate composition — The construction of the underwater sill would change the bottom geometry by creating an underwater dam with the crest at minus 50 feet mean lower low water (Plate E-6). The substrate in the vicinity of the sill would be changed from basically bedrock overlain by mud and silt to broken rock.

b. Water circulation — Dr. R. B. Krone (1977) investigated the effects of the sill on suspended sediment concentrations, using the San Francisco Bay-Delta Model and found that the effects of the sill on currents affecting upstream transport of sediments are barely detectable in the model data. The near-bed currents also indicate that the sill is not likely to impede the downstream transport of fine sand. However, surface currents above the sill will increase and water surface elevations may slightly increase during high flows.

c. Salinity gradient.

- Model tests of the selected plan (35-foot channel) to Sacramento using 1968 hydrologic conditions, an average dry year, indicate that the plan would cause no measurable change in salinities in San Pablo Bay (downstream of the sill), Suisun Bay, in Suisun Marsh, the lower Sacramento and San Joaquin Rivers, and the Delta. Using 1977 hydrologic conditions, a critically dry year, model tests also show that the plan would cause no measurable change in salinity in San Pablo Bay (downstream of the sill), Suisun Bay, Suisun Marsh, the lower Sacramento and San Joaquin Rivers, and the remainder of the system, with the exception of the upper Sacramento River (upstream of Rio Vista), where salinities would not be entirely reduced to preproject levels. However, even with this increase, there would be no adverse effect on domestic or agricultural water uses. Further tests of the submerged sill will be conducted during advanced engineering and design studies to reevaluate past studies and further adjust the height of the sill so that, within the accuracy of the model, salinities are returned to preproject conditions.

d. Exchanges of constituents between sediments and overlying water — Since quarry and derrick rock would be used in construction of the sill, no exchange is expected to take place.

SECTION IV

CHEMICAL-BIOLOGICAL INTERACTIVE EFFECTS

4.01 Evaluation of chemical-biological interactive effects — The material to be used for the sill meets the exclusion criteria as outlined in the 404 guidelines in that it is of naturally occurring material from a source which is removed from sources of pollutants.

4.02 Water column effects — Since the fill material meets the exclusion criteria and is not expected to contain any pollutants, the effect on the water column is expected to be insignificant. There are no contaminants expected to be released from the placement of the fill material.

4.03 Effects on benthic community — No adverse effects to the benthic community are expected to occur from the release of chemical constituents from fill material placement.

SECTION V

DESCRIPTION OF SITE COMPARISON

Comparison of the total chemical constituents in the sediments of the placement site with those of the fill material is not considered necessary due to the low potential for contamination by the fill material.

SECTION VI

WATER QUALITY STANDARDS

Available water quality data collected by the State of California's Central Valley Regional Water Quality Control Board from 1963 to 1972 indicate that, except for salinity, all existing water quality parameters meet the Board's 1975 objectives. Water Quality for the first half of 1979 was generally excellent as measured against the new Decision 1485 standards for the Delta. Although the first half of 1979 was classified as a dry year the standards were met by a wide margin. Construction of the Sacramento River Deep Water Ship Channel project is expected to result in fluctuations in concentrations of nutrients, turbidity, and salinity. Only minor impacts of an extremely local and short-term duration are anticipated regarding project-generated nutrients and turbidity increases. Impacts associated with salinity concentrations, on the other hand, are considered more significant and of greater magnitude. Consequently, physical model tests were conducted by the Corps of Engineers at the San Francisco Bay-Delta Model in Sausalito, California. Model tests predict that the selected plan would have no effect on salinities in San Pablo Bay, Suisun Bay, and the Delta during an average dry year or critically dry year. Test results predict minor salinity increases in the Sacramento River upstream of Rio Vista during a critically dry year. The model tests also indicate that the addition of a submerged sill to the the selected plan would have no effect in San Pablo Bay, Suisun Bay or the Delta during an average dry year and may reduce salinities in Suisun Bay below preproject conditions during a critically dry year. During a critically dry year, the sill would not entirely reduce salinities in the upper Sacramento River (upstream of Rio Vista) below preproject conditions, however, there would still be no adverse effect on domestic or agricultural water supplies.

SECTION VII

SELECTION OF DISPOSAL SITE

7.01 Need for the proposed activity — Deepening and widening of the Sacramento Deep Water Ship Channel is being proposed as a result of a detailed investigation of economic need and other factors indicating its feasibility. However, the proposed work might adversely affect some aspects of the environment. These adverse effects include a potential increase in salinity in the Sacramento-San Joaquin Delta as a result of channel deepening. A monitoring system would be established to measure salinity distributions in the Delta prior to construction. If salinity levels increase as a result of deepening, as determined by post-authorization model tests or post-construction monitoring, a submerged rock sill would be constructed in Carquinez Strait requiring the placement of quarry or derrick stone in the estuary at Dillon Point. Alternatives to the submerged sill will be investigated during advanced engineering and design studies if the project is authorized.

7.02 Alternatives considered — Several possible features were considered for mitigation of increased salinity intrusion. These measures included increasing Delta outflow, building a channel constriction, closing western Delta channels, and constructing a submerged sill. Of the alternative features considered, the submerged sill appears to be the most effective at mitigating salinity intrusion at reasonable cost and with a minimum of biological impact.

7.03 Impact on environmental features — An evaluation of the following environmental features identified potential impacts as minimal; food chain; diversity of plant and animal species; movement into and out of feeding, spawning, breeding and nursery areas; wetlands having significant functions of water quality maintenance; areas that serve to retain natural high waters or flood waters; turbidity; esthetic, recreation and economic values; threatened and endangered species.

7.04 Impacts on water uses at disposal sites — The placement of fill material at Dillon Point in Carquinez Strait will not significantly affect water uses at the site. Environmental and other features considered in evaluating the effects of the project on various water uses are: municipal water supplies; navigation; shellfish; fisheries, wildlife; recreation activities; threatened and endangered species; benthic life; wetlands; submerged vegetation; size of disposal site; and Coastal Zone Management Programs.

7.05 Considerations to minimize harmful effects — Considerations given to minimize impacts during construction of underwater sill include utilization of relatively clean rock fill free from contaminants; timing of construction so as to prevent interference with migrating fish; and sufficient public information to be made available and warning devices and signing regarding the structure and its construction to insure safe passage by ships and recreation boaters and anglers. In addition, placement of fill material will be done in such a manner so as to meet State water quality criteria.

SECTION VIII

STATEMENT AS TO CONTAMINATION OF FILL MATERIAL IF FROM A LAND SOURCE

The fill material to be used in construction of the underwater sill — quarry rock — is determined to be free of unacceptable quantities, concentrations, or forms of constituents deemed critical.

SECTION IX

MIXING ZONE

The mixing zone, that zone affected by the actual placement of fill material, has not been determined but should not be substantially affected because clean quarry and derrick stone would be placed in the area. Information from the model studies has not indicated adverse effects from possible changes in currents or sedimentations.

SECTION X

CONCLUSIONS AND DETERMINATIONS

Based on studies conducted during the feasibility investigation and information gathered for the environmental statement and this 404 evaluation, the impact of constructing the underwater sill at Dillon Point in Carquinez Strait on aquatic systems would be minimal. The greatest impact would be upon those benthic organisms directly covered by the fill placement. In addition, there is a possibility that the sill could have an overall beneficial or enhancing effect on upstream portions of the estuary by causing a small decrease in salinity over preproject conditions, bringing this parameter closer to conformance with the State of California's Regional Water Quality Control Board's water quality criteria.

Paul F. Kavanaugh

PAUL F. KAVANAUGH
Colonel, CE
District Engineer

OFFICE STUDY

STOCKTON SHIP CHANNEL

AND

SACRAMENTO RIVER DEEP WATER SHIP CHANNEL

A P P E N D I X 5

IMPACTS ON SALINITY DISTRIBUTION

PREPARED BY THE
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
DEPARTMENT OF THE ARMY

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OFFICE STUDY

STOCKTON SHIP CHANNEL AND SACRAMENTO RIVER DEEP WATER SHIP CHANNEL IMPACTS ON SALINITY DISTRIBUTION

1. Introduction

This report presents the results of recently completed model tests of the Stockton and Sacramento River Deep Water Ship Channels. The report contains a summary of the model testing procedures, the tests conducted and their results, and conclusions drawn. Detailed information on the model characteristics, testing procedures, and results follow the summary and conclusions.

Initial model tests of the Stockton Ship Channel were conducted at the San Francisco Bay-Delta Model between 1973 and 1975. These tests showed a slight increase in salinity concentrations at several locations in the Delta as a result of deepening the Stockton Ship Channel and constructing the False River Cutoff. Tests of deepening both the Sacramento River Deep Water Ship Channel and the Stockton Ship Channel were also conducted in 1975 and showed a slightly higher increase in salinity at certain stations than did the Stockton Channel alone. The results of the tests on the Stockton Ship Channel were presented in the Draft Interim General Design Memorandum (GDM) dated June 1976. During review of the draft GDM and EIS by interested agencies and organizations, many concerns were raised about the slight increases in salinity caused by the channel deepening and realignment. Another concern expressed during review of the GDM in 1976 regarded the combined effect of the channel deepening and the State proposed Peripheral Canal on salinity distributions. It was therefore decided to reexamine the project effects on water quality in more detail. In order to determine the possible effects on water quality of deepening the Sacramento and Stockton Ship Channels, and also any mitigation measures that may be required, several related studies were conducted by the Corps in 1977 and 1978. Hydroscience, Inc., analyzed the effects of a submerged sill in Carquinez Strait on water quality of the western Delta-Suisun Bay area under contract to the Corps of Engineers, and completed their final report in May 1978. Dr. Krone, University of California at Davis, studied the effects of the sill on suspended sediment concentrations under contract to the Corps, and prepared a final report in October 1977. The Corps' Waterways Experiment Station (WES) has recently completed tests of hydrodynamic effects of the sill, and has issued a report on study results. Also, during this period, tests were conducted at the Bay-Delta Model to determine (1) the effects on salinity of deepening the Sacramento and Stockton Ship Channels; and (2) the effects on salinity of installing a submerged sill in Carquinez Strait. These model tests were conducted both with and without the proposed Peripheral Canal, and results are presented in this report.

2. Summary and Conclusions

This paragraph summarizes the model characteristics, the model testing procedures, and the test results. A brief description of the tests conducted is also presented.

The San Francisco Bay-Delta Model is a distorted scale, fixed-bed hydraulic model of the San Francisco Bay and Sacramento-San Joaquin Delta estuary. The model has been verified against prototype stages, velocities, and salinities. The model's ability to reproduce identical test results (repeatability) varies with several factors, including station location and time of the year. The observed repeatability or resolving power of the model based on available repeat tests is subsequently presented in this report.

Both dynamic and steady-state tests were conducted at the model. During dynamic tests, the historic river inflows were varied in accordance with historic river flows for a specified period, such as 1977. During steady-state tests, river inflows were held constant at a fixed level while the mean tide was reproduced in the ocean. In order to reduce the large volume of data collected from these tests, the results were averaged to form monthly average salinities for the dynamic tests and tidal cycle average salinities for the steady-state tests.

One plan was tested for each ship channel. The channel depths were limited to 35 feet below mean lower low water due to the downstream channel constraint at this depth. Although the downstream channel is authorized for deepening to 45 feet under the John F. Baldwin project, it appears unlikely at this time that this work will be completed in the foreseeable future. The test of the Stockton Ship Channel included deepening the channel to 35 feet from Avon, in Suisun Bay, to the Port of Stockton using the existing channel alignment. This plan, which does not include the False River Cutoff, is called Plan D-1 in this report. The test of the Sacramento River Deep Water Ship Channel combined with the Stockton Channel included deepening the existing 30-foot Sacramento Channel to 35 feet between Pittsburg and the Port of Sacramento and deepening the Stockton Channel as described above. This plan is referred to as Plan H-1 in this report. Both Plans D-1 and H-1 were compared to existing channel conditions to determine impact on salinity distribution.

Both base and plan tests were conducted at the model. Base tests include the existing prototype channel geometry and inflows and tidal conditions identical to those used in plan tests. The results of the base tests were used as a baseline for comparison with plan conditions. Plan tests were conducted for both the Stockton and the Sacramento Ship Channels as previously discussed.

As previously discussed, other tests were conducted to determine the effects of the submerged sill on the estuary. These tests included velocity measurements conducted in an undistorted scale model of the Carquinez Strait at the Waterways Experiment Station in Vicksburg, Mississippi. In these tests, velocity measurements were taken both with and without the sill at various depths and locations within the Carquinez Strait area. Other tests were conducted at the Bay-Delta Model in Sausalito to determine the effect of the sill on tidal stages throughout the estuary. A study was also conducted by Dr. Ray Krone at the Bay-Delta Model on the effects of the sill on sediment transport. A study was also conducted by Hydroscience, Inc., using data from the Bay-Delta Model to predict the effects of the submerged sill on biological parameters in Suisun Bay and the western Delta. The Bay-Delta Model was used in this study to furnish transport information and hydrodynamic characteristics, while mathematical models were used to predict changes in biological parameters in the study area.

The results of these tests show that any changes in salinity due to deepening the Stockton Ship Channel alone and the Stockton Ship Channel combined with deepening of the Sacramento River Deep Water Ship Channel to 35 feet below mean lower low water are smaller than the model can accurately predict. The tests also show that including the submerged sill would reduce salinities to below preproject conditions at many locations in Suisun Bay and the Delta. The tests and studies of the submerged sill by WES show that with a tidal flow of 500,000 cfs there would be a small 1-2.5 foot per second local increase in velocities at flood and ebb tide in the vicinity of the sill. Bay-Delta Model studies and analysis by Dr. Krone show that tidal stages would not be affected under normal conditions and would be increased by a maximum of 0.4 feet at certain locations in Suisun Bay and by less than 0.2 feet in the remainder of the Delta during extreme flood conditions. Dr. Krone also concluded that sediment deposition would not be affected by the sill. Biological studies by Hydroscience, Inc., have shown that the sill would have no effect on phytoplankton concentrations and dissolved oxygen.

On the basis of model test results and results of related studies, it can be concluded that deepening the Stockton Ship Channel to 35 feet would have no measurable effect on salinity distributions or concentrations in the estuary and that, since there would be no measurable change in salinities and hence no change in transport characteristics, there would be no change in the null or entrapment zone. This conclusion differs from the findings in 1976 of a slight increase in salinity concentrations because the False River Cutoff has now been eliminated from the plan. Furthermore, subsequent deepening of the Sacramento River Deep Water Ship Channel would also have no measurable impact on salinities in the estuary, and construction of the submerged sill in Carquinez Strait would reduce salinities to below preproject at several locations in Suisun Bay and the Delta. Model and related tests also show that construction of the sill would cause no change in sediment transport, tidal stages, or velocities (except near the sill). Consequently, there would be no measurable increases in salinity resulting in long term changes in the estuary as a result of constructing the project with or without the sill. In particular, there is no reason to expect long term changes in the null or entrapment zone nor in the bottom contours of the estuary. A pre- and post-project monitoring program may be advisable to verify that deepening the Stockton and Sacramento River Deep Water Ship Channels will cause no significant adverse changes in the estuary. With such a program, salinities would be monitored prior to and after channel deepening. If a significant adverse change in salinities is determined to be caused by the deepening, the submerged sill in Carquinez Strait could be constructed. Monitoring would then continue after sill construction to determine its effectiveness.

3. The Model

The following paragraphs describe the San Francisco Bay-Delta Model in terms of its correspondence and verification with the prototype, its resolution or sensitivity, and the characteristic of the data it produces.

a. **Correspondence of model information and prototype standards.** — Values of measured salinity levels in the model and the prototype cannot be directly compared. Salinity distributions observed with preproject, or existing, prototype conditions modeled (base tests) provide the baseline to which the plans must be compared.

b. **Model verification.** — In using the results of hydraulic model tests to predict the effect of channel deepening and/or widening on hydraulic and salinity phenomena, there are three major factors that must be considered in evaluating the reliability of the model predictions. The first of these is model verification, or demonstration that the model will reproduce observed prototype phenomena (for conditions existing at the time field data were collected) of the type to be developed in the predictive mode. The San Francisco Bay-Delta Model has been verified for tides and currents throughout the model area, based on historical data collected by many agencies, and has been verified for salinity phenomena by comparing model salinities with those observed in the prototype in 1968 using boundary controls in the model representative of 1968 events observed in nature. Boundary controls derived directly from prototype measurements included stream flows, export pumping, and ocean salinity. The 19-year mean tide was run repetitiously in the model ocean, since previous tests had shown that this tide accurately portrayed the effects of varying tides on hydraulic and salinity conditions throughout the model area. Published estimates of agricultural water withdrawals and returns in the delta were used in the initial model verification test, and it was found necessary to make modest adjustments to both the volume and time phasing of these estimates to obtain a best fit between model and prototype with respect to salinity concentrations throughout the model and especially in the delta channels. On an overall basis, verification of the San Francisco Bay-Delta model is excellent. The model has demonstrated its ability to reproduce pertinent prototype phenomena with an accuracy at least equal to the accuracy of prototype data used for verification purposes. Verification data were published in the San Francisco Bay-Delta Model Technical Memorandum No. 1., "Model Verification and Results of Sensitivity Tests," June 1976. In addition, Hydroscience, Inc., in their comparisons of hydraulic model results with prototype data, found that the Bay-Delta Model " . . . represents the prototype conditions quite adequately" (May 1978 report previously referenced).

c. **Salinity fluctuations.** — Salinities at any location in the Bay-Delta system exhibit both diurnal and seasonal fluctuations. Diurnal fluctuations are generated by tidal current; seasonal fluctuations by the varying rates of freshwater flows through the system resulting from seasonal runoff, releases from upstream impoundments, irrigation withdrawals and returns, evapotranspiration, etc. Both diurnal and seasonal fluctuations are reproduced by the model. Furthermore, as a consequence of the difference in density between fresh and saline water, a vertical variation of salinity is usually evident.

d. **Raw data characteristics.** — Raw data obtained from the model consist of instantaneous salinity measurements. During dynamic tests, the sampling rate for most stations was once every ten tidal cycles, with a few stations sampled every five cycles. During steady-state tests, no samples were taken until salinities came to steady-state, at which time samples were taken at 36-second intervals for one or two tidal cycles. An averaging method was employed to minimize the influence of random errors in individual measurements.

e. **Model repeatability.** — An important factor that must be considered about the predictive capability of the model is the repeatability of the model, or the duplication of model results from identical tests. If model repeatability is not good, then a change indicated by the model between existing and plan conditions, or between one plan and another plan, may be due to poor repeatability rather than to the plan being tested. The San Francisco Bay-Delta Model, like its prototype, is a highly dynamic system, and thus exact repetition of test results under the most carefully controlled boundary conditions should not be expected. Convective and advective eddy diffusion, both of which are significant to salinity distribution, are not repetitious phenomena within a highly dynamic system, and thus samples obtained from identical points and at identical times from test to test cannot be expected to yield identical salinity concentrations, even though boundary controls and channel conditions are as nearly identical as possible. Furthermore, the effects of these factors on repeatability of model tests are greater in some portions of the model than in other portions. For example, the repeatability of salinity concentrations at a station located in a well defined channel should be better than one located in a deep channel bounded on one or both sides by extensive shallows or for one located near channel junctions. In these latter cases, both horizontal and lateral salinity gradients are evident throughout the tidal cycle, and the diffusive exchange of water between the channel and the adjacent shallows, or between the primary channel and one or more tributary channels, has significant impact on salinity concentrations measured at a discrete point. In the analysis performed to obtain best estimates of model repeatability, this factor has also been evaluated to the extent that available data would permit.

The model tests conducted for the Stockton Ship Channel and the Sacramento Ship Channel were single tests, either steady-state or dynamic, and, therefore, duplicate tests in these series were not available to evaluate model repeatability. However, in subsequent tests of various elements of the John F. Baldwin Ship Channel, three of the steady-state tests and all of the dynamic tests were duplicated. Dynamic test results analyzed to obtain the best possible measure of model repeatability included results from the following three pairs of base tests:

(1) Existing base conditions.

(2) Base test conditions for the Baldwin Ship Channel (Plan H-1).

(3) Improved Sacramento, Stockton, and West Richmond Ship Channel (Plan L).

The model test repeatability values obtained from analyzing data from selected stations are summarized in the following tabulation:

San Francisco Bay Model Repeatability — Dynamic Tests

Area	Station Analyzed	Repeatability: Observed Ranges (%)	Repeatability: Recommended Value (%)
Golden Gate	1	1.0-1.9	2.0
San Pablo Bay	6	1.7-4.4	4.5
Suisun Bay	9	2.5-5.2	5.0
Chipps Island Reach	11A	2.5-7.7	7.5
Lower Sacramento River	22	5.7-7.7	7.5
Lower San Joaquin River	14A	4.1-8.3	8.5
Central Delta	18	4.8-9.0	9.0
South Delta	35	3.5-7.5	7.5
South Delta	0	3.1-7.3	7.5

Since no definable seasonal pattern in model repeatability was evident in the data analyzed, a single repeatability value is recommended for each of the above model areas. These values were developed from an analysis of average monthly salinities. Test to test variability of individual salinity measurements (same station and time) may be larger, particularly at the Delta stations.

Repeatability limits for these important stations were used to estimate repeatability limits for neighboring stations. Table 1 shows the station name and number and its associated repeatability limits for dynamic tests.

Information available from repeat steady-state tests is more limited. Two sets of repeat tests were run during the February 1980 test series sponsored by the State and the Water and Power Resources Service (WPRS). These tests represented current channel conditions with the Sacramento Ship Channel and Franks Tract Levee System (a) open and (b) closed, a low Delta outflow of 3400 cfs, and no export pumping. The only other repeat steady-state tests are from the J. F. Baldwin Channel study and provide no salinity data above Station 22 on the Sacramento River and Station 14A on the San Joaquin River. Three sets of tests were run but only two provide any information above Station 6 in San Pablo Bay. One set of tests was for Plan M (improvement of J. F. Baldwin, Stockton, and Sacramento Ship Channels) and the other set was for Plan M with a barrier at Dillon Point. Analysis of these limited data provides a frame of reference for reviewing results of steady-state tests but does not provide a sound basis for recommending specific repeatability values in all areas of the model. The available data suggest that repeatability of tidal cycle average salinities at Station 1 (Golden Gate) and Station 6 (San Pablo Bay) is within 1.5 percent and that repeatability at Station 9 (Suisun Bay) and Station 11A (Chipps Island Reach) is within about 3 percent. However, at Stations 14A (Lower San Joaquin River) and 22 (Lower Sacramento River), repeatability in the two test series differed greatly. At these stations, the State-WPRS tests showed repeatability values of about 4 percent while the Baldwin tests produced repeatability values as high as about 20 percent. Only the State-WPRS tests provided salinity measurements in the central and southern Delta areas, indicating a repeatability of about five percent. Given the difference in repeatability values at Stations 14A and 22 between the two test series, it is probably not wise to assume that repeatability in the Delta areas would be within 5 percent in all test programs.

Another factor which must be taken into consideration in interpreting results of steady-state tests is stability between tidal cycles within a test. Analysis of several steady-state tests (some of the tests cited above and some other tests which were not repeated) indicated that variability between cycles might reach seven percent at some of the Delta stations even when the test appeared to have been run to stability. In other tests where it appeared the test had been terminated before the model had fully stabilized, the variability between cycles near the end of the run was as high as 11 percent at some of the delta stations.

Based on analysis of all available duplicate tests conducted in the model, it appears that model repeatability is as defined in the above paragraphs for dynamic and steady-state tests. Differences in salinities between a base test and a plan test that fall within the model repeatability values recommended herein are considered to be as likely attributable to model repeatability as to the effects of the plan being tested. On the other hand, differences which fall outside these repeatability values could indicate changes in salinities, either plus or minus, to be expected if the plan in question should be constructed in the prototype.

f. **Model accuracy.** — The third major factor, in addition to model verification and model repeatability, to be considered in evaluating the predictive capacity of the Bay-Delta Model is the accuracy with which the model can be expected to predict changes in prototype hydraulic and salinity phenomena as the result of a change in channel depth and/or width. Much of the experience on this subject is within the staff of the U.S. Army Waterways Experiment Station (WES) in Vicksburg, Mississippi. The Waterways Experiment Station has worked over a great number of years with models of this type and the remainder of this paragraph is a statement of their views. The changed channel depths of width effected by a given plan are different from those to which the model was verified, and the question follows as to whether some minor readjustment of the model roughness might be required to portray accurately the plan condition. If such is the case, the model could be expected to slightly over-predict the effects of channel enlargement on salinity intrusion; that is, salinities predicted by the model should be slightly greater than would occur in the prototype under identical boundary conditions. Post construction studies have been made in a few cases in an attempt to define precisely the predictive accuracy of models similar to the San Francisco Bay-Delta Model. While in no case has a significant difference between model prediction and prototype performance been discovered, the fact remains that to date it has not been possible to obtain post construction measurements from a prototype under the identical set of boundary controls used for model tests. Based on experience, it is believed that the capability of the San Francisco Bay-Delta model in predicting salinity changes in the prototype effected by changes in channel widths or depths of the magnitude of those involved in these studies is well within the reliability of prototype measurements that might be made during a post construction study. Stated in another way, it is believed that the predictive capability of the model is essentially equal to the repeatability of the model and is much more reliable than would be obtained through extensive pre and post construction studies in the prototype as a means for identifying the effects of the plans under investigation.

4. Test Conditions

Tests were conducted of the effects of deepening the Stockton and Sacramento Ship Channels to 35 feet below mean lower low water (mllw). Tests were also conducted with the existing configuration of these waterways for comparison purposes. Depths greater than -35 feet mllw were not tested due to the downstream channel constraint at this depth. The two plan tests conducted were referred to as Plans D-1 and H-1 and are described as follows:

Plan D-1 includes deepening the Suisun Bay and Stockton Ship Channels to 35 feet without construction of the authorized False River Cutoff. Plan H-1 adds deepening of the Sacramento River Deep Water Ship Channel to 35 feet to the features included in Plan D-1. The channel configurations tested are tabulated below:

EXISTING AND PROPOSED CHANNEL DIMENSIONS IN FEET[1]

Channel	Existing Dimensions Bottom Width	Existing Dimensions Depth	Authorized Plan D-1 Bottom Width	Authorized Plan D-1 Depth	Proposed Plan H-1 Bottom Width	Proposed Plan H-1 Depth
Stockton Ship Channel						
Golden Gate to Avon	600	35	600	35	600	35
Avon to Middle Point	300	30	600	35	600	35
Middle Point to Pittsburg	300	30	400	35	400	35
Pittsburg to Antioch (New York Slough)	400	30	400	35	400	35
Antioch to Prisoners Point	400	30	400	35	400	35
Prisoners Point to Stockton	225	30	225	35	225	35
Sacramento River Deep Water Ship Channel						
New York Slough (Pittsburg) to Junction Point (SRDWSC Mile 15.0)	300	30	300	30	400	35
Junction Point to Manmade Channel (Mile 18.6)	300	30	300	30	300	35
Channel Mile 18.6 to Sacramento	200	30	200	30	250	35

[1]Existing channel from Golden Gate to Avon currently maintained at -35 feet mllw.

Tests were also conducted of alternative locations for a submerged sill in Carquinez Strait which showed that a sill at the Dillon Point site was most effective in reducing salinities in Suisun Bay and the Delta. Detailed tests of a submerged sill at Dillon Point were therefore conducted in conjunction with the two plans. The submerged sill tested would have a crest elevation at -50 feet mllw, a 12-foot crest width, and side slopes of 1 vertical on 2 horizontal. Results of a test of a sill with a higher crest elevation, but with a notch for deep-draft navigation, showed little increase in the sill's effectiveness in reducing salinity intrusion. The proper distorted shape of the sill, as determined by the Waterways Experiment Station, had a crest width of 0.12 foot and side slopes of 1 vertical on 0.9 horizontal.

5. Model Testing Procedure

Both dynamic and steady-state tests were conducted of the existing (base) and plan conditions. Dynamic tests were conducted because they produce a good representation of prototype conditions during the modeled time period, i.e., 1977. Steady-state tests as requested by the State of California and the Water and Power Resources Service were conducted for evaluation of the Peripheral Canal in order to eliminate the need for varying the inflows and canal releases and because, during low flow conditions, the prototype approaches a steady-state condition. In addition, to improve the reliability of all model test results, the model operation was simplified by eliminating the 12 discrete channel depletion and 24 discrete agricultural return flow stations and combining these flows with the primary inflows to and exports from the model. This reduced the inflow points from 27 to 3 and the outflow points from 14 to 2. This simplification resulted in no change in total Delta outflow and therefore did not affect the model's ability to predict the plan's effect on salinity distributions. (Refer to paragraph 7a for the analysis supporting this conclusion.) The following subparagraphs describe the details of dynamic and steady-state tests.

a. **Dynamic.** — Essential aspects of the dynamic testing methodology were:

(1) Delta inflows and outflows were varied in time to correspond to historical prototype data for the calendar years 1968 and 1977 as shown on Tables 2 and 3. The 1968 hydrology was chosen because prototype salinity data for that year were used to verify the model. 1968 is considered a low flow year, but not an extreme condition. The 1977 hydrology was used because 1977 is considered a critically dry year and the effects of channel deepening on salinity are the most serious during extremely low outflow conditions, such as those which occurred in 1977 (flow of about 4,000 cfs). There would be no effect on salinity when outflows of 15,000 cfs or greater occur, such as during years with average or above average precipitation.

(2) The tide used reproduced a 19-year mean prototype tide. A period of 19 years constitutes a full tidal cycle, for during this period of time the more important of the tidal variations will have gone through complete cycles. Therefore, results derived from 19 years of tide observations constitute mean values. Previous testing programs have shown that this tide accurately portrays the effect of varying tides on salinity conditions throughout the model area.

(3) Each test corresponded to one prototype year.

(4) Salinity values were derived from electrical conductivity measurements, calibrated with standard solutions.

(5) Water samples for salinity measurements were obtained at local slack water, both higher high and lower low, as indicated by surface floats near the sampling stations.

(6) At stations where both surface and bottom samples were taken, they were obtained simultaneously.

(7) Locations of the sampling stations are shown on Charts 1-7.

(8) During tests, the model ocean salinity was continually monitored and salt added as necessary to maintain the salinity at 33,000 parts per million (ppm).

b. **Steady-state.** — The essential aspects of the steady-state testing methodology were:

(1) Delta inflows and outflows were held at constant levels furnished by the Water and Power Resources Service, Mid-Pacific Region. As shown on Table 4, inflows were 15,300 cfs and total Delta outflow was 4,700 cfs. The values supplied by WPRS for Delta inflow and outflow represent approximate flows required to meet the dry-year criteria adopted in the Delta Water Quality Criteria signed by WPRS, the Department of Water Resources, and other agencies, dated 19 November 1965. This assumes that critically dry conditions, such as 1977, would exist but that sufficient carryover storage would be available in upstream reservoirs to meet water quality criteria and to export water from the Central Valley Project (CVP) and State Water Project (SWP) pumping plants.

(2) In tests which included the Peripheral Canal operation, diversions to and releases from the Canal were held constant at levels furnished by WPRS. Total Delta outflow equalled that for without Peripheral Canal tests.

(3) The tide used reproduced a 19-year mean prototype tide.

(4) Salinity values were derived from electrical conductivity measurements, calibrated with standard solutions.

(5) After the model had been operated long enough for salinities to repeat themselves from tidal cycle to tidal cycle (or come to steady-state), water samples for salinity measurements were obtained at 36-second intervals in the model, representing 2-hour intervals in the prototype.

(6) At stations where both surface and bottom samples were taken, they were obtained simultaneously.

(7) Locations of the Sampling Stations are shown on Charts 1-7.

(8) During tests, the model's ocean salinity was continually monitored and salt added as necessary to maintain the salinity at 33,000 ppm.

c. **Method of data analysis.** — For each condition tested, the instantaneous salinity measurements at selected stations were analyzed as follows:

(1) For dynamic tests, average monthly mid-depth salinities were calculated using surface, bottom, higher-high-water and lower-low-water measurements. These averages were calculated for approximately 20 stations throughout the Bay-Delta system.

(2) For steady-state tests, the 2-hour surface and bottom measurements were combined for each station to form the average mid-depth tidal cycle salinity.

(3) For both dynamic and steady-state tests, salinity was plotted against time for Stations 11A (Chipps Island), 14A (Blind Point), 22 (Emmanton), 18 (Prisoners Point), 35 (West Canal at Clifton Court Forebay), and 0 (Contra Costa Canal Intake). These stations are located near water quality monitoring points in the prototype and salinity standards have been set for some of these points.

6. Model Tests

a. **Base tests.** — Salinity levels for base conditions were established by operating the model with hydrology and tide identical to those used for the plan tests and geometry representative of existing prototype conditions. Four base tests were conducted as follows:

(1) Dynamic salinity test with 1977 hydrology.

(2) Dynamic salinity test with 1968 hydrology.

(3) Steady-state salinity test with a Delta outflow of 4,700 cfs.

(4) Steady-state salinity test with Peripheral Canal and Delta outflow of 4,700 cfs.

b. **Plan tests.** — The following plan tests were conducted:

(1) **Dynamic tests.** —

i. Plan D-1 (1977 hydrology).

ii. Plan D-1 with submerged sill (1977 hydrology).

iii. Plan H-1 (1977 Hydrology).

iv. Plan H-1 with submerged sill (1977 hydrology).

v. Plan H-1 (1968 hydrology).

vi. Plan H-1 with submerged sill (1968 hydrology).

(2) **Steady-state tests.** —

i. Plan D-1 (4,700 cfs outflow).

ii. Plan D-1 with Peripheral Canal (4,700 cfs outflow).

iii. Plan D-1 with Peripheral Canal and submerged sill (4,700 cfs outflow).

iv. Plan H-1 with Peripheral Canal (4,700 cfs outflow).

v. Plan H-1 with Peripheral Canal (4,700 cfs outflow).

vi. Plan H-1 with Peripheral Canal and submerged sill (4,700 cfs outflow).

(3) **Submerged sill tests.** —

i. Velocity tests were conducted for with and without sill conditions in the undistorted scale model at WES.

ii. Tidal stage measurements were taken with and without the submerged sill for a steady-state Delta outflow of 410,000 cfs. This flow was continued for about 15 tidal cycles for each condition and represents a flow volume much in excess of the maximum flood of record. This condition is more extreme than a larger instantaneous flow with less volume because of the large storage capacity in the Delta Channels.

7. **Model Test Results**

The following paragraphs present a detailed analysis of model test results. The analysis used the repeatability limits given in Table 1. The analysis is supported by Tables 5 through 20 and Charts 8 through 19.

a. **Effects of use of simplified hydrology on model test results.** — To confirm the validity of using simplified hydrology (see page 10, Model Testing Procedure), comparisons were made between the following dynamic tests.

(1) Base tests for 1968 hydrology — with vs. without simplified hydrology.

(2) Plan D-1 tests for 1968 hydrology — with vs. without simplified hydrology.

(3) Base tests for 1977 hydrology — with vs. without simplified hydrology.

(4) Plan D-1 vs. base tests with simplified hydrology and Plan D-1 vs. base without simplified hydrology, 1968 hydrology.

Comparisons (1), (2), and (3) above are shown in Tables 5, 6, and 7, respectively. Results show that absolute salinities in San Pablo and Suisun Bays are essentially (within the repeatability of the model) identical with or without use of simplified hydrology (without use of simplified hydrology can also be called "full hydrology"). For identical channel conditions, small decreases in salinity values with use of the simplified hydrology (compared to full hydrology) are apparent at some stations in the Central and Southern Delta for dry (1968) and critically dry hydrologic conditions (1977). Stations on the lower Sacramento River (higher streamflows than Central and South Delta) show virtually no change in salinities between "full" and simplified hydrology during the average (1968) dry year, but show small decreases with the use of simplified hydrology during the critically dry year (1977). Generally, results show that, compared to full hydrology, simplified hydrology values are lower at those locations in the Delta where flows are relatively small and are essentially identical to full hydrology at locations where flows are relatively large.

The effect of a given plan on salinity at a given station is determined by observing the difference between base and plan salinities at that particular station. Table 8 displays such information for two sets of tests using 1968 hydrology, 1 set with simplified hydrology, the other without the use of simplified hydrology. Conclusions drawn from the two sets are identical, i.e., the use of simplified hydrology does not affect whether or not the plan tested changed salinities from base conditions. In a few instances (1 or 2 months of the year at scattered locations), those tests using simplified hydrology predicted a greater increase in salinity due to the plan than predicted by tests not using simplified hydrology. Thus, Table 8 shows that by use of simplified hydrology, any increase in salinity caused by the plan being evaluated will either be the same or greater than the increase predicted without the use of simplified hydrology.

The data contained in Table 8 was derived and utilized to evaluate the effect of using full versus simplified hydrology and should not be used for evaluating the effect of channel deepening on Delta salinity.

b. **Effects of deepening the Stockton Ship Channel (Plan D-1) on salinity distributions. —**

(1) **Plan D-1.** — The differences between plan and base tests, shown in Table 9 and Chart 8, indicate the effect of the plan on average mid-depth monthly salinities as derived from the dynamic salinity tests using 1977 hydrology. Similarly, Table 10 and Chart 9 indicate plan effects on average mid-depth tidal cycle salinities, as derived from steady-state tests. The differences shown at Station 0 in the dynamic tests and in the steady-state tests are not indicative of plan effects but rather represent model testing discrepancies between plan and base tests.

This conclusion is based on a comparison between Plan D-1 and Plan H-1 test results at Station 0 and four neighboring stations. Plan H-1 (deepening both the Sacramento and Stockton channels), intuitively, should have the same or more adverse impacts than Plan D-1 (deepening the Stockton Channel alone). Test results were compared as follows for Station 18, 31, 33, 35, and 0:

(i) Dynamic tests.

(aa) 1977 plan channel condition.

(bb) 1977 plan with sill channel condition.

(ii) Steady-state tests.

(aa) Plan with peripheral canal channel conditions.

(bb) Plan with peripheral canal and submerged sill channel conditions.

The tabulation on the following page shows that, in most cases, Plan H-1 effects are indeed the same as or more adverse than Plan D-1. The only time this relationship does not hold true is at Station 0 for the plan channel conditions. Since Station 0 is inconsistent with the results of neighboring stations and inconsistent with results at Station 0 for other dynamic and steady state tests, model test results are probably due to a discrepancy and not the result of Plan D-1.

COMPARISON OF PLAN D-1 vs PLAN H-1
TEST RESULTS AT SELECTED STATIONS

Dynamic Model Test Results
Plan Channel Conditions
1977 Hydrology

Average Monthly Salinities
Parts per Thousand

	Station 18			Station 31			Station 33			Station 35			Station 0		
	Plan D-1	Plan H-1	Change	Plan D-1	Plan H-1	Change	Plan D-1	Plan H-1	Change	Plan D-1	Plan H-1	Change	Plan D-1	Plan H-1	Change
Jan	.22	.23	+.01	.86	.85	-.01	.42	.43	+.01	.36	.36	.00	.51	.49	-.02
Feb	.24	.25	+.01	.84	.85	+.01	.47	.48	+.01	.50	.48	-.02	.57	.56	-.01
Mar	.24	.24	.00	.68	.71	+.03	.42	.42	.00	.46	.45	-.01	.47	.44	-.03
Apr	.26	.26	.00	.73	.74	+.01	.42	.43	+.01	.47	.45	-.02	.45	.42	-.03
May	.27	.28	+.01	.97	.98	+.01	.49	.51	+.02	.43	.47	+.04	.52	.45	-.07
Jun	.33	.35	+.02	1.04	1.07	+.03	.58	.61	+.03	.57	.57	.00	.60	.56	-.04
Jul	.32	.34	+.02	1.06	1.11	+.05	.60	.61	+.01	.56	.58	+.02	.63	.60	-.03
Aug	.35	.36	+.01	1.20	1.20	.00	.64	.66	+.02	.58	.60	+.02	.69	.62	-.07
Sep	.37	.39	+.02	1.15	1.24	+.09	.68	.70	+.02	.63	.63	.00	.71	.58	-.13
Oct	.42	.42	.00	.89	.92	+.03	.65	.66	+.01	.65	.66	+.01	.64	.60	-.04
Nov	.36	.37	.01	.81	.84	+.03	.60	.61	+.01	.60	.63	+.03	.61	.59	-.02
Dec	.26	.28	.02	.74	.79	+.05	.49	.52	+.03	.50	.48	-.02	.52	.50	-.02

Dynamic Model Test Results
Plan with Sill Channel Condition
1977 Hydrology

Average Monthly Salinities
Parts per Thousand

	Station 18			Station 31			Station 33			Station 35			Station 0		
	Plan D-1	Plan H-1	Change	Plan D-1	Plan H-1	Change	Plan D-1	Plan H-1	Change	Plan D-1	Plan H-1	Change	Plan D-1	Plan H-1	Change
Jan	.21	.21	.00	.86	.76	-.10	.41	.39	-.02	.35	.34	-.01	.47	.45	-.02
Feb	.23	.23	.00	.87	.75	-.12	.48	.42	-.06	.45	.43	-.02	.55	.48	-.07
Mar	.22	.23	+.01	.66	.64	-.02	.39	.39	.00	.47	.41	-.06	.42	.41	-.01
Apr	.24	.25	+.01	.68	.71	+.03	.39	.41	+.02	.44	.44	.00	.38	.39	+.01
May	.25	.26	+.01	.92	.95	+.03	.46	.47	+.01	.44	.44	.00	.42	.44	+.02
Jun	.32	.33	+.01	.99	1.02	+.03	.55	.56	+.01	.55	.54	-.01	.51	.55	+.04
Jul	.31	.33	+.02	1.04	1.08	+.04	.57	.59	+.02	.53	.55	+.02	.55	.57	+.02
Aug	.33	.34	+.01	1.15	1.27	+.12	.62	.63	+.01	.57	.57	.00	.57	.62	+.05
Sep	.35	.36	+.01	1.09	1.13	+.04	.66	.67	+.01	.60	.61	+.01	.52	.62	+.10
Oct	.39	.41	+.02	.85	.88	+.03	.61	.61	.00	.62	.63	+.01	.55	.58	+.03
Nov	.34	.31	-.03	.77	.79	+.02	.57	.58	+.01	.58	.59	+.01	.54	.56	+.02
Dec	.26	.26	.00	.72	.73	+.01	.50	.48	-.02	.46	.44	-.02	.45	.49	+.04

Steady State Test Results

Average Tidal Cycle Salinities
Parts Per Thousand

Station Number	Plan with P.C. Channel			Plan with P.C. and Sill		
	Plan D-1	Plan H-1	Change	Plan D-1	Plan H-1	Change
18	.45	.51	+.06	.45	.50	+.05
31	.71	.82	+.11	.71	.81	+.10
33	.40	.41	+.01	.40	.41	+.01
35	.41	.43	+.02	.40	.43	+.03
0	.45	.49	+.04	.45	.49	+.04

One possible explanation for the discrepancy is that a mass of salt water could have been trapped in the vicinity during the Plan D-1 test. This mass of salt water could persist for the following reasons; (1) the station is at the extreme edge of the model; (2) no large "flushing" flows occurred in 1977 hydrology which could have dispersed the salty water; and (3) the simplified hydrology operation eliminated agricultural return drainage in the vicinity of the station which could have flushed the area. However, it has not been fully to determined if this or some other reason was responsible for the model discrepancy.

(2) **Plan D-1 with submerged sill.** — The differences between plan and base tests, shown on Table 11 and Chart 10, indicate the effect of the plan on average mid-depth monthly salinities as determined from dynamic tests using 1977 hydrology. These results are consistent among stations, and show that Plan D-1 with the submerged sill would have no effect on salinities in San Pablo Bay, but would reduce salinities in Suisun Bay, Suisun Marsh, the lower Sacramento and San Joaquin Rivers, and the Central Delta. There would thus be a general reduction in salinity throughout the system with this plan during a critically dry year.

(3) **Plan D-1 with Peripheral Canal.** — Model test results of this plan were compared with results of a base test with the Peripheral Canal to isolate the effects of the plan from those of the Peripheral Canal. This comparison is shown on Table 12 and Chart 11. These results show no effect on salinity in the system similar to that which was shown in the comparison of Plan D-1 with base conditions. It can therefore be concluded that the plan would have no measurable effect on salinity distributions, regardless of whether or not the Peripheral Canal is assumed to be a preproject condition.

(4) **Plan D-1 with Peripheral Canal and submerged sill.** — As with the previous plan, the results of this plan test were compared with those of the base test, which included the Peripheral Canal. The result of this comparison is shown on Table 13 and Chart 12. These results show that the plan would have no measurable effect on salinities in San Pablo Bay downstream of the sill, and would decrease salinities in Suisun Bay and the lower Sacramento and San Joaquin Rivers. These changes are similar to those previously presented in subparagraph 7.b.(2) for Plan D-1 with submerged sill, and hence it can be concluded that adding the plan with submerged sill to the system would have no effect on some stations and reduce salinities to below preproject conditions at other stations during a critically dry year, regardless of whether or not the system included the Peripheral Canal.

c. **Effects of deepening both the Sacramento and Stockton Ship Channels (Plan H-1) on Salinity Distributions.** —

(1) **Plan H-1.** — The differences between plan and base tests, shown on Table 14 and Chart 13, indicate the plan's effect on average mid-depth monthly salinities as determined from dynamic salinity tests using 1977 hydrology. In addition, Table 15 and Chart 14 indicate the effect of the plan on average mid-depth tidal cycle salinities as determined from steady-state tests. It can be concluded from these test results that the plan would have no effect on salinities in Suisun Bay, Suisun Marsh, the lower San Joaquin River and the Central and Southern Deltas. Minor increases averaging .07 parts per thousand may occur near Rio Vista and Cache Slough along the Sacramento River Deep Water Ship Channel during a critically dry year (1977 condition). Conversely, test results show no effect on salinity during an average dry year (1968 conditions).

Results of tests using 1968 hydrology are shown in Table 16 and Chart 15.

(2) **Plan H-1 with submerged sill.** — The differences between base and plan tests, shown in Table 17 and Chart 16, indicate the effect of Plan H-1 with submerged sill on salinity distributions as determined from dynamic salinity tests using 1977 hydrology. Also, Table 18 and Chart 17 show the difference between base and plan tests as derived from dynamic salinity tests using 1968 hydrology. These results are consistent between the two tests and between stations and show a general reduction in salinity throughout the Suisun Bay-Delta system. In particular, the results show that the plan would cause no measurable change in salinity downstream of the sill (in San Pablo Bay) a decrease in salinity upstream of the sill in Suisun Bay, Suisun Marsh, the lower Sacramento and San Joaquin Rivers, and the remainder of the system, with the exception of the upper Sacramento River (upstream of Rio Vista), where salinities would not be entirely reduced to preproject levels. However, even with this increase there would be no adverse effect on domestic or agricultural water uses. The results also show that Plan H-1 with the submerged sill has no effect using 1968 hydrology, an average dry year.

(3) **Plan H-1 with Peripheral Canal.** — As with the Plan D-1 tests, the results of this test were compared with results of a base test with the Peripheral Canal as shown on Table 19 and Chart 18. These results are consistent with results of Plan H-1 tests without Peripheral Canal as discussed in subparagraph 7.c.(1). It can therefore be concluded that Plan H-1 would have the same effect on ambient conditions, whether or not the Peripheral Canal is included in the system.

(4) **Plan H-1 with Peripheral Canal and submerged sill.** — As with the previous test, the results of this test were compared with results of a base test which included the Peripheral Canal as shown in Table 20 and Chart 19. These results are consistent with results of Plan H-1 tests with the submerged sill but without the Peripheral Canal as discussed in subparagraph 7.c.(2). It can therefore be concluded that Plan H-1 with submerged sill would have the same effect on ambient conditions, whether or not the Peripheral Canal is included in the system.

d. **Effects of submerged sill on flow velocities.** — Undistorted model tests were conducted of the submerged sill by the Waterways Experiment Station in Vicksburg, Mississippi. The primary purpose of these tests was to design the distorted shape of the sill for use in the Bay-Delta Model; however, velocity measurements were also taken on 4 lines upstream and 4 lines downstream and at the centerline of the sill. These locations are shown on Figure 1. Results of tests with and without the sill are shown on Figures 2 and 3 for flood and ebb flows, respectively. As can be seen from those figures, the sill has no effect on velocities upcurrent of the sill and velocities return to essentially base conditions within 2,000 feet downcurrent of the sill, except for the crest of the sill and along the south side of the strait, where velocities are increased by 1.0 to 2.5 feet per second (total of about 5.5 feet per second) for a tidal flow of 500,000 cfs, at flood and ebb tides, for about 4,000 feet downcurrent of the sill. This increase in flow velocities on the south side is offset by a velocity decrease of about 1.0 foot per second on the north side, such that the average cross-sectional velocity remains essentially unchanged. Since the sill has little effect on current velocities except in the immediate vicinity of the structure, it would not affect long-term sedimentation and erosion patterns, except at the base of the sill, due to development of an eddy at the downcurrent toe. Further, increases and decreases in flow velocities are a natural day-to-day occurrance due to varying channel geography, ebb, and flood tidal action, and varying release rates from upstream reservoirs.

e. **Effects of submerged sill on water surface elevation.** — Tests were conducted at the Bay-Delta Model in Sausalito to determine the effect of the submerged sill on water surface elevations. Test results showed that the sill had virtually no effect on water surface elevations throughout the system during average flow conditions. To further test the effect under critical flow conditions, steady flow tests were conducted with and without the sill using a 410,000 cfs total Delta outflow for about 15 tidal cycles. During these tests, measurements of water surface elevation were taken at various locations throughout the system. These results are shown on Chart 20 and indicate that under extreme flood conditions the sill would increase the water surface elevations by a maximum of 0.4 foot at certain locations in Suisun Bay and by less than 0.2 foot in the remainder of the Delta.

TABLE 1

SAN FRANCISCO BAY-DELTA MODEL
REPEATABILITY LIMITS
DYNAMIC TESTS

(PERCENT)

Station Name	Station No.	Limit 1/
Golden Gate	1	2
Tiburon	3	4.5
San Pablo	4	4.5
Pinole Point	5	4.5
Davis Point	6	4.5
Martinez	7	5
Port Chicago	9	5
Grimmly Bay	9A	5
Suisun Slough		5
Montezuma Slough	9E	- 2/
Montezuma Slough	9I	- 2/
Dillion Point	10	7.5
Chipps Island	11A	7.5
Antioch - SJR	13	8.5
Blind Point - SJR	14A	8.5
Jersey Point - SJR	15	8.5
Twitchel Island	16	9.0
Webb Reach	17	9.0
San Andreas	J	9.0
Prisoners Point	18	9.0
Stockton - SJR	20C	9.0
Sherman Island	21	7.5
Emmanton - Sac R	22	7.5
Three Mile Slough	22A	7.5
Rio Vista	23	7.5
Cache Slough	24	7.5
Dutch Slough	31	7.5
Old R - Woodward	33	7.5
Middle River	34	7.5
W. Canal - CFB	35	7.5
Contra Costa Canal	0	7.5

1/ Limits are positive and negative about the base salinity.
2/ No limits have been developed for Stations 9E and 9I.

TABLE 2
1968 SIMPLIFIED DELTA INFLOW-WITHDRAWAL DATA
(IN CFS)

	Time Flow Changed Model Cycle	Inflows - CFS Sacra- mento River	Mokelumne River	San Joaquin River	Withdrawals - CFS Export Pumping State & USBR	Contra Costa Canal	Delta Net Outflow CFS
Jan							
1	1	15,100	200	3,000	0	100	18,700
6	6	14,100	200	3,700	200	100	17,700
11	11	21,100	400	3,600	300	100	24,700
16	16	32,600	600	3,100	700	100	35,500
21	21	23,200	300	2,700	1,800	100	24,300
26	26	20,500	700	2,600	1,600	100	22,100
Feb							
1	31	16,300	800	2,600	1,200	100	18,400
6	36	29,200	400	2,400	1,100	100	30,800
11	41	24,700	400	2,600	1,500	100	26,100
16	46	29,300	1,200	2,200	1,500	100	31.100
21	51	61,600	3,200	3,400	1,900	100	66,200
26	56	66,900	1,400	3,700	1,400	100	70,500
Mar							
1	61	62,400	1,400	3,000	2,800	100	63,900
6	66	42,600	1,400	3,200	4,600	100	42,500
11	71	31,500	1,300	3,000	4,900	100	30,800
16	76	35,200	1,300	3,300	5,200	100	34,500
21	81	26,300	700	3,500	4,300	100	26,100
26	85	21,600	800	2,500	4,400	100	20,400
Apr							
1	90	20,500	700	2,600	5,200	100	18,500
6	95	17,100	500	1,700	6,000	100	13,200
11	100	14,300	400	800	6,300	100	9,100
16	105	11,100	300	600	5,900	100	6,000
21	110	10,000	100	600	5,900	200	4,600
26	115	10,300	100	600	5,200	200	5,600

TABLE 2 (Cont'd.)

	Time Flow Changed Model Cycle	Inflows - CFS Sacra-mento River	Mokelumne River	San Joaquin River	Withdrawals - CFS Export Pumping State & USBR	Contra Costa Canal	Delta Net Outflow CFS
May							
1	120	10,600	100	500	5,600	200	5,400
6	125	13,000	100	600	6,000	200	7,500
11	130	13,400	100	700	6,100	100	8,000
16	135	13,800	100	700	6,800	100	7,700
21	140	13,100	100	600	6,700	200	6,900
26	145	11,600	0	400	5,300	200	6,500
June							
1	150	9,100	0	400	5,000	200	4,300
6	155	11,000	0	400	5,400	200	5,800
11	160	10,300	0	400	6,200	200	4,300
16	164	9,100	0	400	5,800	200	3,500
21	169	9,500	0	400	6,300	200	3,400
26	174	9,700	0	400	6,900	200	3,000
Jul							
1	179	10,500	0	400	6,900	200	3,800
6	184	11,100	0	400	6,600	200	4,700
11	189	10,900	0	400	6,700	200	4,400
16	194	10,600	0	400	6,300	200	4,500
21	199	10,600	0	400	6,700	200	4,100
26	204	11,900	0	400	6,500	200	5,600
Aug							
1	209	11,700	0	400	5,700	200	6,200
6	214	11,600	0	400	5,500	200	6,300
11	219	11,700	0	400	5,100	200	6,800
16	224	11,800	0	400	5,100	200	6,900
21	229	13,000	0	700	6,900	200	6,600
26	234	12,000	0	700	4,600	200	7,900
Sep							
1	239	10,700	0	700	4,700	200	6,500
6	244	12,200	0	700	5,100	200	7,600
11	249	14,000	0	700	6,200	200	8,300
16	253	13,000	0	700	6,800	200	6,700
21	258	11,900	0	700	7,200	200	5,200
26	263	11,600	0	700	6,700	200	5,400

TABLE 2 (Cont'd.)

	Time Flow Changed Model Cycle	Inflows - CFS Sacra-mento River	Inflows - CFS Mokelumne River	Inflows - CFS San Joaquin River	Withdrawals - CFS Export Pumping State & USBR	Withdrawals - CFS Contra Costa Canal	Delta Net Outflow CFS
Oct							
1	268	11,700	0	900	7,000	200	5,400
6	273	10,000	0	1,000	7,000	200	3,800
11	278	10,900	100	1,300	7,300	100	4,900
16	283	12,000	100	1,600	6,200	100	7,400
21	288	11,600	100	1,200	4,600	200	8,100
26	293	11,600	100	1,700	5,900	100	7,400
Nov							
1	298	12,500	200	2,000	5,800	100	8,800
6	303						
11	307						
16	312						
21	317						
26	322						
Dec							
1	327						
6	332						
11	337						
16	342						
21	347						
26	352						
Jan							
1	357						
6	362						

TABLE 3
1977 SIMPLIFIED DELTA INFLOW-WITHDRAWAL DATA
(IN CFS)

Time Flow Changed Model Cycle	Inflows - CFS: Sacramento River	Inflows - CFS: Mokelumne River	Inflows - CFS: San Joaquin River	Withdrawals - CFS: Export Pumping State & USBR	Withdrawals - CFS: Contra Costa Canal	Delta Net Outflow CFS
-90	10,100	0	2,000	7,100	100	4,900
-85	8,800	0	1,700	5,600	100	4,800
-80	7,700	0	1,300	4,050	150	4,800
-75	7,600	0	1,200	3,050	150	5,600
-70	7,600	0	1,200	2,550	150	6,100
-65	8,000	100	1,200	3,450	150	5,700
-60	7,600	100	1,200	3,650	150	5,100
-55	7,400	0	1,200	4,350	150	4,100
-50	7,100	0	1,000	3,900	100	4,100
-45	7,700	0	1,100	4,350	150	4,300
-40	7,500	0	1,100	3,900	200	4,500
-35	8,000	0	1,200	4,750	150	4,300
-30	7,300	100	1,000	3,900	100	4,400
-25	7,100	100	900	3,500	100	4,500
-20	6,800	0	800	3,100	100	4,400
-15	6,000	100	700	2,200	100	4,500
-10	6,700	0	700	2,600	100	4,700
-5	7,300	0	800	3,400	100	4,600

TABLE 3 (Cont'd.)

	Time Flow Changed Model Cycle	Inflows - CFS Sacra-mento River	Mokelumne River	San Joaquin River	Withdrawals - CFS Export Pumping State & USBR	Contra Costa Canal	Delta Net Outflow CFS
Jan							
1	1	9,800	100	800	6,000	100	4,600
6	6	10,600	100	1,300	7,200	100	4,700
11	11	8,800	100	1,200	5,000	100	5,000
16	16	9,900	100	1,400	6,300	100	5,000
21	21	10,000	100	1,300	6,300	100	5,000
26	26	10,600	100	1,500	8,250	150	3,800
Feb							
1	31	9,500	100	1,400	6,450	150	4,400
6	36	8,800	0	1,100	4,550	150	5,200
11	41	8,100	0	900	3,850	150	5,000
16	46	6,900	0	800	2,350	150	5.200
21	51	8,200	0	700	3,250	150	5,500
26	56	5,400	100	1,000	2,150	150	4,200
Mar							
1	61	6,300	100	800	2,450	150	4,600
6	66	6,700	100	800	2,750	150	4,700
11	71	7,100	100	900	3,400	100	4,600
16	76	8,000	100	1,000	4,700	100	4,300
21	81	7,000	0	900	3,700	100	4,100
26	85	6,400	0	700	3,200	100	3,800
Apr							
1	90	6,200	0	500	2,200	100	4,400
6	95	5,400	0	400	1,050	150	4,600
11	100	5,700	0	300	1,300	100	4,600
16	105	5,600	0	200	1,200	100	4,500
21	110	5,500	0	200	1,400	100	4,200
26	115	5,600	0	200	1,800	100	3,900
May							
1	120	7,100	0	200	3,400	100	3,800
6	125	6,500	0	200	2,800	100	3,800
11	130	8,600	0	500	5,300	100	3,700
16	135	6,600	0	500	3,300	100	3,700
21	140	6,300	0	400	2,500	100	4,100
26	145	6,100	0	400	2,300	100	4,100

TABLE 3 (Cont'd.)

	Time Flow Changed Model Cycle	Inflows - CFS Sacramento River	Mokelumne River	San Joaquin River	Withdrawals - CFS Export Pumping State & USBR	Contra Costa Canal	Delta Net Outflow CFS
Jun							
1	150	5,100	0	200	1,050	150	4,100
6	155	5,200	0	200	1,200	200	4,000
11	160	5,200	0	200	1,400	200	3,800
16	164	5,500	0	200	1,650	150	3,900
21	169	5,600	0	200	1,700	200	3,900
26	174	6,000	0	200	2,100	200	3,900
Jul							
1	179	6,200	0	200	2,250	150	4,000
6	184	6,400	0	200	2,450	150	4,000
11	189	6,000	0	200	2,050	150	4,000
16	194	6,000	0	200	2,150	150	3,900
21	199	6,100	0	200	2,350	150	3,800
26	204	6,100	0	200	2,450	150	3,700
Aug							
1	209	6,100	0	200	2,250	150	3,900
6	214	6,100	0	200	2,450	150	3,700
11	219	6,000	0	200	2,150	150	3,900
16	224	6,000	0	200	2,050	150	4,000
21	229	6,500	0	200	2,550	150	4,000
26	234	7,000	0	100	3,050	150	3,900
Sep							
1	239	6,700	0	200	2,950*	150	3,800
6	244	6,700	0	200	2,850*	150	3,900
11	249	6,700	0	200	2,850*	150	3,900
16	253	5,700	0	200	2,000*	100	3,800
21	258	6,200	0	200	2,300*	100	4,000
26	263	5,300	0	200	1,300*	100	4,100
Oct							
1	268	5,100	0	300	1,200*	100	4,100
6	273	4,600	0	200	800*	100	3,900
11	278	4,100	0	300	750*	150	3,500
16	283	4,100	0	300	450*	150	3,800
21	288	4,400	0	300	350*	150	4,200
26	293	4,700	0	300	350*	150	4,500

*Includes 100 CFS for EBMUD.

TABLE 3 (Cont'd.)

	Time Flow Changed Model Cycle	Inflows - CFS Sacramento River	Mokelumne River	San Joaquin River	Withdrawals - CFS Export Pumping State & USBR	Contra Costa Canal	Delta Net Outflow CFS
Nov							
1	298	5,800	0	300	1,250*	150	4,700
6	303	6,000	0	400	2,050*	150	4,200
11	307	5,600	0	400	1,850*	150	4,000
16	312	6,400	0	500	2,450*	150	4,300
21	317	7,700	0	400	3,100*	100	4,900
26	322	8,400	100	800	4,600*	100	4,600
Dec							
1	327	7,200	100	800	3,650*	150	4,300
6	332	6,400	0	600	1,250*	150	5,600
11	337	6,600	0	600	1,200*	100	5,900
16	342	16,700	200	400	10,400*	100	6,800
21	347	17,100	300	400	9,600	100	8,100
26	352	15,700	500	400	10,000	100	6,500
Jan							
1	357	13,800	500	800	9,000	100	6,000

TABLE 4
STEADY-STATE DELTA INFLOW-WITHDRAWAL DATA
(In CFS)

	INFLOWS				WITHDRAWALS			
	SACRA-MENTO RIVER	MOKEL-UMNE RIVER	SAN JOAQUIN RIVER	PERIPHERAL CANAL AT INDICATED LOCATIONS	EXPORT PUMPING STATE & USBR	CONTRA COSTA CANAL	PERIPHERAL CANAL AT HOOD	DELTA NET OUTFLOW
Without Periph-eral Canal	13,500	400	1,400	-	10,300	300	-	4,700
With Periph-eral Canal	13,500	400	1,400	1,200	-	-	11,800	4,700
Snodgrass Sl.				(200)				
Beaver Sl.				(50)				
Hog Sl.				(50)				
Sycamore Sl.				(50)				
White Sl.				(100)				
Disappointment Sl.				(100)				
San Joaquin R.				(100)				
Whiskey Sl				(50)				
Middle R.				(50)				
Roberts I. Canal				(100)				
Middle to Old R.				(50)				
Old River				(300)				

TABLE 5
STOCKTON SHIP CHANNEL
SALINITY STUDY
DYNAMIC MODEL TEST RESULTS
BASE WITHOUT VS. BASE WITH
SIMPLIFIED HYDROLOGY
1968 HYDROLOGIC CONDITIONS
AVERAGE MONTHLY SALINITIES
(PARTS PER THOUSAND)

	Station 1			Station 3			Station 4			Station 5			Station 6			Station 7		
	Base wo/s[1]	Base w/s[2]	Change	Base wo/s	Base w/s	Change	Base wo/s	Base w/s	Change	Base wo/s	Base w/s	Change	Base wo/s	Base w/s	Change	Base wo/s	Base w/s	Change
Feb	29.8	29.6	.2 (+1 %)	26.1	26.4	.3 (1 %)	19.9	22.2	+1.12 (+6 %)	20.4	20.1	-0.3 (-1 %)	14.7	14.5	-0.2 (-1 %)	7.56	7.52	-0.04 (-4 %)
Mar	28.9	28.5	.4 (+1 %)	24.7	24.7	0 (0 %)	21.0	20.7	-.3 (-1 %)	18.7	18.5	-0.2 (-1 %)	12.2	11.9	-0.3 (-2 %)	5.74	5.50	-0.24 (-4 %)
Apr	30.2	30.0	.2 (+1 %)	28.0	27.7	-.3 (-1 %)	23.8	23.7	-.1 (0 %)	22.5	22.2	-0.3 (-1 %)	18.0	18.0	-0.3 (2 %)	11.0	10.7	-0.3 (-3 %)
May	31.1	31.2	0 (0 %)	29.2	29.4	+.2 (+1 %)	26.4	27.6	+.2 (+1 %)	24.9	25.0	+0.1 (0 %)	21.6	21.6	0.0 (0 %)	15.0	15.0	0.0 (0 %)
Jun	31.6	31.6	0 (0 %)	30.0	29.9	-.1 (0 %)	27.2	25.5	-1.70 (-6 %)	26.1	26.0	-0.1 (0 %)	23.7	22.8	-0.9 (4 %)	16.7	16.6	-0.1 (-1 %)
Jul	31.7	31.8	+.1 (0 %)	30.5	30.4	-.1 (0 %)	28.2	28.5	+.3 (+1 %)	27.1	27.0	-0.1 (0 %)	24.1	23.9	-0.2 (-1 %)	18.5	18.4	-0.1 (-1 %)
Aug	31.6	31.6	0 (0 %)	30.3	30.3	0 (0 %)	28.2	28.1	-.1 (0 %)	26.7	26.7	0.0 (0 %)	23.5	23.5	0.0 (0 %)	17.5	17.5	0.0 (0 %)
Sep	31.6	31.6	0 (0 %)	29.9	29.9	0 (0 %)	27.8	27.3	-.5 (-2 %)	26.1	26.1	0.0 (0 %)	23.1	22.6	-0.5 (-2 %)	16.7	16.3	-0.4 (-2 %)
Oct	31.7	31.5	-.2 (-1 %)	30.3	30.0	-.3 (-1 %)	27.9	27.6	-.3 (-1 %)	26.5	26.2	-0.3 (-1 %)	23.3	23.1	-0.2 (-1 %)	17.3	16.9	-0.4 (-2 %)

	Station 9			Station 9A			Station 11A			Station 13			Station 14A			Station 15		
	Base wo/s	Base w/s	Change	Base wo/s	Base w/s	Change	Base wo/s	Base w/s	Change	Base wo/s	Base w/s	Change	Base wo/s	Base w/s	Change	Base wo/s	Base w/s	Change
Feb	3.05	2.93	-0.12 (-4 %)	.67	.65	-0.02 (-3 %)	.30	.26	-0.04 (-13 %)	.19	.15	-.04 (-21 %)	.22	.16	-0.06 (-27 %)	.22	.16	-0.06 (-27 %)
Mar	1.56	1.52	-0.04 (-3 %)	.27	.22	-0.05 (-20 %)	.17	.14	-0.03 (-18 %)	.15	.13	-.02 (-13 %)	.17	.13	-0.04 (-24 %)	.16	.13	-0.03 (-19 %)
Apr	7.09	6.78	-0.31 (-4 %)	3.30	3.08	-0.22 (-7 %)	1.81	1.75	-0.06 (-3 %)	.39	.36	-.03 (-8 %)	.22	.19	-0.03 (-14 %)	.17	.15	-0.02 (-12 %)
May	10.8	10.8	0.0 (0 %)	7.80	7.79	0.01 (0 %)	4.36	4.50	+0.14 (3 %)	1.33	1.37	+.04 (+3 %)	.61	.61	0.00 (0 %)	.43	.42	-0.01 (-2 %)
Jun	12.7	12.7	0.0 (0 %)	9.94	9.67	-0.27 (-3 %)	6.24	6.30	+0.06 (1 %)	2.47	2.47	+.00 (0 %)	1.18	1.17	-0.01 (-1 %)	.84	.86	+0.02 (2 %)
Jul	14.5	14.4	-0.1 (-1 %)	11.9	11.7	-0.2 (-2 %)	8.21	8.04	-0.17 (2 %)	3.97	3.89	-.08 (-2 %)	2.25	2.19	-0.06 (-3 %)	1.73	1.77	+0.04 (2 %)
Aug	13.3	13.3	0.0 (0 %)	10.8	10.9	+0.1 (1 %)	6.81	6.91	+0.10 (1 %)	2.95	3.01	+.06 (+2 %)	1.56	1.63	+0.07 (6 %)	1.15	1.27	+0.12 (1 %)
Sep	12.9	12.1	-0.8 (-6 %)	10.0	9.30	-0.70 (-7 %)	5.90	5.51	-0.39 (-7 %)	2.29	2.01	-.28 (-12 %)	1.14	.95	-0.19 (-17 %)	.80	.69	-0.11 (14 %)
Oct	13.0	12.8	-0.2 (-2 %)	10.3	10.0	-0.3 (-3 %)	6.58	6.26	-0.32 (-5 %)	2.73	2.54	-.19 (-7 %)	1.38	1.23	-0.15 (-11 %)	.96	.88	-0.08 (-8 %)

1/ wo/s - without simplified hydrology
2/ w/s - with simplified hydrology

TABLE 5 (Continued)

	Station 16			Station 17			Station J			Station 18			Station 20C			Station 22		
	Base wo/s	Base w/s	Change	Base wo/s	Base w/s	Change	Base wo/s	Base w/s	Change	Base wo/s	Base w/s	Change	Base wo/s	Base w/s	Change	Base wo/s	Base w/s	Change
Feb	.20	.15	−.05 (−25 %)	.25	.17	−.08 (−31 %)	.17	.13	−.04 (−24 %)	.30	.20	−0.10 (−33 %)	.44	.40	−0.04 (−7 %)	.12	.11	−0.01 (−8 %)
Mar	.15	.12	−.03 (−20 %)	.17	.14	−.03 (−18 %)	.13	.12	−.01 (−8 %)	.22	.16	−0.06 (−27 %)	.41	.40	−0.01 (−2 %)	.11	.11	0.00 (0 %)
Apr	.13	.12	−.01 (−8 %)	.14	.12	−.02 (−14 %)	.12	.11	−.01 (−8 %)	.15	.13	−0.02 (−13 %)	.42	.39	−0.03 (−7 %)	.16	.15	−0.01 (−6 %)
May	.19	.19	.00 (0 %)	.14	.12	−.02 (−14 %)	.13	.11	−.02 (−15 %)	.14	.12	−0.02 (−14 %)	.30	.22	−0.08 (−27 %)	.36	.33	−0.03 (−8 %)
Jun	.34	.36	+.02 (+6 %)	.19	.20	+.01 (+5 %)	.16	.16	.00 (0 %)	.16	.14	−0.02 (−13 %)	.22	.15	−0.07 (−32 %)	.77	.80	+0.03 (4 %)
Jul	.71	.72	+.01 (+1 %)	.39	.38	−.01 (+3 %)	.27	.26	−.01 (−4 %)	.24	.23	−0.01 (−4 %)	.25	.16	−0.09 (−36 %)	1.50	1.48	−0.02 (−1 %)
Aug	.50	.53	+.03 (+6 %)	.29	.29	0 (0 %)	.19	.21	+.02 (11 %)	.23	.21	−0.02 (−9 %)	.35	.21	−0.14 (−40 %)	.93	1.03	+0.10 (11 %)
Sep	.37	.30	−.07 (−19 %)	.22	.18	−.04 (−18 %)	.16	.14	−.02 (−13 %)	.18	.15	−0.03 (−17 %)	.36	.19	−0.17 (−47 %)	.65	.56	−0.09 (−14 %)
Oct	.39	.36	−.03 (−8 %)	.24	.19	−.05 (−21 %)	.18	.15	−.03 (−17 %)	.19	.15	−0.04 (−21 %)	.37	.19	−0.18 (−49 %)	.84	.77	−0.07 (−8 %)

	Station 22A			Station 23			Station 24			Station 31			Station 33			Station 35		
	Base wo/s	Base w/s	Change	Base wo/s	Base w/s	Change	Base wo/s	Base w/s	Change	Base wo/s	Base w/s	Change	Base wo/s	Base w/s	Change	Base wo/s	Base w/s	Change
Feb	.16	.13	−0.03 (−19 %)	.12	.11	−0.01 (−8 %)	.12	.11	−0.01 (−8 %)	.29	.20	−0.09 (−31 %)	.50	.35	−0.15 (−30 %)	.46	.40	−0.06 (−13 %)
Mar	.14	.12	−0.02 (−14 %)	.11	.11	0.00 (0 %)	.12	.11	−0.01 (−8 %)	.21	.16	−0.05 (−24 %)	.36	.24	−0.12 (−33 %)	.40	.32	−0.08 (−20 %)
Apr	.13	.11	−0.02 (−15 %)	.12	.11	−0.01 (−8 %)	.12	.11	−0.01 (−8 %)	.16	.13	−0.03 (−19 %)	.20	.15	−0.05 (−25 %)	.24	.18	−0.06 (−25 %)
May	.16	.15	−0.01 (−6 %)	.12	.11	−0.01 (−8 %)	.12	.11	−0.01 (−8 %)	.26	.21	−0.05 (−19 %)	.18	.14	−0.04 (−22 %)	.20	.13	−0.07 (−22 %)
Jun	.32	.32	0.00 (0 %)	.14	.14	0.00 (0 %)	.12	.11	−0.01 (−8 %)	.45	.41	−0.04 (−9 %)	.26	.21	−0.05 (−19 %)	.25	.17	−0.08 (−32 %)
Jul	.68	.66	−0.02 (−3 %)	.21	.20	−0.01 (−5 %)	.12	.11	−0.01 (−8 %)	.97	.95	−0.02 (−2 %)	.51	.45	−0.06 (−12 %)	.42	.34	−0.08 (−19 %)
Aug	.45	.45	0.00 (0 %)	.15	.14	−0.01 (−7 %)	.12	.11	−0.01 (−8 %)	.73	.77	+0.04 (5 %)	.49	.44	−0.05 (−10 %)	.45	.36	−0.09 (−20 %)
Sep	.31	.23	−0.08 (−26 %)	.14	.12	−0.02 (−14 %)	.12	.11	−0.01 (−8 %)	.52	.41	−0.11 (−21 %)	.34	.25	−0.09 (−26 %)	.32	.22	−0.10 (−31 %)
Oct	.35	.29	−0.06 (−17 %)	.14	.12	−0.02 (−14 %)	.12	.10	−0.02 (−14 %)	.55	.48	−0.07 (−13 %)	.34	.26	−0.08 (−24 %)	.31	.22	−0.09 (−29 %)

	Station 0		
	Base wo/s	Base w/s	Change
Feb	.30	.29	−0.01 (−3 %)
Mar	.23	.20	−0.03 (−13 %)
Apr	.16	.13	−0.03 (−19 %)
May	.23	.15	−0.08 (−35 %)
Jun	.39	.23	−0.16 (−41 %)
Jul	.65	.57	−0.08 (−12 %)
Aug	.55	.52	−0.03 (−5 %)
Sep	.37	.28	−0.09 (−24 %)
Oct	.39	.29	−0.10 (−26 %)

TABLE 6
STOCKTON SHIP CHANNEL
SALINITY STUDY
DYNAMIC MODEL TEST RESULTS
PLAN D-1 WITHOUT VS. PLAN D-1 WITH
SIMPLIFIED HYDROLOGY
1968 HYDROLOCIC CONDITIONS
AVERACE MONTHLY SALINITIES
(PARTS PER THOUSAND)

	Station 3			Station 4			Station 5			Station 6			Station 7			Station 9		
	Plan wo/a[1]	Plan w/a[2]	Change	Plan wo/s	Plan w/a	Change	Plan wo/s	Plan w/s	Change	Plan wo/s	Plan w/s	Change	Plan wo/s	Plan w/s	Change	Plan wo/s	Plan w/s	Change
Feb	27.0	26.5	-.5 (-2 %)	23.0	22.3	-.7 (-3 %)	20.6	20.2	0.4 (2 %)	14.2	14.7	+0.5 (+3 %)	7.39	7.21	-0.18 (-2 %)	3.09	2.83	-0.26 (-8 %)
Mar	25.4	24.9	-.5 (-2 %)	20.8	20.7	-.1 (0 %)	18.3	18.2	-0.1 (-1 %)	12.6	11.7	-0.9 (-7 %)	5.32	5.14	-0.18 (-3 %)	1.50	1.32	-0.18 (-12 %)
Apr	28.3	28.0	-.3 (-1 %)	24.5	24.2	-.3 (-1 %)	22.7	22.2	-0.5 (-2 %)	18.5	18.1	-0.4 (-2 %)	11.2	10.7	-0.5 (-4 %)	6.47	6.53	+0.06 (1 %)
May	29.8	29.6	-.2 (-1 %)	26.9	26.7	-.2 (-1 %)	25.4	25.2	-0.2 (-1 %)	21.9	21.8	-0.1 (0 %)	15.3	15.1	-0.2 (-1 %)	10.6	10.5	-0.1 (10 %)
Jun	30.3	30.2	-.1 (0 %)	27.8	27.7	-.1 (0 %)	26.2	26.3	+0.1 (0 %)	23.2	23.1	-0.1 (0 %)	17.0	16.9	-0.1 (-1 %)	12.8	12.6	-0.2 (-2 %)
Jul	30.9	30.7	-.2 (-1 %)	28.8	28.8	0 (0 %)	27.4	27.3	-0.1 (0 %)	24.6	24.5	-0.1 (0 %)	18.8	18.7	-0.1 (-1 %)	14.6	14.5	-0.1 (-1 %)
Aug	30.8	30.5	-.3 (-1 %)	28.8	28.5	-.3 (-1 %)	27.3	27.3	0.0 (0 %)	24.1	24.1	0.0 (0 %)	18.1	18.0	-0.1 (-1 %)	13.5	13.6	+0.1 (1 %)
Sep	30.3	30.4	-.1 (0 %)	27.8	28.1	+.3 (+1 %)	26.7	26.7	0.0 (0 %)	23.5	23.4	-0.1 (0 %)	16.8	16.8	0.0 (0 %)	13.0	12.6	-0.4 (-3 %)
Oct	-	30.5	-	-	28.1	-	26.8	26.7	-0.1 (0 %)	23.7	23.7	0.0 (0 %)	17.5	17.4	-0.1 (-1 %)	13.0	13.1	+0.1 (1 %)

	Station 9A			Station 11A			Station 13			Station 14A			Station 15			Station 16		
	Plan wo/s	Plan w/s	Change	Plan wo/a	Plan w/s	Change	Plan wo/s	Plan w/s	Change	Plan wo/a	Plan w/s	Change	Plan wo/s	Plan w/s	Change	Plan wo/s	Plan w/s	Change
Feb	.76	.72	-0.04 (-5 %)	.32	.30	-0.02 (-6 %)	.19	.14	-.05 (-26 %)	.21	.15	-0.06 (-29 %)	.21	.15	-0.06 (-29 %)	.20	.15	-.05 (-25 %)
Mar	.21	.22	-0.01 (-5 %)	.16	.15	-0.01 (-6 %)	.14	.12	-.02 (-14 %)	.16	.13	-0.03 (-19 %)	.16	.13	-0.03 (-19 %)	.15	.12	-.03 (-20 %)
Apr	3.48	3.28	-0.20 (-6 %)	2.06	1.81	-0.25 (-12 %)	.40	.37	-.03 (-8 %)	.22	.19	-0.03 (-14 %)	.18	.15	-0.03 (-17 %)	.14	.11	-.03 (-21 %)
May	8.24	7.80	-0.44 (-5 %)	4.66	4.55	-0.11 (-2 %)	1.42	1.38	-.04 (-3 %)	.65	.63	-0.02 (-3 %)	.46	.43	-0.03 (-7 %)	.20	.19	-.01 (-5 %)
Jun	10.0	10.0	0.0 (0 %)	6.63	6.54	-0.09 (-1 %)	2.60	2.54	-.06 (-2 %)	1.28	1.24	-0.04 (-3 %)	.90	.87	-0.03 (-3 %)	.36	.37	+.01 (+3 %)
Jul	12.4	12.2	-0.20 (-2 %)	8.44	8.77	-0.33 (-4 %)	4.13	4.15	-.02 (0 %)	2.38	2.36	-0.02 (-1 %)	1.84	1.84	0.0 (0 %)	.75	.75	0 (0 %)
Aug	11.3	11.3	0.0 (0 %)	7.34	7.29	-0.05 (-1 %)	3.08	3.25	-.17 (-6 %)	1.66	1.73	+0.07 (4 %)	1.25	1.30	-0.05 (-4 %)	.53	.54	+.01 (+2 %)
Sep	9.91	9.94	+0.03 (0 %)	6.10	6.13	-0.03 (0 %)	2.26	2.28	+.02 (+1 %)	1.06	1.09	+0.03 (3 %)	.79	.79	0.0 (0 %)	.33	.32	-.01 (-3 %)
Oct	10.5	10.5	0.0 (0 %)	6.94	7.01	-0.07 (-1 %)	2.75	2.80	+.05 (+2 %)	1.38	1.42	+0.04 (3 %)	.96	.98	+0.02 (2 %)	.39	.39	0 (0 %)

TABLE 6 (Continued)

	Station 17			Station J			Station 20C			Station 21			Station 22			Station 22A		
	Plan wo/s	Plan w/s	Change	Plan wo/s	Plan w/s	Change	Plan wo/s	Plan w/s	Change	Plan wo/s	Plan w/s	Change	Plan wo/s	Plan w/s	Change	Plan wo/s	Plan w/s	Change
Feb	.24	.16	-.08 (-33 %)	.16	.16	-.01 (-6 %)	.45	.40	-0.05 (-11 %)	.14	.12	-0.02 (-14 %)	.12	.10	-0.02 (-17 %)	.16	.13	-0.03 (-19 %)
Mar	.15	.13	-.02 (-13 %)	.13	.11	-.02 (-15 %)	.42	.40	-0.02 (-5 %)	.13	.11	-0.02 (-15 %)	.11	.10	-0.01 (-9 %)	.13	.11	-0.02 (-15 %)
Apr	.14	.11	-.03 (-21 %)	.12	.10	-.02 (-17 %)	.42	.40	-0.02 (-5 %)	.49	.47	-0.02 (-4 %)	.17	.14	-0.03 (-18 %)	.13	.11	-0.02 (-15 %)
May	.14	.13	-.01 (-7 %)	.12	.11	-.01 (-8 %)	.31	.23	-0.08 (-26 %)	1.56	1.55	-0.01 (-1 %)	.40	.35	-0.05 (-13 %)	.17	.16	-0.01 (-6 %)
Jun	.21	.18	-.03 (-14 %)	.16	.15	-.01 (-6 %)	.27	.15	-0.12 (-44 %)	2.76	2.74	-0.02 (-1 %)	.87	.82	-0.05 (-6 %)	.34	.32	-0.02 (-6 %)
Jul	.41	.39	-.02 (-5 %)	.27	.25	-.02 (-7 %)	.29	.16	-0.13 (-45 %)	4.17	4.03	-0.14 (-3 %)	1.58	1.52	-0.01 (-1 %)	.73	.70	-0.03 (-4 %)
Aug	.31	.28	-.03 (-10 %)	.20	.19	-.01 (-5 %)	.35	.21	-0.14 (-40 %)	3.30	3.24	-0.06 (-2 %)	1.03	1.02	0.0 (0 %)	.50	.47	-0.03 (-6 %)
Sep	.20	.18	-.02 (-10 %)	.16	.14	-.02 (-13 %)	.35	.19	-0.16 (-46 %)	2.40	2.41	+0.01 (0 %)	.64	.65	+0.01 (.02 %)	.28	.26	-0.02 (-7 %)
Oct	.22	.20	-.02 (- 9%)	.17	.16	-.01 (-6 %)	.30	.18	-0.12 (-40 %)	2.84	2.79	-0.05 (-2 %)	.84	.87	+0.03 (.04 %)	.35	.34	-0.01 (-3 %)

	Station 23			Station 24			Station 31			Station 33			Station 35			Station 0		
	Plan wo/s	Plan w/s	Change	Plan wo/s	Plan w/s	Change	Plan wo/s	Plan w/s	Change	Plan wo/s	Plan w/s	Change	Plan wo/s	Plan w/s	Change	Plan wo/s	Plan w/s	Change
Feb	.12	.10	-0.02 (-17 %)	.12	.10	-0.02 (-17 %)	.32	.19	-0.13 (-41 %)	.49	.35	-0.14 (-29 %)	.45	.40	-0.05 (-11 %)	.44	.28	-0.16 (-36 %)
Mar	.11	.10	-0.01 (-9 %)	.12	.10	-0.02 (-17 %)	.23	.15	-0.08 (-35 %)	.35	.23	-0.12 (-34 %)	.40	.34	-0.06 (-15 %)	.32	.19	-0.13 (-41 %)
Apr	.12	.10	-0.02 (-17 %)	.12	.10	-0.02 (-17 %)	.17	.12	-0.05 (-29 %)	.20	.14	-0.06 (-30 %)	.25	.18	-0.07 (-28 %)	.17	.12	-0.05 (-29 %)
May	.11	.11	0.00 (0 %)	.12	.10	-0.02 (-17 %)	.45	.22	-0.23 (-51 %)	.19	.14	-0.05 (-26 %)	.19	.13	-0.06 (-32 %)	.18	.14	-0.04 (-22 %)
Jun	.15	.13	-0.02 (-13 %)	.11	.10	-0.01 (-9 %)	.50	.43	-0.07 (-14 %)	.26	.20	-0.06 (-23 %)	.24	.17	-0.07 (-29 %)	.27	.23	+0.04 (+15 %)
Jul	.21	.20	-0.01 (-5 %)	.12	.11	-0.01 (-9 %)	.97	1.00	+0.03 (+3 %)	.52	.47	-0.05 (-10 %)	.42	.34	-0.08 (-19 %)	.61	.58	-0.03 (-5 %)
Aug	.15	.15	0.00 (0 %)	.12	.10	-0.02 (-17 %)	.78	.79	+0.01 (+1 %)	.51	.45	-0.06 (-12 %)	.44	.37	-0.07 (-16 %)	.56	.53	-0.03 (-5 %)
Sep	.13	.12	-0.01 (-8 %)	.12	.11	-0.01 (-9 %)	.47	.46	-0.01 (-2 %)	.33	.27	-0.06 (-18 %)	.31	.23	-0.08 (-26 %)	.34	.30	-0.04 (-12 %)
Oct	.14	.14	0.00 (0 %)	.12	.11	-0.01 (-9 %)	.53	.55	+0.02 (+4 %)	.32	.28	-0.04 (-13 %)	.30	.24	-0.06 (-20 %)	.36	.34	-0.02 (-6 %)

1/ wo/s - without simplified hydrology.
2/ w/s - with simplified hydrology.

TABLE 7
STOCKTON SHIP CHANNEL
SALINITY STUDY
DYNAMIC MODEL TESTS RESULTS
BASE WITHOUT VS. BASE WITH
SIMPLIFIED HYDROLOGY
1977 HYDROLOGIC CONDITIONS (DROUGHT)
AVERAGE MONTHLY SALINITIES
(PARTS PER THOUSAND)

	Station 1			Station 3			Station 4			Station 5			Station 6			Station 7		
	Base wo/s[1]/	Base w/s[2]/	Change	Base wo/s	Base w/s	Change	Base wo/s	Base w/s	Change	Base wo/s	Base w/s	Change	Base wo/s	Base w/s	Change	Base wo/s	Base w/s	Change
Jan	32.1	32.5	+.4 (1 %)	30.8	31.3	+.5 (2 %)	29.2	29.1	-.1 (0 %)	27.7	28.3	+0.6 (2 %)	25.3	25.3	0.0 (0 %)	19.3	19.6	+0.3 (2 %)
Feb	32.1	32.2	+.1 (0 %)	30.8	31.0	+.2 (+1 %)	28.9	29.0	+.1 (0 %)	27.6	27.9	+0.3 (1 %)	24.9	25.0	+0.1 (0 %)	19.1	19.4	+0.3 (2 %)
Mar	32.2	32.1	-.1 (0 %)	30.9	30.7	-.2 (-1 %)	29.0	28.8	-.2 (-1 %)	27.7	27.7	0.0 (0 %)	25.0	24.9	-0.1 (0 %)	19.2	19.3	-0.1 (-1 %)
Apr	32.1	32.1	-0 (0 %)	30.9	31.0	+.1 (0 %)	29.2	29.0	-.2 (-1 %)	27.8	28.0	+0.2 (1 %)	25.7	25.2	-0.5 (-2 %)	19.6	19.6	0.0 (0 %)
May	32.1	32.1	.0 (0 %)	30.1	31.0	+.1 (0 %)	29.2	29.3	+.1 (0 %)	28.0	28.0	0.0 (0 %)	25.2	25.4	+0.2 (1 %)	-	-	- -
Jun	32.2	32.3	+.1 (0 %)	30.9	31.1	+.2 (1 %)	29.4	29.3	-.1 (0 %)	27.9	28.2	+0.3 (1 %)	24.9	25.5	+0.6 (2 %)	-	-	- -
Jul	32.5	32.5	.0 (0 %)	31.3	31.3	.0 (0 %)	29.7	29.7	.0 (.0%)	28.5	28.5	0.0 (-1 %)	25.8	25.6	-0.2 (-2 %)	20.8	20.4	-0.4
Aug	32.3	32.1	-.2 (-1 %)	31.3	31.1	-.2 (-1 %)	29.8	29.7	-.1 (0 %)	28.4	28.3	-0.1 (0 %)	25.9	25.8	-0.1 (0 %)	20.B	20.6	-0.2 (-1 %)
Sep	32.4	32.3	-.1 (0 %)	31.3	31.2	-.1 (0 %)	29.6	29.7	+.1 (0 %)	28.4	28.5	+0.1 (0 %)	25.8	25.7	-0.1 (0 %)	20.6	20.5	-0.1 (0 %)
Oct	32.3	32.1	-.2 (-1 %)	31.1	31.2	+.1 (0 %)	29.6	29.4	-.2 (0 %)	28.3	28.4	+0.1 (0 %)	25.7	25.6	-0.1 (0 %)	20.8	20.5	-0.3 (-1 %)
Nov	32.1	32.0	-.1 (0 %)	31.1	31.0	-.1 (0 %)	29.6	29.3	-.3 (0 %)	28.2	28.1	-0.1 (0 %)	25.4	25.3	-0.1 (0 %)	20.3	20.1	-0.2 (-1 %)
Dec	32.1	32.2	+.1 (0 %)	30.8	30.9	+.1 (0 %)	29.0	29.0	.0 (0 %)	27.7	27.7	0.0 (0 %)	24.9	24.7	-0.2 (1 %)	19.0	18.6	-0.4 (-2 %)

	Station 9			Station 9A			Station 11A			Station 13			Station 14A			Station 15		
	Base wo/s	Base w/s	Change	Base wo/s	Base w/s	Change	Base wo/s	Base w/s	Change	Base wo/s	Base w/s	Change	Base wo/s	Base w/s	Change	Base wo/s	Base w/s	Change
Jan	15.3	15.8	+0.5 (3 %)	13.0	13.1	+0.1 (1 %)	9.00	9.06	+0.06 (1 %)	4.43	4.42	-.01 (0 %)	2.36	2.39	+0.03 (1 %)	1.71	1.74	+0.03 (2 %)
Feb	15.0	15.4	+0.4 (3 %)	12.8	13.1	+0.3 (2 %)	8.85	8.97	+0.12 (1 %)	4.08	4.27	+.19 (5 %)	2.12	2.27	+0.15 (7 %)	1.58	1.66	+0.08 (5 %)
Mar	15.3	15.2	-0.1 (-1 %)	12.8	12.9	+0.1 (1 %)	8.88	8.97	+0.09 (1 %)	4.02	3.96	+.06 (-1 %)	2.01	1.98	-0.03 (-1 %)	1.36	1.34	-0.02 (-1 %)
Apr	15.6	15.7	+0.1 (1 %)	13.3	13.4	+0.1 (1 %)	9.45	9.26	-0.19 (-2 %)	4.22	4.23	.01 (0 %)	2.11	2.10	-0.01 (0 %)	1.40	1.36	-0.04 (-3 %)
May	16.0	16.1	+0.1 (1 %)	13.8	13.9	+0.1 (1 %)	9.84	9.85	+0.01 (0 %)	4.72	4.86	+.14 (+3 %)	2.48	2.61	+0.13 (5 %)	1.77	1.89	+0.12 (7 %)
Jun	16.0	16.2	+0.2 (1 %)	14.0	14.2	+0.2 (1 %)	9.95	10.1	+0.15 (2 %)	4.7	4.93	+.17 (+4 %)	2.46	2.61	+0.15 (6 %)	1.70	1.84	+0.14 (8 %)
Jul	16.7	16.6	-0.1 (-1 %)	14.5	14.4	-0.10 (-1 %)	10.5	10.2	+0.30 (3 %)	5.36	5.12	-.24 (-4 %)	2.86	2.74	-0.12 (-4 %)	2.03	1.99	-0.04 (-2 %)
Aug	16.8	16.8	0.0 (0 %)	14.8	14.7	-0.1 (-1 %)	10.7	10.7	0.0 (0 %)	5.28	5.46	+.18 (+3 %)	3.04	3.06	+0.02 (1 %)	2.18	2.19	+0.01 (0 %)
Sep	16.6	16.7	+0.1 (1 %)	14.6	14.7	+0.1 (1 %)	10.6	10.6	0.0 (0 %)	5.37	5.37	.00 (0 %)	2.98	2.93	-0.05 (-2 %)	2.20	2.20	0.0 (0 %)
Oct	17.6	17.6	0.0 (0 %)	14.6	14.5	-0.1 (-1 %)	10.6	10.4	-0.2 (-2 %)	5.28	5.13	-.15 (-3 %)	2.84	2.70	-0.14 (-5 %)	1.98	1.86	-0.12 (-6 %)
Nov	16.4	16.2	-0.2 (-1 %)	14.3	14.0	-0.3 (-2 %)	10.3	9.79	-0.51 (-5 %)	5.01	4.75	-.26 (-5 %)	2.70	2.56	-0.14 (-5 %)	2.00	1.79	-0.21 (-11 %)
Dec	14.8	14.7	-0.1 (-1 %)	13.1	12.8	-0.3 (-2 %)	8.35	7.99	-0.36 (-4 %)	3.96	4.05	-.09 (+2 %)	2.26	2.10	-0.16 (-7 %)	1.68	1.55	-0.13 (-8 %)

TABLE 7 (Continued)

	Station 18			Station 20C			Station 21		
	Base wo/s	Base w/s	Change	Base wo/s	Base w/s	Change	Base wo/s	Base w/s	Change
Jan	.28	.23	-0.05 (-18 %)	-.61	.51	-0.10 (-16 %)	5.46	5.54	+.08 (+4 %)
Feb	.30	.28	-0.02 (-7 %)	.59	.61	+0.02 (+3 %)	5.21	5.82	+.61 (12 %)
Mar	.30	.24	-0.06 (-20 %)	.57	.58	+0.01 (+2 %)	5.60	5.37	-.23 (-4 %)
Apr	.32	.26	-0.06 (-19 %)	.51	.49	-0.02 (-4 %)	5.90	5.88	-.02 (0 %)
May	.31	.27	-0.04 (-13 %)	.45	.38	-0.07 (-16 %)	6.78	6.64	-.14 (-2 %)
Jun	.36	.33	-0.03 (-8 %)	.46	.36	-0.10 (-22 %)	6.99	6.91	+.08 (-1 %)
Jul	.39	.34	-0.05 (-13 %)	.47	.35	-0.12 (-26 %)	7.21	6.93	-.28 (-4 %)
Aug	.42	.35	-0.07 (-17 %)	.49	.34	-0.15 (-31 %)	7.29	7.42	+.13 (2 %)
Sep	.42	.37	-0.05 (-12 %)	.49	.35	-0.14 (-29 %)	7.44	6.83	-.61 (-8 %)
Oct	.47	.41	-0.06 (-13 %)	.50	.37	-0.13 (-26 %)	7.27	7.02	-.25 (-3 %)
Nov	.43	.36	-0.07 (-16 %)	.52	.42	-0.10 (-19 %)	6.60	6.58	-.02 (0 %)
Dec	.32	.26	-0.06 (-19 %)	.49	.36	-0.13 (-27 %)	4.95	4.59	-.36 (-7 %)

	Station 22			Station 22A			Station 23		
	Base wo/s	Base w/s	Change	Base wo/s	Base w/s	Change	Base wo/s	Base w/s	Change
Jan	1.97	1.87	-0.10 (-5 %)	.90	.77	-0.13 (-14 %)	.27	.23	-0.04 (-15 %)
Feb	2.00	1.98	-0.02 (-1 %)	.87	.84	-0.03 (-3 %)	.30	.26	-0.04 (-13 %)
Mar	2.05	1.97	-0.08 (-4 %)	.87	.77	-0.10 (-11 %)	.31	.27	-0.04 (-13 %)
Apr	2.42	2.32	-0.10 (-4 %)	1.01	.92	-0.09 (-9 %)	.39	.34	-0.05 (-13 %)
May	2.66	2.69	+0.03 (+1 %)	1.19	1.12	-0.07 (-6 %)	.39	.38	-0.01 (-3 %)
Jun	2.94	2.97	+0.03 (+1 %)	1.31	1.28	-0.03 (-2 %)	.56	.52	-0.04 (-7 %)
Jul	3.35	3.02	-0.33 (-1 %)	1.49	1.31	-0.18 (-12 %)	.65	.52	-0.13 (-20 %)
Aug	3.49	3.25	-0.24 (-7 %)	1.65	1.45	-0.20 (-12 %)	.74	.61	-0.13 (-18 %)
Sep	3.42	3.21	-0.21 (-6 %)	1.58	1.44	-0.14 (-9 %)	.66	.58	-0.08 (-12 %)
Oct	3.48	3.17	-0.21 (-6 %)	1.64	1.46	-0.18 (-11 %)	.82	.66	-0.16 (-20 %)
Nov	3.01	2.74	-0.27 (-9 %)	1.39	1.18	-0.21 (-15 %)	.61	.48	-0.13 (-21 %)
Dec	1.69	1.54	-0.15 (-9 %)	.83	.69	-0.14 (-17 %)	.31	.24	-0.07 (-23 %)

	Station 24			Station 35		
	Base wo/s	Base w/s	Change	Base wo/s	Base w/s	Change
Jan	.15	.12	-0.03 (-20 %)	.49	.39	-0.10 (-20 %)
Feb	.15	.12	-0.03 (-20 %)	.57	.55	-0.02 (-4 %)
Mar	.16	.12	-0.04 (-25 %)	.52	.49	-0.03 (-16 %)
Apr	.16	.13	-0.03 (-19 %)	.56	.47	-0.09 (-6 %)
May	.15	.14	-0.01 (-7 %)	.55	.46	-0.09 (-16 %)
Jun	.20	.17	-0.03 (-15 %)	.63	.57	-0.06 (-10 %)
Jul	.20	.16	-0.04 (-20 %)	.65	.56	-0.09 (-14 %)
Aug	.21	.18	-0.03 (-14 %)	.72	.60	-0.12 (-17 %)
Sep	.20	.17	-0.03 (-15 %)	.73	.62	-0.11 (-15 %)
Oct	.31	.23	-0.08 (-26 %)	.73	.64	-0.09 (-14 %)
Nov	.23	.17	-0.06 (-26 %)	.71	.60	-0.11 (-18 %)
Dec	.16	.12	-0.04 (-25 %)	.59	.51	-0.08 (-16 %)

TABLE 8
STOCKTON SHIP CHANNEL SALINITY STUDY
PLAN D-1 VS. BASE WITH SIMPLIFIED HYDROLOGY,
AND PLAN D-1 VS. BASE WITHOUT SIMPLIFIED HYDROLOGY
1968 HYDROLOGIC CONDITIONS
AVERAGE MONTLY SALINITIES
PARTS PER THOUSAND

	Station 3						Station 4						Station 5					
	Base wo/s[1]	Plan wo/s[2]	Change	Base w/s	Plan w/s	Change	Base wo/s	Plan wo/s	Change	Base w/s	Plan w/s	Change	Base wo/s	Plan wo/s	Change	Base w/s	Plan w/s	Change
Feb	26.1	27.0	+.90 (+3 %)	26.4	26.5	+.10 (+0 %)	19.9	23.0	+3.10 (+16 %)	22.2	22.3	+.1 (0 %)	20.4	20.6	+0.2 (+1 %)	20.1	20.2	+0.1 (0 %)
Mar	24.7	25.4	+.70 (+3 %)	24.7	24.9	+.20 (+1 %)	21.0	20.8	-.20 (-1 %)	20.7	20.7	0 (0 %)	18.7	18.3	-0.4 (-2 %)	18.5	18.2	-0.3 (-2 %)
Apr	28.0	28.3	+.30 (+1 %)	27.7	28.0	+.30 (+1 %)	23.8	24.5	+.70 (3 %)	23.7	24.2	+.50 (+2 %)	22.5	22.7	+0.2 (+1 %)	22.2	22.2	0.0 (0 %)
May	29.2	29.8	+.60 (+2 %)	29.4	29.6	+.20 (+1 %)	26.4	26.9	+.50 (+2 %)	27.6	26.7	-.90 (-3 %)	24.9	25.4	+0.5 (2 %)	25.0	25.2	+0.2 (+1 %)
Jun	30.0	30.3	+.30 (+1 %)	29.9	30.2	+.30 (+1 %)	27.2	27.8	+.60 (+2 %)	25.5	27.7	+2.2 (+9 %)	26.1	26.2	+0.1 (0 %)	26.0	26.3	+0.3 (+1 %)
Jul	30.5	30.9	+.40 (+1 %)	30.4	30.7	+.30 (+1 %)	28.2	28.8	+.60 (+2 %)	28.5	28.8	+.30 (+1 %)	27.1	27.4	+0.3 (+1 %)	27.0	27.3	+0.3 (+1 %)
Aug	30.3	30.8	+.50 (+2 %)	30.3	30.5	+.20 (+1 %)	28.2	28.8	+.60 (+2 %)	28.1	28.5	+.40 (+1 %)	26.7	27.3	+0.6 (+2 %)	26.7	27.3	+0.6 (+2 %)
Sep	29.9	30.3	+.40 (+1 %)	29.9	30.4	+.50 (+2 %)	27.8	27.8	0 (0 %)	27.3	28.1	+.80 (+3 %)	26.1	26.7	+0.6 (+2 %)	26.1	26.7	+0.6 (+2 %)
Oct	-	-	-	30.0	30.5	+.50 (+2 %)	-	-	-	27.6	28.1	+.50 (+2 %)	26.5	26.8	+0.3 (+1 %)	26.2	26.7	+0.5 (+2 %)

	Station 6						Station 7						Station 9					
	Base wo/s	Plan wo/s	Change	Base w/s	Plan w/s	Change	Base wo/s	Plan wo/s	Change	Base w/s	Plan w/s	Change	Base wo/s	Plan wo/a	Change	Base w/s	Plan w/s	Change
Feb	14.7	14.2	-0.5 (-3 %)	14.5	14.7	+0.2 (+1 %)	7.56	7.39	-0.17 (-2 %)	7.52	7.21	-0.31 (-4 %)	3.05	3.09	+0.04 (+1 %)	2.93	2.83	-0.10 (-3 %)
Mar	12.2	12.6	+0.4 (+3 %)	11.9	11.7	-0.2 (-2 %)	5.74	5.32	-0.42 (-7 %)	5.50	5.14	-0.36 (-7 %)	1.56	1.50	-0.06 (-4 %)	1.52	1.32	-0.20 (-13 %)
Apr	18.3	18.5	+0.2 (+1 %)	18.0	18.1	+0.1 (+1 %)	11.0	11.2	+0.2 (+2 %)	10.7	10.7	0.0 (0 %)	7.09	6.47	-0.62 (-9 %)	6.78	6.53	-0.25 (-4 %)
May	21.6	21.9	+0.3 (+1 %)	21.6	21.8	+0.2 (+1 %)	15.0	15.3	+0.3 (+2 %)	15.0	15.1	+0.1 (+1 %)	10.8	10.6	-0.2 (-2 %)	10.8	10.5	-0.3 (-3 %)
Jun	23.7	23.2	-0.5 (-2 %)	22.8	23.1	+0.3 (+1 %)	16.7	17.0	+0.3 (+2 %)	16.6	16.9	+0.3 (+2 %)	12.7	12.8	+0.1 (+1 %)	12.7	12.6	-0.1 (-1 %)
Jul	24.1	24.6	+0.5 (+2 %)	23.9	24.5	+0.6 (+3 %)	18.5	18.8	+0.3 (+2 %)	18.4	18.7	+0.3 (+2 %)	14.5	14.6	+0.1 (+1 %)	13.3	13.6	+0.3 (+2 %)
Aug	23.5	24.1	+0.6 (+3 %)	23.5	24.1	+0.6 (+3 %)	17.5	18.1	+0.6 (+3 %)	17.5	18.0	+0.5 (+3 %)	13.3	13.5	+0.2 (+2 %)	13.3	13.6	+0.3 (+2 %)
Sep	23.1	23.5	+0.4 (+2 %)	22.6	23.4	+0.8 (+4 %)	16.7	16.8	+0.1 (+1 %)	16.3	16.8	+0.5 (+3 %)	12.4	13.0	+0.6 (+5 %)	12.1	12.6	+0.5 (+4 %)
Oct	23.3	23.7	+0.4 (+2 %)	23.1	23.7	+0.6 (+3 %)	17.3	17.5	+0.2 (+1 %)	16.9	17.4	+0.5 (+3 %)	13.0	13.0	0.0 (0 %)	12.8	13.1	+0.3 (+2 %)

1/ wo/s - without simplified hydrology.
2/ w/s - with simplified hydrology.

TABLE 8 (Continued)

	Station 9A						Station 11A						Station 13					
	Base wo/s	Plan wo/s	Change	Base w/s	Plan w/s	Change	Base wo/s	Plan wo/s	Change	Base w/s	Plan w/s	Change	Base wo/s	Plan wo/s	Change	Base w/s	Plan w/s	Change
Feb	.67	.76	+0.09 (+13 %)	.65	.72	+0.07 (.11 %)	.30	.32	+0.02 (+7 %)	.26	.30	+0.04 (+15 %)	.19	.19	0 (0 %)	.15	.14	-.01 (-7 %)
Mar	.27	.21	-0.06 (-22 %)	.22	.22	0.00 (0 %)	.17	.16	-0.01 (-6 %)	.14	.15	+0.01 (+7 %)	.15	.14	-.01 (-7 %)	.13	.12	-.01 (-8 %)
Apr	3.30	3.48	+0.18 (+5 %)	3.08	3.28	+0.20 (+6 %)	1.81	2.06	+0.25 (+12 %)	1.75	1.81	+0.06 (+3 %)	.39	.40	+.01 (+3 %)	.36	.37	+.01 (+3 %)
May	7.80	8.24	+0.44 (+6 %)	7.79	7.80	+0.01 (0 %)	4.36	4.66	+0.30 (+7 %)	4.50	4.55	+0.05 (+1 %)	1.33	1.42	+.09 (+7 %)	1.37	1.38	+.01 (+1 %)
Jun	9.94	10.0	+0.06 (+1 %)	9.67	10.0	+0.33 (+3 %)	6.24	6.63	+0.39 (+6 %)	6.30	6.54	+0.24 (+4 %)	2.47	2.60	+.13 (+5 %)	2.47	2.54	+.07 (+3 %)
Jul	11.9	12.4	+0.5 (+4 %)	11.7	12.2	+0.50 (+4 %)	8.21	8.44	+0.23 (+3 %)	8.24	8.77	+0.53 (+6 %)	3.97	4.13	+.16 (+4 %)	3.89	4.15	+.26 (+7 %)
Aug	10.8	11.3	+0.5 (+5 %)	10.9	11.3	+0.40 (+4 %)	6.81	7.34	+0.53 (+8 %)	6.91	7.29	+0.38 (+5 %)	2.95	3.08	+.13 (+4 %)	3.01	3.25	+.24 (+8 %)
Sep	10.0	9.91	-0.09 (-1 %)	9.30	9.94	+0.64 (+7 %)	5.90	6.10	+0.20 (+3 %)	5.51	6.13	+0.62 (+11 %)	2.29	2.26	-.03 (-1 %)	2.01	2.28	+.27 (+13 %)
Oct	10.3	10.5	+0.2 (+2 %)	10.0	10.5	+0.50 (+5 %)	6.58	6.94	+0.36 (+5 %)	6.26	7.01	+0.75 (+12 %)	2.73	2.75	+.02 (+1 %)	2.54	2.80	+.26 (+10 %)

	Station 14A						Station 15						Station 16					
	Base wo/s	Plan wo/s	Change	Base w/s	Plan w/s	Change	Base wo/s	Plan wo/s	Change	Base w/s	Plan w/s	Change	Base wo/s	Plan wo/s	Change	Base w/s	Plan w/s	Change
Feb	.22	.21	-0.01 (-5 %)	.16	.15	-0.01 (-6 %)	.22	.21	-0.01 (-5 %)	.16	.15	-0.01 (-6 %)	.20	.20	.00 (0 %)	.15	.15	.00 (0 %)
Mar	.17	.16	-0.01 (-6 %)	.13	.13	0.00 (0 %)	.16	.16	0.00 (0 %)	.13	.13	0.00 (0 %)	.15	.15	.00 (0 %)	.12	.12	.00 (0 %)
Apr	.22	.22	0.00 (0 %)	.19	.19	0.00 (0 %)	.17	.18	+0.01 (+6 %)	.15	.15	0.00 (0 %)	.13	.14	+.01 (+8 %)	.12	.11	+.01 (8 %)
May	.61	.65	+0.04 (+7 %)	.61	.63	+0.02 (+3 %)	.43	.46	+0.03 (+7 %)	.42	.43	+0.01 (+2 %)	.19	.20	+.01 (+5 %)	.19	.19	0 (0 %)
Jun	1.18	1.28	+0.10 (+8 %)	1.17	1.24	+0.07 (+6 %)	.84	.90	+0.06 (+7 %)	.86	.87	+0.01 (+1 %)	.34	.36	+.02 (+6 %)	.36	.37	+.01 (+3 %)
Jul	2.25	2.38	+0.13 (+6 %)	2.19	2.36	+0.17 (+8 %)	1.73	1.84	+0.11 (+6 %)	1.77	1.84	+0.07 (+4 %)	.71	.75	+.04 (+6 %)	.72	.75	+.03 (+4 %)
Aug	1.56	1.66	+0.10 (+6 %)	1.63	1.73	+0.10 (+6 %)	1.15	1.25	+0.10 (+9 %)	1.27	1.30	+0.03 (+2 %)	.50	.53	+.03 (+6 %)	.53	.54	+.01 (+2 %)
Sep	1.14	1.06	-0.08 (-7 %)	.95	1.09	+0.14 (+15 %)	.80	.79	-0.01 (-1 %)	.69	.79	+0.10 (+14 %)	.37	.33	-.04 (-11 %)	.30	.32	+.02 (+7 %)
Oct	1.38	1.38	0.00 (0 %)	1.23	1.42	+0.19 (+15 %)	.96	.96	0.00 (0 %)	.88	.98	+0.10 (+11 %)	.39	.39	+.00 (0 %)	.36	.39	+.03 (+8 %)

TABLE 8 (Continued)

Station 17

	Baae wo/a	Plan wo/a	Change	Base w/s	Plan w/a	Change
Feb	.25	.24	−.01 (−4 %)	.17	.16	−.01 (−6 %)
Mar	.17	.15	−.02 (−12 %)	.14	.13	−.01 (−7 %)
Apr	.14	.14	.00 (0 %)	.12	.11	−.01 (−8 %)
May	.14	.14	.00 (0 %)	.12	.13	+.01 (+8 %)
Jun	.19	.21	+.02 (+11 %)	.20	.18	−.02 (−10 %)
Jul	.39	.41	+.02 (+5 %)	.38	.39	+.01 (+3 %)
Aug	.29	.31	+.02 (+7 %)	.29	.28	−.01 (−3 %)
Sep	.22	.20	−.02 (−9 %)	.18	.18	.00 (0 %)
Oct	.24	.22	−.02 (−8 %)	.19	.20	+.01 (+5 %)

Station J

	Base wo/s	Plan wo/s	Change	Baae w/a	Plan w/a	Change
Feb	.17	.16	−.01 (−6 %)	.13	.16	+.03 (+23 %)
Mar	.13	.13	.00 (0 %)	.12	.11	−.01 (−8 %)
Apr	.12	.12	.00 (0 %)	.11	.10	−.01 (−9 %)
May	.13	.12	−.01 (−8 %)	.11	.11	0 (0 %)
Jun	.16	.16	.00 (0 %)	.16	.15	−.01 (−6 %)
Jul	.27	.27	.00 (0 %)	.26	.25	−.01 (−4 %)
Aug	.19	.20	+.01 (+5 %)	.21	.19	−.02 (−10 %)
Sep	.16	.16	.00 (0 %)	.14	.14	0 (0 %)
Oct	.18	.17	−.01 (−6 %)	.15	.16	+.01 (+7 %)

Station 20C

	Base wo/a	Plan wo/a	Change	Base w/a	Plan w/a	Change
Feb	.44	.45	+0.01 (+2 %)	.40	.40	0.00 (0 %)
Mar	.41	.42	+0.01 (+2 %)	.40	.40	0.00 (0 %)
Apr	.42	.42	0.00 (0 %)	.39	.40	+0.01 (+3 %)
May	.30	.31	+0.01 (+3 %)	.22	.23	+0.01 (+5 %)
Jun	.22	.27	+0.05 (+23 %)	.15	.15	0.00 (0 %)
Jul	.25	.29	+0.04 (+16 %)	.16	.16	0.00 (0 %)
Aug	.35	.35	0.00 (0 %)	.21	.21	0.00 (0 %)
Sep	.36	.35	−0.01 (−3 %)	.19	.19	0.00 (0 %)
Oct	.37	.30	−0.07 (−19 %)	.19	.18	−0.01 (−5 %)

Station 22

	Baae wo/a	Plan wo/a	Change	Base w/s	Plan w/a	Change
Feb	.12	.12	0.00 (0 %)	.11	.10	−0.01 (+9 %)
Mar	.11	.11	0.00 (0 %)	.11	.10	−0.01 (−9 %)
Apr	.16	.17	+0.01 (+6 %)	.15	.14	−0.01 (−7 %)
May	.36	.40	+0.04 (+11 %)	.33	.35	+0.02 (+6 %)
Jun	.77	.87	+0.10 (+13 %)	.80	.82	+0.02 (+3 %)
Jul	1.50	1.58	+0.08 (+5 %)	1.48	1.52	+0.04 (+3 %)
Aug	.93	1.03	+0.10 (+11 %)	1.03	1.02	−0.01 (−1 %)
Sep	.65	.64	−0.01 (−2 %)	.56	.65	+0.09 (+16 %)
Oct	.84	.84	0.00 (0 %)	.77	.87	+0.10 (+13 %)

Station 22A

	Baae wo/a	Plan wo/a	Change	Base w/a	Plan w/s	Change
Feb	.16	.16	0.00 (0 %)	.13	.13	0.00 (0 %)
Mar	.14	.13	−0.01 (−7 %)	.12	.11	−0.01 (−8 %)
Apr	.13	.13	0.00 (0 %)	.11	.11	0.00 (0 %)
May	.16	.17	+0.01 (+6 %)	.15	.16	+0.01 (+7 %)
Jun	.32	.34	+0.02 (+6 %)	.32	.32	0.00 (0 %)
Jul	.68	.73	+0.05 (+7 %)	.66	.70	+0.04 (+6 %)
Aug	.45	.50	+0.05 (+11 %)	.45	.47	+0.02 (+4 %)
Sep	.31	.28	−0.03 (−10 %)	.23	.26	+0.03 (+13 %)
Oct	.35	.35	0.00 (0 %)	.29	.34	+0.05 (+17 %)

Station 23

	Base wo/a	Plan wo/a	Change	Base w/a	Plan w/a	Change
Feb	.12	.12	0.00 (0 %)	.11	.10	−0.01 (−9 %)
Mar	.11	.11	0.00 (0 %)	.11	.10	−0.01 (−9 %)
Apr	.12	.12	0.00 (0 %)	.11	.10	−0.01 (−9 %)
May	.12	.11	−0.01 (−8 %)	.11	.11	0.00 (0 %)
Jun	.14	.15	+0.01 (−7 %)	.14	.13	−0.01 (−7 %)
Jul	.21	.21	0.0 (0 %)	.20	.20	0.00 (0 %)
Aug	.15	.15	0.00 (0 %)	.14	.20	+0.06 (+43 %)
Sep	.14	.13	−0.01 (−7 %)	.12	.12	0.00 (0 %)
Oct	.14	.14	0.00 (0 %)	.12	.14	+0.02 (+17 %)

TABLE 8 (Continued)

	Station 24					
	Base wo/s	Plan wo/s	Change	Base w/s	Plan w/s	Change
Feb	.12	.12	0.00 (0 %)	.11	.10	−0.01 (−9 %)
Mar	.12	.12	0.00 (0 %)	.11	.10	−0.01 (−9 %)
Apr	.12	.12	0.00 (0 %)	.11	.10	−0.01 (−9 %)
May	.12	.12	0.00 (0 %)	.11	.10	−0.01 (−9 %)
Jun	.12	.12	0.00 (0 %)	.11	.10	−0.01 (−9 %)
Jul	.12	.12	0.00 (0 %)	.11	.11	0.00 (0 %)
Aug	.12	.12	0.00 (0 %)	.11	.10	−0.01 (−9 %)
Sep	.12	.12	0.00 (0 %)	.11	.11	0.00 (0 %)
Oct	.12	.12	0.00 (0 %)	.10	.11	+0.01 (+9 %)

	Station 31					
	Base wo/s	Plan wo/s	Change	Base w/s	Plan w/s	Change
Feb	.29	.32	+0.03 (+10 %)	.20	.19	−0.01 (−5 %)
Mar	.21	.23	+0.02 (+10 %)	.16	.15	−0.01 (−6 %)
Apr	.16	.17	+0.01 (+6 %)	.13	.12	−0.01 (−8 %)
May	.26	.25	−0.01 (−4 %)	.21	.22	+0.01 (+5 %)
Jun	.45	.45	0.00 (0 %)	.41	.43	+0.02 (+5 %)
Jul	.97	.97	0.00 (0 %)	.95	1.01	+0.06 (+6 %)
Aug	.73	.78	+0.05 (+7 %)	.77	.79	+0.02 (+3 %)
Sep	.51	.47	−0.04 (−8 %)	.41	.46	+0.05 (+12 %)
Oct	.55	.53	−0.02 (−4 %)	.48	.55	+0.07 (+15 %)

	Station 33					
	Base wo/s	Plan wo/s	Change	Base w/s	Plan w/s	Change
Feb	.50	.49	−0.01 (−2 %)	.35	.35	0.00 (0 %)
Mar	.36	.35	−0.01 (−3 %)	.24	.23	−0.01 (−4 %)
Apr	.20	.20	0.00 (0 %)	.15	.14	−0.01 (−7 %)
May	.18	.19	+0.01 (+6 %)	.14	.14	0.00 (0 %)
Jun	.26	.26	0.00 (0 %)	.21	.20	−0.01 (−5 %)
Jul	.51	.52	+0.01 (+2 %)	.45	.47	+0.02 (+4 %)
Aug	.49	.51	+0.02 (+4 %)	.44	.45	+0.01 (+2 %)
Sep	.34	.33	−0.01 (−3 %)	.25	.27	+0.02 (+8 %)
Oct	.34	.32	−0.02 (−6 %)	.26	.28	+0.02 (+8 %)

	Station 35					
	Base wo/s	Plan wo/s	Change	Base w/s	Plan w/s	Change
Feb	.46	.45	−0.01 (−2 %)	.40	.40	0.00 (0 %)
Mar	.40	.40	0.00 (0 %)	.32	.34	+0.02 (+6 %)
Apr	.24	.25	+0.01 (+4 %)	.18	.18	0.00 (0 %)
May	.20	.19	−0.01 (−5 %)	.13	.13	0.00 (0 %)
Jun	.25	.24	−0.01 (−4 %)	.17	.17	0.00 (0 %)
Jul	.42	.42	0.00 (0 %)	.34	.34	0.00 (0 %)
Aug	.45	.44	−0.01 (−2 %)	.36	.37	+0.01 (+3 %)
Sep	.32	.31	−0.01 (−3 %)	.22	.23	+0.01 (+5 %)
Oct	.31	.30	−0.01 (−3 %)	.22	.24	+0.02 (+9 %)

	Station 0					
	Base wo/s	Plan wo/s	Change	Base w/s	Plan w/s	Change
Feb	.30	.29	−0.01 (−3 %)	.29	.28	−0.01 (−3 %)
Mar	.23	.32	+0.09 (+39 %)	.20	.19	−0.01 (−5 %)
Apr	.16	.17	+0.01 (+6 %)	.13	.12	−0.01 (−8 %)
May	.23	.18	−0.05 (−22 %)	.15	.14	−0.01 (−7 %)
Jun	.39	.27	−0.12 (−31 %)	.23	.23	0.00 (0 %)
Jul	.65	.56	−0.09 (−14 %)	.57	.58	+0.01 (+2 %)
Aug	.55	.56	+0.01 (+2 %)	.52	.53	+0.01 (+2 %)
Sep	.37	.34	−0.03 (−8 %)	.28	.30	+0.02 (+7 %)
Oct	.39	.36	−0.03 (−8 %)	.29	.34	+0.05 (+17 %)

TABLE 9

STOCKTON SHIP CHANNEL
SALINITY STUDY
DYNAMIC MODEL TEST RESULTS
PLAN D-1 VS. BASE
1977 DROUGHT CONDITION
AVERAGE MONTHLY SALINITIES
PARTS PER THOUSAND
CHANGE

	Station 1			Station 3			Station 4			Station 5			Station 6			Station 7		
	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change
Jan	32.5	31.9	-.6 (-2 %)	31.3	30.6	-.7 (-2 %)	29.1	28.8	-.3 (-1 %)	28.3	27.6	-0.7 (-2 %)	25.2	24.9	-0.3 (-1 %)	19.6	19.1	-0.5 (-3 %)
Feb	32.2	31.9	-.3 (-1 %)	31.0	30.6	-.7 (-2 %)	29.0	28.8	-.3 (-1 %)	27.9	27.5	-0.4 (-1 %)	25.0	24.7	-0.3 (-1 %)	19.4	19.0	-0.4 (-2 %)
Mar	32.1	31.9	-.2 (-1 %)	30.7	30.7	.0 (0 %)	29.0	28.9	-.1 (0 %)	27.7	27.4	-0.3 (-1 %)	24.9	24.7	-0.2 (-1 %)	19.3	18.9	-0.4 (-2 %)
Apr	32.1	31.9	-.2 (-1 %)	31.0	30.7	-.3 (-1 %)	29.0	29.2	+.2 (+1 %)	28.0	27.7	-0.3 (-1 %)	25.2	25.0	-0.2 (-1 %)	19.6	19.4	-0.2 (-1 %)
May	32.1	31.9	-.2 (-1 %)	31.0	30.8	-.2 (-1 %)	29.3	29.1	-.2 (-1 %)	28.0	27.8	-0.2 (-1 %)	25.4	25.2	-0.2 (-1 %)	20.0	19.9	-0.1 (-1 %)
Jun	32.3	31.9	-.4 (-1 %)	31.1	30.8	-.3 (-1 %)	29.3	29.2	-.1 (0 %)	28.2	27.9	-0.3 (-1 %)	25.5	25.2	-0.3 (-1 %)	20.1	20.0	-0.1 (0 %)
Jul	32.5	32.1	-.4 (-1 %)	31.3	31.0	-.3 (-1 %)	29.7	29.5	-.2 (-1 %)	28.5	28.1	-0.4 (-1 %)	25.6	25.5	-0.1 (0 %)	20.4	20.2	-0.2 (-1 %)
Aug	32.1	32.2	+.1 (0 %)	31.1	31.1	.0 (0 %)	29.7	29.3	-.4 (-1 %)	28.3	28.2	-0.1 (0 %)	25.8	25.7	-0.1 (0 %)	20.6	20.5	-0.1 (0 %)
Sep	32.4	32.2	-.2 (0 %)	31.3	30.9	-.4 (-1 %)	29.6	29.3	-.3 (-1 %)	28.5	28.1	-0.4 (-1 %)	25.7	25.5	-0.2 (-1 %)	20.5	20.4	-0.1 (0 %)
Oct	32.1	32.1	.0 (0 %)	31.2	31.0	-.2 (-1 %)	29.4	29.4	.0 (0 %)	28.4	28.2	-0.2 (-1 %)	25.6	25.6	0.0 (0 %)	20.5	20.4	-0.1 (0 %)
Nov	32.0	32.1	+.1 (0 %)	31.0	30.9	-.1 (0 %)	29.3	29.2	-.1 (0 %)	28.1	28.0	-0.1 (0 %)	25.3	25.3	0.0 (0 %)	20.1	20.0	-0.1 (0 %)
Dec	32.2	32.0	-.2 (-1 %)	30.9	30.8	-.1 (0 %)	29.0	29.2	-.2 (-1 %)	27.7	28.8	+1.1 (+4 %)	24.7	24.7	0.0 (0 %)	18.6	19.1	+0.5 (+3 %)

	Station 9			Station 9A			Station 9B			Station 9E			Station 9I			Station 11A		
	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change
Jan	15.8	15.0	-0.8 (-5 %)	13.1	12.8	-0.3 (-2 %)	11.8	11.5	-0.3 (-3 %)	10.5	10.1	-0.4 (-4 %)	12.2	12.0	-0.2 (-2 %)	9.06	8.93	-0.13 (-1 %)
Feb	15.4	15.0	-0.4 (-3 %)	13.0	12.7	-0.3 (-2 %)	11.9	11.6	-0.3 (-3 %)	10.5	10.2	-0.3 (-3 %)	12.1	11.9	-0.2 (-2 %)	8.97	8.91	-0.06 (-1 %)
Mar	15.2	14.9	-0.3 (-2 %)	12.9	12.6	-0.3 (-2 %)	11.8	11.5	-0.3 (-3 %)	10.4	10.2	-0.2 (-2 %)	12.0	11.8	-0.2 (-2 %)	8.96	8.75	-0.21 (-2 %)
Apr	15.7	15.4	-0.3 (-2 %)	13.4	13.1	-0.3 (-2 %)	12.1	11.8	-0.3 (-2 %)	10.8	10.3	-0.5 (-5 %)	12.4	12.2	-0.2 (-2 %)	9.26	9.24	-0.02 (0 %)
May	16.1	15.8	-0.3 (-2 %)	13.9	13.8	-0.1 (-1 %)	12.4	12.1	-0.3 (-2 %)	11.2	10.9	-0.3 (-3 %)	13.0	12.8	-0.2 (-2 %)	9.85	9.92	+0.07 (+1 %)
Jun	16.2	15.9	-0.3 (-2 %)	14.2	14.1	-0.1 (-1 %)	12.8	12.6	-0.2 (-2 %)	11.7	11.3	-0.4 (-3 %)	13.3	13.2	-0.1 (-1 %)	10.1	10.1	0.0 (0 %)
Jul	16.6	16.2	-0.4 (-2 %)	14.4	14.2	-0.2 (-1 %)	13.1	12.8	-0.3 (-2 %)	12.1	11.5	-0.6 (-5 %)	13.5	13.3	-0.2 (-1 %)	10.2	10.2	0.0 (0 %)
Aug	16.8	16.4	-0.4 (-2 %)	14.7	14.5	-0.2 (-1 %)	13.4	13.1	-0.3 (-2 %)	12.3	11.8	-0.5 (-4 %)	13.8	13.7	-0.1 (-1 %)	10.7	10.6	-0.1 (-1 %)
Sep	16.7	16.6	-0.1 (-1 %)	14.7	14.5	-0.2 (-1 %)	13.6	13.4	-0.2 (-1 %)	12.5	12.0	-0.5 (-4 %)	13.8	13.7	-0.1 (-1 %)	10.6	10.5	-0.1 (-1 %)
Oct	16.6	16.4	-0.2 (-1 %)	14.5	14.2	-0.3 (-2 %)	13.6	13.4	-0.2 (-1 %)	12.5	12.0	-0.5 (-4 %)	13.6	13.6	0.0 (0 %)	10.4	10.2	-0.2 (-2 %)
Nov	16.2	15.8	-0.4 (-2 %)	14.0	13.9	-0.1 (-1 %)	13.5	13.4	-0.1 (-1 %)	12.1	11.8	-0.3 (-2 %)	13.3	13.2	-0.1 (-1 %)	9.79	9.76	-0.03 (0 %)
Dec	14.7	14.7	0.0 (0 %)	12.8	12.8	0.0 (0 %)	13.1	12.9	-0.2 (-2 %)	11.5	10.8	-0.7 (-6 %)	12.3	12.3	0.0 (0 %)	7.99	8.18	+0.19 (+2 %)

TABLE 9 (Continued)

	Station 13			Station 14A			Station 15			Station 16			Station 18			Station 20C		
	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change
Jan	4.42	4.28	-0.14 (3 %)	2.39	2.31	-0.08 (-3 %)	1.74	1.65	-0.09 (-5 %)	.70	.68	-.02 (-3 %)	.23	.22	-0.01 (-4 %)	.51	.41	-0.10 (-20 %)
Feb	4.26	4.06	-0.20 (-5 %)	2.27	2.11	-0.16 (-7 %)	1.66	1.56	-0.10 (-6 %)	.70	.68	-.02 (-3 %)	.26	.24	-0.02 (-8 %)	.61	.50	-0.11 (-18 %)
Mar	3.96	3.90	-0.06 (-2 %)	1.98	1.93	-0.05 (-3 %)	1.34	1.29	-0.05 (-4 %)	.56	.54	-.02 (-4 %)	.24	.24	0.00 (0 %)	.58	.45	-0.13 (-22 %)
Apr	4.23	4.12	-0.11 (-3 %)	2.10	2.02	-0.08 (-4 %)	1.36	1.33	-0.03 (-2 %)	.60	.58	-.02 (-3 %)	.26	.26	0.00 (0 %)	.49	.41	-0.08 (-16 %)
May	4.86	4.70	-0.16 (-3 %)	2.61	2.56	-0.05 (-2 %)	1.89	1.84	-0.05 (-3 %)	.77	.76	-.01 (-1 %)	.27	.27	0.00 (0 %)	.38	.34	-0.04 (-11 %)
Jun	4.92	4.89	-0.03 (-1 %)	2.61	2.62	+0.01 (0 %)	1.84	1.79	-0.05 (-3 %)	.83	.82	-.01 (-1 %)	.33	.33	0.00 (0 %)	.35	.33	-0.02 (-6 %)
Jul	5.12	5.06	-0.06 (-1 %)	2.74	2.80	+0.06 (+2 %)	1.99	1.92	-0.07 (-4 %)	.86	.84	-.02 (-2 %)	.34	.32	-0.02 (-6 %)	.35	.33	-0.02 (-6 %)
Aug	5.46	5.34	-0.12 (-2 %)	3.06	2.96	-0.10 (-3 %)	2.19	2.13	-0.06 (-3 %)	.93	.93	.0 (0 %)	.35	.35	0.00 (0 %)	.34	.33	-0.01 (-3 %)
Sep	5.37	5.30	-0.07 (-1 %)	2.93	2.97	+0.04 (+1 %)	2.20	2.18	-0.02 (-1 %)	.95	.94	-.01 (-1 %)	.37	.37	0.00 (0 %)	.35	.34	-0.01 (-3 %)
Oct	5.13	5.02	-0.11 (-2 %)	2.70	2.63	-0.07 (-3 %)	1.86	1.82	-0.04 (-2 %)	.90	.90	-.00 (0 %)	.41	.42	+0.01 (+2 %)	.37	.37	0.00 (0 %)
Nov	4.75	4.75	0.00 (0 %)	2.56	2.49	-0.07 (-3 %)	1.79	1.79	0.00 (0 %)	.81	.81	.0 (0 %)	.36	.36	0.00 (0 %)	.42	.41	-0.01 (+2 %)
Dec	3.75	4.05	+0.40 (+11 %)	2.10	2.17	+0.07 (+3 %)	1.55	1.59	+0.04 (+3 %)	.70	.72	+.02 (-3 %)	.26	.26	0.00 (0 %)	.36	.35	-0.01 (-3 %)

	Station 22			Station 22A			Station 23			Station 24			Station 31			Station 33		
	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change
Jan	1.87	1.79	-0.08 (-4 %)	.77	.75	-0.02 (-3 %)	.23	.24	+0.01 (+4 %)	.11	.12	+0.01 (+9 %)	.90	.86	-0.04 (-4 %)	.43	.42	-0.01 (-2 %)
Feb	1.98	1.86	-0.12 (-6 %)	.84	.80	-0.04 (-5 %)	.26	.26	0.00 (0 %)	.11	.12	+0.01 (+9 %)	.94	.84	-0.10 (-11 %)	.51	.47	-0.04 (-8 %)
Mar	1.97	1.91	-0.06 (-3 %)	.77	.76	-0.01 (-1 %)	.27	.27	0.00 (0 %)	.12	.12	0.00 (0 %)	.86	.68	-0.18 (-21 %)	.43	.42	-0.01 (-2 %)
Apr	2.32	2.26	-0.06 (-3 %)	.92	.88	-0.04 (-4 %)	.34	.33	-0.01 (-3 %)	.13	.14	+0.01 (+8 %)	.77	.73	-0.04 (-5 %)	.43	.42	-0.01 (-2 %)
May	2.69	2.60	-0.09 (-3 %)	1.12	1.09	-0.03 (-3 %)	.38	.40	+0.02 (+5 %)	.13	.14	+0.01 (+8 %)	.99	.97	-0.02 (-2 %)	.50	.49	-0.01 (-2 %)
Jun	2.97	2.85	-0.12 (-4 %)	1.28	1.25	-0.03 (-2 %)	.52	.53	+0.01 (+2 %)	.17	.18	+0.01 (+6 %)	1.04	1.04	0.00 (0 %)	.58	.58	0.00 (0 %)
Jul	3.02	2.91	-0.11 (-4 %)	1.31	1.27	-0.04 (-3 %)	.52	.52	0.00 (0 %)	.16	.16	0.00 (0 %)	1.12	1.06	-0.06 (-5 %)	.61	.60	-0.01 (-2 %)
Aug	3.24	3.17	-0.07 (-2 %)	1.45	1.44	-0.01 (-1 %)	.61	.61	0.00 (0 %)	.17	.18	+0.01 (+6 %)	1.22	1.20	-0.02 (2 %)	.64	.64	0.00 (0 %)
Sep	3.21	3.14	-0.07 (-2 %)	1.44	1.44	0.00 (0 %)	.58	.60	+0.02 (+3 %)	.16	.17	+0.01 (+6 %)	1.15	1.15	0.00 (0 %)	.68	.68	0.00 (0 %)
Oct	3.17	3.08	-0.09 (-3 %)	1.46	1.44	-0.02 (-1 %)	.66	.67	+0.01 (+2 %)	.23	.24	+0.01 (+4 %)	.92	.89	-0.03 (-3 %)	.63	.65	+0.02 (+3 %)
Nov	2.74	2.69	-0.05 (-2 %)	1.18	1.16	-0.02 (-2 %)	.48	.48	0.00 (0 %)	.17	.17	0.00 (0 %)	.82	.81	-0.01 (-1 %)	.59	.60	+0.01 (+2 %)
Dec	1.54	1.57	-0.03 (-2 %)	.69	.71	+0.02 (+3 %)	.24	.24	0.00 (0 %)	.12	.12	0.00 (0 %)	.74	.74	0.00 (0 %)	.50	.49	-0.01 (-2 %)

TABLE 9 (Continued)

	Station 35			Station 0		
	Base	Plan	Change	Base	Plan	Change
Jan	.39	.36	-0.03 (-8 %)	.51	.51	0.00 (0 %)
Feb	.55	.50	-0.05 (-9 %)	.60	.57	-0.03 (-5 %)
Mar	.49	.46	-0.03 (-6 %)	.48	.47	-0.01 (-2 %)
Apr	.47	.47	0.00 (0 %)	.43	.45	+0.02 (+5 %)
May	.46	.43	-0.03 (-7 %)	.46	.52	+0.06 (+13 %)
Jun	.57	.57	0.00 (0 %)	.55	.60	+0.05 (+9 %)
Jul	.56	.56	0.0 (0 %)	.60	.63	+0.03 (+5 %)
Aug	.60	.58	-0.02 (-3 %)	.62	.69	+0.07 (+11 %)
Sep	.62	.63	+0.01 (+2 %)	.58	.71	+0.13 (+22 %)
Oct	.64	.65	+0.01 (+2 %)	.58	.64	+0.06 (+10 %)
Nov	.60	.60	0.00 (0 %)	.56	.61	+0.05 (+9 %)
Dec	.51	.50	-0.01 (-2 %)	.47	.52	+0.05 (+11 %)

TABLE 10
STOCKTON SHIP CHANNEL
STEADY-STATE MODEL TEST RESULTS
PLAN D-1 VS. BASE
AVERAGE TIDAL CYCLE SALINITIES
PARTS PER THOUSAND
(CHANGE)

Station	AVE-Plan Salinity P	AVE Base Salinity B	Change	
1	32.3	32.1	+0.2	(+1 %)
3	31.3	31.2	+0.1	(0 %)
4	29.3	29.0	+0.3	(+1 %)
5	28.0	27.8	+0.2	(+1 %)
6	24.8	24.8	0.0	(0 %)
7	19.3	19.2	+0.1	(+1 %)
9	14.6	14.8	-0.2	(-1 %)
9A	12.0	12.2	-0.2	(-2 %)
9B	11.7	11.9	-0.2	(-2 %)
9E	10.1	10.2	-0.1	(-1 %)
10	10.5	10.8	-0.3	(-3 %)
11A	8.04	8.09	-0.05	(-1 %)
13	4.28	4.45	-0.17	(-4 %)
14A	2.73	2.86	-0.13	(-5 %)
15	2.06	2.14	-0.08	(-4 %)
16	1.22	1.32	-0.10	(-8 %)
18	.36	.41	-0.05	(-14 %)
20C	.29	.31	-0.02	(-7 %)
22	1.05	1.16	-0.11	(-10 %)
22A	1.06	1.11	-0.05	(-5 %)
23	.14	.15	-0.01	(-7 %)
24	.11	.10	+0.01	(+9 %)
33	.82	.88	-0.06	(-7 %)
34	.38	.42	-0.04	(-11 %)
35	.54	.51	+0.03	(6 %)
0	.99	1.06	-0.07	(-7 %)

TABLE 11
STOCKTON SHIP CHANNEL
SALINITY STUDY
DYNAMIC MODEL TEST RESULTS
PLAN D-1 WITH SILL VS. BASE
1977 DROUGHT CONDITION
AVERAGE MONTHLY SALINITIES
PARTS PER THOUSAND
(CHANGE)

	Station 1			Station 3			Station 4			Station 5			Station 6			Station 7		
	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change
Jan	32.5	32.3	-.2 (-1 %)	31.3	30.9	-.4 (-1 %)	29.1	29.2	+.1 (0 %)	28.3	27.9	-0.4 (-1 %)	25.2	24.9	-0.3 (-1 %)	19.6	19.2	-0.4 (-2 %)
Feb	32.2	32.0	-.2 (-1 %)	31.0	30.7	-.3 (-1 %)	29.0	29.1	+.1 (0 %)	27.9	27.8	-0.1 (0 %)	25.0	24.9	-0.1 (0 %)	19.4	19.1	-0.3 (-2 %)
Mar	32.1	32.3	+.2 (+1 %)	30.7	30.9	+.2 (+1 %)	29.0	28.9	-.1 (0 %)	27.7	27.7	0.0 (0 %)	25.0	24.6	-0.4 (-2 %)	19.3	18.8	-0.5 (-3 %)
Apr	32.1	32.2	+.1 (0 %)	31.0	31.0	.0 (0 %)	29.0	29.5	+.5 (+2 %)	27.9	27.9	0.0 (0 %)	25.2	24.9	-0.3 (-1 %)	19.6	19.2	-0.4 (-2 %)
May	32.1	32.1	.0 (0 %)	31.0	30.9	-.1 (0 %)	29.3	29.5	+.2 (+1 %)	28.0	28.0	0.0 (0 %)	25.4	25.2	-0.2 (-1 %)	20.0	19.7	-0.3 (-2 %)
Jun	32.3	32.4	+.1 (0 %)	31.1	31.2	+.1 (0 %)	29.3	29.5	+.2 (+1 %)	28.2	28.2	0.0 (0 %)	25.5	25.3	-0.2 (-1 %)	20.1	20.0	-0.1 (0 %)
Jul	32.5	32.3	-.2 (-1 %)	31.3	31.1	-.2 (-1 %)	29.7	29.4	-.3 (-1 %)	28.5	28.3	-0.2 (-1 %)	25.6	25.4	-0.2 (-1 %)	20.4	20.1	-0.3 (-1 %)
Aug	32.1	32.2	+.1 (0 %)	31.1	31.1	.0 (0 %)	29.7	29.9	+.2 (+1 %)	28.3	28.4	+0.1 (0 %)	25.8	25.6	-0.2 (-1 %)	20.6	20.4	-0.2 (-1 %)
Sep	32.4	32.3	-.1 (0 %)	31.3	31.2	-.1 (0 %)	29.6	29.7	+.1 (0 %)	28.5	28.5	0.0 (0 %)	25.7	25.5	-0.2 (-1 %)	20.5	20.3	-0.2 (-1 %)
Oct	32.1	32.3	+.2 (+1 %)	31.2	31.1	-.1 (0 %)	29.4	29.8	+.4 (+1 %)	28.4	28.5	+0.1 (0 %)	25.6	25.6	0.0 (0 %)	20.5	20.1	-0.4 (-2 %)
Nov	32.0	32.2	+.2 (+1 %)	31.0	31.0	.0 (0 %)	29.3	29.7	+.4 (+1 %)	28.1	28.2	+0.1 (0 %)	25.3	25.4	0.1 (0 %)	20.1	19.8	-0.3 (-1 %)
Dec	32.2	32.1	-.1 (+0 %)	30.9	31.0	+.1 (0 %)	29.0	29.2	+.2 (+1 %)	27.7	27.9	+0.2 (+1 %)	24.7	24.8	+0.1 (0 %)	18.6	19.0	+0.4 (-2 %)

	Station 9			Station 9A			Station 9B			Station 9E			Station 9I			Station 11A		
	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change
Jan	15.8	14.6	-1.2 (-8 %)	13.1	12.5	-0.6 (-5 %)	11.8	11.0	-0.8 (-7 %)	-	-	- -	-	-	- -	9.06	8.41	-0.65 (-7 %)
Feb	15.4	14.6	-0.8 (-5 %)	13.0	12.2	-0.8 (-6 %)	11.9	11.2	-0.7 (-6 %)	-	-	- -	-	-	- -	8.97	8.30	-0.67 (-7 %)
Mar	15.2	14.4	-0.8 (-5 %)	12.9	12.1	-0.8 (-6 %)	11.8	11.1	-0.7 (-6 %)	10.4	9.59	-0.81 (-8 %)	12.0	11.3	-0.7 (-6 %)	8.97	8.15	-0.82 (-9 %)
Apr	15.7	14.9	-0.8 (-5 %)	13.4	12.5	-0.9 (-7 %)	12.0	11.2	-0.8 (-7 %)	10.8	9.86	-0.94 (-9 %)	12.4	11.6	-0.8 (-6 %)	9.26	8.82	-0.44 (-5 %)
May	16.1	15.4	-0.7 (-4 %)	13.9	13.2	-0.7 (-5 %)	12.4	11.6	-0.8 (-6 %)	11.2	10.2	-1.0 (-9 %)	13.0	12.3	-0.7 (-5 %)	9.84	9.67	-0.17 (-2 %)
Jun	16.2	15.7	-0.5 (-3 %)	14.2	13.5	-0.7 (-5 %)	12.7	12.1	-0.6 (-5 %)	11.7	10.9	-0.8 (-7 %)	13.3	12.6	-0.7 (-5 %)	10.1	9.88	-0.22 (-2 %)
Jul	16.6	15.8	-0.8 (-5 %)	14.4	13.8	-0.6 (-4 %)	13.1	12.3	-0.8 (-6 %)	12.1	11.1	-1.0 (-8 %)	13.5	12.9	-0.6 (-4 %)	10.2	10.0	-0.2 (-2 %)
Aug	16.7	16.2	-0.5 (-3 %)	14.6	14.1	-0.5 (-3 %)	13.4	12.8	-0.6 (-4 %)	12.2	11.4	-0.8 (-7 %)	12.8	13.3	-0.5 (-4 %)	10.7	10.3	-0.4 (-4 %)
Sep	16.7	15.9	-0.8 (-5 %)	14.7	14.0	-0.7 (-5 %)	13.6	12.9	-0.7 (-5 %)	12.5	11.5	-1.0 (-8 %)	13.8	13.2	-0.6 (-4 %)	10.6	10.2	-0.4 (-4 %)
Oct	16.6	15.7	-0.9 (-5 %)	14.5	13.8	-0.7 (-5 %)	13.6	12.9	-0.7 (-5 %)	12.5	11.5	-1.0 (-8 %)	13.6	13.1	-0.5 (-4 %)	10.4	9.90	-0.50 (-5 %)
Nov	16.2	15.7	-0.5 (-3 %)	14.0	13.5	-0.5 (-4 %)	13.5	12.9	-0.6 (-4 %)	12.1	11.2	-0.9 (-7 %)	13.3	12.8	-0.5 (-4 %)	9.79	9.54	-0.25 (-3 %)
Dec	14.7	14.5	-0.2 (-1 %)	12.8	12.5	-0.3 (-2 %)	13.1	12.5	-0.6 (-5 %)	11.5	10.6	-0.9 (-8 %)	12.2	11.9	-0.3 (-2 %)	7.99	8.03	+0.04 (-1 %)

TABLE 11 (Continued)

	Station 14A			Station 15			Station 16			Station 18			Station 20C			Station 21		
	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change
Jan	2.39	2.20	-0.19 (-8 %)	1.74	1.54	-0.20 (-11 %)	.70	.63	-.07 (-10 %)	.23	.21	-0.02 (-9 %)	.51	.43	-.12 (-24 %)	5.54	4.23	-1.31 (-24 %)
Feb	2.27	2.02	-0.25 (-11 %)	1.66	1.45	-0.21 (-13 %)	.70	.61	-.09 (-13 %)	.26	.23	-0.03 (-12 %)	.61	.51	-.10 (-16 %)	5.82	4.21	-1.61 (-28 %)
Mar	1.98	1.79	-0.19 (-10 %)	1.34	1.16	-0.18 (-13 %)	.56	.49	-.07 (-13 %)	.24	.22	-0.02 (-8 %)	.58	.44	-.14 (-24 %)	5.37	4.14	-1.23 (-23 %)
Apr	2.10	1.89	-0.21 (-10 %)	1.36	1.23	-0.13 (-10 %)	.60	.53	-.07 (-12 %)	.26	.24	-0.02 (-8 %)	.49	.42	-.07 (-14 %)	5.88	4.67	-1.21 (-21 %)
May	2.61	2.45	-0.16 (-6 %)	1.89	1.72	-0.17 (-9 %)	.77	.71	-.06 (-8 %)	.27	.25	-0.02 (-7 %)	.38	.34	-.04 (-11 %)	6.64	5.17	-1.47 (-22 %)
Jun	2.61	2.51	-0.10 (-4 %)	1.84	1.67	-0.17 (-9 %)	.83	.78	-.05 (-6 %)	.33	.32	-0.01 (-3 %)	.35	.32	-.03 (-9 %)	6.91	5.61	-1.30 (-19 %)
Jul	2.74	2.66	-0.08 (-3 %)	1.99	1.86	-0.13 (-7 %)	.86	.80	-.06 (-7 %)	.34	.31	-0.03 (-9 %)	.35	.32	-.03 (-9 %)	6.93	5.88	-1.05 (-15 %)
Aug	3.06	2.92	-0.14 (-5 %)	2.19	2.07	-0.12 (-5 %)	.93	.89	-.04 (-4 %)	.35	.33	-0.02 (-6 %)	.34	.32	-.02 (-6 %)	7.42	5.90	-1.52 (-20 %)
Sep	2.93	2.81	-0.12 (-4 %)	2.20	2.06	-0.14 (-6 %)	.95	.91	-.04 (-4 %)	.37	.35	-0.02 (-5 %)	.35	.33	-.02 (-6 %)	6.83	5.76	-1.07 (-16 %)
Oct	2.70	2.45	-0.25 (-9 %)	1.86	1.72	-0.14 (-8 %)	.90	.86	-.04 (-4 %)	.41	.39	-0.02 (-5 %)	.37	.35	-.02 (-5 %)	7.02	5.80	-1.22 (-17 %)
Nov	2.56	2.38	-0.18 (-7 %)	1.79	1.67	-0.12 (-7 %)	.81	.77	-.04 (-5 %)	.36	.34	-0.02 (-6 %)	.42	.38	-.04 (-10 %)	5.67	5.70	-.03 (-1 %)
Dec	2.10	2.15	+0.05 (-2 %)	1.55	1.56	+0.01 (-1 %)	.70	.72	+.02 (+3 %)	.26	.26	0.00 (0 %)	.36	.34	-.02 (-6 %)	4.59	3.89	-.70 (-15 %)

	Station 22			Station 22A			Station 23			Station 24			Station 31			Station 33		
	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change
Jan	1.87	1.61	-.26 (-14 %)	.77	.68	-.09 (-12 %)	.23	.22	-0.01 (-4 %)	.11	.12	+0.01 (+9 %)	.90	.86	-0.04 (-4 %)	.43	.41	-0.02 (-5 %)
Feb	1.98	1.68	-.30 (-15 %)	.84	.72	.12 (-14 %)	.26	.23	-0.03 (-12 %)	.11	.12	+0.01 (+9 %)	.94	.87	-0.07 (-7 %)	.51	.48	-0.03 (-6 %)
Mar	1.97	1.69	-.28 (-14 %)	.77	.66	-.11 (-14 %)	.27	.24	-0.03 (-11 %)	.12	.12	0.00 (0 %)	.86	.66	-0.20 (-23 %)	.43	.39	-0.04 (-9 %)
Apr	2.32	2.05	-.27 (-12 %)	.92	.82	-.10 (-11 %)	.34	.31	-0.03 (-9 %)	.13	.13	0.00 (0 %)	.77	.68	-0.09 (-12 %)	.43	.39	-0.04 (-9 %)
May	2.69	2.39	-.30 (-11 %)	1.12	1.00	-.12 (-11 %)	.38	.35	-0.03 (-8 %)	.13	.13	0.00 (0 %)	.99	.92	-0.07 (-7 %)	.50	.46	-0.04 (-8 %)
Jun	2.97	2.67	-.30 (-10 %)	1.28	1.16	-.12 (-9 %)	.52	.48	-0.04 (-8 %)	.17	.16	-0.01 (-6 %)	1.05	.99	-0.06 (-6 %)	.58	.55	-0.03 (-5 %)
Jul	3.02	2.75	-.27 (-9 %)	1.31	1.17	-.14 (-11 %)	.52	.48	-0.04 (-8 %)	.16	.15	-0.01 (-6 %)	1.12	1.04	-0.08 (-7 %)	.61	.57	-0.04 (-7 %)
Aug	3.24	3.01	-.23 (-7 %)	1.45	1.31	-.14 (-10 %)	.61	.56	-0.05 (-8 %)	.17	.16	-0.01 (-6 %)	1.21	1.15	-0.06 (-5 %)	.64	.62	-0.02 (-3 %)
Sep	3.21	2.92	-.29 (-9 %)	1.44	1.32	-.12 (-8 %)	.58	.52	-0.06 (-10 %)	.16	.16	0.00 (0 %)	1.15	1.09	-0.06 (-5 %)	.68	.66	-0.02 (-3 %)
Oct	3.17	2.93	-.24 (-8 %)	1.46	1.28	-.18 (-12 %)	.66	.61	-0.05 (-8 %)	.23	.21	-0.02 (-9 %)	.92	.85	-0.07 (-8 %)	.63	.61	-0.02 (-3 %)
Nov	2.74	2.66	-.08 (-3 %)	1.18	1.08	-.10 (-8 %)	.48	.48	0.00 (0 %)	.17	.16	-0.01 (-6 %)	.82	.77	-0.05 (-6 %)	.59	.57	-0.02 (-3 %)
Dec	1.54	1.50	-.04 (-3 %)	.69	.72	+.03 (-4 %)	.24	.23	-0.01 (-4 %)	.12	.12	0.00 (0 %)	.74	.72	-0.02 (-3 %)	.50	.50	0.00 (0 %)

TABLE 11 (Continued)

	Station 35			Station 0		
	Base	Plan	Change	Base	Plan	Change
Jan	.39	.35	-0.04 (-10 %)	.51	.47	-0.04 (-8 %)
Feb	.55	.45	-0.10 (-18 %)	.60	.55	-0.05 (-8 %)
Mar	.49	.47	-0.02 (-4 %)	.48	.42	-0.06 (-13 %)
Apr	.47	.44	-0.03 (-6 %)	.43	.38	-0.05 (-12 %)
May	.46	.44	-0.02 (-4 %)	.46	.42	-0.04 (-9 %)
Jun	.57	.55	-0.02 (-4 %)	.55	.51	-0.04 (-7 %)
Jul	.56	.53	-0.03 (-5 %)	.60	.55	-0.05 (-8 %)
Aug	.60	.57	-0.03 (-5 %)	.62	.57	-0.05 (-8 %)
Sep	.62	.60	-0.02 (3 %)	.58	.52	-0.06 (-10 %)
Oct	.64	.62	-0.02 (-3 %)	.58	.55	-0.03 (-5 %)
Nov	.60	.58	-0.02 (-3 %)	.56	.54	-0.02 (-4 %)
Dec	.51	.46	-0.05 (-10 %)	.47	.45	-0.02 (-4 %)

TABLE 12
STOCKTON SHIP CHANNEL
SALINITY STUDY
STEADY-STATE MODEL TEST RESULTS
PLAN D-1 WITH PERIPHERAL CANAL VS. BASE WITH PERIPHERAL CANAL
AVERAGE TIDAL CYCLE SALINITIES
PARTS PER THOUSAND
(CHANGE)

Station	AVE-Plan Salinity P	AVE Base Salinity B	Change	
1	32.2	32.4	-0.2	(-1 %)
3	31.4	31.4	0.0	(0 %)
4	29.5	29.4	+0.1	(0 %)
5	28.3	28.2	+0.1	(0 %)
6	25.3	25.2	+0.1	(0 %)
7	19.9	19.9	0.0	(0 %)
9	15.6	15.6	0.0	(0 %)
9A	13.1	13.1	0.0	(0 %)
9B	12.5	12.6	-0.1	(-1 %)
9E	11.2	11.4	-0.2	(-2 %)
10	11.6	11.9	+0.3	(+3 %)
11A	9.21	9.31	-0.10	(-1 %)
13	4.25	4.50	-0.25	(-6 %)
14A	1.65	1.82	-0.17	(-10 %)
15	1.13	1.29	-0.16	(-14 %)
16	.68	.80	-0.12	(-18 %)
18	.45	.50	-0.05	(-11 %)
20C	.45	.45	0.0	(0 %)
22	2.34	2.64	-0.30	(-13 %)
22A	1.09	1.26	-0.17	(-16 %)
23	.43	.50	-0.07	(-16 %)
24	.19	.22	-0.03	(-16 %)
33	.40	.40	0.00	(0 %)
34	.38	.39	-0.01	(-3 %)
35	.41	.42	-0.01	(-2 %)
0	.45	.47	-0.02	(-4 %)

TABLE 13
STOCKTON SHIP CHANNEL
SALINITY STUDY
STEADY-STATE MODEL TEST RESULTS
PLAN D-1 WITH PERIPHERAL CANAL AND SUB. SILL
VS.
BASE WITH PERIPHERAL CANAL
AVERAGE TIDAL CYCLE SALINITIES
PARTS PER THOUSAND
(CHANGE)

Station	AVE-Plan Salinity P	AVE Base Salinity B	Change	
1	32.5	32.4	+0.1	(0 %)
3	31.4	31.4	0.0	(0 %)
4	29.6	29.4	+0.2	(+1 %)
5	28.5	28.2	+0.3	(+1 %)
6	25.3	25.2	+0.1	(0 %)
7	19.6	19.9	-0.3	(-2 %)
9	14.9	15.6	-0.7	(-5 %)
9A	12.8	13.1	-0.3	(-2 %)
9B	12.4	12.6	-0.2	(-2 %)
9E	10.9	11.4	-0.5	(-5 %)
10	11.0	11.9	-0.9	(-8 %)
11A	8.85	9.31	-0.46	(-5 %)
13	4.06	4.50	-0.44	(-11 %)
14A	1.59	1.82	-0.23	(-14 %)
15	1.09	1.28	-0.19	(-17 %)
16	.67	.80	-0.13	(-19 %)
18	.45	.50	-0.05	(-11 %)
20C	.45	.45	0.0	(0 %)
22	2.27	2.64	-0.37	(-16 %)
22A	1.07	1.26	-0.19	(-18 %)
23	.41	.50	-0.09	(-22 %)
24	.18	.22	-0.04	(-22 %)
33	.40	.40	0.00	(0 %)
34	.39	.39	0.00	(0 %)
35	.40	.42	-0.02	(-5 %)
0	.45	.47	-0.02	(-4 %)

TABLE 14
SACRAMENTO RIVER DEEP WATER SHIP CHANNEL
SALINITY STUDY
DYNAMIC MODEL TEST RESULTS
PLAN H-1 VS. BASE
1977 DROUGHT CONDITION
AVERAGE MONTLY SALINITIES
PARTS PER THOUSAND
(CHANGE)

	Station 1			Station 3			Station 4			Station 5			Station 6			Station 7		
	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change
Jan	32.5	32.3	-.2 (-1 %)	31.3	31.0	-.3 (-1 %)	29.1	29.3	+.2 (+1 %)	28.3	27.9	-0.4 (-1 %)	25.3	25.1	-0.2 (-1 %)	19.6	19.3	-0.3 (-2 %)
Feb	32.2	32.3	+.1 (0 %)	31.0	30.9	-.1 (0 %)	29.0	29.3	+.3 (+1 %)	27.9	27.7	-0.2 (-1 %)	25.0	24.9	-0.1 (-0 %)	19.4	19.0	-0.4 (-2 %)
Mar	32.1	32.3	+.2 (+1 %)	30.7	31.0	+.3 (+1 %)	29.0	29.1	+.1 (0 %)	27.7	28.0	+0.3 (+1 %)	24.8	25.0	+0.1 (+1 %)	19.3	19.1	-0.2 (-1 %)
Apr	32.1	32.4	+.3 (1 %)	31.0	31.1	+.1 (0 %)	29.0	29.2	+.2 (+1 %)	27.9	28.0	+0.1 (+0 %)	25.2	25.1	-0.1 (-0 %)	19.6	19.5	-0.1 (-0 %)
May	32.1	32.3	+.2 (+1 %)	31.0	31.1	+.1 (0 %)	29.3	29.5	+.2 (+1 %)	28.0	28.1	+0.1 (+0 %)	25.4	25.5	+0.1 (0 %)	20.0	20.0	0.0 (-0 %)
Jun	32.3	32.4	+.1 (0 %)	31.1	31.1	.0 (0 %)	29.3	29.5	+.2 (+1 %)	28.2	28.2	0.0 (0 %)	25.5	25.6	+0.1 (+1 %)	20.1	20.2	+0.1 (0 %)
Jul	32.5	32.5	0 (0 %)	31.3	31.4	+.1 (0 %)	29.7	29.5	-.2 (-1 %)	28.5	28.3	-0.2 (-1 %)	25.6	25.6	0.0 (0 %)	20.4	20.3	-0.1 (-0 %)
Aug	32.1	32.5	+.4 (+1 %)	31.1	31.4	+.3 (+1 %)	29.7	29.6	-.1 (0 %)	28.3	28.5	+0.2 (+1 %)	25.8	25.9	+0.1 (0 %)	20.6	20.7	+0.1 (+0 %)
Sep	32.4	32.5	+.1 (0 %)	31.3	31.3	0 (0 %)	29.6	29.7	+.1 (+0 %)	28.5	28.4	-0.1 (-1 %)	25.7	25.9	+0.2 (+1 %)	20.5	20.7	+0.2 (+1 %)
Oct	32.1	32.5	+.4 (1 %)	31.2	31.3	+.1 (0 %)	29.4	29.6	+.2 (+1 %)	28.4	28.4	0.0 (+0 %)	25.6	25.6	0.0 (0 %)	20.5	20.3	-0.2 (-1 %)
Nov	32.0	32.4	+.4 (+1 %)	31.0	31.3	+.3 (+1 %)	29.3	29.7	+.4 (+1 %)	28.1	28.3	+0.2 (+1 %)	25.3	25.6	+0.3 (+1 %)	20.1	20.3	+0.2 (+1 %)
Dec	32.2	32.4	+.2 (+1 %)	30.9	31.1	+.2 (+1 %)	29.0	29.2	+.2 (+1 %)	27.7	27.8	+0.1 (+1 %)	24.7	25.1	+0.4 (+2 %)	18.6	19.3	+0.7 (+4 %)

	Station 9			Station 9A			Station 9B			Station 9E			Station 9I			Station 11A		
	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change
Jan	15.8	15.0	-0.8 (-5 %)	13.1	12.9	-0.2 (-2 %)	11.8	11.4	-0.4 (-3 %)	10.5	10.0	-0.5 (-5 %)	12.2	11.9	-0.3 (-2 %)	9.06	8.75	-0.31 (-3 %)
Feb	15.4	14.9	-0.5 (-3 %)	13.0	12.6	-0.4 (-3 %)	11.9	11.6	-0.3 (-3 %)	10.5	10.0	-0.5 (-5 %)	12.1	11.8	-0.3 (-2 %)	8.97	8.64	-0.33 (-4 %)
Mar	15.2	14.9	-0.3 (-2 %)	12.9	12.5	-0.4 (-3 %)	11.8	11.4	-0.4 (-3 %)	10.4	9.9	-0.5 (-5 %)	12.0	11.7	-0.3 (-2 %)	8.97	8.80	-0.17 (-2 %)
Apr	15.7	15.3	-0.4 (-2 %)	13.4	13.0	-0.4 (-3 %)	12.0	11.7	-0.3 (-3 %)	10.8	10.3	-0.5 (-5 %)	12.4	12.2	-0.2 (-2 %)	9.26	9.12	-0.14 (-2 %)
May	16.1	16.0	-0.1 (-1 %)	13.9	13.6	-0.3 (-3 %)	12.4	12.1	-0.3 (-2 %)	11.2	10.8	-0.4 (-4 %)	13.0	12.7	-0.3 (-2 %)	9.85	9.82	-0.03 (0 %)
Jun	16.2	16.2	0.0 (+0 %)	14.2	13.8	-0.4 (-3 %)	12.7	12.4	-0.3 (-2 %)	11.7	11.3	-0.4 (-3 %)	13.3	13.1	-0.2 (-2 %)	10.1	10.1	0.0 (0 %)
Jul	16.6	16.1	-0.5 (-3 %)	14.4	13.9	-0.5 (-3 %)	13.1	12.7	-0.4 (-3 %)	12.1	11.5	-0.6 (-5 %)	13.5	13.2	-0.3 (-2 %)	10.2	10.0	-0.2 (-2 %)
Aug	16.8	16.4	-0.4 (-2 %)	14.6	14.3	-0.3 (-2 %)	13.4	13.1	-0.3 (-2 %)	12.2	11.8	-0.4 (-3 %)	13.8	13.6	-0.2 (-1 %)	10.7	10.5	-0.2 (-2 %)
Sep	16.7	16.3	-0.4 (-2 %)	14.7	14.2	-0.5 (-3 %)	13.6	13.3	-0.3 (-2 %)	12.5	11.9	-0.6 (-5 %)	13.8	13.6	-0.2 (-1 %)	10.6	10.5	-0.1 (-1 %)
Oct	16.6	16.1	-0.5 (-3 %)	14.5	13.8	-0.7 (-5 %)	13.6	13.2	-0.4 (-3 %)	12.5	11.8	-0.7 (-6 %)	13.6	13.4	-0.2 (-1 %)	10.4	10.2	-0.2 (-2 %)
Nov	16.2	16.2	0.0 (0 %)	14.0	13.8	-0.2 (-1 %)	13.5	13.2	-0.2 (-1 %)	12.1	11.6	-0.5 (-4 %)	13.3	13.2	-0.1 (-1 %)	9.79	9.77	-0.02 (0 %)
Dec	14.7	15.1	+0.4 (+3 %)	12.8	12.7	-0.1 (-1 %)	13.0	12.8	-0.2 (-2 %)	11.5	10.9	-0.6 (-5 %)	12.2	12.3	+0.1 (+1 %)	7.99	8.34	+0.35 (-4 %)

TABLE 14 (Cont'd.)

	Station 13			Station 14A			Station 15			Station 16			Station 18			Station 20C		
	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change
Jan	4.42	4.19	-0.23 (-5 %)	2.39	2.23	-0.16 (-7 %)	1.74	1.62	-0.12 (-7 %)	.70	.66	-.04 (-6 %)	.23	.23	0.00 (0 %)	.51	.40	-0.11 (-22 %)
Feb	4.26	4.01	-0.25 (-6 %)	2.27	2.13	-0.14 (-6 %)	1.66	1.54	-0.12 (-7 %)	.70	.66	-.04 (-6 %)	.26	.25	-0.01 (-4 %)	.61	.49	-0.12 (-20 %)
Mar	3.96	3.94	-0.02 (-1 %)	1.98	1.98	0.00 (0 %)	1.34	1.29	-0.05 (-3 %)	.56	.56	.00 (0 %)	.24	.24	0.00 (0 %)	.58	.48	-0.10 (-17 %)
Apr	4.23	4.16	-0.07 (-2 %)	2.10	2.08	-0.02 (-1 %)	1.36	1.32	-0.04 (-3 %)	.60	.61	+.01 (+2 %)	.26	.26	0.00 (0 %)	.48	.39	-0.09 (-19 %)
May	4.86	4.80	-0.06 (-1 %)	2.61	2.61	0.00 (0 %)	1.89	1.85	-0.04 (-2 %)	.77	.79	+.02 (+3 %)	.27	.28	+0.01 (+4 %)	.38	.35	-0.03 (-8 %)
Jun	4.93	4.92	-0.01 (0 %)	2.61	2.68	+0.07 (+3 %)	1.84	1.82	-0.02 (-1 %)	.83	.85	+.02 (+2 %)	.33	.35	+0.02 (+6 %)	.35	.33	-0.02 (-6 %)
Jul	5.12	5.09	-0.03 (-1 %)	2.74	2.74	0.00 (0 %)	1.99	1.91	-0.08 (-4 %)	.86	.88	+.02 (+2 %)	.34	.34	0.00 (0 %)	.35	.34	-0.01 (-3 %)
Aug	5.46	5.30	-0.16 (-3 %)	3.06	3.00	-0.06 (-2 %)	2.19	2.12	-0.07 (-3 %)	.93	.94	+.01 (+1 %)	.35	.36	+0.01 (+3 %)	.34	.34	0.00 (0 %)
Sep	5.36	5.34	-0.02 (0 %)	2.93	3.01	+0.08 (+3 %)	2.20	2.18	-0.02 (-1 %)	.95	.98	+.03 (+3 %)	.37	.39	+0.02 (+5 %)	.35	.35	0.00 (0 %)
Oct	5.13	4.92	-0.21 (-4 %)	2.70	2.62	-0.08 (-3 %)	1.86	1.82	-0.04 (-2 %)	.90	.92	+.02 (+2 %)	.41	.42	+0.01 (+2 %)	.37	.38	+0.01 (+2 %)
Nov	4.75	4.79	+0.04 (-1 %)	2.56	2.51	-0.05 (-2 %)	1.79	1.81	+0.02 (+1 %)	.81	.85	+.04 (+5 %)	.36	.37	+0.01 (+3 %)	.42	.42	0.00 (0 %)
Dec	3.75	4.15	+0.40 (-11 %)	2.10	2.27	+0.17 (+8 %)	1.55	1.67	+0.12 (+8 %)	.70	.77	+.07 (+10 %)	.26	.28	+0.02 (+8 %)	.36	.37	+0.01 (+2 %)

	Station 21			Station 22			Station 22A			Station 23			Station 24			Station 31		
	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change
Jan	5.54	4.59	-0.95 (-17 %)	1.87	1.86	-0.01 (-1 %)	.77	.75	-0.02 (-3 %)	.23	.26	+0.03 (+13 %)	.11	.12	+0.01 (+9 %)	.90	.85	-0.05 (-6 %)
Feb	5.82	4.54	-1.28 (-22 %)	1.98	1.89	-0.09 (-5 %)	.84	.81	-0.03 (-4 %)	.26	.29	+0.03 (+12 %)	.11	.12	+0.01 (+9 %)	.94	.85	-0.09 (-10 %)
Mar	5.36	4.61	-0.75 (-14 %)	1.97	1.99	+0.02 (+1 %)	.77	.79	+0.02 (+3 %)	.27	.30	+0.03 (+11 %)	.12	.13	+0.01 (+8 %)	.86	.71	-0.15 (-17 %)
Apr	5.88	5.01	-0.87 (-15 %)	2.32	2.30	-0.02 (-1 %)	.92	.92	0.00 (0 %)	.34	.41	+0.07 (21 %)	.13	.16	+0.03 (+23 %)	.77	.74	-0.03 (-4 %)
May	6.64	5.64	-1.00 (-15 %)	2.69	2.78	+0.09 (+3 %)	1.12	1.13	+0.01 (+1 %)	.38	.50	+0.12 (32 %)	.13	.17	+0.04 (+31 %)	.99	.98	-0.01 (-1 %)
Jun	6.90	6.13	-0.77 (-11 %)	2.97	3.08	+0.11 (+4 %)	1.28	1.33	+0.05 (+4 %)	.52	.74	+0.22 (42 %)	.17	.26	+0.09 (+53 %)	1.05	1.07	+0.02 (+2 %)
Jul	6.93	5.97	-0.96 (-13 %)	3.02	3.01	-0.01 (0 %)	1.31	1.33	+0.02 (+2 %)	.52	.69	+0.17 (33 %)	.16	.24	+0.08 (+50 %)	1.12	1.11	-0.01 (-1 %)
Aug	7.42	6.19	-1.23 (-17 %)	3.25	3.32	+0.07 (+2 %)	1.45	1.48	+0.03 (+2 %)	.61	.79	+.18 (30 %)	.17	.28	+0.11 (+65 %)	1.22	1.20	-0.02 (-2 %)
Sep	6.83	6.41	-0.42 (-6 %)	3.21	3.31	+0.10 (+3 %)	1.44	1.48	+0.04 (+3 %)	.58	.80	+0.22 (+38 %)	.17	.27	+0.10 (+59 %)	1.15	1.24	+0.09 (+8 %)
Oct	7.02	6.04	-0.98 (-14 %)	3.17	3.22	+0.05 (+2 %)	1.46	1.40	-0.06 (-4 %)	.66	.91	+0.25 (+38 %)	.23	.34	+0.11 (+48 %)	.92	.92	0.00 (0 %)
Nov	6.58	5.58	-1.00 (-15 %)	2.74	2.80	+0.06 (+2 %)	1.18	1.19	+0.01 (+1 %)	.48	.62	+0.14 (+30 %)	.17	.23	+0.06 (+35 %)	.82	.84	+0.02 (+2 %)
Dec	4.59	4.23	-0.36 (-8 %)	1.54	1.69	+0.15 (+10 %)	.69	.77	+.08 (+12 %)	.24	.32	+0.08 (+33 %)	.12	.14	+0.02 (+17 %)	.74	.79	+0.05 (+7 %)

TABLE 14 (Cont'd.)

	Station 33			Station 35			Station 0		
	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change
Jan	.43	.43	0.00 (0 %)	.39	.36	-0.03 (-8 %)	.51	.49	-0.02 (-4 %)
Feb	.51	.48	-0.03 (-6 %)	.55	.48	-0.07 (-13 %)	.60	.56	-0.04 (-7 %)
Mar	.43	.42	-0.01 (-2 %)	.49	.45	-0.04 (-8 %)	.48	.44	-0.04 (-8 %)
Apr	.43	.43 (0 %)	0.00	.47	.45 (+8 %)	-0.02	.43	.42 (-2 %)	-0.01
May	.50	.51	+0.01 (2 %)	.46	.47	+0.01 (+2 %)	.46	.45	-0.01 (-2 %)
Jun	.58	.61	+0.03 (+5 %)	.57	.57	0.00 (0 %)	.55	.56	+0.01 (+2 %)
Jul	.61	.61	0.00 (0 %)	.56	.58	+0.02 (+4 %)	.60	.60	0.00 (0 %)
Aug	.64	.66	+0.02 (+3 %)	.60	.60	0.00 (0 %)	.62	.62	0.00 (0 %)
Sep	.68	.70 (+3 %)	+0.02	.62	.63 (+2 %)	+0.01	.58	.58 (0 %)	0.00
Oct	.63	.66	+0.03 (+5 %)	.64	.66	+0.02 (+3 %)	.58	.60	+0.02 (+3 %)
Nov	.59	.61	+0.02 (+3 %)	.60	.63	+0.03 (+5 %)	.56	.59	+0.03 (+5 %)
Dec	.50	.52	+0.02 (+4 %)	.51	.48	-0.03 (+6 %)	.47	.50	+0.03 (+6 %)

TABLE 15
SACRAMENTO RIVER DEEP WATER SHIP CHANNEL
SALINITY STUDY
STEADY-STATE MODEL TEST RESULTS
PLAN H-1 VS. BASE
AVERAGE TIDAL CYCLE SALINITIES
PARTS PER THOUSAND
(CHANGE)

Station	AVE-Plan Salinity P	AVE Base Salinity B	Change	
1	32.5	32.1	+0.4	(+1 %)
3	31.6	31.2	+0.4	(+1 %)
4	29.3	29.1	+0.2	(+1 %)
5	27.9	27.8	+0.1	(+0 %)
6	24.8	24.8	0.0	(0 %)
7	19.1	19.2	-0.1	(-1 %)
9	14.1	14.8	-0.7	(-5 %)
9A	11.5	12.2	-0.7	(-6 %)
9B	11.4	11.9	-0.5	(-4 %)
9E	9.60	10.2	-0.6	(-1 %)
10	10.1	10.8	-0.7	(-7 %)
11A	7.76	8.09	-0.33	(-4 %)
13	4.08	4.45	-0.37	(-9 %)
14A	2.57	2.86	-0.29	(-11 %)
15	1.89	2.14	-0.25	(-13 %)
16	1.13	1.32	-0.19	(-17 %)
18	.33	.41	-0.08	(-24 %)
20C	.29	.31	-0.02	(-6 %)
22	1.11	1.16	-0.05	(-4 %)
22A	.98	1.11	-0.13	(-12 %)
23	.20	.15	+0.05	(+33 %)
24	.11	.10	+0.01	(+10 %)
33	.75	.89	-0.14	(-16 %)
34	.35	.42	-0.07	(-17 %)
35	.49	.51	-0.02	(-4 %)
0	.89	1.06	-0.17	(-16 %)

TABLE 16
SACRAMENTO RIVER DEEP WATER SHIP CHANNEL
SALINITY STUDY
DYNAMIC MODEL TEST RESULTS
PLAN H-1 VS. BASE
1968 CONDITION
AVERAGE MONTLY SALINITIES
PARTS PER THOUSAND
(CHANGE)

	Station 1			Station 3			Station 4			Station 5			Station 6			Station 7		
	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change
Feb	29.6	30.2	+.6 (+2 %)	26.4	26.8	+.4 (+2 %)	22.2	22.3	+.1 (0 %)	20.1	20.1	0.0 (0 %)	14.5	14.4	-0.1 (-1 %)	7.52	6.99	-0.53 (-7 %)
Mar	28.5	29.6	+1.1 (+4 %)	24.7	25.1	+.4 (+2 %)	20.7	20.7	.0 (0 %)	18.5	18.7	+0.2 (+1 %)	11.9	12.3	+0.4 (+3 %)	5.49	5.51	+0.02 (0 %)
Apr	30.0	30.7	+.7 (+2 %)	27.7	28.3	+.6 (+2 %)	23.7	24.1	+.4 (+2 %)	22.2	22.6	+0.4 (+2 %)	18.0	18.1	+0.1 (+1 %)	10.6	10.6	0.0 (0 %)
May	31.2	31.5	+.3 (+1 %)	29.4	29.7	+.3 (+1 %)	27.6	26.5	-1.1 (-4 %)	25.0	25.2	+0.2 (+1 %)	21.6	21.7	+0.1 (+0 %)	15.0	15.1	+0.1 (+1 %)
Jun	31.6	31.9	+.3 (+1 %)	29.9	30.2	+.3 (+1	27.5	27.5	.0 (0 %)	26.0	26.2	+0.2 (+1 %)	22.8	23.0	+0.2 (+1 %)	16.6	16.7	+0.1 (+1 %)
Jul	31.8	32.1	+.3 (+1 %)	30.4	30.8	+.4 (+1 %)	28.5	28.8	+.3 (+1 %)	27.0	27.2	+0.2 (+1 %)	23.9	24.4	+0.5 (+2 %)	18.4	18.5	+0.1 (+1 %)
Aug	31.6	32.0	+.4 (+1 %)	30.3	30.8	+.5 (+2 %)	28.1	28.0	-.1 (0 %)	26.7	27.1	+0.4 (+2 %)	23.5	24.0	+0.5 (+2 %)	17.5	17.9	+0.4 (+2 %)
Sep	31.6	32.0	+.4 (+1 %)	29.9	30.4	+.5 (+2 %)	27.3	27.7	+.4 (+1 %)	26.1	26.3	+0.2 (+1 %)	22.6	23.2	+0.4 (+2 %)	16.3	16.5	+0.2 (+1 %)
Oct	31.5	32.4	+.9 (+3 %)	30.0	31.3	+1.3 (+4 %)	27.6	29.2	+1.6 (+6 %)	26.2	26.7	+0.5 (+2 %)	23.1	23.6	+0.5 (+2 %)	16.8	17.1	+0.3 (+2 %)

	Station 9			Station 9A			Station 9B			Station 9E			Station 9I			Station 11A		
	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change
Feb	2.93	2.79	-0.14 (-5 %)	.65	.73	+0.08 (+12 %)	3.66	2.08	-1.58 (-43 %)	-	-	- -	-	-	- -	.27	.29	+0.02 (+7 %)
Mar	1.52	1.74	+0.22 (+14 %)	.21	.25	+0.04 (+19 %)	1.57	1.05	-0.52 (-33 %)	-	-	- -	-	-	- -	.14	.16	+0.02 (+14 %)
Apr	6.76	6.53	-0.23 (-3 %)	3.08	3.34	+0.26 (+8 %)	1.41	1.13	-0.28 (+19 %)	.59	.58	-0.01 (-2 %)	2.23	2.40	+0.17 (+8 %)	1.75	1.93	+0.18 (+10 %)
May	10.7	10.7	0.0 (0 %)	7.78	7.70	-0.08 (-1 %)	4.05	3.91	-0.14 (-3 %)	3.69	3.68	-0.01 (-.00 %)	6.49	6.65	+0.16 (+2 %)	4.50	4.76	+0.26 (+6 %)
Jun	12.7	12.5	-0.2 (-2 %)	9.67	9.57	-0.10 (-1 %)	6.15	6.25	+0.10 (+2 %)	5.91	5.90	-0.01 (-.00 %)	8.46	8.53	+0.07 (+1 %)	6.30	6.34	+0.04 (+1 %)
Jul	15.2	14.7	-0.5 (-3 %)	11.7	11.9	+0.2 (+2 %)	8.61	8.57	-0.04 (-3 %)	8.33	8.29	-0.04 (-.00 %)	10.7	10.9	+0.2 (+2 %)	8.04	8.39	+0.35 (+4 %)
Aug	13.3	13.6	+0.3 (+2 %)	10.9	11.1	+0.2 (+2 %)	9.71	9.88	+0.17 (+2 %)	8.88	8.86	-0.02 (-00 %)	10.3	10.5	+0.2 (+2 %)	6.91	7.20	+0.29 (+4 %)
Sep	12.1	12.2	+0.1 (+1 %)	9.30	9.44	+0.14 (+2 %)	9.20	9.45	+0.25 (+3 %)	7.65	7.73	+0.08 (+1 %)	8.79	9.04	+0.25 (+3 %)	5.51	5.81	+0.30 (+5 %)
Oct	12.8	12.7	-0.1 (-1 %)	9.95	9.91	-0.04 (-0 %)	8.90	9.12	+0.22 (+2 %)	7.53	7.70	+0.17 (+2 %)	9.11	9.35	+0.24 (+3 %)	6.26	6.62	+0.36 (+6 %)

TABLE 16 (cont'd)

	Station 13			Station 14A			Station 15C			Station 16			Station 18			Station 20C		
	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change
Feb	.15	.15	0.00 (0 %)	.16	.16	0.00 (0 %)	.16	.16	0.00 (0 %)	.15	.15	+.00 (0 %)	.20	.21	+0.01 (+5 %)	.40	.40	0.00 (0 %)
Mar	.13	.13	0.00 (0 %)	.13	.13	0.00 (0 %)	.13	.13	0.00 (0 %)	.12	.13	+.01 (+8 %)	.16	.17	+0.01 (+6 %)	.40	.39	-0.01 (-2 %)
Apr	.36	.38	+0.02 (+6 %)	.19	.21	+0.02 (+10 %)	.15	.16	+0.01 (+7 %)	.12	.12	.00 (0 %)	.13	.13	0.00 (0 %)	.39	.37	-0.02 (-5 %)
May	1.37	1.39	+0.02 (+1 %)	.61	.65	+0.04 (+7 %)	.42	.44	+0.02 (+5 %)	.19	.19	.00 (0 %)	.12	.12	0.00 (0 %)	.20	.22	+0.02 (+10 %)
Jun	2.47	2.50	+0.03 (+1 %)	1.17	1.21	+0.04 (+3 %)	.86	.85	-0.01 (-1 %)	.36	.35	-.01 (-3 %)	.14	.14	0.00 (0 %)	.15	.15	0.00 (0 %)
Jul	3.89	3.95	+0.06 (+2 %)	2.19	2.27	+0.08 (+4 %)	1.77	1.79	+0.02 (+1 %)	.72	.73	+.01 (+1 %)	.23	.23	0.00 (0 %)	.16	.16	0.00 (0 %)
Aug	3.01	3.08	+0.07 (+2 %)	1.63	1.66	+0.03 (+2 %)	1.27	1.24	-0.03 (-2 %)	.53	.51	-.02 (-4 %)	.21	.21	0.00 (0 %)	.21	.21	0.00 (0 %)
Sep	2.01	2.10	+0.09 (+4 %)	.95	.99	+0.04 (+4 %)	.69	.72	-0.03 (-4 %)	.30	.29	-.01 (-3 %)	.15	.15	0.00 (0 %)	.19	.19	0.00 (0 %)
Oct	2.54	2.59	+0.05 (+2 %)	1.23	1.29	+0.06 (+5 %)	.88	.89	+0.01 (+1 %)	.36	.37	+.01 (+3 %)	.15	.16	0.01 (+7 %)	.19	.18	-0.01 (-5 %)

	Station 21			Station 22A			Station 23			Station 24			Station 31			Station 33		
	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change
Feb	.12	.13	+0.01 (+8 %)	.11	.12	+0.01 (+9 %)	.11	.11	.00 (0 %)	.11	.12	.01 (0 %)	.13	.14	+0.01 (+8 %)	.35	.36	+0.01 (+3 %)
Mar	.12	.12	0.00 (0 %)	.11	.11	0.00 (0 %)	.11	.11	.00 (0 %)	.11	.11	.00 (0 %)	.12	.12	0.00 (0 %)	.24	.24	0.00 (0 %)
Apr	.43	.47	+0.04 (+9 %)	.15	.15	0.00 (0 %)	.11	.11	.00 (0 %)	.11	.11	.00 (0 %)	.11	.12	+0.01 (+9 %)	.15	.15	0.00 (0 %)
May	1.53	1.66	+0.13 (+9 %)	.33	.40	+0.07 (+21 %)	.11	.12	+.01 (+9 %)	.11	.11	.00 (0 %)	.15	.16	+0.01 (+7 %)	.14	.14	0.00 (0 %)
Jun	2.74	2.71	-0.03 (-1 %)	.80	.84	+0.04 (+5 %)	.14	.14	.00 (0 %)	.11	.11	.00 (0 %)	.32	.30	-0.02 (-6 %)	.21	.21	0.00 (0 %)
Jul	3.89	4.04	+0.15 (+4 %)	1.79	1.77	-0.02 (-1 %)	.20	.24	+.04 (+20 %)	.11	.11	.00 (0 %)	.66	.69	+0.03 (+5 %)	.45	.46	+0.01 (+2 %)
Aug	3.08	4.07	+0.99 (+32 %)	1.02	1.07	+0.05 (+5 %)	.14	.17	+.03 (+21 %)	.11	.11	.00 (0 %)	.46	.47	+0.01 (+2 %)	.44	.44	0.00 (0 %)
Sep	2.09	2.25	+0.16 (+8 %)	.56	.61	+0.05 (+9 %)	.12	.12	.00 (0 %)	.11	.11	.00 (0 %)	.24	.23	-0.01 (-4 %)	.25	.24	-0.01 (-4 %)
Oct	2.63	2.67	+0.04 (+2 %)	.77	.81	+0.04 (+5 %)	.12	.14	+.2 (0 %)	-	-	-	.30	.32	+0.02 (+7 %)	.26	.26	0.00 (0 %)

TABLE 16 (cont'd)

	Station 35			Station 0		
	Base	Plan	Change	Base	Plan	Change
Feb	.40	.40	0.00 (0 %)	.29	.30	+0.01 (+3 %)
Mar	.32	.34	+0.02 (+6 %)	.20	.20	0.0 (0 %)
Apr	.18	.20	+0.02 (+11 %)	.13	.13	0.0 (0 %)
May	.13	.14	+0.01 (+8 %)	.15	.15	0.0 (0 %)
Jun	.17	.18	+0.01 (+6 %)	.23	.24	+0.01 (+4 %)
Jul	.34	.34	0.00 (0 %)	.55	.55	0.0 (0 %)
Aug	.36	.37	+0.01 (+2 %)	.52	.51	-0.01 (-2 %)
Sep	.22	.22	0.00 (0 %)	.28	.27	-0.01 (-4 %)
Oct	.22	.22	0.00 (0 %)	.29	.31	+0.02 (+7 %)

TABLE 17
SACRAMENTO RIVER DEEP WATER SHIP CHANNEL
SALINITY STUDY
DYNAMIC MODEL TEST RESULTS
PLAN H-1 WITH SILL VS. 8ASE
1977 DROUGHT CONDITION
AVERAGE MONTLY SALINITIES
PARTS PER THOUSAND
(CHANGE)

	Station 1			Station 3			Station 4			Station 5			Station 6			Station 7		
	Base	Plan	Change	8ase	Plan	Change	Base	Plan	Change	8ase	Plan	Change	8ase	Plan	Change	8ase	Plan	Change
Jan	32.5	32.2	-.3 (-1 %)	31.3	31.2	-.1 (0 %)	29.1	29.3	+.2 (+1 %)	28.3	28.0	-0.3 (-1 %)	25.3	24.8	-0.5 (-2 %)	19.6	18.9	-0.3 (-2 %)
Feb	32.2	32.1	-.1 (0 %)	31.0	31.0	.0 (0 %)	29.0	29.0	0 (0 %)	27.9	27.6	-0.3 (-1 %)	25.0	24.5	-0.5 (-2 %)	19.4	18.8	-0.6 (-3 %)
Mar	32.1	32.2	+.1 (0 %)	30.7	31.0	+.3 (+1 %)	29.0	28.8	-.2 (-1 %)	27.7	27.7	0.0 (0 %)	24.9	24.6	-0.3 (-1 %)	19.3	18.8	-0.5 (-3 %)
Apr	32.1	32.4	+.3 (+1 %)	31.0	31.2	+.2 (+1 %)	29.0	29.2	+.2 (+1 %)	27.9	28.0	+0.1 (0 %)	25.2	24.9	-0.3 (-1 %)	19.6	19.3	-0.3 (-2 %)
May	32.1	32.4	+.3 (+1 %)	31.0	31.4	+.4 (+1 %)	29.3	29.6	+.3 (+1 %)	28.0	28.3	+0.3 (+1 %)	25.4	25.4	0.0 (0 %)	20.0	20.0	0.0 (0 %)
Jun	32.3	32.4	+.1 (0 %)	31.1	31.2	+.1 (0 %)	29.3	29.4	+.1 (0 %)	28.2	28.3	+0.1 (0 %)	25.5	25.4	-0.1 (0 %)	20.1	20.0	-0.1 (0 %)
Jul	32.5	32.5	.0 (0 %)	31.3	31.3	+.0 (0 %)	29.7	29.7	+.0 (0 %)	28.5	28.5	0.0 (0 %)	25.6	25.6	0.0 (0 %)	20.4	20.4	0.0 (0 %)
Aug	32.1	32.6	+.5 (+2 %)	31.1	31.4	+.3 (+1 %)	29.7	29.9	+.2 (+1 %)	28.3	28.7	+0.40 (+1 %)	25.8	25.8	0.0 (%)	20.6	20.6	0.0 (0 %)
Sep	32.4	32.4	.0 (0 %)	31.3	31.2	-.1 (0 %)	29.6	29.5	-.1 (0 %)	28.5	28.4	-0.1 (0 %)	25.7	25.6	-0.1 (0 %)	20.5	20.5	0.0 (0 %)
Oct	32.1	32.6	+.5 (+2 %)	31.2	31.3	+.1 (0 %)	29.4	29.7	+.3 (+1 %)	28.4	28.6	+0.2 (+1 %)	25.6	25.6	0.0 (0 %)	20.5	20.2	-0.3 (-1 %)
Nov	32.0	32.5	+.5 (+2 %)	31.0	31.3	+.3 (+1 %)	29.3	29.7	+.4 (+1 %)	28.1	28.5	+0.4	25.3	25.7	+0.4 (2 %)	20.1	20.0	-0.1 (0 %)
Dec	32.2	32.4	+.2 (+1 %)	30.9	31.2	+.3 (+1 %)	29.0	29.1	+.1 (0 %)	27.7	28.0	+0.3	24.7	24.7	0.0 (0 %)	18.6	19.0	+0.4 (+2 %)

	Station 9			Station 9A			Station 98			Station 9E			Station 9I			Station 11A		
	Base	Plan	Change	8ase	Plan	Change	8ase	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change
Jan	15.8	14.6	-1.2 (-8 %)	13.1	12.0	-1.1 (-8 %)	11.8	10.9	-0.9 (-8 %)	-	-	- -	-	-	- -	9.06	8.30	-0.76 (-8 %)
Feb	15.4	14.3	-1.1 (-7 %)	13.0	11.8	-1.2 (-9 %)	11.9	10.9	-1.0 (-1 %)	-	-	- -	-	-	- -	8.97	8.29	-0.68 (-6 %)
Mar	15.2	14.4	-0.8 (-5 %)	12.9	11.9	-1.0 (-8 %)	11.8	10.9	-0.9 (-8 %)	10.4	9.45	-0.95 (-9 %)	12.0	11.2	-0.8 (-7 %)	8.97	8.38	-0.59 (-7 %)
Apr	15.7	14.9	-0.8 (-5 %)	13.4	12.5	-0.9 (-7 %)	12.1	11.1	-1.0 (-1 %)	10.8	9.81	-0.99 (-9 %)	12.4	11.7	-0.7	9.26	8.79	-0.47 (-5 %)
May	16.1	15.4	-0.7 (-4 %)	13.9	13.1	-0.8 (-6 %)	12.4	11.6	-0.8 (-6 %)	11.2	10.3	-0.9 (-8 %)	13.0	12.3	-0.7	9.85	9.52	-0.33 (-3 %)
Jun	16.2	15.8	-0.4 (-2 %)	14.2	13.4	-0.8 (-6 %)	12.7	12.0	-0.7 (-6 %)	11.7	10.9	-0.8 (-7 %)	13.3	12.7	-0.6	10.1	9.86	-0.24 (-2 %)
Jul	16.6	16.0	-0.6 (-4 %)	14.4	13.6	-0.8 (-6 %)	13.1	12.4	-0.7 (-5 %)	12.1	11.1	-1.0 (-1 %)	13.5	12.9	-0.6	10.2	9.92	-0.28 (-3 %)
Aug	16.8	16.2	-0.6 (-4 %)	14.7	13.9	-0.8 (-5 %)	13.5	12.6	-0.9 (-7 %)	12.3	11.3	-1.0 (-1 %)	13.8	13.2	-0.6	10.7	10.2	-0.5 (-5 %)
Sep	16.7	16.0	-0.7 (-4 %)	14.7	13.8	-0.9 (-6 %)	13.6	12.8	-0.8 (-6 %)	12.5	11.5	-1.0 (-1 %)	13.9	13.2	-0.7	10.6	10.1	-0.5 (-5 %)
Oct	16.6	15.8	-0.8 (-5 %)	14.5	13.6	-0.9 (-6 %)	13.6	12.8	-0.8 (-6 %)	12.5	11.5	-1.0 (-1 %)	13.6	13.0	-0.6	10.4	9.90	-0.50 (-5 %)
Nov	16.2	15.6	-0.6 (-4 %)	14.0	13.5	-0.5 (-4 %)	13.5	12.8	-0.7 (-5 %)	12.1	11.3	-0.8 (-7 %)	13.3	12.8	-0.5	9.79	8.73	-1.06 (-11 %)
Dec	14.7	14.4	-0.3 (-2 %)	12.8	12.3	-0.5 (-4 %)	13.1	12.4	-0.7 (-5 %)	11.5	10.6	-0.9 (-8 %)	12.3	11.9	-0.4	7.99	7.80	-0.19 (-2 %)

TABLE 17 (cont'd)

	Station 13			Station 14A			Station 15			Station 16			Station 18			Station 20C		
	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change
Jan	4.42	3.89	-0.53 (-12 %)	2.39	2.00	-0.39 (-16 %)	1.74	1.41	-0.33 (-19 %)	.70	.58	-.12 (-17 %)	.23	.21	-0.02 (-9 %)	.51	.49	-0.02 (-4 %)
Feb	4.26	3.63	-0.63 (-15 %)	2.27	1.86	-0.41 (-18 %)	1.67	1.34	-0.33 (-20 %)	.70	.57	-.13 (-19 %)	.26	.23	-0.03 (-12 %)	.61	.57	-0.04 (-7 %)
Mar	3.96	3.62	0.34 (-9 %)	1.98	1.78	-0.20 (-10 %)	1.34	1.16	-0.18 (-13 %)	.56	.50	-.06 (-11 %)	.24	.23	-0.01 (-4 %)	.58	.44	-0.14 (-24 %)
Apr	4.23	3.94	-0.29 (-7 %)	2.10	1.89	-0.21 (-10 %)	1.36	1.22	-0.14 (-10 %)	.60	.56	-.04 (-7 %)	.26	.25	-0.01 (-4 %)	.48	.34	-0.14 (-29 %)
May	4.86	4.56	-0.30 (-6 %)	2.61	2.46	-0.15 (-6 %)	1.89	1.75	-0.14 (-7 %)	.77	.73	-.04 (-5 %)	.27	.26	-0.01 (-4 %)	.38	.33	0.05 (-13 %)
Jun	4.93	4.79	-0.14 (-3 %)	2.61	2.52	-0.09 (-3 %)	1.84	1.74	-0.10 (-5 %)	.83	.81	-.02 (-2 %)	.33	.33	0.00 (0 %)	.35	.31	-0.04 (-11 %)
Jul	5.12	4.95	-0.17 (-3 %)	2.74	2.65	-0.09 (-3 %)	1.99	1.84	-0.15 (-8 %)	.86	.85	-.01 (0 %)	.34	.33	-0.01 (-3 %)	.35	.32	-0.03 (-9 %)
Aug	5.46	5.20	-0.26 (-5 %)	3.05	2.86	-0.19 (-6 %)	2.19	2.01	-0.18 (-8 %)	.93	.89	-.04 (-4 %)	.35	.34	-0.01 (-3 %)	.34	.32	-0.02 (-6 %)
Sep	5.37	5.29	-0.08 (-1 %)	2.93	2.84	-0.09 (-3 %)	2.20	2.16	-0.04 (-2 %)	.95	.94	-.01 (0 %)	.37	.36	-0.01 (-3 %)	.35	.34	-0.01 (-3 %)
Oct	5.13	4.80	-0.33 (-6 %)	2.70	2.51	-0.21 (-8 %)	1.86	1.74	-0.12 (-6 %)	.90	.88	-.02 (-2 %)	.41	.41	0.00 (0 %)	.37	.36	-0.01 (-3 %)
Nov	4.75	4.51	-0.24 (-5 %)	2.56	2.34	-0.22 (-9 %)	1.79	1.56	-0.23 (-13 %)	.81	.80	-.01 (0 %)	.36	.31	-0.05 (-14 %)	.42	.39	-0.03 (-7 %)
Dec	3.75	3.91	+0.16 (-4 %)	2.10	2.04	-0.06 (-3 %)	1.55	1.21	-0.34 (-22 %)	.70	.70	.00 (0 %)	.26	.26	0.00 (0 %)	.36	.36	0.00 (0 %)

	Station 21			Station 22			Station 22A			Station 23			Station 24			Station 31		
	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change
Jan	5.53	4.17	-1.36 (-25 %)	1.87	1.64	-0.23 (-12 %)	.77	.68	-0.09 (-12 %)	.23	.23	0.00 (0 %)	.11	.12	+0.01 (+9 %)	.90	.76	-0.14 (-16 %)
Feb	5.82	4.23	-1.59 (-27 %)	1.98	1.67	-0.31 (-16 %)	.84	.68	-0.16 (-19 %)	.26	.24	-0.02 (8 %)	.11	.12	+0.01 (+9 %)	.94	.75	-0.19 (-20 %)
Mar	5.36	4.35	-1.01 (-19 %)	1.97	1.80	-0.17 (-9 %)	.77	.70	-0.07 (-9 %)	.27	.27	0.00 (0 %)	.12	.13	+0.01 (+8 %)	.86	.64	-0.22 (-26 %)
Apr	5.88	4.75	-1.13 (-19 %)	2.32	2.20	-0.12 (-5 %)	.92	.87	-0.05 (-5 %)	.34	.39	+0.05 (+15 %)	.13	.16	+0.03 (+23 %)	.77	.71	-0.06 (-8 %)
May	6.64	5.37	-1.27 (-19 %)	2.89	2.57	-0.32 (-11 %)	1.12	1.05	-0.07 (-6 %)	.38	.46	+0.08 (+21 %)	.13	.16	+0.03 (+23 %)	0.99	.95	-0.04 (-4 %)
Jun	6.90	5.84	-1.06 (-15 %)	2.97	2.92	-0.05 (-2 %)	1.28	1.23	-0.05 (-4 %)	.52	.68	+0.16 (+31 %)	.17	.24	+0.07 (+41 %)	1.05	1.02	-0.03 (-3 %)
Jul	6.93	5.79	-1.14 (-17 %)	3.02	2.90	-0.12 (-4 %)	1.31	1.28	-0.03 (-2 %)	.52	.68	+0.16 (+31 %)	.16	.23	+0.07 (44 %)	1.12	1.08	-0.04 (-4 %)
Aug	7.42	6.19	-1.23 (-17 %)	3.25	3.20	-0.05 (-2 %)	1.45	1.37	-0.08 (-5 %)	.61	.78	+0.17 (+28 %)	.17	.26	0.09 (+53 %)	1.22	1.27	-0.05 (-4 %)
Sep	6.83	6.0	-0.77 (-11 %)	3.21	3.13	-0.08 (-2 %)	1.44	1.40	-0.04 (-3 %)	.58	.75	+0.17 (+29 %)	.16	.25	+0.09 (+56 %)	1.25	1.13	-0.12 (-10 %)
Oct	7.02	5.93	-1.09 (-15 %)	3.17	3.10	-0.07 (-2 %)	1.46	1.37	-0.09 (-6 %)	.66	.83	+0.17 (+26 %)	.23	.33	+0.10 (+43 %)	.92	.88	-0.04 (-4 %)
Nov	6.58	4.73	-1.85 (-28 %)	2.74	2.41	-0.33 (-12 %)	1.18	1.13	-0.05 (-4 %)	.48	.60	+0.12 (+25 %)	.17	.23	+0.06 (+35 %)	.82	.79	-0.03 (-4 %)
Dec	4.59	3.92	-0.67 (-15 %)	1.54	1.87	+0.33 (-21 %)	.69	.71	+0.02 (-3 %)	.24	.28	+0.04 (+17 %)	.12	.14	+0.02 (+17 %)	.74	.73	-0.01 (-1 %)

TABLE 17 (cont'd)

	Station 33			Station 35			Station 0		
	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change
Jan	.43	.39	-0.04 (-9 %)	.39	.34	-0.05 (-13 %)	.51	.45	-0.06 (-12 %)
Feb	.51	.42	-0.09 (-18 %)	.55	.43	-0.12 (-22 %)	.60	.48	-0.12 (-20 %)
Mar	.43	.39	-0.04 (-9 %)	.49	.41	-0.08 (-16 %)	.48	.41	-0.07 (-15 %)
Apr	.43	.41	-0.02 (-5 %)	.47	.44	-0.03 (-6 %)	.43	.39	-0.04 (-9 %)
May	.50	.47	-0.04 (-8 %)	.46	.44	-0.02 (-4 %)	.46	.44	-0.02 (-4 %)
Jun	.58	.56	-0.02 (-3 %)	.57	.54	-0.03 (-5 %)	.55	.55	0.00 (0 %)
Jul	.61	.59	-0.02 (-3 %)	.56	.55	-0.01 (-2 %)	.60	.57	-0.03 (-5 %)
Aug	.64	.63	-0.01 (-2 %)	.60	.57	-0.03 (-5 %)	.62	.62	0.00 (0 %)
Sep	.68	.67	-0.01 (-1 %)	.62	.61	-0.01 (-2 %)	.58	.62	+0.04 (-7 %)
Oct	.63	.61	-0.02 (-3 %)	.64	.63	-0.01 (-2 %)	.58	.58	0.00 (0 %)
Nov	.59	.58	-0.01 (-2 %)	.60	.59	-0.01 (-2 %)	.56	.56	0.00 (0 %)
Dec	.50	.48	-0.02 (-4 %)	.51	.44	-0.07 (-14 %)	.47	.49	+0.02 (4 %)

TABLE 18
SACRAMENTO RIVER DEEP WATER SHIP CHANNEL
SALINITY STUDY
DYNAMIC MODEL TEST RESULTS
PLAN H-1 WITH SILL VS BASE
1968 CONDITION
AVERAGE MONTHLY SALINITIES
PARTS PER THOUSAND
(CHANGE)

	Station 1			Station 3			Station 4			Station 5			Station 6			Station 7		
	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change
Feb	29.6	30.2	+.6 (+2 %)	26.4	26.6	+.2 (+1 %)	22.2	22.1	-.1 (0 %)	20.1	20.2	+0.2 (+1 %)	14.5	15.1	+0.6 (+4 %)	7.52	6.57	+0.95 (+13 %)
Mar	28.5	29.6	+1.1 (+4 %)	24.7	24.6	+.1 (0 %)	20.7	20.5	-.2 (-1 %)	18.5	18.2	-0.3 (-2 %)	11.9	11.5	-0.4 (-3 %)	5.49	4.81	-0.68 (-12 %)
Apr	30.0	30.6	+.6 (+2 %)	27.7	28.0	+.3 (+1 %)	23.7	23.8	+.1 (0 %)	22.2	22.4	+0.4 (+2 %)	18.0	17.2	-0.8 (-4 %)	10.6	10.5	-0.1 (-1 %)
May	31.2	31.5	+.3 (+1 %)	29.4	29.6	+.2 (+1 %)	27.1	26.6	-1.0 (0 %)	25.0	25.1	+0.1 (0 %)	21.6	21.4	-0.2 (-1 %)	15.0	14.6	-0.4 (-3 %)
Jun	31.6	31.9	+.3 (+1 %)	29.9	30.3	+.4 (+1 %)	27.5	27.6	+.1 (0 %)	26.0	26.3	+0.3 (+1 %)	22.8	22.9	+0.1 (0 %)	16.6	16.5	-0.1 (-1 %)
Jul	31.8	32.2	+.4 (+1 %)	30.4	30.8	+.4 (+1 %)	28.5	28.5	.0 (0 %)	27.0	27.3	+0.3 (+1 %)	23.9	24.2	+0.3 (+1 %)	18.4	18.3	-0.1 (-1 %)
Aug	31.6	32.1	+.5 (+2 %)	30.3	30.7	+.4 (+1 %)	28.1	28.3	+.2 (+1 %)	26.7	27.1	+0.4 (+1 %)	23.5	23.7	+0.2 (+1 %)	17.5	17.5	0.0 (0 %)
Sep	31.6	31.5	-.1 (0 %)	29.9	30.4	+.5 (+2 %)	27.3	27.6	+.3 (+1 %)	26.1	26.4	+0.3 (+1 %)	22.6	22.9	+0.3 (+1 %)	16.3	16.3	0.0 (0 %)
Oct	31.5	32.0	+.5 (+2 %)	30.0	30.5	+.5 (+2 %)	27.6	28.1	+.5 (+2 %)	26.2	26.7	+0.5 (+2 %)	23.1	23.2	+0.1 (0 %)	16.8	16.9	+0.1 (+1 %)

	Station 9			Station 9A			Station 9B			Station 9E			Station 9I			Station 11A		
	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change
Feb	2.93	2.42	-0.51 (-17 %)	.64	.60	-0.04 (-6 %)	3.68	3.45	-0.23 (-6 %)	1.33	.98	-0.35 (-26 %)	1.13	.95	-0.18 (-16 %)	.26	.26	0.00 (0 %)
Mar	1.52	1.12	-0.40 (-26 %)	.21	.20	-0.01 (-5 %)	1.57	1.55	-0.02 (-1 %)	.17	.15	-0.02 (-12 %)	.27	.23	-0.04 (-15 %)	.14	.14	0.00 (0 %)
Apr	6.76	5.98	-0.78 (-12 %)	3.08	2.81	-0.27 (-9 %)	1.41	1.26	-0.15 (-11 %)	.59	.50	-0.09 (-10 %)	2.23	2.05	-0.18 (-8 %)	1.75	1.59	-0.16 (-9 %)
May	10.7	9.93	-0.77 (-7 %)	7.78	7.70	-0.08 (-1 %)	4.05	3.60	-0.45 (-11 %)	3.69	3.20	-0.49 (-13 %)	6.49	6.04	-0.45 (-7 %)	4.50	4.07	-0.43 (-10 %)
Jun	12.7	12.0	-0.70 (-6 %)	9.67	9.16	-0.51 (-5 %)	6.15	5.66	-0.49 (-8 %)	5.91	5.31	-0.60 (-10 %)	8.56	7.98	-0.48 (-6 %)	6.30	5.88	-0.42 (-7 %)
Jul	15.2	13.8	-1.4 (-9 %)	11.7	11.4	-0.30 (-3 %)	8.61	8.11	-0.50 (-6 %)	8.33	7.76	-0.57 (-7 %)	10.7	10.3	-0.40 (-4 %)	8.04	7.82	-0.22 (-3 %)
Aug	13.3	12.9	-0.40 (-3 %)	10.9	10.5	-0.40 (37 %)	9.71	9.27	-0.44 (-5 %)	8.88	8.22	-0.66 (-7 %)	10.28	9.91	-0.37 (-4 %)	6.91	6.66	-0.25 (-4 %)
Sep	12.1	11.8	-0.30 (-3 %)	9.30	8.92	-0.38 (-4 %)	9.20	8.85	-0.45 (-5 %)	7.65	7.20	-0.45 (-6 %)	8.79	8.43	-0.36 (-4 %)	5.51	5.28	-0.23 (-4 %)
Oct	12.8	12.2	-0.60 (-5 %)	9.95	9.50	-0.45 (-5 %)	8.90	8.57	-0.33 (-4 %)	7.53	7.09	-0.44 (-6 %)	9.11	8.85	-0.26 (-3 %)	6.26	6.28	+0.02 (0 %)

TABLE 18 (cont'd)

	Station 13			Station 14A			Station 15			Station 16			Station 18			Station 20C		
	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change
Feb	.14	.14	0.00 (0 %)	.16	.15	−0.01 (−6 %)	.16	.15	−0.01 (−6 %)	.15	.14	−.01 (−1 %)	.20	.20	0.00 (0 %)	.40	.40	0.00 (0 %)
Mar	.13	.13	0.00 (0 %)	.13	.13	0.00 (0 %)	.13	.13	0.00 (0 %)	.12	.13	+.01 (+8 %)	.16	.16	0.00 (0 %)	.40	.40	0.00 (0 %)
Apr	.36	.34	−0.02 (−6 %)	.19	.19	0.00 (0 %)	.15	.15	0.00 (0 %)	.12	.12	.00 (0 %)	.13	.13	0.00 (0 %)	.39	.38	−0.01 (−3 %)
May	1.37	1.17	−0.20 (−15 %)	.61	.55	−0.06 (−10 %)	.42	.38	−0.04 (−10 %)	.19	.17	−.02 (− 5 %)	.12	.12	0.00 (0 %)	.22	.22	0.00 (0 %)
Jun	2.47	2.25	−0.22 (−9 %)	1.17	1.09	−0.10 (−9 %)	.86	.74	−0.12 (−14 %)	.36	.30	−.06 (−17 %)	.14	.14	0.00 (0 %)	.15	.14	−0.01 (−7 %)
Jul	3.89	3.66	−0.23 (−6 %)	2.29	2.06	−0.10 (−4 %)	1.77	1.60	−0.20 (−11 %)	.72	.65	−.07 (−10 %)	.23	.21	−0.02 (−9 %)	.16	.16	0.00 (0 %)
Aug	3.01	2.79	−0.22 (−7 %)	1.63	1.46	−0.20 (−12 %)	1.27	1.10	−0.20 (−16 %)	.53	.46	−.07 (−13 %)	.21	.19	−0.02 (−10 %)	.21	.19	−0.02 (−10 %)
Sep	2.01	1.83	−0.18 (−9 %)	.95	.86	−0.09 (−9 %)	.69	.62	−0.07 (−10 %)	.30	.25	−.05 (−17 %)	.15	.14	−0.01 (−7 %)	.18	.18	0.00 (−0 %)
Oct	2.54	2.38	−0.16 (−6 %)	1.23	1.13	−0.10 (−8 %)	.88	.78	−0.10 (−11 %)	.36	.31	−.05 (−14 %)	.15	.14	−0.01 (−7 %)	.19	.19	0.00 (0 %)

	Station 21			Station 22			Station 22A			Station 23			Station 24			Station 33		
	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change	Base	Plan	Change
Feb	.12	.12	0.00 (0 %)	.11	.11	0.00 (0 %)	.13	.13	0.00 (0 %)	.11	.11	.00 (0 %)	.11	.11	.00 (0 %)	.35	.34	−0.01 (−3 %)
Mar	.12	.12	0.00 (0 %)	.11	.11	0.00 (0 %)	.12	.12	0.00 (0 %)	.11	.11	.00 (0 %)	.11	.11	.00 (0 %)	.24	.23	−0.01 (−4 %)
Apr	.43	.40	−0.03 (−7 %)	.15	.14	−0.01 (−7 %)	.11	.12	+0.01 (+9 %)	.11	.11	.00 (0 %)	.11	.11	.00 (0 %)	.15	.14	−0.01 (−7 %)
May	1.53	1.36	−0.17 (−11 %)	.33	.32	−0.01 (−3 %)	.15	.15	0.00 (0 %)	.11	.11	.00 (0 %)	.11	.11	.00 (0 %)	.14	.14	0.00 (0 %)
Jun	2.74	2.36	−0.38 (−14 %)	.89	.71	−0.02 (−2 %)	.32	.27	0.00 (0 %)	.14	.13	−.01 (−7 %)	.11	.11	.00 (0 %)	.21	.19	−0.02 (−10 %)
Jul	3.89	3.67	−0.22 (−6 %)	1.79	1.56	−0.23 (−13 %)	.66	.60	−0.06 (−9 %)	.20	.20	.00 (0 %)	.11	.11	.00 (0 %)	.45	.41	−0.04 (−9 %)
Aug	3.08	2.87	−0.21 (−7 %)	1.02	.91	−0.11 (−11 %)	.46	.40	−0.06 (−13 %)	.14	.15	+.01 (+7 %)	.11	.11	.00 (0 %)	.44	.41	−0.03 (−7 %)
Sep	2.09	2.03	−0.06 (−3 %)	.56	.51	−0.05 (−9 %)	.24	.23	−0.01 (−4 %)	.12	.12	.00 (0 %)	.11	.11	.00 (%)	.25	.22	−0.03 (−12 %)
Oct	2.63	2.40	−0.23 (−9 %)	.77	.71	−0.06 (−8 %)	.30	.27	−0.03 (−10 %)	.12	.13	+.01 (8 %)	−	−	− (%)	.26	.24	−0.02 (−8 %)

TABLE 18 (cont'd)

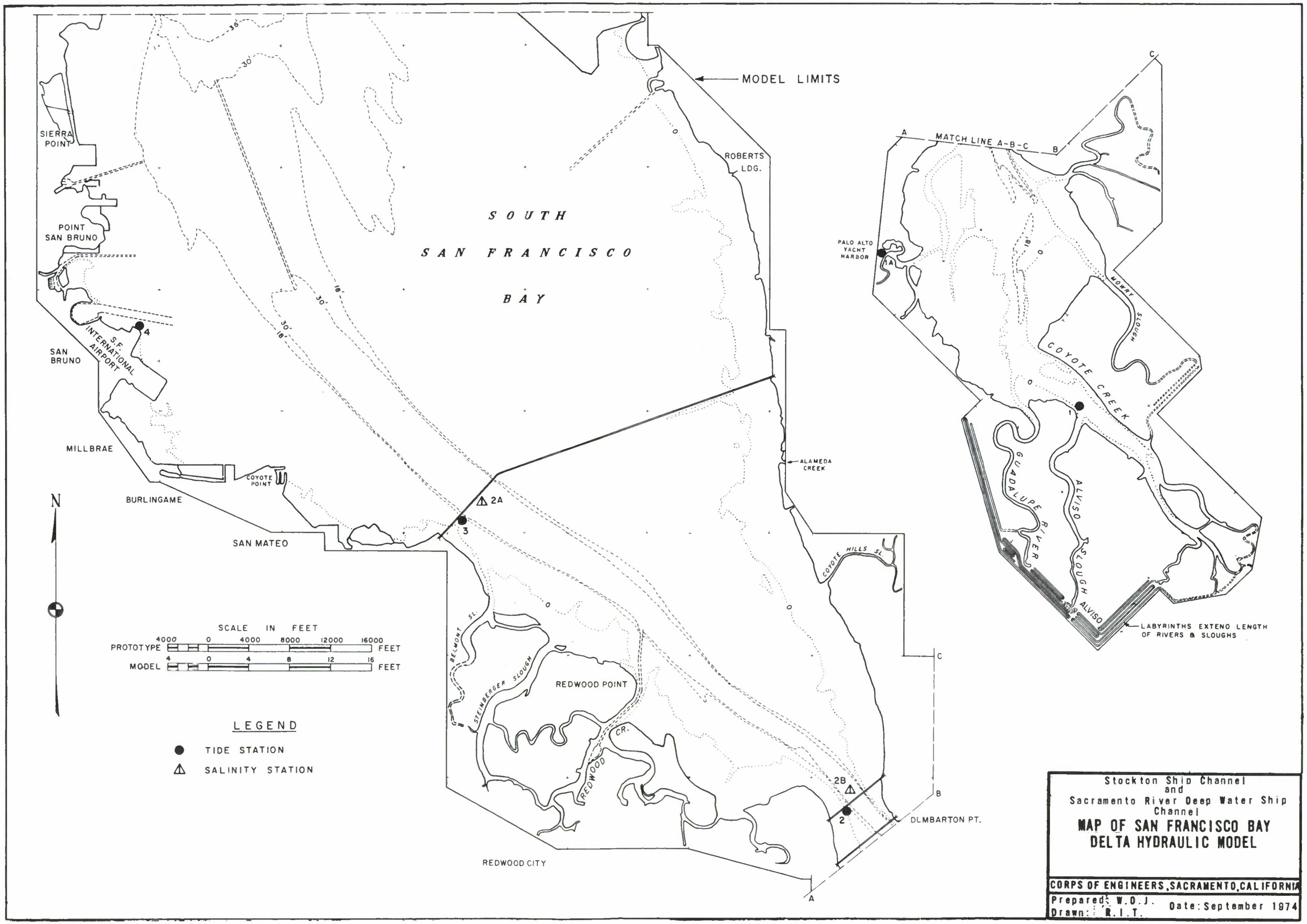
	Station 35			Station 0		
	Base	Plan	Change	Base	Plan	Change
Feb	.40	.39	-0.01 (-3 %)	.29	.27	-0.02 (-7 %)
Mar	.32	.33	+0.01 (-3 %)	.20	.19	-0.01 (-5 %)
Apr	.18	.20	+0.02 (-11 %)	.13	.13	0.00 (0 %)
May	.13	.13	0.00 (0 %)	.14	.14	0.00 (0 %)
Jun	.17	.16	-0.01 (-6 %)	.23	.21	-0.02 (-9 %)
Jul	.34	.31	-0.03 (-9 %)	.55	.50	-0.05 (-9 %)
Aug	.36	.32	-0.04 (-11 %)	.52	.46	-0.06 (-12 %)
Sep	.22	.20	-0.02 (-9 %)	.28	.25	-0.03 (-11 %)
Oct	.22	.21	-0.01 (-5 %)	.29	.28	-0.01 (-3 %)

TABLE 19
SACRAMENTO RIVER DEEP WATER SHIP CHANNEL
SALINITY STUDY
STEADY-STATE MODEL TEST RESULTS
PLAN H-1 WITH PERIPHERAL CANAL VS. BASE WITH PERIPHERAL CANAL
AVERAGE TIDAL CYCLE SALINITY
PARTS PER THOUSAND
(CHANGE)

Station	AVE-Plan Salinity P	AVE Base Salinity B	Change	
1	32.6	32.4	+0.20	(+1 %)
3	31.8	31.4	+0.40	(+1 %)
4	29.4	29.4	0.0	(0 %)
5	28.3	28.1	+0.20	(+1 %)
6	25.3	25.2	+0.10	(0 %)
7	20.1	19.9	+0.20	(-1 %)
9	15.4	15.1	-0.20	(-1 %)
9A	12.9	13.1	-0.20	(-2 %)
9B	12.4	12.6	-0.20	(-2 %)
9E	11.1	11.4	-0.30	(-3 %)
10	11.6	11.9	-0.30	(-3 %)
11A	9.31	9.30	+0.01	(0 %)
13	4.42	4.50	-0.08	(-2 %)
14A	1.82	1.82	0.0	(0 %)
15	1.28	1.29	-0.01	(-1 %
16	.82	.80	+0.02	(+2 %)
18	.51	.49	+0.02	(+4 %)
20C	.41	.45	+0.01	(+2 %)
22	2.69	2.64	+.05	(+2 %)
22A	1.29	1.26	+0.03	(+2 %)
23	.68	.50	+0.18	(26 %)
24	.30	.22	+0.08	(27 %)
33	.41	.40	+0.01	(+2 %)
34	.40	.39	+0.01	(+3 %)
35	.43	.41	+0.02	(+5 %)
0	.49	.47	+0.02	(+4 %)

TABLE 20
SACRAMENTO RIVER DEEP WATER SHIP CHANNEL
SALINITY STUDY
STEADY-STATE MODEL TEST RESULTS
PLAN H-1 WITH PERIPHERAL CANNAL AND SUB. SILL
VS.
BASE WITH PERIPHERAL CANAL
AVERAGE TIDAL CYCLE SALINITY
PARTS PER THOUSAND
(CHANGE)

Station	AVE-Plan Salinity P	AVE Base Salinity B	Change	
1	32.4	32.4	0.0	(0 %)
3	31.6	31.4	+0.2	(+1 %)
4	29.5	29.5	0.0	(0 %)
5	28.4	28.1	+0.3	(+1 %)
6	25.4	25.2	+0.2	(+1 %)
7	19.7	19.9	-0.2	(-1 %)
9	14.9	15.6	-0.7	(-5 %)
9A	12.6	13.1	-0.5	(-4 %)
9B	12.2	12.6	-0.4	(-3 %)
9E	10.6	11.4	-0.8	(-8 %)
10	11.2	11.9	-0.7	(-6 %)
11A	8.98	9.30	-0.32	(-4 %)
13	4.28	4.50	-0.22	(-5 %)
14A	1.72	1.82	-0.10	(-6 %)
15	1.23	1.28	-0.05	(-4 %)
16	.79	.80	-0.01	(-1 %)
18	.50	.50	0.00	(0 %)
20C	.46	.45	+0.01	(+2 %)
22	2.56	2.64	-0.08	(-3 %)
22A	1.22	1.26	-0.04	(-3 %)
23	.66	.50	+0.16	(+24 %)
24	.29	.22	+0.07	(+24 %)
33	.41	.40	+0.01	(+2 %)
34	.41	.39	+0.02	(+5 %)
35	.43	.42	-0.01	(-2 %)
0	.49	.47	+0.02	(+4 %)



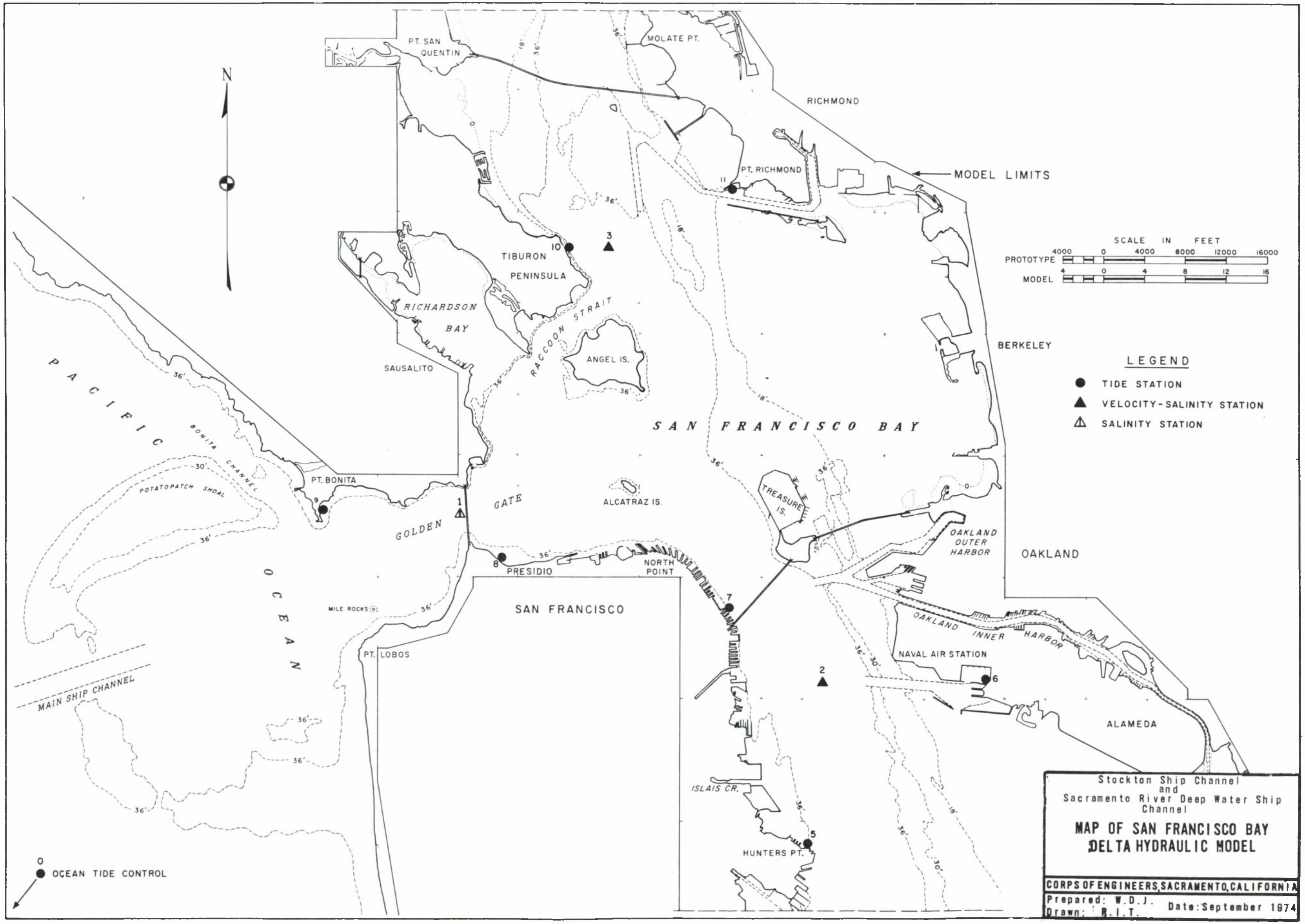
Stockton Ship Channel
and
Sacramento River Deep Water Ship Channel

MAP OF SAN FRANCISCO BAY
DELTA HYDRAULIC MODEL

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

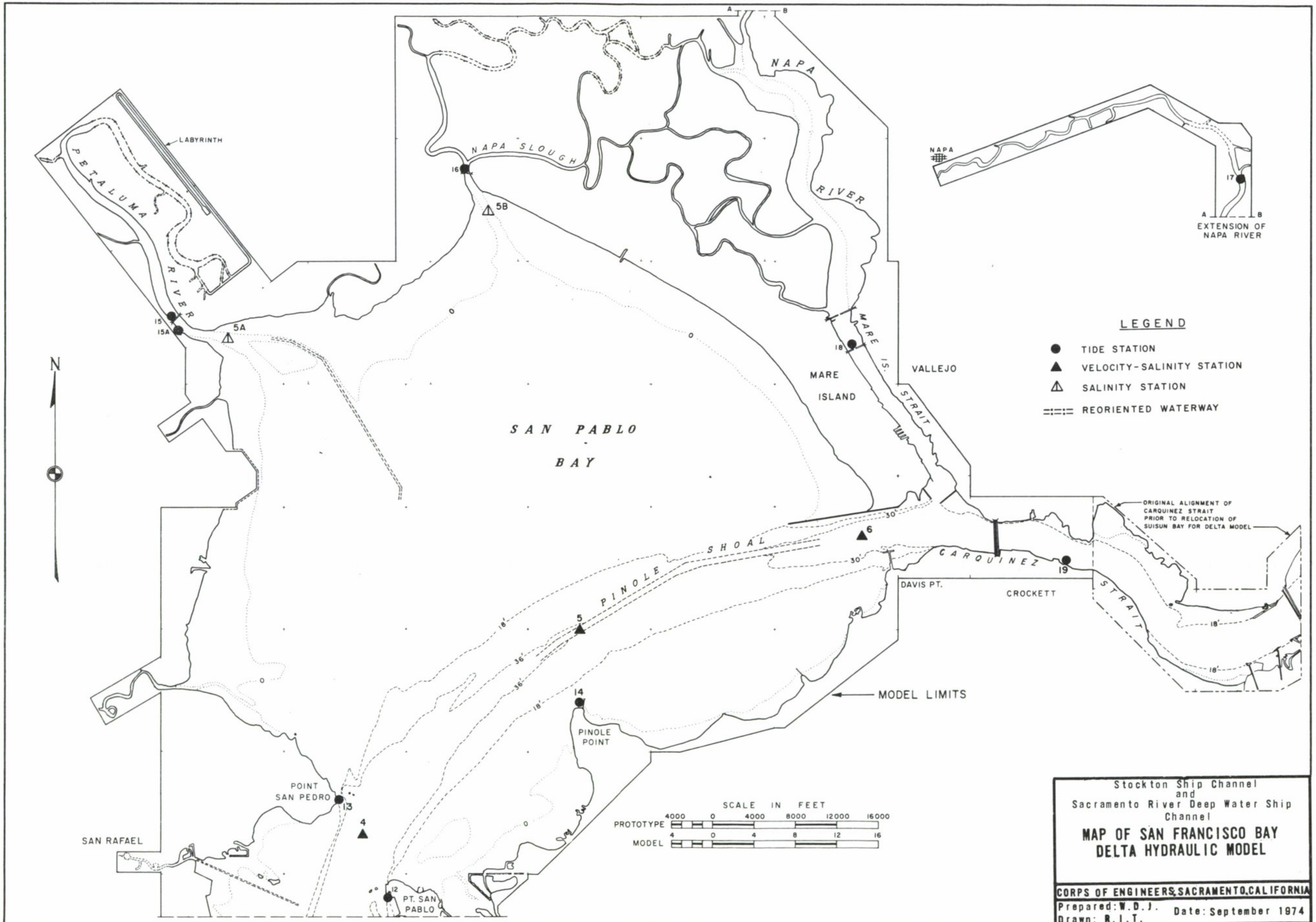
Prepared: W.O.J. Drawn: R.I.T. Date: September 1974

CHART 1



Stockton Ship Channel
and
Sacramento River Deep Water Ship Channel
MAP OF SAN FRANCISCO BAY
DELTA HYDRAULIC MODEL
CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA
Prepared: W.D.J.
Drawn: R.I.T.
Date: September 1974
LEGEND
TIDE STATION
VELOCITY-SALINITY STATION
SALINITY STATION
SCALE IN FEET
PROTOTYPE 4000 0 4000 8000 12000 16000
MODEL 4 0 4 8 12 16
MODEL LIMITS
N
PT. SAN QUENTIN
MOLATE PT.
RICHMOND
PT. RICHMOND
BERKELEY
OAKLAND
OAKLAND OUTER HARBOR
OAKLAND INNER HARBOR
NAVAL AIR STATION
ALAMEDA
TIBURON PENINSULA
RICHARDSON BAY
SAUSALITO
RACCOON STRAIT
ANGEL IS.
SAN FRANCISCO BAY
TREASURE IS.
ALCATRAZ IS.
GOLDEN GATE
PT. BONITA
PRESIDIO
NORTH POINT
SAN FRANCISCO
PT. LOBOS
MILE ROCKS
ISLAIS CR.
HUNTERS PT.
PACIFIC OCEAN
BONITA CHANNEL
POTATOPATCH SHOAL
MAIN SHIP CHANNEL
OCEAN TIDE CONTROL

Chart 2



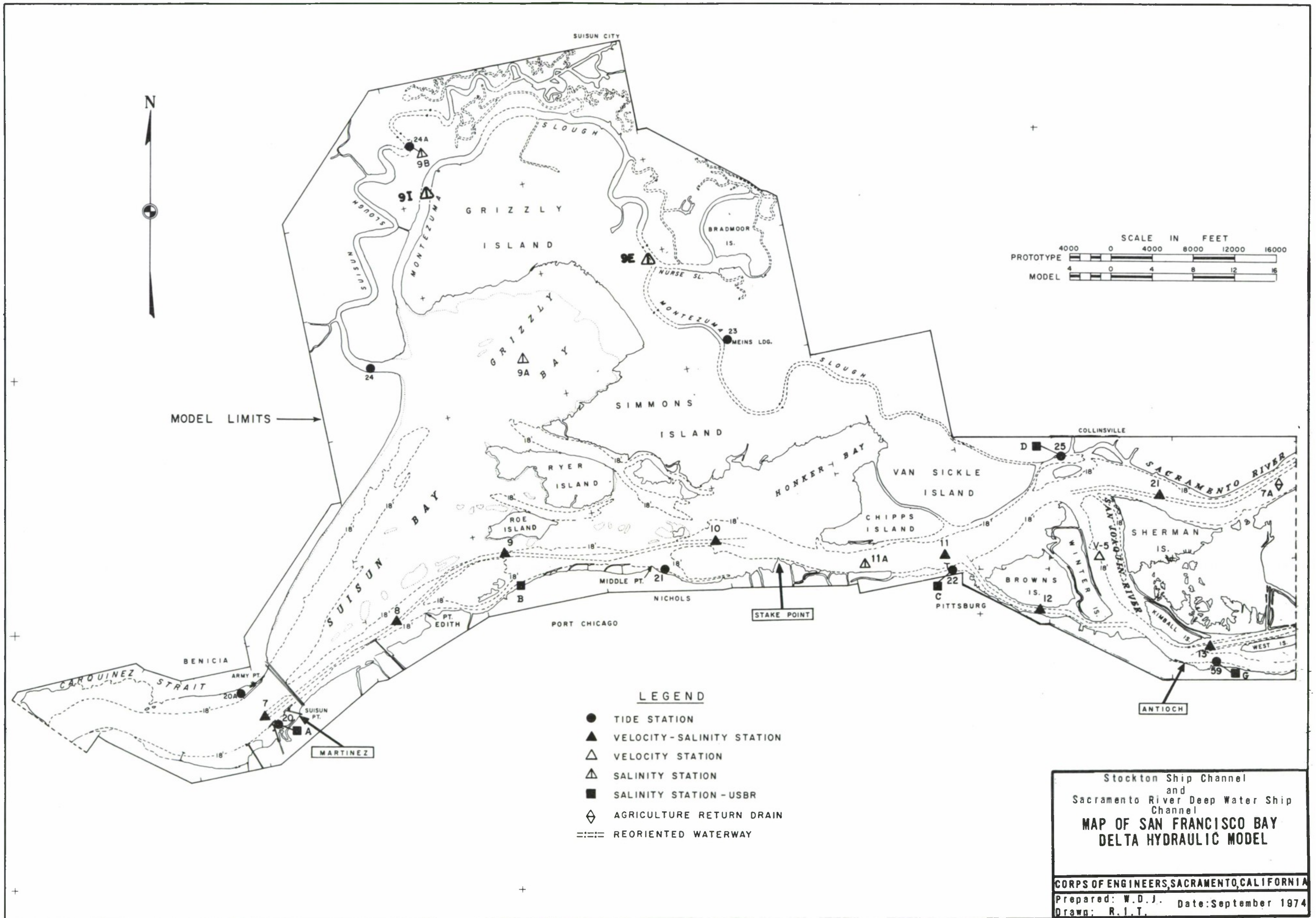
Stockton Ship Channel
and
Sacramento River Deep Water Ship Channel

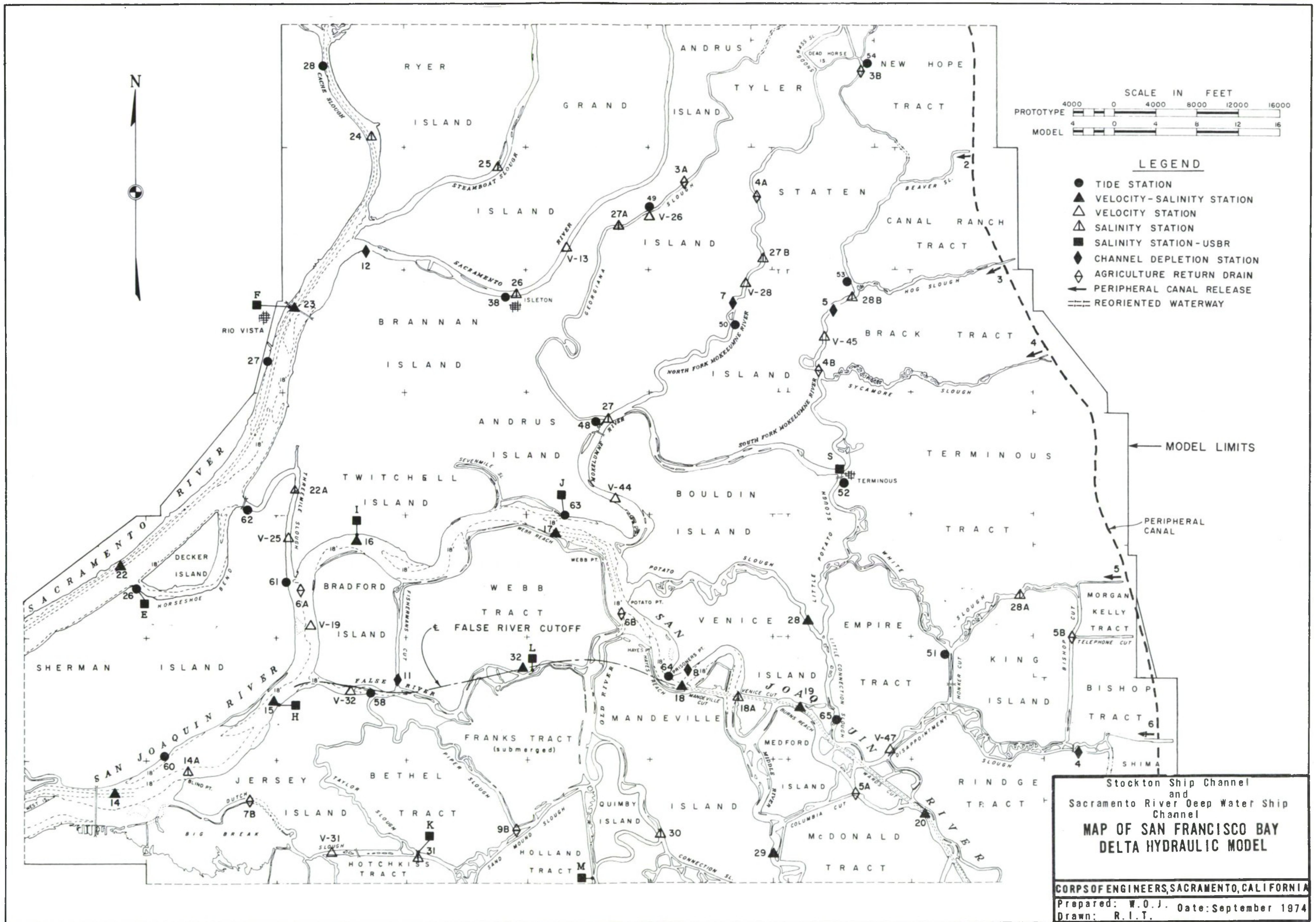
MAP OF SAN FRANCISCO BAY DELTA HYDRAULIC MODEL

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: W.D.J. Drawn: R.I.T. Date: September 1974

Chart 3


Stockton Ship Channel
and
Sacramento River Deep Water Ship Channel
MAP OF SAN FRANCISCO BAY
DELTA HYDRAULIC MODEL
CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA
Prepared: W.D.J.
Drawn: R.I.T.
Date: September 1974
LEGEND
TIDE STATION
VELOCITY-SALINITY STATION
VELOCITY STATION
SALINITY STATION
SALINITY STATION - USBR
AGRICULTURE RETURN DRAIN
REORIENTED WATERWAY
SCALE IN FEET
PROTOTYPE 4000 0 4000 8000 12000 16000
MODEL 4 0 4 8 12 16
N
MODEL LIMITS
SUISUN CITY
GRIZZLY ISLAND
GRIZZLY BAY
SIMMONS ISLAND
BRADMOOR IS.
NURSE SL.
MONTEZUMA SLOUGH
SUISUN SLOUGH
MEINS LDG.
RYER ISLAND
ROE ISLAND
HONKER BAY
VAN SICKLE ISLAND
CHIPPS ISLAND
COLLINSVILLE
SACRAMENTO RIVER
SAN JOAQUIN RIVER
SHERMAN IS.
WINTER IS.
BROWNS IS.
KIMBALL IS.
WEST IS.
ANTIOCH
PITTSBURG
STAKE POINT
NICHOLS
MIDDLE PT.
PORT CHICAGO
PT. EDITH
SUISUN BAY
SUISUN PT.
MARTINEZ
ARMY PT.
BENICIA
CARQUINEZ STRAIT
24A
9B
9I
9E
9A
23
24
25
D
21
7A
V-5
11
11A
22
C
12
13
59
G
10
21
9
B
8
7
20
20A
A
Chart 4



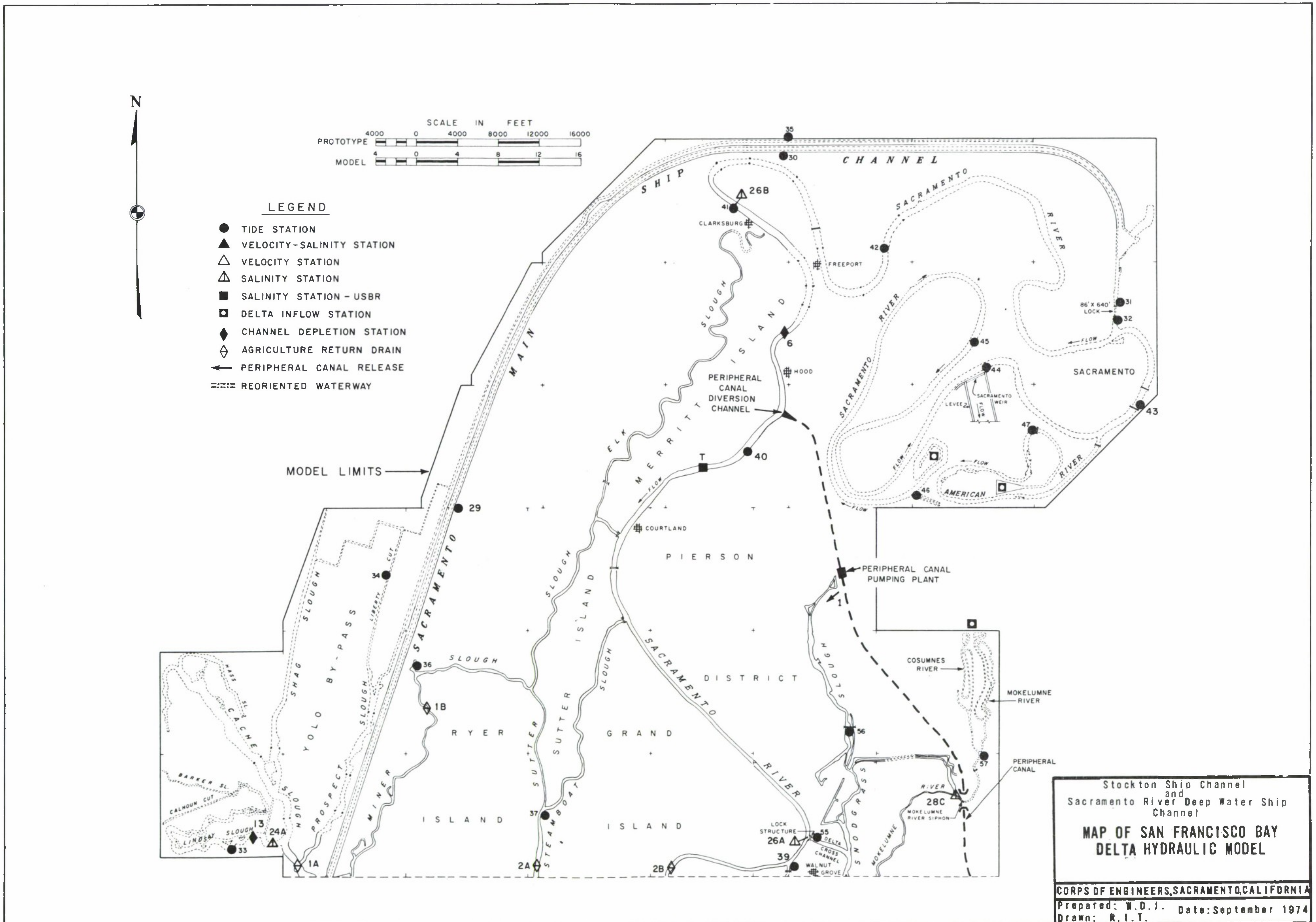
Stockton Ship Channel
and
Sacramento River Deep Water Ship Channel

MAP OF SAN FRANCISCO BAY DELTA HYDRAULIC MODEL

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: W.O.J.
Drawn: R.I.T.
Date: September 1974

Chart 5



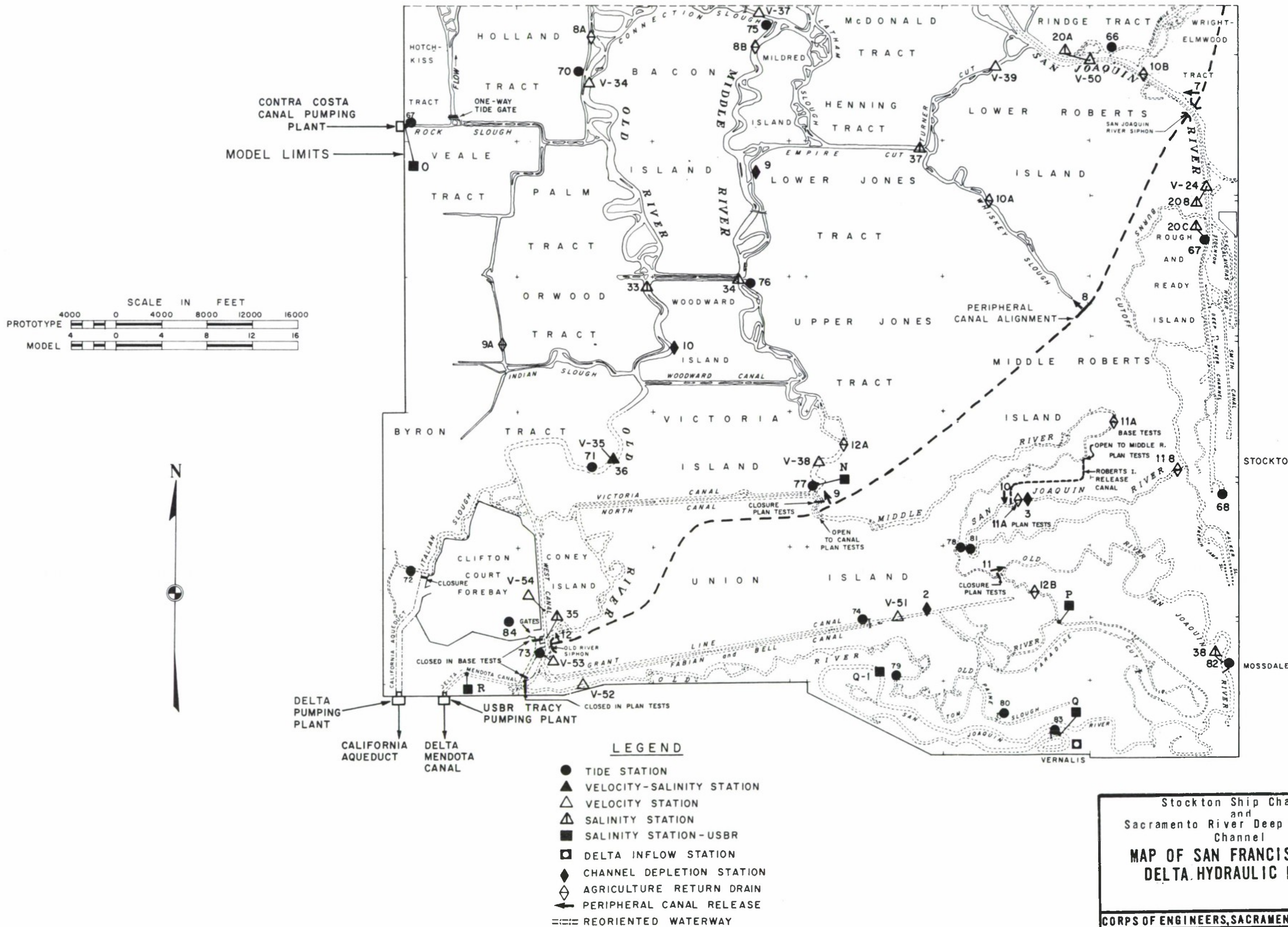
Stockton Ship Channel
and
Sacramento River Deep Water Ship Channel

MAP OF SAN FRANCISCO BAY DELTA HYDRAULIC MODEL

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: W.D.J. Date: September 1974
Drawn: R.I.T.

Chart 6



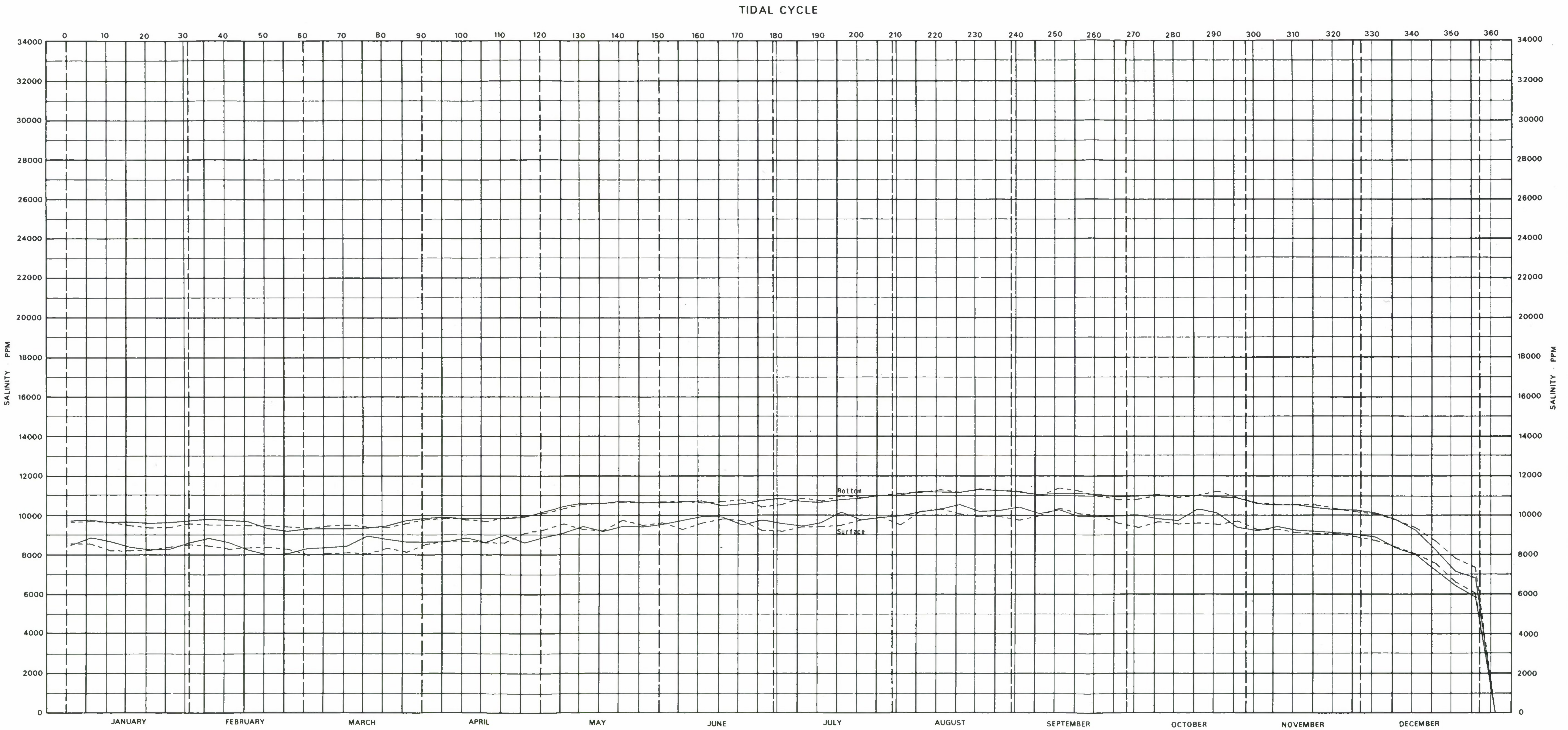
Stockton Ship Channel
and
Sacramento River Deep Water Ship Channel

MAP OF SAN FRANCISCO BAY DELTA HYDRAULIC MODEL

CORPS OF ENGINEERS, SACRAMENTO, CALIFORNIA

Prepared: W.O.J. Drawn: R.I.T. Date: September 1974

Chart 7



SSC 1977 SIMP HYD STA 11A TEST B54,P87

NOTE: 19-YEAR MEAN TIDE: INFLOW AND WITHDRAWALS OF 1968

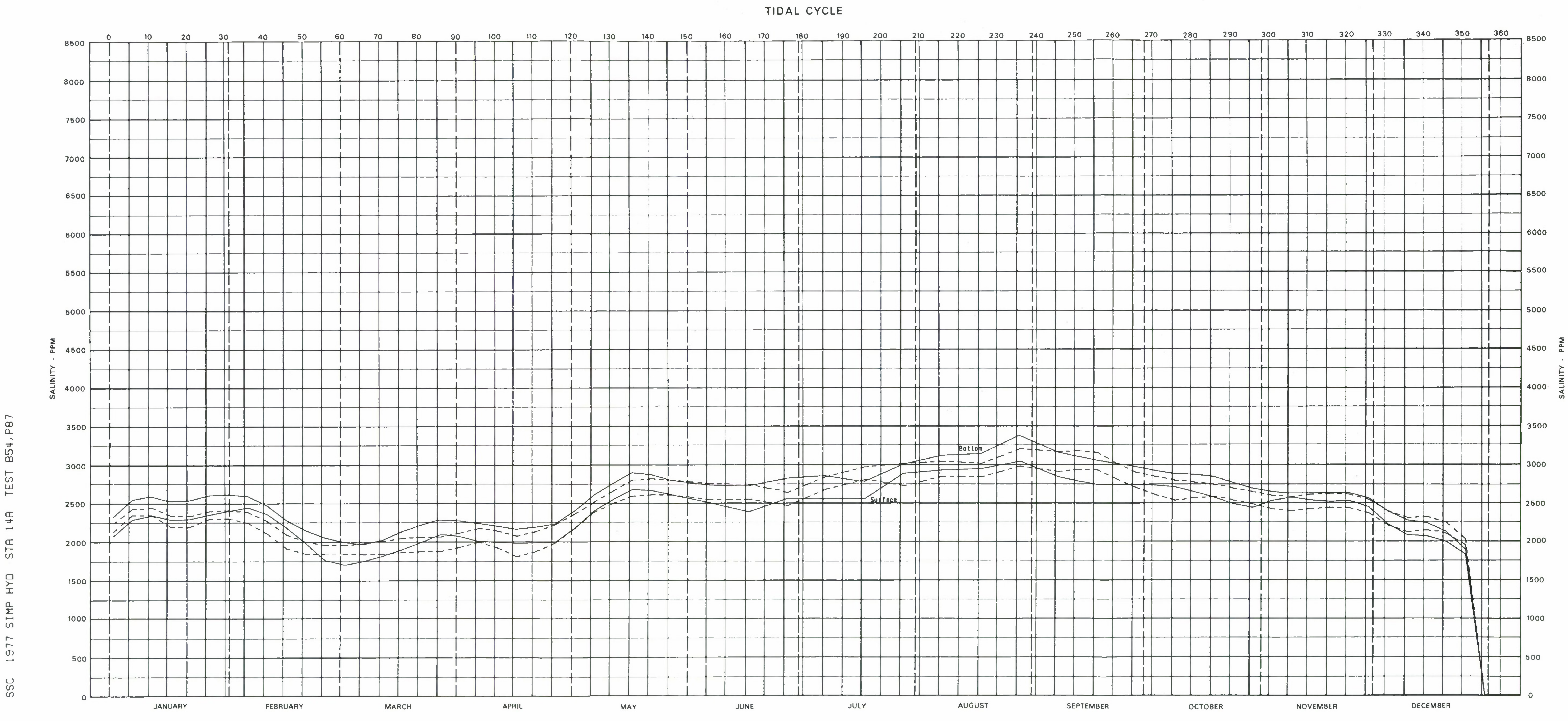
AVERAGE OF TESTS	BASE	PLAN
MEAN SALINITY		
BOTTOM SALINITY		
SURFACE SALINITY		

S. F. BAY - DELTA MODEL

MEAN SALINITIES FOR DYNAMIC TESTS

Stockton Ship Channel
1977 Hydrology
Station 11A

Chart 8 Sheet 1 of 4



NOTE: 19-YEAR MEAN TIDE: INFLOW AND WITHDRAWALS OF 1968.

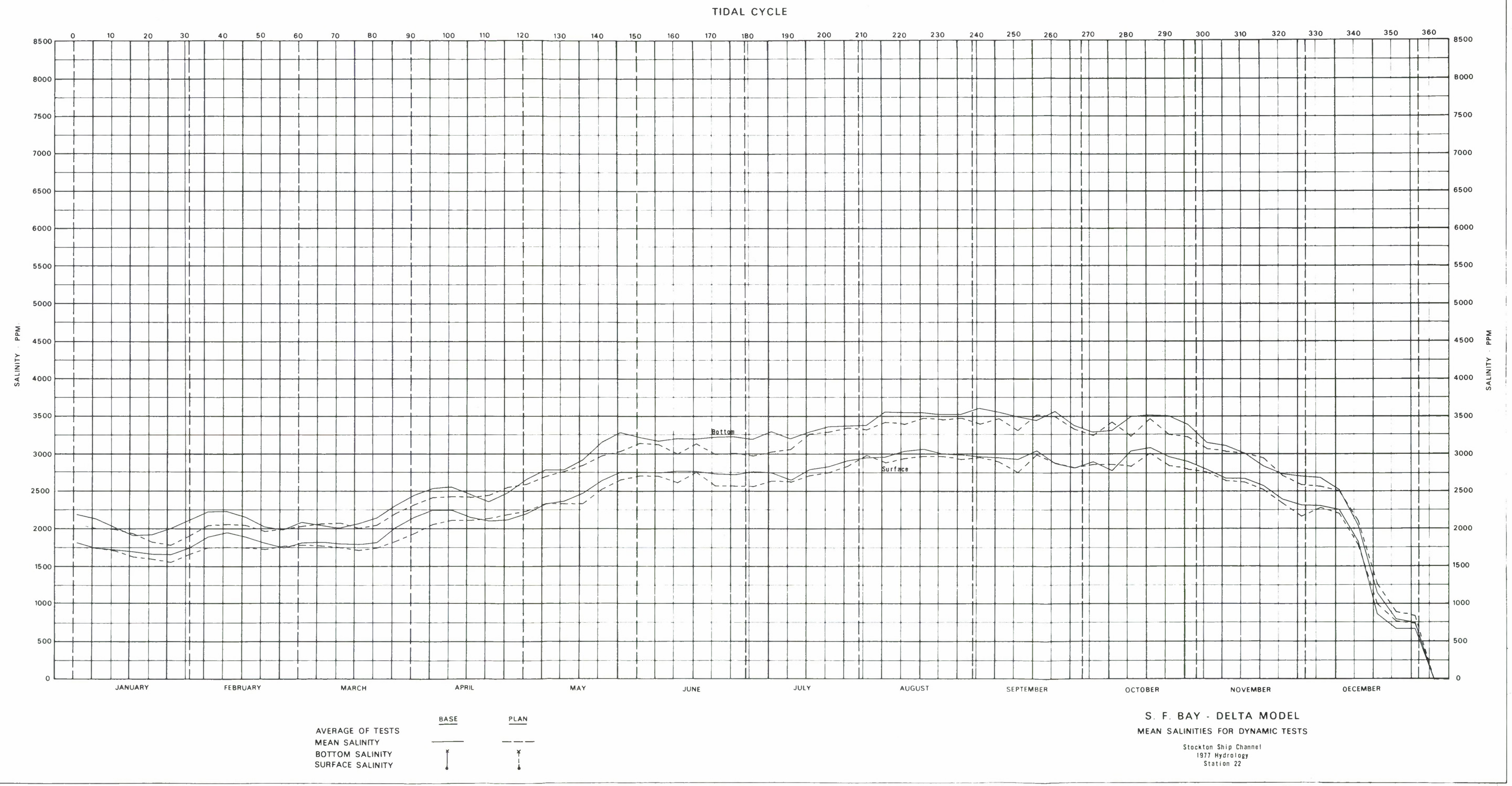
AVERAGE OF TESTS	BASE	PLAN
MEAN SALINITY	———	— — —
BOTTOM SALINITY		
SURFACE SALINITY		

S. F. BAY - DELTA MODEL

MEAN SALINITIES FOR DYNAMIC TESTS

Stockton Ship Channel
1977 Hydrology
Station 14A

Chart 8 Sheet 2 of 4



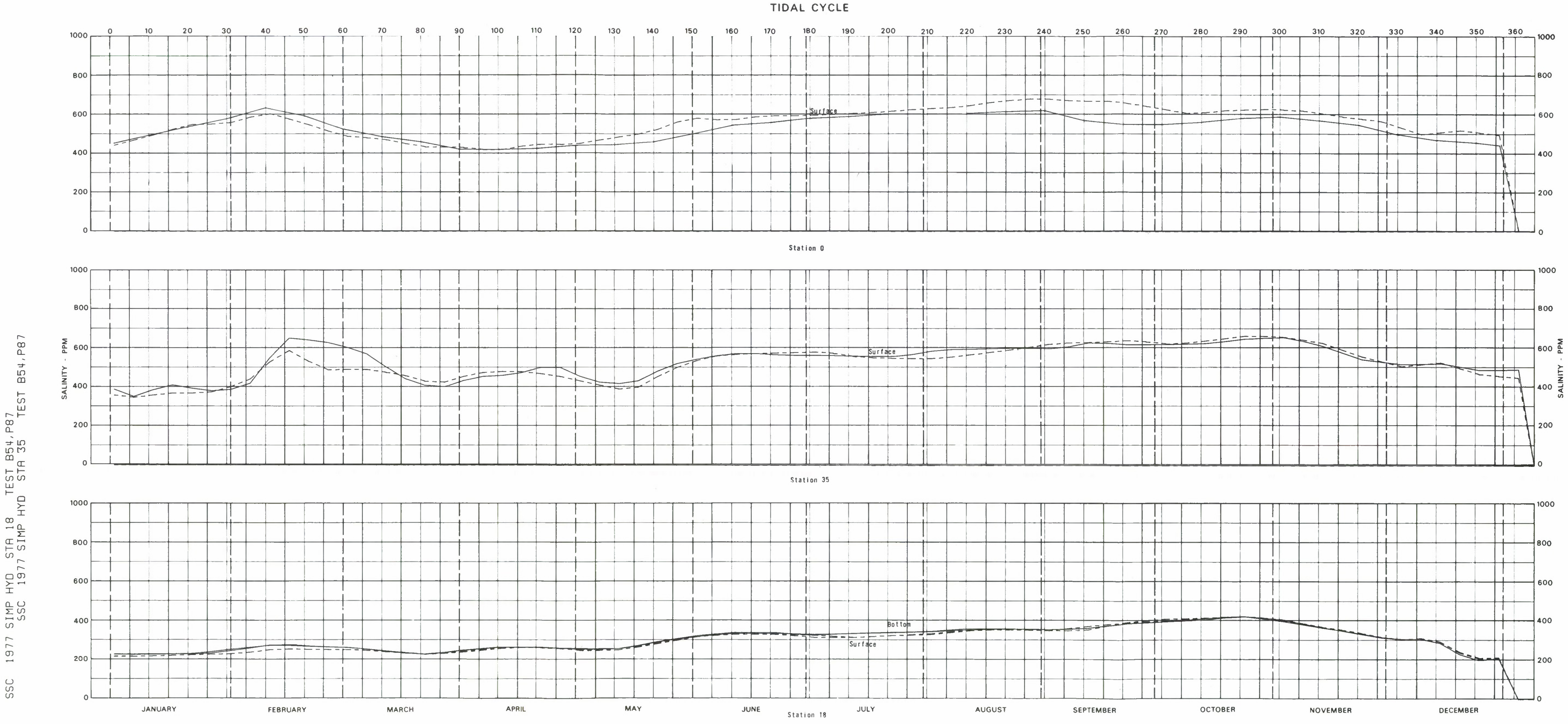
SSC 1977 SIMP HYD STA 22 TEST B54,P87

S. F. BAY - DELTA MODEL

MEAN SALINITIES FOR DYNAMIC TESTS

Stockton Ship Channel
1977 Hydrology
Station 22

Chart 8 Sheet 3 of 4



NOTE: 19-YEAR MEAN TIDE: INFLOW AND WITHDRAWALS OF 1968

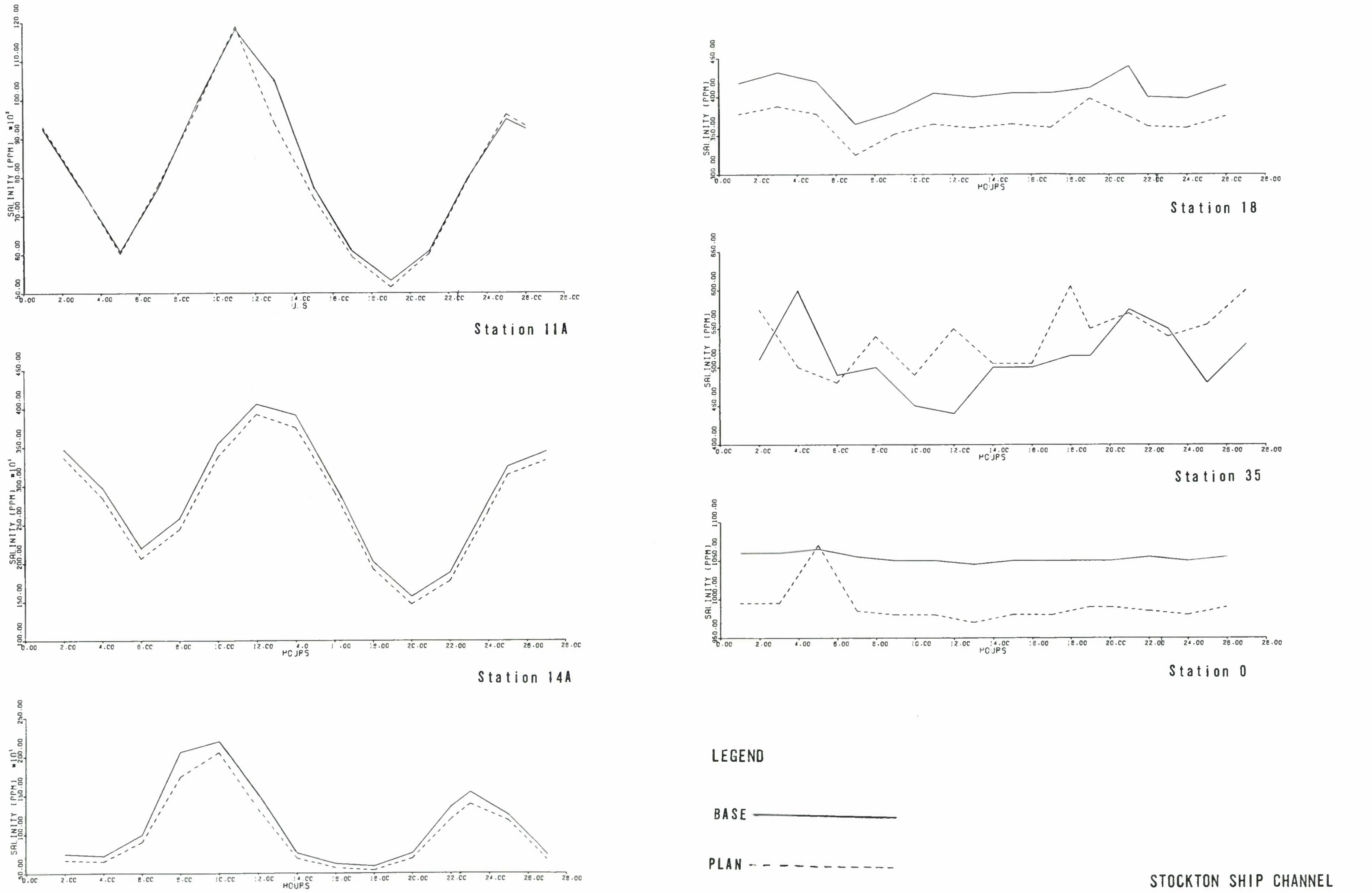
	BASE	PLAN
AVERAGE OF TESTS		
SURFACE SALINITY	—•—	—•— (dashed)

S.F. BAY - DELTA MODEL

MEAN SALINITIES FOR DYNAMIC TESTS

Stockton Ship Channel
1977 Hydrology

Chart 8 Sheet 4 of 4

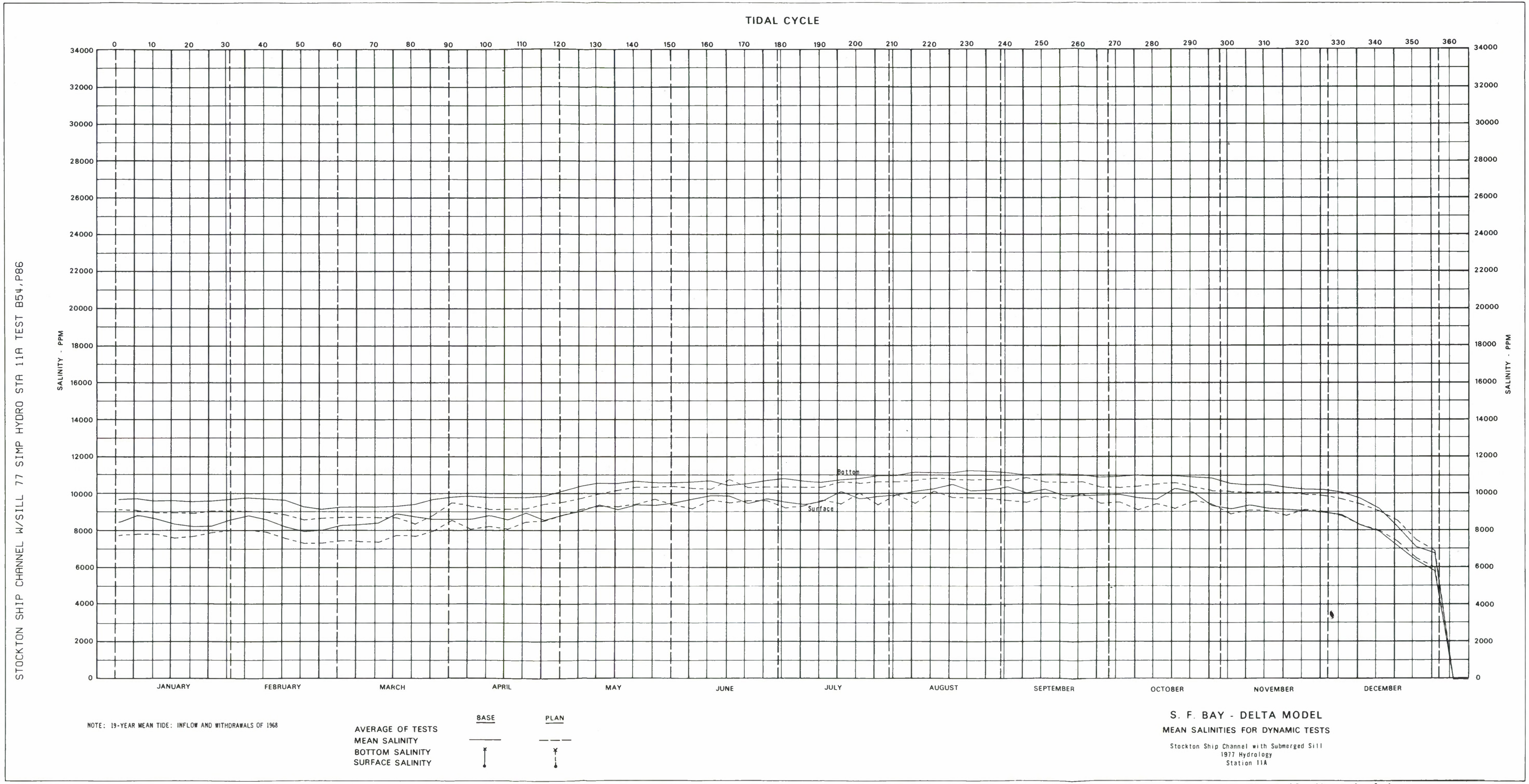


STOCKTON SHIP CHANNEL

Steady State Model Test Results
Plan D-1 vs Base

Tidal Cycle Plot

Chart 9



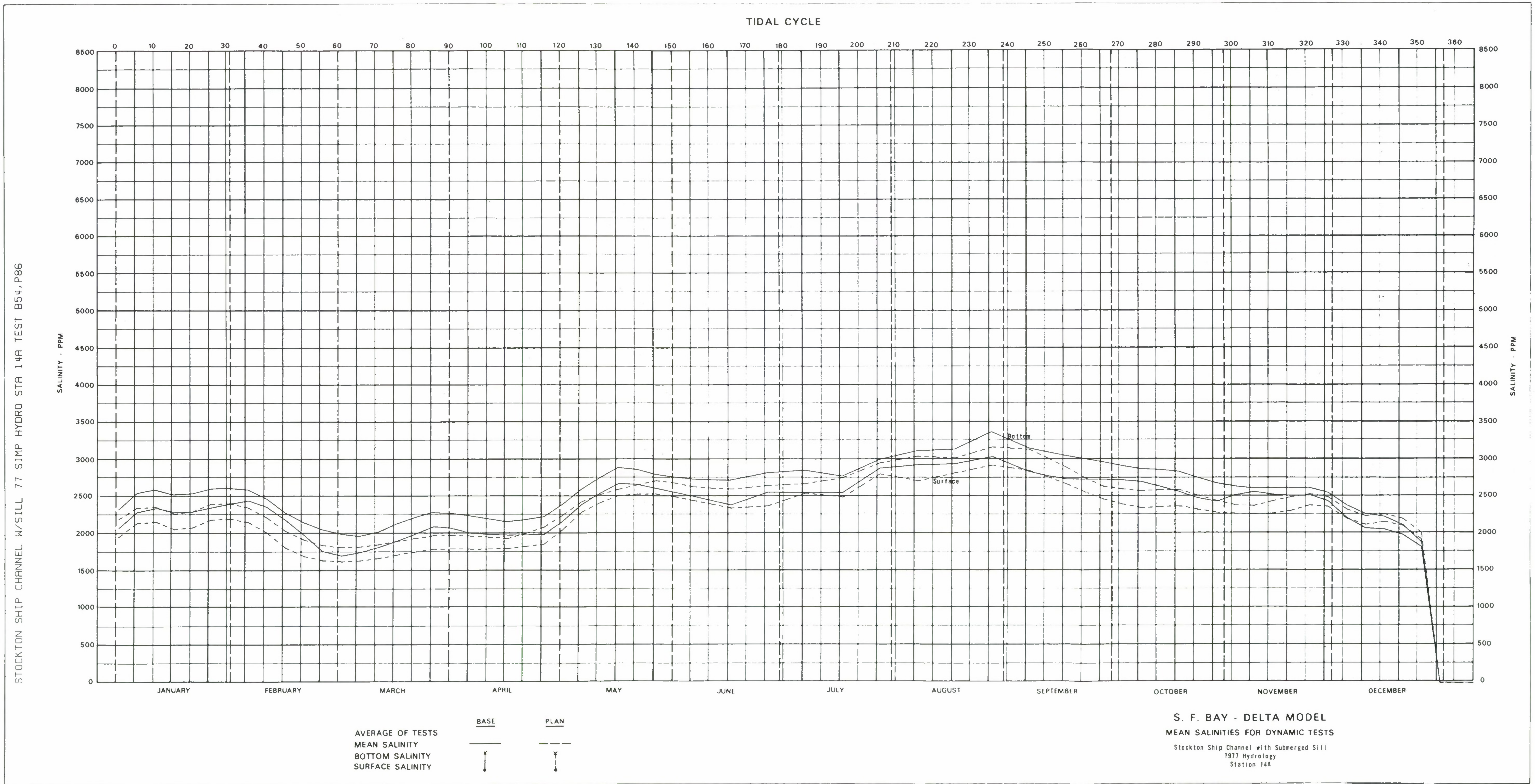
NOTE: 19-YEAR MEAN TIDE: INFLOW AND WITHDRAWALS OF 1968

S. F. BAY - DELTA MODEL

MEAN SALINITIES FOR DYNAMIC TESTS

Stockton Ship Channel with Submerged Sill
1977 Hydrology
Station 11A

Chart 10 Sheet 1 of 4



S. F. BAY - DELTA MODEL

MEAN SALINITIES FOR DYNAMIC TESTS

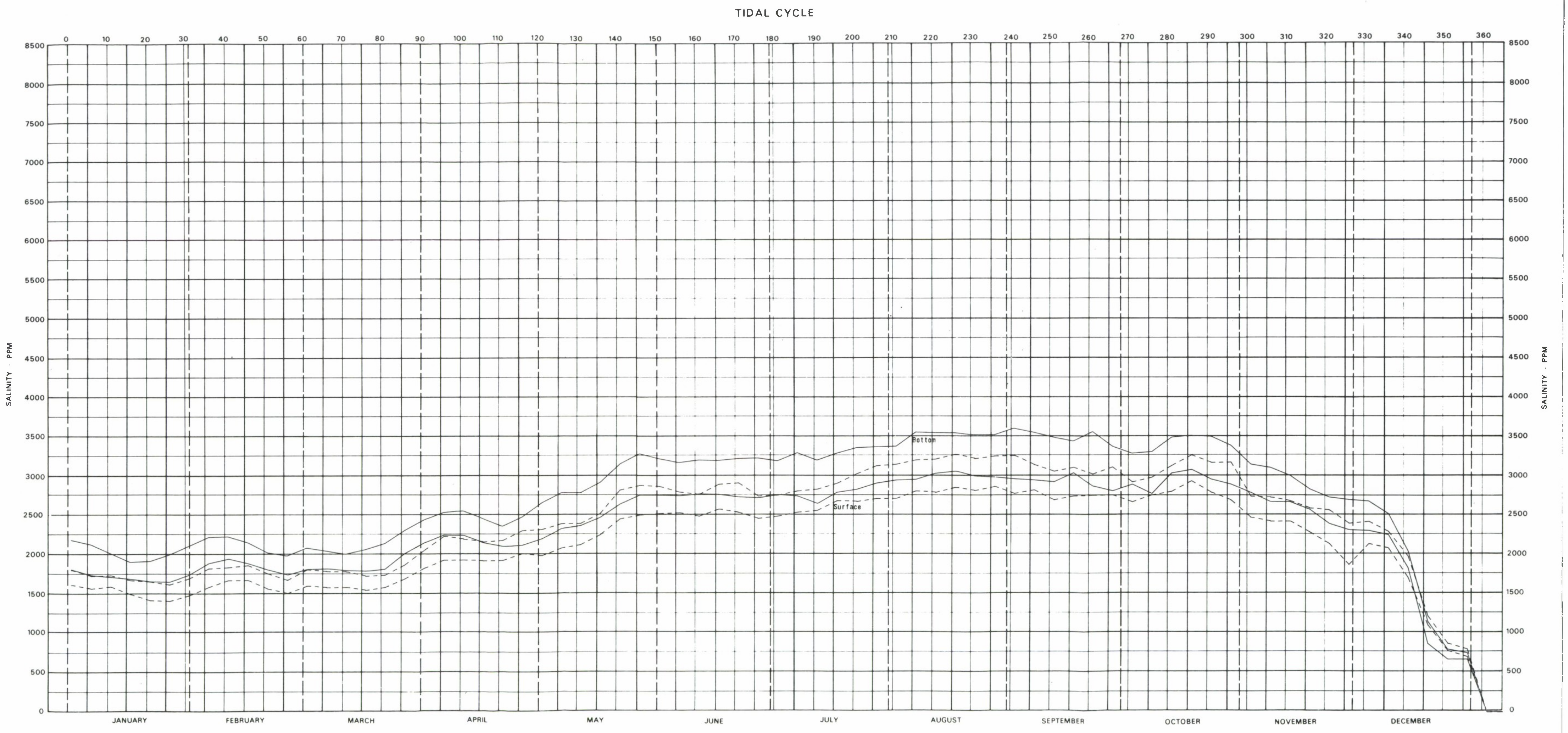
Stockton Ship Channel with Submerged Sill

1977 Hydrology

Station 14A

Chart 10 Sheet 2 of 4

STOCKTON SHIP CHANNEL W/SILL 77 SIMP HYDRO STA 22 TEST B54,P86



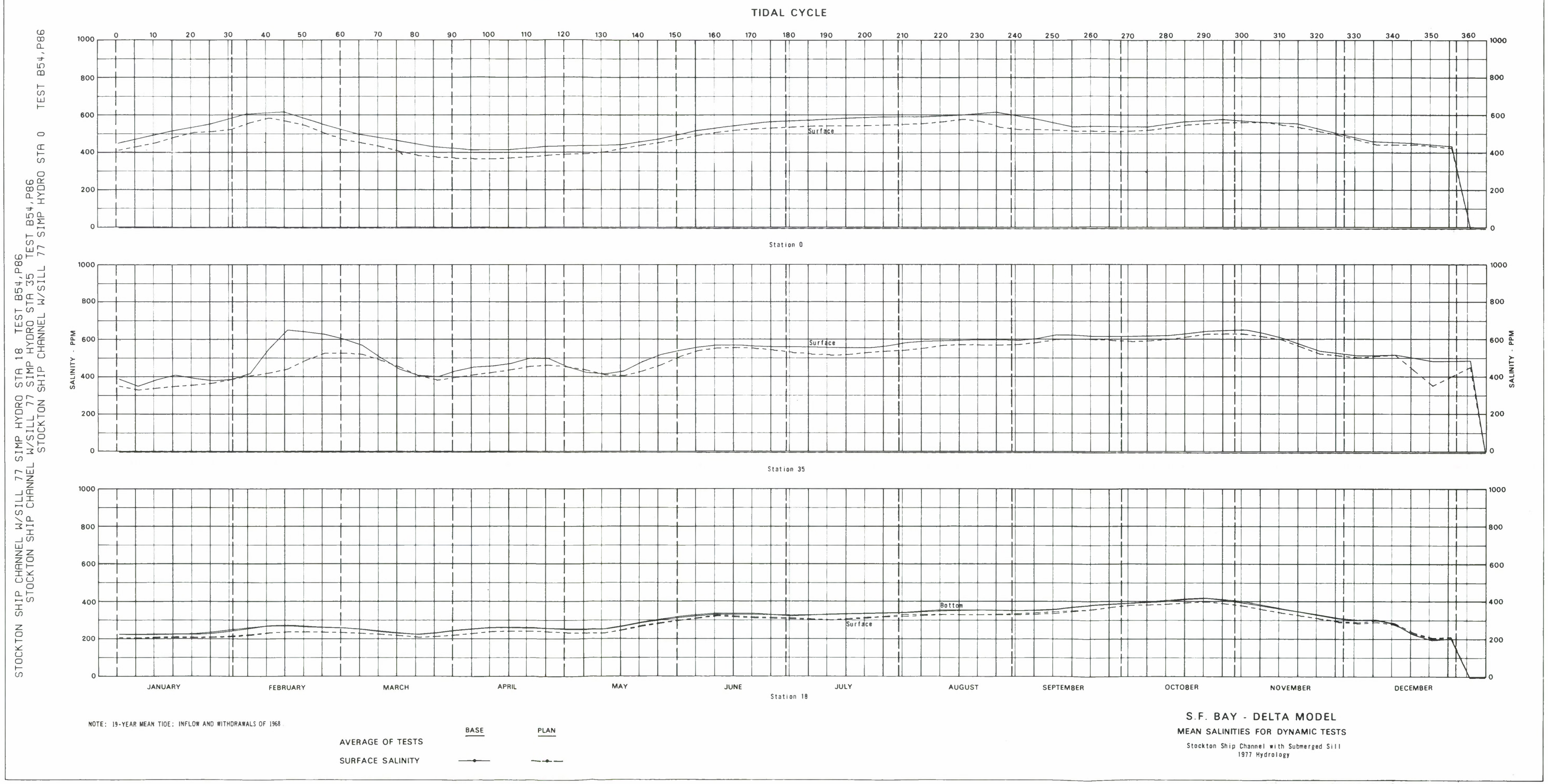
	BASE	PLAN
AVERAGE OF TESTS		
MEAN SALINITY	———	— — —
BOTTOM SALINITY		
SURFACE SALINITY		

S. F. BAY - DELTA MODEL

MEAN SALINITIES FOR DYNAMIC TESTS

Stockton Ship Channel with Submerged Sill
1977 Hydrology
Station 22

Chart 10 Sheet 3 of 4



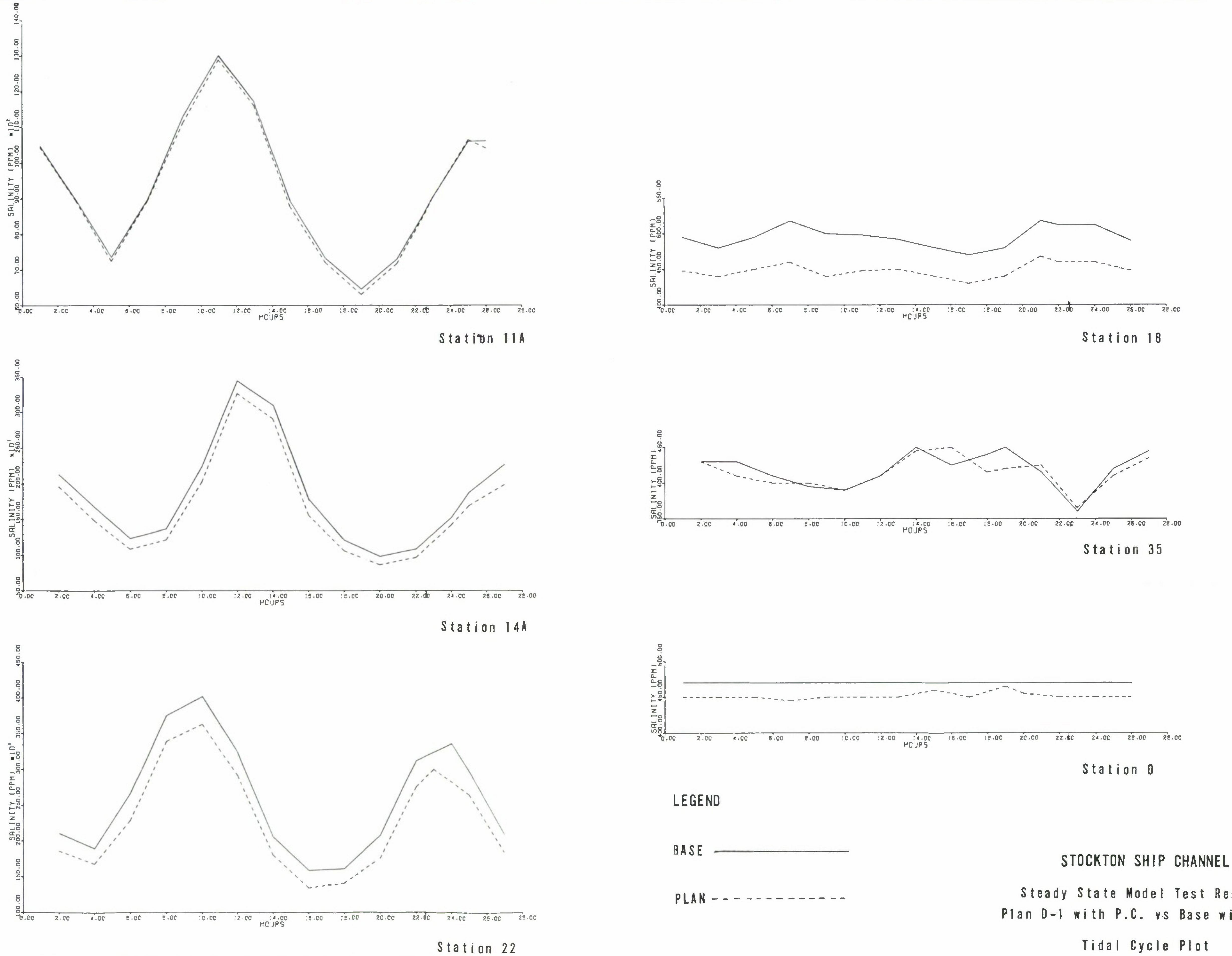
S.F. BAY - DELTA MODEL

MEAN SALINITIES FOR DYNAMIC TESTS

Stockton Ship Channel with Submerged Sill

1977 Hydrology

Chart 10 Sheet 4 of 4



LEGEND

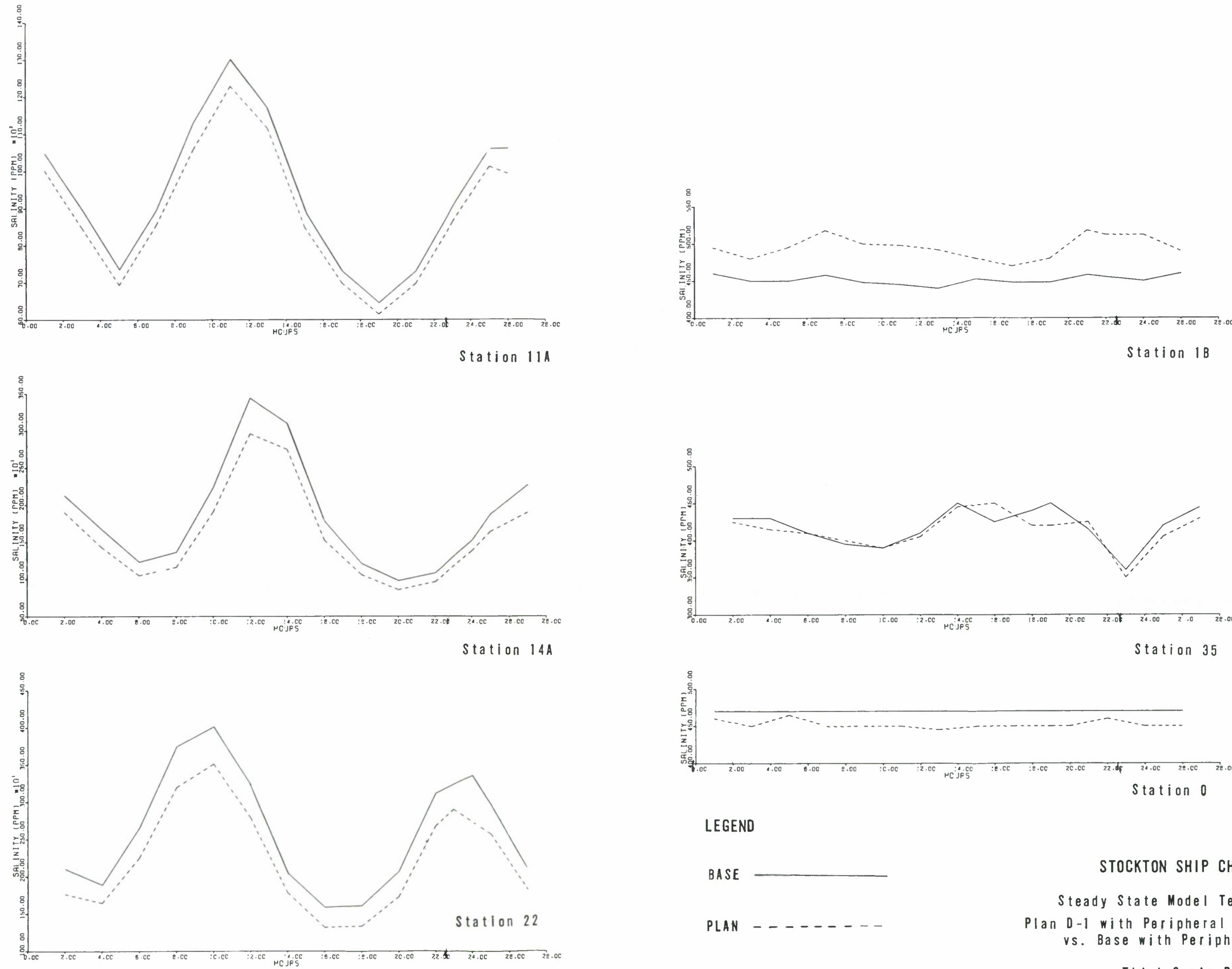
BASE ————————

PLAN - - - - - - - - - - - -

STOCKTON SHIP CHANNEL

Steady State Model Test Results
Plan D-1 with P.C. vs Base with P.C.

Tidal Cycle Plot

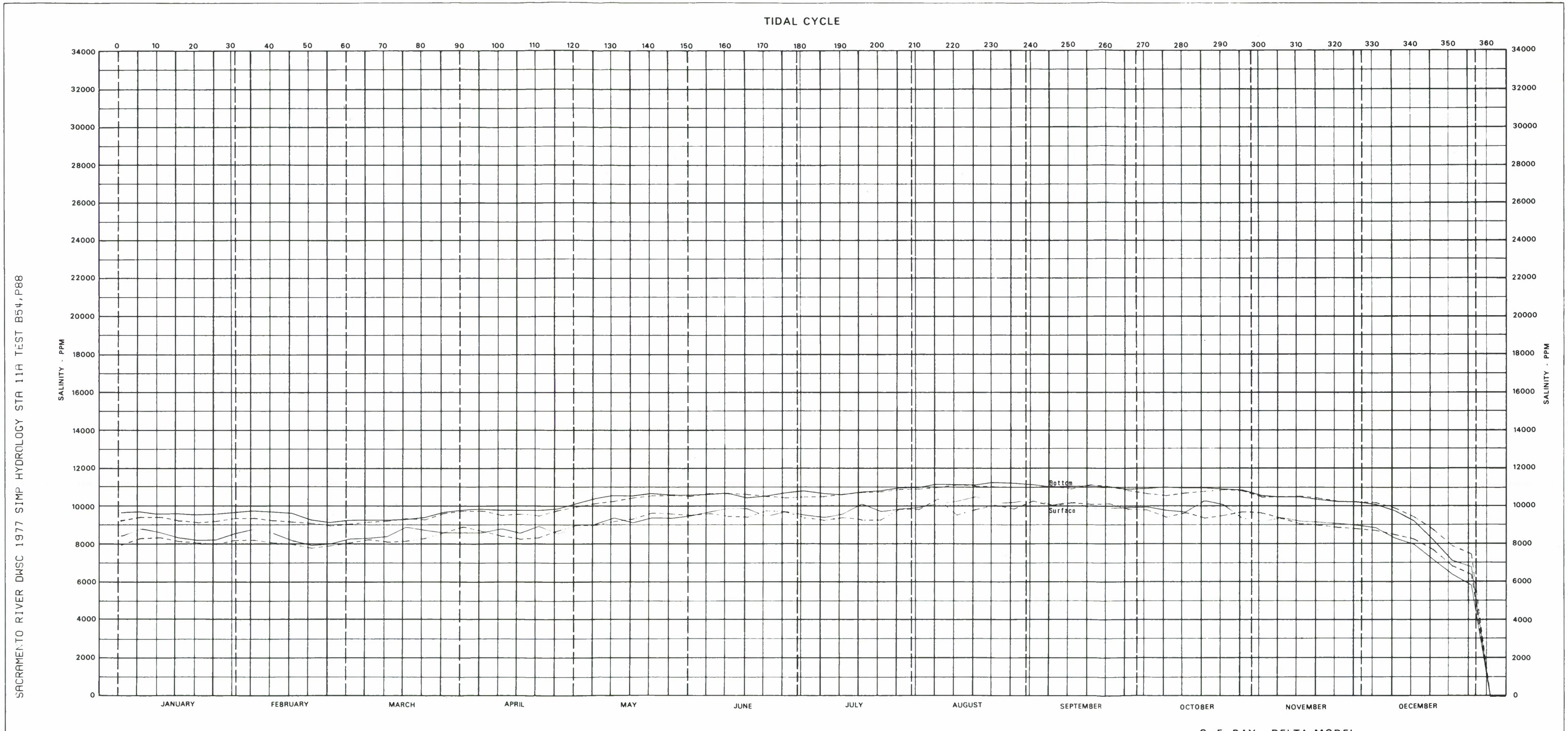


STOCKTON SHIP CHANNEL

Steady State Model Test Results

Plan D-1 with Peripheral Canal and Sill
vs. Base with Peripheral Canal

Tidal Cycle Plot

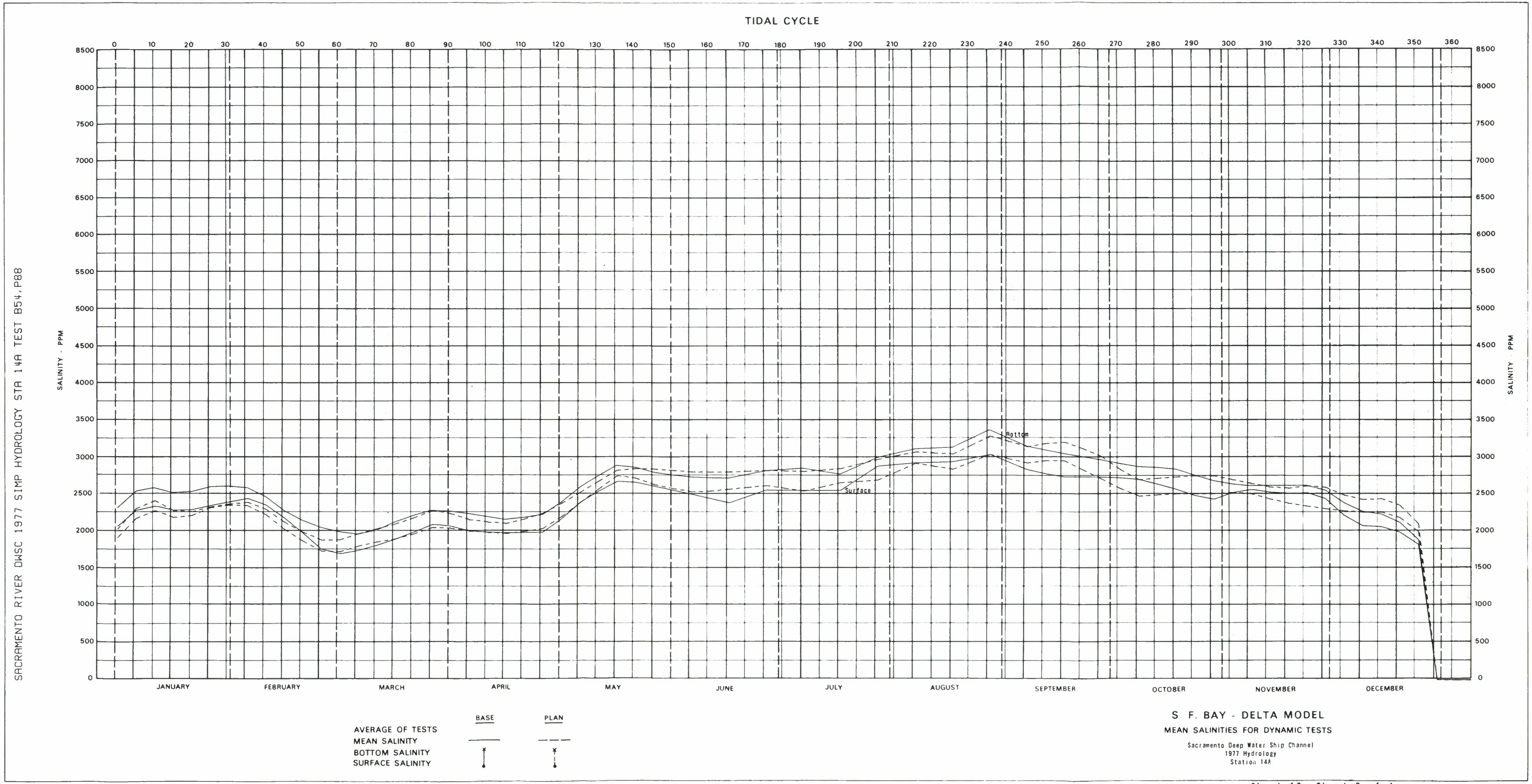


S. F. BAY - DELTA MODEL

MEAN SALINITIES FOR DYNAMIC TESTS

Sacramento Deep Water Ship Channel
1977 Hydrology
Station 11A

Chart 13 Sheet 1 of 4

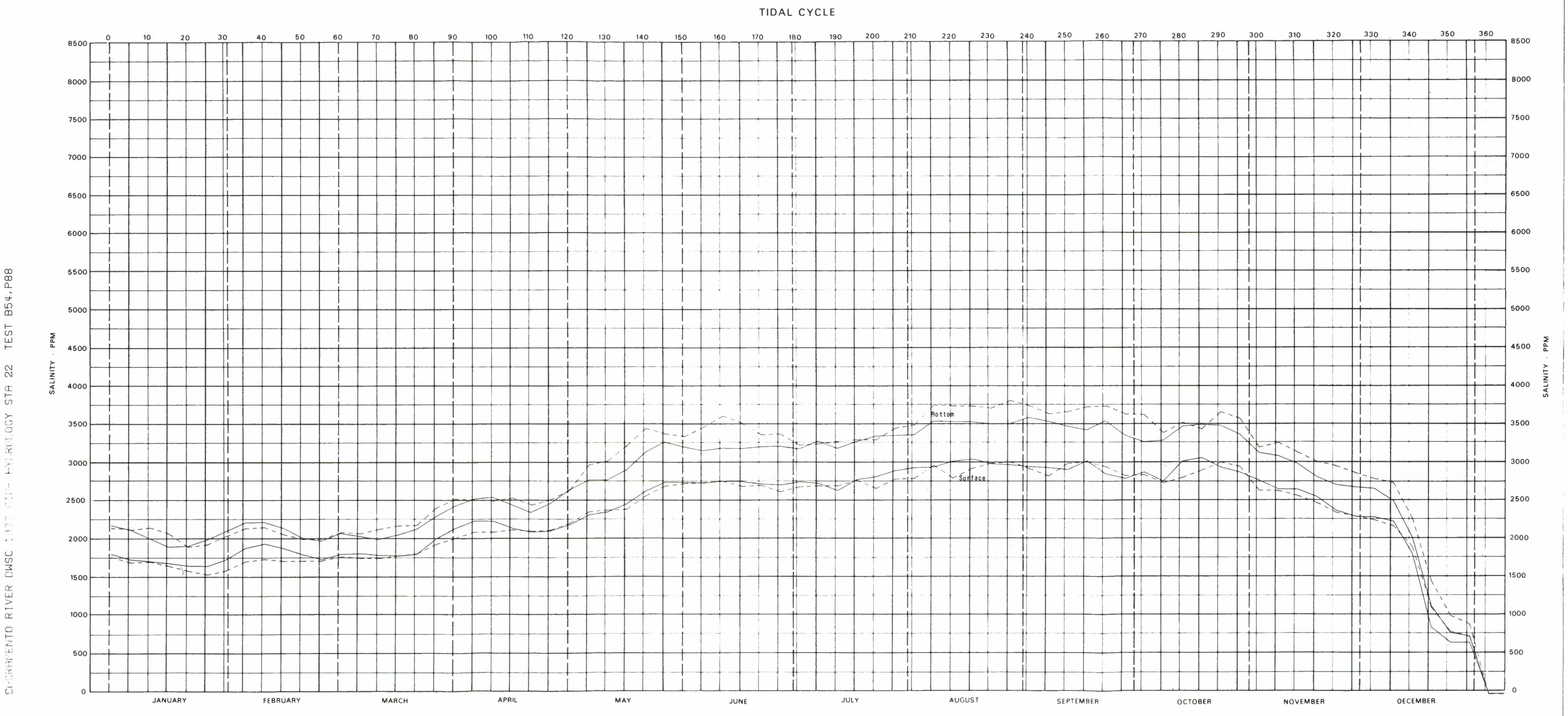


S. F. BAY - DELTA MODEL

MEAN SALINITIES FOR DYNAMIC TESTS

Sacramento Deep Water Ship Channel
1977 Hydrology
Station 14A

Chart 13 Sheet 2 of 4



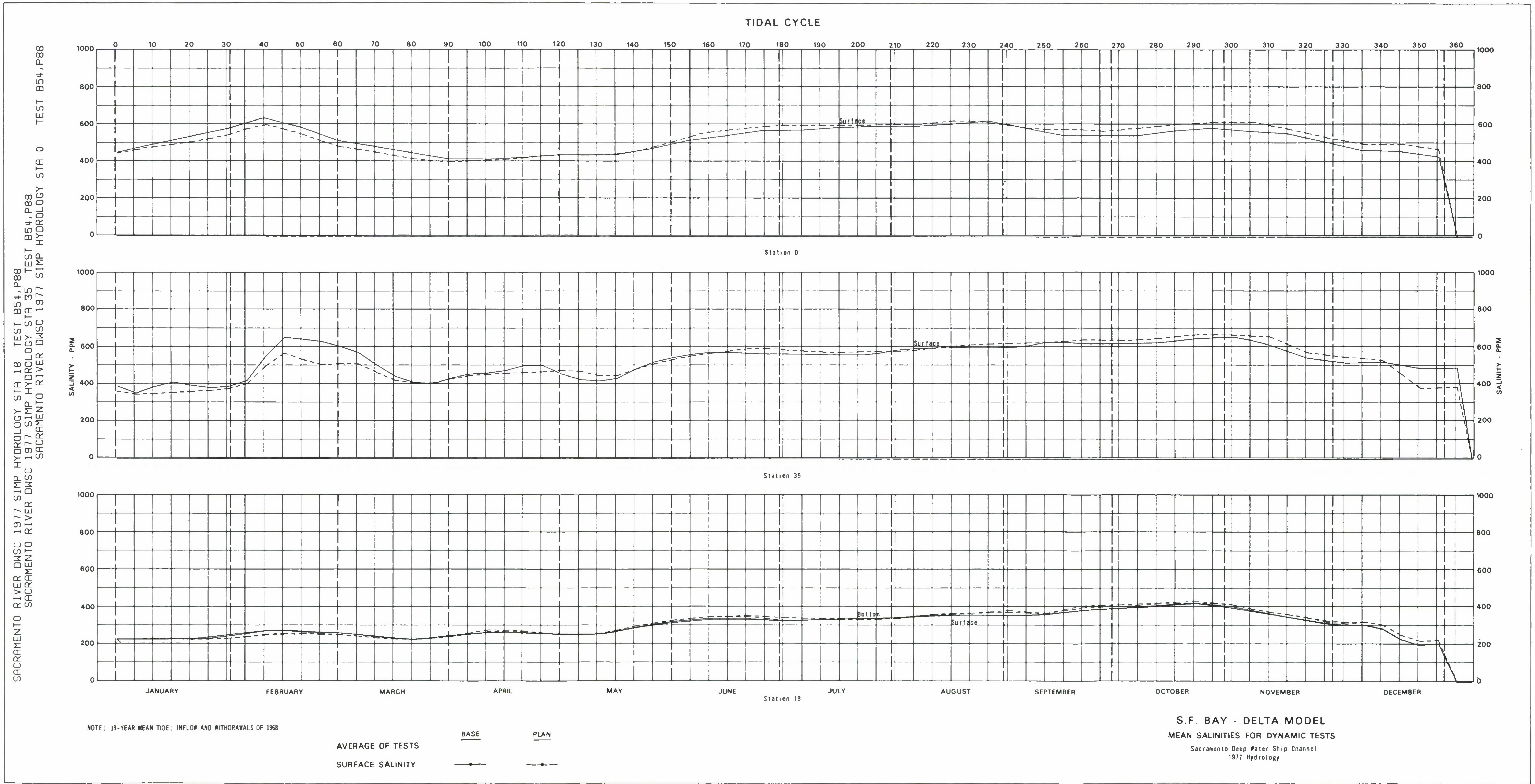
AVERAGE OF TESTS | BASE | PLAN
MEAN SALINITY
BOTTOM SALINITY
SURFACE SALINITY

S. F. BAY - DELTA MODEL

MEAN SALINITIES FOR DYNAMIC TESTS

Sacramento Deep Water Ship Channel
1977 Hydrology
Station 22

Chart 13 Sheet 3 of 4

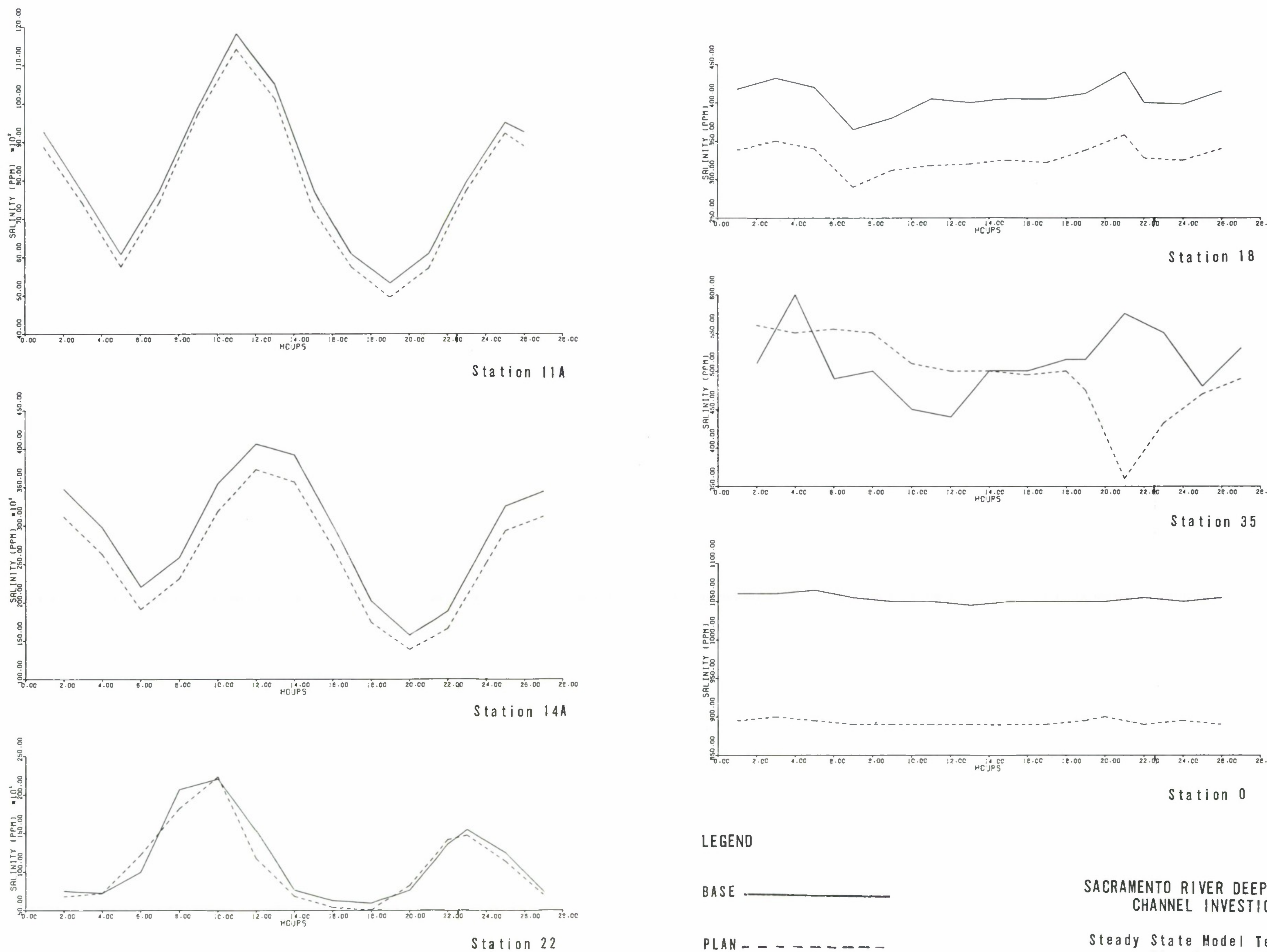


S.F. BAY - DELTA MODEL

MEAN SALINITIES FOR DYNAMIC TESTS

Sacramento Deep Water Ship Channel
1977 Hydrology

Chart 13 Sheet 4 of 4



LEGEND

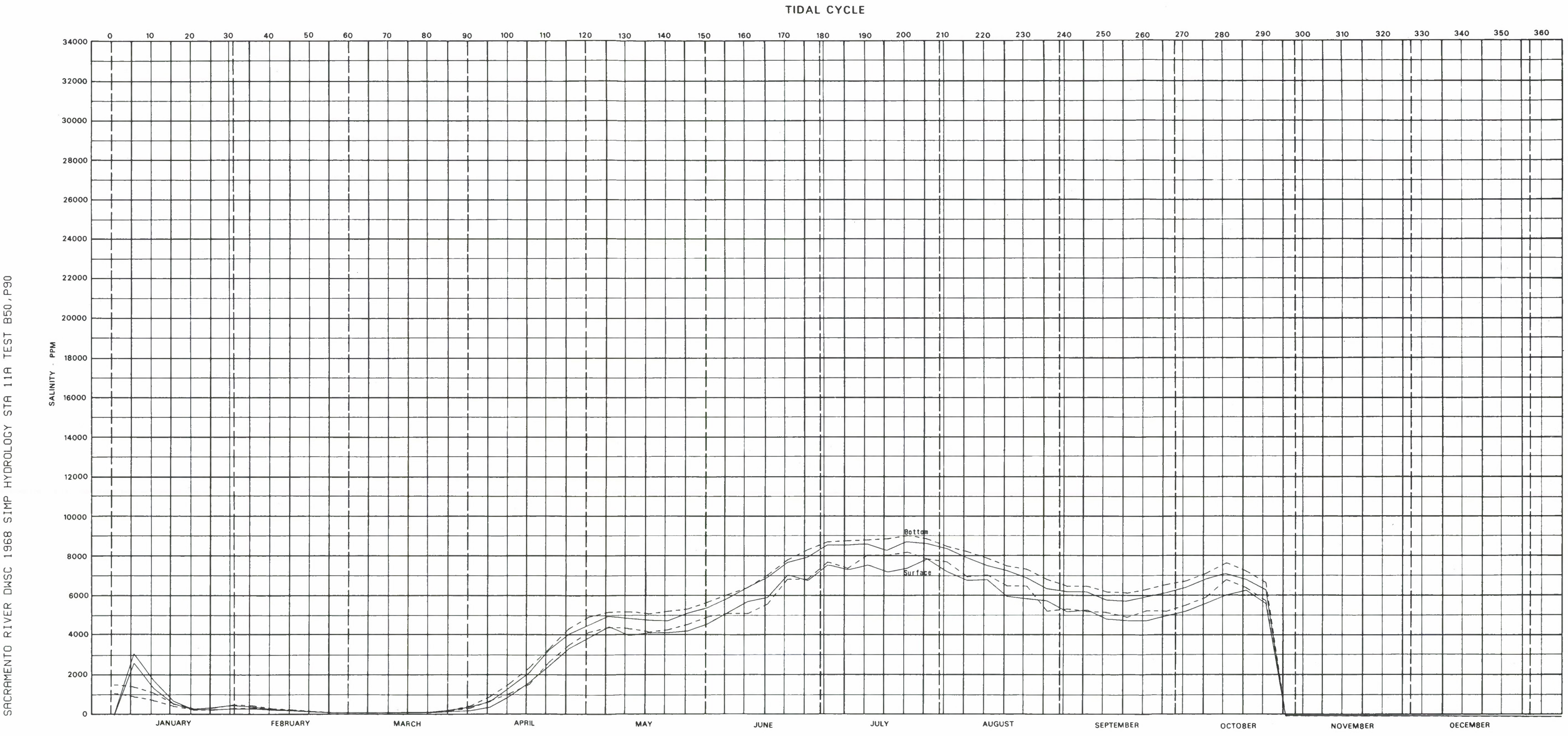
BASE ———————

PLAN - - - - - - - -

SACRAMENTO RIVER DEEP WATER SHIP CHANNEL INVESTIGATION

Steady State Model Test Results
Plan H-1 Vs Base

Tidal Cycle Plot



NOTE: 19-YEAR MEAN TIDE: INFLOW AND WITHDRAWALS OF 1968

AVERAGE OF TESTS	BASE	PLAN
MEAN SALINITY	———	— — —
BOTTOM SALINITY		
SURFACE SALINITY		

S. F. BAY - DELTA MODEL

MEAN SALINITIES FOR DYNAMIC TESTS

Sacramento Deep-Water Ship Channel
1968 Hydrology
Station 11A

Chart 15 Sheet 1 of 4

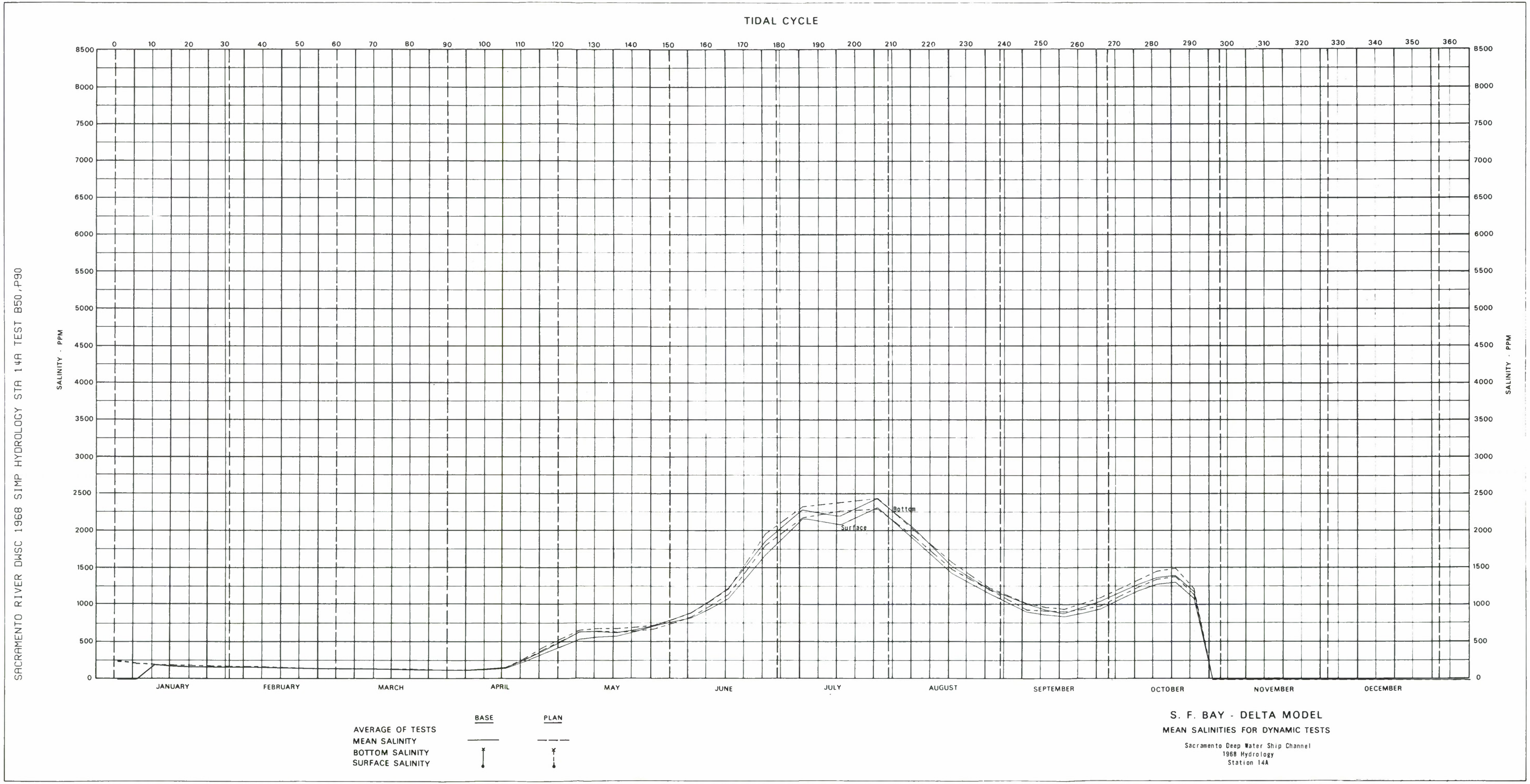


Chart 15 Sheet 2 of 4

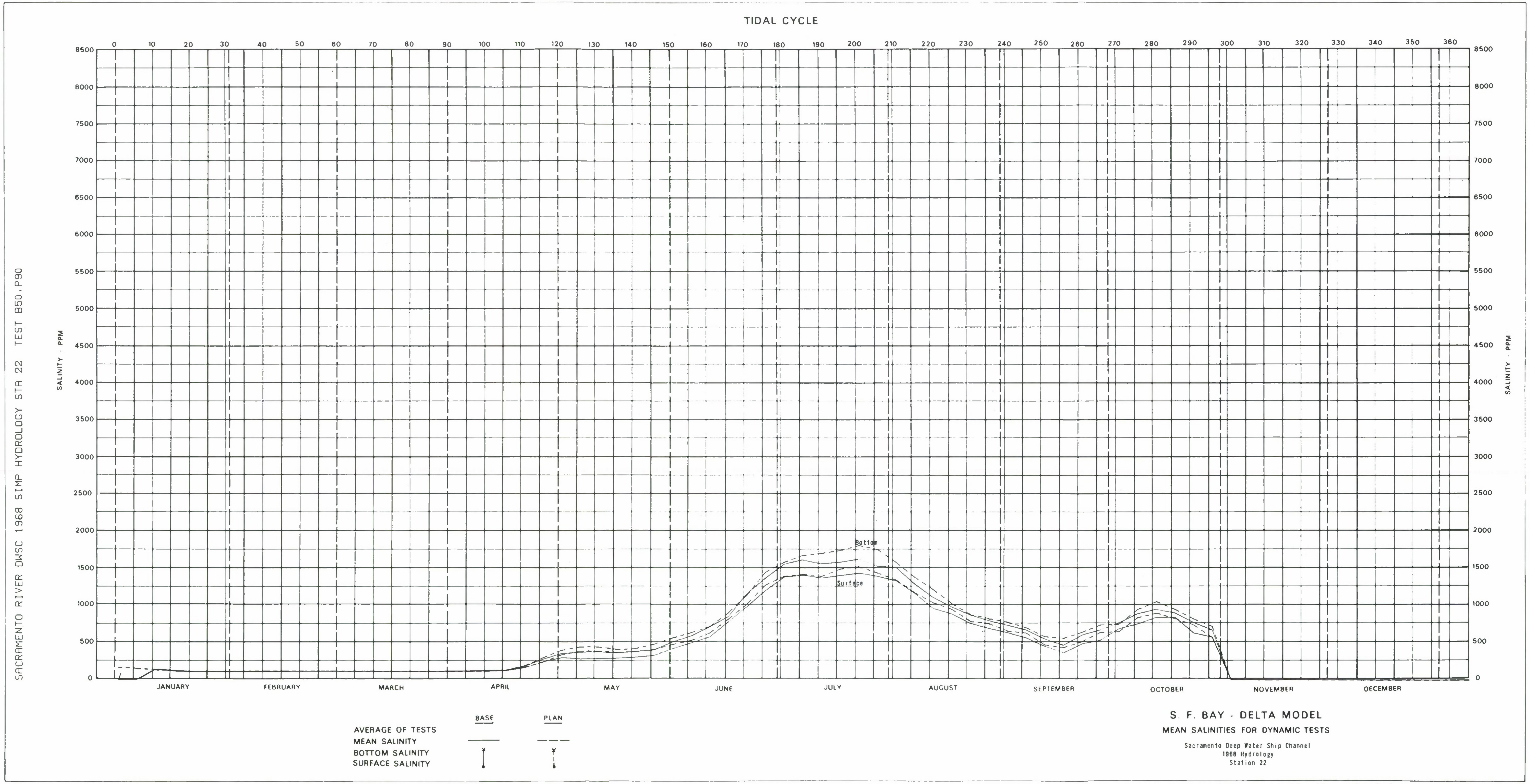
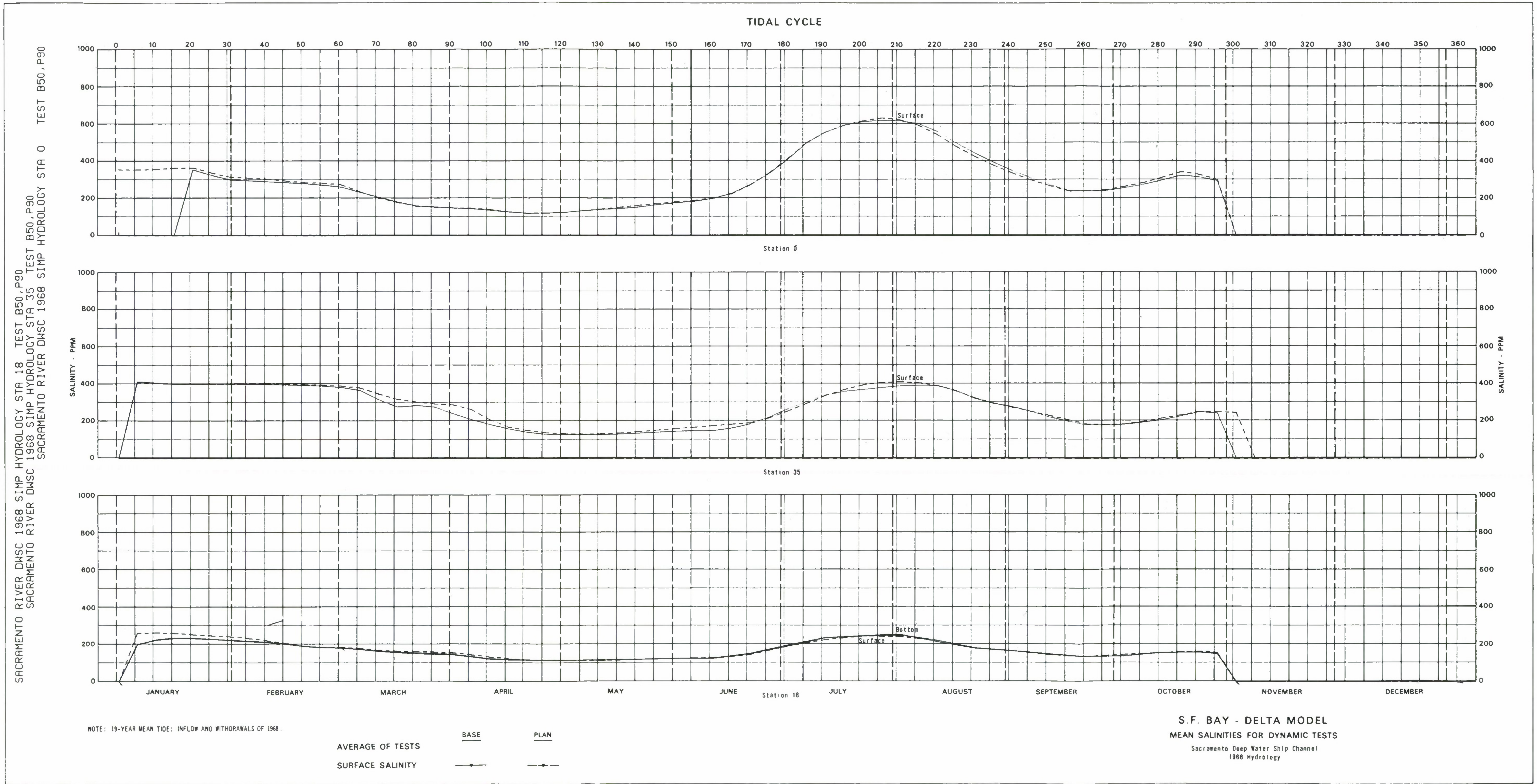


Chart 15 Sheet 3 of 4



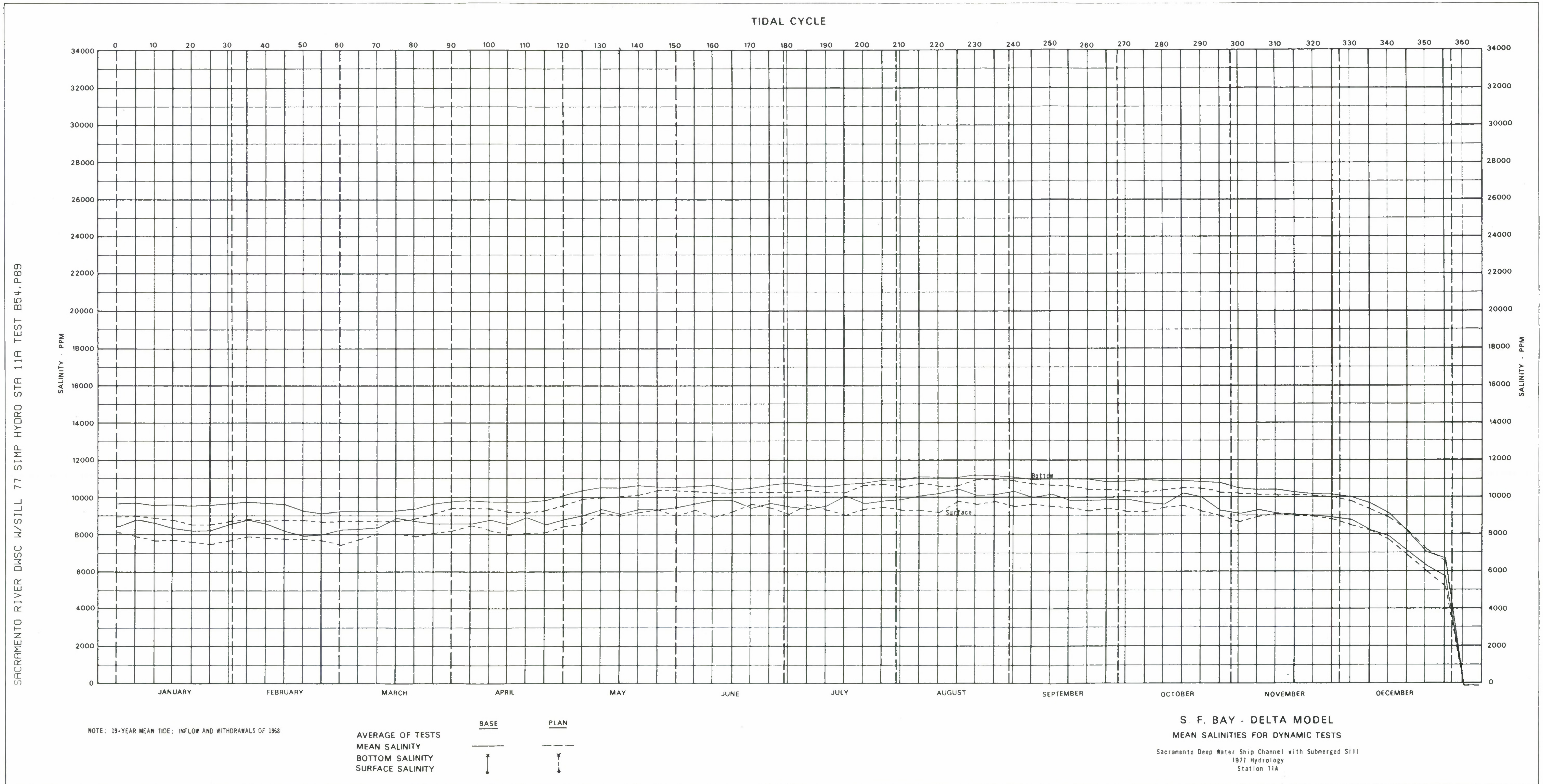
S.F. BAY - DELTA MODEL

MEAN SALINITIES FOR DYNAMIC TESTS

Sacramento Deep Water Ship Channel

1968 Hydrology

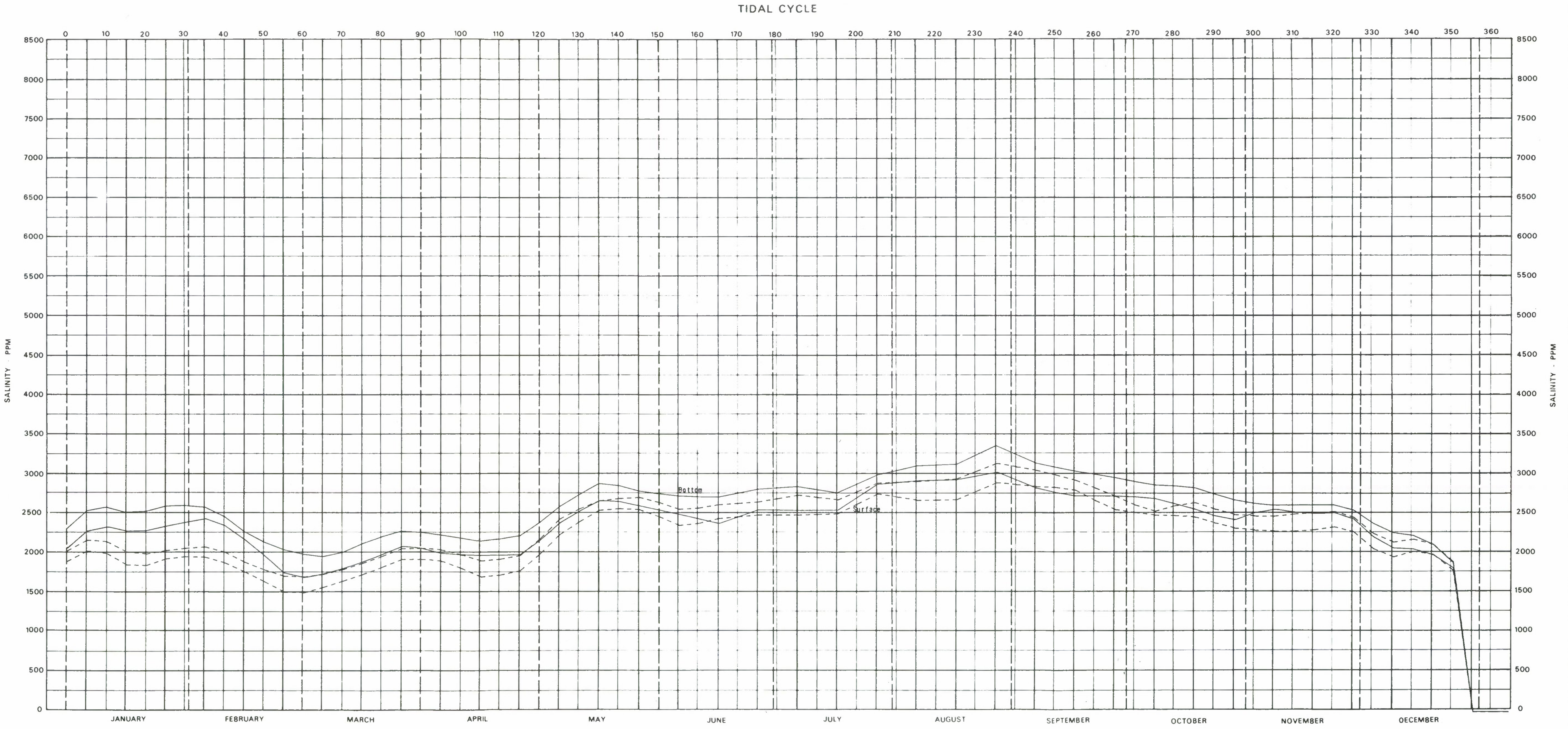
Chart 15 Sheet 4 of 4



NOTE: 19-YEAR MEAN TIDE: INFLOW AND WITHDRAWALS OF 1968

S. F. BAY - DELTA MODEL
MEAN SALINITIES FOR DYNAMIC TESTS
Sacramento Deep Water Ship Channel with Submerged Sill
1977 Hydrology
Station 11A

SACRAMENTO RIVER DWSC W/SILL 77 SIMP HYDRO STA 14A TEST B54,P89



AVERAGE OF TESTS	BASE	PLAN
MEAN SALINITY		
BOTTOM SALINITY		
SURFACE SALINITY		

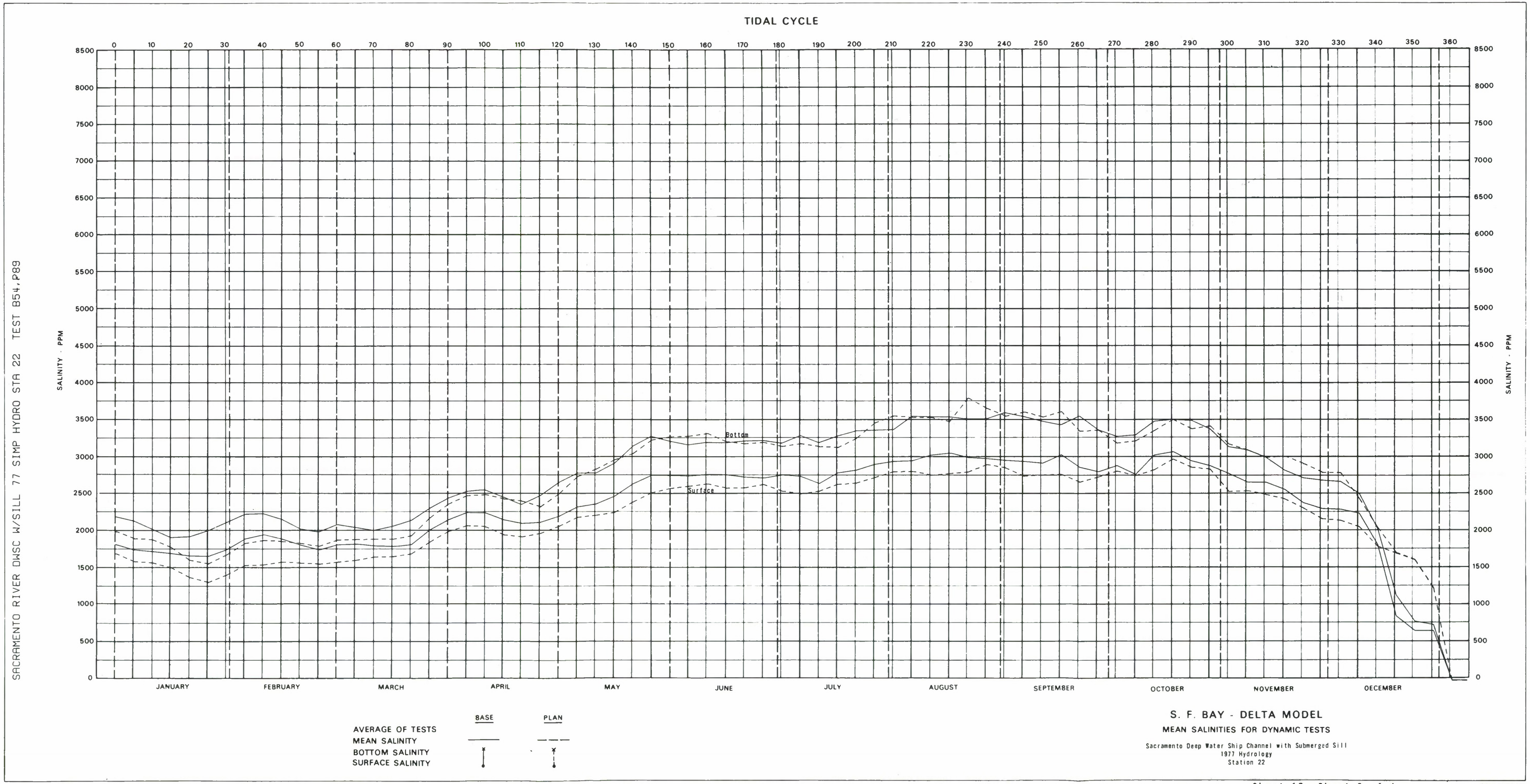
S. F. BAY - DELTA MODEL

MEAN SALINITIES FOR DYNAMIC TESTS

Sacramento Deep Water Ship Channel with Submerged Sill
1977 Hydrology
Station 14A

Chart 16 Sheet 2 of 4

GPO 190-228-1971



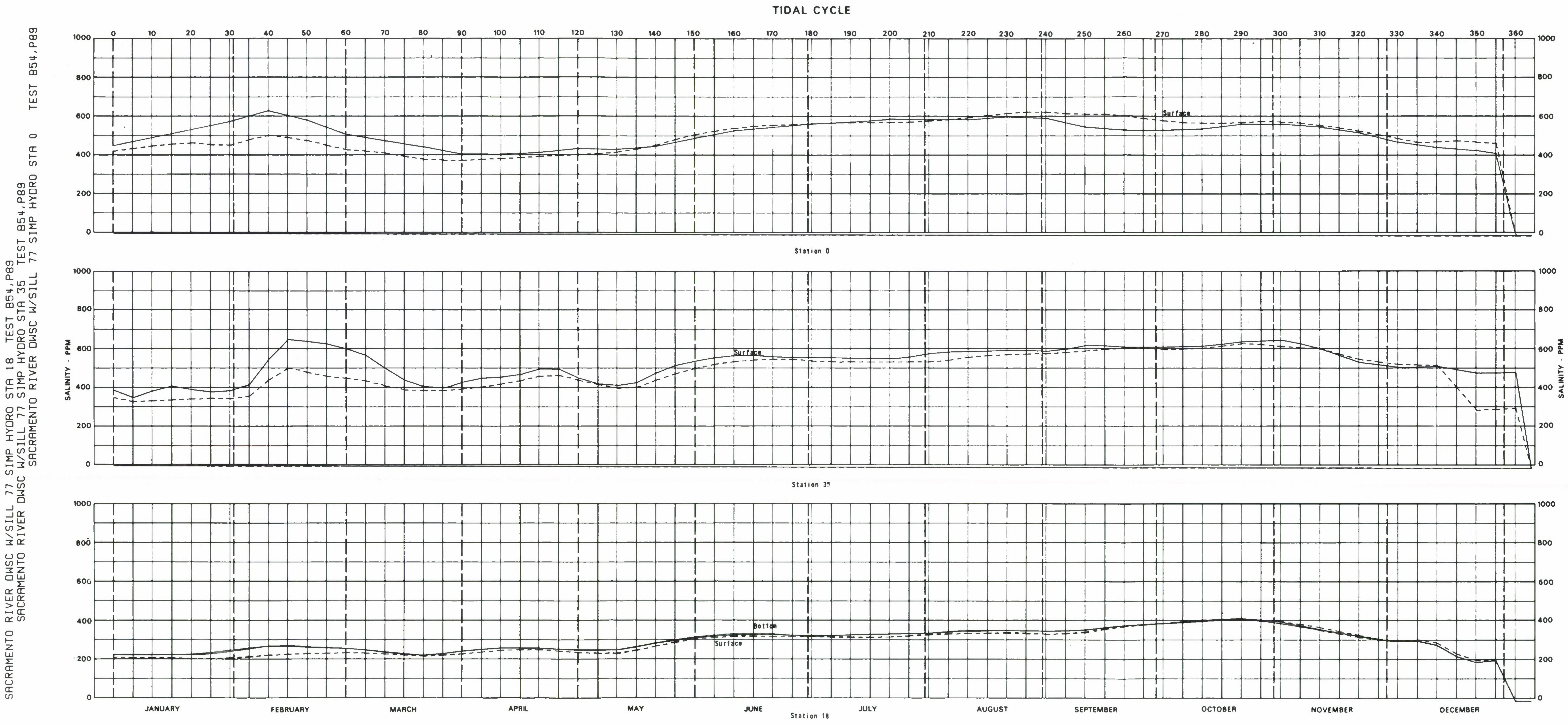
S. F. BAY - DELTA MODEL

MEAN SALINITIES FOR DYNAMIC TESTS

Sacramento Deep Water Ship Channel with Submerged Sill
1977 Hydrology
Station 22

Chart 16 Sheet 3 of 4

GPO 790-223-1977



NOTE: 19-YEAR MEAN TIDE; INFLOW AND WITHDRAWALS OF 1968.

AVERAGE OF TESTS — BASE, PLAN

SURFACE SALINITY

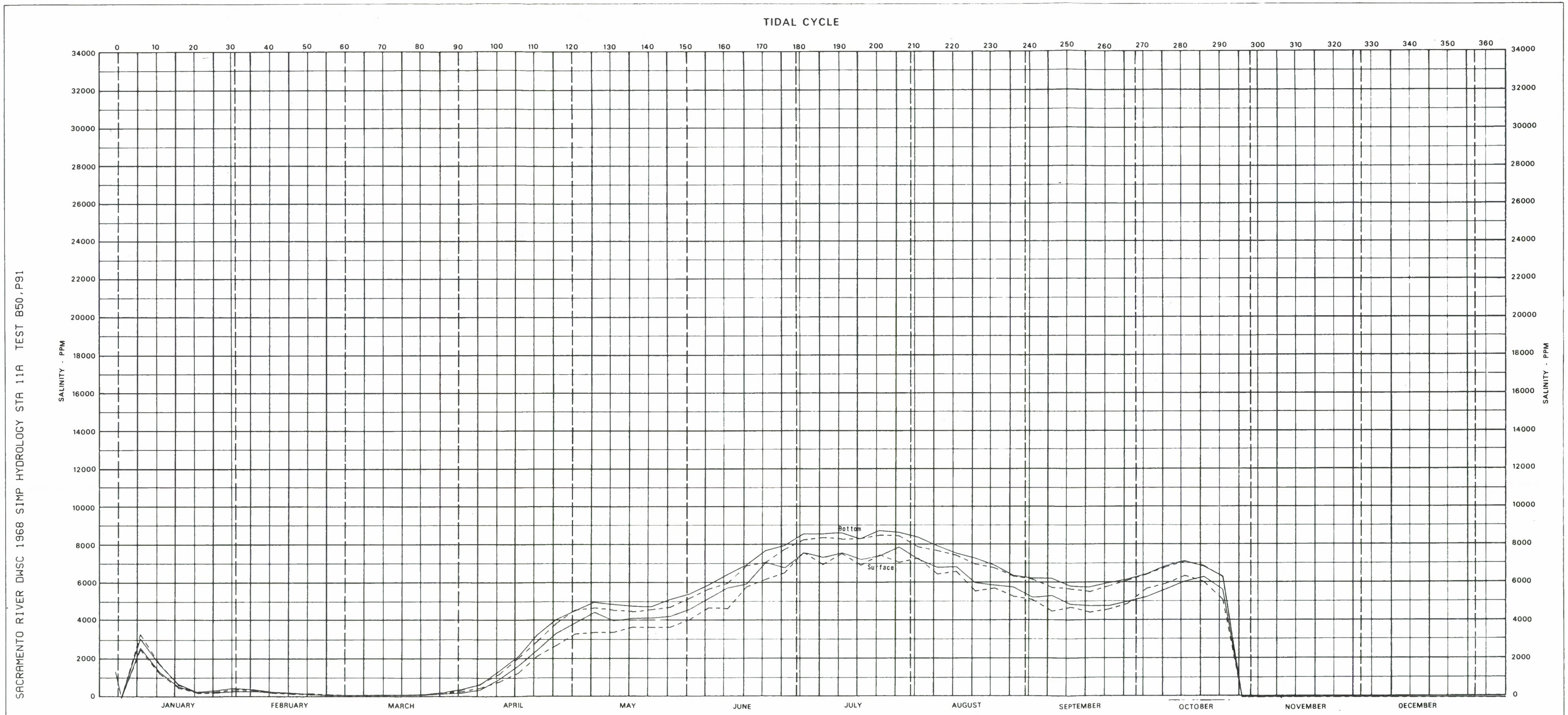
S.F. BAY - DELTA MODEL

MEAN SALINITIES FOR DYNAMIC TESTS

Sacramento Deep Water Ship Channel with Submerged Sill

1977 Hydrology

Chart 16 Sheet 4 of 4



NOTE: 19-YEAR MEAN TIDE: INFLOW AND WITHDRAWALS OF 1968

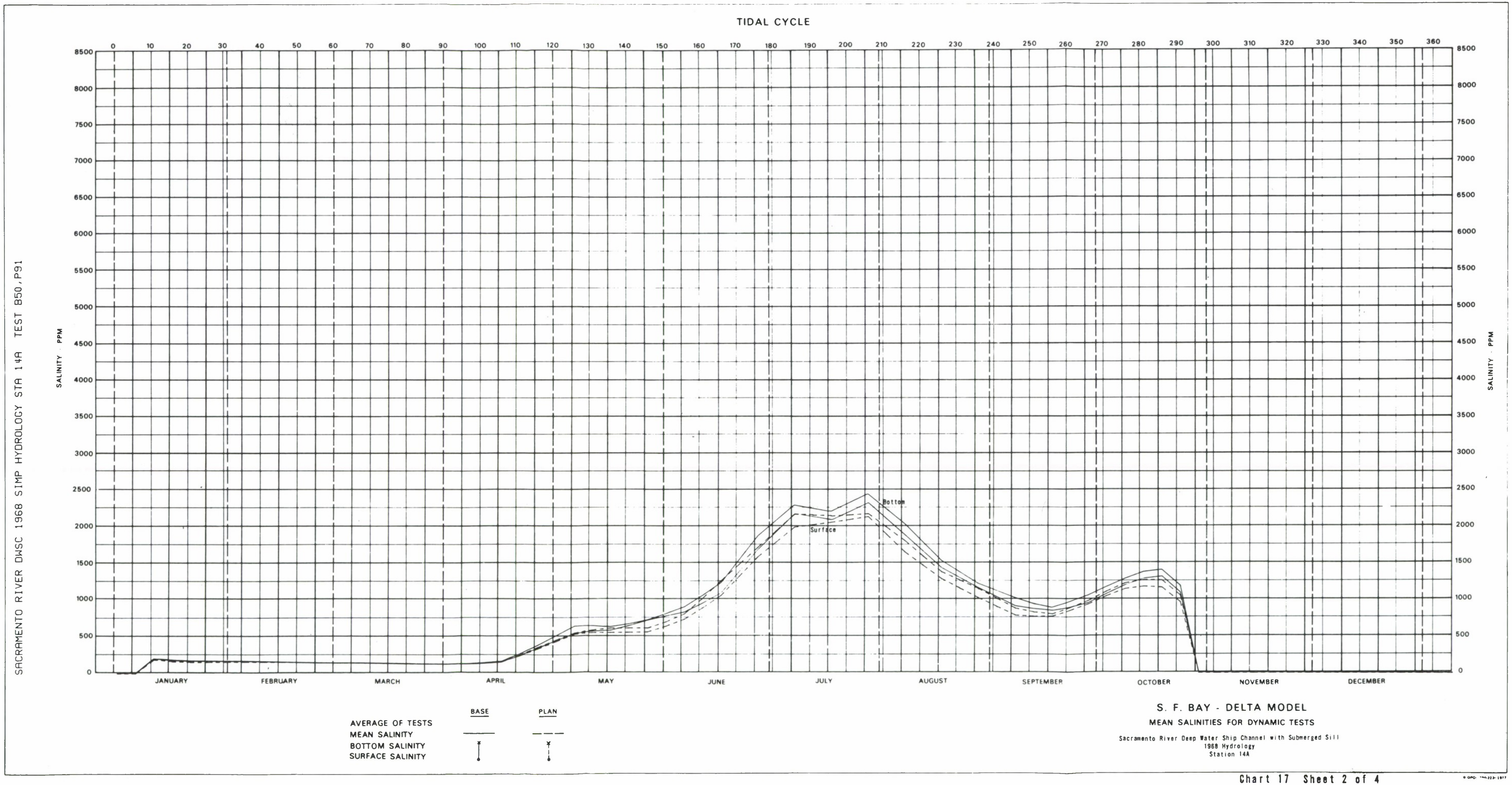
AVERAGE OF TESTS	BASE	PLAN
MEAN SALINITY		
BOTTOM SALINITY		
SURFACE SALINITY		

S. F. BAY - DELTA MODEL

MEAN SALINITIES FOR DYNAMIC TESTS

Sacramento River Deep Water Ship Channel with Submerged Sill
1968 Hydrology
Station 11A

Chart 17 Sheet 1 of 4

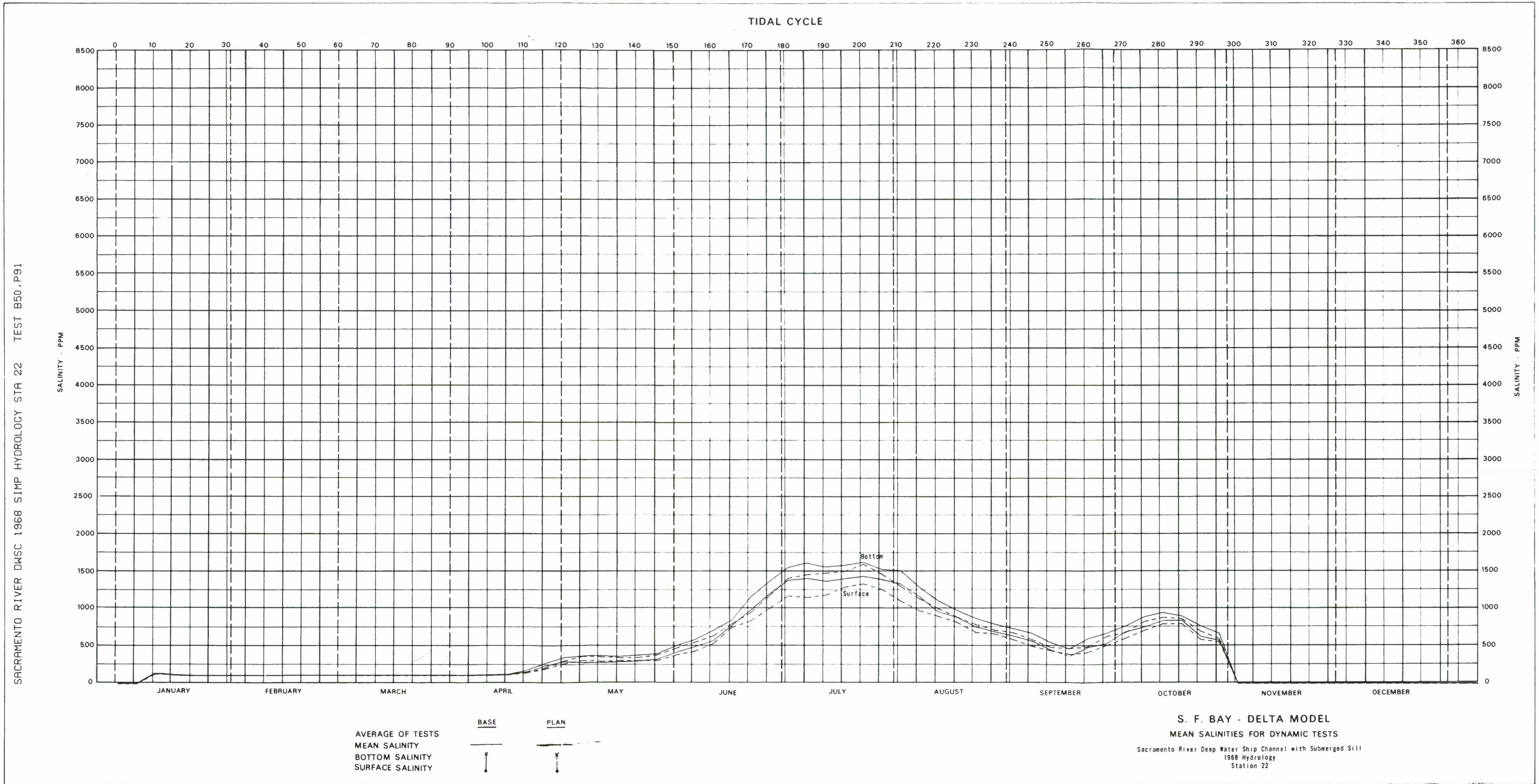


S. F. BAY - DELTA MODEL

MEAN SALINITIES FOR DYNAMIC TESTS

Sacramento River Deep Water Ship Channel with Submerged Sill
1968 Hydrology
Station 14A

Chart 17 Sheet 2 of 4

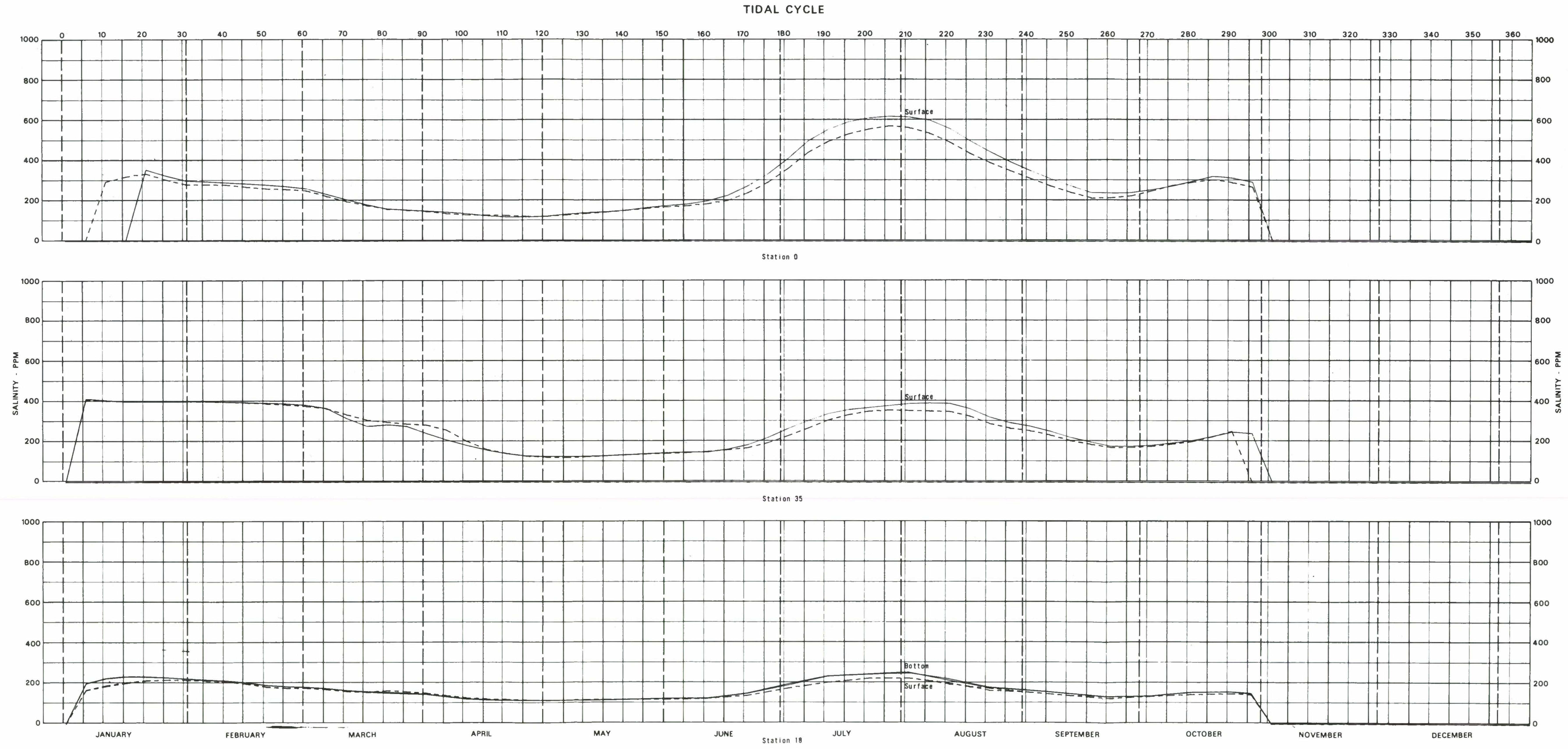


S. F. BAY - DELTA MODEL

MEAN SALINITIES FOR DYNAMIC TESTS

Sacramento River Deep Water Ship Channel with Submerged Sill
1968 Hydrology
Station 22

Chart 17 Sheet 3 of 4



SACRAMENTO RIVER DWSC 1968 SIMP HYDROLOGY STA 18 TEST B50,P91
SACRAMENTO RIVER DWSC 1968 SIMP HYDROLOGY STA 35 TEST B50,P91
SACRAMENTO RIVER DWSC 1968 SIMP HYDROLOGY STA 0 TEST B50,P91

NOTE: 19-YEAR MEAN TIDE; INFLOW AND WITHDRAWALS OF 1968.

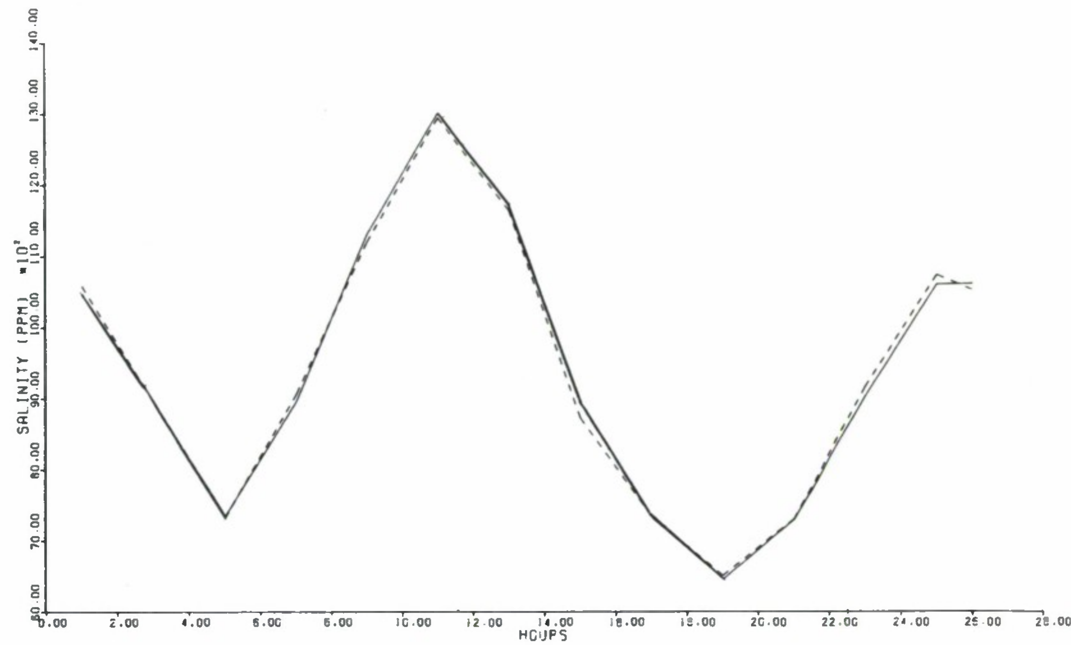
	BASE	PLAN
AVERAGE OF TESTS		
SURFACE SALINITY	—•—	–•–

S.F. BAY - DELTA MODEL

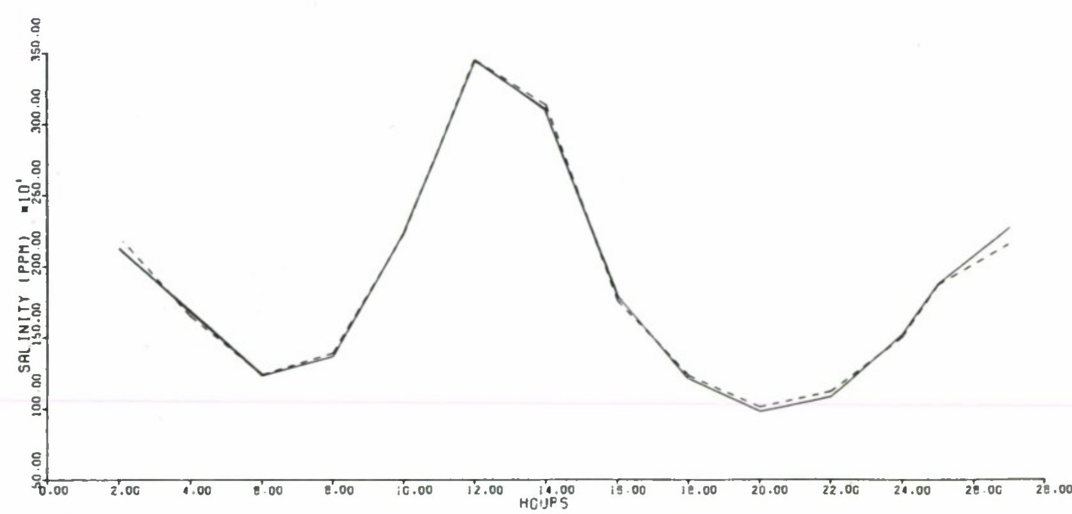
MEAN SALINITIES FOR DYNAMIC TESTS

Sacramento River Deep Water Ship Channel with Submerged Sill
1968 Hydrology

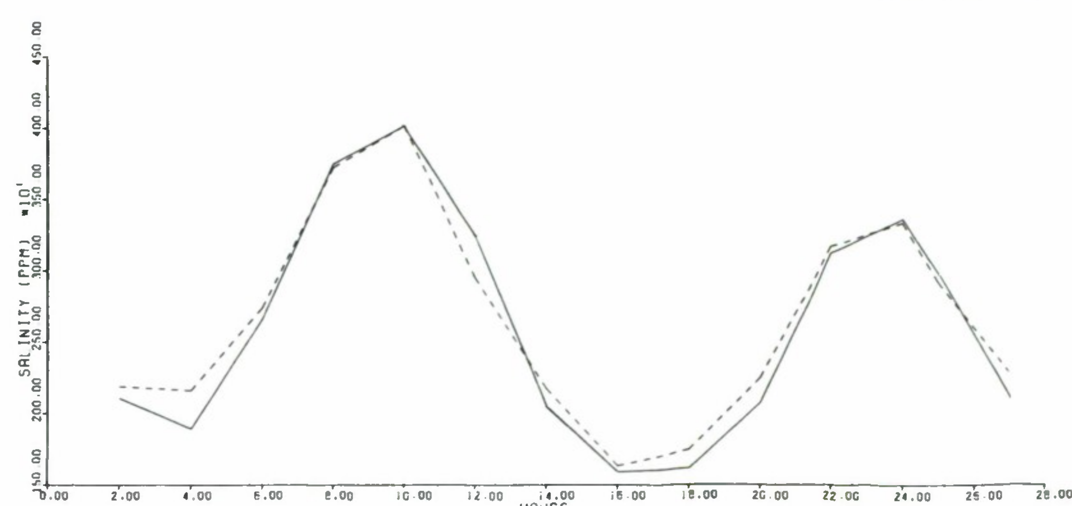
Chart 17 Sheet 4 of 4



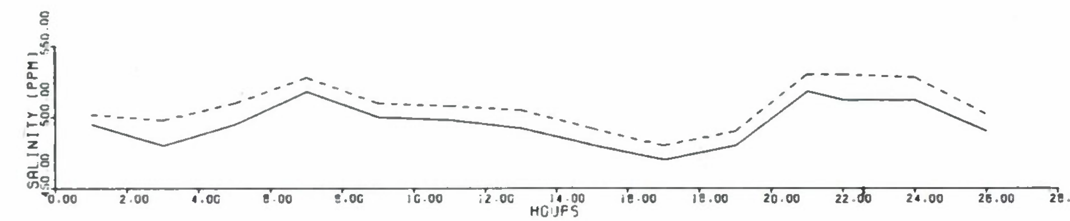
Station 11A



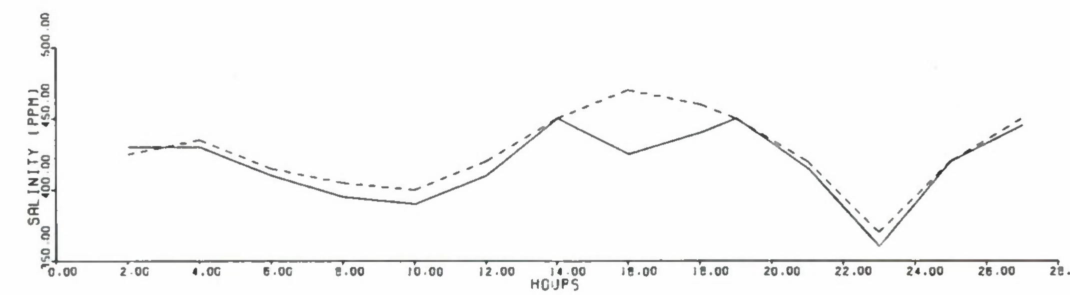
Station 14A



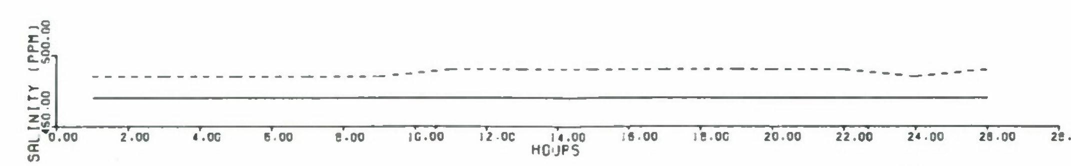
Station 22



Station 18



Station 35



Station 0

LEGEND

BASE

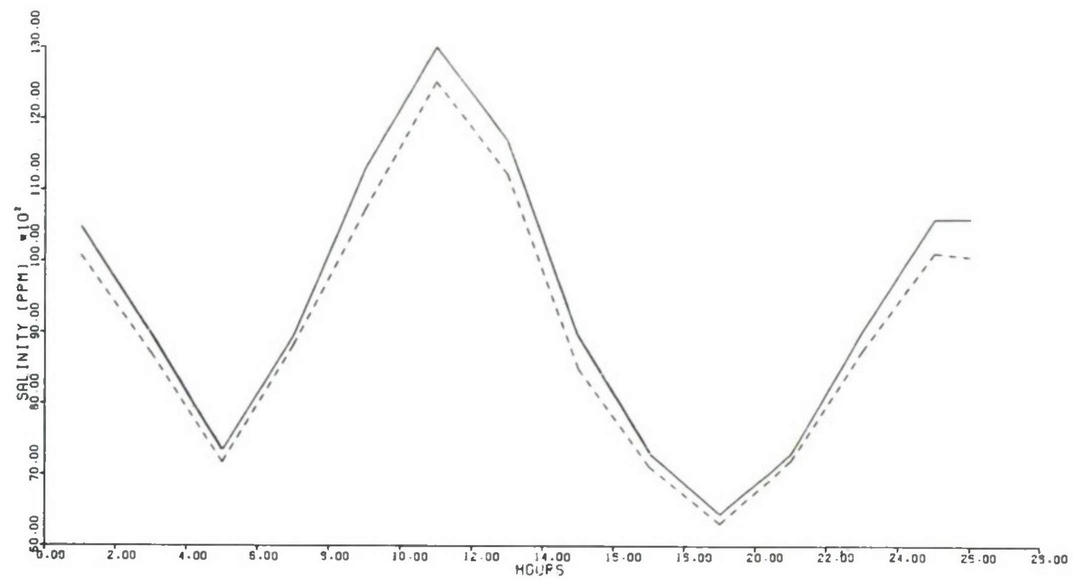
PLAN

SACRAMENTO RIVER DEEP WATER SHIP CHANNEL INVESTIGATION

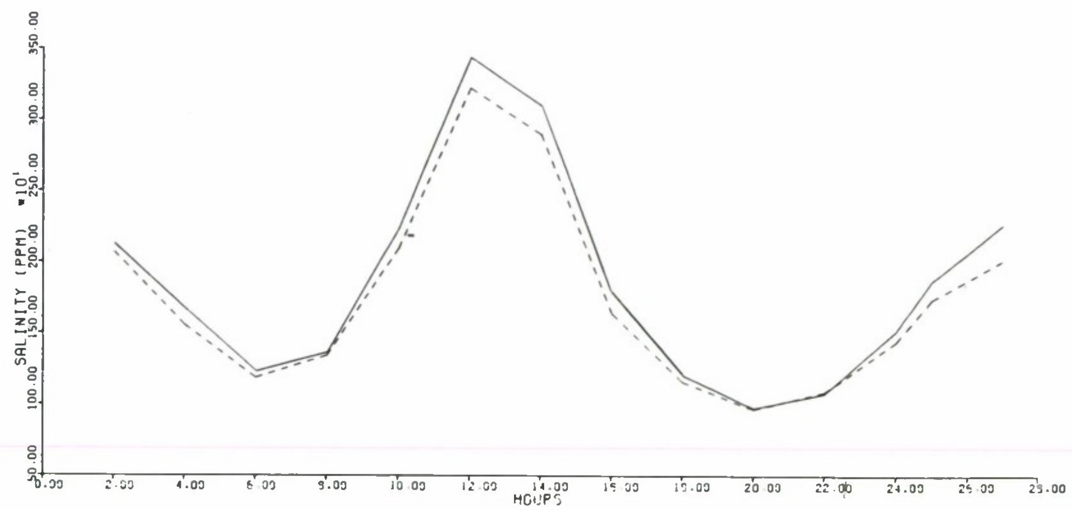
Steady State Model Test Results

Plan H-1 with Peripheral Canal
vs Base with Peripheral Canal

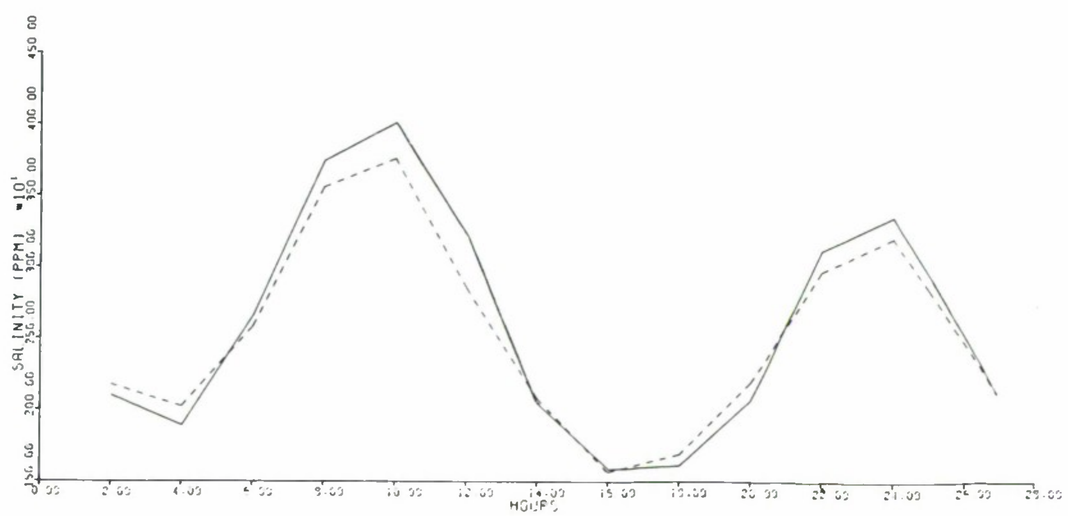
Tital Cycle Plot



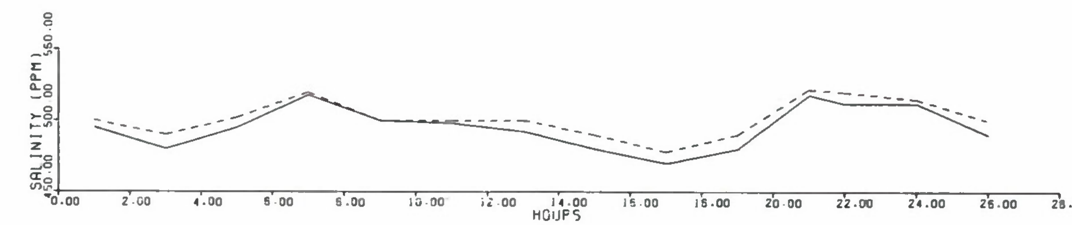
Station 11A



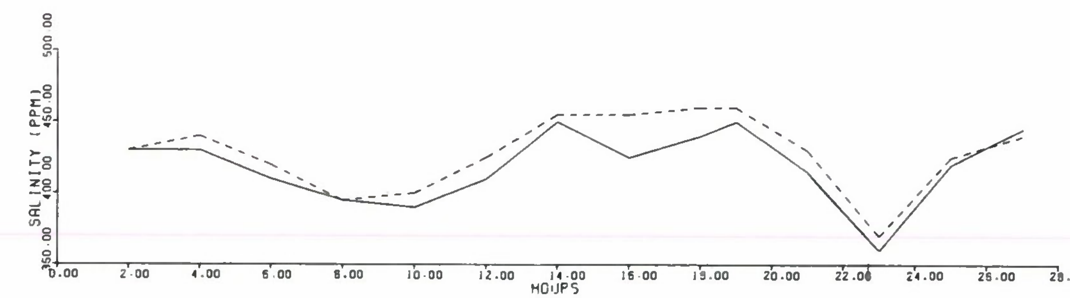
Station 14A



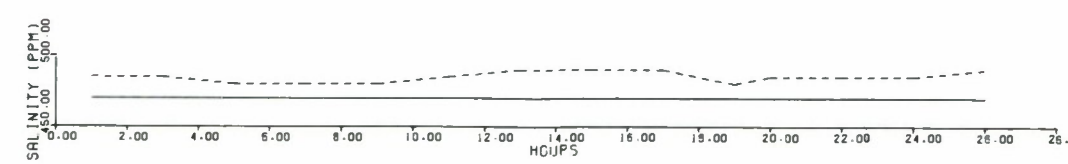
Station 22



Station 18



Station 35



Station 0

LEGEND

BASE ————————

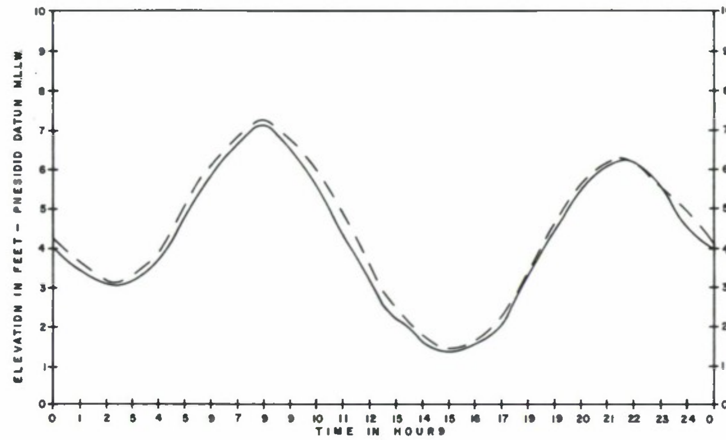
PLAN - - - - - - - - - - - -

SACRAMENTO RIVER DEEP WATER SHIP CHANNEL INVESTIGATION

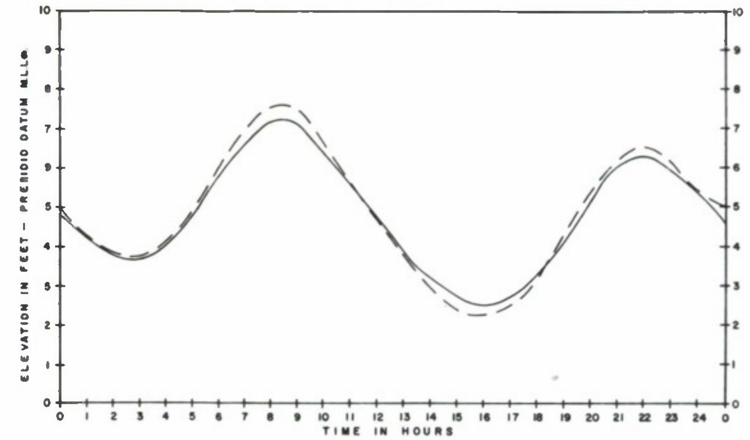
Steady State Model Test Results

Plan H-1 with P.C. and Sill vs Base with P.C.

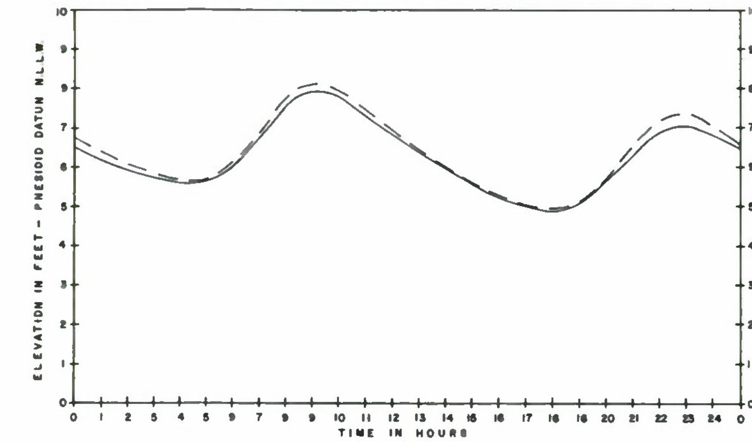
Tidal Cycle Plot



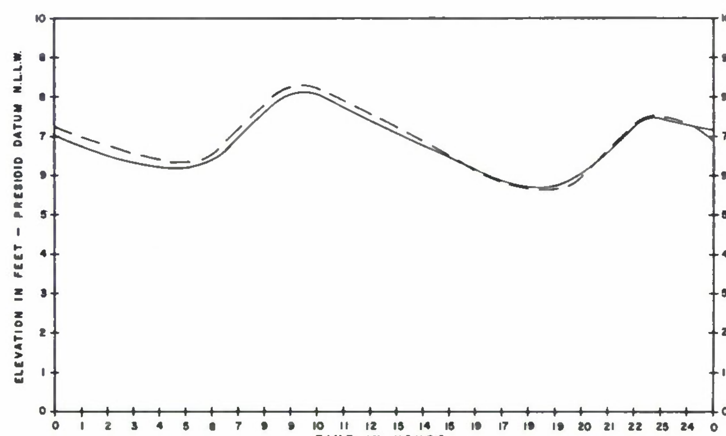
STATION 19
DILLON POINT



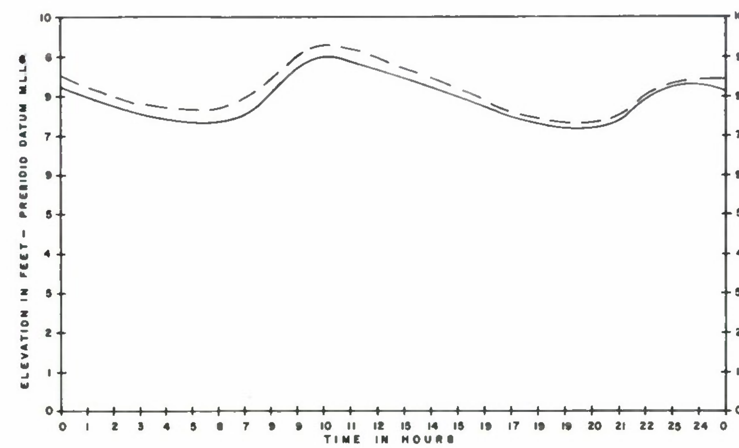
STATION 20
MARTINEZ



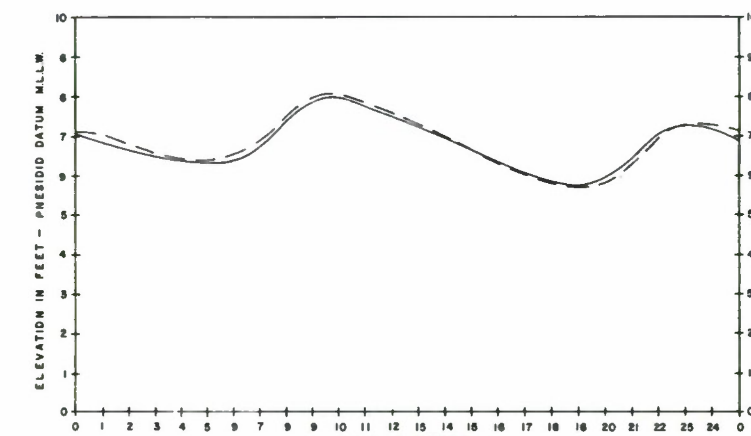
STATION 22
PITTSBURG



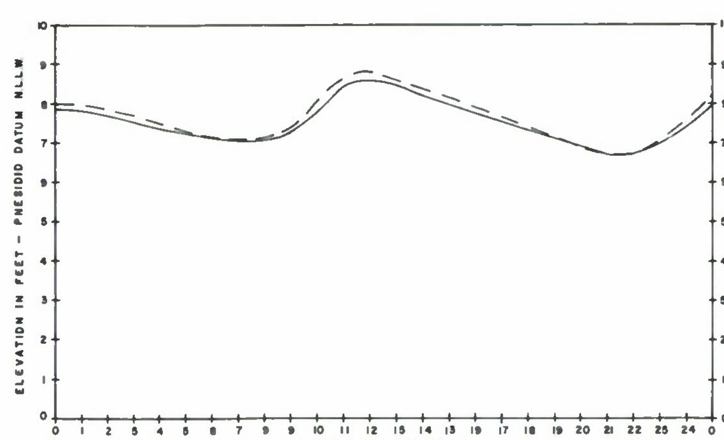
STATION 25
COLLINSVILLE



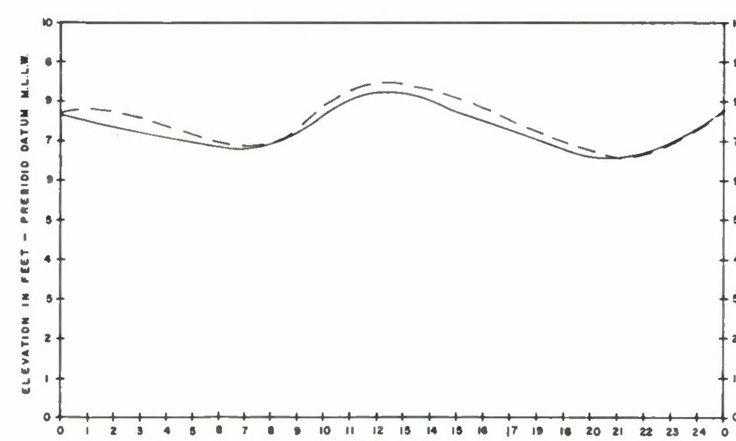
STATION 27
RIO VISTA



STATION 59
ANTIOCH



STATION 66
RINDGE TRACT NEAR 14 MILE SLOUGH



STATION 70
OLD RIVER NEAR ROCK SLOUGH

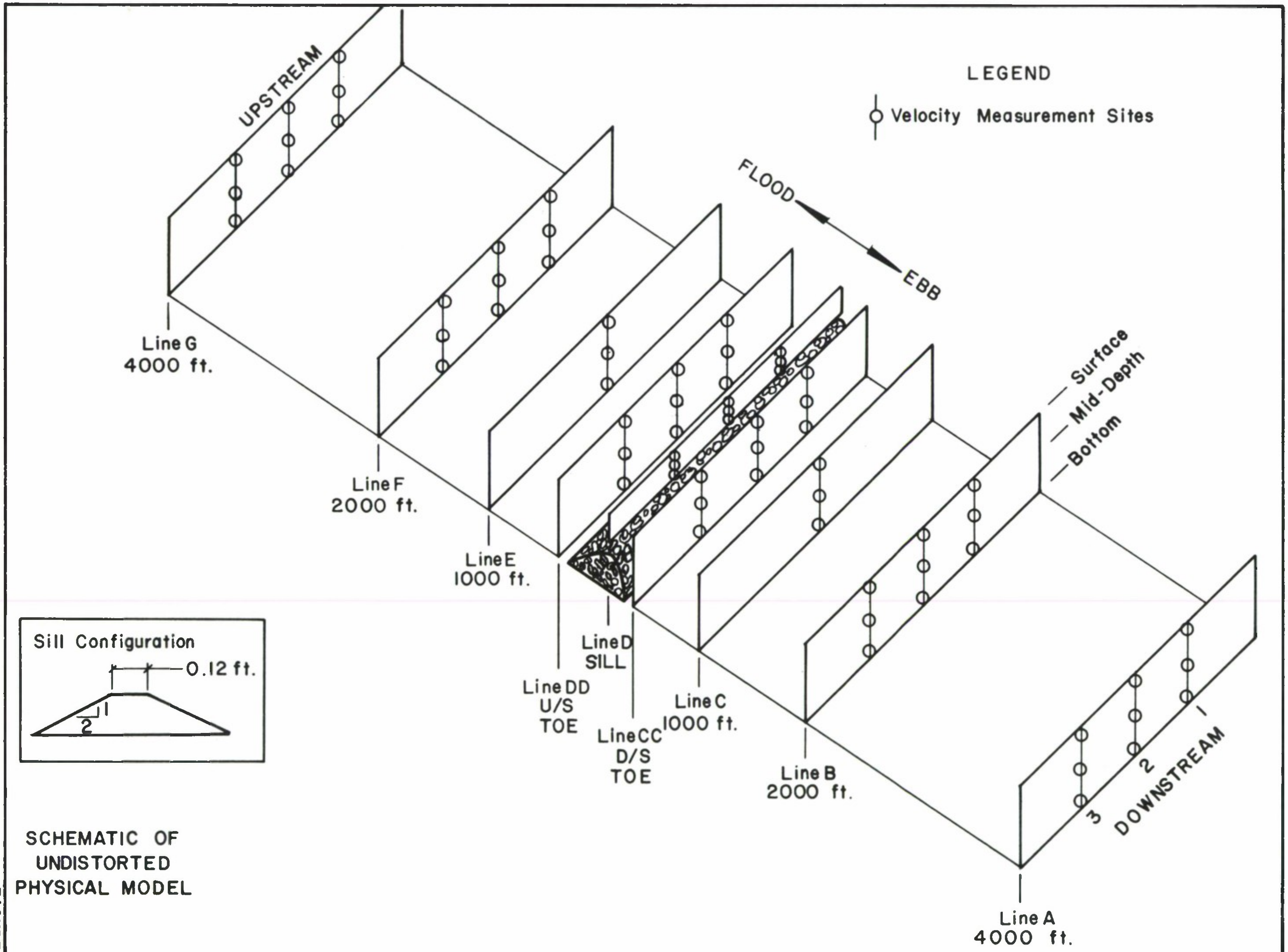
LEGEND

BASE ————
WITH SILL — — — —

SACRAMENTO RIVER
DEEP WATER SHIP CHANNEL,
CALIFORNIA

SUBMERGED SILL EFFECT ON TIDAL STAGE

SACRAMENTO DISTRICT, CORPS OF ENGINEERS
JANUARY 1979



SCHEMATIC OF
UNDISTORTED
PHYSICAL MODEL

FIGURE 1

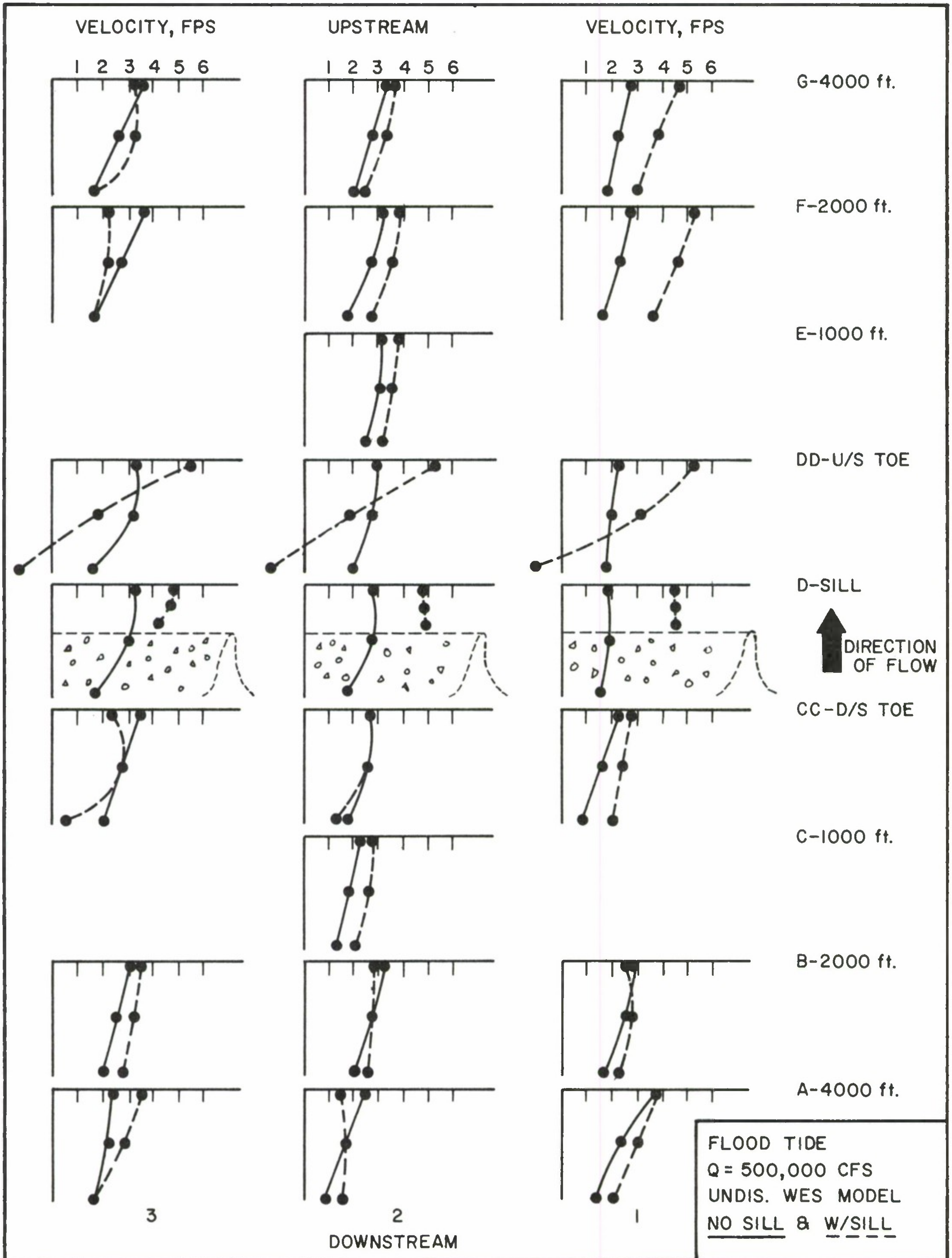

VELOCITY, FPS
UPSTREAM
VELOCITY, FPS
1 2 3 4 5 6
1 2 3 4 5 6
1 2 3 4 5 6
G-4000 ft.
F-2000 ft.
E-1000 ft.
DD-U/S TOE
D-SILL
DIRECTION OF FLOW
CC-D/S TOE
C-1000 ft.
B-2000 ft.
A-4000 ft.
3
2
1
DOWNSTREAM
FLOOD TIDE
Q = 500,000 CFS
UNDIS. WES MODEL
NO SILL & W/SILL

FIGURE 2

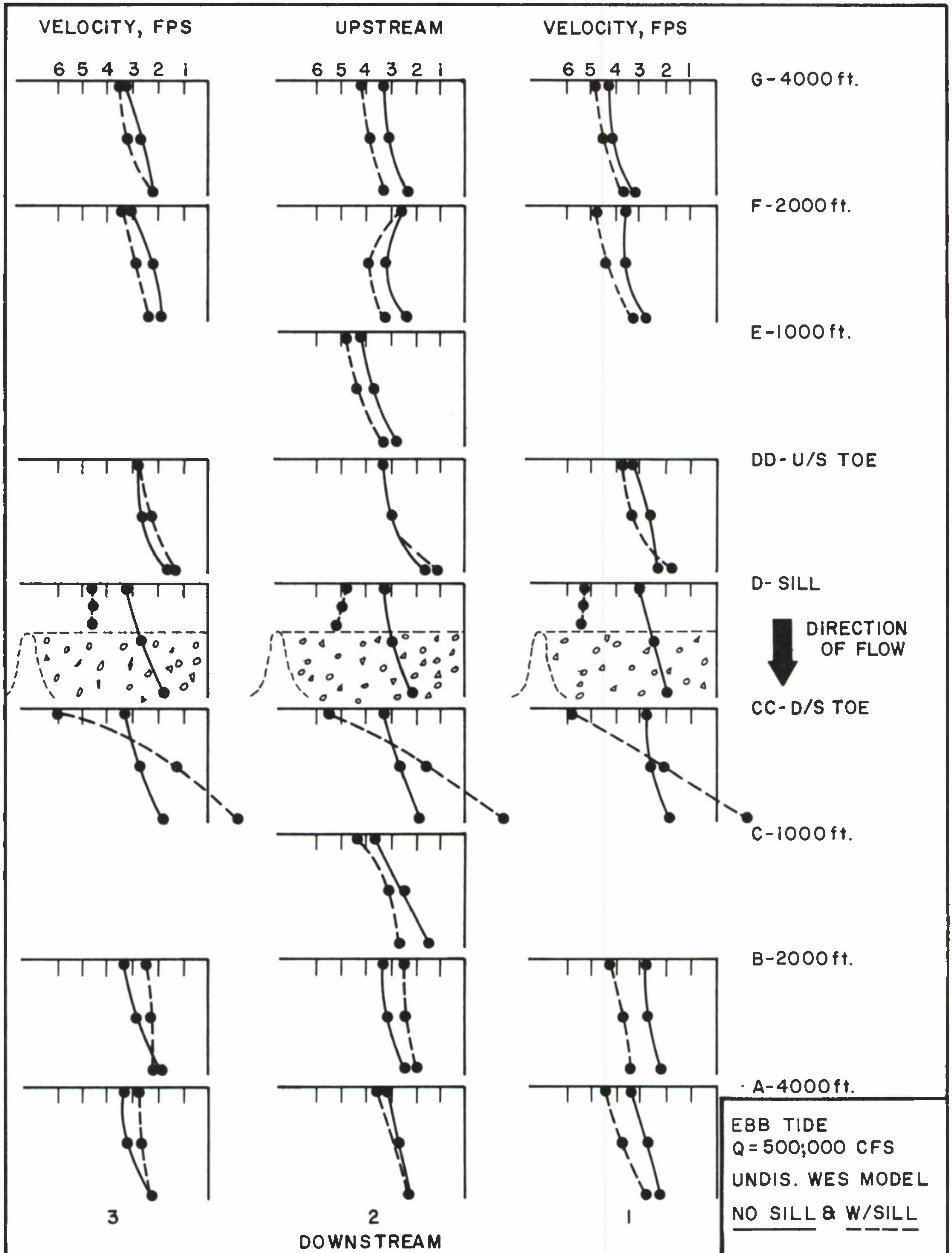

VELOCITY, FPS
UPSTREAM
VELOCITY, FPS
6 5 4 3 2 1
6 5 4 3 2 1
6 5 4 3 2 1
G-4000 ft.
F-2000 ft.
E-1000 ft.
DD-U/S TOE
D-SILL
DIRECTION OF FLOW
CC-D/S TOE
C-1000 ft.
B-2000 ft.
A-4000 ft.
3
2
1
DOWNSTREAM
EBB TIDE
Q = 500,000 CFS
UNDIS. WES MODEL
NO SILL & W/SILL

FIGURE 3

DEPARTMENT OF THE ARMY
WATERWAYS EXPERIMENT STATION. CORPS OF ENGINEERS
P. O. BOX 631
VICKSBURG. MISSISSIPPI 39180

IN REPLY REFER TO: WESHV

18 July 1979

Mr. George C. Weddell
Chief, Engineering Division
U. S. Army Engineer District, Sacramento
650 Capitol Mall
Sacramento, CA 95814

Dear Mr. Weddell:

As you are aware, the San Francisco Bay-Delta Model Advisory Committee met at the model on 10 July 1979 to consider a number of questions raised by your office concerning model tests of the Stockton Ship Channel and Sacramento River Deep Water Channel projects. A brief report by the committee that addresses each of these questions is inclosed for your information.

A copy of the inclosed report has been furnished to each committee member and to Mr. Wardell Johnson of the model staff for information purposes.

Please let me know if further assistance from the Advisory Committee is needed on this matter.

Sincerely,

H. B. Simmons

H. B. SIMMONS
Member, Advisory Committee

1 Incl
As stated

CF:
Dr. Krone
Dr. Pritchard
Dr. Fischer
Mr. Albrecht
Mr. Johnson

Review by Advisory Committee of Bay-Delta Model Tests of the Stockton Ship Channel and Sacramento River Deep Water Channel Projects

During our meeting of 11 July 1979, the Advisory Committee considered the questions posed by the Sacramento District. The following responses to these questions are the results of review of the material provided to the Committee members, consideration of material presented by the staff of the Engineering Division of Sacramento District during the meeting, and our previous experience with the Bay-Delta model.

a. Are the results of steady-state and dynamic tests consistent?

The results of the steady-state and dynamic tests appear to be consistent within the precision of model predictions. There appear to be some identifiable causes of variation, such as small changes in ocean salinities or fresh water inflows, and some salinity variations even after many tidal cycles at steady-state that have not been attributed to any known cause and that leave a narrow band of uncertainty in model predictions. This band of uncertainties can be narrowed by repetitions of tests. Such repetitions would involve considerable increases in costs of model tests, however.

b. "Simplified" hydrology, defined on page 9 of the February 1979 Office Study was used for steady-state and dynamic tests. However, "full" hydrology (without elimination of agricultural drains, etc.) was used in verification of the model. Is the use of simplified hydrology acceptable, considering model accuracy and project elements; i.e., the channels are being deepened only 5 ft to the same depth as downstream channels? Note that 1977 hydrology (drought conditions) was used.

Simplified hydrology, using changed Sacramento River flow and export pumping to simulate channel depletions, were used in model tests to reduce the cost of the tests. The very small effect of the channel deepening predicted by the model under these conditions suggest that changes in the prototype would also be small. Basic considerations of impacts of distributed withdrawals on the transport of salts in Delta channels, however, led the Committee to express concern about the validity of salinity predictions in the interior of the Delta, such as at Stations 0 and 35.

Results of base tests using more detailed channel depletions (tests 27, 30, 34, 35, 40, 41, 45, 46, and 49) can be compared with base test 50 which utilizes the simplified hydrology to determine the effect of this model change on its representations of existing salinities. Further, Plan test 83 using detailed hydrology can be compared with Plan test 84 to assess the effect on the prediction for the Plan. Finally, the two pairs of base and plan tests can be compared. The results of such comparison should provide evaluation of the effect of this model simplification.

Channel depletions in the Delta are unverifiable. The method of withdrawal does not facilitate measurement, farm practices and demands vary widely, and no means haveyet been found to complete a water balance around the Delta. We are only able to adjust channel depletions in the model until salinities in the model simulate salinities in the prototype.

c. Since dynamic tests were verified using the existing prototype and since steady-state tests have no basis for verification, are the results of the dynamic tests more valid? Should steady-state test results be used in analyzing the effects of channel deepening? If so, how?

The dynamic tests simulate temporally changing hydraulic conditions. If the model faithfully simulates these conditions, it should also simulate steady-state conditions: the two are nearly identical under 1977 hydrology. A critical flow condition was selected for tests of the effect of channel deepening on salinity in the Delta. Unless a more critical flow condition can be identified, this test should be adequate.

d. Based on the model studies that have been conducted what conclusions related to salinity do you believe are appropriate when considering the effects of channel deepening, particularly with respect to some of the upstream stations such as "0" and "35"?

The model test results show changes that are within variations that would be expected if there were no effect of deepening the channel. It can be concluded that the model test results do not predict changes in salinity due to channel deepening; i.e., changes measured are smaller than the model can accurately predict.

e. Steady-state tests were conducted with and without the Peripheral Canal to determine the possible effect of that proposed facility on channel deepening; do results of those tests appear reasonable? Should tests of the Peripheral Canal be rerun using dynamic test procedures?

The 1977 hydrology was apparently selected for these tests because it was the critical condition. No more critical condition is evident except that of lower Delta outflows. If lower outflows are contemplated, it may be desirable to simulate those conditions. Long times (many annual cycles) may be necessary before such low outflows are adequately simulated, however.

No additional tests are warranted unless a more critical operating condition is identified.

f. We are examining the possibility of a pre- and post-project monitoring program to (1) determine the effects of channel deepening and to (2) determine the need for a submerged sill. Considering the variability of hydrology, etc., is gathering data on such parameters as salinity, sediment transport, velocity, etc. meaningful, and could conclusions be reasonably drawn from such a monitoring program?

The wide variation of salinities in the Delta under present and future conditions limits the probability of determining from field data the very small changes in salinities (if any) expected on the basis of the model tests. It would be desirable, however, to have reliable salinity data from eastern portions of the channel. Monitoring stations of other agencies should be investigated for adequacy. If such stations are not already in existence, a limited number of high quality, well maintained salinity monitoring stations should be installed. Measurements of other parameters would be useful for other purposes, but for evaluating the effects of the channel deepening on salinity only salinity need be measured.

g. Are additional model tests recommended?

As stated above, any changes that might occur in the salinity distribution as a result of the proposed project are smaller than the model can accurately predict; consequently, except as noted below, we recommend that no further salinity tests in the hydraulic model relative to this project be undertaken.

In Item (b) above we have recommended that four specific tests be evaluated to determine the effects of the simplified hydrology on the salinity within the Delta. A majority of the Committee, Dr. Fischer dissenting, feels that further tests might be indicated if this evaluation shows significant differences in the salinities as measured in the Delta with simplified hydrology as compared to full hydrology.

SACRAMENTO RIVER DEEP WATER
SHIP CHANNEL, CALIFORNIA
FEASIBILITY REPORT AND
ENVIRONMENTAL IMPACT STATEMENT
FOR NAVIGATION AND RELATED PURPOSES

Comments and Responses

APPENDIX 6

PREPARED BY THE
SACRAMENTO DISTRICT, CORPS OF ENGINEERS
DEPARTMENT OF THE ARMY

This appendix contains all comments which were received specifically as a result of coordination of the draft feasibility report and environmental impact statement. Responses to comments received on the draft environmental impact statement are also included in this appendix. Responses to comments received on the draft feasibility report are included in that document.

Comments and Responses

All comments received were reviewed and the feasibility report and environmental impact statement were revised as warranted. Additional information or elaboration is required to respond to some comments. This information is presented below.

Many agencies recommended that the cumulative impacts of the Sacramento, Stockton, and Baldwin ship channels be discussed in a single document since the Delta would be subjected to their combined effects if all the channels were constructed. In responding to this comment, differences between the projects as related to position in the authorization process should be distinguished. The Baldwin and Stockton Channels have been authorized for construction by Congress. Advanced engineering and design (AE&D) studies are now being conducted on those projects. A General Design Memorandum (GDM) and EIS addressing the impacts of the Stockton Ship Channel is scheduled to be completed in 1980. AE&D studies of the Baldwin Channel are also underway at this time, however, unresolved environmental problems are hampering completion of those studies. The investigation of the Sacramento River Deep Water Ship Channel is a feasibility study. The purpose of this study is to determine if it is economically, socially, and environmentally feasible to deepen the Sacramento Channel. Congress will use the results of this investigation to determine whether the project should be authorized for construction. If authorization is received, AE&D studies would then be conducted on the Sacramento Channel as they have been for the Stockton and Baldwin Channels.

AE&D studies would address in detail many of the concerns, comments, and recommendations developed during the feasibility investigation. These post-authorization studies of salinity intrusion and submerged sill or alternative mitigation measures would be conducted by the Corps of Engineers in cooperation with the California Department of Water Resources and other concerned State and Federal agencies. These studies will reevaluate the salinity incursion effects of channel deepening. The results of these studies would be compared to existing conditions. The impacts of the proposed project would be addressed in an EIS which would accompany the General Design Memorandum describing the studies.

If the post-authorization studies indicate a measurable increase in salinity levels, a submerged sill or alternative mitigative measure would be constructed as part of the Sacramento River Deep Water Ship Channel project and completed at the same time as that project.

With respect to the Baldwin Channel, studies of that project would consider the deepened Sacramento and Stockton Channels as a preproject condition. Any adverse impact associated with the Baldwin project would have to be mitigated by that project.

Amendments to the Endangered Species Act of 1973 were enacted into law in 1978 and 1979 during final stages of this planning study, and implementing regulations by the lead agencies have not been promulgated. A list of endangered and threatened species was developed by the Corps of Engineers and coordinated with the Office of the Secretary of the Interior. An assessment of the impacts on known endangered species in the project area was conducted by the Corps of Engineers with the finding that no significant impacts are expected. No adverse comments on the impact finding were received during coordination of the report and draft Environmental Impact Statement. Consultation will be initiated after authorization.

The following table of "Comments and Responses" summarizes comments made on the draft EIS, who made the comment, and where in the report the response is located. Some comments on the draft EIS did not require a revision to the report, only a direct response. These comments, together with their responses, may be found beginning on page 4.

A listing of letters received and copies of the letters may be found beginning on page 10.

Comments and Responses

Comment	Location of Modification	Agency/Organization
Questions validity of salinity studies and/or Hydroscience model.	Page 86, 87, Appendix 1, E-11, DEIS Page 3-12.	Resources Agency, National Marine Fisheries Service, U.S. Geologic Survey, and ABAG.
Evaluate environmental impacts of sill.	Pages 86, 87. Appendix 1, Page E-4 and E-12. Appendix 3, Page 3-18. Appendix 4, Page 3.	U.S. Geologic Survey, National Marine Fisheries Service, Resources Agency, Environmental Protection Agency, U.S. Department of the Interior, California Regional Water Quality Control Board, and ABAG.
Expand discussion on heavy metal release.	Appendix 1, Page B-14. Appendix 3, Page 3-18.	California Regional Water Quality Control Board, Environmental Protection Agency, City and County of San Francisco, and ABAG.
Mosquito abatement on constructed marshlands.	Appendix 3, Page 3-21.	Solano County Mosquito Abatement District.
Describe habitat at DMD sites.	Appendix 1, Page B-17, B-18.	California Waterfowl Association
Discuss dredged soil and potential problems of disposal.	Appendix 3, Page 3-17.	Division of Mines and Geology, California Regional Water Quality Control Board, Resources Agency, and Bureau of Mines.
Identify upland habitat mitigation.	Appendix 3, Page 3-21.	Resources Agency, and Environmental Protection Agency.
Industrialization of Collinsville-Montezuma Hills area should be considered part of the project and its impacts should be discussed.	Page 65, 75.	National Marine Fishery Service.

Discuss 404 requirements.	Appendix 4.	Regional Water Quality Control Board.
Include Donlon Island as enhancement.	Appendix 3, Page 3-21.	Resources Agency.
Indicate compliance with Section 7 of Endangered Species Act.	Appendix 3, Page 3-14.	Department of Interior.
Discuss chemical and biological characteristics of channel sediments.	Appendix 1, Page B-14. Appendix 3, Page 3-18.	Department of Interior, City and County of San Francisco, and ABAG.
Update water quality standards reflecting Decision 1485.	Appendix 4, Page 5.	Resources Agency.
Include analysis of effects of project on water quality other than salinity.	Appendix 1, Page B-11, B-14.	EPA, City and County of San Francisco, and ABAG.
Expand air quality impacts section.	Appendix 3, Page 3-20.	EPA
Timing of construction activities to avoid impacts on anadromous fish.	Appendix 3, Page 3-15.	ABAG.
Provide information on future land use on DMD sites.	Appendix 1, Page D-33. Appendix 3, Page 3-26.	Yolo County Planning Department.
Expand discussions on cumulative impacts on planktonic and benthic organisms and fish.	Appendix 1, Page B-19 and B-20, and Appendix 6.	National Marine Fisheries Service.
Discussion of known endangered species of wildlife.	Appendix 1, Pages B-23 through B-26.	U.S. Concord Naval Weapons Station.
Incorrect statement regarding zoning in vicinity of port.	Appendix 3, Page 3-26.	Yolo County Planning Department.

1. **Comment** — The Environmental Impact Statement should include a projection of trips to be generated and an analysis of impacts to existing transportation facilities. (Business and Transportation Agency and Resources Agency.) The DEIS should qualitatively discuss the impacts of future developments, particularly potential petrochemical industry development, resulting from channel deepening (ABAG).

Response — A complete analysis of secondary impacts such as those discussed above will be included in the Environmental Impact Statement which would be prepared in the Advanced Engineering and Design (AE&D) Stage.

2. **Comment** — Phytoplankton densities, as defined by chlorophyll resources, decrease rather than increase in the area immediately upstream of the entrapment zone. Page B-17 (Department of the Interior).

Response — Information on page B-17 concerning phytoplankton was obtained from a report titled Neomisu Studies, 7 June 1977, by Arthur Knutson of Hydroscience, Inc., as referenced. A detailed explanation of this data is included in the referenced report.

3. **Comment** — The final EIS should more fully address the effects of the project on users of water from the Delta (Resources Agency).

Response — The impacts of the project on water uses was considered and addressed as necessary. Recall that this report concludes that proposed deepening will not affect Delta water quality.

4. **Comment** — Section IV, Parts 4.10 and 4.11 must be expanded to reflect the requirements of 40 CFR 1508.7 "Cumulative Impact" and 40 CFR 1508.8 "Effects" (National Marine Fisheries Service).

Response — The information on cumulative impact and effects contained in the EIS is sufficient for this feasibility-level stage of planning. If the proposed project is authorized by Congress, additional information on these points would be obtained during the AE&D stage and presented in additional reports (e.g., draft and final Phase 1, General Design Memorandum).

5. **Comment** — The EIS should include mitigation measures to minimize the increased salinity and other associated water quality impairments due to ballast water discharge from ships using the channel (Environmental Protection Agency).

Response — Control of ballast discharge is the responsibility of the Environmental Protection Agency and Regional Water Quality Control Board as indicated in the EIS. Water quality problems have developed out of enforcement problems, not project operation, and are not the responsibility of the project.

6. **Comment** — The draft statement indicates that only one of eleven possible sites would be developed for recreational use. Consideration should be given to incorporation of certain less intensive recreational development options (Department of Interior).

Response — Pursuant to the requirements of Public Law 89-72, the Corps of Engineers can develop recreation areas only where non-Federal sponsors agree to administer recreation developments and pay 50 percent of capital costs and all O&M costs or if another Federal agency undertakes administration pursuant to their separately authorized programs. Although additional recreation opportunities were considered, Solano County is the only sponsor to declare its intent and for only one recreation site as indicated in the EIS and feasibility report.

7. **Comment** — Will dredging activities result in an increased rate of methylation of mercury in sediments due to exposure of previously biologically relatively isolated sediments to organisms capable of methylation? Do the dense, mercury-containing particles in the sediment tend to lag behind during dredging? What is the potential for filter feeders and fish in the neighborhood of the dredging operation to acquire increased mercury contents during the several years required to complete this project? If fish and shellfish increase in mercury content, what would be the effect on commercial and sport fisheries? The unsupported statement on page D-38 that "Any increase in turbidity and possible resuspension of toxic materials as a result of dredging would not be expected to have an adverse effect on fish, fish eggs, and fish larvae. Suction dredging would not cause any detectable increase inturbidity." although it states above in the same paragraph "There may be some short-term local increase in turbidity . . . ," does not adequately deal with the possible impacts on important fishery resources (City and County of San Francisco).

Response — The conclusion on page D-38 that there will be no adverse effect due to the possible resuspension of toxic materials is supported by various pieces of evidence. Perhaps the most important are studies done by Engler (1977) and reported on page 3-12 of the EIS. The results as reported show that pesticides and heavy metals which are absorbed to sediment particles are not usually released into the water during disturbance from dredging. In many cases, dredging actually reduces the amount of these toxic substances by removing them with the bottom sediments. The tests conducted by Engler were made with toxic sediments. Those sediments tested in the Sacramento Deep Water Ship Channel thus far have shown very low levels of heavy metals. In addition, suction dredging does not cause as high a disturbance to bottom sediments, and therefore less turbidity than other methods of dredging. Additional studies conducted since the Engler studies, the results of which are included in the EIS (page 3-12), further support our conclusions. The apparent contradiction between statements about the impacts of suction dredging on turbidity arose because the reviewer apparently missed the conclusion of the second statement which reads "There may be some short-term local increases in turbidity **and decreases in dissolved oxygen near the discharge from the dredged material disposal area"** which did not apply to suction dredging.

8. **Comment** — The dredge spoils are to be deposited on land and, in part, used for recreational development. What means are proposed to prevent environmental mercury dispersion from these spoils? (City and County of San Francisco)

Response — Based on the information we have collected to date, we do not feel heavy metals will be a problem. If during further studies it is decided that heavy metal contamination is a possibility, appropriate measures will be included to prevent this contamination. Mitigation measures could include controlled release from upland spoil site discharge to minimize turbidity and seeding to prevent erosion.

9. **Comment** — The genus of the California Poppy is Eschscholtzia not Eschsholzia (page B-15) (City and County of San Francisco).

Response — Actual spelling is Eschscholzia.

10. **Comment** — Expand description of the John F. Baldwin and Stockton Ship Channels to include that reach of the project which would extend upstream of the Sacramento River to the Collinsville-Montezuma Hills Area (National Marine Fisheries Service).

Response — The Avon to New York Slough Reach is common to the Stockton and Sacramento Ship Channels. The Stockton Channel does not extend to the Collinsville-Montezuma Hills area. The channel reach upstream of New York Slough is designated as the Sacramento River Deep Water Ship Channel. The New York Slough to Collinsville reach is included in the selected plan and is thoroughly described in Appendix 1 Section E.

11. **Comment** — Discuss the impact of the project on prime agricultural land (Soil Conservation Service).

Response — At the time the report was prepared no survey was available for the project area delineating prime and unique farm lands. However, the DMD sites proposed for use on this project were previously used as DMD sites for the original construction of the channel. Therefore no impact to prime and unique farm land is expected.

Comments and Responses

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S. I. HAYAKAWA
CALIFORNIA

GENE PRAT, PH. D.
ADMINISTRATIVE ASSISTANT

United States Senate
WASHINGTON, D.C. 20510

COMMITTEES:
AGRICULTURE, NUTRITION, AND FORESTRY
FOREIGN RELATIONS
SMALL BUSINESS

November 19, 1979

Colonel Paul Kavanaugh
District Engineer
U.S. Corps of Engineers
650 Capitol Mall
Sacramento, CA 95814

Dear Colonel Kavanaugh:

I am writing this letter regarding the proposed Sacramento Deep Water Ship Channel. The project is currently under study by the United States Corps of Engineers. Hearings have recently been held on the proposal. I respectfully request that this letter be made part of the hearing record.

As you are aware, deepening the channel from 30 to 35 feet will make the Port of Sacramento more competitive by allowing a greater number of ships to successfully navigate the channel. It is my understanding that the project's benefits outweigh the costs, and that possible salinity problems resulting from the deepening of the channel can be overcome.

I believe that this project is necessary in order to maintain Sacramento's economic vitality as a center of shipping and commerce. I am pleased to lend my support to the project.

Sincerely yours,

S. I. Hayakawa

S. I. Hayakawa

SIH/mg

ALAN CRANSTON
CALIFORNIA

United States Senate
WASHINGTON, D.C. 20510

February 29, 1980

Colonel Paul Kavanaugh
District Engineer, Sacramento District
Army Corps of Engineers
650 Capitol Mall
Sacramento, California 95814

Dear Colonel Kavanaugh,

It is my understanding that you will soon forward the District Engineer report on the deepening of the Port of Sacramento to the Division Engineer with your recommendation on the project. This letter is to let you know that I support the proposed deepening of the Port of Sacramento, assuming the remaining environmental problems can be resolved.

There is a great need to deepen the Port of Sacramento from 30 to 35 feet to accommodate the new generation of cargo ships now in service and to ensure that Sacramento continues to be a viable port.

I am aware that there has been considerable concern about the possibility of salt water intrusion as a result of the project. While I share this concern for the protection of the Delta, I'm hopeful you can work out a solution to the salinity problem with the State of California and that an economically feasible and environmentally sound project can go forward.

With best regards,

Cordially,

Alan Cranston

Alan Cranston

NORMAN D. SHUMWAY
14TH DISTRICT, CALIFORNIA

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MARK A. DENERO
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CHRISTOPHER C. SEEGER
ADMINISTRATIVE ASSISTANT

COMMITTEE ON BANKING, FINANCE AND URBAN AFFAIRS

October 26, 1979

Colonel Paul F. Kavanaugh
District Engineer
U.S. Army Corps of Engineers
65D Capitol Mall
Sacramento, California 95814

Dear Colonel Kavanaugh:

For the record of the public hearing on Tuesday, November 19, 1979, I am writing to express my strong support for the Port of Sacramento's channel deepening project.

I have long been an observer of the efforts of the Port officials to deepen the channel since the Sacramento project closely resembles a similar effort on the part of officials from the Port of Stockton--which is within my congressional district.

A deeper channel for Sacramento means larger dry bulk carriers and other more modern vessels will have the opportunity to berth in Sacramento's port. The impact on the Sacramento economy would be most beneficial, and at a time when our nation's trade deficit is so overwhelming, the channel improvements would certainly enhance the effort to decrease this deficit.

Again, let me stress my support for this most vital project.

With best regards,

Sincerely,

NORMAN D. SHUMWAY
Member of Congress

NDS/blp

cc: Mr. Melvin Shore,
PORT DIRECTOR
Port of Sacramento

Committee on Public Works and Transportation

Congress of the United States
House of Representatives
Room 2165, Rayburn House Office Building
Washington, D.C. 20515
TELEPHONE: AREA CODE 202, 225-4472

October 26, 1979

Colonel Paul F. Kavanaugh
District Engineer
U. S. Engineers
650 Capitol Mall
Sacramento, California 95814

Dear Colonel Kavanaugh:

Sacramento River Deep Water Channel Deepening Project

I am advised that there will be a public hearing held on November 13, 1979, relative to your report on deepening the Sacramento River Deep Water Ship Channel. I write to support that deepening and urge that the report be expedited on its way back to the Congress.

The original channel and harbor project was finished in 1963 after earlier benefit/cost ratio studies reported favorably. The 1955 study that reported favorably, was based upon the premise of moving 853,000 tons of cargo per year on the average over the 50 year economic life of the project. Here in the 16th year, the Port is already serving the agricultural and forestry needs of the area by handling almost 2 million tons per year. In fact, the Port recently handled the 20 millionth ton which is almost one-half of that projected for 50 years of operation.

The continued economic viability of the Port is threatened, however, by the needs of the world's fleet. These vessels have grown in size, hence in draft, to the point where many of those calling cannot load to full capacity. These vessels must be topped-off at other ports. Such a procedure destroys the economic base of the port and can only ultimately lead to a decline in volume which would trigger a series of events that would undermine the foundation of the Port's activity.

It should also be pointed out that over 90% of the Port's business is export of commodities, many of them from northern California. These local commodities not only create employment in our area, but they also assist in feeding peoples around the world. The fact that these commodities are exported is also vital to assisting in rectifying the balance-of-payments problem the country is facing.

I note that your report has addressed any environmental problems including mitigation where necessary. With this in mind and recognizing the great economic value of this project to the area and the country, I urge that your report be approved and speeded on its way back to the Congress.

Sincerely yours,

HAROLD T. (BIZZ) JOHNSON
Chairman

HTJ:g

VIC FAZIO
4TH DISTRICT, CALIFORNIA

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DISTRICT DIRECTOR:
WYMAN RILEY

DISTRICT REPRESENTATIVE:
JUDY KERN

November 13, 1979

Col. Paul F. Kavanaugh
District Engineer, U. S. Engineers
650 Capitol Mall
Sacramento, CA. 95814

Dear Col. Kavanaugh:

If Sacramento is to remain a viable port, it is imperative that the Sacramento Deep Water Channel be dredged to allow passage of an increasing number of larger vessels. The economics of the shipping industry have dictated the building of larger ships capable of carrying greater tonnage in order to provide the benefit of lower transportation costs. Already, the current 30-foot channel depth is no longer able to accomodate some ships when fully loaded. These vessels are forced to top off at other locations with resulting delays which translate into higher operational costs. The additional expenditure is then passed on to the consumer in the form of higher prices.

Many of the benefits to be gained from increased use of the Port facilities are obvious while others may not be so readily apparent. A study conducted by the California State University, Sacramento, shows that the Port presently creates approximately 5,000 direct and indirect jobs and brings approximately $60 million into the area annually. This, of course, would expand proportionately with growth.

Due to the nature of the cargoes it handles, the Sacramento Port is primarily an export port and thus helps to offset the balance of payments deficit which reached the neighborhood of $18 billion in the first nine months of this year. Additional benefits will be derived by virtue of the fuel savings generated from greater use of shipping vs. truck transportation and the accompanying reduction in air pollution.

The Corps. investigation has determined that deepening of the channel will not adversely affect Delta flows or increase salinity intrusion. The conversion of a 45-acre area on Prospect Island to a wetland habitat will serve to mitigate the impact on wildlife and any temporary displacement of fish and wildlife food sources in the dredging area would quickly be replaced.

The economic benefits to be gained by further dredging of the Deep Water Channel are difficult to dispute. The Port of Sacramento will gradually become non-competitive if a deeper channel is not created which will result in a loss of jobs and other benefits to surrounding communities. Furthermore, additional delays in the project will substantially increase the cost because of inflation.

I strongly support the deepening of the channel to 35 feet, and offer my assistance in securing Congressional support for the funding necessary to bring this project to conclusion.

Sincerely,

Vic Fazio

VIC FAZIO
Member of Congress

VF:jkj

ROBERT T. MATSUI
3RD DISTRICT, CALIFORNIA

COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE
SUBCOMMITTEES:
COMMUNICATIONS
TRANSPORTATION AND COMMERCE

COMMITTEE ON GOVERNMENT OPERATIONS
SUBCOMMITTEES:
COMMERCE, CONSUMER AND MONETARY AFFAIRS
GOVERNMENT ACTIVITIES AND TRANSPORTATION

SELECT COMMITTEE ON NARCOTICS ABUSE AND CONTROL

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January 16, 1980

Colonel Paul F. Kavanaugh
District Engineer, U.S. Engineers
650 Capitol Mall
Sacramento, California 95814

Dear Colonel Kavanaugh:

I have been advised that on November 13, 1979, the Army Corps of Engineers held a public hearing to report on your investigation of deepening the S.R.D.W.S.C. I should like to take the opportunity to address this most important issue.

The Port of Sacramento is an integral part of the economic well-being of this area, and the entire state of California. In order to enhance its value, it is essential that we look to means of improving the service that the port now provides. The increase in the general size of the average ship in the world fleet, the need to modernize to maintain and indeed improve the American competitive position in world trade, and the prospective increase in foreign markets for California, all dramatize the need for deepening the channels of the Port of Sacramento.

I commend you on undertaking this investigation and urge you to continue your efforts in this regard.

Thank you for the opportunity to present my views.

Very truly yours,

Robert T. Matsui

ROBERT T. MATSUI
Member of Congress

RTM:ssd

PLEASE RESPOND TO: ☐ WASHINGTON OFFICE ☐ DISTRICT OFFICE

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State Senator
Jim Nielsen
Fourth District
Napa, Sacramento, Solano, Sonoma, and Yolo Counties

COMMITTEES
Agriculture and Water Resources
Education
Natural Resources and Wildlife
Revenue and Taxation
Joint Committee on Fairs Allocation and Classification
Vice Chairman of Senate Rural Caucus
Capitol Area Committee

November 13, 1979

Colonel Paul F. Kavanaugh
District Engineer, U.S. Engineers
650 Capitol Mall
Sacramento, California 95814

Dear Colonel Kavanaugh:

Regretfully, I will not be able to attend the final public hearing to be held this evening for the purpose of public comment on the Corps of Engineers' study of the feasibility of deepening the Sacramento River Deep Water Ship Channel. I have reviewed the Corps' study and wish to express my full support of its adoption.

The Port of Sacramento plays a key role in world trade. Its record of success has far surpassed its earliest estimated projections. There is no question as to the economic importance of the Port, its potential to the area, and the importance of water transportation as a valuable means of energy conservation. For these reasons and many more advantages, I encourage the adoption of this study and the deepening of the Deep Water Ship Channel.

Sincerely,

Jim Nielsen

JIM NIELSEN

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NORMAN S. WATERS
Assemblyman
7th District

CHAIRMAN
ASSEMBLY RURAL CAUCUS

COMMITTEES
- Local Government
- Agriculture
- Ways and Means
- Joint Committee on Fairs, Allocation and Classification
- Western States Forestry Task Force
- Chairman, Subcommittee on Fairs with Horseracing

November 7, 1979

Colonel Paul F. Kavanaugh
District Engineer
U.S. Engineers
650 Capitol Mall
Sacramento, California 95814

Dear Colonel Kavanaugh:

I'm sorry but I will not be able to attend your public hearing on November 15 on the deepening of the Sacramento River Deep Water Ship Channel, but I want to go on record as strongly supporting this project.

The impact of the Channel on the economy of Sacramento and the foothill counties since its opening in 1963 has been tremendous. Much of the timber harvested in California finds its way through the Port of Sacramento. The rice that is raised here in the Valley that feeds people all over the world goes through the Port.

There can be no question of how important the Channel is to the economy of Northern California. If this is going to continue then the Channel is going to have to be expanded. The existing Channel is inefficient and unsafe.

I strongly support the improvement of the Channel. The Port of Sacramento is a vital part of the Sacramento economy.

Sincerely,

NORMAN S. WATERS

NSW.plj

ALPINE SACRAMENTO AMADOR CALAVERAS SAN JOAQUIN EL DORADO MONO TUOLUMNE

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AGRICULTURE

LINDA THAYER
ADMINISTRATIVE ASSISTANT

JEFF SHELTON
FIELD REPRESENTATIVE

BARBARA MORRIS
FIELD REPRESENTATIVE

November 20, 1979

Colonel Paul F. Kavanaugh
U. S. Army Corps of Engineers
Sacramento District
650 Capitol Mall
Sacramento, California 95814

Dear Colonel Kavanaugh:

I am writing you to add my support for the proposed deepening of the Sacramento River Deep Water Ship Channel from 30 to 35 feet. My reasons are not unique; they represent the vital need to improve the Port of Sacramento's competitive position by lowering shipping costs to this area's producers and consumers.

The Port's direct employment of 1600 people, with another 3200 jobs indirectly created, and its generation of over $60 million dollars a year is a substantial economic benefit to the community. The Port is an important transit point for the shipping of various bulk cargoes, of which rice and wheat are important products to my district.

But the competitive position of the Port and the bulk product producers is threatened. The Deep Water Channel cannot fully accommodate many transport vessels because it was originally designed for ships with a 28.7 foot draft. Newer vessels with a draft of 33 to 38 feet must now light load at the Port and top off in the Bay Area.

I understand that the adverse impact on wheat shippers alone can be measured at $2 per ton increased shipping costs. This differential can only increase as reliance on increasingly more expensive alternative transportation modes continues.

I am pleased that the Corps has conducted extensive modeling tests which have determined that there will be no increase in salinity as a result of the channel deepening and that, as a safeguard, a sill has been designed that will eliminate any increase in salinity in the event the Corps' prediction is flawed in some way. However, I urge the Corps, as a condition of its proceeding with this project, to be prepared to take whatever steps are necessary to guarantee the environmental integrity of the Delta. This must include the development of alternative irrigation systems should salinity intrusions or any other environmentally damaging conditions arise or appear likely to occur.

The deepening of the channel will benefit the Port and it will benefit many and varied industrial and agricultural producers in California. The need for the project is undeniable and I urge a favorable acceptance of the channel deepening proposal.

Sincerely,

Thomas M. Hannigan

Thomas M. Hannigan

TMH:jsn

cc: Mr. Melvin Shore
Mr. Ivory J. Rodda

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
2828 Chiles Road, Davis, CA 95616

November 20, 1979

Lt. Col. James G. Johnaon
U. S. Army Corps of Engineera
650 Capitol Mall
Sacramento, California 95814

Dear Colonel Johnson:

Re Draft Feasibility Report, Draft EIS, Sacramento River Deep Water Ship Channel Investigation, California

We acknowledge receipt of the aubject draft report and draft environmental impact statement. We are concerned about the loas of agricultural production and posaible adverse impact the project might have upon prime agricultural land: no direct mention of prime land is made. Though the study states there will be no adverse effect upon soils, there is no discussion of soil class or land capability concerning the 3,500 acrea of land required for dredged material disposal.

Aside from the described increase in salinity, the proposed project will not affect agricultural water.

The SCS is concerned about the extensive removal of native vegetation and how this will affect wildlife. It appears mitigation, including cresting 45 acres of habitat on Prospect Island, will compensate for this loss.

We appreciate the opportunity to review and comment on this study.

Sincerely,

FRANCIS C. H. LUM
State Conservationist

cc: Director, Office of Federal Activities, EPA, Washington, D.C. (5 copies)
N. A. Berg, Administrator, SCS, Washington, D.C. (1 copy)

UNITED STATES
DEPARTMENT OF THE INTERIOR

OFFICE OF THE SECRETARY
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SAN FRANCISCO, CALIFORNIA 94102
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ER 79/1045

1/4/80

Lt. Col. James G. Johnson, CE
Acting District Engineer
Sacramento District, Corps of Engineers
650 Capitol Mall
Sacramento, CA 95814

Dear Colonel Johnson,

The Department of the Interior has received the draft feasibility report and EIS for the Sacramento River Deep Water Ship Channel, California, and (ER 79/1045) offers the following comments for your consideration.

<u>Comments on Draft Feasibility Report</u>

Our principal concern with respect to the Corps of Engineers' proposal to deepen the Sacramento River Deep Water Ship Channel from its present depth of 30 feet to 35 feet relates to the effect that channel deepening would have on salinity distribution in the Sacramento-San Joaquin Delta. Any action which would cause a further incursion of salt water into the Delta could have a profound effect on the fish and wildlife resources associated with this important estuarine area.

The State Water Resources Control Board, in D-1485, has set salinity objectives for the Delta. Any increase in ocean salinity intrusion would require additional Delta outflow in order to maintain the standards. During low flow periods, if the Central Valley Project (CVP) and State Water Project (SWP) must maintain the standards by reservoir releases, any increased Delta outflow requirement would reduce marketable project yield.

In our estimation, deepening and widening the channel would cause the lower saline layer of water to intrude into the estuary further than at present for the same Delta outflow. The net quality at a site would be more saline.

This action could impact the WPRS project operation in that additional reservoir releases of project water may be required to maintain salinity criteria at a particular site. In addition, the entrapment zone, a center of biological productivity which is defined by salinity range, would move upstream. Over a number of years, we would see a net decrease in biological productivity.

The report concludes that, because the physical model was not able to identify (within the accuracy of the model) any increased intrusion, the impact of the proposed project on salinity intrusion would be insignificant. We do not agree with this conclusion. We believe the model studies indicate an adverse impact equivalent to a restoration flow of 300 to 500 ft 3/s.

The project plan for which the Corps is seeking authorization provides for the installation of a corrective facility, i.e., a submerged rock sill or functionally equivalent device in Carquinez Strait, should a monitoring study conducted before, during and after channel deepening reveal that the project has, in fact, caused an unacceptable change in salinity distribution.

This approach is acceptable only if the authorization for the project requires a full consideration of all factors (not just salinity) affecting the distribution and abundance of fish and wildlife resources in the Delta before arriving at a decision whether to build the submerged sill. It is very possible that, given additional information, the disadvantage to fish and wildlife resources assignable to a submerged sill could outweigh the benefits to be gained by all interests through the restoration of salinity distribution to the pattern that prevailed before channel deepening.

The project authorization should require specifically that, in the event installation of a submerged sill (or functionally equivalent device) is contemplated subsequent to channel deepening, the Corps of Engineers shall: (1) fund a special study by the Fish and Wildlife Service to ascertain the probable impacts of a submerged sill on fish and wildlife resources; (2) give full and equal consideration to the recommendations of the Service, based on such study, in arriving at a decision concerning the advisability of constructing a submerged sill; and (3) prepare a supplemental environmental impact statement solely addressing the construction of the sill and incorporating all information obtained in the studies conducted under (1) above. The supplemental EIS shall receive full public review as specified under provisions of the National Environmental Policy Act and the regulations promulgated by the Council on Environmental Quality.

The project plan provides for the creation of 45 acres of wetland at Prospect Island to compensate for the loss of such habitat along the manmade reach of the ship channel. At this time, the project plan does not provide for the compensation of upland habitat losses that will occur at the dredged material disposal areas during project construction and maintenance. Recent discussions between the Service and Corps planners reveal that these losses could be satisfactorily offset through the development and preservation of wildlife habitat on portions of the disposal areas. This matter will be addressed in the Service's forthcoming detailed report to the Corps of Engineers, prepared pursuant to the Fish and Wildlife Coordination Act.

Comments of the Draft Environmental Statement

General Comments

Fish and Wildlife Resources

The draft environmental statement presents a reasonably accurate description of project impacts on fish and wildlife resources, given the present state of knowledge concerning the natural resource base of the project area. It is likely, however, that modification of those parts of the statement pertaining to the submerged sill would be found necessary following detailed study of that feature in relation to its potential impacts on fish and wildlife. As discussed in our comments on the draft feasibility report, the Fish and Wildlife Service believes that a special study of this matter should be undertaken, as a requirement of project authorization, so that full consideration can be given to fish and wildlife needs in arriving at a decision concerning construction of a submerged sill, or other facility, to correct an adverse salinity condition that might be induced by channel deepening. We also believe a supplemental environmental impact statement should be prepared prior to construction of the sill addressing solely that feature and incorporating all information derived from the aforementioned study.

The discussion on threatened, rare, and endangered plants and animals indicates that preliminary information on such species has been assembled by the Corps of Engineers. Compliance with the Endangered Species Act requires that the District Engineer officially request the Regional Director of the Fish and Wildlife Service, Portland, Oregon, for a list of endangered and threatened species, or species that have been proposed for listing, that may be present in the area affected by the proposed action. A subsequent assessment may lead to an official consultation under provisions of Section 7 of the Endangered Species Act.

Cultural Resources

The subject draft statement was reviewed in consultation with the Interagency Archeological Service (IAS). A letter dated October 31, 1979, from the IAS requested further information on the impact of the proposed project on cultural, specifically archaeological, resources, including a copy of the cultural resource reconnaissance survey. Response was never received from the project sponsors (Sacramento Office, Army Corps of Engineers).

We suggest that the information requested in the letter of October 31, 1979, be supplied to IAS and that these concerns be addressed in the final environmental statement.

The draft statement does not contain enough substantive information to allow an adequate review of the effects of the proposed project on cultural resources that may be located in the area. The statement does not indicate the areas that were surveyed for cultural resources, nor the intensity of the investigation. Additionally, the statement does not discuss the cultural resources identified in terms of their location, possible impacts resulting from the proposed action, or recommendations for mitigation measures. Without this information included in the statement we are unable to determine if cultural resource concerns have been adequately considered and if compliance with Federal regulations has occurred.

The most effective means for an adequate consideration of cultural resources are contained in Title 36 CFR 800. Compliance with these procedures should be documented in the final EIS. Documentation of consultation with the SHPO and other appropriate authorities should also be contained in the final statement.

Recreational Resources

The draft statement indicates that only one of eleven possible sites would be developed for recreational use. Other recreational opportunities (such as bike trails, hiking trails, and other less intensive development options) are not discussed. Consideration should be given to incorporation of certain less intensive recreational development options.

Specific Comments

Pages E-2 and E-3, Dredged Material Disposal. Although dredged material from channel deepening activities will be placed on land disposal sites, the chemical and biological characteristics of the channel sediments should be indicated. This information would be useful in assessing any potential for adverse effects on surface water quality that may result from toxic substances resuspended in the water column during dredging.

Page 8 mentions that the historic towns of Collinsville and Rio Vista are in close proximity to the proposed project area. It is unclear from the statement whether any portions of these towns will be affected by the project. We recommend that an historical archeologist be retained to evaluate any areas of Rio Vista and Collinsville that may be affected by the proposed action.

Page 31 indicates analyses "... have been made on increasing Delta outflow ..." to "... offset any increased salinity intrusion..." due to the proposed action. No indication of the quantity of additional outflow is given. This quantification should be given in the final report.

Page 39 - Under "Potential Fish and Wildlife Enhancement," remove the words "fish and" from the paragraph title and in the second line of the paragraph. It is not clear that disposal of dredged materials on lands will enhance fishery resources.

Page 41 (also pages E-17, 3-17, 3-19) state that "no impacts on cultural resources are expected since project construction sites were actually examined for the presence of cultural material. Because cultural resources often extend far below the surface of the ground, surficial ground disturbance may not necessarily affect the subsurface integrity of cultural resources that may be located in the project area. We recommend that a qualified archeologist be retained to intensively survey all of the project area and conduct subsurface testing in areas where the ground surface is disturbed.

Page 41 states that the cultural resources reconnaissance report recommends covering the prehistoric site with dredged material. Burial of sites is considered a controversial protection measure and may not be the most effective means of mitigating adverse impacts to this site. Consultation with the SHPO should determine if the site is eligible for inclusion on the National Register per the criteria set forth in Title 36 CFR 60. If the site is considered to be a significant resource, then appropriate mitigation measures should be developed in consultation with the SHPO and the Advisory Counsil on Historic Preservation. The results of this consultation should be documented in the final statement.

Page 59, last paragraph - What would the submerged sill do to the salinity caused seasonal shift of marine benthic organisms from San Pablo Bay to Suisun Bay and back again? Would it not block this shift? Appendix 1, page B-6, Hydrology, General, No. 9 - Computed Delta outflow averaged near 21 million acre-feet for the period 1912 to 1977. The

average was a little greater than that in the period 1950 to 1977, and a little less than that in the period 1912 to 1949. The average for the period 1970-1977 was near 19 million acre-feet and contained two of the driest years on record. These facts would indicate that the text value of 16 million acre-feet is in error.

Page B-17 - Change the third word of the second line to read "decreases" rather than "increases." Phytoplankton density, as defined by chlorophyll measures, decreases in the area immediately upstream of the entrapment zone.

Appendix 3, 3-6 discusses three aboriginal sites located during the survey, one of which may be eligible for inclusion in the National Register. The final statement should contain a more complete description of these sites, possible impacts and proposed measures to mitigate any adverse effects.

Appendix 4, Table 1 - The mean 95 percent confidence limit for average monthly salinities for the Chipps Island station (11A) is .41 p/t TDS. Based on data we have obtained from use of the model, the .41 p/t TDS salinity variation is equivalent to a restoration Delta outflow of about ± 200 to 300 ft ^{3}/s. Therefore, the "noise" in the model could mask a significant change between Base and project model tests. Even a 100 ft ^{3}/s project impact could require an additional water supply depletion of about 72,000 acre-feet in a year such as 1977. A 300 ft ^{3}/s impact could negate the yield developed by the New Melones Project.

In addition, the model studies (steady state for Plan H-1) indicate that the project would increase ocean salinity intrusion, especially in the upper Sacramento River. Our review concentrated on Plan H-1, because it has the greatest potential for impact; therefore, the difference from a Base study would be more likely to be distinguishable from model "noise." The steady state tests were reviewed because past studies indicate that steady state tests have about half the model "noise" when compared to dynamic tests. This improvement apparently results from greater reliability in that samples are collected throughout the tidal cycle rather than only at high and low slack water. Also, the varying of only one parameter between tests (Base and Plan) defined more precisely the impact of that change, especially when the impact varies with Delta outflow.

The attached Figure 1 shows aplot of Chipps Island (11A) salinity for the Base and Plan H-1 tests (with Peripheral Canal) as the tests approach steady state. The last three samples for the Plan H-1 test do not agree with the trend of the previous 12 samples. This difference is greater than would normally be expected in the "noise" of steady state tests and probably represents an error in flow setting in the model test. However, using all Plan H-1 data points, the relative salinities for Base and Plan H-1 at or near steady state conditions are about 9,300 p/m TDS and 9,400 p/m TDS, respectively. The increase in salinity of the Plan H-1 of 100 p/m TDS at Chipps Island represents a requirement for a restoration flow of about 50 ft ^{3}/s. If the last three sample points for Plan H-1 are not considered, the required restoration flow would be about 100 ft ^{3}/s.

A similar comparison was also made for the model tests without the Peripheral Canal (Figure 2). However, it was apparent that the Base and Plan tests were not to the same degree of approach to a steady state condition and therefore not comparable. The tests should have been continued to obtain a closer approach to steady state.

Figure 3 presents a correlation of salinity at Rio Vista (23) versus Chipps Island (11A) for Base and Plan H-1 tests for conditions both with and without the Peripheral Canal. The salinity values are averages of top and bottom samples for the final two sampling runs of each test. The curve relationships for the Base tests are taken from earlier model studies for the Base conditions with and without the Peripheral Canal. The equivalent restoration flow to return Rio Vista salinity to the base relationship would be about 300 ft ^{3}/s for conditions with a Peripheral Canal and about 500 ft ^{3}/s for conditions without Peripheral Canal. These restoration flows would be in addition to the 50 ft ^{3}/s flow necessary to restore the base salinity at Chipps Island.

The report cover letter states that a water quality monitoring network would be established and that, if the project is found to increase salinity significantly, the submerged sill in Carquinez Strait would be constructed.

The "noise" or unmeasurable flows in the real Delta are probably an order of magnitude larger than those in the model. Therefore, if the model does not have the sensitivity to distinguish the impact of the project, it is assumed that the prototype monitoring network would not.

Concerning the assertion on pages 5-13 that the increase in salinity at Cache Slough would not exceed drinking standards, it should be pointed out that use of model results on other than a comparative basis between Base and Plan conditions is questionable, especially in an area such as Cache Slough where local return flows may play a significant role in determining water quality.

Thank you for the opportunity to review these documents. If you have any questions on these comments, please contact me directly.

Sincerely yours,

Patricia S. Port

Patricia Sanderson Port
Regional Environmental Officer

cc: Director, OEPR (w. copy incoming)
Director, Fish and Wildlife Service
Director, Heritage Conservation & Recreation Service
Director, National Park Service
Director, Geological Survey
Director, Bureau of Land Management
Commissioner, Water and Power Resources Service
Commissioner, Bureau of Indian Affairs
Reg. Dir., FWS
Reg. Dir., HCRS
Reg. Dir., NPS
Reg. Dir., GS
Reg. Dir., BLM
Reg. Dir., WPRS
Reg. Dir., BIA
SHPO

Figure 2

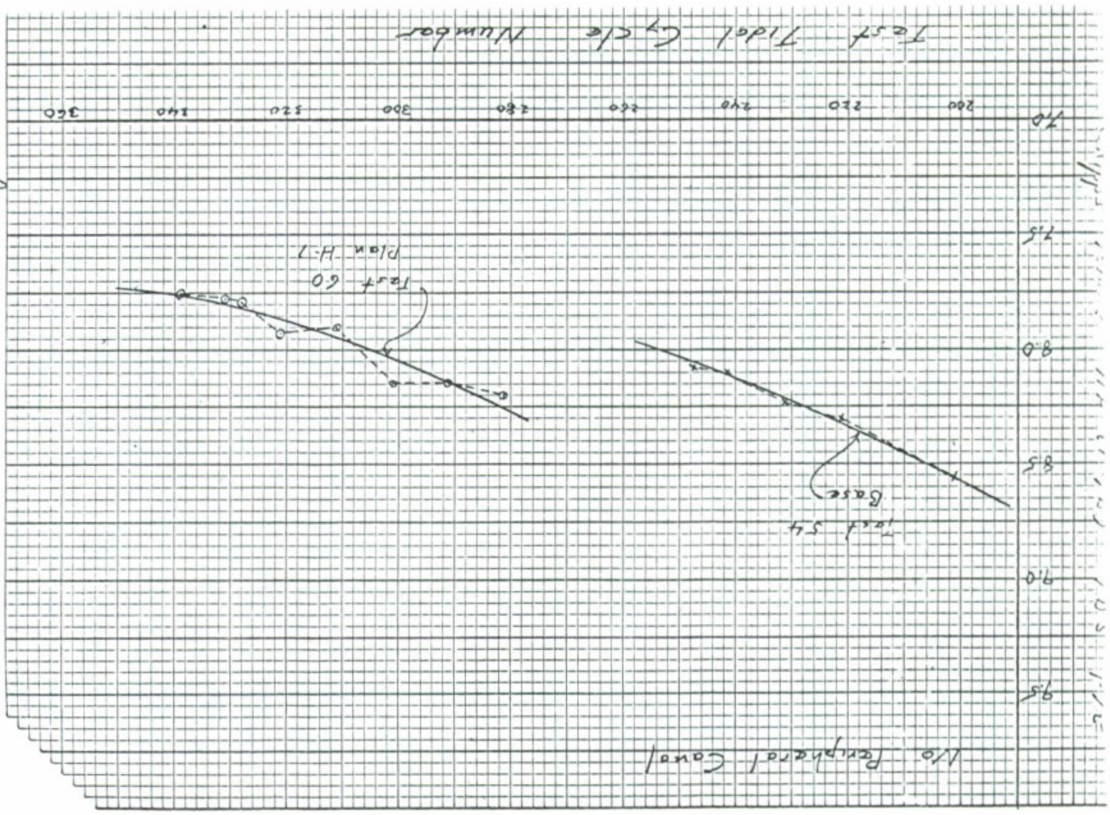
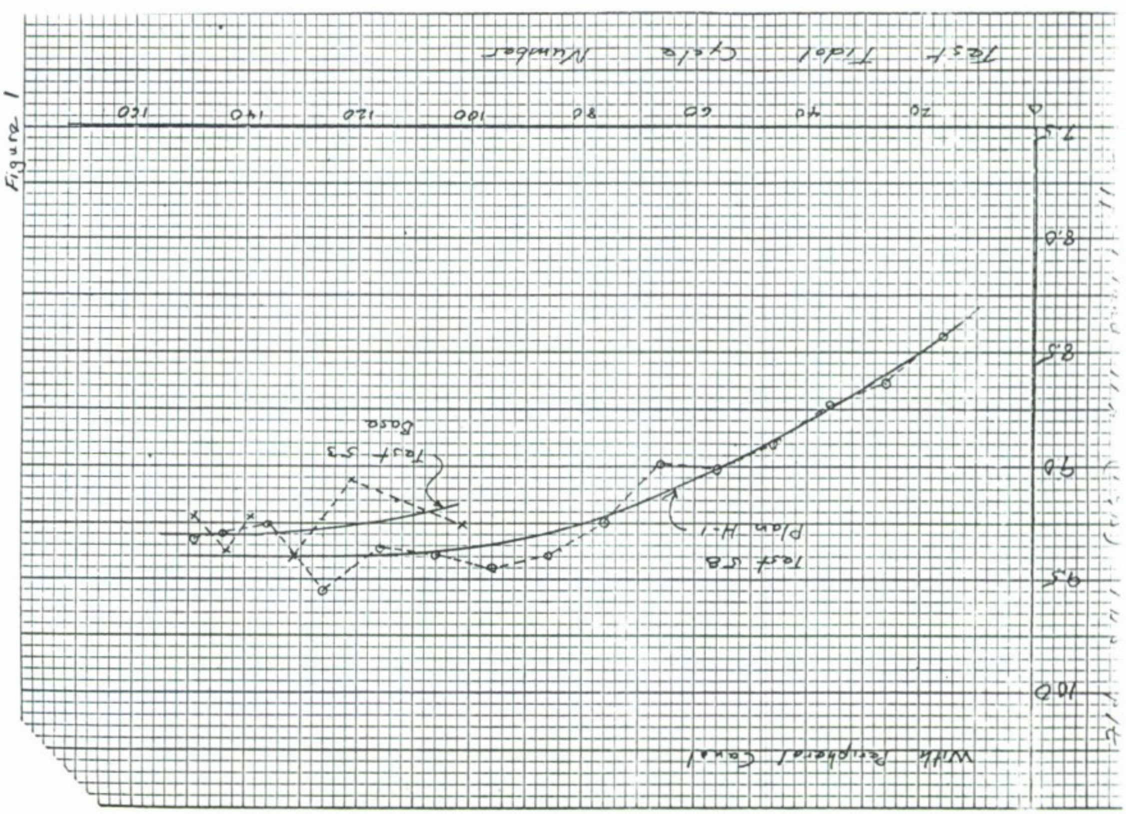


Figure 1



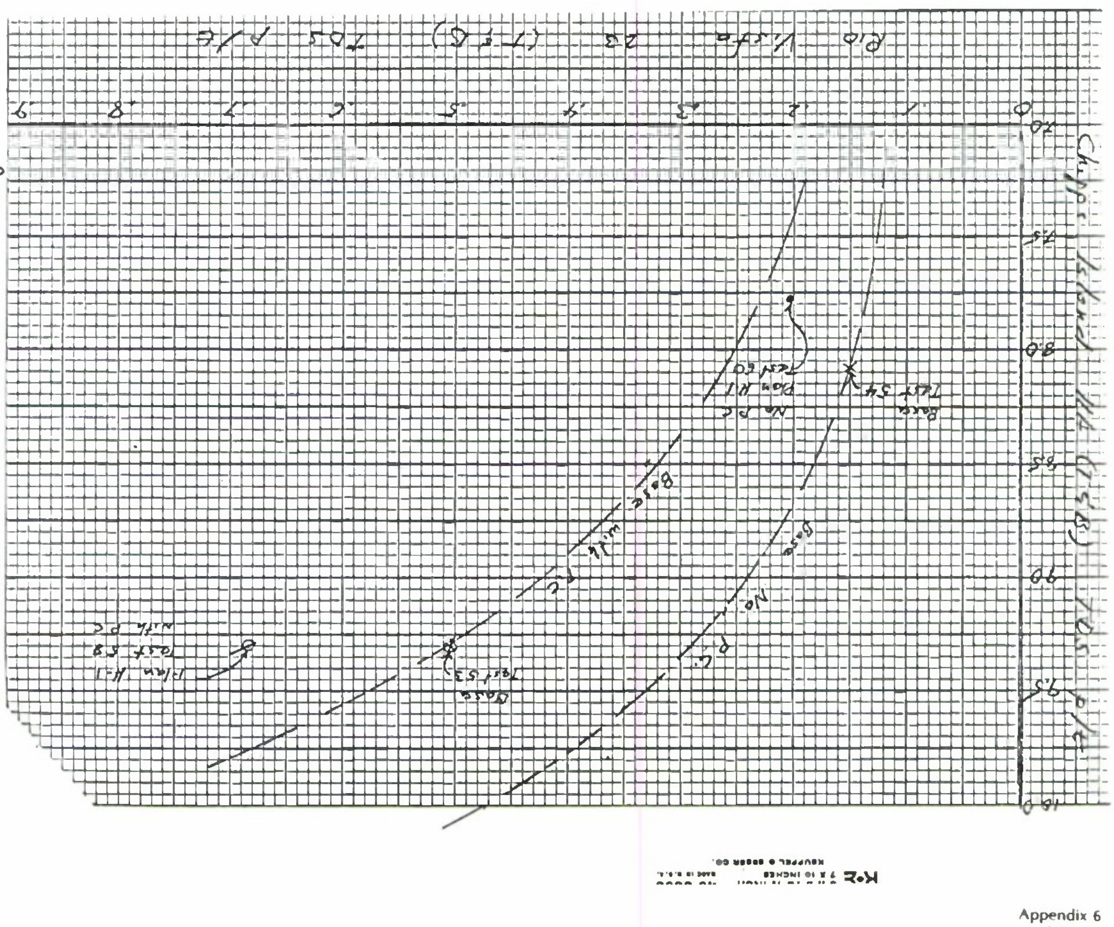


Figure 3

UNITED STATES
DEPARTMENT OF THE INTERIOR
OFFICE OF THE SECRETARY
PACIFIC SOUTHWEST REGION
BOX 36098 · 450 GOLDEN GATE AVENUE
SAN FRANCISCO, CALIFORNIA 94102
(415) 556-8200

Engr.

February 1, 1980

ER79/1045

Mr. Mark S. Capik
Chief, Investigations Section D
Water Resources Planning Branch
U.S. Army Corps of Engineers
650 Capitol Mall
Sacramento, CA 95814

Dear Mr. Capik,

Attached please find a letter dated 27 December 1979 from the U.S. Geological Survey of the Department of the Interior. This letter, which you have already received, contains comments pertinent to your Sacramento River Deep Water Ship Channel Investigation (ER79/1045).

These comments should have been coordinated through my office and not sent directly to you. This letter formally requests that you consider these comments as an addendum to the Departmental letter dated Jan. 4, 1980 on the same subject.

The writers of this letter have been instructed as to the proper channels for Departmental comments, and I trust we will be sending you consolidated comments on the Corps' projects in the future.

I hope that the late receipt of our comments will not be too inconvenient. Thank you for your consideration in this unusual matter.

If you have any questions regarding this matter, please contact me directly.

Sincerely,

Patricia S Port

Patricia Sanderson Port
Regional Environmental Officer

cc: Director, OEPR (w. copy incoming)
Director, Fish and Wildlife Service
Director, Heritage Conservation and Recreation Service
Director, National Park Service
Director, Geological Survey
Director, Bureau of Land Management
Commissioner, Bureau of Reclamation
Commissioner, Bureau of Indian Affairs
Regional Directors
T. John Conomos, GS

United States Department of the Interior

GEOLOGICAL SURVEY

27 December 1979

Mark S. Capik
Chief, Investigations Section D
Water Resources Planning Branch
U.S. Army Corps of Engineers
650 Capitol Mall
Sacramento CA 95814

Dear Mr. Capik:

As a group of (chemical, physical, geological, biological) oceanographers doing basic research on the San Francisco Bay system, we feel compelled to assist USACE in its evaluation of potential consequences of deepening the Sacramento shipping channel and the possible placement of a sill (submerged barrier) as a mitigation measure to control salinity intrusion. To meet this end, we pose here a series of queries that should be addressed in a final assessment of the project. We request that this letter beome part of the EIS proceedings.

The Sacramento-San Joaquin estuary is a valuable natural resource that supports both commercial and recreational fisheries (sturgeon, striped bass, shad, etc.). Since the food chain of the estuary is based upon primary production by phytoplankton, any environmental impact that affects productivity of phytoplankton will have an effect on higher organisms, including striped bass. The drought of 1976-77 demonstrated this dramatically - low summer phytoplankton biomass was coincident with very low abundance of zooplankton, *Neomysis* and larval striped bass. Our first series of questions, therefore, addresses the general topic of ecological consequences associated with the project. These questions are followed by several questions relating to the new hydraulic conditions created by the barrier.

1. The Draft EIS contends that the project will have no effect on phytoplankton; this contention is based solely on model output from Hydroscience, Inc. Does USACE recognize that models are simplifications, of necessity, and that they use approximations and assumptions? Does USACE sufficiently understand the assumptions made by Hydroscience to judge whether the model output is a valid and accurate predictor of consequences of the project? The following are questions that may assist

USACE in evaluating the capability of the Hydroscience model to answer the specific question: "What are consequences of the project on phytoplankton productivity in the estuary?"

a. Is USACE satisfied with Hydroscience's contention that the model simulates well phytoplankton biomass in the estuary? Does USACE have enough confidence in the model's accuracy to accept resolution of phytoplankton biomass on the scale of several µg/L chlorophyll a (they project an increase of chlorophyll a from 8 to 13 µg/L)? This question is posed in light of observations that the model has errors as large as 60 µg/L in predicting chlorophyll a concentration (e.g., Port Chicago, 1970), and that the model has failed to simulate some large algal blooms (spring bloom in 1976, summer bloom of 1970).

b. Is USACE satisfied with the documentation of Hydroscience's model (i.e., do they understand how it is structured and formulated)? For example, a reduction factor "r" is incorporated to reduce growth rates of phytoplankton. What is the mathematical form of this function "r" and on what physiological basis was it formulated? Why is phytoplankton growth reduced at temperatures $> 18^{\circ}C$ when the majority of physiological studies demonstrate that this is not the case for phytoplankton (see Eppley, 1972)?[1] Why are phytoplankton populations simulated with a one-dimensional box model where settling velocity is zero, and suspended particulates are modeled with a two-dimensional model that allows particle settling? This question is posed in light of studies by the USBR which show that natural phytoplankton from Suisun Bay settle rapidly. Why are simulated zooplankton populations not shown, and does the Hydroscience model simulate well zooplankton population changes? This is a very important question because zooplankton (1) regulate phytoplankton population changes and (2) are the link between phytoplankton productivity and fish.

c. Does USACE understand current theories (Cloern, 1979; Ball and Arthur, 1979; Arthur and Ball, 1979)[2] about factors that regulate phytoplankton biomass in the Sacramento-San Joaquin Estuary? In particular, does it understand the current theory that the interaction between estuarine circulation (two-layer flow) and the settling of phytoplankton is responsible for the buildup of phytoplankton populations in Suisun

1/ Eppley, R. W., Temperature and Phytoplankton Growth in the Sea. Fisheries Bull. 70: p. 1063-85.

2/ Chapters in San Francisco Bay:The Urbanized Estuary. Edited by T. J. Conomos. Allen Press, Lawrence, Kansas.

Bay during summer? If so, how does it reconcile that this interaction is not acknowledged by the one-dimensional Hydroscience model? Does it understand that the failure of the Hydroscience model during spring 1976, and failure of the model to simulate well the distribution of phytoplankton in the turbidity maximum (p. 107 of the Hydroscience report), may be a consequence of this omission? Does USACE understand that the empirical relationships between phytoplankton population size and Delta discharge result from the effects of estuarine circulation on phytoplankton? Is USACE satisfied that the Hydroscience model is capable of realistically predicting impacts of the project on phytoplankton biomass, even through this important physical mechanism is not part of the ecological model?

d. The Hydroscience model was run for flows of 4,400 cfs and 10,000 cfs. How do phytoplankton populations respond to periods of very low flow (such as 1500 cfs, as in 1977)? Does this model simulate the population changes of phytoplankton observed during the very low flows of 1977?

2. In light of the foregoing questions, how will the sill affect gravitational circulation in Suisun Bay? While the hydraulic model indicates that the sill would reduce salinity intrusion, what happens to other transport properties which are important to ecosystem dynamics? Moreover, since there is a great difference in mixing characteristics between the Bay model, stratified flumes, and the Bay system, how can the effects be properly evaluated? While the sill can be calibrated in an engineering sense to control salinity, how can one be assured that other, costly technical fixes will not be required to mitigate any undesirable side effects?

3. How will the sill affect migrations of fish and(or) transport of larval stages, particularly in relation to both benthic and pelagic species? Will there be excessive mortality due to increased current speed and turbulence levels? Will there be any problems with increased shoreline erosion due to the higher speeds in Carquinez Strait? Will increased surface velocities pose a hazard to boating?

4. What are the explicit criteria that USACE will use to determine whether a mitigation measure (e.g., the Carquinez Strait sill) will be necessary? This question is posed because it is difficult to determine, from the available information, what mitigation measures, if any, will be appropriate to maintain salinity standards. Further, the type of the measure described is largely scientifically unproved when applied to tidal reaches. What technical criterion will be used to establish the degree of mitigation necessary and the type of measure to use?

We regret the delay in our comments; however, we learned of the status of this project only through the newspaper. We felt obligated to review the draft EIS and model results in some detail, and this has taken more time than expected. We would appreciate being kept informed of further developments.

Sincerely,

James E. Cloern
JAMES E. CLOERN
T. John Conomos
T. JOHN CONOMOS
Frederic H. Nichols
FREDERIC H. NICHOLS
David H. Peterson
DAVID H. PETERSON
Roy A. Walters
ROY A. WALTERS
Research Oceanographers

cc: Richard J. Lerseth, Department of Water Resources
James Carson, U.S. Fish & Wildlife Service, Sacramento
Dan Odenweller, Department of Fish & Game, Stockton
Robert E. Brown Jr., State Water Resources Control Board
Edward Clifton, U.S. Geological Survey, Chief, Pacific Artic Branch of Marine Geology
Frsnk Trainer, U.S. Geological Survey, Water Resources

United States Department of the Interior
BUREAU OF MINES
EAST 315 MONTGOMERY AVENUE
SPOKANE, WASHINGTON 99207

November 26, 1979

U.S. Army Corps of Engineers
Sacramento District
650 Capital Mall
Sacramento, CA 95814

Attn.: Investigations Section D

Gentlemen:

We have reviewed the Information Summary for the Sacramento River Deep Water Ship Channel Investigation. Our brief comments are confined to mineral resources and disposal site hazards.

Deepening the shipping channel to the Port of Sacramento according to the selected plan would have no significant impact on local or regional mineral resources. A slight benefit should result from improved efficiency in handling mineral cargoes.

The mineral composition of the sand fraction of the dredge spoils should be determined in detail. Once raised by dredging, heavy minerals such as rutile, zircon, ilmenite, chromite, and monazite, if present, might be economically recovered by essentially non-polluting gravity methods. With approximately 30 million cubic yards of material to be excavated, quantities of contained heavy minerals could be significant.

Day-use and camping facilities are proposed for 30 acres of the disposal area. Anticipated use for the balance of the 3,500 acre disposal area has not been described. Since the project area has a record of moderate seismic activity, local land-use planning authorities should be advised of the hazards of siting dwellings or other permanent structures on dredge spoils.

These comments are offered as technical assistance only. They do not comprise an offical Department of the Interior or Bureau of Mines environmental statement or review.

Sincerely,

R. N. Appling, Jr., Chief
Western Field Operations Center

United States Department of the Interior
HERITAGE CONSERVATION AND RECREATION SERVICE
PACIFIC SOUTHWEST REGION
SAN FRANCISCO, CALIFORNIA 94102

IN REPLY REFER TO:
743

Interagency Archeological Services
450 Golden Gate Avenue, Box 36065

October 31, 1979

United States Army Corps of Engineers
Sacramento District
Attention: Investigations Section D
650 Capitol Mall
Sacramento, California 95814

Dear Sir:

We are writing in response to the request for comments on the Sacramento River Deep Water Ship Channel Investigation. We note on page 9 of the Information Summary, Sacramento River Deep Water Ship Channel Investigation, September, 1979, that a cultural resources reconnaissance report has been prepared, and that at least one prehistoric site will be impacted by proposed construction activitiea.

Our office is charged with executing the Secretary of the Interior's responsibilities under Public Law 93-291 (the Archeological and Historic Preservation Act of 1974). If the referenced construction may result in the loss or destruction of significant cultural data, we request written notification in accordance with Section 3(a) of the Act. It would be helpful if the information checked in red on the enclosed form, "Notification of a Threatened Cultural Resource" could be provided. Receipt of the requested data will assist us in gathering information to make the determinations required by Section 4(a) of the Act.

In addition, our agency is responsible under Section 3(a) (16 U.S.C. Section 469-1 et seq.) for receiving reporta required of agencies by the Act. Please forward copies of the cultural reaources reconnaissance report and any other cultural resource studies you have obtained that are relevant to the proposed project.

Your attention to this matter will be greatly appreciated.

Sincerely,

Garland J. Gordon, Chief
Interagency Archeological Services
San Francisco

Enclosure

cc: Calif. SHPO Attn: Jeff Bingham

U.S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
REGION NINE
Two Embarcadero Center, Suite 530
San Francisco, California 94111

ARIZONA
CALIFORNIA
NEVADA
HAWAII
GUAM
AMERICAN SAMOA

Engr.

November 28, 1979

IN REPLY REFER TO
HED-09

Lieutenant Colonel James G. Johnson
Acting Sacramento District Engineer
U. S. Army Corps of Engineers
650 Capitol Mall
Sacramento, California 95814

Dear Colonel Johnson:

We have reviewed the Draft Environmental Impact Statement and Feasibility Report for the Sacramento River Deep Water Ship Channel Investigation, California, and find that the proposed project will not affect the Federal-aid highway program. Therefore, we have no comments to offer.

We appreciate this opportunity to review the subject project documents.

Sincerely yours,

Mitchell Tanner
for Neil Dillabough, Director
Office of Environment and Design

FEDERAL ENERGY REGULATORY COMMISSION
REGIONAL OFFICE
555 BATTERY STREET, ROOM 415
SAN FRANCISCO, CA 94111

December 17, 1979

Colonel Paul F. Kavanaugh
District Engineer
Sacramento District
U.S. Army Corps of Engineers
630 Capitol Mall
Sacramento, CA 95814

Dear Colonel Kavanaugh:

This is in response to your letter of October 24, 1979, requesting our review and comments on your draft feasibility report and environmental impact statement for the Sacramento River Deep Water Ship Channel Investigation, dated September 1979.

We have reviewed your draft report to determine the effect on matters affecting the Federal Energy Regulation Commission's responsibilities. Such responsibilities relate to the licensing of non-federal hydroelectric projects and associated transmission lines; certification for construction and operation of natural gas pipeline facilities, defined to include both interstate pipeline and terminal facilities; and the permission and approval required for the abandonment of natural gas pipeline facilities.

Our review indicates there would not be any significant impacts in those areas of concern nor serious conflicts with this agency's responsibilites if this plan were adopted.

Sincerely,

Eugene Neblett
Regional Engineer

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

Southwest Region
300 South Ferry Street
Terminal Island, CA 90731

December 10, 1979 FSW/WSL

Colonel Paul F. Kavanaugh
District Engineers
Sacramento District
Corps of Engineers
650 Capitol Mall
Sacramento, CA 95814

Dear Colonel Kavanaugh:

We have reviewed the Draft Feasibility Report on the Sacramento River Deepwater Ship Channel, Sacramento, Yolo, Solano and Contra Costa Counties, California, and provide the attached comments for your consideration.

It is our opinion that deepening and widening of the Sacramento River Deepwater Ship Channel would jeopardize fishery resources of San Francisco Bay and its tributaries and could adversely affect programs aimed at the protection and restoration of such resources. Therefore, we recommend that project construction be deferred pending completion of the evaluation of the effects of deepening the Stockton Ship Channel (John F. Baldwin and Stockton Ship Channels) and until additional evaluations and assessments are made on the cumulative impact that the proposed project would have on the San Francisco Bay and the tributaries system fishery resources.

Questions concerning the report may be directed to Mr. William Leet of my staff who is located at 3150 Paradise Drive, Tiburon, CA 94920, Telephone (415) 556-0565.

Sincerely,

Gerald V. Howard
Regional Director

cc:
J. McKevitt, U.S.F&WS

National Marine Fisheries Service Report
on
Draft Feasibility Report on
the Sacramento River Deep Water
Ship Channel - - Sacramento District,
Corps of Engineers, Sept. 1979.

Project Description

The project would involve deepening the 47-mile long Sacramento ship channel from 30 to 35 feet MLLW and widening it from 300 to 400 feet between Pittsburg and Junction City and from 200 to 250 feet between Cache Slough and the Port of Sacramento. Material dredged initially from the channel would be placed at nine adjacent upland sites. Maintenance dredging would be required periodically for all reaches of the project. In order to mitigate for the potential increase in salinity intrusion, a submerged rock sill would be constructed in Carquinez Strait to restrict the flow of saline waters into Suisun Bay and the Sacramento River. Also being considered are upstream channel constrictions which would impede the tidal flow and reduce the amount of salt transported upstream. The plan includes development of two recreation areas as an enhancement measure, and a 45-acre marsh as a fish and wildlife compensation measure. The purpose of the project would be to improve deep-draft navigation channels to and from the Port of Sacramento and to enhance existing environmental and recreational conditions in the study area.

Fisheries Issues

Water projects and related developments in the San Francisco Bay and tributaries system have caused or contributed to major declines in anadromous fish populations because they have eliminated important spawning and rearing habitat and have altered habitat in downstream areas by changing flow regimes and salinity distribution. Major water diversions physically transport young fish out of the river into canals and irrigated fields. Other factors such as wastes from municipal and industrial effluent , urban runoff and pesticides all have caused habitat changes to occur. Such pollution sources have had lethal and sublethal effects on fish populations. Riverbank irregularities important as feeding areas and refuges from predators have been eliminated by levee development and channelization. Channelization of streams also caused water velocities to increase causing a reduction in habitat available to food organisms.

San Francisco Bay has been modified substantially by construction and maintenance of navigation channels. Such channels have altered salinity distribution within the bay, and spoil disposal necessitated by their maintenance has resulted in the disruption of the environment by increasing turbidity in the water column, by resuspending pollutants, by smothering of benthic organisms and by changing substrate particle size. These activities have altered the community structure of marine and estuarine organisms.

Potential Impacts of Project Development

Deepening and widening of the existing navigation channel would physically alter important fish habitat. Maintenance dredging would periodically disrupt biological communities which become established in the altered areas. The adverse impacts of the proposed project would be increased if the current practice of aquatic disposal of spoil material is continued in Suisun Bay.

Habitat alterations would also occur from changes in salinity distribution, which property has a major influence on the productivity of the area and on the distribution and structure of aquatic communities. The center of high productivity or the entrapment zone in the estuary is located in Suisun Bay, well within the area of project influence. Careful consideration must be given to the changes in salinity which could occur with project development, the effect such changes would have on the extent and location of the entrapment zone and the biological implications of altering the entrapment zone.

In speculating about changes in salinity, consideration also must be given to various other proposed actions which would influence salinity distribution. These include the reduction of Delta outflow due to export of 8.5 million acre-feet of water from a point upstream; the possible discharge of agricultural drain waters from the San Joaquin Valley into Suisun Bay; and the reclamation of waste water in the San Francisco Bay area. At the present time waste-water discharged into San Francisco Bay contributes significantly to the volume of freshwater inflow to the Bay and directly effects the salinity of the system.

The project would encourage industrial development in the Collinsville-Montezuma Hills area. Urbanization of adjacent areas would likely occur to accomodate an expanded workforce. Industrial development would require that aquatic habitats be further altered to provide ingress and egress of ships to waterside areas. Urbanization also would result in an increased demand for high quality domestic water and a need to dispose of waste-water including sewage and urban runoff. Water areas developed for industrial use generally have reduced fishery values and serve as a sump for pollutants which are chronically or periodically dispersed into adjacent areas. Urban waste-water could be expected to add substantially to the pollution burden of the area.

Project implementation would increase the risk of major accidents in San Francisco Bay and adjacent waters by encouraging increased vessel traffic. Development of one or more petro-chemical complexes in the Collinsville-Montezuma Hills area would increase the liklihood that a major spill of toxic material would occur in this biologically important reach of the estuary.

Discussion

Construction of the proposed project would result in the loss or degradation of habitat necessary for maintenance of anadromous and other fisheries resources. The probable industrial and urban development in the Collinsville-Montezuma Hills area also would be damaging to fish populations and their habitats. These impacts or losses, when viewed cumulatively, may be unacceptable.

We believe that the proposed project would affect salinities in Suisun Bay and the Delta. Model studies conducted by the Corps of Engineers and others, indicate that no significant change would occur. However, uncertainties in the models, the use of 1968 (the year the State Water Pumps began operation) and 1977 (the 2nd year of a 2 year drought) as prototype years, the apparent failure to account for increased water export and the failure to consider possible discharge of agricultural waste-water into Suisun Bay leads us to believe additional studies are needed prior to drawing conclusions as to potential project effects. In addition, construction of a sill at the Carquinez Straits coupled with constriction

of upstream channels could affect the existing flow patterns in the Delta. The possible effects of this on the productivity of the estuary and on the entrainment of fish through existing water diversion facilities should be determined prior to initiating construction. Similarly, the liklihood of increasing the risk of major accidents in San Francisco Bay and adjacent waters, especially petro-chemical related accidents, should be analyzed and reported.

UNITED STATES DEPARTMENT OF COMMERCE
Maritime Administration
Western Region
450 Golden Gate Ave., Box 36073
San Francisco, California 94102

December 12, 1979

LTCOL James G. Johnson
Acting District Engineer
Sacramento District
U. S. Army Corps of Engineers
650 Capitol Mall
Sacramento, CA 95814

Desr Colonel Johnson:

Subject: Draft Feasibility Report and Draft Environmental Impact Statement (EIS) Sacramento River Deep Water Ship Channel Investigation, California

After reviewing the subject report, there appears to be economic justification for deepening the existing channel from 30 to 35 feet. The Port of Sacramento is an important bulk cargo handling port on the West Coast. The major growth in the foreign trade from the West Cosst is going to be in the bulk cargo category.

A major deficiency in our U. S.-flag fleet has been the lack of vessels to carry a modest ahare of dry bulk cargoes which comprise over 40 percent of U. S. foreign trade shipments. The Maritime Administration is initiating a U. S.-flag dry bulk program. It is our firm belief that there will be more dry bulk ships built and operated under U. S.-flag than what we have today.

From this prospective and from a national defense posture, it is important that we have ports with required herbor depths to meet the needs of U. S.-flag ships of the future. A channel depth of 30 feet is not sufficient to meet such requirementa.

The Maritime Administration has a responsibility to assist the port industry. While environmental factors must be considered in this project for Sacramento, the economic factors are also important if the port is going to participate in the future growth of maritime commerce of California.

We appreciate the opportunity to comment on this report.

Sincerely,

T. J. PATTERSON, JR.
Western Region Director

UNITED STATES DEPARTMENT OF COMMERCE
The Assistant Secretary for Science and Technology
Washington, D.C. 20230
(202) 377-XXX 4335

December 28, 1979

Lt. Colonel James G. Johnson
Department of the Army
Sacramento District, Corps of Engineers
650 Capitol Mall
Sacramento, California 95814

Dear Colonel Johnson:

This is in reference to your draft Environmental Impact Statement entitled, "Sacramento River Deep Water Ship Channel, California." The enclosed comments from the National Oceanic and Atmospheric Administration are forwarded for your consideration.

Thank you for giving us an opportunity to provide these comments, which we hope will be of assistance to you. We would appreciate receiving seven copies of the final statement.

Sincerely,

Sidney R. Galler
Sidney R. Galler
Deputy Assistant Secretary
for Environmental Affairs

Enclosure: Memos from:
NOAA-National Marine Fisheries Service-Gerald V. Howard
NOAA-National Ocean Survey-Robert B. Rollins

Rec'd PP/EC
26 DEC 1979

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
300 South Ferry Street
Terminal Island, California 90731

December 10, 1979 F/SWR33:WSL

TO: Richard E. Lehman
Acting Director, Office of Ecology and Conservation, PP/EC

THRU: James W. Rote
Director, Office of Habitat Protection, F/HP

FROM: Gerald V. Howard
Regional Director, F/SWR

SUBJECT: Review of Draft Environmental Impact Statement (DEIS No. 7910.40)
Sacramento River Deep Water Ship Channel, California

We have reviewed the subject DEIS and have determined that it does not conform to the regulations (40 CFR Parts 1500 - 1508) for implementing the provisional procedures of the National Environmental Policy Act (NEPA). The NMFS has prepared a separate report on the project under provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended 16 U.S.C.). That report, dated December 10, 1979, is intended for inclusion in the Corps of Engineers' feasibility report which will be submitted to Congress to be considered for authorization. For your information, a copy of the report is enclosed.

General Comments

The Corps of Engineers draft feasibility report, which accompanied the subject DEIS, failed to address many fishery related issues which we view as important. Based on a review of the project documents, it is our opinion that deepening and widening of the Sacramento River Deep Water Ship Channel will jeopardize fishery resources of the San Francisco Bay and tributaries system and will impede programs aimed at the protection and restoration of these resources. We recommend that the Corps of Engineers conduct additional studies to determine the cumulative impact that project construction would have on the San Francisco Bay and tributaries system fishery resources. Based on the data obtained from such studies, the document should be revised so as to describe more accurately the project related environmental impacts. During this revision, particular attention should be given to the requirements of 40 CFR Parts 1500 - 1508.

Specific Comments

Section I, Part 1.03 - Project Purpose

The project purpose should be expanded to reflect the anticipated industrial developments which would occur in the Collinsville - Montezuma Hills area. Potential types of industries which would be attracted to this area by the proposed project are described on pages B-71 through B-77 of Appendix 1 "Resources and Economy of the Study Area." Project associated benefits due to future industrialization and project-induced tonnage in the Collinsville-Montezuma Hills area are described on page 4B of the "Study and Report", and amount to about 38% of the total estimated annual project navigation benefits. Inasmuch as benefits are ascribed to such industrialization it should be considered part of the project and its impacts should also be discussed.

Section 1, Part 1.06 - Compatibility with existing and proposed projects

This discussion should expand the description of the John F. Baldwin and Stockton Ship Channels to include that reach of the project which would extend upstream on the Sacramento River to the Collinsville-Montezuma Hills area.

Section II, part 2.10 - Planktonic and Benthic organisms

This discussion or the discussions in Sections 24, 25 and 26, "Resources and Economy of the Study Area", should elaborate upon the cumulative impacts that water and related developments have had on the aquatic food chain organisms and their habitats. The importance of the food chain to anadromous fish stocks should also be discussed.

Section II, Part 2.11 - Fish

This discussion or the discussions in Section B, 27, 2B, 29, 30, 31, 32 and 33 should elaborate on the cumulative impacts that water and related developments have had on the fisheries and their habitats. Many of these impacts were identified in our December 10, 1979 FWCA comments on the draft feasibility report on the project.

Section IV, Parts 4.10 and 4.11

These discussions must be expanded to reflect the requirements of 40 CFR 150B.7 "Cumulative Impact" and 40 CFR 150B.8 "Effects". In expanding these discussions, careful consideration should be given to the potential impacts of project development and their discussion as contained in our December 10, 1979 FWCA comments on the draft feasibility report on the project.

Section V, Part 5.01, Section VII, Part 7.01 and Section VIII, Part B.01

These sections should be expanded to take into account the more complete impact description which would accrue if the proceeding comments and recommendations are adopted by the Corps of Engineers.

Attachment

National Marine Fisheries Service Report
on
Draft Feasibility Report on
the Sacramento River Deep Water
Ship Channel - - Sacramento District,
Corps of Engineers, Sept. 1979.

Project Description

The project would involve deepening the 47-mile long Sacramento ship channel from 30 to 35 feet MLLW and widening it from 300 to 400 feet between Pittsburg and Junction City and from 200 to 250 feet between Cache Slough and the Port of Sacramento. Material dredged initially from the channel would be placed at nine adjacent upland sites. Maintenance dredging would be required periodically for all reaches of the project. In order to mitigate for the potential increase in salinity intrusion, a submerged rock sill would be constructed in Carquinez Strait to restrict the flow of saline waters into Suisun Bay and the Sacramento River. Also being considered are upstream channel constrictions which would impede the tidal flow and reduce the amount of salt transported upstream. The plan includes development of two recreation areas as an enhancement measure, and a 45-acre marsh as a fish and wildlife compensation measure. The purpose of the project would be to improve deep-draft navigation channels to and from the Port of Sacramento and to enhance existing environmental and recreational conditions in the study area.

Fisheries Issues

Water projects and related developments in the San Francisco Bay and tributaries system have caused or contributed to major declines in anadromous fish populations because they have eliminated important spawning and rearing habitat and have altered habitat in downstream areas by changing flow regimes and salinity distribution. Major water diversions physically transport young fish out of the river into canals and irrigated fields. Other factors such as wastes from municipal and industrial effluent , urban runoff and pesticides all have caused habitat changes to occur. Such pollution sources have had lethal and sublethal effects on fish populations. Riverbank irregularities important as feeding areas and refuges from predators have been eliminated by levee development and channelization. Channelization of streams also caused water velocities to increase causing a reduction in habitat available to food organisms.

San Francisco Bay has been modified substantially by construction and maintenance of navigation channels. Such channels have altered salinity distribution within the bay, and spoil disposal necessitated by their maintenance has resulted in the disruption of the environment by increasing turbidity in the water column, by resuspending pollutants, by smothering of benthic organisms and by changing substrate particle size. These activities have altered the community structure of marine and estuarine organisms.

Potential Impacts of Project Development

Deepening and widening of the existing navigation channel would physically alter important fish habitat. Maintenance dredging would periodically disrupt biological communities which become established in the altered areas. The adverse impacts of the proposed project would be increased if the current practice of aquatic disposal of spoil material is continued in Suisun Bay.

Habitat alterations would also occur from changes in salinity distribution, which property has a major influence on the productivity of the area and on the distribution and structure of aquatic communities. The center of high productivity or the entrapment zone in the estuary is located in Suisun Bay, well within the area of project influence. Careful consideration must be given to the changes in salinity which could occur with project development, the effect such changes would have on the extent and location of the entrapment zone and the biological implications of altering the entrapment zone.

In speculating about changes in salinity, consideration also must be given to various other proposed actions which would influence salinity distribution. These include the reduction of Delta outflow due to export of 8.5 million acre-feet of water from a point upstream; the possible discharge of agricultural drain waters from the San Joaquin Valley into Suisun Bay; and the reclamation of waste water in the San Francisco Bay area. At the present time waste-water discharged into San Francisco Bay contributes significantly to the volume of freshwater inflow to the Bay and directly effects the salinity of the system.

The project would encourage industrial development in the Collinsville-Montezuma Hills area. Urbanization of adjacent areas would likely occur to accomodate an expanded workforce. Industrial development would require that aquatic habitats be further altered to provide ingress and egress of ships to waterside areas. Urbanization also would result in an increased demand for high quality domestic water and a need to dispose of waste-water including sewage and urban runoff. Water areas developed for industrial use generally have reduced fishery values and serve as a sump for pollutants which are chronically or periodically dispersed into adjacent areas. Urban waste-water could be expected to add substantially to the pollution burden of the area.

Project implementation would increase the risk of major accidents in San Francisco Bay and adjacent waters by encouraging increased vessel traffic. Development of one or more petro-chemical complexes in the Collinsville-Montezuma Hills area would increase the liklihood that a major spill of toxic material would occur in this biologically important reach of the estuary.

Discussion

Construction of the proposed project would result in the loss or degradation of habitat necessary for maintenance of anadromous and other fisheries resources. The probable industrial and urban development in the Collinsville-Montezuma Hills area also would be damaging to fish populations and their habitats. These impacts or losses, when viewed cumulatively, may be unacceptable.

We believe that the proposed project would affect salinities in Suisun Bay and the Delta. Model studies conducted by the Corps of Engineers and others, indicate that no significant change would occur. However, uncertainties in the models, the use of 1968 (the year the State Water Pumps began operation) and 1977 (the 2nd year of a 2 year drought) as prototype years, the apparent failure to account for increased water export and the failure to consider possible discharge of agricultural waste-water into Suisun Bay leads us to believe additional studies are needed prior to drawing conclusions as to potential project effects. In addition, construction of a sill at the Carquinez Straits coupled with constriction of upstream channels could affect the existing flow patterns in the Delta. The possible effects of this on the productivity of the estuary and on the entrainment of fish through existing water diversion facilities should be determined prior to initiating construction. Similarly, the liklihood of increasing the risk of major accidents in San Francisco Bay and adjacent waters, especially petro-chemical related accidents, should be analyzed and reported.

EIS CATEGORY CODES

Environmental Impact of the Action

LO--Lack of Objections

EPA has no objection to the proposed action as described in the draft impact statement; or suggests only minor changes in the proposed action.

ER--Environmental Reservations

EPA has reservations concerning the environmental effects of certain aspects of the proposed action. EPA believes that further study of suggested alternatives or modifications is required and has asked the originating Federal agency to reassess these aspects.

EU--Environmentally Unsatisfactory

EPA believes that the proposed action is unsatisfactory because of its potentially harmful effect on the environment. Furthermore, the Agency believes that the potential safeguards which might be utilized may not adequately protect the environment from hazards arising from this action. The Agency recommends that alternatives to the action be analyzed further (including the possibility of no action at all).

Adequacy of the Impact Statement

Category 1--Adequate

The draft impact statement adequately sets forth the environmental impact of the proposed project or action as well as alternatives reasonably available to the project or action.

Category 2--Insufficient Information

EPA believes that the draft impact statement does not contain sufficient information to assess fully the environmental impact of the proposed project or action. However, from the information submitted, the Agency is able to make a preliminary determination of the impact on the environment. EPA has requested that the originator provide the information that was not included in the draft statement.

Category 3--Inadequate

EPA believes that the draft impact statement does not adequately assess the environmental impact of the proposed project or action, or that the statement inadequately analyzes reasonably available alternatives. The Agency has requested more information and analysis concerning the potential environmental hazards and has asked that substantial revision be made to the impact statement.

If a draft impact statement is assigned a Category 3, no rating will be made of the project or action, since a basis does not generally exist on which to make such a determination.

Rec'd PP/EC
0 3 DEC 1979

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SURVEY
Rockville, Md. 20852

NOV 2 3 1979 OA/C52x6:JLR

TO: PP - Richard L. Lehman

FROM: OA/C5 - Robert B. Rollins

SUBJECT: OEIS #7910.40 - Sacramento River - Oeep Water Ship Channel, California

The subject statement has been reviewed within the areas of the National Ocean Survey's (NOS) responsibility and expertise, and in terms of the impact of the proposed action on NOS activities and projects.

The following comments are offered for your consideration.

The Office of Oceanography, NOS, has reviewed the subject statement. Tidal hydraulic considerations of the Sacramento Ship Channel and Oeltaic Region have been reviewed and found accurate and adequate for the proposed project.

Geodetic control survey monuments may be located in the proposed project area. If there is any planned activity which will disturb or destroy these monuments, NOS requires not less than 90 days' notification in advance of such activity in order to plan for their relocation. NOS recommends that funding for this project includes the cost of any relocation required for NOS monuments. Attached are data locating and describing monuments in the vicinity of the proposed project.

Attachments

Engr

UNITEO STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
215 Framont Street
San Francisco, Ca. 94105

D-COE-K32016-CA

George Ruddell
U.S. Army Corps of Engineers
ATTN: Investigations Section D
650 Capitol Mall
Sacramento CA 95814

7 JAN 1980

Dear Mr. Ruddell:

The Environmental Protection Agency (EPA) has received and reviewed the draft environmental impact statement (DEIS) titled SACRAMENTO RIVER DEEP WATER SHIP CHANNEL, CALIFORNIA.

The EPA's comments on the DEIS have been classified as Category ER-2. Definitions of the categories are provided on the enclosure. The classification and the date of the EPA's comments will be published in the Federal Register in accordance with our responsibility to inform the public of our views on proposed Federal Actions under Section 309 of the Clean Air Act. Our procedure is to categorize our comments on both the environmental consequences of the proposed action and the adequacy of the environmental statement.

The EPA appreciates the opportunity to comment on this draft environmental impact statement and requests three copies of the final environmental impact statement when available.

If you have any questions regarding our comments, please contact Susan Sakaki, Acting EIS Coordinator, at (415)556-6925.

Sincerely yours,

Sheila M. Prindiville
for Paul De Falco, Jr.
Regional Administrator

Enclosure

GENERAL CONCERNS

If the proposed deepening of the Sacramento Ship Channel takes place, as well as the J.F. Baldwin Ship Channel, what will be the total effect on Suisun Bay, salt water incursion, and drinking water? Would the cumulative effects of the two projects produce effects worse than either project by itself? Would the proposed mitigation measure, a submerged sill, accomodate the increased salinity from deepening both channels? How much additional delta outflow would be required to maintain delta water quality standards with both channels deepened? How would the deepened ship channels with the proposed cross delta facility affect water quality in the Bay and the Delta?

THE SUBMERGED SILL

EPA recognizes the potential need for some measures, such as the installation of a submerged sill, to control and prevent any increased salinity incursion into the delta as a result of the deeper channel. However, the total environmental effects of the submerged sill have not been adequately described in the DEIS. The FEIS should address the following concerns:

1) The salinity level upstream of the structure could be significantly higher than the surrounding waters during an ebb tide, for the water is trapped upstream with the sill in place.

2) If 9.56 million cubic yards of sediment flow through this area, as estimated by the U.S. Army Corps of Engineers in the Dredge Disposal Study, San Francisco Bay and Estuary, Appendix 'E' - Material Release, August 1977, page 7, the possibility of extensive sedimentation in the area of the sill would occur. The environmental effects of this have not been fully represented in the DEIS. It is also possible that there may be a sediment build-up on both sides of the sill such that, over a period of time, the slope becomes so gradual that the sill becomes ineffective in controlling salt water intrusion. Therefore, the need for maintenance dredging at the sill should be addressed.

3) According to the U.S. Fish & Wildlife Service Report (Appendix 2; August 3, 1979), a submerged sill poses problems for fish and wildlife apart from salinity considerations. Potential impacts on the dynamics of the nutrient zone (especially transport of detritus and concentrations of phytoplankton and zooplankton), the movement of aquatic organisms, and the transport of toxic materials and sediments must also be considered.

4) Specifically under EPA guidelines at 40CFR 230.5(a)(1), the following objective shall be considered in making a determination of any proposed discharge of fill for the submerged sill: to avoid discharge activities that significantly disrupt the chemical, physical and biological integrity of the aquatic ecosystem, of which aquatic biota, the substrate, and the normal fluctuations of water level are integral components.

Accordingly, the EPA would not agree to the placement of fill for a submerged sill unless the potential impacts on water quality and fish and wildlife resources are adequately considered.

DELTA WATER QUALITY
(Appendix 1, D-39, paragraph 75)

As stated in Appendix 1, D-39, Alternative Measures to Control Salinity Intrusion, "increasing delta outflow is not a viable alternative due to the present lack of available water for such purpose and the high costs to develop future water supplies." To determine adequate mitigation measures in the event of salt water incursion as a result of channel deepening, what amount of additional delta outflow would be needed to maintain water quality objectives? What is the cost of the sill versus the cost of increasing delta outflow?

THE SELECTED PLAN, NY SLOUGH TO SACRAMENTO
(Appendix 1, E-1, paragraph 2)

The draft EIS states that, "the selected plan also provides for supplementing as necessary the existing water quality monitoring network in the Sacramento-San Joaquin Delta to include high quality salinity monitoring stations. These stations would measure salinity levels in the Delta before, during, and after deepening and widening of the channel. If salinity levels increase to unacceptable levels above preproject conditions, subsequent to channel deepening, a submerged sill would be constructed in Carquinez Straits to mitigate for the increased salinity..." The California State Water Resources Control Board (SWRCB) should be included as one of the coordinating agencies in determining the locations of the additional salinity monitoring stations. As required under Section 313, Clean Water Act, 1977, the project must comply with water quality standards, the State Water Quality Management Plan, and Decision 1485 adopted by the State of California (October 13, 1978). The U.S. Army Corps of Engineers should coordinate with the California SWRCB to determine whether the project is in compliance. Since construction of the submerged sill or the implementation of other measures may be necessary to mitigate for the increased salinity, these measures and their impacts should be considered as part of the project and included in the final environmental impact statement (FEIS).

WATER QUALITY
(Appendix 1, B-11, paragraph 17)

The draft EIS states that, "the total dissolved solids generally exceed the 500 ppm objective between mile 35 and the turning basin (51). This is due primarily to salt water ballast discharge in the turning basin." The FEIS should provide the current estimated amount of ballast discharge and the average flow rate in this area. In addition, how much of an increase in ballast discharge would there be with the proposed project depth? The Water Quality Management Plan for the Sacramento Regional Area Planning Commission, adopted by U.S. EPA on June 14, 1979, indicated, "that ships dumping ballast water as they proceed up the deep water channel" is a problem of interest. While this ballast discharge problem is being studied by the U.S. Army Corps of Engineers, as indicated in the draft EIS, the final FIS should include mitigating measures to minimize the increased salinity and other associated water quality impairments due to ballast water discharge.

Additionally, since the data on dissolved oxygen (DO) included in the DEIS collected in 1965 showed occasional DO concentrations below 5.0 ppm, the water quality standard, EPA requests that the final EIS include analysis showing the effect of deepening the ship channel on channel circulation and water quality, including DO concentrations.

DREDGING

The draft EIS states that, "limited information is available concerning concentration of heavy metals (lead, chromium, copper, zinc, arsenic, and mercury) in the section of the channel between Cache Slough and Collinsville." The final EIS should provide an analysis of the dredged material, specifically for heavy metals, organics, and other toxic materials. The final EIS should estimate the quality of surface water return and leachate of effluent returning to the water body to insure against extensive violation of existing water quality standards, as well as to address potential impacts on water quality and the need for water quality certification and a National Pollution Discharge Elimination System Permit, as appropriate (Clean Water Act, Sections 401 and 402).

The draft EIS (Appendix 4; Section 7.05) discusses considerations to minimize harmful effects from the proposed project by timing of construction so as to prevent interference with migrating fish.

Under EPA guidelines 230.5(b)(3)(ii), dredging and disposal operations should be scheduled to avoid interference with fish spawning cycles and to minimize interference with migration patterns and routes.

Therefore, the final EIS should include schedules for dredging the channel and disposal operations for construction of the proposed submerged sill to minimize adverse impacts on migrating fish.

AIR QUALITY

The DEIS does not quantify air pollutant emissions associated with the proposed project. The FEIS should estimate emissions from all project related sources at the estimated time of completion (ETC) and ETC +20 for each alternative given on page 21.

UNITED STATES
NAVAL WEAPONS STATION
CONCORD, CALIFORNIA 94520

0533:RGG:ts
11DOD
11 DEC 1979

From: Commanding Officer, Naval Weapons Station, Concord, CA 94520
To: Department of the Army, Sacramento District, Corps of Engineers, 650 Capitol Mall, Sacramento, CA 945814

Subj: Draft Feasibility Report of Sacramento River Deep Water Ship Channel, California dtd September 1979

Ref: (a) Corps of Engineers ltr SPKED-W of 24 Oct 1979

1. As requested by reference (a), a review of the subject plan has been made by Naval Weapons Station, Concord. While the overall channel project is strongly endorsed by the station, the possible use of Navy property for dredged material disposal sites needs to be restudied.

2. Paragraph 13 of page E-5 and Plate E-1 indicate two dredge spoils sites within the station's boundaries. Originally these sites were discussed between COE and station personnel circa 1974. Subsequently, major changes have occurred both in our facilities planning and actual construction which now preempts use of some of the indicated land for dredge spoils disposal.

3. In addition, portions of our Tidal Area are under consideration by the Fish and Wildlife Service for designation as a National Wildlife Refuge. The Draft Environmental Statement also does not address known endangered species of wildlife resident within the station.

4. Considering the above, a visit to the station for further discussion of possible dredge spoil sites is strongly recommended. Point of contact is Mr. Robert Guyman, Code D533, AUTOVDN 253-5611, (415)671-5611.

Harold Baltazor
HAROLD BALTAZOR
By direction

OFFICE OF THE SECRETARY
RESOURCES BUILDING
1416 NINTH STREET
95814

(916) 445-5656

Department of Conservation
Department of Fish and Game
Department of Forestry
Department of Navigation and Ocean Development
Department of Parks and Recreation
Department of Water Resources

EDMUND G. BROWN JR.
GOVERNOR OF
CALIFORNIA

Air Resources Board
California Coastal Commission
California Conservation Corps
Colorado River Board
Energy Resources Conservation and Development Commission
Regional Water Quality Control Boards
San Francisco Bay Conservation and Development Commission
Solid Waste Management Board
State Coastal Conservancy
State Lands Commission
State Reclamation Board
State Water Resources Control Board

THE RESOURCES AGENCY OF CALIFORNIA
SACRAMENTO, CALIFORNIA

JAN 04 1980

Colonel Paul F. Kavanaugh
District Engineer
U.S. Army Corps of Engineers
650 Capitol Mall
Sacramento, CA 95814

Dear Colonel Kavanaugh:

The State of California has reviewed the "Sacramento River Deep Water Ship Channel, Draft Feasibility Report and Draft Environmental Impact Statement", submitted through the Office of Planning and Research in the Governor's Office.

This review, which fulfills the requirements of Part II of Office of Management and Budget Circular A-95 and the National Environmental Policy Act of 1969, was coordinated with the Departments of Boating and Waterways, Conservation, Fish and Game, Parks and Recreation, Water Resources, Food and Agriculture, Health, and Transportation; the Air Resources, Reclamation, Solid Waste Management, and State Water Resources Control Boards; and the San Francisco Bay Conservation and Development and State Lands Commissions. A copy of all comments received from the reviewing State agencies is attached.

The cumulative impact of deepening the Sacramento, Baldwin, and Stockton Channels should be discussed in one environmental document. Although any part of the proposed developments could be constructed independently, the Delta system will be subjected to their combined effects.

The report concludes that deepening the Stockton Ship Channel would not affect salinity distributions or concentrations in the estuary and that subsequent deepening of the Sacramento Ship Channel would also have no measurable impact on salinities. A Department of Water Resources analysis of the data in the report and meetings with the Corps and its Bay-Delta Model Advisory Committee, however, indicate that the model is not able to measure

relatively small increases in salinity which could require as much as 400 cubic feet per second of additional Delta outflow to counteract. The State Water Project and the Central Valley Project would be obligated to release this additional amount of water from upstream storage to meet the water quality standards of State Water Resources Control Board Decision 1485. An increase in salinity could have an adverse impact on agricultural, municipal, and industrial uses and on wildlife habitat.

The Corps proposal to delay the implementation of mitigation measures until an adverse impact is discovered by monitoring water quality is unacceptable. The monitoring program, as proposed by the Corps, would be ineffective in measuring small salinity increases. We believe there is a real possibility of an adverse impact. Mitigation for this impact must become part of the authorization, design, and construction of the channel-deepening projects and must be implemented.

If a sill or similar device to induce additional turbulence in Carquinez Strait is specified as the mitigation device, we must then be reasonably assured that it will, in fact, reduce salinity intrusion and be environmentally acceptable. As part of its activities to complete its feasibility report on the Sacramento Deep Water Ship Channel, the Corps should implement the undistorted scale model, using saline stratified flow as recommended by its Advisory Committee. At the Carquinez Strait and Chipps Island channel constrictions, sand dunes move along the bottom during low flow periods. The effect of the proposed sill on these dunes and the resultant effects on inorganic particulate transport must be investigated further and discussed in the final document. The State uses a design flood of 700,000 cfs in evaluating the effect of a sill, while the Corps uses a 410,000 cfs value. The reasons for this difference and the probable effects of higher flows, if they can be expected, should be addressed by the Corps.

Because of the uncertainties related to the sill, the Corps should study other mitigation measures, including development of locks in the Sacramento River Deep Water Channel at the lower end of Prospect Island and through flow increases from purchase or additional water development.

The report appears to consider the impact of this project on fish and wildlife adequately, but the final report should more fully describe possible mitigation measures. For example, the Corps has not defined the measures planned for the unavoidable loss of upland habitat caused by widening the channel and at spoil disposal sites. We suggest that the final report specifically indicate the upland mitigation site, with an environmental easement or other dedication provided to assure its continued availability for wildlife. In addition, we recommend that the authorization for this project include the wetlands enhancement at Donlon Island mentioned on page 39 of the draft report.

The report does not mention the existence of Younger Bay Mud, which is present both in the proposed channel area and underlying adjacent filled areas. The report should address potential lateral spreading of this and other materials toward the excavated channel. This phenomenon would result in subsidence of adjacent areas, particularly those upon which fill has been placed. The report should also discuss whether any structures or usable land might be affected.

The effect of increased ship traffic and an increase in water level on levee maintenance in the Suisun Marsh should be considered in more detail. If the increased traffic and larger ships--coupled with even a small rise in the water level--increases the maintenance problems with the levees, some program to rectify that situation should be included in the project.

The report should also present a more detailed discussion of the economic impacts of the project. The economic analysis, as described in the draft report, is too narrow in scope. From that description, it appears that insufficient consideration was given to the options of using other west coast port facilities, existing or proposed, as alternatives to the further development of the Port of Sacramento. This is particularly true for the facilities serving shipping that passes through the Golden Gate. For example, the Sacramento and Stockton ports are competitors, both specializing in bulk commodity shipping. If only one of the channels is deepened, the other port could suffer severe economic consequences. The report should show the projected changes in shipping at the two ports if one or both channels are deepened. Other potentially competing developments are proposed for Oakland, Richmond, and Los Angeles.

The report should clearly show that the Sacramento channel proposal is part of a comprehensive plan for the coordinated development of west coast shipping. The relationship of the Port of Sacramento development to regional shipping needs should be discussed.

The report does not adequately account for the risk and uncertainty involved in projecting benefits to 50 years in the future. With the rapidly evolving variety of transportation routes and modes, as well as the many variables that affect foreign trade, it appears that either the period of analysis should be shortened or the projected benefits should be weighed against the risk and uncertainty involved. This is particularly important in determining the optimum channel depth.

The industrial development that the selected plan induces will be likely to generate substantial additional highway traffic, particularly in the vicinity of the industrial area near the Port of Sacramento and near Collinsville. The adequacy of existing roadway facilities should be an integral part of any decision to approve a growth-inducing project such as the one proposed. The Environmental Impact Statement should include a projection of trips to be generated and an analysis of impacts on existing transportation facilities.

We appreciate having been given an opportunity to review this document.

Sincerely,

James W Burns

JAMES W. BURNS
Assistant Secretary for Resources

Attachments

cc: Director of Management Systems
Office of Planning and Research
1400 Tenth Street
Sacramento, CA 95814
(SCH 79110814)

STATE OF CALIFORNIA—RESOURCES AGENCY

EDMUND G. BROWN JR., Governor

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION
1111 JACKSON STREET, ROOM 6040
OAKLAND 94607

Phone: Area Code 415
464-1255

January 28, 1980

File No. 1112.06 (NAR) vjw

Colonel Paul F. Kavanaugh
District Engineer, Sacramento District
U. S. Army Corps of Engineers
Federal & Courthouse Building
650 Capitol Mall
Sacramento, CA 95814

Dear Colonel Kavanaugh:

Subject: Draft EIS, Sacramento River Deep Water Ship Channel

We have reviewed the Sacramento River Deep Water Ship Channel Draft Environmental Impact Statement (DEIS). The following comments are late because we had to request a copy of the DEIS.

1. Heavy Metal Release

We agree with Dr. Selina Bendix's comments in her December 26, 1979 letter to the Corps regarding the lack of adequate information in the DEIS to evaluate water quality impacts of the project (copy attached). We especially agree with her expressed concerns regarding mercury in the sediments. The DEIS should include a full discussion of the potential for mercury methylation. We believe that hydraulic or suction dredging will stir sediments into the water column to a significant extent. The DEIS presents no evidence to the contrary.

We question the basis for the statement on page 40 that, "other water quality parameters, such as turbidity, dissolved oxygen, heavy metal concentrations, and nutrient concentrations, will not be affected by the dredging." Heavy metal releases do occur, although the extent may vary. A technical report of the Oakland Inner Harbor dredging states, "... one sediment suspension, when incubated under aerobic, agitated conditions, exhibited a marked drop in pH from near 8.0 to 3.6. The acidic condition was accompanied by a high net release of trace metals." (Technical Report DS-78-6, Office, Chief of Engineers, U. S. Army, 1978, p. 25.) It is highly probable that numerous pockets of mercury exist throughout the project area. Release of that element into the water column as a result of dredging, with consequent uptake by marine organisms, is also highly probable.

2. Required Regulatory Procedures

The DEIS should discuss the regulatory procedures required under Section 404 of the Clean Water Act of 1977 (P.L. 95-217) to inform interested parties of State Requirements. State interests are protected by implementation of Waste Discharge Requirements, and Certification procedures.

3. Land Disposal Sites

The dredge spoils, according to the DEIS, are to be deposited on land which, in some instances, will be used for recreation. These areas are shown on maps with each site's acreage and the quantity of dredged spoil. No mention is made of means to prevent return flow which could carry heavy metals and suspended solids back into State Waters. A calculation of the volume of return flow from each site should be presented, with a program for monitoring the supernatant. Mention should also be made of the proposed measures to be taken, during pipeline transport of dredged material, to minimize impacts on adjacent marsh land areas.

4. Submerged Sill Installation

The DEIS states that extensive measures were undertaken to determine the project's impact on salinity distribution. Page 5-3, appendix 5, Summary and Conclusions, indicates that deepening the Stockton Ship Channel and the Sacramento River Deepwater Ship Channel would have no measurable impact on salinity distributions in the estuary. The Bay Delta Model and related tests also show that construction of the proposed submerged sill in Carquinez Straits, "... would cause no changes in sediment transport, tidal stages, or velocities (except near the sill). Consequently, there would be no increase in salinity resulting in long-term changes in the estuary as a result of constructing the project with or without the sill." If this is correct, the justification for installation of the sill needs to be explained in greater detail. The DEIS does not address the specific question of the sill's effect upon fish migration.

5. Final Environmental Impact Statement

We found the format and general organization of the DEIS difficult to comprehend and cumberson to use. The concerns expressed in these comments should be addressed in the Final Environmental Impact Statement.

Colonel Paul F. Kavanaugh - 3 - January 28, 1980

We appreciate the opportunity to comment on this proposal. If you have any questions regarding these remarks, please call Mr. Norman Rial at (415) 464-0503.

Sincerely,

FRED H. DIERKER
Executive Officer

cc: Mr. James Robertson
Executive Officer, Region 5
3201 S Street
Sacramento, CA 95816

Colonel John M. Adist
District Engineer
U. S. Army Corps of Engineers
211 Main Street
San Francisco, CA 94105

STATE OF CALIFORNIA—BUSINESS AND TRANSPORTATION AGENCY EDMUND G. BROWN JR., Governor

DEPARTMENT OF TRANSPORTATION
P. O. BOX 3366 RINCON ANNEX
SAN FRANCISCO 94119
(415) 557-1840

T.TK

November 21, 1979

04-CC
SCH #79110814

Mr. Mark Capek
U. S. Army Corps of Engineers
650 Capitol Mall
Sacramento, CA 95814

Subject: Comments on Sacramento River Deep Water Ship Channel, California

Although there was some discussion on Intermodal Transportation, impacts and implications due to the facilities attracting and perhaps concentrating vehicular support traffic are not addressed. If this has been considered and found not to be significant nor relative, we request to be advised.

Sincerely yours,

T. R. LAMMERS
District Director

By R. W. Sieker

R. W. SIEKER
District CEQA Coordinator

State of California

Business and Transportation Agency

Memorandum

F.T.K.

To : Ms. Ann Barkley
Division of Transportation Planning

Attn: Mr. Fred Karkirchner
A-95 Coordinator

Date: November 29, 1979

File : 10-Sol-12,84
Sacramento River Deep
Water Ship Channel

SCH No. 79 110814

From : DEPARTMENT OF TRANSPORTATION
D. L. Wieman, District 10 Director

Subject:

We have reviewed the above-noted report and offer the following comments:

This project would promote recreation in the delta area and induce development of industry near Collinsville. This development would adversely affect State highways in the area by increasing congestion and Structural Section deterioration.

Any improvements to the State highways would have to be paid for by the State unless Federal highway matching funds are available. The U. S. Army Corps of Engineers, as per pages 53 and 55 of the report, would not participate in financing highway improvements.

Caltrans' current five-year (STIP) State Transportation Improvement Program does not include funds for mitigating the effects of large industrial or recreational developments that may be induced by the improvements of the channel.

Any work performed within the State highway right of way will require an encroachment permit. Application for the permit may be obtained at the Department of Transportation Office of the Maintenance Superintendent at 2019 W. Texas Street, P. O. Box 8, Fairfield, CA 94533.

Please allow a minimum of 4 to 6 weeks to process the application and issue a permit. More time will be required for complex projects or projects without adequate information, environmental clearances, etc.

John Gagliano
JOHN GAGLIANO, P.E.
A-95 Coordinator
(209) 948-7875
ATSS 423-7875

REM:mej
Attach.
cc:RJFelton

STATE OF CALIFORNIA—BUSINESS AND TRANSPORTATION AGENCY

EDMUND G. BROWN JR., Governor

DEPARTMENT OF TRANSPORTATION
1120 N STREET
SACRAMENTO, CALIFORNIA 95814
(916) 445-4400

December 10, 1979

U.S. Army Corps of Engineers
Sacramento District
650 Capitol Mall
Sacramento, CA 95814

Attention Investigations Section D

Gentlemen:

We wish to comment on the Feasibility Report for the Sacramento River Deep Water Channel dated September 1979. The proposal is to deepen the ship channel to -38 elevation at the Rio Vista Bridge (our Bridge No. 23-24).

The proposal, according to Mr. Jim Veres of your office, includes funds for lowering the submarine cable at the Rio Vista Bridge and providing scour protection for the footings of the bridge, which would be exposed by the lower channel.

We will have no objections to the dredging if these adjustments are made.

Sincerely,

W. R. Green
W. R. GREEN
Chief, Office of Planning and Design

STATE OF CALIFORNIA—BUSINESS AND TRANSPORTATION AGENCY — EDMUND G. BROWN JR., Governor

DEPARTMENT OF ECONOMIC AND BUSINESS DEVELOPMENT

1120 N STREET
P.O. BOX 1499
SACRAMENTO, CALIFORNIA 95805
(916) 322-1394

November 30, 1979

Colonel Paul Kavanaugh
U.S. Army Corps of Engineers
Sacramento District
650 Capitol Mall
Sacramento, CA 95814

Dear Colonel Kavanaugh:

As director of California's Department of Economic and Business Development, I wish to encourage the U.S. Army Corps of Engineers to consider carefully the significant economic benefits of deepening the Sacramento River Deep Water Ship Channel.

Deepening of the Sacramento River Ship Channel is of vital importance to the economy of the Port of Sacramento, the surrounding cities and communities, and much of the Central Valley. This project would enable the Port to continue to serve as an important conduit for California's agricultural exports as well as a focal transportation center for business and industry.

Testimony at the public hearing on November 13th overwhelmingly favored the deepening of the Sacramento River Ship Channel. I am hopeful that those concerns which were voiced will be addressed by the Corps and that a favorable decision to deepen the channel can be reached.

Cordially,

Betty Bryant
BETTY BRYANT
Director

cc: Ivory J. Rodda, Chairman
Port of Sacramento Commission

Melvin Shore, Director
Port of Sacramento

Gerald Meral, Deputy Director
Department of Water Resources

Clint Whitney, Acting Executive Director
State Water Resources Control Board

RON E. WHITEHEAD
SHERIFF-CORONER

Sheriff-Coroner
P.O. Box 179
Woodland, Calif.
95695
916-666-8585

October 23, 1979

Colonel Paul F. Kavanaugh
District Engineer, U.S. Engineers
650 Capitol Mall
Sacramento, CA 95814

Dear Colonel Kavanaugh:

I would like to take this opportunity to state that I am in complete support of the Corps of Engineers' study on the feasibility of deepening the Sacramento River Deep Water Ship Channel.

I will also be present to make my comments orally, at the hearing on November 13, 1979, in the Sacramento County Board of Supervisors Chambers.

Very truly yours,

Ron E. Whitehead
RON E. WHITEHEAD
SHERIFF/CORONER

REW:b
cc: Melvin Shore
Port Director

COUNTY OF YOLO

PLANNING DEPARTMENT
292 WEST BEAMER
WOODLAND, CALIFORNIA 95695
TELEPHONE 666-8556
AREA CODE 916

November 6, 1979

Mr. Mark Capik
U.S. Army Corps of Engineers
Sacramento District
Attention: Investigation Section D
650 Capitol Mall
Sacramento, Ca. 95814

Dear Mr. Capik:

The Yolo County Community Development Agency has reviewed the draft feasibility report and environmental impact report for the Sacramento River Deep Water Ship Channel investigation. The following specific comments are provided to you as a result of this review:

1. Appendix 1 - D-17. The statement indicates that no industrialization is anticipated on the east side of the channel below channel mile 37. This statement should note that in Yolo County, no industrialization is anticipated on the west side south of the existing industrial zoned property.

2. The selected disposal sites appear appropriate. The expanded disposal sites as depicted in Plate D-5 which were not selected pose significant impacts due to disposal of sedement on prime farm lands.
The EIS should discuss in more detail the change of use for those lands from agricultural use to use as disposal sites. For those sites not used as a recreational site or a wetland habitit area, what will be their new use?

3. Appendix 3, 3-20
The statement included in the paragraph on land use (4.17) which reads "There's 2000 acres in the upper channel area (south side) zoned for future industrial use", is incorrect. It should read that there are approximately 2000 acres south of the Port which are currently zoned Agricultural General (A-1) and are designated on the East Yolo General Plan for Agricultural-1st Phase/Industrial-2nd Phase.

COUNTY OF YOLO
PLANNING DEPARTMENT
292 WEST BEAMER STREET
WOODLAND, CALIFORNIA 95695
TELEPHONE (916) 666-8556

Generally, the feasibility report and the draft environmental impact statement adequately responds to these issues which would directly affect Yolo County. We appreciate the opportunity to review the document and if any further information is needed from Yolo County, please do not hesitate to ask.

Sincerely,

Gloria S. McGregor
Community Development Director

Janet M. Ruggiero

Janet Ruggiero, Deputy Director
Advanced, Housing and Parks Planning

GSM/JMR/bar

November 13, 1979

To: Colonel Paul F. Kavanaugh
District Engineer, U.S. Engineers
650 Capitol Mall
Sacramento, CA 95814

I received a call this morning from Frank Perreira who called to voice his support for the Army Corps of Engineers' proposal to widen and deepen the Sacramento River Channel. He said that the record will show that it is both a needed and worthwhile project and that it will encourage additional business and trade.

Don W. Nottoli
Administrative Assistant to
Toby Johnson

DWN:ms

Solano County Mosquito Abatement District

Embree G. Mezger, Manager-Entomologist

P.O. BOX 304, SUISUN, CALIF. 94585

Telephone (707) 425-5768

Meetings: Second Monday Every Month
Mosquito Bldg., Suisun Plaza: 7:30 p.m.

November 28, 1979

U.S. Army Corps of Engineers
Sacramento District
Attention: Investigations Section D
650 Capitol Mall
Sacramento, California 95814

Subject: Sacramento River Deep Water Ship Channel Investigation - Proposed Establishment of A 45 Acre Wetland Habitat, Prospect Island, Solano County

Dear Sirs:

I appreciate being sent the Information Summary Sacramento River Deep Water Ship Channel Investigation. Due to a prior commitment on November 13, 1979 I was unable to attend the Public Meeting and Workshop on the afore mentioned subject. However, at this time I wish to express some concerns the Solano County Mosquito Abatement District has in wetland habitats.

Historically wetlands are extremely productive for producing disease bearing and pest mosquitoes if such wetlands are not properly managed. In recent years many Federal, State and Regional agencies have advocated through the process of mitigation the establishment of wetlands without regard of these habitats for the production of mosquitoes.

Recently, in 1977 the Coastal Region of the California Mosquito and Vector Control Association Inc. in collaboration with the Vector Biology and Control Section, California Department of Health Services have developed criteria for mosquito prevention in Dredge Material Disposal Projects and Wastewater Reclamation or Disposal Projects. Enclosed are copies of these mosquito prevention cirteria for your reference and utilization.

The Board of Trustees of the Solano County Mosquito Abatement has adopted these criteria as polices and as such requests that they be utilized to prevent the production of mosquitoes in the proposal to establish a 45 acre wetland, Prospect Island, Solano County.

Sincerely,

Embree G. Mezger

Embree G. Mezger
Manager-Entomologist

EGM:mjg
cc: Board of Trustees
Richard Brann, Supervisor 5th District, Solano County
Reuben Junkert, P.E., Calif. Dept. of Health Services

Standard Recommendations to Prevent Mosquito Problems
Associated with Dredge Material Disposal
by the Coastal Region of the
California Mosquito and Vector Control Association 1/

1. Background Statement: In many instances, dredge material disposal sites, on land, have become mosquito breeding sources. This is primarily due to inadequate de-watering of the disposal site.

Following is a list of recommendations to be directed to planning and regulatory agencies for their use to lessen the real post disposal impact of mosquito production in dredge material disposal sites.

II. Recommendations for LAND DISPOSAL OF DREDGE MATERIAL

Subsequent to the de-watering phase of the projects, physical changes occur (i.e. uneven subsidence) that may impound water or impede drainage and thereby create mosquito sources. Steps should be taken to establish and maintain an effective, long-term, drainage system to preclude mosquito production.

1. After sufficient subsidence has occurred, conduct a topographical engineering survey to delineate depressions that would trap and hold water. The survey would also dictate proper emplacement of permanent ditches and drainage structures.
2. Ditch and emplace drainage structures as necessary to establish a drainage system that will prevent standing water (continuing subsidence of the land must be considered).
3. Plan and fund a long-term maintenance program for the site. The program should include:
   a. Maintenance of ditches as required (e.g. grading, vegetation removal, etc.).
   b. Maintenance and repair of water control structures.
   c. Disking cracked ground as needed.
   d. Maintenance of levees as needed. (Levees should be capable of supporting heavy equipment).
4. If permanent bodies of water, such as marshes, lakes or ponds are planned for the site, the local mosquito or vector control agency should be contacted in order to provide their design criteria to prevent mosquitoes.

1/ Prepared in cooperation with the California Mosquito & Vector Control Association

III. Recommendations for DREDGE MATERIAL DISPOSAL FOR WETLAND DEVELOPMENT (SALT MARSHES)

Salt marshes inherently possess great potential for the production of mosquitoes. Mosquito control can be provided by physical and biological control mechanisms if a system of water recirculation ditches is employed. A recirculation system can be operated to enhance the wildlife benefits of the marsh as well as to provide mosquito control.

1. The outboard levee system should be maintained until the dredge disposal and de-watering phases have been completed and the site can be properly prepared for restoration to marsh land.
2. After sufficient subsidence has occurred, conduct a topographical engineering survey to provide the basis for planning the recirculation system. (Expertise of design of recirculation systems should be obtained by contacting the local mosquito or vector control agency).
3. Delineate depressions that would trap and hold tidal or storm waters.
4. Establish a recirculation system.
   a. Construct sloughs and ditches, and connecting ditches as needed, to depressions that would trap and hold tidal or storm waters.
   b. Disk all cracked ground caused by shrinkage or subsidence prior to breaching levees.
5. Additional benefits would be realized by the emplacement of water control structures in the outboard levee as an alternative to breaching the levee. By controlling tidal water in this manner, emergency control of mosquitoes could easily be applied and maintenance of the recirculation system would be more easily accomplished. Wetland management in general would also be significantly enhanced.
6. Secure appropriate permits before the outboard levee is breached. The outboard levee systems should continue to be maintained until the project has been approved by all concerned agencies including the local mosquito and vector control agencies. (Concerned agencies may include: U.S. Corps of Engineers, San Francisco Bay Conservation and Development Commission, San Francisco Water Quality Control Board, California State Lands Commission, California Department of Health, California Department of Fish and Game, California Reclamation Board, California State Coastal Commission, Local Planning Agencies and others.)

STATE OF CALIFORNIA HEALTH AND WELFARE AGENCY
EDMUND G. BROWN JR., Governor

DEPARTMENT OF HEALTH
714 P STREET
SACRAMENTO, CALIFORNIA 95814
(916) 445-4408

January 25, 1978

Vector and Waste Management Section

Criteria For Mosquito Prevention In
Wastewater Reclamation Or Disposal Projects 1/

I. Background Statement.

Recent changes in California water pollution regulations and current emphasis for reuse of wastewater have serious prospects for mosquito production. Proposals for reusing effluent and surface runoff or preventing these waters from flowing directly into estuaries or water courses can create new mosquito sources. Kinds of proposals under consideration for the diversion and reuse of wastewater are: (1) impoundments for reclamation; (2) agriculture irrigation; (3) recharge of ground water; (4) development of marshland and wetland habitat; and (5) industrial proposals.

"Mosquito breeding" and "mosquito breeding places" in published literature are generally referred to as the developing aquatic life stages of the mosquito and to the water-holding depressions, sites or containers in which the aquatic stages are found. A site becomes a source when it holds water suitable for mosquito development and at some time produces mosquitoes if left uncontrolled.

Mosquito control is accomplished by one or a combination of three methods: (a) use of chemicals; (b) biological control; and (3) manipulation of physical features. Chemicals are useful for intermittent or emergency control, but are not recommended for consistent use because of cost, environmental concerns and inherent development of physiological resistance to the chemicals by the mosquitoes. Perhaps the best known and most common biological control agent is the small fish Gambusia affinis. This species is found widely throughout the state and in certain situations is helpful in keeping populations of mosquito larvae down to moderate levels. The effectiveness of this fish is influenced by such factors as density of the aquatic vegetation, rate of larval production and the availability of other organisms preferred by the fish. Manipulation or design of the physical features to prevent a source from developing is the best long-term solution. Recognizing the fact that this goal may be both difficult and expensive, alternatives containing appropriate physical features, water management and biological control possibilities should be realistically explored.

The following criteria are based on ecological facts known to inhibit mosquito production. It is important that local mosquito control agencies and the Vector and Waste Management Section, State Department

1/ Prepared in cooperation with the California Mosquito & Vector Control Association

of Health, be notified about impending wastewater use projects. Coordination and cooperation among agencies is vital in order to avoid creation of unnecessary conditions conducive to mosquito production. Certain projects may require a contract arrangement between the owner and local mosquito control agency. The contract would provide for surveillance and control measures that may become necessary.

These criteria have not been developed to limit or discourage the use of animal waste storage ponds commonly used for temporary storage of animal wastes on dairies and feedlots. Some of the criteria are applicable, but animal waste storage ponds present additional problems beyond the scope of these criteria.

II. Wastewater Management.

A. Water Use.

1. All sites designated for wastewater reclamation or final disposal (cropland, marshes, etc.) should either be graded or ditched as necessary for proper drainage.

2. Sites for temporary impoundments used for waterfowl feeding areas or for production of food should be flooded according to time intervals and seasonal schedules adjusted to prevent the emergence of adult mosquitoes. Contact the local mosquito control agency or the Vector and Waste Management Section, State Department of Health, for specific details.

3. The use of wastewater in crop irrigation requires careful land preparation and judicious water management to prevent excess static water areas.

4. Establishment of wetland habitat requires areas of deep water (four feet); land grading or ditching to allow removal of all water from the shallow areas; water control structures, pumps, etc., for complete water management and access provisions for marsh management equipment such as boats and aquatic or terrain vehicles.

5. Excess water at the low ends of sites used for marsh flooding or crop irrigation must be either recycled, utilizing a return system, or disposed of in a drainage facility.

6. Water control devices such as pumps, weirs, and flood gates should be of proper capacity to draw down the temporary impoundments within a time designated by local mosquito control agency or the Vector and Waste Management Section, State Department of Health. Generally a 24 hour draw down period is sufficient for most areas of the State.

B. Storage Ponds.

1. Ponds may be any shape but should not have small coves or irregularities around their perimeters.

2. Ponds should be designed to be emptied by gravity or pumping for cleaning or drying and have graded bottoms so all water can be removed.

3. Side slopes of excavations and levees should be as steep as possible, consistent with soil characteristics and risk factors.

4. Where steep side slopes cannot be economically achieved, the slopes should be lined with suitable material such as concrete to 3 ft. below the water line or sterilized to achieve weed control.

5. Minimum top width of embankments should be 12 ft. and adequately constructed to support maintenance vehicular traffic.

6. An access ramp should be provided on an inside slope for launching a small boat for midge control.

7. Ponds designed for long term storage should have a minimum storage depth of four ft.

8. A maintenance program for weed and erosion control along inner slopes is essential.

9. All accumulations of dead algae, vegetation and debris should be routinely removed from the impounded water surface and properly disposed of.

C. Water Conveyance Facilities.

1. Ditches must be maintained free of emergent, marginal and floating vegetation.

2. Ditches should be sized and graded for adequate flow and must not be used for water storage.

3. Unpressurized and low pressure pipelines, commonly used in irrigation distribution systems, should be designed to be emptied when not in use and should not be used for water storage because of the mosquito breeding potential in the partially filled pipes.

CITY OF SACRAMENTO

OFFICE OF THE CITY CLERK
915 I STREET
CITY HALL ROOM 203
SACRAMENTO, CALIFORNIA 95814
TELEPHONE (916) 449-5426

LORRAINE MAGANA
CITY CLERK
HUBERT F. ROGERS
CHIEF DEPUTY CITY CLERK

December 12, 1979

Army Corps of Engineers
ATTN: Mr. Marc Kapic
650 Capitol Mall
Sacramento, CA 95814

Dear Mr. Kapic:

On December 11, 1979, the City Council adopted the attached resolution supporting implementation of the deepening of the Sacramento River deep water ship channel.

Sincerely,

Lorraine Magana
Lorraine Magana
City Clerk

LM:HO'

Encl.

cc: John Christian (Port of Sacramento)

Item No. 47

RESOLUTION NO. 79-856

Adopted by The Sacramento City Council on date of

December 11, 1979

RESOLUTION SUPPORTING IMPLEMENTATION OF THE DEEPENING OF THE SACRAMENTO RIVER DEEP WATER SHIP CHANNEL

WHEREAS, the Port of Sacramento has provided economic, industrial and cultural growth and benefits to the City of Sacramento; and

WHEREAS, the present port facilities, specializing in bulk cargoes, are currently handling 2,000,000 tons per year, well above the expected average of 857,000 tons when the deep water channel was constructed; and

WHEREAS, an increasing number of vessels calling at the Port in the future are expected to be of the newer, larger type with drafts in excess of 30 feet when loaded.

NOW, THEREFORE, BE IT RESOLVED that the City Council of the City of Sacramento does hereby strongly urge and wholeheartedly support the implementation of the deepening alternative outlined in the Corps of Engineers investigative study of the Sacramento River Deep Water Ship Channel for the following reasons, among others:

1. Bulk cargoes require the direct call of larger ships to meet the economic requirements of world trade and numerous ships loading at the Port of Sacramento are now unable to load completely due to the draft limitations;

2. Sacramento Valley agriculture has benefited considerably by having the Port available for valley crops to reach world markets and by bringing in fertilizers for agricultural use;

3. Deepening of the deep water channel will assist the Sacramento community to expand its economic base by attracting new water-transportation oriented industries;

4. Of the four alternatives cited in the Corps of Engineers Study, only the deepening alternative is economically efficient. A 2 to 1 benefit-cost ratio is indicative of an exceptional return on the federal investment when calculated with an interest rate of more than 6%; and

5. The study indicates that deepening the channel will provide the greatest opportunity for making positive contributions to both environmental quality and the environmental goals designated in city, county and regional plans.

BLAINE H. FISHER
VICE MAYOR

ATTEST:

LORRAINE MAGANA
CITY CLERK

79-856

Planning Department

County Administration Building, North Wing
P.O. Box 951
Martinez, California 94553

Anthony A. Dehaesus Director of Planning

Phone: 372-2026

Contra Costa County

December 17, 1979

James G. Johnson, Lieutenant Colonel, CE
Acting District Engineer
Department of the Army
650 Capital Mall
Sacramento, CA 95814

Dear Sir:

Thank you for the opportunity to review the report entitled "Sacramento River Deep Water Channel, California, Draft Feasibility Report and Draft Environmental Impact Statement for Navigation and Related Purposes".

This Draft Report contains far more information than can be absorbed by a casual reading, therefore, these comments deal with only those concerns that are readily apparent. Policy matters and a full technical review cannot be accomplished by staff within your review period. At this point all we can do is raise technical issues with proposed and alternative spoils sites.

Plate 2, Sheet 1 of 6, shows several dredge disposal areas. The most northwesterly site is one that has been previously utilized by the Contra Costa County Flood Control District and the Corp of Engineers for dredge material from the Walnut Creek project. The County needs to deposit over 800,000 yards of material over a five year period from that facility. Our concern is that the preemption of this site for other use might force the County and the Corp to find an alternative site at great expense to the taxpayer.

The disposal site just southerly of that adjacent to the Walnut Creek channel is part of the property belonging to the ACME Fill Corporation. That landfill site is the cornerstone of this County's Solid Waster Management Plan. If spoils are deposited on this site which would negatively impact the life of that facility, it would be of serious concern to this County.

An alternative disposal site shown on Plate D-2 north of the Atchison Topeka and Santa Fe Railroad is owned by the Pacific Gas and Electric Company and is the site of the proposed Pittsburg #9 power generation plant. That project is currently undergoing Notice of Intention hearings before the State Energy Commission. While we do not have an opinion on the use of this site for spoils, it's status as a proposed power plant site will likely continue for some time to come.

We are encouraged by the tentative findings on the potential use of a sill on mitigating water quality problems (especially salt water intrusion) and will be reviewing that information in more detail in the future. Protecting Delta water quality is a precondition to County support of this project.

Thank you again for an opportunity to review this report. This reply has been reviewed by the County Public Works Department and has their approval.

Sincerely yours,

Anthony A. Dehaesus
Director of Planning

AAD:ag3

cc: County Administrator
Members of the Board
Public Works Director

BOARD OF SUPERVISORS
COUNTY OF SACRAMENTO
SUITE 2450 / COUNTY ADMINISTRATION BUILDING
700 H STREET / SACRAMENTO, CALIFORNIA 95814/440-5411

December 21, 1979

Col. Paul J. Kavanaugh, District Engineer
U. S. Army Corps of Engineers
Federal Courthouse Bldg.
650 Capitol Mall

Dear Colonel:

Re: Resolution No. 79-1699

The Board of Supervisors, County of Sacramento, at a regular meeting held on December 18, 1979 approved a resolution supporting the deepening of the Sacramento River Deep Water Ship Channel.

Transmitted herein is copy of Resolution No. 79-1699 for your information.

Very truly yours,

Betty D. Poohar

BETTY D. POOHAR, Clerk
Board of Supervisors

BDP:kl

Enclosure

Copy to Sec. 0
Jm

U.S. Army Corps of Engineers

RESOLUTION NO. 79-1699

RESOLUTION OF THE BOARD OF SUPERVISORS OF THE COUNTY OF SACRAMENTO SUPPORTING DEEPENING OF SACRAMENTO RIVER DEEP WATER SHIP CHANNEL

WHEREAS, the Sacramento River Deep Water Ship Channel was authorized by Congress in the River and Harbor Act of July 24, 1946; and,

WHEREAS, the Committee on Public Works, House of Representatives, authorized studies of deepening said Channel; and,

WHEREAS, the Board of Supervisors of Sacramento County adopted Resolution No. 76-803 in support of deepening said Channel; and,

WHEREAS, the Corps of Engineers has recommended a plan for deepening and widening the Suisun Bay and Sacramento River Deep Water Ship Channel from New York Slough to the Port of Sacramento; and,

WHEREAS, said Plan provides for a water quality monitoring program, for establishing recreational facilities, for converting 45 acres to wetland habitat, and for a submerged sill in Carquinez Strait if necessary to offset any salinity intrusion, in addition to widening and deepening of said Channel; and,

WHEREAS, should the project not proceed, deeper draft vessels would call at other ports; and,

WHEREAS, an investigation of alternatives reveals that deepening said Channel to accommodate larger vessels provides the greatest contribution to economic development while addressing all planning objectives and environmental concerns;

NOW, THEREFORE, BE IT RESOLVED that the Board of Supervisors of the County of Sacramento does hereby reaffirm its support of the deepening of the Sacramento River Deep Water Ship Channel.

BE IT FURTHER RESOLVED that the Clerk of the Board of Supervisors is hereby directed to transmit copies of this Resolution to the Sacramento District of the U. S. Army Corps of Engineers and to the Port of Sacramento.

On a motion by Supervisor Collin, seconded by Supervisor Sheedy, the foregoing Resolution was passed and adopted by the BOARD OF SUPERVISORS of the County of Sacramento, State of California, this 18th day of December, 19 79, by the following vote to-wit:

AYES:	Supervisors,	Collin, Johnson, Sheedy, Wade
NOES:	Supervisors,	None
ABSENT:	Supervisors,	Smoley

In accordance with Section 25103 of the Government Code of the State of California a copy of this document has been delivered to the Chairman of the Board of Supervisors, County of Sacramento, on

DEC 18 1979

By [illegible]
Deputy Clerk, Board of Supervisors

Sandra R. Smoley
CHAIRPERSON OF THE BOARD OF SUPERVISORS

(SEAL)

ATTEST: [illegible]
Clerk of the Board of Supervisors

FILED

DEC 18 1979

BOARD OF SUPERVISORS

By [illegible]
CLERK OF THE BOARD

Sacramento Regional Area Planning Commission

Suite 300, 800"H" Street, Sacramento, California 95814
(Mailing Address: P.O. Box 808, Sacramento, California 95804)
(916) 441-5930

NOTICE OF COMMISSION ACTION

December 24, 1979

James Johnson
U.S. Army Corps of Engineers
Attn: Investigations Section D
650 Capitol Mall
Sacramento, CA 95814

Dear Mr. Johnson:

Re: Draft Feasibility Report and Draft EIS for the Sacramento River Deep Water Ship Channel Investigation

The Commission has completed its review of your Draft Feasibility Report and Draft Environmental Impact Statement. The review was conducted by the Commission in accordance with its Areawide Clearinghouse responsibilities for the Sacramento Regional Area.

As part of its review, the Commission made the following comments:

- That the State Water Resources Control Board and Department of Water Resources staffs have expressed concern about possible salinity problems resulting from the project.
- That the Draft Feasibility Report and Draft Environmental Impact Statement are adequate.
- That a file of letters of support is available at the SRAPC office.
- That if financing for the non-federal funding comes from bond revenues or other property tax sources, there should be an evaluation of the benefits to the property being taxed; of the value increment due to the channel deepening; and effect upon total property tax.

"A Council of City and County Governments"

At its meeting on December 20, 1979, the Commission voted to comment favorably on the report and statement, and to urge that it be approved. If we may be of further assistance, please let us know.

Sincerely,

O. R. Waltrip Jr

O. R. WALTRIP, JR.
Chairman

ORW:JMH:jw

XEROX CERTIFIED COPY

FILED
DEC 28 1979
PETER McNAMEE, Clerk
By Pete E. Lucas
Deputy

RESOLUTION NO. 79-205

(Resolution Supporting Deepening of the Sacramento River Deep Water Ship Channel

WHEREAS, the Sacramento-Yolo Port District was created as a political subdivision of the State of California by a four to one favorable vote of the people of the District in April, 1947; and

WHEREAS, said District was charged with the responsibility of cooperating with the Corps of Engineers by supplying rights-of-way for construction and maintenance, by relocating utilities and by constructing, maintaining, and operating termi al facilities at the harbor created by the said Corps; and

WHEREAS, the port facilities are currently handling a great volume of cargo; and

WHEREAS, the port has developed significant volumes of bulk rice moving to offshore markets; and

WHEREAS, the Corps of Engineers has been authorized by the Congress to study the feasibility of deepening the Sacramento River Deep Water Ship Channel to as much as forty foot depth,

NOW, THEREFORE, BE IT RESOLVED by the Bord of Supervisors of the County of Yolo that this Board does support the idea of deepening the Sacramento River Deep Water Ship Channel, and

BE IS FURTHER RESOLVED that they be urged to recommend in favor of the proposed deepening.

/ / / / /
/ / / / /
/ / / / /
/ / / / /

OFFICE OF THE COUNTY COUNSEL
COUNTY OF YOLO
P.O. BOX 127
WOODLAND, CA 95695

PASSED AND ADOPTED by the Board of Supervisors of the County of Yolo, State of California, this 26th day of December, 1979, by the following vote:

AYES: DeMars, Thompson, Edmonds, Marchand.

NOES: None.

ABSENT: Black.

Betsey A. Marchand
CHAIRMAN OF THE BOARD OF SUPERVISORS
COUNTY OF YOLO, STATE OF CALIFORNIA
12-28-79

ATTEST:
PETER McNAMEE, CLERK
BY Pete E. Lucas
DEPUTY
(SEAL)

STATE of CALIFORNIA } SS.
COUNTY of YOLO

The Foregoing Instrument Is A Correct Copy Of The Original On File In This Office.

ATTEST Dec 28 19 79

By Pete E. Lucas
Deputy

OFFICE OF THE COUNTY COUNSEL
COUNTY OF YOLO
P.O. BOX 127
WOODLAND, CA 95695

City and County of San Francisco

Department of City Planning

26 December 1979

District Engineer
Sacramento District
U. S. Army Corps of Engineers
Federal & Courthouse Bldg.
650 Capitol Mall
Sacramento, CA 95814

RE: Sacramento River Deep Water Ship Channel Draft EIS; our case No. EE 79.403/NLA

Dear Sir:

The following comments on subject DEIS are submitted on behalf of the City and County of San Francisco.

1. The DEIS has been limited to what was felt to be "a concise analysis of the significant impacts of the proposed plan and alternatives to the proposed plan." This brevity, though to be commended in an EIS, has been carried to an extreme that results in omission of key information and in lack of adequate information to permit evaluation of the proposed project.

2. Page A-6 states that "A Bottom Sampling Program, completed in January 1975, was conducted to determine the ... pollutant content of the bottom material in the existing channel." I have been unable to find the results of this Program in the DEIS or accompanying Draft Feasibility Report.

3. The Sacramento River watershed drains an area with the highest natural mercury (as cinnabar) content in the United States (Bailey, E. H., Mercury in the United States, Mineral Investigations Resource Map MR-30, USGS, 1962). Mercury containing sediments could therefore be expected in this River. As a result of gold rush period mercury use, mercury wastes deposited in California streams have worked their way towards and into San Francisco Bay to augment natural mercury sources. Sediments in Suisum Bay have been found to have the highest mercury contents in the area from Rio Vista to the southern end of San Francisco Bay: up to 2.00 ppm (parts per million) at the edge of Suisun Bay with a mean of 0.46 ppm, 1.20 ppm at Rio Vista, and up to 1.20 in the Suisun Bay channel with a mean of 0.12 ppm (D. S. McCulloch, et al, Distribution of Mercury in Surface Sediments in San Francisco Bay Estuary, California, Basic Data Contribution 14, USGS, 1971). The DEIS indicates on page 3-1 that "The proposed plan provides for deepening and widening existing Suisun Bay and Sacramento deep water channels from New York Slough to the Port

Copy to Lee.O +EPS
Jim

(415) 558-4656   100 Larkin Street   San Francisco, CA 94102

of Sacramento ...," going through the area where USGS found mercury in the sediments. The USGS study area ended at Rio Vista; however, as this was a high reading, one can resonably presume that mercury is found in sediments further upstream.

The DEIS does not directly acknowledge that mercury will be found in the sediments to be dredged, mercury is not listed in the DEIS index, pp. 3-ix to 3-xii.

4. Mercury can be converted to alkyl mercury compounds by microorganisms in sediments (Wood, J. M., Biological Cycles for Toxic Elements in the Environment, Science 183:1049, 1974) and soils (Knowles, M. E., et. al, Formation of Methylmercury in a Terrestrial Environment, Nature 249:674, 1974).

Mercury accumulates as it moves through the aquatic food chain, appearing in highest concentrations in fish, where most of it appears as alkyl mercury compounds. In 1971 the California State Dept. of Health recommended that no one eat more than one meal a week of striped bass or channel catfish caught in San Francisco Bay and warned pregnant women not to eat these fish at all (Dr. Ephraim Kahn, M. D., media interviews and personal communication, 1971). Methyl mercury tends to preferentially accumulate in the mammalian fetus where it can produce permanent neurological damage at concentrations which produce few or no symptoms in the mother (Amin-Zaki, et. al, Prenatal Methylmercury Poisoning, Am. J. Dis. Child. 133:172, 1979). The mercury content of fish in the San Francisco Bay estuary is, therefore, not a trivial matter.

Will dredging activities result in an increased rate of methylation of mercury in sediments due to exposure of previously biologically relatively isolated sediments to organisms capable of methylation? According to Fred Kindel (Environmental Section, Sacramento District, Army Corps of Engineers, telephone conversation, 20 December 1979), suction dredging does not tend to stir up sediments into the water column but the method has not been tested on mercury-bearing sediments. Is the lack of induced turbidity absolute, or relative, compared to other dredging methods? The latter seems probable. Do the denser, mercury-containing, particles in the sediment tend to lag behind during dredging? What is the potential for filter feeders and fish in the neighborhood of the dredging operation to acquire increased mercury contents during the several years required to complete this project? If fish and shellfish increase in mercury content, what would be the effect on commercial and sport fisheries? Page B-17 states that "The study area is considered to be one of the most important areas for fisheries resources in California." The unsupported statement on page D-38 that "Any increase in turbidity and possible resuspension of toxic materials as a result of dredging would not be expected to have an adverse effect on fish, fish eggs, and fish larvae. Suction dredging would not cause any detectable increase in turbidity.", although it states above in the same paragraph "There may be some short-term local increases in turbidity...," does not adequately deal with the possible impacts on important fisheries resources.

5. The dredge spoils are to be deposited on land and, in part, used for recreational development. What means are proposed to prevent environmental mercury dispersion from these spoils?

6. The proposed plan would allow larger and probably less maneuverable ships to use the Sacramento Channel. What effect would this have on the mix of ships on San Francisco Bay? Would there be any increase in the probability of accidents? Would increased ship traffic result in increased saltwater ballast discharge at the Port of Sacramento and consequent degradation of water quality (see page 6, Draft Feasibility Report)?

7. Page 12 of the Draft Feasibility Report indicates that "There is a good potential for the petrochemical industry locating in the Collinsville-Montezuma Hills area."; similar comments are made on page B-73. If the deepening of the channel is a prerequisite for such development, the DEIS should qualitatively discuss the impacts of such development.

8. Appendix 1, pages B-42-3 describes the transportation facilities available at Sacramento. Similar information is not given for San Francisco and Oakland ports, nor is information on space available for bulk storage at these ports (page D-8) presented. As a result, the reader cannot independently evaluate the alternatives presented. In general, the lack of depth of analysis of the alternatives precludes meaningful comparison to the proposed plan. Inadequate information is given about the assumptions used in the economic analysis (e.g. what is the "standard methodology" referenced on page F-30?) and it appears that the economic analysis of alternatives considered only the Sacramento area rather than the entire Bay Area.

9. On pages 47, B-69 and D-8 it is stated that present practice and the Intermodal Alternative involve topping-off "some of the larger bulk grain vessels" at the Islais Creek grain terminal at the Port of San Francisco. What would be the economic effect on the Port of San Francisco of the loss of this trade due to deepening of the Sacramento River Channel? What would be the economic effects on the Port of San Francisco of increased trade due to adoption of the Intermodal alternative?

10. One of the most important environmental and economic problems faced by the United States is the use of energy, hence it is surprising that the energy intensiveness of the alternatives is not discussed in DEIS Section VI - Alternatives. Note, moreover, that although "full" compliance with the California Environmental Quality Act (CEQA) is indicated as appropriate on page 3-vii, there is no discussion of mitigation of energy consumption, as required by CEQA. Energy consumption is mention (page D-10, etc.), but never discussed, so that the reader cannot evaluate the methodology used in arriving at the stated conclusions.

11. The genus of the California poppy is Eschscholtzia not Eschsholzia (page B-15).

Thank you for the opportunity to comment on this DEIS.

Very truly yours,

Selina Bendix

Selina Bendix, Ph.D.
Environmental Review Officer

cc: Toby Rosenblatt, President, Planning Commission
Edward David, Port Director
Mary Burns, Mayor's Office
Paul DeFalco, EPA Region IX
Nicholas Yost, CEQ
Ron Bass, State Office of Planning & Research

ABAG
Association of Bay Area Governments
Hotel Claremont · Berkeley, California 94705 · (415) 841-9730

January 25, 19BD

Mr. Mark Capik
Department of the Army
U.S. Army Engineer District, Sacramento
Corps of Engineers
65D Capitol Mall
Sacramento, CA 95814

Dear Mr. Capik:

Thank you for the opportunity to comment on the draft feasibility report and EIS for the Sacramento River Deep Water Ship Channel. Staff has reviewed these documents and is forwarding the following comments. ABAG's Executive Board has not taken a position on these reports or the proposed project. Our comments relate to two major issues: economic development and water quality.

1. Economic Development. The economic analysis in the report is too general and should be supplemented as follows:

a. In addition to discussing the economic benefits at the Port of Sacramento and the Collinsville-Montezuma Hills area, the report should document economic impacts on other regional port facilities in the Bay Region (San Francisco, Oakland, Richmond). There is a brief discussion of the impact on the grain terminal at Islais Creek in San Francisco, but this should be expanded to include other commodities and the capacity of Bay Area ports to handle them. Accordingly, the transportation costs, environmental, and socioeconomic effects of accommodating induced economic growth at Bay Area ports should be considered in the analysis of alternatives.

b. In analyzing the project in terms of national economic development (NED) benefits, the report should acknowledge that San Francisco, Oakland, and Richmond all have severe unemployment problems, in excess of the rates cited in Sacramento, Solano, and Contra Costa Counties. The report should state whether the no-project alternative would result in increased economic activity at each of the affected Bay Area ports and the extent to which this activity would reduce unemployment in these cities. The underlying question is whether NED benefits would accrue to other locations if the project is not implemented.

Representing City and County Governments in the San Francisco Bay Area

2. Water Quality. For us, the possible construction of a submerged sill and mercury and lead contamination resulting from dredging activities are severe environmental problems associated with this project. We understand that other agencies are commenting on these impacts, and we are not providing technical comments which would duplicate their concerns. We do, however, recommend full consideration of these issues in the final EIS. ABAG has a special interest in the mercury and lead contamination impacts as they affect recreational and commercial shellfish harvesting. ABAG's Environmental Management Plan includes a policy to facilitate the reestablishment of these activities.

The EIS should also consider the following water quality impacts:

1. The dredge disposal sites situated along the project are planned for recreational/habitat/agricultural reclamation after a two-year period to allow for stabilization of dredge spoils materials. During that interim period, the dried exposed spoils materials are extremely vulnerable to wind and water erosion. With adverse weather conditions, soil can be transported to neighboring agricultural areas or to adjacent sensitive riparian/marsh habitats. Previous disposal sites--such as Decker Island and levees along the ship channel--which have been elevated by filling and will be elevated further by the proposed project, are particularly vulnerable to this problem.

ABAG recommends the inclusion of mitigation measures to provide temporary erosion control measures such as vegetative cover during this interim period. Alternatively, permanent vegetative cover could be established in conjunction with planned reclamation activities.

2. In the environmental setting and in the impact discussion on fisheries and wildlife, little information is given on the temporal and seasonal movements of aquatic organisms and the timing of the dredging operations. Channel deepening has been recognized for potential short-term increases in turbidity and water quality changes. These construction (and later on maintenance) impacts could be of consequence if they occurred during the striped bass or other anadromous fishery migration period, for example. Thus, careful timing of construction activities (a five-year period in the Suisun Bay and Sacramento River) could minimize the effect on fish migrations and movements of aquatic organisms.

Thank you again for the opportunity to comment. If you have any questions, please call me.

Sincerely,

Charles Q. Forester

Charles Q. Forester,
Director of Planning

November 12, 1979

Col. Paul F. Kavanaugh
District Engineer, U.S. Engineers
650 Capitol Mall
Sacramento, CA 95814

Dear Col. Kavanaugh:

In reviewing the history of the Sacramento Metropolitan Chamber of Commerce, we have found that the Chamber members before us accurately recognized the potential of a navigational channel in the Sacramento River. In 1916 the Chamber helped raise enough money to conduct the first major survey and our records are replete in support of the channel until it's completion in 1963.

We have never lost our interest in the Port of Sacramento and recognize the vital role it has played on the economy of Northern California. We are cognizant of the Port district's problem of accommodating larger ships, their increased cargo capabilities, and the limited factor of a 30 foot draft at mean lower low water. Given the shipping industry trend toward larger vessels, the curtailment of "lighter aboard ship" service and the astronomical cost of intermodal transportation of cargo to alternate points -- we unhesitantly support the plan selected by the Sacramento District, Corps of Engineers --- deepening the deep water channel.

The Port of Sacramento has made great strides in the years since the first ship made it's way from the coast. It's efficient management has led to a healthy growth in both lean and prosperous years with little burden to the taxpayers.

We feel that the channel, without further delay, must be deepened to keep the Port viable and competitive. Making a way for the Port to accommodate larger ships would be socially and economically beneficial to Northern California. The deepening will allow continued expansion of the Port and the Industry it serves. There will be additional employment and our agricultural and industrial base will be strengthened.

917 - 7th Street
P.O. Box 1017, Sacramento, CA 95805 • (916) 443-3771

The deepening will offer Sacramento valley agriculture the continued opportunity of competitively reaching world markets and the ability of bringing in reasonable priced commodities for their use. It should also be recorded that the deepening will assist the community to expand it's economic base by attracting new water-transportation oriented industries.

Enclosed is a copy of a Sacramento Metropolitan Chamber of Commerce resolution in support of the deepening, dated February 16, 1971.

Sincerely,

Robert W. Bell

Robert W. Bell
President

PJS/bk

Enclosure

1-02-02

RESOLUTION IN SUPPORT OF DEEPENING OF THE

SACRAMENTO RIVER

DEEP WATER SHIP CHANNEL

WHEREAS, the Sacramento-Yolo Port District was created as a political subdivision of the State of California by a four to one favorable vote of the people of the District in April 1947, and

WHEREAS, the terminal facilities of the Sacramento-Yolo Port District were placed in operation in July 1963 and have undergone significant expansions primarily in the capability to handle bulk cargoes, and

WHEREAS, the port facilities are currently handling cargo at the rate of approximately 1,500,000 tons per year, and

WHEREAS, the port has developed significant volumes of bulk rice moving to offshore markets having handled more than 2,500,000 tons of rice since 1963, and

WHEREAS, the Corps of Engineers has been authorized by Congress to study the feasibility of deepening the Sacramento River Deep Water Ship Channel to as much as forty foot depth, and

WHEREAS, the economies of larger ships are creating a demand for a deeper channel if the needs of the commerce of the area are to be served,

NOW THEREFORE BE IT RESOLVED, that the Sacramento Metropolitan Chamber of Commerce does support the ~~idea of~~ deepening the Sacramento River Deep Water Ship Channel, and

BE IT FURTHER RESOLVED, that the Corps of Engineers be urged to recommend in favor of the proposed deepening, and

BE IT FURTHER RESOLVED, that copies of this resolution be furnished to the Corps of Engineers at the public hearing on the study, to be held in the evening of March 3, 1971, in the chambers of the Sacramento County Board of Supervisors.

APPROVED: BOARD OF DIRECTORS
DATE: February 16, 1971

ATTEST:

WEST SACRAMENTO DISTRICT
CHAMBER OF COMMERCE

Broderick • Bryte • Clarksburg • Southport • West Sacramento
P.O. Box 404, West Sacramento, CA 95691 • (916) 371-7042

November 13, 1979

U.S. Army Corp Engineers
Sacramento District
ATTN: Investigations Section D
650 Capitol Mall
Sacramento, CA 95814

Gentlemen:

The Industrial Development Committee of the West Sacramento District Chamber of Commerce has reviewed the information summary dated September, 1979, prepared by the Sacramento District, Corp of Engineers, entitled Sacramento River Deep Water Ship Channel Investigation. That Committee is in agreement with the findings of that summary and supports the recommendation contained therein, i.e., that the Sacramento River Deep Water Ship Channel be deepened to a depth of 35 feet.

The Chamber of Commerce believes that the report properly sets forth the added value to the local economy and the savings in fuel that can be realized by permitting fully loaded vessels to sail to and from the Port of Sacramento; and the possibility of cleaner air as a result of fewer motor vehicles traveling shorter distances on the highways of the region that will result from the proposed deepening of the channel.

The Chamber of Commerce is aware of the fact that the Port District has through direct employment and the benefits to others within the area been responsible for the creation of approximately 5,000 jobs exclusive of jobs which have resulted during periods of construction on the ship channel or Port District facilities.

The Chamber of Commerce believes that the deepening of the ship channel will continue to lead to the growth of the general economy in the Sacramento Metropolitan area, particularly in basic industries such as agriculture, raw material production, and manufacturing and in the expansion of foreign trade through the Port of Sacramento.

The Chamber of Commerce believes that the summary makes it clear that the ecology of the area will be properly protected under the proposed expansion program.

Therefore the West Sacramento District Chamber of Commerce urges that the United States Army Corps of Engineers, Sacramento District recommend this project to the United States Army Corp of Engineers and to the Congress of the United States. It believes the project should be given the highest priority for approval and budget.

Very truly yours,

Howard Turner
President

HT/cc
C.C.: Port Commissioners
Mel Shore
Dennis Clark
Yolo & Sacramento County Board of Supervisors
State Assemblyman Hannigan
State Senator Nielson
Congressman Fazio

SACTO
Sacramento Area Commerce and Trade Organization
917 7th Street • P.O. Box 1132, Sacramento, California 95805 • (916) 441-2144

Statement by: Alan D. Ewen
Executive Director
Sacramento Area Commerce and Trade Organization (SACTO)

Before: The Public Meeting on Proposed Plan of Improvement
for Sacramento River Deep Water Ship Channel,
November 13, 1979

To: U.S. Army Corps of Engineers, Sacramento District
Attention: Investigations Section D
630 Capitol Mall
Sacramento, CA 95814

This is an unqualified statement of support for the plan of deepening the ship channel.

The Sacramento Area Commerce and Trade Organization (SACTO) is a private, nonprofit corporation whose primary mission is to attract new commercial and industrial enterprise to the capital city region of California. In this sense it seeks corporate capital investment to build and equip new industrial plants. Thus it is a major agency engaged in creating new jobs and building the trading activities in this area of California commerce.

In the course of our discussions with the managers of corporate real estate assets in major corporations across the nation and in some foreign countries, we are invariably questioned on the physical capabilities of the Port of Sacramento and its future role in the advancing development of water-borne traffic. These references specifically refer to movements between this major inland metropolitan area and overseas points--Pacific rim countries, particularly.

The fact that the Port of Sacramento attracts this attention on the part of durable goods manufacturers and distributors--both domestic and foreign--is deserved. It is recognized as an integral part of an intermodal transportation

system for which there is none comparable in any other inland California metropolitan area. This network is the equal in quality of major coastal areas in the state, but it has not reached its capacity useage by a considerable extent. Its geographic location for reception (inbound) and distribution (outbound) of raw materials and finished product, and of dry and liquid bulk shipments, is just without parallel. This is especially true, of course, for the manufacturing, mining, and agricultural hinterland of the central region of the western part of the United States.

In view of this widening focus of attention by industry and commerce, the Port and organizations like SACTO have become increasingly sensitive to the need for continuously improving its capacity to contribute to the economic growth and development of this vital region of California. While it is significant that industrial leadership in the broad region of the Port's service recognizes this as a positive long-range need, local business directors recognize it as a sine quo non for the life of a community investment of this magnitude.

It is a well-known fact that if the Port is to maximize its service to its publics, and if it is to fulfill the mission which the federal government designed for it in the original instance, the project to deepen the ship channel must go forward. So long as the present channel depth does not equate to the physical demand of the worldwide shipping industry, this facility may be faced with fewer ship calls and a consequent gradual and certain decline in regional commercial activity. This will have a consequent effect of some negative proportions on much-needed industrial capital investment and job-creation potential.

Thank you for allowing me to make this statement on a public issue of such great importance to the future economic vitality of this capital city community.

ADE:drw
11/7/79

EDWIN D. WITTER
SACRAMENTO

10/20/79

Colonel Paul F Kavanaugh
District Engineer U.S. Engineers
650 Capitol Mall
Sacramento, Calif.

Dear Colonel Kavanaugh

The past growth and record of the Sacramento Port would indicate the need for the deepening of the canal in order to meet the demand of larger vessels which wish to and must serve Sacramento, if we have facilities to meet their demand.

I trust the district engineer office may concede the necessity of Port authority request.

Very truly yours
Edwin D. Witter
Consultant
Dean Witter Reynolds Inc

Asa M. Clark, Jr. REAL PROPERTY BROKER
1330 21st STREET SUITE 103 | SACRAMENTO, CALIFORNIA 95814 | (916) 446-7629

October 22, 1979

Colonel Paul F. Kavanaugh
Diatrict Engineer
U.S. Engineers
650 Capitol Mall
Sacramento, Calif. 95814

Dear Colonel Kavanaugh:

This letter is in support of the deepening of the Sacramento River Deep Water Ship Channel. I understand there is a Hearing on November 13, 1979 in regard to this propoaed deepening of the Channel, and I wanted my views to be on record with you prior to that date. I also intend to be at the Hearing if at all possible.

I am in total support of the deepening of the Sacramento River Deep Water Ship Channel as the opening of the Channel to larger draft vessels seems to me to be not only economical for the Port and its uaers, but very practical. With the increased cost of fuel, it seems only logical that ship carriers are going to uae the largest vessela possible in order to keep their ton mileage cost at a minimum. It would seem to be such a waste to allow this very useful, and, I might add, very costly investment, which has proved itself, to stay at its present design when outside forces are at work that may limit the Channel's use if the deepening is not accomplished.

Thank you very much for your attention to my view. If I can be of further help, I would be most happy to do so.

Sincerely,

Asa M. Clark, Jr.

Asa M. Clark, Jr.

AMC:ds

cc: Melvin Shore
Port Director

Telephone (916) 444-2000

DOWNTOWN PLAZA PROPERTIES

WILLARD E. NIELSEN
Executive Vice President

October 23, 1979

Colonal Paul F. Kavanaugh
Diatrict Enginaer, U. S. Engineera
650 Capitol Mail
Sacramento, CA 95814

Dear Colonel Kavanaugh:

On November 13 you will be taking evidence toward the feasibility of the deepening of the Sacramento deep water channel, and I am sending you this letter in support of this action.

We in Sacramento are most proud of the Port and the splendid record it has maintained to this date. However, we do know that in order to increase the tonage, it will be necessary to deepen the channel so that larger cargoes may be handled at the port. I should like to offer the following factors which I believe have merit in support of the deepening:

1. It would bring the ocean going vessels closer to the source of supply of California agricultural products thereby conserving energy and the use of the busy freeways for the transportation of these materials by truck to the coastal ports.

2. It will be more efficient for the vesaela to operate leaving the Sacramento port with a full cargo, instead of a partial load and then stopping at a deeper coastal port to top out the load.

3. Wa believe the sale of California agricultural products to the foreign market, particularly in Southeaat Asia, greatly enhancea the balance of payment between our country and the countries in the Asian market.

555 CAPITOL MALL, SUITE 340 • SACRAMENTO, CALIFORNIA 95814

4. I am told that the shipa are much easier handled when fully loaded while operating in the channel because there is leas freeboard which may be affected by the strong winda which we have from time to time in the Sacramento valley. This, in itaelf, should be a substantial safety factor.

I know there are many more stronger arguments that may be preaented, but please accept this letter as my total aupport for the deepening of our channel for the Port of Sacramento.

Very truly youra,

Willard E. Nielsen

WEN:mh

cc: Melvin Shore

IMC CARBON PRODUCTS
245 Park Avenue • New York, N.Y. 10017
Telephone: (212) 661-4300 • Cable: INMINCH

INTERNATIONAL MINERALS & CHEMICAL CORPORATION

October 23, 1979

U.S. Army Corps of Engineers
Sacramento District
650 Capitol Mall
Sacramento, California 95814

Attention: Investigations Section D

Gentlemen:

We fully encourage and support the deepening of the channel draft in the Port of Sacramento. Since most shippers are dependent upon chartering large vessels which need greater draft, the deepening of the channel is almost imperative in order to compete on today's worldwide ocean trade market.

Ships which currently are obliged to top off cargo in the San Francisco Bay area because of draft restrictions in Sacramento, will be afforded the advantage of being able to load fully in Sacramento after the channel is deepened, thus saving extra port expenses which prove costly in the overall freight picture. As future shippers through the Port of Sacramento, we wholeheartedly support the deepening of the channel.

Very truly yours,

Richard R. Wolf
Manager - Special Products

RRW:mav

cc: A. James Ince
National Accounts Manager
Port of Sacramento
44 Montgomery Street
San Francisco, California 94104

R. B. ABBOTT & CO., INC.

Cable "ABBOTTCO"

260 CALIFORNIA STREET • SAN FRANCISCO, CALIFORNIA 94111
TELEX WU 340579 • TELEPHONE 392-8894

October 23, 1979

US Army Corps of Engineers
Sacramento District
Attn: Investigations, Section D
650 Capital Mall
Sacrmento, Ca. 95814

Gentlemen:

As freight forwarders and charter brokers we are keenly aware of the fact that the present 30' depth of the Sacremento channel is inadequate, considering that many vessels have to top off in the San Franciso Bay area, in order not to exceed present depth limits.

The Portof Sacremento, being basically a Bulk port, handling grain as well as being a strong potential for energy items such as coal, will certainly, in our opinion need a minimum of 37' and possibly 40' if it is to meet future requirements of its exporters and importers.

Relief of this kind will not only enhance the port but be of benifit to our country as a whole.

Yours very truly

Frank R. Harlocker
President

SAN FRANCISCO LOS ANGELES

MONITOR STEAMSHIP AGENCY, INC.

~~ONE CALIFORNIA STREET, SAN FRANCISCO, CALIFORNIA 94111~~

TELEX: (910) 372-6515
RCA: 27341
CABLE ADDRESS: MONITOR
TELEPHONE: (415) 986-6584

October 23, 1979

U.S. Army Corp. of Engineers
Sacramento District
600 Capital Mall
Sacramento, CA. 95814
Attn: Investigation Section D

Gentlemen:

It has come to our attention that a hearing will be held on November 13, concerning the need for deepening the water approaches to the Port of Sacramento.

As agents for several owners who have vessels calling quite frequently in Sacramento to load primarily grain products. We are concerned with the fact that vessels with limited draft must be used to load the cargoes. It should be obvious to all concerned that the deep draft to Sacramento should be at least of a depth capable of handling fully loaded Panamax size vessels. It is most important to the economy of the country and specifically California that products available for export from the Port of Sacramento are competitive in CIF sales prices and the premium freight rate paid for commodities moved on shallow draft vessels could be eliminated by having deep water access to the Port.

Very truly yours,

MONITOR STEAMSHIP AGENCY INC.

James F. O'Donnell
President

JFO"d:cp

MARINE TERMINALS CORPORATION

SAN FRANCISCO • OAKLAND • LOS ANGELES • LONG BEACH • SAN DIEGO • PORT HUENEME • SACRAMENTO

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290 STEUART STREET
SAN FRANCISCO, CALIF. 94105
986-6578

October 24, 1979

U. S. Army Corps of Engineers
Sacramento District
Investigation Section D
650 Capital Mall
Sacramento, California 95814

Re: Marine Terminals Corporation
Statement in Support of
Deepening the Sacramento Channel

Gentlemen:

Marine Terminals Corporation is concerned about the future growth potential of the Port of Sacramento because of the channel depth limitations.

As a major stevedore contractor in California, we have various customers who ship out of the Port of Sacramento. Over the years, lumber, logs and dry bulk commodities have increased in volume to become an important part of our business. However, because of the channel depth,we project a leveling off in cargo tonnage in the near future.

On more than one occasion our customers have expressed their concern about the channel limitations and its impact on their future fleet expansions. If the channel were deeper, larger ships could call in Sacramento and their present fleets would not have to "top-off" their Sacramento loads in San Francisco before leaving the Bay Area (which they currently do).

Many dollars have been spent by the Port of Sacramento to develop their facilities into modern and efficient terminals. The problem is to utilize these facilities to their greatest extent over the long term. After investing such sums of money, it is mandatory that the channel be of sufficient size and depth to accommodate the largest general cargo and dry bulk vessels now sailing. Otherwise, they will be lost to other areas and countries. We emphasize the importance of accommodating any vessel interested in this trade.

Very truly yours,

MARINE TERMINALS CORPORATION

C. R. Redlich
President

CRR;mb

October 24, 1979

Colonel Paul F. Kavanaugh
District Engineer, U.S. Engineers
650 Capitol Mall
Sacramento, California 95814

Dear Sir:

We note with sincere interest in your public hearings on the matter of deepening the Sacramento Deep Water Ship Channel.

We would like to add our total support to the proposed deepening program. Central California has half a channel, let's make it a full channel and by this action compliment the balance of the facilities, such as the Port facilities themselves. Everybody should be aware of the positive economic imput that this facility has had on Central California. Also make us competitive on the world market-bring ocean going vessels right into the heart of one prime agricultural area of the world.

SINCERELY,

JOHN F. OTTO, INC.

By [signature]
John F. Otto
President

c.c. Melvin Shore
Port Director

John F. Otto, Inc.
1717 Second Street P.O. Box 2858
Sacramento, CA 95812
(916) 441-6870

License #178809

SIDNEY H. BIERLY
CONSULTANT
3615 Bausell Street • Sacramento, CA 95821 • Telephone 916-483-4151

October 24, 1979

Colonel Paul F. Kavanaugh
District Engineer, United States Corps of Army Engineers
650 Capitol Mall
Sacramento, CA. 95814

Dear Colonel Kavanaugh

I am intensely interested in the orderly and proper improvement of the facilities leading up to and including the Port of Sacramento. For twenty six years I acted as the General Manager of the California Fertilizer Association, and though I retired at the end of 1976, my interest in western agriculture and the input industries continues unabated.

The Port of Sacramento provides access to the great Central Valleys for the shipment to this area of large quantities of fertilizer and other crop production input materials, and it is the point of shipment to world markets of agricultural crops, raw and processed, at reasonable cost.

The Sacramento Deep Water Channel at present will accommodate only smaller vessels at present, and the cargo-carrying fleets of the world are adding more deeper-draft vessels as economics permit. These vessels cannot use the present channel, and cargo must be transshipped at great expense. The Corps of Engineers has been studying the feasibility of deepening this channel since 1970, and the final hearing will be held in Sacramento on November 13, 1979, for hearing public comment. I will not be able to attend this hearing, and will appreciate it if this letter will be considered, and made a part of record.

I strongly urge that the Corps of Engineers approve the deepening of the Sacramento River Channel to a depth of at least thirty five (35) feet, so as to be able to accommodate a good many more vessels in world trade than is now possible.

Sincerely

[signature]
Sidney H. Bierly

THE PROCTER & GAMBLE MANUFACTURING COMPANY

POWER INN AND FRUITRIDGE ROADS

MAILING ADDRESS:
POST OFFICE BOX 13220
SACRAMENTO, CALIF. 95813

October 24, 1979

Colonel Paul F. Kavanaugh
District Engineer, U.S. Engineers
650 Capitol Mall
Sacramento, California 95814

Dear Colonel Kavanaugh:

I understand you will soon be hearing final public input with respect to the deepening of the Sacramento River Deep Water Ship Channel. This letter is to express my personal support for the proposal to increase the depth of the channel. I feel this is a necessary step in order to assure orderly growth of our local economy and the transportation network supporting this economy.

Sincerely,

Alan W. Koppes,
Plant Manager

AWK/kr

cc: Mr. Melvin Shore

NIPPI SALES CORPORATION

555 CAPITOL MALL · SUITE 655 · SACRAMENTO, CALIFORNIA 95814
CABLE ADDRESS: "NIPPI SACRAMENTO" · TELEX No. 377-450 · TELEPHONE: (916) 444-5711

October 25, 1979

U.S. Army Corps of Engineers
Sacramento District
Attention: Investigations Section D
650 Capitol Mall
Sacramento, California 95814

RE: Channel Deepening Project

Dear Sirs:

We received the information regarding the meeting of this coming November 13, 1979; concerning the porject of channel deepening.

We would very much appreciate that important project.

We are now shipping and exporting about ten vessels of logs to a foreign country a year through the channel between Sacramento and San Francisco Bay, but have never loaded a full cargo on each vessel because of the shallow depth in the channel.

So, securing a deeper channel would enable us to trade much more easily in this area.

Therefore, we hope the Sacramento County Board of Supervisors will make a decision of carrying out this project.

Sincerely,

NIPPI SALES CORPORATION

Mr. T. Taniguchi,
Vice-President

SK:TT:dyh

GOODWIN-COLE

October 25, 1979

Colonel Paul F. Kavanaugh
District Engineer, U.S. Engineers
650 Capitol Mall
Sacramento, CA 95814

Dear Colonel Kavanaugh:

It is my understanding that the Corps of Engineers will hold a meeting on November 13, 1979, to study the feasability of deepening the Sacramento River Deep Water Ship Channel.

A few days ago in San Francisco, I read an article concerning a ship that had docked in Sacramento to load. Due to inadequate depths of our channel, it was necessary for the ship to return to the port of San Francisco to complete its loading program.

It is regretable that we are not able to fully service from our great port.

As a Sacramento business, we at the Goodwin-Cole Company appreciate the importance of the Port of Sacramento, and request your study and support of this important program.

Very truly yours,

Robert L. Cole

Robert L. Cole, President
Goodwin-Cole Company

RLC:jd

1315 ALHAMBRA BOULEVARD • SACRAMENTO, CALIFORNIA 95816 • (916) 452-6641

F. MELVYN LAWSON
2700 - 22nd STREET
SACRAMENTO, CALIFORNIA 95818

October 26, 1979

Colonel Paul F. Kavanaugh
District Engineer, U.S. Engineers
650 Capitol Mall
Sacramento, CA 95814

Dear Colonel Kavanaugh:

It is my understanding that the Corps of Engineers' study of the feasibility of deepening the Sacramento River Deep Water Ship Channel, which began in 1970, will be up for final public hearing on November 13, 1979.

As a native-born Sacramentan, and one who has watched closely the impact of the Deep Water Ship Channel on Sacramento and the Sacramento area, I enthusiastically endorse the Corps' Study, which has been done in painstaking depth.

I earnestly urge approval of the study and of its implementation.

Sincerely,

F. Melvyn Lawson

Southern Pacific Transportation Company

Southern Pacific Building • One Market Plaza • San Francisco, California 94105

R. L. KING
VICE PRESIDENT-TRAFFIC

October 26, 1979

AVP-480-Port of Sacramento

U. S. Army Corps of Engineers
Investigation Section D
650 Capital Mall
Sacramento, California 95814

Gentlemen:

This is to advise you that Southern Pacific Transportation Company supports the improvement and deepening of the channel which serves the Port of Sacramento to at least thirty-seven feet. My understanding is that this subject will be considered by your group in the very near future.

Having the additional depth in the channel will be of substantial value to the Port of Sacramento, to a number of international marketing firms who would more effectively utilize the Port with improved channel draft available and to Southern Pacific that handles a substantial amount of traffic to and from the Port of Sacramento. Also, the additional channel depth will permit full loading of ocean-going vessels which now is not possible and this could be substantially more energy efficient.

Your favorable consideration of this subject will be sincerely appreciated by the various publics involved including Southern Pacific Transportation Company.

Sincerely,

R L King

CRESCENT WHARF AND WAREHOUSE COMPANY
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October 29, 1979

U. S. Army Corps of Engineers
Sacramento District
Investigation D
650 Capitol Mall
Sacramento, California 95814

Gentlemen:

This letter is written in full support of the proposal to increase the depth of the ship channel to the Port of Sacramento.

As a contracting stevedore, we are acutely aware of the present restrictions for the unhindered passage of many modern cargo vessels due to draft. On many and increasing occasions as ships continually become larger, we find we can only partially load a vessel at Sacramento and that vessel then must come to the Bay Area or other deep water berth to "top off" to her full capacity.

This situation has pyramiding side effects: wider deployment and less efficient labor utilization; energy loss, steaming time without benefit of capacity useage of the vessel, or conversely the additional energy and cost to move the commodity from the nearby originating sources overland distances to a suitable port location.

The Sacramento Valley produces and prepares many commodities that are prominent in the foreign trade market and the Port of Sacramento, in many cases, is the closest Port to continue the water portion of the export and import pipeline. Because much of the Ports exports are shipped in bulk, i.e., Rice and other grains, larger ships are required for large volume orders to be economically moved.

Thus as we have noted, for energy savings, job inducements, service to products of the areas and certainly not to forget the huge investment in the Port of Sacramento, which should not be allowed to become obsolete

because of access, we encourage early approval of the channel project.

Sincerely,

CRESCENT WHARF AND WAREHOUSE COMPANY

H. B. Copsey

H. B. Copsey,
Vice President

HBC
tej

Fred F. Noonan Company, Inc.

AGENTS AND BROKERS
PRINCIPAL OFFICE • ONE CALIFORNIA STREET • SAN FRANCISCO, CALIFORNIA 94111

October 30, 1979

U.S. Army Corps of Engineers
Sacramento District
Investigative Section D
650 Capitol Mall
Sacramento, California 95814

Gentlemen:

We understand that an application is presently before the Corps of Engineers to dredge the Sacramento ship channel to forty feet from its present limitation of thirty-two feet.

We act as ship agents for many ships which go to Sacramento to load bulk commodities such as logs, grain, rice, etc. The size of these ships have increased in recent years and many of them are unable to load efficiently down to their deep water load line because of draft limitations in the channel. Accordingly, these ships have in recent months, particularly with wheat to China which is new business for California and for California farmers, had to top off and load additional tonnage at the Port of San Francisco grain elevator.

We therefore wholeheartedly support the deepening of the Sacramento channel and all of its approaches so that California farm products can find their way economically to China, India, Pakistan, Southeast Asia, wherever, after having loaded at a single loading port.

Very truly yours,

FRED F. NOONAN COMPANY, INC.

Fred F. Noonan
President

FFN/dh

TELEPHONE: 415-981-6204 • TWX: 910-372-7235 • CABLE: FREONOON • TELEX: 470094

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WGM WILSON & GEO. MEYER & CO.
Chemical Marketing Since 1850

October 30, 1979

U. S. Army Corps of Engineers
Sacramento District
ATTENTION: Investigations Section D
650 Capitol Mall
Sacramento, CA 95814

Subject: Sacramento River Deep Water Ship Channel Deepening Project

Gentlemen:

Our firm imports at the present time approximately 150,000 tons per annum of fertilizer materials in bulk to the Port of Sacramento. We anticipate over the years an increase in the range of at least 10% per year.

Currently we fill 27,000 short ton vessels in Heroya, Norway, and lighten ship in order to meet draft requirements of the Sacramento River by stopping in San Diego to discharge cargo. It would be possible for us to deliver full cargos directly to Sacramento without a stop in San Diego if the ship channel were deepened.

With the high cost of ocean freight due to increased fuel costs, it is apparent that to maintain this importation from Norway we will find it necessary to use larger vessels in the nature of 30,000 to 40,000 short tons, perhaps even larger. Currently we do not find it possible to import cargos on vessels of this tonnage because of the draft limitations on the Port of Sacramento.

We urge you to give favorable consideration to the deepening of the draft of Sacramento River so that larger vessels may be accommodated at the Port of Sacramento for the benefit of the agriculture of California, which depends upon fertilizer imports for a part of its fertilizer supply.

Cordially,

WILSON & GEO. MEYER & CO.

Jeffery W. Meyer
President

JWM/mpr

270 Lawrence Ave., South San Francisco, CA 94080 · Telephone (415) 871-1770 · Telex 331425 · Cable Address: GEOMEYER

PACIFIC INTERNATIONAL RICE MILLS, INC. pirmi 100 CALIFORNIA STREET, SUITE 900, SAN FRANCISCO, CALIFORNIA 94111 (415) 982-6888

October 30, 1979

Investigations Section D
U.S. Army Corps of Engineers
Sacramento District
650 Capitol Mall
Sacramento, California 95814

Dear Sirs:

The Port of Sacramento has seen numerous rice carrying vessels pass through its waters in the past several years, and the volume is ever increasing. The bulk rice elevator is constantly busy loading rice for such varied places as Portugal, Italy, Korea and Puerto Rico. As the world demand for rice increases, so does the demand for the deep-water Port of Sacramento.

Having been a party to numerous shipments ourselves, we at Pacific International Rice Mills, Inc., have from time to time been limited in the tonnage we are able to put aboard vessels on account of the limited draft in the ship channel. We have on more than one occasion loaded several vessels of thirty-thousand tons each, rather than just one of sixty-thousand tons, adding unnecessarily to the cost of exporting rice grown by the California farmer. In order to provide better returns to the producers in California, and to keep more monies in the United States as opposed to spending dollars on freight paid to foreign vessel owners, we suggest that action be taken promptly to deepen the channel to fifty feet. Such a move would not only open the Port to numerous other vessels, but it would also enable the facilities presently on the ship channel to operate more efficiently.

We are certain that a review of this request will justify the expenditure of funds necessary to achieve these ends. If additional information regarding use of the Port of Sacramento by rice shippers is needed, we shall be glad to furnish same to you.

Respectfully submitted,

PACIFIC INTERNATIONAL RICE MILLS, INC.

William S. Perell

William S. Perell

WSP/kp

cc: James Ince, Port of Sacramento

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San Francisco, California

AREA CODE 415
TELEPHONE 391-3710
CABLE ADDRESS CALSTEBAL

October 30, 1979

U.S. Army Corp of Engineers
Sacramento District
Sec. D
650 Capitol Mall
Sacramento, California 95814

Gentlemen:

It is our understanding that a meeting is scheduled for the 13th of November, in Sacramento relative to the question of providing greater depth to the Sacramento Ship Channel. If possible, we will have a representative at this meeting, in-as-much as it is a matter for which we have a deep concern.

The necessity for adequate channel depth is dictated by requirements of present and contemplated new buildings of large bulk carriers moving the cargoes serviced thru the Port of Sacramento. Vessels, with the capability of moving these exports worldwide, should be afforded the opportunity to do so in one call and not be restricted by draft, thus being subjected to added operating expense and delays, necessitated by an additional call at a second facility in order to "top-off".

These are problems recognized by all of us, and which we trust will be given due consideration during this meeting.

If we can in any way be of assistance in future hearings, contact us at your convenience.

Very truly yours,

E. R. Cullen
President

ERC:lib
cc: James Ince -
Port of Sacramento

MAITLAND S. PENNINGTON

October 31, 1979

1107 NINTH STREET
SACRAMENTO, CALIFORNIA 95814
(916) 447-9133

Colonel Paul F. Kavanaugh
District Engineer, U.S. Engineers
650 Capitol Mall
Sacramento, California 95814

Dear Sir:

I regret my absence from the country does not permit my appearing before you to testify regarding the deepening of the Sacramento River Channel.

There are several points which underline the need for prompt approval and funding of this project:

1. Ships are being built larger and of deeper draft and at higher cost with each new generation of vessels.

When the Sacramento Ship Channel was first conceived ships of 10/15,000 D.W.T. were considered large and built at a cost of $1,000/2,500,000. Today's bulk ships run in size up to 500,000 tons, with drafts of 100 feet or more. Ships of 50/80,000 tons are commonplace and cost $25/50,000,000.

The foregoing points out that both size and cost are important.

The modern ship is much too large to come economically to Sacramento. The large, modern ship comes to Sacramento, loads to 30 feet and then proceeds to the Bay area, where it "tops off", causing substantial increase in cost to the buyer, and making similar cargo from other areas of the world more and more competitive with local products.

2. The principal cargoes moving through the Port of Sacramento outbound are grains, chips, and rice, from 85 to 95% bulk. Some rice is bagged but usually in full ship loads. Inbound fertilizer is a total bulk movement. About 1,750,000 tons is bulk.

Incrsased channel depth would permit the use of larger ships, bringing into full play the economics of scale.

3. The need to convert many energy intensive operations, such as the production of electricity by use of coal fired boilers in domestic arsas and the increased export of coal from western mines, points to Sacramento as the logical and effective point of transport mode - rail to water, water to rail.

4. Failure to improve the channel would continue to make the investment to date of close to $100,000,000 less effective and efficient.

5. On the other hand, increasing the depth to 35, preferably 40 feet, would increase several times the effectiveness and economic value of the investment. It will also maintain and improve the competitive position of the port and Western farmers, miners, and foresters.

6. It is reasonable to assume that inflation will continue for some time at perhaps a slower rate than current. Should this project be delayed another 10 years it is reasonable to assume cost will be up 50% or more.

The tax payer will in this project receive a higher benefit for his dollar than is usually found in public works projects of this kind.

This project will be well managed and directed by the Port Commission and the Port Director, who have made an excellent record of innovative agressiveness.

The writer has had considerable experience with the ports and Merchant Marine nationally and internationally.

Very truly yours,

MAITLAND S. PENNINGTON

MSP:LW

MAITLAND S. PENNINGTON

STAR SHIPPING (U.S.W.C.) INC.
425 CALIFORNIA STREET • SAN FRANCISCO, CALIFORNIA 94104
TELEPHONE: (415) 433-4900 • CABLE ADDRESS: "STARBAY" • RCA TELEX: 278787

Head office:
Star Shipping A/S
Bergen, Norway

Branch offices:
London, England
Long Beach, Calif.
New York, N.Y.
Portland, Oregon
Sydney, N.S.W.
Tokyo, Japan
Vancouver, B.C.

October 31, 1979

Department of the Army
Sacramento District Corps of Engineers
650 Capitol Mall
Sscramento, Calif. 95814

Attention: Investigations, Section "D"

Subject: Navigational improvements and modifications of the Sacramento River Deep Water Ship Chsnnel, California.

Gentlemen:

We refer to announcements from the Sacramento Board of Port Commissioners regarding the scheduled public meeting to take place at 7:30 pm on 13th November 1979 at the Sacramento County Board of Supervisors Chambers, 700 H Street, Sacramento, California, for there to further discuss the above captioned subject. We hereby wish to add the following comments to become a part of the record of that meeting, for forwarding to the Department of the Army, Washington, D.C.

As operators and agents of a large fleet of ocean carriers between the U.S. West Coast and Europe and the U.S. West Coast and the Far East, we must naturally familiarize ourselves with the vsrious ports and navigable waters on the West Coast, and as such know thst the controlling depth up the Sacramento River is only 30 feet st M.L.L.W.

Knowing quite well that there have been experiences of delays to ships brought about by the existing draft restrictions causing vessels to await the tide and others having to complete loading in the lower San Francisco Bay Area. We have to concern ourselves with the resulting serious costs of such delays. We would also mention that in common with all steamship operators, we are cognizsnt of the continuing increase in size of vessel creating a need for a deeper water depth than now exists relative to the subject channel. Furthermore, it should also be mentioned, that the Port of Sscramento hss proven itself as an important inlet snd outlet for waterborn cargoes and it would greatly serve the community if the port were deepened to effect more efficent shipping operations.

....../

We therefore agree to the need and encourage the deepening of the Sacramento River Ships Channel to at least 37 feet but preferable 40 feet controlling depth above Mean Lower Low Water.

Yours truly,

OK

Ole Kalve
Assistant General Manager

OK:lmg

cc: Star Shipping A/S, Bergen
Melvin Shore, Port Director, Port of Sacramento
A. James Ince, National Accounts Manager, Port of Sacramento

Texasgulf Chemicals Co.
A Division of Texasgulf Inc.
P.O. Box 30321 4509 Creedmoor Road Raleigh, North Carolina 27612 (919) 782-7070

October 31, 1979

U. S. Army Corps of Engineers
Sacramento District
Attention: Investigations Section D
650 Capital Mall
Sacramento, CA 95814

Gentlemen:

This letter is in response to a notice received from the Port of Sacramento relative to a public meeting to be held on November 13, 1979 regarding your presentation involving proposed modification to the Sacramento River Deep Water Ship Channel, specifically the question of the feasibility of deepening the channel.

Texasgulf Inc. is a major mining company engaged in exploration, mining and marketing of various base elemental products such as soda ash, sulphur, phosphates, potash, metals and other similar commodities on a world wide basis.

We are currently producing and marketing soda ash, potash and sulphur in geographic areas which would allow Texasgulf Inc. to utilize the facilities of the Port of Sacramento provided the overall economics proved favorable. One very important limitation with respect to the Port of Sacramento is that the size and depth of the Deep Water Ship Channel limits the size of ocean going vessels which can call at the Port.

The transportation savings realized by utilizing larger, more cargo efficient ocean going vessels is obvious and we shall not dwell on this in detail. The potential transportation savings afforded by larger cargo shipments will have a definite bearing on occasion as to whether Texasgulf Inc. could or would utilize the Port of Sacramento facilities.

Texasgulf Inc. earnestly solicits your consideration and supports the Port of Sacramento's efforts to deepen and widen the Sacramento River Deep Water Channel to a depth of

at least 40 feet mean low level.

Respectfully,

Jack G. Diver
Manager, Marine Contracts

Corporate Transportation and
Distribution Department

JGD:krt

cc: Port of Sacramento
San Francisco Office
44 Montgomery Street
Suite 1730
San Francisco, CA 94104
Attention: Mr. A. James Ince

CABLE FRIBRICE
TELEX 232596 COC UR

TELEPHONE 212-826-5100

CONTINENTAL GRAIN COMPANY
RICE DIVISION
277 PARK AVENUE
NEW YORK, N. Y. 10017

October 31, 1979

U.S. Army Corp Of Engineers
Sacramento District
Attention: Investigations Section "D"
650 Capital Mall
Sacramento - California 95814

Gentlemen:

We understand that you have under consideration a proposal to dredge the channel in order that larger vessels can safely navigate deep water ship channel to Sacramento and remain safely afloat.

Continental Grain Company are exporters of rice from Sacramento to foreign destinations. More and more the rice industry is finding it beneficial and economical to ship rice in bulk whenever possible instead of in bags. This results in savinga of the cost of the bag, stevedoring and time in loading. As an example, at the present time there are shipments of rice being loaded to Korea which will total 250,000 tons. There are also many other shipments of brown rice and paddy rice in bulk to other destinations.

The cost of ocean freight is a big item in our calculation of a sale price to our overseas customers. Therefore wherever possible we try to use a larger vessel which results in a lesser freight rate than using two smaller vessels.

At the present time we are limited to 30 feet 6 inches in draft in the ship channel. This limits the size of the vessel which we can use in Sacramento. It results in our having to charter smaller vessels at additional cost to us or chartering larger vessels again at additional cost since we must pay for a second load port (San Francisco) to complete the cargo. Additionally, if we charter the larger vessel we have to pay extra costs for inland transportation of the rice from Sacramento to San Francisco.

We foresee the demand for larger quantities of bulk rice in our foreign markets. The port of Sacramento is a major bulk commodity handling port in California. The trend is toward larger vessels in order to move bulk commodities at economical freight rates. It is our opinion that the present channel should be dredged to at least 37 feet in order to keep the port of Sacramento competitive with other ports in the United States. We therefore recommend the serious consideration to the proposal.

Very truly yours,
CONTINENTAL GRAIN COMPANY

Charles Hornbostel
Traffic Manager

CH/sr

FRITZ COMPANIES

November 2, 1979

U.S. Army Corps of Engineers
Sacramento District
650 Capitol Mall
Sacramento, CA 95814

Attention: Investigations Section D

Gentlemen:

Inasmuch as we will not be able to attend the forthcoming public hearing on the proposed channel deepening to the Port of Sacramento, we would like to go on record as favoring this proposal with an optimum depth of forty (40) feet.

We base our opinion on the necessity of having a deepwater port available for the export of bulk commodities. A forty-foot channel, in our opinion, would provide adequate drafts for vessels most suitable to the handling of various bulk commodities with specific emphasis on grain and coal. In particular, we feel that California is in need of a modern, high-speed coal facility to serve the export requirements of the mines being developed in Utah and Colorado.

We thank you for your consideration of the above.

Very truly yours,

David F. Schmidt
Manager
Chartering Department

DFS:lh

cc: J. Ince, Port of Sacramento

FRITZ COMPANIES, INC.
142 SANSOME STREET • SUITE 600 • SAN FRANCISCO, CA 94104 • (415) 393-8360

TELEX: WU: (S.F.) 3-4289
CABLE: MARUBENI SAN FRANCISCO

Marubeni AMERICA CORPORATION

650 CALIFORNIA STREET SAN FRANCISCO, CALIFORNIA 94108 (415) 433-4550

November 2, 1979
Letter No. CN-948

U.S. Army Corp of Engineers
Sacramento District
Attn: Investigations Section D
650 Capitol Mall
Sacramento, CA 95814

Subject: Public meeting Nov. 13, 1979, regarding Deepening of Port of Sacramento Channel

Gentlemen:

As one of the major shippers of wood chip to Japan through the Port of Sacramento, we are quite interested in those developments which will bring about a smoother, less expensive operation for us. One of the areas in which this can be accomplished involves the deepening of the subject channel as indicated and shown in exhibit by you.

The vessels now used in connection with wood chip movements are sometimes delayed resulting in an additional cost to us because of inadequate channel depth wherein the ship actually has to await the tide because of the draft required based on the ship being fully loaded and requiring a draft deeper than the 30 Ft. MILLW now existing.

Naturally, because we are one of the larger trading companies in Japan, we make a continuing effort to develop other cargoes both inbound and outbound and find that vessel size could be a hindrance to our efforts knowing the lack of proper draft in the current depth of the channel. Being in the business of international trade, we are quite well aware of the tendency toward larger vessels requiring deeper drafts.

We respectfully request that due consideration be given toward deepening the channel involved in this subject matter to a depth of

40 Ft. MILLW as this will result in a better operation for us and a saving in our cost as well as a possible saving in the maintenance of the channel in the future.

Yours very truly,

MARUBENI AMERICA CORPORATION
San Francisco Branch

T. Nakai
Vice President
and General Manager

TN/mb

Beker Industries Corp.
124 West Putnam Avenue, Greenwich, Connecticut 06830
Telephone: 203/622-5700, TWX 710-579-2918
Telex 96-58-62 Cable: FERTILIZER

November 5, 1979

U.S. Army Corps of Engineers
Sacramento District
Attn: Investigations Section D.
650 Capitol Mall
Sacramento, CA 95814

Gentlemen:

Reference is made to the Notice of Public Meeting and Workshop on the Sacramento River Deep Water Ship Channel Investigation to be held at The Sacramento County Board of Supervisors' Chamber on November 13, 1978.

Beker Industries Corporation welcomes the opportunity in supporting and expressing its desire for deepening the Sacramento River Channel especially to the Port of Sacramento. We, as one of the major producers of Phosphatic Fertilizers in the country, maintain one of our major plants in Conda, Idaho which has a yearly production capacity of over 200,000 tons P_2O_5. In addition we can manufacture Diammonium Phosphate, Triple Superphosphate in granular and/or Run-of-Pile form, plus Phosphoric Acid. This particular plant is approximately 850 miles from the Port of Sacramento and its served by the Union Pacific Railroad which logistically would be favorable for our export market. However, in the past few years, we have been unable to competitively participate in tenders offered by such countries as Bangladesh, India etc., due to high shipping costs. One way to compete is to equate the per ton shipping cost (which currently is favorable on shipments from the U.S. Gulf) by shipping larger quantities enabling one to negotiate ocean freight rates at a more competitive level. We have to-date been restricted to shipments of about 20/22000 ton due to the limited draft at Sacramento.

The Port of Sacramento is of particular interest to us, due to its ample storage facilities and modern equipment. In my opinion a deeper draft channel would also encourage regular liner services with their larger vessels to call the Port of Sacramento which would facilitate centralizing our export activities including our current shipments to New Zealand.

We sincerely trust with our added voice, we can encourage such a project.

Very truly yours,

BEKER INDUSTRIES CORPORATION

P. R. Wilson
Senior Vice President-Marketing

PRW/eab

Management/Marketing Associates, Inc.
consultants to management in research, planning, organization development

November 5, 1979

U. S. Army Corps of Engineers
Sacramento District
Attn: Investigations Section D
650 Capitol Mall
Sacramento, CA 95814

Re: Channel Deepening Support

Gentlemen:

The recent notice of Public Meeting and Workshop on the Sacramento Deep Water Ship Channel was received with considerable interest and enthusiasm. For many years my involvement with the Port has been as an international business executive who required the best possible services from public ports. In this regard I have spent considerable time and effort evaluating the draft restrictions presented by the Sacramento River Deep Water Channel. My experience provides a clear basis of fact for supporting the workshop to encourage discussion of and action for the deepening of the Sacramento River channel.

As my personal schedule makes it impossible to personally attend the Board of Commissioner's public meeting, I respectfully request this letter serve as an endorsement to continue the current investigation of the plan option to deepen the Sacramento River Channel. It is my position that the Port of Sacramento serves vital shipping needs of California. These needs can be improved by the deepening of the channel.

Sincerely,

David H. Redmond
Consultant

cc: Mr. Melvin Shore
Port of Sacramento

The Bank of California Tower · 707 Southwest Washington · Portland, Oregon 97205 · (503) 228-9327

H.J. BAKER & BRO.
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TELEPHONE
212-567-0200
CABLE ADDRESS
"BAKERBRO"
TELEX 1-2487
420944
223462
620288

November 5, 1979

U.S. Army Corps of Engineers
Sacramento Districts
650 Capitol Mall
Sacramento, California 95814

Attention: Investigations Section D -

Gentlemen,

We understand that a hearing has been scheduled for November 13, 1979 to investigate and determine the need to increase the present deep water channel depth at the port of Sacramento, from 30 feet to 37 feet mean low water level.

H.J. BAKER & BRO., INC. fully supports the proposal to deepen the channel, as this will increase the cargo size of bulk carriers calling at the port and will allow many large bulk carriers to utilize Sacramento as first port. The overall result of this action should result in lower cost for U.S. Importers and should result in lower freight for exports and thus making American Exports more competitive on the International Market Place.

Very truly yours,

H.J. BAKER & BRO., INC.

B.W. Schapers

B.W. Schapers
Director Ocean Transportation

BWS/lr

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THE PRO-PAK CORPORATION, FERNANDINA BEACH, FLORIDA • H. J. BAKER & BRO. (CANADA) LTD., MONTREAL

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Woodward & Dickerson, Inc.

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CABLE "WOODWARD"
TELEPHONE
AREA CODE 215 527-5200

TWX 510-662-3381
WU TELEX 084-5244

6 November 1979

U.S. Army Corp of Engineers
Sacramento District
Attention: Investigations D
650 Capitol Mall
Sacramento, CA 95914

Dear Sir:

This letter is in reference to the meeting you are having on 13 November 1979 concerning deepening the channel serving the Port of Sacramento.

In the near future, we hope to export large quantities of sodium carbonate and sodium sulphate through the Port of Sacramento. A deeper channel of at least 37 feet would be of immense benefit as it would allow larger vessels to be utilized in this trade.

If we can be of any assistance in bringing to reality a deeper channel, please contact us.

Sincerely,
WOODWARD & DICKERSON, INC.

R.B. Mitchell
Vice President

RBM/kf

11-6-79

Colonel Paul F. Kavanaugh

My name is William F. Drum
I am a retired grain merchant.
I have been interested in the Port of Sacramento since its inception.
First shipments came in parcel shipts of less than cargo lots of alfalfa pellets and bagged rice. From these meager beginnings in 1963 traffic has grown to generous proportions to where the grain facility tonnage is now estimated to be 1½ million tons in the current fiscal year.
This growth is attributable to the rapidly expanding demand for U.S. grains in the world market. California grown wheat because of its improved quality through breeding has found favor in the orient and South America.
Reduced transcontinental freight rates have at last rendered corn and grain sorghums competitive with gulf shipments for oriental destinations.
Along with this growth in traffic the size of vessels and its accompanying increase in draft has reduced the number of vessels that can be wholly served from the port. Likewise smaller vessels because of unit costs find it difficult to compete. As older vessels retire from service they will be replaced with larger ones which will make it even more difficult for this port.
We therefore urge the authority to promptly approve the deepening of the channel so that provision for funds can proceed to where work can begin.

Wm F. Drum

①

& MOSS
REALTORS

REAL ESTATE AND INSURANCE

711 J STREET
SACRAMENTO, CA. 95814
PHONE: 444-8864

November 6, 1979

Colonel Paul F. Kavanaugh
District Engineer, U.S. Engineers
650 Capitol Mall
Sacramento, California 95814

Dear Colonel Kavanaugh:

As a Port Commodore, and interested citizen, I strongly endorse the deepening of our Port's Ship Channel. It will add to our seeking a broader based economy and help Sacramento keep apace in orderly growth and expansion.

This is Sacramento's golden opportunity—now.

Sincerely,

H. M. MOSS
President

HMM/jms

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1215 21st STREET, SACRAMENTO	95814	1-446-6434	8791 ELK GROVE BLVD., ELK GROVE	95624	1-685-2069
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10415 FOLSOM BLVD., RANCHO CORDOVA	95670	1-362-3252	3475 SUNSET BLVD., ROCKLIN	95677	1-624-4561

ARCO Petroleum Products Company
Export Sales
Petroleum Coke and Fuels
515 South Flower Street
Los Angeles, California 90071
Telephone 213 486 2839

C. W. Sauer
Manager

November 6, 1979

U. S. Army Corps of Engineers
Sacramento District
650 Capitol Mall
Sacramento, California 95814

Attentioo: Investigations Section D

Gentlemen:

It is our understanding that the Corps of Engineers is neariog completion of studies to determioe whether deepeoing the Sacramento River Deep Water Ship Channel would be feasible. For your information, Atlantic Richfield Compaoy has recently entered into s three year contract with the Port of Sacramento to ship a minimum of 250,000 metric tons of export cargo through the Port's bulk fscility.

While we sre very pleased with the existing Port facilities, we are concerned thst for certain portions of our business, the existing drsft limitaitons may creste vessel operation problems as it is most economical especially for shipments to the European market to utilize Panamax sized vessels. We feel deepening the channel from 30 to 35 feet will enable us to be more competitive with suppliers st other Ports and therefore, we heartily support the project.

If you require additional ioformation regarding our contemplsted movement, please do not hesitste to communicate with us.

Yours very truly,

C. W. Sauer

CWS:egy

ARCO Petroleum Products Company is a Division of AtlanticRichfieldCompany

DIAMOND INTERNATIONAL CORPORATION

CALIFORNIA LUMBER DIVISION
P. O. BOX D
RED BLUFF, CALIFORNIA 96080
916-527-2231

Nov 9 8 54 AM '79

November 7, 1979

Mr. Melvin Shore, Port Director
Port of Sacramento
World Trade Center
West Sacramento, California 95691

Dear Mr. Shore:

Our company has been exporting wood chips to Japan from the Port of Sacramento since 1966 and we value this business highly. It is also our intention to continue this business for the foreseeable future.

Therefore, we strongly urge that efforts be made to deepen the channel and protect this business of the export of wood chips from Sacramento by keeping it competitive with other ports.

Sincerely,

M. J. Huetter
M. J. Huetter
Vice President and
General Manager

MJH:jw

Port Sacramento Industrial Park

3900 Industrial Boulevard • West Sacramento, California 95691 • 916/372-5100

November 7, 1979

Colonel Paul F. Kavanaugh
District Engineer, U.S. Engineers
650 Capitol Mall
Sacramento, CA 95814

Subject: Proposed Deepening of Sacramento Deep Water Ship Channel

Dear Colonel Kavanaugh:

Port Sacramento Land Company is the owner/developer of a 600-acre industrial park which includes frontage on the Deep Water Ship Channel. Sites are available within the Park which provide private industry with direct access to the Sacramento Deep Water Ship Channel.

We are vitally concerned and interested in the success of the proposed deepening of the Ship Channel in order that we may continue to attract industry to the Sacramento area. As the price of fuel continues to increase, it becomes evermore important for industry to be able to utilize the most economical means of transporting goods available. If the Port of Sacramento is to continue as a viable port of call for the cargo vessels now in use and being developed for the future, it is essential to increase the depth of the Sacramento Deep Water Ship Channel. Furthermore, in light of the considerable sums of taxpayers funds already expended for the present facilities at the Port of Sacramento, it would be a considerable waste to allow this facility to become obsolete.

Respectfully submitted,

E. W. Christman
Vice President and General Manager

ags

LONE STAR INDUSTRIES, INC.
Cement & Construction Materials Group

Pacific Region
2800 Campus Drive
San Mateo, Ca. 94403
415 574-7100

November 8, 1979

U. S. Army Corps of Engineers
Sacramento District
Investigative Section D
650 Capitol Mall
Sacramento, CA 95814

Gentlemen:

It is my understanding that the Port of Sacramento has applied to the Corps of Engineers to dredge the Sacramento channel to forty feet from its present thirty-two feet draft.

Our company, Lone Star Industries, Inc., Pacific Region, is currently doing extensive shipping and such an extension of the draft at Sacramento could be influential to us economically and could result in our use of the Port channel which we are not now using.

We would appreciate your consideration of this permit and our recommendation. It could result in beneficial trade for the Port and American economy on the Pacific Coast with trade from Asia and other countries we are now negotiating with for the importation of product.

Very truly yours,

LONE STAR INDUSTRIES, INC.
Pacific Region

R. G. McAlister
Regional Vice President

RGM:bh

Union Chemicals Division

Union Oil Company of California
Union Oil Center, Box 60455, Los Angeles, California 90060

(213) 486-6854

UNION 76

November 8, 1979
S&T-79-176

Port of Sacramento
Sacramento - Yolo Port District
World Trade Center
West Sacramento, California 95691

ATTENTION: Mr. Ivory J. Rodda, Chairman

Gentlemen:

In response to the announcement from the Sacramento - Yolo Port District that a public meeting will be held by the Board of Commissioners on November 13, 1979, Union Chemicals Division of the Union Oil Company of California wishes to express their view in favor of deepening the Sacramento Deepwater Ship Channel.

Union Chemicals Division is presently operating a terminal for bulk fertilizer storage in the Continental Port Industrial Park on the Sacramento River Deepwater Ship Channel. This site, which is accessible from the Pacific Ocean, provided an outlet for Union's fertilizer into the California farming areas in the Sacramento Valley and upper San Joaquin Valley.

The Sacramento terminal is served by Union's own gas carrier, M/V CORNUCOPIA, which has a fully laden draft of 29 feet 6 inches. The present water depth in the waterways between New York Slough and Sacramento preclude loading the vessel to maximum capacity.

The location of Union's fertilizer plant in Alaska is a key factor in California's agricultural economy - an industry which is the most important in the State. Natural gas is available to Union in Alaska and natural gas is required as a raw material for production of nitrogen fertilizer. Natural gas is short in the lower 48 states and California is no exception. Projections by the utilities companies and by the Public Utilities Commission staff indicate that within 3 or 4 years, California may not have enough natural gas for the highest priority user - private residence.

California nitrogen fertilizer plants have been forced to curtail operations because of natural gas pricing and availability. There is a genuine and realistic fear that future gas shortages could result in a serious reduction of nitrogen fertilizer supply. This would literally result in a disaster to the California agricultural industry.

The assured supply of gas in Alaska and the ability to deliver fertilizer to California farmers through the West Sacramento Terminal will substantially reduce this potential danger. This will permit our agricultural industry to develop, to grow, and to prosper.

The Cornucopia was built specifically to travel between Alaska and the West Coast of the U.S.A.. The 29'6" draft was selected to be compatible with the water depth in the Sacramento Channel. Shallows at the point of confluence of Sacramento River with the channel and other high points caused by silting or sloughing of the banks has prevented operation at design load. Further, lack of sufficient water under the keel at near maximum load makes the vessel slow in response to helm changes.

Major ships are not designed with loaded drafts of less than 30 feet because they become less seaworthy. If the Port of Sacramento hopes to attract vessels of major stature, a channel depth of 35 feet is essential.

Due to the shut-down of 75% of domestic ammonia production plants, California farmers are now heavily dependent on receiving nitrogen fertilizers through a sea-port. The Sacramento Deepwater Ship Channel and the Union terminal provides this sea-port. However, the present circumstances raise questions as to the Channel being able to accomodate not only the Union vessel, but other large modern vessels as well. Union, therefore, strongly recommends deepening of the Sacramento Deepwater Channel to at least a minimum depth of 35 feet.

Sincerely,

R D Mc Mahon

R. D. Mc Mahon
Manager
Supply & Transportation

CAD:ROM:res

MDC LTD.
MARINE DEVELOPERS & COUNSELORS
~~XXX~~ 105 MONTGOMERY ST. SUITE ~~XXXX~~ 802 SAN FRANCISCO, CALIFORNIA 94104
(415) 392-5354

9 November 1979

U. S. Army - Corps of Engineers
Sacramento District
650 Capitol Mall
Sacramento, CA 95814

Attn: Investigations Section D

Gentlemen:

As international maritime consultants specializing in transportation and port studies, we are frequently requested to develop rate studies comparing costs of transporting bulk commodities from various West Coast ports to points in Japan and elsewhere. Recently we have completed two such studies which include the Port of Sacramento as a potential shipping port for coal.

In preparing such reports we attempt to develop a total rate package, i.e., mine to consumer, rather than simply develop the marine portion of the cost. As a result of our work in these studies we have come to realize that the Port of Sacramento has substantial advantages, in connection with environmental considerations, rail haul and terminals, that other West Coast ports do not. Additionally, in a physical sense it can accommodate a Panamax size ship of approximately 60-65,000 DWT.

That size ship is an efficient coal hauler and is in fact the workhorse of the international fleet. Unfortunately, however, although in terms of length and beam such a ship can reach Sacramento, the limiting channel draft is such that the loaded ship must depart Sacramento less than two thirds full, i.e., with only 40,000 tons of cargo.

It is my understanding that the Corps is contemplating dredging the channel. The figure I hear is 35-37 feet. Certainly this would be a tremendous improvement and I would strongly recommend it if that is the top limit you can consider.

I would even more strongly recommend, however, that you seriously consider 40 feet. This draft would make the port

available to a majority of the world's bulk carriers which, coupled with the environmental rail and transfer advantages Sacramento already enjoys, would make it one of the most economically viable ports on the Canadian-U.S.-Mexican coast lines.

If we can provide any additional information please do not hesitate to call.

Sincerely,

Hugh C. Downer

Hugh C. Downer

HCD:HH

ROGER G. MELDAHL
Senior Vice President-Marketing

WP
Western Pacific Railroad Co.
526 Mission Street • San Francisco, CA 94105

November 9, 1979

U. S. Army Corps of Engineers
Sacramento District
650 Capitol Mall
Sacramento, CA 95814

Attention: Investigation Section D

Gentlemen:

I understand that there is to be a Public Hearing November 13, 1979, to discuss improvements to the Sacramento Ship Channel. The Western Pacific Railroad is vitally interested in these proceedings, and the potentially beneficial effect that they may have on Northern California commerce.

Because of increased import and export demand for ores, chemicals, fertilizers, forest products and grains, a deep-water channel is necessary for the Port of Sacramento to be competitive in these markets. The alternative of having to "top off" loads at other ports is uneconomic and minimizes opportunities to fully utilize the facilities of this port.

Through our long working association, Western Pacific Railroad recognizes the Port of Sacramento to be a major West Coast bulk port. Through our ongoing independent marketing efforts, we are aware of the trend toward larger and deeper draft vessels. Western Pacific believes that deepening the Sacramento Ship Channel will be in keeping with this trend and allow the Port of Sacramento to continue to serve the growing needs of the shipping community.

Cordially,

Roger G Meldahl

Adams Grain Company

P. O. BOX 120
WOODLAND, CALIFORNIA 95695

DUNNIGAN, CALIF. PHONE (916) 724-3310 | OFFICE PHONE (916) 662-7351 | RESIDENCE PHONE (916) 662-2169 | WOODLAND, CALIF. PHONE (916) 662-6301

November 9, 1979

U.S. Army Corps of Engineers
Sacramento District
Attention: Investigations Section D
650 Capitol Mall
Sacramento, California 95814

Gentlemen:

Re: <u>Channel Deepening Support</u>

A deeper channel for our grain trade is a necessity.

We are in support of this and will attend the hearing on November 13, 1979.

Very truly yours,

David S. Adams
David S. Adams

DSA:nab

cc: Port of Sacramento

NORTH AMERICAN MARITIME AGENCIES

100 CALIFORNIA ST. • SAN FRANCISCO, CALIF. 94111 • PHONE 981-0343 • TWX 910-372-7424 • CABLE: MARITACO
17 BATTERY PLACE • NEW YORK, N.Y. 10004 • PHONE 422-6629 • TWX 710-581-5514 • CABLE ADDRESS: NYMARITACO
510 WEST SIXTH STREET • LOS ANGELES, CALIF. 90014 • PHONE 624-4094 • TWX 910-321-4149 • CABLE: MARITACO

SAN FRANCISCO

November 9, 1979

U.S. Army Corps. of Engineers
Sacramento District
Attn: Investigations Section D
650 Capitol Mall
Sacramento, California 95814

Dear Sir:

In a continuing world demand for bulk cargo and representing a major steamship company who ship bulk cargo from the west coast, we recognize a potential for increased cargo from the Port of Sacramento. In this respect we hope the Corps of Engineers will give full consideration to the proposed plan to modify the ship channel.

Sincerely,

NORTH AMERICAN MARITIME AGENCIES

Porter A. Smith

PORTER A. SMITH - Vice Pres.

cc: A. James Ince
National Accounts Manager
Port of Sacramento
San Francisco Office
44 Montgomery St., Su.1730
San Francisco, Calif.94104

General Agents for MARITIME COMPANY OF THE PHILIPPINES

U.S. West Coast Agents for: NAURU PACIFIC LINE • POLISH OCEAN LINES • SAUDI NATIONAL LINES
COSTA LINE • SOUTH AFRICAN MARINE CORP.(N.Y.) • NETUMAR LINE • CROSSOCEAN SHIPPING CO.

Leon Olson, *President* Joe Selenski, *Treasurer*

California Allied Printing Trades Conference

6877 Serenity West Sacramento, California 95823 • Phone (916) 391-6525

November 10, 1979

U. S. Army Corps of Engineers
Sacramento District
Investigations Section D
650 Capitol Mall
Sacramento, CA 95814

Gentlemen:

This letter is written in support of the proposal to increase the depth of the Ship Channel to the Port of Sacramento. The increased depth would allow more of the ocean-going vessels to use the channel, thereby making our Port more attractive to shippers, and ships could leave with a full cargo instead of having to stop at a deeper coastal port to fill their load.

It is a known fact that a lot of ship owners are building larger ships, which is another reason why the channel should be deepened.

Our Port area has a lot of room for expansion and industrial sites are available in the vicinity, which with improved shipping facilities will be an incentive for manufacturers to locate in and near the Port, and, in turn, will create more needed employment for the community.

We, therefore, are in complete support of the need that the Sacramento Channel be deepened to 40 feet.

Sincerely yours,

Joe Selenski

JOE SELENSKI
Secretary-Treasurer

COM-STRUCT
INTERNATIONAL
8600 - 23rd Avenue • Sacramento, California 95826 • (916) 381-2771
(Fibershel Sac) Telex 37-7352

November 13, 1979

U. S. Army Corps of Engineers
Sacramento District
Attention: Investigations Section D
650 Capitol Mall
Sacramento, California 95814

Gentlemen:

Fibershel manufactures and exports houses, hotels, hospitals and worker camps throughout the world.

Our plant is located in Sacramento and we have utilized the Port of Sacramento for shipments to Venezuela, Algeria, North Yemen and Saudi Arabia.

We are limited with our vessel charters because of the deep draft of the larger break bulk carriers. We have, in fact, lost opportunities to charter a vessel at a lower cost because of draft restrictions at the Port.

The cost and restrictions on our product make it uneconomical in the foreign market for us to truck or rail to a more distant port.

Very truly yours,

FIBERSHEL, a Division of
Com-Struct International

Richard L. Wardelman

Richard L. Wardelman
Export Manager

RLW:wm

The Northern California
Ports and Terminals Bureau, Inc.

66 JACK LONDON SQUARE • OAKLAND 94607 • (415) 444-3188

STATEMENT

November 13, 1979 Hearing
Sacramento Channel Deepening

This statement presents the views of the Northern California Ports and Terminals Bureau, Inc. (NORCAL) on the Sacramento Channel deepening. NORCAL is a nonprofit corporation that was formed in 1958 and is comprised of the publicly utilized ports that serve the Bay-Delta area. It includes both publicly owned and privately owned ports.

During the last several years NORCAL has been engaged in regional studies to project the requirements for movement of goods as a basis for planning future port facilities. These studies were carried out by independent consultants and have been reviewed extensively by regional planning agencies in the San Francisco Bay Area. These studies show in general that major increases in the amounts of dry cargoes, both foreign and domestic, can be expected over the next 40 years. For example, they show that the overall tonnage that will have to be handled by northern California ports will increase from about 18 million short tons a year in 1980 to 36 million short tons a year in 1990 and to 58 million short tons a year by the end of the century. To express it another way, it is projected that the dry cargo handling requirements in the northern California area will quadruple from the 1975 level by the year 2000.

These projected levels are the medium projections for such growth. They are based on a disaggregation of the projected growth in worldwide trade, based on a strong correlation between the growth of gross national product in the countries affected and the amount of international commerce that can be expected. They reflect the recent historical high rates of increase in growth in countries like Japan, South Korea, Taiwan and the expected increasing growth rates in other countries along the western rim of the Pacific. These projections were made prior to the changing status of the Panama Canal and prior to the prospect of resumption of trade with the People's Republic of China. Other significant factors that will require additional shipping include the energy shortage and the plight of the Cambodians. All of these developments will tend to push the projections toward the high side instead of the low side of the medium.

In order to meet these needs, it is apparent that all NORCAL ports will have to operate at peak efficiency with improved facilities that are modernized to accommodate the appropriate ships of the world fleet. As older ships are gradually phased out of action and newer ships replace them, there is a continuing tendency toward larger ships. These ships will require deeper water for safe and efficient utilization and for achieving the cost savings available when they can be fully loaded. The incremental deepening proposed will meet the needs for modernization of the Sacramento Channel in the near future.

It is therefore important to the State of California, and to Northern California particularly, that all the NORCAL ports continue to evaluate the important role that they play in world trade and in the maintenance of the economy of this area. In those places where channel deepening can be justified, as demonstrated in the Summary Report the Corps of Engineers has issued in connection with this hearing, it is important that projects go forward as rapidly as possible so that each port can be prepared to handle its share of the world trade in an efficient manner. Therefore, NORCAL strongly supports the completion of the studies required and the favorable action by local, regional, State and Federal authorities so that this important project can proceed.

RICE GROWERS ASSOCIATION OF CALIFORNIA
P. O. BOX 958 • SACRAMENTO, CALIFORNIA 95804 • PHONE (916) 371-6941

November 13, 1979

U. S. Army Corps of Engineers
Sacramento District
Attention: Investigations Section D
650 Capitol Mall
Sacramento, California 95814

Gentlemen:

As Traffic Manager for the Rice Growers Association of California, I am submitting this statement to emphasize our full support for deepening of the Sacramento River Deep-Water Channel, as outlined in your Draft Feasibility Report.

Our Association represents approximately 2,000 rice growers in the State of California and is responsible for the milling and marketing of over 50% of the rice grown in California.

The rice industry in California is now in the process of completing the harvest of one of the largest rice crops in its history. This year, like many years, 60% or more of California's rice crop will be available for export by water. Considering the projected figure of 1.7 million tons of rice from the harvest that is now nearing completion, it is apparent that a monumental task of export marketing lies ahead. The success or failure of this export program will be directly dependent upon the California rice industry's ability to be competitive in the world market, and the competitive position will be solely dependent on the total cost factors. The industry's costs of marketing, milling and transporting the rice will determine whether or not we are successful in the export market. A few dollars saved with an efficient, economical system can mean the difference between competing or not competing with the other rice producing areas in the world.

The ever-increasing cost of transportation today stresses, more than ever, the dire need for less costly, more efficient methods of transporting our rice, and we feel that the deepening of the Sacramento River Deep-Water Channel will go a long way in reducing the over-all costs that are now incurred. With the majority of ocean vessels getting larger and larger, and the smaller vessels being phased out, the options that we once enjoyed no longer exist. Unless the ship channel is deepened in order to offset some of the changes that have occurred in vessel sizes, it can be predicted that the cost of moving rice for export by water will continue to rise more each year. In order to continue to move our rice by water throughout the world, we

will have to, more and more, transport rice by truck or rail to the Bay Area terminals so that the vessels that load less than capacity at the Port of Sacramento can be "topped off" in the Bay Area. We have been forced to use this practice in the past and can only foresee more frequent use of this costlier method in years to come unless conditions are changed to prevent it from happening.

Since agriculture is California's Number 1 industry and the central valley of California is the primary area of agriculture, the Port of Sacramento is in a most vital location. The Port of Sacramento should be, and could be, the focal point for California agricultural commodities, whatever the volume, that will be needed to satisfy the growing demands of a hungry world. This can only be accomplished by expanding the capabilities of the Port. It is for this reason that the only feasible alternative is the deepening of the Sacramento River Deep-Water Channel as quickly as possible.

Very truly yours,

RICE GROWERS ASSOCIATION
OF CALIFORNIA

R. A. Bartram

R. A. Bartram
Traffic Manager

RAB:lr

LEVIN METALS CORP.

Corporate Office □ 1800 South First Street □ San Jose, Calif. 95112
(408) 294-8443 □ Telex 346361 □ CABLE "LEMAS" SAN JOSE

November 14, 1979

U.S. Army Corp of Engineers
Sacramento Oistrict
ATTN: Investigations Section D
650 Capitol Mall
Sacramento, California 95814

Gentlemen:

We understand that you are considering modifying the Sacramento River deep water ship channel to accommodate larger and fully loaded vessels. In view of this, we would like to encourage this modification to deepen the channel to a depth of at least 40' mean low low level.

Anytime we load a ship at the Port of Sacramento, we have had to move the vessel to San Francisco for topping-off because of an insufficient depth in the Sacramento River deep water channel.

We anticipate an increasing volume of business with the orient and the problems we have found because of insufficient depth in the channel will get more severe unless action is taken to deepen the channel.

In view of the above, we strongly feel the deepening of the channel should commence at the earliest date possible.

Very truly yours,

William S. Benak
President

WSB/lhm

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GATES & SONS, INC.

12276 Gates Place
Grass Valley, California 95945
Telephone: (916) 273-4185 • (408) 637-0205
Robert A. Gates

November 17, 1979

U. S. Army Corps of Engineers, Sacramento District
650 Capitol Mall
Saoramento, CA 95814

Attn: Investigations Section D

Gentlemen:

We are in the Log Export business and load and ship logs from the Port of Sacramento.

Due to the channel only being 30' deep, we have to be extremely careful in loading, especially at low tide, as the ship rests on the bottom at this time. At best we cannot put a maximum load on the ship.

This naturally adds to our costs in loading time and loss of freight volume.

It appears that unless the channel can be deepened to accommmodate larger ships and eliminate the added costs, we should try to relocate at another port.

Hoping that our veiws and opinions are of help in making the decision to select a plan to elimlnste these problems and make the Port of Sacramento competitive.

Sincerely,

Robert A. Gates, President
Gates & Sons, Inc.

cc: Port of Sacramento
Attn: Richard Burton

RAG:tg

Transpacific Transportation Company

650 California Street
San Francisco, California 94108
Telephone (415) 986-0786
Telex RCA 278225 ITT 470115
Cables: TRANSTRANS

November 19, 1979

U.S. Army Corp of Engineers
Sacramento District
650 Capital Mall
Sacramento, CA 95814

Attention: Investigation Section D

DREDGING SACRAMENTO CHANNEL

Gentlemen:

We have carefully reviewed proposal for the U.S. Army Corp of Engineers to deepen the maritime channel of the Port of Sacramento.

As we regularly have vessels calling at the Port of Sacramento either to discharge and/or load cargoes we are in complete support of the deepening of the Sacramento channel. This will certainly reduce cost of handling cargoes to and from the Port simply because increased draft will permit vessels to handle larger consignments both in and out of the Port of Sacramento.

Very truly yours,

TRANSPACIFIC TRANSPORTATION COMPANY

E. R. O'Donnell
E. R. O'Donnell
Vice President, Operations

EROD:sh

Worldwide Ocean Services — Liner/Husbanding/Towing
Los Angeles San Francisco Portland Seattle Vancouver

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Teletype/ 910-372-6017
Telex: 910-372-7971
Telefax: (415) 982-3805
Cable: "OVERSEAS"

November 20, 1979

U. S. Army Corps of Engineers
Sacramento District
Attention: Investigation Section "D"
650 Capitol Mall
Sacramento, CA 95814

Port of Sacramento
Deepening of the Channel

Dear Sirs:

We understand that the Corps of Engineers had a meeting on November 13 to discuss the deepening of the channel up to the Port of Sacramento. We further understand that the Corps of Engineers has recommended deepening the cbannel from 30 - 32 feet to possibly 35 - 37 feet.

While we are delighted with the Corps' recommendation to deepen the channel by 5 - 7 feet or so, we are concerned that not deepening the channel to 40 feet at this time may prove to be short-sighted. At 35 feet, many of the vessels that we are agents for will still not be able to load down to their marks; most of the ships will still have to top off in the Bay Area. If there's any chance at all that the Corps can recommend dredging to 40 feet, we hope it will do so. We, of course, are not in a position to evaluate the matter from all sides, as possibly you are--it's only from the carrier vantage point that we make this recommendation, but we do want to be sure that you have our thoughts for the record.

Yours very truly,

Carl F Blom
Carl F. Blom

CFB:lb

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CALIFORNIA FARM BUREAU FEDERATION

2855 TELEGRAPH AVENUE
BERKELEY, CALIFORNIA 94705
TELEPHONE (415) 644-7000

November 20, 1979

U.S. Army Corps of Engineers
Sacramento District
Investigation Section D
650 Capitol Mall
Sacramento, California 95814

Re: Sacramento River Deep Water Ship
Channel Investigation

The California Farm Bureau Federation is the state's largest general farm organization with more than 95,000 member families in 54 counties. With particular reference to our 950 rice producers, 2600 wheat farmers, 5300 feed grain producers and 500 timber producers, we would like to comment in favor of the proposal to deepen the Sacramento River Deep Water Ship Channel.

California agriculture depends heavily on exports for a major portion of its commodity sales. In 1978, approximately $2.4 billion in farm products left the state destined for foreign ports. If the current trend in trade expansion continues, California agricultural exports will surely total well above the high mark set in 1979.

A key to California's success in the agricultural export business has been a readily available supply of high quality products at competitive prices. The maintenance of favorable prices is a result of not only efficient farming practices, but also of economical shipping rates and cost effective port facilities. In this regard, it is important to maintain adequate port access so as to allow for the use of increasingly larger shipping vessels. As freight costs continue to escalate in response to climbing fuel and labor costs, increased use of the larger capacity freighters will become a necessity in order to remain competitive in the export markets. As the Corps of Engineers, the Port of Stockton and the Port of Sacramento have pointed out, current depths of the Sacramento River Deep Water Ship Channel are not adequate to accomodate the larger modern freighters required for cost effective shipping of California commodities.

Whether the products are rice, feed grains, wheat or wood chips, future trends in shipping rates will not allow for the economic use of smaller ships at the Port of Sacramento, or the "topping off" of larger carriers at other ports once these boats are partially loaded in Sacramento. Additionally, as pointed out in the recently completed Corps of Engineers Investigation, the increased use of "LASH" barges is not a viable method of answering the increased demand on shipping facilities.

The California Farm Bureau agrees with the conclusion reached by the U.S. Army Corps of Engineers that the most viable alternative is that which provides for the deepening of the existing shipping channel from 30 to 35 feet and widening as

necessary to maintain navigation safety. Although the costs involved are substantial, they must be viewed as an investment in California's future with regard to international trade. With the assurance for a strong, competitive inland port system, California agriculture, along with other industries, will continue to prosper as opportunities for trade expansion continue.

We appreciate the opportunity to present our views, and thank you for the serious consideration of our position.

Sincerely,

FREDERICK J. HERINGER
President

FJH:jmr
cc: Mr. Mel Shore, Port of Sacramento
Mr. Alex Krygsman, Port of Stockton

BANK OF AMERICA

A B GILMAN
Senior Vice President

November 26, 1979

Colonel Paul F. Kavanaugh
District Engineer, U.S. Engineers
650 Capitol Mall
Sacramento, CA 95814

Dear Colonel Kavanaugh:

This letter is written in regard to the Sacramento District Corps of Engineers' study of the feasibility of deepening the Sacramento River Deep Water Ship Channel.

I have had the opportunity to carefully review the "Information Summary of the Deep Water Ship Channel Investigation"; and, in my opinion, the alternative which providea for deepening the existing channel from 30 to 35 feet and widening the channel as necessary for navigation safety offera logical and deserving benefits for the economy of the Sacramento area. The project would provide the Port of Sacramento and the market served with much needed shipping capability and lower unit costs. In addition, the project would provide employment during the project and permanently at the Port of Sacramento as a result of increased port use.

As pointed out in the excellent study, deepening the channel to 35 feet would not adversely affect environmental considerations, except in the Suisun Bay area where the effect, at worst, would be temporary. In the longer view, it appeara the proposed channel deepening would be socially as well as economically favorable to the study area and the greater Sacramento Region.

As a concerned citizen and a member of the Sacramento area business community, it is my considered hope that thia project will be approved and accomplished at an early date.

Sincerely,

ABG:bk

Kerr Steamship Company, Inc.

Suite 315
Watergate Tower
1900 Powell Street
Oakland, California 94608

SAN FRANCISCO
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VERA CRUZ

CABLE ADDRESS
"KERRLINE"

SAN FRANCISCO
TELEX NUMBERS:
RCA 278306
ITT 470821
WUI 67888
WU 340110

TELEPHONE:
(415) 885-3371

November 28, 1979

U. S. Army Corps. of Engineers
Sacramento District
Investigation Section "D"
650 Capitol Mall,
Sacramento, California 95814

Gentlemen:

REF: OP-1191/79

REFERENCE - STUDY OF DEEPENING
SACRAMENTO RIVER CHANNEL AND CANAL

This letter is written in support of a proposed measure to deepen the Sacramento River Channel and Canal.

Vessels consigned to our agency which have called at the Port of Sacramento this year have numbered ten in total over the first ten and a half months. All of these vessels loaded grain at the elevators and every vessel because of draft limitations were required to proceed to a deep water berth in the Port of San Francisco to complete loading. Having to shift the vessel to San Francisco to complete loading causes undue delays to the vessel, increases loading costs, increases pilotage, lines, tugs and dockage costs.

It being understood that all vessels sailed from Sacramento at maximum draft allowable of 31' 6" to 31' 9" maximum in fresh water the following is a list of vessels handled by our agency calling Sacramento reflecting date of sailing from San Francisco amount of cargo loaded Sacramento, amount of cargo loaded San Francisco to top off the vessel and make her seaworthy under International Grain Regulations and being able to depart with a full load of cargo from the Bay area together with the final departure draft from San Francisco.

VESSEL	DATE OF SAILING	LONG TON CARGO LOADED SACTO.	LONG TON CARGO LOADED S.F.	DRAFT SAILING S.F.
M/S CAPT. GEORGE	4/18/79	18,750	11,591	36' 10"
M/S ALLEPO	6/21/79	24,841	5,291	35' 09"
M/S KYUKO MARU	6/26/79	32,950	5,401	39' 03"
M/S KYRAKATINGO	7/ 3/79	33,436	7,212	34' 11"
M/S UNISON	7/13/79	32,077	9,208	36' 07"
M/S ON LEE	7/24/79	26,934	8,256	40' 09"
M/S ON DING	8/ 4/79	24,000	7,718	37' 00"
M/S CASPIAN SEA	8/18/79	26,171	7,558	38' 01"
M/S ZHI HAI	10/13/79	21,164	2,067	33' 06"
M/S ON YEUNG	11/ 9/79	26,935	7,095	36' 06"

KERR STEAMSHIP COMPANY, INC.

As you can see from the above eight (8) of the ten (10) vessels or 80% of the vessels handled by our agency in this time period sailing fully loaded would require a draft in excess of 35' 00".

In view of the fact that trade has opened up with China this last year we can expect an ever increasing number of vessels to call at the Port of Sacramento in the near future, however, it is not altogether conducive when vessels must make two calls to complete loading when one call at a deep water port would suffice.

We believe there is a necessity and need to deepen the Sacramento River Channel and Canal to make available more than one deep water berth in the Bay area and fully support any movement that will realize this end.

Very truly yours,

KERR STEAMSHIP COMPANY, INC.
AGENT

G K Westerman

Captain G. K. Westerman
Assistant Vice President

GKW: tac

LYKES BROS. STEAMSHIP CO., INC. Lykes Lines
OWNERS, OPERATORS AND AGENTS
CABLE "LYKES"

December 19, 1979

Port of Sacramento
Sacramento - Yolo Port District
World Trade Center
West Sacramento, CA 95691

Attn. Mr. I.J.Rodda
Chairman, Port Commission

Dear Mr. Rodda:

RE: Sacramento River Deep Water Ship Channel Investigation

This is to confirm our support for the deepening of the Sacramento River Deep Water Ship Channel. We believe the "Selected Plan" is the appropriate alternative. Progress in the maritime industry has been leading toward larger capacity, deeper draft vessels, and the existing channel is inadequate to safely or efficiently accomodate these vessels.

Furthermore, trade with the Orient is expanding rapidly, and considering the nature of the cargo moving through your facilities, it will play an important part in the future of the Port of Sacramento.

We are looking forward to extensive utilization of this improved waterway in the future.

Very truly yours,

LYKES BROS.STEAMSHIP CO.,INC.

W J Buenger

W.J. BUENGER
Manager Operations
West Coast Division

WJB/atr.

HEADQUARTERS: LYKES CENTER, NEW ORLEANS. BRANCHES: HOUSTON, GALVESTON, BEAUMONT, CHICAGO, DALLAS, KANSAS CITY, LAKE CHARLES, MEMPHIS, MOBILE, NEW YORK, ST LOUIS, SAN FRANCISCO, TAMPA, LONG BEACH, WASHINGTON, ANTWERP, BREMEN, DURBAN, GENOA, HONG KONG, LONDON, TOKYO

Engr

CALIFORNIA WATERFOWL ASSOCIATION

555 VETERANS BOULEVARD • REDWOOD CITY, CALIFORNIA 94063 • (415) 365-3072

February 14, 1980

U.S. Army Corps of Engineers
650 Capitol Mall
Sacramento, CA 95814

Attention: Mr. Ray Williams, Investigations Section D

SUBJECT: SACRAMENTO RIVER DEEP WATER CHANNEL
DRAFT FEASIBILITY REPORT - SEPT. 1979

Dear Mr. Williams:

The California Waterfowl Association has reviewed with interest and care the subject report and has the following comments:

1) page 10, last full paragraph - the specific basis for the projected increase in rice tonnage exported needs to be explained.

2) page 12, first paragraph - clarification would be desirable as to whether the projected increase in shipment tonnage is all at the Port of Sacramento.

3) page 48 - the table presenting the Estimated Average Annual Navigation Benefits should include the tonnage estimate on which the dollar benefits are based.

4) Appendix 1, page D-38, Section 67 - the current habitat at the disposal sites should be described.

5) Appendix 1, page D-38, Section 68 - the narrative should make it clear whether or not the cumulative effects of the Stockton and Sacramento Channels are being discussed.

6) Appendix 1, page E-15, Section 26 - the apparent conflict between the language of this section and various other places where the draft claims that there would be no increase in Suisun Marsh salinities needs to be resolved.

7) The effect (or lack of it) on the high tide salinity levels in the Suisun Marsh needs to be discussed. In particular, the report should describe the project effects (if any) on the quality of the water at Collinsville which would be used to implement the U.S. Water and Power Resource Service's Suisun

continued on page -2-

Marsh water supply plan.

We appreciate the opportunity of comment on this report.

Very truly yours,

Dan Chapin

D. Chapin, Chairman
Resource Committee

cc: Al Candlish, USWPRS
George Deatherage, DRR
Glenn L. Rollins, DF&G
Frank Michney, USFWS

GPO 889-166/059

TO: Defense Technical Information Center
ATTN: DTIC-O
8725 John J. Kingman Road, Suite 0944
Fort Belvoir VA 22060-6218

22 October 2008

FROM: US Army Corps of Engineers
Sacramento District Library
1325 J Street, Suite 820
Sacramento CA 95814-2292

SUBJECT: Submission of technical reports for inclusion in Technical Reports Database

The enclosed documents from USACE Sacramento District are hereby submitted for inclusion in DTIC's technical reports database. The following is a list of documents included in this shipment:

- ADB344304 • Lemon Reservoir Florida River, Colorado. Report on reservoir regulation for flood control, July 1974
- ADB344333 • Reconnaissance report Sacramento Metropolitan Area, California, February 1989
- ADB344346 • New Hogan Dam and Lake, Calaveras River, California. Water Control Manual Appendix III to Master Water Control Manual San Joaquin River Basin, California, July 1983
- ADB344307 • Special Flood Hazard Study Nephi, Utah, November 1998 (cataloged)
- ADB344344 • Special Study on the Lower American River, California, Prepared for US Bureau of Reclamation – Mid Pacific Region and California Dept. of Water Resources..., March 1987
- ADB344313 Transcript of public meeting Caliente Creek stream group investigation, California, held by, the Kern County Water Agency in Lamont, California, 9 July 1979
- ADB344302 • Initial appraisal Sacramento River Flood control project (Glenn-Colusa), California, 10 February 1989
- ADB344485 • Report on November-December 1950 floods Sacramento-San Joaquin river basins, California and Truckee, Carson, and Walker rivers, California and Nevada, March 1951
- ADB344268 • Reexamination Little Dell Lake, Utah, February 1984
- ADB344197 • Special report fish and wildlife plan Sacramento River bank protection project, California, first phase, July 1979
- ADB344264 • Programmatic environmental impact statement/environmental impact report Sacramento River flood control system evaluation, phases II-V, May 1992
- ADB344201 • Hydrology office report Kern river, California, January 1979
- ADB344198 • Kern River – California aqueduct intertie, Kern county, California, environmental statement, February 1974
- ADB344213 • Sacramento river Chico Landing to Red Bluff, California, bank protection project, final environmental statement, January 1975
- ADB344265 • Cottonwood Creek, California, Information brochure on selected project plan, June 1982
- ADB344261 • Sacramento river flood control project Colusa Trough Drainage Canal, California, office report, March 1993
- ADB344343 • Detailed project report on Kern River-California aqueduct intertie, Kern County, California, February 1974

- ADB344267 Sacramento River Flood Control Project, California, Right Bank Yolo Bypass and Left Bank Cache Slough near Junction Yolo Bypass and Cache Slough, Levee construction, General Design, Supplement No. 1 to Design Memorandum #13, May 1986
- ADB344246 Redbank and Fancher Creeks, California, General Design Memorandum #1, February 1986
- ADB344260 Cache Creek Basin, California, Feasibility report and environmental statement for water resources development Lake and Yolo counties, California, February 1979
- ADB344199 Sacramento River Deep Water Ship channel, California, Feasibility report and environmental impact statement for navigation and related purposes, July 1980
- ADB344263 Sacramento River flood control project, California, Mid-Valley area, phase III, Design Memorandum, Vol. I or II, June 1986
- ADB344262 Marysville Lake, Yuba River, California, General Design Memorandum Phase I, Plan Formulation, Preliminary Report, Appendixes A-N, Design Memorandum #3, March 1977

The **distribution statement is A** approved for public release; distribution is unlimited.

The Sacramento District source code is **410637**. Please return any materials that aren't appropriate for the technical reports database.

Please acknowledge receipt of shipment by sending email message to Frances.J.Sweeney@usace.army.mil.

Thank you,

Frances J. Sweeney
Library Manager
USACE, Sacramento District Library
916-557-6660