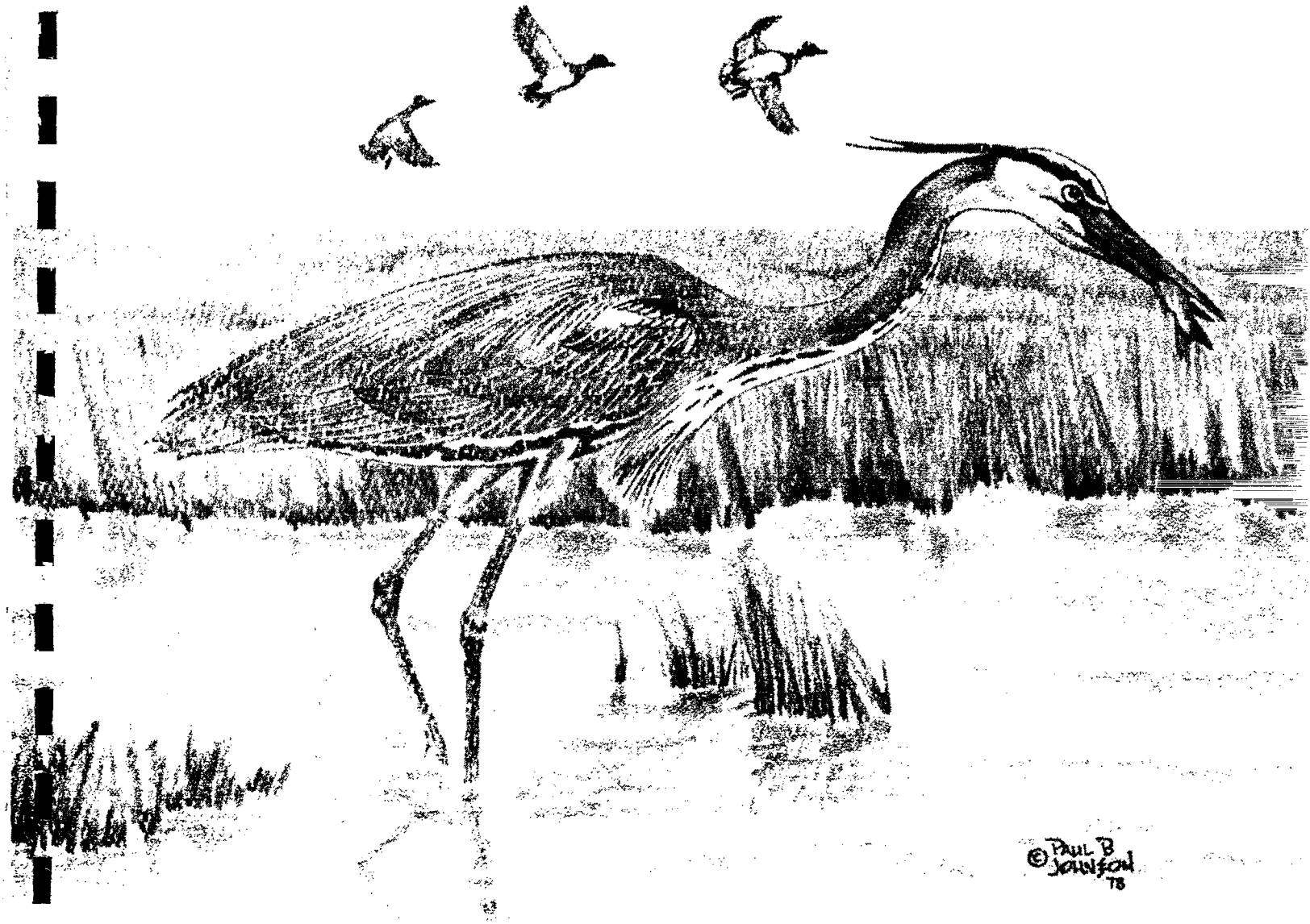
STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES

# PLAN OF PROTECTION FOR THE SUISUN MARSH including ENVIRONMENTAL IMPACT REPORT




Central District
February 1984

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# PLAN OF PROTECTION FOR THE SUISUN MARSH

## including

# ENVIRONMENTAL IMPACT REPORT

Central District

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## FOREWORD

Suisun Marsh is located in southern Solano County, just beyond the confluence of the Sacramento and San Joaquin rivers. The Marsh represents over 10 percent of California's remaining wetland area, and is one of the largest contiguous brackish water marshes in the United States.

In August 1978, the State Water Resources Control Board issued Water Right Decision 1485, which established conditions for the permits of the U. S. Bureau of Reclamation for the Central Valley Project and of the California Department of Water Resources for the State Water Project. Order No. 7 of Decision 1485 provides for protection of the Marsh and requires the permittees to develop a plan, in cooperation with other agencies, that will ensure that water quality standards adopted by the Board for full protection of the Marsh are met. Such a plan must be satisfactory to the Board and include appropriate environmental documentation, a monitoring network, physical facilities, operating and management procedures, and assurances to restore and maintain Suisun Marsh primarily as a brackish water marsh capable of producing high quality feed and habitat for waterfowl and other marsh-related wildlife when suitable management practices are followed.

This report sets forth a plan prepared in response to Order No. 7, including a final Environmental Impact Report (EIR). Because many of the details of the Plan have not yet been put into final form, a program EIR format has been used. The EIR will be used when decisions are made to proceed with particular facilities or components of the Plan of Protection.

James U. McDaniel, Chief
Central District



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CONTENTS


| | Page |
|---|---|
| FOREWORD | iii |
| SUMMARY | 1 |
| Delta Outflow | 1 |
| Physical Facilities | 1 |
| Monitoring Program | 2 |
| Management Program | 2 |
| Environmental Documentation | 4 |
| Chapter 1. INTRODUCTION | 7 |
| Chapter 2. RELATED STUDIES AND ACTIONS | 19 |
| Soil-Water-Salt Relationship in Suisun Marsh | 19 |
| Legislative and Administrative Action | 20 |
| Waste Water Reuse for Marsh Management | 21 |
| Conclusions | 22 |
| Recommendations | 24 |
| Chapter 3. RESOURCES AND REQUIREMENTS | 27 |
| Soils | 27 |
| Water Resources | 28 |
| Salinity | 30 |
| Turbidity | 36 |
| Chlorophyll *a* | 37 |
| Dissolved Oxygen | 38 |
| Biological Resources | 38 |
| Vegetation and Flora | 39 |




C—053615

C-053615

Page

Fish . . . . . 41
Wildlife . . . . . 42

Rare and Endangered Species . . . . . 45

Recreation . . . . . 46

General Water Requirements . . . . . 47

Water and Soil Salinity Requirements . . . . . 48

Levee Maintenance Requirements . . . . . 50

Mosquito Abatement Requirements . . . . . 51

Chapter 4. PLAN OF PROTECTION ALTERNATIVES . . . . . 53

Alternative Plans . . . . . 53

No-Action Plan . . . . . 53
Nonstructural Plan . . . . . 53
Overland Supply Plan . . . . . 56
Combination Plan . . . . . 59

Alternative Water Sources . . . . . 61

Sacramento River Basin . . . . . 61
Solano County Treated Waste Water . . . . . 67
Contra Costa County Waste Water . . . . . 70
San Joaquin Valley Agricultural Drainage . . 70

Chapter 5. FACILITIES AND WATER SUPPLY FOR COMBINATION PLAN . . . . . 73

Facilities . . . . . 79

Montezuma Slough Control Structure . . . . . 80

Roaring River Slough Distribution System . . . . . 89

Grizzly Island Distribution System . . . . . 93

Potrero Hills Ditch . . . . . 93

Goodyear Slough Facilities . . . . . 96

Boynton-Cordelia Ditch . . . . . 99

Lower Joice Island . . . . . 103



C—053616

C-053616

Page

Cygnus Area . . . . . 103

Annie Mason Island . . . . . 103

Overall Facilities . . . . . 103

Water Supply . . . . . 103

Chapter 6. MANAGEMENT . . . . . 107

Chapter 7. MONITORING PROGRAM . . . . . 109

Monitoring Program Participation . . . . . 110

Channel Water Quality . . . . . 110

Diversion Water Quality . . . . . 111

Water Level Recorders . . . . . 111

Soil Water Salinity . . . . . 111

Plant and Wildlife Survey . . . . . 114

Reports . . . . . 114

Chapter 8. IMPLEMENTATION SCHEDULE . . . . . 117

Chapter 9. ENVIRONMENTAL IMPACT REPORT, PLAN OF PROTECTION, SUISUN MARSH PHYSICAL FACILITIES 123

Environmental Impact Report Summary . . . . . 123

Purpose of the Plan of Protection . . . . . 123
Project Description . . . . . 123
Environmental Impacts . . . . . 124
Alternatives . . . . . 125
Area of Controversy . . . . . 128
Issues to be Resolved . . . . . 130

Description and Use of the EIR . . . . . 132

Related Environmental Documentation . . . . . 133

Water Quality Standards . . . . . 133
Management Plans . . . . . 134
Monitoring Program . . . . . 134
Physical Facilities . . . . . 134



C—053617

C-053617

| | Page |
|---|---|
| Description of Project Facilities | 135 |
| Environmental Setting | 135 |
| General Environmental Effects of Proposed Actions | 137 |
| Construction | 137 |
| Construction Staging | 137 |
| Land | 140 |
| Water Resources | 141 |
| Water Quality | 141 |
| Recreation | 145 |
| Fish | 145 |
| Flora | 148 |
| Wildlife | 149 |
| Air Quality | 151 |
| Scour and Sedimentation | 151 |
| Seepage | 151 |
| Navigation | 152 |
| Esthetics | 152 |
| Historical, Archeological, and Cultural Resources | 153 |
| Access | 153 |
| Energy | 153 |
| Utilities | 154 |
| Turbidity | 154 |
| Socioeconomic Factors | 154 |
| Vectors | 154 |
| Excavation Spoil and Fill | 155 |
| Effects of Individual Facilities | 156 |
| Montezuma Slough Control Structure | 156 |
| Grizzly Island Distribution System | 161 |
| Potrero Hills Ditch | 163 |
| Cordelia-Goodyear Ditch and Goodyear Slough Control Structure | 164 |
| Boynton-Cordelia Ditch | 166 |
| Unavoidable Adverse Environmental Effects and Compensation Measures | 168 |
| Aquatic Habitat | 169 |
| Marsh and Upland Habitat | 169 |
| Alternatives | 173 |
| No Action Plan | 173 |
| Nonstructural Plan | 173 |
| Overland Supply Plan | 174 |



C—053618

C-053618

Page

Relationship Between Local Short Term Uses of the Environment and the Maintenance and Enhancement of Long Term Productivity . . . . . 174

Significant Environmental Changes, Growth Inducing Impacts . . . . . 175

Consultation . . . . . 175

Report Preparation . . . . . 176

Appendix A CONTRACT ON INITIAL FACILITIES BETWEEN DEPARTMENT OF WATER RESOURCES, DEPARTMENT OF FISH AND GAME, AND SUISUN RESOURCE CONSERVATION DISTRICT

Appendix B MONITORING PROGRAM METHODOLOGY

Appendix C WATER RIGHTS DECISION 1485

Appendix D BIOLOGICAL ASSESSMENT OF THE IMPACTS OF THE SUISUN MARSH MANAGEMENT PLAN (DFG for USBR)

Appendix E SECTION 7 DETERMINATION, SUISUN MARSH MANAGEMENT STUDY, SOLANO COUNTY, CALIFORNIA

Appendix F AQUATIC RESOURCES OF SUISUN MARSH WITH AN ANALYSIS OF THE FISHERY EFFECTS OF A PROPOSED WATER QUALITY MAINTENANCE PLAN (Alan Baracco)

Appendix G CALIFORNIA BLACK RAIL BREEDING SEASON SURVEY IN CENTRAL CALIFORNIA (Timothy D. Manolis)

Appendix H STUDY OF THE SALT MARSH HARVEST MOUSE IN SUISUN BAY, CALIFORNIA (Howard S. Shellhammer)

Appendix I ENDANGERED AND THREATENED WILDLIFE, CALIFORNIA CLAPPER RAIL (Thomas E. Harvey)

Appendix J PROCEDURE FOR DETERMINING MITIGATION FOR CHANNEL ISLAND WATERFOWL FOOD PRODUCTION

Appendix K ENDANGERED AND RARE PLANTS SURVEY (Stephen P. Rae)

Appendix L LETTER ON RECOMMENDED MITIGATION ALTERNATIVE FOR THE SUISUN MARSH PLAN OF PROTECTION

Appendix M RECREATION PLAN

Appendix N FLORA OF THE SUISUN MARSH AREA



C—053619

C-053619

Appendix O SUMMARY OF COMMENTS ON PLAN OF PROTECTION FOR THE SUISUN MARSH INCLUDING DRAFT ENVIRONMENTAL IMPACT REPORT, DATED SEPTEMBER 1980

Page

## Figures


| | | |
|---|---|---|
| A | Suisun Marsh Physical Facilities . . . . . | 3 |
| B | Suisun Marsh Service Areas . . . . . | 5 |
| 1 | Suisun Marsh Location Map . . . . . | 9 |
| 2 | Water Quality Frequency Distribution, Sacramento River at Collinsville (Without CVP and SWP) . . . | 13 |
| 3 | Water Quality Frequency Distribution at Mouth of Suisun Slough (Without CVP and SWP) . . | 14 |
| 4 | Water Quality Frequency Distribution, Sacramento River at Collinsville (With CVP and SWP Operating Under March 1978 SWRCB Draft Standard) . . . . | 15 |
| 5 | Water Quality Frequency Distribution at Mouth of Suisun Slough (With CVP and SWP Operating Under March 1978 SWRCB Draft Standard) . . . . | 16 |
| 6 | Water Quality Frequency Distribution, Sacramento River at Collinsville (With CVP and SWP Operating Under Basin Plan 2 and 4-Agency Fish Agreement) . | 17 |
| 7 | Water Quality Frequency Distribution at Mouth of Suisun Slough (With CVP and SWP Operating Under Basin Plan 2 and 4-Agency Fish Agreement) . | 18 |
| 8 | Salinity Monitoring Stations . . . . . | 31 |
| 9 | Salinity Levels at Mean High-High Tide with Delta Outflow Index of 5,800 $ft^3/s$ . . . . . | 32 |
| 10 | Salinity Levels at Mean High-High Tide with Delta Outflow Index of 14,300 $ft^3/s$ . . . . . | 33 |
| 11 | Average Monthly Range of Salinity vs Delta Outflow at Station S-42 in Interior Marsh . . . . . | 35 |
| 12 | Pintails in Central Valley and Suisun Marsh . . . | 43 |
| 12a | Economic Impact of Acreage Taken Out of Production. | 57 |
| 13 | Suisun Marsh Alternative Water Sources . . . . | 63 |




C—053620

C-053620

| | | Page |
|---|---|---|
| 14 | Treated Waste Water Subareas | 65 |
| 15 | Waste Water | 69 |
| 16 | Combination Plan Physical Facilities | 75 |
| 17 | Suisun Marsh Without Management Facilities | 76 |
| 18 | Suisun Marsh With Management Facilities | 77 |
| 19 | Montezuma Slough Control Structure and Roaring River Slough Distribution System Intake | 81 |
| 20 | Location Map, Montezuma Slough Control Structure | 82 |
| 21 | Overall Plan, Montezuma Slough Control Structure | 83 |
| 22 | Slough Closure, Montezuma Slough Control Structure | 84 |
| 23 | Control Structure (Boat Lock), Montezuma Slough Control Structure | 85 |
| 24 | Control Structure, Montezuma Slough Control Structure | 86 |
| 25 | Roaring River Slough Distribution System | 91 |
| 26 | Roaring River Slough Intake Structure | 92 |
| 27 | Grizzly Island Distribution System | 94 |
| 28 | Potrero Hills Ditch | 95 |
| 29 | Goodyear Slough Facilities | 98 |
| 30 | Vallejo Wastewater Delivery Plan | 100 |
| 31 | Boynton-Cordelia Ditch | 101 |
| 32 | Monitoring Plan | 113 |
| 33 | Implementation Schedule - Suisun Marsh Facilities | 121 |

## Tables

| | | |
|---|---|---|
| 1 | Inventory of Water Quality in the Suisun Marsh | 29 |
| 2 | Historical Delta Outflow-Associated Electrical Conductivity and Total Dissolved Solid Values for Suisun Marsh and Suisun Bay | 34 |



C—053621

C-053621

| | | Page |
|---|---|---|
| 3 | Turbidity Measurements in Suisun Marsh and Suisun Bay at Various Delta Outflows . . . . . | 36 |
| 4 | Chlorophyll Levels in Suisun Marsh and Suisun Bay for Various Outflow Ranges . . . . . | 37 |
| 5 | Rare and Endangered Species that Inhabit the Suisun Marsh Area . . . . . | 45 |
| 6 | Summary of Recreation Benefits for Suisun Marsh . | 46 |
| 7 | Soil Salinity Tolerances of Marsh Plant Species . | 48 |
| 8 | Typical Schedule for Operating Montezuma Control Structure as a Tide Gate . . . . . | 88 |
| 9 | Suisun Marsh Details of Overall Facilities . . . | 102 |
| 10 | Change in Habitat with Marsh Facilities . . . . | 127 |



C—053622

C-053622

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The Resources Agency
DEPARTMENT OF WATER RESOURCES

CENTRAL DISTRICT

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United States Bureau of Reclamation
United States Fish and Wildlife Service
California Department of Fish and Game
California Department of Water Resources

Cover drawing courtesy of
California Department of Fish and Game

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## SUMMARY

This report presents a Plan of Protection to mitigate the effects of the Federal Central Valley Project (CVP) and the State Water Project (SWP) on the Suisun Marsh. The State Water Resources Control Board (SWRCB), in Water Right Decision 1485 of August 18, 1978, set specific water quality standards for the Marsh. The U. S. Bureau of Reclamation (USBR) and the California Department of Water Resources (DWR) were directed to meet the water quality standards by October 1, 1984. Participation of both USBR and DWR is required before the full implementation of the Plan of Protection can be achieved.

The Plan of Protection is a proposal to maintain water quality criteria in the Marsh. Major categories dealt with in the Plan are: Delta outflow, physical facilities, a monitoring program, a management program, and an environmental impact report.

### Delta Outflow

Outflow from the Sacramento and San Joaquin rivers, supplemented by project releases, would provide the required quality of water in the Sacramento River at Collinsville for circulation through the Marsh. This plan presumes that the CVP and SWP will jointly share in these project releases.

### Physical Facilities

A series of control structures and new or enlarged channels (Figure A), as needed, would distribute quality water available at Collinsville throughout the Marsh. These facilities would move water from east to west and also from north to south. The control structure located near the eastern end of Montezuma Slough would be the foremost facility. Between October and June, in years when meeting the marsh water quality criteria requires water of a better quality than is normally circulating in the sloughs, this structure would tidally pump water from the Sacramento River near Collinsville through Montezuma Slough for further distribution throughout the Marsh by the new and enlarged channels.

The control structures would be channel closures of one or more of the following types:

- Culverts having flap gates and/or slide gates.
- Radial gates.
- Radial gates with boat lock and flashboard opening.
- Boat-lock-type vertical gate "doors".



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The channels would be dredged or "draglined" and would carry water to specific areas to improve quality in interior marsh channels and replace diversions from Suisun, Grizzly, and Honker bays. Fish screens would be installed as part of the diversion facilities for Roaring River Slough and the Grizzly Island Distribution System. Screens may also be required for Goodyear Slough facilities. Figure B shows the areas to be served.

The total cost of the facilities, including planning, right of way, design, construction, and mitigation costs, was estimated at about $118 million in 1982 dollars, plus operation, maintenance, and replacement costs.

The facilities are being constructed in two phases: Initial Facilities and Overall Facilities. The Initial Facilities, which consist of Roaring River Slough, Morrow Island Distribution System, and the Goodyear Slough Outfall, became operational in 1981.

The Overall Facilities include the Initial Facilities plus two control structures, a distribution system, and three conveyance ditches. The Overall Facilities can not be completed by the October 1, 1984, deadline provided in Decision 1485. The estimated earliest possible completion date is October 1988. However, as an alternative it is proposed to construct the facilities in stages, completing construction by about 1998. This will allow DWR to test the performance of units against model predictions to verify the need for and proper design of subsequent units.

DWR believes its participation in implementing the Plan of Protection should be limited to that necessary to mitigate SWP impacts on the Marsh, estimated to be 50 percent of the total cost of the Plan. It is expected that construction of the USBR portion of the facilities will occur when USBR funds and authorization are obtained. The Montezuma Slough Control Structure will be the first unit of the Overall Facilities to be constructed, as originally planned.

## Monitoring Program

The monitoring program will provide water and soil salinity data from selected locations throughout the Marsh. It will relate to the electrical conductivity of the applied water, soil electrical conductivity data, plant production, and changes in the marsh habitat. It is expected that the basic program will be modified after several years of data collection, as project objectives shown by the modeling program are achieved.

## Management Program

While the Plan of Protection will assure that adequate quality water will be available, the overall health of the Marsh



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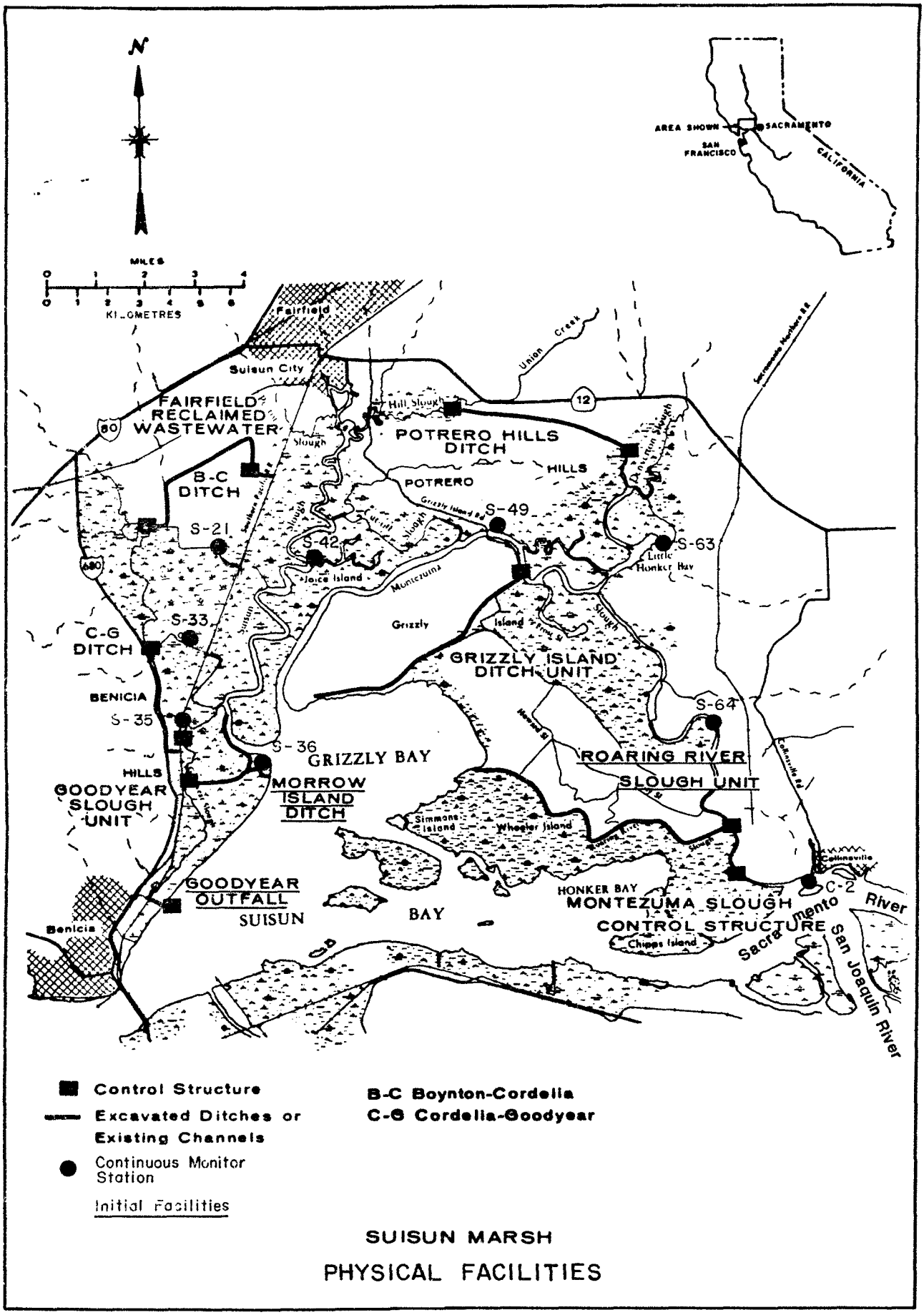
FIGURE A




SUISUN MARSH

PHYSICAL FACILITIES

can be assured only with the cooperation of marsh landowners. To obtain that cooperation, the Suisun Resource Conservation District (SRCD), the Department of Fish and Game (DFG), and the U. S. Soil Conservation Service (SCS) have prepared regulations and a management program for the Marsh as a whole and management plans for each individual private land ownership.

## Environmental Documentation

The environmental documentation covers the impacts of all phases of the Plan of Protection. The supplemental outflow for salinity protection was analyzed in the final environmental impact report prepared by the State Water Resources Control Board for Decision 1485, dated August 1978. The impacts of the Initial Facilities were covered in an initial study and a negative declaration prepared by DWR in October 1978.

The environmental impacts of the remaining portions of the Plan of Protection are analyzed in a program environmental impact report (EIR) that appears as Chapter 9 in this plan. DWR prepared a program EIR because the Plan of Protection and the physical facilities will not all be carried out at the same time. The Plan calls for a number of separate actions to be carried out by different agencies to protect existing environmental conditions in the Marsh. The EIR provides detailed analysis of the effects of the access road to the Montezuma Slough Control Structure and of the control structure itself, because those facilities would be constructed in the near future. The details of their construction are well worked out and their impacts are susceptible to full analysis.

The Plan calls for a pause for monitoring and evaluation before other facilities are constructed. The monitoring and evaluation will be used to validate the analysis presented in the EIR and the accuracy of the projections from the computer model. The information will be used to determine whether alterations should be made in any of the physical facilities and possibly to determine whether particular followup facilities will be needed at all. Because the details of these later facilities are subject to change, their impacts have been analyzed in more general terms.

Several other aspects of the Plan of Protection are not yet in final form. Negotiations are still proceeding between the DWR and the USBR concerning USBR's role in the Plan of Protection. Individual land management plans are being developed by the SRCD and SCS. After the plans have been developed, they will be submitted to DFG for approval and to the San Francisco Bay Conservation and Development Commission (BCDC) for endorsement. There may be petitions by DWR to SWRCB concerning water quality requirements.



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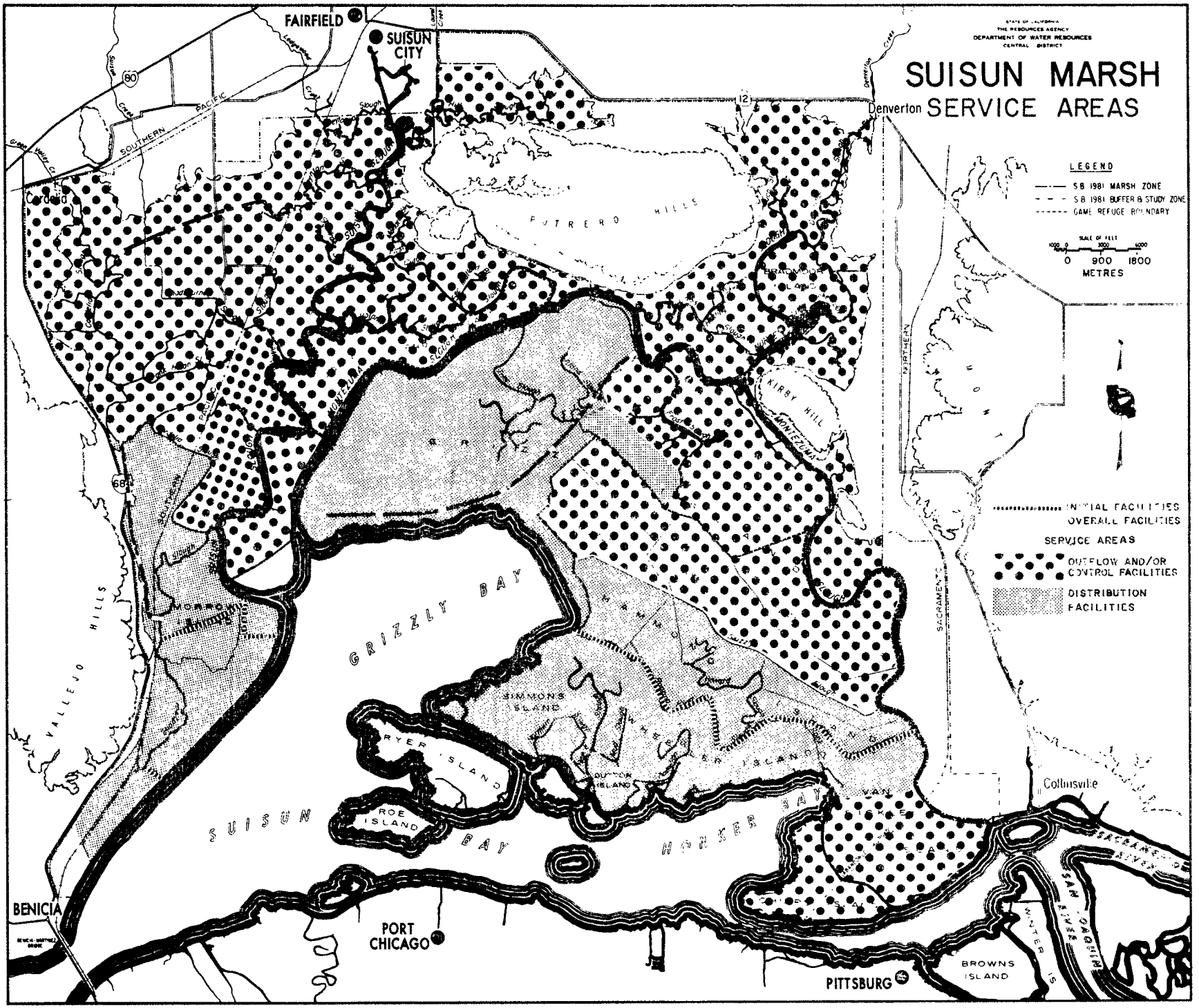


FIGURE B

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This program EIR discusses the possible environmental effects of these various activities as they can be forseen at this time. Where there is a range of reasonable alternatives available at these different decision points, the EIR identifies those alternatives and their likely environmental consequences to the degree that they can be reasonably foreseen at this time.

DWR will review the later activities in the light of the program EIR to determine whether an additional environmental document will need to be prepared. If the later activity would have environmental effects that were not examined in the program EIR, a new initial study would be prepared leading either to an EIR or to a negative declaration focusing on the particular effect that had not been analyzed in the program EIR. If DWR determines that there would be no new significant environmental effect or that there would be no new feasible alternatives or mitigation measures available that would substantially lessen any of the remaining significant effects of the project, DWR could approve the particular component of the plan as being within the scope of the program EIR. In such a circumstance, no new environmental documentation would be required.

With each commitment to a part of the Plan of Protection or its physical facilities, DWR will review the EIR and any supplement and consider adopting mitigation measures or alternatives it determines to be feasible to substantially lessen the significant effects of the overall program or the particular component.



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# Chapter 1. INTRODUCTION

In August 1978, the State Water Resources Control Board (SWRCB) issued Water Right Decision 1485, which established updated conditions for the permits of the U. S. Bureau of Reclamation (USBR) for the Central Valley Project (CVP) and the State Department of Water Resources (DWR) for the State Water Project (SWP). Conditions for permits related to Suisun Marsh are stated in Order No. 7 as follows:

> For the protection of the Suisun Marsh, permittees shall:
>
> (a) Develop a plan for Suisun Marsh by July 1, 1979, in cooperation with other agencies which will ensure that the standards in Table II for full protection of the Marsh are met. Such plan must be satisfactory to the Board and shall include appropriate EIR/EIS documentation, a monitoring network, physical facilities, operating and management procedures, and assurances to restore and maintain Suisun Marsh primarily as a brackish water marsh capable of producing high quality feed and habitat conditions for waterfowl and other marsh-related wildlife using best practical management practices.
>
> (b) Implement fully such Suisun Marsh plan by October 1, 1984. Under this plan, water quality standards for full protection of Suisun Marsh shall be met by no later than October 1, 1984.
>
> (c) Implement initial components of the Suisun Marsh Plan, on which there is general agreement by affected parties, to achieve the following goals by January 1, 1980:
>
> - Conveyance and delivery of water from Montezuma Slough to wetland areas on Grizzly, Simmons, Wheeler, Dutton, Van Sickle, and Hammond Islands which are presently flooded with water from Honker, Suisun, and Grizzly Bays.
>
> - Conveyance and delivery of water from Goodyear Slough to certain adjacent wetland areas and provision of outflow from Goodyear Slough into either Grizzly or Suisun Bays.



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(d) Report to the Board by January 15 of each year on progress toward implementation of mitigation facilities.

The purpose of this report is to present the Plan of Protection for the Suisun Marsh.* The Plan was written by DWR, based on information gathered by DWR and USBR in cooperation with the Suisun Marsh Technical Committee of the 4-Agency Ecological Study Program, which includes the U. S. Fish and Wildlife Service (FWS), the California Department of Fish and Game (DFG), DWR, and USBR.

This report describes the Marsh, its needs, the Plan developed pursuant to Order 7(a), alternatives, and environmental impacts of the Plan.

Suisun Marsh is located in southern Solano County, beyond the confluence of the Sacramento and San Joaquin rivers, as shown in Figure 1. The Marsh represents over 10 percent of California's remaining wetland and is one of the largest contiguous brackish water marshes in the United States. The Marsh, a major wintering ground for waterfowl of the Pacific Flyway, has provided a feeding and resting area for up to 28 percent of California's waterfowl during the autumn of low rainfall years.

The Marsh was formed by silt deposits from the overflow water of Suisun and Montezuma sloughs and the Sacramento and San Joaquin rivers and also from a buildup of peat soils. The brackish water quality within the Marsh is influenced by both saltwater tidal cycles and freshwater outflow from the Sacramento and San Joaquin rivers. The managed wetlands of the Marsh are diked so that the effects of daily tidal fluctuations can be controlled. Large portions of the undiked area are submerged daily. Parts of higher ground are flooded by seasonal high tides.

Suisun Marsh is subject to annual intrusion of saline water from San Francisco Bay. The hydraulic barrier provided by the variable freshwater outflow from the Sacramento-San Joaquin Delta historically limited salinity intrusion to short periods during dry summer months in most years. Development of Suisun Marsh for agriculture began on a small scale in the 1850s, when low sod levees were built, and continued into the 1880s, when a complete levee system protected much of the land from normal tidal flooding. Suisun Marsh lands were used for growing various cereal grains and row crops plus dairy and beef cattle.

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* Decision 1485, Order 7(a), required this report by July 1, 1979. SWRCB granted an extension to October 1, 1979. The initial draft of this report was presented to SWRCB on September 27, 1979.



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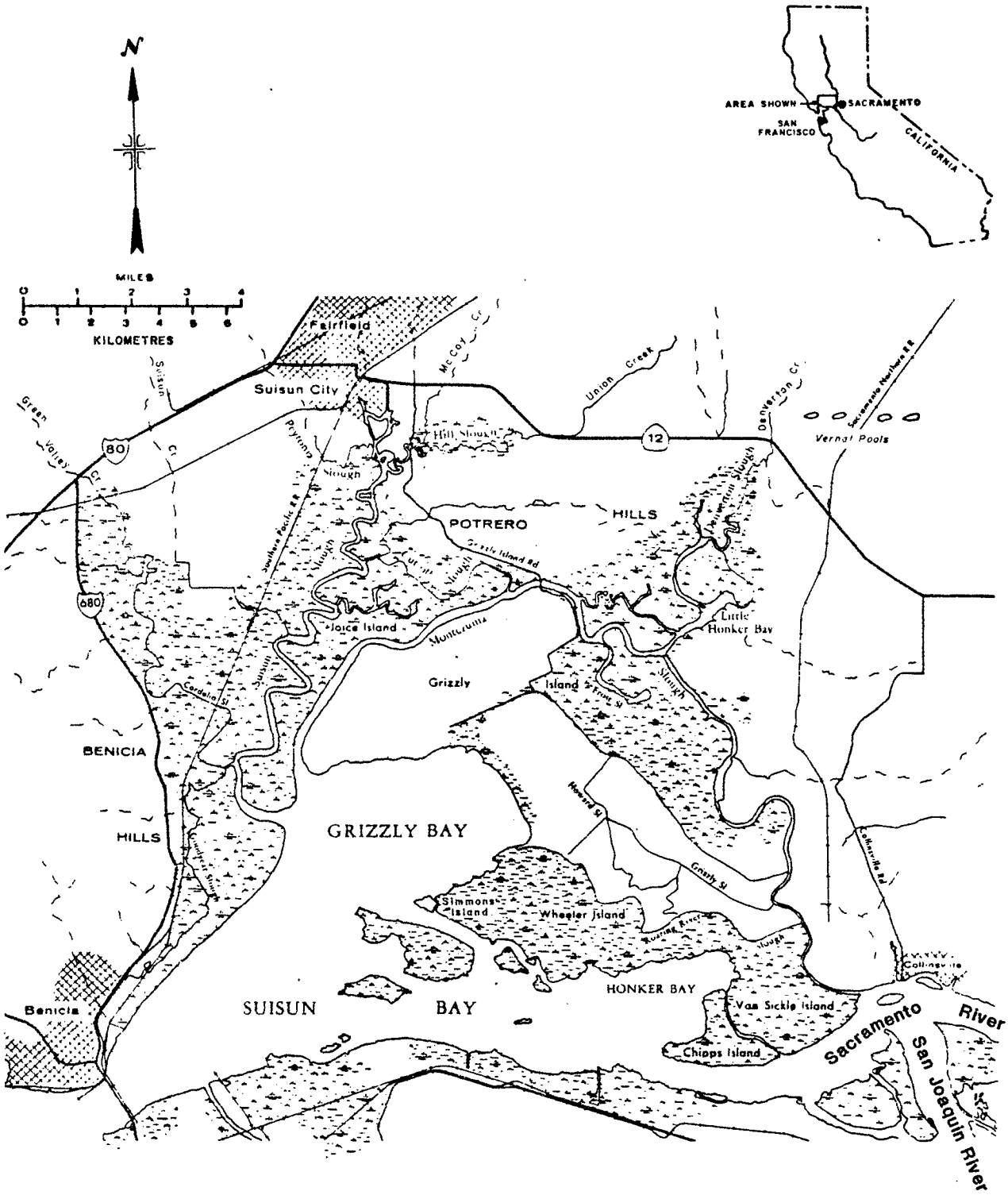
FIGURE 1




SUISUN MARSH

**LOCATION MAP**

During the early 1900s, upstream water diversions markedly reduced Delta outflows and allowed more salinity intrusion. By the early 1930s, the annual summer saline intrusion period had lengthened to the point where commercial farming became impractical, and the farms were converted to managed wetlands for waterfowl habitat. Because of poor drainage and the accumulation of salts in heavy soil, commercial agriculture has failed on all but Grizzly Island and high ground in other areas of the Marsh.

The first waterfowl hunting clubs were organized in 1880 after Southern Pacific Railroad completed laying track across the Marsh, making access easier. In the 1930s, about 28,000 acres of the Marsh were being used for organized waterfowl hunting.

Since the 1930s, the continued increase in upstream diversions has further reduced Delta outflows, and the duration of salinity intrusion into the Marsh has increased to a level that threatens waterfowl food plants. The trend is significant because a brackish water marsh, such as the Suisun, is considered to be five times more valuable as waterfowl habitat than is a salt marsh, such as those in San Francisco Bay.

Until recently, Suisun Marsh was little regarded, being an area of light population and of limited agricultural and industrial importance. Its value, which lies mainly in wildlife habitat and as a recreational area, was discounted. The Marsh has only recently been threatened by urban development and highway construction, by contamination from municipal waste disposal, and by destructive encroachment of ocean salinity due to increased upstream diversions. These threats, in combination with an increased awareness of the Marsh's value as a unique wetland area, have prompted interest in protecting the area.

Urban and industrial development in and around the Marsh has been controlled with the passage of Assembly Bill 1717, which added the Suisun Marsh Preservation Act of 1977 to the Public Resources Code. Effects of saltwater intrusion into the Marsh will be controlled in part by implementation of the Plan of Protection proposed in this report.

Ocean salt water intrudes into the bays and sloughs surrounding Suisun Marsh when the freshwater outflow from the Delta falls below the level needed to prevent the tides from carrying salt water upstream from San Pablo Bay. The rate at which water flows out of the Delta is governed by several factors, including seasonal and annual variations in precipitation and runoff in the Central Valley basin. Other factors include physical changes, such as dredging for ship channels and levees, upstream water use, and water imports from or exports to other basins.

To maintain the brackish nature of the Marsh and to ensure the germination of important waterfowl food plants, it is important to have water of the right quality available in late



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winter and early spring to leach accumulated salts out of the soil. Individual landowners oversee the leaching process. The presence of water of too degraded a quality for effective leaching has been a problem only in critically dry years, such as 1976 and 1977, but as Delta outflows have been reduced and altered by increased diversion, use, export, and physical alteration in and above the Delta, the frequency of time when salinity levels in and near the Marsh are high has increased, and this trend will continue.

The CVP and SWP, two of the largest diverters of water, are expected to have an increasingly significant impact on the viability of Suisun Marsh as a brackish waterfowl habitat. The volume of water stored and exported is expected to increase. A significant portion of the water stored by the projects for use in the current year and in later, drier years must be captured in the spring, when the rate of Delta outflow is critical for the Marsh.

DWR is authorized to mitigate its impacts on the Marsh under the Davis-Dolwig Act (Water Code Sections 11900 through 11925), which authorizes DWR to operate the SWP to provide protection and, where feasible, enhancement of fish and wildlife and for recreation to the extent that such features are consistent with other uses of the project. Congressional authorization is needed to facilitate USBR participation in mitigating adverse Marsh impacts caused by operation of the CVP.

In an effort to quantify project effects, a study was made to determine water quality expected at Collinsville and at the mouth of Suisun Slough under present and future water development conditions. The study's purpose was to put marsh conditions into perspective -- with and without project operation -- by determining how often water quality at these sites would be inadequate and the extent of the inadequacy.

The study reveals that without the SWP and the CVP the water quality standards of Decision 1485 would be met at these sites most of the time at the 1980 level of water development (Figures 2 and 3). At the 1980 level of development, including SWP and CVP operation, the study shows overall Delta outflow reduced and regulated. The study projects quality improvement in the fall but some degradation during the critical spring months, when leaching takes place to reduce soil salinities (Figures 4 and 5). At the level of development expected by the year 2000, including SWP and CVP operation, the study shows that Delta outflow would be under control more of the time than in 1980. Water quality at Collinsville would be protected, but violation of the Decision 1485 standards would increase at the mouth of Suisun Slough (Figures 6 and 7).

Chapter 4 discusses the belief of DWR and USBR that protecting the Marsh with Delta outflow alone does not represent a reasonable and beneficial use of water under the California

Constitution (Article X, Section 2). Construction and operation of the physical facilities described in this report appears to be the only practical alternative.

Some of the facilities identified in Order 7(c) of Decision 1485 have been constructed. These facilities, called the Initial Facilities, benefit areas in which salinity intrusion posed an immediate threat. Although the Initial Facilities are helpful, all facilities in the plan may be necessary for full mitigation.

An agreement was signed by DWR and USBR for sharing the cost of the Initial Facilities. The agreement among Suisun Resource Conservation District (SRCD), DFG, and DWR concerning construction, operation, and maintenance of the Initial Facilities is included as Appendix A. SRDC, DFG, DWR and USBR are negotiating a contract to cover construction, operation, and maintenance of the overall facilities and water quality standards for the Marsh. It is USBR's position that it will not be able to enter into such an agreement until authorizing legislation for that purpose is enacted by the Congress. Therefore a bill to that effect presently is being drafted. In the meantime the contract under consideration necessarily only provides for DWR to be responsible for its share of the facilities and water.

The U. S. Bureau of Reclamation prepared a report, "Special Report on the Suisun Marsh Management Plan" (formerly part of Solano County Water Project Feasibility Study), which includes the feasibility of USBR participation in the Plan of Protection. The USBR report is intended to support legislation in Congress to authorize USBR participation. A draft of the report has been reviewed by various State and Federal agencies, interested individuals, and organizations. It was revised to reflect suggestions and comments and was made available for review. It was available for public review in April 1981 and was completed during the first quarter of 1982. The report was sent to the Commissioner in Washington D.C. in July 1982.



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# WATER QUALITY FREQUENCY DISTRIBUTION SACRAMENTO RIVER AT COLLINSVILLE

BASED ON 50 YEARS OF HYDROLOGIC RECORD, 1921-1971 ADJUSTED TO REFLECT 1980 LEVEL OF USE WITHOUT CVP AND SWP

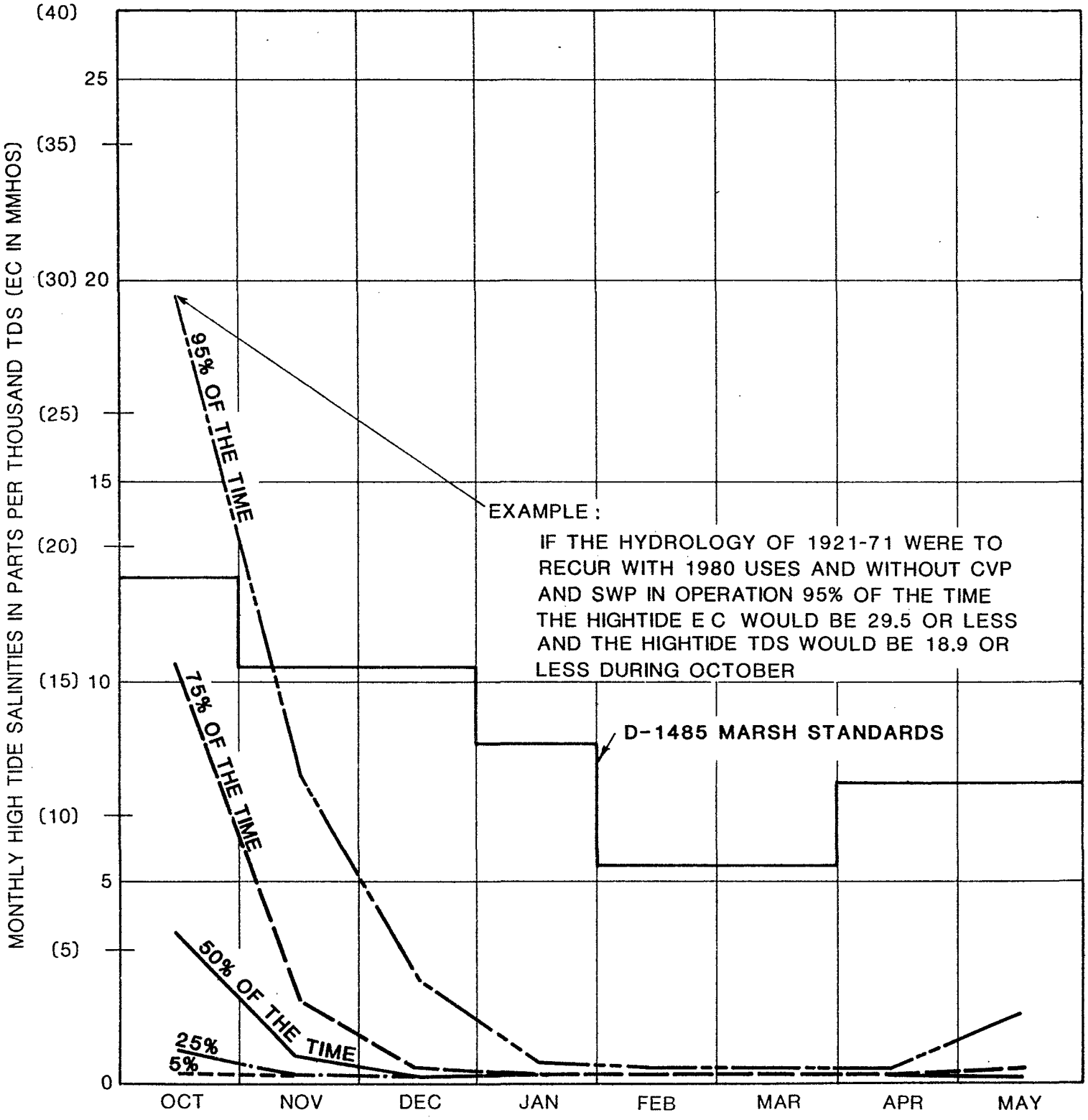
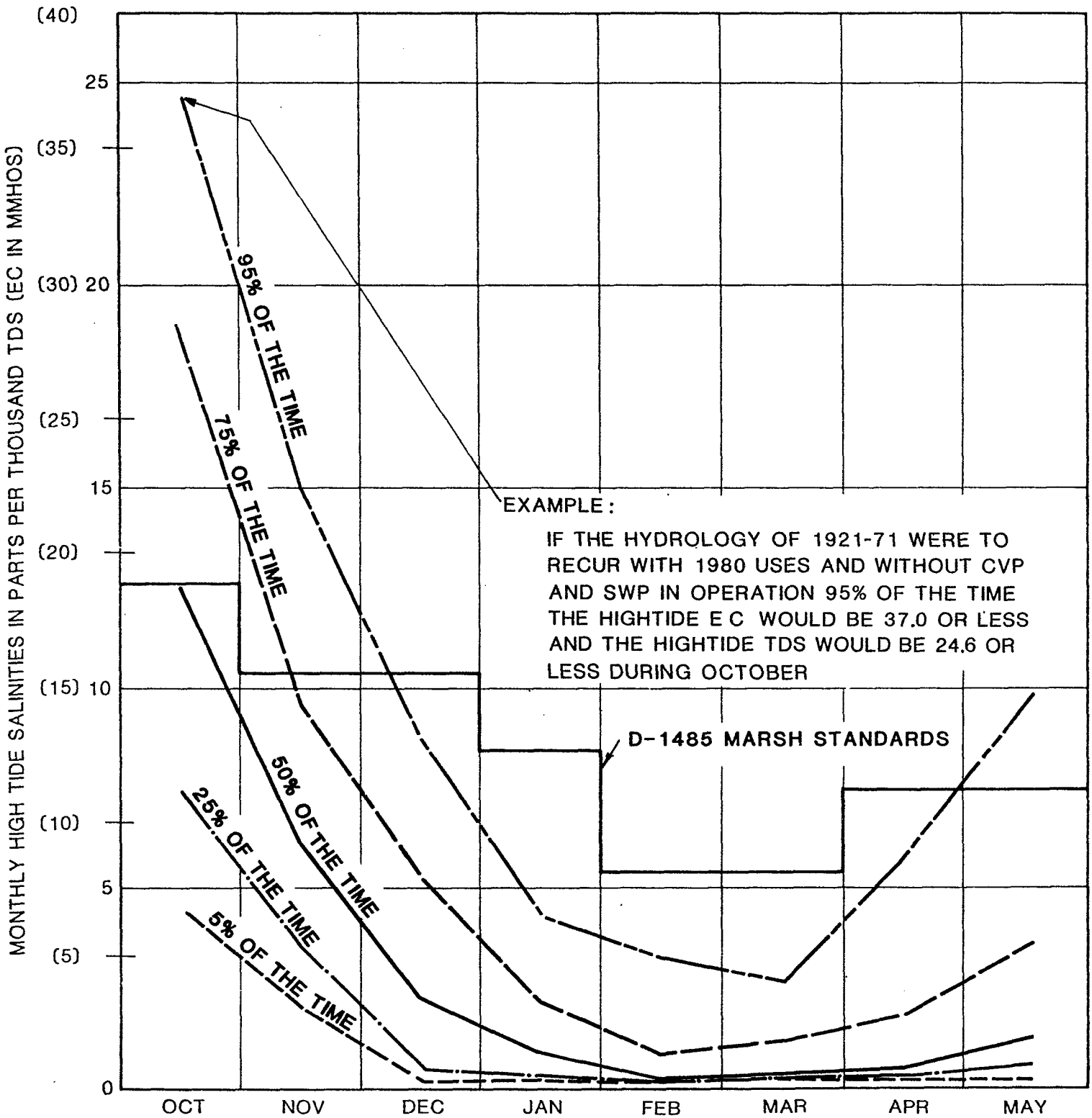


FIGURE 3

# WATER QUALITY FREQUENCY DISTRIBUTION AT MOUTH OF SUISUN SLOUGH

BASED ON 50 YEARS OF HYDROLOGIC RECORD, 1921-1971 ADJUSTED TO REFLECT 1980 LEVEL OF USE WITHOUT CVP AND SWP



# WATER QUALITY FREQUENCY DISTRIBUTION SACRAMENTO RIVER AT COLLINSVILLE

BASED ON 50 YEARS OF HYDROLOGIC RECORD, 1921-1971 ADJUSTED TO REFLECT 1980 LEVEL OF USE WITH CVP AND SWP OPERATING UNDER AUGUST 1978 SWRCB STANDARD

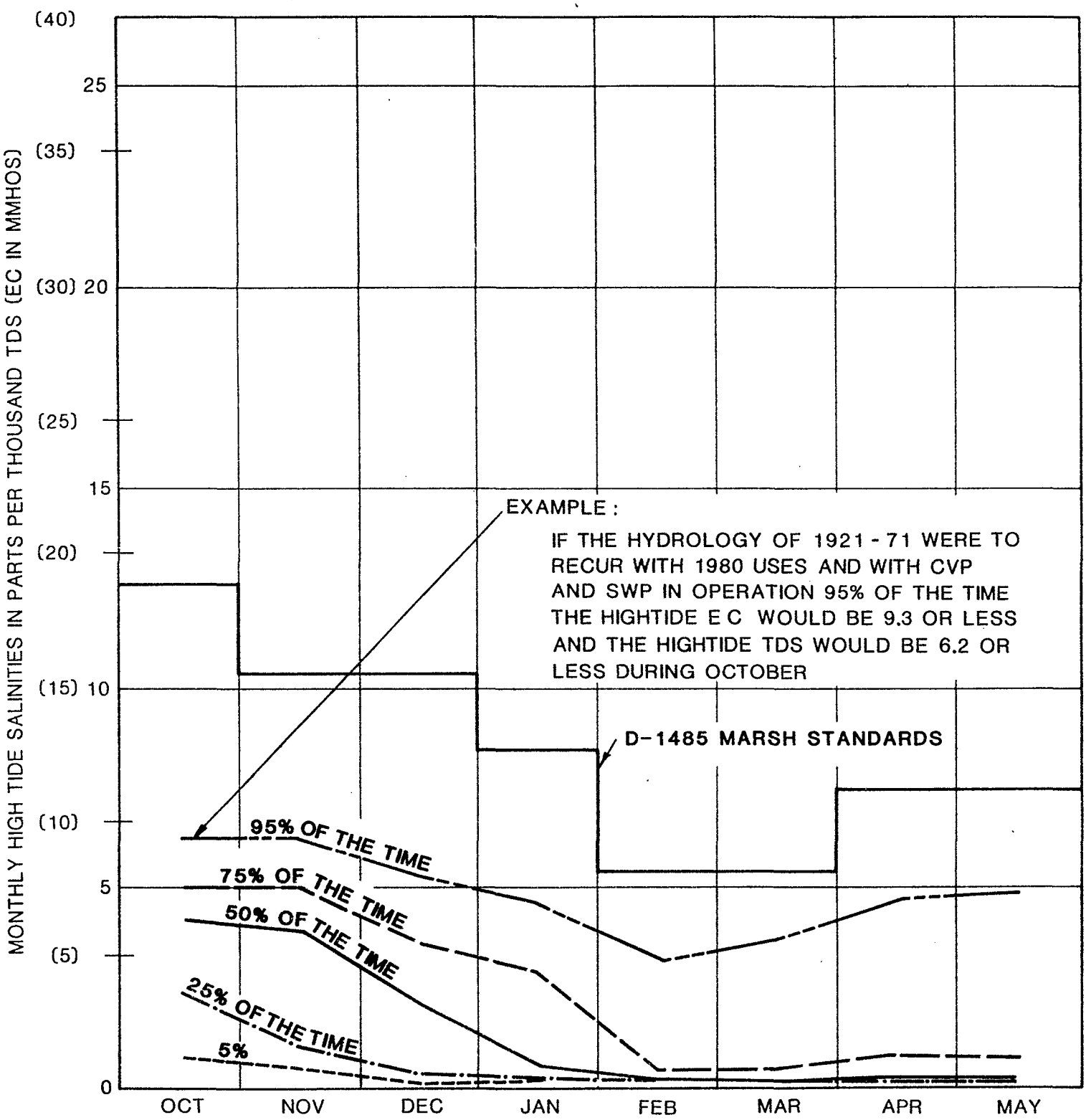
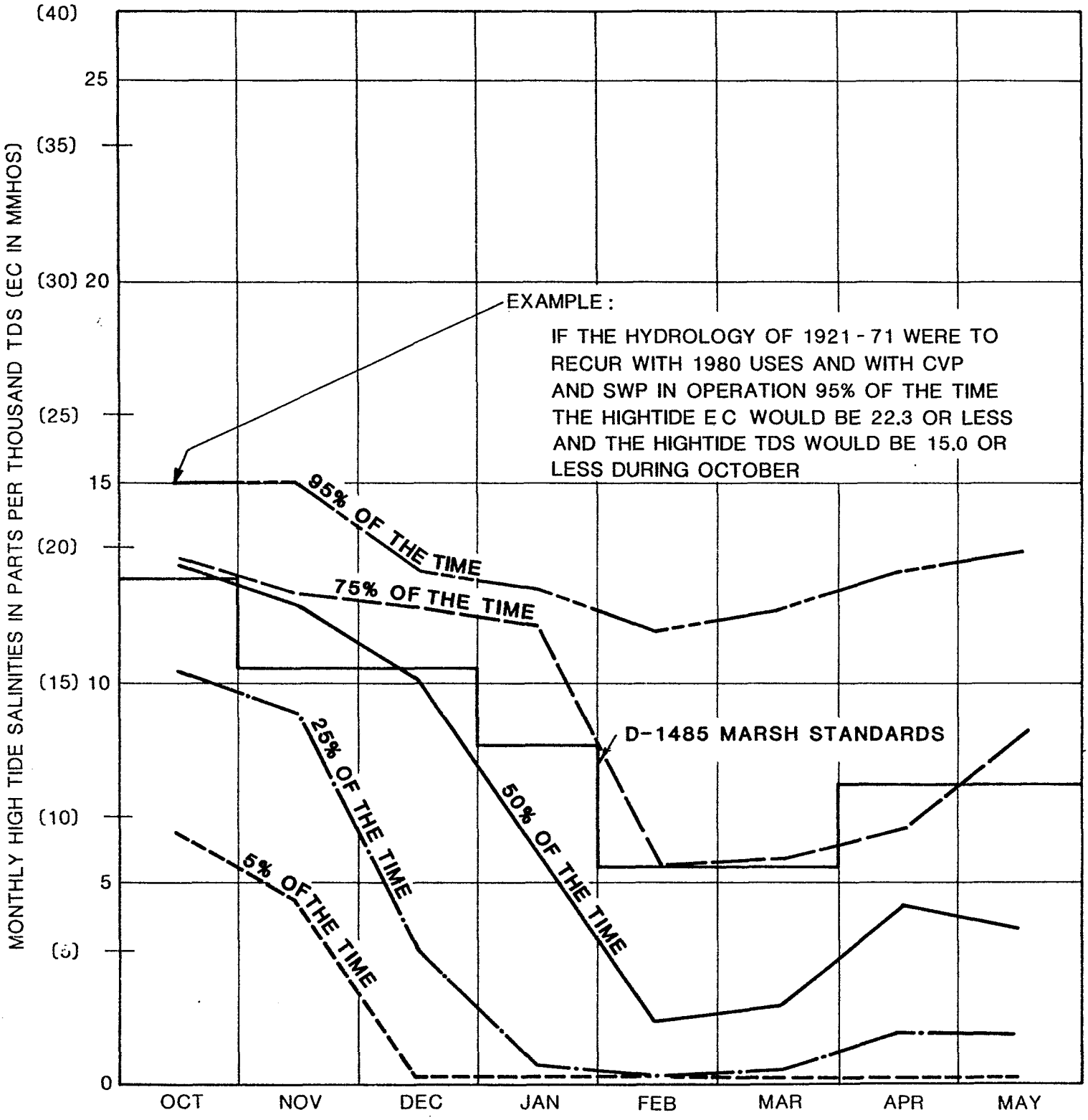


FIGURE 5

# WATER QUALITY FREQUENCY DISTRIBUTION AT MOUTH OF SUISUN SLOUGH

BASED ON 50 YEARS OF HYDROLOGIC RECORD, 1921-1971 ADJUSTED TO REFLECT 1980 LEVEL OF USE WITH CVP AND SWP OPERATING UNDER AUGUST 1978 SWRCB STANDARD





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# WATER QUALITY FREQUENCY DISTRIBUTION SACRAMENTO RIVER AT COLLINSVILLE

BASED ON 50 YEARS OF HYDROLOGIC RECORD, 1921 - 1971 ADJUSTED TO REFLECT 2000 LEVEL OF USE WITH CVP AND SWP OPERATING UNDER BASIN PLAN 2 AGRICULTURE AND 4-AGENCY FISH AGREEMENT

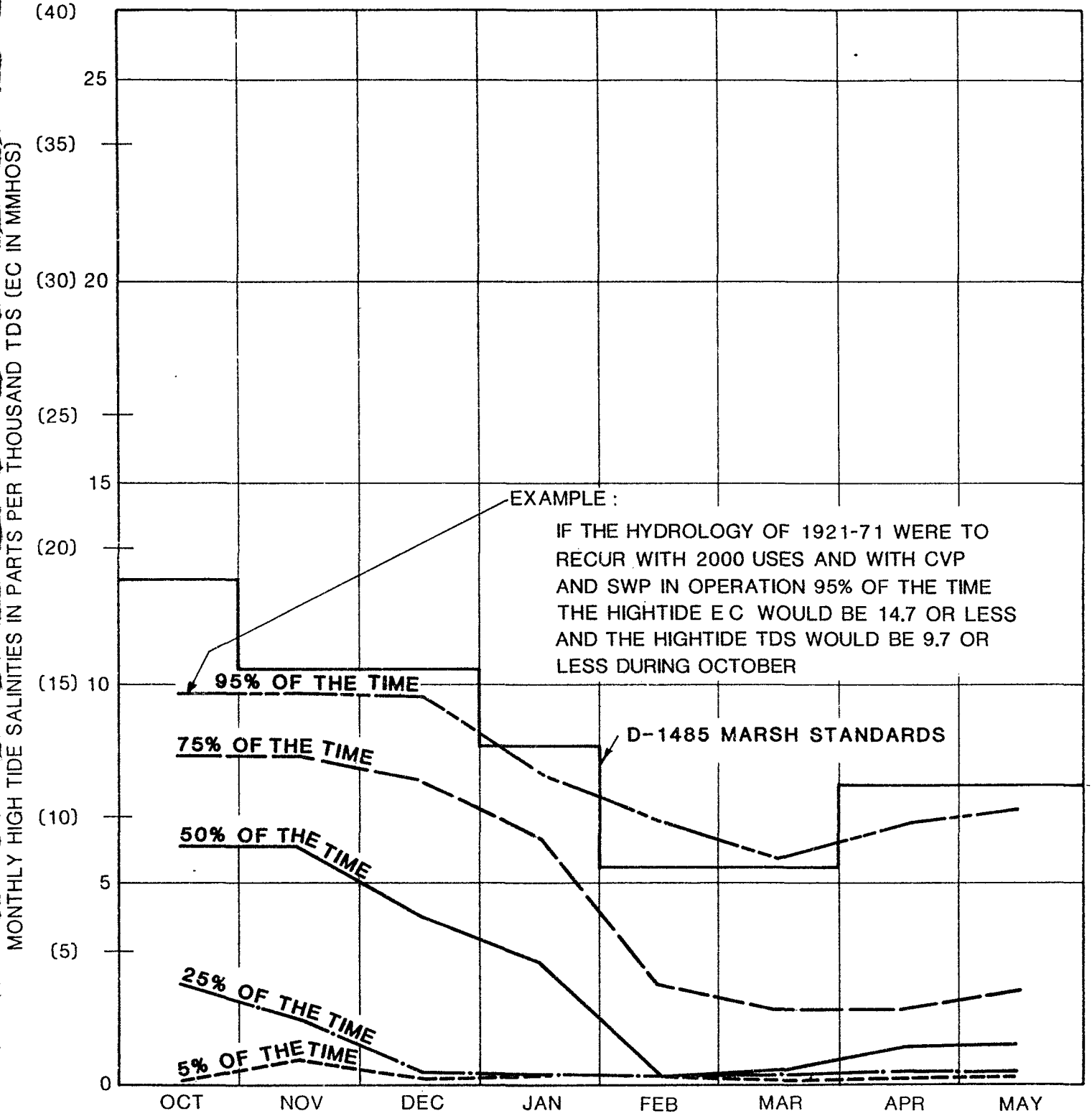
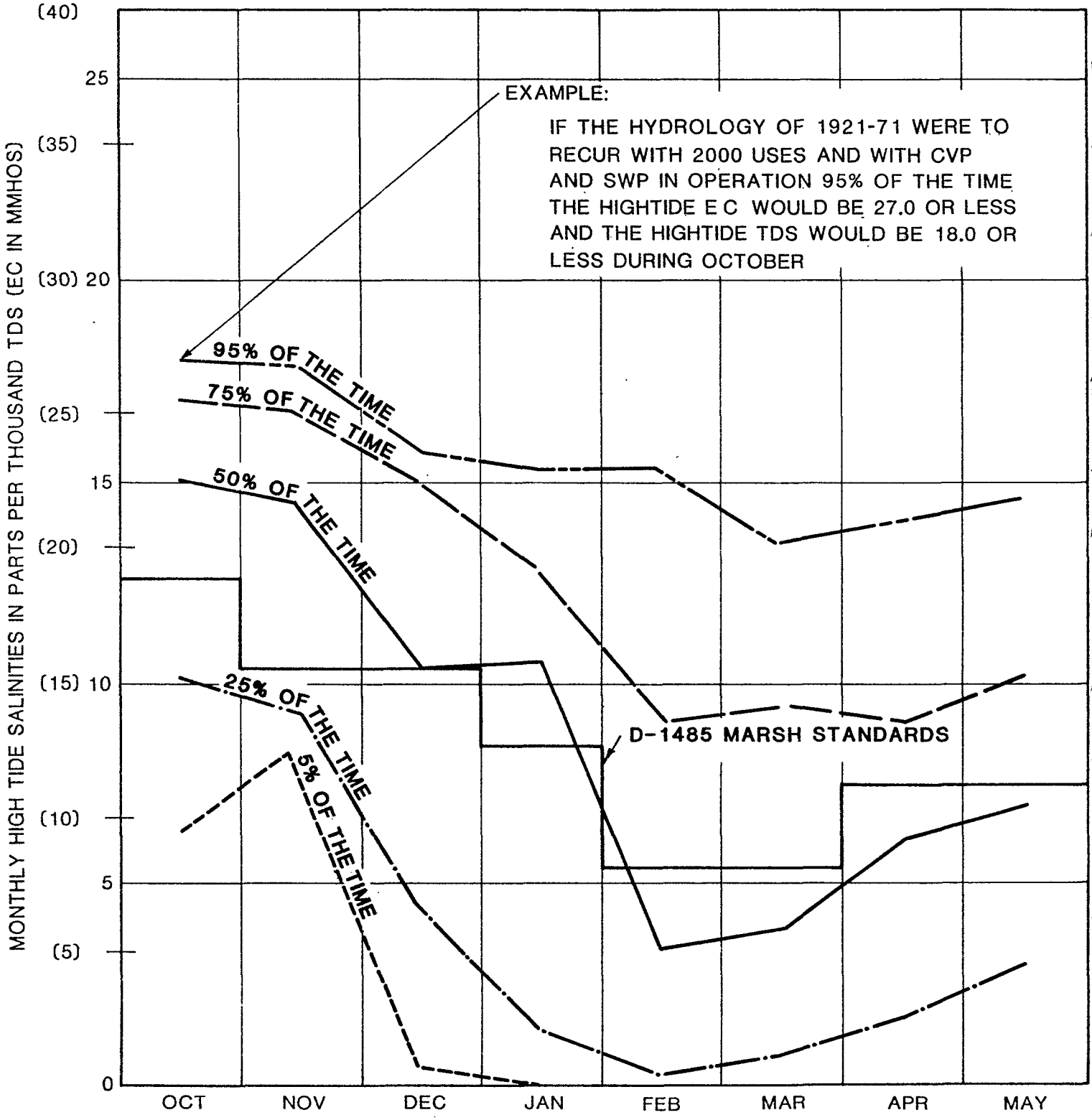


FIGURE 7

# WATER QUALITY FREQUENCY DISTRIBUTION AT MOUTH OF SUISUN SLOUGH

BASED ON 50 YEARS OF HYDROLOGIC RECORD, 1921 - 1971 ADJUSTED TO REFLECT 2000 LEVEL OF USE WITH CVP AND SWP OPERATING UNDER BASIN PLAN 2 AGRICULTURE AND 4-AGENCY FISH AGREEMENT



## Chapter 2. RELATED STUDIES AND ACTIONS

Studies of the Suisun Marsh and actions to protect it have been in progress for many years. This chapter briefly recounts some of these studies and actions. The development of the Plan of Protection presented in this report was based mostly on the data and information developed through actions discussed in this chapter.

### Soil-Water-Salt Relationship in Suisun Marsh

The Department of Fish and Game (DFG) has been investigating the ecological relationship of the State and Federal water development programs to the Sacramento-San Joaquin estuary. Several reports directly related to Suisun Marsh were published as a result of this investigation, including: "An Evaluation of the Suisun Marsh as a Wildlife Area" (George, 1965), "Soil-Water-Salt Relationships of Waterfowl Food Plants in the Suisun Marsh of California" (Mall, 1969), and "Relationships Between Soil Salinity and the Salinity of Applied Water in the Suisun Marsh of California" (Rollins, 1973).

The three reports show the value of various marsh plants as waterfowl food, the influence of salinity and flooding on the growth and distribution of those marsh plants, and the relationship between salinity in the sloughs and salinity in the soils. The studies show that alkali bulrush, brass buttons, and fat hen -- in that order -- were the three most important waterfowl food plants then available in the Marsh. Alkali bulrush seed production is maximized when root-zone soil salinity in May is between 7 and 10 parts per thousand total dissolved solids (ppt TDS).

In his report of factors that affect these preferred waterfowl food plants, Mall shows that the length of flooding has the most influence on plant distribution and survival. Soil salinity ranked second in importance, with optimal levels between 2 and 9 ppt TDS. The studies also show that more intensive management of private lands and State wildlife areas, improved water control and drainage facilities, and a supplemental supply of fresh water could reduce the effects of increased salinity in the water obtained from Honker, Grizzly, and Suisun bays and attain desired conditions.

In the report on the relationship between soil salinity and salinity of applied water, Rollins also attributes the above as the most efficient and economical way of attaining desired soil conditions for waterfowl food plants. A habitat management scheme was also devised.



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Much of the information available on wildlife ecology and marsh management was consolidated by a DFG study "A Guide to Waterfowl Habitat Management in Suisun Marsh" (Rollins 1981). Aerial surveys of the waterfowl population have been made regularly, and aerial surveys of marsh plants were made in 1961, 1973, 1978, and 1981.

## Legislative and Administrative Action

Under the State's Suisun Marsh Preservation Act of 1974, the San Francisco Bay Conservation and Development Commission (BCDC) and DFG prepared a Suisun Marsh Protection Plan to preserve the integrity of and assure continued wildlife use of the area. The fish and wildlife portion of the plan, prepared by DFG, includes an inventory of the ecological characteristics of the Marsh and its surroundings and a recommendation for natural resource protection. The plan proposes that two areas be established:

- A primary management area, which would encompass 58,600 acres of tidal marsh, managed wetlands, and adjacent grasslands, and 29,500 acres of bays and waterways, most of which are already under the jurisdiction of BCDC.

- A secondary management area of about 27,897 acres, which would include grassland areas immediately adjacent to the Marsh to act as a buffer between the Marsh and surrounding developing areas.

Under specific guidelines, Solano County prepared and is administering a local protection plan in the buffer zone. The Suisun Resource Conservation District (SRCD) has similar responsibilities in the primary management area. BCDC represents the State's interests, serving as the agency issuing land use permits for major projects in the primary management area and as an appellate body with limited functions in the secondary management area.

The plan also recommends that the State purchase about 1,800 acres of the Marsh, that adequate water quality be maintained in the Marsh, and that land tax assessing practices reflect the need for a coordinated effort to protect the Marsh.

On September 30, 1977, the State Legislature passed Assembly Bill 1717, which adopted the Suisun Marsh Protection Plan and provided for acquisition of land and easements within and around the Marsh to ensure its protection and to prevent encroachment that would reduce the value of its resources. Assembly Bill 1717 also provides for the development of a marsh management program, including private individual ownership management plans, by the SRCD.



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The 1975 Water Quality Control Plan for the San Francisco Bay Basin, adopted by the State Water Resources Control Board (SWRCB), established standards to protect Suisun Marsh. This plan was approved by the Environmental Protection Agency under Section 303 of the Federal Clean Water Act. The standards were developed from results of the soil salinity studies previously discussed to protect important food sources for waterfowl. The standards require that the quality of water provided to the Marsh between April 15 and June 1 produce a salinity not to exceed 9 ppt TDS in the first foot of soil.

On September 19, 1977, the Secretary of Resources Agency established "A Policy for the Preservation of Wetlands in Perpetuity", and on July 30, 1980, amended the wetland policy to include additional conditions. This policy includes a discussion of appropriate mitigation for the loss of wetlands. Enforcement of this policy has been suspended pending its clarification. A similar Federal policy established by Executive Order 11990 on Protection of Wetlands (Federal Register, Vol. 42, No. 101, May 25, 1977) is the guideline for Federal agencies.

In August 1978, the SWRCB adopted Decision 1485. That decision superseded the salinity requirements of the basin plans with a specific Water Quality Control Plan for the Sacramento-San Joaquin Delta and Suisun Marsh. The Decision 1485 water quality provisions for Suisun Marsh are given in Appendix C.

Other laws affecting the Marsh include the Federal Pollution Control Act (Public Law 92-500) and the Porter-Cologne Water Quality Control Act. These laws set standards for treatment of plant effluent and provide funding assistance to local communities to pay for construction of treatment plants. The two acts provided funds for construction of the Fairfield Regional Sewage Treatment Plant, which discharges into Boynton Slough in the Marsh.

The President has signed Federal legislation (HR 4084 Fazio), which authorized the U. S. Bureau of Reclamation (USBR) to pay half the cost (but not to exceed $2.5 million) of planning, designing, constructing, operating, and maintaining the Initial Facilities of the Plan of Protection. An agreement was signed between DWR and USBR on February 18, 1982, and the funds have been transferred.

## Waste Water Reuse for Marsh Management

In 1973, USBR, in cooperation with the City of Fairfield and the Solano Irrigation District, began a waste water reclamation and reuse pilot demonstration program for Suisun Marsh using secondary treated effluent from the Cordelia Treatment Plant. The purpose of the program was to investigate the potential for beneficial reuse of treated waste water for irrigated agriculture and waterfowl food production. The program



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demonstrated that it is possible to flood marsh ponds with treated waste water without excessive growth of algae and pond weeds or production of insect vectors, if the recommended management schedule is followed and if the cover of desirable marsh plants and grasses is adequate.

Under an agreement between Fairfield and Solano Irrigation District, treated waste water is apportioned for irrigation to Solano Irrigation District during dry months, May through September, and is delivered directly to duck clubs along Boynton Slough by Fairfield-Suisun Sewer District and Solano Irrigation District from October through April.

For the onsite testing program water from two sources was applied to three duck clubs. Each of the three clubs had 100 acres of ponds.

The program compared results of three types of application -- waste water only, a blend of slough water and waste water, and slough water only -- under identical management programs. The purpose of the program was to evaluate:

- Any potentially harmful effects, using each source of water, from excessive nitrogen and phosphorus, high biochemical oxygen demand (BOD), low dissolved oxygen (DO), excess algae growth, and increased pH, which creates conditions conducive to waterfowl botulism.

- The effects of treated waste water on plant production and waterfowl.

- The potential for algal growth and disease.

Conclusions and recommendations of the study follow.

## Conclusions

The beneficial and adverse effects of waste water and the means of limiting the adverse effects were determined. Monitoring the discharge to Boynton Slough defined effects of waste water during both wet and dry weather. Data obtained lead to the following conclusions:

- The use of waste water by duck clubs will produce spring filamentous algae blooms in open water areas under the standard alkali bulrush management schedule. The algae were unsightly and suppressed the growth of pickleweed, but did not deter waterfowl.



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- Modification of the operation schedule, to provide for a long drain period between January 31 and March 20, will eliminate or minimize the growth of filamentous algae if water is completely drained from low-lying pond areas.

- Adequate "spreader" drainage ditches are required to completely drain water from low-lying areas and to remove salts through gravity flow of ground water into the ditches. The ideal spreader ditch is about 1.5 feet deep and 2 feet wide and has 2- to 4-inch berms on each side. The berms will force the final 1 to 2 inches of water to percolate through the soil into the ditches.

- The use of waste water has greatly improved waterfowl vegetation in the ponds.

- During the study, there was only a slight decrease in soil salinity, possibly because of inadequate spreader ditches.

- Ammonia ($NH_3$-N) sometimes increased to more than 1 mg/L in the ponds; however, since nitrates ($NO_3$) can only be converted to ammonia ($NH_3$) through assimilation into plant organic material and subsequent reduction of the organic material, the increase could not be attributed to the waste water.

- The discharge of Fairfield-Suisun waste water to Boynton Slough caused a decrease in salinity and increases in nitrate, nitrogen, and phosphorus levels.

- There was no change in turbidity, dissolved oxygen, chlorophyll, or algae growth in Boynton Slough due to the waste water discharges. Concentrations of these constituents varied, as they did in Peytonia and Suisun sloughs.

- It appears that turbidity, which limits the available light, is the single factor limiting algae growth in the waterways of Suisun Marsh. This agrees with conclusions reached during several previous studies conducted by USBR in the Suisun Bay-Suisun Marsh area.

- Because stations at Peytonia Slough, Chadbourne Slough, and Boynton Slough are not similar, they do not provide for a comparison of effects due to waste water discharge.

- Dissolved oxygen levels were always high when zooplankton populations were high. This association in well circulated ponds will assure that botulism will not occur. Botulism occurs in ponds with low dissolved oxygen and high populations of dead or decaying animal organisms.



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Recommendations

Fairfield-Suisun Sewer District waste water should be used to supply the Gray Goose, Suisun Farm, and Walnut Creek gun clubs, in accordance with their agreements with the city of Fairfield and Fairfield-Suisun Sewer District. Waste water in excess of needs by these clubs and of irrigation needs should be discharged to Boynton Slough or to the proposed Boynton-Cordelia Ditch unit of the Overall Facilities for supply to the western part of the Marsh. The discharge should be permitted during the Regional Water Quality Control Board's dry weather period, May through September, as well as during the wet weather period.

Specific recommendations are as follows:

- A waste water supply of 1.5 cubic feet per second per 100 acres of pond area is adequate for the Gray Goose, Suisun Farm, and Walnut Creek duck clubs. This waste water should be augmented and mixed with an equal supply of slough water. September delivery of waste water should be permitted to fill supply ditches, but only where supply ditches and water level control capability meet Solano County Mosquito Abatement District approval. Waste water supplied directly to these three clubs will not reduce the total supply to the Marsh, other than that lost to evaporation, and will provide a degree of nitrogen and phosphorus removal in pond outflows to Boynton and Peytonia sloughs.

- Gray Goose, Suisun Farm, and Tule Farm should improve drainage and salt management by constructing spreader ditches to drain low-lying pond areas and ground water.

- When the Boynton-Cordelia Ditch unit of the Suisun Marsh Overall Facilities is constructed, provision should be made to use the Tomassini borrow pit of 20 to 40 acres as a waste water storage pond or as a combination Boynton Slough waste water mixing and tidal pumping basin.

- The Regional Water Quality Control Board should permit dry weather discharge of Fairfield-Suisun waste water, in excess of irrigation needs, to Boynton Slough. This discharge should only be for waste water not used for irrigation, not in lieu of irrigation. The dry weather discharge should not exceed a one-to-one mix or a turbidity of less than 25 formazin turbidity units.

- Dry weather discharge to Boynton Slough or to the Boynton-Cordelia Ditch should be a specific exception to the Regional Water Quality Control Board's dry weather discharge prohibition. The Fairfield-Suisun waste water has specific high-quality conditions: low biochemical oxygen demand, suspended solids, turbidity, and complete nitrification of ammonia. Water in Suisun Marsh also



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has certain turbidity, salinity, and tidal mixing characteristics that have prevented biostimulatory growth of algae. These conditions may not be present in other areas of San Francisco Bay.

- The monitoring program should be reduced to the four sites in Boynton Slough from the railroad bridge to the confluence with Suisun Slough. The Department of Water Resources regularly monitors water quality in Suisun Slough at Joice Island. If necessary, these data may be used as a Suisun Slough site.

- Phytoplankton analyses have been a part of the monitoring schedule. Phytoplankton analyses do not, however, represent a standard water quality indicator. These analyses are costly and, to be useful, should be accompanied with an equally costly evaluation program. Chlorophyll analyses provide a more useful measure of algae growth. Phytoplankton analyses should, therefore, be eliminated from the monitoring schedule.



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## Chapter 3. RESOURCES AND REQUIREMENTS

Wildlife habitat in Suisun Marsh has been increasingly threatened by declining water quality. The Marsh, which is home to a wide variety of fish and wildlife, has historically been naturally brackish during summer and early fall. However, with Delta outflows reduced due to State and Federal water project operations and other upstream diversions, the average duration of annual ocean salinity intrusion is increasing. When this intrusion extends into the marsh management season (September through May), it results in increased soil water salt levels that discourage growth of plants that provide food for wintering waterfowl. In dry years, the aquatic flora and fauna inhabiting marsh waterways are also affected.

With increased soil salinities, habitat management becomes increasingly critical. Unless proper management practices are adopted, using better quality water, it is feared that the number of waterfowl in the Marsh will be reduced.

### Soils

Suisun Marsh was formed by the deposition of silt carried by overflows from Suisun Slough, Montezuma Slough, and the Sacramento and San Joaquin river systems. Soils in the Marsh range from organic types containing small amounts of mineral matter to mineral soils with little organic matter. Soils with higher mineral content are generally located adjacent to the sloughs, where most of the mineral sediments were deposited in vegetation when high tides and floodwater spread outward from the sloughs. Farther from the sloughs, where soils are at lower elevation and drainage is poorer, less sediment has been deposited. The result has been a greater ratio of organic matter to mineral matter. The marsh soils are acidic, with moderate salinity and fertility.

Soils within the Marsh and adjacent areas are generally excellent to good for marsh vegetation and wildlife. These areas include the diked and managed wetlands.

In the upland area surrounding the Marsh, particularly around Rockville and Cordelia, soils are suited for agriculture, with great versatility in the types of crops that can be grown. On the portions of Grizzly Island above the mean maximum tidal elevation on the gentle slopes of the Potrero Hills, in parts of the Montezuma Hills, and on the southern slopes of the hills around Rockville, soils are suited for dry farming and grazing.



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Erosion of surrounding soils is an important factor affecting the Marsh. Erosion increases sedimentation, particularly in water channels and low grasslands, and can adversely alter aquatic and wildlife habitats.

Soils on the steep slopes in the southern and central parts of the Potrero Hills and on the eastern slopes of the Benicia Hills are easily eroded. The Rockville Hills, between Green Valley and Suisun Valley, also include slopes with high erosion potential. Disturbing easily eroded soil areas and removing or degrading their vegetation intensifies erosion potential.

Subsidence due to withdrawal of oil and gas or water from underground reservoirs has not been a problem in Suisun Marsh. Five natural gas fields -- Van Sickle Island, Suisun Bay, Ryer Island, Kirby Hill, and Denverton Creek -- are in or near the Marsh. In 1972 these fields had 28 producing wells. Three wells reached peak gas production within the last nine years. The limited subsidence that has occurred in the Marsh is a natural geologic process associated with the settlement of relatively new sediments, compaction of the soft soils, and oxidation, burning, and wind erosion of the peat soils.

## Water Resources

The marsh channels are subject to tidal influence. The maximum high tide varies from 5.4 feet in Grizzly Bay to 6.0 feet in the upper end of Suisun Slough and Cordelia Slough. The natural movement of water in the Marsh is influenced by the stream inflow to the northern Marsh and by local runoff. However, floodflows and tidal flows from the Sacramento River into Montezuma Slough and tidal flows from adjacent bays are the determining factors in marsh water circulation patterns.

The direction of net flow through Montezuma Slough is from west to east, except during large Delta outflows. The net flow near the eastern end of the slough is estimated to be about 300 cubic feet per second. The maximum velocity within this channel is about 2.0 feet per second.

Water quality in the sloughs has always varied considerably, depending on season and from year to year. During winter and spring, floodflows provide fresh water to channels. During summer and fall, low Delta outflows allow deep penetration of saline water from San Francisco Bay.

Table 1 is an inventory of water quality parameters selected to describe recent characteristics of surface water within the Marsh. From 1963 to 1978, the parameters were



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monitored at several sites to reflect the quality of water in major marsh sloughs and other bodies of water, except for the managed wetland areas within dikes. The water quality inventory represents the general characteristics of all sources sampled: freshwater runoff, ocean water, agricultural return flows, municipal and industrial waste discharges, and managed wetlands return flows.

Table 1

INVENTORY OF WATER QUALITY IN THE SUISUN MARSH[1/]

| Parameter[2/] | Number of Observations | Maximum | Minimum | Mean |
|---|---|---|---|---|
| Water Temperature-°C | 1,577 | 25 | 1 | 15.8 |
| Turbidity-FTU[3/] | 1,529 | 1,500 | 2 | 51.7 |
| Transparency-inches | 786 | 84 | 0 | 11 |
| Spec. Conductivity-micromhos | 6,432 | 27,600 | 154 | 7,354 |
| Chloride | 707 | 10,000 | 4 | 2,368 |
| Total Alkalinity | 415 | 221 | 8 | 125 |
| Total Hardness | 99 | 1,887 | 50 | 565 |
| Total nitrogen | 538 | 15.12 | 0.21 | 2.05 |
| Nitrate+nitrite Nitrogen | 894 | 12.40 | 0.01 | 0.62 |
| Ammonia nitrogen | 894 | 1.70 | 0.01 | 0.13 |
| Organic nitrogen | 538 | 14.98 | 0.08 | 1.20 |
| Ortho Phosphorus | 893 | 4.60 | 0.01 | 0.16 |
| Chlorophyll *a* | 966 | 260 | 0.3 | 25 |
| Pheophytin *a* percent | 934 | 89 | 0.1 | 13 |
| Chlorophyll *a* percent | 934 | 94 | 17 | 58.5 |
| Biochemical oxygen demand | 325 | 18.1 | 0 | 3.5 |
| Dissolved oxygen | 1,474 | 18.8 | 2.2 | 7.9 |

1/ The period of record for the composite of all sample sites in the Marsh is 1963 through 1978.
2/ All units are parts per million (ppm) except where otherwise indicated.
3/ Formazin turbidity unit.



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## Salinity

The magnitude and scheduling of Delta outflow are the most important factors influencing the quality (mainly salinity) of surface water within the Marsh. With the construction of upstream storage, the Delta outflow pattern was changed; additional upstream development has further altered it. Outflow has been increased from July through November and has been reduced from December through June. The increase in outflow from July through November has caused a decrease in salinity during that time of year.

The decrease in salinity is most pronounced at Collinsville and is least evident at the mouth of Suisun Slough, which is related to salinity at the Martinez station. The difference in degree of outflow impact is due to the locations of the Collinsville and Martinez stations. The station at Collinsville monitors river water; the station at Martinez monitors a large embayment, where the effect of outflow is diminished.

The effect of outflow fluctuations on salinity in Montezuma Slough at the Grizzly Island Bridge (Innisfail Ferry) in the Marsh is similar to that at Martinez, because the tides that fill the marsh channels come primarily from Grizzly Bay. It is presumed that the salinity in Montezuma Slough would show an increasing trend, much like that of Suisun Slough as shown in post-1960 period studies.

Continuous electrical conductivity (EC) monitors, operated since 1965 at the sites shown on Figure 8, show that salinity levels vary throughout the Marsh.

The quality degrades generally from north to south and from east to west. The Department of Water Resources (DWR) estimates that maintaining the Decision 1485 Delta standards would require, under steady state conditions, an estimated average outflow of about 6,000 cubic feet per second, but to maintain Decision 1485 post-1984 Marsh standards at the mouth of Suisun and Montezuma sloughs under steady state conditions would require an average estimated outflow of about 15,000 cubic feet per second. Because of the deterioration in water quality within the Marsh due to operation of the marsh management areas, the outflow necessary to maintain the marsh channel salinity at Decision 1485 post-1984 standards without the Overall Facilities must be increased to about 30,000 cubic feet per second. If, however, a water distribution system is provided for the Marsh, both the Delta and Marsh salinity standards can be met under steady state conditions with with an average of 6,000 cubic feet per second outflow to maintain salinity control in the river west of Collinsville. The lines of equal salinity at mean high-high tide for the two outflows are presented in Figures 9 and 10.

Monitoring Site S-42, on Suisun Slough in the interior Marsh (see Figure 8), typifies the relationship of salinity to



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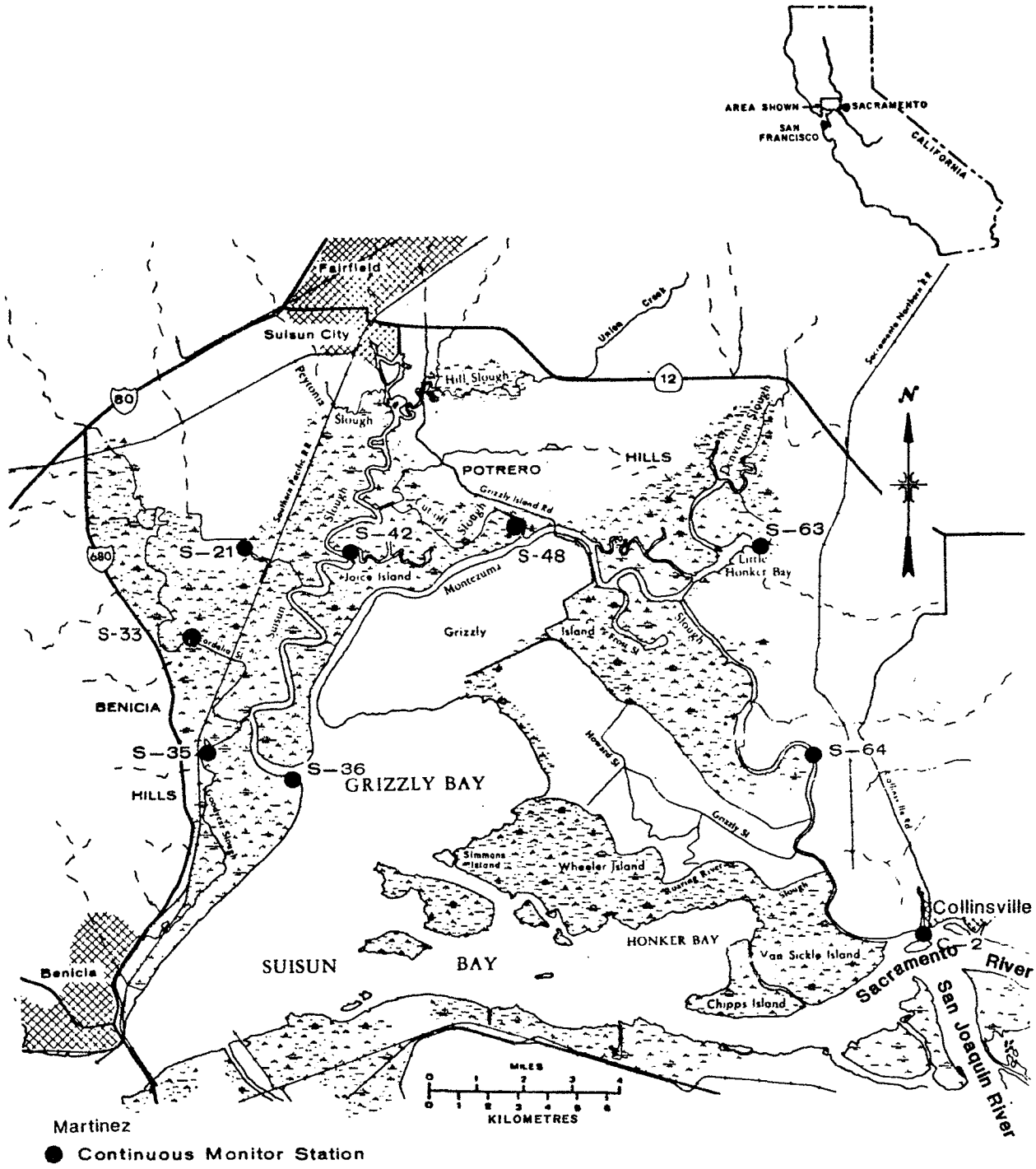
FIGURE 8




SUISUN MARSH

**SALINITY MONITORING STATIONS**



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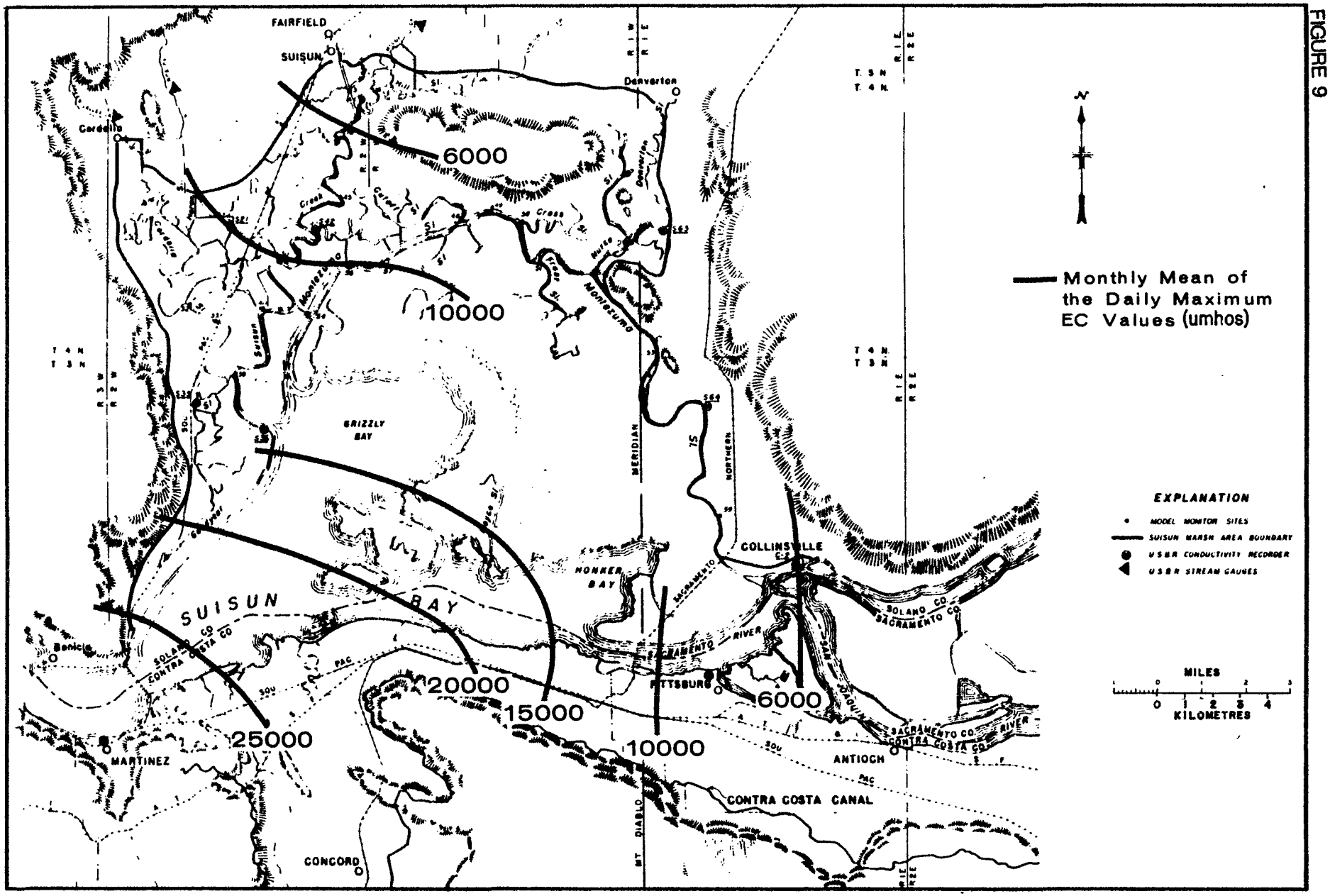
FIGURE 9




SUISUN MARSH

**SALINITY LEVELS AT MEAN HIGH-HIGH TIDE WITH DELTA OUTFLOW INDEX OF 5,800 ft³/s**

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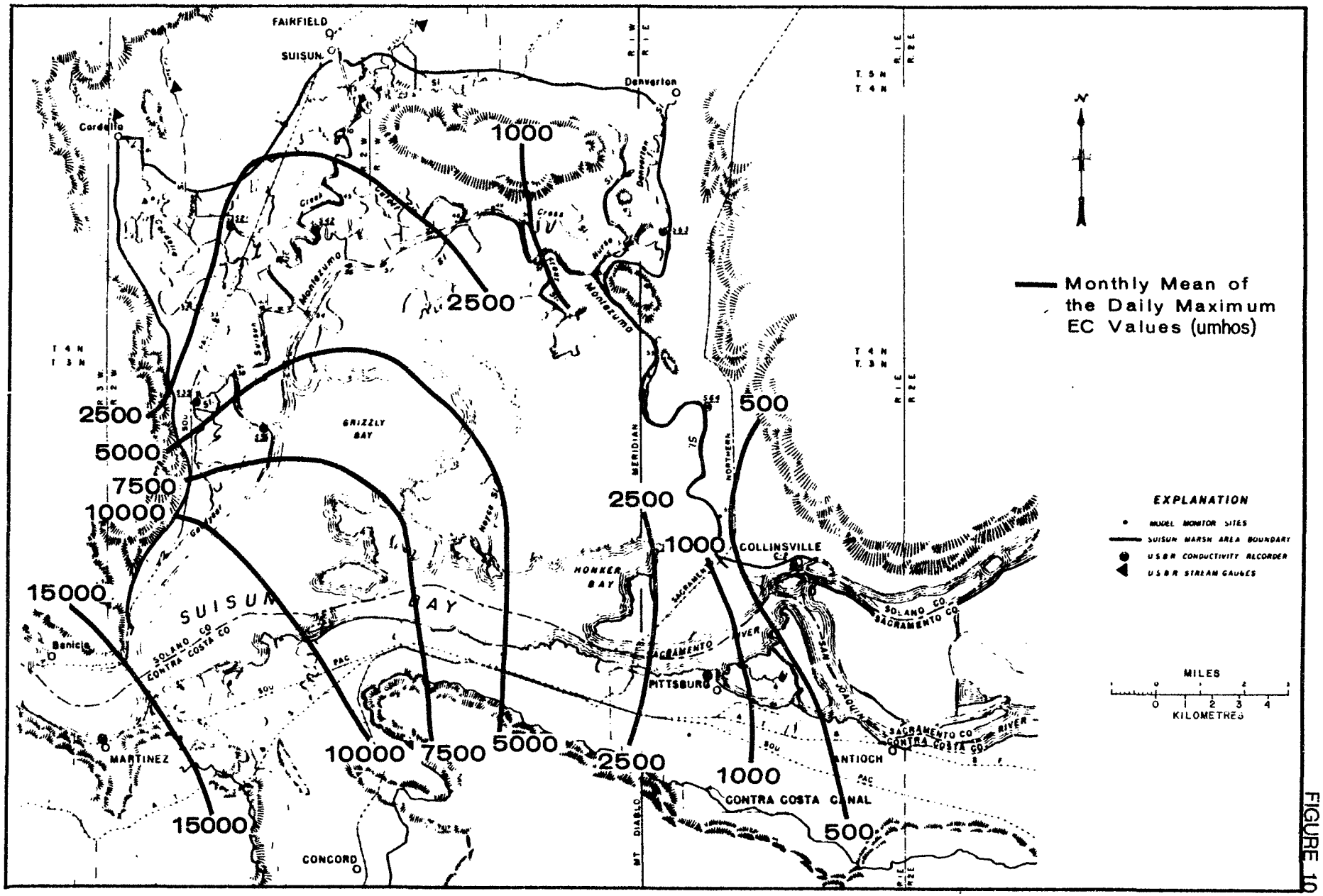


FIGURE 10

SUISUN MARSH

SALINITY LEVELS AT MEAN HIGH-HIGH TIDE WITH DELTA OUTFLOW INDEX OF 14,300 ft³/s

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outflow. Data from this long-term monitoring show a wide range of salinities for a given outflow. This variation in salinity, shown as an envelope curve in Figure 11, is due to:

- Variable marsh tributary freshwater inflows other than Delta outflow.
- The calculation of Delta outflow, which depends on an estimate of consumptive use in the Delta. Consumptive use, which cannot be measured directly, is believed to fluctuate widely.
- The rate of change in the Delta outflow. EC, particularly in a large body of water such as Suisun Bay, does not change rapidly with a change in outflow.
- The magnitude of the tide as it varies over the 14-day tidal cycle (the higher the tide, the greater the proportion of sea water).

The greatest variation in the mean daily salinity occurs during the lower outflow periods. The greatest variations in salinity within the Marsh occur during outflows of less than 20,000 cubic feet per second. Table 2 presents observed ranges of average monthly EC values at outflows varying from 3,300 to 142,000 cubic feet per second.

**Table 2**

**HISTORICAL DELTA OUTFLOW-ASSOCIATED ELECTRICAL CONDUCTIVITY AND TOTAL DISSOLVED SOLID VALUES FOR SUISUN MARSH AND SUISUN BAY***

| Outflow (cfs) | Marsh Range | | Bay Range | |
|---|---|---|---|---|
| | EC (umhos) | TDS (ppm) | EC (umhos) | TDS (ppm) |
| 3,300 | 7,800-17,000 | 5,000-11,000 | 10,000-22,000 | 6,400-14,000 |
| 4,200 | 7,300-16,000 | 4,600-10,200 | 12,000-25,000 | 7,700-16,000 |
| 5,800 | 4,000-11,000 | 2,600- 7,000 | 5,000-23,000 | 3,200-14,700 |
| 7,900 | 2,500-10,000 | 1,600- 6,400 | 5,000-20,000 | 3,200-12,800 |
| 12,500 | 2,200- 7,500 | 1,400- 4,800 | 3,000-16,000 | 1,920-10,200 |
| 16,700 | 400- 5,000 | 250- 3,200 | 1,500-14,000 | 1,000- 9,000 |
| 33,000 | 300- 3,500 | 200- 2,200 | 300- 7,000 | 200- 4,500 |
| 75,000 | 200- 2,000 | 130- 1,300 | 200- 2,500 | 130- 1,600 |
| 142,000 | 200- 1,500 | 130- 1,000 | 200- 1,500 | 130- 1,000 |

* These are composite values developed from average values for various salinity stations in the Bay and Marsh.



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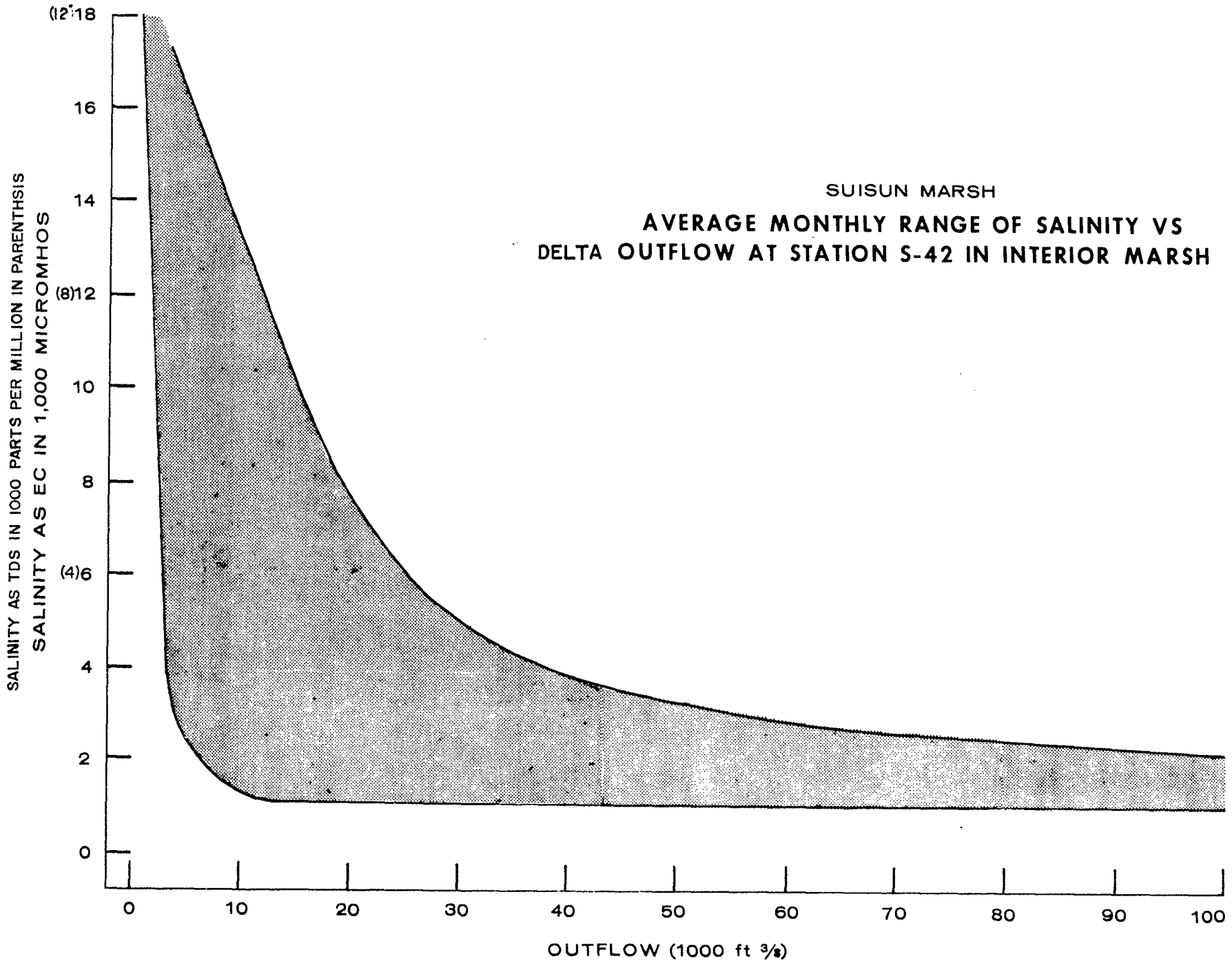


FIGURE 11

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During autumn from 1965 through 1971, the U. S. Bureau of Reclamation (USBR) released fresh water from Putah South Canal through McCoy, Suisun, and Green Valley creeks into the Marsh to test the effectiveness of supplemental fresh water in controlling marsh salinity. In most cases, effectiveness of the releases was masked by coincident increases in outflow from the Delta. During the 1966 and 1968 tests, however, the salinity reduction was more than would be expected by the corresponding increase in Delta outflow. The releases were about 40,000 acre-feet in 1966 and 48,000 acre-feet in 1968. These freshwater releases appeared to decrease salinity in the northern Marsh up to 5,000 micromhos EC, or about 3,000 ppm TDS. It was concluded that a modest amount of supplemental water would not benefit the Marsh significantly unless appropriate distribution facilities were provided.

## Turbidity

The level of turbidity in the marsh sloughs and bays is an important measurement for water quality. An increase in turbidity reduces light penetration in water, and this is detrimental to phytoplankton, which is the first link in the aquatic food chain. A reduction in turbidity would increase light penetration, which could also increase algae growth that could deplete the supply of dissolved oxygen. Table 3 shows turbidity ranges observed in the Marsh at various Delta outflows. The average turbidity in Suisun Bay ranged from 30 to 40 Formazin turbidity units (FTU) in the ship channels to 50 FTU in the embayments.

Table 3
TURBIDITY MEASUREMENTS IN SUISUN MARSH AND SUISUN BAY AT VARIOUS DELTA OUTFLOWS

| Outflow (cfs) | Marsh Turbidity Range* (FTU) | Bay Turbidity Range* (FTU) | Collinsville Turbidity (FTU) |
|---|---|---|---|
| 2,200 | 10- 30 | 4- 18 | 15 |
| 6,000 | 27- 63 | 7- 35 | 25 |
| 13,600 | 35- 88 | 16-100 | 30 |
| 13,900 | 21- 76 | 11- 42 | 27 |
| 19,000 | 60- 75 | 30- 68 | 20 |
| 21,600 | 70-130 | 18- 50 | 17 |
| 32,500 | 70-115 | 26- 70 | 30 |
| 141,500 | 38- 80 | 19- 23 | 20 |

* These are composite values developed from information from stations in the Bay and the Marsh. Measurements of turbidity at some locations in the Marsh are sometimes much higher than the ranges identified.



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Turbidities within Suisun Bay vary with the magnitude of Delta outflow and are influenced dramatically by daily changes in prevailing winds and tides. There is indication, however, that the turbidity level decreases at high outflows after the initial sediment loadings subside. The turbidity of the Bay lessens as outflows drop to summer lows, but an area of maximum turbidity, or entrapment zone (mixing area for bay and river waters), established in Suisun Bay could cause an overall period of maximum turbidity for the year. Turbidity in some channels of the Marsh appears to be tidally influenced by the Bay, with the range of turbidities in the Marsh generally about twice those in the Bay. In the drought years of 1976 and 1977, turbidity levels in the Marsh were below normal.

## Chlorophyll a

Chlorophyll a level is the measurement of algae present. The chlorophyll a levels in Suisun Bay and in marsh waterways immediately adjacent to the Bay could be partially influenced by Delta outflow. Table 4 shows the productivity of chlorophyll a at given outflows and various seasons of the year.

Observations suggest that algae production is enhanced when the entrapment zone is adjacent to Suisun Bay and occurs at outflows between 4,000 and 25,000 cubic feet per second.

Table 4

CHLOROPHYLL LEVELS IN SUISUN MARSH AND SUISUN BAY FOR VARIOUS OUTFLOW RANGES*

| Average Outflow (cfs) | Period for Averages | Mean Chlorophyll Range (ug/L) Suisun Bay | Suisun Marsh | Season |
|---|---|---|---|---|
| 2,200 | Aug-Oct 1977 | 1-5 | 2-80 | Fall |
| 3,400 | Mar-May 1977 | 2-5 | 2-10 | Spring |
| 6,000 | Jun-Aug 1972 | 10-40 | 15-30 | Summer |
| 7,800 | Mar-Apr 1976 | 5-25 | 5-35 | Early Spring |
| 13,600 | Sep-Oct 1970 | 20-50 | 5-30 | Fall |
| 13,900 | Oct-Nov 1972 | 5-20 | 5-25 | Late Fall |
| 19,000 | Sep-Oct 1969 | 10-20 | 10-30 | Fall |
| 19,500 | Sep-Oct 1974 | 10-20 | 10-20 | Fall |
| 21,600 | Jun 1971 | 10-30 | 30-70 | Summer |
| 32,500 | Feb-Mar 1971 | 2-6 | 5-12 | Winter |
| 141,500 | Jan 1974 | 1 | 3-8 | Winter |

* These are composite values developed from information from stations in the Bay and Marsh.



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Chlorophyll a production in the Bay peaks at different times than it does in the Marsh. Peak production in the Bay generally occurs during summer and fall and in the Marsh during spring and summer.

Values of chlorophyll a within the Marsh have ranged from 0.3 to 260 micrograms per liter (ug/L), with a mean value of 22 ug/L, based on 1,193 samples taken from September 1968 to August 1978. Chlorophyll a levels in the major creeks and sloughs change with the tide and streamflow.

Many marsh water bodies are shallow, yet turbid. The shallowness may partially account for the relatively high chlorophyll a concentrations. Maximum chlorophyll a concentrations generally occur during spring algae blooms, which peak in April, May, or early June. The maximum chlorophyll a concentrations are generally in the 40 to 80 ug/L range. The inorganic nitrogen concentrations are sometimes depleted to nutrient-limiting levels during periods of high algae growth. This causes erratic growth peaks irrespective of outflow.

Phytoplankton identifications during the summer of 1972 indicate that the dominant group of algae present was diatoms, followed by green algae.

Increased growth of algae or pond weed could have these adverse effects: visual nuisance, pollution, low dissolved oxygen levels, high pH, and increased incidence of waterfowl botulism and insect vectors.

### Dissolved Oxygen

From September 1968 to August 1978, the average dissolved oxygen (DO) for the Marsh was 7.9 ppm, with a maximum of 18.8 and a minimum of 2.2 ppm. Of the 18 marsh sites reviewed, ten had readings of less than 5.0 ppm, four had readings of less than 4 ppm, two had readings of less than 3 ppm, but none had readings of less than 2 ppm of DO. During the same period in Suisun and Honker bays, all the low DO measurements occurred in areas of decreased water exchange, in areas of high phytoplankton levels, or near areas of waste discharge. The level of dissolved oxygen is low during runoff from highly vegetated areas for 3 to 4 weeks after fall flooding.

## Biological Resources

Although no longer a natural marsh, since the lands have been leveed, Suisun Marsh is still important to the ecosystems of the San Francisco Bay area and the Pacific Ocean. The constant flow of the tide washes nutrients back and forth in the marsh water, benefiting the food chain and accounting for its high productivity. The abundance and diversity of flora and fauna



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in the Marsh make it a unique resource in the San Francisco Bay region and the Nation.

## Vegetation and Flora

Suisun Marsh, as legally defined (Public Resources Code Section 29100-29103), encompasses a variety of conditions capable of supporting plant life, including upland, wetland, and aquatic environments. The primary management area of the Marsh is the approximately 85,000 acres of marshland and waterways that many call "Suisun Marsh". However, the Marsh also includes the secondary management area, which is 27,897 acres of uplands adjacent to the lowland marsh area.

The upland sites (terrestrial environments) in Suisun Marsh are within the secondary management area and on drained lowlands, levees, and small pieces of higher ground within the primary management area. The major vegetation types for these terrestrial sites are: grassland, shrubland, cultivated crops, riparian vegetation, and eucalyptus groves.

The grasslands, which occur primarily on the higher ground adjacent to the marshlands, are dominated by introduced annual species, wild oat (*Avena fatua*), smooth brome (*Bromus mollis*), ripgut (*B. diandrus*), wild barley (*Hordeum spp.*), and ryegrass (*Lolium spp.*). Remnants of the native perennial grassland flora (e.g. *Stipa pulchra*) are found occasionally. Some of the grasslands occur on diked-off lowland areas, which would be marshland naturally. These grasslands are seasonally quite wet and the species composition reflects this environment, with saltgrass (*Distichlis spicata*) and other marsh species a part of the grassland vegetation.

The shrublands are dominanted by coyotebush (*Baccharis pilularis*), California rose (*Rosa californica*), and blackberry (*Rubus ursinus*), and are found on levees and roadsides. In addition, some grasslands or croplands not grazed or cultivated are invaded by shrubs over a period of time.

The most important species on the cultivated areas is barley (*Hordeum vulgare*), which has been planted extensively on higher ground on Grizzly Island for wildlife food. Some fallow cropland and frequently disturbed environments are invaded by weeds, including many broadleaf annuals.

Riparian vegetation is scarce, but the little found along some of the tributaries to the Marsh -- especially the creeks that drain into the northwest portions -- is important to many wildlife species. This vegetation, consisting mostly of woody plants such as willows and alders that are more tolerant of high moisture levels, provides nesting and resting cover for many birds.

Eucalyptus, the major tree species of the Marsh, was planted several decades ago. The groves and rows of tall trees provide valuable roosting and nesting sites for certain birds, particularly great blue herons and egrets. The Suisun Marsh eucalyptus stands are protected by State law (Assembly Bill 1717, 1977).

The wetlands are transitional lands between upland and aquatic environments. The Suisun Marsh wetlands make up most of the primary management area and consist of tidal marshes, leveed marshlands, and some intermittently marshy higher fringe areas. Most of the leveed marshlands, once primarily tidal marshes also, are now managed by private landowners and the Department of Fish and Game (DFG) to attract and support migratory waterfowl.

In the tidal marsh areas, the dominant plants are tules (*Scirpus acutus* and *S. californicus*) and cattails (*Typha spp.*). Although the tules and cattails are not the food preferred by waterfowl, they provide important habitat for many other species of marsh-dependent wildlife. This vegetation also protects the levees from wave action caused by wind and boats.

The leveed marshlands include managed and unmanaged wetlands. The managed wetlands, which comprise over 52,300 acres, or 89 percent of the total marshland area, support brackish marsh vegetation consisting of many species, but only a few cover more than 1 percent of the marshlands. The dominant plants are: saltgrass, pickleweed (*Salicornia virginica*), alkali bulrush (*Scirpus robustus*), tules (*S. acutus* and *S. californicus*), cattails (*Typha spp.*), Baltic rush (*Juncus balticus*), brass buttons (*Cotula coronopifolia*), fat hen (*Atriplex patula*), and olney bulrush (*S. olneyi*). Saltgrass, pickleweed, alkali bulrush, and tules make up about two-thirds of the total marshland cover. Variations in salinity, soils, flooding, and management create shifting patterns of plant cover as certain species are favored and others discouraged (see Chapter 2). Alkali bulrush, fat hen, and brass buttons constitute the bulk of the food supply for waterfowl. The unmanaged marshlands and the higher fringe areas (often referred to as seasonal marshes) contain the same species as the managed wetlands, but environmental conditions usually produce vegetation that is dominated by the more salt-tolerant or less flood-tolerant species, such as saltgrass.

The aquatic environments are the bays, sloughs, ditches, creeks, and deeper permanent ponds. These open water areas support very little higher plant growth, except on their edges or in slow waters where truly aquatic species may be found, such as pondweeds (*Potamogeton spp.*), duckweeds (*Lemna spp.*), and ditch-grass (*Ruppia cirrhosa*).

In summary, the entire Suisun Marsh consists of many cover types, but marshland vegetation clearly occupies the most acreage. This marsh vegetation is dominanted by only a few species, thus yielding an overall vegetation that could be considered highly



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homogeneous when viewed on a large scale. However, the marsh flora is much more diverse than this overview of the vegetation would indicate. Over 200 species have been identified for Suisun Marsh (see Appendix N).

Several rare plants may also be found in Suisun Marsh:

- Aster chilensis var. lentus (Suisun aster)
- Cicuta bolanderi (water hemlock)
- Cirsium hydrophilum var. hydrophilum (Suisun thistle)
- Cordylanthus mollis ssp. mollis (soft-haired bird's beak)
- Lasthenia conjugens (Contra Costa gold fields)
- Lathyrus jepsonii ssp. jepsonii (Delta tule pea)
- Legenere limosa (Greene's legenere)
- Lilaeopsis masonii (mud flat quill-plant)

These plant species are on the State or Federal lists of rare, threatened, or endangered plants. The California Native Plant Society includes these same plants on its list of special concern.

## Fish

Suisun Marsh supports a diverse assemblage of fish species and invertebrates. Many species spend only a part of the year or a portion of their life cycle in the Marsh. Others move within the Marsh in response to their environmental requirements. Suisun Marsh sloughs are nursery areas for young-of-the-year striped bass. Of the young bass population in the Delta estuary, an average of 9 to 9.6 percent reside in Montezuma Slough in midsummer, although in 1973, 21 percent of the total young bass population was found there. Adult bass also use marsh sloughs.

Montezuma Slough supports numerous opossum shrimp (Neomysis), the major food for young striped bass. Concentrations of Neomysis in the slough are frequently among the highest anywhere in the estuary, although the slough represents less than 3 percent of their total range. In early summer of 1973, the slough contained about 17 percent of the total Delta Neomysis population.

White and green sturgeon are found in marsh sloughs and in adjacent waters. Two other important anadromous fish -- chinook salmon and steelhead trout -- pass through the Marsh, either as adults migrating to spawning grounds or as smolts moving to the ocean.

Catfish, common in portions of the Marsh, contribute significantly to local sport fishing. Other species of fish in the Marsh include minnows, carp, American shad, threadfin shad, Delta and longfin smelt, tule perch, and the yellowfin goby. Shad and smelt are important forage for striped bass and other predatory fish.



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## Wildlife

Suisun Marsh is a key waterfowl wintering area on the Pacific Flyway. Ducks wintering in the Marsh include pintail, mallard, wigeon, greenwinged teal, shoveler, ruddy duck, and canvasback. White-fronted, snow, and Canada geese are also represented.

In August, ducks and geese begin to arrive in California from their northern nesting grounds. Early fall counts have shown that, on the average, 25 to 28 percent of the waterfowl in the State may be in the Marsh during fall of dry or critical years because of the scarcity of suitable waterfowl habitat elsewhere during those times. The Marsh is used less intensively during wet years, when waterfowl are attracted to other areas within the Central Valley. Marsh duck populations have, in the past, peaked at about one million.

In the last 8 years, the percentage of pintails using the Marsh has declined. In a May 1979 report, the U. S. Fish and Wildlife Service (USFWS) evaluated the trends of pintail using the Marsh as a wintering area. Following is a summary of that report:

> "Chabreck et al (1975) stated that an important aspect of any wildlife management plan is providing optimum habitat and that duck usage in regions where the birds are abundant can be used as an indicator of habitat quality. In recognition of this fact, the results of waterfowl surveys over a 20-year period of time were utilized to analyze populations of pintails wintering in the Suisun Marsh. To accomplish this, pintail population indices were developed for Suisun Marsh for a 20-year period (1958-1977) and compared with possible causative factors of changes in population levels. Pintail populations in the Marsh appear to have declined over the period of study. Prior to 1969, pintail population levels in the Marsh were correlated positively with Central Valley population levels. Since that time Central Valley populations have generally increased while Marsh populations have decreased particularly during late fall and early winter."

The results of the surveys made for Suisun Marsh and the Central Valley are shown in Figure 12. The USFWS made the following conclusions based on these surveys:

> "While many factors may influence pintail populations on a short-term basis the principal factors appearing to affect pintail usage of Suisun Marsh over the period of analysis were increased production of cereal grains and water development projects providing rafting areas. Increased production of corn in the Delta in combination with leaching practices and flooding for hunting following harvest has resulted in large numbers of pintails utilizing the Delta



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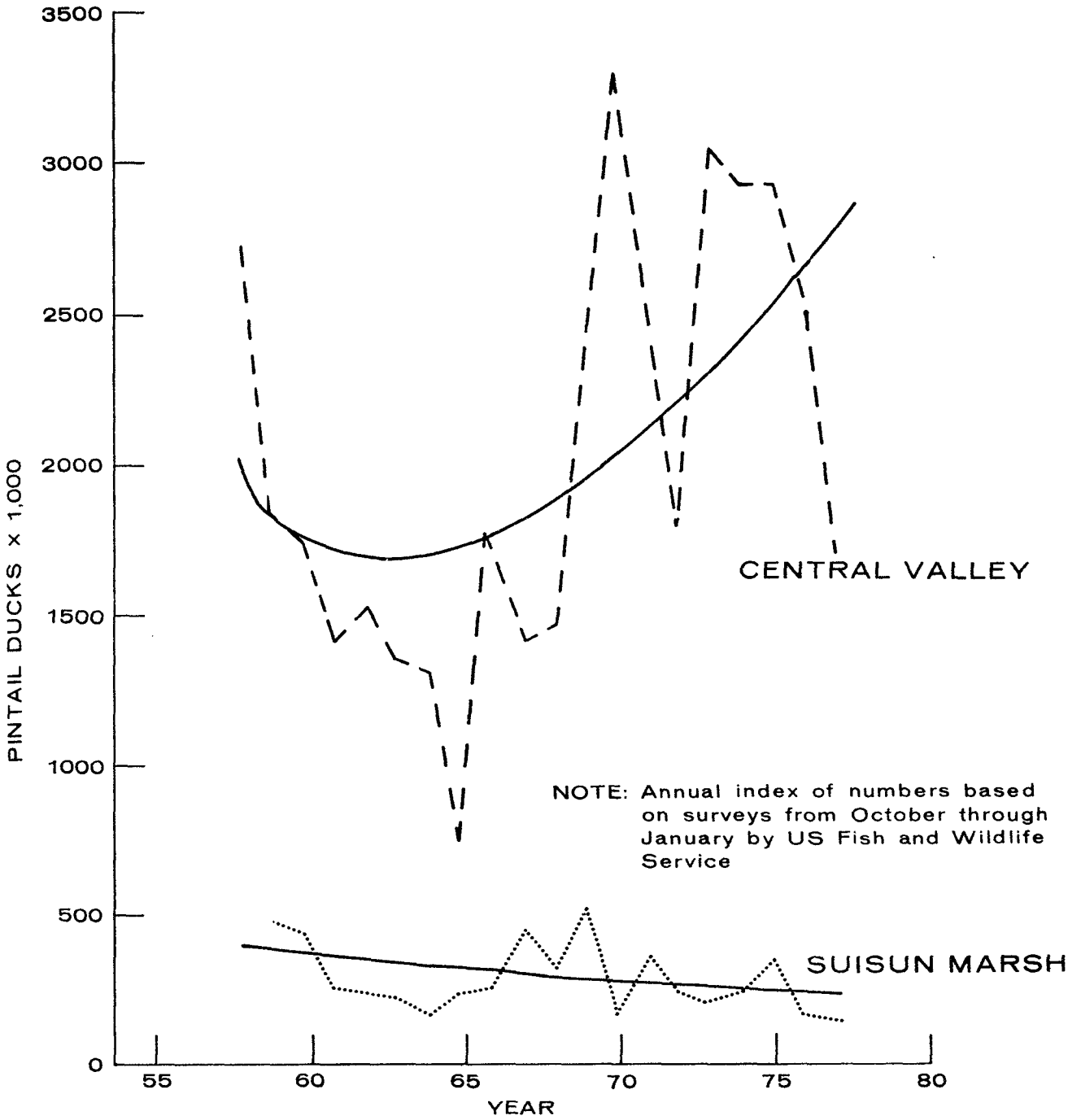
FIGURE 12




SUISUN MARSH

**PINTAILS IN CENTRAL VALLEY AND SUISUN MARSH**



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since the late 1960's. Water development projects such as Clifton Court and Bethany Reservoir in the Delta, and San Luis Reservoir adjacent to the grasslands, now harbor large numbers of birds where water did not exist prior to the late 1960's.

Pintails are known to be highly adaptable to certain environmental changes such as changing food supplies and water availability. Because of this and the changes that have occurred relative to these factors from 1958 to 1977, it appears that the distribution patterns of pintails in the Central Valley have been altered and that the numbers of birds which once utilized Suisun Marsh has been reduced in favor of alternative habitat."

The long-term value of agricultural areas as sources of food for wintering waterfowl is decreasing as efficiency of harvesting increases and less grain is left in the field. A review of data on rice production over the past 20 to 25 years shows that from 1955 to 1960 a harvesting efficiency of 65 percent resulted in about 490,000,000 pounds of grain left in the field and available for wildlife. From 1972 to 1976, harvesting efficiency increased to about 90 percent, and the amount of grain left in the field was only about 276,000,000 pounds, a net reduction of about 45.5 percent.

While availability of alternative preferred food supplies has reduced pintail usage of the Marsh in recent years, it must be recognized that the Marsh provides permanently available natural habitat and food supply. By contrast, the acreage planted to corn in the Delta is determined by economic factors that can change drastically. In addition, waste cereal grains are primarily used by field feeding species (mallard and pintail), and harvested fields are of lower value to species such as widgeon, teal, and shovelers that are more dependent on natural waterfowl foods.

Migratory patterns of waterfowl and habitat factors throughout California can change abruptly, so there is a need to protect areas such as Suisun Marsh to maintain the wintering waterfowl population of the Central Valley.

The Marsh is also home to many upland game species, including ringnecked pheasant, mourning dove, Audubon cottontail, and blacktailed jackrabbit. Farmlands, adjacent dikes, and noncultivated lands provide good upland habitat. During hunting season, when duck ponds are flooded, available habitat for pheasant is reduced. Pheasants, therefore, use the marshland borders for cover and as an alternative food source.

Fur-bearing mammals in upland areas of the Marsh include opossum, long-tailed weasel, spotted and striped skunks, gray fox, and bobcat. Mink, muskrat, river otter, beaver, and raccoon inhabit the waterways, wetlands, and adjacent riparian zones. The



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habitat of muskrat, beaver, mink, and river otter appears to be limited by the effects of high salinity. Years of increased salinity may result in reduced muskrat populations, but they recover in a year or two when lower salinity returns. Mink and river otter are usually less tolerant of saline conditions than are muskrat, and their populations recover more slowly.

The area also supports a variety of nongame wildlife, including song birds, hawks, owls, large mammals such as Tule Elk, small mammals, reptiles, and amphibians.

## Rare and Endangered Species

The Marsh is within the range of several species classified by Federal or State governments as rare or endangered. These are shown in Table 5.

**Table 5**

**RARE AND ENDANGERED SPECIES THAT INHABIT THE SUISUN MARSH AREA**

| Endangered | | Rare |
|---|---|---|
| U. S. Fish and Wildlife Service | California Department of Fish and Game | California Department of Fish and Game |
| California clapper rail | California clapper rail | California black rail |
| Aleutian Canada goose | Tule white-fronted goose | Yellow-billed cuckoo |
| Bald eagle | Bald eagle | Giant garter snake |
| Peregrine falcon | Peregrine falcon | Alameda striped racer |
| Salt marsh harvest mouse | Salt marsh harvest mouse | Swainson's hawk |

No rare or endangered fish species are found in the Marsh. The Aleutian Canada goose, bald eagle, and peregrine falcon have occasionally been seen using the Marsh as a resting area enroute to another part of the State. The California clapper rail, recently found in the Marsh, feeds primarily on organisms exposed in the tidal marshes at low tide. The salt marsh harvest mouse, a resident of the Marsh, lives primarily in areas dominated by pickleweed. Both the clapper rail and the harvest mouse are considered by the USFWS and DFG to be endangered. Habitat preferred by the black rail occurs in the Marsh, but recent surveys in the Marsh have not found the black rail.



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## Recreation

Suisun Marsh is important for recreation. It offers fishing, hunting, nature study, and sightseeing. Recreation use and its dollar values, estimated by the USFWS, are summarized in Table 6. The dollar values were derived by procedures outlined in the Federal Register, "Water Resources Council, Water and Related Land Resources, Establishment of Principles and Standards for Planning", Volume 38, No. 174, Part II, September 10, 1973.

**Table 6**

**SUMMARY OF RECREATION BENEFITS FOR SUISUN MARSH**
**(Estimated Minimum Benefits)**

| Activity | Recreation Days* | Net Benefits |
|---|---|---|
| Fishing (in the sloughs) | 44,000 | $ 99,000 |
| Hunting Waterfowl | 48,200 | 433,800** |
| Hunting Upland Game | 45,200 | 226,000 |
| Trapping Mammals | -- | 12,000 |
| Other | 12,000 | 27,000 |
| TOTAL | 149,400 | $797,800 |

* The recreation-days presented are estimates for days expended in Suisun Marsh proper,and not for the entire Suisun Bay estuary.

** A more realistic total estimate of hunter expense generated would be about $6 million per year. This is based in part on the costs to club members such as initiation, annual fees, dues, and assessments.

Waterfowl hunting is the major recreation in the Marsh. Grizzly Island and Joice Island Wildlife Management Areas, totaling 13,700 acres, are public hunting areas. Some waterfowl hunters use boats in sloughs and bays at the edge of the Marsh. In June 1977, there were 138 private clubs, totaling about 43,135 acres, in the Marsh. The annual waterfowl harvest in California from 1960 to 1974 averaged about 3 million ducks and geese. Over 9 percent of these birds were taken in the Marsh.

Fishing is also important within the Marsh. Although launching ramps provide boat access to most marsh waterways, most fishing is done from land.



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Nature study, a rapidly growing form of recreation, includes bird watching, nature photography, hiking, and other nonconsumptive uses associated with fish and wildlife resources. People are drawn to the marshes to see, hear, and study wildlife. Nature study is an important activity in the Marsh.

Recreation demands are expected to continue to increase. Over 4 million people now live in an 11-county area within a 50-mile day-use zone of Suisun Marsh. Based on projections by the California Department of Finance, population in the 11-county area will increase about 27 percent between 1975 and 1995, with a further increase of 31 percent by 2020. With the population nearing 7 million, Suisun Marsh will be in great demand for recreation. To meet the recreation demand, ecological balance in the Marsh must be maintained or improved.

The public does not benefit from the Marsh to the same extent that private landowners do, because of limited access to the 65 percent of the marshlands under private ownership. The general public has not in the past contributed to the maintenance of the wildlife values to the extent that private landowners have.

## General Water Requirements

Because of increased salinities, it has been increasingly difficult to maintain the brackish marsh plant species that make Suisun Marsh a valuable waterfowl wintering habitat. Water quantity is not a problem for the Marsh, because of its proximity to tidal waters; the critical factor is water quality, specifically salinity.

For the Marsh to retain its unique character, the salinity of water used on the managed wetland areas should not normally exceed 12 parts per thousand total dissolved solids. During recent dry years, the longer duration of higher salt concentrations in the adjacent channel water has adversely affected the aquatic flora of marsh waterways and lands. In 1977, the driest year on record, marsh waterfowl food production was only about 25 percent of normal, and tidal marsh vegetation was killed as far east as Meins Landing, on Montezuma Slough.

Unless water of adequate quality is provided and more intensive water management practices are adopted, many of the managed wetlands will experience adverse changes in waterfowl food plants, causing losses in number and species of waterfowl and other wildlife. The areas most likely to be adversely affected are those with poor water control facilities, poor management practices, and a highly saline water source.

## Water and Soil Salinity Requirements

Tolerances of marsh plant species to soil salinity are presented in Table 7.

Table 7

SOIL SALINITY TOLERANCES OF MARSH PLANT SPECIES

| Marsh Plant | Mean Annual Salinities | | Mean Annual Soil Salinity at Which Plant Species have the Maximum Competitive Advantage | |
|---|---|---|---|---|
| | TDS (ppt) | EC (mmhos) | TDS (ppt) | EC (mmhos) |
| Fat Hen | 12.8-49.2 | 20.0-76.9 | 19.0-29.0 | 29.7-45.3 |
| Brass Buttons | 8.9-30.5 | 13.9-47.6 | 22.0 | 34.3 |
| Alkali Bulrush | 6.9-32.5 | 10.8-50.8 | 22.0 | 34.3 |
| Narrowleaf Cattail | 8.1-25.5 | 12.6-39.8 | 16.2 | 25.3 |
| Olney Bulrush | 8.5-20.7 | 13.3-32.3 | 16.0-22.0 | 25.0-34.3 |
| Baltic Rush | 16.2-23.6 | 25.3-36.9 | 16.0 | 25.0 |
| Salt Grass | 11.6-43.5 | 18.1-68.0 | 32.0-33.5 | 50.0-52.3 |
| Pickleweed | 18.5-81.0 | 28.9-126.5 | 31.0-35.5 | 48.4-55.4 |

*The mean annual salinities are an average of extreme spring lows and extreme fall highs. The lower salinities must occur during the spring growing season for most of these species to survive. These values relate to salinity in the first foot of soil.

Source: Mall (1969)

Continued and increased diversions from the Delta add to the duration of salinity intrusion, especially during years of below normal rainfall, and eventually can severely restrict production of waterfowl food plants. Two or more years of extended high salinity intrusion could alter the plant community. Dry years have significantly reduced seed production, which in turn has reduced the food supply for wintering waterfowl. This happened most recently during 1976 and 1977. Perennial plants such as alkali bulrush, stressed during the drought, took several years to recover.

To maintain acceptable alkali bulrush seed production, a soil salinity of not more than 9 ppt TDS must be attained in the first foot of soil during May, the critical month for seed production. Water salinity criteria deemed necessary to achieve optimum seed production with good management in the Marsh, as



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specified in Decision 1485 by the State Water Resources Control Board (SWRCB), are shown below:

| Month | Mean Monthly High Tide Conductivity (mmhos) |
|---|---|
| October | 19.0 |
| November | 15.5 |
| December | 15.5 |
| January | 12.5 |
| February | 8.0 |
| March | 8.0 |
| April | 11.0 |
| May | 11.0 |

DWR will propose to the SWRCB that the November salinity standard established at 15.5 mmhos be changed to 16.5 mmhos to allow a more reasonable ramping of marsh water qualities. Since this is outside the critical time, February to May, there would be no significant adverse effects from this change. DFG and Suisun Resource Conservation District (SRCD) are expected to support this change.

DWR will also propose that these standards be relaxed when two or more dry or critical years occur in sequence. It is not proposed to relax the Decision 1485 post-1984 standards during an isolated dry or critical year, or in the first year in a sequence of dry or critical years. The years when the relaxed standards would apply are termed deficiency periods and are defined in the proposed DWR/DFG/SRCD agreement to be:

- A critical year following a dry or critical year.
- A dry year following a year in which the Four Basin Index was less than 11.35.
- A dry year following a dry year that was preceded by a critical year.

The proposed relaxed standards for deficiency periods, tentatively agreed to by DFG and SRCD, are shown below.

| Month | Mean Monthly High Tide Conductivity (mmhos) |
|---|---|
| October | 19.0 |
| November | 16.5 |
| December | 15.6 |
| January | 15.6 |
| February | 15.6 |
| March | 15.6 |
| April | 14.0 |
| May | 12.5 |

The relaxed standards have been proposed because it is believed to be inequitable for the Marsh to receive sufficient water to achieve optimum seed production during an extended drought, while the remainder of California is expected to be subjected to deficiencies and cutbacks in water supplies. Conversely, it is not proposed to apply relaxed standards to the Marsh in an isolated dry or critical year, or in the first in a sequence of dry or critical years because it was believed to be inequitable to impose deficiencies in water quality on the Marsh, while the remainder of California is unlikely to be subjected to cutbacks in supply. The proposed standards would result in less than optimum seed production, but would ensure survival of vegetation throughout the Marsh.

Under terms of the proposed DWR/SRCD/DFG contract, these deficiency year standards will be subject to field verification and adjustment, if necessary, to assure that the Marsh is provided an adequate level of protection. If the SWRCB does not approve the proposed standards, the Board could impose alternative standards which, in its opinion, will provide adequate mitigation. The status of the DWR/DFG/SRCD contract standards would then be subject to review by the parties.

To grow certain waterfowl food plants with water quality established by Decision 1485, the managed wetland areas must have at least two leaching cycles and a 45-day circulation period each year between January and late April. The water management facilities in many of the managed wetland areas are incapable of accomplishing this. Surveys of 109 duck clubs by the U. S. Soil Conservation Service (SCS) in 1973 show that almost 20 percent had main water supply ditches and 45 percent had circulation ditches incapable of meeting this objective. Inadequate water intake facilities were reported for 42 percent of the clubs, and 36 percent had inadequate drainage systems. The maintenance of a healthy wildlife habitat depends on upgrading water management capability in managed wetland areas.

As provided in Assembly Bill 1717, the Suisun Resource Conservation District is preparing engineering level management plans, which, by survey and computing techniques, will determine facilities needed by each private ownership and will oversee their construction in the years following construction of the Overall Facilities.

## Levee Maintenance Requirements

Maintenance of levees in the Marsh is a continuous and expensive process. The nature of the soils, tidal and wind action, winter floodflows, boat wakes, and burrowing animals cause deterioration. The organic soils cause levee subsidence. The SCS estimated that in 1974 the Marsh had over 194 miles of exterior levees, many needing renovation. Virtually all clubs have interior levees, many in poor condition and needing renovation.



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Draglining soil from the sloughs and marsh areas adjacent to the levees creates steep banks and deepened ditches, which result in poor footings for the levees. There are fewer problems with levees having a border of natural tidal marsh, because of the buffer effect of vegetation on waves and floodflows. The DFG has suggested that the expected increase in salinity levels on the bayside of exterior levees may kill the protective vegetation, thus compounding the levee maintenance problem.

A good levee system is important to marsh management, but it is not the responsibility of the Central Valley Project (CVP) or State Water Project (SWP). The annual cost of needed levee improvement and proper maintenance over the past five years was estimated at more than $1,000 per mile. Exterior levee repair costs are between $3 and $4 per foot. Many small clubs cannot afford the repairs and improvements. This detracts from effective marsh management.

The SRCD has suggested to the landowners within Suisun Marsh that it may be to their advantage to form a levee maintenance district, a reclamation district, or several reclamation districts. The landowners would then have a vehicle for obtaining funds for maintenance and for repair of flood damage.

Assembly Bill 2090, which became law in October 1982, enables the SRCD to issue bonds and levy assessments to finance improvements on individual properties within the Marsh, and it provides a means to reimburse individual club owners for 50 percent of the O&M costs incurred in improving the wildlife habitat (not to exceed $5,000). This law, when implemented, will aid the landowners in maintaining their exterior levees.

## Mosquito Abatement Requirements

Mosquitos inhabit the Marsh year-round and reach their peak during spring and fall. The Solano County Mosquito Abatement District conducts a comprehensive program to alleviate the pests and prevent vector-related human disease. Abatement methods used by the District include ditching, draining, spraying, burning, and stocking the permanent ponds with mosquito fish. The District opposes management practices that promote conditions favorable to mosquitoes.

## Chapter 4. PLAN OF PROTECTION ALTERNATIVES

Development of the Plan of Protection involved consideration of alternative marsh protection plans and alternative sources of water.

### Alternative Plans

Four alternative plans were considered for the Marsh, a no-action plan, a nonstructural plan, an overland supply plan, and a combination plan.

#### No-Action Plan

If no remedial action were taken, Suisun Marsh would continue to get adequate quantities of water to flood the waterfowl management areas, because the waterways used to distribute water within the Marsh are influenced by tidal action. However, as greater amounts of fresh water are diverted upstream from the Marsh, the duration of salinity intrusion in marsh channels will continue to increase. To maintain the variety of brackish water dependent vegetation, an overall intensification of water and land management procedures within the Marsh could, within limits, lessen the effect of increased salinity. Even with intensified management practices, the quality of marsh vegetation and seed production would decline during a series of dry years, such as 1976 and 1977. Since the no-action plan would, therefore, not protect the Marsh, it was not considered further.

#### Nonstructural Plan

Without constructing channel control structures and distribution facilities, increasing Delta outflow would be the only way to achieve water quality mandated for the Marsh by the State Water Resources Control Board (SWRCB) in Decision 1485. This nonstructural alternative is consistent with demands by Bay area residents to maintain high outflows to benefit the San Francisco Bay estuary.

During a dry year, when the Central Valley Project (CVP) and State Water Project (SWP) divert 5,000 to 7,000 cubic feet per second, the estimated supplemental outflow required to maintain Decision 1485 criteria at the mouth of Suisun Slough and at the western end of Montezuma Slough varies between 1.8 and 2.0 million acre-feet. This is in addition to the outflow required to meet Decision 1485 fish, agricultural, and municipal and industrial standards. Decision 1485's protection of Suisun Marsh is an attempt to balance the limitations of available water supply



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against the mitigation responsibility of the projects. This balance is based on the constitutional mandate, "...that the water resources of the State be put to beneficial use of the fullest extent of which they are capable... and that unreasonable use and unreasonable diversion be prevented" (Article 10, Section 2, California Constitution).

In the "Water Quality Control Plan for the Sacramento-San Joaquin Delta and Suisun Marsh", adopted in August 1978, the State Water Resources Control Board states, on page VI-11:

> ". . . Full protection of the Marsh solely with outflow could require in excess of 2 million acre-feet (in terms of project yield) in addition to that outflow required to meet the interim Marsh standards (RT Vol. XXII, p. 101). This would result in a one-third reduction in combined SWP and CVP exportable yield from existing facilities. The Bureau, the Department, Fish and Game, and the U. S. Fish and Wildlife Service are working to develop supplemental water supplies for the Marsh. Such supplemental supplies are a more desirable method for protecting the Marsh and mitigating the adverse impacts of the CVP and SWP on this extremely valuable resource."

To maintain the Decision 1485 criteria for water in the interior Marsh during a critically dry year, the additional supplemental water necessary would have to increase to about 4.8 million acre-feet. This supplemental water would vary between 2.6 and 4.8 million acre-feet during wet and critically dry years, respectively, with an average of about 3.7 million acre-feet. This would be in addition to the outflow required to meet fish, agricultural, and municipal and industrial Delta standards.

The 4.8 million acre-feet would be made up of the 2 million acre-feet of project yield and the balance would be uncontrolled outflow. Without facilities, developing this volume of yield would require construction of several new dams, with the associated construction impacts.

Another alternative would be for the CVP and SWP to decrease exports from the Delta to the San Joaquin Valley and Southern California. This could result in one of two things in the agricultural area. The ground water basins would have to be pumped to make up for the cutback in Delta water to maintain the present total area in production, or a large amount of farmland would have to be taken out of production. The ground water basins in the urban areas of Southern California would also have to be pumped to make up for the cutback in Delta water, or water from other sources would have to be acquired at additional expense.

Excessive mining of the ground water could result in an overdraft and its related problems. In either case, there would be a servere adverse impact on the farm communities, the water contractors, and the State of California.

Impacts of a decrease in deliveries to the San Luis Unit are discussed in the "Special Task Force Report on San Luis Unit", prepared under Public Law 94-46, and "Draft Supplement to the Final Environmental Statement, San Luis Unit", (DES 79-50, July 30, 1979).

The State's share of water necessary for full protection of the Marsh is 2.4 million acre-feet: 1 million acre-feet of project yield and 1.4 million acre-feet of uncontrolled outflow. Based on the requests up to year 2000 for deliveries of entitlement water, this quantity of firm yield is adequate to irrigate 300,000 to 500,000 acres of agricultural land.

If these lands are all kept in production, the farming community could be faced with additional high costs brought about by lowering the ground water table, with its attached impacts of having to drill new wells or increasing the depth of existing wells and, therefore, increasing the pumping energy costs for the increase in depths (1.7 kWh to lift 1 acre-foot one foot in elevation). These increases in energy and their related costs will partially, if not totally, negate any savings realized by not pumping SWP water; these costs total about $3,000,000. Excessive mining of the ground water will cause ground subsidence. If this occurs, the subsidence will affect water distribution systems and other structures and facilities. Repair or replacement costs depend on the amount of subsidence and could be considerable. Depending on the farm practices and crops grown, there could be an accompanying buildup of salt in the soil due to reduced leaching of the fields.

If agricultural lands are taken out of production, there would be a total loss of $1,190 per acre to the State economy (shown on Figure 12a), which includes gross crop losses of $727 per acre together with the gross losses in the related farm industries, losses in wages of farm employees and employees of associated farm industries of $463 per acre. These losses would have a direct effect on retail trade and services in the affected areas. In reality, taking agricultural land out of production would have a domino effect on the local and State economy. As some of the lands taken out of production may have permanent crops planted, such as vineyard or orchards, the capital investment that put these lands into production would be lost.

SWP water contracts provide that in years of water shortages, deficiencies of 50 percent of their water supply are imposed on the agricultural water users before the municipal and industrial users begin taking deficiencies. When the agricultural users have absorbed about a 670,000 acre-feet deficiency, the municipal and industrial water users will start to take deficiencies.

A 1 million acre-foot curtailment in firm yield of SWP water would have a serious financial impact throughout the State. While urban users can probably fall back on a tax base to meet

outstanding financial obligations, the agricultural users of SWP water depend primarily on water sales for revenue to meet their financial obligations. In both instances, these financial obligations include repayment of the cost of the SWP, the urban water users' additional costs for a replacement water supply, and additional bonded indebtedness to the local water districts for the construction of distribution systems and other works. The shortage would result in a lack of incoming revenues from water sales, which could force some water districts to hold up payments on the contracts to the State and payments on their own bonded indebtedness. Any default by water agencies would cause financial markets to downgrade California State and local bond ratings, thereby requiring California State and local agencies to pay higher rates of interest with future bond sales. The higher interest rates would cause a further drain on limited tax revenues, thereby increasing the fiscal squeeze on many governmental programs. The Burns-Porter bonds for the SWP would not go into default, because they are ultimately backed by the State's taxing power. If, however, payments by water contractors were not able to pay the interest and principal on the Burns-Porter bonds, monies from the State's General Fund would be required for making payments on the bonds. The State would have less revenues available to support other worthwhile programs.

Overland Supply Plan

In the overland supply alternative, fresh water would be delivered overland to each management area within the Marsh. The water would be provided from a canal system similar to the North Bay Aqueduct, with an intake at Calhoun Cut or Lindsey Slough. The canal would be located north of and parallel to the Marsh. A distribution system would then deliver water to each major existing internal distribution system. Where there are no internal systems, a network of ditches and structures would be constructed. The overland supply system would require siphons under existing channels. Where the operating head was insufficient to deliver the necessary quantity of water, pumping plants would be required. The existing channels would operate as drains for the water discharged from the clubs. The quantity of water distributed would be about 200,000 to 300,000 acre-feet.

The canal from Calhoun Cut or Lindsey Slough would require a pumping plant at the point of diversion, because the canal would cross land higher than the Sacramento River and the Marsh. Operating the pumps would involve a major cost for energy consumption. The canal would cross the Jepson Prairie area, which is environmentally sensitive because of vernal pools and rare plants. In addition, parts of Calhoun Cut and Lindsey Slough have been designated as scenic or natural areas.



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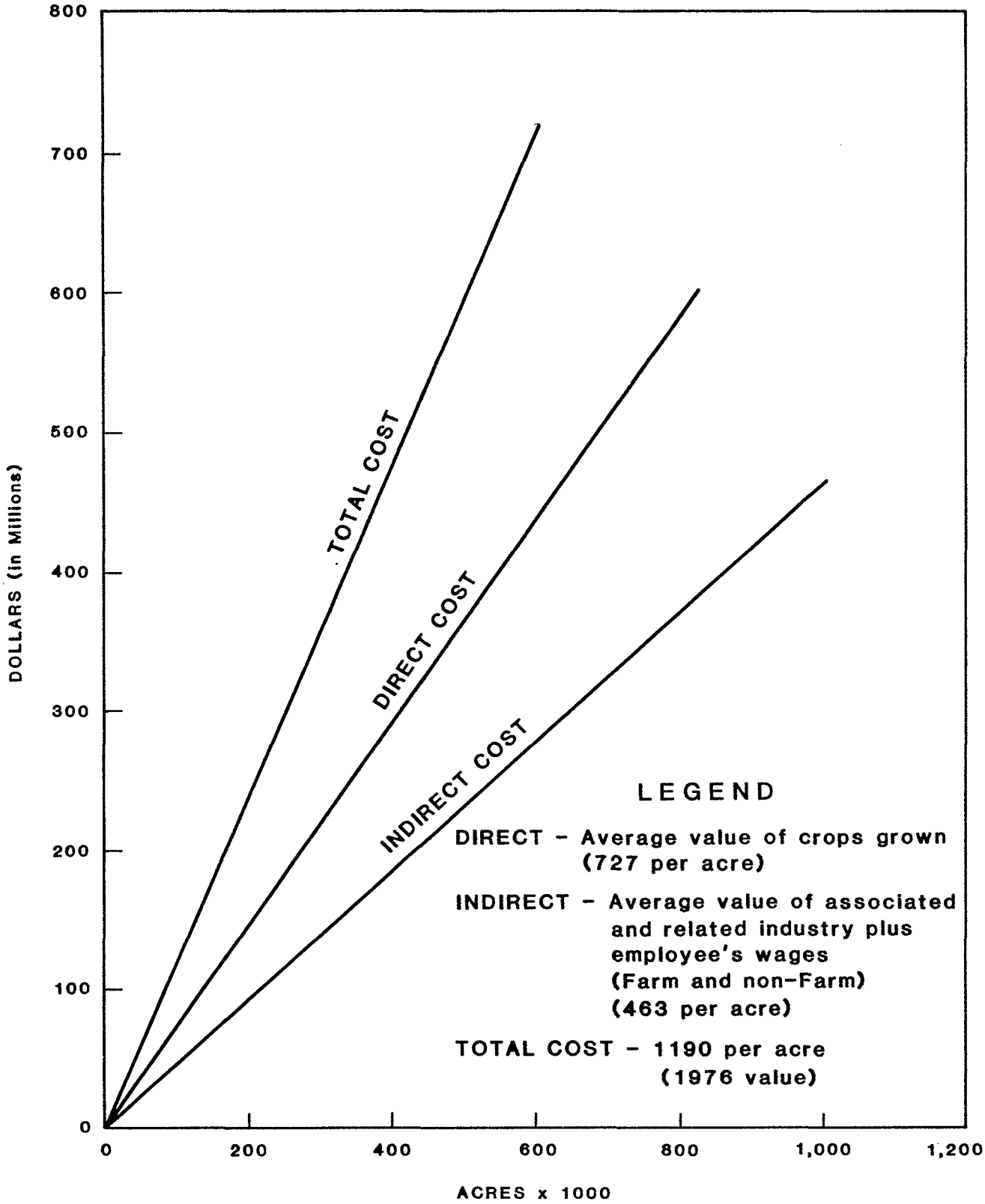
FIGURE 12a

# SUISUN MARSH

## ECONOMIC IMPACT OF ACREAGE TAKEN OUT OF PRODUCTION



Instead of constructing a separate canal, the project could have used the North Bay Aqueduct, which has its own pumping plant and canal facilities. This, however, would have required enlargement of the North Bay Aqueduct as far as Fairfield, with more land disturbance than the aqueduct was expected to involve. Because the alignment of the North Bay Aqueduct was north of Fairfield, this was no longer considered.

The U. S. Soil Conservation Service (SCS), in its 1975 report, evaluated a Suisun Marsh plan similar to this alternative. About 3.1 million cubic yards of earth would have to be moved to construct the conveyance system. This would be in addition to 1.4 million cubic yards of levee work. The levee cross sections within the Marsh would be increased to 7 feet high, with top widths of 25 feet.

In addition to these features, 25 sloughs would have to be blocked off, a major slough crossing constructed beneath Montezuma Slough, and the major drain ditches on the managed wetlands would require extensive work.

Construction of distribution canals and ditches would require the movement of about 2.8 million cubic yards of earth; this could increase to 3.1 million cubic yards when it becomes necessary to increase the height of the levees for proper functioning of those canals having inverts below sea level.

The distribution system evaluated by SCS had to be designed to handle the peak flow required to meet the maximum demand for water. October has the highest demand, necessitating delivery of 109,800 acre-feet of water. This required a design flow of 2,900 cubic feet per second for the initial section of the distribution canal.

Construction cost of "in Marsh" facilities was estimated at $22.9 million (in 1975 dollars). Based on experience in constructing the Initial Facilities, this amount is overly optimistic. Vast amounts of material would have to be removed and disposed of, and large volumes of fill material would be needed. This would require spoil dump sites and material borrow areas, with their environmental constraints.

Because the diversion point would be either Lindsay Slough or Calhoun Cut, both of which tap Sacramento River water, the water would have to be replaced on a one-for-one basis with project water to maintain salinity control below Rio Vista. In addition, salmon runs could be affected by use of Sacramento River water, because the salmon would stray from normal migration routes, causing delays that would affect future populations.

Implementing this plan would radically alter the nature of the Marsh, changing the managed area from brackish to freshwater habitat. This change would adversely affect the salt



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marsh harvest mouse, due to the loss of pickleweed, a brackish water plant.

In addition, this plan requires much more water than the other plans, degrades the water quality of existing channels, and isolates existing channels from their original water supplies. This would require significantly more Marsh habitat than with the Combination Plan. For the above reasons, this alternative was not considered further.

Combination Plan

Of the alternatives tested, the most cost effective and water efficient means of protecting the Marsh seems to be the staged construction of control and distribution facilities to move water throughout the Marsh. Staging of construction will include test periods to verify the need for and design of subsequent stages. This concept, combined with the availability of adequate quality water at Collinsville and appropriate club management, is the combination plan.

The distribution facilities of the combination plan are shown on Figure A in the Summary and Figure 16 in Chapter 5. They consist of inchannel control structures, which can act as tidal pumps or closures, and new or enlarged earthen channels to distribute water from the major marsh channels.

Within the Marsh, water would be controlled and distributed by Montezuma Slough and Goodyear Slough control structures, the Potrero Hills Ditch, and the Boynton-Cordelia Ditch connection. Water would be supplied to Simmons and Wheeler Islands by the Roaring River Slough Distribution System. Grizzly Island would be served by the Grizzly Island Distribution System. The western reaches of the Marsh would be served by the Cordelia-Goodyear Ditch and the Morrow Island Distribution System. In addition, onsite facilities would supply water to Annie Mason Island.

Four areas of the Marsh would not benefit by these facilities. They are the southwest tip of Grizzly Island, the southern end of Joice Island, the Van Sickle-Chipps Island area, and the channel islands.

The southernmost ends of Grizzly Island and Joice Island are unleveed and would remain natural marsh areas subject to daily tidal flooding. No attempt would be made to protect these areas from increased salinity.

Chipps Island, in the southeast corner of the Marsh is about 950 acres, divided among 3 owners who operate about 500 acres as managed wetlands. The water quality offshore of Chipps Island is expected to be adequate for many years. If degradation occurs in the future, facilities to provide better



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quality water may be required under terms of the DWR/DFG/SRCD contract. These facilities could take the form of overland channels diverting from Montezuma Slough, or relocation of individual diversion structures to the south side of the island. Diesel powered pumps may be required with relocated diversion structures. The more economically feasible option appears to be relocation of individual diversion structures. The cost of this option, including the provision of diesel powered pumps and fuel for the life of the facility, is estimated at $1,900,000. This estimate assumes that the existing main ditches are usable with a minimum of work. It also assumes that the clubs' existing drain facilities can be used.

The channel islands -- Roe, Ryer, Freeman, and Snag -- have a total area of 1,384 acres, about 60 percent of which is leveed. Their location in Suisun Bay makes it impractical to serve them directly by physical facilities. Providing sufficient Delta outflow to maintain the water salinity objectives there is not considered to be a beneficial use of water. The channel islands would continue to divert offshore water or revert to an uncontrolled or natural marsh area. Waterfowl habitat value on these islands is expected to decrease.

DWR regards the loss of habitat on the channel islands to be a significant effect of the diversions of water by the SWP, the USBR, and all other upstream diverters. The degradation would not be caused by the Plan of Protection for Suisun Marsh, because the plan was never designed to protect those islands. Further, the plan does not result in a decrease in minimum Delta outflow below levels permitted by the Interim standards of Decision 1485. Nevertheless this Plan of Protection examines various posibilities for including mitigation for the loss of habitat on the islands in the Plan because consideration and approval of the Plan provides an opportunity to mitigate a significant effect of past commitments to proceed with the State Water Project.

The Suisun Marsh Technical Committee, using the point scale habitat evaluation procedure, determined that the acquisition and development of 580 acres of new wetlands would be appropriate mitigation for the impacts of both the SWP and the CVP. DWR's portion is assumed to be 290 acres. If the value of the wetland habitat on the offshore islands is diminished by the actions of others, the computation of appropriate mitigation for the CVP and SWP should be reevaluated. Following is the assumed range of options for DWR's share of this mitigation.

- DWR could provide funds to DFG to purchase wetlands to compensate for the potential loss of habitat on the offshore islands due to the impact of the SWP. The amount to be provided would not be discounted to compensate for its being an "up-front" payment.



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- DWR could provide funds to DFG to purchase wetlands to compensate for the potential loss of habitat on the offshore islands due to the impact of the SWP. The amount to be provided to DFG would be discounted to compensate for its being an "up-front" payment.

- DWR could provide funds to DFG to purchase and develop wetlands to mitigate for loss of habitat on the offshore islands when such loss of habitat can be demonstrated to have occurred.

- DWR might not mitigate for the loss of wetlands on offshore islands in the event that none of the mitigation options are feasible.

Selection among these options will be made through negotiation of a Memorandum of Understanding between DWR and DFG and through actions by SWRCB and other regulatory agencies. DFG considers the no mitigation option unacceptable.

## Alternative Water Sources

The sources of water that have been reviewed as possible supplies to improve the quality of Suisun Marsh include water from the Sacramento River basin, reclaimed municipal and industrial waste water from southern Solano County and eastern-central Contra Costa County, ground water, and agricultural drainage (see Figure 13).

The use of treated waste water from any source must be acceptable to the State Department of Health Services and the San Francisco Regional Water Quality Control Board.

### Sacramento River Basin

Possible sources of water from the Sacramento River Basin include the West Sacramento Valley Canal, Sacramento treated waste water, a diversion through Lindsey Slough, Calhoun Cut, Putah South Canal, North Bay Aqueduct, and a diversion from the Sacramento River near Collinsville.

West Sacramento Valley Canal. The proposed West Sacramento Valley Canal Unit is being reformulated by the U. S. Bureau of Reclamation (USBR) using the federal Multiple Objective Planning Principles and Standards planning procedures. The unit would connect the Tehama-Colusa Canal, now under construction, to the Federal Solano Project distribution facilities operated by Solano Irrigation District (SID). The proposed project could deliver water directly to Solano and Yolo counties and, by exchange, to Lake and Napa counties. Because of the uncertainty of construction of the West Sacramento Valley Canal, it has not been considered available to provide supplemental water to Suisun

Marsh. If its development becomes feasible, the Marsh could become a project service area should supplemental fresh water be needed in the future.

Sacramento Treated Waste Water. By the year 2000, a maximum of about 183,000 acre-feet of treated waste water from the Sacramento Regional Wastewater Treatment Plant could be made available each year for use in Solano County. The distribution of treatment plant effluent by month is shown below.

| Suisun Marsh | | Agriculture | |
|---|---|---|---|
| Month | Acre-Feet | Month | Acre-Feet |
| October | 16,500 | April | 14,500 |
| November | 14,500 | May | 14,500 |
| December | 14,500 | June | 14,500 |
| January | 14,500 | July | 16,500 |
| February | 14,500 | August | 17,000 |
| March | 14,500 | September | 17,000 |
| Subtotal | 89,000 | Subtotal | 94,000 |
| Total | 183,000 acre-feet | | |

Waste water from Sacramento would be siphoned under the Sacramento River and conveyed through the Yolo Bypass and along the old Sacramento Northern Railroad alignment for delivery to four subareas: High Prairie, Reclamation Districts, Montezuma Hills, and Montezuma Slough (Figure 14). The preliminary design of this system has been developed by the firm of CH2M Hill and Associates under contract with SID.

The period of use of treated waste water in marsh channels depends on the SWRCB, the San Francisco Bay Regional Water Quality Control Board (SFRWQCB), and the State Department of Health Services (DHS). These agencies establish discharge criteria. Discharge of treated waste water to the Marsh is restricted to October through May.

Sacramento treated waste water, which is currently discharged to the Sacramento River, is projected to have a quality suitable for restricted agricultural use. This treated waste water is included in the estimate of total Delta inflow. Its diversion into south-central Solano County would require full replacement to maintain salinity repulsion outflow for the western Delta. Using Sacramento treated waste water in the Marsh would reduce any health hazard to municipal water users downstream from the Sacramento outfall and could eliminate the need for additional advanced treatment. The plan was not, however, considered further because costs of the conveyance system are extreme and such use would require the release of stored project water in dry and critical years to maintain Delta standards. Also, use of Sacramento treated waste water in the Marsh is not recommended, because other alternatives require less water for Delta outflow.



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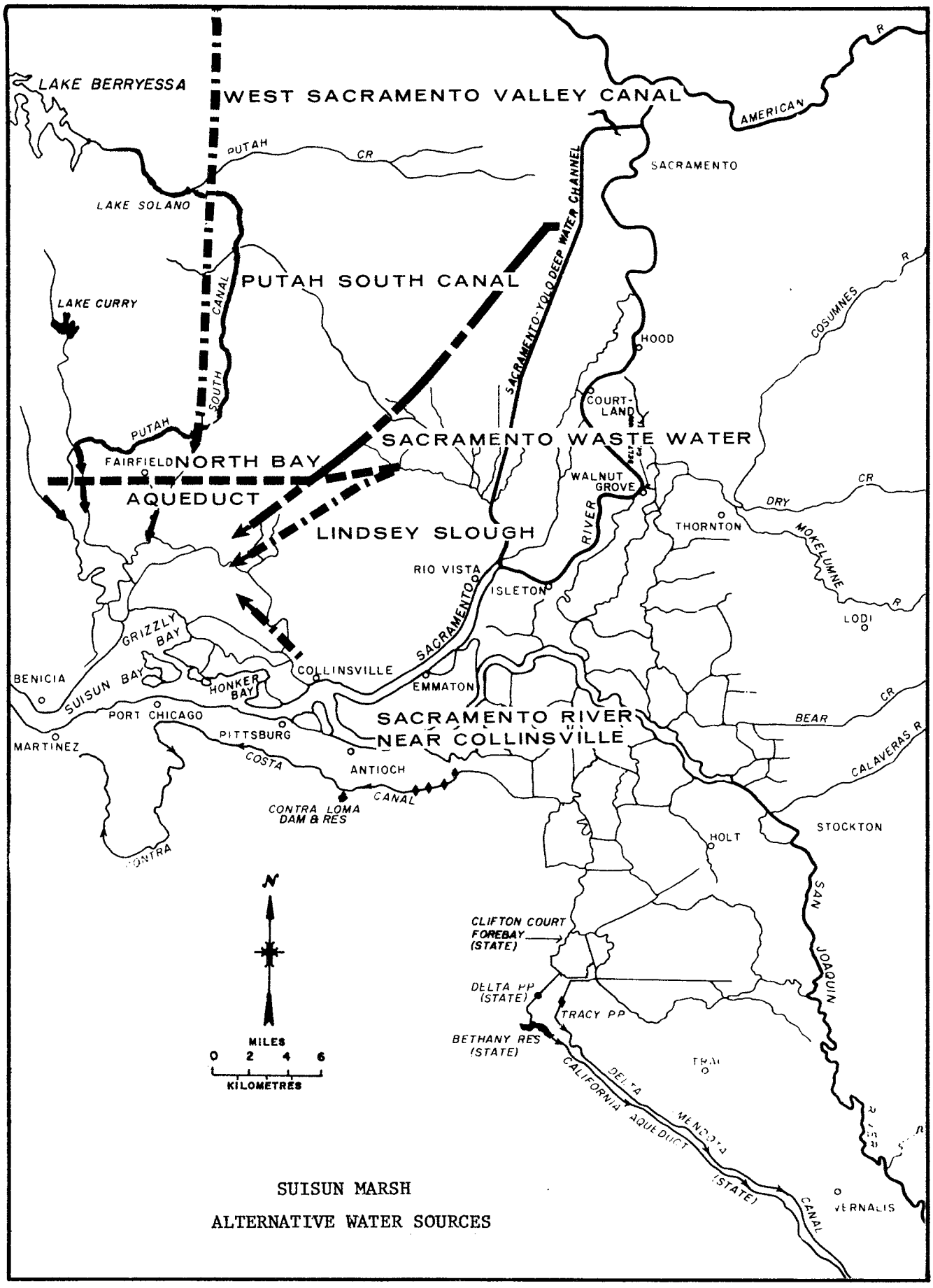
FIGURE 13




SUISUN MARSH

ALTERNATIVE WATER SOURCES

Lindsey Slough Diversion. Diversions from Lindsey Slough to the Marsh were first investigated in 1935 and were reported to the Board of Supervisors of Solano County by Joseph E. Spink (Engineer). These same diversions from Lindsey Slough to the Marsh were later evaluated as part of USBR's "Montezuma Hills Unit Appraisal Report", October 1971. Water could be tidally pumped, then flow by gravity from Lindsey Slough, east of the area designated "natural area" in the Resources Agency's "Delta Master Recreation Plan" (1976) through the Denverton Channel to a control structure on Denverton Creek, which is a tributary to Montezuma Slough. This system would serve the eastern Marsh and agricultural lands in the south-central county area. The system could also serve as an alternative means of delivering water developed by the West Sacramento Valley Canal Unit to the southeastern portion of the county. The USBR has estimated that the maximum volume required in drier years, when salinity intrusion is greatest, would be as high as 300,000 acre-feet. All water diverted from Lindsey Slough would require a one-for-one replacement at Rio Vista for control of Delta salinity intrusion.

In addition, parts of Lindsey Slough have been designated as scenic or natural areas. The Jepson Prairie area is environmentally sensitive because of its vernal pools and rare plants. Delay in preparation of the Lindsey Slough Diversion feasibility reports could be expected due to environmental and cultural concerns.

Using Sacramento River water at Lindsey Slough in the northern portion of the Marsh would have an effect on the marsh vegetation and on fish migration. The change in local vegetation would be from a brackish water to fresh water vegetation, which would be especially detrimental for the salt marsh harvest mouse because of the loss of pickleweed, its major habitat. The upstream migration of fish would be affected due to confusion and straying from normal migration routes, ensuring migration delays. In addition, the cost in dollars and impacts on both upstream and marsh environments were considered excessive. For these reasons, the Lindsey Slough diversion was not considered further.

Putah South Canal. Putah South Canal is one of the principal facilities of the Federal Solano Project. It has a design capacity sufficient to provide the estimated Solano Project yield plus supplemental water that could come from Lake Berryessa, the proposed West Sacramento Valley Canal, and ground water supplies. The canal provides a means of supplying agricultural, municipal, and industrial water to the western portion of Solano County. It can also deliver water to the northwestern portion of the Marsh by releasing water into Green Valley, Suisun, and McCoy creeks.

The canal could develop additional yield through use of surface and ground water. Canal operation could be used to distribute additional water to the western area of the Marsh. Because the capacity of Putah South Canal has been committed, the use of this physical facility was not considered further.



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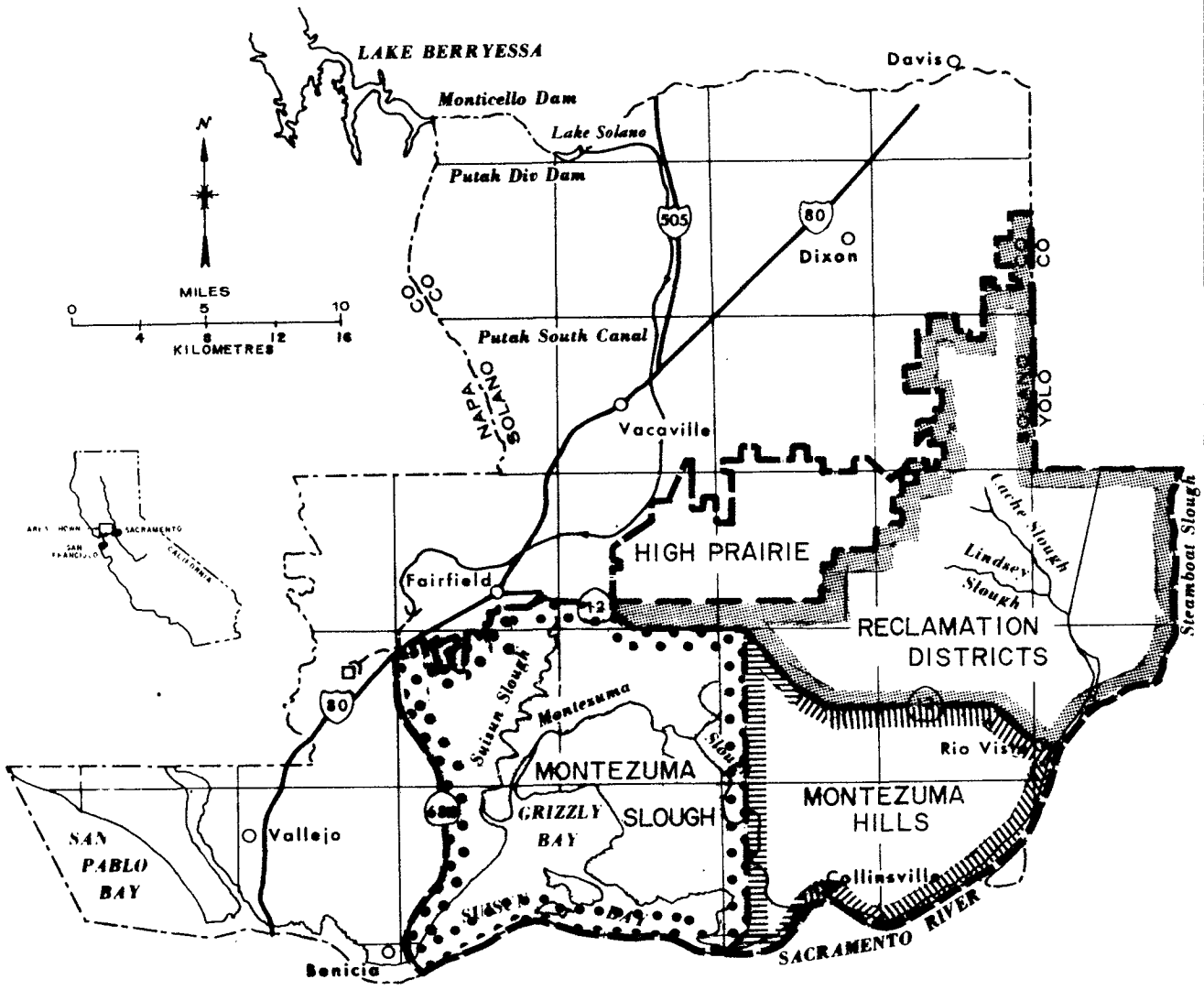


**TREATED WASTE WATER SUBAREAS**

Planned North Bay Aqueduct. The North Bay Aqueduct will be one of the principal facilities of the SWP. It will have a design capacity of 120 cubic feet per second and will have its intake on Cache Slough north of Hastings Cut. The pipeline will run west from the intake to the abandoned Sacramento Northern Railroad right of way, and will follow the right of way southwesterly to tie into the existing Phase I facilities.

The design capacity of the North Bay Aqueduct would have to be increased to 450 cubic feet per second to meet the needs of the west portion of the Marsh, an increase to over 3.5 times its current design capacity. This would delay completion of design and the construction schedule, and would also affect construction and right of way costs.

Construction of North Bay Aqueduct inlet structures on Cache Slough would require approach channel improvements to enable the additional quantity of water to pass through. These improvements would convert dry farmland and present wetland into surface water or ditches, which could have an adverse environmental impact.

All water diverted from the North Bay Aqueduct for salinity control in the Marsh would require a one-for-one replacement at Rio Vista for Delta salinity control.

Using the good quality Sacramento River water available from the pipeline in the northwesterly and westerly portion of the Marsh would have adverse effects on marsh vegetation in the vicinity of the discharge and on fish migration. Vegetation would change from brackish water to freshwater species, which would be especially detrimental for the salt marsh harvest mouse because of the loss of pickleweed, its major habitat. Upstream migration of fish would be delayed because fish would become confused and would stray out of normal migration routes.

The cost of replacing water, additional capacity, right of way, pumping, and impacts on the environment were all considered excessive. For these reasons this supply alternative was not considered further.

Sacramento River near Collinsville. Water could be tidally pumped into Montezuma Slough and forced to flow west toward Grizzly Bay by a control structure located near the eastern end of Montezuma Slough, about 1.5 miles north of the Sacramento River. The normal flow in the slough at low Delta outflow levels is easterly from Grizzly Bay toward Collinsville, with an average rate of 300 cubic feet per second in the reach between the Roaring River Slough intake and Collinsville. Reversing this flow would convey the better quality water available at Collinsville throughout the Marsh, reducing the effect of salinity intrusion. The degree of reduction in marsh salinity would depend on the quantity diverted and the quality at Collinsville, which in turn would depend on Delta outflows.



C—053687

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Not all water diverted into Montezuma Slough would need to be replaced, because it would already have accomplished much of its salinity control function and would become available again at Benicia. A mathematical analysis was made to determine the net impact of the diversion on Delta outflow. The maximum flow pumped into Montezuma Slough from Collinsville is expected to be 2,100 cubic feet per second. About 20 percent (420 cubic feet per second) may need to be replaced when needed to maintain salinity control in the river west of Collinsville from September through May. The analysis also shows that the plan would increase the surface level of Montezuma Slough about 6 inches at high tide at the control structure when it is operating and in the closed position. This increase would diminish with distance from the control structure. There would be no increase at Nurse Slough. The increase would not damage levees or cause any adverse impacts, because the control structure is expected to be operated only at times of low outflow, when the levees have ample freeboard.

The Montezuma Slough control structure would interrupt eastward flows of water from Suisun Bay. As a consequence, at low flows through the control structure, a net reduction of salinity would be expected between Collinsville and the areas where salinity is now increased by the 300 cubic foot per second eastward flow in Montezuma Slough.

## Solano County Treated Waste Water

Sources of reclaimed municipal and industrial treated waste water have been considered for use in Suisun Marsh and other areas of Solano County. The quantities of municipal and industrial waste water produced in Solano County in 1978 included:

| | Acre-Feet |
|---|---|
| Fairfield-Suisun | 10,100 |
| Vacaville | 6,400 |
| Benicia | 1,200 |
| Vallejo | 9,600 |
| Dixon | 800 |
| Rio Vista | 500 |
| Total | 28,600 |

Waste water from eastern and central Contra Costa County could also be made available (Figure 15).

Direct discharge of treated waste water into the Marsh to maintain desired salinity levels would depend on obtaining discharge permits from the San Francisco Regional Water Quality Control Board, which considers each request on its own merit, and on concurrence of the State Department of Health Services.



C—053688

C-053688

Fairfield. Because effluent from the Fairfield subregional treatment plant is not part of the Delta supply to the Central Valley Project and State Water Project, use of this source would not require replacement to maintain salinity repulsion for the western Delta. A 3-mile channel with a capacity of 46 cubic feet per second would convey the treated waste water from the terminus of an existing 48-inch effluent pipe to Cordelia Slough.

The treatment plant began operation in October 1976. Annual treated waste water output was 10,000 acre-feet in 1978 and is estimated to be 14,930 acre-feet by 1984 and 22,840 acre-feet by 2000, depending on the rate of increased municipal and industrial use. The effluent undergoes tertiary treatment before discharge.

A contract between Solano Irrigation District (SID) and the city of Fairfield calls for the first right of refusal of this water by SID from April through September. This supply is available for irrigation of field crops during that period. The remainder would be about 6,700 to 10,000 acre-feet by the year 1984, and 13,600 to 17,500 acre-feet by 2000. It would be available for delivery to the Marsh from October through March.

Under provisions of the contract between SID and Fairfield, and under the terms of the discharge permit granted by the Regional Water Quality Control Board, Fairfield is discharging tertiary treated waste water to Suisun Marsh for waterfowl habitat management. A 4-year demonstration project was developed by the USBR, using treated waste water to flood certain management areas within the Marsh. The suitability of this source of water has been proven by the study, with certain provisions. Approval by the Regional Board and the Department of Health Services may also depend on results of the demonstration project. To use the treated waste water for management of wetlands, separate agreements have been made with three duck clubs. These agreements may need to be amended to allow use of this source of water in other areas of the Marsh.

Vacaville. The amount of waste water treated by the city of Vacaville will increase from about 6,400 acre-feet in 1978 to 9,700 to 12,000 acre-feet in 2000, depending on the increase in the rate of municipal and industrial use. The treatment plant is being upgraded to handle projected increases in effluent and to facilitate the reuse of treated waste water for irrigation of a greater variety of crops. During the winter, some plant effluent will be stored for irrigation during the following spring and summer. The plant effluent will generally be used by Solano Irrigation District and Maine Prairie Irrigation District. Excess water will be discharged to Barker Slough.

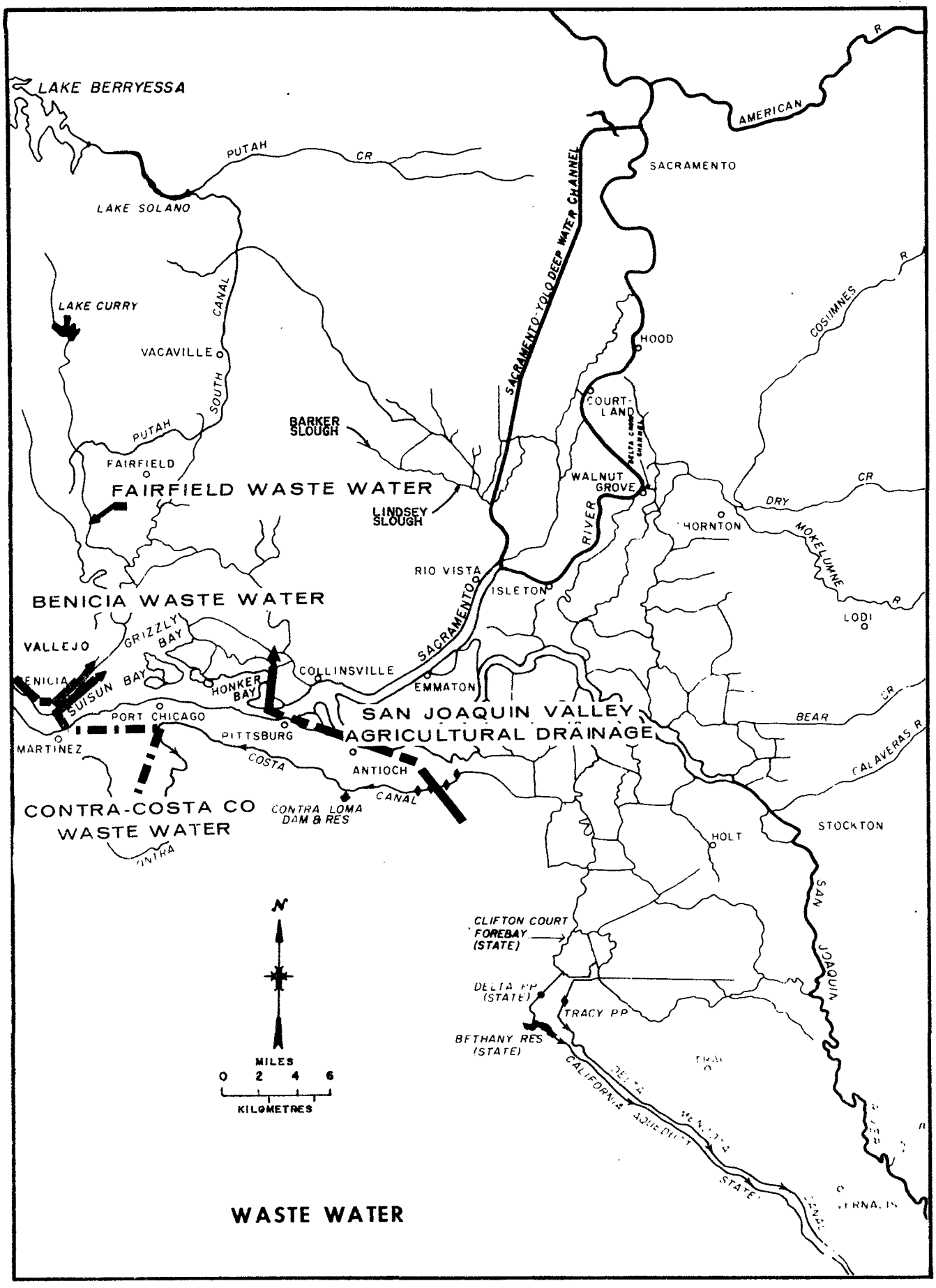
Benicia. The 1978 effluent for the city of Benicia of about 1,200 acre-feet per year is projected to increase to about 3,100 acre-feet by 2000. The rate of discharge is almost constant at about 1.5 cubic feet per second. The flow of Sulphur Springs



C—053689

C-053689

FIGURE 15


LAKE BERRYESSA
PUTAH
CR
LAKE SOLANO
LAKE CURRY
CANAL
VACAVILLE
SOUTH
PUTAH
FAIRFIELD
FAIRFIELD WASTE WATER
BARKER SLOUGH
LINDSEY SLOUGH
SACRAMENTO-YOLO DEEP WATER CHANNEL
SACRAMENTO
AMERICAN
R
HOOD
COURT-LAND
WALNUT GROVE
RIVER
COSUMNES
R
DRY
CR
THORNTON
MOKELUMNE
R
LODI
RIO VISTA
ISLETON
BENICIA WASTE WATER
VALLEJO
GRIZZLY BAY
SUISUN BAY
HONKER BAY
COLLINSVILLE
EMMATON
SAN JOAQUIN VALLEY AGRICULTURAL DRAINAGE
PORT CHICAGO
PITTSBURG
MARTINEZ
COSTA
ANTIOCH
CANAL
CONTRA LOMA DAM & RES
CONTRA-COSTA CO WASTE WATER
BEAR
CR
CALAVERAS R
STOCKTON
HOLT
SAN JOAQUIN
CLIFTON COURT FOREBAY (STATE)
DELTA PP (STATE)
TRACY PP
BETHANY RES (STATE)
CALIFORNIA AQUEDUCT
STATE
N
MILES
0 2 4 6
KILOMETRES
WASTE WATER

Creek, controlled by Lake Herman, could augment the treated waste water flow during years of above normal runoff. The quality of the treated waste water is or can be made acceptable for both industrial and Suisun Marsh use. Because the quantity is small, it could only influence the southern end of Goodyear Slough. It has, therefore, not been considered a practical source of supply.

Vallejo. About 9,600 acre-feet now available from the Vallejo Waste Water Treatment Plant is expected to increase to from 10,500 to 13,900 acre-feet by the year 2000, depending on the rate of municipal and industrial use. A 23 cubic foot per second pipeline and a pumping plant would be required to transport treated waste water from the city plant to Goodyear Slough, near Lake Herman Road northeast of Benicia Creek, where it would be used exclusively for Marsh management. Additional treatment to remove nitrogen would be required prior to discharging the waste water into marsh channels. Benicia Industrial Park is also interested in using this water. It has, therefore, not been considered a source of water for the Marsh.

## Contra Costa County Waste Water

Treated waste water from eastern and central Contra Costa County could be conveyed to Solano County. The collected waste water could either be piped across the Benicia bridge or siphoned under the channel.

An annual quantity of 62,000 acre-feet would be available by the year 2000. Only about 12,000 acre-feet, however, could be considered available to the Marsh, because plans have been made to reclaim the remainder for other purposes. Because water quality considerations would limit the use of this water from October through May, only 7,000 acre-feet could be used in the Marsh. The cost of such a proposal would be prohibitive and, therefore, this option was not evaluated further.

## San Joaquin Valley Agricultural Drainage

The planned point of disposal for the San Joaquin Valley Drain is the western Delta near the city of Pittsburg. The quality and quantity of water to be discharged into the western Delta depends on the amount of reuse within the valley and the area being drained. The projected drainage volumes and quality for the critical months in the Marsh for 1990 are:



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| | San Luis Drain | | Valleywide Drain | |
|---|---|---|---|---|
| | Volume (Acre-feet) | Water Quality (TDS-ppm) | Volume (Acre-feet) | Water Quality (TDS-ppm) |
| October | 1,800 | 6,300 | 7,900 | 4,700 |
| November | 1,200 | 7,000 | 5,300 | 5,200 |
| December | 900 | 7,000 | 3,400 | 5,200 |
| January | 900 | 7,300 | 3,400 | 5,400 |
| February | 2,100 | 6,800 | 9,200 | 5,000 |
| March | 2,700 | 7,200 | 11,900 | 5,300 |
| April | 3,600 | 6,800 | 15,800 | 5,000 |
| May | 3,600 | 7,000 | 15,800 | 5,200 |
| Total | 16,800 Acre-feet | | 72,700 Acre-feet | |

This drainage water could be siphoned under the channel near Chipps Island and conveyed north across Chipps and Van Sickle islands to Montezuma Slough, north of the proposed control structure. The drain water could then be tidally pumped up Montezuma Slough and distributed throughout the Marsh by tidal action.

Although this water supply is partially a new source and would not require replacement to meet quality standards in the western Delta, it is brackish and of less value in freshening Suisun Marsh than are other alternative sources. As part of the Interagency Drainage Program, the Department of Fish and Game and the U. S. Fish and Wildlife Service plan to use this water for new marshes for the San Joaquin Valley.

The following factors eliminated this source from further consideration:

- The uncertainty of drain construction.
- The salinity of the discharge.
- The nature of the chemical constituents (boron, heavy metals, fertilizers, pesticides) that may have unknown effects on Suisun Marsh waters and soils.
- The cost of siphoning under the channel.
- The fact that the water would not be available by 1984.

If the drain is eventually developed, however, water from it could be considered for replacing water diverted into the Marsh from the Sacramento River at Collinsville. Studies would have to show that the water quality was adequate and that it posed no threat to public health. The quality of the agricultural drainage water now projected appears questionable for waterfowl food plants.



C—053692

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## Chapter 5. FACILITIES AND WATER SUPPLY FOR COMBINATION PLAN

A mathematical model was developed by Hugo Fischer, Inc., under contract to the U. S. Bureau of Reclamation (USBR) to simulate channel hydraulics and salinities and to predict pond salinities on individual ownerships in the Marsh. The Suisun Marsh model is actually two models--one for flow and one for quality. The model was used to compare alternative facilities, supplemental water supplies, and management techniques, including:

- Filling the ponds by mechanical pumping at low tide versus flooding at high tide.
- Introducing imported water directly to club ponds via canal versus releasing the imported water into the sloughs for transport to the club ponds.
- Increasing flow within Montezuma Slough by construction of tidal gates near Collinsville.
- Revising intake and discharge structures for filling the ponds.
- Changing the routing of water in Cordelia, Goodyear, and Roaring River sloughs by constructing barriers or new channels.
- Modifying duck club soil-leaching operations to reflect practices recommended by the Soil Conservation Service and Department of Fish and Game.
- Evaluating the optimum size and desirable sequence of construction of facilities.
- Evaluating the impacts on the Marsh of various proposed revisions to the Decision 1485 water quality standards.
- Using various combinations of these.

The model was designed to simulate a 280-day period beginning on September 1 and ending on June 6. During the hunting season, the duck club land is flooded and water is circulated. When the season is over, club land is drained. During the spring months the land is alternately flooded and drained to flush out soil salts. Between June 6 and September 1, most of the duck clubs are dry.



C—053693

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Each model run included assumptions of base conditions for rainfall, evapotranspiration, and local inflow from Green Valley, McCoy, and Suisun creeks. Base conditions were varied depending on the year type being studied. Some of the base condition years used were 1931, 1952, 1955, 1957, 1966, and 1977.

The 1931 historical hydrology was used in simulating the minimum outflow to meet Delta standards during a critically dry year. The resulting salinity at Collinsville and the mouth of Suisun Slough represented the highest salinity water available to the Marsh. The facilities needed to be included in the Combination Plan to meet Decision 1485 post-1984 standards with this outflow were determined by making a series of model runs.

Facilities of the Combination Plan (see Figure 16) will convey and distribute water from Collinsville to meet water quality standards in the marsh channels and lands with the least impact on marsh wetlands. It is essential that the facilities of the Plan be adequate to assure compliance with the Decision 1485 post-1984 standards even in critically dry years. Relaxations of the Decision 1485 post-1984 standards are not proposed in isolated dry or critically dry years, or in the first of a series of dry or critically dry years.

Figures 17 and 18 present results of model studies on salinity within marsh channels, without and with operation of the Combination Plan. The assumption of the model studies used to develop those figures included a critical year hydrology, the year 2020 level of development, and meeting post-1984 Decision 1485 water quality and flow standards in the western Delta and Suisun Bay only. These studies also demonstrated (Figure 18) that Marsh criteria could be met at the interior Marsh control points with the configuration of a Montezuma Slough tidal pump, Potrero Hills Ditch, Boynton-Cordelia Ditch and Goodyear Slough facilities.

Existing standards for two control points -- S-36 and at the western mouth of Montezuma Slough -- could not be met with the proposed facilities. However, lands near these control points are to be serviced with quality water by overland facilities, the Morrow Island Distribution Facilities, and Grizzly Island Ditch, rather than directly from the channels and Grizzly Bay.

Locations of the salinity monitoring stations are shown on Figures 8 and 16.

The Corps of Engineers' Bay-Delta hydraulic model was used in conjunction with USBR stage recorders located within the Marsh to make a number of determinations for verification of model output from the Hugo Fischer mathematical model. These determinations consisted of the direction of flow of Montezuma Slough, the location of a null zone if one existed, the time the tide reached its peak, and the selection of the approximate location for the control structure. This information was used for verification of data and put into the mathematical model being used for present determination of present conditions.



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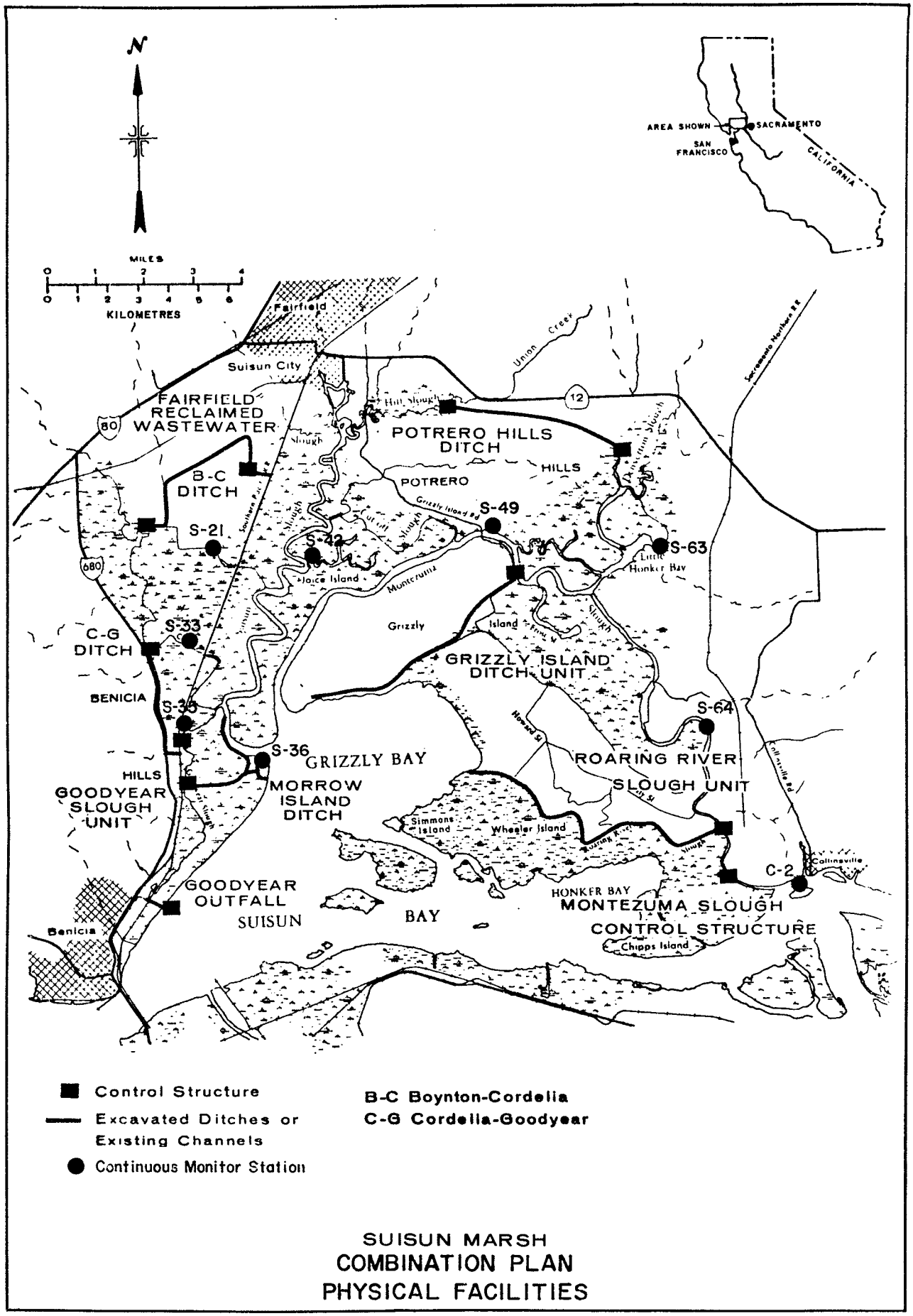


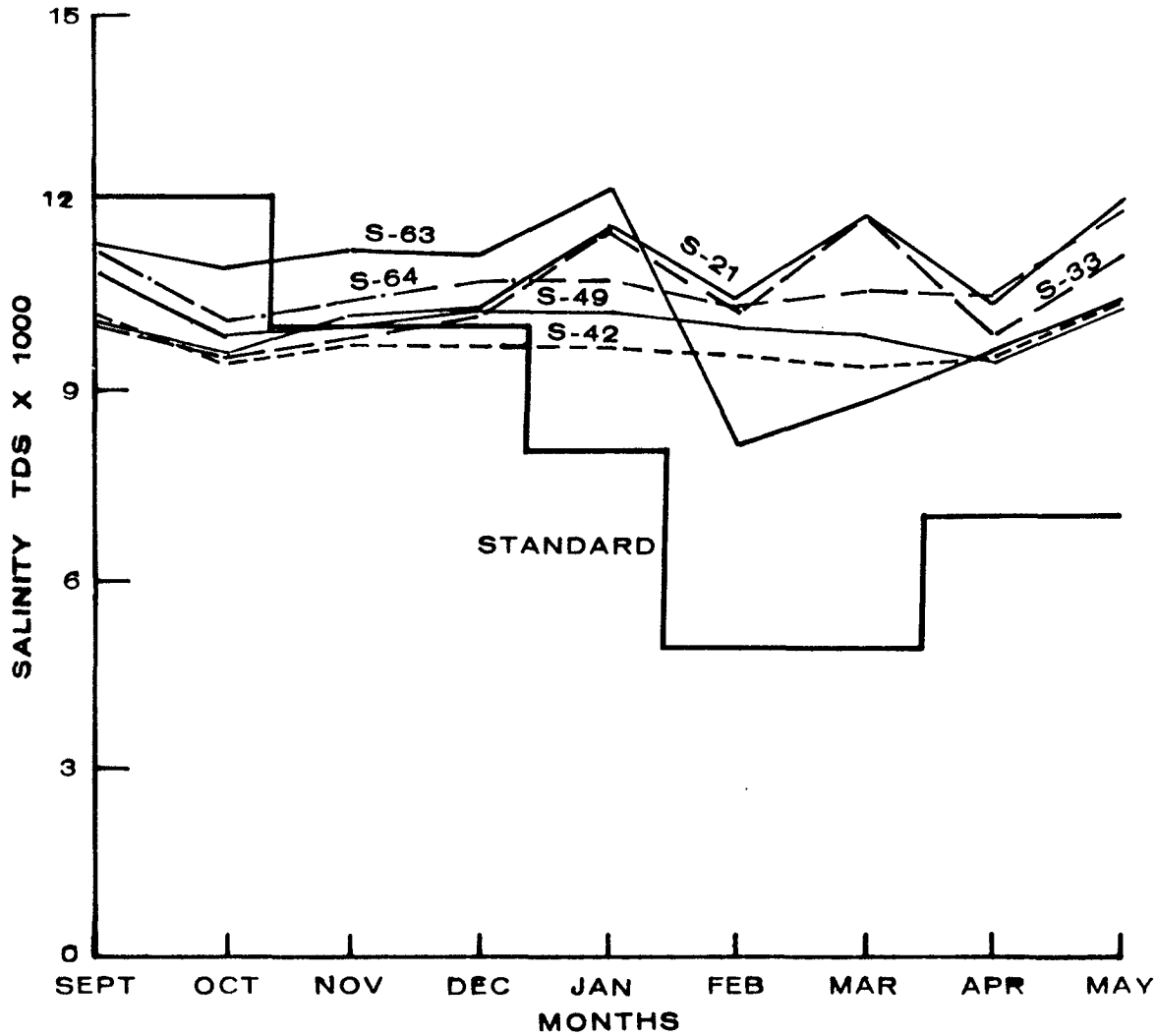

SUISUN MARSH
COMBINATION PLAN
PHYSICAL FACILITIES





C-053695

FIGURE 17




Note: Includes duck club discharge

SUISUN MARSH

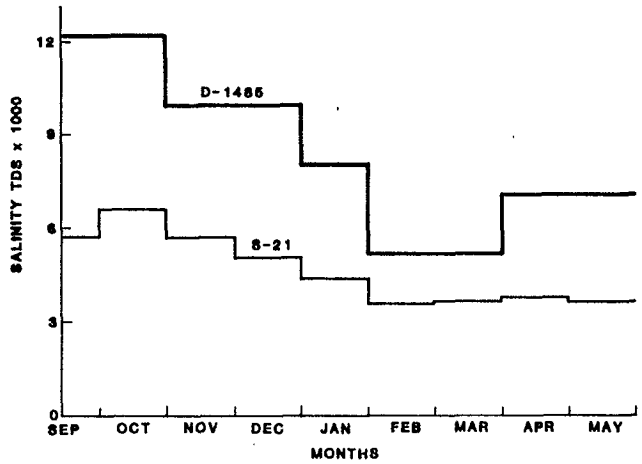
**SUISUN MARSH WITHOUT MANAGEMENT FACILITIES**
**SALINITY AT HIGH TIDE IN YEAR 2020**
**MEETING DECISION 1485 DELTA STANDARDS DURING CRITICAL YEAR**

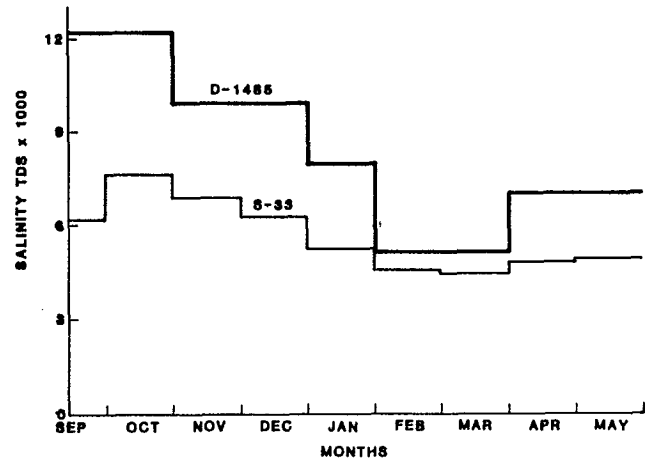


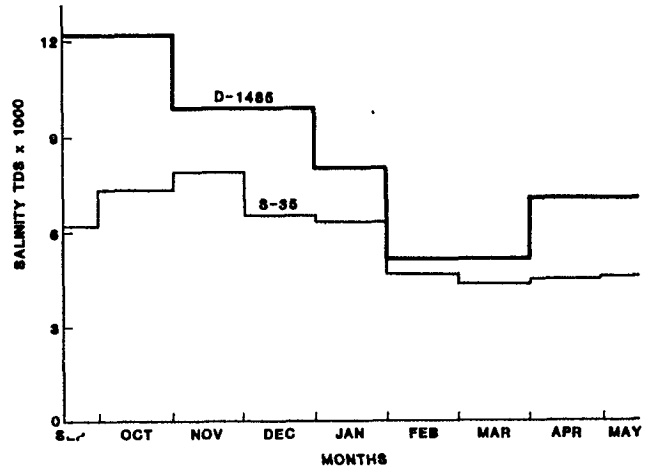
C—053696

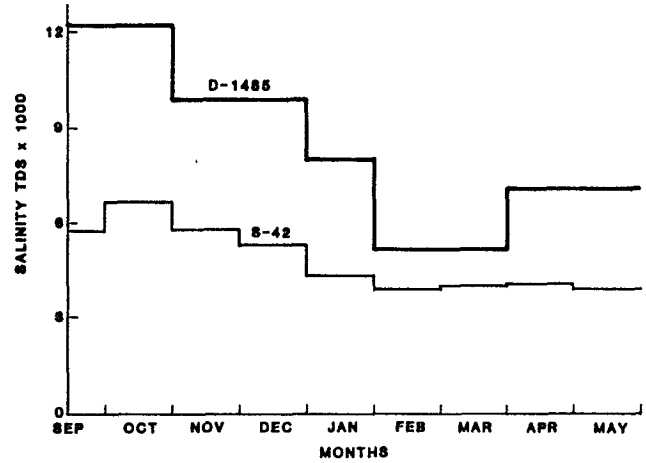
C-053696

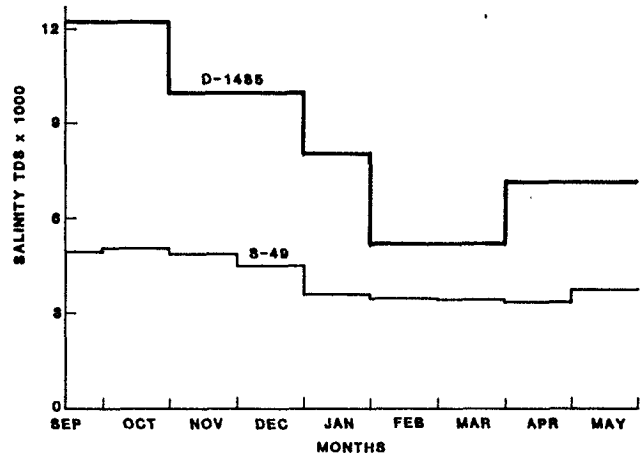
FIGURE 18

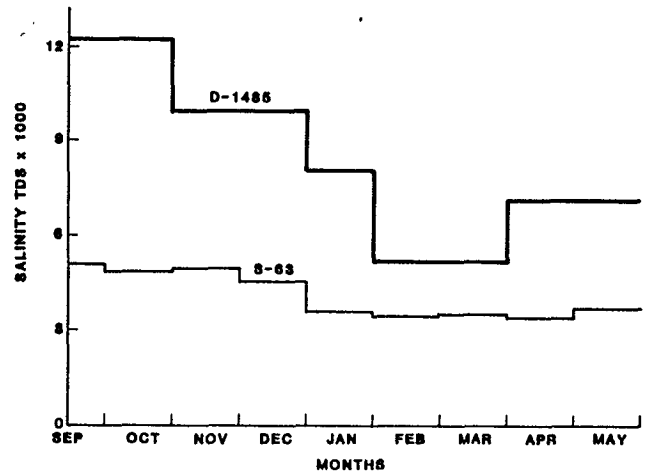


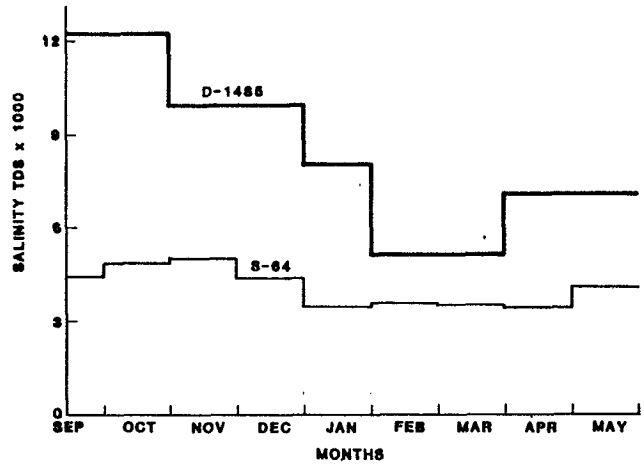




**SUISUN MARSH**

**SUISUN MARSH SALINITY WITH MANAGEMENT FACILITIES**
**SALINITY AT HIGH TIDE IN YEAR 2020**
**MEETING DECISION 1485 DELTA STANDARDS DURING CRITICAL YEAR**

## Facilities

Facilities included in the Combination Plan and their estimated costs, based on the January 1982 index, are:

| | Construction and Right of Way ($1,000) | Annual OM&R ($1,000) |
|---|---|---|
| Potrero Hills Ditch | 32,462 | 9 |
| Montezuma Slough Control Structure | 13,400 | 152 |
| Grizzly Island Distribution System | 19,400 | 56 |
| Boynton-Cordelia Ditch | 19,200 | 7 |
| Goodyear Slough Facilities* | 6,300 | 19 |
| Initial Facilities** | 12,160 | 117 |
| Annie Mason Island Pump Facility | 35 | 20 |
| Lower Joice Island Facility | 20 | |
| Cygnus Area Facility | 20 | |
| Mitigation lands | | |
| Acquisition | 3,000 | -- |
| Development | 7,000 | 110*** |
| Total Estimated Cost | 112,997 | 490 |
| Monitoring Program-All Facility | | 340 |
| Total | 112,997 | 830 |

* Goodyear Slough Facilities includes Cordelia-Goodyear Ditch and Goodyear Slough Control Structure.
** Includes Roaring River Distribution System, Morrow Island Distribution System, and Goodyear Slough Outfall.
***DFG pumping costs are not included.

Note: For additional costs, see Implementation Schedule Figure 33, Page 107.

The cost estimates do not include on-club inlet and outlet structures requiring enlargement or relocation. The number of structures and their locations are being determined by the Suisun Resources Conservation District (SRCD).

A description of the facilities and their operating criteria follows.



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Montezuma Slough Control Structure

The Montezuma Slough Control Structure, shown in Figures 19 through 24, would be the keystone to the entire Marsh management system. During periods when Delta outflow would not be sufficient to produce the water quality needed for proper management of the Marsh, the gates would be used to tidally pump water from the Sacramento River near Collinsville into Montezuma Slough to be distributed through the Marsh by the other facilities.

In a water year when operation of the structure was needed from September through May (and when deficiencies have not been declared under the DWR, DFG, and SRCD contract) about 1,122,000 acre-feet would be tidally pumped, and the salinity level within Montezuma Slough would be improved by about 5,000 ppm TDS. Operation of the control structure is based on the tidal differential at the structure. On the incoming tide, the flow in Montezuma Slough at the structure is generally from east to west, which moves the quality water from the Sacramento River near Collinsville into Montezuma Slough. On the outgoing tide, the flow in Montezuma Slough is generally from west to east under low flow conditions, moving the low quality water from Grizzly Bay into the Marsh. The resulting net mean flow is from west to east at 300 cubic feet per second.

When the control structure is tidally pumping, the gates will be open when Montezuma Slough flow is from east to west, allowing the quality water from the Sacramento River to enter the Marsh. When the natural flow in Montezuma Slough would be from west to east without the control structure, the gates will be closed, stopping the flow to the east and forcing the water to flow westerly. This traps the quality water and forces it to flow into the Marsh. This process is repeated with each tidal cycle and is sufficient to move an average daily flow of 2,100 cubic feet per second, or 125,000 acre-feet per month, into Montezuma Slough. In combination with other facilities, this is adequate to maintain water quality within the Marsh.

A concrete control structure with three radial gates would be constructed at Montezuma Slough about 1.5 miles from its eastern end to take advantage of a relatively good marsh foundation. The structure would include both a boat lock 70 feet long and 20 feet wide and a 60-foot-wide flashboard opening for emergency access. The control structure, to be built in the dry land east of Montezuma Slough, would include approach channels and a closure for the existing slough. Economic reasons and the need to keep normal flows in Montezuma Slough during construction have dictated this method. The closure would be located where best foundation conditions are found. Public recreation facilities at the structure are proposed.

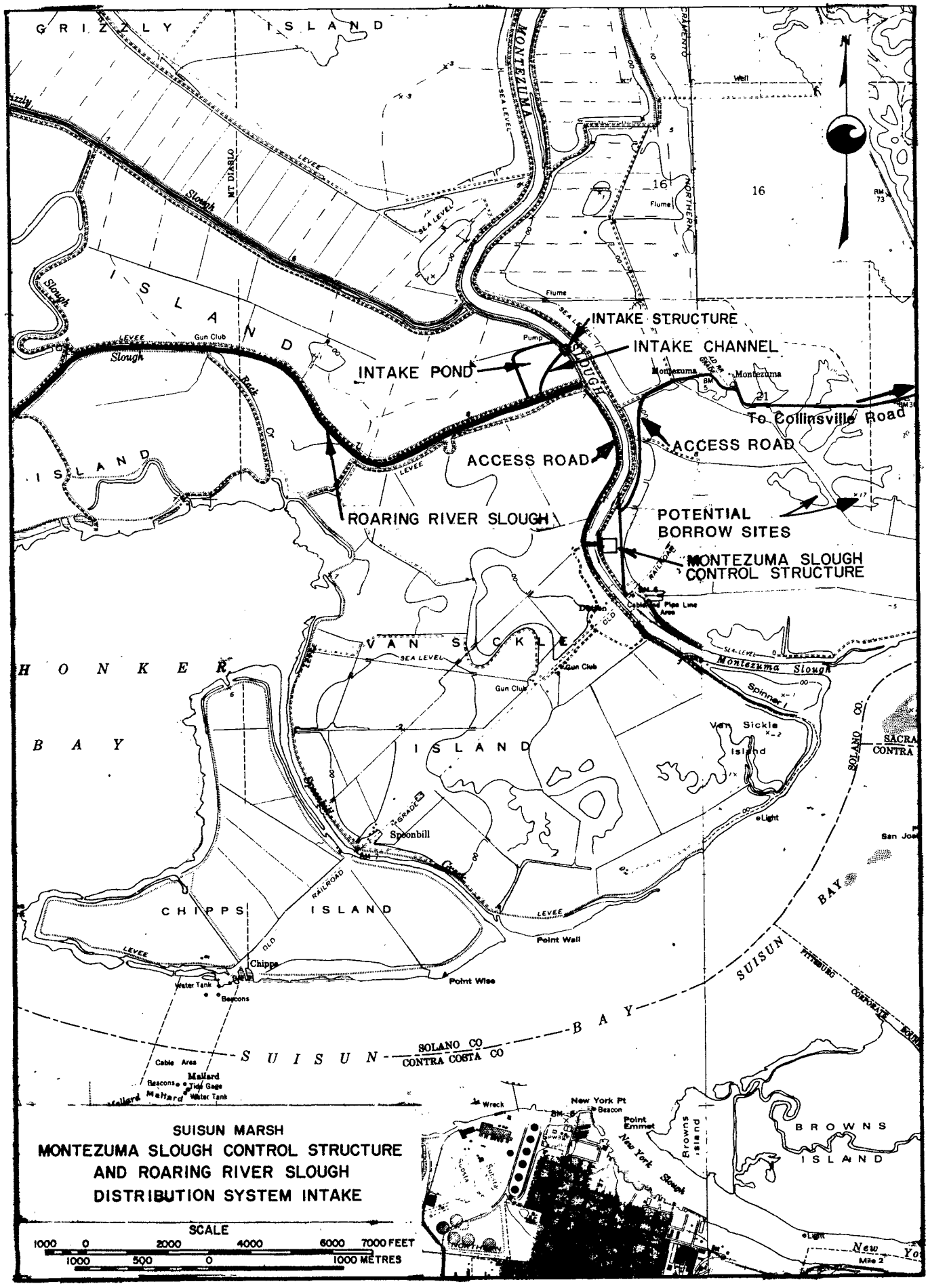
When the gates are closed, the structure would act as a barrier; when operated as tidal gates, flow would be in one direction. When the gates and flashboard opening are open, flow



C—053699

C-053699

FIGURE 19



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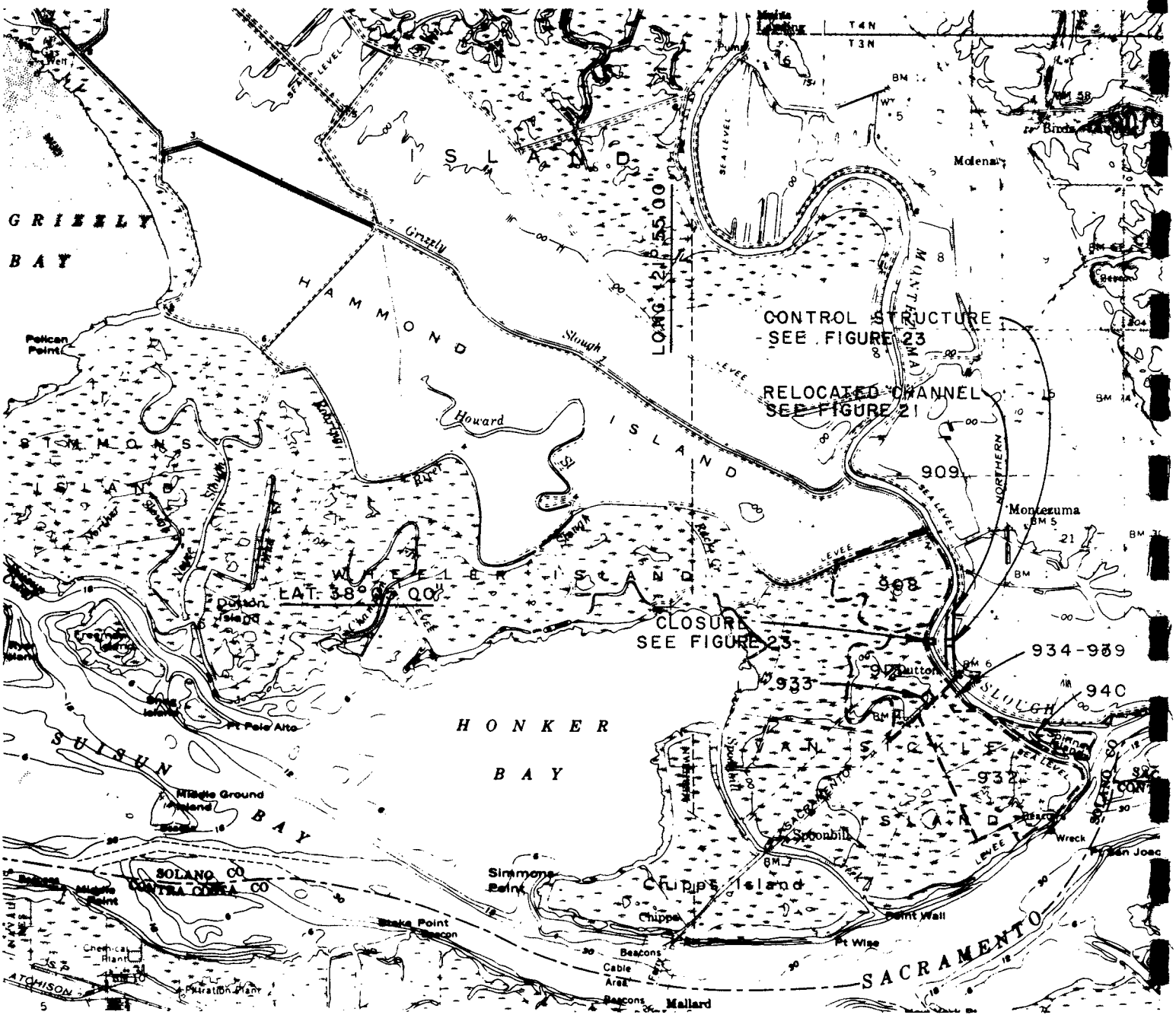
C-053700

FIGURE 20

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## SUISUN MARSH
MONTEZUMA SLOUGH CONTROL STRUCTURE

## LOCATION MAP
SOLANO COUNTY, CALIFORNIA

NOTES

1. ELEVATIONS REFER TO NATIONAL GEODETIC VERTICAL DATUM OF 1929
2. MAP FROM U.S.G.S. 15' QUAD. PITTSBURG, CALIF.

NOV. 1981



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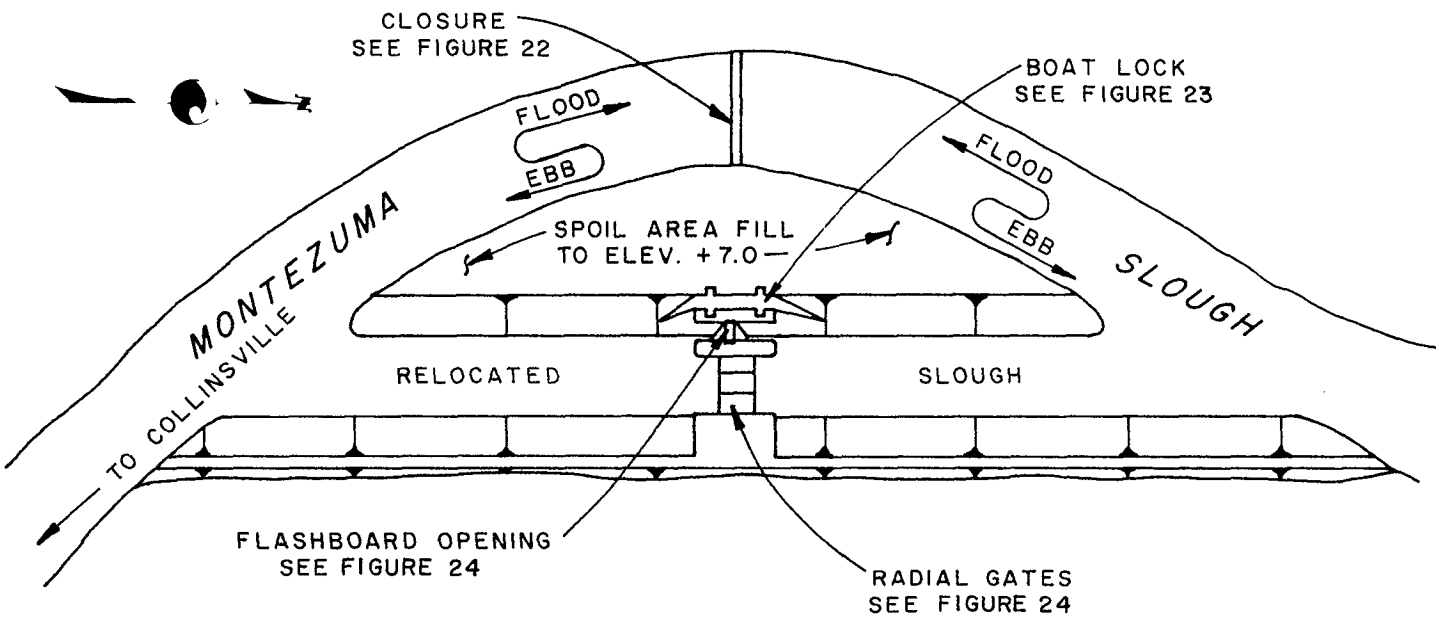
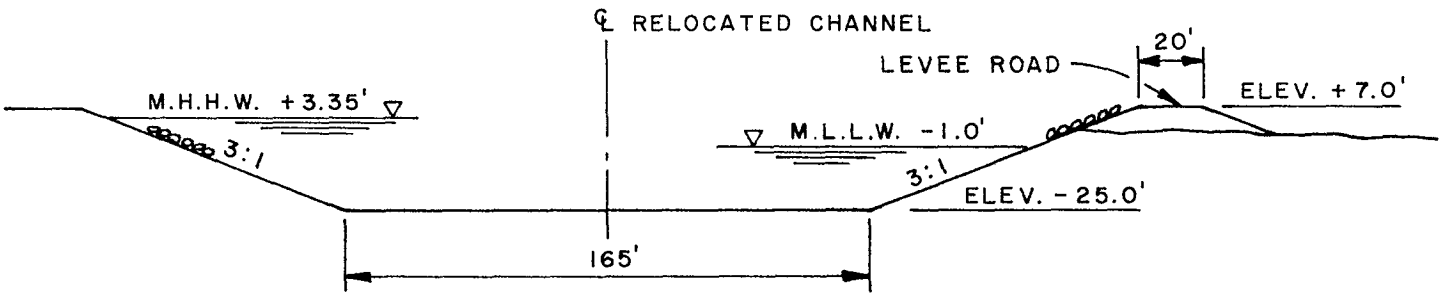



PLAN




RELOCATED SLOUGH

Not to Scale

SUISUN MARSH
MONTEZUMA SLOUGH CONTROL STRUCTURE

OVERALL PLAN

SOLANO COUNTY, CALIFORNIA

NOTES

1. ELEVATIONS REFER TO NATIONAL GEODETIC VERTICAL DATUM OF 1929

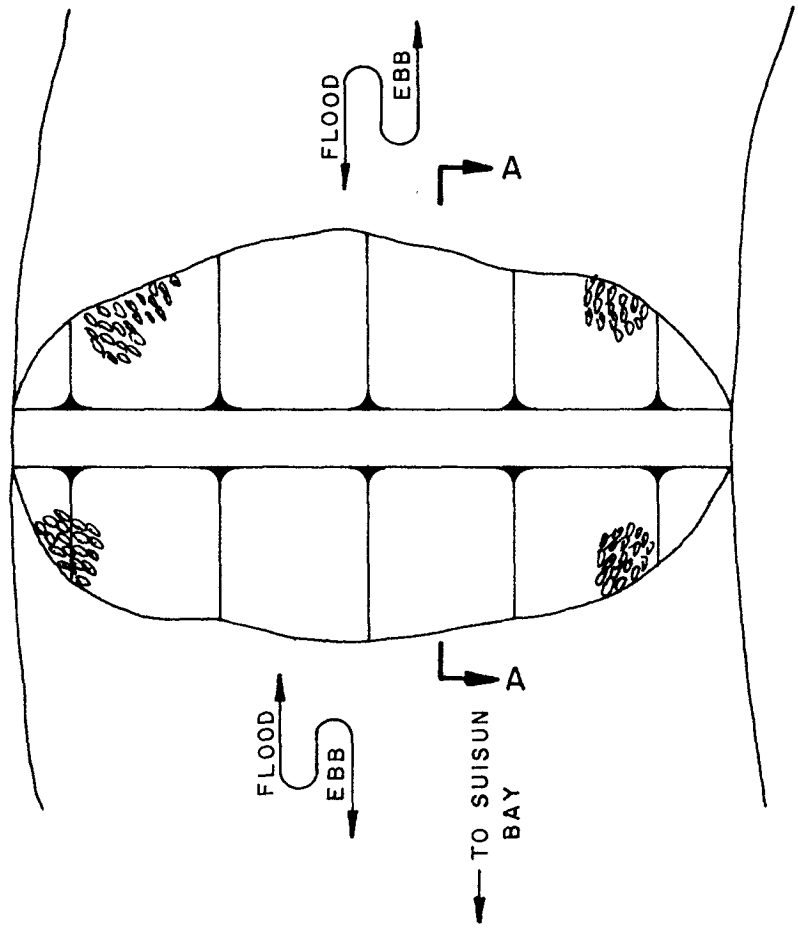
NOV. 1981



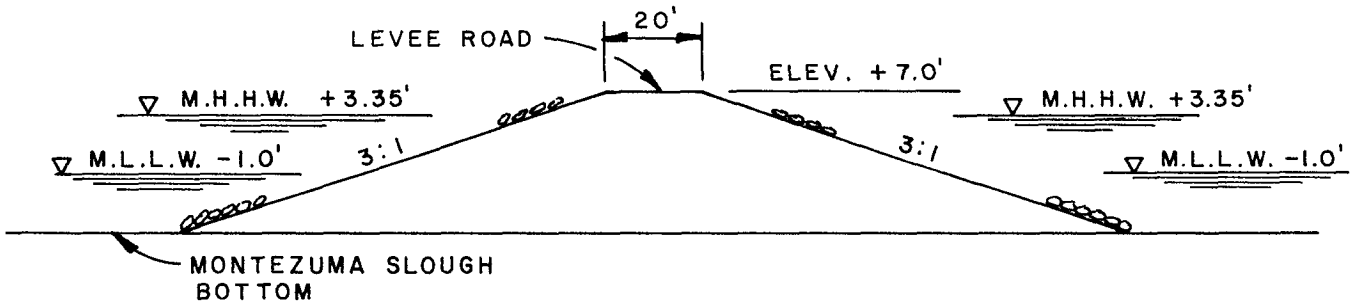


C-053702

FIGURE 22




PLAN




SECTION A-A

Not to Scale

SUISUN MARSH
MONTEZUMA SLOUGH CONTROL STRUCTURE
SLOUGH CLOSURE
SOLANO COUNTY, CALIFORNIA

NOTES

1. ELEVATIONS REFER TO NATIONAL GEODETIC VERTICAL DATUM OF 1929

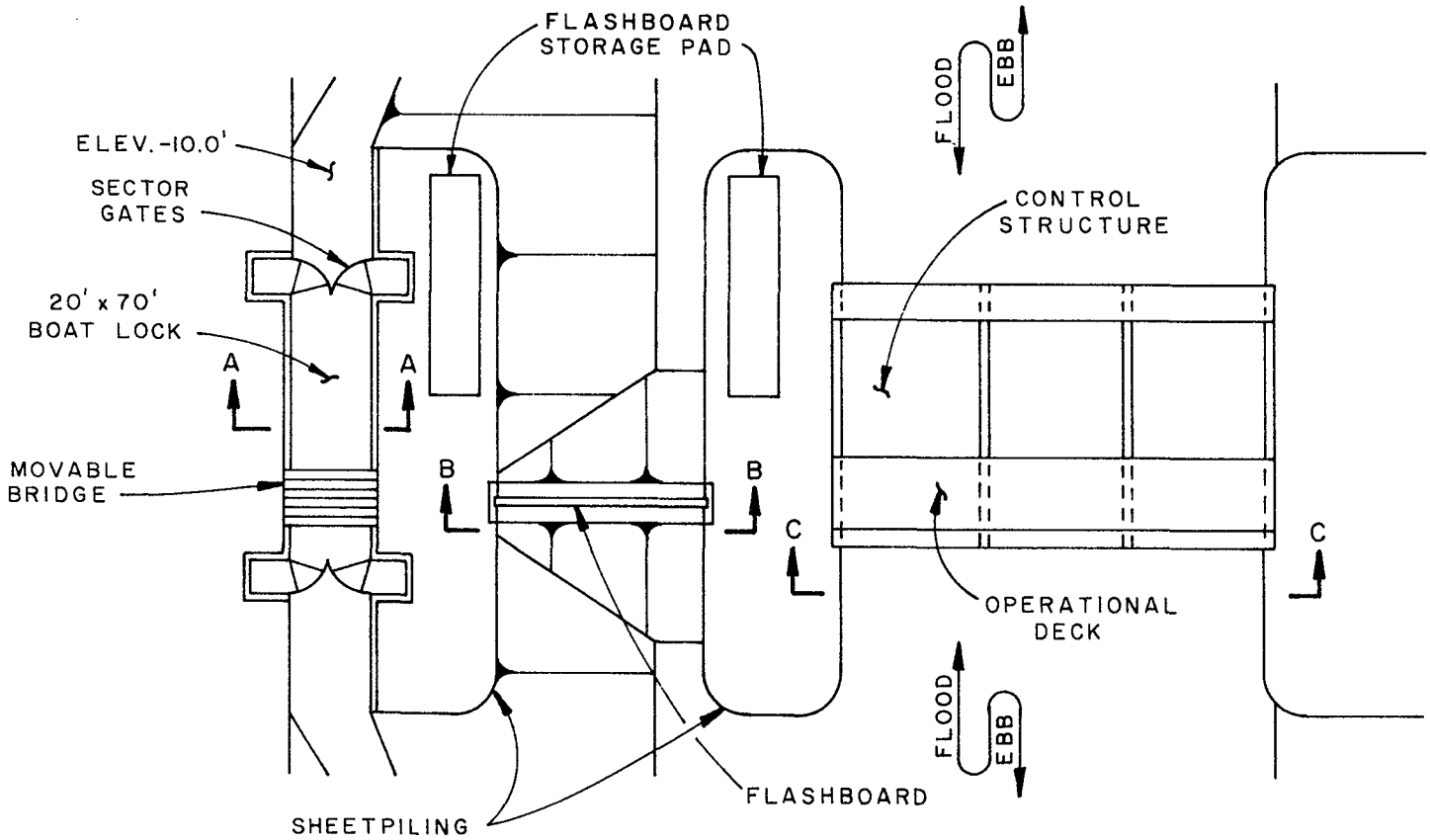
NOV. 1981



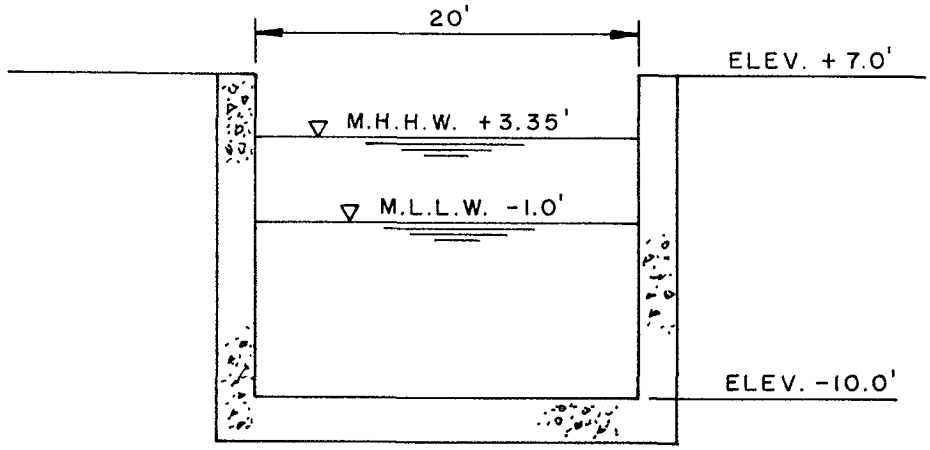


C-053703

FIGURE 23




PLAN




SECTION A-A
(BOAT LOCK)

Not to Scale

SUISUN MARSH
MONTEZUMA SLOUGH CONTROL STRUCTURE

CONTROL STRUCTURE

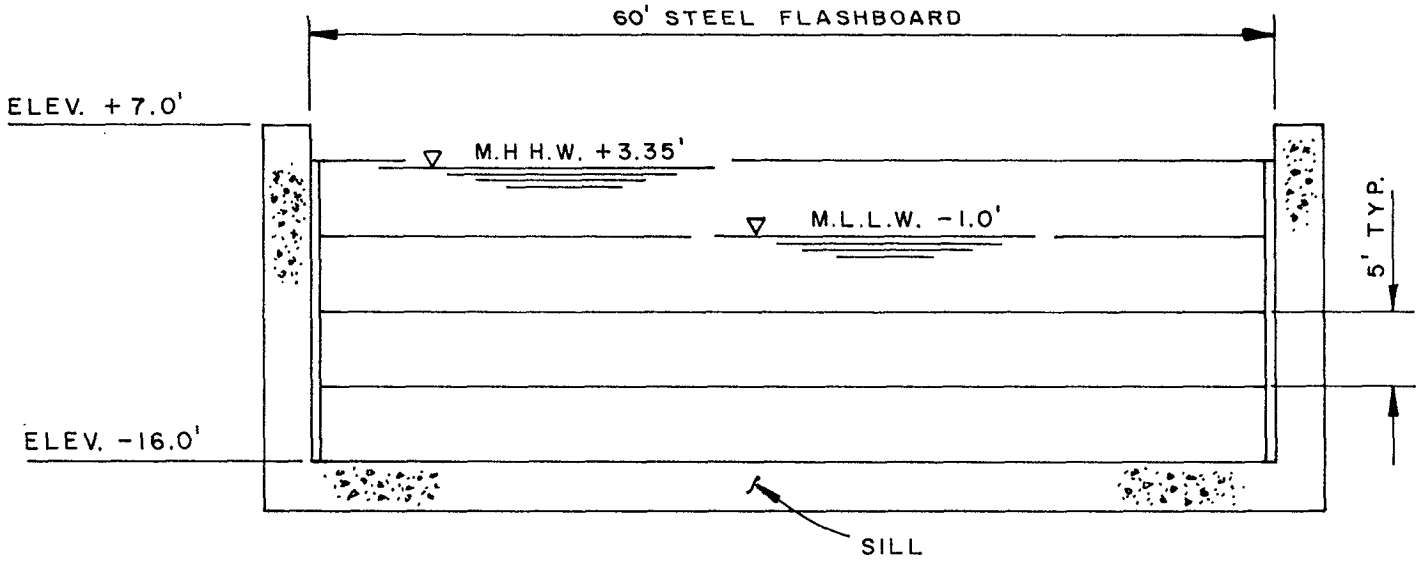
SOLANO COUNTY, CALIFORNIA

NOTES

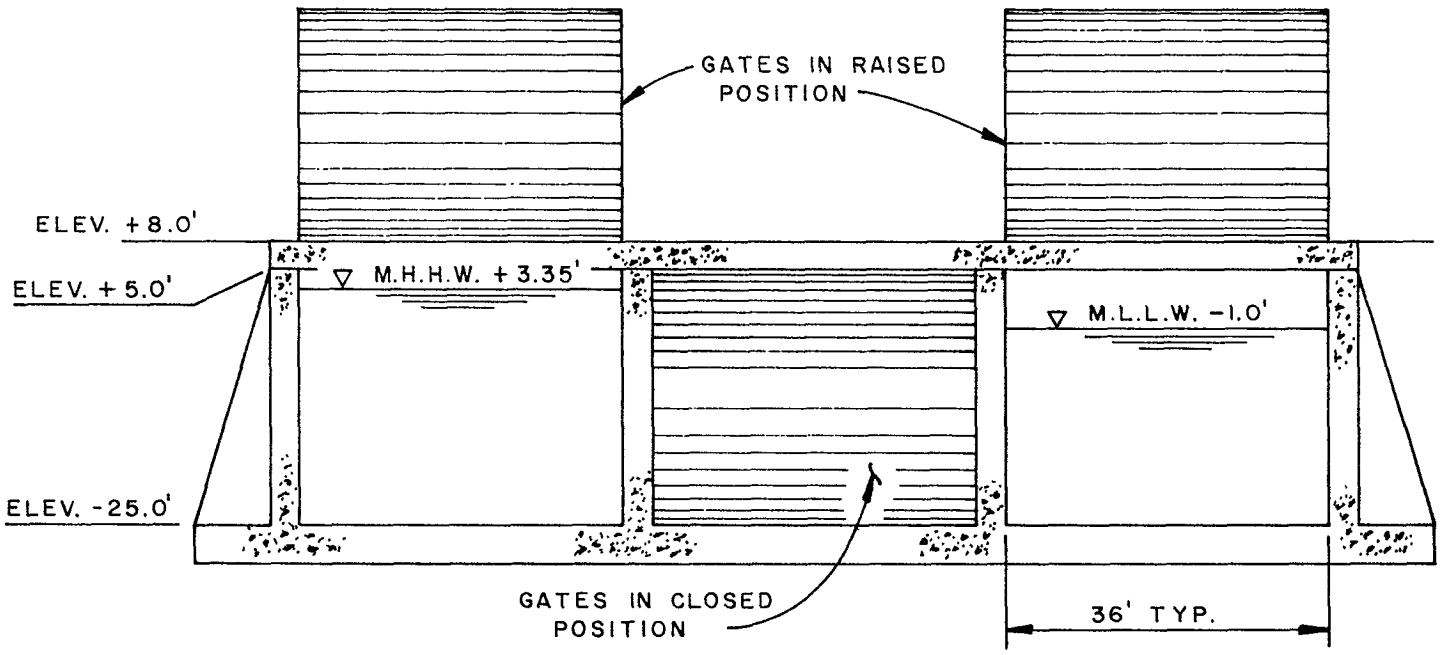
1. ELEVATIONS REFER TO NATIONAL GEODETIC VERTICAL DATUM OF 1929
2. ADJACENT PROPERTY OWNERS, SEE SHEET
   909 TITLE AND TRUST CO., et. al.
   913 RICHARD P. AMARO

NOV. 1981

FIGURE 24




SECTION B-B
(FLASHBOARD)




SECTION C-C
(CONTROL STRUCTURE)

Not to Scale

SUISUN MARSH
MONTEZUMA SLOUGH CONTROL STRUCTURE

CONTROL STRUCTURE

SOLANO COUNTY, CALIFORNIA

NOTES

1. ELEVATIONS REFER TO NATIONAL GEODETIC VERTICAL DATUM OF 1929

NOV. 1981

would be unobstructed in either direction. Criteria for operation of the gates would be based on the magnitude of Delta outflow, availability of supplemental water from sources north of the Marsh, and the net effect on the repulsion of ocean salinity from the western Delta that results from tidal pumping into Montezuma Slough. Short-term operations would also be affected by the occurrence of floodflows in the western Delta and the need to provide for fish migration.

The Montezuma Slough Control Structure would be left open to permit natural tidal movement in the slough at all times when it is not needed to help maintain adequate water quality in the Marsh. Outflows in excess of 10,000 to 15,000 cubic feet per second are generally sufficient to maintain acceptable water quality throughout the Marsh without the use of the control structure. Days having these high outflows can occur in any type of water year, as can days with outflows less than these levels.

The boat locks and flashboard opening would be open from the later part of May through August, when there is peak traffic (50 to 90 boats a day) through the slough. The flashboards will be removed to allow boats easy access through the structure, and to permit fish to pass through unobstructed. The boat locks would be either automated or would have an operator on duty when the control structure is tidally pumping.

When the structure was operating, the tide gates and boat lock would be open when the flow in Montezuma Slough was from east to west and restricted when the flow in Montezuma Slough was from west to east. In an emergency, the flashboards could be removed for levee repair. The tide gates and boat lock operation would permit fish to pass more than half the time each day at acceptable water velocities, thus minimizing any adverse effect on fish migration. Table 8 gives a proposed operation schedule for the control structure.

The 1922-1954 Delta outflow study was projected to a 1980 operation study by including the Central Valley Project and State Water Project facilities at that time. This study was then projected to 2020 level, which included the following adjustment to outflow.

- Storage reduction (- flow).
- Trinity River import (- flow).
- Storage increases (+ flow).
- Anticipated 2020 level of CVP and SWP exports (+ flow).
- Flows necessary to meet Decision 1485 Delta standards.

The water supply conditions were prepared on a monthly basis for the three water year types to determine the water needs of the Marsh to meet salinity standards of Decision 1485 and the seven-reach model covering San Francisco Bay.

Table 8

TYPICAL SCHEDULE FOR OPERATING
MONTEZUMA CONTROL STRUCTURE AS A TIDE GATE*
(PERCENT OF TIME OPERATED)

| Month | Water Supply Conditions** Dry or Critical Year | Normal Year | Wet Year |
|---|---|---|---|
| September | 100 | 100 | 0 |
| October | 70 | 91 | 33 |
| November | 80 | 82 | 22 |
| December | 90 | 73 | 11 |
| January | 90 | 55 | 0 |
| February | 90 | 36 | 11 |
| March | 100 | 27 | 11 |
| April | 70 | 0 | 0 |
| May | 60 | 0 | 0 |

*. Based on projected 2020 level Delta outflow study for 1922 to 1954, assuming existing CVP and SWP facilities and D-1485. The control structure will be operated in excess of these percentages when such operation benefits wildlife habitat without adversely impacting SWP or fish. This could increase the percent of time operated by about 10 percent in November, December, and January of normal and wet years.

** Four-River Classification of water years.

The recreational facilities being considered for the Montezuma Slough Control Structure are outlined in Appendix M.

An alternative to the radial gate control structure was evaluated that included a series of flapgates, which would operate hydraulically. It would restrict the flow from west to east to 20 to 30 percent of the opening during a flood tide and maintain unrestricted flow from east to west during an ebb tide. The design was proposed to eliminate the boat lock and provide unrestricted fish passage. The restricted flow channel, however, would need to extend about 3 miles along the channel to achieve the desired effect. It was, therefore, found technically infeasible. A control structure that would reduce the opening sufficiently (5 to 10 percent) would also create high velocities, which would be hazardous for boaters and cause scouring near the structure.

Access Roads. Access roads shown on Figure 19 to the control structure will be provided on both the east and the west sides of Montezuma Slough. On the west side of Montezuma Slough, access will be over the existing levee road, which will be improved for construction and maintenance use. On the east side of Montezuma



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Slough, the access road will extend for about 2.4 miles, from the existing Collinsville Road to the Montezuma Slough Control Structure. For about 1.4 miles, the access road will overlie an abandoned county road. This portion will be substantially at existing ground level, with two paved 12-foot lanes and 3-foot shoulders. The remaining mile of the road will ultimately be raised to elevation 5.0 USGS datum. This access road will be improved for both construction and recreational use. Construction of this access road would require about 100,000 cubic yards of material for fill and road surfacing. A number of possible material sites were reviewed, with different methods of deliveries. The most economical sites with satisfactory material available are on-site sources and commercial pits.

Adjacent to the proposed road site are two low knolls which could provide satisfactory material for the road base. These knolls are about 2,000 feet south of the proposed road and are within the "secondary management area". Use of this site would not require the material to be hauled over long distances or over public roads.

Two commercial pits located within 10 miles of the proposed road site have satisfactory material available for road base. Barges and trucks were both reviewed as methods of delivery.

Commercial barge delivery is not economically feasible. To get the barges close to the pit in Potrero Hills, Luco Slough would have to be dredged. The dredged material would have to be disposed of in an acceptable manner. Availability of barges and the costs of extra handling of all material before and after loading on barges further compounded the problem.

Hauling the road base material by truck proved to be the best method of delivery and to have the least impacts. Because the construction site is in a remote area, material may have to be hauled over long distances. The increase in vehicular traffic would raise the levels of exhaust fumes and noise, although both would still be below harmful levels and the increase would be of short duration. If dust became a problem, levels could be reduced by applying water. Hauling by truck could result in some impact on the county road system, mainly on Collinsville Road. Arrangements to mitigate this impact could be made through a contract between DWR and Solano County.

## Roaring River Slough Distribution System

Facilities of the Roaring River Slough Distribution System, shown on Figures 25 and 26, supply water to Simmons and Wheeler islands through an enlargement of the existing slough. This system is one unit of the Initial Facilities and was constructed in 1979-80. About 8 miles of channel have been improved with levee construction, new turnouts, and crossing

structures. Roaring River Slough was dredged for material to improve its south and north levees. The slough was extended southwest along the interior of the Grizzly Bay levee for about 0.75 mile. The ditch connecting Roaring River Slough to Mud Slough was dredged for material to construct levees along both channels. Three crossings over Roaring River Slough were removed to provide access for the dredge and to permit improvement of adjacent levees. Eastern and western crossings were replaced. Turnouts and culverts with gates were placed at various points in the levees along Roaring River Slough to provide water to the adjacent managed wetland areas, which, using existing facilities, continue to drain into Grizzly, Suisun, and Honker bays.

An intake structure was built and a pond was created adjacent to the slough's eastern end. To supply sufficient water to this unit's service area of about 5,000 acres, the water level in Roaring River Slough must never fall to more than 2 feet below high tide. This requires a slough peak intake capacity of 700 cubic feet per second during the short period of each high tide and a pond to supply an adequate sustained flow below high tide to the individual management areas. Public recreation will be provided in association with the pond.

Design criteria are based on a cycle of 10 days flooding and 20 days draining. This requires a mean daily flow of 120 to 150 cubic feet per second to flood half of the service area to a depth of 1.5 feet in 10 days, assuming the root zone is saturated prior to initial fall flooding. After a full season of operating at criteria water quality, this amount of flow would flood each management area at least two times by April 1 to leach accumulated salts from the root zone.

An intake structure constructed in 1979 from Montezuma Slough (Figure 26) consists of eight 60-inch culverts with flap gates and slide gates. The intake discharges to the 40-acre Hammond Island pond (Figure 25) at the southeast corner of the Department of Fish and Game (DFG) property, adjacent to Montezuma and Roaring River sloughs. A 200-foot section of levee between the pond and Roaring River Slough has been removed to connect the slough with the pond.

Fish screens are being provided to minimize the diversion of fish into Roaring River Slough. Although existing water diversion facilities throughout the Marsh are unscreened, DFG determined that the high peak flow of about 700 cubic feet per second into this slough would require screens. A prototype fish screen was designed and constructed in front of two of the eight culverts. An evaluation of the screens provided the basis for the design of more screens for this diversion structure and for others throughout the Marsh. The second stage installation of fish screens has been completed.



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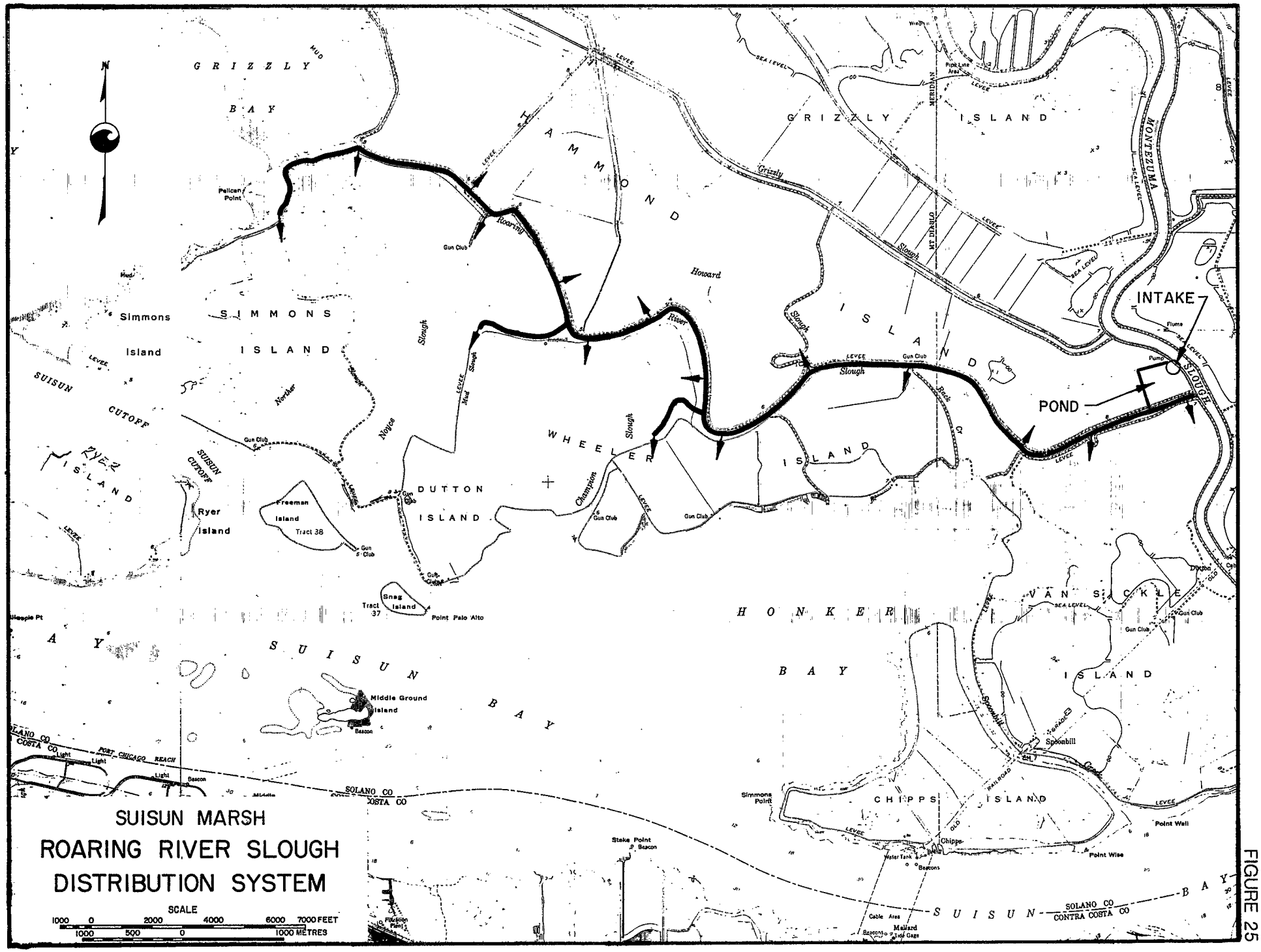


FIGURE 25

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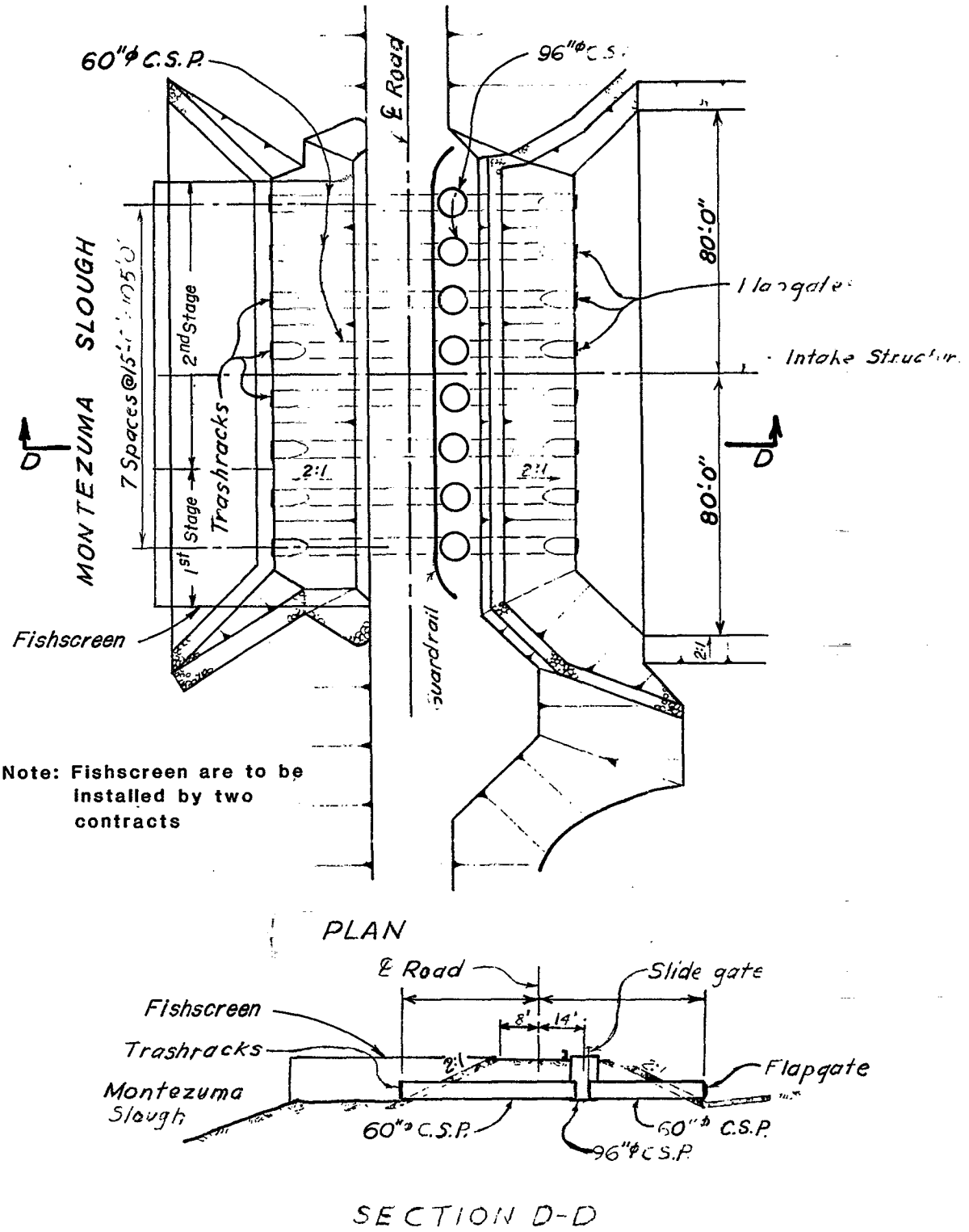
FIGURE 26




SUISUN MARSH

**ROARING RIVER SLOUGH INTAKE STRUCTURE**



C—053711

C-053711

## Grizzly Island Distribution System

Grizzly Island Distribution System facilities, shown on Figure 27, would serve the leveed lands on western Grizzly Island, which now take water from Grizzly Bay and Montezuma Slough. The Grizzly Island Distribution System would run about 6.2 miles from Montezuma Slough near Frost Slough to the southwesterly area of the island.

Facilities would be similar to those for Roaring River Slough Distribution System. Existing ditches would be enlarged to handle a mean daily flow of 190 cubic feet per second with the water level in the ditch not falling more than 2 feet below high tide. The design criteria will be the same as those for the Roaring River Slough intake. The new water conveyance system would be designed to operate at a maximum stage of +7 feet, according to U. S. Geological Survey (USGS) datum, in Montezuma Slough. Enough water would be diverted to a 100 acre-foot regulating pond during high tide to satisfy the mean flow requirement. A fish screen similar to the one to be constructed at the intake to Roaring River Slough would be provided. Public recreation facilities are being considered for this facility.

Tree Slough was considered as an alternative for the Grizzly Island Distribution System intake structure and regulatory pond area. A structure with tidal gates would have been constructed at the south end of Tree Slough. Water would have been tidally pumped south from this structure through enlarged existing ditches to the Grizzly Island ditch for further distribution.

An increased length of fish screens and bypass ditches would be required to reduce the environmental impact on fish. The cost of the needed fish screens and bypass ditches and the bypass flow required were excessive, so this alternative was dropped.

## Potrero Hills Ditch

A ditch about 3.5 miles long with control structures at both ends would be built between the upper reaches of Luco and Hill sloughs and would follow, as much as practical, the existing terrain. This facility would move water from the Denverton Slough area in the east to the Hill and Suisun slough area in the northern-central portion of the Marsh. The approach and outlet channels for Luco and Hill sloughs would be widened to 120 feet at the upper ends for about 1 mile total, to provide the quantity of water the ditch needs to operate properly. The ditch would improve the quality in the central and northern extremities of the Marsh (see Figure 28).

The structures will be operated at all times to prevent siltation of the ditch.

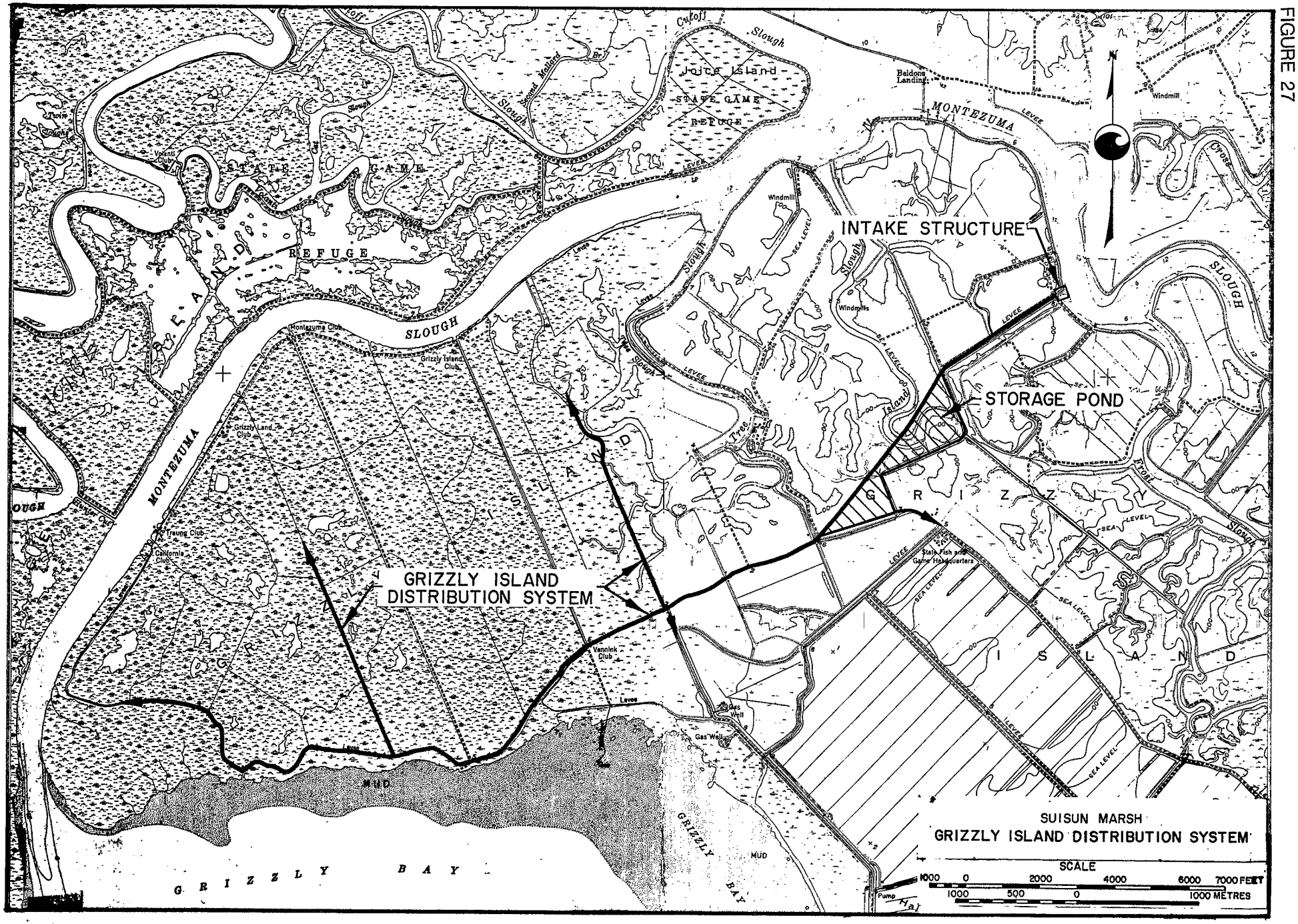



FIGURE 27

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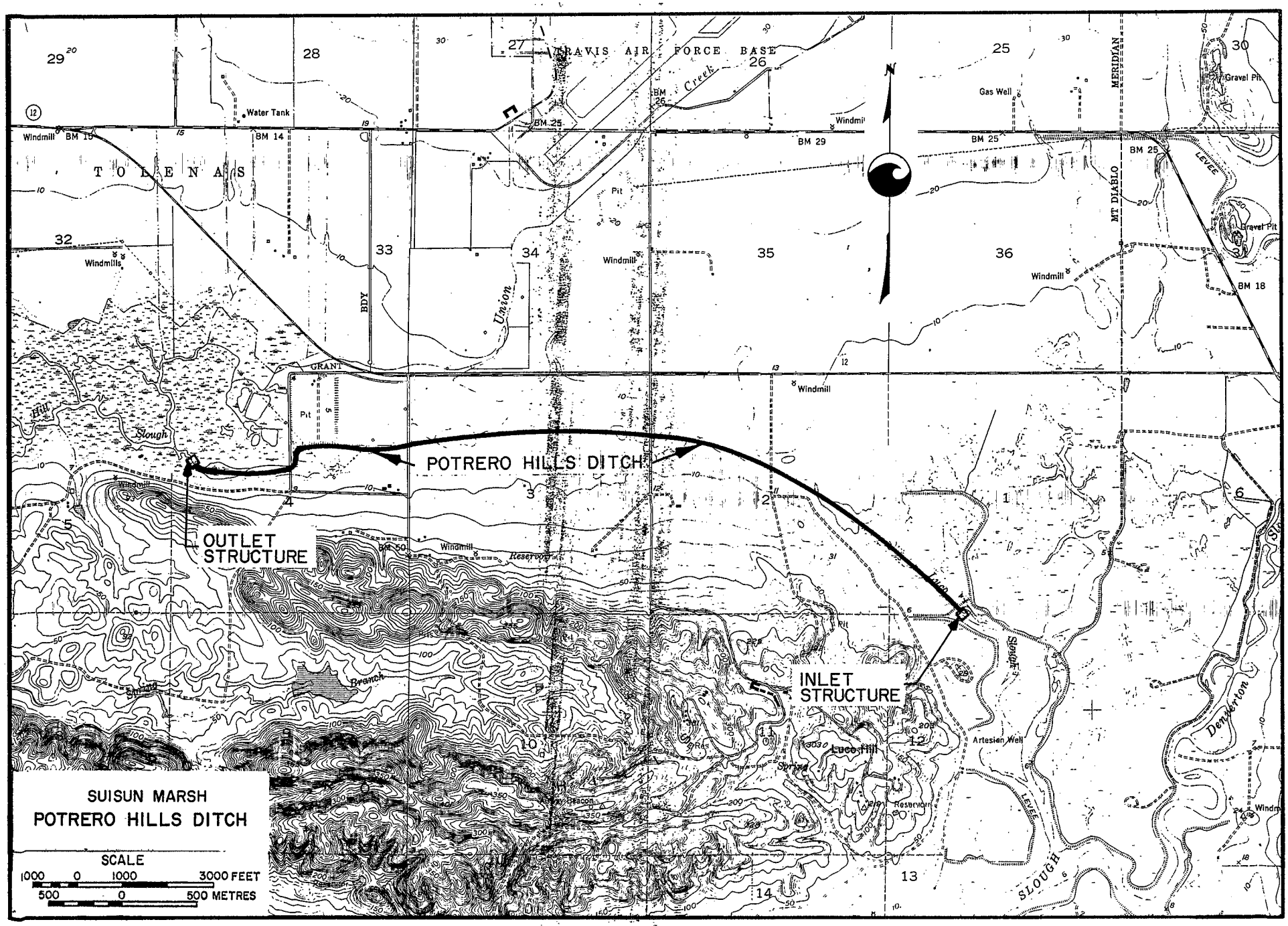


FIGURE 28

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The design capacity of the ditch would allow conveyance of an average of 340 cubic feet per second with a maximum head differential of about 4.3 feet. The maximum cut required for the ditch would be about 16 feet. Maximum water depth would be about 10 feet, with a water surface elevation of +3 feet. The maximum surface width would be about 165 feet and the bottom width would be 105 feet.

A recreation pond is being considered for this unit because of the high potential recreational value and the close proximity to highly populated areas (Appendix M). The size of the pond will be limited to not more than twice the width of the ditch so the ditch velocity can be maintained to prevent siltation. The size of the pond should not exceed 12 acres. If a pond is included, the width of the ditch may be reduced slightly.

The Cutoff Slough Unit was considered, then dropped as an alternative for the Potrero Hills Ditch. Structures with tidal gates would have been constructed across the east and west ends of Cutoff Slough. These gates would have tidally pumped water from Montezuma Slough west to Suisun Slough to improve water quality in the central portion of the Marsh. The gates would have been operated in the same manner as those for the Potrero Hills Ditch.

Cutoff Slough is shallow and crooked. To facilitate the movement of water, 9,000 feet of the channel would have been widened by about 30 feet and deepened 4 to 6 feet. A 8,000-foot "short cut" channel would have been constructed to decrease the length of Cutoff Slough. Because of the extensive amount of environmentally sensitive wetland habitat that would be disturbed and the resulting adverse impacts on the California clapper rail, this alternative was dropped. The quality of water conveyed by Potrero Hills Ditch would be superior to that conveyed by the Cutoff Slough alternative, and the area of benefit would be greater because Potrero Hills would also improve the quality in Hill Slough and the upper end of Suisun Slough.

Model predictions indicate the possibility that the Potrero Hills Ditch may not be required to achieve water quality standards. This will be explored during the proposed program of staged construction with testing.

## Goodyear Slough Facilities

Facilities on Goodyear Slough would furnish an improved quality of water to about 3,400 acres adjacent to the slough. Proposed facilities include:

- The Cordelia-Goodyear Ditch, a new gravity flow channel 2.8 miles long from Ibis Club area on Cordelia Slough to a point south of Morrow Island Farm boat dock on Goodyear Slough.



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- The Goodyear Slough outfall channel and structure.
- The Goodyear Slough Control Structure (USBR Pierce Harbor Control Structure).
- A 2.5-mile-long Morrow Island Distribution System.

These facilities, shown on Figure 29, would eliminate the diversion of water from Suisun-Grizzly Bay via Suisun Slough to lands in the vicinity of and adjacent to Goodyear Slough. Water in the slough, which is sometimes highly saline, would be replaced with better quality water from Cordelia Slough.

Impacts to fish have not yet been evaluated. The facilities will be monitored upon completion of construction for several years to determine the effect on local fisheries. Upon completion, the results will be evaluated as to the needs of screening the intake structures.

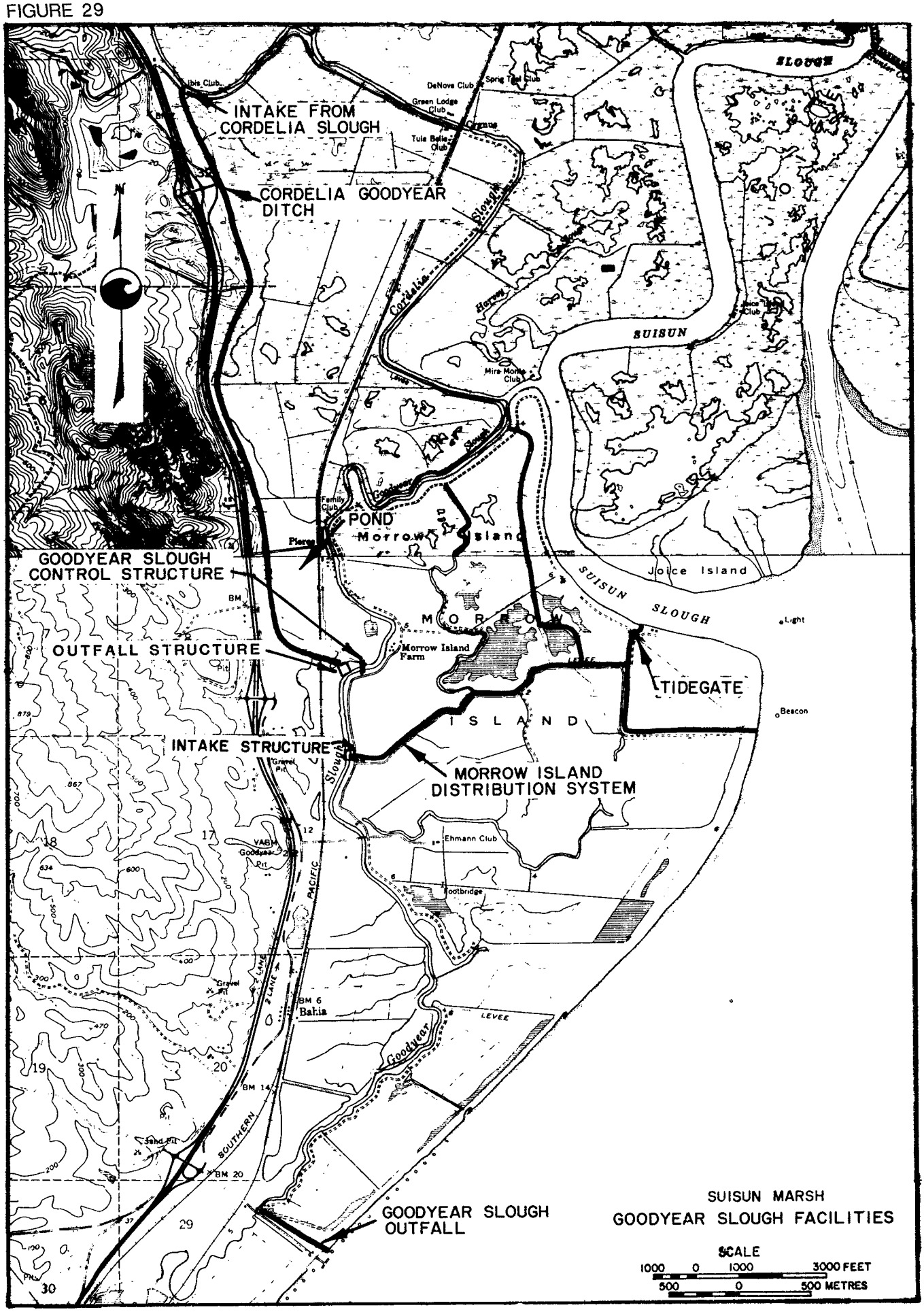
The Cordelia-Goodyear Ditch would have two control structures, including ten 48-inch culverts with flap gates and a 18-acre pond at the south end. The intake would be located near the Ibis Club. The ditch would tidally pump water south to Goodyear Slough. It would be about 2.8 miles long, 9 feet deep, with a bottom width of 42 feet, 2:1 side slopes, and a maximum capacity of 156 cubic feet per second. Public recreation facilities are proposed at the pond.

The Goodyear Slough Control Structure, located south of Morrow Island Farm boat dock, would control flow from Goodyear Slough northerly toward Suisun Slough, as needed for quality control. The control structure would include ten 48-inch culverts with flap gates on the bayside ends and vertical slide gates on the slough side. The structure would be open during high runoff periods and from July through September.

The Morrow Island Distribution System, part of the Initial Facilities constructed in 1979-80, is located about 0.5 mile south of the Goodyear Slough Control Structure. It diverts water from Goodyear Slough to the easternmost area of Morrow Island. Water is tidally pumped through three 48-inch culverts at the Goodyear Slough end as needed to flood or drain adjacent lands. When drainage is of a quality too poor for reuse, it can be tidally pumped into Suisun Slough at the northeast end.

The Goodyear Slough Outfall has been constructed at the south end of the slough (Figure 29). A channel about 69 feet wide has been dredged from the south end of the slough to Suisun Bay (about 2,800 feet). The excavated material was used for levee construction. The control structure consists of four 48-inch culverts with flap gates on the bay side and vertical slide gates on the slough side. This outfall has increased circulation in Goodyear Slough by tidally pumping water through Goodyear Slough into Suisun Bay.

FIGURE 29


INTAKE FROM CORDELIA SLOUGH
CORDELIA GOODYEAR DITCH
GOODYEAR SLOUGH CONTROL STRUCTURE
OUTFALL STRUCTURE
INTAKE STRUCTURE
POND
Morrow Island
MORROW ISLAND
TIDEGATE
MORROW ISLAND DISTRIBUTION SYSTEM
GOODYEAR SLOUGH OUTFALL
SUISUN SLOUGH
Joice Island
Cordelia Slough
Goodyear Slough
Ibis Club
DeNove Club
Green Lodge Club
Tule Belle Club
Mira Monte Club
Family Club
Morrow Island Farm
Ehmann Club
Footbridge
Bahia
Beacon
Light
LEVEE
SOUTHERN PACIFIC
SUISUN MARSH
GOODYEAR SLOUGH FACILITIES
SCALE
1000 0 1000 3000 FEET
500 0 500 METRES

As an alternative to the Cordelia-Goodyear channel, delivering water from the Vallejo Waste Water Treatment Plant to the southern reach of Goodyear Slough was evaluated. The delivery plan is shown on Figure 30. This alternative was eliminated because of its high cost, uncertainty about availability of waste water, and possible restriction on its discharge without further treatment.

The effectiveness of the Goodyear Slough facilities depends on the availability of supplemental water supplies. For example, the Cordelia-Goodyear Ditch is effective only if there is an adequate amount of supplemental flow in the northwestern area of the Marsh.

## Boynton-Cordelia Ditch

The Boynton-Cordelia ditch, shown on Figure 31, will tidally pump enough water from Suisun Slough via Boynton Slough to Cordelia Slough to meet standards in the western Marsh. The capacity of Boynton Slough would be improved to convey a flow of up to 205 cubic feet per second from the Southern Pacific Railroad to its western end, about 3,500 feet. A new ditch with an average capacity of 205 cubic feet per second would be constructed northward 2,600 feet to a control structure. The control structure would release water into a pond. Through a separate structure, the pond could also receive effluent from a 48-inch discharge line of the Fairfield Wastewater Treatment Plant. Water from the pond would flow to Cordelia Slough through a new ditch about 3 miles long. The average capacity of this ditch would be 240 cubic feet per second, and it would terminate in a control structure. The capacity of Cordelia Slough would be improved to convey a flow of up to 222 cubic feet per second. Public recreation facilities are proposed at the pond.

The treated waste water from the Fairfield plant would supplement the tidal flow to Cordelia Slough. By the year 2000, a maximum of about 32 cubic feet per second of supplemental treated waste water would be available. Section I, Item D of a contract between Fairfield and Solano Irrigation District, dated January 8, 1974, outlines the rates of delivery of treated waste water to the District and to the Marsh. If monitoring shows that more water is needed in Cordelia Slough to maintain water quality, the system could be enlarged.

Operation of the ditch would not depend on the amount of treated waste water available from the treatment plant. A minimum of 80 cubic feet per second will be maintained for circulation to Cordelia Slough by tidal action. The ditch would fill when there is high tide in Boynton Slough, and it would empty when the tide is low in Cordelia Slough.



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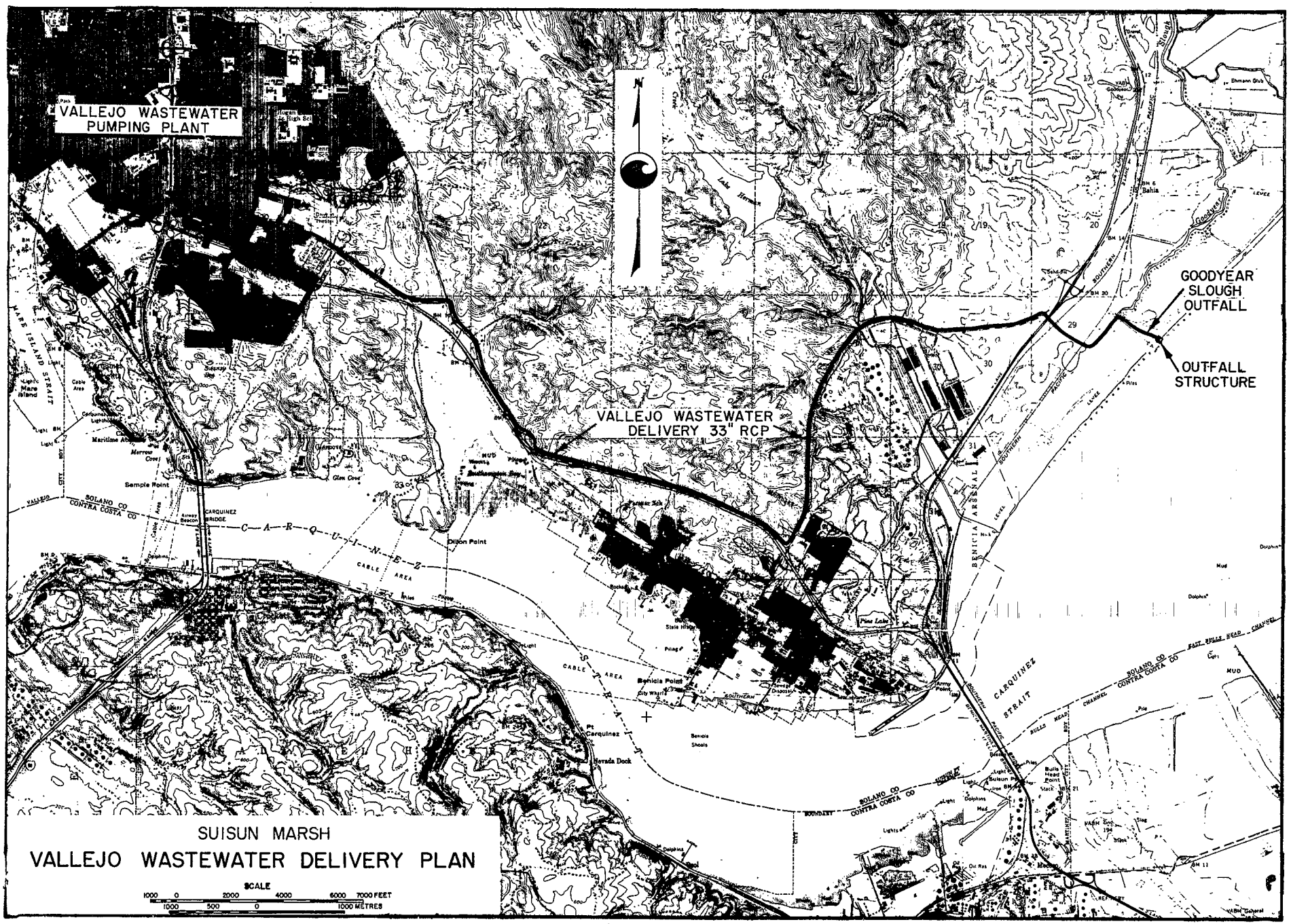


FIGURE 30

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C—053719

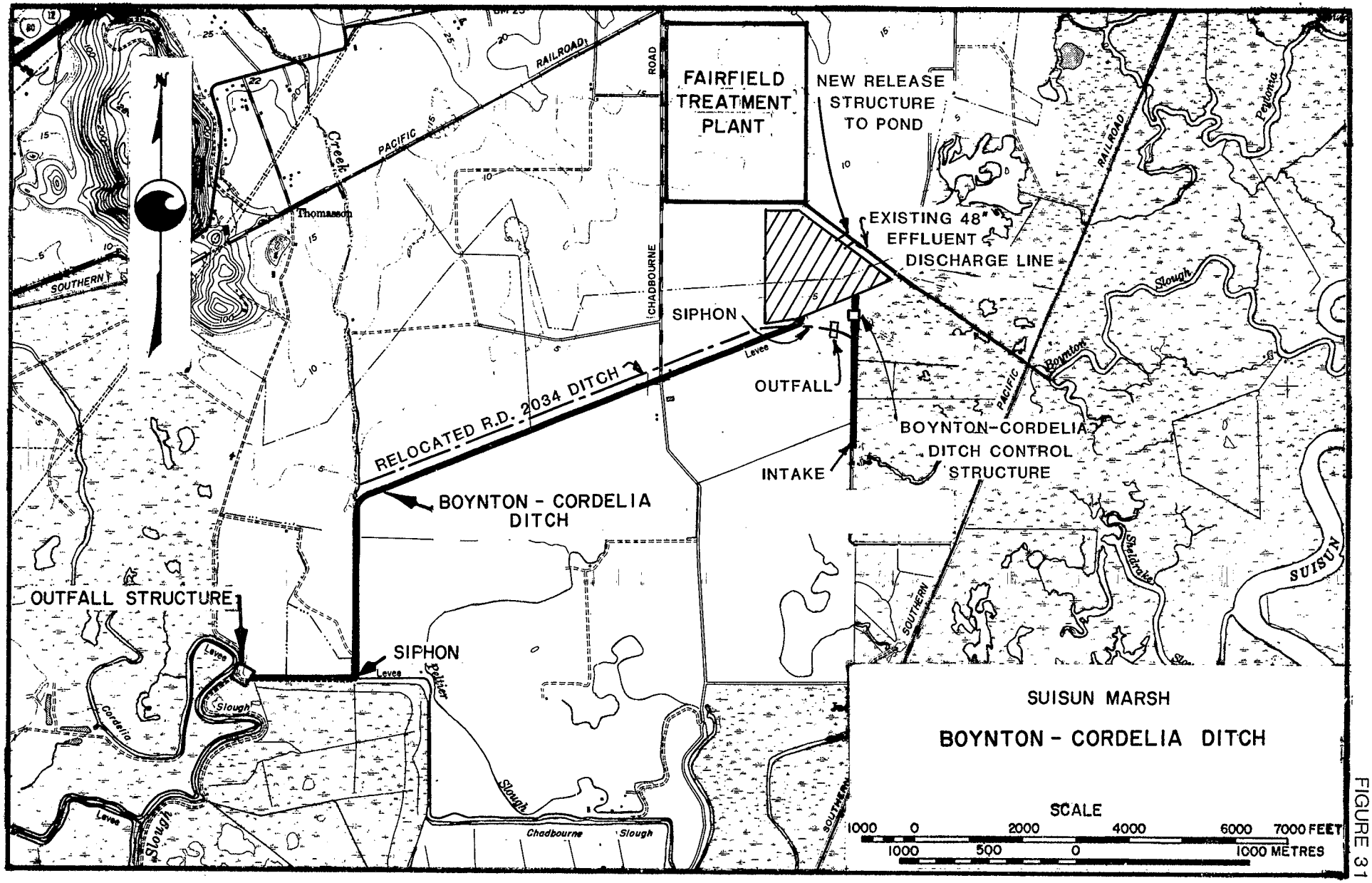


FIGURE 31

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TABLE 9

| | MONTEZUMA SLOUGH CONTROL STRUCTURE AND APPROCH CHANNELS | MONTEZUMA SLOUGH CONTROL STRUCTURE ACCESS-ROAD | ROARING RIVER SLOUGH DISTRIBUTION SYSTEM INTAKE STRUCTURE | HAMMOND ISLAND POND | ROARING RIVER SLOUGH CHANNEL | GRIZZLY ISLAND DISTRIBUTION SYSTEM INTAKE STRUCTURE | GRIZZLY ISLAND POND | GRIZZLY ISLAND CHANNEL | POTRERO HILLS DITCH CHANNEL | LUCO SLOUGH | HILL SLOUGH | GOODYEAR SLOUGH FACILITIES CORDELIA - GOODYEAR DITCH CHANNEL | GOODYEAR SLOUGH FACILITIES OUTFALL STRUCTURE | GOODYEAR SLOUGH FACILITIES CONTROL STRUCTURE | GOODYEAR SLOUGH FACILITIES MORROW ISLAND SYSTEM CHANNEL | BOYNTON - CORDELIA SLOUGH CHANNEL | BOYNTON SLOUGH | ANNIE MASON ISLAND DIESEL PUMP | CYGNUS AREA FACILITIES | LOWER JOICE ISLAND FACILITIES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CHANNEL LENGTH STRUCTURE | 1100ft 350ft | Road 2miles | 160ft | 1400ft | 8miles | 240ft | N.A. | 6.2miles | 3.5miles | 1.46miles | 5.3miles | 2.8miles | 2800ft | 154ft | 2.5miles | 3.5miles | 3.33miles | N.A. | N.A. | N.A. |
| CHANNEL AVE. WIDTH STRUCTURE | 382ft 238ft | Road 30ft | N.A. | 1200ft | Dredge Existing Channel | N.A. | N.A. | 211ft | 210ft | 193ft | 212ft | 100ft | 69ft | 100ft | Existing Channel | 169ft | 175ft | N.A. | N.A. | N.A. |
| AVE. DEPTH | 32ft | N.A. | N.A. | 8ft | | N.A. | N.A. | 14ft | 10ft | 12ft | 11ft | 9ft | 9ft | 10ft | | 12ft | 12ft | N.A. | N.A. | N.A. |
| Q (AVERAGE FLOW RATE OVER 24 HOUR PERIOD) | 2095cfs Westward at max. tidal pumping capability | N.A. | 164cfs | N.A. | 164cfs | 190cfs | N.A. | 190cfs | 340cfs | 349cfs | 324cfs | 156ft | 130cfs | 500cfs | 120cfs | 205cfs | 213cfs | 14cfs | | |
| BOTTOM WIDTH | 190ft | N.A. | N.A. | N.A. | Dredge Existing Channel | N.A. | N.A. | 92ft Ave | 105ft | 121ft | 88ft | 42ft | 15ft | N.A. | Existing Channel | 98ft | 105ft | N.A. | N.A. | N.A. |
| DEPTH OF WATER (MAX) | 28ft | N.A. | N.A. | N.A. | | N.A. | N.A. | 14ft Ave | 10ft | 12ft | 11ft | 9ft | 7ft | N.A. | | 12ft | 12ft | N.A. | N.A. | N.A. |
| WIDTH OF WATER (MAX) | 360ft | N.A. | N.A. | N.A. | | N.A. | N.A. | 175ft Ave | 165ft | 193ft | 148ft | 97ft | 54ft | N.A. | | 169ft Ave. | 175ft | N.A. | N.A. | N.A. |
| STRUCTURE | 3-Radial gates 36ft x 30ft 1-Flashbrd opening 60ft x 23ft 1-Boat lock 20ft x 70ft | NONE | Intake Structure | N.A. | N.A. | Intake Structure | 100acre Foot | N.A. | Intake & Outlet Structure | N.A. | N.A. | 1-20 acre Pond Intake & Outlet Structure | Outlet Structure | Intake & Outlet Structure | Intake & Outlet Structure | 1-20 acre Pond Intake & Outlet Structure | N.A. | 20hp | Outlet Structure | Intake Structure |
| NUMBER OF PIPES | N.A. | N.A. | 8 | N.A. | N.A. | 10 | N.A. | N.A. | 16 | N.A. | N.A. | 10 | 4 | 10 | 6 | 12 | N.A. | 1 | 1 | 1 |
| SIZE OF PIPES | N.A. | N.A. | 60in C.S.P. | N.A. | N.A. | 60in C.S.P. | N.A. | N.A. | 60in C.S.P. | N.A. | N.A. | 48in C.S.P. | 48in C.S.P. | 48in C.S.P. | 48in C.S.P. | 48in C.S.P. | N.A. | 20in W.S.P. | 36in C.S.P. | 36in C.S.P. |
| RIGHT OF WAY REQUIRED | 29acres | 26acres Permanent Easement | Included in pond | 40acres | 300acres 70ft outside existing levees | Included in channel | 100acres | Ave. width 250ft 188acres | Ave. width 260ft 128acres | | | Ave. width 200ft 89acres | Ave. width 150ft 10acres | Included in channel | Ave. width 250ft 75acres | Ave. width 250ft 125acres | | | | |

## SUISUN MARSH DETAILS OF OVERALL FACILITIES

NOTE: N.A. = NOT APPLICABLE

C-053721

C-053721

## Lower Joice Island

Water quality in the lower reaches of Montezuma and Suisun sloughs will be such that lower Joice Island will require a 36-inch corrugated steel pipe with gate and flashboard riser to enable the island to flood faster when the water quality is good. The Department of Fish and Game (DFG), U. S. Fish and Wildlife Service (FWS), and SRCD have agreed that this installation will ensure adequate water quality for the lower Joice Island area.

## Cygnus Area

In the Cygnus area, predicted salinities in the area of supply are within existing Decision 1485 standards except for the supply for the lower pond on Club 415 (Arnold Ranch Club), which is marginal. DFG, FWS, and SRCD have agreed that installing a 36-inch corrugated steel pipe drain with gate and flashboard riser for this pond will ensure adequate water quality in this area.

## Annie Mason Island

Annie Mason Island would be supplied by a diesel pump that would pump from Grizzly Bay at low tide. The pump would operate when water quality on the island required improvement from October through April. Levees about Annie Mason Island are not now in good repair. The pumping equipment will be built and installed when the landowner has improved the island's levee system to provide adequate protection of the island.

## Overall Facilities

Details of the Suisun Marsh Overall Facilities are given in Table 9.

# Water Supply

Under low flow conditions, an estimated 20 percent of the water pumped through Montezuma Slough Control Structure must be replaced if needed to maintain water quality and salinity standards in the vicinity of Chipps Island. A series of operation studies was made to assess the quantity of replacement water needed. All studies were run for a 57-year period -- 1922 through 1978 -- and year 2000 level of development. Assumptions of facilities, operations, and depletions above the Delta were constant for all studies. Delta Overland Facilities were assumed in and operating to eliminate consideration of the western Delta in-channel water quality control. The four major studies are described below:

Study 1: The interim Marsh standards and not the post-1984 in Decision 1485 were presumed to be in effect. A



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C-053722

through-Delta transfer facility was presumed to be operating. This assumption eliminated the possibility of carriage water masking the impacts of the Marsh standards on required outflow. Only the Initial Facilities of the Suisun Marsh Plan of Protection were assumed to be operating.

Study 2: All the Study 1 assumptions were retained except those for Marsh facilities and Marsh water quality standards. Montezuma Slough Control Structure, Boynton-Cordelia Ditch, and Cordelia-Goodyear Ditch were assumed to be operating. The facilities were assumed to be operated to meet the post-1984 Decision 1485 standards.

Study 3: All the Study 2 assumptions were retained except the facilities were assumed to be operated to meet the post-1984 Decision 1485 standards, including relaxations to be proposed in some deficiency years (described in Chapter 3).

Study 4: The Study 4 assumptions were identical to those for Study 3 except that no through-Delta facility was assumed.

A comparison of Study 1 and 2 demonstrated that if the post-1984 standards take effect without the relaxations proposed in deficiency years, the potential firm yield of the SWP and CVP will decrease almost 500,000 acre-feet from that possible with the current (interim) standards in effect. The minimum annual required outflow will increase by about the same amount.

A comparison of Study 1 and 3 demonstrated that it would cost the CVP and SWP about 30,000 acre-feet more of potential firm yield to meet the Marsh standards proposed (with deficiency year relaxations) in this Plan than it would to meet the interim Marsh standards.

A month-by-month comparison of Delta outflow predicted in Study 1 and Study 2 was made. No significant alterations in the pattern of Delta outflow was observed.

Although the quantity of additional water needed to achieve the standards in the Marsh does not appear to be large, particularly before construction of a through-Delta facility, provision of the water by reduction of exports or releases from the upstream storage reservoirs of DWR and USBR should be assured. Future decisions about supplying this water could include consideration of the following alternatives:

1. An agreement could be reached between DWR and USBR to assure provision of the water needed.

2. DWR could provide all the water needed. This could, at times, reduce the amount of exportable yield and is not believed to be equitable to SWP contractors.



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C-053723

DWR would request that the SWRCB review the question of USBR's responsibility to mitigate its impact on the Marsh. This could be adopted as an interim solution if eventual USBR participation appears likely.

3. DWR could furnish only its share, assumed to be half, of the total water needed. DWR would request that the SWRCB review the question of USBR's responsibility to mitigate its impact on the Marsh. Securing USBR participation in the remaining water needed would be left to others. This also could be adopted as an interim solution.

4. Both agencies could make no added releases to meet Marsh standards, pending an SWRCB review of the relative responsibilities of DWR and USBR to mitigate their impacts on the Marsh.

The ultimate selection among these alternates will depend on the outcome of the negotiations among DWR, DFG, and SRCD for contractual commitment in the Marsh, the actions of SWRCB or other permitting agencies, and efforts to ensure USBR participation in the Marsh project.

DWR believes the full participation of USBR is essential if full mitigation of the impacts of the projects on the Marsh is to be accomplished. This participation could involve the cost of construction as well as the furnishing of stored water for the Marsh. USBR participation could be enabled through legislative authorization, a coordinated operating agreement between DWR and USBR, other USBR-DWR agreements, or a DWR-USBR-DFG-SRCD agreement. Any of these or a combination of these could resolve the uncertainty of USBR participation. In any event, USBR participation involving the expenditure of Federal funds will require congressional authorization.

One issue that impedes USBR participation is its belief that post-1984 standards in Decision 1485 provide water to Suisun Marsh of a better quality than would be required to mitigate for CVP and SWP impacts. Studies are being made cooperatively by DWR, USBR and SWRCB to identify how much, if any, enhancement is provided. The following is judged to be the reasonable range of conclusions of this work:

1. Decision 1485 standards could be shown to provide less than mitigation for the impacts of the SWP and CVP on the Marsh.

2. Decision 1485 standards could be shown to provide a reasonable approximation of mitigation for the impacts of the SWP and CVP on the Marsh.

3. Decision 1485 standards could be shown to provide enhancement to the Marsh, but the standards with the

proposed relaxations in some dry and critical years could be shown to provide a reasonable approximation of the water quality that would mitigate the impacts of the CVP and SWP on the Marsh.

4. The standards in the DWR/DFG/SRCD contract could be shown to provide better quality water to the Marsh than that needed to mitigate the impacts of the CVP and SWP.

Conclusion 3 is believed to be the most likely result of the studies for purposes of preparing the remainder of this report.

The State Water Resources Control Board (SWRCB) is expected to consider the results of these studies, along with other evidence, in assessing the adequacy of the Plan of Protection and the proposed relaxations to the Decision 1485 standards. If the SWRCB finds that the proposed standards provide an adequate level of protection to the Marsh, SWRCB could approve them whether or not they represent full mitigation for the impacts of the CVP and the SWP. If the proposed standards do not provide an adequate level of protection, SWRCB would have to judge whether or not the standards represent full mitigation for the impacts of the CVP and the SWP. If they do not provide an adequate level of protection, but do represent full mitigation, DWR would expect that SWRCB would seek mitigation from diverters other than CVP and the SWP before enforcing the standards. If the standards do not provide an adequate level of protection and do not represent full mitigation, SWRCB may order standards that differ from those proposed in this plan and do provide an adequate level of protection to be met in the Suisun Marsh.

If the DWR/DFG/SRCD contract is to be signed before SWRCB makes its findings it will be necessary to include in the contract a means of resolving the potential discrepancy between the contract standards and the ordered standards.



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C-053725

## Chapter 6. MANAGEMENT

The Suisun Resource Conservation District (SRCD) has primary responsibility for regulating and improving water management practices on privately owned lands within the Marsh. To carry out its responsibility, SRCD is revising management plans and evaluating flood and drain facilities for individual ownerships with managed wetlands. These plans identify the water management facilities necessary to flood and drain each property within 30 days. This work formerly was funded with Federal Coastal Management Funds administered through the San Francisco Bay Conservation and Development Commission (BCDC). It is now funded through Department of Fish and Game (DFG). A detailed management plan for each property is expected to be completed by February 29, 1984.

The individual management plans will include the number, size, and location of inlet and outlet structures and of drain and fill ditches, and will specify the times to fill and drain. Maintenance on privately owned lands will be carried out by the landowners in accordance with their approved management plans.

SRCD has established standards and regulations for construction within the primary management area of the Marsh. These are incorporated in SRCD's Suisun Marsh Management Program, which has been certified by BCDC.

Department of Water Resources (DWR) will be responsible for management of the major water control structures of the project. These structures are as described in Chapter 5, including operation and maintenance of the project.

The contract being negotiated between DWR, DFG, and SRCD makes DWR responsible for the extraordinary maintenance of the portion of the north levees of the Roaring River Slough unit on the Grizzly Island Wildlife Area and makes DFG responsible for the ordinary maintenance.

Routine maintenance of the project will be an annual program of inspecting the structures, checking them for corrosion and potential structural failure, and checking levees for subsidence. All deficiencies will be corrected during the off-season, June to September, except for emergency repairs, which will be completed as soon as possible.

The operational procedures for project facilities have not been established. These procedures will be solidified when the facilities are complete and have been in satisfactory operation for at least two years.



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C-053726

## Chapter 7. MONITORING PROGRAM

A salinity and habitat monitoring progam for Suisun Marsh is needed to meet requirements in State Water Resources Control Board (SWRCB) Decision 1485 and in the San Francisco Bay Conservation and Development Commission (BCDC) permit and to evaluate the operation of the Plan of Protection.

Condition 7(a) of Decision 1485 requires that the Plan of Protection include a monitoring network that is satisfactory to SWRCB. The network must include monitoring of channel water electrical conductivity (EC) on a continuous basis at six sites in the Marsh, periodically in Montezuma Slough near Suisun Bay, and continuously at two sites on the Sacramento River at Chipps Island and Collinsville.

The BCDC permit 35-78 requires:

- A comparison of water and soil salinities within the area served by the Suisun Marsh Initial Facilities to the salinities in neighboring areas not served.
- Comparison of water and soil salinities with measurements taken in preceding years.
- An assessment of any significant changes in the composition, diversity, or density of plant and wildlife populations in any area affected by the operation of the facilities.

The U. S. Bureau of Reclamation (USBR) and the Department of Water Resources (DWR) have monitored channel water salinities in the Marsh for several years to determine salinities to be used in planning studies, and to assist in verification of Fischer's computer model. The monitoring efforts have also helped determine the daily releases of water from upstream supplies for downstream and project uses. DWR is now conducting all the monitoring in the Marsh, having taken over all USBR stations.

Details of the equipment and methodology have been discussed with representatives from the U. S. Department of Agriculture's Salinity Laboratory at Riverside, California, the University of California, Davis, SWRCB, Department of Fish and Game (DFG), and the Suisun Resources Conservation District (SRCD). The equipment and methodology that will be used to obtain and process the data for this program are described in Appendix B.

The proposed sites of the Suisun Marsh Monitoring Program are shown on Figure 32. This program was carefully



C—053727

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designed and approved by the Suisun Marsh Technical Committee (SMTC) to meet the monitoring requirements in Decision 1485 and other applicable permits. The program not only monitors channel water salinity for compliance with Decision 1485, but also provides a mechanism for determining the resulting soil water salinities on individual ownerships. Soil water salinity and length of submergence are the two most important factors governing vegetative composition in Suisun Marsh (Mall 1969, Pearcy et al. 1982).

## Monitoring Program Participation

When USBR participation in the Plan of Protection has been secured, DWR presumes USBR will participate in the monitoring program. Pending USBR participation in the Plan DWR will explore the following options for the monitoring program.

- DWR could operate the entire program as described in the Plan of Protection until USBR participation has been secured.
- DWR could operate the entire program as described in the Plan of Protection for a specified limited term, during which attempts to secure USBR participation would be made.
- DWR could operate a less extensive program than outlined in the current monitoring program, but one that would still achieve the needs outlined in the various project permits, applicable agreements, and State Water Resources Control Board requirements.

Because monitoring programs are exempt from the provisions of the California Environmental Quality Act of 1970 (Section 15106 of the State EIR Guidelines), impact of the various participation options need not be discussed.

For the purposes of preparing the Plan of Protection and EIR, DWR has presumed that it will operate the entire program for a limited term, during which attempts to secure USBR participation are made. The program is made up of the elements discussed below.

## Channel Water Quality

As required by Decision 1485, six sites in the Marsh and two sites in the Sacramento River (Chipps Island or its equivalent and Collinsville) are being monitored. A new site near the west end of Montezuma Slough will be monitored periodically. Continuous monitoring equipment has been installed at three new sites on tidal sloughs within the Marsh. Periodic monitoring at the site in Grizzly Bay (D7) will be continued. These locations are shown on Figure 32.



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C-053728

The proposed contract among DWR, DFG, and SRCD includes a suggestion that three new monitoring sites be established to replace three of the monitoring sites established by Decision 1485 (S-36 to S-21, S-35 to S-75, and S-33 to S-97). The proposed sites will be more responsive to salinity changes in the water supplied by the facilities. They will also better reflect water quality at diversion points of the clubs. The State Water Resources Control Board must approve the proposed changes in monitoring sites before the change becomes effective.

The post-1984 water quality standards established by Decision 1485 were based on the best information then available. SWRCB has expressed a willingness to reevaluate those standards in light of new information developed by this project. A proposal for the revised standards is contained in the contract among DWR, DFG, and SRCD. That proposal is that after the facilities are operable, post-1984 Decision 1485 standards be met except when a deficiency period is declared in a series of dry and critical years. During a deficiency period it is proposed that the Decision 1485 standards be relaxed as defined in Chapter 5. Whenever surplus flows are available in the Delta, the facilities would be operated to provide better than the minimum allowed by the standards to the extent that such improved standards are beneficial to the Marsh and do not harm fish.

## Diversion Water Quality

The EC of applied water will be obtained at each major diversion point of the areas to be monitored on a continuous basis. The specific location for each recorder will be selected to be compatible with the specific sites to be monitored for soil water salinity.

## Water Level Recorders

Water level recorders will be installed and continuous records obtained at all areas being monitored for soil water salinity. These recorders will show how each area's water is managed, when the drain and flood cycles occur, and for what duration.

## Soil Water Salinity

Soil water salinity will be monitored in the top foot of soil, using soil water extractors installed, in triplicate, 6 inches below the soil surface at about 50 sites on 13 management areas. The western, central, and eastern Marsh are all represented. Sites have been chosen that vary in management practices and cover the five major soil types: Joice, Reyes, Tamba, Suisun, and Valdez. Likewise, several of the major vegetation types were covered. Samples are located in sites dominated by either alkali



C—053729

C-053729

bulrush, pickleweed, fat-hen, or brass buttons. Sites with complex vegetative matrices of each of these species were also sampled.

The management areas proposed to be monitored (see Figure 32) are:

- Areas numbered 406, 416, 426, 501, 504, 520, 513, 702, 804, 905.
- The eastern portion of Grizzly Island Wildlife Area.
- Joice Island Wildlife Area.

In addition, one soil monitoring site is located on area 423.

Any change of monitoring locations will be coordinated with Suisun Marsh Technical Committee (SMTC), SWRCB, and BCDC.

The accuracy of determining the average EC of water in the top foot of soil using a single extractor at the 6-inch level will be tested by comparing it with the results from extractors placed 3 inches and 9 inches deep on Reyes and Joice series soils at locations of both high and low surface water salinity.

The salinity tolerance of important marsh plants was based on soil water salinities determined gravimetrically. They formed the basis upon which Decision 1485 water quality standards were developed. To assure that monitoring results are sound, soil samples will be collected adjacent to the selected tri-level soil water extractors and analyzed in the laboratory during the first year of the monitoring. This will determine the relationship between soil water EC obtained gravimetrically and that obtained with the soil water extractors.

SWRCB and/or DFG will conduct the statistical analysis necessary to determine the relationship between the two sampling procedures. SWRCB and DFG will conclude their analysis and will report findings to SMTC within three months following receipt of one full year of sampling data. The sampling methodology will be reevaluated at that time.

The sampling methodology will be regularly reevaluated to determine future needs. For example, at the end of the first year it may be determined that the collection of soil samples at the tri-level soil extractors can be eliminated if the data are proving that the soil water extractors are accurately reflecting soil water conditions. Likewise, it is expected that some of the sampling and sampling sites can be eliminated based on data received and analyzed.



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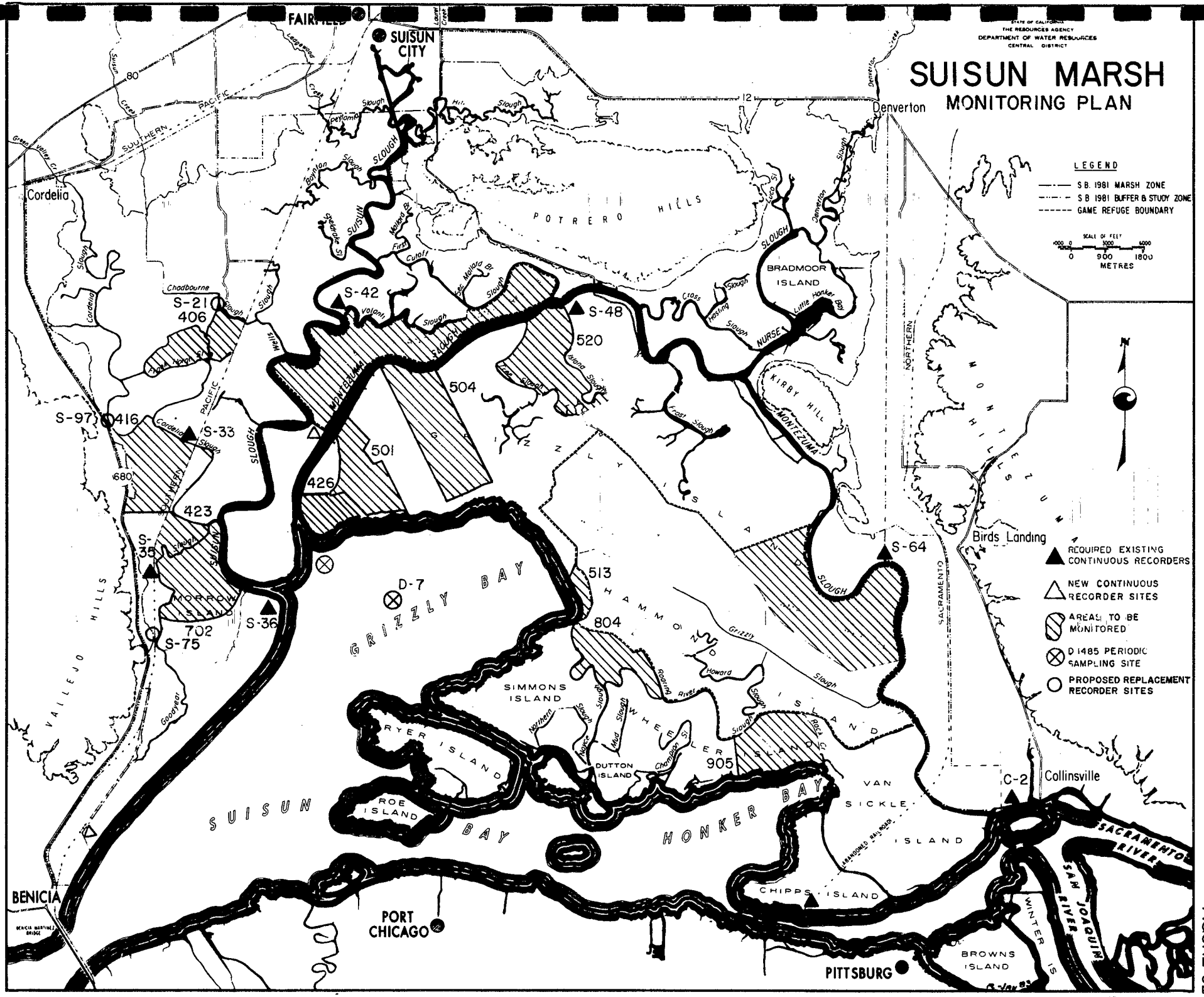


FIGURE 32

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## Plant and Wildlife Survey

Vegetative sampling is an important segment of the overall monitoring program for the Plan of Protection. Species composition of vegetation and seed production of major waterfowl food plants near each set of soil water extractors will be determined by DFG each year.

Vegetation sampling will also be carried out marshwide. The overall vegetative composition of Suisun Marsh will be determined every three years, using color aerial photography and ground verification. The results of these surveys will be compared to results from flights in 1961, 1973, 1978, and 1982 and will be reported, in acres and percent of total vegetation, for each major plant species.

The marshwide aerial photo survey will also be used to monitor the extent of preferred salt marsh harvest mouse habitat. This monitoring is a requirement of the U. S. Fish and Wildlife Service Section 7 determination (Appendix E). The biological assessment in Appendix D (pages 47 to 49) describes the methodology for this monitoring.

DFG will continue aerial waterfowl surveys. Under contracts, fish and wildlife experts will survey fish, clapper rail, black rail, and salt marsh harvest mouse populations when significant changes in plant density and composition are evident.

Under contract to DWR starting January 1979, the University of California at Davis (UCD) has monitored fish populations in selected Suisun Marsh channels to help determine if the Marsh Plan adversely affects this important aquatic resource. The monitoring, a voluntary DWR program, consisted of monthly trawl and beach seine samples at eight locations. UCD prepared annual project reports, which consist of periodic summaries. Biologists from UCD, DFG, and DWR have been analyzing any apparent trends for causative mechanisms regarding fish populations. This has been an informative program, providing needed baseline data. On DFG's recommendation, it was suspended August 1, 1983, but may be reinstituted after completion of the Overall Facilities.

## Reports

Preliminary data will be made available by DWR as soon as possible following collection. A report of data for each water year, to be produced jointly by DWR and DFG, will include:

- A summary of the channel, diversion, drain, soil water salinity, and water level measurements; the plant survey and production measurements; and waterfowl population surveys.



C—053732

C-053732

- The status of the overall vegetative composition of the Marsh (every third year).
- Results of any surveys made of California clapper rail and salt marsh harvest mouse populations.
- Comparisons of soil water, supply ditch, and channel water salinities to plant production to demonstrate the effectiveness of the program and identify areas where additional action is needed.
- Results of other studies as they become available.
- Conclusions and recommendations on modification of the monitoring program to achieve its objectives.

This report will be completed by April 1 each year.



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C-053733

## Chapter 8. IMPLEMENTATION SCHEDULE

Order No. 7(b) of State Water Resources Control Board (SWRCB) Decision 1485 stated:

> "Implement fully such Suisun Marsh Plan by October 1, 1984. Under this plan, water quality standards for full protection of the Suisun Marsh shall be met by no later than October 1, 1984."

The Department of Water Resources (DWR) notified SWRCB, by letter of July 26, 1982, that the Overall Facilities will not be completed by October 1, 1984. However, they are expected to be completed consistent with this plan. The implementation schedule, Figure 33, which includes all major elements of the Plan and estimates of the total costs, illustrates the earliest possible completion date.

DWR intends to obtain U. S. Bureau of Reclamation (USBR) participation in the Overall Facilities so that each agency provides 50 percent of the actual funds needed. If there is a continuing delay in obtaining this participation, DWR believes that its participation in implementation of the Plan of Protection should be limited to that necessary to mitigate State Water Project (SWP) impacts on the Marsh -- estimated to be 50 percent of the total cost of the Plan of Protection. A greater level of participation by DWR would impose an obligation upon State Water Project contractors to fund mitigation of impacts unrelated to the SWP. Proceeding with facilities beyond DWR's share is assumed to occur only if USBR participation in the Plan of Protection has been secured.

Solano County, in its comments on the Plan of Protection and Draft EIR, expressed its opinion as to the desirability of assuring the performance of the Plan of Protection, to minimize its cost and the potential for adverse impact on the Marsh's fragile wetlands.

DWR believes that to respond to the concern of Solano County and achieve the greatest benefit from the facilities with the least cost and adverse environmental impact on the Marsh, the facilities should be constructed in stages. Staging of construction will include test periods during which field operation data can be obtained and compared to the Marsh model predictions to correct or update the conservative data used. The updated data will then be used to verify the need for and design of subsequent stages. Staging of construction will assure that only the facilities needed to serve the Marsh are constructed and that these facilities are sized correctly. This will minimize the environmental impact on the Marsh, the loss of wetlands, and effects on endangered species.

Although unlikely, it is conceivable that testing will demonstrate that the Plan of Protection cannot achieve the water quality standards. In this event, it will be necessary to reevaluate the Plan and develop alternative proposals for accomplishing mitigation of the Central Valley Project and State Water Project impacts on the Marsh. Because the Montezuma Slough Control Structure is such a significant element of the Plan, it is presumed to be an essential element even if a modified plan must be developed.

The first stage proposed is the Montezuma Slough Control Structure and access road. Construction of the access road, the first part of this stage, should be completed at least a year before construction of the control structure is started. The Montezuma Slough Control Structure is the keystone to the entire Marsh management system. Construction of this facility alone will yield more than three fourths of the water quality benefits of the project. After completion of the structure, and subject to securing USBR participation in the Plan, construction of the remaining facilities would be staged according to one of the following options:

1. Proceed with design and construction of all facilities as rapidly as personnel and funds permit.

2. Test the water quality resulting from operation of the Montezuma Slough Control Structure for a 2- or 3-year period. If the next unit, now assumed to be Boynton-Cordelia Ditch were shown to be needed to meet water quality standards, it would then be constructed. There would be a similar test period before constructing each subsequent unit.

3. Test the water quality resulting from operation of the Montezuma Slough Control Structure for a 2- or 3-year period to determine whether Boynton-Cordelia Ditch, Cordelia-Goodyear Ditch, and Grizzly Island Distribution System were needed to meet applicable water quality standards. If these facilities were needed, Boynton-Cordelia Ditch would be completed by a specified time (estimated to be five years) from the date of completion of the Montezuma Slough Control Structure. Cordelia-Goodyear Ditch would be completed one year later, and Grizzly Island Distribution System would be completed two years later. The need for Potrero Hills Ditch would be evaluated in a second test period. If needed, Potrero Hills Ditch would be constructed by the fifth year after completion of the Cordelia-Goodyear Ditch.

4. Defer further construction of any of the Overall Facilities until assured of USBR participation in the Plan of Protection.



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Selection of an option would depend on the outcome of negotiations among DWR, DFG, and SRCD for a contract relating to the Plan of Protection and actions by SWRCB and/or other permitting agencies. For purposes of preparing the implementation schedule and the remainder of this report, Option 3 or a variation of it is presumed to be selected.

If USBR participation is delayed and for a period of time the only facilities serving the Marsh are the DWR-constructed facilities -- the Initial Facilities, Montezuma Control Structure, Annie Mason Facility, Cygnus Facility, lower Joice Island facility, and Boynton-Cordelia Ditch -- the model predicts a quality worse than the initial Decision 1485 by 10 percent in February and March at Station S-35. All other model salinities under this scenario are similar to those shown on Figure 18.

Because the model predicts that the standards will be so nearly met without construction of Cordelia-Goodyear Ditch, Goodyear Slough Control Structure, and Potrero Hills Ditch, DWR believes it is possible that staging construction will demonstrate that one or more of these facilities will not be needed to actually meet water quality standards. This speculation is based on the premise that the model is conservative in its predictions.

DWR believes that Grizzly Island facilities will be needed.

Construction of the facilities outlined in Chapter 5 will require permits from Federal, State, and local agencies charged with regulating changes within the Delta, marshland, and waterways. Permits will have to be obtained from:

- San Francisco Bay Conservation and Development Commission, for construction in the Marsh.
- U. S. Army Corps of Engineers, for construction in or near waterways.
- U. S. Army Corps of Engineers, for disposal of spoil material in waterways or on wetlands.
- State Department of Fish and Game, for construction in waterways where fish are present.
- State Lands Commission, for construction on or near State of California sovereign lands.
- State Water Resources Control Board, Regional Water Quality Control Board, State Department of Health Services, for water quality and use of treated waste water.

- Solano County, for construction in the Marsh and use of material sites within the county.



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# IMPLEMENTATION SCHEDULE - SUISUN MARSH FACILITIES

ALL COSTS IN DOLLAR x 1000

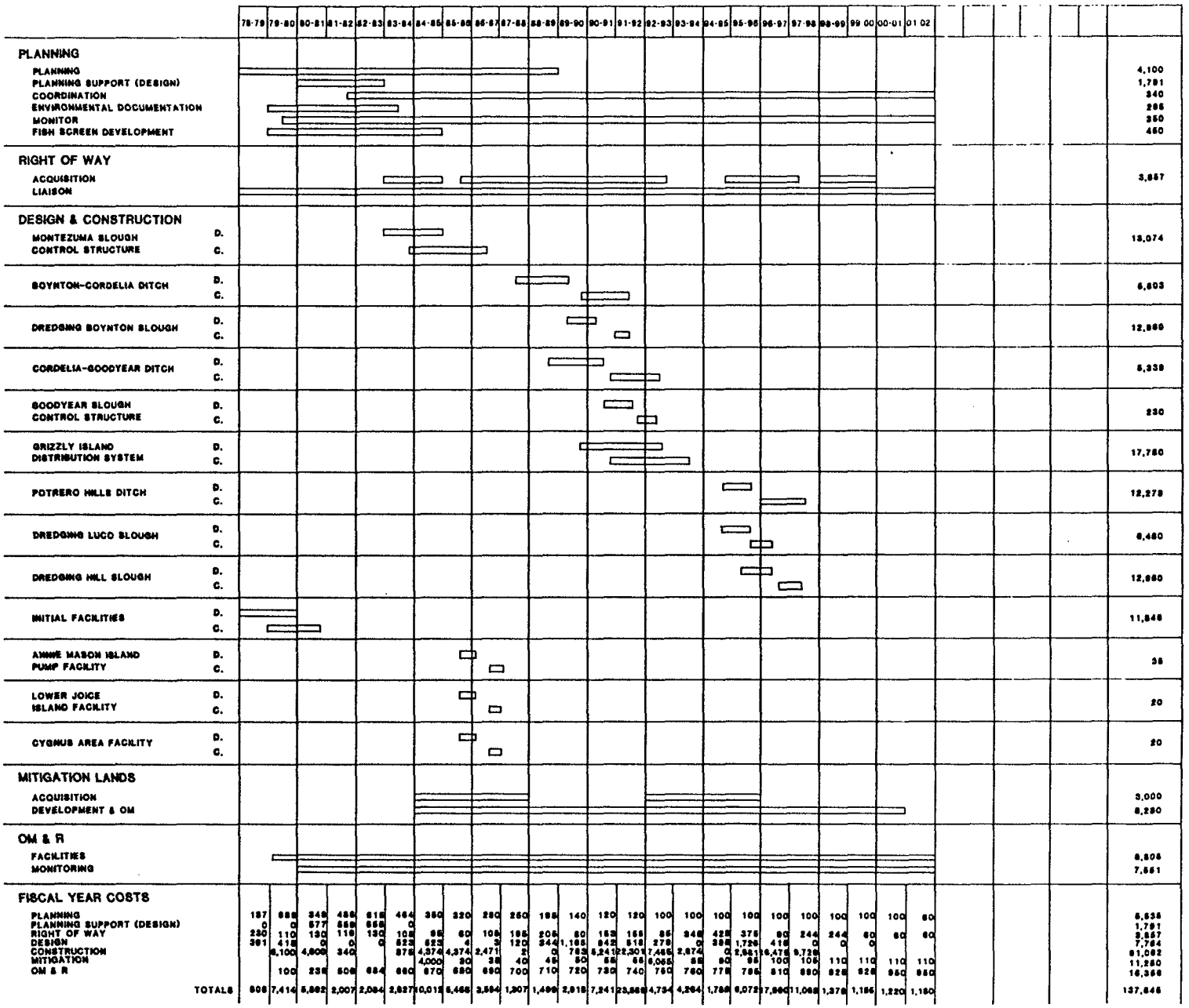


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FIGURE 33

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# Chapter 9. ENVIRONMENTAL IMPACT REPORT
# PLAN OF PROTECTION, SUISUN MARSH PHYSICAL FACILITIES

## Environmental Impact Report Summary

### Purpose of the Plan of Protection

The Suisun Marsh Plan of Protection is designed to protect the brackish water nature of Suisun Marsh. The Plan, as presented, is mitigation for the effects on Suisun Marsh of the exportation of water from the Delta by the Federal Central Valley Project (CVP) and the State Water Project (SWP). If the Plan of Protection is not implemented, reduced Delta outflows will result in increased intrusion of salt water into Suisun Bay and the Marsh. The Marsh would gradually lose its brackish nature, becoming more saline. When constructed, facilities of the Plan of Protection will create new ponds, waterways, and levees from areas that are now wetlands.

### Project Description

The Suisun Marsh Plan of Protection has four components:

1. Supplemental reservoir releases to meet water quality standards. Releases necessary to comply with Decision 1485 standards are described in detail in the final EIR prepared by the State Water Resources Control Board (SWRCB) for its Decision 1485. The changes to Decision 1485 proposed in the Plan of Protection are described in Chapter 5.

2. Physical facilities. These are described in detail in Chapter 5.

3. A management plan for the Marsh. This is described in Chapter 6. The Department of Water Resources (DWR) would manage, operate, and maintain the major water control structures of the project. The management of marshland and other lands, including intake and outlet structures, within the Marsh will be the responsibility of the Suisun Resource Conservation District (SRCD), the private wetland owners, and the other landowners.

4. A monitoring program. This is described in Chapter 7.



C—053739

C-053739

The key physical facility would be the Montezuma Slough Control Structure. The structure would use tidal differential to transport the better quality water available at Collinsville through the Marsh.

When the control structure is tidally pumping, the gates will be open when the flow in Montezuma Slough is from east to west, allowing the better quality water from the Sacramento River to enter the Marsh. When the flow in Montezuma Slough is from west to east, the gates will be closed, stopping the flow to the east and forcing the water to flow westerly. This traps the quality water and forces it to flow into the Marsh.

Water distribution systems needed to meet water quality standards would be constructed to convey the quality water onto islands in the Marsh for flooding the ponds and salinity control. Water would be diverted from the sloughs into managed wetlands within the islands by means of culverts with flap gates. The flap gates would allow water to flow into the wetlands when tides raised the water in the slough to above the level of the ponds. The flaps would prevent the water from flowing back into the slough when the tide dropped the level of the slough to below that of the pond. Ditches would convey the water to other parts of the islands for use.

Additional facilities needed to meet water quality standards would be constructed to promote the flow of quality water into the upper ends of several sloughs during rising tides and to flow out toward the bay with the falling tides. The Boynton-Cordelia Ditch would convey quality water from Boynton Slough and reclaimed waste water from the Fairfield-Suisun waste water treatment plant to Cordelia Slough, in the northwestern portion of the Marsh. The Cordelia-Goodyear Ditch would move water from Cordelia Slough to Goodyear Slough at the western edge of the Marsh. Water from Goodyear Slough would be conveyed to the Morrow Island Ditch for distribution on Morrow Island and the Goodyear Slough Outfall at the southwest end of the Marsh. The Potrero Hills Ditch would allow quality water to flow from Luco Slough, around the Potrero Hills, into the upper reaches of Hill Slough. The water would then flow into the north end of Suisun Slough to freshen the water there. Based on the computer model studies, the Potrero Hills Ditch may not be required.

A monitoring system has been developed to measure salinity throughout the Marsh and to provide information for evaluating the operation of the facilities. Construction of the facilities would be staged, with pauses for monitoring and testing between the construction of different units.

## Environmental Impacts

The Plan of Protection would have one significant environmental effect that would not be mitigated to insignificance



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by features of the Plan. This effect would be the conversion of up to 437 acres of seasonal, managed, and tidal marshlands to upland habitat or open water in ponds or channels if the entire project were constructed. The upland habitat would be created on new levees, and the new water surface acreage would be created for the ponds and ditches that would convey water through the Marsh to protect its brackish nature. Options for mitigating this loss of wetlands are discussed in the unavoidable adverse impacts portion of this chapter. Full replacement of the potential loss of wetlands if all facilities of the Plan of Protection were constructed would entail purchase and development of 437 acres of new managed marshland within the Suisun Marsh area. Of these acres, 100 would be managed as preferred habitat for the endangered salt marsh harvest mouse to replace the acreage impacted during construction of the facilities.

No significant impacts are expected on rare, threatened, endangered or candidate species other than the impacts on the salt marsh harvest mouse, described above.

The Cutoff Slough area is preferred habitat for the endangered California clapper rail. A 1979 survey estimated that 25 clapper rails was present in that area. To avoid disturbing this habitat, the Plan of Protection deliberately excluded channel enlargements in Cutoff Slough.

Black rail surveys for this report found no black rails in the areas potentially impacted by project construction. Black rails found in a 1976 survey were located in areas such as tidal sloughs that would not be impacted by project construction.

The disturbance of up to 541 acres of upland habitat is not seen as a significant effect of the project. The disturbances of the upland habitat would occur in widely separated locations. Due to the expected phasing of the different features of the project, the disturbances would also be widely separated in time. One disturbed area would have time to recover before another area would be disturbed. The disturbance would also be mitigated by seeding the up to 445 acres of new levees.

## Alternatives

The Plan of Protection identifies four alternative approaches to protecting the Marsh. These are:

1. The No Action Plan. This approach would involve taking no action to protect the Marsh and would represent the "no project" alternative.

   If no action is taken to protect the Marsh, the duration of salinity intrusion into the channels of the Marsh will increase as greater amounts of water are diverted upstream and in the Delta. Seed production in the Marsh



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C-053741

will decrease, and less food will be available for waterfowl. Vegetation dependent on brackish water conditions will decline and will be replaced by vegetation more typical of saltwater marshes. Rare or endangered species that rely on the brackish conditions will be adversely affected. The natural productivity of the Marsh will decline.

2. The Nonstructural Plan. The nonstructural plan would protect the water quality in Suisun Marsh by increasing Delta outflows. If outflows alone were used to meet water quality standards in the Marsh, outflows would need to be increased up to 4.8 million acre-feet to maintain Decision 1485 criteria for interior Marsh water during dry and critical years. This outflow is made up of 2 million acre-feet of project yield and 2.4 million acre-feet of uncontrolled outflow. These increased outflows could be achieved either by increasing releases from the State and Federal reservoirs or by decreasing exports from the Delta. Reservoir releases would impair the ability of the SWP and CVP to meet contractual commitments to deliver water. Reduced SWP exports would violate existing contracts and could cause 300,000 to 500,000 acres of irrigated farmland to be taken out of production or an increase in urban and rural ground water pumping. The loss of agricultural production would have adverse economic impacts throughout the State that would make this alternative infeasible. This approach would involve less uncertainty about the impacts on fish than would the Combination Plan, but there is also no evidence that it would protect fish better than would the Combination Plan.

3. The Overland Supply Plan. In the overland supply alternative, fresh water would be delivered overland to each management area within the Marsh. The water could come from a number of possible sources. These sources include the Sacramento River upstream from Rio Vista via Calhoun Cut or Lindsey Slough, the Putah-South Canal coming from Lake Berryessa, the proposed West Sacramento Valley Canal, or the North Bay Aqueduct.

   Most of these sources of water would require major canals or conveyances would need to be constructed to transport the water to the edge of the Marsh. A distribution system would then deliver water to each major existing internal distribution system. Where there are no internal systems, a network of ditches and structures would have to be constructed. The overland supply system would need siphons under existing channels. Where the operating head is insufficient to deliver the necessary quantity of water, pumping plants would be required. The quantity of water distributed would be roughly 200,000 to 300,000 acre-feet.



C—053742

C-053742

The overland supply alternative would involve major construction and environmental disturbances for the conveyance systems. Most of the sources of water would require pumping, with increased energy consumption. Diversions, such as from Lindsey Slough, West Sacramento Valley Canal, or treated City of Sacramento waste water, which would tap the flows of the Sacramento River above Rio Vista, would require a one-for-one replacement with project water to control salinity below Rio Vista.

In addition, the salmon runs could be affected by the use of Sacramento River water, because the salmon would stray from normal migration routes, causing delays that would diminish future populations. Implementing this plan could alter the nature of the Marsh, changing some managed areas from brackish to freshwater habitat. This change would adversely affect the harvest mouse, due to the loss of pickleweed, which depends on more saline conditions. This plan requires more water than the combination plan but less than the nonstructural plan.

If constructed with siphons under Montezuma Slough, the overland supply plan would have the advantage of not involving a control structure on Montezuma Slough.

4. Combination Plan. This is the proposed alternative, involving a combination of elements from the other alternatives. The central feature of this plan is a control structure on Montezuma Slough that would use tidal forces to move the better quality water available at Collinsville through the Marsh. During the fall and winter, when additional supplies of quality water are needed to control salinity in the Marsh, the control structure would be placed in operation. The gates would be open when the flow in Montezuma is from east to west, allowing the quality water from the Sacramento River to enter the Marsh. When the flow in Montezuma Slough is from west to east, the gates would be closed, stopping the flow to the east and forcing the water to flow westerly. The resulting quality water in the sloughs would be diverted to serve the management areas within the Marsh, relying mostly on tidal forces to move the water. Some additional ditches and control structures would be needed to move the quality water to other sloughs. The Fairfield-Suisun waste water treatment plant would provide a second source of quality water for repulsion of salinity in the western portions of the Marsh.

This approach would involve, as a significant effect, the conversion of up to 437 acres of marshland habitat to open water in channels and ponds and to upland



C—053743

C-053743

habitat on new levees. Less water would be required than for the nonstructural plan and the overland supply plan. The use of tidal forces would minimize the energy requirements.

The combination plan would involve less interference with adult salmon runs than would the overland supply plan, but slightly more than would the nonstructural plan. Delays to adult salmon migration would be limited to periods when the Montezuma Control Structure was in operation and then to only that part of each tidal cycle when the gates in the control structure would be closed. Any potential predation losses to juvenile salmon and steelhead at the control structure would be more than offset by screening the intakes of the Roaring River and Grizzly Island units and thereby screening currently unscreened diversions of water. During the portion of the year when the control structure was in operation, recreational boaters could be delayed in moving through the control structure, but only during the portion of the tidal cycle when the gates would be closed. A boat lock in the control structure would allow passage during daylight hours when the gates were closed, but if a large number of boats needed to pass through the lock, delays of up to one-half hour could be experienced. The gates would remain open during the peak recreational boating seasons.

## Areas of Controversy

The National Marine Fisheries Service has expressed concern that the Montezuma Slough control structure could have an adverse effect on anadromous fish. It expects that predatory fish such as adult striped bass might congregate in the eddies on the downstream side of the support piers for the control structure. From the eddies, the striped bass could dart out and seize the juvenile salmon and steelhead migrating downstream to the ocean. To minimize this potential problem, the structure was redesigned with long, continuous supports tapered at the downstream end rather than many separate round supports. This change would minimize the eddy effect and decrease the number of places where predatory fish could congregate.

This concern for losses to migrating salmon and steelhead is based on experience Department of Fish and Game (DFG) gained in other areas, such as the Fish Facilities at Clifton Court. Should fish monitoring outlined in the Memorandum of Understanding now being negotiated between DWR and DFG indicate a problem, solutions would be implemented. In any event, DWR believes that the project would more than make up any losses to juvenile salmon and steelhead at the control structure by screening those areas served by the Roaring River and Grizzly



C—053744

C-053744

Island units and thereby replacing unscreened diversions of water from sloughs and bays. The screens would prevent the juvenile fish from being swept onto the managed wetlands with the diversions of irrigation water, as they are now. As a result the project is expected to improve the rate of survival of young salmon and steelhead moving through the Marsh.

A second area of controversy involves inconvenience to recreational boaters. From the later part of May until October, the control structure would remain open and would have no adverse effect on boating through Montezuma Slough. In the fall and winter, the control structure would be closed during the outgoing tides. To mitigate this intermittent obstruction of Montezuma Slough to boating traffic and to minimize delays to boaters, a boat lock has been included in the design to allow boats to pass through when the structure is operating. Boaters could be delayed by up to one-half hour while waiting to use the lock. When the structure was not operating, flashboards would be removed to allow boaters a larger, unrestricted passage through the structure.

DWR believes that these occasional delays would not be significant. The delays would occur, if at all, during the fall and winter, which is a time of relatively light boating use of the area. Further, as partial mitigation for the impact on boaters, DWR is proposing to build a boat launching ramp at the Grizzly Island Bridge.

The controversy over the effect on boating has arisen because boating interests have urged the Department to modify the Grizzly Island Bridge to allow larger boats to use Montezuma Slough. The existing bridge is high enough to allow boats up to 21 feet high to pass through. The request by boaters is for modification of the existing bridge or a new bridge that would allow passage of boats requiring more than the 21-foot clearance. The Department has declined to replace the Grizzly Island Bridge. The bridge is part of the existing environment for the purposes of this project and the Plan of Protection would not require changes in the bridge. Any delays caused by the control structure would only affect boats small enough to pass under the bridge.

Providing a substantial enhancement, such as modifying the Grizzly Island Bridge for larger watercraft, is not justifiable mitigation for the impact of the control structure, because most of the watercraft that would be subject to delay at the structure are not limited by the existing bridge. These modifications to the bridge would also create substantial adverse impacts on other travelers; each day, about 100 vehicles would be delayed while the span was open. Further, the cost of replacing the bridge would be excessive. The bridge has been a source of contention with boaters since its construction in 1958. DWR believes that it is inappropriate for this project to be burdened with the cost of resolving the controversy over a problem not caused by this project.

Issues to be Resolved

Several major issues remain to be resolved in the Suisun Marsh Plan of Protection. The resistance of these issues to resolution provided part of the impetus for preparing this as a program Environmental Impact Report.

One major issue is how much of the plan will actually be implemented and how rapidly. Resolution of this issue depends on the results of testing following the construction of each of the units and on U. S. Bureau of Reclamation (USBR) participation in implementation of the plan. The staging of construction described in Chapter 8 will allow a pause for testing completed facilities and adjusting the proposed design of subsequent facilities to ensure that the design will be appropriate and effective. Achieving the goals of the Plan of Protection is thus assured while the potential adverse impacts of the Plan are minimized.

Staging of construction was included in the Plan of Protection in part because of concerns as to the reliability of the mathematical model of water flows and salinities used in developing the Plan. Although the model describes water qualities and floodflows under current conditions with a high degree of accuracy, its performance under other conditions has yet to be demonstrated. Many assumptions worked into the model were deliberately conservative to protect against actual future water qualities being worse than predicted. DWR believes that water qualities resulting from implementing the plan are more likely to be better than predicted than worse. If conditions are better than predicted, one or more features of the Plan of Protection may not be needed.

Securing USBR participation in implementing the Plan of Protection influences how much of and how rapidly the plan will be implemented, because DWR believes that DWR's participation in implementation of the plan should be limited to that necessary to mitigate SWP impacts on the Marsh, estimated to be 50 percent of the total cost of the Plan of Protection. USBR participation could be enabled through legislative authorization of a coordinated operating agreement between DWR and USBR, other USBR agreements, or a DWR-USBR-DFG-SRCD agreement.

Another major issue is assuring that the water needed would be provided from upstream reservoirs of the CVP and/or SWP. Actions for resolving this issue and the impacts of those options are discussed under "General Environmental Effects of Proposed Action" in this chapter. The question of USBR's role in the Plan of Protection is a key element of this issue.



C—053746

C-053746

A third major issue is which option for mitigating the loss of wetlands through construction of the DWR portion of the overall facilities will be adopted. Although the proposed Plan of Protection will help protect the Suisun Marsh environment, construction of the features of the plan will permanently convert to water surface up to 437 acres of marsh and 96 acres of upland habitat. This loss of marsh habitat is the one significant environmental effect of the project, because it would adversely affect the endangered salt marsh harvest mouse and potential habitat of the rare black rail. Possible options for mitigating this impact are discussed in this chapter. Selection among them will be made through development of a Memorandum of Understanding between DWR and DFG and will be influenced by the San Francisco Bay Conservation and Development Commission (BCDC) and Corps of Engineers (USCE) permit processes.

The channel islands of Roe, Ryer, Freeman and Snag would not be served by the facilities proposed in the Plan of Protection. Some degradation of habitat on the channel islands may occur due to reduced Delta outflows. DWR regards this degradation to be a significant effect of Decision 1485 and of the diversions of water by the SWP, the USBR, and all other upstream diverters. The degradation would not be caused by the Plan of Protection and is not examined in this EIR. Nevertheless, various options for possibly including compensation for the loss of habitat on the islands are examined in Chapter 4, because consideration and approval of the Plan of Protection provide an opportunity to examine mitigation of a significant effect of past commitments to proceed with the State Water Project.

Another issue is the placement of dredge spoils from digging or enlarging channels through the Marsh.

The spoil will be placed in locations approved by all regulatory agencies in the necessary permits, but DWR cannot determine at this time where the approved locations will be. The regulatory agencies, including the USCE, the BCDC, and the Regional Water Quality Control Board, will determine what locations will be approved. A number of locations may be considered. The most likely is the spoil disposal site now used by the Corps of Engineers in Carquinez Strait. Depositing the spoil in this location would be the simplest and cheapest alternative. Other possible sites include Delta islands and land sites in Solano County. Depositing the materials on Delta islands would be time consuming and expensive. The spoil would need to be pumped out of the barges rather than dumped through trap doors in the bottom, as would be possible at the Carquinez Strait disposal site. Land disposal unless immediately adjacent to an excavation site would also be expensive due to the many trips by trucks that would be required rather than few trips by much larger barges. Further, most of the material excavated could not be hauled by truck until it had been dewatered and consolidated. No adverse effects are anticipated from the various possible methods of disposing of the spoil.



C—053747

C-053747

## Description and Use of the EIR

This is a program environmental impact report (EIR). The EIR identifies and analyzes the environmental effects of the Plan of Protection for Suisun Marsh and the physical facilities described in this document. The DWR has chosen to prepare a program EIR because the Plan of Protection and the physical facilities will not all be carried out at the same time. The plan calls for a number of separate actions to be carried out by different agencies to protect existing environmental conditions in the Marsh. The physical facilities that may be constructed in the Marsh will be constructed separately over a period of time. There will be a pause for monitoring and evaluation following construction of some of the facilities. The montoring and evaluation will be used to validate the analysis presented in this program EIR and the accuracy of the projections from the mathematical model. The information will be used to determine whether alterations should be made in any of the physical facilities and possibly to determine whether particular followup facilities need to be constructed at all.

The EIR examines the overall effects of the Plan of Protection and the physical facilities so that DWR can understand the likely environmental effects when it makes its first commitments to carry out this program. The first steps in carrying out the program will be the approval and construction of the access road to the site for the Montezuma Slough control structure. Later DWR will decide whether and how to proceed with construction of the control structure. Still later, decisions may be made as to whether to proceed with various ditches and other facilities described in the discussion of the physical facilities.

Many of the details of the Plan of Protection have not yet been put into final form. Negotiations are still proceeding between DWR and the USBR concerning USBR's role in the Plan of Protection. Individual land management plans are being developed by the SRCD, and the Soil Conservation Service (SCS). After the plans have been developed, they will be submitted to DFG for approval and to BCDC for endorsement. There may be petitions by DWR to SWRCB concerning water quality requirements. This EIR discusses the possible environmental effects of these various activities as they can be foreseen at this time. Where there is a range of reasonable alternatives available at these different decision points, the EIR identifies those alternatives and their likely environmental consequences to the degree that they can be reasonably foreseen at this time.

To meet the requirements of Section 15168 of the State CEQA Guidelines describing the program EIR concept, it is not necessary to identify which alternative will be chosen in the future. It is enough to identify the alternatives to be considered and to identify their likely environmental effects.



C—053748

C-053748

DWR will use this EIR when it makes decisions to proceed with particular facilities or components of the Plan of Protection. DWR will review the later activities in light of the program EIR to determine whether an additional environmental document must be prepared. If the later activity would have environmental effects that were not examined in the program EIR, a new initial study would be prepared leading to either an EIR or a negative declaration focusing on the particular effect that had not been analyzed in the program EIR. If DWR determines that there would be no new significant environmental effect or that there are no new feasible alternatives or mitigation measures available that would substantially lessen any of the remaining significant effects from the project, DWR could approve the particular component of the plan as being within the scope of the program EIR. In such a circumstance, no new environmental document would be required. With each commitment to a part of the Plan of Protection or its physical facilities, DWR will consider adopting mitigation measures or alternatives it determines to be feasible to substantially lessen the significant effects of the overall program or the particular component.

Other public agencies will need to use this program EIR when they grant permits or other approvals for parts of this plan. The BCDC will be asked to grant permits for the construction activities within the Marsh. The Regional Water Quality Control Board will need to issue a discharge permit or a letter of certification for construction of the control structure and possibly the various ditches. The State Lands Commission will be asked for approvals of the various facilities located in navigable channels. Solano County will be asked for permits or local reports to be submitted to BCDC for their use in evaluating DWR's permit applications. These other State and local agencies will use the EIR, acting as responsible agencies under CEQA. The USCE will be asked to issue a Section 404 "dredge and fill" permit for the control structure, for the Montezuma Slough closure, and for other construction activities in the wetlands. The USCE will use this document when it complies with the requirements of the National Environmental Policy Act.

## Related Environmental Documentation

This section gives the status of environmental documentation of the plan's four components.

### Water Quality Standards

An environmental analysis of supplementing Delta outflow to meet Decision 1485 standards may be found in the "Final Environmental Impact Report for the Water Quality Control Plan and Water Rights Decision, Sacramento-San Joaquin Delta and Suisun

Marsh", published in August 1978 by the State Water Resources Control Board, P. O. Box 1002, Sacramento, California 95801.

The Plan of Protection includes a proposal to relax the post-1984 Decision 1485 standards in a series of dry and critical years (deficiency period). The proposed deficiency standards are described in Chapter 5. The impact of these standards on outflow and firm yield of the project are described in this chapter. The annual outflow in dry and critical years needed to meet the proposed standards was found to be slightly more than that needed to meet the existing Marsh standards (interim) of Decision 1485. There was a slight shift in the distribution of outflow within the year. Less water was provided in the fall and more in the spring. Because the change in outflow is a slight increase and the shift in pattern is small, DWR believes that these impacts of the proposed standards will not be significant.

## Management Plans

Any environmental documentation needed for the "Individual Ownership" management plans, as outlined in Chapter 6, will be supplied by SRCD. DWR will be responsible for the management, operation, and maintenance of the major water control structures of the project described in Chapter 5. It is proposed to include provisions and standards for fish suggested by DFG in the operational criteria.

## Monitoring Program

The monitoring program requires no environmental documentation, because it is exempt from the provisions of the California Environmental Quality Act of 1970 (Section 15106 of the State EIR Guidelines). Details of the monitoring program, participation, and water qualities are given in Chapter 7.

## Physical Facilities

An "Initial Study -- Suisun Marsh Initial Facilities", dated October 1978, prepared by the Central District, Department of Water Resources, examines environmental aspects of the three physical components of the Suisun Marsh Initial Facilities: Roaring River Slough, Morrow Island Distribution System, and Goodyear Slough Outfall. Based on the Initial Study, a negative declaration was prepared, stating that the project would have no significant adverse effect on the environment.

Copies of the initial study and negative declaration are available from the Department of Water Resources, P. O. Box 388, Sacramento, California 95802.



C—053750

C-053750

The Suisun Marsh Initial Facilities have been completed, including the Roaring River Slough intake fish screens, which were completed in 1983.

The Overall Facilities include the Initial Facilities; however, this EIR will not reexamine the environmental analysis of the facilities included in the Initial Study. It will examine the remaining Overall Facilities. These include:

- Montezuma Slough Control Structure
- Grizzly Island Distribution System
- Potrero Hills Ditch
- Cordelia-Goodyear Ditch
- Goodyear Slough Control Structure
- Boynton-Cordelia Ditch

The impacts of the minor facilities, described in Chapter 5, for Lower Joice Island, the Cygnus area, and Annie Mason Island are not discussed in this EIR. The facilities proposed for Lower Joice Island and the Cygnus area will be steel pipes with flap and slide gates installed through the levees to improve the circulation of water by tidal action.

The Annie Mason Island proposed facility will include a diesel pump in addition to the pipe and gates. It has been determined that the proposed facilities will not cause any significant environmental effect in these areas and, therefore, need not be discussed in the EIR.

## Description of Project Facilities

Project facilities are described in Chapter 5.

## Environmental Setting

Suisun Marsh is south of Fairfield, in southern Solano County (Figure A, page 3). One of the largest, contiguous brackish water marshes in the United States, it comprises over 10 percent of the remaining natural wetland in California. About 30,000 acres are sloughs and small bays; about 50,000 acres are leveed, managed wetlands; and about 5,500 acres are tidal marsh. The project and its service area encompass about 45,000 acres, or about 90 percent of the managed wetlands.

The 85,500 acres of tidal marsh, managed wetlands, seasonal marshes, channels, bays and mudflats, fallow uplands, grain fields, and heavily vegetated levees in and adjacent to the project area provide habitat for an abundance of fish and wildlife. About 45 species of fish, 230 species of birds, 45 species of mammals, 10 species of reptiles, and 5 species of amphibians have been observed in the Marsh. The salt marsh harvest mouse, California black rail, and California clapper rail

are rare or endangered. In addition, the Peregrine falcon, bald eagle, and Aleutian Canada goose, also endangered, occasionally visit the Marsh.

The Marsh's extensive system of waterways provides habitat for a wide variety of game and nongame fish. Catfish, especially white catfish, support a major sport fishery. White and green sturgeon are common. Chinook salmon and steelhead trout use Montezuma Slough as a migration route to and from upstream spawning grounds. Native minnows and carp are abundant in the dead-end sloughs. The Marsh is a major nursery area for young-of-the-year striped bass. Threadfin shad are common and provide food for striped bass and other predatory species.

The Marsh is a major wintering ground for waterfowl in the Pacific Flyway. Desirable food plants and aquatic habitat attract about a million ducks to the Marsh in the fall of years with normal rainfall. During years of drought, the area becomes particularly important to waterfowl because of its large expanse of flooded wetlands and the scarcity of such habitat elsewhere. Early in the fall and in drought years, the Marsh may provide habitat for up to 28 percent of California's wintering duck population. This percentage drops substantially by late fall and early winter.

The Suisun Marsh is primarily used for wildlife areas that provide recreational opportunities. The Marsh is one of the best known duck hunting areas in California. Rabbit and pheasant hunting, fishing, dog training, bird watching, boating, photography, sightseeing, and nature study are also popular. The Marsh supports an estimated 150,000 days of recreation use annually.

DFG owns 12,600 acres in the Marsh, including 10,500 acres on Joice and Grizzly islands, which it manages as wildlife areas. About 38,600 acres are privately owned and have no public access. Most of these private lands are managed by hunting clubs as waterfowl habitat.

The primary objective of regional and local planning is to preserve the natural and managed wetland use of the Marsh and agricultural use of adjacent upland areas. Solano County has designated the tidelands, managed wetlands, and water areas of the Marsh for fish and wildlife production, water recreation, and mineral extraction (natural gas). BCDC has designated the leveed marshlands as managed wetlands and the Grizzly and Joice Island Wildlife Areas as recreation and wildlife areas.

More information about the Suisun Marsh environmental setting may be found in the "Draft EIR, Peripheral Canal Project" (Department of Water Resources, 1974) and in "Suisun Marsh Study" (USDA Soil Conservation Service, 1975).



C—053752

C-053752

## General Environmental Effects of Proposed Actions

This section discusses effects that construction and operation of the facilities would have on various aspects of marsh environment, and it presents possible compensation measures for impacts that may be adverse. Effects of a general nature are discussed here. General effects are those not closely or exclusively related to a specific facility. More specific effects of each facility are examined in a later section.

The Endangered Species Act (50 CFR Part 402) requires Federal agencies to ensure that their activities do not jeopardize the continued existence of a species covered by the Act. Section 7 of the Act requires consultation with the appropriate wildlife agency when a Federal action may impact a listed species.

A biological assessment has been prepared by the DFG for USBR to address the impacts on both the salt marsh harvest mouse and California clapper rail (see Appendix D). The assessment by U. S. Fish and Wildlife Service (USFWS) has been completed, and the Section 7 determination has been prepared (see Appendix E).

### Construction

Construction work would have little environmental impact. Work would mainly be confined to areas the finished facilities would occupy. Other affected areas would be restored to preproject conditions. Roads damaged by heavy equipment would be rebuilt to preproject condition. Roads requiring relocation due to construction would be built to county specifications. Staging areas used for temporary storage of materials and equipment, located either outside the Marsh or on marshlands already modified for vehicular use, would be returned to their preproject state.

Operation of equipment and increased vehicular traffic would raise levels of dust and exhaust fumes in the immediate area during construction. Noise levels, which would also be higher than usual, would be below harmful levels. If dust became a problem, water would be applied by trucks according to contract specifications.

Because the various facilities would be far apart and would not be built simultaneously, construction impacts at any one time would be relatively minor.

### Construction Staging

The Montezuma Slough Control Structure would be the first component of the plan to be constructed. Its operation is essential to the effectiveness of all other components of the plan, and would also result in the greatest improvement in water



C—053753

C-053753

quality. It would be an expensive feature, but its construction will yield more than three-fourths of the needed improvement in water quality. The decision to stage construction of facilities will not delay construction of the Montezuma Slough Control Structure or postpone the time when the Marsh will realize its benefits. The possible sources of delay in construction of the Montezuma Slough Control Structure are challenges to the adequacy of the EIR, and review and acceptance by the SWRCB of the Plan of Protection, its EIR, and its proposed water quality standards. Construction could also be delayed by difficulties in obtaining the required permits. These potential delays are common to all staging options. The options for staging the construction of the remaining facilities and the impacts of these options are listed below:

1. Proceed with design and construction of all facilities as rapidly as personnel and funds permit. There would be no test period after construction of a facility to compare the operation of the facility with model predictions. The need for and design of subsequent units could not be verified. If a particular facility were later found to have not been needed, the Marsh would have been subjected to unnecessary disruption and adverse impacts. If a constructed facility were determined to be of improper size or design, a second construction project would be required, with its attendent disruption and adverse impacts on the Marsh. This option would also result in compression of design and construction schedules. The advantage of this option is that the Marsh would more quickly realize the incremental benefits of the Plan of Protection beyond the substantial benefit provided by the Montezuma Slough Control Structure. The entire plan could be implemented more rapidly but the need for specific facilities would have to be evaluated after the fact.

2. Test the water quality resulting from operation of the Montezuma Slough Control Structure for a 2- or 3-year period. If the next unit, now assumed to be Boynton-Cordelia Ditch were shown to be needed to meet water quality standards, it would then be constructed. There would be a similar test period before constructing each subsequent unit. In all cases a facility would be constructed only if needed to achieve water quality standards. The disadvantage of this proposal is that if an adequate time were allowed after the test period for incorporating the results into design, full implementation of the Plan of Protection would be delayed considerably. The advantages of this option are that it appears to assure that only the facilities needed to achieve the water quality standards are constructed and there is some assurance that those facilities will be of the correct size and design.



C—053754

C-053754

3. Test the water quality resulting from operation of the Montezuma Slough Control Structure for a 2- or 3-year period to determine whether Boynton-Cordelia Ditch, Cordelia-Goodyear Ditch, and Grizzly Island Distribution System were needed to meet applicable water quality standards. If these facilities were needed, Boynton-Cordelia Ditch would be completed by a specified time (estimated to be five years) from the date of completion of the Montezuma Slough Control Structure. Cordelia-Goodyear Ditch would be completed one year later, and Grizzly Island Distribution System would be completed two years later. The need for Potrero Hills Ditch would be evaluated in a second test period. If needed, Potrero Hills Ditch would be constructed by the fifth year after completion of the Cordelia-Goodyear Ditch. In all cases, a facility would be constructed only if needed to achieve water quality standards. A disadvantage of this option would be some compression of design and construction schedules. It is presumed that when the control structure was tested, the need for a proper design of Boynton-Cordelia Ditch, Cordelia-Goodyear Ditch, and Grizzly Island Distribution System could be ascertained. If this assumption is incorrect, Cordelia-Goodyear Ditch may not be sized and designed properly. The advantage of this option is potentially less delay before full implementation of the Plan of Protection than with the second option.

4. Defer further construction of any of the Overall Facilities until assured of USBR participation in implementing the Plan of Protection. The disadvantages of this option are delays in achieving full mitigation for SWP impacts on the Marsh because of lack of USBR participation. This does not appear to be equitable to the Marsh. The advantage of this option is that it more nearly assures equity to State Water Project contractors, because their investment in the Marsh would be limited until USBR became a full participant. DWR anticipates that SWRCB may resist this option.

Selection of an option could depend on the outcome of negotiations among DWR, DFG, and SRCD for a contract relating to the Plan of Protection and actions by SWRCB and/or other permitting agencies. For purposes of preparing the implementation schedule and the remainder of this report, Option 3 or a variation of it is presumed to be the most likely to be selected.

Regardless of the construction staging option selected, DWR believes that its contribution toward implementing the Plan of Protection should be limited to that necessary to mitigate SWP impacts on the Marsh -- estimated to be 50 percent of the total cost of the Plan of Protection. A greater contribution by DWR would improperly require State Water Project contractors to fund mitigation of impacts unrelated to the SWP. Proceeding with

facilities beyond DWR's share is assumed to occur only if USBR participation in implementing the Plan of Protection has been secured. If the control structure achieves greater water quality improvement than is predicted by the model, one or more other features of the plan may not be needed.

If Potrero Hills Ditch is not needed, there will be some changes in the overall impacts of the project. Because they are deadend, Luco Slough and Hill slough are now subject to times of nearly stagnant water, resulting in low dissolved oxygen levels. Deletion of the Potrero Hills Ditch will allow the low dissolved oxygen conditions to continue. Eliminating Potrero Hills Ditch will also result in greater westward flow through Montezuma slough west of its confluence with Nurse Slough. The net direction of flow through Hunter's Cut would not be altered. If Cordelia-Goodyear Ditch and the Goodyear Slough Control Structure are not needed, the impacts of the other marsh facilities should not be altered. If the control structure works better than the conservative prediction, of the mathematical model, one or more other features of the plan may not be needed. The feature least likely to be constructed is the Potrero Hills Ditch. This ditch would cost more than other features of the plan, but would produce only marginal improvements in water quality. The mitigation plan will reflect the staged nature of the project and the fact that some facilities may not be required after testing is completed. Therefore, some of the wetland compensation acreage may not be needed.

Land

About 1,081 acres would be disturbed or changed by the total project. Of this, up to 540 acres would be wetland habitat and up to 541 acres would be upland habitat consisting mainly of dry farm or pasture land. The project would establish or reestablish up to 103 acres of wetlands and 445 acres of upland habitat, mainly along levees. About 6 acres of the upland habitat would become maintenance roads, and an undetermined area of fringe marshes would be created along the margins of newly constructed waterways. Therefore, up to 437 acres of wetland habitat would be converted to upland vegetation and water surface, and 96 acres of upland vegetation would be converted to water surface.

The proposed project would provide a firm supply of quality water to about 45,000 acres of managed marshlands, allowing continuity of the existing land use for brackish wetland wildlife habitat. This would conform with Solano County and BCDC objectives.



C—053756

C-053756

## Water Resources

Because the project would change only diversion points, and not the quantity of water diverted, the facilities would not have a significant impact on the quantity of water consumed within the Marsh. When the Montezuma Slough Control Structure is operating, however, and when project releases are being made to sustain Delta outflow, about 20 percent of the water tidally pumped into the Marsh would have to be replaced by releases from upstream reservoirs to meet SWRCB salinity standards in the vicinity of Montezuma Slough.

## Water Quality

Figures 17 and 18 (Chapter 5) illustrate how salinities within marsh channels can be improved with the use of management facilities during a critically dry year at the year 2020 level of development.

Without the facilities, salinity in marsh channels during a critical or dry year, under expected year 2020 conditions, would generally be 100 percent higher than the post-1984 Decision 1485 standard for February and March and 40 percent higher than the standard for April and May. With the facilities, channel salinity could be reduced to the standard, or to a lower level. The operating schedule, Table 8 (Chapter 5), indicates that the facilities would be flexible enough in most years to adjust salinity in the channels to be better than the standard if desirable. If at those time it becomes necessary to operate the facilities all the time, this flexibility will be lost.

A contract is being negotiated among Department of Water Resources, Department of Fish and Game, and Suisun Resource Conservation District that will identify the responsibilities of the parties with respect to the planning, design, operation, and maintenance of the completed marsh facilities to mitigate for the impact of the State Water Project on the marsh environment. The agreement will include provisions for the Marsh to take deficiencies in water quality during some dry or critical years.

In the event two or more dry or critical years occur in a row, with upstream storage at a low level, DWR may be permitted under the terms of the proposed contract to declare deficiency periods when necessary. During such deficiency periods, relaxed water quality standards are proposed. The standards proposed are described in Chapter 5. Operation studies were made to evaluate the impacts of the proposed relaxed standards.

All studies were run for a 57-year period -- 1922 through 1978 -- and year 2000 level of development. Assumptions of facilities, operations, and depletions above the Delta were constant for all studies. Delta Overland Facilities were assumed in and operating to eliminate consideration of the western Delta



C—053757

C-053757

agricultural standards, in channel water quality control. All other Decision 1485 agricultural, municipal and industrial, and fish standards were presumed to be met. The four major studies are described below:

Study 1: The interim Marsh standards and not the post-1984 in Decision 1485 were presumed to be in effect. A through-Delta transfer facility was presumed to be operating. This assumption eliminated the possibility of carriage water masking the impacts of the Marsh standards on required outflow. Only the Initial Facilities of the Suisun Marsh Plan of Protection were assumed to be operating.

Study 2: All the Study 1 assumptions were retained except those for Marsh facilities and Marsh water quality standards. Montezuma Slough Control Structure, Boynton-Cordelia Ditch, and Cordelia-Goodyear Ditch were assumed to be operating. The facilities were assumed to be operated to meet the post-1984 Decision 1485 standards.

Study 3: All the Study 2 assumptions were retained except the facilities were assumed to be operated to meet the post-1984 Decision 1485 standards, including relaxations to be proposed in some dry and critical years (described in Chapter 3).

Study 4: The Study 4 assumptions were identical to those for Study 3 except that no through-Delta facility was assumed.

These studies were compared to determine the incremental impacts upon the firm yield of the project. Firm yield is the maximum agricultural, municipal and industrial water deliveries which can be achieved each year without imposing more than a 50 percent agricultural deficiency in any one year or a 100 percent agricultural deficiency in any seven years.

A comparison of Study 1 and 2 demonstrated that if the post-1984 standards take effect, the potential firm yield of the projects will decrease almost 500,000 acre-feet from that possible with the current (interim) standards in effect.

A comparison of Study 1 and 3 demonstrated that it would cost the CVP and SWP about 30,000 acre-feet more of firm yield to meet the post-1984 Decision 1485 standards with the relaxations proposed in this Plan than it would to meet the interim Marsh standards.

Although meeting post-1984 Marsh standards with the deficiency relaxation will require about 30,000 acre-feet more outflow than the standards now in effect, they do represent a considerably smaller impact on firm yield than would have been required to meet the proposed post-1984 standards without the proposed relaxation in some dry and critical years. The impact of the proposed standards on yield of the projects is not expected to be significant.



C—053758

C-053758

The percentage of time that the proposed standards would control minimum Delta outflows for the purpose of operating the projects was determined from Study 3 (with a through-Delta facility) and Study 4 (no through-Delta facility). These percentages are:

| | Oct. | Nov. | Dec. | Jan. | Feb. | March | April | May | Average |
|---|---|---|---|---|---|---|---|---|---|
| Study 3 | 32 | 49 | 39 | 33 | 26 | 35 | 47 | 37 | 37 |
| Study 4 | 7 | 5 | 7 | 23 | 18 | 28 | 30 | 37 | 19 |

A month-by-month comparison of Delta outflow predicted in Study 1 and Study 3 during the critical period was made to determine if any shift in the distribution of outflows within the year would occur by meeting the proposed standards rather than the existing (interim) standards.

A slight shift in the distribution of outflow within the year was detected. Less water was provided in the fall and more in the spring. This shift is anticipated to be a slight general benefit to the Marsh, including those areas not served by the Plan of Protection. The fresher water in the spring should be slightly more favorable for seed production of waterfowl food plants and could have a small beneficial effect for the distribution of juvenile striped bass in the lower estuary. It is not likely to have any impact on the migratory habits of adult striped bass. No impact is expected on the occurrence of flushing flows in San Francisco Bay. Because the change in outflow from that currently required is a slight increase and the shift in pattern is small, it is believed that the impacts of the proposed standards on outflow will not be significant.

The proposed deficiency year standards are designed to provide the quality of water necessary to keep the important waterfowl food plants alive. Because of the naturally occurring salinity gradient in the Marsh, providing this quality water to the most salinity susceptible areas will result in better than minimal quality water in some other areas. A Marsh model run was made to assess the estimated impact of the proposed deficiency standard on Alkali Bulrush in the Marsh. Present Decision 1485 standards are set to provide 90 percent production and 60 percent germination. The model run indicated that meeting the deficiency criteria would reduce production and germination below expected Decision 1485 levels in approximately one-third of the Marsh. Model runs showed that approximately 9,500 acres, or 17 percent, of the Marsh would experience 62 percent seed production and 44 percent seed germination. An additional 17 percent of the Marsh, or approximately 9,500 acres, would receive salinities resulting in 23 percent seed production and 16 percent seed germination. However, in spite of these reduced levels of production of germination, salinities are not expected to be high enough to result in Alkali Bulrush tuber mortality.

It is appropriate to assess not only the maximum possible impact of the deficiency standards but the frequency with which these impacts may occur. Of the 684 months in the 57-year study period, 80 months met the criteria for application of the deficiency standards. However, the operations studies predict that sufficient outflow would be present at Collinsville to provide the Marsh with better than the minimum water quality allowed under the deficiency standards in a significant percentage of the months, as listed below:

| | Oct. | Nov. | Dec. | Jan. | Feb. | March | April | May | Average |
|---|---|---|---|---|---|---|---|---|---|
| Study 3 | 0 | 0 | 21 | 57 | 17 | 17 | 33 | 33 | 21 |
| Study 4 | 71 | 79 | 86 | 93 | 100 | 67 | 33 | 33 | 75 |

In months when the proposed deficiency standards could be applied, the Marsh would receive better than the minimum water quality allowed in 75 percent of the months prior to construction of a through-Delta facility and in 21 percent of the months after a through-Delta facility is constructed. Much of the improvement above the minimum occurs in February through May, which is the critical period for waterfowl food production.

The project would improve circulation of water within existing marsh channels. Increases in eutrophication or other deterioration in the water quality should not occur even during a critical or dry year.

Water quality in the Marsh has always varied considerably from year to year. The Marsh facilities will enhance the stability of the water quality within the desirable range. This should be of benefit to the alkali bullrush, the key waterfowl food plant.

The Overall Facilities will mitigate the impacts of the proposed deficiency year relaxations as follows.

The Marsh facilities will move quality water from the Sacramento River at Collinsville throughout the Marsh much faster than would be achieved by the natural movement of water from Grizzly Bay. The quality of water at Collinsville is also of higher quality than that at Grizzly Bay. The possible modifications of the existing facilities in areas with managed wetlands and the improvements of their operational procedures for flooding and draining, in conjunction with the better quality water, will help the managed wetland recover more quickly from a deficiency period.

In non-deficiency periods, facility operation can be modified to provide channel water salinities in the Marsh that are significantly better than the Decision 1485 requirements at times when upstream water releases, exports, and fish would not be adversely affected. These improved salinities could help offset



C—053760

C-053760

salt buildup incurred during deficiency periods. Monthly Delta outflows predicted in Studies 3 and 4 were reviewed to determine the percentage of the time over the 50-year study when the quality served to the Marsh could be better than post-1984 Decision 1485 standards. These percentages are:

| | Oct. | Nov. | Dec. | Jan. | Feb. | March | April | May | Total |
|---|---|---|---|---|---|---|---|---|---|
| Study 3 | 65 | 51 | 61 | 65 | 74 | 65 | 49 | 61 | 62 |
| Study 4 | 93 | 86 | 93 | 70 | 74 | 67 | 67 | 60 | 76 |

These studies demonstrate the potential for significant enhancement of the Marsh to better than post-1984 Decision 1485 standards in 76 percent of all months until a through-Delta facility is constructed. After construction of a through-Delta facility, the potential for providing the Marsh with better than post-1984 Decision 1485 standards exists in 62 percent of the months.

## Recreation

Fishing opportunities would increase overall with the increase in waterways and with provision of public recreation facilities. Existing recreation facilities, such as duck clubs, would be somewhat impacted in the project areas, because a small fraction of land now used for duck hunting would be used for project facilities. The overall success of duck hunting would probably be maintained at its present level; if the Marsh were allowed to become saline, success would decrease.

The tidal southern tips of Grizzly Island and Joice Island, which consist of 550 acres, are not leveed and, therefore, will not be fully protected by the Plan. The species of vegetation growing there are expected to change, and this could reduce existing recreation potential. It may provide good habitat for the salt marsh harvest mouse.

## Fish

Resident fish habitat would increase by up to 533 acres of new water bodies within the Marsh.

The redistribution of water within marsh channels would affect aquatic resources in four major ways: changes in salinities, changes in water velocities, changes or delays in migration, and diversion of fish into interior sloughs and ponded areas.

Suisun Marsh supports a diverse assemblage of fish and invertebrate species. Changes in salinity caused by wide fluctuations in freshwater flow throughout the year and between years creates an ever-changing environment, affecting the abundance and



C—053761

C-053761

distribution of aquatic populations. Many species spend only a part of the year or a portion of their life cycle in the Marsh. Others move within the Marsh in response to their environmental requirements. The selected plan will establish an environment that will favor euryhaline and freshwater species over those that require more saline water. Because the plan is designed to maintain water quality at about the present level, no major species changes are anticipated.

Predictions concerning the effect of the selected plan on individual species are difficult because of interactions among species or environmental factors not controlled within the Marsh. As an illustration, a reduction in salinity may enhance the Marsh as striped bass habitat. However, if changes in water flow patterns adversely affect Neomysis populations, the major food of young striped bass, the overall effect on bass may be detrimental. Likewise, if some factor outside the Marsh controls striped bass abundance, such as conditions in the spawning areas, improving salinities within the Marsh may not benefit the overall bass population.

Analysis of striped bass data collected in marsh channels indicates that populations are higher in years with moderate or high Delta outflow. To the extent that the proposed plan will maintain salinity conditions comparable to those existing under moderate and high Delta outflows, the plan should not have a detrimental effect on striped bass abundance in the Marsh. Young-of-the-year bass abundance in the Marsh, however, depends on overall abundance in the estuary, which is affected by outflow and diversions in late spring and summer, by dispersion of fish into all available habitat, and by other factors not now understood. Therefore, bass abundance in the Marsh may be low in a dry year, even with improved water quality provided by the plan.

With present flow conditions, water velocities in marsh channels influence the abundance and distribution of fish and fish food organisms. The selected plan would alter the velocity and direction of flow in marsh channels, particularly Montezuma Slough. Velocities with and without the selected plan have been computed using a mathematical model of the Marsh developed by Hugo B. Fischer, Inc. For this analysis, freshwater outflow from the Sacramento and San Joaquin rivers was considered critically low, making the flow in Montezuma Slough 300 cubic feet per second in a west to east direction without the plan and 2,100 cubic feet per second in an east to west direction with the plan. This would be the most drastic change in channel velocities.

In the model, the marsh channels are represented by a 41-segment network without facilities of the plan and a 56-segment network with facilities of the plan. Net velocities in segments have been computed with and without the plan. The selected plan is predicted to increase the net velocity in most marsh channels. Velocities, however, are still fairly low, and no significant effect on aquatic resources is expected. The possible exception



C—053762

C-053762

is in the eastern portion of Montezuma Slough, where net velocities approach or exceed those found limiting for Neomysis. Their populations, therefore, could be transported westward in Montezuma Slough, with a corresponding reduction in fish in eastern Montezuma Slough that depend heavily on Neomysis for food, notably juvenile striped bass. Phytoplankton populations may be reduced somewhat due to shorter residence times; however, levels are normally low during the months the facilities will be in operation, which should minimize significant effects.

Studies have not identified any significant impacts on Neomysis shrimp within Suisun waterways as a result of the Plan of Protection (Alan Baracco, DFG, October 1980, and attached updated memorandum of August 8, 1983, see Appendix F).

Anadromous fish passing through the Marsh will be affected by the selected plan at several locations. At certain times of some years movement of chinook salmon, steelhead trout, American shad, sturgeon, and striped bass in Montezuma Slough will be delayed for about half of each tidal cycle (when the gates are closed during the outgoing tide), at the Montezuma Slough control structure when it is in operation as a tidal pump. Although such delays will probably not significantly affect migration of adults, they could affect the downstream migration of juvenile fish by increasing predation near the structure. The magnitude of any increase in predation is difficult to predict, but it could be significant during peaks in juvenile outmigration if large numbers of predators (such as adult striped bass) build up near the control structure.

This concern for losses to migrating salmon and steelhead is based on experience DFG gained in other areas, such as the Fish Facilities at Clifton Court. Should fish monitoring outlined in the Memorandum of Understanding between DWR and DFG indicate a problem, solutions will be implemented. In any event, DWR believes that screening the intakes of the Roaring River and Grizzly Island units, thereby preventing present unscreened diversions of water from sloughs, would more than make up any expected losses to juvenile salmon and steelhead at the control structure. The screens will prevent the juvenile fish from being swept out of the channel with the diversions of water, as they are now. As a result, the project is expected to benefit the survival of young salmon and steelhead moving through the Marsh.

Migration of steelhead using streams adjacent to the Marsh, especially Suisun Creek, could be delayed by changes in waterflow patterns and by physical barriers.

At times, operation of project facilities would alter the length and location of the interface between saline and brackish water in the marsh channels. This effect, in itself, should not significantly affect fish, but it would alter the characteristics of some channels in terms of being a fish food source. The change, beneficial or adverse, would probably not be significant.

## Flora

Construction of all of the facilities would affect up to 1,183 acres of marsh, upland vegetation, and existing waterways. Up to 437 acres of seasonal and tidal marsh would be permanently converted to upland vegetation and water surface. The loss of marshland vegetation is the most serious effect and is considered a significant environmental impact. Options for compensating for this loss of wetlands are described in the "Unavoidable Environmental Effects" portion of this chapter. The Suisun Marsh Technical Committee proposed that up to 437 acres of land throughout the Marsh be acquired by DFG for this compensation (see Appendix L). At least 100 acres should be managed for the specific habitat requirements of the salt marsh harvest mouse to compensate for loss from construction of project facilities. The loss of 541 acres of upland grass and cultivated land disturbed by the project would be mitigated by planting grasses and shrubs on the 445 acres of new levees.

Table 10 summarizes the total vegetation change expected due to construction of the facilities -- Grizzly Island Distribution System, Potrero Hills Ditch, Boynton-Cordelia Slough Connection, and Cordelia-Goodyear Ditch.

Table 10

CHANGE IN HABITAT WITH MARSH FACILITIES
(In Acres)

| | Wetland Vegetation | | | Upland Vegetation | | | Water Surface | | |
|---|---|---|---|---|---|---|---|---|---|
| | Dis-turbed | Estab-lished* | Net Change | Dis-turbed | Estab-lished* | Net Change | Dis-turbed | Estab-lished* | Net Change |
| Montezuma Slough Control Structure | | | | 55 | 35** | -20 | 0.3 | 20.3 | +20.3 |
| Roaring River Slough Unit | 186 | 103 | -83 | 66 | 99 | +33 | 88 | 138 | +50 |
| Grizzly Island Ditch Unit | 172 | | -172 | 151 | 137 | -14 | | 186 | +186 |
| Potrero Hills Ditch | 49 | | -49 | 71 | 38 | -33 | 2 | 84 | +82 |
| Goodyear Slough Unit | 86 | | -86 | 87 | 71 | -16 | | 102 | +102 |
| Boynton-Cordelia Ditch | 47 | | -47 | 111 | 65 | -46 | 12 | 105 | +93 |
| TOTAL | 540 | 103 | -437 | 541 | 445** | -96 | 102.3 | 635.3 | +533.3 |

* Established or reestablished.
**Includes 11 acres of road surface.



C—053764

C-053764

The adopted mitigation plan is expected to reflect the staged nature of the project and the fact that some facilities may not be required after testing is completed. If this occurs, the computation of wetland compensation acreage will need to be revised.

The channel islands of Roe, Ryer, Freeman, Snag, and Middle Ground are not fully covered by the Plan of Protection, and would continue to be served from channels. During drier years, increased salinity could result in a reduction of waterfowl food plants. Appropriate compensation for the adverse effect of Decision 1485 and diversions of the CVP, SWP, and others on the channel islands has been determined to be 580 acres of land within the Marsh (see Appendices D, E, J, and L). Options for mitigating this impact are described in Chapter 4.

Narrow stands of tules, cattails, and submerged aquatic plants would likely develop along the shallow ditch banks, but the area these plants would cover cannot be estimated.

From July through September 1980, Stephen P. Rae, State Plant Ecologist, DFG, periodically visited the area proposed for ground disturbance. Based on his field surveys and review of file information, he has not been able to document the existence of the following plant species within the proposed areas of activity:

*Aster chilensis* var. *lentus* (Suisun aster)
*Cicuta bolanderi* (water hemlock)
*Cirsium hydrophilum* var. *hydrophilum* (Suisun thistle)
*Cordylanthus mollis* ssp. *mollis* (soft-haired bird's beak)
*Lasthenia conjugens* (Contra Costa gold fields)
*Lathyrus jepsonii* ssp. *jepsonii* (Delta tule pea)
*Legenere limosa* (Greene's legenere)
*Lilaeopsis masonii* (Mudflat guill-plant)

These plant species are on the State or Federal lists of rare, threatened, or endangered plants. The California Native Plant Society includes these same plants on its list of special concern (see Appendix K).

## Wildlife

The major adverse impact of the project on wildlife would be that associated with the permanent loss of up to 437 acres of seasonal and tidal marsh. Although this represents less than one percent of the existing managed wetland, DFG considers the loss significant. Possible compensation for this loss is discussed in the "Unavoidable Adverse Environmental Effects" portion of this chapter.

Temporary loss of upland habitat due to the project would have a temporary negative impact on some local wildlife; this impact would be offset by seeding the levees and allowing



C—053765

C-053765

volunteer vegetation to take control. The net permanent loss of up to 96 acres of upland habitat could have a small adverse impact on some species, but since the project construction will be staged, with at least two years of monitoring between each stage, and because facilities will be some distance apart, this impact should be minimal.

The development of 533 acres of new water surface and associated emergent and aquatic flora would benefit several species of aquatic mammals and birds.

The aquatic barriers that would be created by the new ditches are not expected to have a significant adverse impact on wildlife. While it is true that construction of the facilities would create barriers to the free movement of land-dependent animals, no adverse effects on animal communities are expected for several reasons. First, no known migration trails cross the ditch alignments, probably because the area is dominated by resident rather than migratory animals. Second, the ditches will not represent a barrier to many animals, such as birds, swimming mammals, and insects. Third, there are plans for road crossings with fill approaches. The wide road shoulders will undoubtedly be used as animal pathways.

Open channels have considerable wildlife value, especially when compared to grasslands or agricultural areas. The edge effect and diversity of wildlife species that prefer water areas and riparian channel banks far outweigh any adverse impacts expected. Because the genetic exchange of plant life is carried out mostly by the transfer of pollen and seeds (by birds, insects, and the wind), the ditches will have no effect in this area of concern.

The salt marsh harvest mouse (endangered) is known to inhabit Suisun Marsh (Shellhammer, 1981; see Appendix H). The permanent loss of seasonal and tidal marsh would have an adverse impact on the mouse, because the largest portion of lands lost are seasonal marsh or managed wetlands. While the reduction in wetland acreage could have an adverse effect on the salt marsh harvest mouse, overall the project will preserve the habitat of the mouse. Protecting the brackish nature of the Marsh will maintain the plant species that serve as the main habitat for the mouse. Further, the levees along the new channels and around the new ponds may provide valuable habitat for the mouse during the fall and spring high tides, when the marshes are flooded. As a result, the project is expected to have no overall adverse effect on the salt marsh harvest mouse, and it may actually improve conditions for the mouse.

The California black rail (rare), found in the Marsh in the past (Manolis, 1977; see Appendix G), is usually in the immediate vicinity of tidal sloughs in the tidal marsh areas. It has not been found in surveys done for this project. The project will permanently affect a very small amount of tidal sloughs. The



C—053766

C-053766

project could, in the long run, increase the potential black rail habitat in Suisun Marsh, because all the new facilities for water delivery would be tidally influenced. Plant growth along the new ditch banks could be used for cover, and the tidal zone for feeding, by the black rail.

The California clapper rail (endangered) was first discovered at the Marsh in December 1978 (Harvey, 1980; see Appendix I). From March 18 to August 17, 1979, Harvey censused the clapper rails in the Marsh and estimated a population of about 25, found mainly along narrow tidal marsh fringes in the Cutoff Slough area. Harvey's findings represent virtually all that is known about the clapper rail in the Marsh.

The impacts on black rail habitat and on the salt marsh harvest mouse should be considered in light of the overall effect of the proposed facilities on the Marsh; that is, the increase in food production for waterfowl and the retention of the Marsh as a brackish marsh, rather than a saltwater marsh. Also, the project may benefit the salt marsh harvest mouse area in the long term, because the upland vegetation on new levees could provide important fall and spring habitat, when the managed wetlands are normally flooded (see Appendix D).

## Air Quality

Improved Marsh management will probably reduce air pollution caused by present burning practices by some of the landowners.

## Scour and Sedimentation

The velocities created by the control structures and channel modification would be well below scour velocities; thus scour would not be a problem.

Sedimentation within marsh channels has always been a problem that must be rectified periodically. DWR has considered this in designing marsh facilities. If deposits eventually accumulate to the point of interfering with operation of facilities, drainage and removal must take place. The dredged material will be disposed of in a manner acceptable to BCDC, Solano County, and other regulatory agencies. The facilities with higher velocities would not experience deposition.

## Seepage

Available technical information on seepage through the region's levees is limited to areas east of the Marsh. No studies or data relative to seepage in the project area could be found;



C—053767

C-053767

however, based on engineering knowledge and experience with similar conditions in nearby areas, the increase in water levels in sloughs is expected to slightly increase seepage. This would occur when water is being released from sloughs to flood adjacent lands, and it would not cause a problem. When the adjacent ponds are draining, the water surface in the slough would be maintained at a lower level, and there would be no increased seepage. Any slight increase in seepage rate is not expected to have an adverse effect on vegetation, wildlife, or levee maintenance.

Navigation

Boat traffic in Montezuma Slough could be delayed near the control structure during portions of those years when maintaining Marsh water quality requires operation of the structure. The gates, flashboard opening, and lock would be open to traffic in all years from the end of May through September and in those years when the water quality is sufficient that operation of the structure is not required. When the structure gates are open, no delay to navigation is expected.

The Goodyear Slough control structure would impose a permanent barrier to boats. To minimize the impact, this structure has been placed upstream of Pierce Harbor and the Morrow Island Farm boat docks; there are no docks in the remaining 3 miles of slough.

Esthetics

The proposed project would involve construction of several miles of new levees and improvement of several miles of existing levees. Material for these levees would be obtained by draglining or dredging a channel. The barren slopes could cause a short-term impact that would be mitigated by seeding the levee areas with a mixture of upland grasses, herbs, and native shrubs and allowing the native vegetation to take control.

A more lasting esthetic impact would result from constructing levees in previously unleveed areas. While the levees would tend to break the natural transition between the aquatic habitat of the sloughs and the wetland habitat of the Marsh, this visual impact would be relatively minor. The Montezuma Slough control structure gates, when open, would extend about 20 to 25 feet above the levee banks, presenting an esthetic impact in the structure area. Suitable plantings will be made to screen the structure to reduce this impact. The structure would, of course, be quite visible from Montezuma Slough itself, and from some areas of the Marsh not covered by the screen.



C—053768

C-053768

## Historical, Archeological, and Cultural Resources

In April 1979, Dr. D. L. True of the University of California, Davis, surveyed the proposed routes of Denverton Channel, Potrero Hills Ditch, and the North Bay Aqueduct for cultural resources. Dr. True's surveys indicated that no historical, archeological, or paleontological resources would be affected by construction of the proposed facilities.

An archeological records search conducted in September 1982 for DWR by the Northwest Information Center (Department of Anthropology, Sonoma State University, Rohnert Park) indicated that no known archeological sites, National Register sites, or California Historical Landmarks are within boundaries of any proposed project location. All areas to be affected by the proposed project are considered, however, to be archeologically sensitive, due to the possibility of encountering buried prehistoric materials. Because of this, close attention will be paid during land disturbing activity for prehistoric site indicators such as obsidian flakes, locally darkened midden soils, marine shell deposits, bone, or human remains. Should such site indicators be found, work in that vicinity will be halted, and a qualified archeologist will be summoned for evaluation and recommendations for protection and preservation of the resource.

## Access

Most of the facilities would be on privately owned land. Easements will be acquired to allow access for construction, operation, and maintenance of facilities.

The project would not have a long-term impact on public or private access to the Marsh from the facilities that intercept certain public and private roads. Access in these cases would be maintained by constructing bridges or inverted siphons. Public road closures might be necessary for short periods during construction. Short detours around work areas would be provided for local traffic, and all means available would be used to minimize disruptions.

## Energy

The tides would provide the major part of the energy needed for pumping in the project's operations, but energy would be required for operation of the gates and locks at the Montezuma Slough control structure. The energy consumption of the Montezuma Slough control structure during a season (September to the latter part of May) will be 60,000 kWh during normal years and 71,000 kWh during critical years.

A relatively small amount of fuel would be used in construction. The Grizzly Island distribution system would be



C—053769

C-053769

equipped with fish screens. If operation of the cleaning mechanisms required outside energy, it would not exceed about 7,000 kWh annually. A relatively small amount of fuel would be required annually by the diesel pumps on Annie Mason Island. The managed mitigation lands, depending on their location, could require a relatively small amount of energy for pumping.

Utilities

Montezuma Slough control structure would require tapping into existing power lines at the site. If motorized fish screen cleaners are required at Grizzly Island distribution system intake, a tap into the existing power lines at the site could be made. The system would require the permanent relocation of Pacific Gas and Electric Company (PGandE) power lines located along the alignment. Temporary relocation of power lines, or temporary disruption of electric service, may be required during construction in the immediate area of power line crossings. DWR will work with the affected utility company where permanent or temporary relocations are required. Other facilities would require temporary relocation of utility lines or temporary disruption of utility service during construction in the immediate area of utility line crossings. Temporary relocation of utility lines would be required to allow dredge access to several construction sites.

Turbidity

During construction, turbidity would increase for a short time in some of the sloughs, but operation of the facilities would not cause turbidity.

Socioeconomic Factors

Annual operation and maintenance costs for 45,000 acres of managed marsh wetlands would increase. Assembly Bill 2090, which became law in October 1982, provides that State funds may be obtained to reimburse club owners for 50 percent of the O&M costs incurred in improving the wildlife habitat.

The project is not expected to have a significant impact on population growth, housing, public services, or human health.

Vectors

Mosquitos, common to all marshes, have evolved tolerances to a wide variety of environmental conditions. They all pass through larval and pupal stages in water. Mosquito larvae survive most successfully in shallow, ponded water where



C—053770

C-053770

natural predators do not have a favorable environment. Mats of dense vegetation in shallow water also afford protective cover for mosquito larvae. Mosquitos develop from egg to adult stage much more rapidly in warm water. Under optimum conditions, they can reach adult stage in 5 days; after this, they increase explosively if not controlled.

Mosquito abatement measures have been developed over the years in Suisun Marsh to prevent conditions conducive to mosquito production during the warmer part of the year. In general, the following measures apply to the leveed portions of the Marsh:

- No water levels are allowed to fluctuate after April 1.
- All ponds should be draining by June 1, except permanently flooded ponds that have stabilized, circulating water.
- No flooding of ponds is allowed in the fall before October 1 or more than three weeks prior to the duck hunting season, except on limited areas selected by the Solano County Mosquito Abatement District.

According to Dennis Beebe, Manager, Solano County Mosquito Abatement District, flooded saltgrass and pickleweed stands provide the best mosquito habitat in the Marsh. The densest populations of mosquito larvae in the Marsh will probably be found in these two cover types.

Mosquito fish are used extensively for control. These small, top-feeding minnows tolerate brackish water and can survive in very shallow water. They are found throughout the Marsh and can be transplanted into new ponds, if necessary. While all small fish, regardless of species, tend to eat mosquito larvae, mosquito fish eat more.

The changes in waterways, ponds, and adjacent lands resulting from this project should have no measurable effect on the mosquito population or on the abatement programs.

## Excavation, Spoil, and Fill

The project would involve excavation of up to 1,121,000 cubic yards of material. About half of this would be used for construction of project facilities, and the remainder would be used in other projects outside the Marsh or disposed of in a manner acceptable to regulatory authorities.

The manner by which the remaining material will be disposed of is undecided; method of disposal will be up to the contractor, if feasible. In any case, the excess material will be



C—053771

C-053771

disposed of in a manner acceptable to BCDC, Solano County, the Corps of Engineers, and other agencies governing disposals.

The following methods of disposal have been investigated. About half of the excess material might be needed by the city of Fairfield; about a fourth of the excess might be used for cover on landfills in the Potrero Hills area, or it could be spread on grazing lands in the Marsh's secondary management zone. Other methods investigated include reinforcing the waterside toe of Delta levees, filling flooded Delta islands to create tidal marsh, reclaiming quarries in or near the Marsh, landfilling at the proposed Benecia Industrial Development, or constructing holding pond levees at the Fairfield-Suisun sewer plant. Where economically feasible, the dredged material could be used for levee construction by the club owners and through SRCD, if arrangements are made prior to construction. The material can also be disposed of in the USCE disposal site off of Carquinez Strait, which is now used for this purpose.

DWR believes there will be no significant effect on the environment when dredge spoil is disposed of in a manner approved by all relevant regulatory agencies. The same assumption is reflected in the categorical exemption in the State CEQA Guidelines, 14 Cal. Admin. Code, Section 15101, which exempts maintenance dredging where spoil is disposed of in a manner approved by all relevant regulatory agencies.

Construction of project facilities would require importation of about 150,000 cubic yards of material from outside the project area, mainly for road surfacing and base material. This material would be obtained from an approved source, and it would be transported and placed in a way that would minimize impacts on the environment.

## Effects of Individual Facilities

The specific effects each facility described in the Plan of Protection would have on the marsh environment are outlined below:

### Montezuma Slough Control Structure

This facility is described on page 80.

Land. The Montezuma Slough control structure would modify about 29 acres of pasture and would create about 20 acres of new water surface and about 9 acres of levees for upland habitat. Access to the control structure will be provided on both the east and the west sides of Montezuma Slough. On the west side of Montezuma Slough access will be over the existing levee road, which will be improved for construction and maintenance usage. On the east side of Montezuma Slough access will be over the existing traveled way



C—053772

C-053772

from Collinsville Road to the east levee of the slough, then south along the landside levee toe to the control structure. This access will be improved for both construction and recreation usages.

The area surrounding the existing roadway and the proposed new roadway is in grassland and is used for occasional grazing. It is protected from flooding by a levee along the east bank of Montezuma Slough.

About 1 mile of the existing road is within the secondary zone of the Marsh, and the vegetation within the area to be occupied by the widened roadway is mostly grasslands dominated by introduced annual species, including wild oats, wild barley, and rye grass.

About 1 mile of the proposed roadway will be over pasture land in the primary Marsh zone. At times this pasture land becomes quite wet, and the species of vegetation reflects this condition, with some salt grass and other marsh species of vegetation becoming part of the grassland vegetation.

About three quarters of a mile of the proposed roadway will be above the 5.9 USGS contour.

The proposed road will require a total of 26 acres of land, of which 3 acres is now in traveled way and the remaining 23 acres is in pasture. This land is a portion of the Southern Pacific Land Company's holdings in this area. Construction of the proposed road will disturb some 20 acres of pasture land in the primary Marsh zone, of which 15 acres is below the 5.0 USGS contour line.

The selection of a material source for road construction, which has not yet been made, will partially determine the nature of the impact on land in the area. The amount of fill used for the access road will be the minimum amount required to provide a roadway able to carry the heavy vehicles and construction equipment needed to construct the control structure. The fill material will be a mineral material from existing commercial borrow pits near Highway 12, or from two low knolls in the southeast corner of Section 21. Between 70,000 and 100,000 yards of material is needed. The knolls would be excavated to elevation 0 or 5.0 USGS. Both knolls are within the secondary Marsh zone and are within the Collinsville water-related industrial area. The area is now in grassland. The topsoil would be replaced and the area returned to its present vegetation when the work is completed. A temporary access road, about 0.7 mile, would be constructed from the knolls to the new road and the material would be transported along the existing roads to the construction site. Upon completion of the hauling, the temporary roadway would be restored to its natural condition and would be reseeded to native grasses. The use of these knolls as a material source would save DWR an estimated $500,000 over the cost of bringing material in from existing pits

near Highway 12. In addition to these savings, the use of this material source will have lower impacts on the surrounding area. The levels of noise, emissions, and dust will be reduced. All hauling will be on-site. The haul distance will be 1 to 2 miles rather than 16 miles each way. Potential adverse impacts on public roads, such as increased traffic and damage to pavement, will be avoided.

The competing environmental factors will be assessed by BCDC when it acts on DWR's application to construct the control structure.

Water Resources. When operating, the control structure would modify the direction, magnitude, and velocity of flows in Montezuma Slough. The present mean flow is 300 cubic feet per second eastward. With the structure operating at maximum tidal pumping capability, this would change to 2,100 cubic feet per second westward. Velocities would change from the present average of 0.08 foot per second and a maximum of 1.3 feet per second eastward, to an average of 0.41 foot per second and a maximum of 1.1 feet per second westward.

During operation, the structure would not affect maximum velocities in either direction at the western end of the slough; at the eastern end, the maximum velocities eastward would be cut by 50 percent and westward by 30 percent. The duration of westward flows would be increased by about 40 percent.

The maximum projected velocities due to the structure would be considerably less than those generated by floodflows in the Sacramento River. The scour velocities for marsh channels are estimated to be more than 2.8 feet per second. This is well above the maximum velocities projected for Montezuma Slough with the structure operating.

With the tide gate operating at maximum capacity, the high tide water levels at the structure in Montezuma Slough would be increased by no more than about 6 inches above levels observed in the absence of the structure. This increase would diminish in relation to distance from the control structure; there would be no increase at Nurse Slough. The water levels with the structure operating will be less than those observed in higher outflow years. Operation of the structure would result in no modification of the low tide stage; therefore, there would be no interference with filling or draining of ponds in the structure area. The average capacity of the control structure to tidally pump water into Montezuma Slough from the Sacramento River would be 2,100 cubic feet per second. Under low flow conditions the water pumped through the Montezuma Slough Control Structure would be part of the salinity control outflow. It has been estimated that about 20 percent of the water pumped by the structure would require replacement when the Delta is under control (quantity of water released from upstream storage appears to equal exports plus



C—053774

C-053774

downstream and Delta needs) to maintain the Chipps Island water quality standards.

The water table at the construction site has been found to be relatively shallow, and pumping will be required to dewater the construction site. This water will be pumped into Montezuma Slough at the rate of 1,400 gallons per minute for a period of 20 months. The San Francisco Bay Regional Water Quality Control Board has reviewed the constituents of this water and the pumping rate, and has determined that no adverse impact will occur. Therefore, a NPDES permit will not be required for this operation.

Water Quality. When in operation, the structure would not depress the dissolved oxygen or increase the phytoplankton growth rate within the eastern portion of the Marsh. There would be a significant reduction in salinity levels within the slough (Figures 16 and 17, Chapter 5). The interface between fresh water and salt water would be relocated slightly eastward within the Sacramento River and Suisun Bay reach, and relocated westward within Montezuma Slough. This relocation would occur because of a change in flow, both in the Sacramento River west of Collinsville and in Montezuma Slough.

Using model runs, the percentage improvement in marsh quality that would be attributable to the Montezuma Slough Control Structure was assessed. The May salinities for each club, as projected by the model, were multiplied by the volume of water required to flood the club. This yields a number that represents the weight of saline material on each club. Summed across all clubs, it represents the weight of water-borne salinity in the Marsh. This process was followed for three model runs:

- With no facilities.
- With only the Montezuma Slough Control Structure.
- With all facilities.

Comparison of the runs indicates that operation of all facilities will reduce the weight of water-borne salinity in the Marsh by 8,800 units. With only the Montezuma Slough Control Structure in operation, the reduction is 7,400 units, or 83 percent.

Recreation. When the control structure is in use, the boat lock would be operated; with the gates open, the boat lock gates would also be open, allowing craft free movement. With the control structure closed, boats could be delayed up to 30 minutes, depending on traffic and on the end of the lock receiving traffic. This delay would not restrict access to the remaining marsh waterways. The U. S. Coast Guard has estimated that an average of about 50 to 90 boats a day use Montezuma Slough, probably more in the summer when the control structure normally would be open (with the flashboards removed and the boat lock open) and many less in winter, when the control structure could be operating.



C—053775

C-053775

Fishing success by boat anglers will increase, as well as fishing from shore. A small picnic area with sanitation facilities will be provided between the control structure and the existing Montezuma Slough. A fish platform and boat mooring facilities will be provided adjacent to the slough closure. On the east side of the control structure, a parking area will be provided with access to Collinsville Road. A fishing platform will be provided on the new channel; to accommodate the handicapped, it will be adjacent to the parking area. Float lines and other safety devices will be installed to protect the public (Exhibit M).

Recreational activities at the control structure and lands west of Montezuma Slough will be limited to fishing and to recreation such as bird watching, photography, and hiking. Hunting will not be permitted at the control structure, and public hunting will not be permitted on the private hunting clubs west of Montezuma Slough. If the lands east of the control structure and Montezuma Slough are acquired as mitigation lands and developed as a wildlife area, hunting could be permitted, (under the jurisdiction of DFG), as well as birdwatching, photography, and hiking during the non-hunting season. In this case, additional access and parking facilities will be provided.

Because access to the facilities is across private property, the necessary rights will have to be acquired if recreation is to be provided. Traffic on the Collinsville road will be increased by the ultimate use of the road as permanent access for operation and maintenance of the structure, and particularly as access to the recreation area.

Fish. Both anadromous and resident fish could concentrate near the structure when it is closed. This could result in losses of the smaller fish to predation. Under maximum operation, the structure and boat lock would be open about 12 hours and closed about 12 hours each day. When not needed, the gates, the flashboard opening, and the lock would be open. Operation may be required in most years, with the duration each year varying from one day to nine months.

Vegetation. During operation, the 6-inch increase in high tide water elevation at the structure would inundate a small amount of terrestrial vegetation along the slough. This inundation would be less than what normally occurs during high outflows or the higher high tides. Construction of the control structure would disrupt about 55 acres of vegetation, composed primarily of pasture land.

Wildlife. The tide gate would improve water quality for the management of wetland wildlife habitat within the Marsh. The 55 acres disturbed by construction is not now flooded and is normally used for pasture. Since the system would generate 24 acres of diverse vegetation along the levees and outside of the new access road, there should be little impact on wildlife in the area. What wildlife there may be in the area will be temporarily



C—053776

C-053776

disturbed during road construction, but should return after its completion. The road right-of-way will be fenced to keep livestock out, but small animals will be able to cross the completed embankment and roadway.

Grizzly Island Distribution System

This system of ditches is described on page 93.

Land. The 6.2-mile Grizzly Island distribution system would modify about 323 acres of land. The facility would create about 81 acres of channel water surface, 105 acres of ponded water surface, and about 137 acres of levees for upland habitat.

Water Resources. A regulatory pond would be located near the intake to reduce the size of the channel and maintain a relatively constant supply. The pond would fill during high tide and be drawn down during low tide.

The distribution system would increase circulation within existing sloughs that are incorporated. The mean daily flow requirement of the system would be 115 cubic feet per second, with a mean velocity of about 0.18 foot per second. The mean velocity would approximate the maximum velocity expected downstream of the pond.

The maximum intake capacity would be about 1,050 cubic feet per second, which corresponds to a velocity of 0.7 foot per second. Water within the regulatory pond would circulate naturally from September through May, when the system supplies water to the managed wetland areas. The rest of the year, the ditches would be kept full and circulation would be maintained by discharging a small amount of water into Grizzly Bay. Water levels would be adjusted in the ditches where seepage occurs.

Water Quality. Salinity levels of water supplied to the service area of the system would be considerably lower than they are in most years now.

Recreation. Fishing opportunities would be increased only with the increased public access along the south side of the ditch, where the ditch borders Van Sickle Road. Because the area involved is private property, the necessary rights will have to be acquired if this type of recreation is to be provided.

A recreation site may be provided adjacent to Grizzly Island pond, providing access to the pond. Bank fishing will be permitted, and non-motorized boat launching facilities and a parking area will be provided. A picnic area, sanitary facilities and trash receptacles will also be provided. Fishing facilities to accommodate the handicapped will also be provided, adjacent to the parking area. Float lines and other safety devices will be installed to protect the public (Exhibit M).

Fish. Resident fish habitat would increase with the increased water areas with the regulatory pond plus the ditch. The intake to the ditch would be screened. The most efficient and practical engineering design would be used, with final design based on experience gained in screening the Roaring River Slough intake.

Screening the intake will lessen the impact of the diversion of juvenile anadromous fish into the system, since the diversions it replaces are unscreened. Fish that pass through the screens may survive and grow in the permanent water areas if water quality is suitable year-round.

Vegetation. Construction activities for Grizzly Island distribution system would disrupt about 323 acres of existing vegetation, 172 acres of managed wetlands, and 151 acres of upland vegetation. The upland vegetation is composed of 24 acres of cultivated grain and pastureland and 127 acres of salt grass. The managed wetlands consist of 88 acres of pickleweed and 84 acres of mixed marsh plants. The mixed marsh vegetation is primarly alkali bulrush, fat hen, tules, brass buttons, and annual herbs.

The project levees would be planted with grasses, mixed herbs, and a variety of native shrubs. In two to five years, the grasses seeded following construction are expected to be replaced naturally by local upland plants. The newly established upland vegetation will total about 137 acres.

The distribution system would establish about 186 acres of new, permanently ponded area. The margins of the regulatory pond would develop stands of emergent and aquatic vegetation. A narrow band of tules and cattails would be allowed to invade the ditch banks naturally, where submerged aquatic plants would also become established.

Wildlife. Some 165 acres of the area that would be disturbed by construction is not normally flooded. Since the system would develop about 137 acres of higher quality upland habitat, there should be no significant long-term adverse impact on wildlife.

The remaining 158 acres that would be affected by the distribution system is seasonally flooded marsh. Although the system would establish about 186 acres of new permanent water area useful as feeding and nesting habitat for a variety of aquatic mammals and birds, this would not offset the loss of seasonal marsh. Species requiring seasonal marsh habitat would be adversely affected.

The migration barrier that would be created by the system is not expected to have a significant adverse impact on marsh wildlife.

Intensive field surveys have verified that the salt marsh harvest mouse inhabits the project area. These surveys have failed to confirm the existance of the black rail in this area.



C—053778

C-053778

About 172 acres of potential mouse habitat would be impacted. This impact is discussed in the Biological Assessment (Appendix D).

Potrero Hills Ditch

This facility is described on page 93.

Land. Construction of the 3.5-mile Potrero Hills Ditch and the approach and outlet channel improvements to Luco and Hill sloughs, which total 13,900 feet in length, would modify 120 acres. The ditch and channel improvements would convert about 71 acres of dry farmland north of Potrero Hills, and about 49 acres of wetland habitat to a permanently filled ditch, with adjoining marsh fringes and upland habitat. The design would include at least four crossings to accommodate vehicle and pedestrian traffic.

Water Resources. Potrero Hills Ditch would fill from the east on the rising tide and drain to the west as the tide falls, controlled by tide gates. The average intake flow would be 340 cubic feet per second, or about 684 acre-feet per day. The average channel velocity would be about 0.22 foot per second. The maximum velocity would be slightly higher.

Water Quality. Operation of Potrero Hills Ditch would improve circulation in Hill and Luco sloughs, both dead-end sloughs. The dissolved oxygen level in these sloughs would increase.

Recreation. The only existing recreation is in the Hill and Luco slough areas, and it is limited to hunting at the private duck clubs and fishing on the sloughs. With construction of Potrero Hills Ditch, a new recreational area will be available (Exhibit M).

A parking area is proposed near Branscomb Road access and the ditch, with a picnic area and sanitation facilities. This site will be equipped with a fishing platform for the handicapped, adjacent to the parking area. The ditch should attract non-motorized fishing boats, for which launching areas will be provided at the access points. A trail is proposed for the north side of the ditch, for nature study and photography, between Scalley and Branscomb roads.

Float lines and other safety devices will be installed to protect the public. Recreation use should be high at this site.

Fish. The ditch and slough channel improvements will add resident fish habitat. The few anadromous fish that do stray into the ditch will not be affected, because the ditch is a through passage to Hill and Suisun sloughs.



C—053779

C-053779

Vegetation. Construction activities for Potrero Hills ditch would disrupt about 120 acres of existing vegetation. This habitat is composed of 71 acres of dry farmland and 49 acres of tidal marsh. The existing marsh vegetation consists primarily of pickleweed, salt grass, and tule stands.

The project levees would be planted with grasses, mixed herbs, and a variety of native shrubs. In two to five years, the grasses seeded following construction are expected to be replaced naturally by local upland plants. The newly established upland vegetation will total about 38 acres.

The Potrero Hills Ditch will establish about 82 acres of new ditch. A narrow band of tules and cattails would be allowed to invade the ditch banks naturally, where submerged aquatic plants would also become established.

Wildlife. The temporary loss of 71 acres of grass uplands is not considered significantly detrimental to birds and mammals inhabiting this area. Replacement of 38 acres with more diverse upland habitat, to be planted after project completion, would partially offset the temporary adverse impacts. The increased diversity in habitat resulting from a waterway in the upland area should increase the diversity and abundance of wildlife.

The barrier created by the ditch should not result in significant adverse impacts to wildlife.

The permanent loss of 49 acres of seasonal and tidal marsh habitat would have a significant adverse impact on resident and migrant marsh-dependent wildlife species. The adverse impact to salt marsh harvest mice is described in the Biological Assessment (Appendix D). The loss of tidal marshland could adversely impact the black rail due to the loss of potential habitat.

The Potrero Hills Ditch is a water conveyance system that will be subject to tidal action, with aquatic plant growth along its perimeter and a tidal zone. The black rail could use this area to some extent as new habitat for cover and feeding.

## Cordelia-Goodyear Ditch and Goodyear Slough Control Structure

These facilities are described on page 96.

Land. The 2.8-mile Cordelia-Goodyear Ditch, 2.5-mile Morrow Island distribution system, and 2,800-foot Goodyear Slough outfall channel and structure would modify about 173 acres. About 102 acres of this would be converted to additional water surface, including a 20-acre pond at the south end of Cordelia-Goodyear Ditch. Most of the Cordelia-Goodyear Ditch would be located at the extreme western edge of the Marsh, parallel to Interstate Highway 680. The ditch would partially isolate the land from the



C—053780

C-053780

highway's frontage road. The Goodyear Slough control structure will not require a significant amount of land.

Water Resources. The maximum design capacity of the Cordelia-Goodyear Ditch is about 156 cubic feet per second. Average and maximum velocities are 0.34 and 1.8 feet per second, respectively.

Water Quality. Cordelia-Goodyear Ditch circulation would be adequate to prevent eutrophication. The salinity level would depend on the quality in Cordelia Slough. Operation of the ditch would improve the salinity and dissolved oxygen levels within Goodyear Slough, south of the Goodyear Slough control structure.

The Goodyear Slough control structure would be operated when and to the extent needed to maintain adequate water quality within Goodyear Slough.

Recreation. Private recreation facilities would be affected only minimally by these facilities. There would be no increase in public access to the area east of Cordelia-Goodyear Ditch, except in the recreation development described below (Exhibit M).

The pond constructed on the south end of the Cordelia-Goodyear Ditch will be improved for recreational use. Access to the recreational area will be from Highway 680 frontage road to a parking area. The recreation area will provide a picnic area and sanitation facilities. Fishing platforms for the handicapped will be provided adjacent to the parking area on adjacent waterways. As this recreational area is within a duck hunting area, use may be restricted to fishing during the off season.

Float lines and other safety devises will be installed for the protection of the public. Recreational use should be high at this site because it is near Fairfield and Suisun City to the north and Benecia, Martinez, and Concord to the south.

Fish. Cordelia-Goodyear Ditch would provide increased fish habitat. When closed, the Goodyear Slough control structure would force migrating fish, wandering from Grizzly Bay through the Goodyear Slough outfall and into Goodyear Slough, to pass through the ditch. Since this route would not impede fish, the impact would not be significant.

Vegetation. The Cordelia-Goodyear Ditch would affect about 88 acres of vegetation. About half of this area is uplands and supports mixed grasses and herbs; the other half is seasonal marshland and supports pickleweed, fat hen, brass buttons, and alkali bulrush.

The ditch would provide 33 acres of new water surface. Following construction, the planting of grasses and shrubs on the new levees would result in about 50 acres of varied upland habitat. A narrow band of tules and cattails would be allowed to



C—053781

C-053781

invade the ditch banks naturally, where submerged aquatic plants would also become established.

The Goodyear Slough control structure would have no significant impact on flora.

Wildlife. The loss of 86 acres of marsh habitat, in itself, is not expected to have a significant adverse impact on most local wildlife populations. The loss of upland habitat would be mitigated by establishing grasses and low shrubs on the new levees. The migration barrier to wildlife created by the ditch is not expected to result in a significant adverse impact. No significant impact on wildlife is expected to result from installing the control structure.

The impact on the salt marsh harvest mouse of permanently converting 102 acres of marsh and upland habitat is described in the Biological Assessment (Appendix D). The permanent loss of a minimum of 10 acres of low-lying pickleweed at the southern end of the Cordelia-Goodyear Ditch could adversely affect potential black rail habitat.

The Cordelia-Goodyear Ditch is a water conveyance system that will be subject to tidal action, with aquatic plant growth along its perimeter and a tidal zone. Because the black rail is a secretive bird, the noise from Highway 680 and Pierce Harbor could eliminate this area from use as habitat.

Boynton-Cordelia Ditch

This facility is described on page 99.

Land. The Boynton-Cordelia Ditch would do two things:

- Supplement the natural inflow to Cordelia Slough with treated waste water, with a connection to the Fairfield-Suisun Treatment Plant discharge line.
- Tidally pump water from the western end of Boynton Slough to Cordelia Slough, providing the treated waste water dilution requirements.

The ditch would extend 3.5 miles through pasture land. The ditch would modify the use of about 158 acres of land and would create about 105 acres of new water surface. It would affect about 47 acres of tidal slough area. The ditch alignment would parallel an existing road and the existing channel. The ditch would siphon under Subeet Road and the upper end of Chadbourne Slough.

Water Resources. The Boynton-Cordelia Ditch would tidally convey 205 cubic feet per second of water from Boynton Slough to Cordelia Slough. The tidally pumped water would provide the required dilution of treated waste water from the Fairfield treatment plant.



C—053782

C-053782

Maximum velocity in the ditch would be 0.76 foot per second, and the average velocities would be 0.23 foot per second. The total quantity of water conveyed by the ditch would depend on treatment plant discharge and other projected uses of treated waste water. The capacity of the Fairfield treatment plant is expected to be 25 million gallons per day by 1985. The effluent, combined with the tidally pumped flow from Boynton Slough, would be discharged into Cordelia Slough and would have a minimum overall dilution ratio of 1 to 1 during February and March.

Flow from Green Valley Creek and Suisun Creek would dilute the discharge in Cordelia Slough during winter and spring, although such dilution would be slight during critically dry years. The mixture of tidally pumped water and treated waste water would be distributed through the western marsh area by tidal dispersion and advective flows.

Water Quality. Boynton Slough would no longer be a dead-end slough, and with the tidal pumping, circulation would increase, along with the level of dissolved oxygen. Since the treatment plant discharge would be channeled to Cordelia Slough, phytoplankton and algae growth should remain the same, but there would be an increase in nitrate, nitrogen, and phosphorus levels. A corresponding decrease in nitrate, nitrogen, and phosphorus levels would be expected in Boynton Slough, which now takes the treatment plant discharge. The treated waste water should not depress dissolved oxygen levels within Cordelia Slough, and salinity levels in the upper reach of Cordelia Slough would be reduced.

Recreation. Private recreation facilities would be affected only minimally by these facilities. With easy vehicle access already provided by Chadbourne Road, the new pond would provide additional fishing opportunities. As all the lands in this area are private, access rights along the new ditch to the pond would have to be provided (Exhibit M).

The pond would be constructed to mix or blend the waters from Boynton Slough with the treated waste water from the Fairfield treatment plant. Access would be from Chadbourne Road along the south levee of Boynton-Cordelia ditch to a parking lot. Fishing platforms for the handicapped would be provided adjacent to the parking area. Sanitation facilities would be provided. Floating barricades, float lines, and other safety devices would be provided to protect the public. As this recreational area is within a private hunting area, use may be limited to fishing during the off season.

Fish. Fish in Boynton Slough might be affected to a minor extent by clearing of the channel. A screen over the treatment plant pipe where it discharges into the ditch would prevent fish from entering the discharge pipe.

Vegetation. Construction activities for the Boynton-Cordelia Ditch and Boynton Slough would disrupt about 158 acres composed of



C—053783

C-053783

111 acres of pasture and upland grassland and 47 acres of salt grass and pickleweed.

The project levees would be planted with grasses, mixed herbs, and a variety of native shrubs. In two to five years the grasses seeded following construction are expected to be replaced naturally by local upland plants. The newly established upland vegetation would total about 65 acres.

The Boynton-Cordelia Ditch would establish about 105 acres of new water surface area. A narrow band of tules and cattails would be allowed to invade the ditch banks naturally, where submerged aquatic plants would also become established.

Wildlife. With the ditch in place, the combination of undisturbed upland habitat and surface water would benefit wildlife in the area. The channel would not act as a significant migration barrier to wildlife. The cover over the siphons would allow wildlife to move across the ditch. The development of additional water surface and diverse upland habitat on the project levees would compensate for the upland habitat destroyed by construction. About 2.3 miles of tidal slough would be adversely affected.

Boynton Slough channel improvement would be limited to removal of bottom sediments and some channel vegetation, but not adjacent vegetation. Spoil might be disposed of by thinly spreading it in low pond areas in a manner that would ensure establishment of vegetation, or by other methods acceptable to the regulatory agencies.

The potential impact of this project feature on the salt marsh harvest mouse is discussed in the Biological Assessment (Appendix D). The permanent loss of about 32 acres of suitable habitat, which would become water surface, is not expected to have a significant adverse impact on the salt marsh harvest mouse. The permanent loss of tidal marshland would, however, decrease potential black rail habitat.

The Boynton-Cordelia Ditch is a water conveyance system that would be subject to tidal action, with aquatic plant growth along its perimeter and a tidal zone. The black rail could use this area to some extent as new habitat or cover and feeding.

## Unavoidable Adverse Environmental Effects and Compensation Measures

The Plan of Protection, as presented, is to mitigate the effects of the CVP and SWP on the Suisun Marsh. Implementation of the plan would have some unavoidable adverse environmental effects, of which one is judged significant and several others minor. The appropriate mitigation or compensation to minimize or eliminate these effects will be implemented if feasible. DWR is



C—053784

C-053784

obligated to examine possible mitigation measures for this loss of wetlands to determine if any are feasible.

Aquatic Habitat

The selected or alternative plan will have several adverse impacts on the fish of Suisun Marsh. The following recommendations were made by DFG to minimize these impacts so that significant reductions in fish populations can be averted.

- Provision should be made for effectively screening small fish from entering the Roaring River Slough and Grizzly Ditch distribution systems and, if necessary, the Morrow Island ditch, pursuant to Fish and Game Code Section 6100.

- Adequate water circulation to maintain high dissolved oxygen contents should always be provided in permanent water areas of the distribution system to protect fish that enter or are produced in these areas.

- An operation schedule for the project should be developed and approved to limit, to the extent possible, increases in water velocities in Montezuma Slough. This would entail tidally pumping less than the full project capacity of 2,100 cubic feet per second at the Montezuma Slough control structure when suitable soil salinities can be maintained with less flow.

- Provisions should be made in the design and operation of the Montezuma Slough control structure so that fish migration is not impeded for extended periods.

- Provisions should be made in the design and operation of all channel siphons so that fish migration is not impeded. This can be accomplished by siphoning project channels under natural channels, such as the Fairfield Wastewater Conveyance Ditch being siphoned under Chadbourne Slough.

- Fish distribution and abundance and fish screen efficiency should be studied after completion of the project; corrective action should be taken if fish are adversely affected by project operations.

Marsh and Upland Habitat

Cumulatively, construction of the many separate features of the project would permanently convert 437 acres of marsh and 96 acres of upland habitat to water surface. An additional 11 acres of upland habitat would be converted to road surface. The loss of marsh habitat is the most serious of these effects, especially because it would adversely affect the endangered salt marsh harvest mouse and potential habitat of the rare black rail

(see Appendix D). This conversion of marsh habitat would be the one significant environmental effect of the project.

The temporary losses of habitat during construction of the individual parts of the plan of protection would not be cumulatively significant. The disturbances to habitat would be isolated in location and in time. Only a small part of the overall disturbance would occur at one time. Due to the expected staging of construction of the facilities, an area disturbed during construction of one facility would have time to recover before another area was disturbed.

During construction of facilities, efforts will be made to minimize any losses to the mouse. Traps will be set in potential mouse habitat to remove mice, if they exist, that could be destroyed by construction activity. These mice may be moved to other suitable habitat, including recently developed habitat capable of supporting mice but not now doing so. Trapping should also take place early in the season to reduce impacts on breeding mice or mice with litters. Construction crews and equipment will work as closely as possible, within the limits and alignments of the project, to reduce disturbance to the rail and mouse.

The loss of upland habitat is secondary in importance because new levees built would be seeded with plants that would provide upland habitat equal to, or better than, what exists. In the long term, the project may benefit the salt marsh harvest mouse by creating habitat it can use in the fall and spring, when the managed wetlands are normally flooded. The black rail habitat however, would not be enhanced to the same extent.

One proposal to mitigate the loss of marsh and upland habitat due to the project is that compensating marsh and upland habitat be established elsewhere. The Suisun Marsh Technical Committee developed a mitigation concept based in part on the point-scale habitat evaluation procedure used by DFG and the USFWS (Appendix L).

The Technical Committee recommended that land be acquired in the Marsh and developed as managed wetlands to replace that impacted by project construction. The land proposed to be acquired is presently marginal or poorly managed wetland, grasslands, or lower elevation high ground.

Approximately one-fourth of the potential wetlands impacted by project construction is salt marsh harvest mouse habitat. The Technical Committee recommended that replacement wetlands for mouse habitat lost be managed as the preferred habitat for the salt marsh harvest mouse.

Poorly managed or marginal wetlands or low-lying lands presently used for agriculture or as grasslands would be acquired and converted to managed wetlands. Some of the lands proposed for acquisition are located near the boundaries of the marsh and would



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serve as buffer zones from future development. Acquired lands could be at an elevation that would require mechanical pumping of water to be properly managed. The private owners from whom the mitigation lands are acquired would lose the use of those lands for hunting or for agriculture.

Should DFG be unable to acquire private lands to develop as wetlands, they will develop replacement wetlands on the DFG owned portion of Grizzly Island. The land use will change from dry farming to a wetlands, resulting in a loss of the grain production from that acreage developed.

If impacts of the project are reduced, particularly by elimination of Cordelia-Goodyear Ditch, Goodyear Slough Control Structure, or Potrero Hills Ditch, it is presumed that the proposed mitigation plan will be appropriately revised.

It is also presumed that DWR need only examine options for mitigating its portion of the Overall Facilities. DWR's portion of the facilities will be defined by a contract among DWR, DFG, and SRCD, but (until further testing) is presumed to consist of the completed Initial Facilities, the Montezuma Slough Control Structure, and the Boynton-Cordelia Ditch. Construction of the remaining facilities depends on USBR participation. Mitigation for those facilities will be examined when they are built.

The following options have been examined for mitigating the loss of wetlands through construction of the DWR portion of the Overall Facilities.

Option 1: DWR could provide DFG with "up-front" funds to purchase and develop wetlands to replace half the total anticipated to be lost through construction of the entire Plan of Protection.

Option 2: DWR could provide DFG with the funds estimated to be the present worth of the cost to purchase and develop wetlands to replace half the total anticipated to be lost through construction of the entire Plan of Protection.

Option 3: DWR could provide funds to DFG to purchase and develop wetlands to replace those already lost through construction of the Initial Facilities. DWR would commit to providing funds for further replacement of wetlands as losses occur with future DWR construction.

Option 4: DWR could purchase and develop wetlands to replace those already lost through construction of the Initial Facilities. DWR could provide further replacement of wetlands as losses occur with future DWR construction.

Option 5: DWR might provide no replacement for wetlands lost during construction if the Department finds that mitigation



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for this impact is not feasible due to excessive cost and the inability of the SWP to support the added cost.

Except for Option 5, all options would achieve replacement of wetlands lost due to construction of DWR's portion of the Overall Facilities. Option 1 would provide DFG with a single large payment, which may be used more effectively than several smaller payments in purchasing and developing replacement wetlands. However, this option is not considered equitable to SWP contractors because it would include payment for mitigation of the effects of Boynton-Cordelia Ditch before that facility is known to be needed. Additionally, the economic value of the advance payment has not been taken into account.

Option 2 would also provide DFG with a single large payment. Payment for mitigation for Boynton-Cordelia Ditch would be included before that facility is known to be needed. The economic value of the advance payment has been taken into account.

Option 3 is believed to be the most equitable option. Funds for replacement wetlands would be provided. Mitigation for impacts of facilities would not be provided until the facility was to be constructed. The amount of wetlands to be developed will vary from 125 acres for only the Initial Facilities to 172 acres if all facilities of the Plan of Protection appear to be needed.

The amount of acreage that would be acquired and developed as salt marsh harvest mouse habitat would be between 25 and 50 acres.

Option 4 is similar to Option 3, except that DWR would purchase and develop replacement wetlands rather than funding these activities.

Option 5 will not mitigate for loss of wetlands due to construction of the facilities. The total wetlands of the Marsh will be reduced by about one percent if all facilities are constructed. DFG considers this option unacceptable. About one-fourth of the wetlands lost and not replaced would be salt marsh harvest mouse habitat. Failure to mitigate for the impact on the mouse in conformance with the Section 7 determination (Appendix E) may prejudice the possibility of obtaining a USCE permit for construction that impacts the mouse habitat.

Selection of an option to be implemented will be made through negotiation of a Memorandum of Understanding between DWR and DFG, as influenced by the BCDC and USCE permit processes. For purposes of preparing the remainder of this report, Option 3 is presumed the most likely to be selected.

Although the proposed project will help protect the Suisun Marsh environment, some long-term impacts are unavoidable. Some degradation of the recreation areas may result from increased



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traffic and public use. Public use of the recreation sites could have some significant long-term effects on air quality and ambient noise quality. Some wildlife species with a low tolerance for cohabitation with people could leave the sites permanently. However, a primary concept of providing recreation facilities is that controlled use is less damaging than the uncontrolled use that would occur were facilities not provided. Controlled use may, in fact, include closing or modifying of a facility if significant conflicts occur with the primary purpose of Suisun Marsh as a wildlife area. Any adverse impact of the recreational areas is believed to be more than offset by the public benefit derived.

## Alternatives

Environmental aspects of alternatives other than the recommended Combination Plan are examined in this section. The alternatives are described in Chapter 4.

### No Action Plan

Adopting inaction as a plan would produce the same results as disregarding the problem of increasing saline water supply to the Suisun Marsh. In years of below-normal runoff, salinity of the Marsh would reach levels that many of the more desirable plants could not tolerate. These plants would gradually be replaced by less desirable, salt-tolerant species. The gradual increase of salt-tolerant species of plants would include pickleweed and salt grass. Dense stands of pickleweed are prized by the salt marsh harvest mouse and black rail for habitat. The western areas of the Marsh would become a salt marsh. Much of the Marsh's value for recreation and waterfowl habitat would be lost.

The No Action Plan was rejected because of unacceptable environmental impacts.

### Nonstructural Plan

Implementing this plan would require reallocating 2 to 4 million acre-feet of water now in agricultural, urban, and industrial use. This would have substantial impacts on the water users (mainly agricultural) who have contracted for project water. The State or Federal Government, or both, would have to renege on contracts, resulting in loss of integrity to the agencies involved. The shortfall in project water supplies for agriculture would put many acres out of production, though some farmers could try to reduce this loss by increasing the overdraft of ground water in the San Joaquin Valley.

The Nonstructural Plan might be rejected on environmental grounds, for its impacts on ground water and agriculture,



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but the best grounds for rejection are economic. Impacts of a decrease in deliveries to the agricultural areas served are outlined in, "Special Task Force Report on San Luis Unit", prepared under Public Law 94-46. The annual net loss to farm income in the agricultural areas has been estimated at $727 per acre. This figure, multiplied by at least 400,000 acres, gives a product of just over $291 million as the annual loss of crop value to the farmers. The cost to the State economy would be far greater, because a loss in a basic industry, such as agriculture, would in turn affect other industries, as outlined in Chapter 4. The Nonstructural Plan was rejected on economic grounds.

Overland Supply Plan

Implementing this plan would substantially alter the environment in certain areas of the Marsh. Because the source of the water supply would be Lindsey Slough or Calhoun Cut, the water quality would be excellent, the water being from the Sacramento River. Putting such high quality water into some areas of the Marsh would change these areas from brackish to a fresh water marsh, with accompanying habitat change. This change would adversely impact the harvest mouse, due to the loss of pickleweed growth, which is its preferred habitat.

Because the water would come from the Sacramento River, chinook salmon would tend to stray out of normal migration routes, causing delays that would affect their reproduction. The large quantities of fresh water could affect the water quality of Montezuma Slough, making it fresher, relocating the entrapment zone and, therefore, the total striped bass population of the Marsh.

Except for Plan 2 this plan requires much more water than the other plans, in addition to degrading water quality of existing channels and isolating existing channels from original water supplies. This would require significantly more marsh habitat than with the combination plan.

Removal and disposal of large quantities of material would be required, as well as large volumes of fill material could be required. This would require the use of spoil dump sites and material borrow areas, with potential adverse environmental impacts.

For all these reasons, the Overland Supply Plan was rejected.

Relationship Between Local Short-Term Uses of the Environment and the Maintenance and Enhancement of Long-Term Productivity

The project would have no cumulative or long-term adverse effects on the environment, other than those discussed



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in the section on unavoidable effects and mitigation. The project might be considered to narrow the range of beneficial uses of the land in Suisun Marsh, because the project would represent a major investment in maintaining the present land use for wildlife habitat, but few would regard this as an adverse impact. The project would pose no long-term risks to health and safety.

## Significant Environmental Changes, Growth Inducing Impacts

The purpose of the project is to avoid a significant environmental change -- degradation of the Marsh -- and this purpose would be accomplished with a minimum of impacts, primary or secondary. Some nonrenewable fossil fuels would be consumed in constructing project facilities, but this would not necessitate an increase in the consumption of fossil fuels on a national, state-wide, or local basis. The project would also require about 8,000 cubic yards of concrete. Use of resources to construct the project is justified by the need to protect the Marsh.

The project would not induce population growth, because it would help to maintain a land use that excludes industry and requires an exceptionally low population density.

## Consultation

The following agencies were consulted in the preparation of the Environmental Impact Report.

### Federal Agencies

U. S. Fish and Wildlife Service
U. S. Bureau of Reclamation
U. S. Soil Conservation Service
U. S. Army Corps of Engineers
National Marine Fisheries Service
U. S. Coast Guard

### State of California

Department of Fish and Game
State Water Resources Control Board
San Francisco Bay Regional Water Quality Control Board
San Francisco Bay Conservation and Development Commission
University of California (Davis)



C—053791

C-053791

Local

Suisun Resource Conservation District
Fairfield-Suisun Sewer District
Solano County

Others

State Water Contractors

## Report Preparation

This Environmental Impact Report chapter was prepared by the Bay-Delta Studies Branch, Central District, Department of Water Resources, based on data organized by the U. S. Bureau of Reclamation, with contributions from the California Department of Fish and Game and numerous other participants.



C—053792

C-053792

# APPENDICES

TABLE OF CONTENTS


| | | Page |
|---|---|---|
| Appendix A | Contract on Initial Facilities Between DWR, DFG and SRCD | |
| Appendix B | Monitoring Program Methodology | |
| | Water Quality | B-1 |
| | Channel Water Quality | B-1 |
| | Diversion and Drain Water Quality | B-2 |
| | Water Level Recorders | B-2 |
| | Soil Salinity | B-2 |
| | Soil Salinity | B-2 |
| | Vegetation | B-5 |
| | Plant Survey | B-5 |
| | Seed Production | B-5 |
| | Wildlife | B-6 |
| | Fisheries | B-7 |
| | Reports | B-7 |
| | Program Implementation | B-8 |
| Appendix C | Water Rights Decision 1485 | |
| Appendix D | Biological Assessment of the Impacts of the Suisun Marsh Management Plan (DFG for USBR) | |
| Appendix E | Section 7 Determination, Suisun Marsh Management Study, Solano County, California | |
| Appendix F | Aquatic Resources of Suisun Marsh with an Analysis of the Fishery Effects of a Proposed Water Quality Maintenance Plan (Alan Baracco) | |
| Appendix G | California Black Rail Breeding Season Survey in Central California (Timothy D. Manolis) | |
| Appendix H | Study of the Salt Marsh Harvest Mouse in Suisun Bay, California (Howard S. Shellhammer) | |
| Appendix I | Endangered and Threatened Wildlife, California Clapper Rail (Thomas E. Harvey) | |
| Appendix J | Procedure for Determining Mitigation for Channel Island Waterfowl Food Production | |
| Appendix K | Endangered and Rare Plants Survey (Stephen P. Rae) | |

| | |
|---|---|
| Appendix L | Letter on Recommended Mitigation Alternative for the Suisun Marsh Plan of Protection |
| Appendix M | Suisun Marsh Proposed Recreation Plan |
| Appendix N | List of Suisun Marsh Vegetation |
| Appendix O | Comments and Responses<br>Letters of Response |

# APPENDIX A

APPENDIX A

CONTRACT

AMONG

THE DEPARTMENT OF WATER RESOURCES,

THE DEPARTMENT OF FISH AND GAME, AND

THE SUISUN RESOURCE CONSERVATION DISTRICT

THIS CONTRACT dated this 18 day of December 1978, is hereby entered into among the California Department of Water Resources ("DWR"), the California Department of Fish and Game ("DF&G"), and the Suisun Resource Conservation District ("SRCD").

R E C I T A L S

a. Diversions of water from Sacramento-San Joaquin Delta by DWR and the United States Bureau of Reclamation ("USBR") to accomplish the purposes of the State Water Project and the Central Valley Project, respectively, have, at times, resulted in reductions in outflow from the Delta. As a result, the water supplies presently available for use on managed wetlands within the Suisun Marsh for the purpose of providing waterfowl habitat have, at times, increased in salinity and these higher salinity levels are present for longer periods of time in certain years. The purpose of this Contract is to partially define the responsibilities of DWR to mitigate for the effects of increased salinity levels of the water available to certain managed wetlands of the Suisun Marsh.

b. A plan for the full resolution of the problem described in Recital a. is scheduled for completion by July 1, 1979, and its full implementation is scheduled by October 1, 1984. In the meantime, DWR proposes to provide partial mitigation by providing certain initial facilities that will be used insofar as possible in connection with the overall Marsh protection and restoration plan.

c. During dry and critical years, the availability of good quality waterfowl habitat in the Marsh becomes particularly important to waterfowl because of the large expanse of this type of habitat which it can provide and the scarcity of such habitat elsewhere in the State.

d. The parties consider that the protection and restoration of the capability of the managed wetlands of the Marsh to produce good quality waterfowl habitat to be in the public interest.

e. The facilities to be constructed are for the purpose of transfer of adequate quality water to certain Marsh areas where, at times, the water quality would otherwise be inadequate.

## A G R E E M E N T

1. Definitions: For the purpose of this Contract:

a. "Marsh" means the managed wetlands within the Suisun Marsh as it is presently defined in the Suisun Marsh Preservation Act of 1977.

b. "Initial Water Distribution Facilities" ("Initial Facilities") means any facilities to be provided by virtue of this Contract which distribute or redistribute water within the Marsh, specifically including water inlet gates to supply water to Individual Ownerships within the Marsh from such facilities and any new water outlet gates on

Individual Ownerships which may be required due to a change in the direction or pattern of water movement on an Individual Ownership as a result in a change in the location of the water inlet gates on that ownership. The Initial Facilities shall be those facilities listed in Attachment A.

c. "Individual Ownership" means a separately-owned parcel of land in the Marsh. Contiguous parcels owned by the same legal entity comprise a single Individual Ownership.

d. "Overall Facilities" means water delivery, distribution and redistribution facilities to be provided as a part of an overall Marsh protection and restoration plan to partially resolve the problem described in Recital a. To the extent feasible, the Initial Facilities will be included as part of the Overall Facilities.

2. a. The purpose of the Initial Facilities is to partially restore and maintain the Marsh as a brackish water marsh capable of producing high-quality feed and habitat conditions for waterfowl and other marsh-related wildlife. The Initial Facilities are intended to partially mitigate the adverse effects on the Marsh of operations of the State Water Project and the Central Valley Project. The Initial Facilities will not materially enhance the overall resources of the Marsh.

b. The construction of the Initial Facilities may provide Individual Ownerships with benefits which they do not presently enjoy. The presently contemplated scope of the Initial Facilities will not fully mitigate the damages to the Individual Ownerships.



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Due to the difficulty of precisely determining the relative extent of the benefits and the damages, all the parties agree that the division of responsibilities set forth herein represents a reasonable balancing of equities.

c. DWR shall design, construct, operate, and maintain the Initial Facilities solely at its expense (or in cooperation with the United States Bureau of Reclamation) and in compliance with the applicable laws, except that:

1. the cost of the operation and maintenance of any water inlet and outlet facilities which supply water to or drain water from an Individual Ownership and which may be provided as part of the Initial Facilities shall be the responsibility of the Individual Ownership, as indicated on Attachment B, provided that initial construction and installation problems have been solved; and
2. the routine maintenance cost for the portion of Roaring River levee on the Grizzly Island Wildlife Management Area shall be the responsibility of DF&G.

d. DWR shall submit all drawings and specifications concerning the Initial Facilities to the SRCD and the appropriate Individual Ownerships for review and comment. If SRCD and the Individual Ownerships do not comment within fifteen (15) working days, DWR may proceed. It is recognized and agreed that SRCD and the Individual Ownerships incur no liability as to the adequacy or suitability of any drawing or specification by providing such comments.

e. DF&G shall review all drawings and specifications concerning the Initial Facilities. It shall be assumed that the drawings and specifications are acceptable if changes are not provided to DWR within 15 working days after submittal.

3. DWR shall complete the construction of the Initial Facilities by October 1, 1980.

4. Where rights-of-way are required for work to be done under this Contract, SRCD, upon the request of DWR, will exercise its best efforts to assure that DWR acquires, at no cost to DWR, the necessary easements or other appropriate title. Acquisition of title is essential to the construction, operation and maintenance of the Initial Facilities; any delay in such acquisition beyond January 1, 1979 may delay completion of the Initial Facilities but shall not relieve DWR of its responsibility to complete the Initial Facilities as expeditiously as possible.

5. Until the Overall Facilities are operational, the State Water Project, shall be operated to meet the following standards:

| Beneficial Use Protected and Location | Parameter | Description | Year Type | Values Jan. - May | Values Oct. - Dec. |
|---|---|---|---|---|---|
| Suisun Marsh Chipps Island at O&A Ferry Landing | Electrical Conductivity | Maximum 28-day running average of mean daily EC | Wet | 12.5 mmhos | 12.5 mmhos |
| | | | Ab. Normal | 12.5 mmhos | 12.5 mmhos |
| | | | Bl. Normal | 12.5 mmhos | 12.5 mmhos |
| | | | Dry or Critical | 12.5 mmhos | 15.6 mmhos |

(The 15.6 mmhos EC Standard applies only when project water users are taking deficiencies in scheduled water supplies, otherwise the 12.5 mmhos EC remains in effect.)

| | | | | |
|---|---|---|---|---|
| Chipps Island | Delta Outflow Index in cfs | Average of the daily Delta outflow index for each month, not less than values shown | Wet | February-May 10,000 cfs |
| | | | Subnormal Snowmelt | February-April 10,000 cfs |
| | | Minimum daily Delta outflow index for 60 consecutive days in the period | Ab. Norm. and Bl. Norm | January-April 12,000 cfs |
| | | | All (if greater flow not required by above standard) 1/ | January-May 6,600 cfs |

1/ Whenever storage is at or above the minimum level in the flood control reservation envelope at two out of three of the following: Shasta Reservoir, Oroville Reservoir, and CVP storage on the American River.



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provided, that if the State Water Resources Control Board (SWRCB) determines that an emergency exists, these standards shall be modified as required to comply with the standards established by SWRCB.

6. In order to assure the reasonable beneficial use of water provided by the Initial Facilities:

a. SRCD shall adopt regulations as provided in Section 9962 of the Public Resources Code which will require the owners of Individual Ownerships receiving water from the Initial Facilities, or their tenants, to manage their lands in accordance with the individual ownership water management programs provided for in Section 29412.5 of the Public Resources Code.

b. SRCD shall diligently exercise its authority to require the landowners or tenants of the Individual Ownerships to operate such ownerships properly and effectively and in accordance with the provisions of Section 29000 of the Public Resources Code and any other applicable laws.

c. In the event SRCD is ineffectual in achieving the desired result under (b) above, it shall immediately petition the Legislature to obtain sufficient authority to do so.

7. In the future, if and when during the term of this contract, SRCD obtains comprehensive bodily injury and property damage liability insurance, it shall name the State as an additional insured and shall maintain the policy in full force and effect for the duration of this Contract. Each policy shall insure SRCD, the State and all officers and employees of the State, while acting within the scope of their

duties, against all claims, suits, or other actions, of any nature brought for or on account of any injury, damage, or loss, including any death, arising out of or connected with work under this Contract, whether liability is attributable to SRCD, to the State or its officers or employees, or to both. The limits of bodily injury coverage shall be not less than $5,000,000 each person and $5,000,000 each occurrence and the limits of property damage shall be not less than $5,000,000 each occurrence. SRCD shall not cancel or modify the policy without forty-five (45) days' prior written notice to the Director of DWR and DWR shall not be responsible for any premiums or assessments on the policy. A certificate showing compliance with this provision shall be submitted to the State by SRCD.

8. DWR and DF&G shall prepare, circulate and complete all environmental documents required by law. No construction of facilities identified herein shall commence prior to their being found environmentally acceptable to all the parties to this Contract.

9. The parties agree to support legislation in the Congress to authorize federal participation in the Initial Facilities and to urge the Department of Interior to support such legislation, and, when passed, to expedite participation.

10. DWR's obligations for capital expenditures under this Contract shall not exceed $3.6 Million.

11. Nothing herein shall relieve DWR of any responsibility which it may have for a full and complete resolution of the problem described in Recital a.

Director
Department of Water Resources

Date DEC 18 1978

Approved as to legal form and sufficiency:

Chief Counsel, Department of Water Resources

I hereby certify that all conditions for exemption set forth in State Administrative Manual Section 1209 have been complied with and this document is exempt from review by the Department of Finance.

Signature

Director
Department of Fish and Game

Date DEC 18 1978

GS approval not required.
(SAM 1206)

President
Suisun Resource Conservation District

Date DEC 18 1978

# INITIAL FACILITIES

I. Roaring River Unit

A. Intake Facilities, including fish screens, control gates, culverts, tide gates and the levee and road over the culverts.

B. Hammond Island Reservoir, including about 30 acres in the southeast corner of DF&G property adjacent to Montezuma Slough and Roaring River and the levees surrounding the reservoir.

C. Roaring River channel, including a north and south levee and the crossing structures.

D. Wheeler Island boat ditches, levee and control gates located as shown on the attached map.

E. The turnouts to certain clubs shown on the attached map. These turnouts include control gated culvert(s) and access thereto.

F. The drainage facility shown on the attached map, consisting of a control gated culvert.



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II. Goodyear Slough Unit

A. Goodyear Slough Outfall, including a structure consisting of culverts with control gates discharging to a channel dredged from Goodyear Slough to the Bay.

B. Morrow Island Ditch, including an intake structure consisting of a levee with control gated culverts through it, a ditch with levees on both sides, an outlet structure consisting of a levee with control gated culverts through it and access thereto, located as shown on the attached map.

C. The turnouts to certain clubs shown on the attached map. These turnouts include control gated culvert(s) and access thereto.

D. The drainage facilities from the certain clubs shown on the attached map. These facilities include control gated culvert(s) and access thereto.

E. The pond levee with flow controlled culverts north of Morrow Island Ditch as shown on the attached map.



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ATTACHMENT B

RESPONSIBILITY FOR
SUISUN MARSH INITIAL WATER FACILITIES
(Actual Work May Be Done By Others)

| ITEM | DESIGN | CONSTRUCT | OPERATE | MAINTAIN |
|---|---|---|---|---|
| **Roaring River Unit** | | | | |
| Intake (including reservoir and fish facilities) | DWR | DWR | DWR | DWR |
| Dredge channel | DWR | DWR | --- | DWR |
| Levees- South | DWR | DWR | --- | DWR |
| North | DWR | DWR | --- | DF&G 2/ |
| Turnouts 1/ | DWR | DWR | Indiv. Ownership | Indiv. Ownership |
| Wheeler Island Boat Ditches & Levee Control Gate | DWR | DWR | Indiv. Ownership | Indiv. Ownership |
| Drain Gates 1/ | DWR | DWR | Indiv. Ownership | Indiv. Ownership |
| **Goodyear Slough Unit** | | | | |
| Goodyear Slough | | | | |
| Outfall (structure and channel) | DWR | DWR | DWR | DWR |
| Morrow Island Ditch | | | | |
| Inlet Structure | DWR | DWR | DWR | DWR |
| Dredge Ditch | DWR | DWR | --- | DWR |
| Levees | DWR | DWR | --- | DWR 3/ |
| Outlet Structure | DWR | DWR | DWR | DWR |
| Turnouts 1/ | DWR | DWR | Indiv. Ownership | Indiv. Ownership |
| Drain Gates 1/ | DWR | DWR | Indiv. Ownership | Indiv. Ownership |

1. Specific turnouts and drain gates to be identified on design plans, all others are a total local responsibility.
2. DG&G's responsibility is limited by Section 2 c. 2.
3. DWR: along Morrow Island Ditch, all others: individual ownership.



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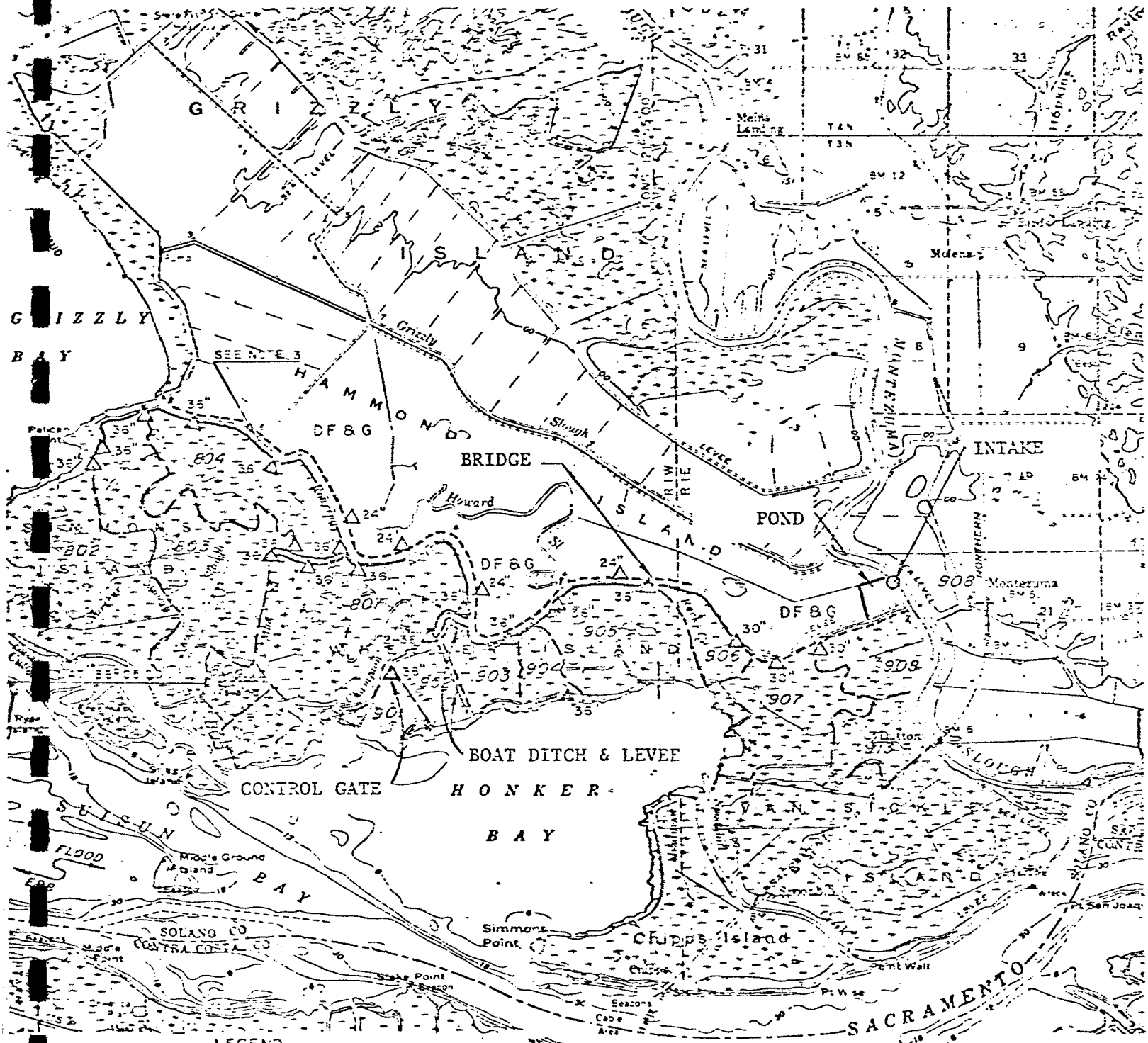


LEGEND

- CONSTRUCT NEW LEVEE
- RAISE EXISTING LEVEE
- △ TURNOUT STRUCTURE
- APPROXIMATE PROPERTY LINES
- 804 CLUB NUMBERS
- ▲ DRAIN GATE

NOTES

1. ELEVATIONS REFER TO NATIONAL GEODETIC VERTICAL DATUM OF 1929
2. MAP FROM U.S.G.S. 15' QUAD. PITTSBURG, CALIF.
3. CROSSING AND CULVERT TO BE REMOVED DURING CONSTRUCTION AND REPLACED TO ORIGINAL CONDITIONS

PROPOSED SUISUN MARSH
INITIAL FACILITIES
ROARING RIVER SLOUGH
LOCATION MAP
SOLANO COUNTY, CALIFORNIA

SCALE: 1:62500



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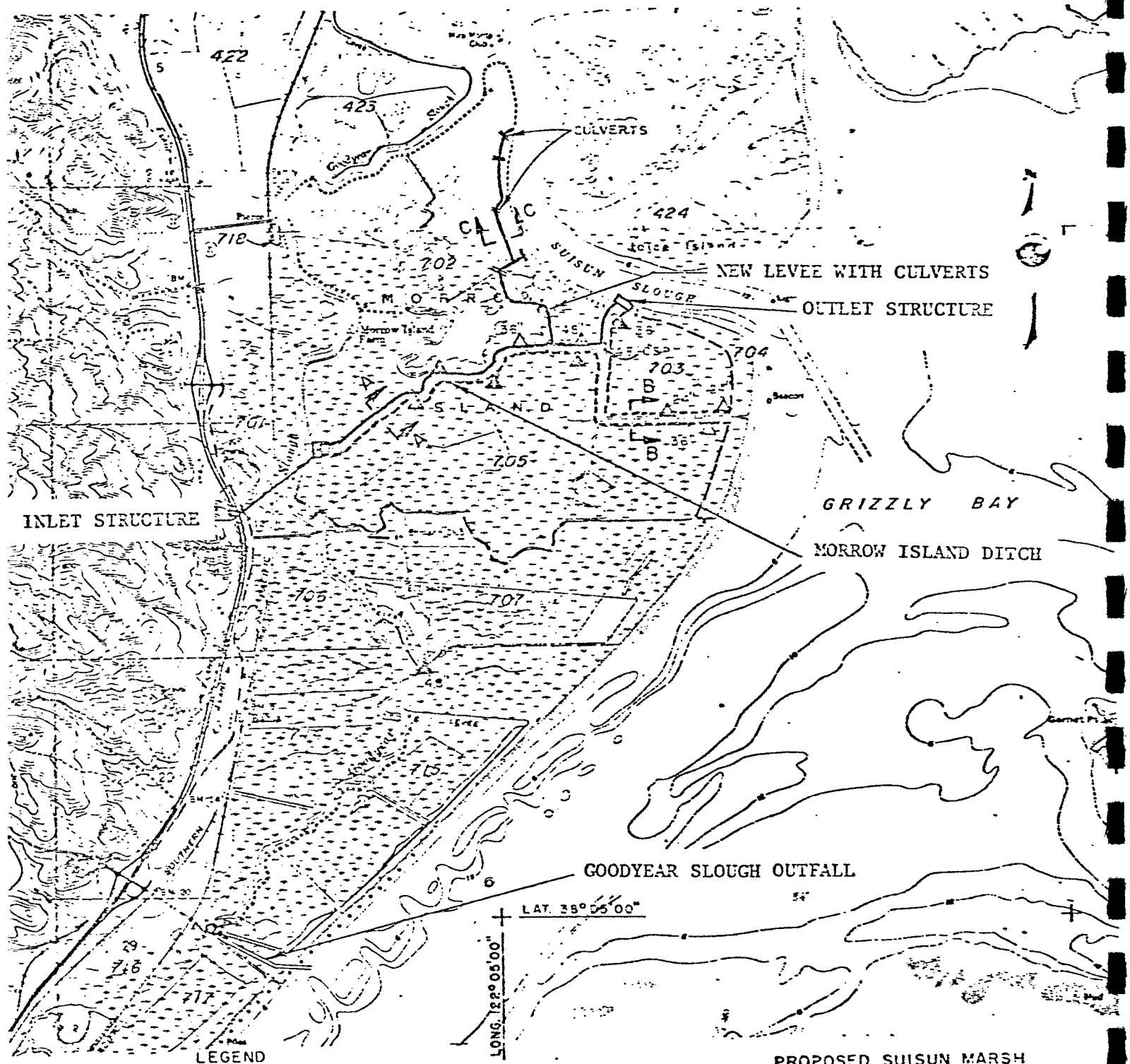


LEGEND

- CONSTRUCT NEW LEVEE
- RAISE EXISTING LEVEE
- TURNOUT STRUCTURE
- APPROXIMATE PROPERTY LINES
- 700 CLUB NUMBERS
- DRAIN GATE

NOTES

1. ELEVATIONS REFER TO NATIONAL GEODETIC VERTICAL DATUM OF 1929
2. MAP FROM U.S.G.S. 7 1/2' QUAD, PORT CHICAGO, CALIF.

SCALE: 1:30000

PROPOSED SUISUN MARSH INITIAL FACILITIES
GOODYEAR SLOUGH
LOCATION MAP
SOLANO COUNTY, CALIFORNIA

ATTACHMENT "A"

Suisun Marsh
Monitoring Program Methodology

The methodology to carry out the Marsh monitoring program is described below. It is divided into water quality, soil salinity, and vegetation.

## Water Quality

I. Channel Water Quality. As required by SWRCB Decision 1485, six sites in the Marsh and two sites on the Sacramento River (Chipps Island or its equivalent and Collinsville) will continue to be monitored for EC by DWR. An additional site known as D-7 (Grizzly Bay) has been and will continue to be periodically monitored by DWR.

A monthly grab sample near the mouth of Montezuma Slough will be collected beginning October 1, 1984. The mean and range of high tide EC's should be recorded at each station monthly and reported to the Suisun marsh Technical Committee (SMTC) and SWRCB.

In addition to the required sites, DWR will install EC sensors and recorders at three new sites on tidal sloughs to provide additional channel water quality data. The monitoring sites are shown in Attachment D.

II. Diversion and Drain Water Quality. EC data will be obtained on a continuous basis at a point on each Individual Ownership being monitored for soil water salinity. The recorders

will be placed at locations determined to be compatible with the specific sites to be monitored for soil water salinity. These locations generally will be at the major inlet, including but not limited to on-ownership project diversion points, of each marsh management unit[1/] being monitored. Field data shall be collected monthly and the mean monthly salinity and range of salinities reported to SMTC.

The EC of standing surface water at each soil water sampling site shall be determined monthly and shall be reported to SMTC.

III. Water Level Recorders. Water level recorders (continuous stage) will be installed on Individual Ownerships being monitored for soil water salinity. These recorders will show how each ownership's water is managed, when the drain and flood cycles occur, and for what time duration. Data will be collected monthly and the mean and range of depths reported to SMTC.

## Soil Water Salinity

I. Soil Water Salinity. Soil water salinity will be monitored in the first foot of soil, utilizing soil water extractors installed in triplicate 6 inches below the soil surface at approximately 50 sites selected to cover major variations in management practices, vegetation, and soil types which have been determined

1/ A Marsh management unit is comprised of an Individual Ownership or a series of ownerships with common drainage facilities.

on the basis of Soil Conservation Service (SCS) criteria. EC of the soil water will be a direct reading. The specific locations to be monitored are shown on Attachment D.

Mean EC of water in the first foot of soil will be determined monthly at each extractor provided that sufficient soil moisture exists to obtain an adequate sample. Mean EC of soil water in the first, second, and third foot of the extractor site monitoring fat-hen will be determined each month. When the soil moisture level approaches or passes the wilting point, usually mid to late summer, it may not be possible to obtain a soil water sample. When this happens soil samples shall be collected and processed gravimetrically. Results shall be reported to SMTC.

Soil water is drawn into and from the soil water extractor by applying a vacuum to tubes extending from the instrument. EC of extracted samples will be measured, using standard procedures with the data recorded in millimhos. EC data will be converted to TDS and chlorides using relationships determined through laboratory analysis. Laboratory analysis of the samples will also include determining pH and carbonate values.

The accuracy of determining average EC of the first foot of soil using a single extractor at the 6-inch level will be tested. The results of monitoring with soil salinity extractors located at 6 inches will be compared to the results from extractors placed at 3 and 9 inches in addition to the 6-inch depth on Reyes and Joice Series soils at locations of both high and low surface water salinity. Sampling sites will be located on the eastern portion of the Grizzly Island Wildlife Area and on the

Morrow Island Land Company (Individual Ownership 702) lands. Samples will be taken monthly from each extractor for one full year.

Since salinity tolerances of important marsh plants were reported gravimetrically by Mall in 1969 and formed the basis upon which the Decision 1485 water quality standards were developed, it will be necessary to determine the relationship between soil EC obtained gravimetrically and that obtained with the soil water extractors.

Soil samples will be collected adjacent to the selected tri-level soil water extractors. There will be two sampling sites, one for each soil type. Soil samples will be collected monthly at 0 to 6 inches and 6 to 12 inch depths. A total of 144 soil samples will be collected (2 soils types X 3 extractors X 2 soil samples 0-6 inches and 6-12 inches X 12 months). These samples should be collected concurrent with the normal sampling activities for one year beginning with the installation of the monitoring instrumentation.

The extraction of soil samples near the buried soil water extractors has a potential for providing tubes for piping of surface water and affecting EC water sampling tubes and EC sensor blocks. These core holes need to be carefully selected and should be a given distance away such as 3 feet. The holes made by the core should be filled, with foreign soil, or closed by stomping in and around the core hole. Otherwise there may be some potential for erroneous results.

DFG shall conduct the statistical analysis necessary to determine the relationship between the two sampling procedures. DFG shall conclude their analysis and shall report their findings to SMTC within three calendar months following their receipt of one full year of sampling data. The sampling methodology shall be reevaluated at that time.

## Vegetation

I. Plant Survey. The composition of the vegetation immediately adjacent to each soil water monitoring site will be determined by DFG under contract with DWR in August of each year. The percent of cover contributed by each plant species present on the sample site will be determined by a method which will not result in invalidating the site in future years. Such method shall be acceptable to the members of SMTC, BCDC, and SWRCB.

II. Seed Production. The seed production of alkali bulrush present immediately adjacent to each soil water monitoring site will be determined in August of each year. Seed yield will be measured by clipping the seed heads from all plants contained within a square-meter plot. The weights of cleaned seed from each plot will be reported in pounds per acre. The results shall be reported by DFG, to SMTC, BCDC, and SWRCB.

The seed production of fat-hen plants adjacent to the soil water monitoring sites on the fat hen monitoring unit shall be determined each year. The time of sampling has yet to be determined but will probably be in September. Results shall be provided by DFG, to SWRCB, BCDC, and SMTC.

The overall vegetative composition of the Marsh shall be determined every third year utilizing color aerial photography in conjunction with ground verification. The results will be reported in acres and percent of total vegetation for each major plant species. DWR will be responsible for providing the color aerial photographs, and DFG will complete the analysis. DFG shall report the results to SMTC, BCDC, and SWRCB.

## Wildlife

Present aerial waterfowl surveys will be continued and will be carried out from September through January of each year. DWR will contract with knowledgeable wildlife experts to make surveys as necessary of the populations of the black and clapper rails, and the saltmarsh harvest mouse within the Marsh.

The results will include the numbers and distribution of each species under study and will be reported to SMTC, BCDC, and SWRCB.

## Reports

Preliminary data will be submitted to SMTC as soon as possible following collection of the data. The preliminary data collected by DWR to be submitted for each month will be the highs, lows, and means of EC of the channel water, pond water, water diverted to the clubs being monitored, any drainage water monitored: the continuous stage records, and soil EC both gravimetrically and by direct readings (extractor values).

An annual report will be produced which will include: (1) the data obtained from each of the parameters discussed above;

and (2) comparisons of soil and channel water salinities and plant production to demonstrate the effectiveness of the program and identify areas where additional action is needed.



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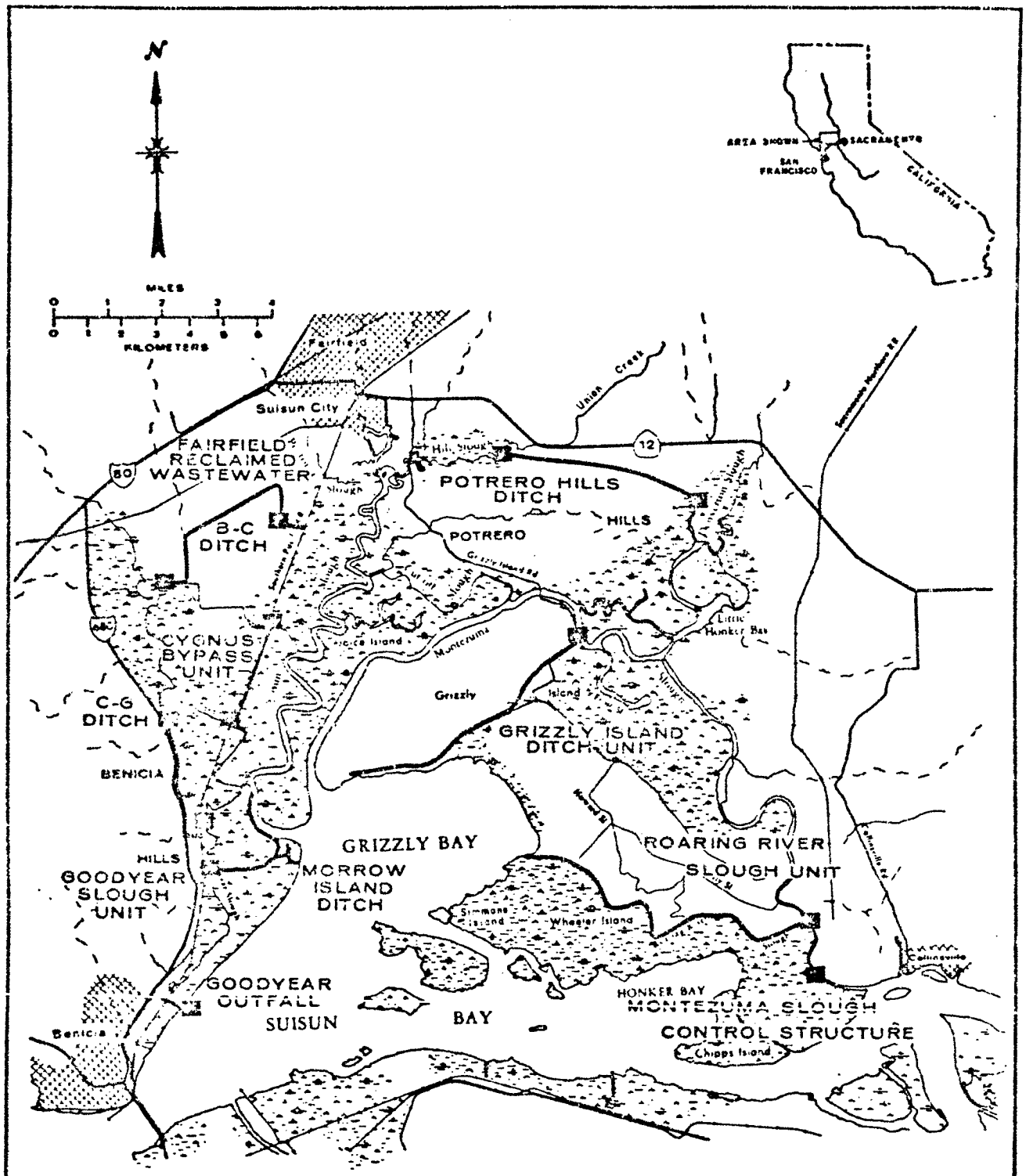
ATTACHMENT "B"




SUISUN MARSH

OVERALL FACILITIES

B-1

C-053820

C-053820

ATTACHMENT "B"

COMPONENTS OF THE OVERALL FACILITIES

I. Roaring River Unit (Constructed)

A. Intake Facilities, including fish screens, control gates, culverts, tide gates, and the levee and road over the culverts.

B. Hammond Island Reservoir, 16.2 hectares (40 acres) in the southeast corner of DF&G property adjacent to Montezuma Slough and Roaring River and the levees surrounding the reservoir.

C. Roaring River channel, including its north and south levees, the Mud Slough arm, including its north and south levees, and the crossing structures.

D. Wheeler Island boat ditches, levee and control gates located as shown on the attached map.

E. Individual Ownership water intake and discharge facilities located where shown on the attached map. These facilities include control gated culverts and access thereto.

F. The drainage facility shown on the attached map, consisting of a control gated culvert.

GRIZZLY ISLAND
GRIZZLY BAY
HAMMON ISLAND
Grizzly Slough
BRIDGE
Howard
DF&G
804
802
803
807
905
903
904
906
907
901
902
908
BOAT DITCH
HONKER BAY
SUISUN BAY
FLOOD EBB
Middle Ground Wetland
Simmons Point
Chipps Island
Point Wall
Pt Wire
SACRAMENTO
SOLANO CO
CONTRA COSTA CO
Pt Fare Aito
Snag Island
Pelican Point
Mallard
Beacons
Cable Area
Mdena
Meiss Landing
T4N
T3N
INTAKE
POND
LEVEE
SEA LEVEL
MONTEZUMA
LEGEND
CONSTRUCT NEW LEVEE
RAISE EXISTING LEVEE
TURNOUT STRUCTURE
APPROXIMATE PROPERTY LINES
804 CLUB NUMBERS
DRAIN GATE
NOTES
1. ELEVATIONS REFER TO NATIONAL GEODETIC VERTICAL DATUM OF 1929
2. MAP FROM U.S.G.S. 15' QUAD. PITTSBURG, CALIF.
3. CROSSING AND CULVERT REMOVED DURING CONSTRUCTION AND REPLACED TO ORIGINAL CONDITIONS.
SCALE: 1:62500
SUISUN MARSH
OVERALL FACILITIES
ROARING RIVER SLOUGH
LOCATION MAP
SOLANO COUNTY, CALIFORNIA
STATE OF CALIFORNIA
DEPT. OF WATER RESOURCES





C-053822

II. Goodyear Slough Unit (Constructed)

A. Goodyear Slough Outfall, including a structure consisting of culverts with control gates discharging to a channel dredged from Goodyear Slough to the Bay.

B. Morrow Island Distribution System, including an intake structure consisting of a levee with control gated culverts through it, a ditch with levees on both sides, outlet structures consisting of levees with control gated culverts through them and access thereto, located as shown on the attached map.

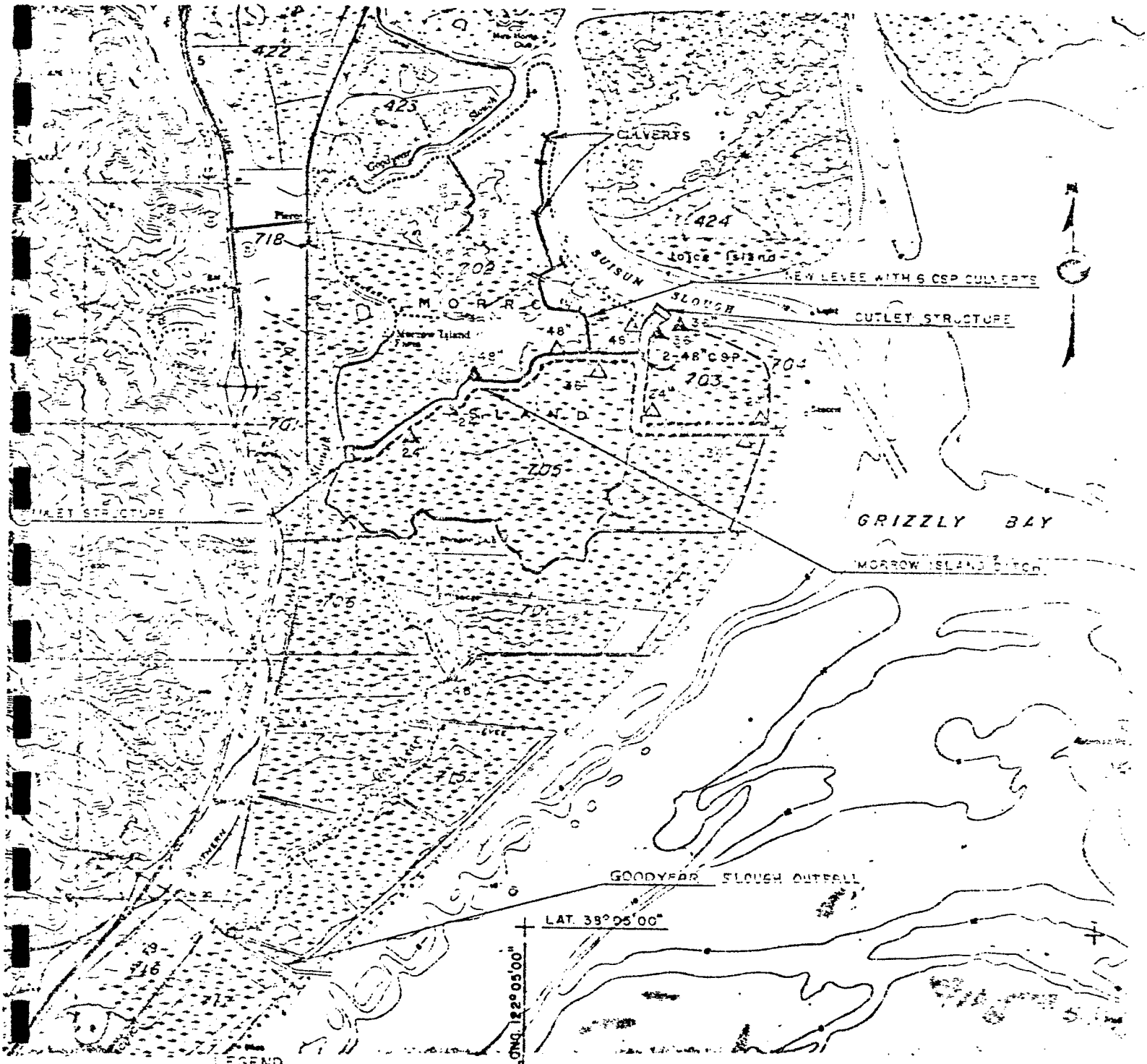
C. Individual Ownership water intake facilities located where shown on the attached map. These facilities include control gated culverts and access thereto.

D. The drainage facilities from the certain Individual Ownerships where shown on the attached map. These facilities include control gated culverts and access thereto.

E. The pond levee with flow controlled culverts north of Morrow Island Ditch as shown on the attached map.

III. Montezuma Slough Control Structure

A. Three radial gates, a boat lock 20 feet wide, and a flashboard opening 60 feet wide.




LEGEND

- CONSTRUCT NEW LEVEE
- RAISE EXISTING LEVEE
- △ TURNOUT STRUCTURE
- APPROXIMATE PROPERTY LINES
- 700 CLUB NUMBERS
- ▲ DRAIN GATE

NOTES

1. ELEVATIONS REFER TO NATIONAL GEODETIC VERTICAL DATUM OF 1929
2. MAP FROM U.S.G.S. 7 1/2' QUAD, PORT CHICAGO, CALIF.

SCALE: 1:30000

SUISUN MARSH
OVERALL FACILITIES
GOODYEAR SLOUGH UNIT

**LOCATION MAP**

SOLANO COUNTY, CALIFORNIA

STATE OF CALIFORNIA
DEPT. OF WATER RESOURCES

MGL-CLE

IV. Grizzly Island Unit

A. Intake Facilities, including fish screens, control gates, culverts, tide gates and the levee and road over the culverts.

B. Reservoir, 48.5 hectares (120 acres) regulating reservoir.

C. Grizzly Island channel, including its north and south levees.

D. Lateral water supply ditches, including their east and west levees.

E. Individual Ownership water intake and discharge facilities located where shown on the attached map. These facilities include control gated culvert(s) and access thereto.

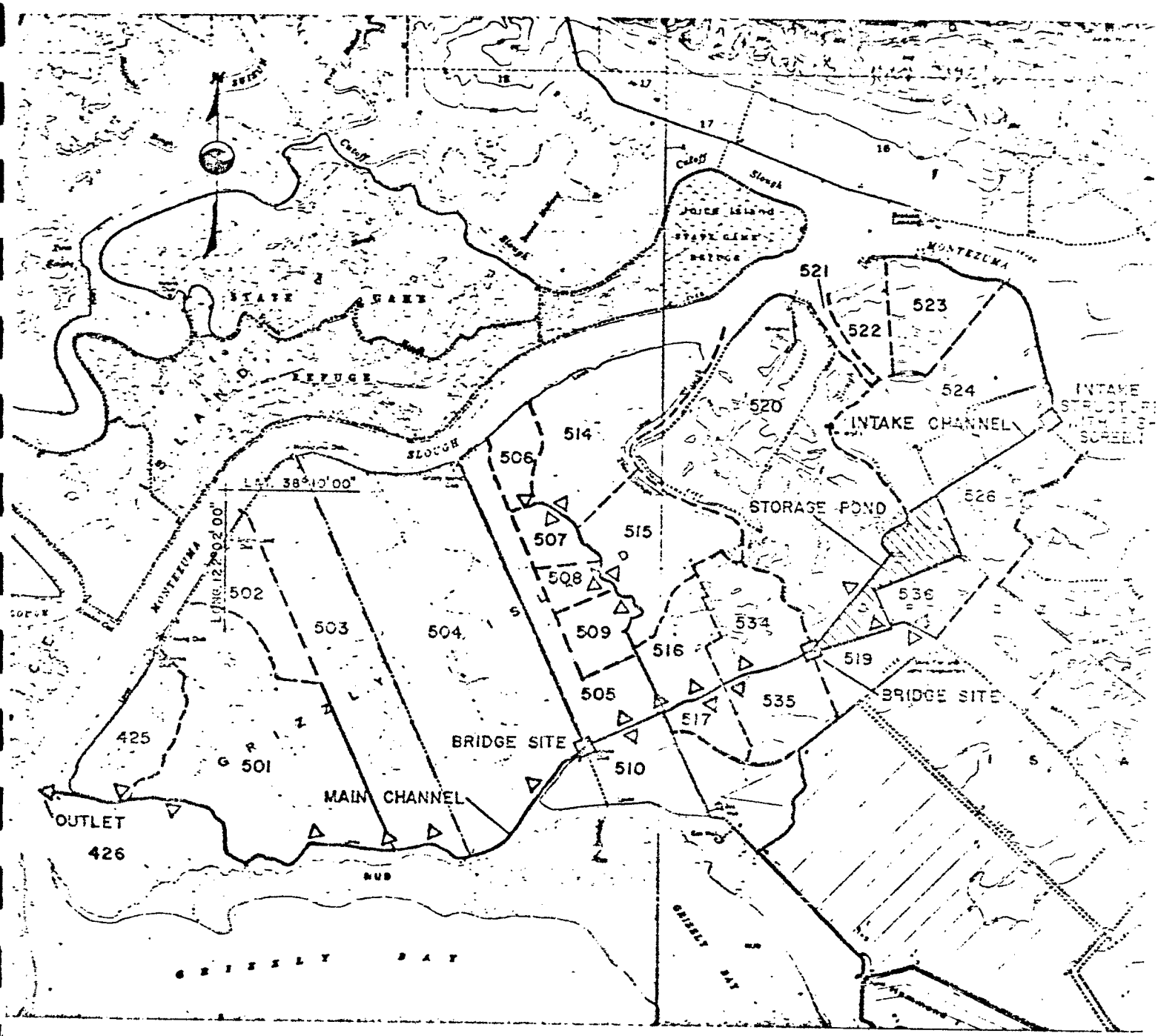
V. Potrero Hills Unit

A. Intake and outlet facilities, including control gates, culverts, the levee and road over the culverts.

B. Potrero Hills channel, including its north and south levees and the crossing structures.

C. Ponds, two 6 hectares (15 acres) ponds.

D. Necessary dredging in Luco and Hill Sloughs.




SCALE: 1:48,000

## LEGEND

- NEW CONSTRUTION
- APPROXIMATE PROPERY LINES
- △ 502 TURNOUT STRUCTURE CLUB NUMBERS

## NOTES

1. ELEVATIONS REFER TO NATIONAL GEODETIC VERTICAL DATUM OF 1929.
2. MAP REDUCED FROM U.S.G.S. 7 1/2' QUAD. FAIRFIELD SOUTH AND DENVERTON.

PROPOSED SUISUN MARSH
OVERALL FACILITIES
GRIZZLY ISLAND UNIT

# LOCATION MAP

SOLANO COUNTY, CALIFORNIA

STATE OF CALIFORNIA
DEPT. OF WATER RESOURCES

VI. Cordelia-Goodyear Unit

A. Intake and outlet facilities, including control structures, control gates, culverts, tide gates, and the levees and road over the culverts.

B. Cordelia-Goodyear channel, including its east and west levees and crossing structures.

C. Pond, one 8 hectare (20 acre) pond.

D. Provision to handle storm runoff from the existing highway culverts.

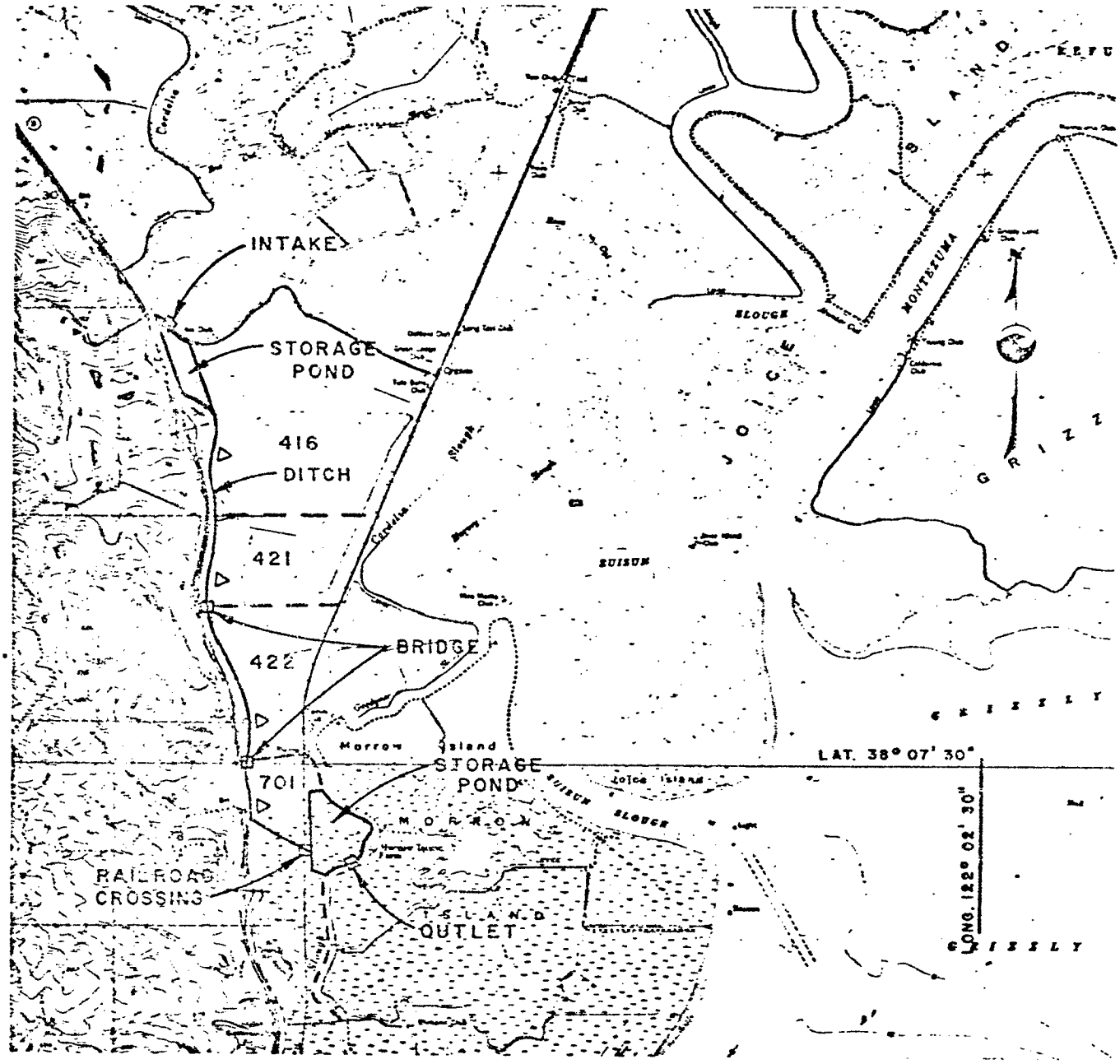
E. Individual Ownership intake and discharge facilities located where shown on the attached map. These facilities include control gated culvert(s) and access thereto.

VII. Goodyear Slough Control Structure

A. Control structure, including control gates and the levee and road over structure.

VIII. Cygnus Unit

A. Drain facility consisting of 36-inch culvert, gate and flashboard riser on Individual Ownership No. 415.




SCALE: 1:48,000

**LEGEND**

| | |
|---|---|
| ——— | NEW CONSTRUTION |
| — — — | APPROXIMATE PROPERTY LINES |
| 422 | CLUB NUMBERS |
| △ | TURNOUT STRUCTURE |

**NOTES**

1. ELEVATIONS REFER TO NATIONAL GEODETIC VERTICAL DATUM OF 1929.
2. MAP REDUCED FROM U.S.G.S. 7.5' QUAD. FAIRFIELD SOUTH, PORT CHICAGO

**PROPOSED SUISUN MARSH OVERALL FACILITIES**
**CORDELIA-GOODYEAR DITCH**

## LOCATION MAP

**SOLANO COUNTY, CALIFORNIA**

**STATE OF CALIFORNIA**
**DEPT. OF WATER RESOURCES**





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IX. Boynton-Cordelia Ditch Unit

A. Intake and outlet facilities, connection from Fairfield Suisun Sanitary District treatment plant.

B. Boynton Cordelia channel, including north and south levees, Chadbourne Road crossing structure and two siphons.

C. Necessary dredging in Boynton Slough relocation of Reclamation Ditch, provision of facility to handle sheet runoff.

X. Lower Joice Island Unit

A. Fill facility consisting of 36-inch culvert and gate on Individual Ownership No. 424.

B. Connection to existing distribution system on Individual Ownership No. 424.

XI. Annie Mason Island Unit

A. Installation of a diesel powered pump on Individual Ownership No. 804.

B. Connection to existing distribution system on Individual Ownership No. 801.



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XII. Van Sickle/Chipps Island Unit (to be constructed when and if needed).

Overland Facilities to provide water from Montezuma Slough to the Individual Ownerships, including intakes, fish screens, channel, stage reservoirs, siphons, levees, lateral water supply ditches, crossing structures, and turnouts.

XIII. Individual Ownership Facilities

A. Individual Ownership water management facilities as provided for in Section 5 of the contract.

ATTACHMENT "C"

ATTACHMENT "C"

RESPONSIBILITY FOR
SUISUN MARSH WATER FACILITIES

| Item | Design | Construction | Operate | Maintain |
|---|---|---|---|---|
| Montezuma Slough Control Structure | | | | |
| All facilities | DWR | DWR | DWR | DWR |
| Grizzly Island Unit | | | | |
| Intake structure | DWR | DWR | DWR | DWR |
| Fish screens | DWR | DWR | DFG 5/ | DWR |
| Ditch (including pond) | DWR | DWR | -- | DWR |
| Laterals | DWR | DWR | -- | DWR |
| Levees 2/ | DWR | DWR | -- | DWR |
| Crossing structures | DWR | DWR | -- | DWR/County 6/ |
| Turnouts | DWR 1/ | DWR 1/ | Landowner | Landowner |
| Potrero Hills Unit | | | | |
| Intake and outlet structures including dredging in Luco and Hill Sloughs | DWR | DWR | DWR | DWR |
| Ditch | DWR | DWR | -- | DWR |
| Crossing structures | DWR | DWR | -- | DWR/County 6/ |
| Cordelia-Goodyear Unit | | | | |
| Intake and outlet structures | DWR | DWR | DWR | DWR |
| Ditch (including ponds) | DWR | DWR | -- | DWR |
| Laterals | DWR | DWR | -- | DWR |
| Levees | DWR | DWR | -- | DWR |
| Crossing structures | DWR | DWR | -- | DWR/County 6/ |
| Turnouts | DWR 1/ | DWR 1/ | Landowner | Landowner |
| Goodyear Slough Control Structure | DWR | DWR | DWR | DWR |
| Boynton-Cordelia Unit 4/ | | | | |
| Intake and outlet structures | DWR | DWR | DWR | DWR |
| Ditch | DWR | DWR | -- | DWR |
| Levees | DWR | DWR | -- | DWR |
| Crossing structures | DWR | DWR | -- | DWR |

| Item | Design | Construction | Operate | Maintain |
|---|---|---|---|---|
| **Cygnus Unit** | | | | |
| Turnouts | DWR 1/ | DWR 1/ | Landowner | Landowner |
| **Roaring River Unit** | | | | |
| Intake structures | DWR | DWR | DWR | DWR |
| Fish screens | DWR | DWR | DFG 5/ | DWR |
| Modified Channel (including pond) | | | | |
| Levees 2/ | DWR | DWR | -- | DWR 3/ |
| Laterals | DWR | DWR | -- | DWR |
| Crossing structures | DWR | DWR | DWR | DWR |
| Turnouts | DWR 1/ | DWR 1/ | Landowner | Landowner |
| **Goodyear Slough Unit** | | | | |
| Intake structure | DWR | DWR | DWR | DWR |
| Outfall structure | DWR | DWR | DWR | DWR |
| Channel | DWR | DWR | -- | DWR |
| Morrow Island Distribution System 2/ | DWR | DWR | -- | DWR |
| Turnouts and drainage facilities | DWR 1/ | DWR 1/ | Landowner | Landowner |
| **Lower Joice Island Unit** | | | | |
| Turnout | DWR | DWR | Landowner | Landowner |
| Connection to the existing distribution system | DWR | DWR | -- | DWR |
| **Annie Mason Island Unit** | | | | |
| Pump | DWR | DWR | Landowner | DWR |
| Connection to the existing distribution system | DWR | DWR | -- | DWR |
| **Van Sickle/Chipps Island Unit** | | | | |
| Intake structure | DWR | DWR | DWR/Recl.Dist. No. 1607 6/ | DWR |
| Fish screens | DWR | DWR | DFG 5/ | DWR |
| Channels | DWR | DWR | -- | DWR |
| Siphons | DWR | DWR | -- | DWR |
| Levees | DWR | DWR | -- | DWR |
| Laterals | DWR | DWR | -- | DWR |
| Crossing structures | DWR | DWR | -- | DWR |
| Turnouts | DWR | DWR | Landowner | Landowner |

1/ Specific turnouts and drain gates to be identified on design plans.

2/ Main channel water control levees only.

3/ North levee, DFG to Boynton Cordelia Ditch will be constructed.

4/ An outfall from its treatment plant by Fairfield-Suisun Sanitary District (FSSD) at its expense.

5/ Operated at DWR expense.

6/ To be determined by separate agreement.

# APPENDIX B

CONTENTS -- APPENDIX B

MONITORING PROGRAM METHODOLOGY


| | Page |
|---|---|
| Water Quality | B-1 |
| Channel Water Quality | B-1 |
| Diversion and Drain Water Quality | B-1 |
| Water Level Recorders | B-2 |
| Soil Salinity | B-2 |
| Soil Water Salinity | B-2 |
| Vegetation | B-4 |
| Plant Survey | B-4 |
| Seed Production | B-4 |
| Wildlife | B-5 |
| Fisheries | B-5 |
| Reports | B-5 |
| Program Implementation | B-6 |

Appendix B

# SUISUN MARSH
# MONITORING PROGRAM METHODOLOGY

The methodology to carry out the monitoring program described in Chapter 7 is described below. It is divided into water quality, soil salinity, vegetation and fisheries elements.

## Water Quality

I. Channel Water Quality. As required by State Water Resources Control Board (SWRCB) Decision 1485, six sites in the Marsh and two sites on the Sacramento River (Chipps Island or its equivalent and Collinsville) will continue to be monitored for EC by the Department of Water Resources (DWR). These sites are instrumented with Martek Electrical Conductivity Sensors and Recorders. An additional site known as D-7 (Grizzly Bay) has been and will continue to be periodically monitored by the DWR.

In addition to the required sites, DWR will install EC sensors and recorders at three new sites on tidal sloughs to provide additional channel water quality data. The monitoring sites are shown on Figure 32. Fisher-Porter EC sensors with punch papertape recorders, which have proven to be effective with a minimum of maintenance and breakdown will be used. These instruments are battery operated and the data tapes can be readily reduced through computerized operations.

The mean and range of high tide EC's should be recorded at each station monthly and reported to the Suisun Marsh Technical Committee (SMTC) and SWRCB prior to the last day of the succeeding month. A monthly grab sample near the mouth of Montezuma Slough will be collected beginning October 1, 1984.

II. Diversion and Drain Water Quality. Utilizing the Fisher-Porter EC instruments previously described, data will be obtained on a continuous basis at a point on each individual ownership being monitored for soil water salinity. The recorder will be placed at locations determined to be compatible with the specific sites to be monitored for soil water salinity. These locations generally will be at the major inlet, including but not limited to on-ownership project diversion points, of each marsh management unit[1] being monitored. Field data shall be collected monthly and the mean monthly salinity and range of salinities reported to the SMTC as soon as possible.

1/ A Marsh management unit is comprised of a single individual ownership or a series of fields on a State Wildlife Area with common drainage facilities.



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The EC of standing surface water at each soil water sampling site shall be determined monthly and shall be reported to the SMTC as soon as possible.

III. Water Level Recorders. Water level recorders (continuous stage) will be installed on all individual ownerships being monitored for soil salinity. These recorders will show how each individual ownership's water is managed, when the drain and flood cycles occur, and for what time duration. Data will be collected monthly and the mean and range of depths reported to the SMTC as soon as possible.

## Soil Water Salinity

I. Soil Water Salinity. Soil water salinity will be monitored in the first foot of soil, utilizing soil water extractors installed in triplicate 6 inches below the soil surface at approximately 50 sites on 12 individual ownerships selected to cover major variations in management practices, vegetation, and soil types which will be determined on the basis of the U. S. Soil Conservation Service (SCS) criteria. The EC of the soil water will be a direct reading. The specific sites to be monitored within each individual ownership shown on Figure 32 were determined during program implementation and selected with the assistance of a Department of Fish and Game (DFG) representative knowledgeable about the Marsh.

The western, central, and eastern Marsh are all represented. Sites have been chosen that vary in management practices and cover the five major soil types: Joice, Reyes, Tamba, Suisun, and Valdez. Likewise, several of the major vegetation types were covered. Samples are located in sites dominated by either alkali bulrush, pickleweed, fat-hen, or brass buttons. Sites with complex vegetative matrices of each of these species were also sampled.

The Marsh management units to be monitored shall be: individual ownership's numbers 406, 416, 426, 501, 504, 520, 513 (tidal), 702, 804, and 905, the eastern portion of the Grizzly Island Wildlife Area and the Joice Island Wildlife Area as shown on Figure 32. Monitoring locations may be altered by consensus of SMTC, SWRCB, and the San Francisco Bay Conservation and Development Commission (BCDC).

The mean EC of water in the first foot of soil will be determined monthly at each extractor provided that sufficient soil moisture exists to obtain an adequate sample. The mean EC of soil water in the first, second, and third foot of the extractor site monitoring fat-hen will be determined each month. When the soil moisture level approaches or passes the wilting point, usually mid to late summer, it may not be possible to obtain a soil water sample. When this happens soil samples shall be collected and



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processed gravimetrically. Results shall be reported to SMTC as soon as possible.

Soil water is drawn into and from the soil water extractor by applying a vacuum to tubes extending from the instrument. The EC of extracted samples will be measured, using standard procedures with the data recorded in millimhos. The EC data will be converted to TDS and chlorides using relationships determined through laboratory analysis. Field analysis of the samples will also include determining the pH value.

The accuracy of determining the average EC of the first foot of soil using a single extractor at the 6-inch level will be tested. The results of monitoring with soil salinity extractors located at 6 inches will be compared to the results from extractors placed at 3 and 9 inches in addition to the 6-inch depth on Reyes and Joice Series soils at locations of both high and low surface water salinity. Sampling sites will be located on the eastern portion of the Grizzly Island Wildlife Area and on the Morrow Island Land Company (Individual Ownership 702) lands. Samples will be taken monthly from each extractor for one full year.

Since salinity tolerances of important marsh plants were reported gravimetrically by Mall in 1969 and formed the basis upon which the Decision 1485 water quality standards were developed, it will be necessary to determine the relationship between soil EC obtained gravimetrically and that obtained with the soil water extractors.

To accomplish this, soil samples will be collected adjacent to the selected tri-level soil water extractors. There will be two sampling sites, one for each soil type. Soil samples will be collected monthly at 0 to 6-inch and 6 to 12-inch depths. A total of 144 soil samples will be collected (2 soil types times 3 extractors times 2 soil samples, at 0-6 inches and 6-12 inches, times 12 months). These samples should be collected concurrent with the normal sampling activities for one year beginning with the installation of the monitoring instrumentation.

The extraction of soil samples near the buried soil water extractors has a potential for providing tubes for piping of surface water and affecting the EC water sampling tubes and the EC sensor blocks. These core holes need to be carefully selected and should be a given distance from the soil water extractors, such as 3 feet. The holes made by the core should be filled, with foreign soil, or closed by stomping in and around the core hole. Otherwise there may be some potential for erroneous results.

The SWRCB and/or DFG shall conduct the statistical analysis necessary to determine the relationship between the two sampling procedures. The SWRCB and DFG shall conclude their analysis and shall report their findings to SMTC within three calendar months following their receipt of one full year of

sampling data. The sampling methodology shall be reevaluated at that time.

## Vegetation

Vegetative sampling is an important segment of the overall monitoring program for the Plan of Protection. This program was carefully designed and approved by the Suisun Marsh Technical Committee (SMTC) to meet the monitoring requirements set forth in the State Water Resources Control Board's Decision 1485 (D-1485). The program not only monitors channel water salinity for compliance with D-1485 but also provides a mechanism for determining the resulting soil water salinities produced on individual ownerships. Soil water salinity and length of submergence are the two most important factors governing vegetative composition in the Suisun Marsh (Mall 1969, Pearcy, et al. 1982).

I. Plant Survey. The composition of the vegetation immediately adjacent to each soil water monitoring site will be determined by DFG in August of each year. The percent of cover contributed by each plant species present on the sample site will be determined by a method which will not result in invalidating the site in future years. Such method shall be acceptable to the members of the SMTC, BCDC, and SWRCB.

II. Seed Production. The seed production of alkali bulrush present immediately adjacent to each soil water monitoring site will be determined in August of each year. Seed yield will be measured by clipping the seed heads from all plants contained within a square-meter plot. The weights of cleaned seed from each plot will be reported in pounds per acre. The results shall be reported by DFG, to SMTC, BCDC, and SWRCB prior to the end of the calendar year.

The seed production of fat-hen plants adjacent to the soil water monitoring sites on the fat hen monitoring unit shall be determined each year. The time of sampling has yet to be determined but will probably be in September. Results shall be provided by DFG, to SWRCB, BCDC, and SMTC no later than December 1.

The overall vegetative composition of the Suisun Marsh shall be determined every third year utilizing color aerial photography in conjunction with ground verification. The results of these surveys will be compared to the results from past flights and will be reported in acres and percent of total vegetation for each major plant species. The DWR will be responsible for providing the color aerial photographs, and the DFG will complete the analysis. The DFG shall report the results to the SMTC, BCDC, and SWRCB within 6 months after receipt of the completed photo survey.

The Marsh-wide aerial photo survey will also be used to monitor the extent of preferred salt marsh harvest mouse habitat. This monitoring is a requirement of the U. S. Fish and Wildlife Service's Section 7 determination (Appendix E). The biological assessment in Appendix D (pages 47 to 49) describes the methodology for this monitoring.

## Wildlife

Present biweekly aerial waterfowl surveys will be continued and will be carried out from September through January of each year. Contracts will be let with DFG or other knowledgeable wildlife experts to make surveys of the populations of the black and clapper rails, and the saltmarsh harvest mouse within the Marsh.

The results will include the numbers and distribution of each species under study and will be reported to SMTC, BCDC, and SWRCB within one month from the end of the year in which the studies are made.

## Fisheries

1. Fish Screen Testing. DWR and DFG have evaluated the effectiveness of the test screen at the Roaring River Slough intake. The test results show that the fish screen at the Roaring River Slough Intake are required. This evaluation provided the basis for the design of more screens for this diversion structure. The second stage installation of fish screens is to be completed by October 1983. Fish occurrence studies will be made after construction of the Morrow Island and Grizzly Island Distribution Systems intakes. Fish screens will be constructed at these intakes if the occurrence studies show a need for them.

2. Fisheries Habitat. DWR will contract with DFG or other knowledgeable experts to study: (a) the fish occurrence and distribution in the marsh channels after completion of the Overall Facilities; (b) impact of predators and disruption of fish associated with the Montezuma Slough control structure; (c) impact of tidal pumping on migratory fish. DWR will continue its support of and participation with the 4-Agency study program including the summer tow net survey, the fall midwater trawl survey, and the Neomysis study. Fisheries evaluation will be coordinated through the 4-Agency study program.

## Reports

Preliminary data will be submitted to the SMTC as soon as possible following collection of the data. The preliminary data collected by DWR to be submitted for each month will be the highs, lows, and means of the EC of the channel water, pond water,

water diverted to the clubs being monitored, any drainage water monitored: the continuous stage records, and the soil EC both gravimetrically and by direct readings (extractor values). The results of the fisheries surveys will be reported as soon as possible after completion of the work.

An annual report will be produced which will include: (1) the data obtained from each of the parameters discussed above; and (2) comparisons of soil and channel water salinities and plant production to demonstrate the effectiveness of the program and identify areas where additional action is needed.

## Program Implementation

Upon approval of the program, permits will be obtained for each site and needed personnel will be recruited. Site selection, instrument installation, and data collection will commence as soon as equipment has been obtained. The program will be implemented on a phased basis beginning upon program approval and will be fully implemented within 2 years.



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C-053842

# APPENDIX C

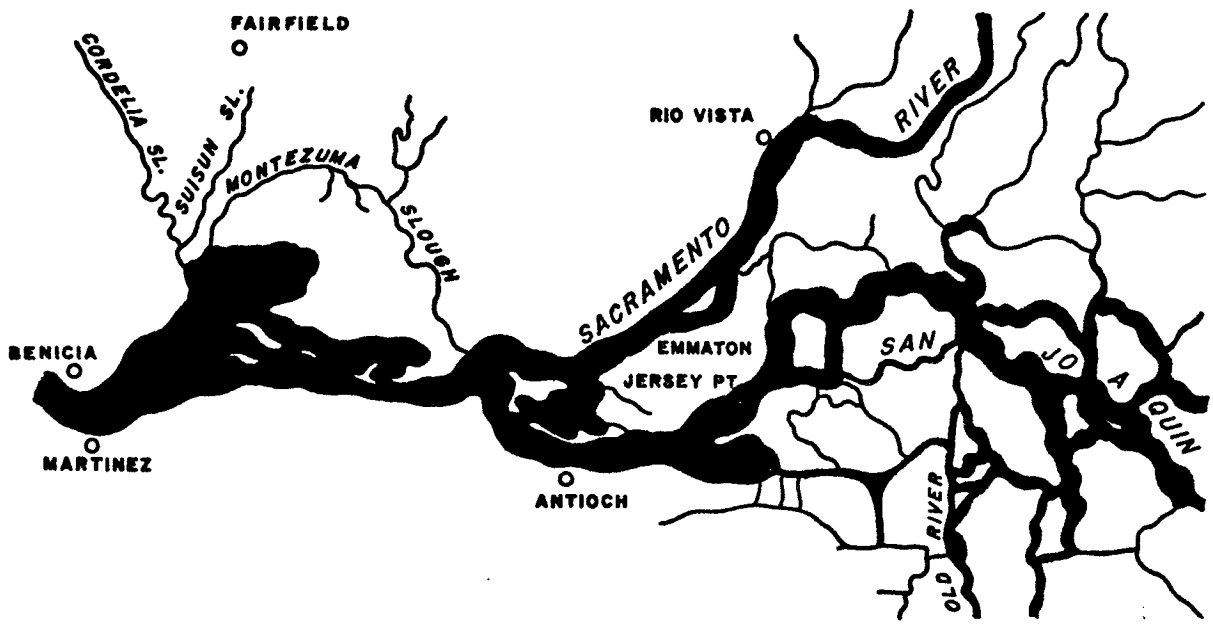
APPENDIX C

# Water Right Decision 1485

In the Matter of Permit 12720 (Application 5625) and Other Permits of United States Bureau of Reclamation for the Federal Central Valley Project and of California Department of Water Resources for the State Water Project.

DECISION IN FURTHERANCE OF JURISDICTION RESERVED IN DECISIONS D 893, D 990, D 1020, D 1250, D 1275, D 1291, D 1308, D 1356, and PERMIT ORDER 124

## Sacramento-San Joaquin Delta and Suisun Marsh




August 1978

STATE WATER RESOURCES CONTROL BOARD

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**STATE WATER RESOURCES**
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APPENDIX C

TABLE OF CONTENTS


| | Page |
|---|---|
| Past Proceedings | 3 |
| Decision 1379 | 4 |
| Present Proceeding | 4 |
| Scope of Board Actions | 8 |
| Beneficial Uses to be Protected | 10 |
| Agriculture | 11 |
| Fish and Wildlife | 12 |
| Suisun Marsh | 14 |
| Municipal and Industrial | 15 |
| Export Uses | 17 |
| Compliance with Standards | 17 |
| Order | 21 |

| | | |
|---|---|---|
| Table I | Permits for Federal Central Valley Project and State Water Project Containing Reserved Jurisdiction Regarding the Sacramento-San Joaquin Delta or Coordination of Terms and Conditions | 31 |
| Table II | Decision 1485, Water Quality Standards for the Sacramento-San Joaquin Delta and Suisun Marsh | 37 |
| Table III | Decision 1485, Delta Estuary Water Quality Monitoring Program | 42 |
| Figure I | Decision 1485, Water Quality Monitoring Locations, Water Quality Profile Routes and Sampling Frequencies | 44 |
| Plate I | Sacramento-San Joaquin Delta | |

STATE OF CALIFORNIA
STATE WATER RESOURCES CONTROL BOARD

| | |
|---|---|
| In the matter of Permit 12720 (Application 5625) and other permits of U. S. Bureau of Reclamation for the Federal Central Valley Project and of California Department of Water Resources for the State Water Project | DECISION 1485 |

DECISION IN FURTHERANCE OF JURISDICTION RESERVED IN PERMITS OF UNITED STATES BUREAU OF RECLAMATION FOR THE FEDERAL CENTRAL VALLEY PROJECT AND DEPARTMENT OF WATER RESOURCES FOR THE STATE WATER PROJECT

BY THE BOARD:

The Sacramento-San Joaquin Delta and Suisun Marsh, located east of San Francisco Bay and south of Sacramento, comprise one of California's most valuable natural resources (see Plate 1). The Delta and Marsh support unique and valuable fish and wildlife resources, a substantial local agricultural economy, and a major water-related industrial corridor in the vicinity of Antioch. Suisun Marsh provides habitat for a wide variety of wildlife and is a major wintering area for waterfowl using the Pacific Flyway.

The Delta is a vital link between river systems of the Sacramento Valley and the water deficient areas to the south and west of the Delta. Two major systems - the State Water Project (SWP) operated by the Department of Water Resources (Department)



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C-053847

and the federal Central Valley Project (CVP) operated by the United States Bureau of Reclamation (Bureau) - withdraw supplies from the Delta for use in areas of need. These projects are the two largest water diversions from the Delta. They provide municipal supplies to areas where over 14 million people live and support an extremely productive agricultural economy in the San Joaquin Valley.[1/]

This decision amends the water right permits of the Department and Bureau for the SWP and CVP facilities. The permits are summarized in Table 1 which is bound at the back of this decision. This decision is in exercise of the Board's reserved jurisdiction to establish or revise terms and conditions for salinity control and for protection of fish and wildlife, and to coordinate the terms of the various permits for the two projects.

The Board's authority to review and amend these permits is derived from Section 1394 of the California Water Code, jurisdiction expressly reserved in the subject permits, Water Code Section 100, and the continuing authority of the Board, as stated in the terms of the permits, to prevent waste, unreasonable use, unreasonable method of use, or unreasonable method of diversion of water, and Section 763.5 of Title 23 of the California Administrative Code.

1/ A detailed description of these projects and their basic operations is contained in the Phase I prehearing staff report dated November 1976.



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Past Proceedings

Water rights for the CVP and SWP have been the subject of a series of proceedings by the Board and its predecessor agency, the State Water Rights Board, over the last 20 years. The complex interaction of Delta inflow, Delta consumptive uses, export diversions, agricultural return flows and tidal action make it difficult to set, with reasonable accuracy, conditions for the Delta of unlimited duration. In recognition of these facts, the Board and its predecessor reserved continuing jurisdiction in permits affecting Delta water supplies issued to the Department and Bureau for subsequent amendment of conditions.

In 1967, Decisions D 1275 and D 1291 authorized issuance of water right permits to the Department for the SWP; all of these permits contain conditions reserving jurisdiction concerning salinity control and protection of fish and wildlife in the Delta and coordination of terms and conditions with those of other permits for the CVP and SWP.

The permits for the federal Central Valley Project were issued pursuant to Decisions D 893 (in 1958), D 990 (in 1961), D 1020 (in 1961), D 1250 (in 1966), 1308 (in 1968) and 1356 (in 1970) and Permit Order 124 (in 1959). Not all of the Bureau permits currently before the Board in this proceeding contain all of the above items. However, in most of these permits jurisdiction was reserved to formulate or revise terms and conditions relative to salinity control in the Delta and to coordinate terms and



C—053849

C-053849

conditions of the permits issued to the Bureau with terms and conditions of other permits issued in furtherance of the CVP and SWP.

Decision 1379. In the exercise of reserved jurisdiction as discussed above and following an extensive hearing during 1969 and 1970, the Board adopted Decision 1379 on July 28, 1971. Decision 1379 established new water quality requirements for the Delta and Suisun Marsh and rescinded the previous requirements in Decisions D 1275 and D 1291. However, Decision 1379 has been stayed by the courts since October 1971 as a result of litigation originally instituted by the Central Valley East Side Project Association and the Kern County Water Agency to set aside the decision. Due to the order staying Decision 1379, requirements of Decision D 1275, as amended by Decision D 1291, remained in effect. However, the federal district court approved a stipulation that the evidentiary record of the Decision 1379 proceeding could be used by the Board in exercising the jurisdiction reserved in other decisions.

Present Proceeding

The present proceeding was initiated on April 29, 1976, with a preliminary hearing on the evidentiary scope of the proceeding. The Bureau participated in the evidentiary proceeding pursuant to a stipulation with the Board covering then pending litigation in California v. United States in which both parties agreed that any condition on water right entitlements held by the Bureau,



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developed through the Delta hearing, shall not become effective until a final judgment of a court of competent jurisdiction has been entered recognizing such Board authority over Bureau appropriations.

On July 3, 1978, the United States Supreme Court issued its decision in California v. United States that a state may impose any condition on control, appropriation, use or distribution of water in a federal reclamation project that is not inconsistent with clear congressional directives respecting the project. The decision thus affirms the Board's authority to impose terms and conditions in Bureau permits including those under consideration herein. The Board is not aware of any congressional directives which are in conflict with the permit conditions contained in this decision. That, however, is a legal issue which was not briefed by the parties to this proceeding.

The present proceeding is a consolidated hearing pursuant to both the water quality control and water right authority of the Board. As a result of the proceeding, the Board not only is amending terms and conditions for the subject permits of the Department and Bureau, but also is adopting a water quality control plan (Delta Plan) containing water quality standards for the protection of beneficial uses of the waters of the Sacramento-San Joaquin Delta and Suisun Marsh.



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To ensure protection of Delta beneficial uses and to make optimum use of storage, pumping and conveyance facilities, operation of the CVP and SWP must be coordinated. Separation of the effects of the two projects on Delta water supplies, uses and environment is not possible. Therefore, terms and conditions related to the Delta, including those for protection of fish and wildlife, must be the same in all of these permits. Inclusion of such terms in some, but not all, of the permits for the CVP and SWP would create confusion and would be unworkable. Therefore, maintenance of the water quality standards set forth in this decision, including flows to be maintained for the protection of fish and wildlife, will be imposed as a condition to all of the CVP and SWP permits shown in Table I.

This decision and the Delta Plan are the culmination of 32 days of evidentiary hearing initiated on November 15, 1976 and concluded on October 7, 1977.

The two documents adopted today by the Board (a water quality control plan and a water right decision) represent a unified effort by the Board to develop and implement under its full authority a single comprehensive set of water quality standards to protect beneficial uses of Delta water supplies. Since the two distinct approvals constitute the whole of a single project, a single environmental impact report (EIR) has been prepared and finalized for both of these documents.



C—053852

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Notwithstanding its integrated actions under these authorities, the Board's water right authority is quite distinct and separate from its water quality control authority. Unlike its water quality control authority under the State Porter-Cologne Water Quality Control Act and the Federal Water Pollution Control Act (PL 92-500) which is a State/federal responsibility, its water right function is strictly a State responsibility.

This water right decision includes as conditions in permits for the CVP and SWP the same standards as are adopted in the Delta Plan except for the southern Delta (as explained below). In view of this, no attempt will be made to duplicate the findings contained in the Delta Plan. Instead, the findings contained in the plan and in the Final EIR are incorporated herein by this reference and are expressly determined to constitute the findings upon which the conclusions and Order contained herein are based.

Both the Delta Plan and EIR have undergone considerable public review. All reviews required by the California Environmental Quality Act have been satisfied. Drafts of the plan and EIR were released for public review on March 15, 1978. Following a review period of over 75 days, a public hearing on the draft plan and Draft EIR was held on May 30, 1978. The hearing record was left open until June 15, 1978 in order to accommodate written comments.

Over 40 parties have submitted extensive comments on the draft plan and Draft EIR. The commenting parties include the project

operators, federal and state water service contractors, Delta water agencies, municipal and industrial users in Contra Costa County, fish and wildlife interests and environmental groups. A summary of the respective concerns of each party and the Board's response to each is set out in a special appendix to the Delta Plan and Final EIR.

Scope of Board Actions

As previously indicated, the jurisdiction reserved by the Board to revise or formulate additional terms and conditions in the water right permits issued to the Department and Bureau affecting Delta water supplies covers three general areas: (1) salinity control, (2) protection of fish and wildlife, and (3) coordination of terms and conditions of the respective permits for the SWP and CVP.

The terms and conditions established under this reserved jurisdiction are based on circumstances expected to prevail over the next ten years. The Board, in limiting the effective period of this decision, recognizes the uncertainty associated with possible future project facilities and the need for additional information on the complex effects of project operations and varying water quality conditions in the Delta and Suisun Marsh. As additional information is developed or as additional factors affecting the Delta and Marsh are identified, the Board will review permit terms and conditions to ensure that beneficial uses of Delta

supplies are protected. Accordingly, the Board in this decision continues the reservation of jurisdiction in the subject permits.

In exercising its reserved jurisdiction, the Board has two broad statutory mandates: (1) protection of vested water rights, and (2) protection of the public interest. These twin responsibilities are discussed in greater detail in Chapter I of the Delta Plan. Of controlling importance to the Board's determination is Part 4.5 of Division 6 of the Water Code, referred to as the Delta Protection Act. The Delta Protection Act accords first priority to satisfaction of vested rights and public interest needs for water in the Delta and relegates to lesser priority all exports of water from the Delta to other areas for any purpose. These statutory policies are subject to the overriding constitutional provision that all uses of water and diversions of water must be reasonable (Article 10, Section 2, California Constitution).

In addition, the projects must be operated so as not to cause any material deterioration of water quality which would impair its usefulness for the reasonable beneficial uses which are made of water by senior right holders (Water Code Section 11461). In order to ensure that the operation of project facilities does not adversely encroach upon vested right holders, the Board must identify the extent to which such rights would have been satisfied in the absence of the projects. This follows from the fundamental requirement that the Board find that unappropriated water is



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available. This does not mean, of course, that the Board in this proceeding is adjudicating individual vested water rights; rather it means that the Board must assess the collective needs of prior rights, as it must in connection with every application that comes before it.

Based on information submitted during the evidentiary hearing, the SWP and CVP facilities covered by the permits before the Board in this proceeding do not appear to have a direct impact on water quality conditions in the southern Delta. Thus, the Board cannot justify imposing terms and conditions through this decision to resolve the water quality problems in the southern Delta.

Beneficial Uses to be Protected

Beneficial uses in the Delta and Suisun Marsh have been classified historically under three broad categories: (1) fish and wildlife, (2) agriculture, and (3) municipal and industrial. Water quality standards have been established for each of these broad categories of use to ensure that each is protected in its own right.

The underlying principle of these standards is that water quality in the Delta should be at least as good as those levels which would have been available had the state and federal projects not been constructed, as limited by the constitutional mandate of reasonable use. The standards include adjustments in the levels of protection to reflect changes in hydrologic conditions experienced under different water year types.



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Agriculture. The application of this principle to agricultural uses in the Delta has resulted in substantially greater protection in the Delta for agricultural uses than that provided in the existing Water Quality Control Plan for the Sacramento-San Joaquin Delta Basin (Basin 5B Plan). The agricultural standards in the Basin 5B Plan reflect criteria that have not changed for over 13 years and are based essentially on the water quality needs of the Bureau's Tracy Pumping Plant in the southern Delta.

Even though this decision is consistent with the Delta Plan, only those elements of the plan for which a project mitigation responsibility or a compelling public interest can be shown have been incorporated into this decision. Thus, as indicated earlier, the specific provisions for agriculture in the southern Delta have not been incorporated into this decision.

The current negotiations between the project operators and the South Delta Water Agency concerning the construction of physical facilities to provide adequate circulation in the southern Delta to meet these standards are discussed in Chapter I of the Delta Plan. These negotiations appear to be directed toward the most practical solution for long-term protection of southern Delta agriculture and should be concluded as soon as practicable, at least by January 1980. If an agreement is not executed by January 1, 1980, the Board will examine in detail southern Delta water rights, determine the causes and sources of any encroachment, and take appropriate action to the extent of the Board's authority.



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Riparian rights would be generally sufficient to provide suitable water quality for agricultural uses in the southern Delta. Upstream depletion and water quality degradation of the San Joaquin River and its tributaries have greatly reduced the flows available for protection of agriculture in the southern Delta. However, the permits of water development facilities in the San Joaquin River watershed, including those of the Bureau[2/], which contribute to southern Delta quality and quantity deterioration are not before the Board, nor has any jurisdiction been reserved in those permits to amend or supplement terms and conditions therein. However, the permits provide that the appropriations authorized thereby are subject to prior vested rights.

In the event facilities under the permits currently before the Board are found to have an effect on water quality conditions in the southern Delta, the Board would use the jurisdiction reserved under this decision to amend terms and conditions in these permits as appropriate.

Fish and Wildlife. The fish and wildlife standards are taken essentially from a draft Four-Agency Agreement developed through five years of negotiations between the Department, Bureau, California Department of Fish and Game (Fish and Game) and U. S. Fish and Wildlife Service. However, the agreement has not yet been

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2/ The SWP has no facilities on the San Joaquin River System. Also, in addition to the New Melones Project on the Stanislaus River the CVP has the Friant Project on the San Joaquin River.



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executed. The criteria in the draft agreement were recommended by Fish and Game and endorsed by the Department, and were extensively analyzed by the Board staff. Based on our most current assessment, the fishery standards provide significantly higher protection than existing basin plans. The Striped Bass Index is a measure of young bass survival through their first summer. The Striped Bass Index would be 71 under without project conditions (i.e., theoretical conditions which would exist today in the Delta and Marsh in the absence of the CVP and SWP), 63 under the existing basin plans, and about 79[3/] under this decision.

While the standards in this decision approach without project levels of protection for striped bass, there are many other species, such as white catfish, shad and salmon, which would not be protected to this level. To provide full mitigation of project impacts on all fishery species now would require the virtual shutting down of the project export pumps. The level of protection provided under this decision is nonetheless a reasonable level of protection until final determinations are made concerning a cross-Delta transfer facility or other means to mitigate project impacts.

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3/ There is some indication that factors other than those considered in the Board's analysis of without project levels may also affect striped bass survival. The effects of these factors are such that the without project levels would be greater than 71. However, the magnitude of this impact is unknown and cannot be quantified at this time.



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Suisun Marsh. Full protection of Suisun Marsh now could be accomplished only by requiring up to 2 million acre-feet of freshwater outflow in dry and critical years in addition to that required to meet other standards. This requirement would result in a one-third reduction in combined firm exportable yield of State and federal projects. In theory, the existing Basin 5B Plan purports to provide full protection to the Marsh. However, during the 1976-77 drought when the basin plan was in effect, the Marsh received little if any protection because the system almost ran out of water and emergency regulations had to be imposed. This decision balances the limitations of available water supplies against the mitigation responsibility of the projects. This balance is based on the constitutional mandate "...that the water resources of the State be put to beneficial use to the fullest extent of which they are capable..." and that unreasonable use and unreasonable diversion be prevented (Article 10, Section 2, California Constitution).

The Bureau, the Department, Fish and Game, and U. S. Fish and Wildlife Service are working together to develop alternative water supplies for the Marsh. Such alternative supplies appear to represent a feasible and reasonable method for protection of the Marsh and mitigation of the adverse impacts of the projects. Under this decision the Department and Bureau are required, in cooperation with other agencies, to develop a plan for Suisun Marsh by July 1, 1979. The Suisun Marsh plan should ensure that the



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C-053860

long-term standards for full protection of Suisun Marsh contained in this decision are met by no later than October 1984.

Until needed physical facilities to provide supplemental supplies to the Marsh are constructed, this decision sets interim standards to protect the Marsh. Also, the decision requires that initial components of the Suisun Marsh plan (on which there is general agreement by affected parties) shall be implemented by January, 1980.

Municipal and Industrial. The level of protection for municipal drinking water supplies under this decision is the same as that of the existing basin plan; however, the period over which salt-sensitive industries would be protected is somewhat shorter than that in the basin plan. The level of protection provided in this decision is equivalent to water quality conditions offshore of Antioch which would occur in the absence of the federal and State projects.

Industries in the vicinity of Antioch have benefited by the operation of project facilities including the Contra Costa Canal, especially during the period 1945-1967. After 1967, when the SWP commenced operations and demands on the CVP increased, the benefits of project operations decreased and will continue to be reduced in the future. The water rights of these industries do not entitle them to flows which are in excess of natural flow



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C-053861

conditions in the Delta. If without project conditions in the Delta are provided by this decision, vested water rights, as limited by reasonable use, will be protected against infringement by the SWP and CVP operations. However, in accordance with the Delta Protection Act, if Delta water users desire additional benefits, they may seek such benefits from the project operators through water service contracts.

In comparing the relative municipal and industrial use protection provided by this decision to the protection afforded by the basin plans, consideration must also be given to conditions relatively certain to occur in the absence of this decision. Under conditions similar to the 1976-77 drought the salt-sensitive industries would in all likelihood receive considerably greater protection under this decision than under the previous approach.

The Basin 5B Plan provides that the Antioch standard should be terminated upon a determination by the Board that adequate substitute supplies are available to all municipal and industrial users in the vicinity of Antioch. During the public hearing on the Delta Plan the Department requested the Board to make such a determination regarding the salt-sensitive industries in the vicinity of Antioch. For each acre-foot of water diverted to beneficial use from a point of diversion offshore at Antioch, 25 acre-feet of freshwater must flow out of the Delta to repel seawater. In view of this and the Department's offer to pay any



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C-053862

increased cost incurred by these principal water users as a result of this substitution, the Board finds that a substitute supply is available and provision of such supply is consistent with the reasonableness requirements of the Constitution. Thus, this decision includes no standard offshore at Antioch. In accordance with the Delta Protection Act (Water Code Section 12202), however, the substitute supply must be of like quantity and quality to that which otherwise would have to be made available offshore at Antioch and must be provided at no additional cost.

Export Uses. Although there are other factors considered in assessing project impacts including the use of upstream reservoir storage, firm exportable yield is the primary measure of the projects' capability to meet export demands. The combined firm exportable yield of the SWP and CVP is the maximum annual delivery capability to meet a given level of firm export demands during a recurrence of the 1928-1934 hydrologic dry period. Under this decision, about 160,000 acre-feet of additional yield will be conserved as compared to the conditions under the basin plans.

Compliance with Standards

The Delta and Marsh comprise a highly productive and immensely valuable ecosystem which must be managed and protected as a matter of statewide public interest. The effect of the Delta Plan and



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this decision is that water quality standards in the Delta must be satisfied prior to any export from the Delta to other areas for any purpose. These standards must be maintained as first priority operating criteria for any and all projects or parts thereof that may be constructed and operated under the permits considered in this decision.

A monitoring program is required by this decision to ensure collection of the data necessary to measure compliance with the water quality standards. This program also specifies special studies that are needed over the next few years to help address major concerns that cannot be confidently resolved now due to lack of data. The program will be implemented through terms and conditions in the Department and Bureau permits.

The Board intends to reopen the hearing on this matter within eight years from the adoption date, depending upon the availability of additional information upon which to re-examine these standards.

As indicated in the Delta Plan, the Board takes no position regarding additional project facilities to be constructed by the Department and Bureau. However, in its review of applications for additional appropriations by the CVP and SWP or of proposed transfer of water utilizing CVP and SWP facilities, the Board will review conservation and wastewater reclamation programs in the proposed service areas to ensure that these additional water



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resources will be used in the most efficient manner possible consistent with the general public interest. Unappropriated water in California is an increasingly short, precious resource. As greater demands are made on a more limited unclaimed supply, the Board must scrutinize proposed uses more intensely than ever before to ensure that vested water rights and the public interest are protected.



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ORDER

IT IS HEREBY ORDERED THAT:

1. The Board continue the reservation of jurisdiction to:

   (a) Formulate terms and conditions relative to flows to be maintained in the Delta for the protection of fish and wildlife in the permits issued pursuant to Applications 5629, 5630, 14443, 14444, 14445A, 17512, 17514A, 18721, 18723, 21636, and 21637 contained in Decisions D 1275, D 1291 and 1356.

   (b) Formulate terms and conditions relative to salinity control in the Delta in the permits issued pursuant to Applications 5625, 5626, 5629, 5630, 9363, 9364, 9365, 9366, 9367, 9368, 13370, 13371, 13372, 14443, 14444, 14445A, 14662, 15764, 17512, 17514A, 18721, 18723, 21542, 21636, 21637 and 22316 contained in Decisions D 893, D 990, D 1020, D 1250, D 1275, D 1291, 1308, and 1356.

   (c) Formulate terms and conditions relative to coordination of terms and conditions of the permits issued pursuant to Applications 5625, 5626, 5627, 5628, 5629, 5630, 9363, 9364, 9365, 9366, 9367, 9368, 14443, 14444, 14445A, 15374,



C—053867

C-053867

15375, 15376, 15764, 16767, 16768, 17374, 17512, 17514A, 18721, 18723, 21542, 21636, 21637 and 22316 contained in Decisions D 990, D 1020, D 1250, D 1275, D 1291, 1308 and 1356 with other permits issued to the United States Bureau of Reclamation in furtherance of the Central Valley Project and permits issued to the Department of Water Resources in furtherance of the State Water Project.

2. Permittees shall maintain, by reduction of direct diversion at the project pumps or by release of natural flow or water in storage, or by operation of the Delta Cross Channel gates, or by any combination of these measures, water quality conditions in the channels of the Delta and Suisun Marsh equal to or better than the standards set forth in the attached Table II entitled "Decision 1485, Water Quality Standards for the Sacramento-San Joaquin Delta and Suisun Marsh". These standards are included in the Water Quality Control Plan for the Sacramento-San Joaquin Delta and Suisun Marsh adopted by the State Water Resources Control Board on August 16, 1978.



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C-053868

3. To the extent that operational constraints on the Central Valley Project to minimize diversion of young striped bass from the Delta during May and June reduce project exports, permittee, the United States Bureau of Reclamation, shall be allowed through coordinated operations to make up such deficiencies during later periods of the year by direct diversion or by rediversion of releases of stored water through State Water Project facilities.

4. To ensure compliance with existing water quality standards, to identify meaningful changes in any significant water quality parameters potentially related to operations of the Federal Central Valley Project and the State Water Project and to reveal trends in ecological changes potentially related to project operations, permittees shall independently or in cooperation with other agencies or individuals:

   (a) Operate and maintain continuous electrical conductivity recorders at the stations indicated in the attached Table III entitled "Decision 1485, Delta Estuary Water Quality Monitoring Program" and shown on the attached Figure I entitled "Decision 1485 Water Quality



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C-053869

Monitoring Locations - Water Quality Profile Routes and Sampling Frequencies" to report mean daily water quality conditions representative of each location.

(b) Conduct the discrete sampling program shown in Table III and on Figure I. The sampling frequency may vary as appropriate. When the monthly Delta outflow index is projected to average greater than 10,000 cfs, the program operators may reduce the sampling frequency of the base parameters to once each month. When the outflow is below 10,000 cfs the sampling frequency of base parameters shall be increased to at least twice a month, if necessary to achieve the monitoring goals.

(c) Conduct water quality profiles in the main navigation channels between Carquinez Strait on the west and Stockton and Rio Vista on the east, using a boat-mounted continuous recorder for the following parameters: water temperature, electrical conductivity, pH, dissolved oxygen, turbidity, and <u>in vivo</u> chlorophyll.

(d) Establish continuous recorders at representative stations in the Delta and Suisun Bay



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C-053870

to collect information on air and water temperature, wind velocity and direction, pH, dissolved oxygen, turbidity, and, where feasible, *in vivo* chlorophyll. These data shall be evaluated and correlated with conditions as they exist in the adjacent main channels.

(e) Conduct ongoing and future monitoring surveys as recommended by California Department of Fish and Game and concurred in by the Board concerning food chain relationships and fisheries impacts as they are affected by CVP and SWP operations in the Delta and Suisun Marsh.

(f) Permittees shall make available to the Board and other interested agencies upon request results of the above monitoring as soon as practicable following the month during which the monitoring was accomplished. Annual reports summarizing the previous calendar year's findings and detailing future study plans shall be submitted to the Board by January 15 of each year. Detailed reports containing the previous year's monitoring results shall be submitted by August 1 of each year.

5. The Delta and Suisun Marsh monitoring program as set forth in Condition No. 4 and Table III shall be



C—053871

C-053871

evaluated continuously by permittees to ensure that the goals of the monitoring program are attained. Permittees should propose appropriate modifications for the concurrence of the Board to ensure attainment of the monitoring goals. Further, the Board will review annually the results of the monitoring program and may make appropriate modifications thereto.

6. Upon request to and approval of the Board, variations in flow for experimental purposes for protection and enhancement of fish and wildlife may be allowed; provided, that such variations in flow do not cause violations of municipal, industrial and agricultural standards in Table II.

7. For the protection of Suisun Marsh, permittees shall:
   (a) Develop a plan for Suisun Marsh by July 1, 1979, in cooperation with other agencies which will ensure that the standards in Table II for full protection of the Marsh are met. Such plan must be satisfactory to the Board and shall include appropriate EIR/EIS documentation, a monitoring network, physical facilities, operating and management procedures, and assurances to restore and maintain



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C-053872

Suisun Marsh primarily as a brackish water marsh capable of producing high-quality feed and habitat conditions for waterfowl and other marsh-related wildlife using best practical management practices.

(b) Implement fully such Suisun Marsh plan by October 1, 1984. Under this plan water quality standards for full protection of Suisun Marsh shall be met by no later than October 1, 1984.

(c) Implement initial components of the Suisun Marsh plan, on which there is general agreement by affected parties, to achieve the following goals by January 1, 1980:

- Conveyance and delivery of water from Montezuma Slough to wetland areas on Grizzly, Simmons, Wheeler, Dutton, Van Sickle, and Hammond Islands which are presently flooded with water from Honker, Suisun and Grizzly Bays.

- Conveyance and delivery of water from Goodyear Slough to certain adjacent wetland areas and provision of outflow from Goodyear Slough into either Grizzly or Suisun Bays.



C-053873

C-053873

(d) Report to the Board by January 15 of each year on progress toward implementation of mitigation facilities.

8. Permittees shall report to the Board on or about January 1 and July 1, 1979 regarding the status and progress of negotiations with the South Delta Water Agency concerning the construction of physical facilities and other measures for long-term protection of southern Delta agriculture. If such agreement is not executed by January 1, 1980, the Board will examine in detail southern Delta water rights, determine the causes and sources of encroachment and take appropriate action.

9. Permittees shall report to the Board by January 15, 1979, and annually thereafter, on the methods to be used in determining flows past Rio Vista and improving accuracy of Delta outflow estimates or on studies to be commenced by that date to determine such procedures. Permittees shall also report annually on methods for making more precise projections of salinity distribution in the Delta under varying inflow, outflow and export conditions.

10. To develop a better understanding of the hydrodynamics, water quality, productivity and



C—053874

C-053874

significant ecological interactions of the Delta and Suisun Marsh so that more accurate predictions of environmental impacts related to operations of the CVP and SWP can be made, permittees shall, independently or in cooperation with other agencies or individuals:

(a) Conduct special studies to meet specific needs and to take advantage of particular circumstances where the data obtained are of significant value. Such studies include, but are not limited to, fish population and zooplankton measurements, waterfowl food plant production measurements, intensive phytoplankton studies, tissue analysis of selected biota, photosynthesis rates, sediment profile and composition, and water velocity.

(b) Develop and improve water quality and biological predictive tools with emphasis on improving the understanding of flow/salinity/phytoplankton relationships in the western Delta, and on improving hydraulic characteristics in existing models to represent more closely true channel characteristics, for



C—053875

C-053875

the following areas of the estuary:

i) Western Delta and Suisun Bay area, including Suisun Marsh.

ii) San Francisco Bay to Golden Gate Bridge.

iii) Interior Delta.

(c) Participate in research studies to determine:

i) Outflow needs in San Francisco Bay, including ecological benefits of unregulated outflows and salinity gradients established by them.

ii) The need for winter flows for long-term protection of striped bass and other aquatic organisms in the Delta.

11. Conditions relating to salinity control and protection of fish and wildlife in the Delta in Decisions D 1275, D 1291 and 1379 are rescinded.

Dated: August 16, 1978

John E. Bryson, Chairman

W. Don Maughan, Vice Chairman

W. W. Adams, Member



C—053876

C-053876

TABLE I

PERMITS FOR FEDERAL CENTRAL VALLEY PROJECT AND STATE WATER PROJECT CONTAINING RESERVED JURISDICTION REGARDING THE SACRAMENTO-SAN JOAQUIN DELTA OR COORDINATION OF TERMS AND CONDITIONS

| Permittee 1/ | Application No. | Permit No. | Source | Direct Diversion | | Storage | | Purpose |
|---|---|---|---|---|---|---|---|---|
| | | | | Quantity(cfs) | Season | Quantity(AF) | Season | |
| USBR | 5625 | 12720 | Sacramento River | 11,000 | Jan.1 to Dec. 31 | 3,190,000 | Oct. 1 to June 30 | Power |
| USBR | 5626 | 12721 | Sacramento River | 8,000 | Jan.1 to Dec. 31 | 3,190,000 | Oct. 1 to June 30 | Irrigation, domestic, stockwatering navigation and recreation |
| USBR | 5627 | 11966 | Trinity River | 1,100 | Jan.1 to Dec. 31 | 1,540,000 | Jan. 1 to Dec. 31 | Power |
| USBR | 5628 | 11967 | Trinity River | 2,500 | Jan.1 to Dec. 31 | 1,540,000 | Jan. 1 to Dec. 31 | Irrigation, domestic, navigation, salinity control and flood control |
| DWR | 5629 | 16477 | Feather River | 7,600 | Jan.1 to Dec. 31 | 380,000 | Oct. 1 to July 1 | Power, recreation, fish and wildlife enhancement |
| DWR | 5630 | 16478 | Feather River | 1,400 | Oct.1 to July 1 | 380,000 | Oct. 1 to July 1 | Irrigation, domestic, municipal, industrial, salinity control, recreation, fish and wildlife enhancement |
| USBR | 9363 | 12722 | Sacramento River | 1,000 | Jan.1 to Dec. 31 | 310,000 | Oct. 1 to June 30 | Municipal and industrial |



C-053877

C-053877

TABLE I (Continued)

PERMITS FOR FEDERAL CENTRAL VALLEY PROJECT AND STATE WATER PROJECT
CONTAINING RESERVED JURISDICTION REGARDING THE SACRAMENTO-SAN JOAQUIN DELTA
OR COORDINATION OF TERMS AND CONDITIONS

| Permittee 1/ | Application No. | Permit No. | Source | Direct Diversion | | Storage | | Purpose |
|---|---|---|---|---|---|---|---|---|
| | | | | Quantity (cfs) | Season | Quantity (AF) | Season | |
| USBR | 9364 | 12723 | Sacramento River | 9,000 | Jan. 1 to Dec. 31 | 1,303,000 | Oct. 1 to June 30 | Irrigation, flood control, domestic, stockwatering, navigation & recreation |
| USBR | 9365 | 12724 | Sacramento River | 2,275 | Jan. 1 to Dec. 31 | 1,303,000 | Oct. 1 to June 30 | Power |
| USBR | 9366 | 12725 | Rock Slough | 200 | Jan. 1 to Dec. 31 | -- | -- | Irrigation and domestic |
| USBR | 9367 | 12726 | Rock Slough | 250 | Jan. 1 to Dec. 31 | -- | -- | Municipal and industrial |
| USBR | 9368 | 12727 | Old River | 4,000 | Jan. 1 to Dec. 31 | -- | -- | Irrigation and domestic |
| USBR | 13370 | 11315 | American River | 8,000 | Nov. 1 to Aug. 1 | 1,000,000 | Nov. 1 to July 1 | Irrigation, salinity control and flood control |
| USBR | 13371 | 11316 | American River | 700 | Nov. 1 to Aug. 1 | 300,000 | Nov. 1 to July 1 | Municipal, industrial, domestic and recreational |
| USBR | 13372 | 11317 | American River | 8,000 | Jan. 1 to Dec. 31 | 1,000,000 | Oct. 1 to July 1 | Power |



C-053878

C-053878

TABLE I (Continued)



PERMITS FOR FEDERAL CENTRAL VALLEY PROJECT AND STATE WATER PROJECT CONTAINING RESERVED JURISDICTION REGARDING THE SACRAMENTO-SAN JOAQUIN DELTA OR COORDINATION OF TERMS AND CONDITIONS

| Permittee 1/ | Application No. | Permit No. | Source | Direct Diversion Quantity (cfs) | Direct Diversion Season | Storage Quantity (AF) | Storage Season | Purpose |
|---|---|---|---|---|---|---|---|---|
| DWR | 14443 | 16479 | Feather River, | 1,360 | Jan. 1 to Dec. 31 | 3,500,000 | Sept. 1 to July 31 | Irrigation, domestic, municipal, industrial, salinity control, recreational, fish and wildlife enhancement |
| | | | Sacramento-San Joaquin Delta Channels | 6,185 | Jan. 1 to Dec. 31 | 42,100 | Jan. 1 to Dec. 31 | |
| DWR | 14444 | 16480 | Feather River | 11,000 | Jan. 1 to Dec. 31 | 3,500,000 | Oct. 1 to July 1 | Power, recreational and fish and wildlife enhancement |
| DWR | 14445A | 16481 | Italian Slough | 2,115 | Oct. 1 to July 1 | 44,000 | Oct. 1 to July 1 | Irrigation, domestic, municipal, industrial, salinity control, recreational and fish and wildlife enhancement |
| USBR | 14662 | 11318 | American River | -- | -- | 300,000 | Oct. 1 to July 1 | Power |



C-053879

TABLE I (Continued) Sheet 4 of 6

**PERMITS FOR FEDERAL CENTRAL VALLEY PROJECT AND STATE WATER PROJECT CONTAINING RESERVED JURISDICTION REGARDING THE SACRAMENTO-SAN JOAQUIN DELTA OR COORDINATION OF TERMS AND CONDITIONS**

| Permittee 1/ | Application No. | Permit No. | Source | Direct Diversion | | Storage | | Purpose |
|---|---|---|---|---|---|---|---|---|
| | | | | Quantity (cfs) | Season | Quantity (AF) | Season | |
| USBR | 15374 | 11968 | Trinity River | 300 | Jan. 1 to Dec. 31 | 200,000 | Jan. 1 to Dec. 31 | Municipal and industrial |
| USBR | 15375 | 11969 | Trinity River | 1,700 | Jan. 1 to Dec. 31 | 1,800,000 | Jan. 1 to Dec. 31 | Irrigation, domestic, fish & wildlife propagation, navigation, water quality control and recreation |
| USBR | 15376 | 11970 | Trinity River | 3,525 | Jan. 1 to Dec. 31 | 1,800,000 | Jan. 1 to Dec. 31 | Power |
| USBR | 15764 | 12860 | Old River | -- | -- | 1,000,000 | Oct. 1 to April 30 | Irrigation, domestic, stockwatering municipal, industrial and recreation |
| USBR | 16767 | 11971 | Trinity River | -- | -- | 700,000 | Jan. 1 to Dec. 31 | Irrigation, domestic and water quality control |
| USBR | 16768 | 11972 | Trinity River | 175 | Jan. 1 to Dec. 31 | 700,000 | Jan. 1 to Dec. 31 | Power |



C-053880

TABLE I (Continued)

PERMITS FOR FEDERAL CENTRAL VALLEY PROJECT AND STATE WATER PROJECT CONTAINING RESERVED JURISDICTION REGARDING THE SACRAMENTO-SAN JOAQUIN DELTA OR COORDINATION OF TERMS AND CONDITIONS

| Permittee 1/ | Application No. | Permit No. | Source | Direct Diversion | | Storage | | Purpose |
|---|---|---|---|---|---|---|---|---|
| | | | | Quantity (cfs) | Season | Quantity (AF) | Season | |
| USBR | 17374 | 11973 | Trinity River | 1,500 | Jan. 1 to Dec. 31 | -- | -- | Irrigation, domestic, municipal, industrial, salinity control, recreation, fish and wildlife enhancement |
| DWR | 17512 | 16482 | Italian Slough and San Luis Creek | -- | -- | 1,100,000 | Oct. 1 to July 1 | Irrigation, domestic, municipal, industrial, salinity control, recreation, fish and wildlife enhancement |
| DWR | 17514A | 16483 | Lindsey Slough | 135 | Oct. 1 to July 1 | -- | -- | Municipal and industrial |
| USBR | 18721 | 16209 | North Fork American River and Knickerbocker Creek | 100 | Nov. 1 to Aug. 1 | 1,700,000 | Nov. 1 to July 1 | Irrigation, recreation, incidental domestic and water quality control |
| USBR | 18723 | 16210 | North Fork American River and Knickerbocker Creek | 6,300 | Jan. 1 to Dec. 31 | 1,700,000 | Nov. 1 to July 1 | Power, incidental recreation and domestic |



C-053881

C-053881

TABLE I (Continued)

PERMITS FOR FEDERAL CENTRAL VALLEY PROJECT AND STATE WATER PROJECT CONTAINING RESERVED JURISDICTION REGARDING THE SACRAMENTO-SAN JOAQUIN DELTA OR COORDINATION OF TERMS AND CONDITIONS

| Permittee 1/ | Application No. | Permit No. | Source | Direct Diversion | | Storage | | Purpose |
|---|---|---|---|---|---|---|---|---|
| | | | | Quantity (cfs) | Season | Quantity (AF) | Season | |
| USBR | 21542 | 15149 | Old River | -- | -- | 1,000,000 | Nov. 1 to April 30 | Power |
| USBR | 21636 | 16211 | North Fork American River and Knickerbocker Creek | 600 | Jan. 1 to Dec. 31 | 800,000 | Nov. 1 to July 1 | Power |
| USBR | 21637 | 16212 | North Fork American River and Knickerbocker Creek | 900 | Nov. 1 to July 1 | 800,000 | Nov. 1 to July 1 | Irrigation, municipal, industrial, domestic, recreation, fish and wildlife enhancement and water quality control |
| USBR | 22316 | 15735 | Rock Slough | -- | -- | 5,400 | Oct. 1 to June 30 | Irrigation, domestic, municipal, industrial, water quality control and recreation |

1/ USBR = Permit held by U.S. Bureau of Reclamation
DWR = Permit held by Department of Water Resources



C-053882

C-053882

Table II
DECISION 1485
WATER QUALITY STANDARDS
FOR THE SACRAMENTO–SAN JOAQUIN DELTA AND SUISUN MARSH[1]

| BENEFICIAL USE PROTECTED and LOCATION | PARAMETER | DESCRIPTION | YEAR TYPE[2] | VALUES | |
|---|---|---|---|---|---|
| **MUNICIPAL and INDUSTRIAL** | | | | | |
| Contra Costa Canal Intake at Pumping Plant No. 1 | Chloride | Maximum Mean Daily $Cl^-$ in mg/l | All | 250 | |
| Contra Costa Canal Intake at Pumping Plant No. 1 or Antioch Water Works Intake on San Joaquin River | Chloride | Maximum Mean Daily 150 mg/l Chloride for at least the number of days shown during the Calendar Year. Must be provided in intervals of not less than two weeks duration. (% of Year shown in parenthesis) | | Number of Days Each Calendar Year Less than 150 mg/l Chloride | |
| | | | Wet | 240 (66%) | |
| | | | Ab. Normal | 190 (52%) | |
| | | | Bl. Normal | 175 (48%) | |
| | | | Dry | 165 (45%) | |
| | | | Critical | 155 (42%) | |
| City of Vallejo Intake at Cache Slough | Chloride | Maximum Mean Daily $Cl^-$ in mg/l | All | 250 | |
| Clifton Court Forebay Intake at West Canal | Chloride | Maximum Mean Daily $Cl^-$ in mg/l | All | 250 | |
| Delta Mendota Canal at Tracy Pumping Plant | Chloride | Maximum Mean Daily $Cl^-$ in mg/l | All | 250 | |
| **AGRICULTURE** | | | | 0.45 EC April 1 to Date Shown | EC from Date Shown[3] to Aug. 15 |
| WESTERN DELTA | | | | | |
| Emmaton on the Sacramento River | Electrical Conductivity | Maximum 14-day Running Average of Mean Daily EC in mmhos | Wet | Aug. 15 | -- |
| | | | Ab. Normal | July 1 | 0.63 |
| | | | Bl. Normal | June 20 | 1.14 |
| | | | Dry | June 15 | 1.67 |
| | | | Critical | -- | 2.78 |
| Jersey Point on the San Joaquin River | Electrical Conductivity | Maximum 14-day Running Average of Mean Daily EC in mmhos | Wet | Aug. 15 | -- |
| | | | Ab. Normal | Aug. 15 | -- |
| | | | Bl. Normal | June 20 | 0.74 |
| | | | Dry | June 15 | 1.35 |
| | | | Critical | -- | 2.20 |
| INTERIOR DELTA | | | | | |
| Terminous on the Mokelumne River | Electrical Conductivity | Maximum 14-day Running Average of Mean Daily EC in mmhos | Wet | Aug. 15 | -- |
| | | | Ab. Normal | Aug. 15 | -- |
| | | | Bl. Normal | Aug. 15 | -- |
| | | | Dry | Aug. 15 | -- |
| | | | Critical | -- | 0.54 |
| San Andreas Landing on the San Joaquin River | Electrical Conductivity | Maximum 14-day Running Average of Mean Daily EC in mmhos | Wet | Aug. 15 | -- |
| | | | Ab. Normal | Aug. 15 | -- |
| | | | Bl. Normal | Aug. 15 | -- |
| | | | Dry | June 25 | 0.58 |
| | | | Critical | -- | 0.87 |



C—053883

C-053883

Table II

DECISION 1485

WATER QUALITY STANDARDS

FOR THE SACRAMENTO–SAN JOAQUIN DELTA AND SUISUN MARSH[1]

| BENEFICIAL USE PROTECTED and LOCATION | PARAMETER | DESCRIPTION | YEAR TYPE[2] | VALUES |
|---|---|---|---|---|
| **FISH AND WILDLIFE** | | | | |
| • *STRIPED BASS SPAWNING* | | | | |
| *Prisoners Point on the San Joaquin River* | *Electrical Conductivity* | *Average of mean daily EC for the period not to exceed* | *All* | *April 1 to May 5* — *0.550 mmhos* |
| *Chipps Island* | *Delta Outflow Index in cfs* | *Average of the daily Delta outflow index for the period, not less than* | *All* | *April 1 to April 14* — *6700 cfs* |
| *Antioch Waterworks Intake on the San Joaquin River* | *Electrical Conductivity* | *Average of mean daily EC for the period, not more than* | *All* | *April 15 to May 5* — *1.5 mmhos* |
| *Antioch Waterworks Intake* | *Electrical Conductivity (Relaxation Provision – replaces the above Antioch and Chipps Island Standard whenever the projects impose deficiencies in firm supplies[5]* | *Average of mean daily EC for the period, not more than the values corresponding to the deficiencies taken (linear interpolation to be used to determine values between those shown)* | *All – whenever the projects impose deficiencies in firm supplies[5]* | *Total Annual Imposed Deficiency MAF* / *April 1 to May 5 EC in mmhos*: 0 / 1.5; 0.5 / 1.9; 1.0 / 2.5; 1.5 / 3.4; 2.0 / 4.4; 3.0 / 10.3; 4.0 or more / 25.2 |
| • *STRIPED BASS SURVIVAL* | | | | |
| *Chipps Island* | *Delta Outflow Index in cfs* | *Average of the daily Delta outflow index for each period shown not less than* | | *May 6–31* / *June* / *July* |
| | | | *Wet* | 14,000 / 14,000 / 10,000 |
| | | | *Ab. Normal* | 14,000 / 10,700 / 7,700 |
| | | | *Bl. Normal* | 11,400 / 9,500 / 6,500 |
| | | | *Subnormal Snowmelt* | 6,500 / 5,400 / 3,600 |
| | | | *Dry[6]* | 4,300 / 3,600 / 3,200 |
| | | | *Dry[7] or Critical* | 3,300 / 3,100 / 2,900 |
| • *SALMON MIGRATIONS* | | | | |
| *Rio Vista on the Sacramento River* | *Computed net stream flow in cfs* | *Minimum 30-day running average of mean daily net flow* | | *Jan.* / *Feb. 1–Mar. 15* / *Mar.16–June 30* |
| | | | *Wet* | 2,500 / 3,000 / 5,000 |
| | | | *Ab. Normal* | 2,500 / 2,000 / 3,000 |
| | | | *Bl. Normal* | 2,500 / 2,000 / 3,000 |
| | | | *Dry or Critical* | 1,500 / 1,000 / 2,000 |
| | | | | *July* / *Aug.* / *Sept. 1–Dec. 31* |
| | | | *Wet* | 3,000 / 1,000 / 5,000 |
| | | | *Ab. Normal* | 2,000 / 1,000 / 2,500 |
| | | | *Bl. Normal* | 2,000 / 1,000 / 2,500 |
| | | | *Dry or Critical* | 1,000 / 1,000 / 1,500 |
| • *SUISUN MARSH* | | | | *Jan.–May* / *Oct.–Dec.* |
| *Chipps Island at O&A Ferry Landing* | *Electrical Conductivity* | *Maximum 28-day running average of mean daily EC* | *Wet* | 12.5 mmhos / 12.5 mmhos |
| | | | *Ab. Normal* | 12.5 mmhos / 12.5 mmhos |
| | | | *Bl. Normal* | 12.5 mmhos / 12.5 mmhos |
| | | | *Dry or Critical* | 12.5 mmhos / 15.6 mmhos |
| | | *(The 15.6 mmhos EC Standard applies only when project water users are taking deficiencies in scheduled water supplies[8] otherwise the 12.5 mmhos EC remains in effect.)* | | |
| *Chipps Island* | *Delta Outflow Index in cfs* | *Average of the daily Delta outflow index for each month, not less than values shown* | *Wet* | *February–May* — *10,000 cfs* |
| | | | *Subnormal Snowmelt* | *February–April* — *10,000 cfs* |
| | | *Minimum daily Delta outflow index for 60 consecutive days in the period* | *Ab. Norm. and Bl. Norm.* | *January–April* — *12,000 cfs* |



C—053884

C-053884

Table II
DECISION 1485
WATER QUALITY STANDARDS
FOR THE SACRAMENTO–SAN JOAQUIN DELTA AND SUISUN MARSH[1]

| BENEFICIAL USE PROTECTED and LOCATION | PARAMETER | DESCRIPTION | YEAR TYPE[2] | VALUES |
|---|---|---|---|---|
| **FISH AND WILDLIFE** | | | | |
| • *SUISUN MARSH* | | | | |
| *Chipps Island (continued)* | *Delta Outflow Index in cfs* | *Average of the daily Delta outflow index for each month, not less than values shown* | *All (if greater flow not required by above standard)—whenever storage is at or above the minimum level in the flood control reservation envelope at two out of three of the following: Shasta Reservoir, Oroville Reservoir, and CVP storage on the American River* | *Jan.–May* 6,600 cfs |
| *Collinsville on Sacramento River (C–2)*<br>*Miens Landing on Montezuma Slough (S–64)*<br>*Montezuma Slough at Cutoff Slough (S–48)*<br>*Montezuma Slough near mouth*<br>*Suisun Slough near Volanti Slough (S–42)*<br>*Suisun Slough near mouth (S–31)*<br>*Goodyear Slough south of Pierce Harbor (S–35)*<br>*Cordelia Slough above S. P. R.R. (S–32)* | *Electrical Conductivity* | *The monthly average of both daily high tide values not to exceed the values shown (or demonstrate that equivalent or better protection will be provided at the location)* | *All – To become effective Oct. 1, 1984* | *Month* / *EC in mmhos*<br>Oct. 19.0<br>Nov. 15.5<br>Dec. 15.5<br>Jan. 12.5<br>Feb. 8.0<br>Mar. 8.0<br>Apr. 11.0<br>May 11.0 |
| • *OPERATIONAL CONSTRAINTS* | | | | |
| *Minimize diversion of young striped bass from the Delta* | *Diversions in cfs* | *The mean monthly diversions from the Delta by the State Water Project (Department) not to exceed the values shown.* | *All* | *May* 3,000 *June* 3,000 *July* 4,600 |
| | | *The mean monthly diversions from the Delta by the Central Valley Project (Bureau), not to exceed the values shown* | *All* | *May* 3,000 *June* 3,000 |
| *Minimize diversion of young striped bass into Central Delta* | | *Closure of Delta cross channel gates for up to 20 days but no more than two out of four consecutive days at the discretion of the Department of Fish and Game upon 12 hours notice* | *All – whenever the daily Delta outflow index is greater than 12,000 cfs* | *April 16–May 31* |
| *Minimize cross Delta movement of Salmon* | | *Closure of Delta Cross Channel gates (whenever the daily Delta outflow index is greater than 12,000 cfs)* | *All* | *Jan. 1–April 15* |



C—053885

C-053885

# Table II
# DECISION 1485
# WATER QUALITY STANDARDS
# FOR THE SACRAMENTO-SAN JOAQUIN DELTA AND SUISUN MARSH 1/

## FISH PROTECTIVE FACILITIES

Maintain appropriate records of the numbers, sizes, kinds of fish salvaged and of water export rates and fish facility operations.

### STATE FISH PROTECTIVE FACILITY

The facility is to be operated to meet the following standards to the extent that they are compatible with water export rates:

(a) King Salmon – from November through May 14, standards shall be as follows:
- (1) Approach Velocity – 3.0 to 3.5 feet per second
- (2) Bypass Ratio – maintain 1.2:1.0 to 1.6:1.0 ratios in both primary and secondary channels
- (3) Primary Bay – not critical but use Bay B as first choice
- (4) Screened Water System – the velocity of water exiting from the screened water system is not to exceed the secondary channel approach velocity. The system may be turned off at the discretion of the operators.

(b) Striped Bass and White Catfish – from May 15 through October, standards shall be as follows:
- (1) Approach Velocity – in both the primary and secondary channels, maintain a velocity as close to 1.0 feet per second as is possible
- (2) Bypass Ratio
  - (i) When only Bay A (with center wall) is in operation maintain a 1.2:1.0 ratio
  - (ii) When both primary bays are in operation and the approach velocity is less than 2.5 feet per second, the bypass ratio should be 1.5:1.0
  - (iii) When only Bay B is operating the bypass ratio should be 1.2:1.0
  - (iv) Secondary channel bypass ratio should be 1.2:1.0 for all approach velocities.
- (3) Primary Channel – use Bay A (with center wall) in preference to Bay B
- (4) Screened Water Ratio – if the use of screened water is necessary, the velocity of water exiting the screened water system is not to exceed the secondary channel approach velocity
- (5) Clifton Court Forebay Water Level – maintain at the highest practical level.

### TRACY FISH PROTECTIVE FACILITY

The secondary system is to be operated to meet the following standards, to the extent that they are compatible with water export rates:

(a) The secondary velocity should be maintained at 3.0 to 3.5 feet per second whenever possible from February through May while salmon are present

(b) To the extent possible, the secondary velocity should not exceed 2.5 feet per second and preferably 1.5 feet per second between June 1 and August 31, to increase the efficiency for striped bass, catfish, shad, and other fish. Secondary velocities should be reduced even at the expense of bypass ratios in the primary, but the ratio should not be reduced below 1:1.0

(c) The screened water discharge should be kept at the lowest possible level consistent with its purpose of minimizing debris in the holding tanks

(d) The bypass ratio in the secondary should be operated to prevent excessive velocities in the holding tanks, but in no case should the bypass velocity be less than the secondary approach velocity.

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## FOOTNOTES

1/ Except for flow, all values are for surface zone measurements. Except for flow, all mean daily values are based on at least hourly measurements. All dates are inclusive.

2/ Footnote 2 is set forth on next sheet.

3/ When no date is shown in the adjacent column, EC limit in this column begins on April 1.

4/ If contracts to ensure such facilities and water supplies are not executed by January 1, 1980, the Board will take appropriate enforcement actions to prevent encroachment on riparian rights in the southern Delta.

5/ For the purpose of this provision firm supplies of the Bureau shall be any water the Bureau is legally obligated to deliver under any CVP contract of 10 years or more duration, excluding the Friant Division of the CVP, subject only to dry and critical year deficiencies. Firm supplies of the Department shall be any water the Department would have delivered under Table A entitlements of water supply contracts and under prior right settlements had deficiencies not been imposed in that dry or critical year.

6/ Dry year following a wet, above normal or below normal year.

7/ Dry year following a dry or critical year.

8/ Scheduled water supplies shall be firm supplies for USBR and DWR plus additional water ordered from DWR by a contractor the previous September, and which does not exceed the ultimate annual entitlement for said contractor.

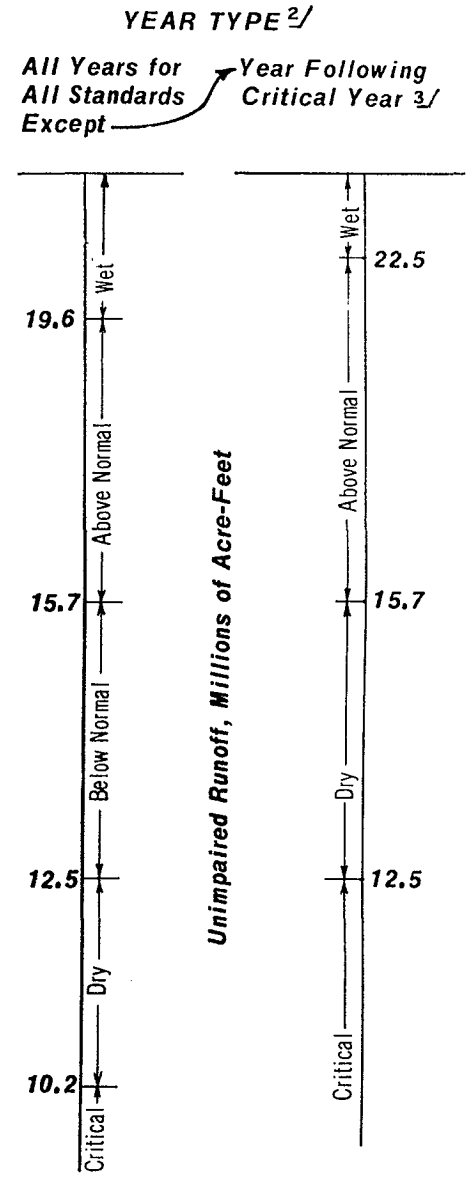
NOTE: EC values are mmhos/cm at 25°C.

# FOOTNOTE 2 OF TABLE II

## YEAR CLASSIFICATION

Year classification shall be determined by the forecast of Sacramento Valley unimpaired runoff for the current water year *(October 1 of the preceding calendar year through September 30 of the current calendar year)* as published in California Department of Water Resources Bulletin 120 for the sum of the following locations: Sacramento River above Bend Bridge, near Red Bluff; Feather River, total inflow to Oroville Reservoir; Yuba River at Smartville; American River, total inflow to Folsom Reservoir. Preliminary determinations of year classification shall be made in February, March and April with final determination in May. These preliminary determinations shall be based on hydrologic conditions to date plus forecasts of future runoff assuming normal precipitation for the remainder of the water year.

| *YEAR TYPE* | *RUNOFF, MILLIONS OF ACRE-FEET* |
|---|---|
| Wet 1/ | equal to or greater than 19.6 (except equal to or greater than 22.5 in a year following a critical year). 3/ |
| Above Normal 1/ | greater than 15.7 and less than 19.6 (except greater than 15.7 and less than 22.5 in a year following a critical year). 3/ |
| Below Normal 1/ | equal to or less than 15.7 and greater than 12.5 (except in a year following a critical year). 3/ |
| Dry | equal to or less than 12.5 and greater than 10.2 (except equal to or less than 15.7 and greater than 12.5 in a year following a critical year). 3/ |
| Critical | equal to or less than 10.2 (except equal to or less than 12.5 in a year following a critical year). 3/ |

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1/ *Any otherwise wet, above normal, or below normal year may be designated a subnormal snowmelt year whenever the forecast of April through July unimpaired runoff reported in the May issue of Bulletin 120 is less than 5.9 million acre-feet.*

2/ *The year type for the preceding water year will remain in effect until the initial forecast of unimpaired runoff for the current water year is available.*

3/ *"Year following critical year" classification does not apply to Agricultural, Municipal and Industrial standards.*



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C-053887

TABLE III - DECISION 1485

DELTA ESTUARY WATER QUALITY MONITORING PROGRAM

| Station Location | Electrical Conductivity | Base Parameters 1/ | Phytoplankton 2/ | Phosphorus, TDS and Cl- 3/ | Heavy Metals, Pesticides 4/ | Benthos 5/ |
|---|---|---|---|---|---|---|
| C2 Sacramento River @ Collinsville | C | | | | | |
| C3 Sacramento River @ Greens Landing | C | SM/M | SM/M | M | SA | SA |
| C4 San Joaquin River @ San Andreas Landing | C | | | | | |
| C5 Contra Costa Canal @ PP #1 | C | | | | | |
| C6 San Joaquin River at Brandt Bridge | C G.H. | | | | | |
| C7 San Joaquin River @ Mossdale | | SM/M | SM/M | M | SA | SA |
| C8 Old River near Middle River | C | | | | | |
| C9 West Canal @ mouth/intake to Clifton Ct. Forebay | C | SM/M | SM/M | M | | |
| C10 San Joaquin River @ Vernalis | C Flow | SM/M | | M | | |
| C13 Mokelumne River @ Terminous | C | | | | | |
| C19 Cache Slough @ City of Vallejo Intake | C | | | | | |
| D4 Sacramento River above Point Sacramento | | SM/M | SM/M | M | SA | SA |
| D6 Suisun Bay at Bulls Head Point nr. Martinez | | SM/M | | M | SA | SA |
| D7 Grizzly Bay @ Dolphin nr. Suisun Slough | | SM/M | SM/M | M | | SA |
| D8 Suisun Bay off Middle Point nr. Nichols | | SM/M | SM/M | M | | |
| D9 Honker Bay near Wheeler Point | | SM/M | SM/M | M | SA | SA |
| D10 Sacramento River @ Chipps Island | C | SM/M | | M | | |
| D11 Sherman Lake near Antioch | | SM/M | | M | SA | SA |
| D12 San Joaquin River @ Antioch Ship Channel | | SM/M | SM/M | M | SA | |
| D12* San Joaquin River @ Antioch Water Works | C | | | | | |
| D14A Big Break near Oakley | | SM/M | | M | SA | SA |
| D15 San Joaquin River @ Jersey Point | C | SM/M | SM/M | M | | |
| D16 San Joaquin River @ Twitchell Is. | | SM/M | | M | | |
| D19 Franks Tract near Russo's Landing | | SM/M | | M | SA | SA |
| D22 Sacramento River @ Emmaton | C | SM/M | | M | | |
| D24 Sacramento River below Rio Vista Bridge | C Flow | SM/M | SM/M | M | | |
| D26 San Joaquin River @ Potato Point | | SM/M | SM/M | M | | |
| D28A Old River near Rancho Del Rio | C | SM/M | | M | SA | SA |
| D29 San Joaquin River @ Prisoners Point | W | | | | | |
| D42 San Pablo Bay near Rodeo | | SM/M | SM/M | M | | |
| DMC1 Delta Mendota Canal | C | | | | | |

(Continued on next page)



C-053888

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TABLE III - DECISION 1485

DELTA ESTUARY WATER QUALITY MONITORING PROGRAM

| Station Location | | Electrical Conductivity | Base Parameters 1/ | Phytoplankton 2/ | Phosphorus, TDS and Cl 3/ | Heavy Metals, Pesticides 4/ | Benthos 5/ |
|---|---|---|---|---|---|---|---|
| MD6 | Sycamore Slough near Mouth | | SM/M | | M | | SA |
| MD7 | South Fork Mokelumne River below Sycamore Slough | | SM/M | SM/M | M | | SA |
| MD10 | Disappointment Slough @ Bishop Cut | | SM/M | SM/M | M | | |
| P8 | San Joaquin River at Buckley Cove | | SM/M | SM/M | M | SA | SA |
| P10 | Middle River @ Borden Highway | C G.H. | SM/M | | M | | |
| P12 | Old River @ Tracy Road Bridge | C G.H. | SM/M | | M | | |
| S31 | Suisun Slough near mouth | C | | | | | |
| S32 | Cordelia Slough above S.P.R.R. | C | | | | | |
| S35 | Goodyear Slough so. of Pierce Harbor | C | | | | | |
| S42 | Suisun Slough near Volanti Slough | C | SM/M | SM/M | M | | |
| S48 | Montezuma Slough at Cutoff Slough | C | | | | | |
| S64 | Miens Landing on Montezuma Slough | C | | | | | |
| D7* | Montezume Slough near mouth | P | | | | | |

* Location close to the station shown
C - Continuous
W - Weekly (April 1 - May 5)
SM - Semi-monthly (twice a month)
M - Monthly
SA - Semi-annually (spring and fall)
G.H. - Gage Height
P - Periodic, to obtain adequate correlation with other stations

1/ Air and water temperature, electrical conductivity, pH, dissolved oxygen, turbidity, water depth to 1% light intensity, secchi disc depth volatile and non-volatile suspended solids, nitrate, nitrite, ammonia, total organic nitrogen, extracted chlorophyll a, silica.

2/ Enumeration and identification to the species level where possible.

3/ Orthophosphate and total phosphorus.

4/ Heavy metals - arsenic, cadmium, chromium (all valences), copper, iron, lead, manganese, mercury, zinc.

Pesticides - chlorinated hydrocarbons to include: Aldrin, Altrazine, BHC, Chlordane, Dacthal, DDD, DDE, DDT, Dieldrin, Endrin, Endosulfan, Heptachlor, Kelthane, Lindane, Methoxychlor, Simazine, Toxaphene, PCB.

Sampling to take place in water column and bottom sediments. Sediment samples are to be taken in transects across the channel.

5/ Benthic samples are to include identification and enumeration to the lowest taxonomic level possible. Samples to be taken in transects across the channel. Continuation of this aspect of the monitoring program will be reevaluated annually.



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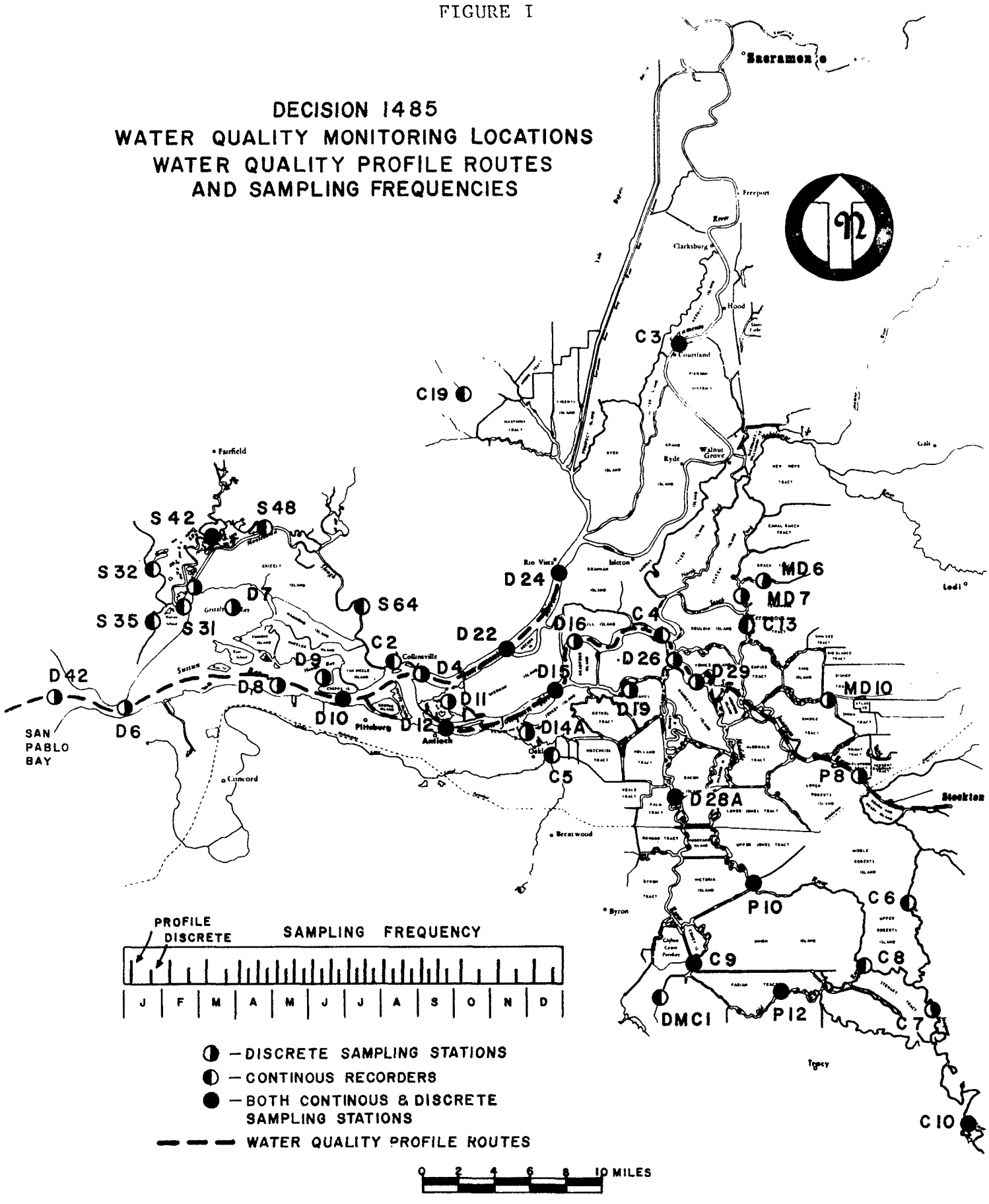
FIGURE I




(BASE MAP PROVIDED BY DEPT. OF WATER RESOURCES)

# APPENDIX D

# BIOLOGICAL ASSESSMENT OF THE IMPACTS OF THE SUISUN MARSH MANAGEMENT PLAN

ON THE

SALT MARSH HARVEST MOUSE
(*Reithrodontomys raviventris halicoetes*)

and

CALIFORNIA CLAPPER RAIL
(*Rallus longirostris obsoletus*)

June 15, 1981

TABLE OF CONTENTS


| | | Page |
|---|---|---|
| LIST OF TABLES | | i |
| LIST OF FIGURES | | ii |
| I. | INTRODUCTION | 1 |
| II. | DESCRIPTION OF PROJECT | 4 |
| III. | SALT MARSH HARVEST MOUSE | 12 |
| | Study Area | 13 |
| | Study Animal | 15 |
| | Study Techniques | 18 |
| | Study Results | 18 |
| | Discussion | 18 |
| IV. | CALIFORNIA CLAPPER RAIL | 24 |
| | Study Area | 24 |
| | Study Animal | 24 |
| | Study Techniques | 25 |
| | Study Results | 25 |
| | Discussion | 25 |
| V. | PROJECT IMPACTS | 28 |
| VI. | PROJECT ALTERNATIVES | 38 |
| VII. | CONSERVATION MEASURES | 40 |
| | Proposed Measures to Lessen Project Impacts | 40 |
| | Compensation | 42 |
| VIII. | REFERENCES | 50 |
| IX. | APPENDICES | 52 |

## LIST OF TABLES


| | | Page |
|---|---|---|
| TABLE 1 | - Decision 1485 Water Quality Standards . . . | 6 |
| TABLE 2 | - Vegetative Composition of the Suisun Marsh . | 14 |
| TABLE 3 | - Trapping Results Summary . . . . . | 20 |
| TABLE 4 | - Salt Marsh Harvest Mice Trapped with Respect to Percent Cover Class of Pickleweed . . | 22 |
| TABLE 5 | - Marsh Vegetation Impacts from Facility Construction . . . . . | 31 |




C—053894

C-053894

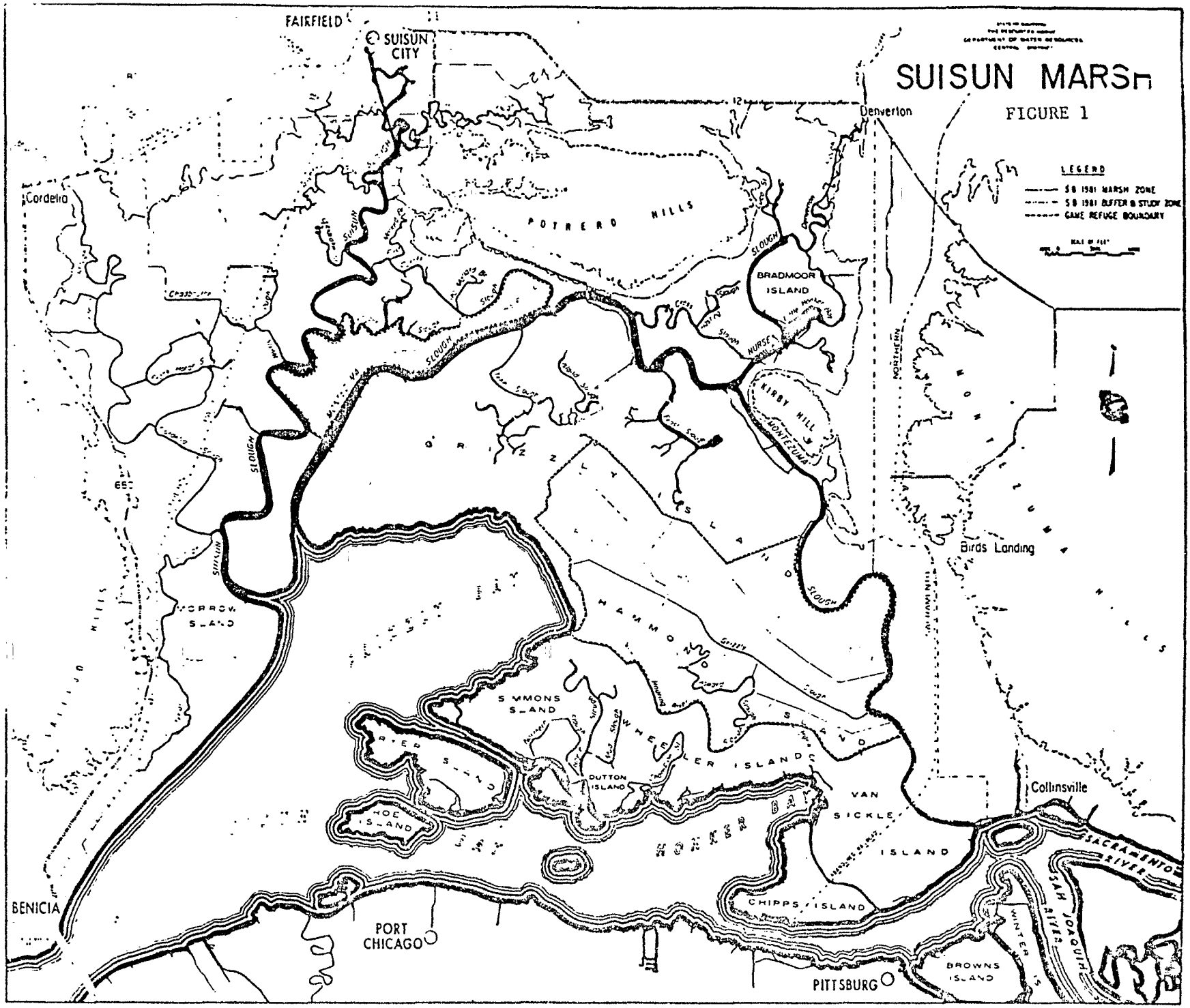
## LIST OF FIGURES


| | | | Page |
|---|---|---|---|
| FIGURE 1 | - | Suisun Marsh . . . . . | 2 |
| FIGURE 2 | - | Suisun Marsh Physical Facilities . . . . . | 7 |
| FIGURE 3 | - | Salt Marsh Harvest Mouse Trapping Areas . . . | 19 |
| FIGURE 4 | - | Clapper Rail Survey Results, Harvey (1980) . . | 26 |
| FIGURE 5 | - | Clapper Rail Survey Results, CDFG (1980). . . | 27 |
| FIGURE 6 | - | Monitoring Plan Locations. . . . . | 33 |
| FIGURE 7 | - | Competitive Ability of Four Marsh Plants . . | 36 |
| FIGURE 8 | - | Plant Distribution in Relation to Water . . . Management Schemes . . . . . | 37 |
| FIGURE 9 | - | Areas in Which Proposed Compensating Acreage is Located . . . . . | 43 |
| FIGURE 10 | - | Hill Slough Wildlife Area-Peytonia Slough Ecological Reserve . . . . . | 45 |
| FIGURE 11 | - | Suisun Marsh Monitoring Zones . . . . . | 48 |

# I. INTRODUCTION

The Suisun Marsh (Marsh), defined in Section 29102 of the California Public Resources Code, represents one of the largest brackish water marshes in the United States (Figure 1). Situated adjacent to Suisun and Grizzly bays in the Sacramento-San Joaquin Estuary in southern Solano County, California, its over 57,000 acres provide one of the most significant waterfowl wintering areas in the Pacific Flyway. The Marsh supports an extremely diverse fauna representing nearly 200 species of wildlife, and provides habitat for two species listed by the U. S. Fish and Wildlife Service (USFWS) and the California Department of Fish and Game (CDFG) as endangered, the salt marsh harvest mouse, Reithrodontomys raviventris (mouse), and the California clapper rail, Rallus longirostris obsoletus, (rail).

The quantity of Delta outflow is the most important factor influencing the salinity of surface water within most of the Marsh. Upstream water development has resulted in a change of pattern and an overall reduction of Delta outflow. With the change in pattern of Delta outflow, channel salinity has increased particularly during the March-through-May period. The California State Water Resources Control Board (SWRCB), in its Decision 1485, established standards for salinity from October through May to protect the Marsh. These standards would either require an increase in Delta outflow of about 3.1 to 4.8 million acre-feet per year above the Delta standards during controlled conditions, or the development of alternatives to deliver water to the Marsh management areas.



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The degradation of the Marsh as a brackish marsh is related to problems with existing channel water quality conditions, Delta outflow, present management practices, and existing interior management facilities. Solutions to these problems are based on Decision 1485 quality standards for Marsh channels. The effect of soil salinity on the distribution and growth of brackish marsh vegetation, relationships between soil and pond salinities, and the relationship between pond salinities and channel salinities formed the basis of these standards. The Suisun Marsh Management Plan (Plan) represents a workable solution based on provision of a specific quality and quantity of supplemental water, and control and distribution facilities.

This Plan would meet Marsh water quality standards by changing the major intake for Marsh water supplies from Grizzly Bay to the Sacramento River near Collinsville, by introducing municipal waste water, and by redistributing water in major Marsh channels to produce a better water quality. The Marsh standards are based on this combined approach of improved and more intensive water management.

This biological assessment includes a description of the proposed project, a summary of results from studies completed in the Marsh and its vicinity for both endangered species, anticipated impacts, project alternatives and proposed conservation measures.



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## II. DESCRIPTION OF THE PROJECT

Historically, the Marsh was a freshwater marsh subject to annual intrusion of saline San Francisco Bay water particularly during dry summer and early fall months (California Department of Water Resources 1980). Early attempts to reclaim the Marsh for agriculture began in the 1850's with the construction of low levees. Levee systems were upgraded and by the late 1800's the majority of the Marsh had been removed from tidal influence. Agricultural attempts met with little lasting success as soil water salinities became too high to support crops. Some pature land still remains within the Marsh. The value of the Marsh to wildlife has, however, remained at an extremely high level in its brackish condition.

The change in seasonal levels of Delta outflow has resulted in increased salinity intrusion into the Marsh during the March through May period when soil salinity conditions affecting plant production are the greatest (Mall 1969). This change threatens the future of the Marsh as a highly productive brackish water marsh.

The Plan is designed to protect against the effects of these increased salinities on the Marsh, and has four major elements. These are: Delta Outflow, Physical Facilities, Monitoring Program and Management Program.

1. <u>Delta Outflow</u>

   Outflow from the Sacramento River, supplemented when necessary by project releases, would provide for the required water quality in the Sacramento River at Collinsville for circulation through the Marsh. This



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C-053899

required water quality is equivalent to the standards included in Decision 1485 for site C-2 (Table 1).

2. Physical Facilities

In order to meet the required water quality at locations within the Marsh as shown in Table 1, specific water control and conveyance structures are needed. Facilities range from new or enlarged channels to a water control structure on Montezuma Slough (Figure 2). Each facility is discussed briefly. More detailed information may be obtained by referring to the Plan of Protection (California Department of Water Resources 1980). Several of the facilities have been completed as a part of the Initial Facilities and are not discussed in this assessment.

a. Montezuma Slough Control Structure

This facility is a keystone to the entire Marsh management system. It is proposed to be a concrete control structure with two radial gates and a boat lock constructed one and one-half miles from the eastern end of Montezuma Slough. The structure will be operated to tidally pump water from the Sacramento River near Collinsville into Montezuma Slough during periods when Delta outflows would not be sufficient to provide adequate water quality.

b. Grizzly Island Distribution System

This facility would consist of utilizing a combination of enlarged existing ditches and a

TABLE 1

Water Quality Required to Protect the Suisun Marsh.*

| Month | EC in mmhos |
|---|---|
| October | 19.0 |
| November | 15.5 |
| December | 15.5 |
| January | 12.5 |
| February | 8.0 |
| March | 8.0 |
| April | 11.0 |
| May | 11.0 |

*Pertains to Collinsville on Sacramento River (C-2), Miens Landing on Montezuma Slough (S-64), Montezuma Slough at Cutoff Slough (S-48), Montezuma Slough near Volanti Slough (S-42), Goodyear Slough south of Pierce Harbor (S-35), and Cordelia Slough at Cordelia Ditch. (SWRCB, D-1485)

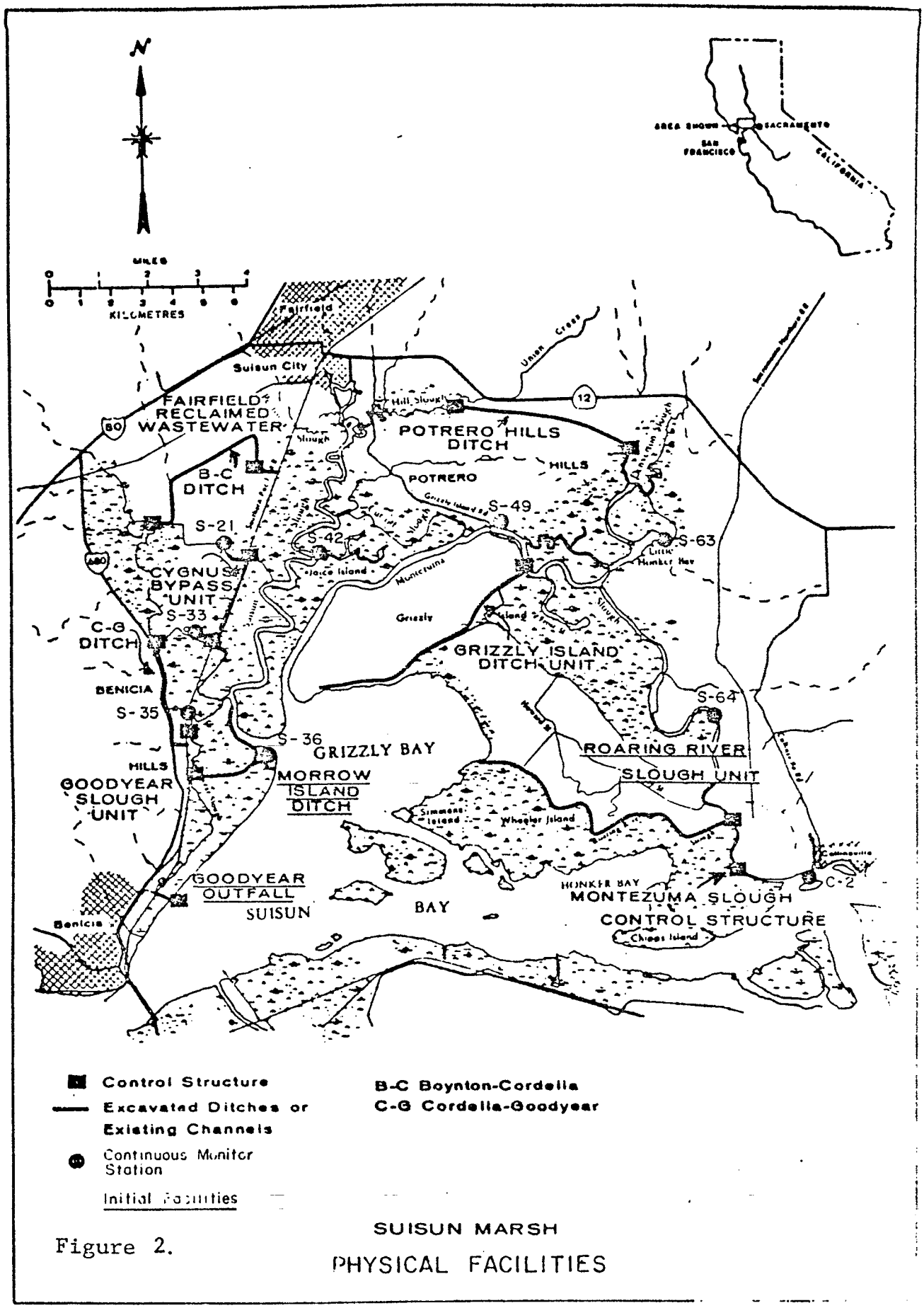


Figure 2.

SUISUN MARSH
PHYSICAL FACILITIES





C-053902

newly constructed channel to take water from Montezuma Slough just west of the mouth of Frost Slough to serve leveed lands on Grizzly Island with adequate quality water. The system would include a 100-acre pond at the east end of the system and provide water to adjacent clubs. The length of the facility is 9.98 km (6.2 miles).

c. Potrero Hills Ditch

This 5.63 km (3.5 miles) long ditch would be constructed between Luco and Hill sloughs. Its purpose is to move water from the vicinity of Denverton Slough in the east to the Hill-Suisun Slough in the north-central portion of the Marsh. This facility would improve water quality in the central and northern extremities of the Marsh.

d. Cordelia-Goodyear Ditch

This facility is a 4.5 km (2.8 miles) channel from the Ibis Club area on Cordelia Slough to a point just south of Pierce Harbor on Goodyear Slough. The ditch would have a 40-acre pond at each end as well as control structures to tidally pump water south to Goodyear Slough. This facility is needed to meet salinity requirements along Goodyear Slough and provide club managers with a higher quality water than possible without this facility.

e. Goodyear Slough (Pierce Harbor) Control Structure

This structure is located just south of Pierce Harbor. Its purpose is to control water flow from Goodyear Slough northerly toward Suisun Slough as needed to provide adequate quality water.

f. Boynton-Cordelia Ditch

This ditch is 5.6 km (3.5 miles) long designed to pump water from Suisun Slough via Boynton Slough to Cordelia Slough to improve salinity in the western Marsh. Treated waste water from the Fairfield Water Treatment Plant would be used to supplement this tidal flow to Cordelia Slough.

g. Cygnus Ditch

This facility is 4.18 km (2.6 miles) long designed to transport water from Chadbourne Slough south to Cordelia Slough to improve water quality in the vicinity of S-33 and provide water to adjacent clubs.

Monitoring Program

The Plan of Protection prepared by the California Department of Water Resources (CDWR) includes a monitoring program that will provide water and soil salinity data from throughout the entire Marsh. This program will evaluate the operation of the Management Facilities. This program is a requirement for the CDWR under the Suisun Marsh Preservation Act of 1977 (AB-1717) and Decision 1485.

Channel water will be monitored continuously at six sites in the Marsh, two sites on the Sacramento River and periodically in Montezuma Slough near its mouth. Water quality will be monitored continuously at each area's major diversion point. Soil-water-salinity will be monitored at approximately 60 sites on 12 areas throughout the Marsh. Continuous water level records will be made at each site monitored for soil-water salinity.

Plant surveys will also be included in the monitoring program. The overall vegetative composition of the Marsh will be determined every three years by the use of color aerial photography with ground verification. Mouse habitat will be intensively monitored using data from these aerial flights. The specifics of this monitoring are described in the Conservation Measures section of this assessment. Major waterfowl food plant seed production will also be monitored.

In addition to the monitoring program described above, other monitoring is being conducted in the Marsh by agencies such as the CDFG and the Soil Conservation Service (SCS). For example, the CDFG has a bi-weekly waterfowl survey every year beginning in September and extending through January. These data will also be used to evaluate the effectiveness of the management facilities.

4. Management Program

The concept of individual club management plans was developed initially to improve marsh conditions for waterfowl. The CDFG, SCS and Suisun Resource Conservation District (SRCD) have been working for over ten years to gain voluntary implementation of

the management plans. The effort to implement these management plans was given considerable impetus by AB-1717. These management plans are also an integral part of the Plan. The SWRCB, using the water quality criteria provided for in /Decision 1485, acknowledged that local landowners would need to employ efficient marsh management practices to successfully maintain the present value of the Marsh to waterfowl and numerous other wildlife associated with this brackish marsh. AB-1717 assigned the primary responsibility for regulating and improving the water management practices on privately owned lands within the Marsh to the SRCD. It requires the SRCD as part of its component of the Local Protection Program to: "include a management program for each managed wetland in private ownership within the primary management area and shall specify all necessary development related to such management." SRCD contracts with the SCS to develop these plans.

These individual club management plans are intended to provide the private landowners with a management tool which, when used in conjunction with the physical facilities, will optimize the wildlife values of their lands. These management plans, which are reviewed by the CDFG and certified by the San Francisco Bay Conservation and Development Commission (BCDC), will also provide a basis upon which SRCD can establish regulations to assure landowners follow good marsh management techniques. Presently SRCD is proposing legislation that will provide the District with the enforcement capabilities necessary to assure compliance. These capabilities would include access rights for club inspection. This legislation will provide them with the funding and authority for this enforcement.

The management plans include an inventory of soils, water control structures, current management procedures being used, and vegetative conditions on the club. Recommendations are then made regarding improved water management including structures needed to effect good water control. Recommended changes in the present vegetation is also considered where appropriate on the club. The Appendix contains examples of two club management plans.

Each management plan is designed to follow one or a combination of five major management types. The management types are: alkali bulrush management, fat hen management, permanent pond management, barley cultivation, and watergrass cultivation. These management plans will provide the high value waterfowl habitat described by Mall (1969). A wide variety of wildlife will also be supported by the diverse habitat conditions that will occur.

## III. SALT MARSH HARVEST MOUSE

A study prepared by Shellhammer (1980) was completed in the Marsh to further document the presence of the mouse, determine the value of the Marsh to the mouse, and list possible impacts of the Plan on the mouse. A similar study by the CDFG was also completed on a 300 acre club (parcel #211) in the northern portion of the Marsh (CDFG 1980a).



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## Study Area

The study area represents a high value brackish water marsh that supports a diverse brackish water plant community and associated wildlife. Habitat conditions include open water areas such as sloughs and permanently ponded areas, tidally flooded areas, diked areas that are seasonally flooded as private duck clubs or state operated wildlife areas, upland areas comprising the levees within the Marsh, and higher ground on Grizzly Island Wildlife Area, private clubs and periphery of the Marsh. Approximately ninety percent of the Marsh is enclosed by a system of low levees (Miller et al 1975). Most of the Marsh lies at or below mean tide elevation and is managed as a seasonal wetland subject to periodic discing and burning.

The vegetative composition of the Marsh has been strongly influenced by man's management activities and the availability of an adequate quality and quantity of fresh water to support brackish marsh conditions. The effects of upstream diversions have been to increase the magnitude and duration of saltwater intrusion into Marsh bays and sloughs. The result has been a gradual trend toward more saline conditions in the Marsh. Table 2 lists the 1973 vegetative composition information determined by the DFG (Rollins 1981). The Appendix includes aerial survey maps of the Marsh's vegetative composition. The 1973 survey results were chosen as more characteristic of the Marsh, since the 1978 survey appeared to be strongly influenced by the drought conditions present from 1976 through 1977. In order to



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TABLE 2.

Vegetative Composition of the Suisun Marsh in 1973.

| Species | Acres | |
|---|---|---|
| Pickleweed | 12,989 | 25.9 |
| Tules | 7,814 | 15.6 |
| Alakli Bulrush | 6,815 | 13.6 |
| Salt Grass | 5,596 | 11.2 |
| Annuals (other than Fat Hen) | 4,365 | 8.7 |
| Crops | 4,143 | 8.3 |
| Fat Hen | 3,976 | 7.9 |
| Brass Buttons | 1,919 | 3.8 |
| Cattail | 1,425 | 2.9 |
| Baltic Rush | 569 | 1.1 |
| Olney Bulrush | 238 | .5 |
| Miscellaneous | 258 | .5 |
| Total | 50,107 | 100.0 |



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More accurately document baseline acreages in the Marsh, pre-drought acreages are used.

## Study Animal

The study animal is listed by the U. S. Department of the Interior (USDI) as an endangered species, as provided for by the Endangered Species Act of 1973 (PL 93-205). Originally found throughout the extensive marshes once bordering the San Francisco Bay east to the vicinity of Collinsville, this species is now restricted to scattered populations within its original range. Loss of habitat due to development by diking and filling is the chief factor in its past decline. Current restrictions on filling by BCDC have begun to reduce this impact within its range. Enhancement throughout its range is recommended to improve this animal's status (DFG 1978).

Two subspecies have been identified by Fisler (1965). The subspecies under consideration here, R.r. halicoetes, occurs from the west end of the San Rafael Bridge to Collinsville along the northern edge of the bay and on the south side from Martinez to Pittsburg. The other subspecies, R.r. raviventris, is found along the San Francisbo Bay shoreline.

The mouse is a new world rodent characterized by a rich brown back with underparts a pinkish cinnamon to whitish color. Although difficult to distinguish from the western harvest mouse (Reithrodontomys megalotis), Techniques utilizing tail length, head and body length, color, behavior and other characteristics have proved effective (Ingles 1965).

The mouse is crepuscular and partially diurnal in its activity and generally has a very calm temperament. Shellhammer (1977) felt that this behavior explains the mouse's requirements for dense cover. Dense salt marshes of pickleweed (Salicornia sp.) gumplant (Grindelia sp.) and fat hen (Atriplex sp.) are characteristic of the principal habitat of the mouse and cover appears to be a major factor affecting utilization (Fisler 1965). Recent DFG studies (1981) support this conclusion. During this trapping study, mice were captured in a dense stand of fat hen with no pickleweed present.

Fisler (1965) found that the mouse can not live on a diet consisting exclusively of pickleweed and salt grass (Distichlis sp.). His study showed that the mouse required a more varied diet including green and dry plant stems and leaves and plant seeds provided by areas supporting diverse habitat matrices. Most research in the Suisun Marsh, nearby in the Collinsville area, and on the Contra Costa shoreline supports these early findings (Biosystems 1978 and Shellhammer 1980).

Most mice were captured in dense, diverse marsh habitats that generally resembled the preferred habitat to be described on page 17. Sparse cover in poor condition provided poor mouse habitat. These same studies found that pickleweed was the most important habitat component. Its occurrence in areas that supported mice was highly significant. Major exceptions appear to be during high water outflows and high tides in tidal areas and when clubs are flooded for hunting or other management purposes. During these times mice seek refuge in more upland areas or on adjacent levees and for short periods of time on emergent vege-



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tation. These refugia are generally densely vegetated and provide excellent escape cover (Shellhammer 1977 and Biosystems Analysis 1978 and 1979). In areas managed for waterfowl, dikes with dense vegetation provide refugia for the mouse when these areas are normally flooded from October through June,

The following guidelines proposed by Shellhammer for inclusion in the recovery plan for the mouse (memo from H. Shellhammer dated 3-10-81) were used as a definition of Preferred Mouse Habitat for the purposes of this assessment:

1. 100 percent cover,
2. A depth of 30 to 50 cm. at summer maximum,
3. A high percentage of pickleweed. Areas conducive to denser populations of mice range from 100 percent pickleweed to 60 to 70 percent pickleweed and a variety of other halophytes, especially fat hen and alkali heath. Scirpus and Typha species do not reduce the quality of such habitat so long as they are not present in large amounts and if they are dispersed as opposed to clumped.
4. There should be no areas, or very few and small areas, of salt grass, brass buttons, alkali bulrush, other Scirpus species or Typha. Upland grasses are valuable as an upland edge but not as a dominant within the marsh as such a situation is conducive to western rather than salt marsh harvest mice.
5. There are no barriers of open ground or water dissecting the vegetation as these mice are extremely dependent on cover. Such open area belts divide potentially large

populations into smaller ones and decrease their chances of survival.

6. The refugia, the areas of marsh, are large. (a) Connections between parts of a marsh supporting one population should be at least 20 m. wide with 100 percent cover of optimum vegetation and have no barriers of open ground or water across them. (b) A considerable portion of each marsh should be habitable throughout the year. The nature of the soil surface and the management practices should result in at least 40 percent of the marsh being useable in the winter, i.e. receiving no to little flooding. A majority of the marsh (80 percent or more) should be of optimum habitat in the summer. (c) A large marsh should have a large edge of halophytes and possibly an adjoining and interdigitating band of upland grasses.
7. The area receives minimal disruptive manipulation and only that needed to produce mouse habitat. Flushing is absent or minimized. Plowing, mowing and/or burning are absent.

As the biological requirements of the mouse are further defined as new information becomes available the definition outlined above should be adjusted to reflect the new information and habitat requirements. If necessary, modifications of the conservation measures of this assessment will also be undertaken. Any changes in the definition or modifications will be agreed upon by the USFWS and CDFG.

## Study Techniques

Shellhammer (1980) trapped in twenty-five locations within the Marsh in the late spring and summer of 1980 (Figure 3). Sherman live traps, baited with sunflower seeds, almonds and walnuts were used. Trap sites were located in the vicinity of the facilities proposed in the Plan. Sites included the following vegetative compositions: dominant alkali bulrush, dominant pickleweed, dominant salt grass and various vegetative mosaics. Table 3 lists the plant composition of the trapping areas.

## Study Results

A total of 5,700 trap days were expended and 21 mice were captured. An additional 107 individuals of other species were captured. Table 3 and Table 4 summarize trapping results by trap site. Shellhammer (1980) trapped the majority of the mice in densely vegetated areas that provided optimum food and cover conditions for the mouse. Lush stands of pickleweed and areas that included other species such as fat hen and brass buttons represented some of the most valuable habitat. The Vennink Stockgate and Grizzly Bay 1 and 2 sites were examples of areas that were predominantly pickleweed and supported the mouse. Meins Landing Mound and Bulrush trap sites were examples of areas with a more diverse habitat. Mice were also captured in alkali bulrush at the Teal Slough trap site.

# DISCUSSION

The results (Shellhammer 1980) corroborate earlier studies completed by Shellhammer and others such as Fisler (1965).

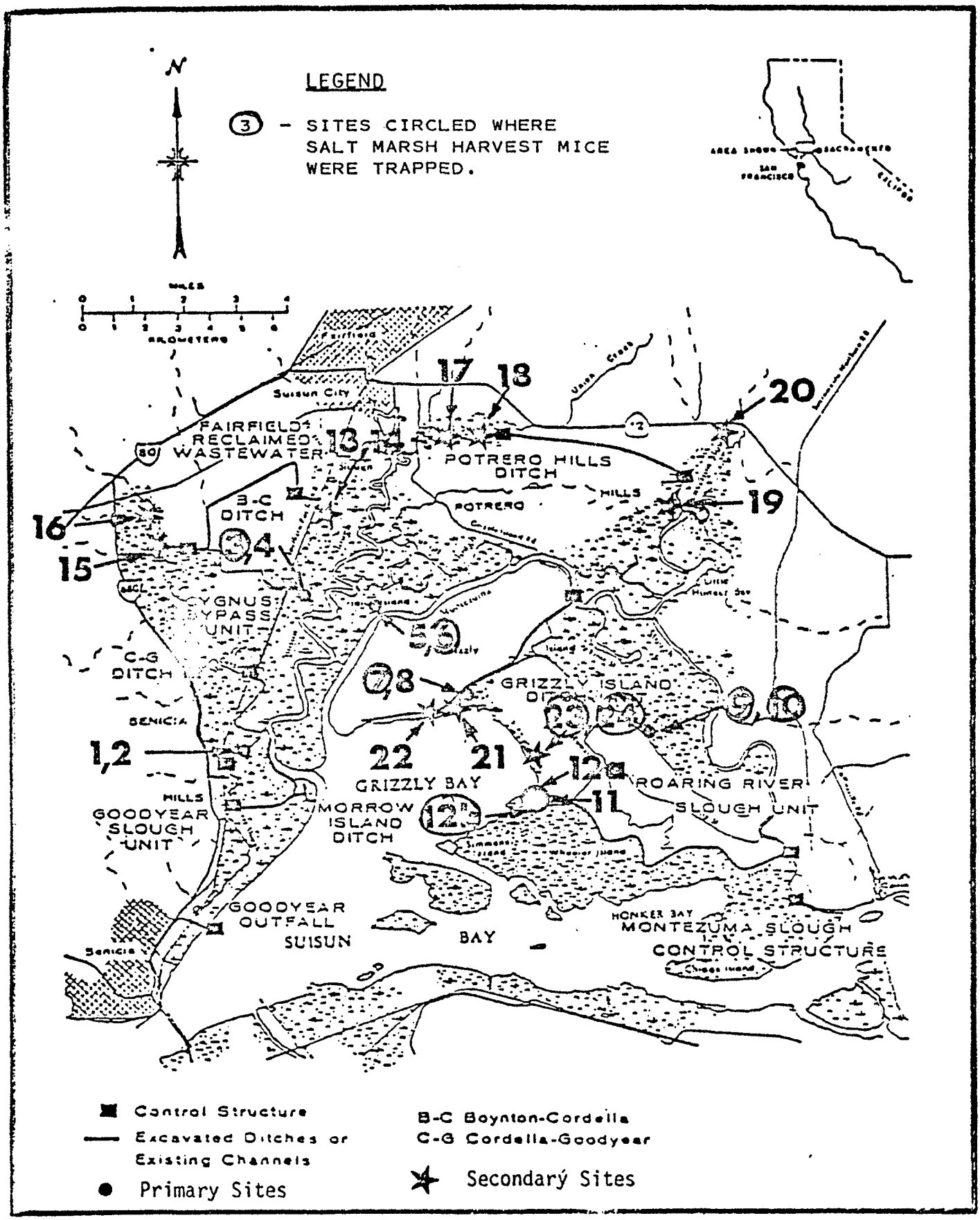


Figure 3
Salt Marsh Harvest Mouse
Trapping areas in Suisun Marsh





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TABLE 3

Summary of trapping results and trapsite % vegetative composition (Shellhammer 1980)

| | AREA | # TRAP NIGHTS | R. r. | BG | PW | AB | BB | SG | FH | C/T | MISC |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. | Morro Island Tule | 300 | 0 | 3 | 1 | 43 | 5 | 8 | 3 | 34 | 7[1] |
| 2. | Morrow Island Dike | 300 | 0 | - | - | - | - | - | - | 27 | 73[2] |
| 3. | Teal Slough | 300 | 2(+2)* | 23 | 7 | 71 | - | - | - | - | - |
| 4. | Teal Boathouse | 300 | 0 | 2 | - | 52 | 44 | - | - | - | - |
| 5. | Joice Is. Footbridge | 300 | 0 | 6 | 27 | 62 | - | - | - | - | - |
| 6. | Joice Is. Powerline | 300 | 1 | - | 31 | - | - | - | - | - | 69[3] |
| 7. | Vennink Stockgate | 300 | 3 | 3 | 97 | - | - | - | - | - | - |
| 8. | Vennink Decoy | 300 | 0 | - | 37 | 28 | - | 31 | 3 | - | 3[1] |
| 9. | Meins Landing Mound | 300 | 2 | 33 | 49 | - | 2 | - | 5 | - | 11[4] |
| 10. | Meins Landing Bulrush | 300 | 2 | 10 | 41 | 2 | 46 | - | 1 | - | - |
| 11. | Simmons Is. Gate | 300 | 0 | 19 | 25 | 36 | 2 | 10 | - | - | 2[5] |
| 12a. | Simmons Is. Road | 150 | 0 | 39 | 40 | 3 | 2 | - | - | - | - |
| 12b. | Simmons Is. 9th Pole | 150 | 4(+2) | 14 | 59 | 1 | 11 | 6 | 3 | - | 6[6] |
| 13. | Jacksnipe Pickleweed | 150 | 0 | 6 | 43 | 41 | 3 | - | 8 | - | - |
| 14. | Jacksnipe Wetlands | 150 | 0 | - | - | 95 | 5 | - | - | - | - |
| 15. | Cordelia Dike | 150 | 0 | - | - | - | - | 20 | - | 37 | 43[7] |
| 16. | Cordelia Pasture | 150 | 0 | 15 | 70 | - | - | 15 | - | - | 1 |
| 17. | Hill Slough Windmill | 150 | 0 | - | 20 | 4 | - | 65 | 1 | - | 10[8] |
| 18. | Hill Slough Dump | 150 | 0 | - | 20 | 6 | - | 58 | - | - | 19[9] |
| 19. | Nurse Slough | 150 | 0 | 9 | - | 51 | 6 | - | - | - | 34[10] |

* recaptures in ().
1-dead material
2-*Baccharis pilularis* 39%, *Rosa Calif.* 13.5% *Phragmites com.* 8%, Misc. 14%
3-*Hordeum hystrix* 39%, Misc. grasses 30%
4-*H. h.* 11%
5-*Rumex pulcher*
6-*Juncus balticus* 2%, Misc. 4%
7-*J. b.* 40%, Misc. 3%
8-*Jaumea carnosa* 8% *Lythrum hyssopifolia*
9-*L. h.* 19%
10-*H. h.* 33%, *Sesuvium sessile* 1%



C—053916

C-053916

Table 3 , continued

| | AREA | # TRAP NIGHTS | R. r. | BG | PW | AB | BB | SG | FH | C/T | MISC |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 20. | Denverton Highway | 150 | 0 | 9 | 89 | - | - | 1 | 1 | - | - |
| 21. | Vennink Building | 150 | 0 | - | - | - | - | - | - | 22 | 78[1] |
| 22. | Vennink Bayside | 150 | 0 | 11 | - | - | - | 5 | - | 32 | 42[2] |
| 23. | Grizzly Bay 1 | 300 | 5(+1) | 11 | 81 | - | 1 | 5 | 2 | - | - |
| 24. | Grizzly Bay 2 | 300 | 2 | 21 | 75 | - | 2 | - | 1 | - | - |
| | TOTALS- | 5,700 | 21 (+5) | | | | | | | | |

R. r. = Reithrodontomys raviventris

1- Lepidium latifolium 28%, Artemisia douglasiana 23%, Rosa californica 10%, Oenanthe sarmentosa 8%, Asparagus officinalis 5%, Misc. 6%.

2-Arundo donax 11%, B. pilularis 10%, R. californica 9%, A. D.3.2%, Misc. 11%.

BG- bare ground
PW- pickleweed
AB- alkali bulrush
BB- brass buttons
SG- salt grass
FH- fathen
C/T-cattails and tules
MISC.- miscellaneous



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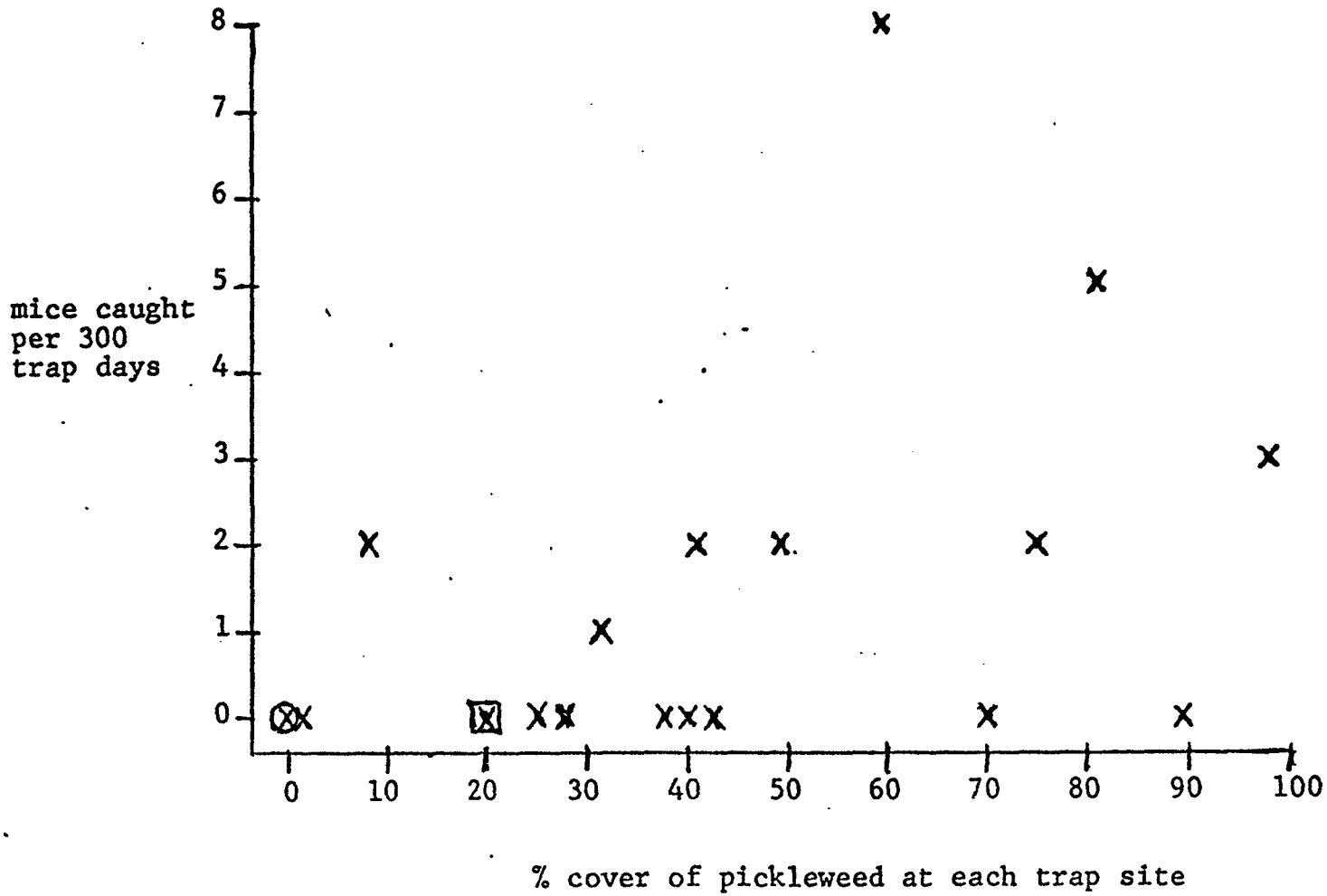
TABLE 4

Relation of mouse abundance and % pickleweed composition at each trapsite.




⊗ This plotted point represents 7 sites with no pickleweed in which no mice were caught.
⊠ This plotted point represents 2 sites with no mice captured.



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These studies demonstrated the value of dense, diverse habitat matrices to the mouse. Those sites studied for the proposed PG&E power plants (Shellhammer 1977) as well as those surveyed in the recent work in the Marsh indicated that combinations of healthy stands of pickleweed, fat hen, and alkali bulrush provide the required habitat of the mouse. Results indicate that the presence of pickleweed alone does not guarantee mice populations will be present (Table 3). The results also show the value of pickleweed in a marsh plant matrix supporting the mouse (Table 3). No mice were trapped in areas where pickleweed was not present in some percentage.

Overall trapping success was poor in the Marsh. This trapping success, when compared to work done in the San Francisco Bay area, indicates that relatively low densities of mice are present in the Marsh. This fact, combined with the present habitat conditions in the Marsh, led to the conclusion that the Marsh presently provided generally poor habitat for the mouse (Shellhammer 1980).



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## IV. CALIFORNIA CLAPPER RAIL

### Study Area

The study area for the rail is that same area as outlined in the study area description for the mouse. Within this study area several specific locations were emphasized in a CDFG survey completed in June 1980 (CDFG 1980b). They include areas near Boynton Slough, Hill Slough, Luco Slough and two sites on Grizzly Island near Tree and Island sloughs. The most intensive survey was completed by Harvey (1980) and included an overall survey of the rail throughout its range.

### Study Animal

The rail is also listed by the USDI as an endangered species, as provided for by the Endangered Species Act of 1973. The rail is a coot-sized bird with adults averaging 14-16½ inches (36-42 cm). This long-billed secretive bird is characterized as grayish-brown with a tawny breast, barred flanks, and a short-upturned tail with white beneath (CDFG 1978). The original range of the rail included Humboldt and Morro bays as well as salt marshes in the San Francisco and San Pablo bays, Napa Marsh, Bolinas and Tomales bays and Elkhorn Slough. Development by diking and filling of suitable rail habitat has reduced its range, however, while there have been few recent records in Humboldt and Morro bays, rail populations have been fairly stable in other areas.



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## Study Techniques

Surveys combined attempts to make visual contact with rails and attempts to elicit responses to taped calls. Harvey (1980) played a 10-15 second series of "clatter" calls from a small boat. Because of the height and density of vegetation in the Marsh study area, call surveys were the principal survey tool. Observations of rail tracks in tidal channels were also noted. The CDFG survey combined truck and foot travel and stressed the alignments for the proposed facilities. This survey was, therefore, limited to nontidal areas (CDFG 1980b).

## Study Results

Harvey (1980) found a density of 2.1 rails/ha in areas with optimum habitat. An estimated total of 25 rails was found with the majority being in the vicinity of Cutoff Slough in the Marsh (Figure 4). The CDFG (1980b) survey resulted in only two rails responding to taped calls (Figure 5).

## Discussion

The occurrence of the rail in the Marsh may be a relatively recent phenomenon. For example, a rail survey conducted as recently as 1975 found no rails in the Marsh (Gill 1979). In addition, no historical records could be found. A survey conducted from December 1978 through July 1979, found an estimated population of 25 rails present through the breeding season (Harvey 1980).

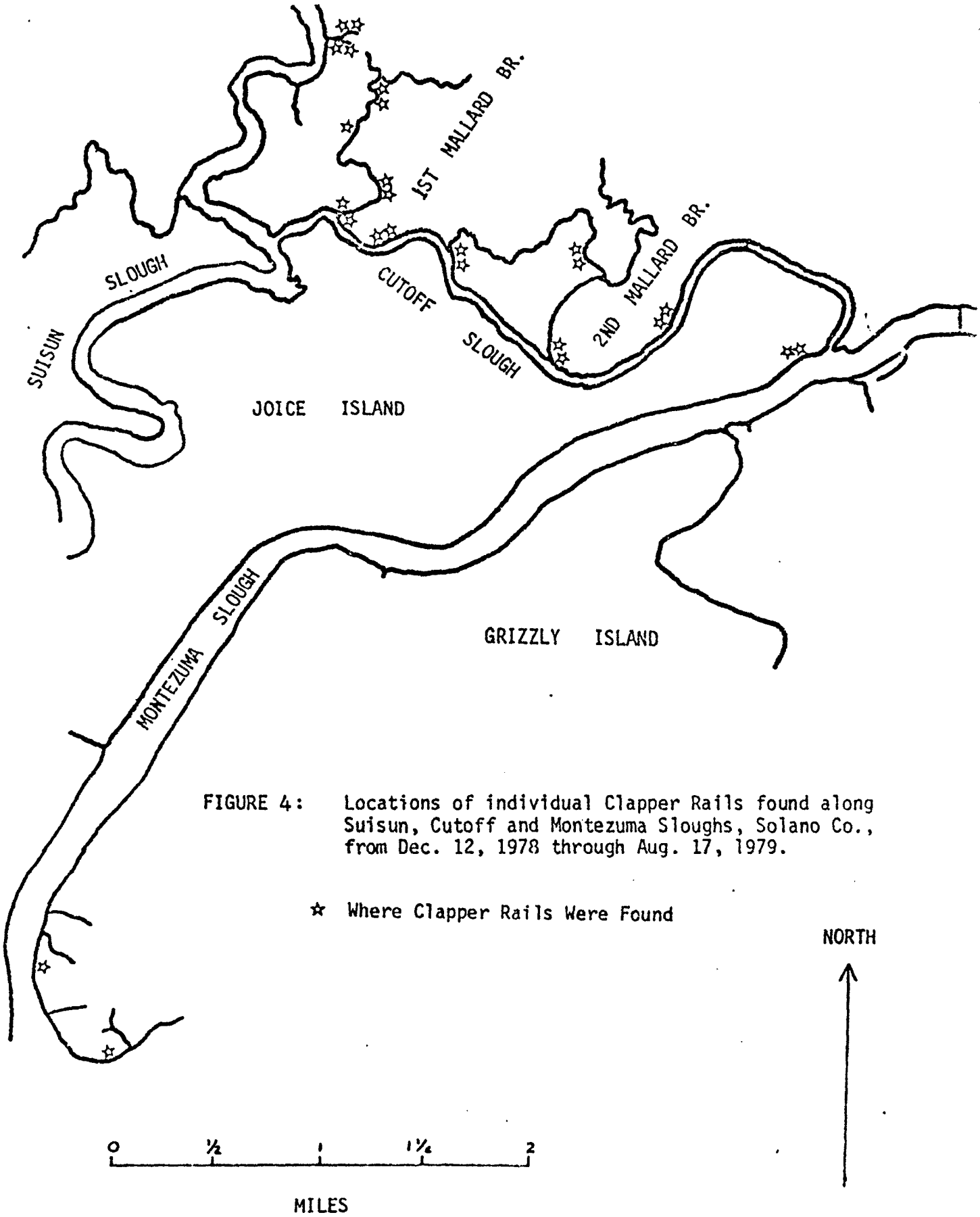


FIGURE 4: Locations of individual Clapper Rails found along Suisun, Cutoff and Montezuma Sloughs, Solano Co., from Dec. 12, 1978 through Aug. 17, 1979.

☆ Where Clapper Rails Were Found



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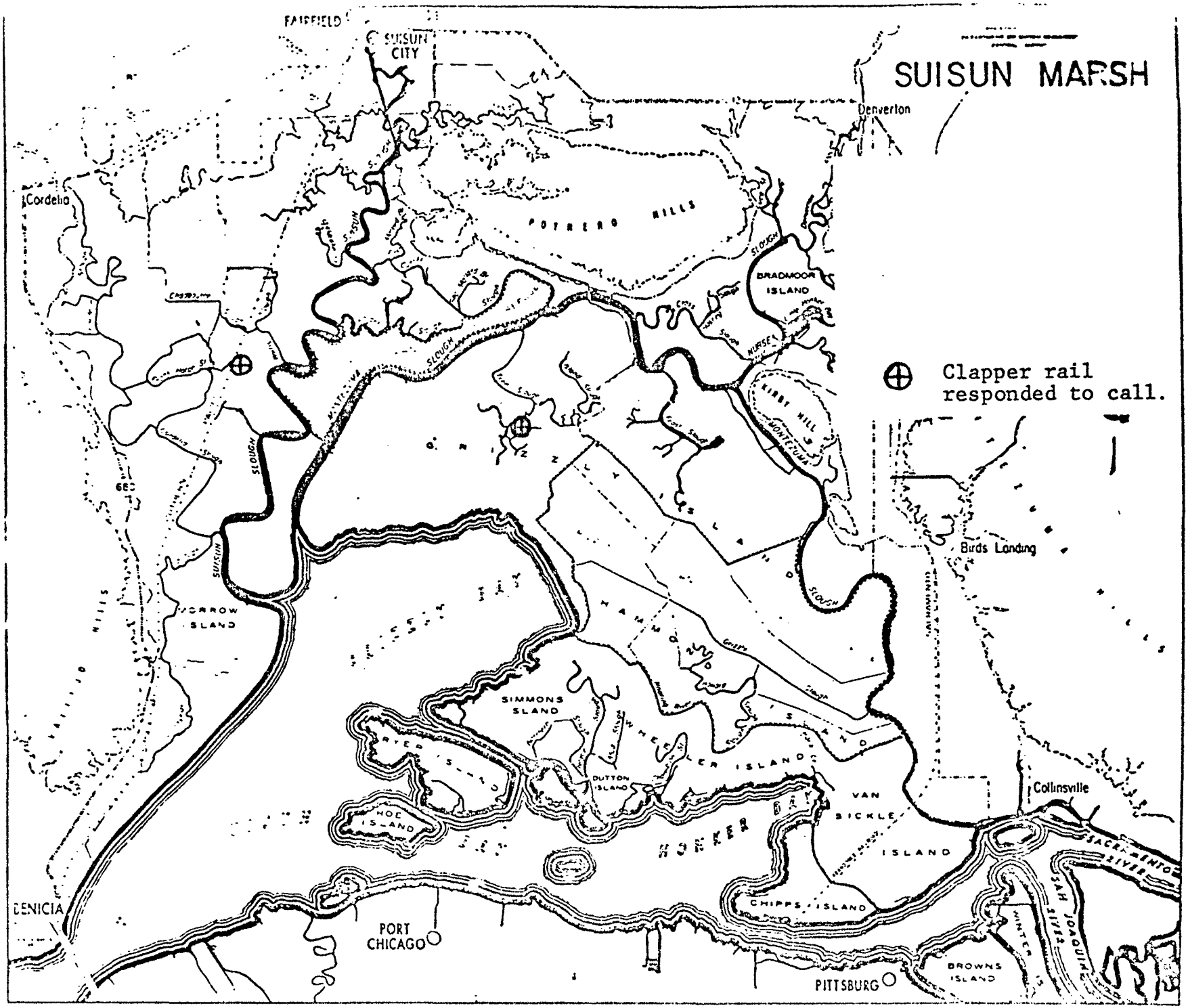




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Previous studies (Applegarth 1938 and Gill 1979) have documented the importance of Spartina spp. to the rail, however, the habitat in the Marsh more closely corresponds to habitat described for the Yuma clapper rail R.l. Yumanensis, consisting of shallow-water areas with mud flats containing dense stands of bulrushes and cattails (Tomlinson and Todd 1973). This tidal habitat is similar to that in the vicinity of Cutoff Slough in the Marsh. The majority of the rails were observed or heard in this area. All rails observed by Harvey (1980) were observed in tidal marshes. Tidal marshes that were utilized generally contained gradually sloping banks, where a mud flat zone would be exposed during low tides. Asiatic clams (Corbicula spp.), softshelled clams (Mya arenaria) and the barnacles (Balanus improvisus), all important rail food items, were found throughout this area (Harvey 1980).

## V. PROJECT IMPACTS

The Plan for the Marsh will impact both the mouse and the rail. All four elements; Delta Outflow, the Physical Facilities, the Monitoring Program and the Management Program will have varying levels of impacts.

1. Delta Outflow Impact

The impact of the project providing Delta outflows to support an adequate water quality at Collinsville will not cause any direct impacts to either the mouse or the rail. The secondary impacts of this project



C—053924

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feature, however, on the mouse may be significant. Consistent water quality at Collinsville may allow for the management program to be more effective. This capability may increase the potential for significant direct impacts from the management program. These direct impacts will be discussed in that section.

2. Physical Facilities Impacts

Potential construction-related impacts of the physical facilities are of two major types, direct and secondary. The first direct impact, construction activity with its increased level of noise, traffic and other human disturbance, may temporarily affect both species. However, no evidence exists that the rail or mouse may be adversely impacted, since populations of both species are found near heavily industrialized areas with high levels of traffic and other human disturbance. In addition, although the CDFG survey in the vicinity of the alignments for the Grizzly Island Ditch route and the Cygnus Ditch route, indicated the presence of the rail (CDFG 1980b), Harvey (1980) located no rails in the area of facilities to be constructed. All rails he found were concentrated near tidal channels. Because of the rail's affinity for these tidal areas, and since no construction is planned there, no impacts are anticipated on the rail.

The second major impact will cause the direct loss of marshland habitat due to project construction. Approximately 340 acres of wetland will be lost. Table 5 breaks down these habitat impacts by facility. In addition to the direct habitat losses due to construction of the physical facilities, individual animals may be impacted by construction equipment. Rails should not be impacted significantly because of their occurrence in tidal areas away from construction sites. None of the impacted areas are considered preferred rail habitat (Harvey 1980). The mouse, however, has been identified in the vicinity of these sites by Shellhammer (1980). In addition, while not surveyed by Shellhammer in his 1980 study, marsh vegetation on the Cordelia-Goodyear Ditch alignment probably also supports the mouse. Table 6 indicates that approximately 80 acres of seasonal marshland supporting a matrix of pickleweed, fat hen, brass buttons, and alkali bulrush would be impacted by this facility. This acreage is included in the 340 acre estimate in Table 5.

Because of their more limited mobility, mice may be directly impacted by construction. Heavy equipment used in removing vegetation, scraping and dredging may destroy mice not able to escape these activities.

Impacts from construction activities will generally be temporary but habitat losses due to constructing the physical facilities will be permanent. Losing 340 acres



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TABLE 5.

Marsh Vegetation Impacts from Facility Construction.

| Facility | Marsh Vegetation Disturbed |
|---|---|
| Montezuma Slough Control Structure | |
| Grizzly Island Ditch | 69.6 hectares (172 acres) |
| Potrero Hills Ditch | 14.2 hectares (35 acres) |
| Cordelia Goodyear Ditch | 32.0 hectares (80 acres) |
| Boynton-Cordelia Ditch | 8.0 hectares (20 acres) |
| Cygnus Ditch | 13.0 hectares (32 acres) |
| Total | 136.8 hectares (339 acres) |



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of marshland habitat, some of which is capable of supporting the mouse, is significant when recognizing the importance of this valuable habitat even in such small amounts. The loss of this habitat could increase the difficulty in effecting a recovery plan for the mouse. Losing this habitat puts a slightly greater burden on other sites to provide enhancement possibilities.

3. Monitoring Program Impacts

Impacts from the monitoring program may affect both species from the installation of new soil-water-salinity monitoring sites, subsequent visits to collect data from these stations and future plant and wildlife survey work (Figure 6). These impacts would result from vegetative trampling, noise and other human disturbance while stations were being installed and data collected.

The monitoring program will also have a secondary impact of providing supporting data to meet the requirements of Decision 1485 and providing information to assist club managers in following their club management plans, which are significant elements of the Plan's management program. The discussion of the impacts of this program is in the following section.

4. Management Program Impacts

The individual club management plans mandated in AB-1717 are also a significant part of the Plan. As

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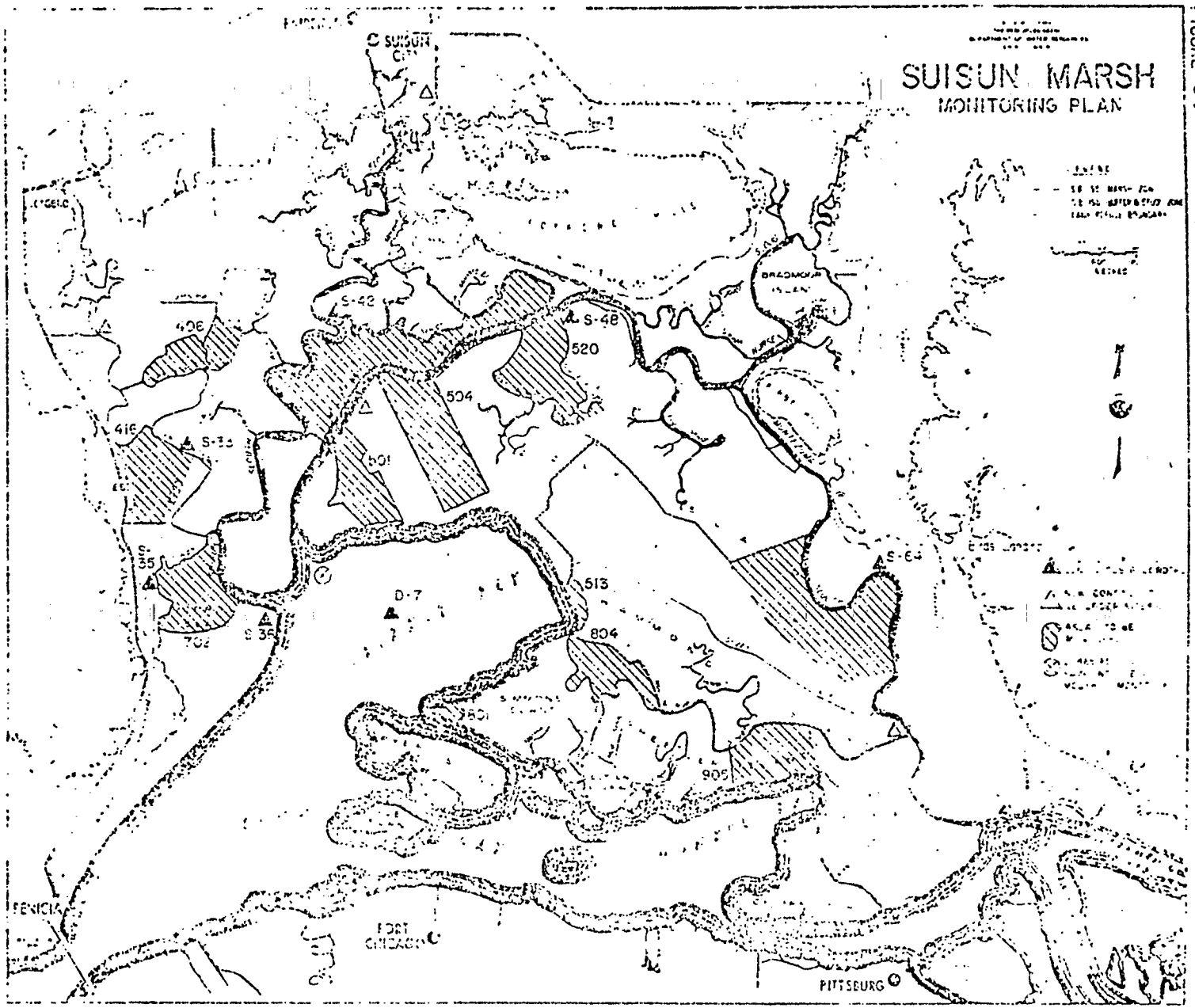


FIGURE 6.



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discussed earlier in the project description, success of maintaining Marsh habitat will hinge on the effectiveness of the physical facilities along with the effective water management outlined in each club management plan.

The impact of the management program on the rail and the mouse is a combination of direct and secondary impacts.

Marsh management plans will not impact habitat conditions in the Cutoff Slough area. As described earlier, Harvey (1980) found this area to contain the highest concentrations of rails. This same study located rails in four locations along Montezuma Slough. Two west of the inlet to Cutoff Slough and two near the outlet to Grizzly Bay.

The impact of the club management plans on the rail will be negligible in light of the recent surveys in the Marsh (CDFG 1980b; Harvey 1980).

Club management plans combined with the physical facilities may have a secondary impact, by temporarily increasing salinities as salt is more effectively leached from Marsh clubs and discharged into Montezuma Slough. No significant changes in vegetation are anticipated due to the short term nature of this impact. In two to three years clubs will have effectively leached large salt concentrations and drain water salinities will stabilize.

The management plans will also impact the mouse. The extent of this impact will depend on an, as yet unknown, level of compliance. Management plan recommendations are designed to improve stands of alkali bulrush, fat hen and brass buttons. In addition, while not designed for it, these stands would also include pickleweed, a recognized crucial component of this matrix for the mouse. This resulting dense matrix of vegetation has been identified by researchers as extremely valuable mouse habitat (Fisler 1965, Biosystems 1978 and 1979). Figure 7 shows diagramatically the anticipated distribution of pickleweed due to management proposed in the club management plans (Mall 1969). The new management plans, however, do not favor the retention or establishment of dense, lush stands of pickleweed, also identified as valuable habitat for the mouse (Shellhammer 1980). Many of the management plans, as recommended, encourage club managers to decrease pickleweed acreage through discing and specific water management activitives. Flooding procedures outlined for alkali bulrush management call for flood and drain cycles that will more effectively leach soil salts and discourage pickleweed. This is a result of the pickleweed's range of salinity and flooding tolerances. Soil-water-salinity less than 30 ppt TDS and soil submergence of more than six months, significantly decrease pickleweed's competitive ability (Figure 8) (Mall 1969).



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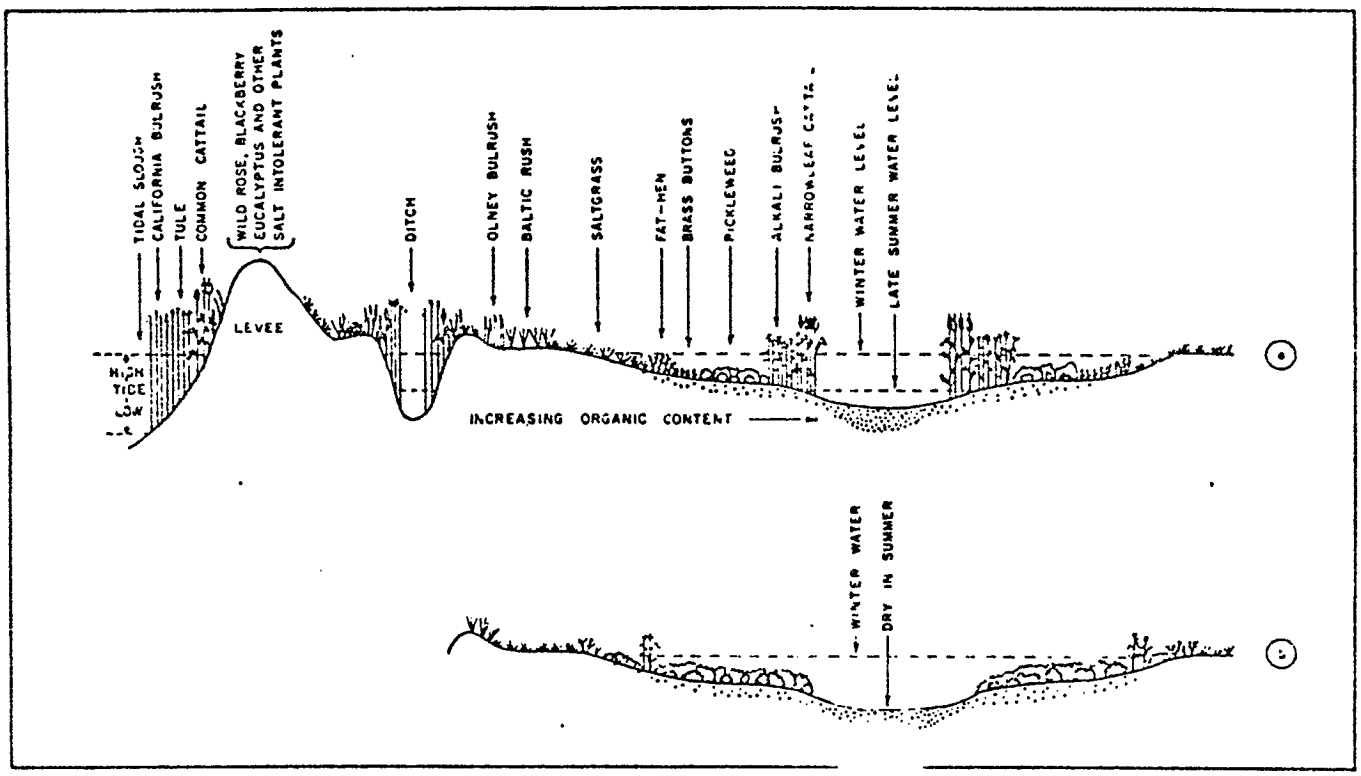


Figure 7. Schematic representation of plant distribution in the Suisun Marsh in relation to two kinds of water management: (a) maintenance of pond water into early summer and (b) early spring water removal. (Mall 1969)



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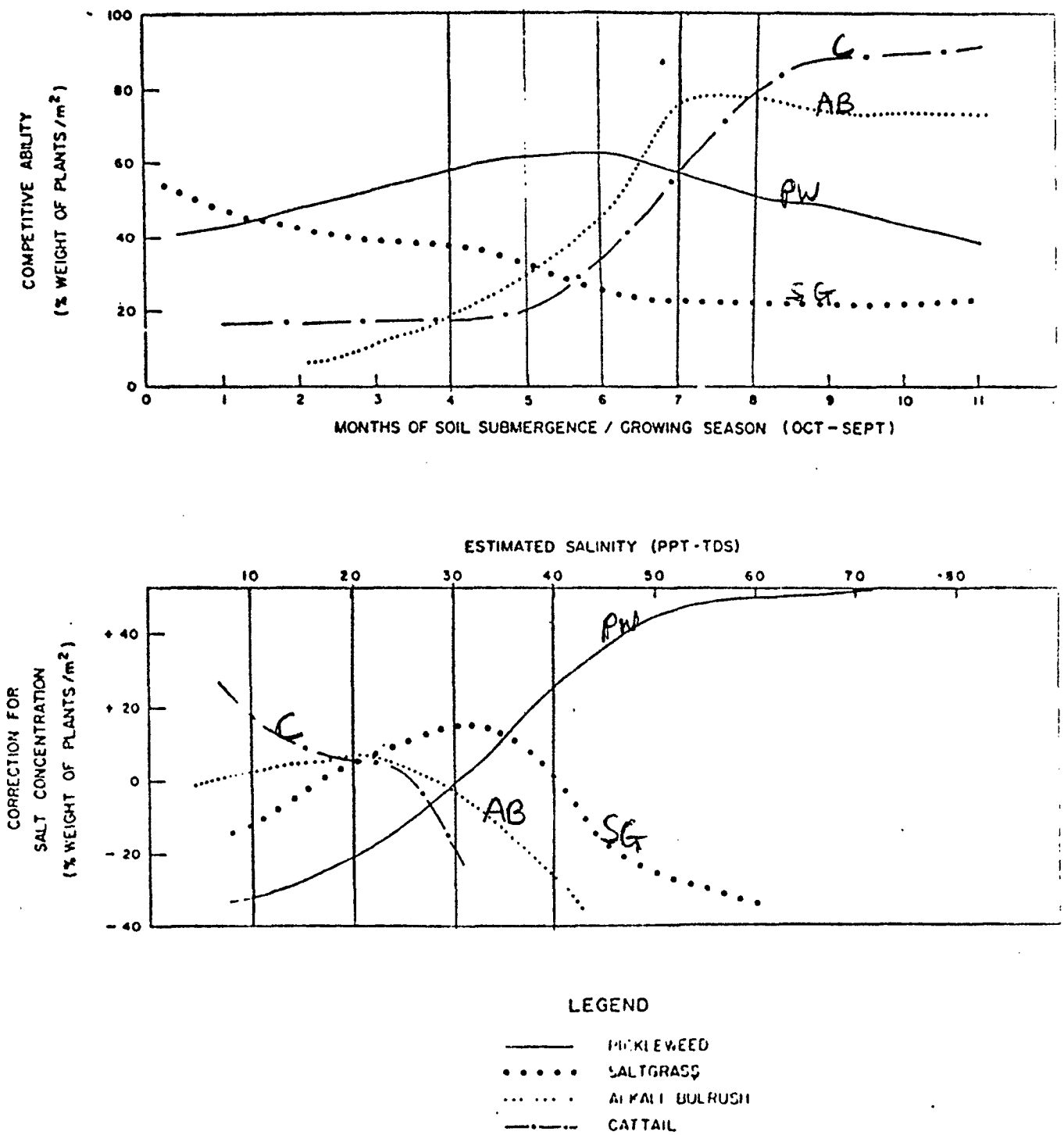


Figure 8. The relation of competitive ability of six Suisun Marsh plants to length of soil submergence and mean annual soil salt concentration. (Mall 1969)



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The cumulative impact of the implementation of the management program would be a decrease in the amount of suitable mouse habitat that is provided by dominant pickleweed. An estimate of the magnitude of this decrease is not presently possible. Full implementation of these management plans will require the enforcement and funding capabilities being sought through legislation by the SRCD. Without this legislation and enforcement, full implementation of these management plans is unlikely. An estimate cannot be made at this time of the level of compliance without legislation.

Any loss of suitable mouse habitat could put a greater burden on other areas such as the Contra Costa shoreline and areas near Collinsville just east of the Marsh for the protection and restoration of the mouse.

## VI. PROJECT ALTERNATIVES

### Relocated Project Facilities

Project channels could be significantly relocated from the present recommended alignments. This alternative would mainly relate to the Potrero Hills Ditch, Cygnus Bypass, Cordelia-Goodyear Ditch and the Boynton-Cordelia Ditch. The present alignments have already been chosen to reduce the impact to wetlands, and the locations of the cross marsh channels are designed to provide required water quality on individual clubs. Computer models were used to evaluate and verify current facility locations. Construction costs could be significantly increased if rerouting facilities did not allow for the use of existing channels. Since significant realignments, for example, of Potrero Hills Ditch would not allow for adequate water quality, and since present alignments were selected to minimize wetland loss, this alternative was rejected.

### Smaller Scale Project

A modified project would eliminate selected features of the proposed Plan. An example would be not constructing the Grizzly Island Distribution System. This alternative would reduce the impacts on the mouse and construction costs would also be significantly reduced. However, water quality requirements could not be met (CDWR 1980). The Marsh would continue, but at a reduced rate, to shift toward a more saline marsh with less wildlife diversity as upstream diversions continued and Delta outflows were reduced. Its value to the wide variety of wildlife currently supported by this brackish marsh would be gradually reduced while some species that prefer a more saline marsh would increase. For these reasons, this alternative was rejected.

## No Project

This alternative would eliminate all physical facilities as proposed in the Plan. This would eliminate the direct loss of wetlands from construction. No impacts would occur from a monitoring program. Eliminating the proposed flows at Collinsville would gradually result in more saline conditions, resulting in decreased wildlife diversity throughout the Marsh. It would benefit the mouse but may reduce the dense tules and cattails along Cutoff Slough and Montezuma Slough which provide habitat for the rail. This would result in a negative impact on the rail.

With funding and increased enforcement authority for the SRCD, impacts from the implementation of the club management plans will continue as mandated by AB-1717. The impacts attributed to the club management programs (page 32) would be present, but to a lesser extent, with a no project alternative.

A no project alternative would allow the current trend of the Marsh toward a salt marsh. As it shifted away from a brackish marsh, its high value to numerous species of fish and wildlife currently using the area would decrease. Birds such as the pintail (*Anas acuta*) and mammals such as river otter (*Lutra canadensis*) would be reduced. The value of the Marsh as a nursery area for striped bass (*Morone saxatilis*) would also be reduced. Because of these reasons, the no project alternative was rejected.

## Increased Delta Outflow

This alternative would require reallocating 1.8 to 2.0 million acre-feet of water now being used for agriculture, urban and industrial uses to the Marsh. Impacts from facility construction would be substantially reduced with a resulting decrease in impacts on the

mouse. However, current water contracts could not be met with this alternative. In addition, the SWRCB has found this alternative to be an inappropriate use for the State's water resources. For these reasons, the alternative was rejected.

## VII. CONSERVATION MEASURES

The following sections describe measures which will be undertaken to maintain viable populations of the mouse and the rail in the Marsh. The primary actions involve the mouse and the goal will be to maintain at least 2,500 acres of Preferred Mouse Habitat distributed throughout the Marsh.

### Proposed Measures to Lessen Project Impacts

There are potential features that, if implemented, could reduce the impact of the Plan of the mouse. It is believed that no significant adverse impacts will occur on the rail. Possibilities to lessen project impacts occur for the physical facilities, monitoring program and management program features of the Plan.

#### Physical Facilities

During the construction of these facilities, efforts will be made to minimize any losses to the mouse. Potential mouse habitat will be trapped to remove mice that would be destroyed by construction activity. These mice may be moved to other suitable habitat, including recently developed habitat capable of supporting mice but not now doing so. Trapping should also take place early in the season to reduce impacts of breeding mice or mice

with litters. Construction crews and equipment will work as closely as possible within the limits and alignments of the project to reduce disturbance to the rail and mouse.

## Monitoring Program

Although impacts from this element of the Plan are minor, possibilities exist for reducing impacts even further. During the installation of the soil-water sampling sites, human disturbance will be kept to a minimum to reduce the impacts of the project feature. This same effort will be made for followup monitoring. Aerial photo verification work will be accomplished using established travel routes whenever possible. Should future work be necessary to survey rail or mouse populations, proven existing techniques (Shellhammer 1980, Harvey 1980) will be used by current experts in the field to collect the required data (as determined by the USFWS and the CDFG) with a minimum of disturbance.

## Management Program

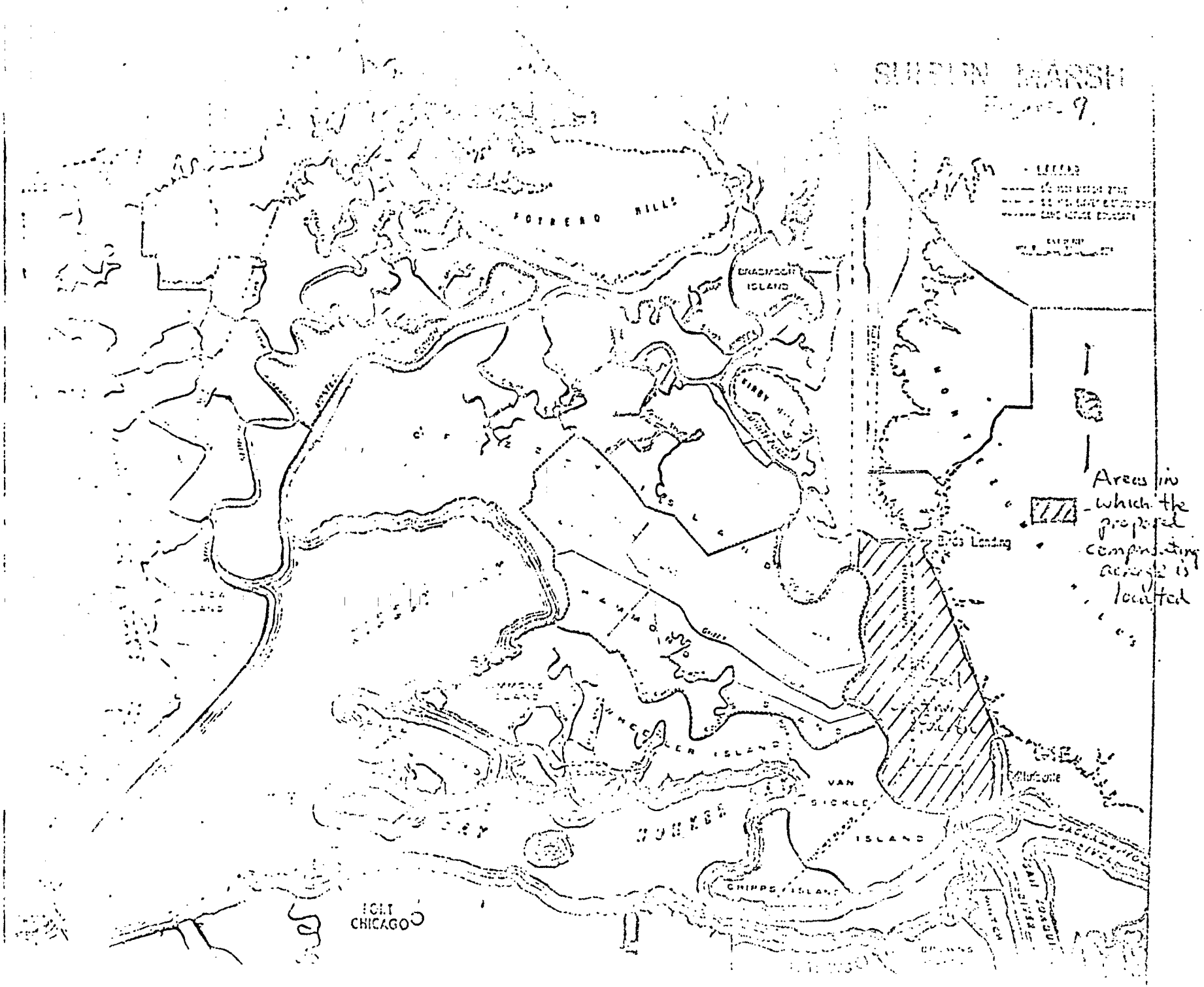
Even though the management program may result in a reduction of Preferred Mouse Habitat as defined on page 17, there will be some cases where the value of the habitat to the mouse will remain the same, or in some cases, be enhanced. Clubs with fat hen management or combinations of fat hen management and alkali bulrush management will produce diverse associations of plants similar to that shown in Figure 7. Should these areas contain the necessary habitat components they will continue to provide mouse habitat. In addition, the management plans along with the proposed facilities will also provide for the conversion of salt grass and pickleweed

areas of little or no value to the mouse or other species of wildlife, such as waterfowl, to dense, productive stands of fat hen, alkali bulrush, brass buttons, and other associated marsh plants that will include pickleweed in the matrix. In general, larger areas of lower habitat quality will be substituted with smaller areas of better habitat quality for the mouse.

Compensation

Because of its status as an endangered species, all reasonable and prudent alternatives which can be taken that would avoid jeopardizing the continued existence of the mouse or adversely modifying its critical habitat must be considered if the proposed action is to be implemented. In addition, because of Presidential Executive Order 11990 (Protection of Wetlands), full compensation is required for wetlands which are adversely impacted. The proposed compensation will accomplish these goals by retaining Preferred Mouse Habitat evenly distributed throughout the Marsh and replacing, acre for acre, the wetland lost due to project construction.

The physical facilities will result in the loss of 340 acres of wetland. Approximately 100 acres of this is considered Preferred Mouse Habitat by the USFWS and the CDFG. To compensate for the loss of wetland, a comparable amount of new wetland will be developed. Tentatively 378 acres of land in the eastern portion of the marsh have been identified for acquisition for this purpose. Management of at least 100 acres of this land as Preferred Mouse Habitat will compensate for the loss of mouse habitat from the construction of project facilities. The specific habitat requirements of the mouse will be met. Management will be coordinated with the CDFG and the USFWS. Figure 9 shows the general area in which this 378 acre



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parcel will be located.

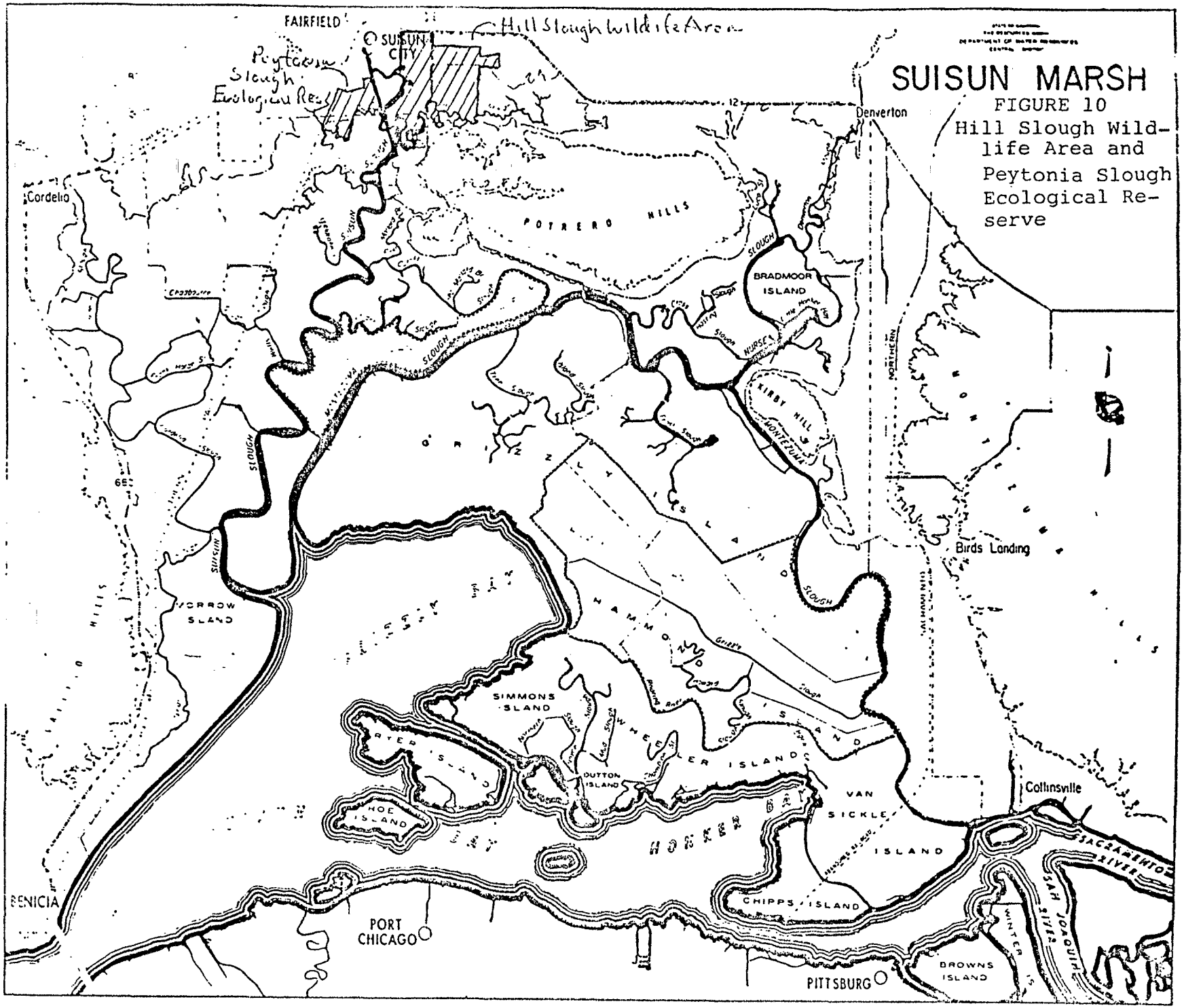
Habitat will also be maintained on a CDFG ecological reserve and several state wildlife areas within the Marsh. Approximately 1,000 acres of these existing areas, and appropriate portions of future acquisitions, will be managed for Preferred Mouse Habitat. Parcels would range in size between approximately 100 and 500 acres. Each parcel would be managed to provide the preferred habitat described earlier in this assessment. This will take the following approach:

A. Selected portions of Grizzly Island and Joice Island Wildlife areas will be retained and managed as Preferred Mouse Habitat. This will be a total of approximately 700 acres.

B. Selected portions of the Hill Slough Wildlife Area will be managed as Preferred Mouse Habitat. This will involve converting areas presently [illegible] totaling approximately 100 acres.

C. The Peytonia Slough Ecological Reserve is currently 206 acres in size. Most of this area is presently good to excellent mouse habitat, The [illegible] will be retained and managed as Preferred Mouse Habitat (Fig. 10).

In addition, an estimated 500 acres of the 1,112 acre Hill Slough Wildlife Area will be converted from salt grass to managed wetlands with the objective being to grow alkali bulrush and fat hen. The resulting vegetative matrix will provide some habitat of value for the mouse (Figure 10). Several areas, such as the channel islands (Ryer, Roe, Freeman, and Snag islands), while not classified as tidal, will not be subject to the proposed Plan.



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Compensation is proposed to offset the waterfowl food loss on these areas. Approximately 580 acres will be acquired in the eastern section of the Marsh for compensation. The CDFG proposes to manage this area for the primary purpose of promoting the establishment of vegetative complexes that are capable of providing increased waterfowl food production. The resulting diverse marsh plant community will secondarily provide some mouse habitat, especially those areas adjacent to upland habitat needed as escape cover during periods of flooding.

Increased channel salinities resulting from future increased water diversions will, as a by-product, improve habitat for the mouse in tidal areas in the Marsh. Resultant increased salinities will make tidal areas more favorable for pickleweed (Mall 1969). Acreage calculations were made using past aerial vegetative surveys. Surveys show that approximately 3,150 acres of tules and/or cattails will be affected. More salt tolerant species such as pickleweed, cordgrass (Spartina sp.), gum plant (Grindelia sp.) and alkali bulrush will become dominant. Not all of this acreage will support the mouse since some areas will be of insufficient size or not in association with adequate escape cover during periods of flooding. However, the increase in pickleweed and other more salt tolerant plants in those areas that meet the habitat requirements will partially compensate for the adverse impact on mouse habitat. Levees built during project construction may also support dense escape cover in some areas that currently lack this critical habitat component.

In the event the proposed conservation measures are not successful, and habitat supporting the mouse shows a significant decrease

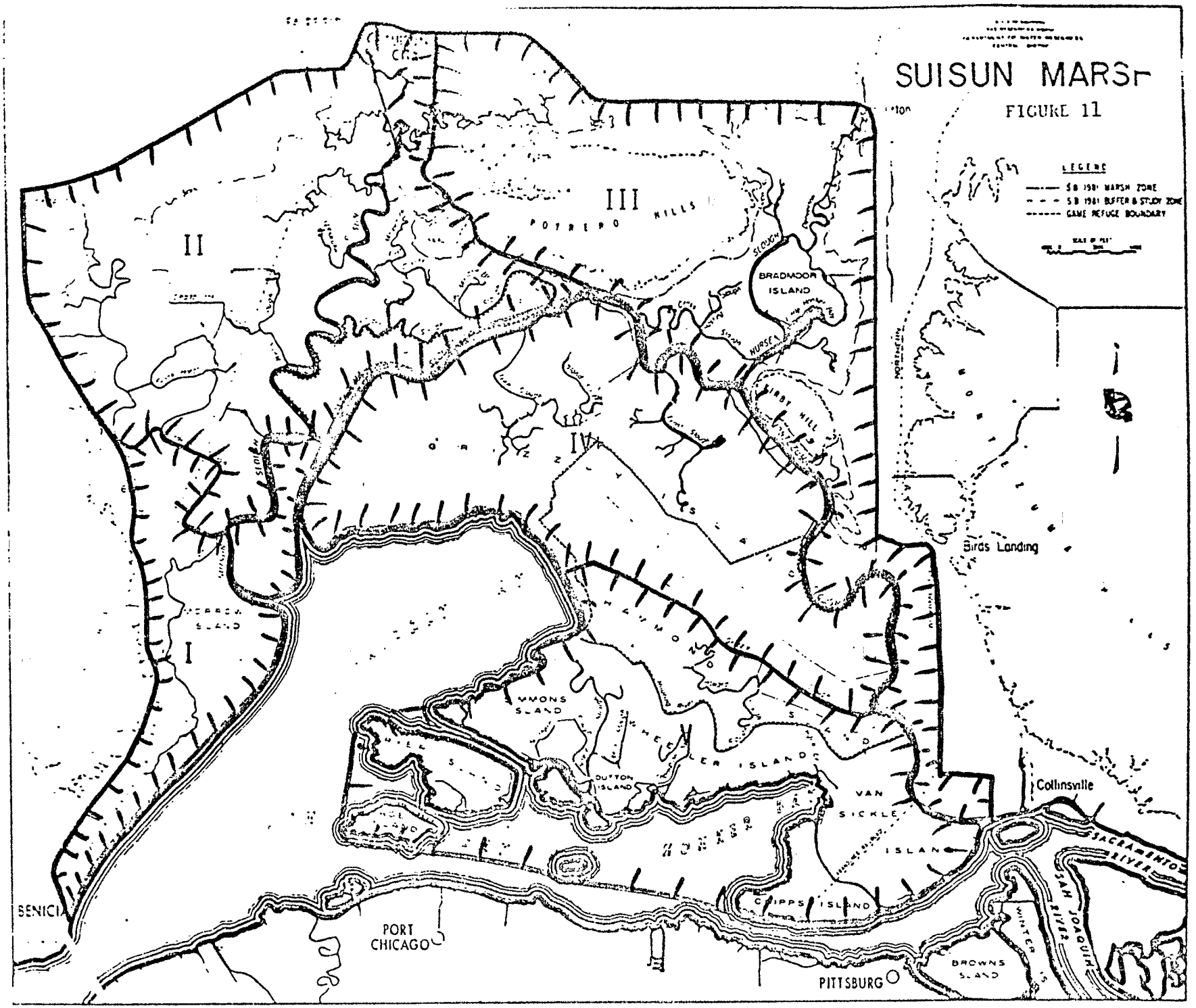
as a result of the Plan, wording in the Three-agency Marsh Management Agreement between the SRCD, CDFG and CDWR will provide for appropriate modifications in selected club plans. A change in Preferred Mouse Habitat would be considered to be significant when the acreage classified as such decreases by one-third in any zone (based on ground verification of the 1981 flight). Management plans would then be modified as necessary on selected clubs to assure the retention of substantial tracts of Preferred Mouse Habitat. Initial recommendations for modification of these club plans would be made jointly by the CDFG and USFWS. Appropriate modifications would be chosen by the CDFG, USFWS, SCS, and SRCD. The SRCD would then be petitioned to make the needed modifications.

The aerial photographs described in the Plan's monitoring program will be used to monitor Preferred Mouse Habitat in each of five zones delineated in Figure 11. Preferred Mouse Habitat, as defined on page 17, was chosen as a basis for measuring changes in mouse habitat. While these areas represent the most valuable habitat to the mouse, they are not the only areas that support mice. However, these preferred habitat areas will provide a useable index to measure changes in all mouse habitat. The Marsh is divided into five zones to more finely tune the monitoring effort. Changes in preferred habitat can be detected with greater accuracy and should corrective measures be indicated, modifications would be made in the area in which impacts occurred. Pickleweed will be used as an initial indicator species in light of the significant relationship between its occurrence and the presence of the mouse. Current pickleweed areas would be mapped using the planned 1981 flight. Ground truthing would then be used to determine the



C—053944

C-053944






C-053945

C-053945

approximate acreage of Preferred Mouse Habitat that meets the density, height and condition requirements outlined previously as preferred habitat. Future flights and ground verification at three year intervals will then be used to monitor changes in the Preferred Mouse Habitat.

The nature and extent of this sampling and amount of ground verification will depend on the acreage of preferred habitat found in the 1981 baseline flight. In any case, similar monitoring efforts will be made on areas under intensive management as well as areas with little or no management. If a significant decrease is indicated in any of the five zones, measures would be taken to modify appropriate club management plans in the zone(s) affected. The goal of this measure shall be that at least 2,500 acres of Preferred Mouse Habitat shall be retained in and adequately distributed throughout the Marsh. This Preferred Mouse Habitat would meet all the criteria previously outlined for preferred habitat. Monitoring of habitat would be a CDFG responsibility provided for through contract with the CDWR and coordinated with the USFWS.

The conservation measures proposed are expected to insure the perpetuation of viable populations of the mouse in the Marsh.



C—053946

C-053946

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C—053948

C-053948

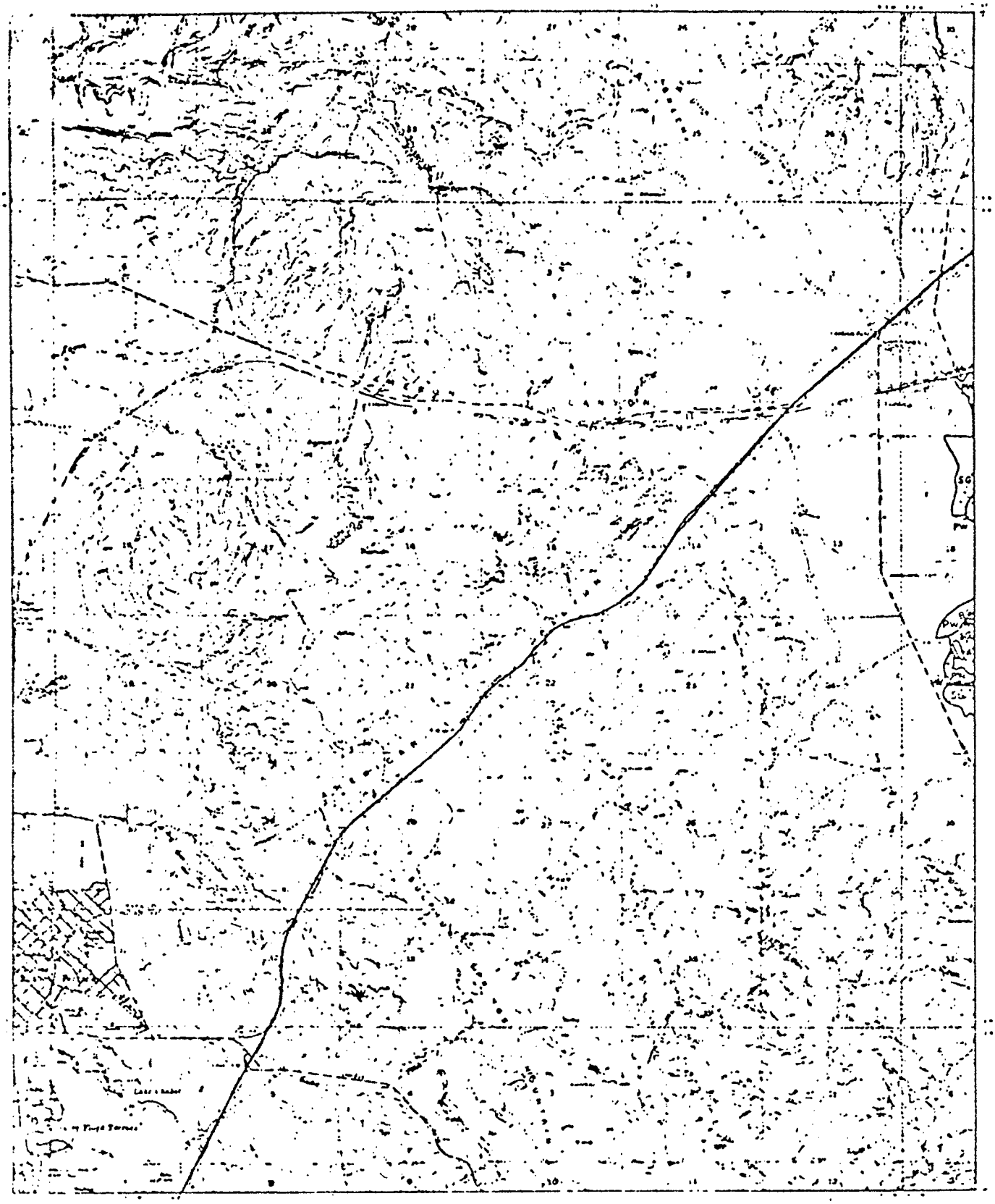
# IX. APPENDICES



C—053949

C-053949

Figure 31-19



SUISUN MARSH
VEGETATION

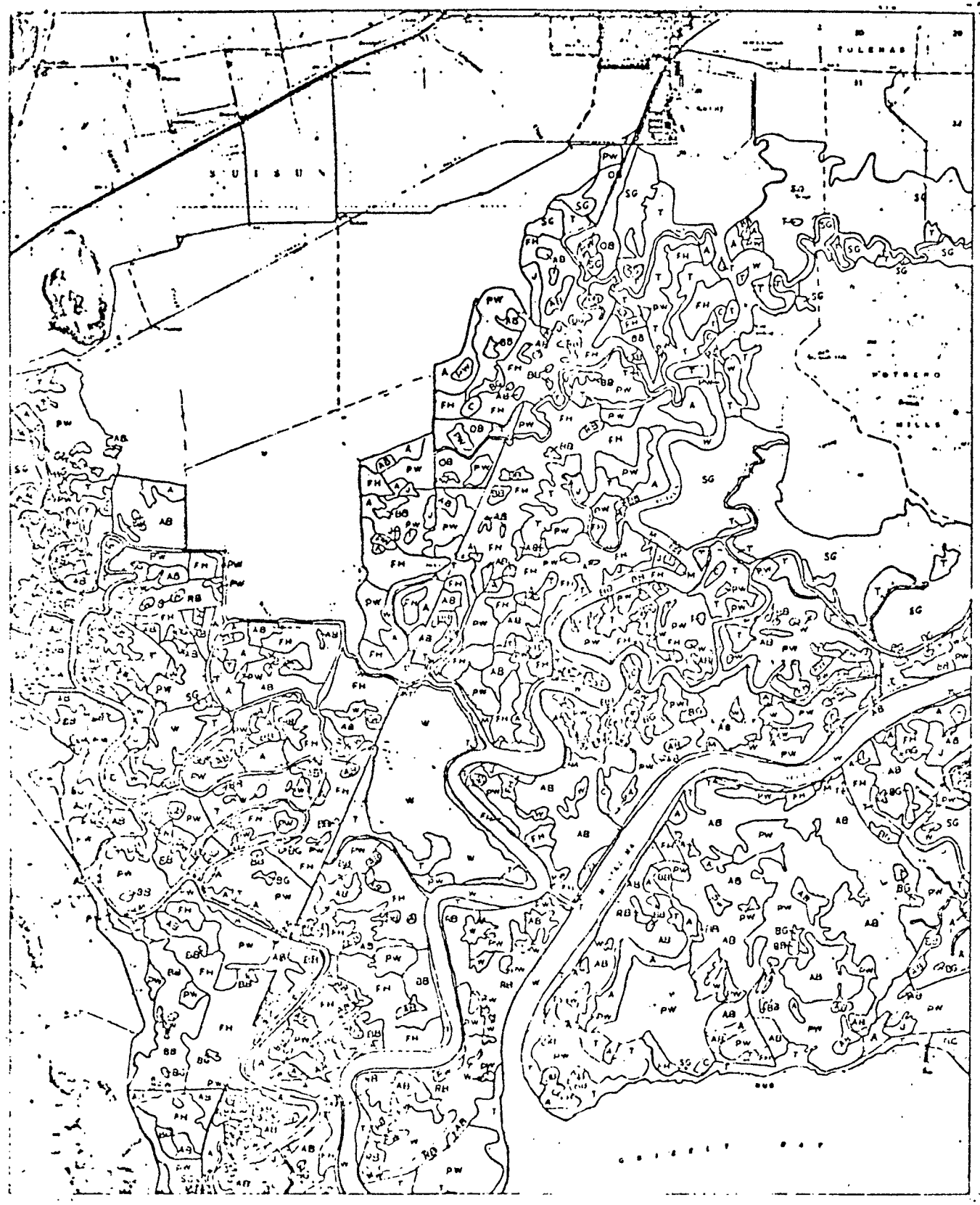
SCALE
1 ½ 0 1 Mile
1000 0 2000 4000 6000 FT

CORDELIA, CALIF

SALTGRASS, PW= PICKLEWEED, BG= BARE GROUND, M= MISCELLANEOUS
W = PONDS 1 INCH = 1 MILE

THE RESOURCES AGENCY
DEPARTMENT OF FISH AND GAME

Figure 31—20




SUISUN MARSH
VEGETATION

SCALE
1 ½ 0 1 Mile

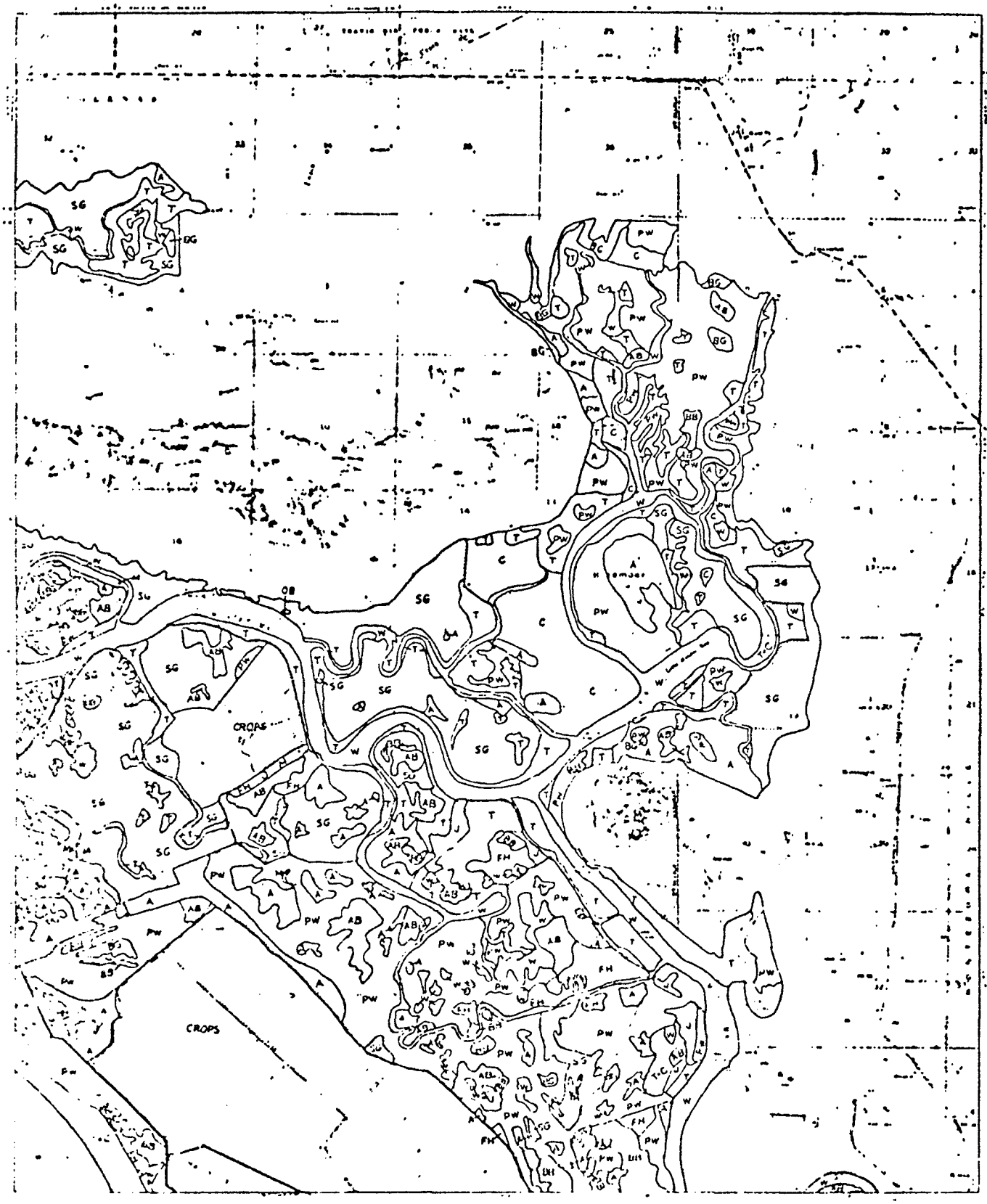
FAIRFIELD SOUTH, CALIF.

SALTGRASS, PW = PICKLEWEED, AB = ALKALI BULRUSH, J = BALTIC RUSH, T = TULES
CATTAILS, BB = BRASS BUTTONS, A = ANNUALS, OB = OLNEY BULRUSH, M = MISCELLANEOUS
BARE GROUND, FH = FAT HEN, W = PONDS 1 INCH = 1 MILE

C—053951

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF FISH AND GAME

Figure 31-21




SUISUN MARSH
VEGETATION

SCALE
1 ½ 0 1 Mile
1000 0 2000 4000 6000 FT

DENVERTON, CALIF

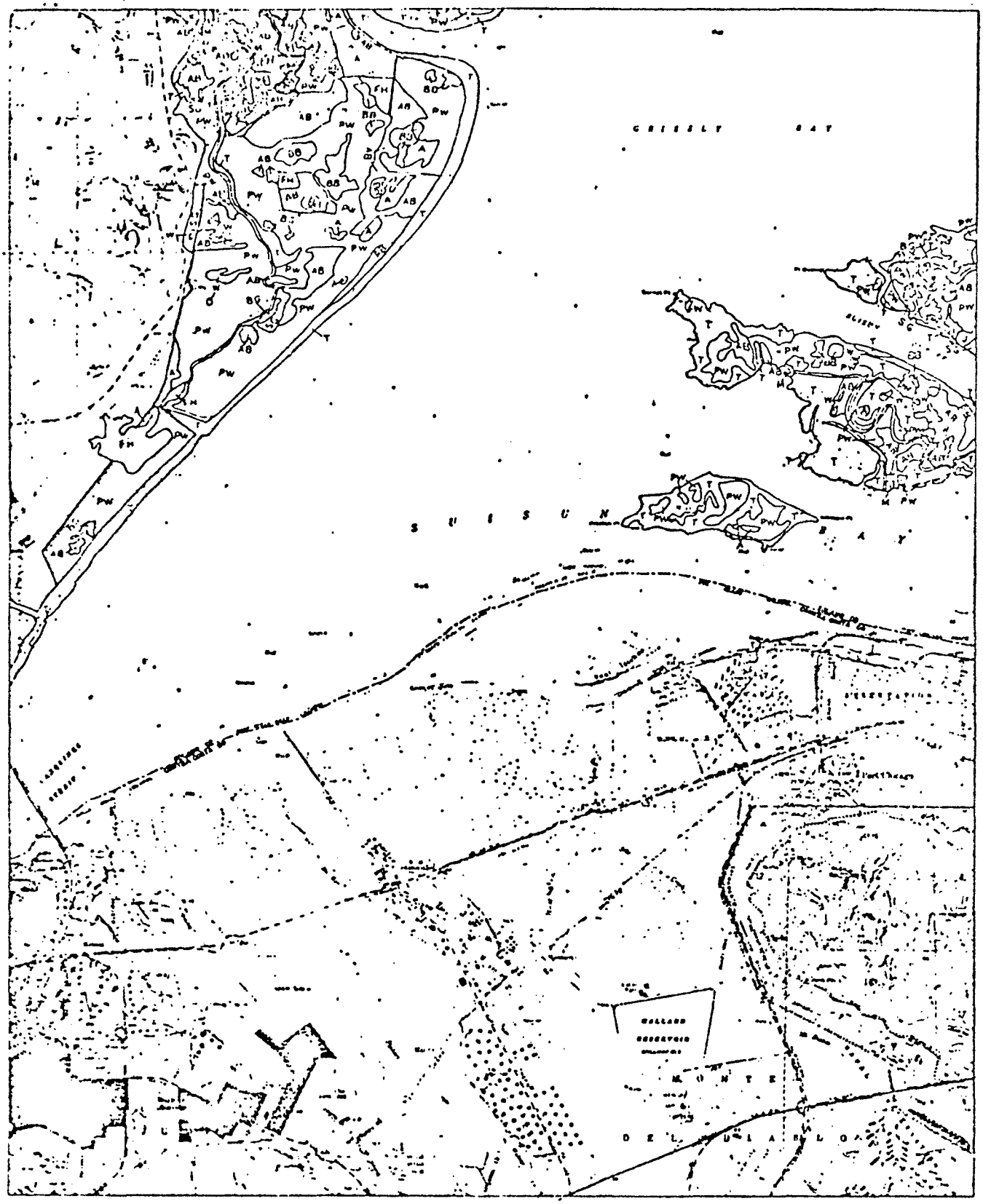
SG=SALTGRASS, PW= PICKLEWEED, AB= ALKALI BULRUSH, J= BALTIC RUSH, T= TULES
CATTAILS, BB= BRASS BUTTONS, A= ANNUALS, M= MISCELLANEOUS, BG= BARE GROUND
AT HEN, W= PONDS 1 INCH = 1 MILE

C-053952

C-053952

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF FISH AND GAME

Figure 32-20




SUISUN MARSH
VEGETATION

SCALE
1 ½ 0 1 Mile
1000 0 2000 4000 6000 FT

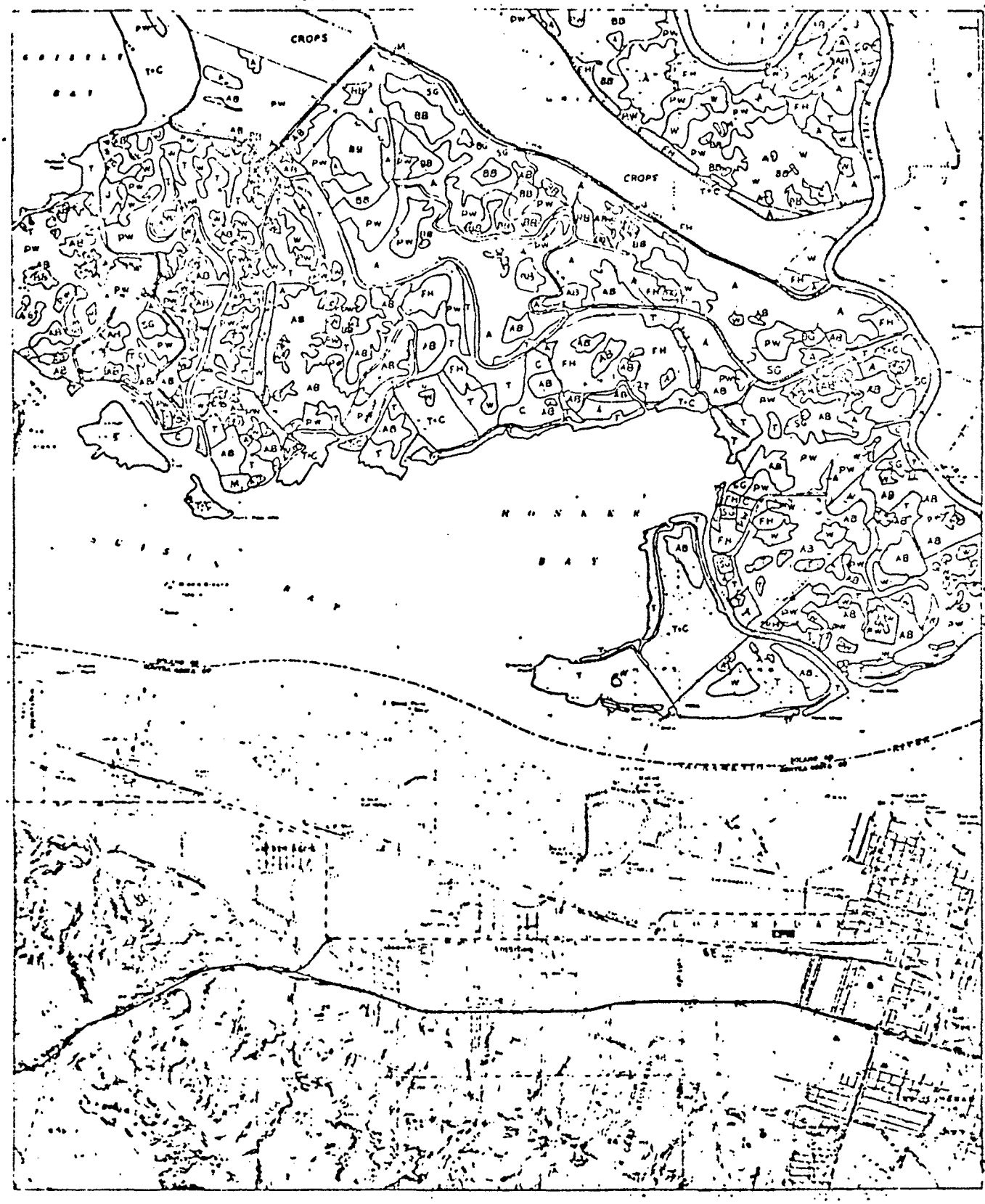
PORT CHICAGO, CALIF

PICKLEWEED, SG=SALTGRASS, AB=ALKALI BULRUSH, J=BALTIC RUSH, T= TULES
CATTAILS, BB= BRASS BUTTONS, A=ANNUALS, OB=OLNEY BULRUSH, M=MISCELLANEOUS

C—053953

THE RES[illegible]CES AGENCY
DEPART[illegible] [illegible]ISH AND GAME

Figure 32-21




SUISUN MARSH
VEGETATION

SCALE
1 ½ 0 1 Mile
1000 0 2000 4000 6000 FT.

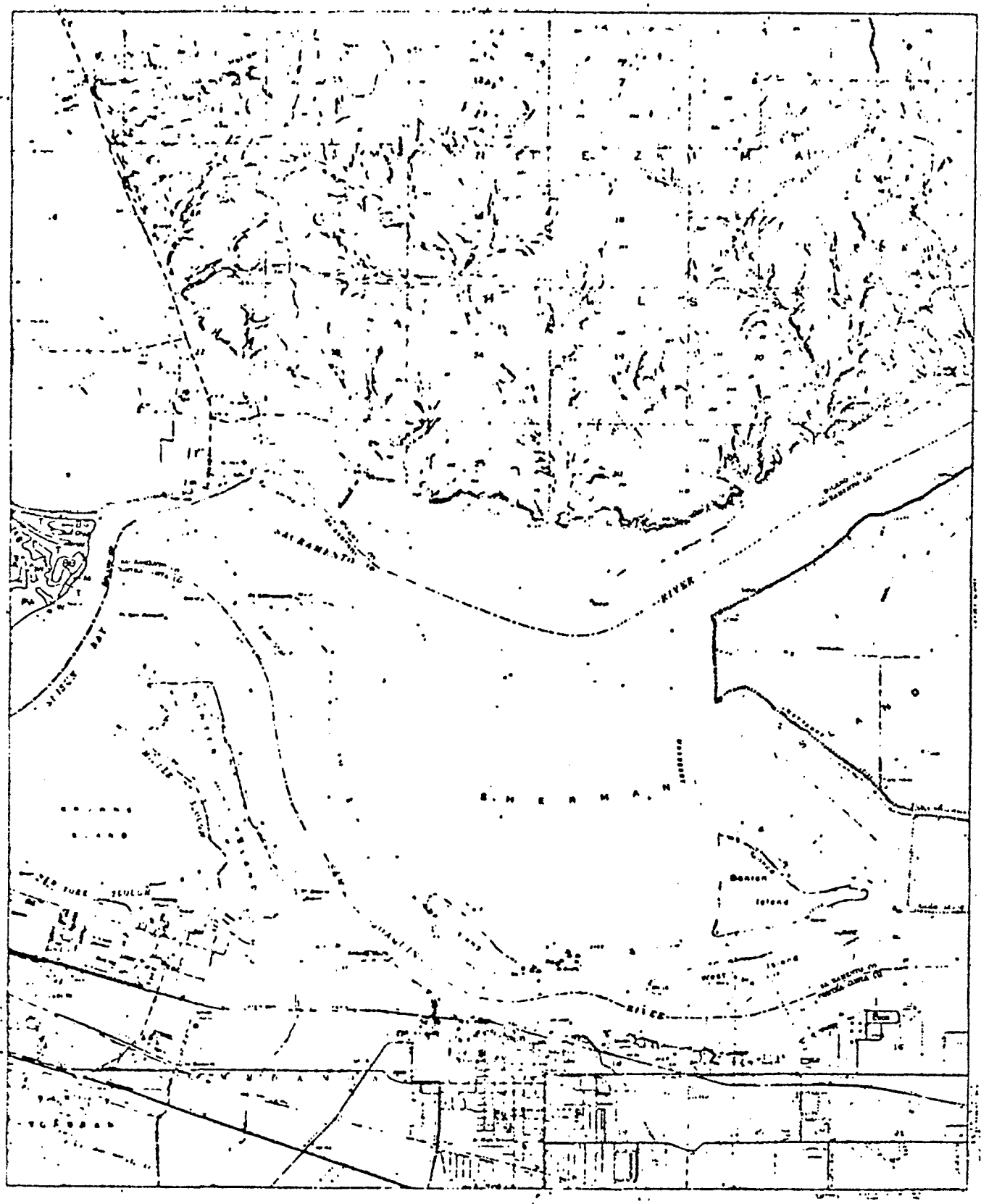
HONKER BAY, CALIF

[illegible]W=PICKLEWEED SG=SALTGRASS AB=ALKALI BULRUSH J=BALTIC RUSH T=TULES
[illegible]=CATTAILS BB=BRASS BUTTONS A=ANNUALS OB=OLNEY BULRUSH W=PONDS
[illegible]=BARE GROUND M=MISCELLANEOUS [illegible]H=FAT HEN 1 INCH = 1 MILE

C—053954

STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF FISH AND GAME

Figure 32—22




SUISUN MARSH
VEGETATION

SCALE
1 ½ 0 1 Mile
1000 0 2000 4000 6000 FT.

ANTIOCH NORTH, CALIF

PW = PICKLEWEED, AB = ALKALI BULRUSH, T = TULES, BB = BRASS BUTTONS
BG = BARE GROUND, W = PONDS, 1 INCH = 1 MILE

C—053955

CLUB # 426 TIP END GUN CLUB

LAND USE SUMMARY

| Field Number | Total Acres | Flooded Acres |
|---|---|---|
| 1 | 215.5 | 215.5 |
| Tidal | 30 | ----- |
| Bay | 407 | ----- |
| TOTAL | 652.5 | 215.5 |

PRESENT CLUB CONDITIONS

WATER CONTROL

The club is presently flooding and draining thru one 36 inch structure, A on the map. Natural channels convey water in the interior part of the property. No dikes occur to divide fields.

The levee receives severe abuse from the weather, and wave action, expecially where exposed to Grizzly Bay. Levee repairs have been a recurring demand in the past including installation of a wooden bulkhead at the inoperable structure B.

VEGETATION

The dense, tall stands of tules make accurate assesment of vegetative composition difficult. After traveling the perimeter levee the following estimates were made:

| | | | |
|---|---|---|---|
| Hardstem bulrush | 60% | Alkali bulrush | 5% |
| Cattails | 10% | Brass Buttons | 5% |
| Baltic rush | 10% | Pickleweed | 5% |

Other 5%

SUMMARY

This club has a mosiac of vegetative cover present. However, the majority are non-food plants. A large portion of the vegetation is so dense that man nor beast can travel through it.

This club has expressed an interest in growing alkali bulrush as its major food plant. However, a desire to maintain brass buttons and the pothole effect created by screens of hardstem bulrush was also expressed. These ideas can be translated into a desire to maintain cover to attract mallards. A larger open water area will be maintained on the west half of the club, which is attractive to pintail.

The alkali bulrush water management schedule is recommended for this club. It appears that this club cannot complete a 30 day flush cycle with one structure. The most immediate concerns for this club are to regain cross-club circulation and vegetation management.

PROJECT - GRIZZLY ISLAND DITCH

The California Department of Water Resources has plans for a water delivery canal that would provide water at the property's northeast corner. The details of this project are not yet finalized. However, at some time in the future, this additional water source may be available on critically dry years. The club would then flood from this canal and drain through existing structures. Consideration should be given in installation of the inlet from the canal so that maximum cross-club circulation is provided.

## CLUB IMPROVEMENTS

### WATER CONTROL

Needed Improvements: The repair or replacement of structure B is needed for adequate drainage and to return cross-club circulation. Cross-club water movement is important to obtain maximum flushing action. It has been determined that duck clubs in the Suisun Marsh need to have the ability to carry out a 30 day flush cycle to sustain food plant production. The size of structure B must be designed to allow completion of the needed flush cycle.

Structure B would allow best utilization of Grizzly Island ditch water if it were relocated to the club's southwest corner. Relocating structure B is only viable if water will be supplied to the club every year rather than on critically dry years only.

The drainage of this property needs improvements. The rank growth of cattails and tules are encouraged by poor drainage. Salt accumulation in the soil cannot be adequately treated without ditches to allow subsurface drainage. The additional drainage ditches, and the spreader ditches, shown on the map overlay labled "needed" should be installed. After the ditches have been installed and structure B repaired, drainage should be re-evaluated.

The main ditch constructed along the north boundry will complete the perimeter circulation ditch and provide a conveyance for Grizzly Island ditch water.

Soil deterioration can occur in isolated areas of stagnant water. Bare areas of soft, uncohesive, black soil result. Spreader ditches should connect isolated low areas to drainage ditches, and can be obtained from Solano County Mosquito Abatement District at nominal cost (see enclosed sheet). Existing ditches also need cleaning to prevent flow restriction by vegetation.

Levee maintenance will be a recurring item. Extensive repairs have been recently completed; new levee material should be disced after drying to fill cracks.

Club members wish to follow the alkali bulrush water management schedule. Flooding after March should be done, as shown in the alkali bulrush water management schedule, to a shallow depth, (4-6 inches), so that high ground areas on which alkali bulrush growth is limited can be established in fat hen. Water should be circulated through the ditches at all times of the year if this can be accomplished without flooding the ponds during the summer. However, at least once each year the ditches should be drained completely for Carp control. Carp were found in the ditches on this club. These fish can be very destructive to pond vegetation.

Optional Improvements: Drainage improvements shown on the map overlay labled "optional" would tremendously increase circulation across the club and remove soil salts. The cost of these improvements must be balanced against improved condition.

### VEGETATION MANAGEMENT

Needed Improvements: The density of vegetation have made areas useless as they cannot be penetrated. To obtain control of the vegetation present, a burn is needed. Disc and mow afterward to receive maximum benefit from the burn.

The burn should be done in the fall if possible. All burned areas should be disced prior to flooding in accordance with the enclosed alkali bulrush water management schedule.

Discing, alone or accompanying a burn, is needed to control undesirable vegetation (i.e. saltgrass, pickleweed, baltic rush, cattail and tule). Discing should be done in the late summer or fall before flooding for the winter. Pond areas that are to be kept free of non-food plants should be disced as needed. Adequate discing should diminish the need to burn in the future.

Optional Improvements: Club members expressed a desire to keep the pothole effect that the club now has, mowing of ponds should be done in an irregular fashion. Patches of unmown vegetation can also be left for a broken pond appearance. Where visual screens are desired between ponds no discing or mowing should be done. If strips along interior sloughs are not disced, borders of cattail and tules will form there also.

OPTIONAL WATER MANAGEMENT SYSTEMS

The club is almost entirely Reyes soils, which are good soils on which to grow fat hen. Once adequate drainage is obtained, the owner may wish to consider managing his club predominantly for fat hen growth. If so, he should follow the enclosed fat hen water management schedule.

CLUB # 714 ELEANOR STONE

This property is under one ownership, but is leased as two different duck clubs; the north 200 acres is the Sprig Haven Duck Club and the south 95 acres is the Six Gun Club.

LAND USE SUMMARY

| | | |
|---|---|---|
| Sprig Haven Duck Club | Total Acres | 200 |
| | Flooded Acres | 180 |
| Six Gun Club | Total Acres | 95 |
| | Flooded Acres | 50 |

PRESENT CLUB CONDITIONS

Both clubs flood from and drain into Goodyear Slough. Sprig Haven, using structure A, and Six Gun using structure B. Structure D, which in the past transferred water from Sprig Haven to Six Gun, was closed off on the Sprig Haven side during 1978. Three openings at F, G, and H underneath the railroad tracks bring rainwater runoff from the hills west of the railroad tracks into a ditch between the railroad tracks and the western levees of the two clubs.

The interior ditches on both clubs are generally well-maintained and provide good water flow. Because both clubs presently flood and drain using only one structure,water circulation is poor.

VEGETATION

Both clubs are predominantly pickleweed, fat hen, and brass buttons. During the summer of 1978, a good growth of fat hen occurred on both the clubs, but during 1979 most of the fat hen failed to reappear. Six Gun Club has a large upland area in the south and west parts of the club that is predominantly vegetated with saltgrass and upland grasses.

A visual estimation of the vegetation composition on the two clubs follows. This vegetation survey was taken in July of 1979. When conditions more conducive to fat hen growth occur, as they did in 1978, fat hen should make up a significant amount of the total vegetation on both clubs.

Sprig Haven - 60% pickleweed, 10% brass buttons, 10% fat hen, 10% saltgrass, 10% wiregrass (Juncus)

Six Gun - 50% pickleweed, 10% brass buttons, 10% fat hen, 30% upland grasses.

SUMMARY

The clubs have had good stands of fat hen and brass buttons, but presently have excessive stands of pickleweed that need control. The clubs are not presently providing good waterfowl food plants because of the predominance of pickleweed. Both clubs are predominantly Reyes soils, on which it

is preferable to grow fat hen rather than alkali bulrush. Sprig Haven has elected to follow the enclosed fat hen management schedule to maintain and improve fat hen stands. The Six Gun Club, however, wishes to grow predominantly alkali bulrush. In order to do so, the enclosed alkali bulrush water management schedule must be followed. Both clubs can flood and drain within 30 days.

## THE GOODYEAR SLOUGH PROJECT

The southern end of Goodyear Slough is presently a deadend slough and during the summer and early fall, salinities in the southern end, where the clubs on # 714 take their flood water, are very high. The California Department of Water Resources has designed a project to open up the southern end of Goodyear Slough through to Suisun Bay, thereby improving water circulation and reducing salinities in the slough. The Goodyear Slough Project will not change the flooding or draining system of either club, but will provide better quality water in the slough which the clubs use for flooding. Flooding with better quality water in the fall will reduce salinities on the clubs and improve the conditions for growth of waterfowl food plants, including both fat hen and alkali bulrush.

## CLUB IMPROVEMENTS

### WATER CONTROL

Needed Improvements: The Sprig Haven Club has decided to install an additional structure at C to improve water circulation. During the hunting season when the club is already flooded, structure C should be set to flood only, and structure A should be set to drain only, so that maximum water circulation can be obtained.

Since structure D is closed off from one side and water interchange between Sprig Haven and Six Gun is prevented, water circulation on Six Gun, therefore, is inadequate. An additional structure should be placed at the north end of Six Gun at E to improve water circulation during the hunting season and during the April-May circulation period, as shown in the alkali bulrush water management schedule. Then structure E would be set for flood only and structure B would be set for drain only.

Both clubs have a good system of main ditches, but both clubs also need more spreader ditches running from the centers of the ponds to the main ditches. The spreader ditches will serve the purpose of improving surface water and soil water drainage in the pond areas, thereby improving salt removal.

The main ditches on both clubs are generally well-maintained and provide adequate water flow. The western ditch in Sprig Haven, however, for about 600' north of the clubhouse is very shallow and highly vegetated. It should be at least 2' deep to increase water flow and soil water drainage capabilities. Inspection of structures, levees and ditches should be carried out annually. Repair and replacement of levees and structures should be done as needed. Ditches and structures should be cleaned of any silt, debris, and vegetation which may be blocking water flow.

Optional Improvements: The openings underneath the railroad tracks at

F, G, and H, bringing fresh water runoff into the ditch west of the club's levees, are presently an untapped source of fresh water. If structures were installed to deliver water from the railroad ditch into the clubs, this fresh water could be used for flooding as a replacement for, or a supplement to, the slough water presently used and would greatly improve the quality of water on the club. By bringing water from the railroad ditch across the property to the drain structure the water circulation pattern would also be greatly improved and water stagnation would be reduced.

For circulation during the winter and for flooding during flush cycles, as much of the runoff water should be used as possible. During some years it may be possible to use only runoff water for winter circulation, flushing, or both and not use water from C and E at all.

The flood structures should have flashboards or slidegates where the structures enters the railroad ditch to control inflow from the ditch, and a flap where the structure enters the club to control backflow from the club into the railroad ditch. If this option is considered, the club members should contact the Soil Conservation Service, Dixon Field Office for further structure design.

At present there is some uncontrolled waterflow from the railroad ditch into the club over the levees. This is because the railroad ditch has been poorly maintained and is blocked with excessive vegetation growth in many places. The ditch no longer has the capacity to hold all of the water runoff and it overflows the levees onto the clubs.

## VEGETATION

Needed Improvements: Much discing is needed on both clubs to reduce pickleweed growth. Disc pickleweed stands in late summer just before flooding for the hunting season. Heavy stands may need to be mowed before discing can be carried out. Flooding immediately after mowing and discing will effectively drown the cut up roots and stem segments of pickleweed.

Mowing and discing, by removing rank vegetation and disturbing the soil will encourage the growth and establishment of brass buttons and fat hen. Discing should be repeated every 4-5 years to remove renewed pickleweed growth until fat hen stands are well-established. Then, discing should be done only as needed to prevent re-invasion of large amounts of pickleweed in fat hen stands.

Mowing of fat hen and alkali bulrush should be done in late summer each year to create open water areas for waterfowl and to improve seed availability. Refer to "Waterfowl Habitat Management in the Suisun Marsh" for a discussion of mowing techniques.

## OPTIONAL WATER MANAGEMENT SYSTEMS

It is likely that because of the soils on Six Gun Club, they would have more success managing for fat hen rather than for alkali bulrush. If, in the future, the Six Gun Club wishes to manage for fat hen, they should follow the fat hen water management schedule.

# APPENDIX E

AREA OFFICE
2800 Cottage Way, Room E-2740
Sacramento, California 95825-1880
DEC 07 1981

Memorandum

To: Regional Director, Bureau of Reclamation, 2800 Cottage Way, Room W-1105, Sacramento, CA 25825-1880

From: Area Manager, Sacramento, CA (SESO) (AFA-SE, 1-1-81-F-130)

Subject: Section 7 Determination, Suisun Marsh Management Study, Solano County, California

This is the response to your August 6, 1981, letter requesting formal Section 7 consultation on the Suisun Marsh Management Plan (SMMP) pursuant to the Endangered Species Act of 1973 (ESA), as amended. The impacts your actions may impose upon the federally listed salt-marsh harvest mouse (Reithrodontomys raviventris) (SMHM) and the California clapper rail (Rallus longirostris obsoletus) (CCR), both directly and indirectly as a result of this project, have been examined.

On November 17, 1981, we received a request from Soil Conservation Service to join this formal consultation. We agree that joint consultation including SCS is appropriate and we, therefore, have sent a copy of this Opinion to the SCS.

Biological Opinion

It is our Biological Opinion that this project, which includes compensatory actions (and insurances of compliance with the intent of the ESA) is not likely to jeopardize the continued existence of either the SMHM or CCR.

In the review of this project the Service examined the Suisun Marsh Study (1976); Sacramento-San Joaquin Delta Strategy Plan (1981); technical draft of the Salt Marsh Harvest Mouse and California Clapper Rail Recovery Plan; and the Biological Assessment of the Impacts of the Suisun Marsh Management Plan (BA) (1981). Furthermore, numerous meetings were attended by representatives of the Service, California Department of Fish and Game (CDFG), Bureau of Reclamation (BR), California Department of Water Resources (DWR), and Soil Conservation Service (SCS). In addition, the Service met with Dr. Howard Shellhammer and Mr. Thomas Harvey, and made several field trips to the Suisun Marsh to examine the proposed project corridor, facility placement, marsh habitat, and ongoing field studies of the endangered SMHM and CCR.

Ecosystem Account

The Suisun Marsh represents one of the largest brackish-water marshes remaining in the United States. The Marsh consists of approximately 57,000 acres of marshland and 27,000 acres of bays and waterways. The Suisun Marsh is located in southern Solano County, California, south of the cities of Fairfield and Suisun (figure 1). It is bounded on the south by Suisun Bay, Honker Bay, and the confluence of the Sacramento and San Joaquin Rivers; on the west by Luther Gibson Freeway (State Highway 21) running from Benicia to Cordelia; on the north by Cordelia Road to the city of Suisun, around the Potrero Hills to Denverton; and on the east from Denverton along Shiloh Road to Collinsville.

The historical nature of the marsh ecosystem is not well understood. Some surmise that it was a freshwater marsh (BA, 1981), and others describe it as brackish (George, et al., 1965). Undoubtedly large portions of land were submerged daily by tides. Flood waters from the Sacramento and San Joaquin Rivers probably covered most of the marsh during the winter and spring and provided freshwater in the channels for a period of time.

Development and consequent degradation (i.e. conversion of marsh to upland) of Suisun Marsh and adjacent areas began on a small scale during the 1850's by individuals who constructed low sod levees. Draining and diking of marsh land increased rapidly during the 1860's and the bulk of the levee work was completed before 1920. Prior to and during reclamation, beef and dairy cattle were pastured in the higher areas of the marsh. Agricultural developments, in spite of reclamation activity, were largely unsuccessful because of poor drainage and the accumulation of salts in the soil. As a consequence, most of these areas have been converted to private duck clubs and State waterfowl management areas.

The diking of the marsh from the influence of the natural diel and seasonal flooding patterns is probably the premier factor responsible for the degradation of this unusual ecosystem. A second factor which also imposes significant impacts on the marsh is the change in water quality. About the time marsh reclamation began, significant water development for agricultural and municipal use was occurring in the Central Valley. Construction of upstream dams began before 1870 and continued at an increasing rate until an unprecedented level was achieved in the period between 1940 and 1970 (Skinner 1972). By 1976, storage and diversion structures which facilitated consumptive use and diversion of water to other basins had already reduced annual Delta outflow from 33.6 to 15.9 million acre-feet. In addition to the reduction of annual outflow, seasonal outflows have also been severely altered. The controlled nature of these flows has resulted in a relatively consistent moderate flow.

However, what remains of the Suisun is a wetland that is managed as a brackish marsh. To insure that these managed "wildlands" remain protected, the California State Water Resources Control Board (SWRCB), in its

Decision (WR) 1485, established standards for water salinity in the Marsh from October through May. Furthermore, the Suisun Marsh Preservation Act of 1977 (AB-1717) requires that the Suisun Marsh be managed for its wildlife resources. This act identifies waterfowl management as a primary concern. A third action that has affected the state of the marsh is the decision by the SWRCB that increasing Delta outflows to protect the State's natural resources is an inappropriate use of the State's water resources (BA, 1981).

A review of the Suisun Marsh resource and its related problems resulted in a memorandum of agreement signed by the Bureau of Reclamation, the Fish and Wildlife Service, and the California Departments of Fish and Game and Water Resources on July 13, 1970.. A goal of this four-agency agreement was to select a water supply and marsh management plan that would protect and enhance waterfowl habitat. The result of their effort is the project being reviewed.

Project Description

This project will be reviewed as four subsets: The physical facilities, the monitoring program, the management programs, and conservation measures.

Physical Facilities: The project is designed to meet marsh water quality standards established by the California State Water Resources Control Board (SWRCB) Decision (WR) 1485. These standards will be achieved by changing the major intake for marsh water supplies from Grizzly Bay to the Sacramento River near Collinsville, by introducing municipal waste water, and by redistributing water in major marsh channels (figure 2). The following description is taken from the BA.

Montezuma Slough Control Structure

This facility is the keystone to the entire marsh management system. This keystone feature will be constructed 1½ miles from the eastern end of Montezuma Slough and will consist of a concrete control structure with two radial gates and a boat lock. The structure will pump water tidally from the Sacramento River near Collinsville into Montezuma Slough during periods when Delta outflows will not be sufficient to provide adequate water quality.

Grizzly Island Distribution System

This facility will consist of a combination of enlarged, existing ditches and a newly-constructed channel that will take water from Montezuma Slough just west of the mouth of Frost Slough. This action will provide leveed lands on Grizzly Island with water of adequate quality. The system will also include a 100-acre pond at the east end and will provide water to adjacent clubs. The length of the facility is 9.98 km (6.2 miles).

Potrero Hills Ditch

This 5.63 km (3.5 mile) long ditch will be constructed between Luco and Hill Sloughs. The ditch will move water from the vicinity of Denverton Slough in the east to the Hill-Suisun Slough in the north-central Marsh where water quality will be improved.

Cordelia-Goodyear Ditch

This facility is a 4.5 km (2.8 miles) channel from the Ibis Club area on Cordelia Slough to a point just south of Pierce Harbor on Goodyear Slough. The ditch will have a 40-acre pond at each end and control structures to pump water tidally south to Goodyear Slough. This facility is needed to meet salinity requirements along Goodyear Slough and provide club managers with higher quality water.

Goodyear Slough (Pierce Harbor) Control Structure

This structure is located just south of Pierce Harbor and will control water flow from Goodyear Slough northerly toward Suisun Slough as needed to provide adequate water quality.

Boynton-Cordelia Ditch

This ditch is 5.6 km (3.5 miles) in length and is designed to pump water from Suisun Slough, via Boynton Slough, to Cordelia Slough to improve water quality in the western marsh. Treated waste water from the Fairfield Water Treatment Plant can be used to supplement the tidal flow to Cordelia Slough.

Cygnus Ditch

This facility is 4.18 km (2.6 miles) in length and is designed to transport water from Chadbourne Slough south to Cordelia Slough to improve water quality.

Monitoring Program: The Plan of Protection prepared by the California Department of Water Resources (DWR) includes a monitoring program that will provide water and soil salinity data from selected sites throughout the entire marsh to evaluate the effectiveness of the physical facilities. This program is a requirement for the DWR under the Suisun Marsh Preservation Act of 1977 (AB-1717) and Water Right Decision (WR) 1485.

Channel water will be monitored continuously at six sites in the marsh, two sites on the Sacramento River, and periodically near the mouth of Montezuma Slough. Water quality will be monitored continuously at each major diversion point. Soil-water salinity will be monitored at approximately 60 sites on 12 areas throughout the marsh. Continuous water level records will be made at each site being monitored for soil-water salinity.

Plant surveys will be included in the monitoring program. The overall vegetative composition of the marsh will be determined every 3 years by the use of color aerial photography in combination with ground verification. Salt-marsh harvest mouse habitat will be intensively monitored using data from the flights and ground verification. Major waterfowl food-plant seed production will also be monitored. The specifics of this monitoring are described in the Conservation Measures section.

In addition to the monitoring program described above, other monitoring is being conducted in the marsh by agencies such as the CDFG and the Soil Conservation Service (SCS). For example, the CDFG has a bi-weekly waterfowl survey every year beginning in September and extending through January. These data will also be used to evaluate the effectiveness of the management facilities.

Management Programs: Individual hunting club management plans were developed by the SCS to provide high-value waterfowl habitat. Implementation of these plans is an integral part of this project (BA, 1981). Designated management programs were determined by the soil type, topography, and water quality at each club.

Each management plan includes an inventory of soils, placement of existing water control structures, review of current management procedures, and current vegetative conditions. Each club also has been provided with recommendations to improve water management. These recommendations include such items as water control structures, levees and canals, and spreader ditches. Each management plan is designed to follow one or a combination of up to five major management regimes to produce waterfowl habitat.

These regimes are alkali bulrush management; fathen management; permanent-pond management; barley cultivation; and watergrass cultivation. Each club is provided guidance for compliance with their particular plan. Generally, guidance is given on retention periods for ponded water; number, duration, and season for leaching cycles; and prescriptions for burning, disking, mowing, or some combination of these. Essentially, the plans are designed to minimize (or eliminate) the occurrence of pickleweed (*Salicornia virginica*), saltgrass (*Distichlis spicata*), baltic rush (*Juncus balticus*), cattails (*Typha* sp.) and/or tules (*Scirpus acutus* and *S. californicus*). Control would then be maintained through implementation of one or another of the management regimes. The positive intent of the management schemes is to enhance production of combinations of waterfowl food plants: alkali bulrush (*Scirpus robustus*), brass buttons (*Cotula coronopifolia*), and fathen (*Atriplex patula*), or of barley (*Hordeum vulgare*).

Conservation Measures: The goal of these measures is to retain at least 2,500 acres of preferred salt marsh harvest mouse habitat adequately distributed throughout the marsh. This mouse habitat must meet all the criteria outlined for preferred habitat (page 8). Monitoring of habitat, a CDFG responsibility, will be provided for through contract with the CDWR and coordinated with the FWS. The conservation measures proposed are expected to insure the perpetuation of viable mouse populations in the marsh.

Measures to minimize impacts as a result of the construction project include an effort to trap and remove all SHHM within the construction corridor. These mice will be translocated to other suitable habitat as determined jointly by the Service and CDFG. Trapping will take place in the early spring to reduce impacts on breeding mice or mice with litters.

Construction crews and equipment will work as closely as possible within the rights-of-way of the project to reduce disturbance to the rail and mouse.

Monitoring stations for soil-salinity determinations will be installed and monitoring will be accomplished with a minimum of habitat disturbance.

Compensation for habitat loss because of the construction of the physical facilities and implementation of the management plans is as follows:

The physical facilities will result in the loss of 340 acres of wetland. Approximately 100 acres of this is considered preferred mouse habitat by the FWS and the CDFG. To compensate for the loss of this wetland, a comparable amount of wetland will be developed. Tentatively, 378 acres of land in the eastern portion of the marsh have been identified for acquisition for this purpose. Management of at least 100 acres of this land, as preferred mouse habitat, will compensate for the loss of mouse habitat from the construction of project facilities. Management will be for the specific habitat requirements of the mouse. Management will be coordinated with the CDFG and the FWS. Figure 3 shows the general area in which this 378-acre parcel will be located.

Habitat will also be maintained on a CDFG ecological reserve and several State wildlife areas within the marsh. Approximately 1,000 acres of these existing areas, and appropriate portions of future acquisitions, will be managed for preferred mouse habitat, such, habitat will be enhanced as a benefit to the harvest mouse. Parcels will range in size from approximately 100 to 500 acres. Each parcel will be managed to provide the preferred habitat described earlier in the BA 1981. Parceling will take the following approach:

1. Selected portions of Grizzly Island and Joice Island Wildlife areas will be retained and managed as preferred mouse habitat. This will total approximately 700 acres.

2. Selected portions of the Hill Slough Wildlife Area will be managed as preferred mouse habitat. This will involve converting approximately 100 acres presently supporting saltgrass to pickleweed.

3. The Peytonia Slough Ecological Reserve is currently 206 acres which is presently good-to-excellent mouse habitat. The Reserve will be retained and managed as preferred mouse habitat (figure 4).

In addition to the proposed conservation measures, and in the event habitat supporting the mouse shows a decrease as a result of the Plan, wording in the Three-Agency Marsh Management Agreement (among the Suisun Resource Conservation District (SRCD), CDFG and DWR) will provide for appropriate modifications in selected club plans. A change in preferred mouse habitat will be significant when the acreage decreases by one-third in any zone (based on data from ground verification of the 1981 flight). Management plans would then be modified, as necessary, for selected clubs to assure the retention of substantial tracts of preferred mouse habitat. Initial recommendations for modification of these club plans would be made jointly by the CDFG and FWS. Appropriate modifications would be chosen by the CDFG, FWS, SCS, and SRCD. The SRCD would then be petitioned by the CDFG, FWS and SCS to make the needed modifications.

Aerial photographs described in the Plan's monitoring program will be used to monitor preferred mouse habitat in each of five zones delineated in figure 5. The marsh is divided into five zones to facilitate the monitoring effort. Preferred mouse habitat will be the basis for measuring changes in mouse habitat but while these areas represent the most valuable habitat, they are not the only areas that support mice. However, changes in these preferred habitat areas should be easier to detect and should provide a usable index to measure changes in all mouse habitat. Pickleweed will be used as an indicator species because of the significant relationship between its occurrence and the presence of the mouse. Current pickleweed areas will be mapped using the planned 1981 flight. Ground truthing will then be used to determine the approximate acreage of preferred mouse habitat that meets the density, height, and condition requirements. Future flights and ground verification at 3-year intervals will then be used to monitor changes in the preferred mouse habitat.

The nature and extent of future sampling and the amount of ground verification will depend on the acreage of preferred habitat found by the 1981 baseline data. In any case, similar monitoring efforts will be made on areas under intensive management as well as areas with little or no management. If a significant decrease in preferred mouse habitat is indicated in any of the five zones, club-management plans will then be modified so that any degraded habitat will be restored.

Species Account

Salt-marsh-harvest mouse

The SHHM is a cricetine rodent endemic to the salt marshes which fringe San Francisco, San Pablo and Suisun Bays. The wetlands and marshes of the original Sacramento-San Joaquin Delta were probably too fresh, and hence the Collinsville-Antioch area probably was and still is the eastern limit of their distribution. *Reithrodontomys raviventris halicoetes* inhabits discontiguous marshes of Suisun and San Pablo Bays. *R. r. raviventris* occurs in remnant marshes of San Francisco Bay from the Carquinez Straits and southern Marin Peninsula south to the Alviso

Slough area (Fisler, 1965; Schaub, 1971). Alteration of historic wetlands via diking, draining and filling has eliminated over 80 percent of the intertidal marshland (Nichols and Wright, 1971). A large area has been converted into diked wetland, most of which is marginal as habitat for harvest mice. Most of the contemporary tidal marshes are fragmented strips situated along outboard dikes and along sloughs, often separated from one another by considerable distances. As a direct consequence, the SMHM population is endangered with extinction and has been so identified by the Department of the Interior (October 13, 1970).

The SMHM is active from the evening twilight hours, with peak activity during the night. Density of SMHM is directly dependent on vegetative composition and cover. Sparse cover in poor condition provides poor mouse habitat. The Salicornia zone of salt and brackish marshes with thick mats of Salicornia appears to support the best population of SMHM. The characteristics of preferred habitat for salt marsh harvest mice in the Suisun Marsh are (Shellhammer and Harvey, draft recovery plan):

(1) 100 percent cover.

(2) Cover with a depth of 30-50 cm at summer maximum.

(3) A high percentage of pickleweed. Areas with the denser populations of harvest mice range from 100 to 50 percent pickleweed and contain a variety of other halophytes, especially fat hen and alkali heath. Scirpus and Typha species do not reduce the quality of such habitat as long as they are not present in large amounts and are well dispersed rather than clumped.

(4) There should be few areas of saltgrass, brass buttons, alkali bulrush, other Scirpus species, or Typha. Upland grasses are valuable as an upland edge to the marsh but not as a dominant within the marsh. Such a situation is conducive to western rather than salt marsh harvest mice.

(5) There are no barriers of open ground or water dissecting the vegetation, as SMHM are extremely dependent on cover. Such open belts divide large populations into smaller ones and decrease their chances of survival.

(6) Each area of marsh is large. Connections between parts of a marsh supporting one population should be at least 20 m wide with 100 percent cover of optimum vegetation and have no barriers or open ground or water across them.

(a) The major portion of each marsh should be habitable throughout the year. The nature of the soil surface and the management practices should result in at least 40 percent of the marsh being useable in the winter, receiving no or little flooding. A majority of the marsh (80 percent or more) should be of optimum habitat in the summer.

(b) A large marsh should have a large edge of halophytes and possibly an adjoining and interdigitating band of upland grasses.

(7) The area receives minimal disruptive manipulation, and only that needed to produce mouse habitat. Flushing is absent or minimized and plowing, mowing and burning are absent.

Habitat destruction has occurred throughout the entire range of this species and is so severe that genetic isolation is a serious threat to extant populations. In the Suisun, levee construction has virtually eliminated the upper marsh zone from many areas and has also subdivided the marsh into smaller units. These units have been further partitioned with the construction of canals and spreader ditches, and the implementation of different management practices. Certain management practices are severely destructive to mouse populations. Practices such as mowing, discing, and burning destroy both individual mice and the habitat. Entire populations can be extirpated by intensive management practices.

The restricted mouse habitat that presently exists in the Suisun Marsh is primarily a by-product of management for waterfowl habitat. A mosaic of fairly large areas of preferred SMHM habitat should be established throughout the marsh to enhance population levels and conserve the species.

California clapper rail. Historically the CCR was an endemic rallid of most estuarine marshes of central coastal and northern coastal California. Since 1900, accelerated habitat loss because of dredging, diking and filling of wetlands significantly reduced both its range and numbers. Since 1944 approximately 2,832 hectares of CCR habitat have been eliminated, representing an additional 20 percent loss in rail habitat (Gill, 1979). As a result of the continual elimination and alteration of California's estuarine marshes, the Secretary of Interior, in accordance with the ESA of 1973, determined that the CCR was endangered. The rail is also listed as an endangered species by the CDFG.

Throughout its range, the rail is restricted to tidal marshes that are interspersed with drainage channels inhabited by an abundant invertebrate fauna (Gill, 1979). Principal vegetative dominants in marshes inhabited by the CCR include: Cordgrass (Spartina foliosa), pickleweed, saltgrass, and gum plant (Grindelia humilis) in the San Francisco Bay marshes; bulrushes, silverweed (Potentilla pacifica) and Baltic rush in Napa marsh, upper Petaluma River, and along Sonoma Creek. The marshes of Elkhorn Slough, Bolinas Lagoon and Tomales Bay are predominantly Salicornia. In Suisun marsh, the CCR inhabits narrow tidal marshes along outboard dikes, dominated by Scirpus spp., Typha spp., Juncus spp., and Salicornia spp. (Harvey, 1980).

The CCR feeds almost entirely on animal matter such as worms and crustaceans. The relative amounts of plant and animal matter in the rail's diet varies with the time of year, stage of tide and geographic locality

(Moffitt, 1941). In Suisun Marsh, Harvey (1980) reported the occurrence of Corbicula spp. and Mya spp. clams and barnacles (Balanus improvisus) in areas supporting clapper rails (Cutoff Slough). He also surmised that rails may be preying on crayfish (Pasifastacus spp.) in the Suisun.

Nests are located on or near the ground, usually on a slight rise near a tidal slough; many well-defined trails lead from the nest to the water. Nest sites are in deuse vegetation where the nesting platform is constructed of the same vegetation and built up to 8 to 15 cm above ground (DeCroot, 1927). The nesting season normally begins in mid-March and extends into July. Late nesting by the rail may include renesting attempts and second broods (Wilbur and Tomlinson, 1976). Although clapper rail breeding has not been verified in the Suisun, the presence and territorial behavior (vocalizations) of rails throughout the nesting season make it highly probable.

The CCR was first discovered in the Suisun in December 1978 (Harvey, 1980). In 1979, Harvey censused for clapper rails in the Suisun from 18 March to 17 August, and estimated a population of about 25 rails, mainly along narrow tidal marsh fringes in the Cutoff Slough area. Besides one or two rather incidental sightings, which indicate that the rail also occurs in non-tidal marshes of the area, the census work done by Harvey in 1979 represents virtually all that is known about the CCR in the Suisun. Thus, other than a few sightings, we know very little about the status and distribution of the CCR in the Suisun.

In addition to the SMHM and CCR, the Suisun Marsh ecosystem supports populations of at least 11 additional species of concern.

Three of these species are listed as rare by the State. They are the California black rail (Laterallus jamaicensis coturniculus), the soft-haired bird's beak (Cordylanthus mollis ssp. mollis), and the mudflat quilt-plant (Lilaeopsis masonii). Nine other species are recognized by the FWS and/or CDFG as candidate or sensitive species. These species and their status are listed below:

Suisun Shrew (Sorex orantus sinuosus) - being considered for inclusion as State species of concern (Alan Craig, pers. comm.).

Salt marsh yellowthroat (Geothlypis trichas sinuosa) - considered for state listing as endangered (Alan Craig, pers. comm.); Dr. Richard Newaldt has petitioned the FWS to list this species.

Suisun song sparrow (Melospiza melodia maxillaris) - being considered as a species of special concern by the State (Alan Craig, pers. comm.).

Hispid bird's beak (Cordylanthus mollis ssp. hispidus) - Under review by FWS (45 FR No. 242, 82499, 15 December 1980) and considered a State candidate.

Contra Costa baeria (Lasthenia conjugens) - Under review by FWS (45 FR No. 242, 82517, 15 December 1980) and considered as State candidate.

Delta tule-pea (Lathyrus jepsonii ssp. jepsonii) - Under review by FWS (45 FR No. 242, 82517, 15 December 1980) and considered a State candidate.

Suisun thistle (Cirsium hydrophilum var. hydrophilum) - Under review by FWS (45 FR No. 242, 82497, 15 December 1980) and considered a State candidate.

Greene's legenere (Legenere limosa) - Under review by FWS (45 FR No. 242, 82517, 15 December 1980) and considered a State candidate.

Project Impacts

Construction and management activities will have great impact on the SMHM and Suisun shrew. Since they occupy nearly the same habitat, the impacts and conservation measures identified for the mouse will be the same for the shrew.

Adverse impacts to the SMHM will result from the construction of the physical facilities and the management program. Approximately 340 acres of wetlands will be lost due to project construction (table 1). Approximately 100 acres of the 340 wetland acres is considered preferred mouse habitat by the FWS and CDFG.

In addition to the direct habitat losses, individual animals will undoubtedly be killed by the heavy equipment used for removing vegetation, scraping and dredging.

The extent of management program impacts will depend on the level of compliance. At present, there is legislation pending that will provide the Suisun Resource Conservation District with authority to enforce compliance with the management plans. As discussed earlier, management plan recommendations are designed to improve stands of alkali bulrush, fathen, and brass buttons, and other food plants for waterfowl. Although individual club management plans differ, the ultimate management goal is to minimize the amount of pickleweed.

Management plans call for the flooding of high grounds prior to the waterfowl hunting season (ca. mid-October). Continued water circulation is recommended, although not all clubs maintain this practice. Water is to be drained at the end of the season. Some clubs maintain a flood and drain cycle until late June, and a few clubs maintain standing ponds year-round. After the final draining the clubs are urged to disc (heavily), burn or both to control "undesirables" such as salt grass, pickleweed, and baltic rush. These areas are often flooded immediately afterwards. Prior to discing, mowing is sometimes recommended and is also used for opening areas for hunting. Management plans encourage the construction and development of spreader ditches to enhance flooding and draining. These ditches should increase the clubs' ability to flood greater areas more effectively and quickly.

Implementation of such management actions will have a devastating impact on the population of SMHM in the Suisun. Preferred mouse habitat will be destroyed. SMHM populations probably will not survive burning, discing, mowing, and flooding, since they are not good dispersers. Discing, mowing and burning will probably kill mice outright. During flooding some mice may escape to emergent vegetation, but they cannot survive there throughout the entire flooding period. Some mice will undoubtedly escape to upland sites along levees and may survive if there is sufficient food and cover. However, SMHM habitat in these areas typically is less than marginal.

These management practices will probably restrict surviving individuals to isolated patches of marginal habitat adjacent to levees or some other upland area. Furthermore, in areas where SMHM may exist, the development of spreader ditches will further dissect the SMHM populations, create barriers to mouse movement, and possibly cause more mouse habitat to be lost to flooding.

The end result from the implementation of the management plans may conceivably be a radical reduction in numbers of SMHM and their habitat, and further isolation of remnant populations.

However, to off-set such impacts which will occur to the SMHM, this project includes compensatory actions as described in this report to insure the continued existence of the SMHM in the Suisun Marsh.

Some of the narrow tidal marshes inhabited by the CCR will be affected by the project. As far as is currently known, clapper rails occur primarily on the tidal side of outboard levees in the Suisun, and rarely on the protected landward side. Although construction and maintenance of levees and channels will likely have positive and negative impacts on the rail, negative impacts potentially outweigh the positive. However, no construction is proposed along Cutoff Slough, where Harvey (1980) found the highest rail densities in the Suisun. Thus, the potential loss of intertidal rail habitat from levee and channel construction will be limited to areas where the rail could occur but as yet has not been observed. Because areas currently known to support rails will not be disturbed by the project, we cannot conclude that the current CCR population in the Suisun will be adversely affected. However, any significant reduction in tidal marshes that are potentially suitable rail habitat could limit future population expansion of the rail. Protection of this potential habitat may be important to the long-term welfare of the rail in the Suisun. Because intertidal habitat largely occurs as narrow fringes along outboard dikes, it is extremely vulnerable to disturbance by construction and maintenance activities. See the recommendations below (under the Biological Opinion) for guidance on protecting this habitat type.

Impacts to species of concern which may result from implementation of the marsh management plan are largely unknown. This is primarily because of a lack of sufficient data on their biology and distribution within the marsh. Nonetheless a plan for the protection of the Suisun Marsh ecosystem should consider all such species, since they too are an integral part of the marsh. The biological assessment is notably lacking in this regard. We point out that the plans emphasis on management of duck food plants, possibly to the detriment of the rarer species of the native flora may provide added threats to those species now under review. Further, there is no discussion of potential impacts to the State listed species perhaps an oversight that should be given additional consideration.

Biological Opinion

It is the Service's opinion that this project, which includes compensatory actions, is not likely to jeopardize the continued existence of the SMHM or CCR. However, the compensatory actions described within the B.A. only insure the protection and maintenance of preferred mouse habitat well-distributed throughout the Suisun Marsh. There is no mechanism to determine whether or not the SMHM and CCR will benefit from the activities in the marsh.

In furtherance of the purposes of the Endangered Species Act (Sections 2(c) and 7(a)(1)) which mandates Federal agencies to utilize their authorities to carry out programs for conservation of listed species, we recommend the following:

1. Survey CCR populations every 3 years in suitable habitats and locations throughout the Suisun. Survey areas should include tidal and non-tidal marshes, vegetative control areas, State lands managed for the SMHM, and private management areas. Surveys should be conducted in conjunction with the habitat monitoring program and aerial surveys. These studies should be conducted by investigators who are thoroughly experienced in clapper rail biology, ecology, and fieldwork. Survey design and data analysis should be coordinated with the CDFG and FWS.

2. Construction activities should not occur during the rail breeding season (March-July) if the action will be destructive to nesting habitat.

3. Likewise, maintainance of channels and sloughs (i.e., dredging, vegetation removal, etc.) should not occur during the breeding season--March through July.

4. In general, construction and maintenance of channels and dikes should be designed to provide and protect intertidal shelves (as wide as possible) along the length of all outboard dikes. Such shelves should be designed to foster establishment of intertidal marsh vegetation and mudflats for optimal CCR habitat. All the CCR's found by Harvey (1980) were restricted to these gradually sloping, intertidal zones. Steep dikes with only very narrow marsh zones supported no rails. Stands of Scirpus acutus and mixtures of other emergent vegetation should be retained on these intertidal shelves. The width of this habitat will necessarily vary, depending on the width of respective tide channels and on engineering considerations. Intertidal shelves at least 15 to 30 feet wide should be designed along the wider tide channels; shelf widths along narrower channels would be proportionately narrower, but should be designed as wide as possible.

5. Systematically survey populations of SMBM by monitoring control areas, management areas, and State areas managed for the SMBM. Trapping efforts should be designed to be compatible with and during the habitat monitoring program and aerial surveys. Such studies must be conducted by investigators well-experienced with the biology and ecology of the SMBM and personally experienced in fieldwork with the SMBM. The design of these surveys and subsequent data review should be coordinated with the CDFG and the FWS.

If these recommendations are instituted, the Service believes that the CCR and SMBM will derive benefits in the Suisun Marsh.

If you should have any questions regarding this opinion, please contact Carl Benz [(916) 440-2791 or FTS 448-2791] at our Sacramento Endangered Species Office.

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# APPENDIX F

State of California
The Resources Agency
DEPARTMENT OF FISH AND GAME

# AQUATIC RESOURCES OF SUISUN MARSH WITH AN ANALYSIS OF THE FISHERY EFFECTS OF A PROPOSED WATER QUALITY MAINTENANCE PLAN

by

Alan Baracco
Bay-Delta Fishery Project

Anadromous Fisheries Branch

Administrative Report No. 80-13

October, 1980

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# AQUATIC RESOURCES OF SUISUN MARSH WITH AN ANALYSIS OF THE FISHERY EFFECTS OF A PROPOSED WATER QUALITY MAINTENANCE PLAN[1/]

by

Alan Baracco
Bay-Delta Fishery Project

## ABSTRACT

The fishery resources of Suisun Marsh are described, including known information on use by anadromous species, and the abundance and distribution of resident fish and invertebrates.

The effects on aquatic resources of a proposed water management plan aimed at maintaining the capability of the marsh to support waterfowl populations is discussed and recommendations for minimizing anticipated effects are described.

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1/ Anadromous Fisheries Branch Administrative Report No. 80-13. Submitted October, 1980.
This study was conducted as part of the Interagency Ecological Study Program for the Sacramento-San Joaquin Estuary whose members include: California Department of Fish and Game, California Department of Water Resources, U. S. Water and Power Resources Service, and U. S. Fish and Wildlife Service.

## INTRODUCTION

Suisun Marsh, located in the San Francisco Bay estuary near the confluence of the Sacramento and San Joaquin rivers, is an important wintering area for waterfowl of the Pacific Flyway. One of the largest estuarine marshes in the United States, Suisun Marsh covers an area of approximately 34,020 ha (84,000 acres), of which nearly 10,935 ha (27,000 acres) are bays and sloughs influenced by tidal action. The remaining 23,085 ha (57,000 acres) are diked wetlands, managed primarily for duck hunting (State Water Resources Control Board 1978 a).

Aside from its importance to waterfowl, the marsh provides valuable habitat for a wide variety of mammals, reptiles, fish, and the invertebrate organisms on which fish and wildlife depend for food. Species of fish utilizing the marsh as nursery habitat and migration routes include striped bass, Morone saxatilis, chinook salmon, Oncorhynchus tshawytscha, steelhead rainbow trout, Salmo gairdneri, American shad, Alosa sapidissima, and sturgeon, Acipenser spp., all valuable gamefish. Resident populations of catfish, Ictalurus spp., centrarchids, notably black crappie, Pomoxis nigromaculatus, are also present as well as several native nongame fish and numerous estuarine and marine species. Invertebrate populations, of which opossum shrimp, Neomysis mercedis, is the most important, are often found at high densities within the marsh, particularly in Montezuma and Suisun sloughs.

Maintaining an abundance of plants preferred by waterfowl as food requires a supply of relatively low salinity water during the period from October to the following May in order to provide proper soil salinities in ponded areas. Soil salinity in the root zone in the spring should be no higher than 9,000 parts per million (ppm) total dissolved solids (TDS) for maximum seed production (Glenn Rollins, Calif. Dept. Fish and Game, pers. comm.).

Due to increased water diversion from the Sacramento and San Joaquin rivers, which are the main freshwater supplies for Suisun Marsh, salinities in marsh channels have sometimes exceeded those needed to maintain maximum seed production. Since 1960 water salinities have generally decreased in September and October but have increased from April to June (U. S. Water and Power Resources Service 1979). Between 1963 and 1978 salinities ranged from 92 to 16,560 ppm TDS at various locations in the marsh. During periods of low Delta outflow salinity increases from north to south and from east to west. Although factors such as local runoff and tidal strength affect salinity, Delta outflow is the most important factor influencing the salinity of surface water within most of the marsh (U. S. Water and Power Resources Service 1979). The frequency of less than optimum soil salinity conditions is expected to increase as upstream water use and export increase, so that by the year 2000 salinities will not meet water quality criteria for maximum seed production for varying periods of time in approximately one-half of all years (memo from G. Deatherage, Calif. Dept. Water Resources to D. Odenweller, Calif. Dept. Fish and Game, May 9, 1979).

The State Water Resources Control Board, as part of Decision 1485, has set water quality criteria for Suisun Marsh channels (State Water Resources Control Board 1978 b). In order to meet D-1485 criteria the U. S. Water and Power Resources Service and the California Department of Water Resources, the two largest diverters from the Delta, have proposed a series of channel, water distribution pattern,

and water source changes within the marsh. The proposal is described in detail in a U. S. Water and Power Resources Service preliminary draft report titled: "Solano County Water Project, California: A Report on the Feasibility of Water Supply Development," dated September, 1979.

Generally, the proposed plan calls for using project supplemented outflows for salinity control and water control and distribution facilities in combination with specific marsh management practices to insure the continued value of the marsh as waterfowl habitat. The distribution facilities consist of in-channel control structures which can act as tidal pumps or closures, and new or enlarged earthen channels which distribute the best available quality water throughout the marsh (selected plan) (Figure 1). If, after several years of initial testing of the selected plan, substantially more water is needed to meet project objectives, supplemental water could be delivered into the northeastern portion of the marsh by a diversion from Lindsey Slough (alternate plan).

The main feature of the selected plan is the Montezuma Slough Control Structure near Collinsville. At this location water will be diverted into Montezuma Slough by tidal pumping to provide an average daily flow of about 28 $m^3/s$ (1,000 cfs) in an east to west direction during October through May as needed to meet water quality criteria. This water, of a higher quality than would be normally available in marsh channels at the same outflows, would then be distributed by tidally activated flap gates into Roaring River Slough, Grizzly Island Ditch, Potrero Hills Ditch, Boynton-Cordelia Ditch, and Cygnus Bypass for use on marsh duck clubs. In the western portion of the marsh the Cordelia-Goodyear Ditch, Morrow Island Ditch, and the Goodyear Slough Outfall would provide the highest quality water available to duck clubs in that area.

The proposed operational schedule for the plan (Table 1) depends on whether or not the Lindsey Slough diversion is needed. The operational schedule without the Lindsey Slough diversion is termed Condition 1 (selected plan), the schedule with Lindsey Slough diversion is termed Condition 2 (alternate plan). The operational schedule may be extended beyond May 31 in below normal water years if better quality water is needed for marsh management past that date.

For the selected plan schedule of operation, the Montezuma Slough Control Structure would be operated as a tidal pump during the months of October through May in those years when the freshwater outflow from the Delta is less than approximately 280 to 420 $m^3/s$ (10,000 to 15,000 cfs). At higher Delta outflows the structure would remain open to permit unimpeded flow patterns in Montezuma Slough. For the alternate plan the Montezuma Slough Control Structure would operate as a channel closure at low Delta outflows, as a tidal pump at normal Delta outflows, and would remain open at high Delta outflows (Table 1).

Roaring River Slough, Grizzly Island Ditch, and Cordelia-Goodyear Ditch intake structures would operate a short period of each high tide to supply water to regulating reservoirs for further distribution. This system, necessitated by the need to maintain high water levels in the distribution ditches, requires an intake capacity of 19.6 $m^3/s$ (700 cfs) for Roaring River Slough, 29.4 $m^3/s$ (1,050 cfs) for Grizzly Island Ditch, and 1.54 $m^3/s$ (55 cfs) for Cordelia-Goodyear Ditch. Channel modifications and construction of regulating reservoirs would create 162 ha (401 acres) of new water surface area, thus increasing habitat for fish, mainly resident species.

This report describes the aquatic resources present in Suisun Marsh, the effects of habitat changes on those resources due to the above described water management proposals, and makes recommendations for aquatic resource protection.

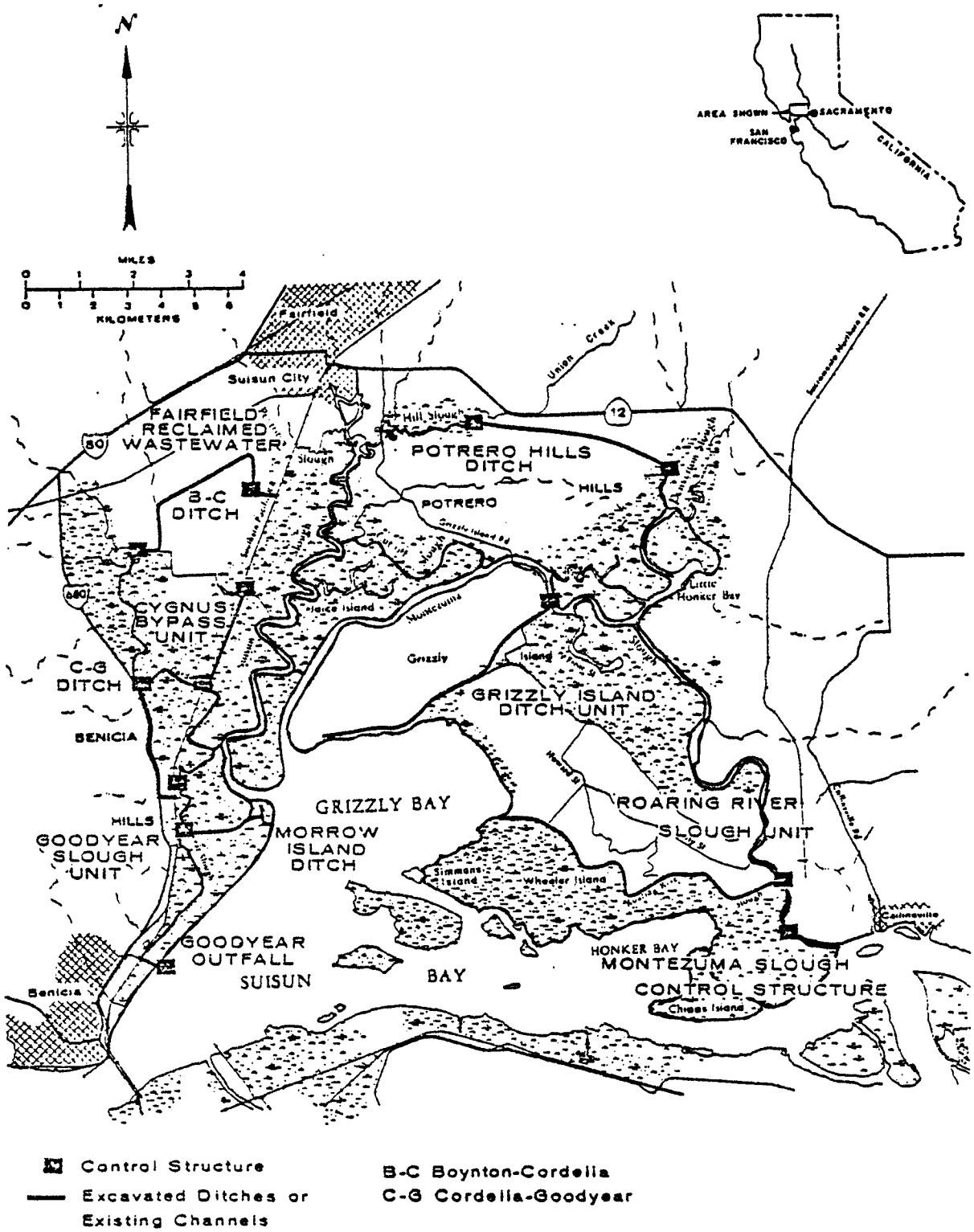


FIGURE 1. Suisun Marsh distribution facilities (Adapted from WPRS 1979).

TABLE 1. Typical Operation Schedules for Montezuma Slough Control Structure

| | Condition 1[a] | | | Condition 2[b] | | |
|---|---|---|---|---|---|---|
| | Below normal year | Normal Year | Wet year[c] | Below normal year | Normal year | Wet year[c] |
| October | T | T | T | C | C | C |
| November | T | T | T | C | C | C |
| December | T | T | O | C | T | O |
| January | T | T | O | C | T | O |
| February | T | O | O | C | T | O |
| March | T | O | O | C | T | O |
| April | T | O | O | C | T | O |
| May | T | T | O | C | C | O |
| June | O | O | O | O | O | O |
| July | O | O | O | O | O | O |
| August | O | O | O | O | O | O |
| September | O | O | O | O | O | O |

C = Closed

T = Tidally operated

O = Opened

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a Assumes that supplemental freshwater is not available at Denverton Slough.

b Assumes that supplemental freshwater is available northeast of the marsh.

c Outflows sufficient to meet the Decision 1485 marsh standards after 1984 at western end of Montezuma Slough. (From WPRS, 1979)

## AQUATIC RESOURCES

Suisun Marsh supports a diverse assemblage of fish species (Appendix 1) and invertebrates. Changes in salinity caused by wide fluctuations in freshwater flow throughout the year and between years creates an ever-changing environment, affecting the abundance and distribution of aquatic populations. Many species spend only a part of the year or a portion of their life cycle in the marsh, others move within the marsh in response to their environmental requirements.

The following discussion by species, or species group, relies on several fishery surveys conducted at various times, durations, and locations within Suisun Marsh, using differing sampling techniques. Tri-annual gill net and otter trawl surveys have been conducted at six sites within the marsh (S-1 through S-6) (Figure 2) between 1974 and 1979 (Calif. Dept. Fish and Game, unpublished data). Midwater trawl surveys have been conducted from September through March at four sites in Montezuma Slough (T-1 through T-4) (Figure 2) between 1967 and 1978, except 1974 (Calif. Dept. Fish and Game, unpublished data). Tow net surveys have been done at three locations in Montezuma Slough (TN-1 through TN-3) (Figure 2) during June or July through July or August from 1959 through 1979, except 1966 (Turner and Chadwick 1972; Calif. Dept. Fish and Game, unpublished data). Beach seining and trawling at various locations has been done periodically (Calif. Dept. Fish and Game, unpublished data; U. S. Fish and Wildlife Service, unpublished data; P. Moyle, U. C. Davis, unpublished data). Neomysis surveys using plankton tow nets started in 1968 and have been done regularly at three locations in Montezuma Slough and at one location in Suisun Slough (N-1 through N-4) (Figure 2).

### Anadromous Fish

#### Chinook Salmon

Chinook salmon migrate through the marsh, especially Montezuma Slough, as juveniles on their way to the ocean and again as adults on their way to spawning areas in the Sacramento and San Joaquin river systems. Juveniles also utilize marsh channels as nursery habitat.

No juvenile chinook salmon were caught during sampling in the summer, fall, and winter of 1974 through 1979 with gill nets and an otter trawl in six small sloughs within the marsh (Calif. Dept. Fish and Game, unpublished data). Trawl surveys conducted at four sites in Montezuma Slough in the fall and winter months between 1967 and 1978 resulted in infrequent catches of juvenile chinook salmon (Calif. Dept. Fish and Game, unpublished data). Sampling techniques used in these surveys, however, were inefficient for this species. Beach seining in Montezuma Slough in March, 1979, and in February and March, 1980, revealed chinook salmon fry in substantial numbers (F. Michny, U. S. Fish and Wildlife Service, pers. comm.; F. Fisher, Calif. Dept. Fish and Game, pers. comm.). These newly hatched fish were found after an extended period of high river flows, and their occurrence in the marsh may be atypical of normal or low water year conditions. Messersmith (1966) found chinook salmon yolk-sac fry in Carquinez Strait in February and March, 1962, another high water period.

Stomach analysis of juvenile (pre-smolt) chinook salmon collected in the spring of 1979 at various locations throughout the Delta (U. S. Fish and Wildlife Service,

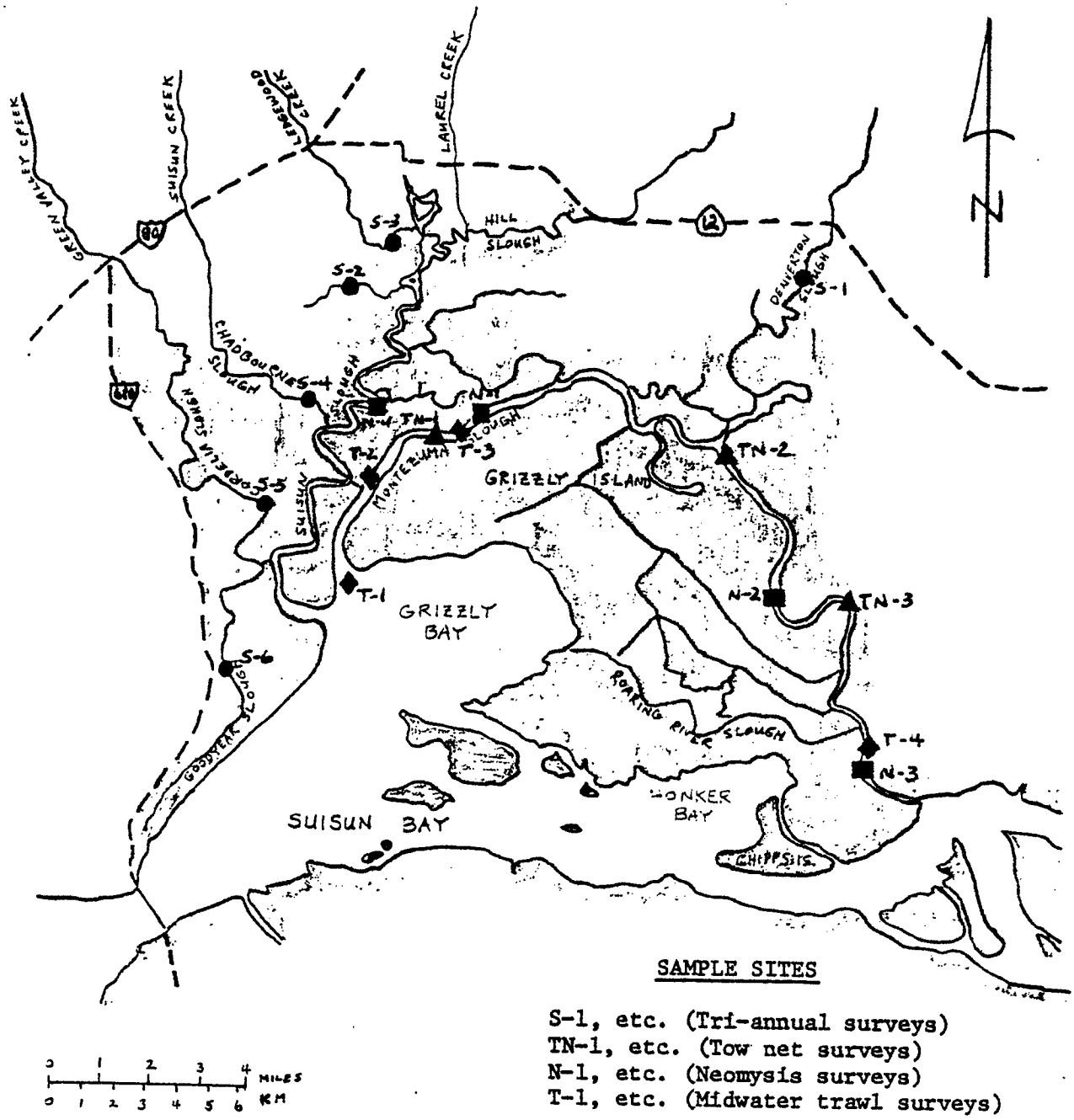


FIGURE 2. Suisun Marsh with fishery survey sampling sites

unpublished data) revealed a diet composed of crustaceans, mainly Daphnia spp. and insects, mainly adult Dipterans. Amphipods were increasingly important in the western Delta, including Suisun Marsh.

## Steelhead Rainbow Trout

Sacramento River steelhead, like chinook salmon, utilize marsh channels, particularly Montezuma Slough, for juvenile and adult migrations and as nursery habitat. In addition, small local steelhead populations utilize marsh channels for migration to and from Suisun, Green Valley, Laurel, and Ledgewood creeks. Migration routes within the marsh for these remnant runs have not been defined, but they probably use Cordelia, Chadbourne, Peytonia, and Suisun sloughs as their principal routes. Gill net sampling in Cordelia, Chadbourne, and Peytonia sloughs caught low but fairly consistent numbers of steelhead (Calif. Dept. Fish and Game, unpublished data). Sampling at other locations within the marsh indicates that steelhead utilize many channels other than those on direct migration routes. Stomach analysis of 13 sub-adult steelhead (36-49 cm [14-19.5 in.]) captured in marsh channels in February, 1979, revealed all to be actively feeding, mostly on fish (mainly threespine stickleback, Gasterosteus aculeatus), crustaceans (mainly amphipods), and insects (U. S. Fish and Wildlife Service, unpublished data).

Sampling in February, June, and October at six sites (S-1 through S-6) (Figure 2) over a period of years indicates that use of the marsh by steelhead is confined to the fall and winter period. During the study 43 fish were captured during February sampling and 43 fish were captured during October sampling, but no steelhead were captured during June sampling. This indicates that steelhead use the marsh mainly for migration and feeding purposes in the fall and winter rather than as year-round nursery habitat, perhaps due to unsuitable environmental conditions during the summer period.

## Striped Bass

Suisun Marsh, particularly Montezuma Slough, is a major nursery area for striped bass. During the summer months an average of about 10% of the young-of-the-year striped bass in the Delta utilize Montezuma Slough (Turner and Chadwick 1972). The proportion of young bass using the marsh is higher in years of high freshwater outflow (L. Miller, Calif. Dept. Fish and Game, pers. comm.). Yearling and older striped bass are abundant in the marsh, especially in the fall and early winter, when a substantial sport fishery exists for adults. Many striped bass are also caught in the interior sloughs and ponds, entering these areas when duck clubs are flooding and draining ponded areas.

Substantial numbers of juvenile striped bass (fish less than 406 mm [16 in.] in length) utilize Montezuma Slough and other sloughs within the marsh throughout the fall and winter months. Tow net surveys during the October through December period since 1967 reveal densities of striped bass between 2.3 and 140.7 fish per tow (Figure 3) (L. Miller, MS). It appears from these data that bass abundance is generally lower in low outflow years, such as 1968, 1976, and 1977, and greater in years with normal or high outflow. Although there are many factors affecting the abundance of juvenile striped bass in the Delta (Stevens 1979), bass are more abundant in Montezuma Slough with higher Delta outflows (L. Miller, Calif. Dept. Fish and Game, pers. comm.). Sampling in interior marsh channels

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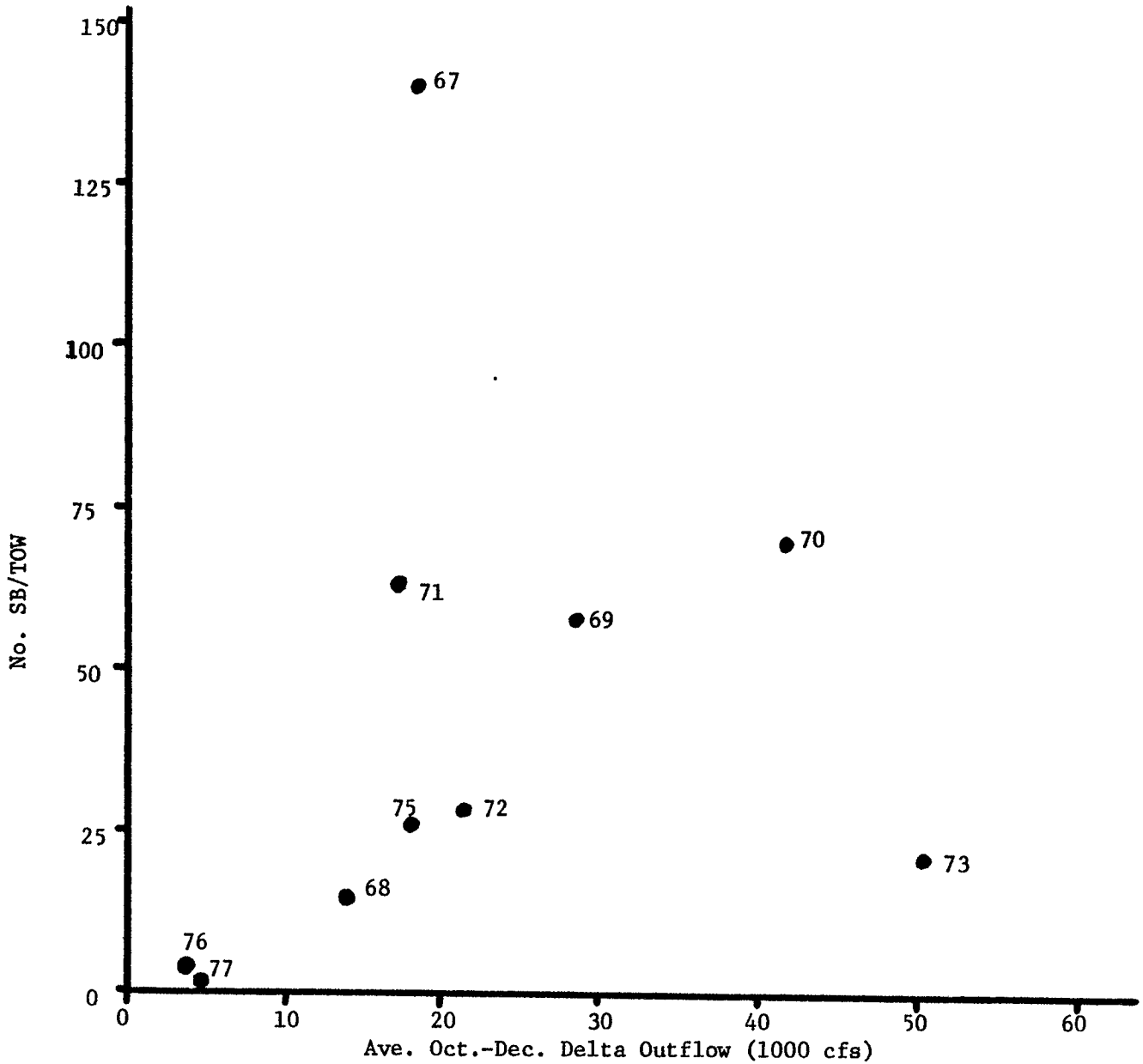


FIGURE 3. Average number of striped bass per midwater trawl tow, October-December for Montezuma Slough, 1967-1977, except 1974.



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in October and February also indicates striped bass are more abundant during and following normal or high outflow conditions (Calif. Dept. Fish and Game, unpublished data). During October, 1974, and February, 1975, sampling (higher outflow), for instance, a total of 836 striped bass were captured. During the same sampling periods in 1976-1977 and 1977-1978 (lower outflow), 273 and 226 bass, respectively, were captured.

### American Shad

Low numbers of American shad have been collected in marsh surveys. Use patterns of the marsh by shad are probably similar to those for chinook salmon, that is, Montezuma Slough serves as an upstream and downstream migration route and also as nursery habitat for a portion of the Delta population. Midwater trawl surveys at four locations in Montezuma Slough in the fall and winter months of 1967 through 1978 (except 1974) reveal a pattern of higher juvenile shad abundance in the fall tapering off to few fish generally by December or January (Table 2) (Calif. Dept. Fish and Game, unpublished data). A similar movement was observed in midwater trawl surveys of Carquinez Strait in 1961-1962 (Messersmith 1966). This pattern corresponds to documented behavior of juvenile shad, which usually migrate to the ocean from upstream nursery areas as temperatures decrease in the fall.

### Sturgeon

Sturgeon appear rarely in survey catches in Suisun Marsh, but they are commonly caught by sport anglers in Montezuma Slough. Use of interior marsh channels by sturgeon is probably low, since only three have been observed in numerous surveys (Calif. Dept. Fish and Game, unpublished data).

## Resident Fish

### Resident Gamefish

Several species of resident gamefish are known to inhabit the marsh, including white catfish, *Ictalurus catus*, brown bullhead, *I. nebulosus*, black bullhead, *I. melas*, channel catfish, *I. punctatus*, black crappie, *Pomoxis nigromaculatus*, white crappie, *P. annularis*, bluegill, *Lepomis macrochirus*, Sacramento perch, *Archoplites interruptus*, and largemouth bass, *Micropterus salmoides*. While white catfish, bullhead, and black crappie were common prior to the 1976-1977 drought, they are much less abundant now (D. Kohlhorst, Calif. Dept. Fish and Game, pers. comm.). A substantial sport fishery exists in marsh channels for catfish, especially during the spring and summer months. Estimates of angler use and success for catfish on the State-owned Grizzly Island Waterfowl Area (including Joice Island) averaged 21,702 angler days of effort and an average catch of 24,269 catfish during the past 5 years (Table 3), although the catch has declined since the 1976-77 drought (Calif. Dept. Fish and Game Region 3 Files).

### Nongame Fish

Numerous nongame fish species inhabit the marsh, including native and introduced minnows and many estuarine and marine species (Appendix 1). Threadfin shad,

TABLE 2. Monthly Total of Juvenile American Shad Captured by Midwater Trawl in Montezuma Slough, 1967-1978 (except 1974).

| | Month | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Year | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar |
| 1967 | - | 14 | 18 | 33 | 1 | 5 | 2 | 0 |
| 1968 | 8 | 15 | 16 | 8 | 4 | 1 | 0 | 0 |
| 1969 | 10 | 0 | 13 | - | 4 | 0 | - | 0 |
| 1970 | 3 | 7 | 0 | 0 | 0 | 0 | 1 | 2 |
| 1971 | - | 2 | 2 | 0 | 0 | 0 | 0 | 0 |
| 1972 | - | 0 | 0 | 6 | 3 | 0 | 0 | 0 |
| 1973 | - | 6 | 2 | 4 | 0 | 0 | - | - |
| 1975 | - | 16 | 4 | 5 | 7 | - | - | - |
| 1976 | - | - | 0 | 4 | - | 1 | - | - |
| 1977 | - | 0 | 0 | 6 | 1 | 2 | - | 0 |
| 1978 | - | 42 | 6 | 9 | 5 | - | 1 | - |
| Average | 7.0 | 10.2 | 5.5 | 7.5 | 2.5 | 1.0 | 0.7 | 0.3 |

TABLE 3. Angler Use and Sport Catch of Catfish on the Grizzly Island Waterfowl Area, 1975-1979.

| Year | Number of anglers | Catfish catch |
|---|---|---|
| 1975 | 19,026 | 42,136 |
| 1976 | 18,115 | 31,396 |
| 1977 | 21,521 | 23,172 |
| 1978 | 18,973 | 15,153 |
| 1979 | 30,876 | 9,489 |
| Average | 21,702 | 24,269 |

Dorosoma petenense, Mississippi silverside, Menidia audens, and two smelts, Delta and longfin, Hypomesus transpacificus and Spirinchus thaleichthys, are abundant and provide forage for striped bass. Various species can usually be found at locations within the marsh that are suitable with respect to salinity. Within the range of salinities observed (essentially freshwater to 16,800 ppm TDS) euryhaline species, such as the yellowfin goby, Acanthogobius flavinanus, can be found throughout the marsh, while species with less salt tolerance, such as Sacramento sucker, Catostomus occidentalis, are limited to less saline areas. For instance, yellowfin gobies have been observed at sampling site S-3 (less saline) during 9 of 15 sampling periods and at site S-5 (more saline) during 11 of 15 sampling periods. Conversely, Sacramento suckers have been found during 14 of 15 sampling periods at site S-3 and only 6 of 15 periods at site S-5 (Calif. Dept. Fish and Game, unpublished data).

### Rare and Endangered Fish

Although Suisun Marsh has a wide variety of native fish species, none are currently listed as endangered, threatened, or rare by either State of Federal governments. The thicktail chub, Gila crassicauda, whose historic range included the marsh, was formerly listed as endangered by the State of California (Calif. Dept. Fish and Game 1978). However, none have been observed since the late 1950's (Moyle 1976) and this species has been recently declared extinct by the California Fish and Game Commission (June 27, 1980).

There are two other fish species common in the marsh, splittail, Pogonichthys macrolepidotus, and the tule perch, Hysterocarpus traski, which are currently being monitored. Although neither species is considered rare or endangered, there is concern due to their limited range. Special management actions may be required in the future if either population starts declining. For the present, however, no additional protection or treatment is warranted for these species.

## Crustaceans

Species composition and relative abundance of crustacean populations in the Sacramento-San Joaquin Estuary changes much like that of fish, species with more tolerance to or affinity for saline conditions being found in the more westerly portions of the system. Crustaceans abundant in Suisun Marsh, such as opossum shrimp, Neomysis mercedis, and the bay shrimps, Crangon spp. and Palaemon macrodactylus, are important as food for many fish.

### Neomysis

Neomysis are generally more abundant in the Sacramento-San Joaquin Estuary at the freshwater end of the salinity gradient (Heubach 1969), although salinity by itself is relatively unimportant for this species. They are most abundant at salinities from essentially fresh water to 7200 ppm TDS and are least abundant at salinities exceeding 18,000 ppm TDS. Conditions favorable to Neomysis are generally found in the vicinity of Suisun Bay in the summer in an area called the entrapment zone (Arthur and Ball 1978). The entrapment zone is the area of the estuary

where saline and freshwater mixing causes a high degree of aggregation and flocculation of suspended material. Landward movement of saline water near the bottom and seaward movement of fresh water near the surface, with a plane of no net motion between, creates longer residence times or "entrapment" of suspended materials, including phytoplankton, and thus creates conditions conducive to high standing crops of invertebrate organisms and fish utilizing them for food. Orsi and Knutson (1979) hypothesize that the hydrology of the entrapment zone and the vertical migration of Neomysis hampers the downstream movements of Neomysis on the ebb tides. Siegfried, et al. (1979) similarly conclude that hydraulic conditions rather than salinity control the abundance of Neomysis in the entrapment zone. In all but the driest years, Suisun Bay supports 60% or more of the summer Neomysis population and Montezuma Slough supports approximately 8% (Calif. Dept. Fish and Game 1976).

Neomysis are not found in areas of high net velocity, high water transparency, low dissolved oxygen content, and high water temperature. Heubach (1969) found Neomysis only where there was some flow reversal during flood tide, net velocity was less than 0.12 m/s (0.4 ft/s), and light intensity on the bottom was less than $10^{-5}$ lux. In other studies, abundance of Neomysis decreased as net velocities increased from 0.021 to 0.107 m/s (0.07 to 0.35 ft/s) (Calif. Dept. Fish and Game 1976). High temperatures (above approximately 25°C [77°F] [Hair 1971]) are lethal to Neomysis. Temperatures above 18°C (65°F) causes a decrease in abundance when dissolved oxygen concentrations are low (Heubach 1969).

Bay Shrimp

Palaemon macrodactylus, a bay shrimp accidentally introduced from Asia, and several species of Crangon, native bay shrimp, are present in the estuary and are important fish food organisms. Palaemon is somewhat more abundant than the native species in Suisun Marsh, probably in response to relatively low salinities in marsh channels. Salinities in the marsh are generally lower than those preferred by Crangon species but within Palaemon's preferred range (Jones and Stokes and EDAW Inc. 1975). Tri-annual surveys of marsh channels with an otter trawl from 1974 to 1979 reveal that Crangon populations are generally higher in October, when salinities are higher and in most years sampled Palaemon is more abundant in June and February, when salinities are lower (Table 4) (Calif. Dept. Fish and Game, unpublished data).

## Zoobenthos

Information on zoobenthos populations of Suisun Marsh is lacking. Studies have been done in adjoining areas, such as Suisun and San Pablo bays, that, due to their close proximity, give some indication of probable species presence and abundance in the marsh.

Even more so than for fish, salinity in the estuary determines the species composition of benthic organisms. Since individuals cannot change location quickly in response to salinity changes, they must be able to tolerate the range of salinities encountered throughout the year and between years. Because of this restriction there is a marked change in species composition in the eastern Carquinez Strait area in most years, with marine and euryhaline species occurring

TABLE 4. Abundance of Crangon and Palaemon in Marsh Channels as Sampled by Otter Trawl, 1974-1979.

| Sample date | Crangon | Palaemon |
|---|---|---|
| June, 1974 | 0 | 265 |
| June, 1975 | 2 | 137 |
| June, 1976 | 185 | 555 |
| June, 1977 | 202 | 137 |
| June, 1978 | 0 | 1640 |
| June Total | 389 | 2734 |
| | | |
| October, 1974 | 556 | 226 |
| October, 1975 | 1770 | 387 |
| October, 1976 | 841 | 633 |
| October, 1977 | 154 | 4 |
| October, 1978 | 186 | 366 |
| October Total | 3507 | 1616 |
| | | |
| February, 1975 | 38 | 114 |
| February, 1976 | 57 | 97 |
| February, 1977 | 18 | 32 |
| February, 1978 | 8 | 31 |
| February, 1979 | 324 | 45 |
| February Total | 445 | 319 |

downstream and euryhaline and freshwater species upstream from this area (Filice 1958, Painter 1966). During the drought of 1976-77, however, many marine species became established in Suisun and Honker bays (Arthur and Ball 1979). Painter (1966) found that the abundance as well as the distribution of zoobenthos changed in the eastern Carquinez Strait area, with more biomass present in San Pablo Bay than in Suisun Bay. This was particularly true for various species of clams. Two small amphipods, Corophium spinicorne and C. stimpsoni, and a spionid worm, Polydora uncata, dominated the zoobenthos of the Suisun Bay area (Painter 1966, Hazel and Kelley 1966). C. stimpsoni, the more numerous of the two amphipods in Suisun Bay, was most abundant in Delta channels when net water velocities were between 0.015 and 0.061 m/s (0.05 and 0.2 ft/s) (Hazel and Kelley 1966). Moderate numbers were found above and below these velocities.

### Phytoplankton

Phytoplankton forms the base of the aquatic food web in the marsh. These microscopic plants are eaten by some fish and are utilized by zooplankton and zoobenthos, which in turn are fed upon by higher animal forms. Phytoplankton populations in the Sacramento-San Joaquin Estuary are dominated by diatoms, green algae, and flagellates (Storrs et al. 1964). Suisun Marsh populations are dominated by diatoms in the genera Coscinodiscus, Cyclotella, and Stephanodiscus (Ball 1977). They normally reach peak population density in the late spring (Ball and Arthur 1979) and are at their lowest density in the winter (Chadwick 1972). Phytoplankton require light for growth, which appears to be the major factor limiting algal growth in the naturally turbid water of the Suisun Bay area (Chadwick 1972). In some years inorganic nitrogen is depleted to growth limiting levels during phytoplankton blooms (Ball 1977). Salinity affects phytoplankton primarily by changing species composition. Hydraulic conditions also affect phytoplankton by changing the residence time of water, turbidity, and nutrient input.

## ANALYSIS OF PROPOSED ACTION

The redistribution of water within marsh channels will have four major effects on aquatic resources relating to: (1) changes in salinities, (2) changes in water velocities, (3) changes and/or delays in migration, and (4) diversion of fish into interior sloughs and ponded areas. Both the selected and alternate plan have most effects in common but the magnitude of some effects will vary depending on which plan is instituted. The following analysis compares future conditions with and without the proposed plan of action.

### Salinity

As discussed in the section on aquatic resources, the presence and abundance of fish species within the marsh change in response to changes in salinities. Either the selected or alternate plan will establish an environment that will favor euryhaline and freshwater species over those that have more saline water requirements. Since the plan is designed to maintain water quality at approximately the same level as occurs currently, no major species changes are anticipated.

Predictions concerning the effect of the selected and alternate plans on individual species are difficult because of interactions among species or environmental factors not controlled within the marsh. As a hypothetical illustration, a reduction in salinity may enhance the marsh as striped bass habitat. However, if changes in water flow patterns adversely affect Neomysis populations, the major food of young striped bass, the overall effect on bass may be detrimental. Likewise, if some factor outside the marsh controls striped bass abundance, such as conditions in the spawning areas, improving salinities within the marsh may not benefit the overall bass population.

Analysis of striped bass data collected in marsh channels indicates that population levels are higher in years with moderate or high Delta outflow. To the extent that the proposed plan will maintain salinity conditions comparable to those existing under moderate and high Delta outflows, the plan should not have a detrimental effect on striped bass abundance in the marsh. Young-of-the-year bass abundance in the marsh, however, is dependent on overall abundance in the estuary, which is controlled by outflow and diversions in late spring and summer and on dispersion of fish into all available habitat. Therefore bass abundance in the marsh in a low water year may be low even with improved water quality provided by the plan.

## Velocity

With present flow conditions, water velocities in marsh channels influence the abundance and distribution of fish and fish food organisms. The selected plan would alter the velocity and direction of flow in marsh channels, particularly Montezuma Slough. Velocities with and without the selected plan in effect have been computed using a mathematical model of the marsh developed by Hugo B. Fischer, Inc. (Fischer and Dykstra 1977). For this analysis, freshwater outflow from the Sacramento and San Joaquin rivers was considered critically low, making the flow in Montezuma Slough 8.4 $m^3/s$ (1,000 cfs) in a west to east direction without the plan and 28 $m^3/s$ (1,000 cfs) in an east to west direction with the plan, the most drastic change in channel velocities.

Net velocities in marsh channels have been computed within 41 and 47 segments without and with the plan, respectively (Figure 4, Table 5). The selected plan increases the net velocity in most marsh channels. However, velocities are still fairly low and no significant effect on aquatic resources is expected. The possible exception is in the eastern portion of Montezuma Slough where net velocities approach or exceed those found limiting for Neomysis. Neomysis populations, therefore, could be transported westward in Montezuma Slough with a corresponding reduction in fish in eastern Montezuma Slough that depend heavily on Neomysis for food, notably juvenile striped bass. Phytoplankton populations may be reduced somewhat due to shorter residence times, however, phytoplankton levels are normally low during the months the plan will be in operation, which should minimize significant effects.

## Migration

Anadromous fish passing through the marsh will be affected by the selected plan at several locations. Chinook salmon, steelhead rainbow trout, American shad,

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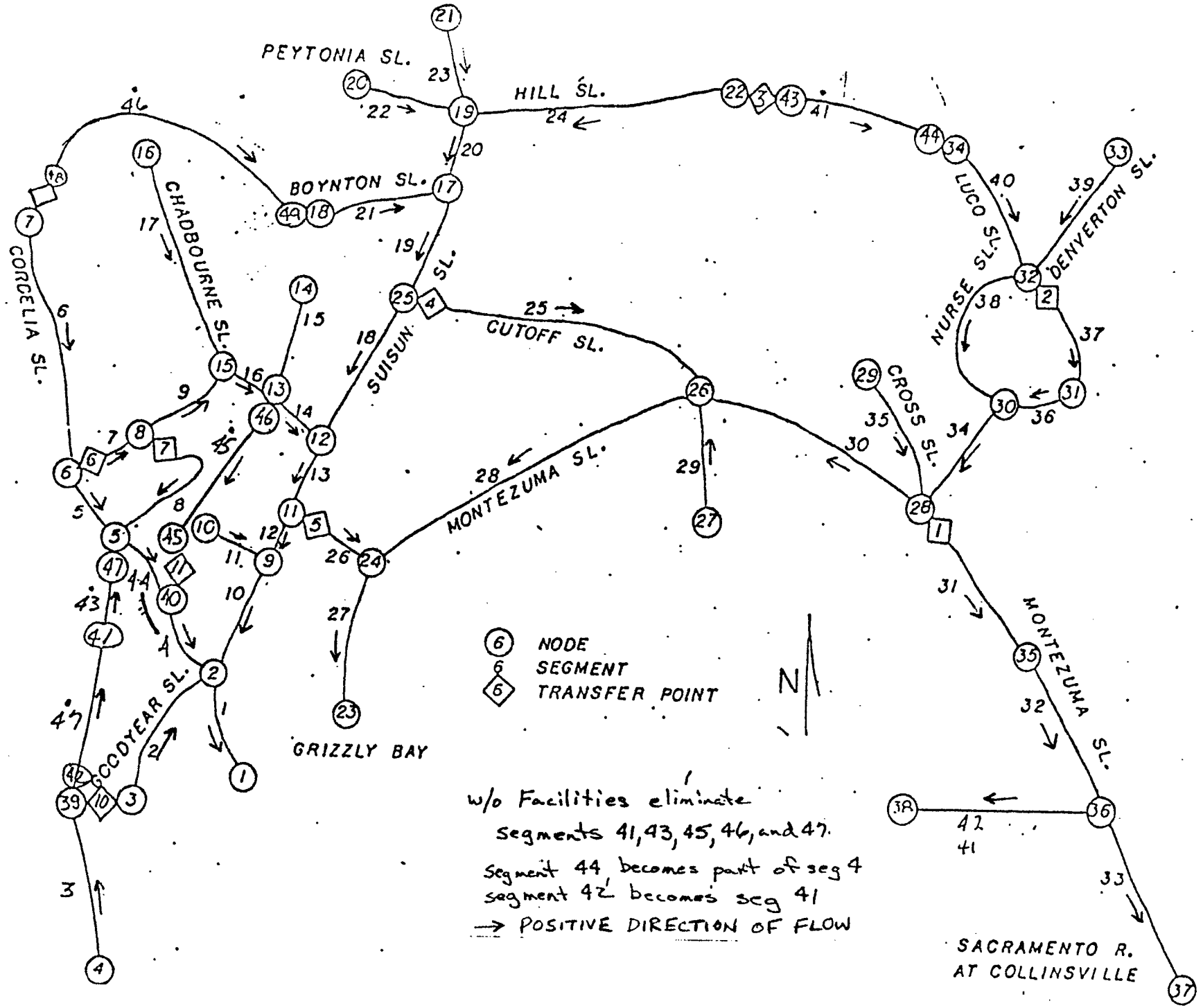


FIGURE 4. Schematic representation of Suisun Marsh (from Fischer and Dykstra, 1977).

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TABLE 5. Net Velocity in Suisun Marsh Channels With and Without the Montezuma Slough Tide Gate.

| Segment | Net velocity (m/s) Without plan | With plan |
|---|---|---|
| 1 | -0.0030 | 0.0031 |
| 2 | -0.0004 | -0.0001 |
| 3 | -0.0001 | -0.0457 |
| 4 | 0.0015 | 0.0185 |
| 5 | 0.0027 | 0.0227 |
| 6 | -0.0003 | 0.0305 |
| 7 | -0.0063 | 0.0132 |
| 8 | -0.0002 | 0.0056 |
| 9 | -0.0061 | 0.0040 |
| 10 | -0.0025 | 0.0005 |
| 11 | 0 | 0 |
| 12 | -0.0022 | 0.0005 |
| 13 | -0.0003 | 0.0017 |
| 14 | -0.0033 | -0.0265 |
| 15 | -0.0002 | -0.0002 |
| 16 | -0.0051 | 0.0029 |
| 17 | -0.0004 | -0.0004 |
| 18 | 0 | 0.0056 |
| 19 | -0.0008 | 0.0021 |
| 20 | -0.0007 | 0.0047 |
| 21 | -0.0003 | -0.0292 |
| 22 | -0.0001 | -0.0001 |
| 23 | -0.0001 | -0.0001 |
| 24 | -0.0009 | 0.0330 |
| 25 | -0.0029 | -0.0131 |
| 26 | 0.0196 | 0.0173 |
| 27 | -0.0009 | 0.0145 |
| 28 | -0.0034 | 0.0109 |
| 29 | -0.0004 | -0.0004 |
| 30 | -0.0047 | 0.0226 |
| 31 | 0.0089 | -0.0569 |
| 32 | 0.0155 | -0.1039 |
| 33 | 0.0169 | -0.1200* |
| 34 | -0.0001 | -0.0084 |
| 35 | 0 | 0 |
| 36 | 0.0007 | 0.0002 |
| 37 | 0.0118 | 0.0045 |
| 38 | -0.0014 | -0.0141 |
| 39 | -0.0001 | -0.0001 |
| 40 | -0.0001 | -0.0651 |
| 41 | -0.0001 | -0.0659 |
| 42 | | -0.0001 |
| 43 | | -0.0338 |
| 44 | | -0.0045 |
| 45 | | -0.0450 |
| 46 | | -0.0406 |
| 47 | | -0.0730 |

* Net velocity above range for *Neomysis*.

sturgeon, and striped bass in Montezuma Slough will be delayed for approximately one-half of each tidal cycle at the Montezuma Slough Control Structure when it is in operation as a tidal pump. While such delays will probably not significantly affect migration of adults, they could affect the downstream migration of juvenile fish by increasing predation in the vicinity of the structure. The magnitude of any increase in predation is difficult to predict but it could be significant during peaks in juvenile outmigration if large numbers of predators (such as adult striped bass) build up near the control structure.

The alternate plan would have a much more pronounced effect on fish using Montezuma Slough as a migration route, since in some years the Montezuma Slough Control Structure would be closed for long periods of time; from October through the following May in the driest years. This would affect a major portion of the chinook salmon, American shad, and striped bass runs using Montezuma Slough and virtually all Sacramento River winter run steelhead migrating by that route. Since environmental conditions several years preceding the return of adult fish could have been conducive to a large proportion of the juvenile population outmigrating through Montezuma Slough, and adults tending to retrace that route, large numbers of fish may be affected.

The alternate plan would also affect adult migration by introducing Sacramento River water from the Lindsey Slough diversion into the upper reach of Denverton and Hill sloughs. Upstream migrating adult fish bound for the Sacramento River, sensing the Sacramento River water, could be drawn into these deadend areas. Substantial delays or losses would occur.

Steelhead utilizing streams adjacent to the marsh, most notably Suisun Creek, could be delayed in their migration by changes in water flow patterns as well as by physical barriers. The selected plan calls for Chadbourne Slough (the lower end of Suisun Creek) to siphon under the Fairfield Wastewater Conveyance Ditch. This siphon may delay migration or create velocities in excess of those negotiable by steelhead.

## Diversion of Fish

The proposed plan will divert water and fish into interior sloughs and ponded areas at numerous locations throughout the marsh. At the largest of these diversions, Roaring River Slough and Grizzly Ditch, fish screens have been proposed as a means of lessening the impact of these diversions on fish. Fish screens are not totally effective, however, and some fish will undoubtedly be diverted.

Smaller diversions at other locations in the marsh could divert substantial numbers of fish, especially juveniles, into ponded areas where mortality would occur due to poor water quality or draining operations. To some extent this diversion takes place today without the plan, since none of the water intake systems on managed areas are currently screened to exclude fish. Some fish, such as catfish and striped bass, would survive and grow in the permanent water areas such as the regulating reservoirs near the Roaring River and Grizzly Island intakes if water quality is suitable year-round.

## RECOMMENDATIONS

The selected or alternate plan will have several adverse impacts on the fishery resources of Suisun Marsh. The following recommendations are made to minimize these impacts so that significant reductions in fish populations can be averted.

1. Provision should be made for effectively screening small fish from entering the Roaring River Slough, Grizzly Ditch, and Morrow Island Ditch distribution systems pursuant to Fish and Game Code Section 6100.

2. Adequate water circulation to maintain high dissolved oxygen contents should be provided at all times in all permanent water areas of the distribution system to protect fish that enter or are produced in these areas.

3. An operation schedule for the project should be formulated and agreed to, limiting, to the extent possible, increases in water velocities in Montezuma Slough. This would entail tidally pumping less than the full project capacity of 28 $m^3/s$ (1,000 cfs) at the Montezuma Slough Control Structure if suitable soil salinities can be maintained in below normal and dry years and full operation only in critically dry years.

4. Provisions should be made in the design and operation of the Montezuma Slough Control Structure so that fish migrations are not impeded for extended periods of time.

5. Provisions should be made in the design and operation of all channel siphons so that fish migration is not impeded. It is suggested that this be accomplished by siphoning project channels under natural channels, such as the Fairfield Wastewater Conveyance Ditch being siphoned under Chadbourne Slough.

6. In the event the alternative plan is instituted (Lindsey Slough diversion) areas likely to attract upstream migrating salmon and steelhead should be monitored. If substantial numbers of fish are attracted to dead-end areas, provisions for alleviating the problem or returning these fish to suitable migration routes should be formulated and implemented as part of the project.

7. Appropriate studies of fish distribution, abundance, and fish screen efficiency should be carried out after completion of the project and corrective action taken if fishery values are adversely affected by project operations.

## ACKNOWLEDGEMENTS

I wish to acknowledge the valuable assistance generously provided in data analysis for this report by members of the Bay-Delta Fishery Project. I also wish to thank Project members Lee Miller, Jim Orsi, Dave Kohlhorst, and Don Stevens for their valuable editorial comments and Dan Odenweller for his editorial and administrative assistance.

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# APPENDIX I

## FISHES OF SUISUN MARSH

| Marine Species | Abundance[1/] | Source[2/] |
|---|---|---|
| Pacific herring<br>*Clupea harengus pallasi* | L | 1 |
| Northern anchovy<br>*Engraulis mordax* | M | 1,2,5 |
| Surf smelt<br>*Hypomesus pretiosus* | L | 3 |
| Plainfin midshipman<br>*Porichthys notatus* | L | 1,3 |
| Pacific tomcod<br>*Microgadus proximus* | L | 3 |
| Topsmelt<br>*Atherinops affinis* | L | 1 |
| Shiner perch<br>*Cymatogaster aggregata* | L | 2,5 |
| Yellowfin goby<br>*Acanthogobius flavimanus* | M | 1,2,3,5 |
| Pacific staghorn sculpin<br>*Leptocottus armatus* | L | 1,3,5 |
| Pacific sanddab<br>*Citharichthys sordidus* | L | 5 |
| Starry flounder<br>*Platichthys stellatus* | L | 1,2,3,5 |
| **Estuarine and Anadromous Species** | | |
| White sturgeon<br>*Acipenser transmontanus* | L | 2,3,5 |
| American shad<br>*Alosa sapidissima* | L | 1,2,3,5 |
| Chinook salmon<br>*Oncorhynchus tshawytscha* | L | 2,3,4,5 |

| | | |
|---|---|---|
| Steelhead rainbow trout<br>*Salmo gairdneri* | M | 2,3,5 |
| Delta smelt<br>*Hypomesus transpacificus* | M | 1,2,3,5 |
| Longfin smelt<br>*Spirinchus thaleichthys* | H | 1,2,3,5 |
| Striped bass<br>*Morone saxatilis* | H | 1,2,3,5 |

Freshwater Species

| | | |
|---|---|---|
| Threadfin shad<br>*Dorosoma petenense* | M | 1,2,3,5 |
| Goldfish<br>*Carassius auratus* | L | 1,2,3,5 |
| Carp<br>*Cyprinus carpio* | L | 1,2,3,5 |
| Hitch<br>*Lavinia exilicauda* | L | 1,3,5 |
| Golden shiner<br>*Notemigonus crysoleucas* | L | 5 |
| Sacramento blackfish<br>*Orthodon microlepidotus* | M | 3,5 |
| Fathead minnow<br>*Pimephales promelas* | L | 5 |
| Splittail<br>*Pogonichthys macrolepidotus* | H | 1,2,3,5 |
| Sacramento squawfish<br>*Ptychocheilus grandis* | L | 2,3,5 |
| Sacramento sucker<br>*Catostomus occidentalis* | L | 3,5 |
| White catfish<br>*Ictalurus catus* | M | 1,2,3,5 |
| Black bullhead<br>*Ictalurus melas* | L | 1,3,5 |
| Brown bullhead<br>*Ictalurus nebulosus* | M | 3,5 |

| | | |
|---|---|---|
| Channel catfish<br>*Ictalurus punctatus* | L | 3,5 |
| Rainwater killifish<br>*Lucania parva* | L | 5 |
| Mosquitofish<br>*Gambusia affinis* | L | 3,5 |
| Mississippi silverside<br>*Menidia audens* | M | 5 |
| Threespine stickleback<br>*Gasterosteus aculeatus* | H | 1,2,3,5 |
| Sacramento perch<br>*Archoplites interruptus* | L | 1,3 |
| Warmouth<br>*Lepomis gulosus* | L | 5 |
| Bluegill<br>*Lepomis macrochirus* | L | 3,5 |
| Largemouth bass<br>*Micropterus salmoides* | L | 3 |
| White crappie<br>*Pomoxis annularis* | L | 1 |
| Black crappie<br>*Pomoxis nigromaculatus* | M | 1,2,3,5 |
| Tule perch<br>*Hysterocarpus traski* | H | 1,2,3,5 |
| Prickly sculpin<br>*Cottus asper* | H | 3,5 |

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1/ Abundance: H = High M = Moderate L = Low

2/ Source:

1. Turner and Chadwick, 1972; Tow net surveys of Montezuma Slough.
2. L. Miller, CDF&G, unpublished data; Midwater trawl surveys of Montezuma Slough.
3. D. Kohlhorst, CDF&G, unpublished data; Gill net and otter trawl surveys of marsh sloughs.
4. F. Fisher, CDF&G, unpublished data; Beach seine surveys of Montezuma Slough.
5. P. Moyle, Univ. of Calif., Davis, unpublished data; Beach seine and otter trawl surveys of marsh sloughs.

State of California

The Resources Agency

# Memorandum

To : Carol Nelson
Department of Water Resources

Date : August 8, 1983

From : **Department of Fish and Game**

Subject: Analysis of Suisun Marsh Channel Velocity Data

At the request of William Sweeny of your staff, we have reviewed the effects on fishery resources attributable to the proposed operation of Suisun Marsh Plan of Protection facilities.

We originally prepared an analysis based on model information available at the time the Draft EIR on the Plan of Protection was issued. The results of that analysis are contained in a report by Alan Baracco titled:

> Aquatic Resources of Suisun Marsh With an Analysis of the Fishery Effects of a Proposed Water Quality Maintenance Plan, Calif. Dept. of Fish and Game Anad. Fish. Br. Admin. Report No. 80-13, October, 1980.

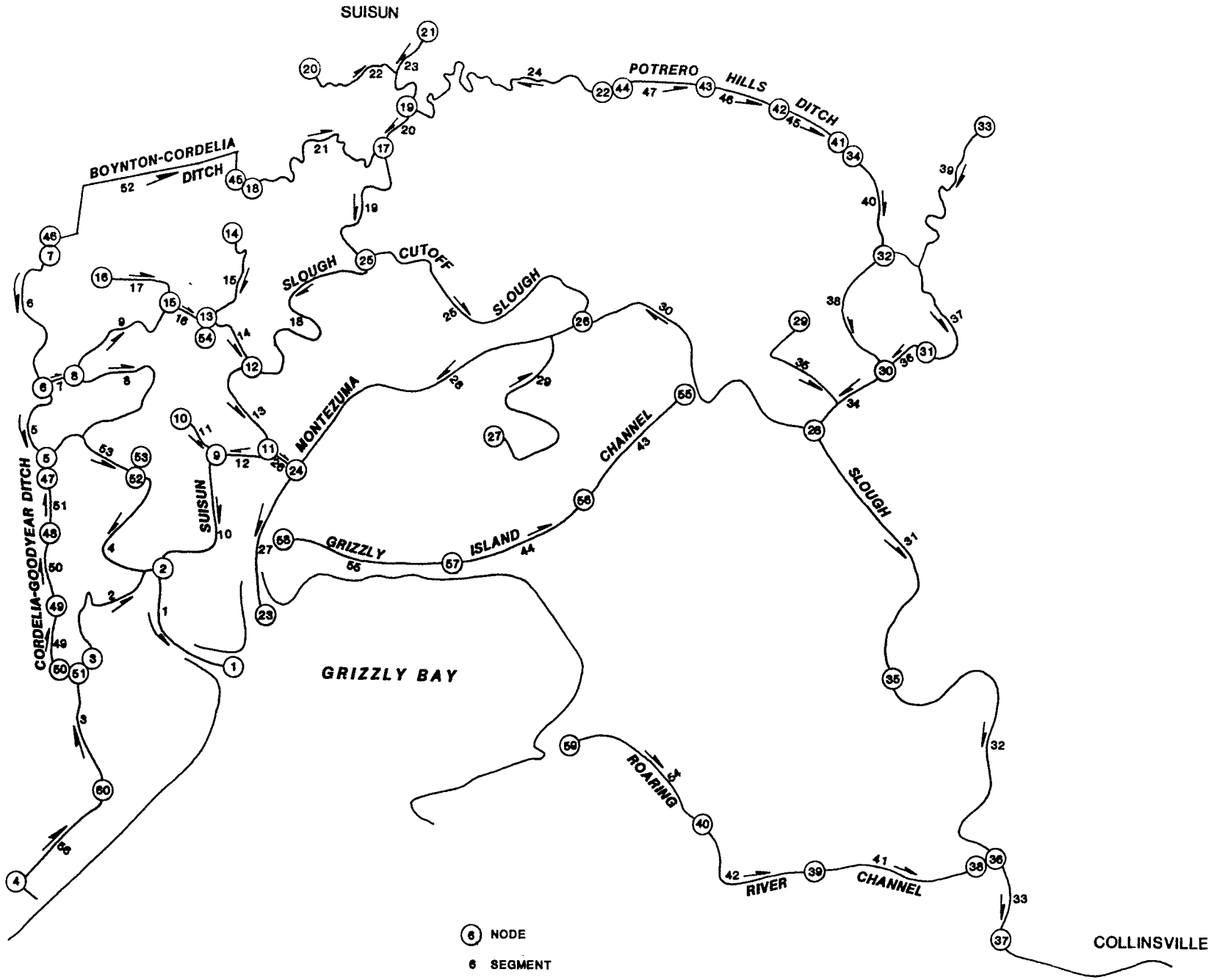
Changes in proposed facilities, and refinement of the mathematical models, have led to somewhat different estimates of channel velocities throughout the marsh than those discussed in the 1980 report (page 17, 18 and 19). Calculation of net channel velocities based on the most recent model runs indicate that velocities with the plan of protection are somewhat higher than without the plan, as was the case in our original analysis, but that velocities are still within the range acceptable for aquatic resource protection (Table 1, attached). The exception to this is in eastern Montezuma slough, where velocities approach or exceed those found limiting for Neomysis. Our conclusions on this item, contained on page 17 of the 1980 report, have not changed with the new model information, however, and effects on Neomysis, striped bass and phytoplankton should be minimal.

The recommendations contained on page 21 of the 1980 report remain valid, especially Numbers 3 and 7 in regard to velocity patterns.

Dan B. Odenweller
Senior Fishery Biologist
Bay-Delta Fishery Project

Attachment

cc: A. Baracco




SUISUN MARSH
MODEL CONFIGURATION

(From Fischer & Dykstra 1977)

C-054007

C-054007

TABLE 1. Net Velocity in Suisun Marsh Channels With and Without the Montezuma Slough Tide Gate

| Segment | Net Velocity (m/s) Without Plan | With Plan |
|---|---|---|
| 1 | .0107 | .0153 |
| 2 | -.0099 | .0343 |
| 3 | -.0174 | -.0388 |
| 4 | .0041 | -.0039 |
| 5 | .0054 | .0622 |
| 6 | -.00001 | .0916 |
| 7 | -.0053 | .0526 |
| 8 | .0038 | .0234 |
| 9 | -.0079 | .0070 |
| 10 | .0164 | .0215 |
| 11 | -.00003 | -.0025 |
| 12 | .0210 | .0278 |
| 13 | .0018 | .0003 |
| 14 | -.0023 | -.0064 |
| 15 | -.00004 | -.0055 |
| 16 | -.0045 | -.0010 |
| 17 | -.00004 | -.0007 |
| 18 | .0013 | .0009 |
| 19 | .0007 | -.0003 |
| 20 | -.0066 | .0130 |
| 21 | -.00005 | -.0480 |
| 22 | -.0016 | -.0017 |
| 23 | .0002 | -.0003 |
| 24 | .0011 | .0833 |
| 25 | .0012 | -.0022 |
| 26 | -.0117 | -.0293 |
| 27 | .0095 | .0246 |
| 28 | .0051 | .0199 |
| 29 | -.00007 | -.0050 |
| 30 | .0105 | .0400 |
| 31 | -.02491 | -.1009 |
| 32 | -.01946 | -.1239* |
| 33 | -.01203 | -.1166 |
| 34 | -.0002 | -.0143 |
| 35 | -.00004 | -.0008 |
| 36 | .0002 | -.0018 |
| 37 | .0030 | -.0383 |
| 38 | -.0021 | -.0497 |
| 39 | .0005 | -.0010 |
| 40 | -.00005 | -.0500 |
| 41 | .00000 | -.0313 |
| 42 | | -.0228 |

*Net velocity above range for Neomysis.

| Segment | Net Velocity (m/s) Without Plan | With Plan |
|---|---|---|
| 43** | 0 | -.0056 |
| 44** | 0 | -.0265 |
| 45** | 0 | -.0659 |
| 46** | 0 | -.0658 |
| 47** | 0 | -.0263 |
| 48** | 0 | 0 |
| 49** | 0 | -.0228 |
| 50** | 0 | -.1052 |
| 51** | 0 | -.1048 |
| 52** | 0 | -.0707 |
| 53 | .0060 | .0006 |
| 54** | 0 | -.0152 |
| 55** | 0 | -.0185 |
| 56 | .0311 | -.0522 |

**Facilities included in Marsh Plan of Protection

# APPENDIX G

State of California
THE RESOURCES AGENCY
Department of Fish and Game

Federal Aid Projects
Pittman Robertson

# CALIFORNIA BLACK RAIL

# BREEDING SEASON SURVEY IN CENTRAL CALIFORNIA

1977[1/]

by

Timothy D. Manolis

CALIFORNIA RESOURCES AGENCY LIBRARY

## ABSTRACT

A survey to locate breeding populations of California black rails (Laterallus jamaicensis coturniculus) in the San Francisco Bay Area, Morro Bay and Los Banos Wildlife Management Area was conducted from March through July 1977. Thirty-two calling black rails were located at sampling stations in tidal marshes bordering San Pablo Bay and its tributaries, the Suisun marshes and the Delta of the Sacramento-San Joaquin River system; seven were heard calling in marshes bordering Morro Bay; and one was heard in Olema Marsh, Marin County. Ninety-five percent of the black rails were in marshes dominated by Salicornia virginica or Scirpus spp. No black rails were found in San Francisco Bay south of the Richmond-San Rafael Bridge or at Los Banos Wildlife Management Area. Breeding black rails seem confined to high marsh habitat at the upper limit of tidal flooding.

1/ Nongame Wildlife Investigations, Endangered Wildlife Program, E-1-1, Study IV, Job 1.3 (August 1977).

C—054011

C-054011

## RECOMMENDATIONS

As a result of a spring and summer survey for California black rails in the San Francisco Bay Region and elsewhere in central California, the Department recommends that:

1. Further censusing be conducted in marshes in the San Francisco Bay Region in order to further define the range of the black rail and the remaining suitable habitat available to this species.

2. More intensive field work, including perhaps trapping and banding, be carried out in marshes harboring populations of black rails in an attempt to better understand the life history and habitat requirements of this species, as well as determine population densities in different marsh types.

3. Federal- and state-owned marshes that contain, or may contain, breeding black rails be managed in a manner that will conserve those qualities that make such marshes attractive to black rails.

4. Regional, county and city agencies and private individuals owning marshlands harboring black rails be made aware of the presents of the birds and be encouraged to aid in their preservation.

5. Preservation and restoration of marshlands be encouraged and influenced by the findings of this and any subsequent studies of black rails.

6. The California black rail be retained on the California Fish and Game Commission list of Rare Animals.

## INTRODUCTION

The California black rail (Laterallus jamaicensis coturniculus) is classified "Rare" by the California Fish and Game Commission, but this secretive, little-known bird's true status in the state has always been difficult to assess. Most recently, Wilbur (1974) and Gill (1977) discussed the status of black rails and both concluded that records of singing birds in the spring and of immatures in late summer indicated the presence of breeding, or at least summering, individuals in the San Francisco Bay Area (see Appendix A for a review of historical records for northern California). Since 1974, Department of Fish and Game and interagency study teams have surveyed a number of sites in northern California to determine the breeding season status of black rails (Jurek 1975 and 1976). Black rails were located in spring and summer in Solano, Napa and San Joaquin counties (Jurek 1976 and DFG files). These findings prompted this study. Its purpose was to clarify the status of this species in northern and central California and to identify its habitat requirements. The study began March 25, 1977, and concluded July 14, 1977. It compliments studies in progress of black rail distribution in southern California by U. S. Fish and Wildlife Service (Endangered Wildlife Research, Ojai) and Bureau of Land Management (Riverside District Office).

## METHODS

Census sites were selected based on the known breeding and nonbreeding season records of black rails. An attempt was made to select as wide a variety of different marsh types for censusing as possible. Censusing involved walking through or adjacent to suspected black rail habitat playing tape-recorded black rail calls in an attempt to elicit responses from birds on territories. Calls were broadcasted using a cassette tape recorder connected to a 15 watt power horn. A standard census tape, with alternating "grr" and "kic-kic-kerr" call sequences (see Results for a discussion of black rail vocalizations) separated by one minute pauses, was most frequently used, particularly during the first visit to a site. Information recorded for each site censused included: date; time; weather; habitat description; number and kind of responses; sightings of other species of special concern, including the salt marsh yellowthroat (Geothlypis trichas sinuosa); and other relevant data. The locations of vocalizing rails were plotted on photocopies of USGS topographic maps. A number of visits to representative Bay Area marshes were made during peak high tide periods in late May and June to view the effects of these tides on the habitat.

## RESULTS

### Distribution

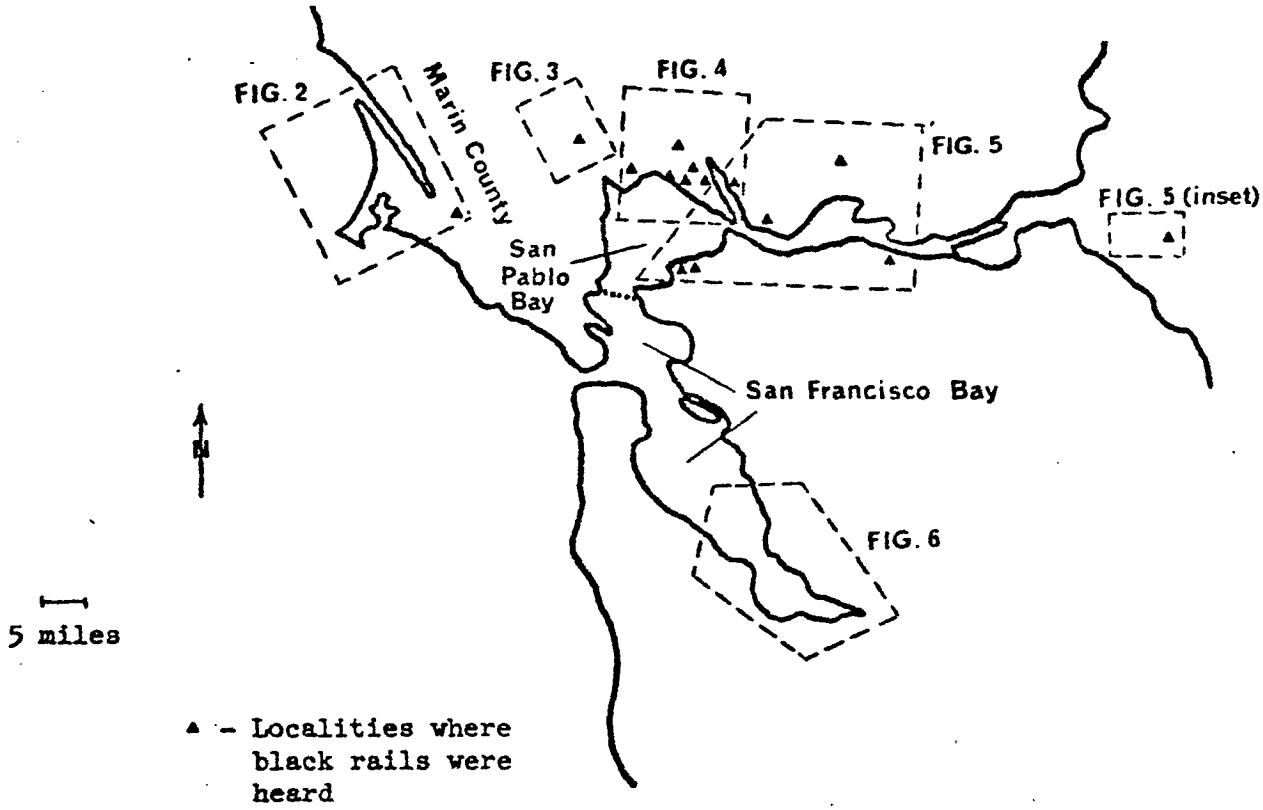
A minimum of 32 black rails was heard in 14 localities in the northern San Francisco Bay Area and the Sacramento-San Joaquin River Delta (Table 1; Figures 1-5). Only one black rail was seen. Twenty-two (69 percent) of the birds found in this area were in marshes bordering San Pablo Bay or the river systems (Napa and Petaluma) that empty into San Pablo Bay from the north. No black rails were found in marshes bordering the Pacific Ocean (sites 37, 40 and 41) or in San Francisco Bay south of the Richmond-San Rafael Bridge (Figure 6). Two other areas in central California were surveyed for black rails. Seven black rails were heard in a census of Salicornia marshes bordering Morro Bay, San Luis Obispo County, on April 14 and 15 (Figure 7). Parts of Los Banos Wildlife Management Area, Merced County, were censused April 15, 16 and 17 with negative results. A more detailed analysis of black rail distribution is presented in Appendix A.



C—054013

C-054013

Figure 1. Locations where black rails were found in the San Francisco Bay Area and key to figures 2-7.




## Habitat

Grinnell and Miller (1944) described the habitat preferred by black rails as "chiefly tidal salt marshes, where associated characteristically with heavy growths of pickleweed (Salicornia). But also occurs in brackish and fresh-water marshes." This description was confirmed by this study. Ninety-five percent (37 of 39 birds) of the black rails found were in marshes dominated by either Salicornia virginica or bulrush (Scirpus spp.), and 54 percent (7 of 13) of the birds in Scirpus-dominated marshes were in or near parts of the marsh where Salicornia virginica was present and fairly abundant. One bird was heard near Suisun City, Solano County, in an area where matted salt grass (Distichlis spicata) merged with a stand of cattails (Typha sp.) and Scirpus sp., and another bird was heard calling from a stand of Typha sp. in Olema Marsh, Marin County. Except for Olema Marsh, all marshes in which black rails were found are tidally influenced. Areas within these marshes where black rails were heard are near the upper limit of tidal flooding. A variety of marshes that are no longer under tidal influence were also checked (sites 16; 18; 19a, b and c; 20; 23; 31; 37 and 40), but no black rails responded at any of these sites. Censuses in marshes that are dominated by Scirpus spp. (sites 10, 19d, 21 and 36) or Salicornia virginica (sites 29, 20, 32, 33, 34a, 35, 38 and 39), but are frequently and/or extensively covered by high tides, also yielded negative results.

The salinity of marshes in which black rails were heard was not measured, but it no doubt varied considerably from very low (Olema Marsh, Marin County and White Slough, San Joaquin County) to rather high (San Pablo Bay marshes) levels. Salinity did not appear to be a factor effecting the distribution of black rails in the Bay area.



C—054014

C-054014

## Calls

Wilbur (1974) summarized information on the calls of black rails. Vocalizations heard during this study included: 1) the song of this species, "kic-kic-kerr", and variations involving dropped or added "kics" (e.g., "kic-kic-kic-kerr"); 2) the "grr" call (a sequence of low, syncopated growling phrases), rattle-"grrs" (a "grr" sequence preceded by, ending in or including a rattle-like call) and rattles; 3) and single notes, sounding like "yip" or "kic" (like first part of song), occasionally given in a sequence ("kic-kic-kic-kic"). Except for occasional spontaneous songs, all calls were elicited by playing taped calls. The defensive nature of these calls, and the fact that they were usually used at close range (6-9 meters or 20-30 feet) indicated that they were probably expressions of territoriality.

Most (12 of 17) of the first responses to the standard census tape came within 30 minutes of the start of the census. Between April 4 and May 14, nine of 11 first responses were "grrs", and 10 of the first responses in this period came within 30 minutes of the starting time. Half (three of six) of the first responses between May 26 and July 5 were "kic-kic-kerrs", and required 30 minutes or more of census time to obtain.



C—054015

C-054015

Table 1

Sites censused for black rails in the San Francisco Bay Area, the Sacramento-San Joaquin River Delta, Merced County and Morro Bay. Location numbers (in parentheses) refer to location numbers mentioned in the text and figures.

| Location | Marsh Type | Date | No. of Birds[1] |
|---|---|---|---|
| **Marin County** | | | |
| (1) Kehoe Marsh | Scirpus, Juncus | 4/5/77 | - |
| | | 6/21/77 | - |
| (2) Shield's Audubon Sanctuary, Inverness | Salicornia, Spartina | 4/5/77 | - |
| (3) Lower Olema Marsh | Typha, Scirpus, Salicornia, Distichlis | 4/5/77 | - |
| (4) Upper Olema Marsh | Typha, Juncus | 4/5/77 | 1 |
| | | 6/21/77 | - |
| (5) Mouth of San Antonio Creek, south shore[2] | Salicornia | 5/4/77 | 4 |
| **Sonoma County** | | | |
| (5) Mouth of San Antonio Creek, north shore | Salicornia | 5/4/77 | 2 |
| (6) Tolay Creek Marsh | Scirpus, Salicornia | 4/4/77 | 2 |
| | | 5/3/77 | 3 |
| | | 5/26/77 | - |
| **Napa County** | | | |
| (7) South Slough (part) | Scirpus, Salicornia | 3/28/77 | - |
| | | 4/27/77 | - |
| (8) Napa Slough | Salicornia, Scirpus | 5/2/77 | 1 |
| (9) China Slough | Salicornia, Scirpus | 5/2/77 | - |
| (10) Fly Bay | Scirpus, Spartina | 6/29/77 | - |
| **Solano County** | | | |
| (7) South Slough (part) | Scirpus, Salicornia | 3/28/77 | - |
| | | 4/27/77 | 1 |
| (11) Mouth of White Slough | Scirpus, Salicornia | 3/28/77 | 1 |
| | | 4/4/77 | - |
| (12) North shore, San Pablo Bay | Salicornia | 4/4/77 | 3 |
| | | 4/27/77 | 2 |
| | | 5/26/77 | 1 |
| | | 6/29/77 | 3 |
| (13) Mouth of South Slough | Scirpus, Salicornia | 5/2/77 | 2-3 |
| (14) Dutchman's Slough | Salicornia, Scirpus | 4/27/77 | - |

1/ Unless otherwise noted, number estimates are based on call responses.

2/ One black rail was heard at Black Point on May 23, 1977, by Bob Stewart, Point Reyes Bird Observatory.



C—054016

C-054016

| Location | Marsh Type | Date | No. of Birds |
|---|---|---|---|
| (15) Southampton Marsh (Benicia State Park) | Salicornia, Scirpus | 3/25/77 | 3 |
| | | 5/18/77 3/ | 2 |
| | | 5/21/77 3/ | 2 |
| | | 5/30/77 3/ | 3 |
| | | 6/4/77 3/ | 1 |
| | | 6/18/77 3/ | 1 |
| | | 7/2/77 3/ | 3 |
| (16) Cordelia (vicinity) | Salicornia | 6/12/77 | - |
| (17) Peytonia Slough Ecological Reserve | (a) Scirpus (mostly) | 6/26/77 | - |
| | (b) Mixed (Distichlis, Typha, Scirpus, Juncus Salicornia | 7/5/77 | 1 4/ |
| (18) Duck Slough | Distichlis, Scirpus, Juncus | 7/5/77 | - |
| (19) Joice Island (State Wildlife Area) | (a) Scirpus, Typha | 5/16/77 | - |
| | (b) Juncus, Salicornia | 5/16/77 | - |
| | (c) Salicornia | 5/16/77 | - |
| | (d) Scirpus | 5/16/77 | - |
| (20) Grizzly Island (State Wildlife Area) | (a) Scirpus, Juncus | 4/21/77 | - |
| | (b) Scirpus, Salicornia | 4/21/77 | - |
| | (c) Salicornia | 4/21/77 | - |
| **San Joaquin County** | | | |
| (21) Mandeville Point (County Park) | Scirpus, Typha | 7/7/77 | - |
| (22) White Slough, (headwaters) | Scirpus, Typha | 4/1/77 | - |
| | | 5/6/77 | - |
| | | 5/29/77 | 3 |
| | | 6/30/77 | 3 |
| (23) Caldoni's Marsh | Scirpus, Juncus | 4/1/77 | - |
| | | 5/6/77 | - |
| | | 5/29/77 | - |
| **Contra Costa County** | | | |
| (24) Pinole | Salicornia | 5/9/77 | 3 |
| | | 5/14/77 | 3 |
| | | 5/23/77 | 2 |
| | | 6/28/77 | 2 |
| | | 7/14/77 | 3 |
| (25) Point Pinole (Regional Park) | Salicornia | 6/16/77 | 1 |
| (26) Martinez Marina | Salicornia, Scirpus | 6/12/77 | - |
| (27) Port Chicago (Naval Reservation) | Scirpus, Salicornia Juncus | 6/11/77 | - |
| (28) Mallard Island | Scirpus, Juncus, Distichlis, Typha | 7/2/77 | 2-3 5/ |

3/ Censused by Mr. Frank Beyer.
4/ Immature black rail found dead in this vicinity on August 11, 1977 (DFG files).
5/ One black rail was accidentally flushed into view.



C—054017

C-054017

| Location | Marsh Type | Date | No. of Birds |
|---|---|---|---|
| **Alameda County** | | | |
| (29) Dumbarton Point | Salicornia, Spartina | 5/10/77 | - |
| (30) Ideal Cement Marsh | Salicornia, Spartina | 5/12/77 | - |
| (31) Coyote Hills Regional Park | Scirpus, Typha, Salicornia | 5/12/77 | - |
| (32) Mowry Slough | Salicornia (mostly) | 5/24/77 | - |
| (33) Albrae Slough | Salicornia (mostly) | 5/24/77 | - |
| (34) San Leandro Bay | (a) Salicornia, Distichlis | 6/14/77 | - |
| Arrowhead Marsh | (b) Spartina, Salicornia | 6/14/77 | - |
| **Santa Clara County** | | | |
| (35) Palo Alto Baylands | Salicornia, Spartina | 4/9/77 | - |
| (36) Triangle Marsh | Scirpus, Salicornia | 5/25/77 | - |
| **San Mateo County** | | | |
| (37) Pescadero Marsh | Scirpus, Salicornia, Typha | 4/8/77<br>7/6/77 | -<br>- |
| (38) Corkscrew Slough | Salicornia, Spartina | 5/13/77 | - |
| (39) Greco Island | Salicornia, Spartina | 5/13/77 | - |
| (40) San Gregorio | Salicornia, Scirpus, Distichlis | 7/6/77 | - |
| (41) Princeton | Salicornia, Typha, Scirpus, Juncus | 7/6/77 | - |
| **Merced County** | | | |
| Los Banos (Wildlife Management Area) | Scirpus, Typha, Juncus | 4/15/77<br>4/16/77<br>4/17/77 | -<br>-<br>- |
| **San Luis Obispo County** | | | |
| Morro Bay | Salicornia | 4/14/77<br>4/15/77 | 2<br>5 |



C—054018

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## DISCUSSION

Post and Enders (1969) hypothesized that black rails find tidal marshes more attractive than diked marshes with similar vegetation possibly because of higher food resource levels in tidal marshes. Little is known about black rail food habits (Wilbur 1974), but they seem to feed on arthropods (Huey 1916). The variety and abundance of arthropods in a marsh are probably affected considerably by the quantity, quality and the nature of fluctuations in the level of water in the marsh. Black rails found in this study were often in the immediate vicinity of tidal sloughs, indicating a concentration of activity in this part of the marsh. This suggests that the intertidal zone is an important part of the habitat of this species.

The frequent association of black rails with pickleweed is possibly a reflection of their preference for high, infrequently flooded marshes, but the importance of pickleweed, and possibly salt grass, as sources of nesting materials and substrates remains to be examined.

The fact that black rails were not found in San Francisco Bay proper may reflect the lack of high marsh habitat around this bay. Many areas of salt marsh in south San Francisco Bay have subsided in the past quarter-century because of human removal of water from underground water supplies (Conradson 1966), and large tracts of low-lying salt marsh in this region abut abruptly against salt pond dikes and other man-made structures, instead of gradually merging into upland habitats as they formerly did. Nearly all the remaining salt marsh in the south bay is completely covered by peak high tides, and often extensively flooded by even moderately high tides (fide San Francisco Bay National Wildlife Refuge personnel and personal observations).

In a census of marshes along the lower Colorado River, Repking and Ohmart (1974) found black rail distribution patterns similar to that observed in this study. They found black rails in high (damp ground and shallow water) marshes with little annual and/or daily fluctuations in water levels, but not in low, deep-water marshes or marshes with considerable annual and/or daily fluctuations in water levels. Ingersoll (1909), Huey (1916) and Stephens (1919) found evidence of profound effects by high tides on black rail populations, and Grinnell and Miller (1944) felt that the "most important hazards to existence [of black rails] on salt marshes appear to be extra high tides". The presence or absence of suitable high marsh vegetation for nesting may be the most limiting factor in determining the distribution of breeding black rails.

This study was conducted during a period of severe drought in northern California. A major effect of the drought has been an increase in salinity levels throughout the Bay Area and the Sacramento-San Joaquin Delta. To determine what effect this may have had, or will have, on black rail distribution and population levels will require further monitoring of this species in the region.

Nesting has not yet been confirmed in this northern end of the subspecies' range (Wilbur 1974). No nests were found in this survey, although the effort to find nests was limited to only one brief search at a marsh in Pinole on June 14. However, at eight sites (sites 5, 6, 12, 13, 15, 22, 24 and 28), the presence of two or more calling birds during the census period highly suggests that these are breeding birds. The habitat preference observed in tidal marshes in this study is also consistent with known nesting distribution in other tidal areas. Furthermore, the extensive amount of territorial calling heard during this survey also is indicative of breeding.

While this survey found black rails in many marshes in the San Francisco Bay Area, most of the bay marshes that may have summer populations of black rails have yet to be censused. Much more survey work will be required to accurately estimate the sizes of black rail populations in the San Francisco Bay estuary (see Appendix A for future survey recommendations).

Analysis of data on responses obtained in this study indicates that April and May, and perhaps March, are the best months to attempt to elicit responses from territorial black rails. In this period, censusers could expect to obtain responses within an hour of the beginning of the census if black rails are present.

## CONCLUSIONS

This study confirms the existence of a summering, and probably breeding, population of California black rails in the San Francisco Bay Region. Also, the study has provided some insight into the habitat requirements of this species. It suggests that tidal or riparian marshes in which the annual and daily cycles of water flow are not subject to extreme fluctuations are suitable for breeding, but that diked marshes usually are not. It also confirms the preference of black rails for high marsh habitat at the upper limits of flood tides.

Effective management programs to preserve suitable nesting habitat for black rails must depend on a better understanding of the interrelationships between this species and other elements, living and nonliving, of the marsh community.

## ACKNOWLEDGMENTS

Many people aided this survey in various ways. Ron Jurek provided the groundwork and assisted in programing the study. Charles Repking provided the taped calls of black rails used in censusing. Frank Beyer, Jack Booth, Kent Fickett, Deborah Gregory, Ron Jurek, Susanne Luther, Bill Manolis, Peter Metropulos, Jim Michaels, Mary Morrison, Cathy Osugi, Diane Renshaw, Tom Rodgers and Lucy Williams aided in field work and other ways.

For providing information and other assistance, I am grateful to Jack Arnold, Beckee Beemer, Laurence Binford, Gerald Brady, Jerry Cawthon, Ted Chandik, Dick Erickson, Don Grider, Roy Leach, Georgianne Manolis, Bob Personius, Bob Rodrigues, Aryan Roest, Glenn Rollins, Barry Sauppe, Gail Scott, Rich Stallcup, Gil Thompson and R. M. Wineman.

My special thanks to anyone I may have failed to mention but who helped in anyway.



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Point Reyes Peninsula, Marin County records of black rails. Numbers in parentheses refer to location numbers in Table 1.

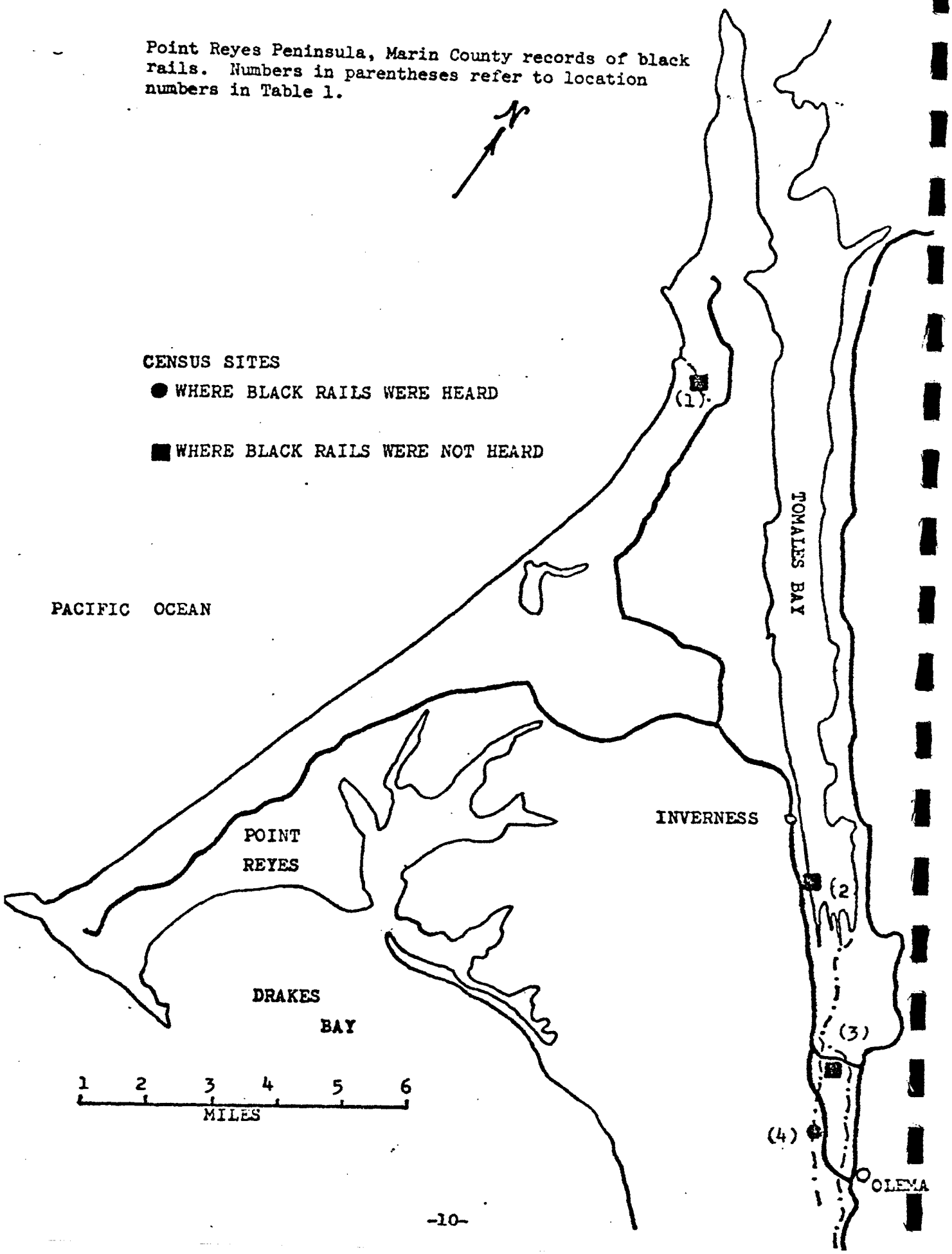




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Figure 3. Petaluma Marsh black rail records. Numbers in parentheses refer to location numbers in Table 1.

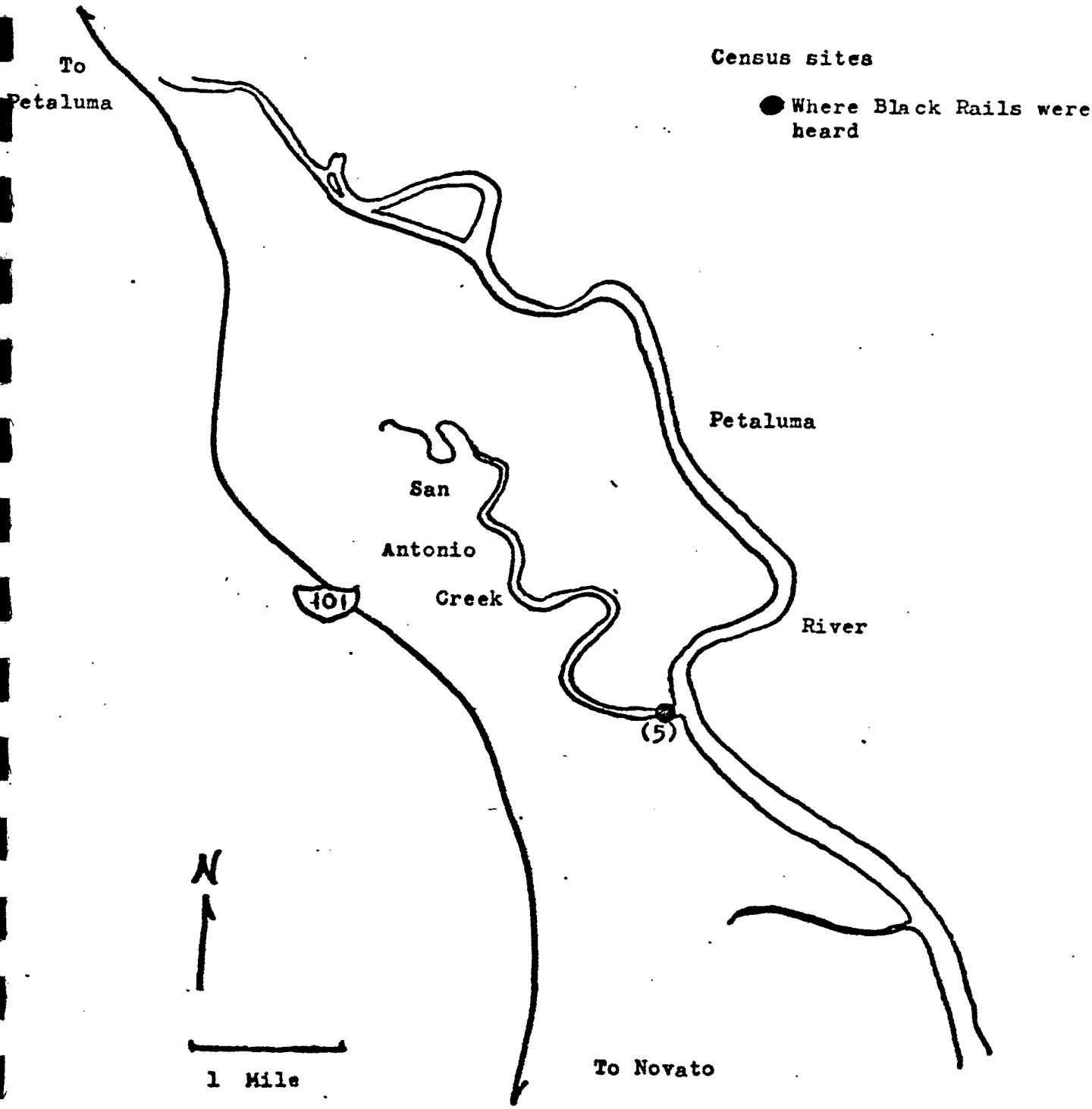




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Figure 4. Napa Marsh records of black rails. Numbers in parentheses refer to location numbers in Table 1.

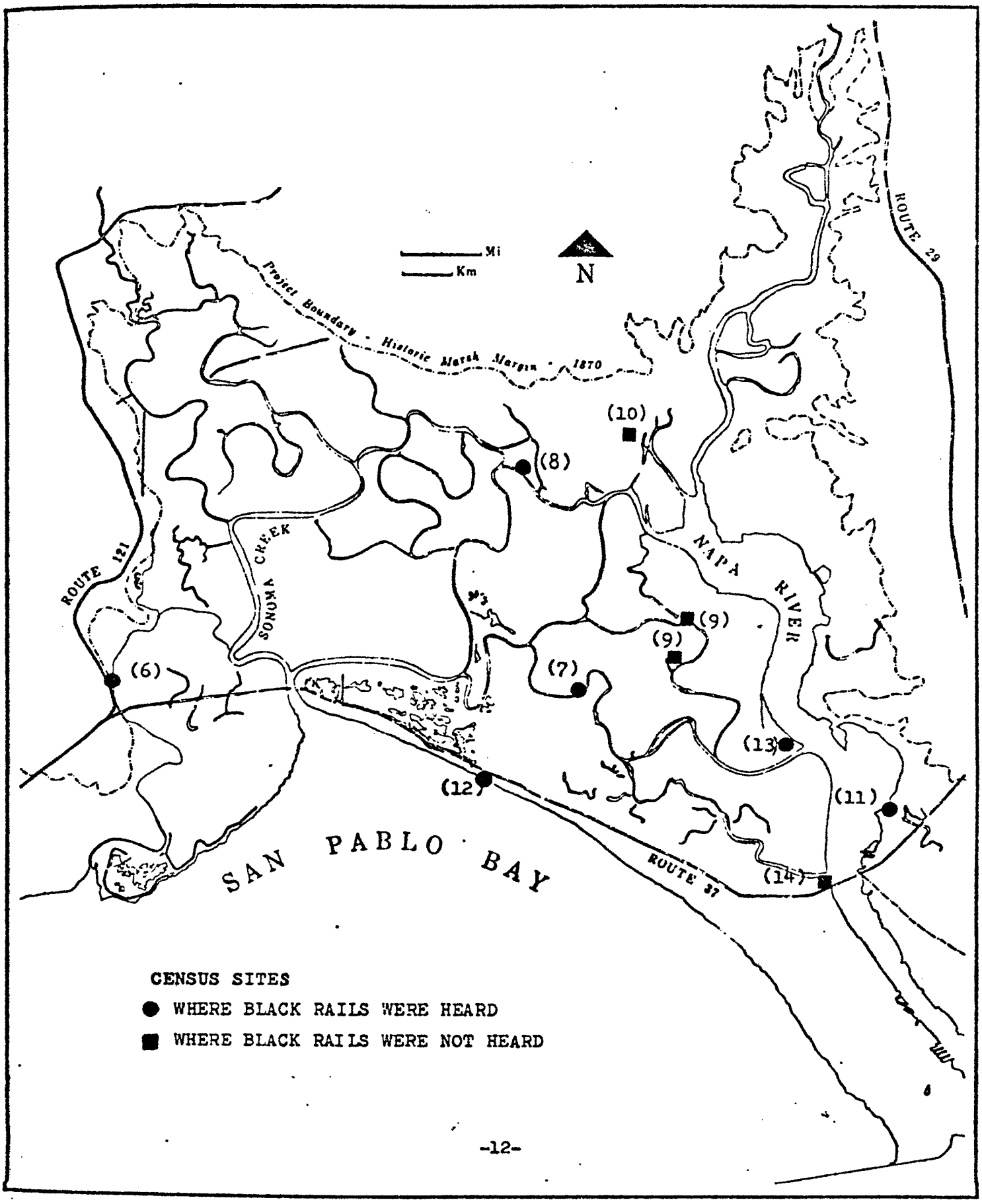
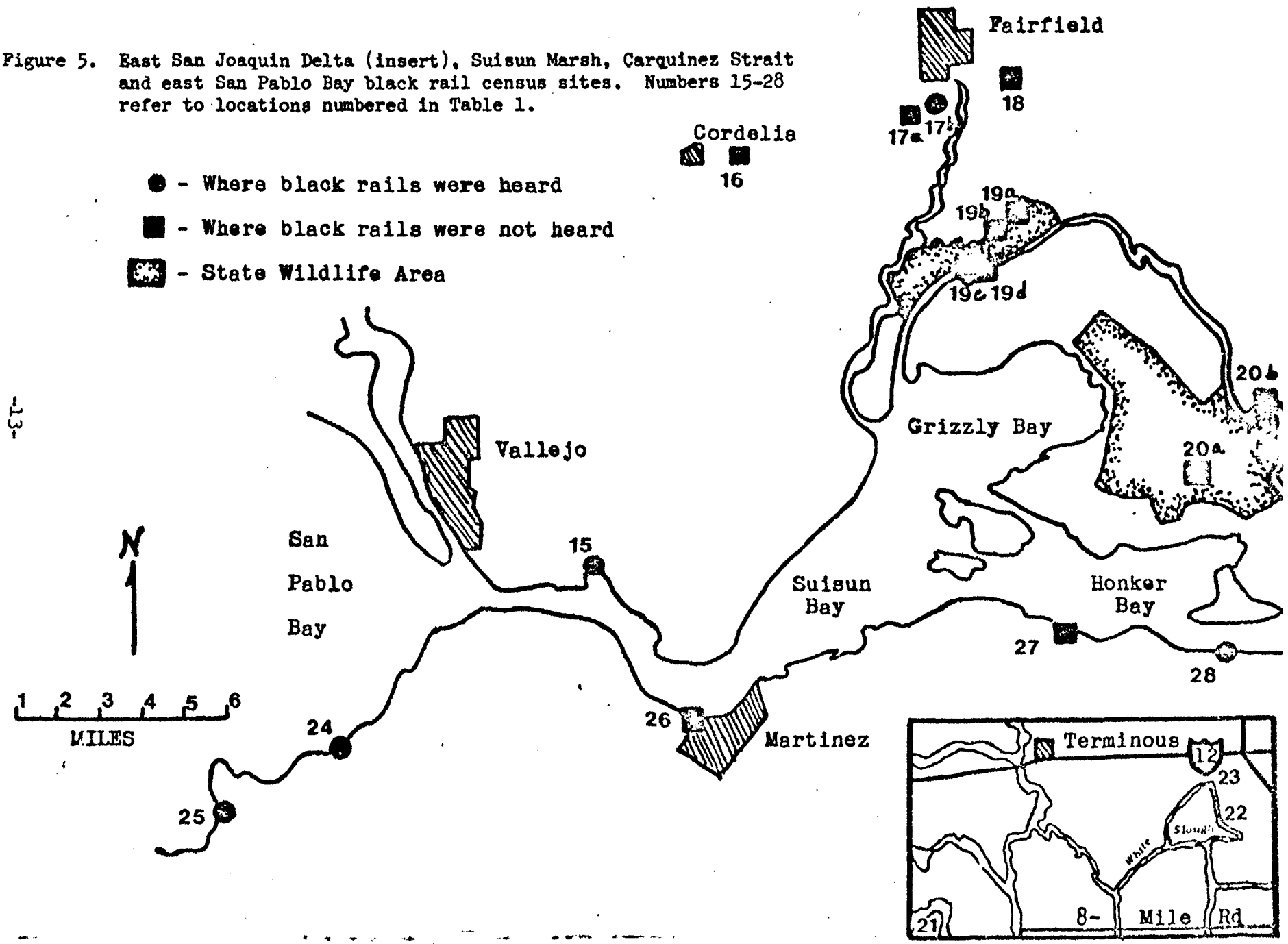


Figure 5. East San Joaquin Delta (insert), Suisun Marsh, Carquinez Strait and east San Pablo Bay black rail census sites. Numbers 15-28 refer to locations numbered in Table 1.



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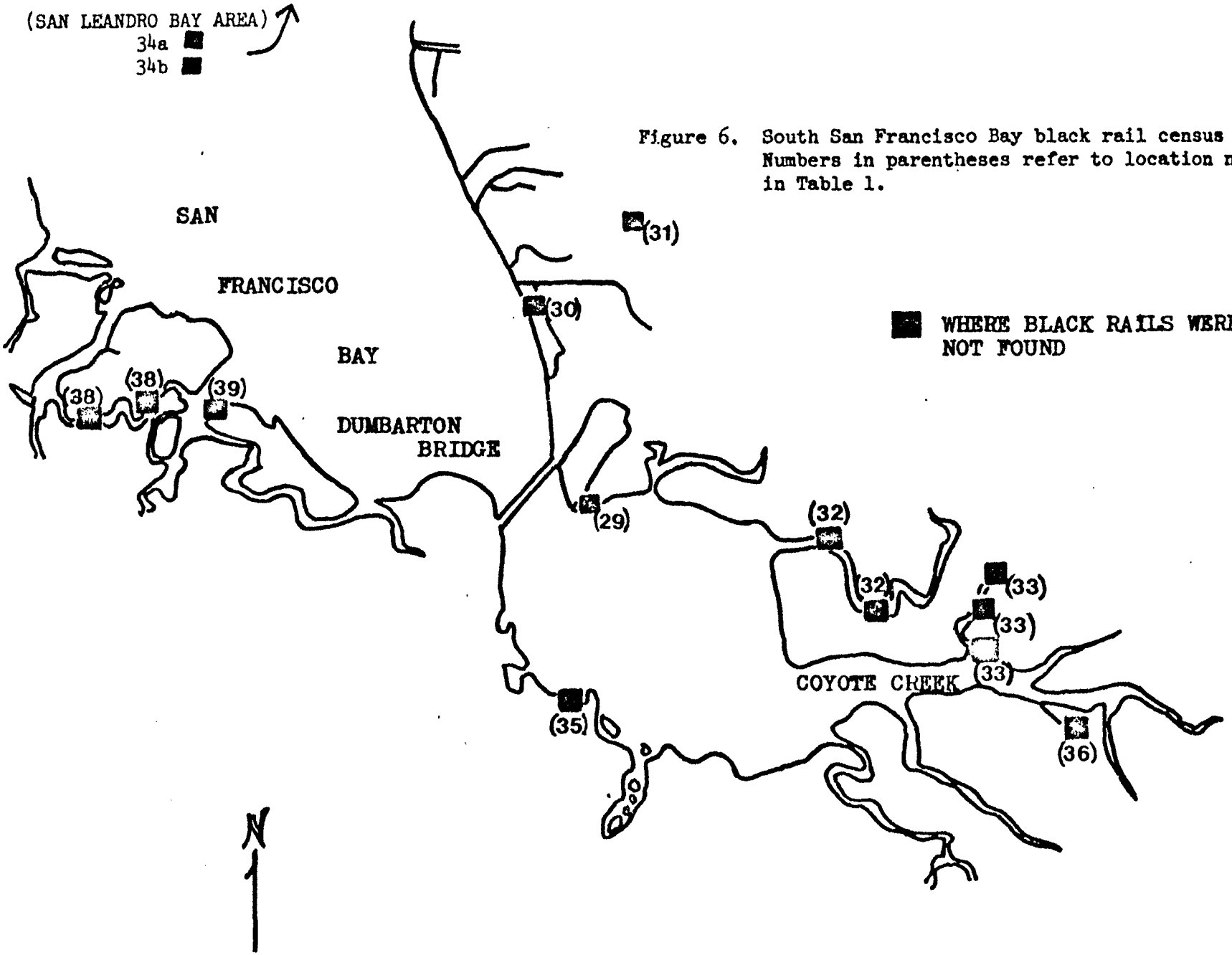


Figure 6. South San Francisco Bay black rail census sites. Numbers in parentheses refer to location numbers in Table 1.



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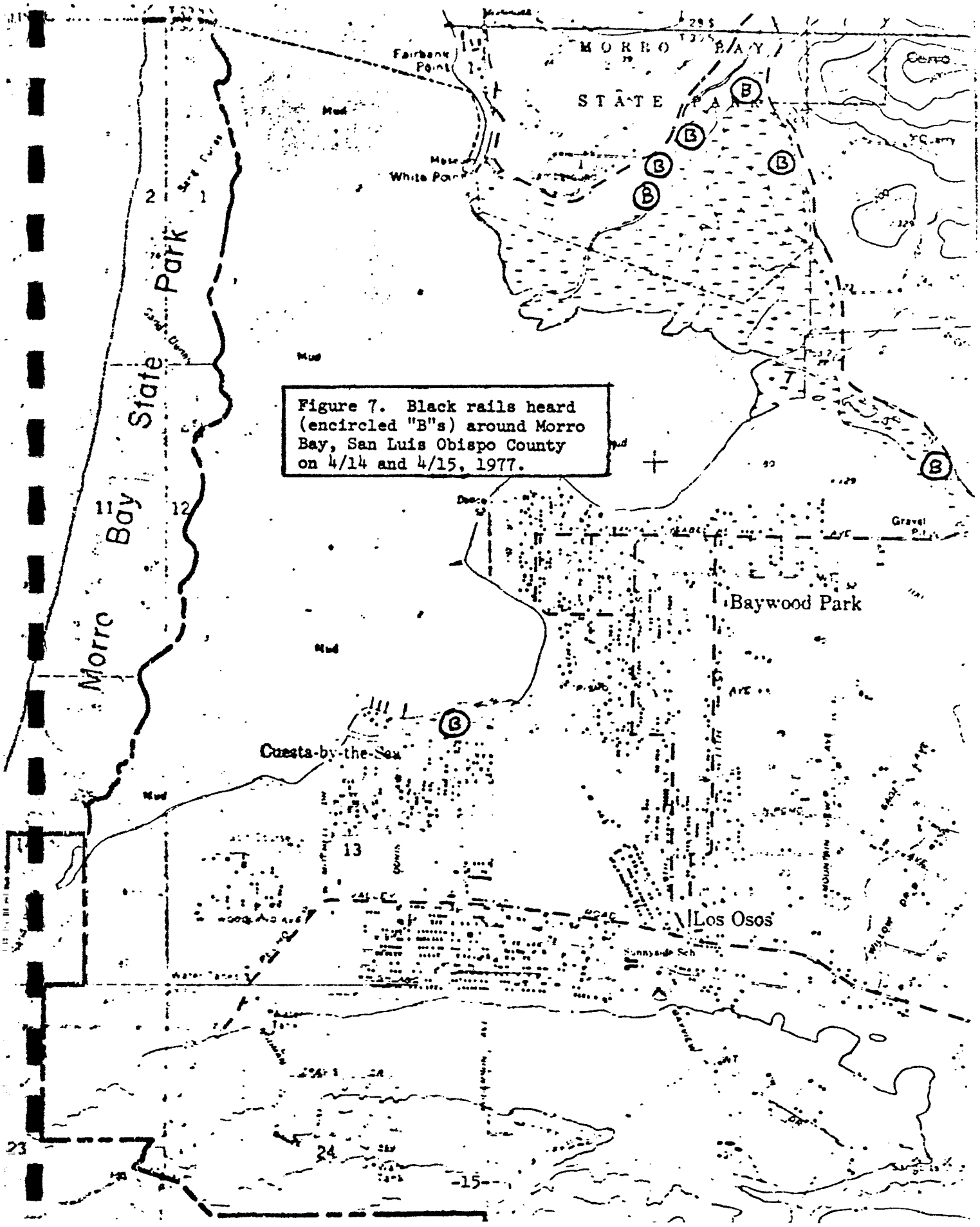


Figure 7. Black rails heard (encircled "B"s) around Morro Bay, San Luis Obispo County on 4/14 and 4/15, 1977.

## APPENDIX A

## REVIEW OF THE DISTRIBUTION OF BLACK RAILS IN NORTHERN AND CENTRAL CALIFORNIA.

This review is based on information from the following sources: Wilbur (1974); specimens in the Museum of Vertebrate Zoology (MVZ), Berkeley, and the California Academy of Sciences (CAS), San Francisco; the files of the Middle Pacific Coast regional editor of American Birds (AB); and information obtained in Department of Fish and Game studies and compiled in the Department's California black rail files in Sacramento (DFG).

### TOMALES BAY AND WESTERN MARIN COUNTY

Specimens of black rails were frequently collected during high flood tides in the fall and winter (September-February) in salt marshes on the edge of Tomales Bay near Marshall and Point Reyes Station, Marin County, from 1897 to at least 1940 (Wilbur 1974; MVZ and CAS). In the period between 1965 and 1967, at least one pair inhabitated a small brackish marsh along the bay near Inverness, Marin County, and probably bred (Gerald Brady, pers. comm.), but they have not been seen there since. One bird was observed in pickleweed near the head of the bay during a flood tide on February 5, 1974 (DFG). Salt marshes around Tomales Bay, not checked in this study, may yet harbor nesting black rails and should be surveyed in the future.

Elsewhere in western Marin County, black rails have been collected or observed at Kehoe Marsh on Point Reyes and in Olema Marsh between October and February. Black rails have been heard in Olema Marsh in April and May of recent years, and it is possible that they breed at this location (AB and DFG). A specimen of black rail from Elk Valley, Marin County, March 13, 1945 (MVZ), is probably a migrant or a nonbreeding wanderer.

### PETALUMA MARSHES

No records from these marshes existed prior to this study. The six birds found at the mouth of San Antonio Creek, Marin and Sonoma Counties, indicate a potentially large, unknown population in these marshes, and further surveying is strongly recommended.

### SAN PABLO BAY

Prior to the 1970's, there seem to have been no records of black rails for marshes around this bay. One was seen at Pinole, Contra Costa County, November 19, 1975; five were seen at the mouth of Gallinas Creek, Marin County, December 11, 1973 and one was seen there on January 7, 1974; and one was seen and heard at Midshipman's Point, Tubbs Is., Sonoma County on February 14 and 26, 1977 (DFG).

Black rails were found along the northeast shoreline of San Pablo Bay, Solano County, and at Pinole and Point Pinole, Contra Costa County, during this study. Further survey work in the fairly extensive marshes around the bay seems warranted, as much of it appears to be suitable for black rails.

## NAPA MARSHES

There appear to be no records for black rails in these marshes prior to 1976; two responses to taped calls were obtained by Department of Fish and Game employees near Fagan Slough, Napa County, on July 14 that year. In this study, black rails were found at five localities in the Napa marshes (Tolay Creek, Sonoma County; Napa Slough, Napa County; two spots along South Slough, Solano County; and the mouth of White Slough, Solano County, and further surveying for black rails in this area seems warranted.

## SOUTHAMPTON MARSH (BENICIA STATE PARK)

Two were observed in this marsh on April 2, 1958, and in the early 1970's this marsh was "discovered" as a good place to observe black rails during high winter tides: a number of records for December through February (AB and DFG). One was heard in the marsh on May 22, 1975 (AB), and single calling birds were heard June 2 and 26, 1976 (DFG files). During frequent censusing of this marsh in summer 1977, Mr. Frank Beyer heard as many as three birds at once, and he estimated four pairs inhabitated this marsh. A black rail, probably a migrant, was found dead in Benicia, Solano County, July 18, 1941 (Wilbur 1974).

## SAN FRANCISCO BAY

A good number of fall and winter (October through February) specimens of black rail were collected in a variety of San Francisco Bay localities (Alameda, Bay Farm Island and Newark, Alameda County; Alviso and Palo Alto, Santa Clara County; and Redwood City, San Mateo County) between 1892 and 1913 (Wilbur 1974; CAS and MVZ). Sight records in the years since then for the southern part of the bay have been in approximately the same areas in the same months. There are two specimens for Palo Alto on May 24, 1930 (CAS); one was seen along Belmont Slough, San Mateo County, in August 1972 (Barry Sauppe, pers. comm.); and one was seen August 7, 1958, at Dumbarton Point, Alameda County (AB). Black rails were not found in the south bay in this study, and it seems unlikely that the species nests in this region because of the lack of suitable habitat (high marsh). There are two specimens from north San Francisco Bay, both in Marin County; one found dead near Manzanita, August 11, 1929 (MVZ), and one from Kentfield, February 8, 1932 (CAS). While high marsh habitat in this part of Marin County has been greatly reduced since the time of these records, remaining salt marsh in this area is probably worth surveying in the future.

A number of records exist of black rails found away from tidal marshes in the San Francisco Bay Region. Most of them are for late summer or fall and indicate a tendency for individuals of this species to wander after the breeding season. Other than records already mentioned above, these records are as follows:

| Location | County | Number of Black Rails | Date | Source |
|---|---|---|---|---|
| S.E. Farallon Is. | San Francisco | 1 | November 7, 1903 | MVZ |
| S.E. Farallon Is. | San Francisco | 1 | June 1905 | CAS |
| S.E. Farallon Is. | San Francisco | 1 | December 1909 | MVZ |
| Merced Lake | San Francisco | 1 | September 20, 1931 | Wilbur 1974 |
| Merced Lake | San Francisco | 1 | October 16, 1932 | Wilbur 1974 |
| Merced Lake | San Francisco | 1 | October 16, 1937 | Wilbur 1974 |
| San Francisco | San Francisco | 1 | February 14, 1942 | MVZ |
| Golden Gate Park | San Francisco | 1 | April 2, 1945 | Wilbur 1974 |
| San Francisco | San Francisco | 1 | August 8, 1945 | CAS |
| Berkeley | Alameda | 1 | August 23, 1922 | Wilbur 1974 |
| Near Niles and Centerville | Alameda | 1 | September 21, 1949 | MVZ |

## SUISUN MARSHES AND NORTHERN CONTRA COSTA COUNTY

pecimens of black rail were collected in the Suisun Marshes September 11, 1913; ctober 19, 1910; and January 15, 1911 (MVZ). Individuals were seen on December 13, 1975, and December 29, 1976, near Cutoff Slough, Solano County, and on December 28, 1974 near Suisun Slough, Solano County (DFG). There is an old winter record for artinez, Contra Costa County (Grinnell and Wythe 1927), and recent (1975 and 1976) winter sightings near Port Chicago, Contra Costa County (DFG). During this survey, black rails were found near Suisun City, Solano County (1 bird[1]), and on Mallard sland, Contra Costa County (two or three birds). Much of the Suisun Marsh is diked, nd apparently unsuitable for nesting black rails, but tidal marshes still left in this area should be checked further for this species.

## SACRAMENTO-SAN JOAQUIN RIVER DELTA

here is a late 19th century record for Stockton; one rail was found dead near n August 26, 1959 (Wilbur 1974). Fish and Game personnel first discovered black rails calling, in response to taped calls, at White Slough Marsh, San Joaquin County, n the summer of 1974, and they have been heard in this marsh every year since. hile such habitat is now fairly rare there, black rails should be looked for elsewhere in the delta where high tidal marsh occurs.

## CENTRAL VALLEY

ne record exists for the Central Valley; one was found dead at Gray Lodge Wildlife anagement Area, Butte County, in March 1962. This was most likely a vagrant. Department surveys for black rail at Sacramento National Wildlife Refuge, Glenn County, t Gray Lodge, and at Los Banos Wildlife Area, Merced County, have all yielded egative results in recent years.

## MONTEREY BAY

lack rails have been collected twice at Santa Cruz, Santa Cruz County: July 19, 1930, and August 25, 1941 (MVZ), and one was found dead there in September 1903 (Wilbur 1974). These records probably pertain to post-breeding wanderers or fall igrants. Marshes along Elkhorn Slough, Monterey County, should be checked in the uture for breeding black rails.

## MORRO BAY

black rail was collected in Morro Bay on April 22, 1961, one was found dead there n December 18, 1972, and one was seen there November 30, 1968 (DFG). Seven black rails were heard in marshes around Morro Bay during this study, and the evidence oints to a resident population of this species at Morro Bay.

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1/ See footnote "4/" on Table 1.

# APPENDIX H

# STUDY OF THE SALT MARSH HARVEST MOUSE IN SUISUN BAY, CALIFORNIA

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Prepared for

U. S. Department of the Interior

Water and Power Resources Service

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# TABLE OF CONTENTS

Introduction . . . . . 1

Description of the Trapping Areas . . 7

Vegetation Sampling By Line Transects . 28

Discussion of the Results of Trapping . 29

Impact of Vegetation Along Ditch Corridors . . . . . 38

Implications of the Proposed Water/ Management Plans on Salt Marsh Harvest Mice . . . . . 50

Literature Cited . . . . 52

## LIST OF FIGURES

| | | |
|---|---|---|
| Figure 1 | Salt Marsh Harvest Mouse Trapping Areas in Suisun Marsh | 2 |
| Figure 2 | Morrow Island Tule (1) and Morrow Island Dike (2) | 12 |
| Figure 3 | Teal Slough (3) and Teal Boathouse (4) | 13 |
| Figure 4 | Joice Island Footbridge (5) and Joice Island Powerline (6) | 15 |
| Figure 5 | Jacksnipe Pickleweed (13) and Jacksnipe Wetlands (14) | 16 |
| Figure 6 | Nurse Slough (19) | 17 |
| Figure 7 | Vennink Stockgate (7), Vennink Decoy (8), Vennink Building (21), Vennink Bayside (22) | 18 |
| Figure 8. | Simmons Island Gate (11), Simmons Island Road (12a) and Simmons Island 9th Pole (12b) | 19 |
| Figure 9 | Hill Slough Windmill (17) and Hill Slough Dump (18) | 21 |
| Figure 10 | Meins Landing Mound (9) and Meins Landing Bulrush (10) | 22 |
| Figure 11 | Grizzly Bay 1 (23) and Grizzly Bay (24) | 24 |
| Figure 12 | Cordelia Dike (15) and Cordelia Pasture (16) | 25 |
| Figure 13 | Denverton Highway (20) | 26 |
| Figure 14 | Location of Plant Transects Along the Potrero Hills Ditch | 40 |
| Figure 15 | Location of Plant Transects Along the Grizzly Island Ditch | 41 |
| Figure 16 | Location of Plant Transects Along the Grizzly Island Ditch (continued) | 42 |
| Figure 17 | Location of Plant Transects Along the Cygnus Bypass Ditch | 43 |

Figure 18 Location of plant transects along the Boynton-Cordelia Ditch . . . . . 44
Figure 19 Potrero Hills Ditch Plant Profile . . 45
Figure 20 Grizzly Island Ditch Plant Profile . . 46
Figure 21 Cygnus Bypass Unit Plant Profile . . . 47
Figure 22 Boynton Cordelia Ditch Plant Profile . . 48

# LIST OF TABLES

Table 1 Summary of Animals Captured At All Trap Sites . 4

Table 2 Plant Composition of Trapping Areas Sampled With Random $m^2$ Plots At 20% of Trapping Sites . 8

Table 3 Principal Vegetation Factors Influencing the Distribution of Salt Marsh Harvest Mice In the Suisun Bay (see also Table ) . . . . . 30

Table 4 Plant Composition of Trapping Areas Assessed with Transects . . . . . 32

Table 5 Abundance of Salt Marsh Harvest Mice with Respect to Percent Cover of Pickleweed Sampled by Random Plots (from Table 3) . . . 34

Table 6 Vegetation Categories Used in Plant Transects Along Ditch Corridors . . . . . 39

# INTRODUCTION

This study was carried out during late spring (late May and early June) and summer (late July through late August) 1980. Thirteen sites at six primary areas (Morrow Island, Teal Island, Joice Island, Vennink Stockgate and Decoy, Meins Landing and Simmons Island, Fig.1 ) were trapped during both seasons, although plant surveys were run only during the earlier trapping period. One portion of Simmons Island was closed to us in the spring so we trapped another nearby site (Simmons Island Road) and our proposed site (Simmons Island 9th Pole) was trapped in the summer, hence three locations for the Simmons Island area. Twelve secondary sites were trapped and surveyed only during the summer. Six of the secondary sites (Cordelia Dike and Pasture, Hill Slough Windmill and Dump, Denverton, and Nurse Slough) were at the periphery of the marsh complex while six were landward within the marsh and near some of the primary sites. All the areas are shown in Figure 1 and considered in detail later in this report. Plant transects were run during the summer through each of the twenty-five trapping sites and along the proposed routes of major ditches.

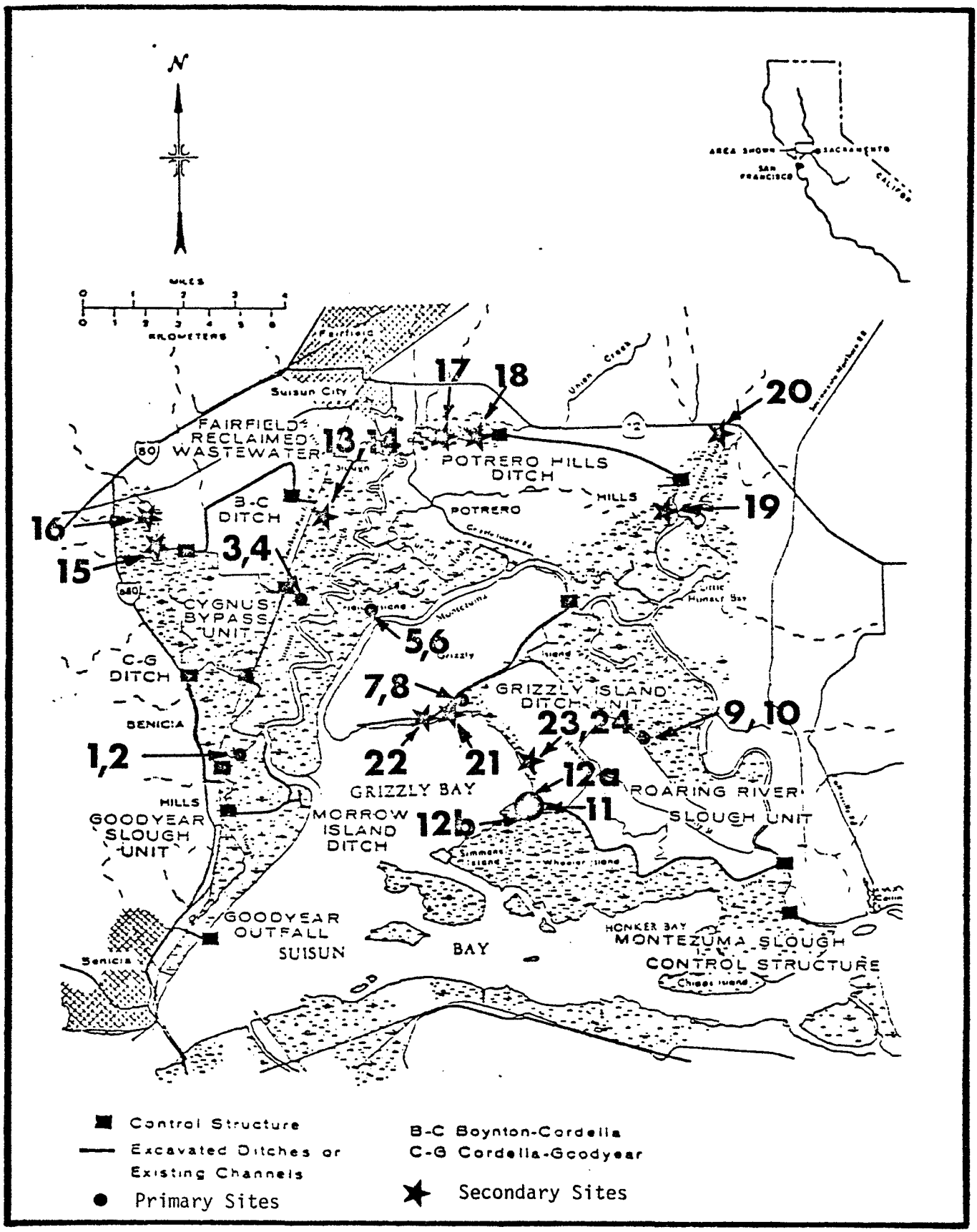


Figure 1.
Salt Marsh Harvest Mouse
Trapping areas in Suisun Marsh

(see Tables 1, 2 or 3 for names of areas)

Our object in selecting trapping sites was to pick localities that reflected the general distribution of plant cover plus the variety of land use and management techniques found in Suisun Marsh. Many of the areas, both primary and secondary are near an end of a ditch proposed in the water plan and hence should be indicators of changes in plant communities in the future. Four of the primary sites were predominantly alkali bulrush while six were predominantly pickleweed. Two sites were mixed alkali bulrush and pickleweed with a considerable component of saltgrass and one was a dike edge. Four of the secondary sites were dominated by pickleweed, two by alkali bulrush, one was a mixture of the two species, two were predominantly saltgrass and three were dike vegetation which is largely ruderal.

Each site was live-trapped for either 150 or 300 trap nights for a grand total of 5,700 trap nights and we captured 21 salt marsh harvest mice (*Reithrodontomys raviventris halicoetes*), 21 western harvest mice (*R. megalotis*), 86 house mice (*Mus musculus*), and seven mice of other species (Table 1.) The harvest mice were marked with ear tags which allowed us to note five recaptures of salt marsh and eight recaptures of western harvest mice. We do not know how many *Mus* were recaptured because we did not tag them or any of the other species.

TABLE 1

Summary of animals captured at all trap sites.

| | AREA | # TRAP NIGHTS | R. r. | R. m. | M. m. | Misc. | TOTALS |
|---|---|---|---|---|---|---|---|
| 1. | Morrow Island Tule | 300 | 0 | 1 | 6 | 1[1] | 8 |
| 2. | Morrow Island Dike | 300 | 0 | 0 | 5 | | 5 |
| 3. | Teal Slough | 300 | 2(+2)* | 1 | 11 | | 14 |
| 4. | Teal Boathouse | 300 | 0 | 1(+1) | 3 | | 4 |
| 5. | Joice Is. Footbridge | 300 | 0 | 0 | 2 | | 2 |
| 6. | Joice Is. Powerline | 300 | 1 | 2 | 3 | | 6 |
| 7. | Vennink Stockgate | 300 | 3 | 3(+1) | 8 | | 14 |
| 8. | Vennink Decoy | 300 | 0 | 0 | 6 | | 6 |
| 9. | Meins Landing Mound | 300 | 2 | 8(+5) | 1 | | 11 |
| 10. | Meins Landing Bulrush | 300 | 2 | 0 | 5 | | 7 |
| 11. | Simmons Is. Gate | 300 | 0 | 0 | 0 | | 0 |
| 12a. | Simmons Is. Road | 150 | 0 | 0 | 0 | | 0 |
| 12b. | Simmons Is. 9th Pole | 150 | 4(+2) | 0 | 6 | 1[1] | 11 |
| 13. | Jacksnipe Pickleweed | 150 | 0 | 0 | 0 | | 0 |
| 14. | Jacksnipe Wetlands | 150 | 0 | 1 | 0 | | 1 |
| 15. | Cordelia Dike | 150 | 0 | 0 | 2 | 1[2] | 3 |
| 16. | Cordelia Pasture | 150 | 0 | 0 | 0 | 3[1] | 3 |
| 17. | Hill Slough Windmill | 150 | 0 | 0 | 0 | | 0 |
| 18. | Hill Slough Dump | 150 | 0 | 0 | 0 | | 0 |
| 19. | Nurse Slough | 150 | 0 | 1 | 12 | | 13 |

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Table 1 , continued

| | AREA | # TRAP NIGHTS | R. r. | R. m. | M. m. | Misc. | TOTALS |
|---|---|---|---|---|---|---|---|
| 20. | Denverton Highway | 150 | 0 | 0 | 2 | 1[3] | 3 |
| 21. | Vennink Building | 150 | 0 | 0 | 6 | | 6 |
| 22. | Vennink Bayside | 150 | 0 | 0 | 1 | | 1 |
| 23. | Grizzly Bay 1 | 300 | 5(+1) | 1(+2) | 0 | | 6 |
| 24. | Grizzly Bay 2 | 300 | 2 | 2 | 0 | | 4 |
| | TOTALS- | 5,700 | 21 (+5) | 21 (+5) | 86 | 7 | 135 |

R. r. = Reithrodontomys raviventris
R. m. = Reithrodontomys megalotis
M. m. = Mus musculus
Misc. = Miscellaneous

[1] = Microtus californicus
[2] = Rattus novegicus
[3] = Peromyscus maniculatus
* = number of recaptures





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The characteristics of various areas will be discussed first, followed by a discussion of the trapping results. Then we will discuss the plant transects along potential ditch corridors and finally the implications of the overall water plan to the ecology of the salt marsh harvest mouse in the Suisun marsh.

## DESCRIPTION OF THE TRAPPING AREAS

The four areas on dikes varied the most from the general vegetation types we sampled. Morrow Island Dike, Cordelia Dike, Vennink Building and Bayside were all covered with very tall and diverse vegetation including giant reed, California tule, cattails (see Table 2). Considerable wild rose was present along the inland edge in several of the areas while alkali bulrush and pickleweed were absent. No salt marsh harvest mice were captured in these areas.

Six areas were dominated by alkali bulrush while three were dominated by it and pickleweed or it, pickleweed and salt grass.

1. Morrow Island Tule (Fig. 2) was a patchwork of alkali bulrush, cattails, reeds and other species at the edge of a well-managed field. Throughout this report "well-managed" will refer to areas managed for duck habitat or duck clubs.
2. Teal Slough (Fig. 3) was almost entirely alkali bulrush except for narrow bands of pickleweed along the small waterways dissecting the fields of bulrush.

TABLE 2

Plant Composition Of Trapping Areas
Sampled With Random $m^2$ Plots At 20%
Of Trapping Stations

| | Ave. Height (cm) | PERCENT COVER | | | | | | | | | Date Surveyed |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | bare ground | pickleweed | alkali bulrush | brass buttons | saltgrass | fat hen | cattail | California bulrush | Misc. | |
| 1. Morrow Island Tule | 111 | 3 | 1 | 43 | 5 | 8 | 3 | 17 | - | 21[1] | 6/7 |
| 2. Morrow Island Dike | 172 | - | - | - | - | - | - | - | - | 100[2] | 6/7 |
| 3. Teal Slough | 58 | 23 | 7 | 71 | - | - | - | - | - | - | 6/7 |
| 4. Teal Boathouse | 52 | 2 | - | 52 | 44 | - | - | - | - | - | 6/7 |
| 5. Joice Is. Footbridge | 48 | 6 | 27 | 62 | - | - | - | - | - | - | 5/26 |
| 6. Joice Is. Powerline | 42 | - | 31 | - | - | - | - | - | - | 69[3] | 5/26 |

[1] = *Scirpus acutus* 17%, dead material 4%

[2] = *Baccharis pilularis* 39%, *S. acutus* 27%, *Rosa californica* 13.5% *Phragmites communis* 8%, misc. 14%

[3] = *Hordeum hystrix* 39%, misc. grasses 30%

* = Species listed by common name are, reading from left to right: *Salicornia pacifica*, *Scirpus robustus*, *Cotula coronopifolia* *Distichlis spicata*, *Atriplex patula*, *Typha* spp., and *Scirpus californicus*



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Table 2, continued

| | Av. Height (cm) | PERCENT COVER | | | | | | | | | Date Surveyed |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | bare ground | pickleweed | alkali bulrush | brass buttons | saltgrass | fat hen | cattail | California bulrush | Misc. | |
| 7. Vennink Stockgate | 45 | 3 | 97 | - | - | - | - | - | - | - | 5/26 |
| 8. Vennink Decoy | 54 | - | 37 | 28 | | 31 | 3 | - | - | 3[1] | 5/26 |
| 9. Meins Landing Mound | 29 | 33 | 49 | - | 2 | - | 5 | - | - | 11[2] | 6/1 |
| 10. Meins Landing Bulrush | 23 | 10 | 41 | 2 | 46 | - | 1 | - | - | - | 6/1 |
| 11. Simmons Is. Gate | 39 | 19 | 25 | 36 | 2 | 10 | | | | 2[3] | 6/1 |
| 12a. Simmons Is. Road | 35 | 39 | 40 | 3 | 2 | - | - | - | - | - | 6/1 |
| 12b. Simmons Is. 9th Pole | 43 | 14 | 59 | 1 | 11 | 6 | 3 | - | - | 6[4] | 7/23 |

[1] = Dead Vegetation 3%

[2] = *Hordeum hystrix* 11%

[3] = *Rumex pulcher* 2%

[4] = *Juncus balticus* 2%, misc. 4%



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Table 2, continued

| | Ave. Height (cm) | PERCENT COVER | | | | | | | | | Date Surveyed |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | bare ground | pickleweed | alkali bulrush | brass buttons | saltgrass | fat hen | cattail | California bulrush | Misc. | |
| 13. Jacksnipe Pickleweed | 73 | 6 | 43 | 41 | 3 | - | 8 | - | - | - | 8/8 |
| 14. Jacksnipe Wetlands | 94 | - | - | 95 | 5 | - | - | - | - | - | 8/8 |
| 15. Cordelia Dike | 74 | - | - | - | - | 20 | - | 24 | 13 | 43[1] | 8/10 |
| 16. Cordelia Pasture | 42 | 15 | 70 | - | - | 15 | - | - | - | 1 | 8/10 |
| 17. Hill Slough Windmill | 27 | - | 20 | 4 | - | 65 | 1 | - | - | 10[2] | 8/22 |
| 18. Hill Slough Dump | 26 | - | 20 | 6 | - | 58 | - | - | - | 19[3] | 8/22 |

[1] = *Juncus balticus* 40%, misc. 3%

[2] = *Jaumea carnosa* 8%, *Lythrum hyssopifolia* 2%

[3] = *Lythrum hyssopifolia* 19%



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Table 2, continued

| | | Ave. Height (cm) | PERCENT COVER | | | | | | | | | Date Surveyed |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | bare ground | pickleweed | alkali bulrush | brass buttons | saltgrass | fat hen | cattail | California bulrush | Misc. | |
| 19. | Nurse Slough | 61 | 9 | - | 51 | 6 | - | - | - | - | 34[1] | 8/21 |
| 20. | Denverton Highway | 42 | 9 | 89 | - | - | 1 | 1 | - | - | - | 8/21 |
| 21. | Vennink Building | 136 | - | - | - | - | - | - | 3 | 19 | 78[2] | 8/18 |
| 22. | Vennink Bayside | 161 | 11 | - | - | - | 5 | - | 12 | 30 | 42[3] | 8/19 |
| 23. | Grizzly Bay 1 | 33 | 11 | 81 | - | 1 | 5 | 2 | - | - | - | 7/23 |
| 24. | Grizzly Bay 2 | 36 | 21 | 75 | - | 2 | - | 1 | - | - | - | 7/23 |

[1] = *Hordeum hystrix* 33%, *Sesuvium sessile* 1%

[2] = *Lepidium latifolium* 28%, *Artemisia Douglasiana* 23%, *Rosa californica* 10%, *Oenanthe sarmentosa* 8%, *Asparagus officinalis* 5%, misc. 6%

[3] = *Arundo donax* 11%, *Baccharis pilularis* 10%, *Rosa californica* 9%, *Artemisia Douglasiana* 3.2%, misc. 11%



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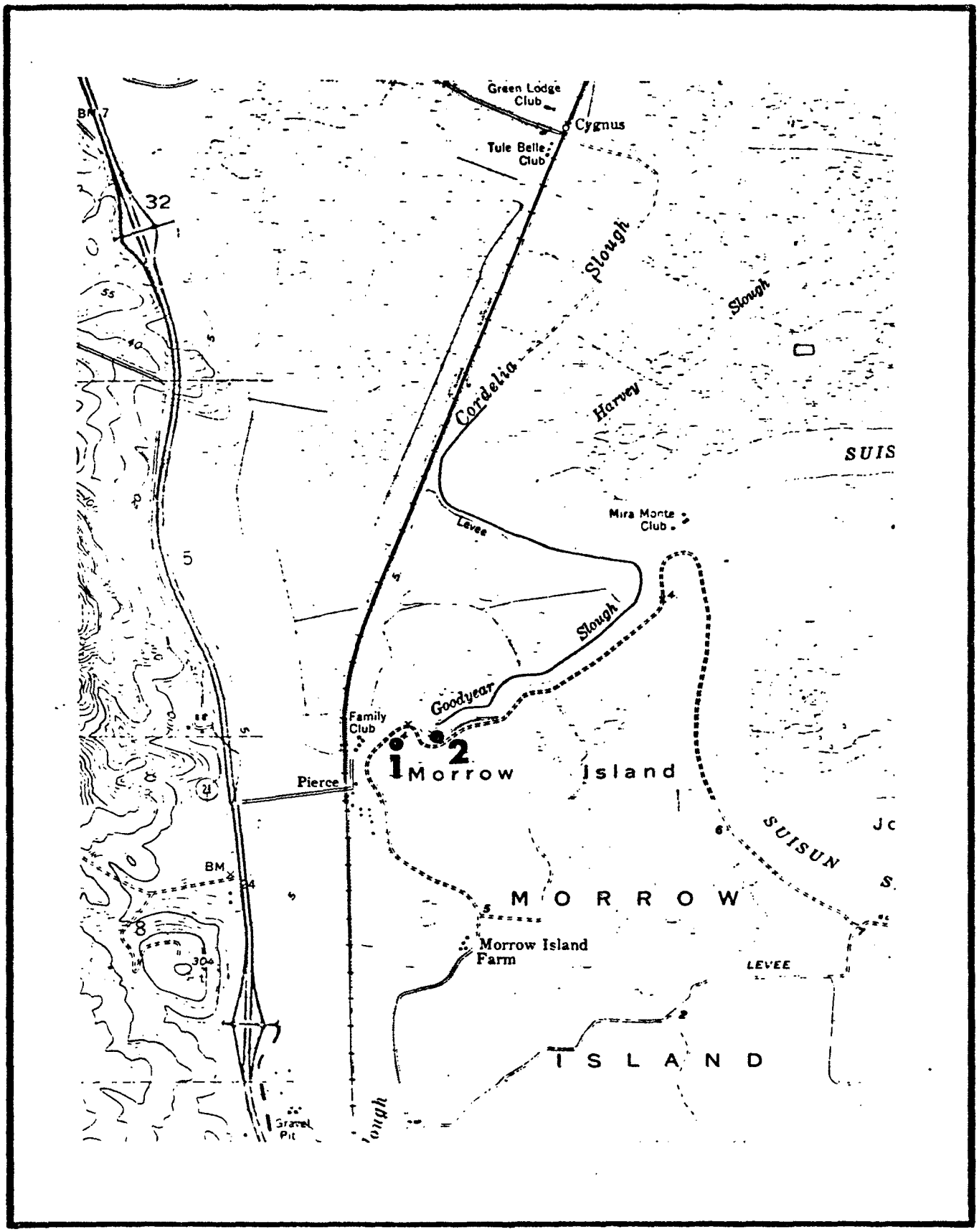


Figure 2. Morrow Island Tule (1) and Morrow Island Dike (2)



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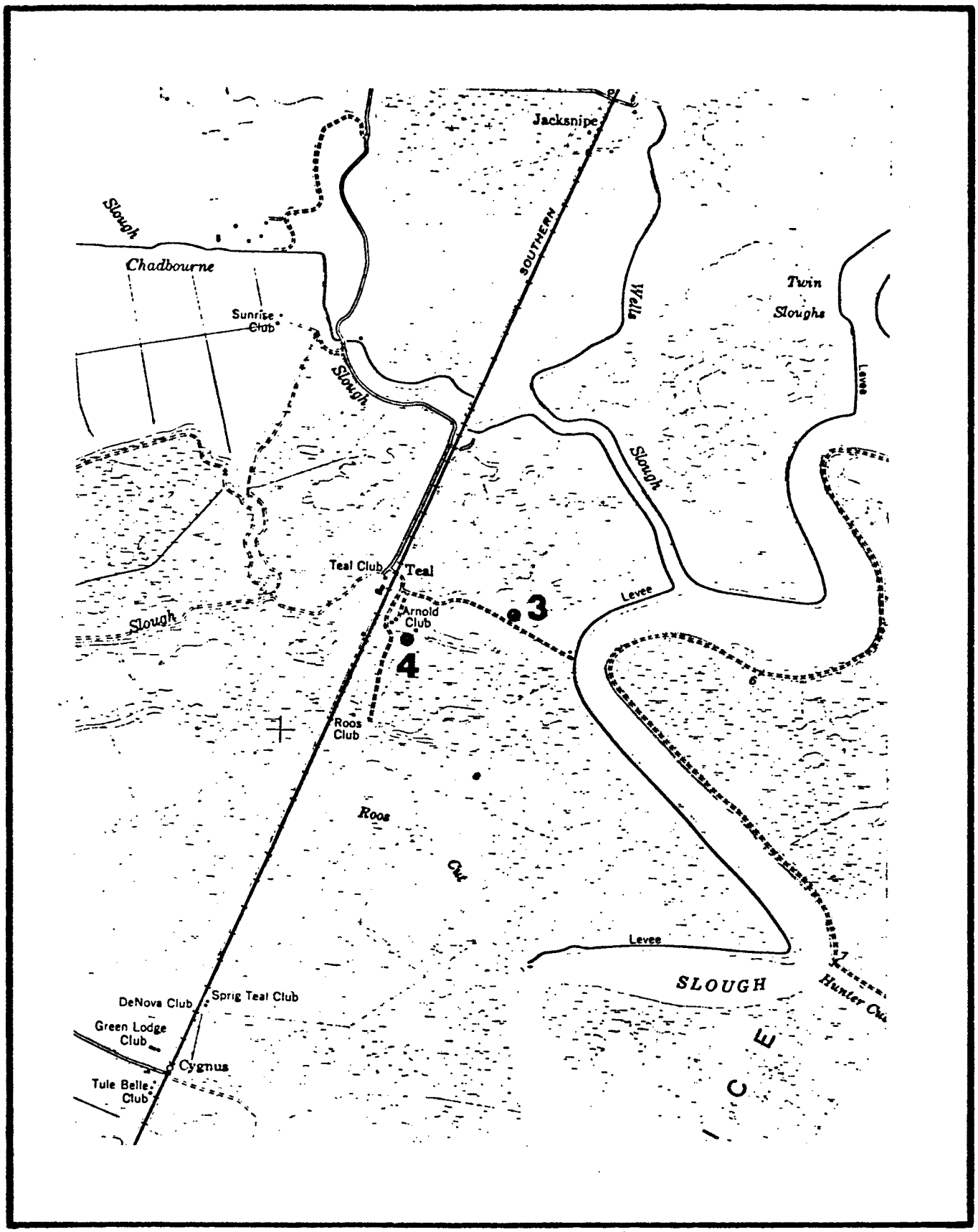


Figure 3. Teal Slough (3) and Teal Boathouse (4)



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3. Teal Boathouse (Fig.3 ) was a mixture of alkali bulrush and brass buttons. Both Teal areas had the appearance of being well-managed for bulrush.
4. Joice Island Footbridge (Fig. 4) was predominatly alkali bulrush with approximately 27 % pickleweed. It was situated in a large field in the middle of the Joice Island unit managed by the California Department of Fish & Game.
5. Jacksnipe Wetlands (Fig.5 ) was almost pure alkali bulrush in an area extremely well-managed by duck clubs.
6. Nurse Slough (Fig. 6 ) was on a duck club property east of the Luco Hills, an area dominated by alkali bulrush and secondarily by a grass Hordeum hystrix.

Two salt marsh harvest mice were captured at the Teal Slough site. One was captured in bulrush several times while the other was captured in a combination of pickleweed, fat hen and bulrush.

The three "mixed" sites were Vennink Decoy, Simmons Island Gate and Jacksnipe Pickleweed (see Table 2 and Figs. 7, 8 & 5 ). One of these sites was dominated by salt grass (Vennink Decoy). No harvest mice of either species were captured at these sites.

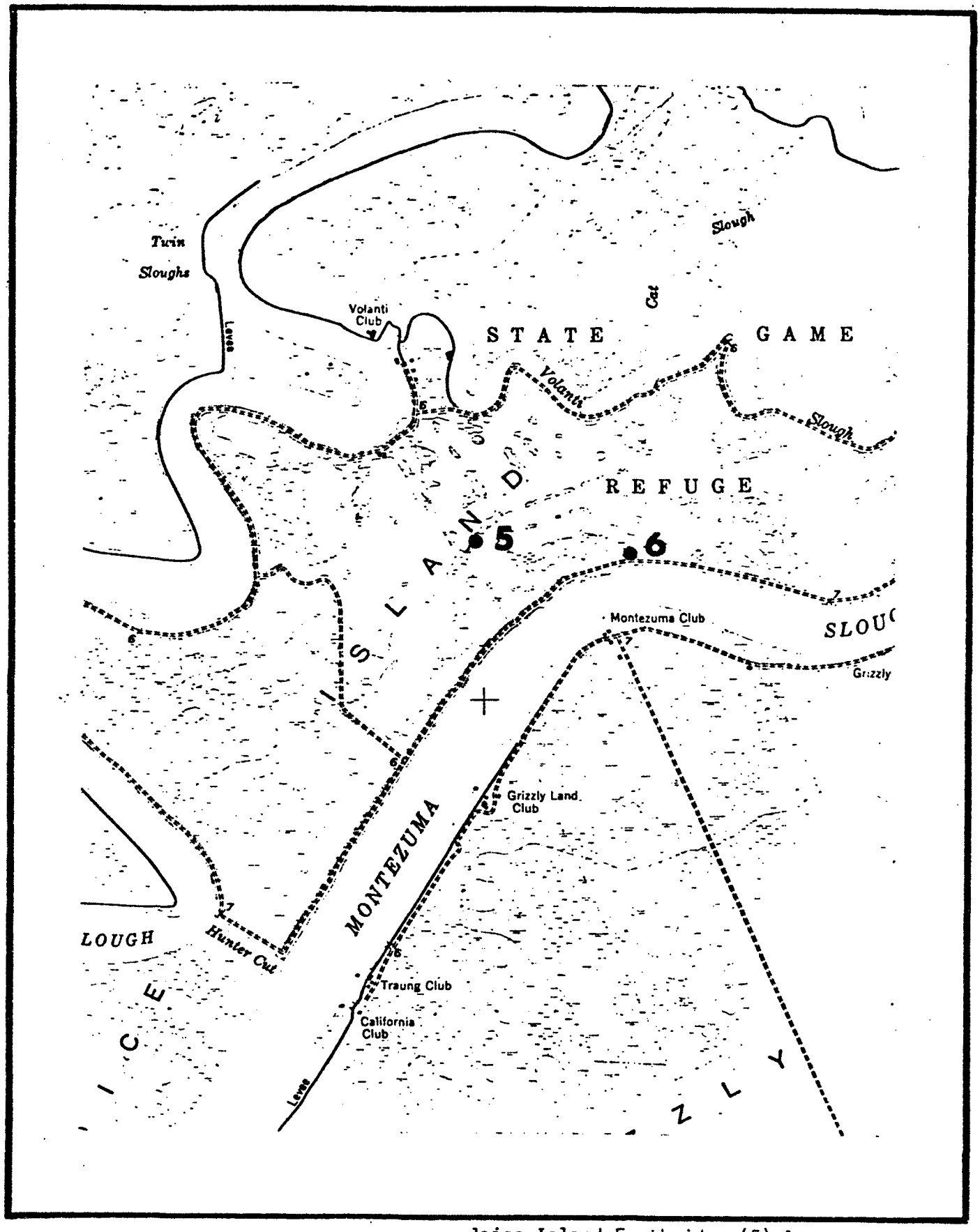


Figure 4. Joice Island Footbridge (5) & Joice Island Powerline (6)

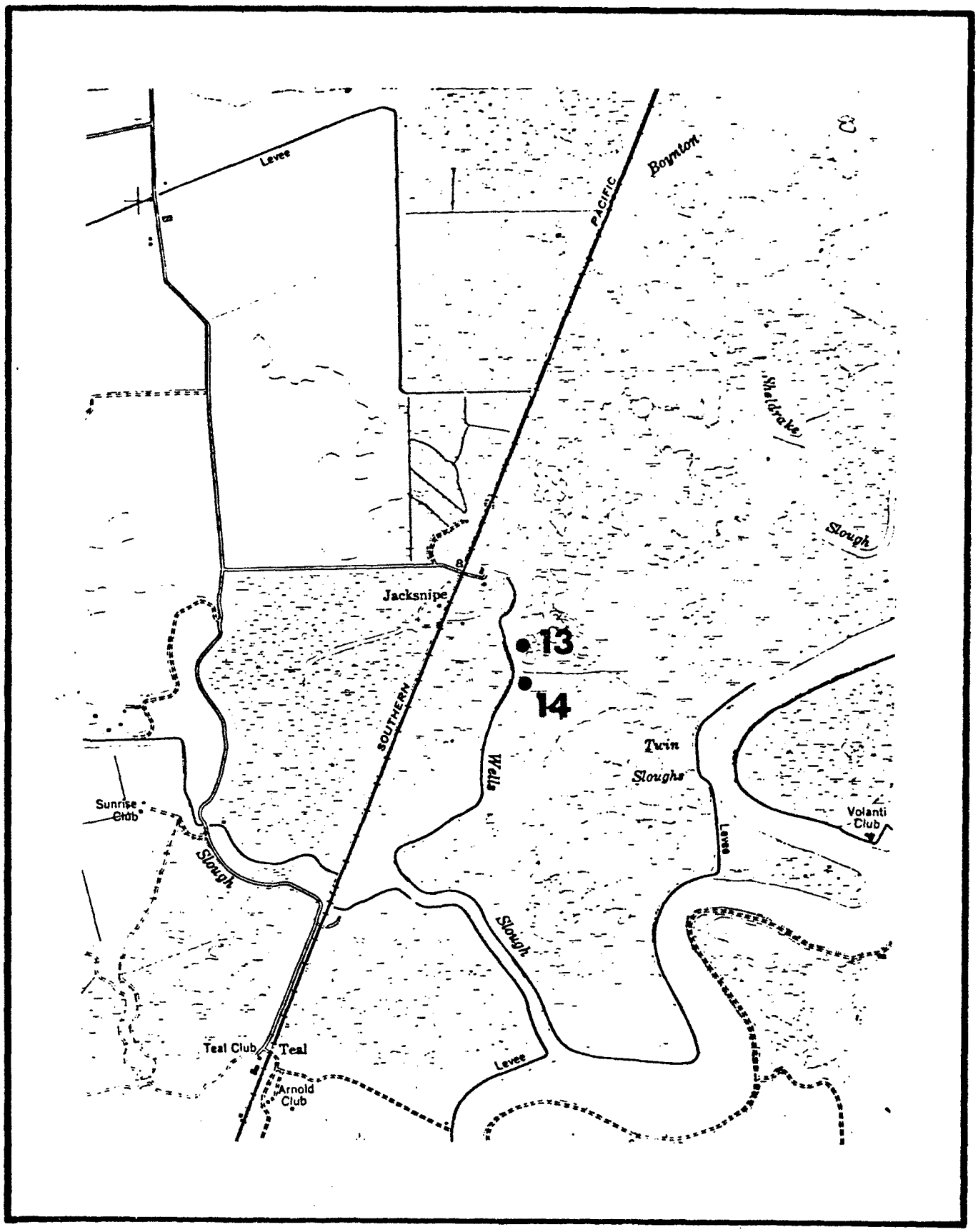


Figure 5. Jacksnipe Pickleweed (13) and Jacksnipe Wetlands (14)

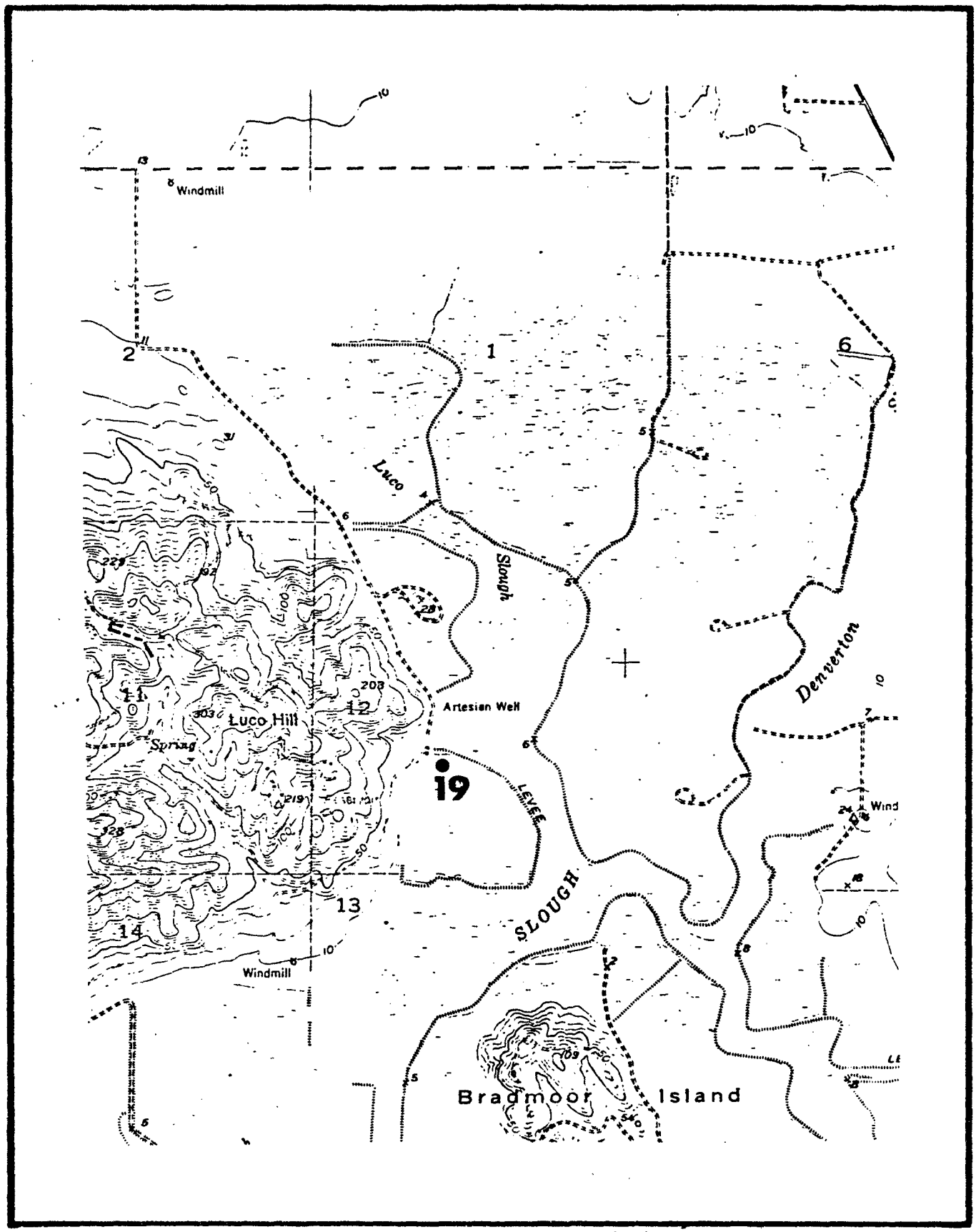


Figure 6. Nurse Slough (19)

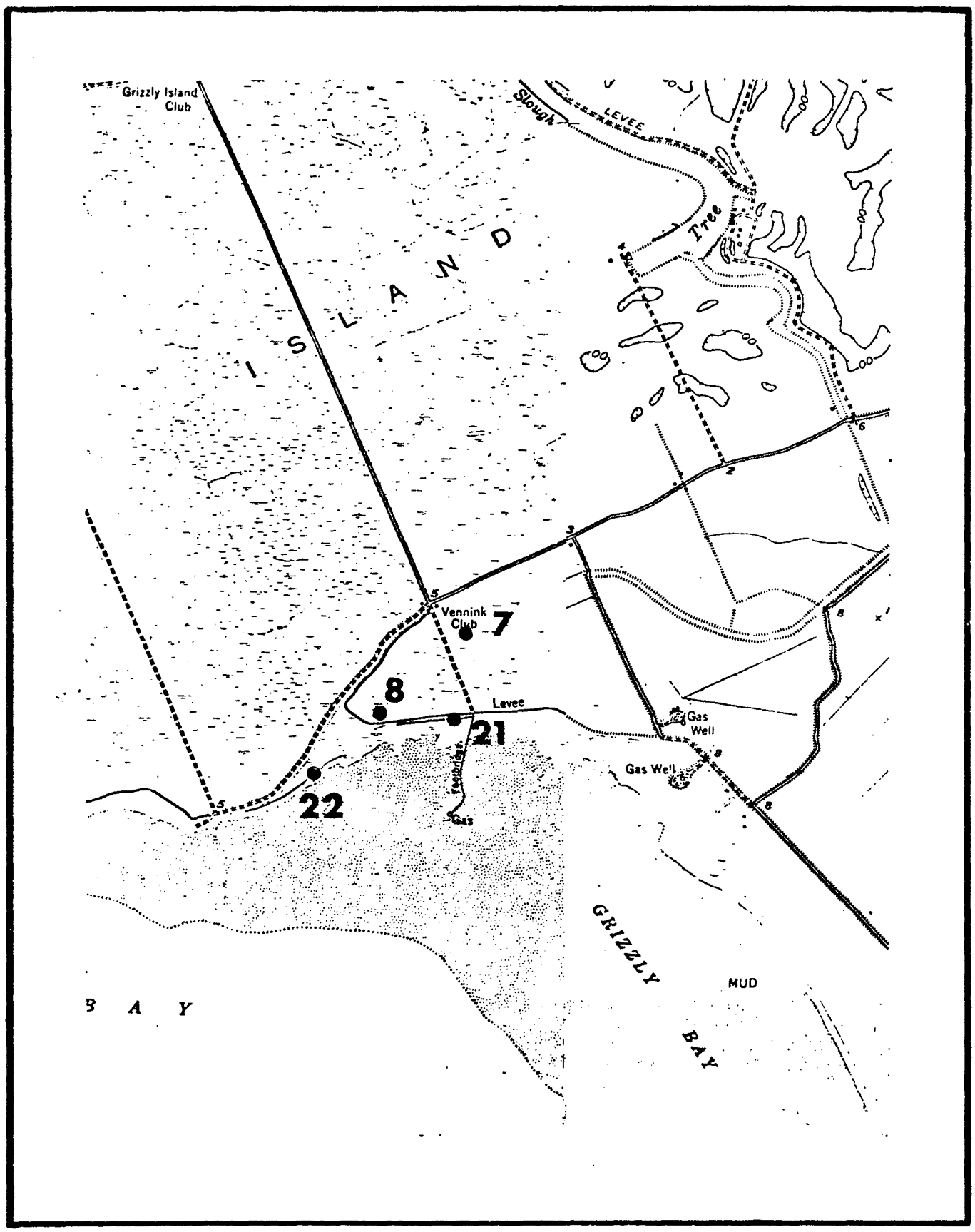


Figure 7. Vennink Stockgate (7), Vennink Decoy (8), Vennink Building (21) and Vennink Bayside (22)

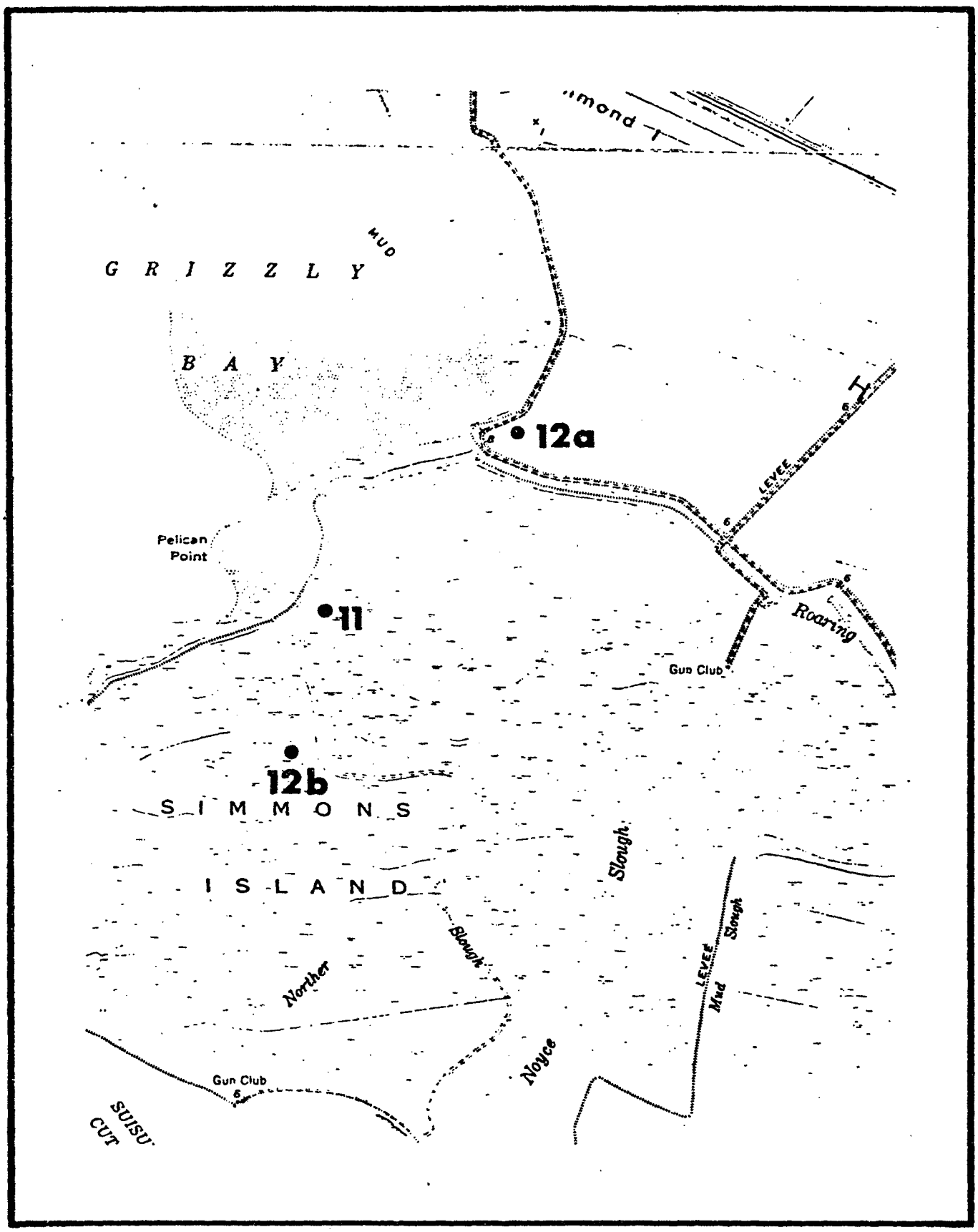


Figure 8. Simmons Island Gate (11), Simmons Island Road (12a) and Simmons Island 9th Pole (12b).



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Two sites (Hill Slough Windmill and Dump, Figs. 9 ) were "cow pastures" dominated by salt grass, a species little if ever inhabited by salt marsh harvest mice. No harvest mice were captured at these sites.

The ten remaining sites are all dominated by pickleweed (or in one case pickleweed and Hordeum). Seven of these sites yielded salt marsh harvest mice, 18 of the 21 mice captured in the study (Table 1). Those areas producing animals are listed first.

1. Joice Island Powerline (Fig. 4 ) was the most diverse of the "pickleweed" sites being a mixture of pickleweed, Hordeum and other grasses. Percentage-wise it is dominated by grasses, but its gestalt is still one of a pickleweed site.
2. Vennink Stock Gate (Fig. 7 ) was a pickleweed site by default, i.e., the area was not managed except for possible occasional mowings. This site was fairly low and probably more saline than others and the pickleweed is there as a "weed". The site was almost pure pickleweed of moderate quality, cover and depth.
3. Meins Landing Mound and Bulrush (Fig.10) are full of misnomers. Meins Landing is far away but is the closest "major" geographical site to be used

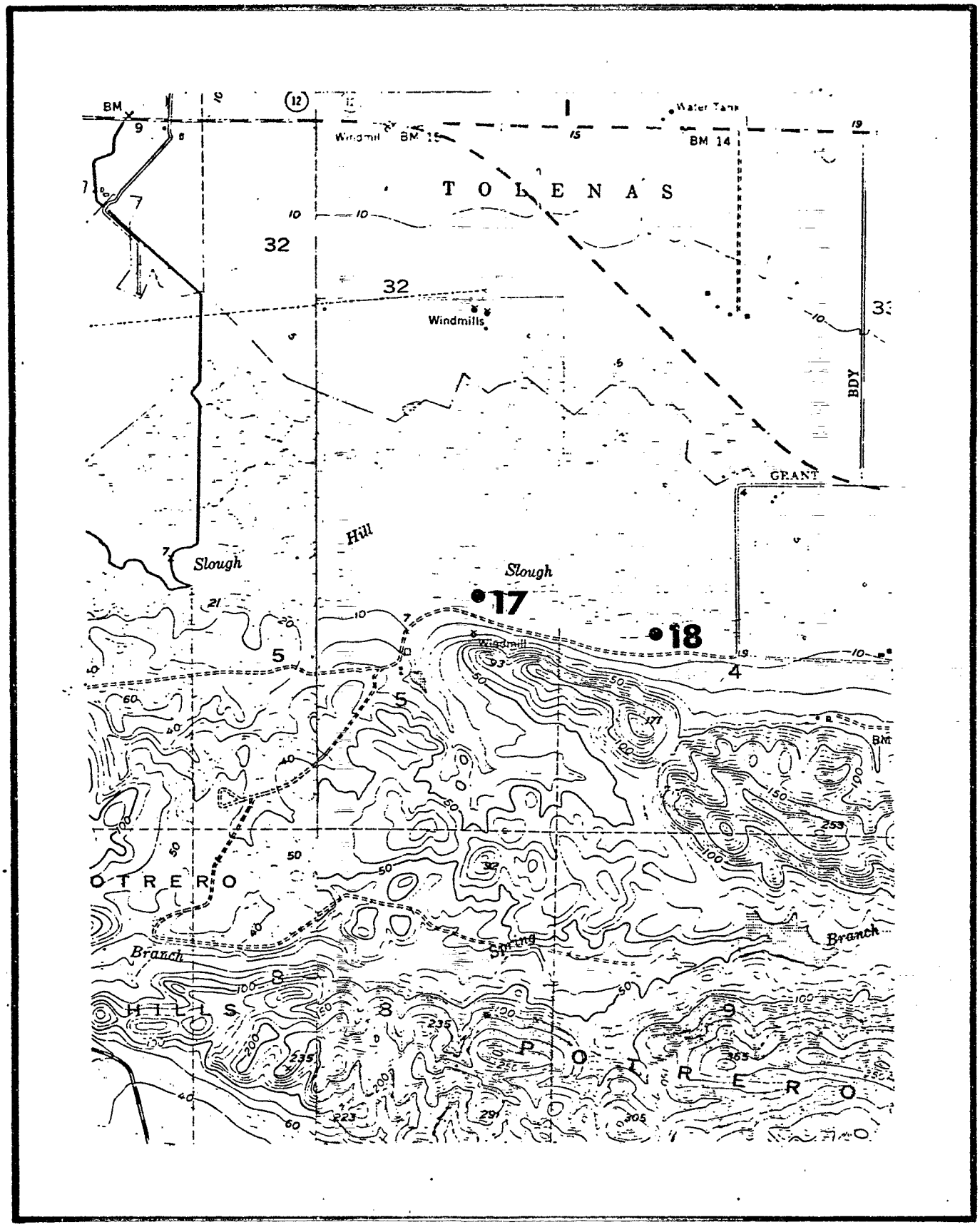


Figure 9. Hill Slough Windmill (17) and Hill Slough Dump (18)





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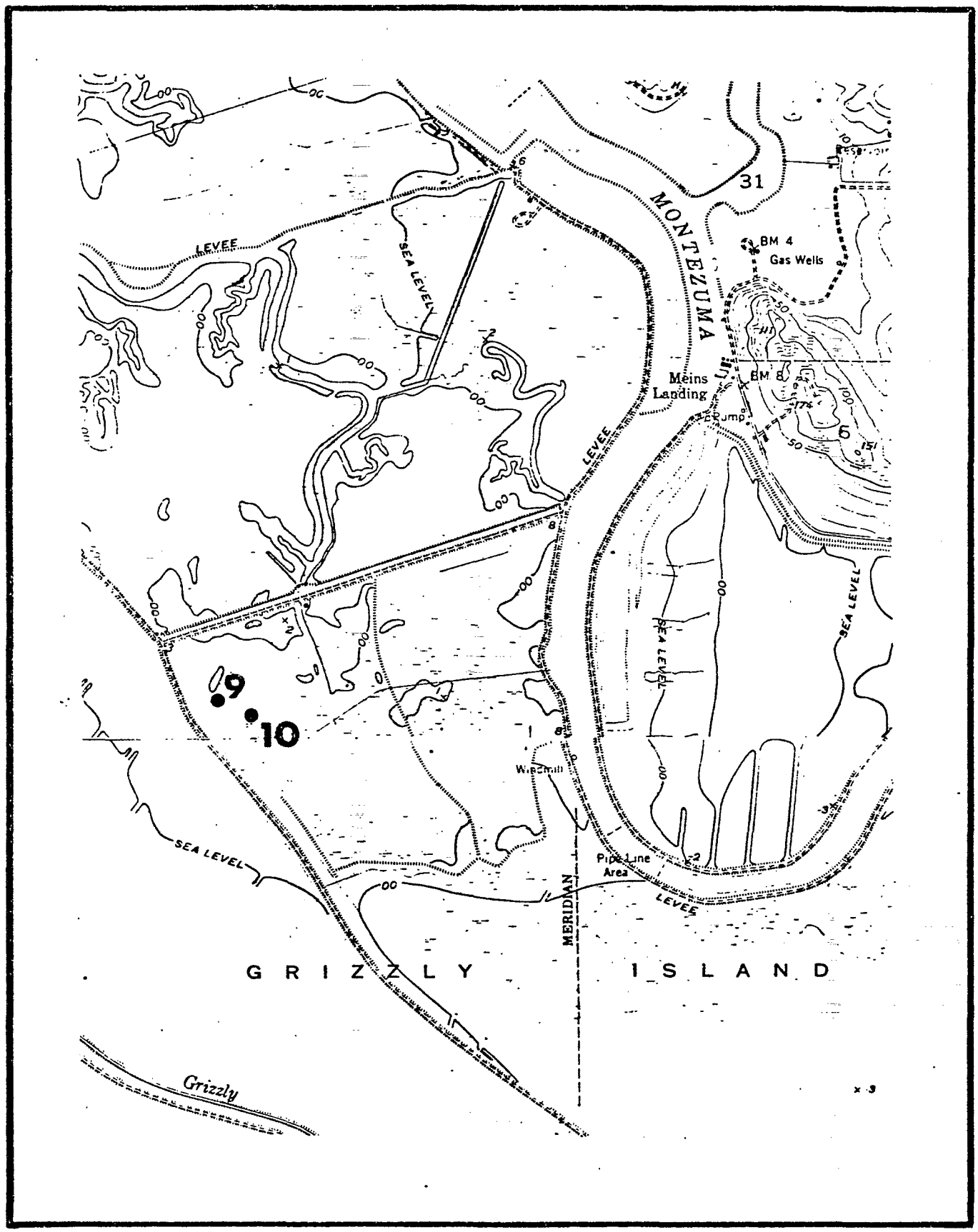


Figure 10. Meins Landing Mound (9) and Meins Landing Bulrush (10)



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as a name, and the Bulrush site was very low in bulrush. The Mound site had considerable grass while a good deal of brass buttons were present at the Bulrush site. The Mound site, with its grassy mix and edge (quite near the road), was considered, when first viewed, as potential salt marsh harvest mouse habitat, and indeed eight animals of this species were subsequently captured there.

4. Simmons Island 9th Pole (Fig.8 ) was a diverse site of moderate to good overall cover and good quality pickleweed on a relatively well-managed duck club.

5. The Grizzly Bay sites (Fig. 11) were apparently outboard of the outboard dikes and could, therefore, receive tidal waters at times. Both sites were covered with pickleweed of moderate height, good percentage of cover and of good quality, i.e. green, succulent and thus provided good cover. The ground was moderately dry. The area west of it was buldozed during part of the time we were trapping it.

These seven sites provided almost all the salt marsh harvest mice. The three pickleweed-dominated sites which did not yield any animals are Simmons Island Road, Cordelia Pasture and Denverton Highway (Figs.1, 2, 6 & 13).

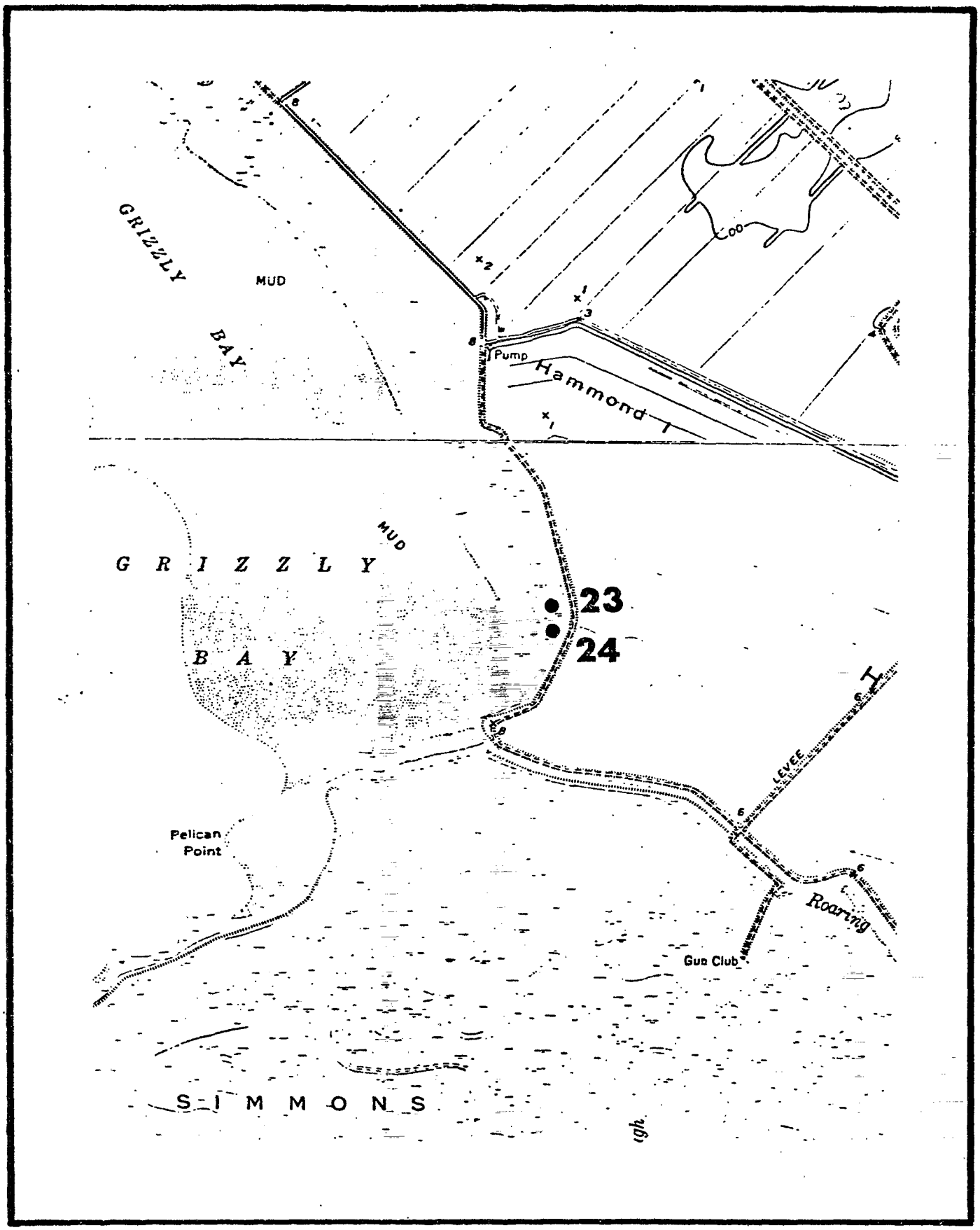


Figure 11. Grizzly Bay 1 (23) and Grizzly Bay 2 (24)



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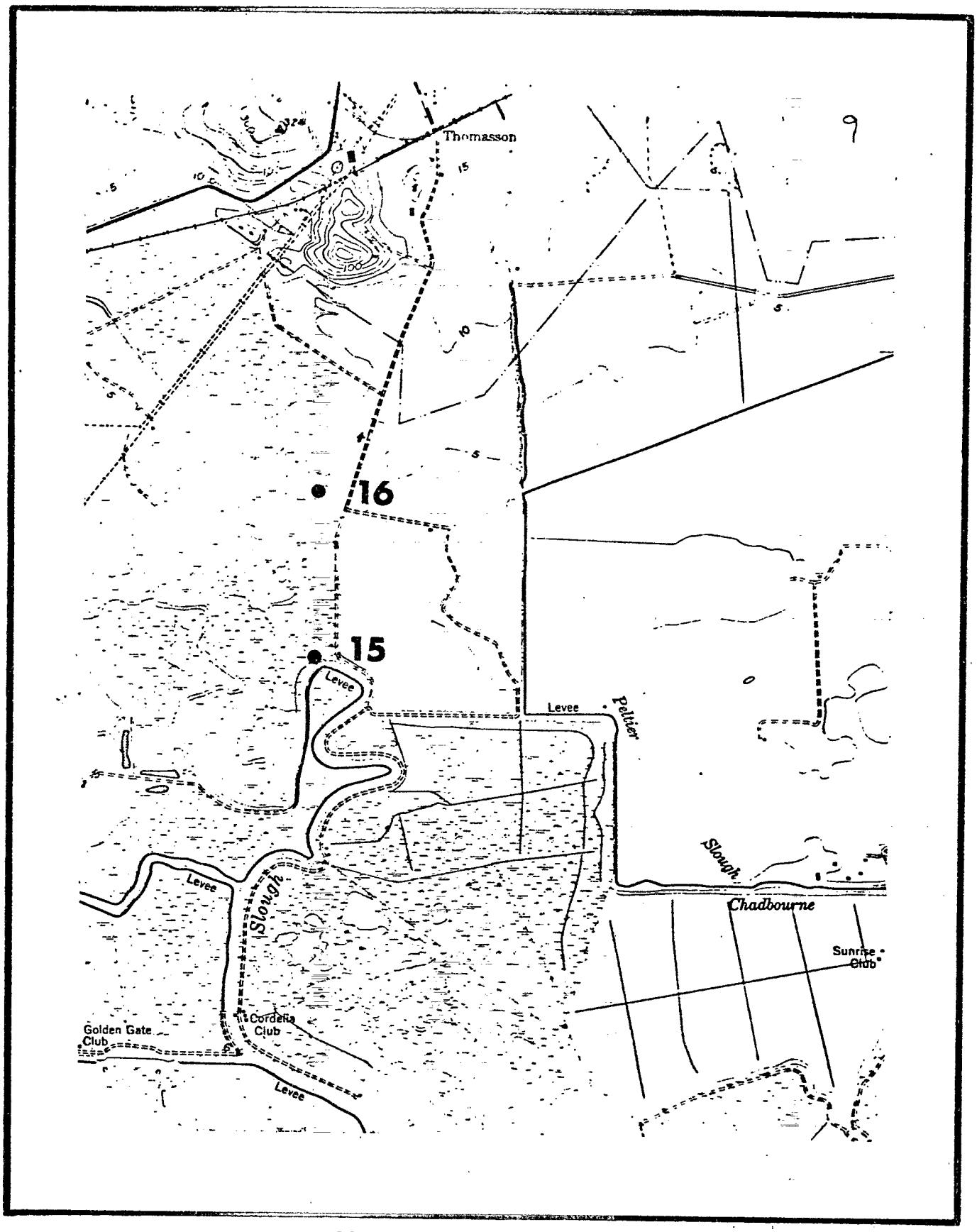


Figure 12.

Cordelia Dike (15) and
Cordelia Pasture (16)



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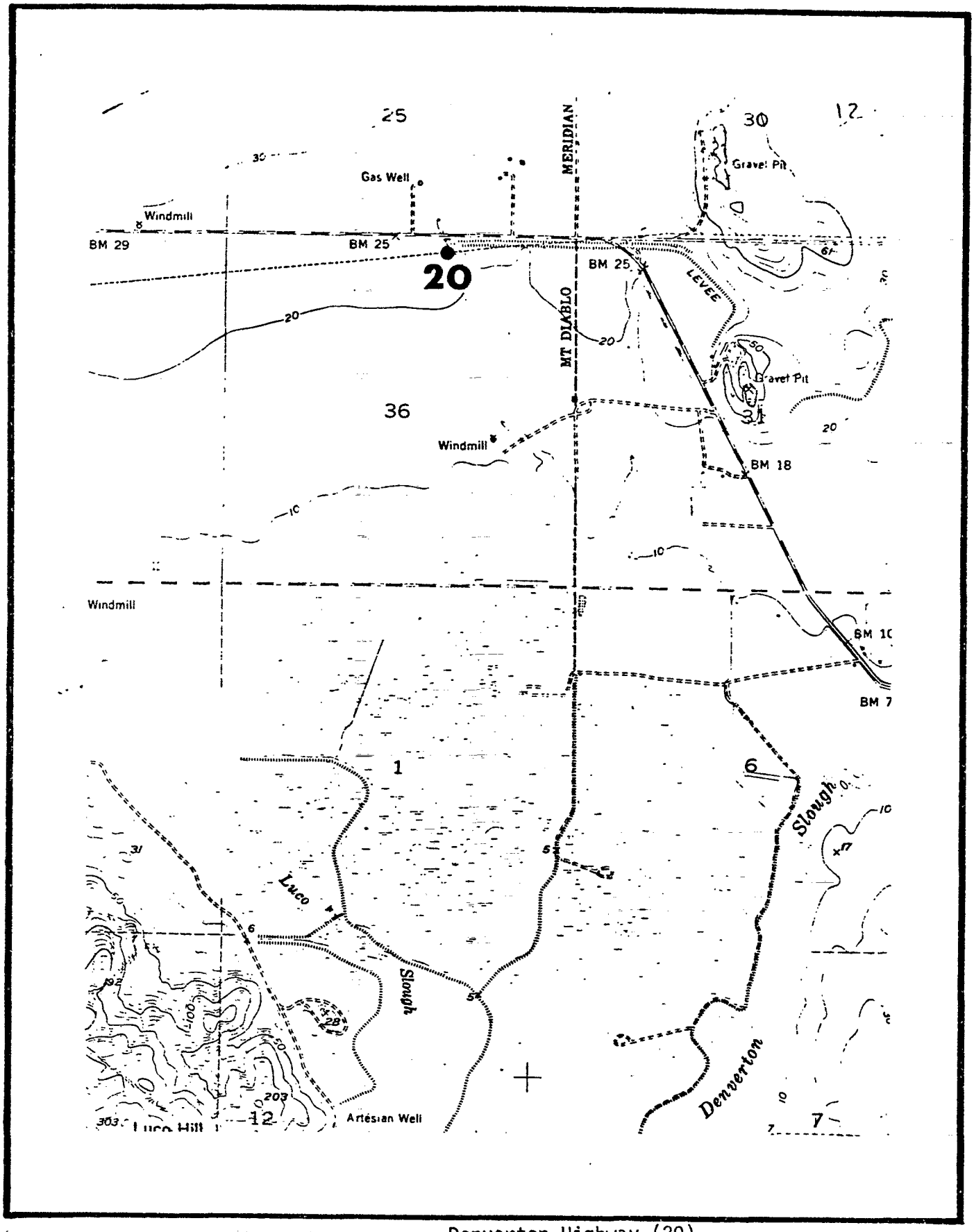


Figure 13. Denverton Highway (20)

The Simmons Island Road site was at a corner of the Grizzly Island California Fish & Game complex and was rather sparcely covered, i.e. 40% bare ground and 40% pickleweed. Cordelia Pasture was a dry, sparse site. The pickleweed cover is listed as 70% (Table 2) but was a poor 70%. Pickleweed can be lush and provide good cover or dry, desiccated and provide poor cover. This area was definitely the latter. Denverton Highway was reasonably good pickleweed, dry but nearer wetter areas in the marsh. It was a site used primarily as pastureland at the north-eastern edge of the entire Suisun Marsh complex. Cordelia Pasture and Simmons Island Road sites contained poor to very poor pickleweed but the Denverton site was moderately in pickleweed cover. It is one of the puzzling sites in this study in that it "should" have yielded some salt marsh harvest mice when compared to other sites that did, but it did not.



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## VEGETATION SAMPLING BY LINE TRANSECTS

Line transects were also run through 24 trapping sites (all but 12a, see Table 1 for a list of the sites) to see if this sampling technique was useful as the random plot sampling technique used by our trapping crew. If it was, then transects could be used in the future studies because of their relative higher efficiency. These transects also will serve as ground truth information for remote sensing of vegetation.

One 110 m transect was run through 20 trapping grid sites (excluding the four dike sites and site 12a). The percent cover of vegetation was estimated to the nearest five percent within 12 one meter square ($1m^2$) quadrates placed at 10 m intervals along each transect.

Four trapping sites required placing trap lines along dikes. Four transects were therefore established across those lines at 50 m intervals and quadrats were placed at two meter intervals, the number of quadrats per line was dependent on the width of the vegetation at each line.

## DISCUSSION OF THE RESULTS OF TRAPPING

Salt marsh harvest mice are more abundant in pickleweed areas than alkali bulrush, salt grass, brass buttons and apparently the vegetation that lines the dikes in the Suisun Bay (Table 3). This same relationship shows up in surveys made of the sites by the line transect method (Table 4), although not as clearly as with the random plot method shown in Table 3. Our present study thus corroborates earlier studies as to the habitat preference of the salt marsh harvest mouse and is best shown in Table 5.

Pickleweed apparently provides the prerequisite amount and type of cover required by members of this species (Fisler, 1965; Wondolleck, 1972; Shellhammer, 1977). Food requirements are not known for salt marsh harvest mice but it seems they consume a relatively large number of food items although alkali bulrush does not appear to have the fleshiness or size relationship that would make it a useable item of food. The cover provided by pickleweed may reduce the amount of predation which is probably higher in more open vegetation such as alkali bulrush and dike vegetation. The latter type are open to predation in their early stages and more open to rails and other moderate to small-sized

TABLE 3

Principal vegetation factors influencing the distribution of salt marsh harvest mice in the Suisun Bay (see also Table 1 )

| AREA | PERCENT COVER Pi | Al | Sa | DiV | # Mice | COMMENTS |
|---|---|---|---|---|---|---|
| 1. Morrow Island Tule | 1 | 43 | 8 | - | - | |
| 2. Morrow Island Dike | - | - | - | 100 | - | |
| 3. Teal Slough | 7 | 71 | - | - | 2 | near pickleweed |
| 4. Teal Boathouse | - | 52 | - | - | - | |
| 5. Joice Is. Footbridge | 23 | 62 | - | - | - | |
| 6. Joice Is. Powerline | 31 | - | - | - | 1 | |
| 7. Vennink Stockgate | 97 | - | - | - | 2 | |
| 8. Vennink Decoy | 37 | 28 | 31 | - | - | |
| 9. Meins Landing Mound | 9 | - | - | - | 2 | |
| 10. Meins Landing Bulrush | 41 | 2 | - | - | 2 | |
| 11. Simmons Is. Gate | 25 | 36 | 10 | - | - | |
| 12a. Simmons Is. Road | 40 | 3 | - | - | - | 39% bare ground |
| 12b. Simmons Is. 9th Pole | 59 | 1 | 6 | - | 4 | |
| 13. Jacksnipe Pickleweed | 43 | 41 | - | - | - | |
| 14. Jacksnipe Wetlands | - | 95 | - | - | - | |
| 15. Cordelia Dike | - | - | 20 | 70 | - | |
| 16. Cordelia Pasture | 70 | - | 15 | - | - | Dry, desiccated |
| 17. Hill Slough Windmill | 20 | 4 | 65 | - | - | |
| 18. Hill Slough Dump | 20 | 6 | 58 | - | - | |
| 19. Nurse Slough | - | 51 | - | - | - | |

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Table 3 , continued

| AREA | PERCENT COVER Pi | Al | Sa | DIV | # Mice | COMMENTS |
|---|---|---|---|---|---|---|
| 20. Denverton Highway | 89 | - | - | - | - | |
| 21. Vennink Building | - | - | - | 100 | - | |
| 22. Vennink Bayside | - | - | 5 | 84 | - | |
| 23. Grizzly Bay 1 | 81 | - | - | - | 5 | |
| 24. Grizzly Bay 2 | 75 | - | - | - | 2 | |

Pi - Pickleweed
Al - Alkali Bulrush
Sa - Saltgrass
DiV - Diked Vegetation
# Mice - Number of salt marsh harvest mice caught

TABLE 4

Plant Composition of Trapping Areas Assessed with Transects

| AREA | PERCENT COVER | | | | | | | MISC. DESCRIBED |
|---|---|---|---|---|---|---|---|---|
| | pickleweed | alkali bulrush | brass buttons | saltgrass | fat hen | California bulrush | Misc. | |
| 1. Morrow Island Tule | 53 | | | 5 | 11 | | 14 | *Juncus balticus* |
| 2. Morrow Island Dike | | | | | | | 66 | *Arundo donax* (59), *Bromus rigidus* (7) |
| 3. Teal Slough | | 75 | | | | | | |
| 4. Teal Boathouse | | 69 | 22 | | 8 | | | |
| 5. Joice Is. Footbridge | 28 | 36 | | | | | | |
| 6. Joice Is. Powerline | 40 | | | | | | 28 | *Hordeum hystrix* (21), *Frankenia grandifolia* (7) |
| 7. Vennink Stockgate | 79 | | | | 6 | | | |
| 8. Vennink Decoy | 22 | 31 | | 18 | 12 | | | |
| 9. Meins Landing Mound | 42 | | 15 | | | | | |
| 10. Meins Landing Bulrush | 35 | | 49 | | 7 | | | |
| 11. Simmons Is. Gate | 22 | 15 | 5 | 6 | | | 6 | *Juncus balticus* |
| 12a. Simmons Is. Road | | | | | | | | |



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Table 4, continued

| AREA | PERCENT COVER pickleweed | alkali bulrush | brass buttons | saltgrass | fat hen | California bulrush | Misc. | MISC. DESCRIBED |
|---|---|---|---|---|---|---|---|---|
| 12b. Simmons Is. 9th Pole | 54 | 11 | | | | | 5 | Chenopodium |
| 13. Jacksnipe Pickleweed | 52 | 41 | | | | | | |
| 14. Jacksnipe Wetlands | 8 | 69 | 9 | | | | | |
| 15. Cordelia Dike | | | | 8 | | 30 | 44 | Carex (20), Juncus balticus (14) |
| 16. Cordelia Pasture | 76 | | | | | | | |
| 17. Hill Slough Windmill | 19 | | | 69 | | | | |
| 18. Hill Slough Dump | 17 | | | 55 | | | 16 | Carex |
| 19. Nurse Slough | | 66 | 7 | 15 | | | 10 | Polypogon monspeliensis |
| 20. Denverton Highway | 82 | | | | | | | |
| 21. Vennink Building | | | | | | 16 | 31 | Euphorbia sp. (15), Artemisia vulgare (13) |
| 22. Vennink Bayside | | | | | | 11 | 35 | Arundo donax (26), Cakile martima (9) |
| 23. Grizzly Bay 1 | 65 | | | 7 | | | 7 | Typha |
| 24. Grizzly Bay 2 | 77 | | | | | | | |



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TABLE 5

Abundance of Salt Marsh Harvest Mice
with Respect to Percent Cover of
Pickleweed Sampled by Random Plots
(from Table 3)

| Cover Class (percent) | $\bar{Y}$ SMHM* Per Cover Class |
|---|---|
| 75 - 100 | 2.25 |
| 50 - 75 | 2.00 |
| 25 - 50 | 0.83 |
| 5 - 25 | 0.40 |
| 0 - 5 | 0.00 |

* $\bar{Y}$ SMHM = Average number of salt marsh harvest mouse

predatory birds when full grown than the tangle provided by pickleweed.

Not all pickleweed vegetation is salt marsh harvest mouse habitat. Dry, open stands, or dry stands so dry as to provide poor cover and/or poor food, even when the percent of cover is moderate (as in Cordelia Pasture) are not acceptable habitat. Relatively poor cover, as at Simmons Island Road, is seldom productive of the mice. Three types of pickleweed vegetation are good habitat - relatively deep tidal marshes (Rice, 1974; Shellhammer, 1977); fairly deep, complex stands behind dikes (as at Collinsville) Biosystems Analysis reports to Pacific Gas and Electric Company and diked off moist pickleweed areas which are highly saline (Zetterquist, 1978). None of the pickleweed areas in the Suisun marsh are very similar to the above, although some come close to the Collinsville type of marsh. Some of the Suisun marshes were deep and somewhat diverse but lacked the vertical complexity found in the most favorable diked-off marshes at Collinsville (Biosystems, op. cit.).

This was an average to below average year for salt marsh harvest mice around the San Francisco Bay. The numbers of captures were lowest in the Suisun Bay where it took a high of 271 trap nights, on the average, to capture one salt marsh harvest mouse (21 animals in 5,700 trap nights, this

study). Two major studies were run in other marshes of the Bay - one by the California Department of Fish & Game primarily in the San Pablo Bay and one by the U. S. Fish & Wildlife Service in the South San Francisco Bay. It took 77 trap nights to capture an animal in the San Pablo Bay (39 animals in 2,986 trap nights). It took 251 trap nights in the South San Francisco Bay (15 animals in 3,765 trap nights). Work done for Pacific Gas and Electric Company by Biosystems Analysis, Inc. at Collinsville produced a capture rate in between the above Bay studies and the present study although exact figures are not possible to release at this time.

There were not many other animals caught besides harvest mice. There were relatively few house mice (only 86, including recaptures, in 5,700 trap nights) which is probably a testimony to the effectiveness of the management techniques used in the area and dominant vegetation present. It might also be the case that this is not an average year for house mice as well, i.e. they are at a low in their somewhat cyclic pattern. The fact that there were only four meadow mice captures is explainable by the same factors as the above, although vegetation type and management techniques are more important in this case. We doubt that salt marsh harvest mice would be abundant in the Suisun Marsh, as compared to the other areas around the Bay, even in a "high" year



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for the species because of the prevalence of alkali bulrush compared to pickleweed.





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## IMPACT ON VEGETATION ALONG DITCH CORRIDORS

### Evaluation of Present Vegetation By Line Transects

Twenty-five meter long transects were established at varying intervals along each ditch site. Six $1m^2$ quadrats were placed at five meter intervals along each transect which amounted to four to ten per corridor depending upon the length of the ditch and the complexity of the vegetation. The transects are located on Figures 14-18.

The vegetation was estimated using the method described for grid sampling. The results were grouped into the nine vegetation types (Table 6).

The vegetation along the ditch corridors is presented graphically on Figures 19-22 . Transect locations are shown as is the number and amount of the various vegetation types.

### Impact of Water Plan On Ditch Corridors

The Potrero Hills Ditch would have little impact on salt marsh harvest mouse habitat, along its corridor, assuming that the corridor will remain as it is, i.e. grassland. Hill



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TABLE 6

Vegetation Categories Used in Plant Transects Along Ditch Corridors

1. Pickleweed - 50% or greater cover of Salicornia pacifica. Other species present include Atriplex patula, Juncus balticus, Distichlis spicata, Salicornia rubra.

2. Saltgrass - 50% or greater cover of Distichlis spicata. Other species present include Frankenia grandifolia, Cotula coronopifolia, ruderal grasses.

3. Grassland - 50% or greater combined cover of Hordeum hystrix, Lolium perenne, Avena fatua, Bromus rigidus. Other species present include Distichlis spicata.

4. Alkali Bulrush - 50% or greater cover of Scirpus robustus. Other species present include Juncus balticus, Atriplex patula.

5. Cattail - 50% or greater cover of Typha sp. Other species present include Scirpus robustus, Scirpus californicus.

6. Giant Reed - 50% or greater cover of Arundo donax. Other species present include Juncus balticus, Distichlis spicata, Achillea lanulosa.

7. Rush - 50% or greater cover of Juncus balticus. Other species present include Scirpus robustus, Grindelia maritima.

8. California Bulrush - 50% or greater cover of Scirpus californicus. Other species present include Typha sp., Juncus balticus, Scirpus robustus.

9. Frankenia - 50% or greater cover of Frankenia grandifolia. Other species present include Distichlis spicata, Atriplex patula, Cotula coronopifolia.

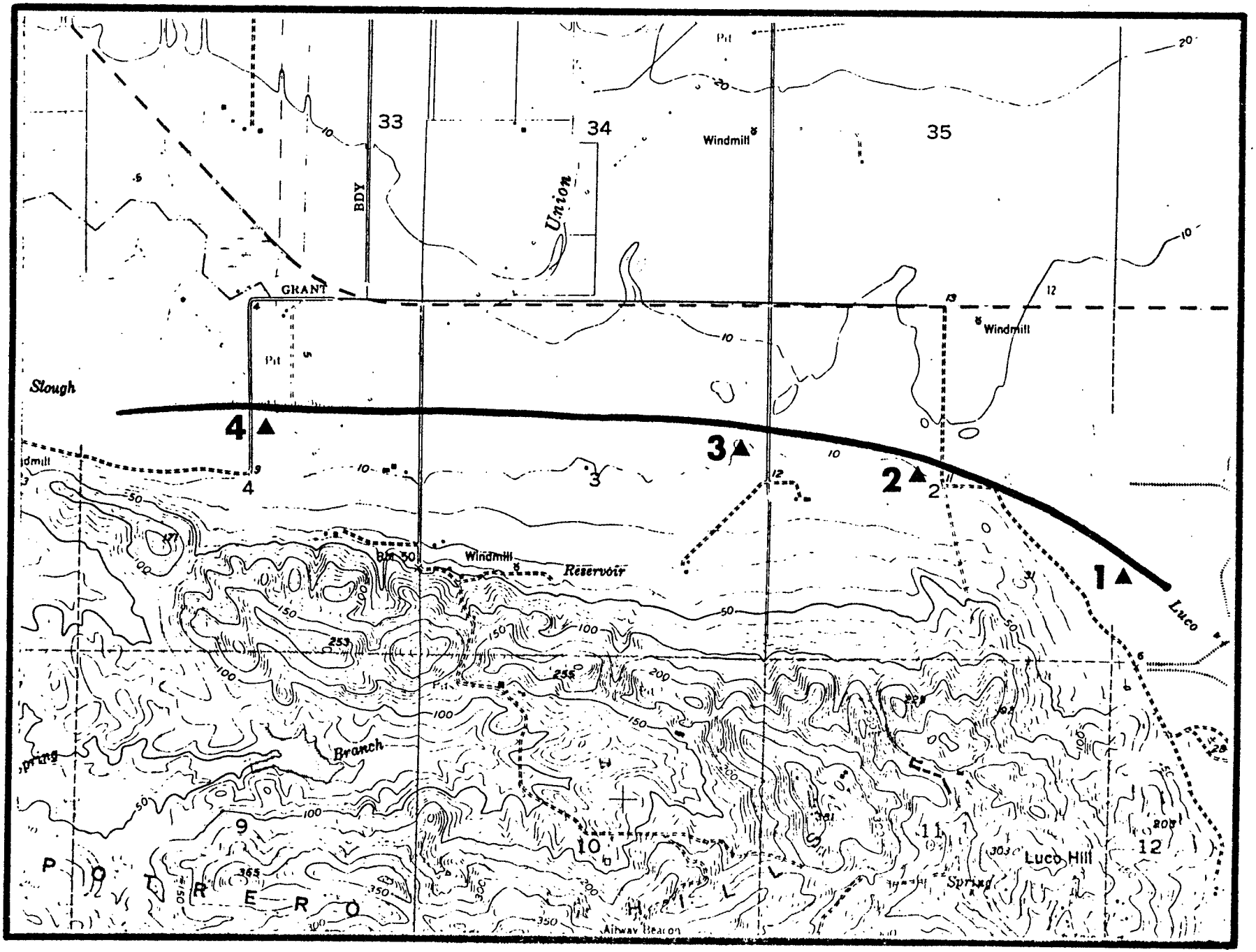


Figure 14. Location of plant transects along the Potrero Hills Ditch.



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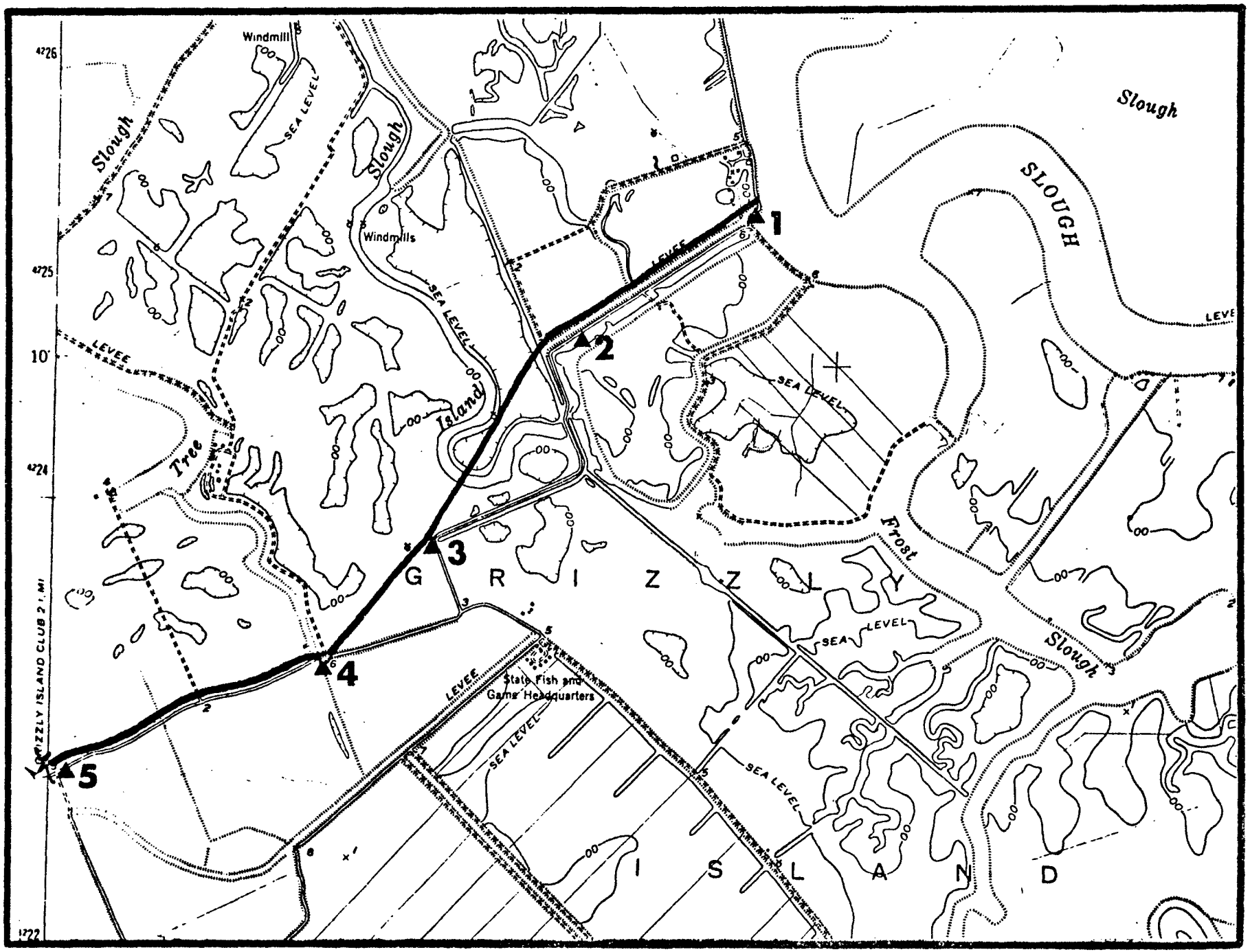


Figure 15. Location of plant transects along the Grizzly Island Ditch



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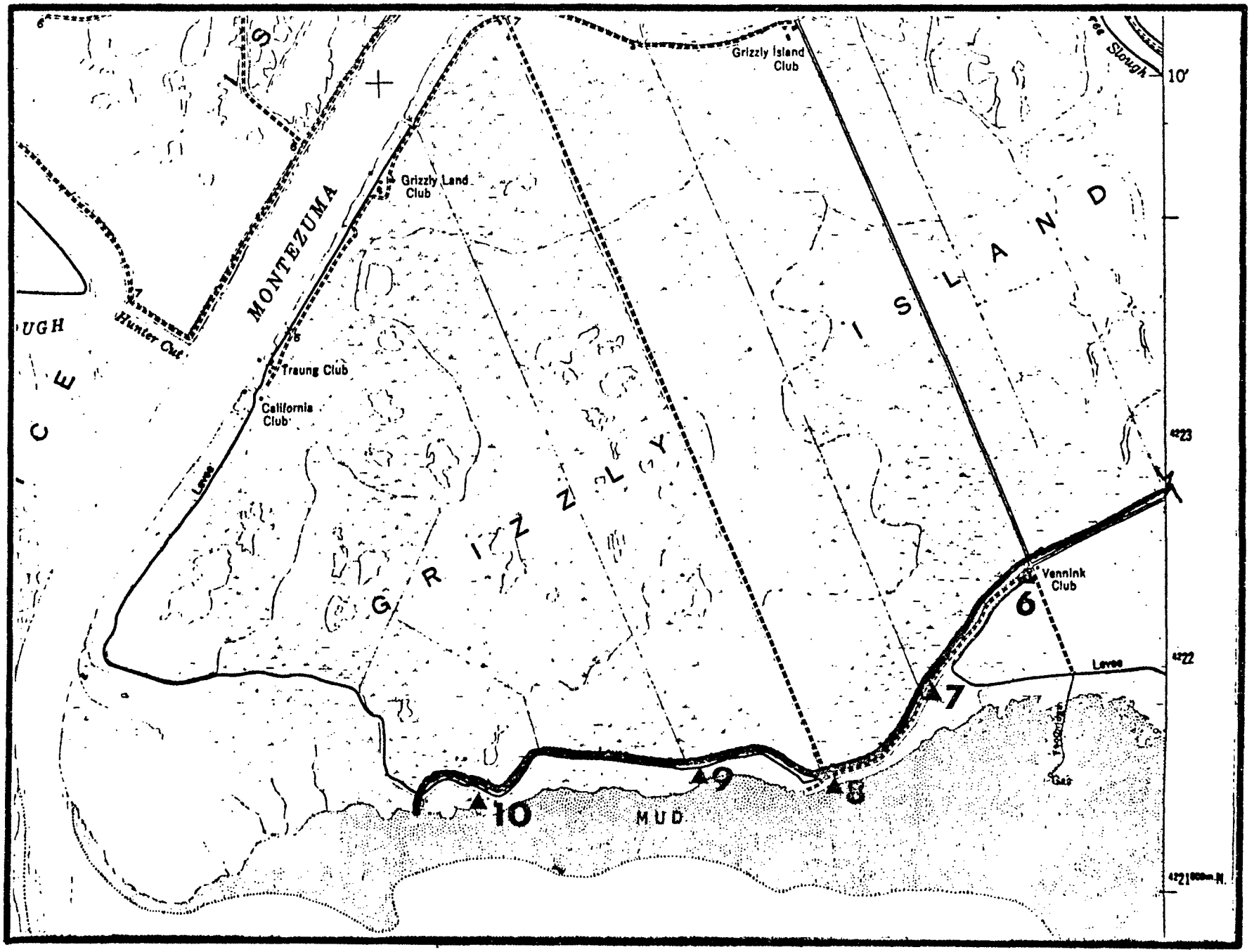


Figure 16. Location of plant transects along the Grizzly Island Ditch



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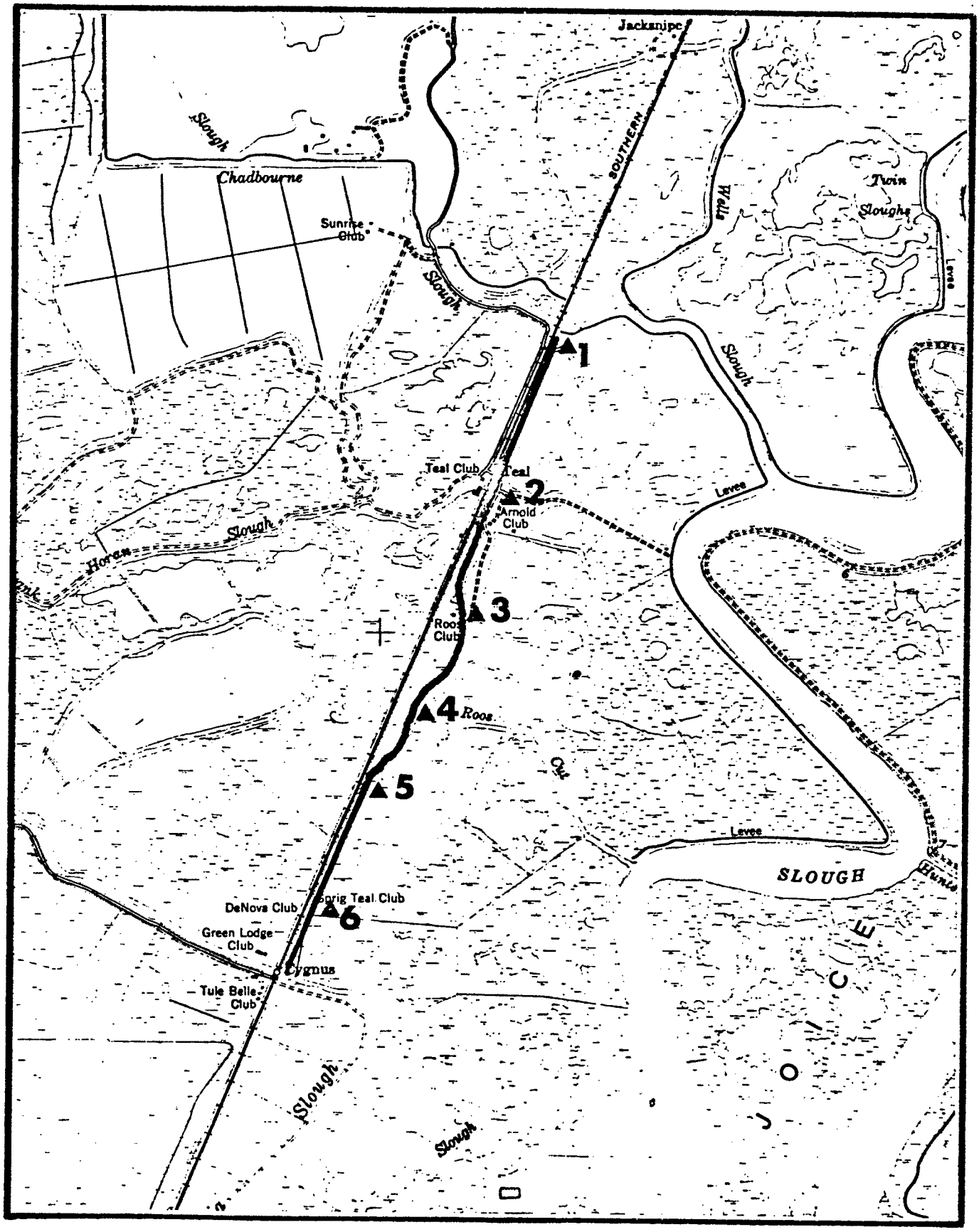


Figure 17. Location of plant transects along the Cygnus Bypass Ditch



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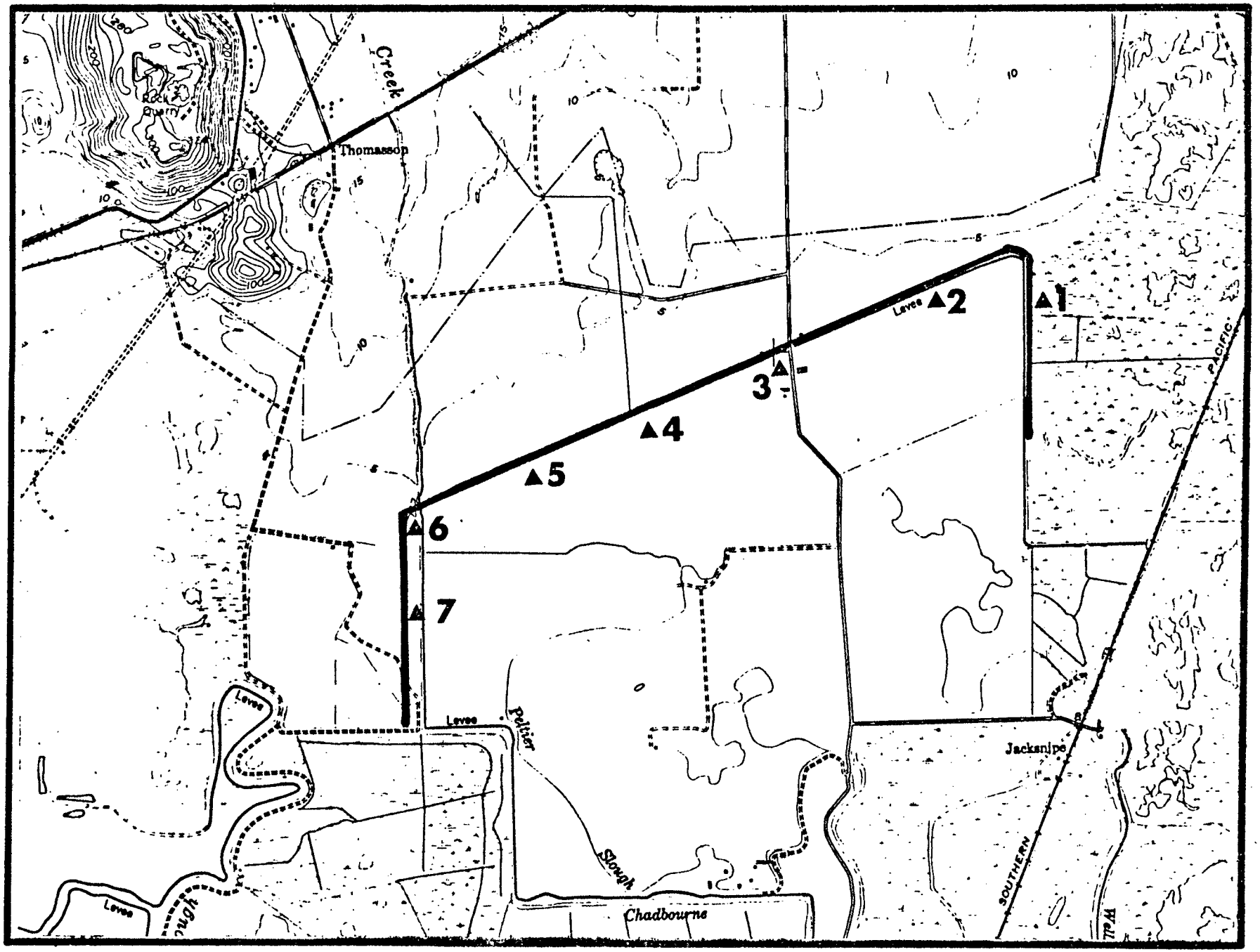


Figure 18. Location of plant transects along the Boynton-Cordelia Ditch



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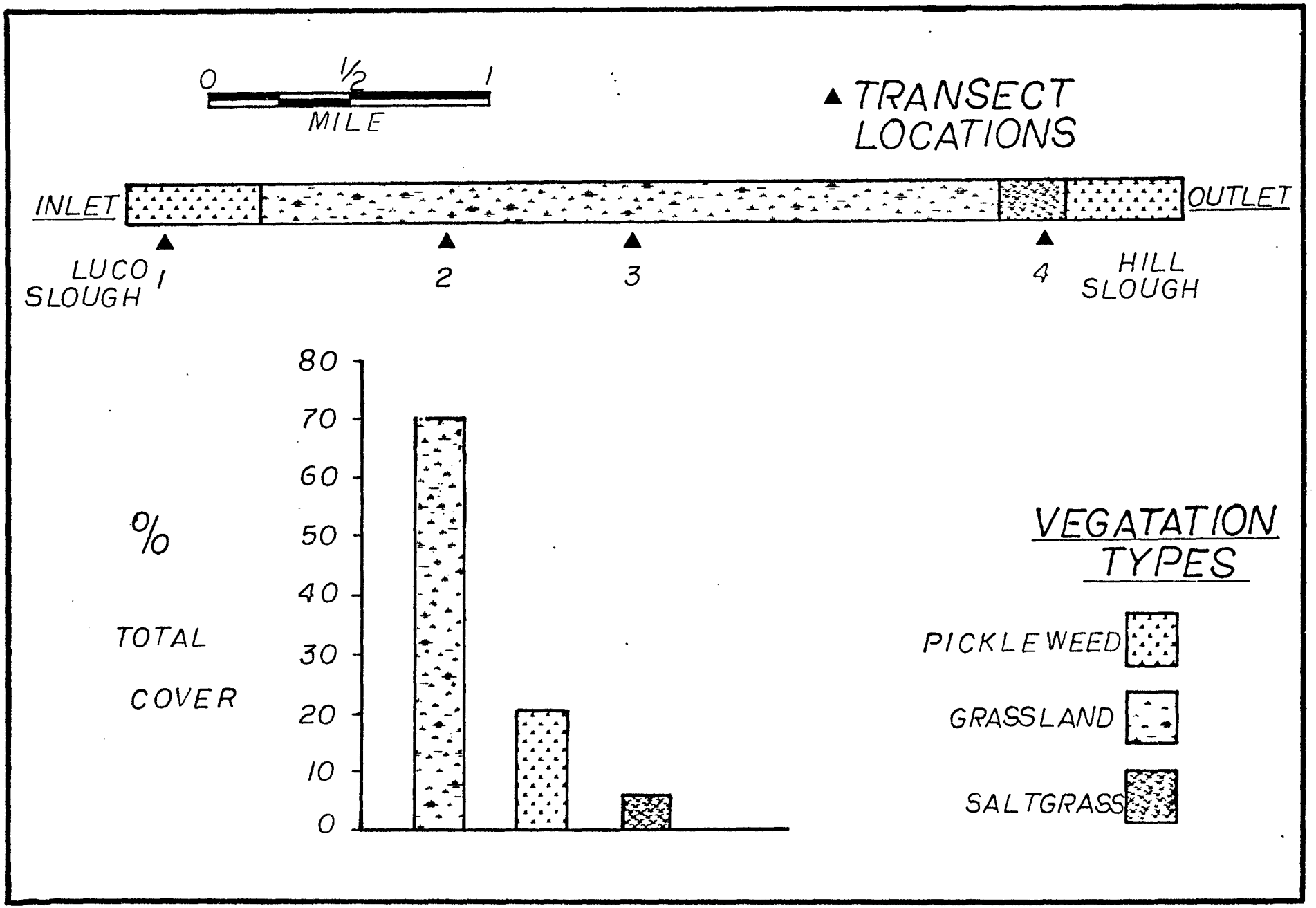


Figure 19. Potrero Hills Ditch Plant Profile



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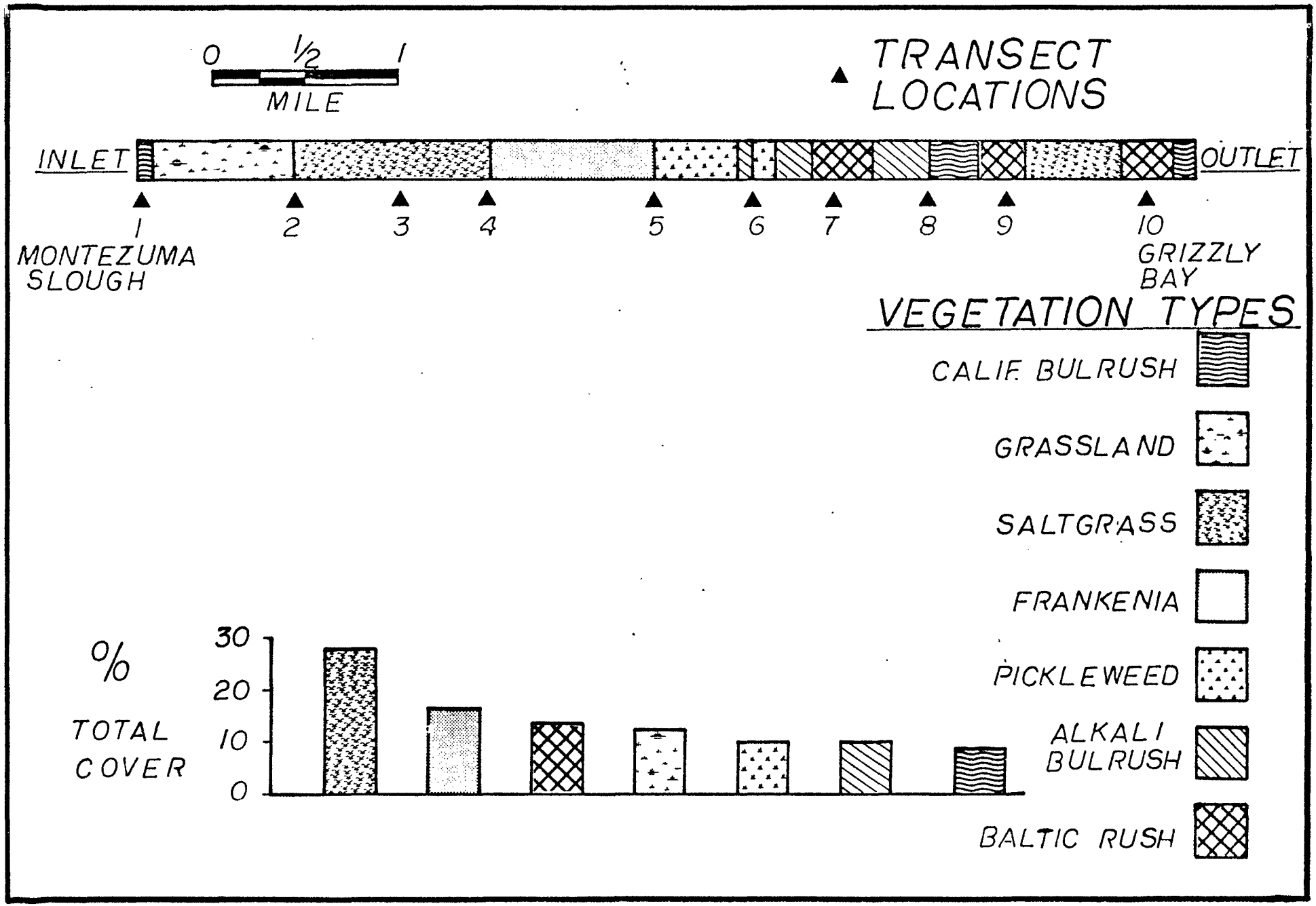


Figure 20. Grizzly Island Ditch Plant Profile



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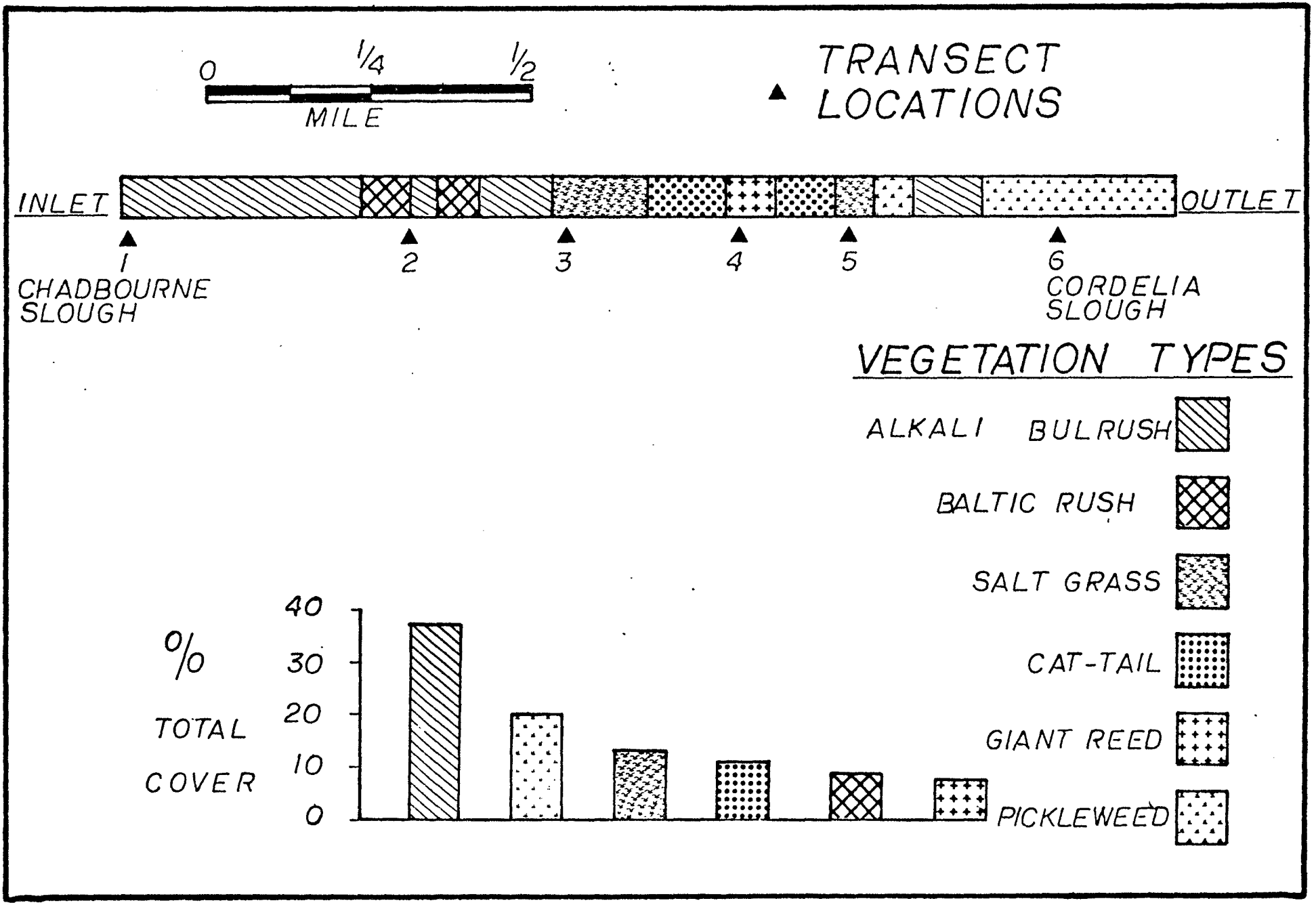


Figure 21. Cygnus Bypass Unit Plant Profile



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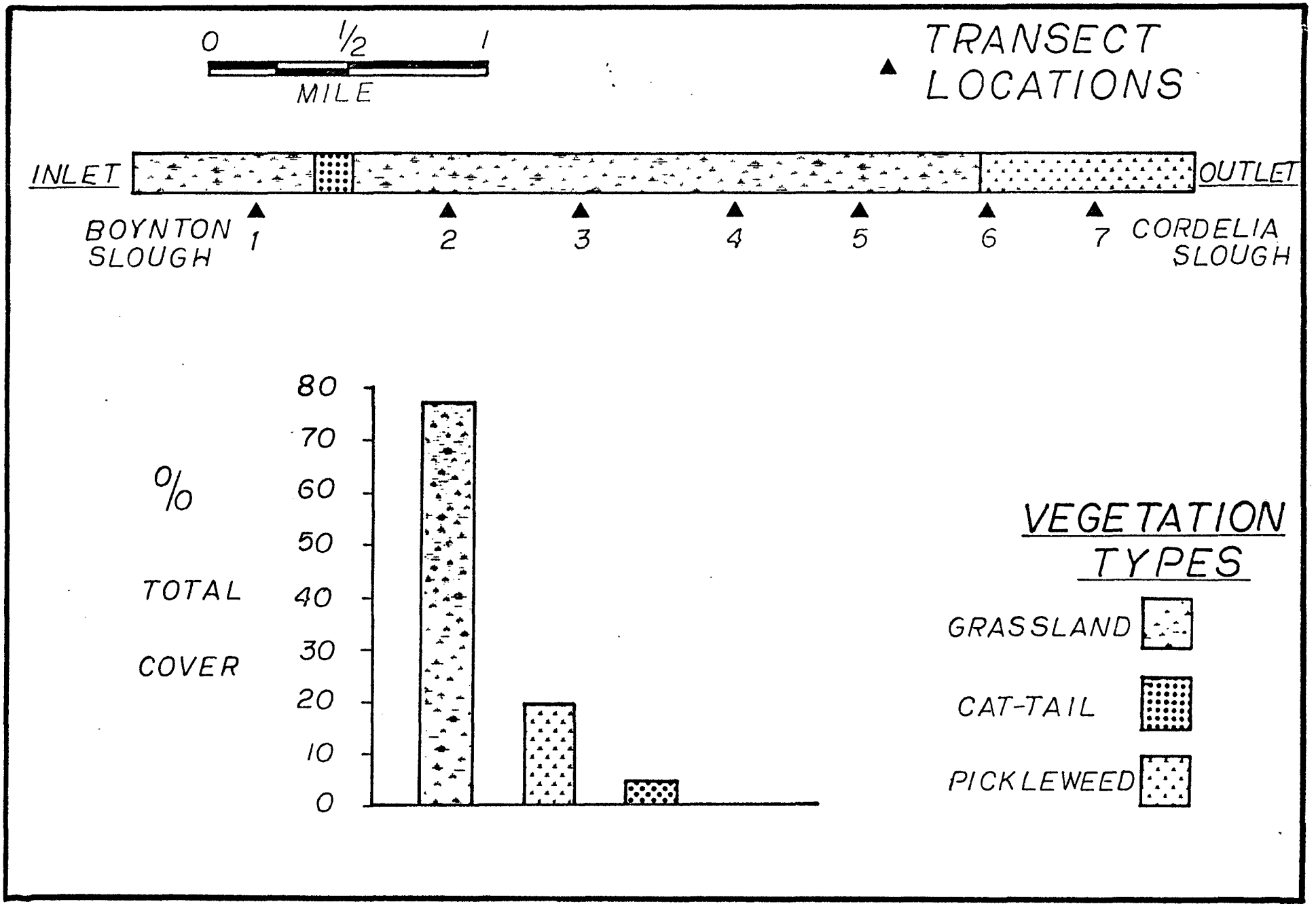


Figure 22. Boynton Cordelia Ditch Plant Profile



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slough will receive the main impact. If it is well managed it can be changed from poor mouse habitat (salt grass type) to another poor mouse habitat (bulrush), or if it poorly managed there may be an increase in pickleweed (good mouse habitat).

Most of the Grizzly Island Ditch corridor is presently very poor habitat for harvest mice (salt grass, Frankenia, rush, grassland and various bulrush vegetation types). Here again optimal management plus the water supplied by this new ditch will lead to less mouse habitat while poor management might lead to more mouse habitat. This "either-or" situation is most significant with the Grizzly Island Ditch as it will effect the largest acreage, areas which today receive minimal management due to the lack of or marginal amounts of low salinity water.

The Cygnus Bypass unit will change the least with the new ditch, as much of the vegetation is already brackish in nature, i.e. nearly 40% alkali bulrush vegetation type.

The Boynton-Cordelia Ditch is like the Potrero Hills Ditch in that most of the corridor is grassland and will stay poor mouse habitat (even though the vegetation type changes) or change to salt marsh harvest mouse habitat depending on the nature and the quality of the management plans developed for it.

## IMPLICATIONS OF THE PROPOSED WATER/MANAGEMENT PLANS ON SALT MARSH HARVEST MICE

The future of salt marsh harvest mice in the Suisun Marshes is dependent on both the effectiveness of the proposed water plan and future marsh management. If the water plan is highly successful in decreasing the salinities of the water in the Suisun Bay (i.e. the criteria for salinity levels can be met and maintained), and if all the duck clubs manage their marshes with maximum effectiveness, then the future of the mouse in the Suisun marsh is dubious. With this senario (which we will call Senario 1) few areas of pickleweed will remain and their individual sizes will be small, hence their populations of salt marsh harvest mice will be small. Such situations lead to local extinctions, decrease interchange between populations and consequent decrease genetic variability and plasticity.

If, however, the water plan is only partially effective and/or marsh management is less than what is hoped for (Senario 2) then a situation intermediate between what exists today and what could be with Senario 1 will come to pass. It would include fewer pickleweed areas although individual marshes might be more productive than today because they had

more moisture and hence better cover. The Suisun marsh is presently generally poor for salt marsh harvest mice and would be a marginal area under Senario 2. Under Senario 1 it would not be an area supportive of this subspecies

At least two alternative courses of action are possible if Senario 1 (i.e. complete and effective management for alkali bulrush and other duck food species) is achieved. The Suisun marsh can be deleted as a unit within the range of the species. Those agencies concerned with the survival of this species could concentrate their efforts in other areas (Alternative 1). The Suisun marsh could be managed to increase its vegetation diversity at the same time that much of its area was being managed intensively and effecttively for waterfowl (Alternative 2). This alternative may require government acquisition of some of the present duck club areas so that some of those areas could be managed for species diversity in general and endangered species, such as the salt marsh harvest mouse is particular.

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Rice, V. 1974. The Population Ecology of the Salt Marsh Harvest Mouse at Triangle Marsh. Unpublished M.A. Thesis. San Jose State University.

Shellhammer, H. 1977. Of Mice and Marshes. San Jose State Studies. 3(1):23-35

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Zetterquist, D. 1978. The Salt Marsh Harvest Mouse (Reithrodontomys raviventris raviventris) in Marginal Habitats. Wasman Journal of Biology. 35:68-76.

# APPENDIX I

California Dept of Fish & Game

Federal Aid Project

JOB FINAL REPORT

Pittman Robertson 9/5/23

CALIFORNIA FISH & GAME LIBRARY
SEP 04 1980

State: California

Project Number: E-W-3 Project Title: Endangered and Threatened Wildlife

Job Number: V-1.8 Job Title: California Clapper Rail Survey and Inventory

Period Covered: October 1, 1978 to September 30, 1979 Job Type:

OBJECTIVES:

Obtain current distribution and population data for the endangered California Clapper Rail.

SUMMARY:

A survey of known and potential habitats of the California Clapper Rail was conducted from December 1978 through July 1979. Censuses revealed: 1) a population of about 25 rails present through the nesting season in Suisun Marsh, Solano Co., where the species had not been recorded prior to December 1978; 2) a population of at least two pairs, at least one of which nested successfully, at Elkhorn Slough, Monterey County; 3) South San Francisco Bay winter population densities which were apparently higher than those found in the early 1970's; and 4) no Clapper Rails at Morro Bay, San Luis Obispo County. The continued presence of small populations of Clapper Rails was confirmed at several remnant salt marshes in the San Francisco Bay area. Cooperators: San Jose State University Foundation, U. S. Fish and Wildlife Service, Leslie Salt Company.

PROCEDURES:

The survey was conducted by Thomas E. Harvey under a California Department of Fish and Game contract with San Jose State University Foundation, with the assistance of agency personnel and volunteers. Census areas and techniques used by Gill (1979) in the early and mid-1970's were duplicated as closely as possible in a number of sample areas in major South San Francisco Bay salt marshes. In addition, Harvey surveyed marshes around the periphery of the California Clapper Rail's historic range, and smaller remnant marshes throughout its range, to determine current distribution.

FINDINGS:

Study findings are included in the appended report:

Harvey, T. E. 1980. California Clapper Rail survey, 1978-1979. Job Final Report, Job V-1.8, Project E-W-3. California Dept. Fish and Game, Sacramento

ANALYSIS:

Study objectives were met. This survey provides basic data needed for development of a recovery plan for the California Clapper Rail, as well as providing environmental consultant firms and federal, state and local agencies with information needed to avoid adverse impacts on the Clapper Rail and its habitat.

RECOMMENDATIONS:

Recommendations are contained in the appended report.

LITERATURE CITED:

Gill, R. 1979. Status and distribution of the California Clapper Rail. California Fish and Game. 65:36-49.

Prepared by: Alan M. Craig
Alan M. Craig
Associate Wildlife Biologist

Approved by: R. D. Mallette
Robert D. Mallette
Nongame Wildlife Coordinator

Approved by: E. G. Hunt
Eldridge G. Hunt, Chief
Wildlife Management Branch

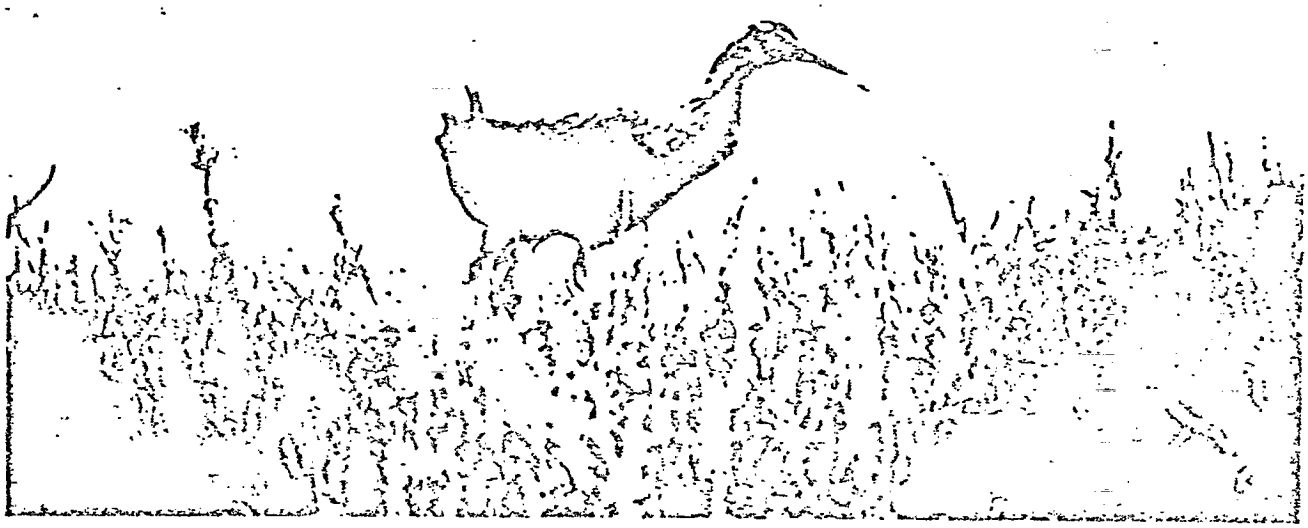
Date: 8/29/80

State of California
THE RESOURCES AGENCY
Department of Fish and Game

# CALIFORNIA CLAPPER RAIL SURVEY, 1978-1979[1/]

by

Thomas E. Harvey



Clapper Rail, Elkhorn Slough, Monterey County, June 21, 1979.
Photo by Russ Shea.


## ABSTRACT

A survey of the California Clapper Rail (Rallus longirostris obsoletus) was conducted from December 1978 through July 1979 in the San Francisco, Monterey and Morro bay areas. Several areas of high abundance were censused as well as some localities in the periphery of the Clapper Rail's range. Nonbreeding season densities of Clapper Rails in South San Francisco Bay appeared to be higher than those found in the early 1970's. In Elkhorn Slough, Monterey County, a population of at least two pairs produced a minimum of two young. In Suisun Marsh, Solano County, an estimated population of 25 rails was present through the breeding season. No Clapper Rails were found at Morro Bay, San Luis Obispo County.


[1/] Supported by Federal Aid for Endangered, Threatened, and Rare Wildlife, Project E-W-3. Job Final Report, Job V-1.8 (July 1980).

## RECOMMENDATIONS

As a result of a survey of California Clapper Rail habitat in the San Francisco Bay region and in Monterey and San Luis Obispo counties, I recommend that:

1. Further surveys be conducted, particularly in the south San Francisco Bay area, to determine both non-breeding and breeding season densities and to better define current population trends.

2. More intensive studies be carried out to monitor the reproductive success of Clapper Rails in a variety of marshes.

3. Surveys of Clapper Rails in Suisun Marsh be continued to determine the stability of this population, its habitat requirements and possible conflicts with existing marsh management programs.

4. Elkhorn Slough, Monterey Co., be acquired by the State or Federal government to insure preservation of the rail habitat.

5. Cover accessible to rails during high flood tides be provided in Elkhorn Slough.

6. Both government and privately-funded projects to preserve and restore tidal marshlands be encouraged.

7. The California Clapper Rail be retained on State and Federal lists of endangered wildlife.



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## INTRODUCTION

Estimates of population abundance for the endangered California Clapper Rail (Rallus longirostris obsoletus) have been presented by Applegarth (1938) and Zucca (1954). Gill (1979) recently summarized the current status and distribution of this subspecies. He estimated that 55% of the total population inhabited marshes of south San Francisco Bay. He also found the overall population relatively stable since the mid 1960s, with some portions exhibiting fluctuations. Recent reports by Wilbur and Tomlinson (1976) and Gill (1979) indicate that Clapper Rails may occur in Humboldt and San Luis Obispo counties in small numbers. A population of fourteen rails has been estimated to inhabit Elkhorn Slough, Monterey County (Varoujean 1972); however, the present status of rails in this area is unclear. Gill (1979) predicted that Clapper Rail range extensions might occur into the Suisun Marsh and northern Contra Costa County areas, if trends in the reduction of outflow from the delta continue.

The main purpose of this study was to examine the current distribution of the California Clapper Rail in the more peripheral portions of its range, in Marin, eastern Solano, northern Contra Costa, Monterey and San Luis Obispo counties. Other objectives were to assess the current status of the rail population in south San Francisco Bay and investigate rail activity at selected sites, anticipating possible development. The study began December 15, 1978 and ended August 1, 1979.

## METHODS

Census sites were selected based on information from current literature and the records of local observers. Census activities were concentrated in areas where the local status of Clapper Rails may need clarification and in several sites already known to support significant rail populations. Visual censuses were conducted during winter flood tides ranging from +6.1' to +7.0' MLLW at Fort Point, San Francisco. Successful results were obtained by inspecting the higher, exposed areas of marshes on foot or from small boats, with the occasional aid of a hunting dog. From the beginning of March through July, sites were surveyed on foot or from small boats while playing tape-recorded Clapper Rail calls in an attempt to elicit vocal responses. A tape of rail "clatter" calls recorded at the Palo Alto Baylands, Santa Clara County, was broadcast using a portable cassette tape recorder and amplified by a 15-watt power horn. These surveys were conducted most effectively during the morning, late afternoon and evening hours. Generally, a 10-15 second series of "clatter" calls was played at least twice at each stop, with a 30-second pause between series. Distance between stops varied, generally depending on mode of transportation and marsh type. Call counts were usually conducted during receding tides, when more cover was available and birds were presumably beginning to forage. Taped calls were broadcast at higher volumes when strong winds were encountered or when large areas of marsh were surveyed. In smaller marshes and sloughs, calls played at lower volumes were believed to be more effective. All taped call surveys in the Suisun Bay area, northern Contra Costa County and Monterey County were conducted from a small boat, powered by either a 7.5 or a 50 horsepower motor. Taped call counts were very useful in Suisun Marsh, where the height and density of the vegetation precluded the use of visual flood tide censuses. At all survey sites, attention was given to the presence or absence of rail tracks in tidal channels.



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All marshes censused on foot were spot-checked for nesting by inspecting the areas bordering tidal channels. Acreage of marsh habitat surveyed was estimated from USGS topographic maps and NOAA nautical charts for several sites in south San Francisco Bay and Suisun Marsh. Non-breeding season densities were calculated from these estimates. During the course of this study, plant and invertebrate samples were collected from Suisun Marsh sloughs supporting Clapper Rails. Records of California Black Rails (Laterallus jamaicensis coturniculus) encountered during these surveys and records obtained from other sources are summarized in this report.

## RESULTS

### Densities

Visual, flood tide counts were conducted successfully in San Mateo, Santa Clara, Alameda, and Contra Costa counties (Table 1; Figures 3, 4). As expected, highest numbers were obtained in marshes which were known to be prime rail habitat, such as the Bay Slough/Bird Island area, the Palo Alto Baylands, the Dumbarton Point area and Ideal Cement Marsh. Totals from these sites were utilized in calculating the densities shown in Table 2. Low counts were obtained in the Millbrae-San Bruno area and near the Bay Bridge Toll plaza. A mean density of 2.35 rails/ha was calculated for south San Francisco Bay. In Suisun Marsh, Solano County, a Cutoff Slough density of 2.1 rails/ha was calculated using a population estimate derived from a combination call and visual count (Figures 5, 6, Site 28).

### Call Counts

Call counts were found most useful in marshes of Contra Costa County, Suisun Marsh and in Elkhorn Slough, Monterey County (Table 1; Figures 4, 5, 6, 7). Responsive rails usually called within 1-5 seconds after playing the tape. Birds evidentally become habituated to taped calls rather quickly and commonly responded only 1-3 times. On several occasions, birds which had not responded to taped calls would suddenly respond when the outboard motor was started. Smith (1973) observed this same behavior while censusing Yuma Clapper Rails (R. l. yumanensis). Call counts in the vicinity of Joice Island, Suisun Marsh (Table 1; Figures 5, 6) indicated a population of about 25 Clapper Rails occurring from March 18 to at least August 17, 1979. In Suisun Marsh, 40% of the rails responding vocally to broadcast calls approached the observer and came into full view. Sightings of rails in Suisun Marsh occurred only during low tide conditions. In Elkhorn Slough, Monterey County (Figure 7, Site 35), a small population of four rails was monitored using call counts on 12 dates between March 8 and August 13, 1979.

### Suisun Marsh Habitat

In Suisun Marsh, Solano County, Clapper Rails were found only along tidal marshes and not in diked channels or ponds. Areas along Cutoff Slough (Figure 6), where Clapper Rails were found, generally supported



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large stands of pure bulrushes, primarily Scirpus acutus, with occasional smaller patches of S. californicus occurring lower on the slough banks. Juncus balticus, Distichlis spicata and Jaumea carnosa occurred evenly near the slough's edges whereas two species of cattail, Typha latifolia and T. domingensis, Grindelia spp. and Salicornia spp. usually occurred in isolated patches. All rail sightings and vocal responses were restricted to gradually sloping banks, where a mud flat zone would be exposed during low tides (Figure 1). Steep, undercut banks along deeper channels, bordered by a narrow marsh zone, were generally unproductive. However, an area of high rail density was encountered along First Mallard Branch, a slough supporting a narrow, fringing marsh (1.5-4 m wide) immediately adjacent to pasture land. Asiatic clams (Corbicula spp.), soft-shelled clam (Mya arenaria) and the barnacle (Balanus improvisus) were also found along branches of Cutoff Slough.

FIGURE 1. Clapper Rail photographed at Cutoff Slough, Solano County on June 7, 1979. Large stands of bulrushes (Scirpus spp.) with a mudflat zone characterized rail habitat.
Photo by Scott Fraser.



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TABLE 1. Sites censused for California Clapper Rails in the San Francisco Bay region and in Monterey and San Luis Obispo counties. Numbers in parentheses refer to site numbers used on figures and in text.

| Location | Date | Marsh Vegetation 1/ | Census Method 2/ | No. Rails Found 3/ |
|---|---|---|---|---|
| **Marin County** | | | | |
| (1) Corte Madera | 12-30-78* | | V, FT | 14[2] |
| (2) Richardson Bay W. | 12-30-78* | | V, FT | 1 |
| " " " " | 03-12-79 | PW, C, G | V, CC | 3 |
| " " " N.E. | 07-21-79 | C, PW, G | CC | – |
| Bolinas Lagoon | 12-30-78* | | V, FT | 1 |
| **San Mateo County** | | | | |
| (3) Brisbane Lagoon | 07-18-79 | PW, G | CC | – |
| (4) San Bruno Point | 01-09-79 | PW, G, G | V, FT | 4 |
| (5) San Francisco Int'l Airport | 07-18-79 | PW, C | CC | – |
| (6) Millbrae-Burlingame | 12-30-78* | PW, C | V, FT | 2 |
| " " " | 01-09-79 | | V, FT | – |
| (7) Marina Lagoon | 07-18-79 | PW, C | CC | – |
| (8) Bay Sl./Bird Island | 01-12-79 | C, PW, G | V, FT, B, D | 25 |
| (9) Smith Slough | 01-11-79 | PW, G | V, FT, B | – |
| (10) Flood Slough | 02-23-79 | PW, G | V, FT, B, D | – |
| **Santa Clara County** | | | | |
| (11) Palo Alto Baylands | 12-29-78 | C, PW, G | V, FT | 49 |
| " " " " | 01-25-79 | | V, FT | 20 |
| (12) Charleston Slough | 01-30-79 | C, PW | V, FT, B, D | 1 |
| (13) Guadalupe Slough | 01-28-79 | PW, C, S | V, FT, B, D | 6 |
| **Alameda County** | | | | |
| (14) Newark Sl. mouth E. | 01-26-79 | PW, C, G | V, FT | 6 |
| " " " " W. | 04-08-79 | PW, C, G | V, CC | 15 |
| " " " " (part) | 01-27-79 | C, PW, G | V, FT, B, D | 7 |
| " " " to... | | | | |
| (15) Dumbarton Point (part) | 01-29-79 4/ | PW, C, G | V, FT | 40 |
| (16) Ideal Marsh | 12-31-78 | PW, C, G | V, FT, B, D | 13 |
| " " " | 01-29-79 | PW, C, G | V, FT, B | 28 |
| (17) Sulphur Creek | 06-08-79 | PW | CC | – |
| (18) Bay Bridge Toll Plaza | 12-27-78 | PW, C, G | V, FT | 2 |
| " " " " " | 03-24-79 | PW, C, G | CC | 2 |
| (19) Emeryville Crescent | 02-27-78 | PW, G, C | V, FT | – |
| " " " | 03-24-79 | PW, G, C | CC | – |
| **Contra Costa County** | | | | |
| (20) Hoffman Marsh | 01-01-79 5/ | PW, C, G | V, FT, B | – |
| " " " | 01-27-79 5/ | PW, C, G | V, FT | – |
| " " " | 06-26-79 | PW, C, G | CC | – |



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ed)

| Location | Date | Marsh Vegetation 1/ | Census Method 2/ | No. Rails Found 3/ |
|---|---|---|---|---|
| Contra Costa County (Cont'd.) | | | | |
| (21) Point Isabel | 01-27-79 5/ | | V, FT | - |
| (22) San Pablo-Wildcat Crks. | 01-10-79 | PW, C, G | V, FT, B | 2 |
| " " " " " | 01-26-79 | PW, C, G | V, FT, B, D, | - |
| (23) San Pablo and north | 07-20-79 | PW, C, G | V, CC, B | 14 |
| (24) Martinez | 04-27-79 | PW, S | CC | 1 |
| (25) Port Chicago, Hastings Sl., Seal, Roe and Ryer Islands | 05-16-79 | S, J, G, PW, T | CC, B | - |
| (26) McAvoy Harbor to Pittsburgh | 05-15-79 | S, G, J, T, PW | CC, B | - |
| Frank's Tract | 07-25-79 | S, T, J | CC | - |
| Solano County | | | | |
| (27) Southampton Bay | 03-26-79 | S, WP, J, T, G | CC | 1 |
| (28) Cutoff Slough, 1st and 2nd Mallard Branches | 12-31-78* | S, J, T, G, PW | CC, B | 2[1] |
| " " " " " " | 03-18-79 | S, J, T, G, PW | CC, B | 17 |
| (29) Second Mallard, Suisun, Sheldrake, Boynton Sls. | 04-01-79 | S, J, T, G, PW | CC, B | 8 |
| (28) 1st and 2nd Mallard Br. | 06-07-79 | S, J, T, G, PW | CC, B | 16 |
| (30) Tree, Montezuma Sloughs | 05-17-79 | S, J, T, G, PW | CC, B | 2 |
| (31) Cordelia, Suisun, Wells, Chadbourne, F. Horan Sls. | 03-25-79 | S, J, T, G, PW | CC, B | - |
| (32) Montezuma, Frost, Nurse, Cross, Hasting Sloughs | 04-30-79 | S, J, T, G, PW | CC, B | - |
| (33) Collinsville-VanSickle, Chipps Islands | 07-19-79 | S, J, T, G, PW | CC, B | - |
| (41) Montezuma Slough W. | 08-17-79 9/ | | | 2 |
| Monterey County | | | | |
| (34) Elkhorn Sl.-Kirby Park | 12-28-78 | PW, G | V, FT, B | - |
| (35,36,38) " " | 01-01-79* | PW, G | V, FT | 3 |
| (35) " " Horseshoe Bend | 02-19-79 | PW | CC, B | - |
| " " " " " | 03-08-79 | PW | CC, B | 2 |
| " " " " " | 03-15-79 | PW | CC, B | 2 |
| " " " " " | 03-22-79 | PW | CC, B | 2 |
| (36) " " Conservancy | 03-23-79 | PW, G | CC | - |
| (37) " " south side | 03-29-79 | PW | CC, B | - |
| (34) " " Kirby Park | 04-04-79 | PW, G | CC, B | - |
| (35) " " Horseshoe Bend | 05-04-79 | PW | CC, B | 2 |
| (36) " " Conservancy | 05-04-79 | PW, G | CC, B | - |
| (38) " " Jetty Road | 06-06-79 | PW, G, S, J | CC, B | - |
| (35a) " " Horseshoe Bend | 06-21-79 6/ | PW | V | 1 |
| " " " " " | 07-12-79 7/ | PW | V | 1 |
| (35) " " " " | 08-07-79 | PW | V | 1 |
| (35a) " " " " | 08-13-79 8/ | PW | V | 3 |



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TABLE 1. (Continued)

| Location | Date | Marsh Vegetation 1/ | Census Method 2/ | No. Rails Found 3/ |
|---|---|---|---|---|
| San Luis Obispo County | | | | |
| Morro Bay | 04-02-79 | PW, G | CC | - |
| " " | 04-03-79 | PW, S, J | CC | 0[3] |

*Census results from the Marin County (Southern), Crystal Springs Reservoir, and Benicia Christmas Bird Counts (Am. Birds 33:644, 648, 655; 1979) are included to provide additional documentation of the presence of Clapper Rails in selected marshes.

1/ G = Gumplant (Grindelia spp.)
PW = Pickleweed (Salicornia spp.)
C = Cordgrass (Spartina foliosa)
S = Bulrushes (Scirpus spp.)
J = Spike Rushes (Juncus spp.)
T = Cattails (Typha spp.)

2/ V = visual count
FT = flood tide
CC = call count
B = with small boat or kayak
D = with hunting dog

3/ Represents numbers of Clapper Rails observed or heard at each site. Numbers of Black Rails are given in brackets.

4/ Censused by S. Bailey.

5/ Censused by D. Erickson.

6/ Observed by R. Shea.

7/ Observed by M. Reilly and M. Sliger

8/ Total for this sighting consisted of 1 adult with 2 young; observation by B. Allen

9/ Observed by S. Fraser.



C—054099

C-054099

TABLE 2. Density results for visual censuses in south San Francisco Bay and call counts in Suisun Marsh, Winter, 1978-79.

| Location | Acres Surveyed | Tidal Height | Density Rails/Hectare |
|---|---|---|---|
| Bay Slough/Bird Island | 25.4 | 6.2 | 2.4 |
| Palo Alto Baylands | 43.1 | 6.7 | 2.82 |
| Dumbarton Point | 141.9 | 6.7 | 0.70 |
| Ideal Marsh | 13.4 | 6.5 | 2.4 |
| " " | 20.2 | 6.7 | 3.41 |
| Cutoff Slough | 20.0 | 0.6 | 2.1 |

## DISCUSSION

As stated earlier, the winter rail density for south San Francisco Bay averaged 2.35 rails/ha and ranged from 0.70 to 3.41 rails/ha (Table 2). Table 3 compares densities from this study with data from previous research.

TABLE 3. Comparison of current nonbreeding Clapper Rail densities (rails/ha) for south San Francisco Bay with past studies. In the body of the table, time periods shown in parentheses refer to time of censuses.

| Location | This Study | Gill (1973, 1979, pers. comm.) | Zucca (1954) | Applegarth (1938) 1/ |
|---|---|---|---|---|
| Ideal Marsh | 2.40(12-31-78)<br>3.41(01-29-79) | 3.45(12-24-71)<br>1.40(11-21-72)<br>0.52(12-09-73)<br>0.70(01-06-74)<br>0.52(01-27-75) | | |
| Palo Alto Baylands | 2.82(12-29-78) | 2.37(01-17-72)<br>2.66(12-10-73)<br>1.21(12-11-73)<br>0.85(01-06-74)<br>1.70(01-08-74) | | |
| Dumbarton Bridge Marsh | | | 2.42(12-08, 09-50)<br>2.99(12-28, 29-51) | 1.63(1937-38)<br>4.44 " "<br>1.73 " " |
| South San Francisco Bay | 2.35(1978-79) | 1.07(1971-75) | | |

1/ Area censused during breeding season.



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The densities I obtained in 1978-79 for Ideal Marsh and Palo Alto Baylands are generally comparable to those reported by Gill for the same sites in 1971 and 1972-73, respectively. However, the current data reflect significantly higher densities than were found between those years and 1976. These higher density figures could be the result of different methods of estimating size of census areas, however, I believe my density figures were conservative. According to Gill (1979), the south San Francisco Bay Clapper Rail population was reduced by approximately 40% in 1972. The recent winter density estimates suggest that this population has increased since the early 1970's.

Such population fluctuations have been reported in New Jersey populations of R. l. crepitans and are believed to be related to a lack of disruptive high tides and subsequent intraspecific competition for nesting territories (Ferrigno 1966). Gill (1979) attributed the 1972 population drop to a reduction in biomass of Cordgrass (Spartina foliosa), the preferred nesting habitat, following the dry winter of 1971-72. This reduction resulted in increased intraspecific competition and utilization of more marginal nesting habitat. The wet years of 1977-78, following the extremely dry period of 1975-76, may account for the evidently higher numbers presently occurring in south San Francisco Bay. Jorgenson (1975) found that population densities for the nearest relative of the California Clapper Rail, R. l. levipes, averaged 0.44 rails/ha in Tijuana Marsh, San Diego County. Estimates of 0.35-0.79 rails/ha were presented by Smith (1973) for R. l. yumanensis in several different regions of Topock Marsh, Mohave Co., Arizona. During this study, Suisun Marsh, which has habitat similar to that occupied by the Yuma Clapper Rail, had a density of 2.1 rails/ha.

Flood tide surveys may be the only reliable method for obtaining accurate information on population size in Elkhorn Slough, Monterey County. Since over 90% of the vegetative cover is comprised of Salicornia, rails have much less cover than in a Spartina - dominated marsh. In this setting, rails may be much less prone to respond to taped calls. Jorgenson (1975) found that R. l. levipes called more when inhabiting dense vegetation. On August 13, 1979, an adult and two young were discovered at Site 35a (Figure 7). Taped calls had been used repeatedly at this locality throughout March and April without obtaining responses.

Varoujean (1972) found all Elkhorn Slough rail activity focused along the main (primary) channel and none on branching (secondary) channels. In this study, rails were found from January through August along secondary channels near Site 35 (Figure 2). The importance of these secondary channels for San Francisco Bay rails has been emphasized by several authors (DeGroot 1927, Applegarth 1938, Gill 1973). Rails were found to range over 0.6-1.0 km of primary channel shoreline and secondary tidal channels. Despite the extensive potential habitat available (770 acres; Browning 1972) and the rich invertebrate population, Elkhorn Slough does not support a significant rail population.

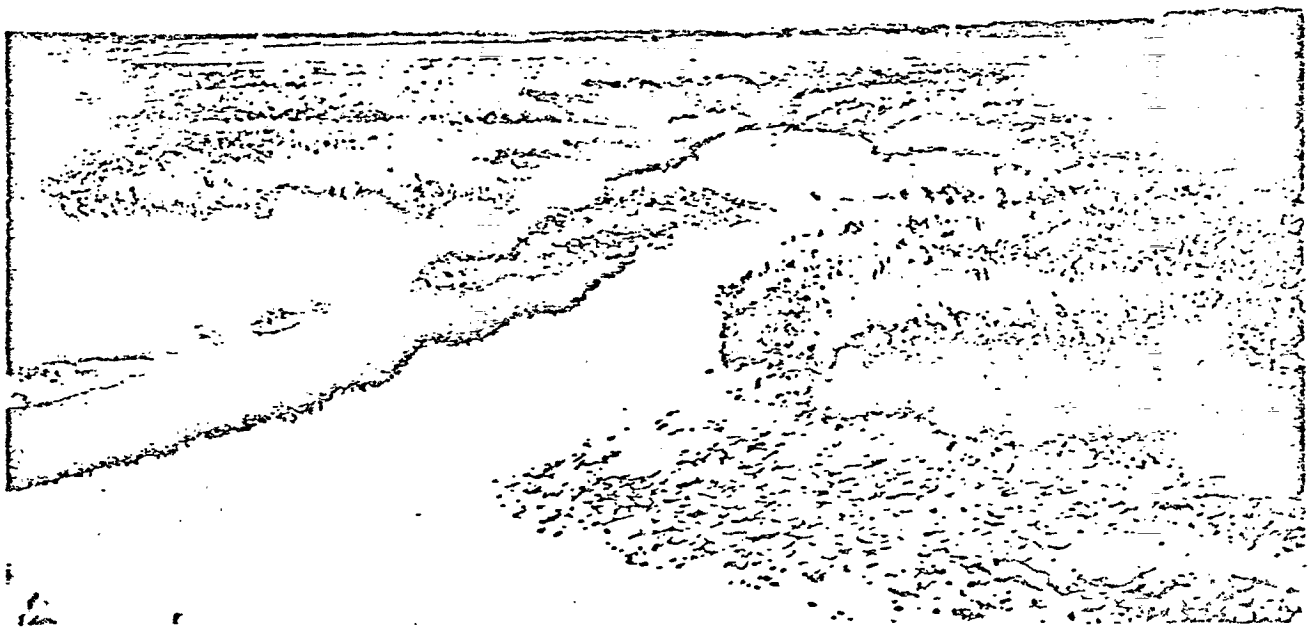

FIGURE 2: Secondary tidal channel on the north side of Elkhorn Slough, Monterey County (Site 35). Rails were recorded here from March 3, 1979 until the project ended.
Photo by Thomas E. Harvey

Many researchers have documented the importance of Spartina marshes for Clapper Rail populations (Applegarth 1938, Jorgensen 1975, Gill 1979). Lacking Spartina, the slough may be unable to provide sufficient cover for breeding rails. Recent studies have shown the water salinities of upper Elkhorn Slough to be too high for germination of Spartina (H. T. Harvey, pers. comm.). Other research has emphasized the importance of adequate drainage and protection from wave action for the maintenance of Spartina (Jorgensen 1975). Another factor contributing to the absence of rails may be the lack of a brushy, upland transition zone which could provide additional cover during high flood tides. Many areas adjacent to the slough are subject to intense grazing pressure or consist of steep dikes.

Current data from the Department of Water Resources do not suggest any recent salinity increases for the Suisun Marsh area (G. Deatheridge, pers. comm.). If salinity increases significantly, it is conceivable that changes in marsh flora and benthic invertebrates will create conditions more suitable for Clapper Rails. Suisun Marsh already supports populations of the Crayfish (Pasifastacus leniusculus) (D. Osborne pers. comm.) and the Asiatic clam (Corbicula) (pers. obs.). Ohmart and Tomlinson (1977) found these invertebrates to be major foods in the diet of the Yuma Clapper Rail. Evidentally, Clapper Rails have begun to exploit these available food resources and to utilize atypical (for R. l. obsoletus) marsh flora as nesting habitat.

Tomlinson and Todd (1973) described the habitat preferences of R. l. yumanensis as being shallow-water areas with mud flats containing dense stands of bulrushes and cattails. These conditions also characterize the rail habitat along Cutoff Slough in Suisun Marsh. One possible conflict

between present management practices in Suisun Marsh and the Clapper Rail is the burning of marsh vegetation for the promotion of new growth. Burning vegetation during a low tide period, compounded by an average tidal range of 3.9', could eliminate a large amount of cover available to rails.

On three different occasions during spring censuses, I heard the "tic-tic-tic-McGreer" or controversial "kicker" call. Bailey (1977) concluded that this call was produced by at least four species of rails. He also believed it was related to reproduction and occurred only under very rare social conditions created by some disturbance. The above call was heard from Clapper Rails at three separate locations during the dates of April 8 and 27 and May 11, 1979. The call was also heard by D. Erickson (pers. comm.) on April 11, 12 and 13 at a location in Alameda County. Since these calls were heard only during the breeding season, it would seem that they were related to reproduction. Applegarth (1938) believed this call was only produced by males during the mating and egg-laying period. Meanley (1969) heard King Rails produce this call only at the beginning of the breeding season. In the San Francisco Bay area, this call does not appear to be a rare event, as it was heard for nearly a 4-day consecutive period in mid-April at the same location. On April 8, the call was heard from approximately fifteen birds throughout the marsh and was commonly given in response to a taped "clatter" call. Extreme high tides did not precede any of the dates when the calls were heard.

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## APPENDIX A

## SUMMARY OF CENSUS RESULTS

Marin County. The Marin County (southern) Christmas Bird Count on December 30, 1976, tallied 14 Clapper Rails and 2 Black Rails in Corte Madera Marsh. This was believed to be a low estimate of the total Clapper Rail population present (P. Schaeffer, pers. comm.). During this study, the highest number of rails seen in Richardson Bay was 3 on March 12, 1979. A Clapper Rail was observed at Bolinas Lagoon on December 4 and 31, 1978 (L. Stenzel and G. Page, pers. comm.).

San Mateo County. Brisbane Lagoon is a very marginal tidal marsh with some thick *Salicornia* at the south corner, but with heavy freeway and train traffic on either side. San Bruno Point evidentally supports a stable population of at least four rails, despite its proximity to industry. San Francisco International Airport Property across from San Bruno Point appeared adequate for rails, but was directly in the path of heavy airline traffic. The Millbrae-Burlingame site is surrounded by heavy industry, but at least a pair of rails still remains. The mouth of Marina Lagoon supports a recent marsh with several large *Spartina* patches. The rest of the lagoon contains no marsh habitat. Bay Slough/Bird Island is an area of excellent habitat with high rail densities. Smith Slough and Flood Slough are primarily small *Salicornia* channels, bordered by steep dikes. Despite its proximity to heavy truck traffic from the Redwood City Dump, a rail was seen on February 6, 1974 in Flood Slough (R. Gill, pers. comm.).

Santa Clara County. The upper reaches of Guadalupe Slough are dominated by freshwater vegetation as a result of the Sunnyvale sewage treatment plant releasing 16.5 million gallons/day. Combining this effluent with the outflow from the San Jose-Santa Clara sewage treatment plant, a total 152 million gallons/day are emptied into lower south San Francisco Bay sloughs (F. Belik, pers. comm.). The effects of this outflow on Clapper Rail distribution should be examined further.

Alameda County. Sulphur Creek is a narrow, *Salicornia*-lined channel near San Lorenzo, in which no rails were found. Freeway expansion in this area may eliminate some breeding habitat for shorebirds. Recent information on rails at Alameda south shore include 6 on December 10, 1977, 7 on December 2, 1978, and 2 on January 27, 1979 (E. Roemer, pers. comm.). The Bay Bridge Toll Plaza portion of the Emeryville crescent marsh continues to support a small population of at least one pair and possibly two pairs, calling through the breeding period. The highest number recorded for this site appears to be 14 for a November flood tide census in 1971 by Milton (1972). No rails were recorded in the eastern portion of the Emeryville crescent marsh during this study. The intense use of this area by sculpture enthusiasts and its effect on Clapper Rails requires further investigation.

Contra Costa County. No rails were found at a narrow marsh north of Golden Gate Fields. Northeast of Central Avenue and east of Point Isabel, an area known as Hoffman Marsh produced no rails during a flood tide census or call count. Individual rails were seen on March 30 and 31, 1978 at this same



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location (G. Thomson pers. comm.). Two isolated sites of rail activity were surveyed near the mouths of San Pablo and Wildcat creeks northwest of Richmond. One was a narrow marsh peninsula to the southeast of Point San Pablo near the mouth of Wildcat Creek. The other was near the San Pablo Creek mouth and to the northeast toward Point Pinole. The 14 birds located there on July 20, 1979 represent only about one-half of the total rails present. One rail was found in an isolated Spartina patch toward Point Pinole. The last survey of these sites was in 1973 (Gould). On April 27, 1979, a single Clapper Rail was heard calling "kek-burr" from a dense thicket of bulrushes near the Martinez Yacht Harbor. Call count surveys by boat produced no rails from Hastings Slough near the Port Chicago Naval Weapons Station to the PG&E power plant west of Pittsburgh. At Frank's Tract/Bethel Island area, no rails responded to taped calls.

Solano County. One rail responded to a taped call at Southampton Bay on March 26, 1979 from site dominated by Salicornia and Juncus. Other recent records at this location for single birds heard were on May 15, 29, and 30, 1977, and July 17, 1978 (F. Beyer, pers. comm.). This marsh continues to be a stronghold for Black Rails, with six individuals heard calling on July 17, 1978 (F. Beyer, pers. comm.). On December 31, 1978, one Clapper Rail was seen and another heard on Cutoff Slough near Joice Island (J. Hein, pers. comm.). This represents the first definite occurrence of Clapper Rails in Suisun Marsh, as no historical records exist (Gill 1979). One Black Rail was also seen off Cutoff Slough during this count. Subsequent call count surveys by boat produced maximum population estimate of 25 Clapper Rails for Cutoff Slough and surrounding tidal sloughs. Call counts were felt to be fairly reliable in censusing, as birds called readily and were easily distinguishable from neighbors. This population may have been missed for some time, as regular rail censuses during Christmas Bird Counts have been done for only 3 years, and only 1 year with taped calls. Past Department of Fish and Game surveys have yielded negative results (Gould 1973, R. Jurek pers. comm.). Breeding in this population was not verified, however, high numbers were present through the breeding season. Some fluctuation in numbers from slough to slough was observed. No rails were found on tidal sloughs west of Suisun Slough, northeast of Montezuma Slough, or in the southern Grizzly Island area east to Collinsville.

Monterey County. After a population estimate of 14 in 1972 (Varoujean 1972), the rail population in Elkhorn Slough apparently declined. No rails were found during flood tide surveys conducted by the Department of Fish and Game December 9-11, 1977, and March 20-21, 1978. In March and on August 4, 1978, I observed single birds on the north side of the channel near Horseshoe Bend, opposite the Elkhorn Dairy Ranch (Site 35, Figure 7). During the Moss Landing Christmas Bird Count of January 1, 1979, one rail was seen north of Kirby Park and another near Jetty Road. A bird was also seen across from the Elkhorn Dairy Ranch (Site 35) during the week of the count (D. Vierra, pers. comm.). A Clapper Rail was seen in the vicinity of Jetty Road on several occasions from November 1978 to February 1979. Periodically from March 8 until August 7, at least a pair of rails was located with taped calls at Site 35. From June 21 to August 7, an individual was occasionally sighted on the south side of the slough near Site 35a. On August 13, an adult bird was seen at this same location with two young birds approximately two-thirds adult size (B. Allen, pers. comm.). This report represents the first verification of nesting at Elkhorn Slough since Varoujean's (1972) report. The location of these three birds corresponds to the area where Varoujean discovered a young bird in 1972. All



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surveys of the upper part of the slough produced no rails. It appears that there are presently at least two pairs of Clapper Rails in Elkhorn Slough. Since Elkhorn Slough is not considered prime rail habitat, exceptional fluctuation in numbers might be expected. The high 1972 population of rails in Elkhorn Slough occurred during a period of reduced growth of Spartina which increased competition for nesting habitat in south San Francisco Bay (Gill 1979). Marginal areas such as Elkhorn Slough may have played an important role in providing additional habitat at that time.

San Luis Obispo County. Morro Bay was once believed to support a small population of Clapper Rails (Brooks 1940). Recent reports of a rail at this locality were cited by Gill (1979). I found no Clapper Rails during 2 days of call counts around Morro Bay in early April (Figure 8). The Salicornia marsh in Morro Bay State Park appeared to be of insufficient depth to provide rails with adequate cover. However, I did locate two Black Rails by calls north of Baywood Park and one west of Cuesta-by-the-Sea in Shark Inlet on April 3, 1979.



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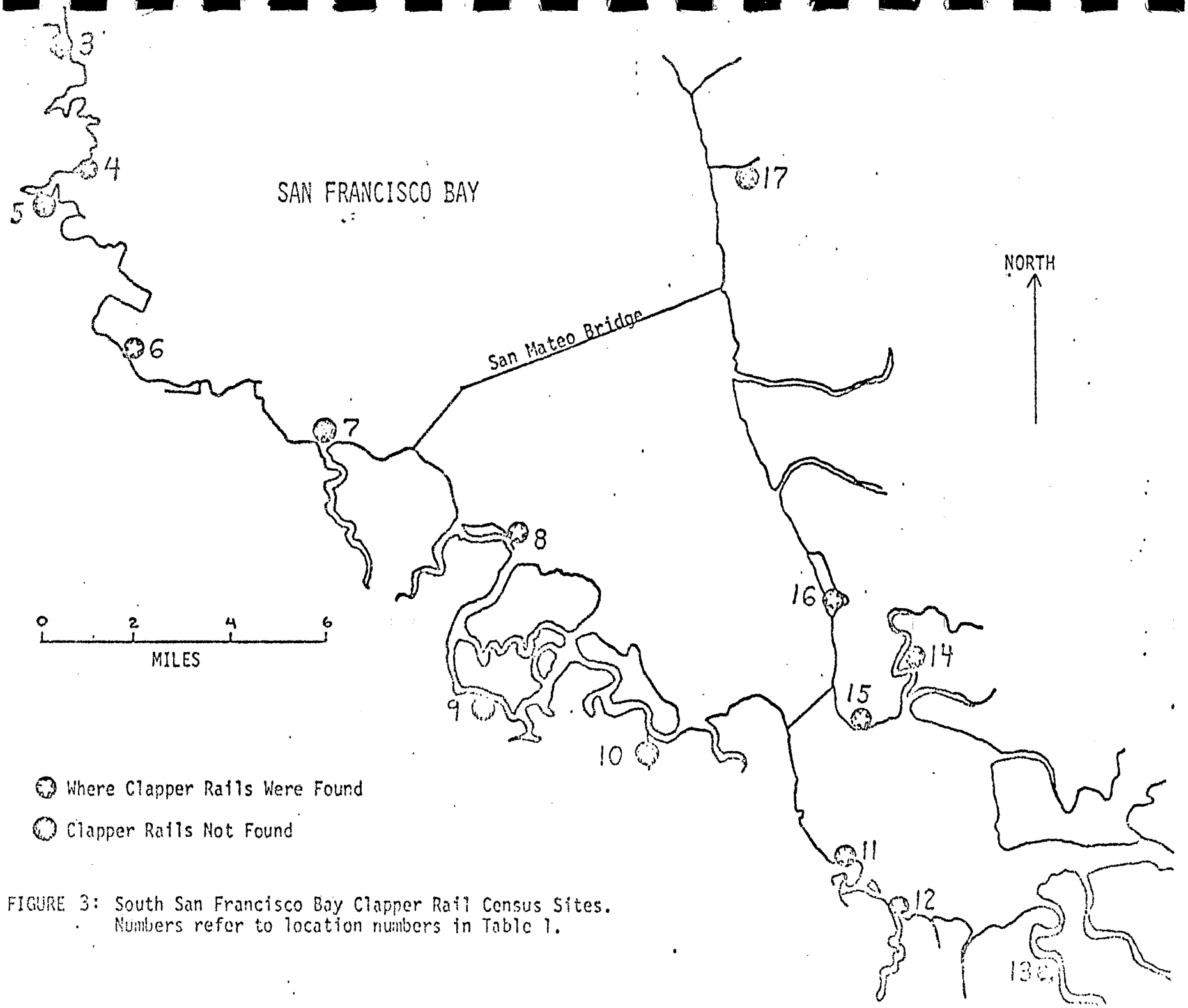


FIGURE 3: South San Francisco Bay Clapper Rail Census Sites. Numbers refer to location numbers in Table 1.



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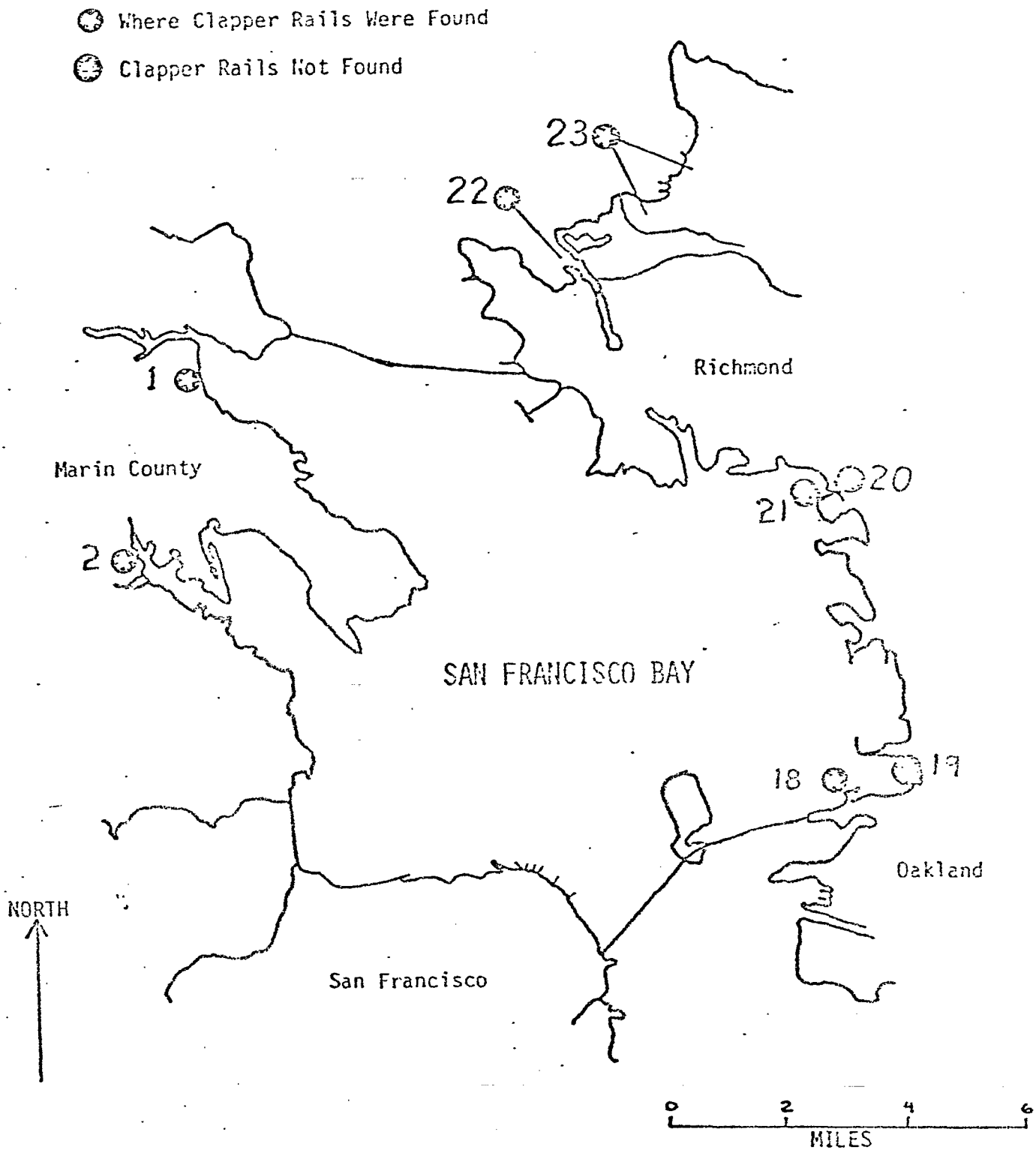


FIGURE 4: Central San Francisco Bay Clapper Rail Census Sites. Numbers refer to location numbers in Table 1.



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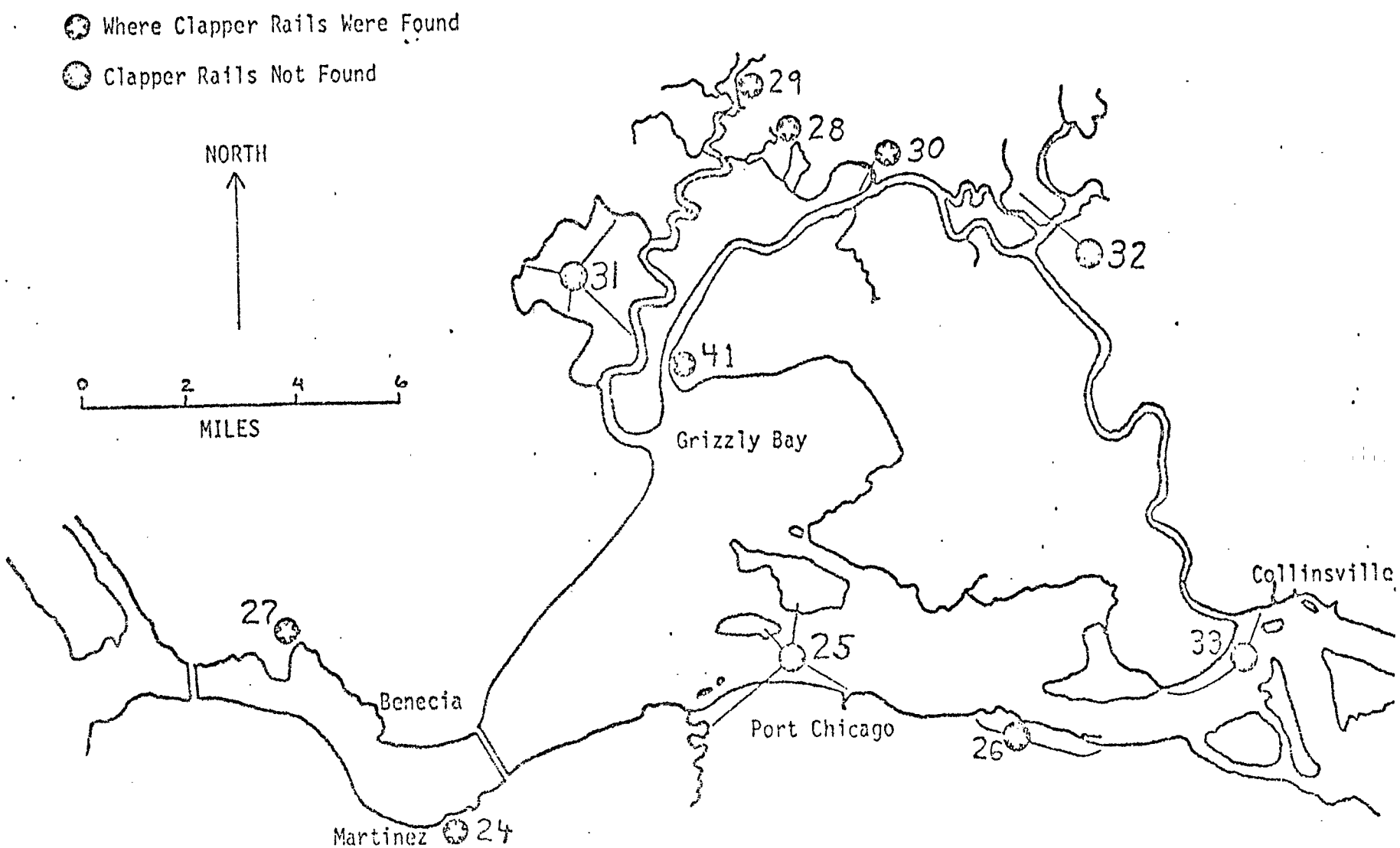
FIGURE 5: Suisun Bay and Northern Contra Costa County Clapper Rail Census Sites. Numbers refer to location numbers in Table 1.



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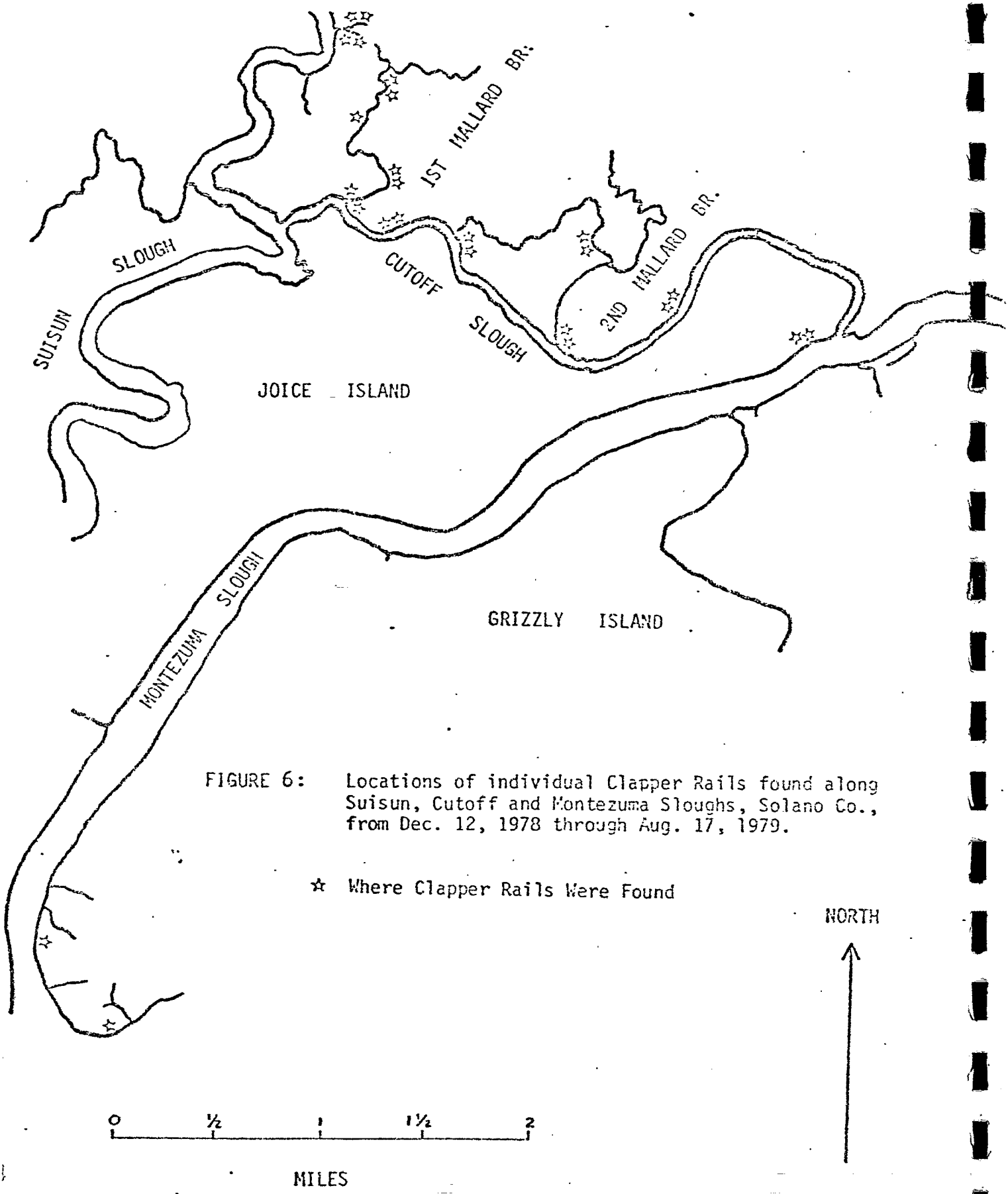


FIGURE 6: Locations of individual Clapper Rails found along Suisun, Cutoff and Montezuma Sloughs, Solano Co., from Dec. 12, 1978 through Aug. 17, 1979.

☆ Where Clapper Rails Were Found



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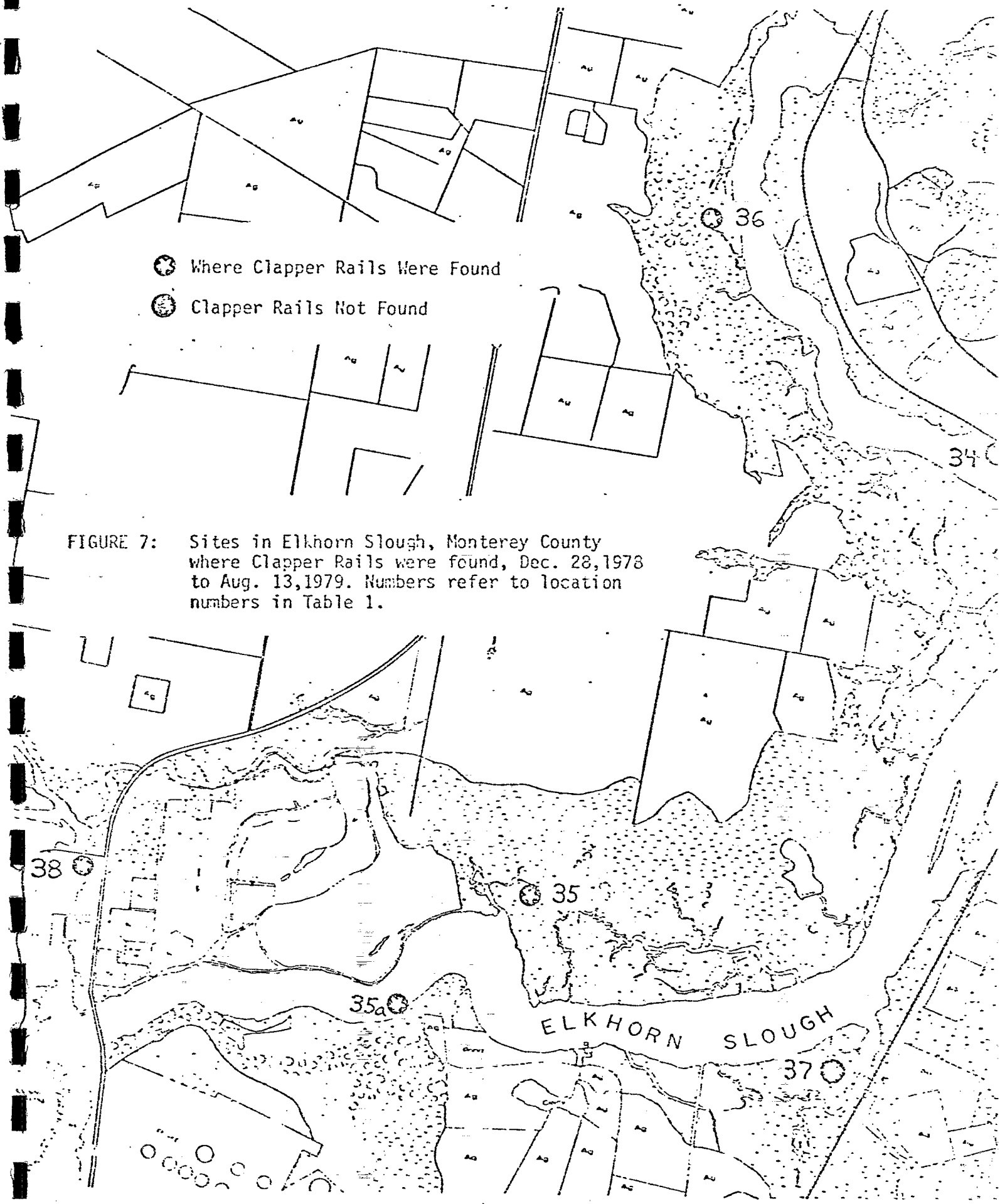


FIGURE 7: Sites in Elkhorn Slough, Monterey County where Clapper Rails were found, Dec. 28,1978 to Aug. 13,1979. Numbers refer to location numbers in Table 1.

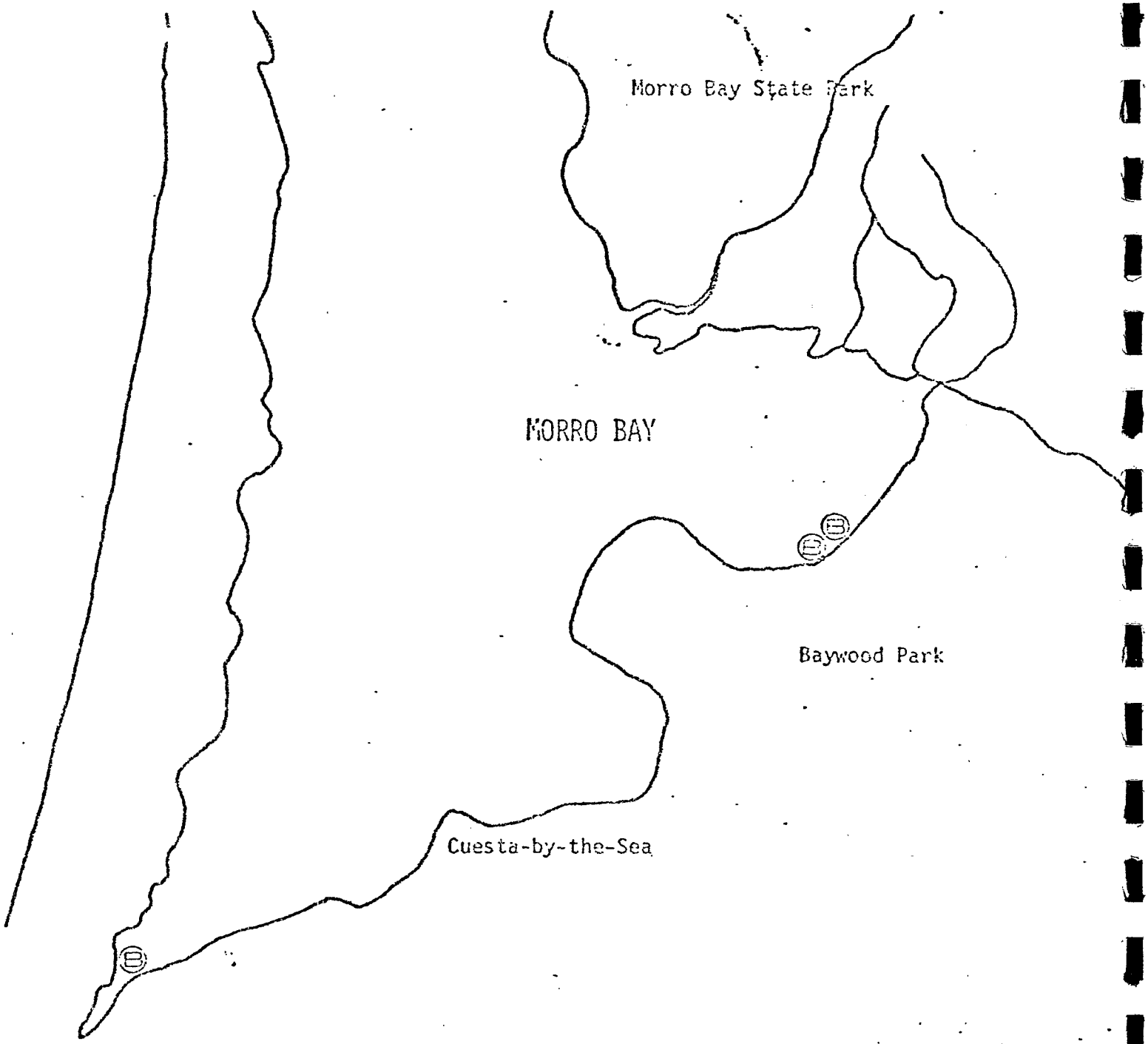


FIGURE 8: Census Sites Around Morro Bay, San Luis Obispo County, Where Black Rails Were Found -- (B)



C—054114

C-054114

# APPENDIX J

SEP 23 1980

State of California

The Resources Agency

# Memorandum

To : Glenn Rollins, Bay-Delta Project

Date: September 22, 1980

From : **Department of Fish and Game** - State Plant Ecologist, Endangered Plant Program

Subject Endangered and Rare Plants

During the period July - September 1980, I have been periodically visiting the areas proposed for ground disturbance within the Suisun Marsh as indicated in the annotated map provided to me. Based upon my field surveys and having reviewed file information, I have not been able to document the occurrence of any of the following plant species within the proposed areas of activity:

*Aster chilensis* var. *lentus*
*Cicuta bolanderi*
*Cirsium hydrophilum* var. *hydrophilum*
*Cordylanthus mollis* ssp. *mollis*
*Lasthenia conjugens*
*Lathyrus jepsonii* ssp. *jepsonii*
*Legenere limosa*
*Lilaeopsis masonii*

Please advise me if you desire clarification.

Steve

Stephen P. Rae
State Plant Ecologist

SPR:jg

C-054116

C-054116

# APPENDIX L

August 23, 1982

SUISUN MARSH TECHNICAL COMMITTEE

SUBJECT: Recommended Mitigation Alternative for the Suisun Marsh Plan of Protection

This is in follow-up to the August 13, 1982, Technical Committee meeting where the July 12, 1982, mitigation alternative memo was discussed. Several excellent suggestions were made to revise the wording which summarized the Committee's recommended mitigation alternative. Below is an attempt to include these suggestions in a rewrite of the alternative for inclusion in the Environmental Impact Report (EIR).

1. Department of Water Resources (DWR) shall contract with Department of Fish and Game (DFG) to acquire and develop new wetland to replace that impacted by project construction (presently estimated at 380 acres); and to replace through development of new wetlands or improvement of existing degraded wetlands the equivalent of 580 acres of land capable of optimum waterfowl food production in the Suisun Marsh. Development of this 580 acres is to mitigate for habitat value lost by not serving the channel islands. This contract shall include a provision of funds for the operation and maintenance (O&M) of the developed areas. This O&M shall include pumping costs if required, however, a diligent effort will be made to keep such costs to a minimum.

2. DFG will make every effort to purchase private lands on Grizzly Island near the Red Barn, lands near Montezuma on the east side of the Marsh, and selected parcels on the west side to achieve the acreage described in Item 1. In the event DFG's acquisition efforts fall short of obtaining all the acreage needed, the remaining wetland would be developed on existing DFG property in the Marsh.

3. DFG will develop the new wetland to include approximately 100 acres of the preferred salt marsh mouse habitat as proposed in the Biological Assessment.

4. The contract will provide for the purchase and/or development of selected parcels that will be of sufficient size to provide public recreational opportunities such as hunting, nature study, and photography.

The recommended alternative will be included in this form in the draft of the final EIR to be circulated in DWR and DFG. Further comments on the recommended alternative can be made at the September 17, 1982, Technical Committee meeting and will be incorporated into the EIR before it is finalized.

Carol Nelson
Acting Chairman
Suisun Marsh Studies

# APPENDIX M

## Appendix M

## RECREATION PLAN

This plan presents a conceptual proposal for the development of public recreation facilities in Suisun Marsh. The Davis-Dolwig Act (Water Code Sections 11900 through 11925) establishes the basic policy that recreation is among the purposes of the State Water Project, and where feasible, public recreation is to be provided in association with water development facilities. The concepts presented herein are consistent with the Davis-Dolwig Act, and with the "Suisun Marsh Protection Plan" developed by the San Francisco Bay Conservation and Development Commission. They include recreation and fish and wildlife uses, such as:

- Access and parking facilities
- Picnic facilities
- A trail system
- Facilities to support fishing, nonmotorized boating, and other day-use activities
- Regulated hunting, bird watching, and nature study

Facilities will be designed to accommodate the physically handicapped user wherever feasible. The fundamental concept of the plan is that project waterways, ponds, and lands will be made available for public use, where feasible.

Recreation areas developed within the Marsh will be managed to assure continuing enjoyment for the user. The proposed recreation development could be operated and maintained by the State or local agencies, or through a cooperative agreement involving both agencies if funding is available.

It should be understood that this recreation plan is conceptual only, and will probably be modified as the project facilities are further defined. Current project planning calls for staged construction of the various project facilities, with the Montezuma Slough Control Structure being built first and others being built as required by contractual agreement. Each recreation feature is associated with a project facility. Development of each recreation site is dependent on construction of the associated project feature and will not proceed in advance of project construction. Locations of individual recreation facilities shown herein are diagrammatic only, and are based on assumed channel alignments and pond locations. The final locations will be determined as each project feature is designed. Furthermore, it is possible that after the project is completed, a particular pond or recreational

facility may become unattractive for recreation uses. For all these reasons, the development of recreation facilities should remain highly flexible.

## General Description of the Area

Suisun Marsh is in southern Solano County, encompassing about 85,000 acres of marshland and small waterways. The Suisun Marsh is the largest contiguous brackish marsh in the continental United States, and is one of the major migrating waterfowl wintering grounds in the Pacific Coast Flyway. The relatively large expanse of unbroken native habitat and the wide diversity of vegetation and aquatic conditions make the Marsh one of the most unique and valuable wildlife habitat areas in California.

The demand for more public recreation sites is high because of the uniqueness of the area and the lack of public access for varied recreation uses. Recreation development proposed in conjunction with water control facilities being constructed within the Suisun Marsh area by the Department of Water Resources should alleviate some of the demand. Most sites have potential for day-use activities such as:

- Small craft boating (no motors)
- Fishing
- Bird watching
- Photography
- Sightseeing
- Hiking or biking
- Nature study
- Picknicking

Much of Suisun Marsh is owned by private duck clubs. They manage the land to maximize the number of waterfowl available to their members. Provisions, such as fencing and signs, would be made at recreation sites to minimize trespass on private lands. Should improper use become a problem, it might be necessary to limit the use of these recreation sites during the waterfowl season (October through January).

The seven sites where recreation facilities are being considered are:

- Montezuma Slough Control Structure and Wildlife Area
- Roaring River Slough Distribution System
- Boynton-Cordelia Ditch
- Grizzly Island Road Boat Ramp
- Cordelia-Goodyear Ditch
- Grizzly Island Distribution System
- Potrero Hills Ditch

Figure 1 shows the project facilities being considered and the location of the recreational sites. Individual site developments are described below.

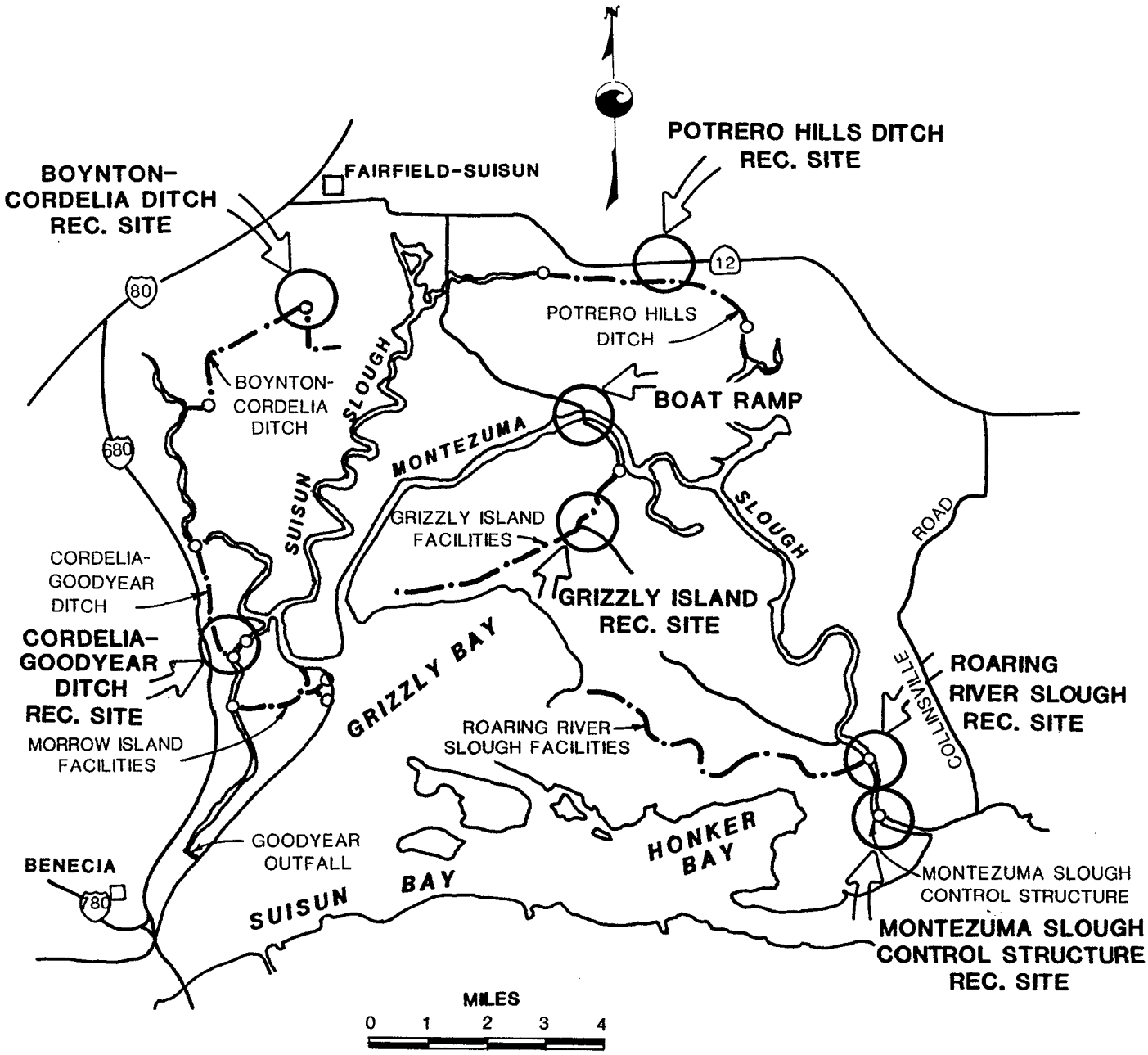


**FIGURE 1**
**SUISUN MARSH–PROJECT FEATURES AND PROPOSED RECREATION SITES**

M-3

## Montezuma Slough Control Structure and Wildlife Area

This area has been proposed as one site where up to 960 acres of wetland could be developed to mitigate for the impacts of the Plan of Protection and the channel islands not served by the project. The area is located south of Bird's Landing, west of Collinsville, and bordered on the west by Montezuma Slough. Travel time from Fairfield and Suisun City would be about 40 minutes. Access would be from Highway 12, south on Shiloh Road to Collinsville Road, and then west on an access road to the area.

The proposal for recreational development of this site is shown on Figures 2 and 3. Parking areas for about 20 vehicles would be provided at each end of the site. Hiking trails would be provided along the east bank of Montezuma Slough. The Montezuma Slough Control Structure would be developed to provide fishing platforms (handicapped accessible), a picnic island, boat mooring facilities and portable sanitary facilities. Portable sanitary facilities would also be furnished near both parking areas.

The wildlife area itself would also be accessible from both parking lots to be used for birdwatching, photography, and nature study. Because of the travel time required and its location, use is expected to be moderate for this site. If there were to be a buildup of predator fish near the control structure, fishing usage might be higher.

A public hunting program is also proposed for this area. The California Department of Fish and Game would operate this program and provide additional chemical toilets and trash receptacles as needed.

This recreation development is based on the selection of the associated 960-acre parcel as the mitigation lands. Several other parcels are being considered for acquisition as mitigation land. If other parcels were chosen, recreational development would be considered on those parcels. In this case, recreational development at the Montezuma Slough Control Structure would be limited to the features directly associated with the structure.

## Roaring River Slough Distribution System

The Roaring River Slough Distribution System was constructed as a part of the Suisun Marsh Initial Facilities to supply water to Simmons and Wheeler Islands in the southeast corner of the Marsh. A pond was constructed adjacent to the intake structure to provide system storage. Travel time to reach this area from Fairfield and Suisun City is about one hour.

The proposed recreation development, shown on Figure 4, includes a 9-mile hiking trail from the Fish and Game parking lot at the end of Grizzly Island Road, down the west bank of Montezuma Slough, along the north and west rim of Roaring River Pond, and

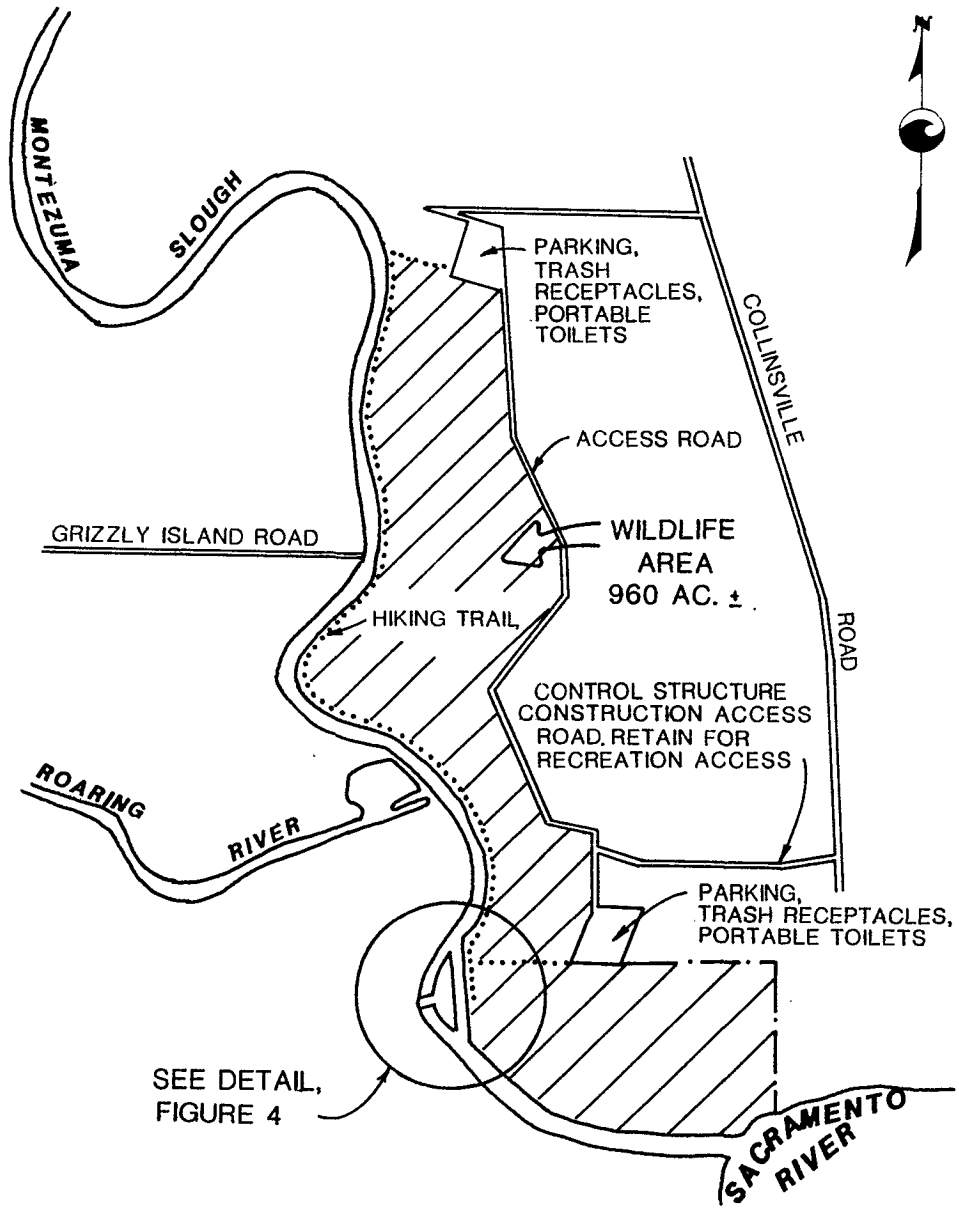


**FIGURE 2**
**MONTEZUMA SLOUGH CONTROL STRUCTURE**
**RECREATION DEVELOPMENT**

M-5

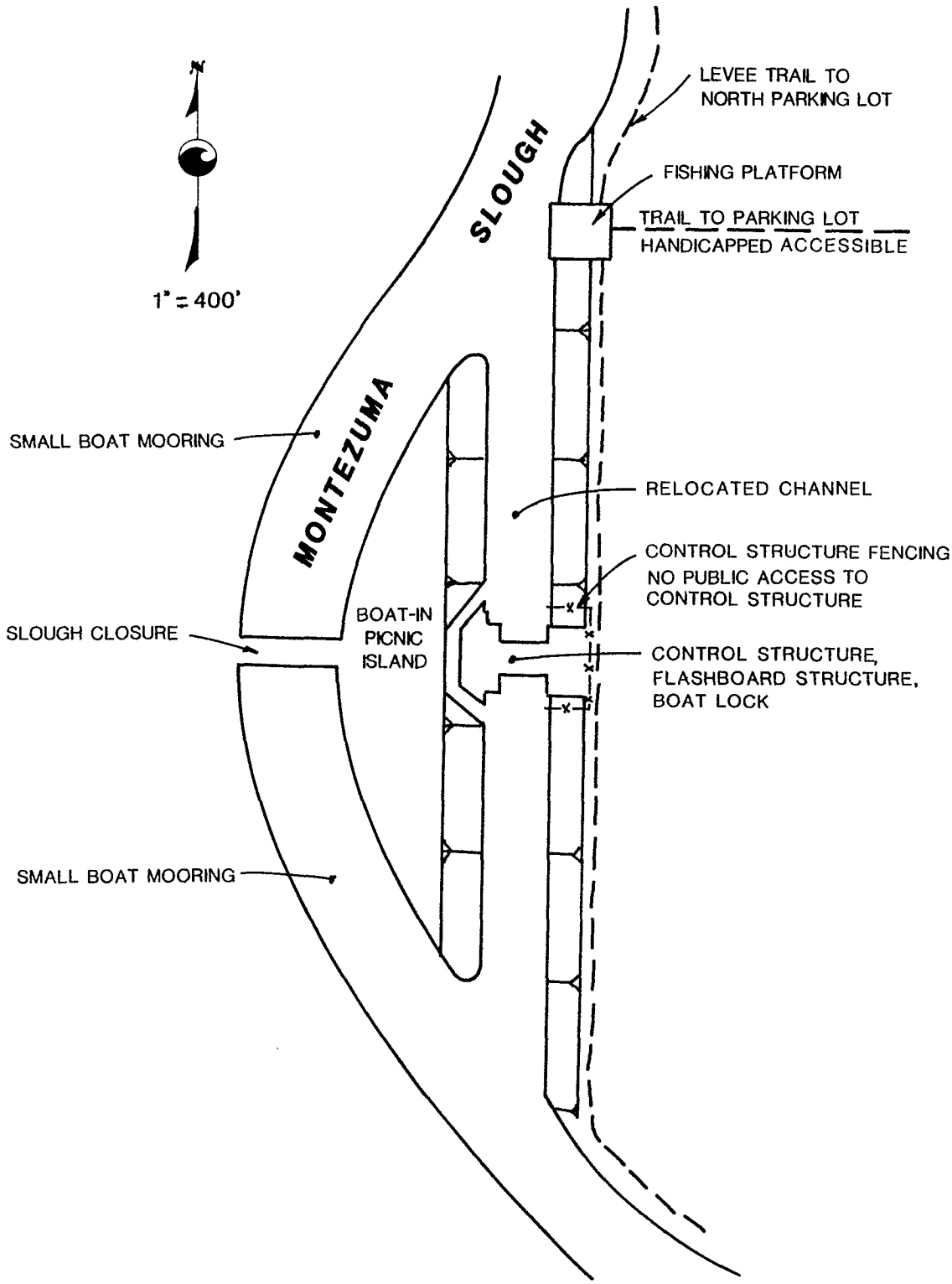


**FIGURE 3**
**MONTEZUMA SLOUGH CONTROL STRUCTURE**
**RECREATION DEVELOPMENT**

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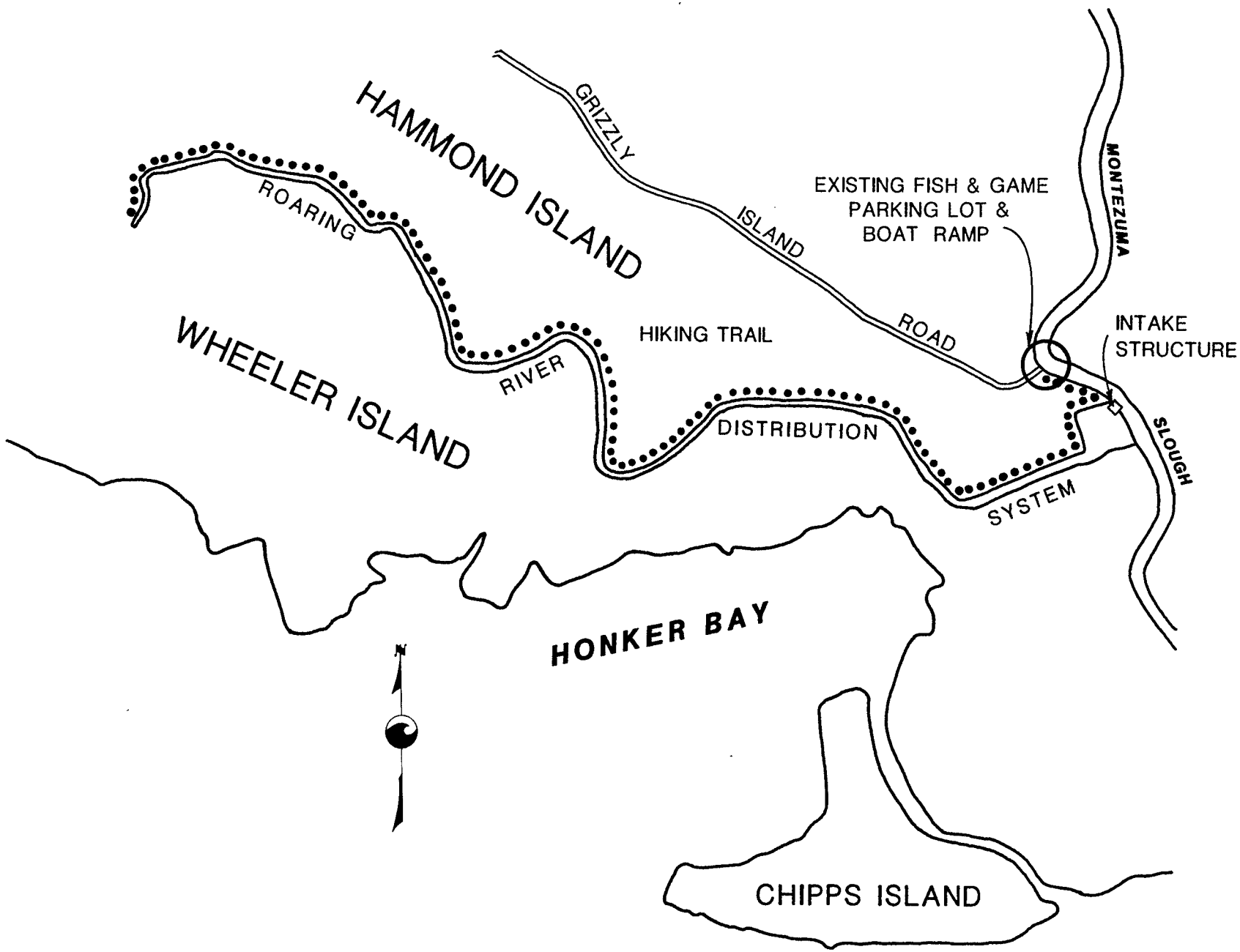


**FIGURE 4**
**ROARING RIVER SLOUGH RECREATION DEVELOPMENT**

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along the north bank of Roaring River Slough. Limited parking is available at the existing Roaring River Control Structure (three to six cars), and limited fishing and carry-in boating can be supported by the pond. Portable sanitary facilities would be provided at the structure to serve hikers and anglers. The Department of Fish and Game would reserve the right to limit access to the trail, with closure probable from September 1 to January 31.

Boynton-Cordelia Ditch

The Boynton-Cordelia Ditch extends from enlarged Boynton Slough to Cordelia Slough, a distance of about 3.5 miles. The average channel width is about 170 feet and the average depth is about 12 feet. The ditch will transport an average of 205 cubic feet per second of good quality water around the northwest corner of the Marsh.

Travel time from Fairfield and Suisun City to the proposed site is about 10 minutes, and the Vacaville and Vallejo areas are within 30 minutes. Access to the 30-vehicle parking area at the south side of the proposed pond would be from a new access road, which would run along the south side of the ditch. This access road will begin at Chadbourne Road, which can be reached from either Interstate 80 or State Highway 12.

Figure 5 shows the proposed recreational development. The pond portion of the facilities would be the main attraction. Nonmotor boat launching would be provided, as well as portable toilets and trash receptacles. Fishing is expected to be good either from boat or from the bank of the pond. Barriers would be installed to restrict boating to the pond area. The pond will receive tertiary treated waste water diluted to a minimum of one to one with Boynton Slough water. The treated waste water meets all quality standards for body contact sports. It will not effect boating or fishing.

Grizzly Island Bridge Boat Ramp

This site is near the Grizzly Island Road Bridge, over Montezuma Slough, about a 20-minute travel time from Fairfield and Suisun City. No project facilities are to be built in this area. The proposed boat ramp at this site would serve as mitigation for any delays suffered by boaters at the Montezuma Slough Control Structure.

The site is already a popular fishing spot. An abandoned ferry slip has been used by the public for boat launching for some time. However, deterioration has made the slip unsafe. The proposed location of the ramp and 30 car parking area is shown on Figure 6.



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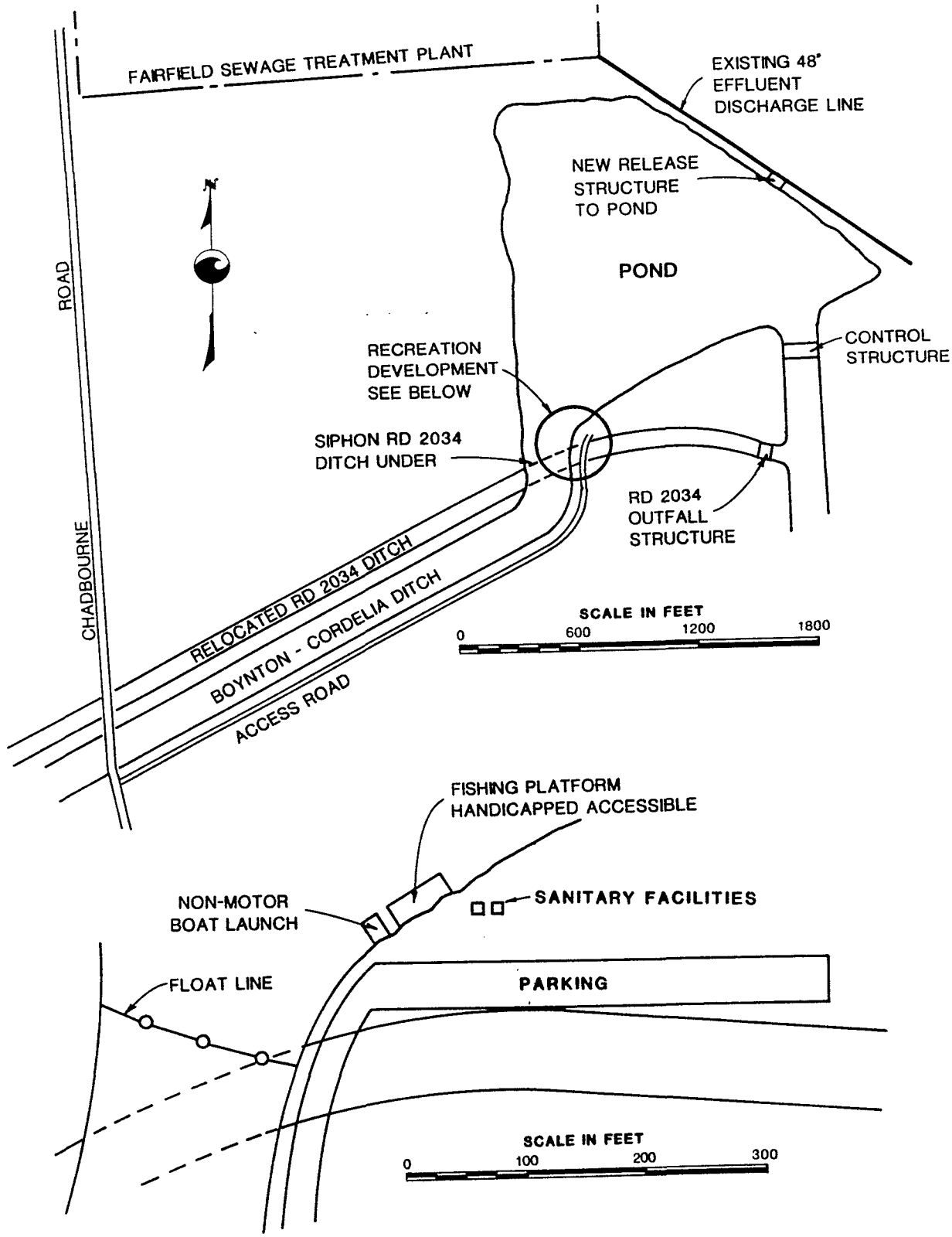


**FIGURE 5**
**BOYNTON – CORDELIA DITCH**
**RECREATION DEVELOPMENT**

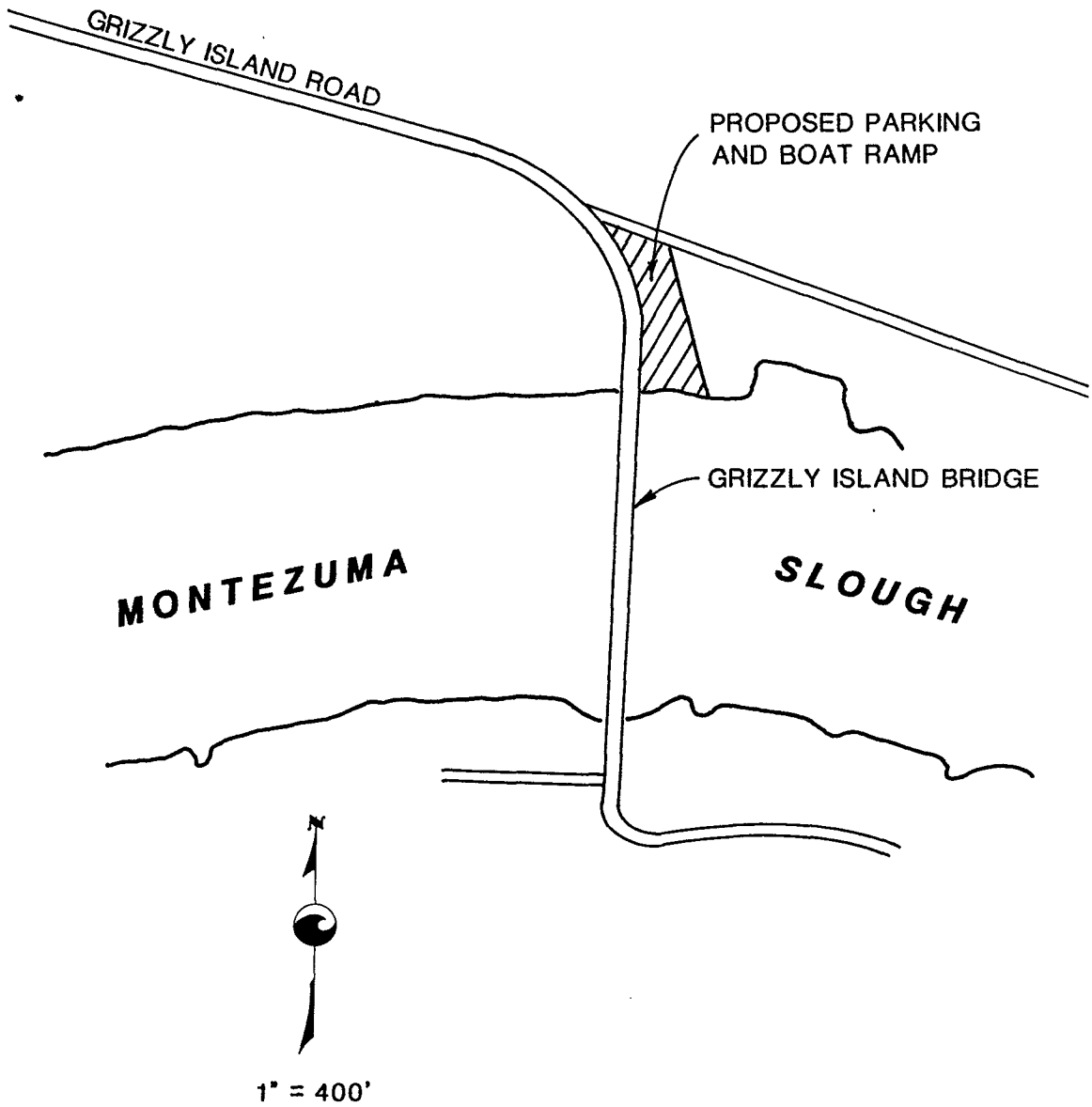


**FIGURE 6**
**GRIZZLY ISLAND BRIDGE BOAT RAMP**

## Cordelia-Goodyear Ditch

The Cordelia-Goodyear Ditch will extend for about 2.8 miles between Cordelia and Goodyear Sloughs along the western periphery of the Marsh. The ditch will be 9 feet deep, with a 42-foot bottom width and will tidally pump about 160 cubic feet per second of good quality water to the southwestern Marsh.

The recreation area would be located south of Pierce Lane, between the Southern Pacific Railroad and Interstate 680. The site is about 20 minutes travel time from Fairfield and Suisun City and from Benecia. Use is expected to be high at this site because of its proximity to population centers, its easy access, and its high visibility from Interstate 680. Pierce Harbor Marina is just across the Southern Pacific Railroad tracks from the proposed site, and this would also tend to increase usage.

The proposed development is shown on Figures 7 and 8. South of Pierce Harbor Road, the ditch would be widened into a pond, about 2,000 feet long and 500 feet wide. Excavated material would be placed in an irregular berm, varying from 150 to 500 feet wide. The berm would be planted with native vegetation. Near the northwest corner of the pond, a 40-car parking lot would be provided, with adjacent picnic and sanitary facilities. A fishing platform (handicapped accessible) and a nonmotorized boat launch area would also be included. Footbridges over the ditch would provide access to a perimeter trail for hiking and bank fishing. Float lines would be provided at all culverts.

## Grizzly Island Distribution System

The Grizzly Island Distribution System will extend about 6 miles through Grizzly Island from an intake structure on Montezuma Slough. A pond of about 100 acre-feet will be required for system storage. The total pond plus channel area will be 80 to 100 acres. The site is about 30 minutes travel time from the Fairfield and Suisun City area. Recreation usage is expected to be moderate.

Recreation facilities, as shown on Figure 9, would include a 20-space parking lot, picnic area, sanitary facilities, a handicapped accessible fishing platform, and nonmotorized boat launch ramp. Float lines would be provided at the inlet to the ditch. Fish screens at the intake might limit fishing use of the site.

## Potrero Hills Ditch

Potrero Hills Ditch will extend for about 3.5 miles between Hill and Luco Sloughs. Its function will be to move water from Luco Slough to the vicinity of Denverton Slough to the west. The top width will be about 190 feet, with a maximum depth of about 13 feet. Control structures on each end will allow an average flow of 340 cubic feet per second.

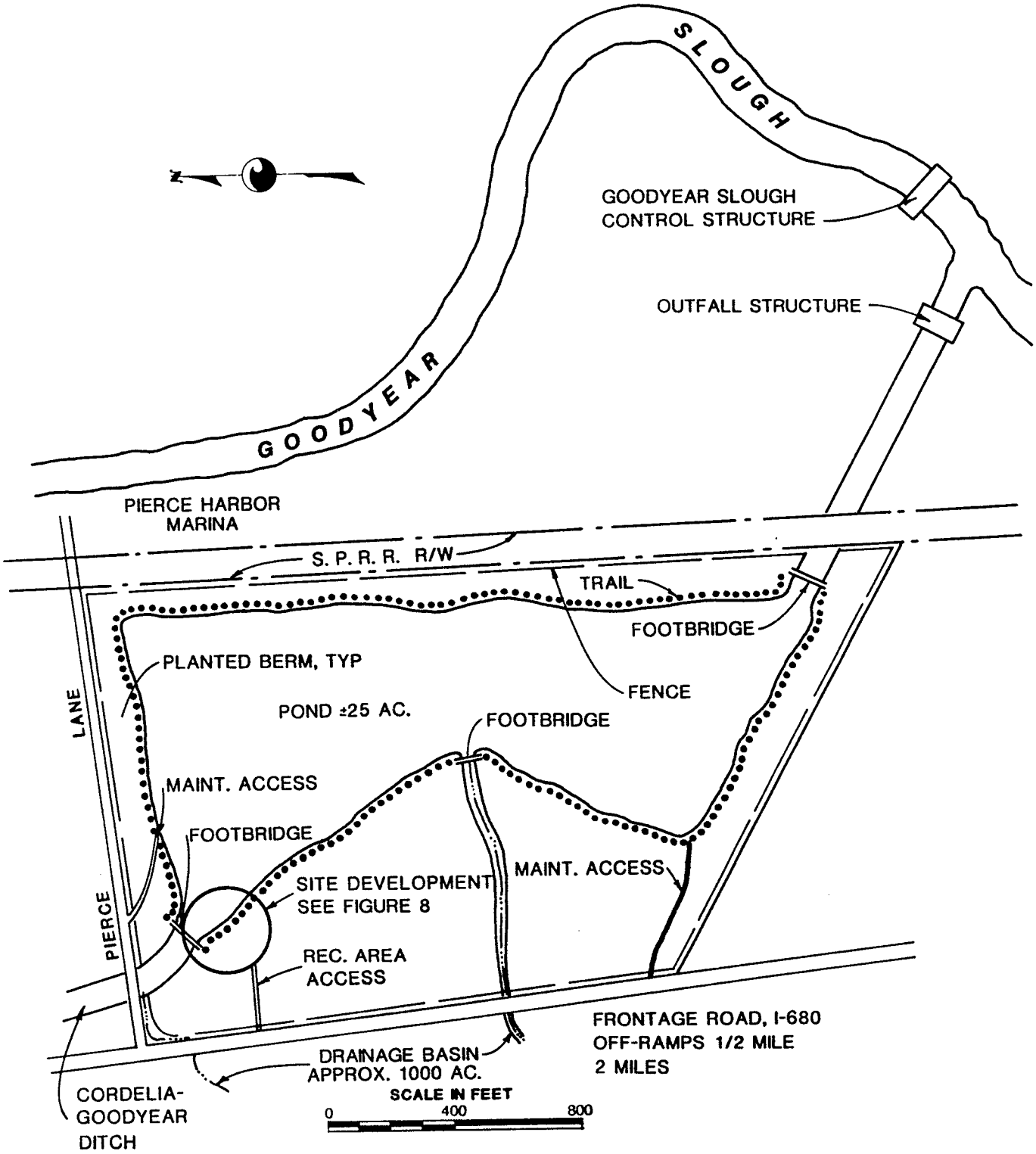


**FIGURE 7**
**CORDELIA - GOODYEAR DITCH**
**RECREATION DEVELOPMENT**

M-12

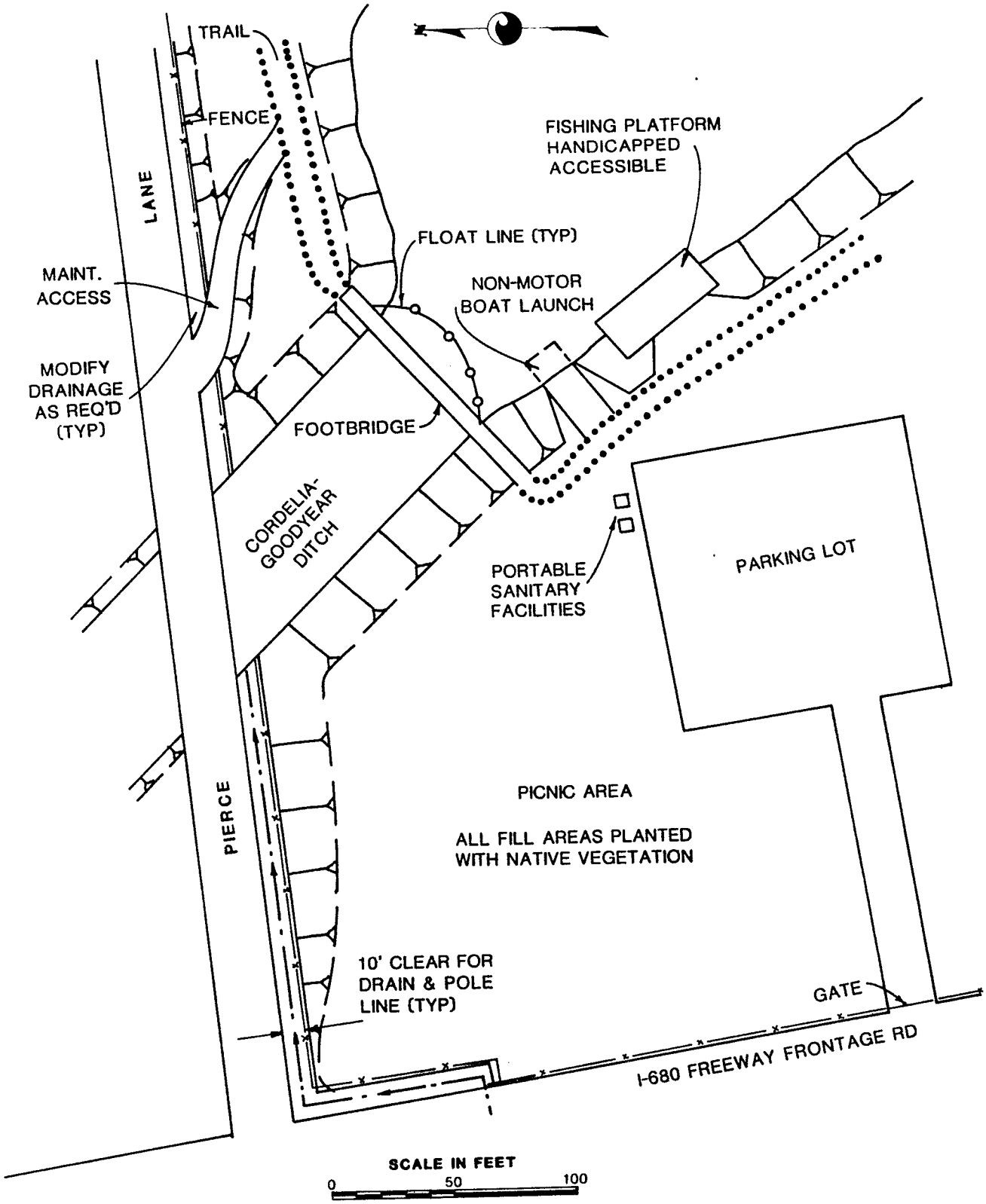


**FIGURE 8**
**CORDELIA - GOODYEAR DITCH**
**RECREATION DEVELOPMENT**

M-13

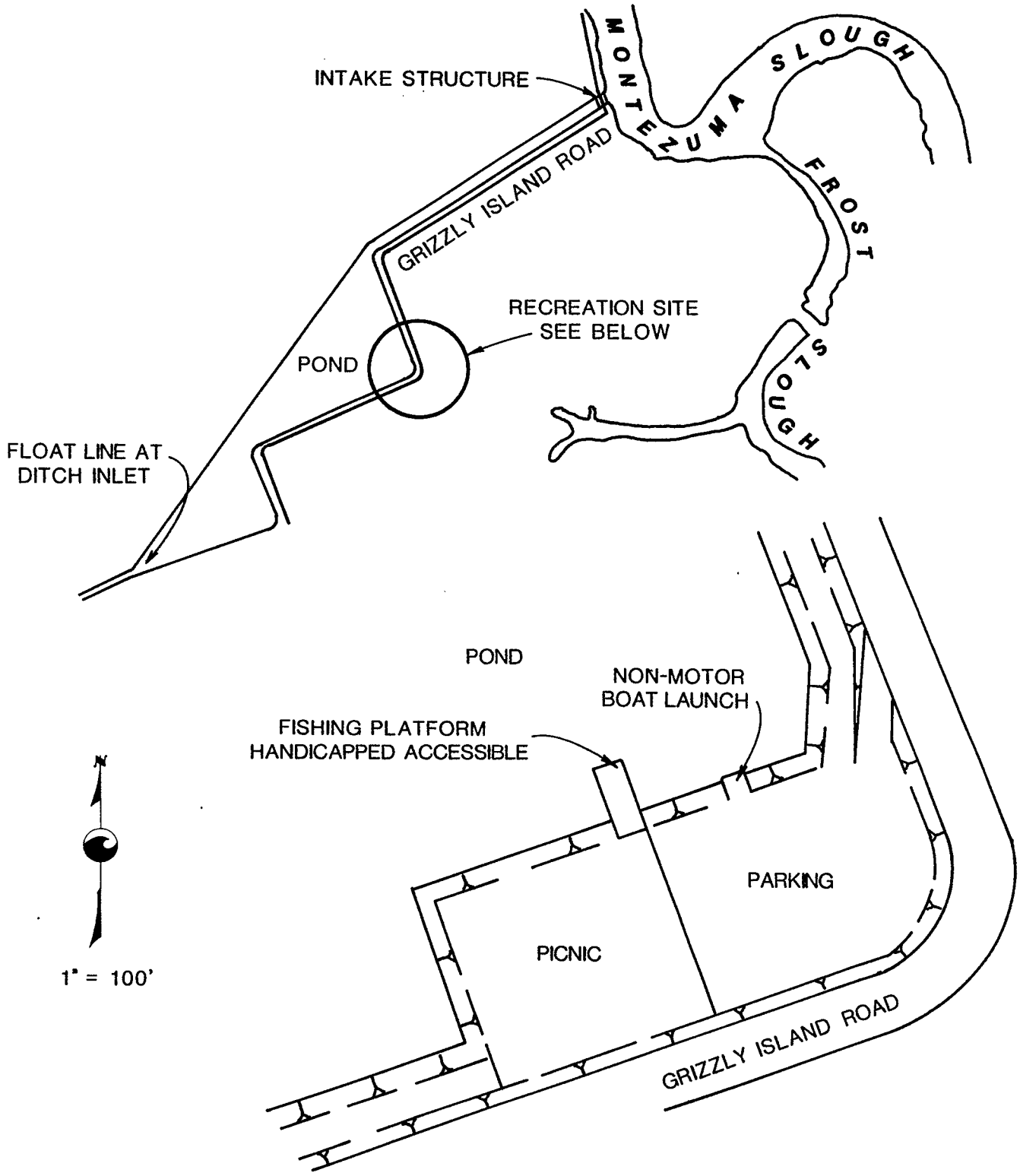


**FIGURE 9**
**GRIZZLY ISLAND DISTRIBUTION SYSTEM**
**RECREATION DEVELOPMENT**

The Potrero Hills Ditch recreation site would be about 10 minutes travel time east of Fairfield and Suisun City. The one-mile segment between Branscome and Scalley Roads is only about 1,500 feet south of Highway 12. It is expected that the site would have high use because of its visibility, easy access, and proximity to developed areas.

Two factors limit development of recreation ponds at this site. First, the pond width can be no greater than twice the channel width, or sedimentation will occur. Second, the channel section will be a deep excavation; widening the channel to establish pond areas would greatly increase excavation costs.

The plan shown on Figure 10 has been developed considering these restrictions. A pond would be excavated in the eastern portion of the curvilinear ditch, deep enough to provide a 3-foot minimum depth of water. The northern edge of the pond would be excavated to an irregular line to avoid the "channel" appearance, while remaining within the width constraint. A 25-car parking lot, nonmotorized boat launch, handicapped fishing platform, picnic area, and portable sanitary facilities would be provided off Branscome Road. Float lines would be provided at the culverts. The maintenance access road along the northern edge of the channel could be used as a 1-mile hiking trail.

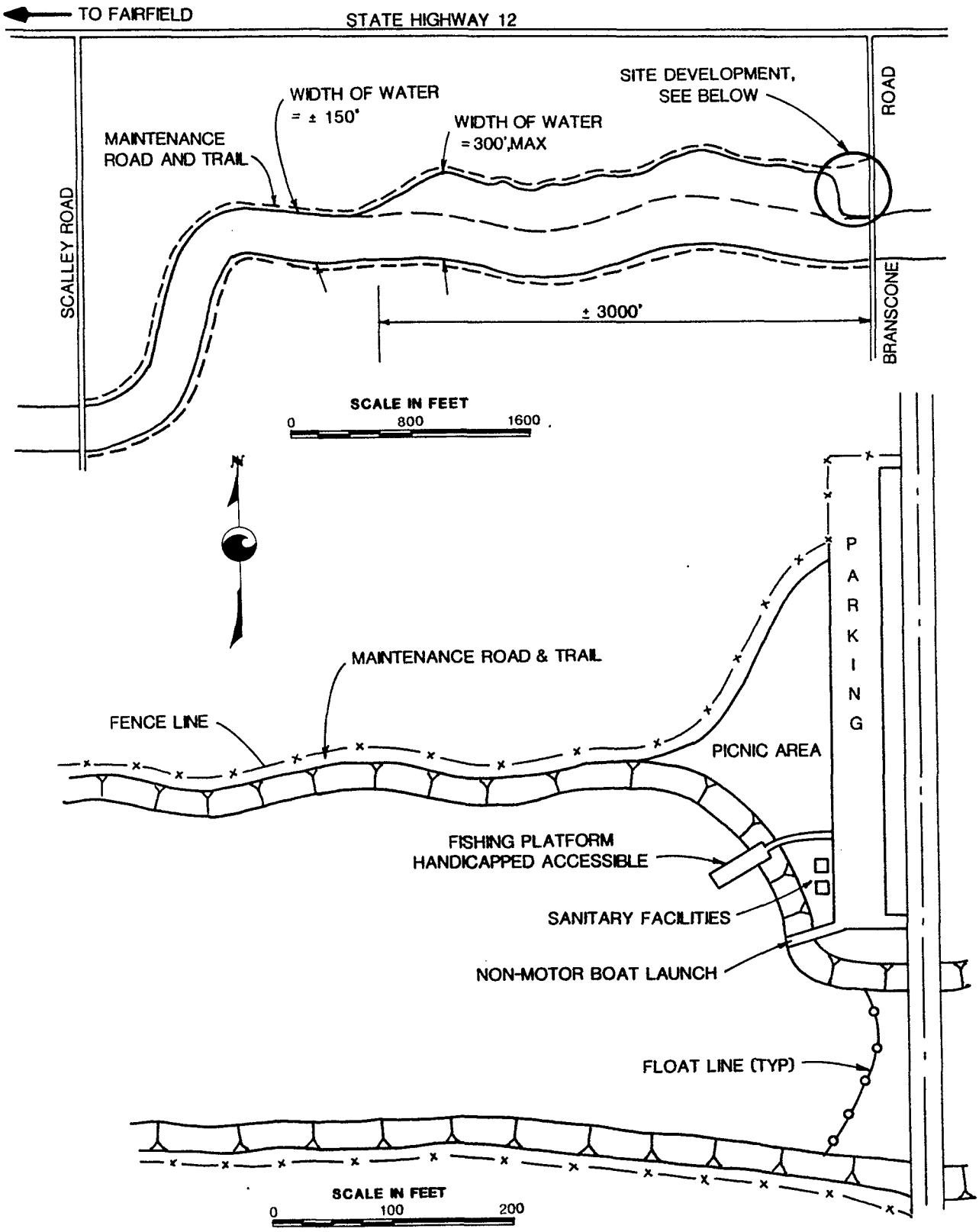


**FIGURE 10**
**POTRERO HILLS DITCH**
**RECREATION DEVELOPMENT**

# APPENDIX N



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Appendix N

FLORA OF THE SUISUN MARSH AREA

**Grasses**

| | |
|---|---|
| Soft chess | Bromus mollis |
| Ripgut | Bromus diandrus |
| Red brome | Bromus rubens |
| Foxtail fescue | Festuca megalura |
| Rat's-tail fescue | Festuca myuros |
| Tall fescue | Festuca arundinacea |
| Annual bluegrass | Poa annua |
| Kentucky bluegrass | Poa pratensis |
| Salt grass | Distichlis spicata |
| Orchard grass | Dactylis glomerata |
| Pampas grass | Cortaderia selloana |
| Common reed | Phragmites communis |
| Creeping wildrye | Elymus triticoides |
| Blue wildrye | Elymus glaucus |
| Meadow barley | Hordeum brachyantherum |
| Foxtail barley | Hordeum jubatum |
| Little barley | Hordeum pusillum |
| Mediterranean barley | Hordeum hystrix |
| Farmer's foxtail | Hordeum leporinum |
| Common barley | Hordeum vulgare |
| Perennial ryegrass | Lolium perenne |
| Italian ryegrass | Lolium multiflorum |
| Tufted hair grass | Desehampsia caespitosa |
| Wild oat | Avena fatua |



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**Grasses, Cont.**

| | |
|---|---|
| Water bent | *Agrostis semiverticillata* |
| Rabbit's-foot grass | *Polypogon monspeliensis* |
| Marsh timothy | *Heleochloa schoenoides* |
| Purple needlegrass | *Stipa pulchra* |
| Sprangletop | *Leptochloa fasicularis* |
| Bermuda grass | *Cynodon dactylon* |
| Gnawed canary grass | *Phalaris paradoxa* |
| Reed canary grass | *Phalaris arundinacea* |
| Harding grass | *Phalaris tuberosa* |
| Canary grass | *Phalaris minor* |
| Barnyard grass | *Echinochloa crusgalli* |
| Johnson grass | *Sorghum halepense* |



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**Trees and Shrubs**

| | |
|---|---|
| Silver saltbush | *Atriplex argentea* |
| Australian saltbush | *Atriplex semibaccata* |
| California blackberry | *Rubus ursinus* |
| California wild rose | *Rosa californica* |
| Toyon | *Heteromeles arbutifolia* |
| Valley oak | *Quercus lobata* |
| Fremont cottonwood | *Papulus fremontii* |
| Yellow willow | *Salix lasiandra* |
| Red willow | *Salix laevigata* |
| Sandbar willow | *Salix hindsiana* |
| Arroyo willow | *Salix lasiolepis* |
| Common fig | *Ficus carica* |
| Blue gum | *Eucalyptus globulus* |
| Lemon | *Citrus* sp. |
| Orange | *Citrus* sp. |
| Buttonbush | *Cephalanthus occidentalis* |
| Blue elderberry | *Sambucus caerulea* |
| Osage orange | *Maclura pomifera* |



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**Herbs and Forbs**

| | |
|---|---|
| Bracken fern | Pteridium aquilinum |
| California buttercup | Ranunculus californicus |
| Yerba mansa | Anemopsis californica |
| Bull mallow | Malva nicaeensis |
| Cheeseweed | Malva parviflora |
| Alkali-mallow | Sida hederacea |
| Common geranium | Geranium dissectum |
| Broad-leaved filaree | Erodium Botrys |
| White-stemmed filaree | Erodium moschatum |
| Red-stemmed filaree | Erodium cicutarium |
| Turkey-mullein | Eremocarpus setigerus |
| Frankenia | Frankenia grandifolia |
| Wild pansy | Viola pedunculata |
| California poppy | Eschscholzia californica |
| Hoary-cress | Cardaria draba |
| Peppergrass | Lepidum latifolium |
| Common peppergrass | Lepidum nitidum |
| Hedge mustard | Sisymbrium officinale |
| Field mustard | Brassica campestris |
| Black mustard | Brassica nigra |
| Wild radish | Raphanus sativus |
| Water-cress | Rorippa Nasturtium-aquaticum |
| Shepherd's-purse | Capsella Bursa-pastoris |
| Common chickweed | Stellaria media |
| Spurrey | Spergula arvensis |

**Herbs and Forbs Cont.**

| | |
|---|---|
| Sand-spurrey | Spergularia marina |
| Miner's lettuce | Montia perfoliata |
| Sea purslane | Sesuvium verrucosum |
| Willow dock | Rumex salicifolius |
| Curly dock | Rumex crispus |
| Fiddle dock | Rumex pulcher |
| Common knotweed | Polygonum aviculare |
| Silver-sheathed knotweed | Polygonum argyrocoleon |
| Willow weed | Polygonum lapathifolium |
| Lady's thumb | Polygonum persicaria |
| Water smartweed | Polygonum punctatum |
| Garden beet | Beta vulgaris |
| Mexican-tea | Chenopodium ambrosioides |
| Lamb's quarters | Chenopodium album |
| Goosefoot | Chenopodium murale |
| Fat hen | Atriplex patula |
| Five-hook bassia | Bassia hyssopifolia |
| Pickleweed | Salicornia subterminalis |
| Russian thistle | Salsola kali |
| Rough pigweed | Amaranthus retroflexus |
| Tumbleweed | Amaranthus albus |
| Common plantain | Plantago major |
| English plantain | Plantago lanceolata |
| Annual plantain | Plantago hookeriana |
| Indian hemp | Apocynum cannabinum |



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**Herbs and Forbs Cont.**

| | |
|---|---|
| Alkali weed | *Cressa truxillensis* |
| Hedge bindweed | *Convolvulus sepium* |
| Bindweed | *Convolvulus arvensis* |
| Saltmarsh dodder | *Cuscuta salina* |
| Heliotrope | *Heliotropium curassavicum* |
| Popcorn flower | *Plagiobothrys bracteatus* |
| Nightshade | *Solanum nodiflorum* |
| Monkey-flower | *Mimulus guttatus* |
| Common mullein | *Verbascum thapsus* |
| Figwort | *Scrophularia californica* |
| Bellardia | *Bellardia trixago* |
| Garden lippia | *Lippia nodiflora* |
| Horehound | *Marrubium vulgare* |
| Hedge-nettle | *Stachys rigidia* |
| Water-horehound | *Lycopus lucidus* |
| Tule-mint | *Mentha arvensis* |
| Silverweed | *Potentilla anserina* |
| Lupine | *Lupinus densiflorus* |
| Annual lupine | *Lupinus bicolor* |
| Alfalfa | *Medicago sativa* |
| Bur-clover | *Medicago hispida* |
| White sweet-clover | *Melilotus albus* |
| Yellow sweet-clover | *Melilotus indicus* |
| Red clover | *Trifolium pratense* |
| Clover | *Trifolium* sp. |
| Bird's foot trefoil | *Lotus corniculatus* |

**Herbs and Forbs Cont.**

| | |
|---|---|
| Wild licorice | *Glycyrrhiza lepidota* |
| Sweetpea | *Lathyrus jepsonii* |
| American vetch | *Vicia americana* |
| Spring vetch | *Vicia sativa* |
| Stinging nettle | *Urtica holosericea* |
| Dwarf nettle | *Urtica urens* |
| Common loosestrife | *Lythrum californicum* |
| Willow-herb | *Epilobium paniculatum* |
| Boisduvalia | *Boisduvalia glabella* |
| Mistletoe | *Phoradendron flavescens* |
| Marsh pennywort | *Hydrocotyle verticillata* |
| Gambleweed | *Sanicula crassicaulis* |
| Purple sanicle | *Sanicula bipinnatifida* |
| Bur-chervil | *Anthriscus scandicina* |
| Rattlesnake weed | *Daucus pusillus* |
| Celery | *Apium graveolens* |
| Poison-hemlock | *Conium maculatum* |
| Water-hemlock | *Cicuta bolanderi* |
| Sweet fennel | *Foeniculum vulgare* |
| Hog fennel | *Lomatium* sp. |
| Cow-parsnip | *Heracleum lanatum* |
| Bee thistle | *Eryngium articulatum* |
| Coyote thistle | *Eryngium vaseyi* |
| Fuller's teasel | *Dipsacus fullonum* |
| Wild cucumber | *Marah watsonii* |

**Herbs and Forbs Cont.**

| | |
|---|---|
| Mule-ears | *Wyethia angustifolia* |
| Common sunflower | *Helianthus annuus* |
| California sunflower | *Helianthus californicus* |
| Poverty weed | *Iva axillaris* |
| Western ragweed | *Ambrosia psilostachya* |
| Spiny clotbur | *Xanthium spinosum* |
| Cocklebur | *Xanthium strumarium* |
| Blow-wives | *Achyrachaena mollis* |
| Fitch's spikeweed | *Hemizonia fitchii* |
| Jaumea | *Jaumea carnosa* |
| Sneezeweed | *Helenium bigelovii* |
| Goldfields | *Baeria chrysostoma* |
| Marsh grindelia | *Grindelia humilis* |
| Gum-plant | *Grindelia camporum* |
| Matchweed | *Gutierrezia californica* |
| Western goldenrod | *Solidago occidentalis* |
| Common aster | *Aster chilensis* |
| Slender aster | *Aster exilis* |
| Horseweed | *Conyza canadensis* |
| Douglas baccharis | *Baccharis douglasii* |
| Mule fat | *Baccharis viminea* |
| Coyote brush | *Baccharis pilularis* |
| Mayweed | *Anthemis cotula* |
| Yarrow | *Achillea borealis* |
| Pineapple weed | *Matricaria matricarioides* |
| Brass-buttons | *Cotula coronopifolia* |



C—054144

C-054144

**Herbs and Forbs Cont.**

| | |
|---|---|
| California sagebrush | *Artemisia californica* |
| Mugwort | *Artemisia douglasiana* |
| Marsh groundsel | *Senecio hydrophilus* |
| Common groundsel | *Senecio vulgaris* |
| Marsh-fleabane | *Pluchea purpurascens* |
| Cotton-batting plant | *Gnaphalium chilense* |
| Milk thistle | *Silybum marianum* |
| Cardoon | *Cynara cardunculus* |
| Bull thistle | *Cirsium vulgare* |
| Suisun thistle | *Cirsium hydrophilum* |
| Italian thistle | *Carduus pycnocephalus* |
| Purple star thistle | *Centaurea calcitrapa* |
| Yellow star thistle | *Centaurea solstitialis* |
| Chicory | *Cichorium intybus* |
| Mountain dandelion | *Agoseris grandiflora* |
| Salisfy | *Tragopogon porrifolius* |
| Smooth cat's ear | *Hypochoeris glabra* |
| Bristly oxtongue | *Picris echioides* |
| Sow thistle | *Sonchus oleraceus* |
| Prickly lettuce | *Lactuca serriola* |
| Common dandelion | *Taraxacum officinale* |
| Sago pondweed | *Potamogeton pectinatus* |
| Slender pondweed | *Potamogeton pusillus* |
| Ditch-grass | *Ruppia cirrhosa* |
| Arrow-grass | *Triglochin striata* |

**Herbs and Forbs Cont.**

| | |
|---|---|
| Common arrow-grass | *Triglochin maritima* |
| Horned pondweed | *Zannichellia palustris* |
| Soap plant | *Chlorogalum pomeridianum* |
| Garden asparagus | *Asparagus officinalis* |
| White mariposa lily | *Calochortus venustus* |
| Duckweed | *Lemna minor* |
| Narrow leaf cattail | *Typha angustifolia* |
| Blue flag cattail | *Typha glauca* |
| Cattail | *Typha domingensis* |
| Common cattail | *Typha latifolia* |
| White brodiaea | *Brodiaea hyacinthina* |
| Harvest brodiaea | *Brodiaea elegans* |
| Baltic rush | *Juncus balticus* |
| Alkali bulrush | *Scirpus robustus* |
| Olney bulrush | *Scirpus olneyi* |
| Slender club-rush | *Scirpus cernuus* |
| Hardstem bulrush | *Scirpus acutus* |
| California bulrush | *Scirpus californicus* |
| River bulrush | *Scirpus fluviatilis* |
| Slender spike-rush | *Heleocharis acicularis* |
| Nut-grass | *Cyperus eragrostis* |
| Umbrella sedge | *Cyperus difformis* |
| Sedge | *Carex* sp. |

# APPENDIX O

# INTRODUCTION

The Plan of Protection and Draft Environmental Impact Report were released for public review on September 23, 1980, followed by a public hearing on November 24, 1980. Many parties commented extensively. Eighteen parties have submitted extensive oral and written comments. The commenting parties represent a broad spectrum of interests in the Suisun Marsh and its waterways.

In compliance with State and Federal requirements, these comments and responses by the Department of Water Resources are contained in this appendix. Where appropriate, these concerns have been incorporated into the Plan and Final EIR.

Agencies, Groups, and Individuals
Submitting Comments

| | Abbreviation |
|---|---|
| State Water Contractors Audit Committee | SWCAC |
| Sierra Club | Sierra |
| U. S. Coast Guard | USCG |
| Pacific Interclub Yacht Association | PYA |
| Solano County | SC |
| Kern County Water Agency | KCWA |
| U. S. Department of the Interior<br>U. S. Bureau of Reclamation | USBR |
| San Francisco Bay Regional Water<br>Quality Control Board | SFRWQCB |
| Pacific Gas and Electric Company | PGandE |
| Suisun Resources Conservation District<br>(Coon) | SRCD Coon |
| Suisun Resources Conservation District<br>(Chapin) | SRCD Chapin |
| Department of Fish and Game<br>(George) | DFG George |
| Department of the Army | USCE |
| National Marine Fisheries Service | NMFS |
| San Francisco Bay Conservation and<br>Development Commission | BCDC |
| State Water Resources Control Board | SWRCB |
| Department of Fish and Game | DFG |
| State Lands Commission | SL |



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Comment: Enhancement to fish and wildlife resulting from this program and other facilities of the State Water Project should be fully reflected in the project purpose cost allocation, this enhancement being the substantial increase of fish and wildlife use of project facilities where none existed prior to construction. (SWCAC)

Response: The Plan of Protection for Suisun Marsh deals exclusively with the effects that water exportation by the Central Valley Project (CVP) and State Water Project (SWP) have on the Marsh now and will have in the future. Because the CVP and SWP are two of the largest diverters and exporters, they will have an increasingly significant and unavoidable impact on the viability of the Marsh as a brackish water habitat area. This impact must be mitigated if feasible.

The beneficial effects of the increase in waterfowl and fish at project facilities have already been used to offset the environmental impacts of the SWP and cannot be applied in Suisun Marsh.

Comment: Of the Suisun Marsh area, 74 percent is in private ownership and not accessible to the public. Any enhancement of the conditions on these lands must be taken into account in the cost allocation process and not charged against the State water contractors. (SWCAC)

Response: State Water Resources Control Board Decision 1485 set specific water quality standards for the Marsh to maintain its brackish water nature. This Plan of Protection was prepared in response to that decision. Its intent was to further compliance with that decision, not to enhance the Marsh or to reevaluate Decision 1485. No enhancements of private ownerships have yet been identified.

Comment: The Project is purportedly required because a diminution of flow of quality water has been caused by diversions of the CVP and SWP and others. The diversion by others includes East Bay Municipal Utility District (EBMUD), City of San Francisco, other Northern California cities, and irrigators in the Sacramento and San Joaquin valleys. The exact relationship is not susceptible to evaluation but a portion of the Project should be allocated to these others as well as the SWP. (SWCAC)

Response: The project is required to mitigate the impact of the CVP and SWP on Suisun Marsh as ordered by SWRCB Decision 1485. In preparing Decision 1485, the SWRCB determined that the out-of-basin diversions by others are small compared to those of the CVP and SWP and if the CVP and SWP were not diverting, the Marsh would receive water of an adequate quality to meet Decision 1485. The SWRCB has indicated that if additional protection for the Marsh is required beyond that furnished by mitigating the impact of the CVP and SWP, it will re-evaluate the need for requiring mitigation by other out-of-basin diverters.

With regard to in-basin diverters, a large part of the water diverted upstream from the Marsh is used by irrigators with water rights senior to those of the CVP and SWP.

The Plan of Protection is not intended to recreate the Marsh conditions that existed before any diversions. It is intended to mitigate only the impact of the CVP and SWP. As such, it is believed to be appropriate to allocate the costs of mitigating impacts of the projects to the CVP and the SWP.

Comment: The expenditures and operating costs for the Suisun Marsh fish screens are high when compared to the limited number of fish affected. (KCWA)

Response: The California Fish and Game Code, Article 5, Section 6100, requires that new diversions of water from streams with populations of salmon and steelhead be screened if the effects of the new diversion will have a deleterious impact. This is believed to be the case in some of the proposed facilities. The expenditures and operating costs for fish screens will be a project expense to mitigate for potential impacts on fish in the Marsh.

Comment: The Goodyear Slough control structure will impose a permanent barrier to navigation for approximately 4 miles. (USCG)

Response: Goodyear is a dead-end slough. At low tide, the waterway at the blocked end tapers to less than 10 feet wide and 2 feet deep. Blocking the last 3 miles would impose very little hindrance to navigation. The present use, local hunting and fishing, should continue.

Comment: The Montezuma Slough water control structure will pose a significant hindrance to navigation, restricting access to more than 22 miles of waterway. (USCG, PYA, SC)

Response: The greatest use of Montezuma Slough by watercraft occurs in the May to September season when the gates and

flashboard will be open continuously, allowing all watercraft easy access to the slough. When the control structure is operating, there will be no restriction of access to Montezuma Slough, only a hindrance. The hindrance will be greatest in dry and critical years, when the structure will be operated nearly 100 percent of the time from September to May. An average of about 20 boats per day could be delayed for a maximum of 30 minutes. In wet years, the structure is operated an average of 10 percent of the time, and an average of 4 boats per day could be delayed. Boats subject to the delay include all craft from small skiffs to large motor craft.

Comment: The lock size is smaller than recommended in our letter of April 3, 1980 (copy enclosed). We recommend that the length be increased to 70 feet. (USCG, PYA)

Response: The boat lock will be a minimum of 20 by 70 feet. A flashboard opening 60 feet wide will accommodate dredges, barges, and pleasure boats when the structure is open. When the structure is operating, the flashboard can be removed in an emergency to allow dredges and barges to pass.

Comment: The method of operation, although not in detail in the DEIR, appears reasonable. Will the lock be manned during hours of operation (except when standing open)? Will there be a radio-telephone installed? (USCG)

Response: The boat locks on the Montezuma Slough Control Structure will include facilities for operating the gates when the structure is tidally pumping. These facilities include those for an operator to control the gates and also radio-telephone installations for operation of the gates from the Delta Field Division offices, including television monitors.

Comment: We still believe that the appropriate mitigation for the waterway obstructions is the elimination of another State-owned obstacle to navigation, the Grizzly Island Bridge. A short drawbridge, perhaps even one operated by passing watercraft, could be installed in the existing bridge. This would improve waterway access for some vessels and could offset the effects of the water control structures. (USCG, PYA)

Response: There will be no obstruction of Montezuma Slough by the presence of the control structure, only a hindrance when the structure is operating. The Department of Water Resources (DWR) and U. S. Bureau of Reclamation (USBR) believe the expenditure of about $3 million to convert the existing Grizzly Island

Bridge into a draw or lift bridge, or about $6 million to build a new bridge is not appropriate mitigation and is not economically justified.

The greatest use of the slough by watercraft will be in May through September, when the gates and flashboard will be open continuously. The boats that would benefit from converting the Grizzly Island Bridge into a lift span would be tall-masted sailboats and large motorcraft that need more than a 21-foot clearance and that do not now use the full 22 miles of the slough.

Providing a substantial enhancement, such as modifying the Grizzly Island Bridge for this class of watercraft, is not justifiable mitigation for the impact of the control structure, because most of the watercraft that would be subject to delay at the structure are not limited by the existing bridge. These modifications to the bridge would also create substantial adverse impacts on another class of travelers; each day, about 100 vehicles would be subjected to a time delay while the span was open.

Building a boat ramp at the Grizzly Island Bridge on Montezuma Slough would benefit a large percentage of watercraft subject to delays at the Control Structure. DWR suggests this would be appropriate mitigation.

> Comment: There is a major emphasis on monitoring all aspects of the project and continually evaluating its performance, which is valuable in assuring the optimum performance of the system, but the report gives the impression that it is not really known how well it will work. It seems critical to Solano County that the performance of the project be assured and the impacts thoroughly addressed prior to spending millions of dollars and adversely impacting that much valuable habitat. (SC)

Response: Condition 7(a), of Decision 1485 (page 26, Appendix C, of the Plan of Protection) ordered that a monitoring network be installed that is satisfactory to the SWRCB. San Francisco Bay Conservation and Development Commission (BCDC) Permit No. 35-78 also requires monitoring as the project or plan is being implemented. It is also critical to DWR to know that the project will work and will keep the Marsh as an environmentally sound brackish water marsh capable of providing habitat for waterfowl, upland game, and fish.

DWR is proposing to stage the construction of facilities, with a period of testing between construction of the various facilities. Staging will allow DWR to test and adjust the

proposed design of the marsh facilities and to build only those facilities that are needed, so that the system constructed will be appropriate to serve the needs of the Marsh with a minimum adverse impact.

The plan is based on a mathematical model that accurately describes existing flows and salinity levels in the Marsh. There cannot be certainty that model predictions will be entirely accurate. Monitoring and staging are necessary to allow adjustments in proposed facilities and operations to avoid adverse effects or unnecessary expenditures if conditions are slightly different than those predicted.

Comment: A major concern is the adverse impact on our local road system by heavy equipment during construction. (SC)

Response: DWR will contract with Solano County for the repair of damage caused by heavy construction equipment on the fragile road system in the Marsh. Roads requiring relocation due to project construction will be rebuilt to meet county requirements, in so far as possible giving consideration to the construction methods used and foundation conditions within the Marsh.

Comment: An area of concern deals with the dredging and removal of natural materials and the disposal of the excess spoil material. (SC, BCDC, Sierra)

Response: Where economically justified and feasible, the dredged material will be used for building levees, filling low ponds and adjusting the bottoms of duck club ponds, and (by club owners through Suisun Resource Conservation District (SRCD)), repairing exterior levees, if arrangements are made prior to construction. The material can also be disposed of in the U. S. Army Corps of Engineers' disposal site off Carquinez Strait, which is now used for this purpose. The manner by which the material will be disposed of is unknown, because the method of disposal will normally be up to the contractor, subject to the approval of BCDC, Solano County, USCE, and other regulatory agencies. Methods will be suggested for the contractor's consideration.

DWR believes there will be no significant effect on the environment when dredge spoil is disposed of in a manner approved by all relevant regulatory agencies. The same assumption is reflected in the categorical exemption in the State CEQA Guidelines, 14 Cal. Admin. Code, Section 15101, which exempts maintenance dredging where spoil is disposed of in a manner approved by all relevant regulatory agencies.

Comment: The County is further concerned that the DEIR does not adequately address the problems of noise and

dust pollution, increased sedimentation and turbidity, sources of borrow materials, and the location of "staging areas" for storage of materials and equipment. (SC)

Response: As with all heavy construction, there will be noise. The Draft EIR stated "...as the area is not close to populated areas there should be no problem". Contracts for construction of the facilities will be staged and, because the locations of facilities are widespread, the noise level within the Marsh will be low. The intensity of noise at the actual construction sites will be below the harmful level. Dust control will be required by standard contracts. Water trucks will be used to keep dust from being a problem.

Sedimentation and turbidity in the work area will be of short duration and will be relatively minor.

Sources of borrow material will be at sites that meet with the approval of Solano County and other regulatory agencies.

Lands already modified for vehicular use, both inside and outside the Marsh, will be used as staging areas to avoid additional environmental impact and to comply with the EIR.

Comment: The report should also indicate what type of governmental permits are necessary and what guidelines must be followed. (SC)

Response: Permits required for the Marsh project have been identified (see Chapter 8).

Comment: The Suisun Marsh Preservation Act and Protection Plan as well as the county's local component of the Suisun Marsh Local Protection Program specifically require certain types of construction techniques and provisions for under-grounding of utilities which must be incorporated in the project. (SC)

Response: DWR will include the techniques and provisions on the plans and in the construction contract, where appropriate (county requirements).

Comment: The project would result in a significant loss of habitat and would create several major barriers to wildlife movement in the Marsh. (SC, BCDC)

Response: The conversion of wetland habitat will be a significant effect on the environment. The project plans include mitigation measures to lessen the impacts. Staging the implementation of the plan may reduce the total amount of habitat converted. Further, staging will allow disturbed areas

to recover before additional areas are disturbed. Live trapping and moving salt marsh harvest mice from the affected areas will minimize the impacts on the mouse. The creation of raised banks and levees will provide marsh animals places of refuge when high spring tides inundate the rest of the Marsh. The plan includes a discussion of mitigation for this effect.

While it is true that construction of the new ditches would create aquatic barriers to the free movement of land-dependent animals, no significant adverse effects on animal or plant communities are expected for several reasons. First, no known migration trails cross the ditch alignment, probably because the area is dominated by resident, rather than migratory, animals. Second, the ditches will not represent a barrier to many plants and animals, such as birds, swimming mammals, insects, and wind-borne seeds. Third, bridges with fill approaches are planned for road crossings. The wide road shoulders will undoubtedly be used as animal pathways.

Open channels have considerable wildlife value, especially when compared to grasslands or agricultural areas. The edge effect and diversity of wildlife species that prefer water areas and riparian channel banks far outweigh any adverse impacts expected.

Comment: The project could result in a loss of fish and wildlife, to an unknown extent. The increased flows within some waterways could also result in the loss of Neomysis shrimp, which is the major food source of striped bass. (SC)

Response: Impacts of the project on fish and wildlife are recognized. The extent of impacts on wildlife from project construction can be estimated by documenting the loss of habitat. The most significant loss would be the wetland habitat removed by the project. To the extent DWR finds feasible, new wetland habitat will be developed to compensate for this loss in accordance with the recommendations of the U. S. Fish and Wildlife Service (USFWS). By the nature of the Plan of Protection, numerous wildlife species will not be lost, but will, instead, benefit from the resulting maintenance of Suisun Marsh as a highly productive brackish water marsh.

Impacts on fish have also been identified by Department of Fish and Game (DFG) staff. Measures proposed in the Plan of Protection will mitigate these impacts. The proposed screening of Grizzly Island Ditch and other facilities as required is an example of steps to reduce fish impacts. Because existing diversions are not now screened, DWR expects that installing screens will result in a net benefit to fish populations. Studies have not identified any significant impacts on Neomysis shrimp within Suisun Marsh waterways as a result of the Plan of Protection (Alan Baracco, DFG, October 1980).

Comment: We do not feel that the proposed plan adequately evaluates the option of the use of increased water releases ("nonstructural") to safeguard the water quality of the Suisun Marsh. We do not agree that such releases cannot be construed "a reasonable and beneficial use of water" as the Department of Water Resources (DWR) contends (see P. I-8). Consistently, the intent of water use for "reasonable and beneficial" purposes has been interpreted to include protection of ecological and environmental values. (Sierra, NMFS)

Response: The State Constitution (Article 10, Section 2) says "...that the water resources of the State be put to beneficial use to the fullest extent of which they are capable" and that unreasonable use and unreasonable diversion be prevented.

In its "Water Quality Control Plan for the Sacramento-San Joaquin Delta and Suisun Marsh", adopted in August 1978, the State Water Resources Control Board states on page VI-11:

> "Full protection of the Marsh solely with outflow could require in excess of 2 million acre-feet (in terms of project yield) in addition to that outflow required to meet the interim Marsh standards (RT Vol. XXII, p. 101). This would result in a one-third reduction in combined SWP and CVP exportable yield from existing facilities. The Bureau, the Department, Fish and Game, and the U. S. Fish and Wildlife Service are working to develop supplemental water supplies for the marsh. Such supplemental supplies are a more desirable method for protecting the marsh and mitigating the adverse impacts of the CVP and SWP on this extremely valuable resource."

To meet Decision 1485 criteria for water quality in the interior Marsh during a critically dry year, supplemental water would have to be increased to about 4.8 million acre-feet per year. The amount of supplemental water would vary between 2.6 and 4.8 million acre-feet during wet and critically dry years, respectively, with an average of about 3.7 million acre-feet. This would be in addition to the outflow required to meet fish, agricultural, and municipal and industrial Delta standards. The 4.8 million acre-feet would be made up of 2 million acre-feet of project yield with the balance being uncontrolled outflow. Without facilities, developing this volume of yield would require construction of new dams, with the associated construction impacts. Another alternative for obtaining this amount of water would be for CVP and SWP to decrease exports from the Delta to the San Joaquin Valley. This would result in a potential loss of 300,000 to 500,000 acres of agricultural production or an increase in ground water overdraft in both the San Joaquin Valley and Southern California. These impacts are discussed on a much

smaller scale for a decrease in deliveries to the San Luis Unit in the "Special Task Force Report on San Luis Unit", prepared under Public Law 94-46, and "Draft Supplement to the Final Environmental Statement, San Luis Unit (DES 79-50, July 30, 1979). Given the high cost of developing more water to provide increased outflows and the high costs to current water users of curtailing water deliveries to provide increased outflows from existing water supplies, it would appear that protecting the Marsh with increased outflows alone would be an unreasonable use of water. The approach seems even more unreasonable when compared with the much lower dollar cost and the much lower increment to Delta outflows involved in the Combination Plan proposed by the Department.

> Comment: We ask if a "middle ground" solution to Suisun Marsh water quality problems cannot be reached by increasing water releases above those advocated by the Plan, but also providing some structural facilities to increase the "efficiency" of such releases. If feasible, such a solution should be evaluated.
>
> Further, water releases must be seen in the context of benefit downstream, e.g., flushing flows for San Francisco Bay.
>
> We urge that the value of increasing water releases be evaluated by the final plan in more detail. (Sierra)

Response: Decision 1485 requires the State Water Project to provide water for the protection of agriculture, fish, and municipal and industrial uses, plus water necessary to protect the Marsh. DWR studies show that during dry and critical years, the Combination Plan outlined in the Plan of Protection represents the most efficient use of water and facilities that complies with the State Constitution (Article 10, Section 2). During most normal and all wet years, the amount of good quality water available will be more than 10,000 to 15,000 cubic feet per second, which is sufficient to maintain acceptable water quality throughout the Marsh and to benefit downstream users.

The SWRCB found in D1485 that the only feasible way to achieve the desired water qualities in the Marsh without unreasonable use of water was with a combination of physical facilities and outflow. The operation of Montezuma Slough Control Structure, the first of the facilities proposed for construction, is predicted by the mathematical model to provide more than 75% of the benefits of the project. It is the one facility that will increase the "efficiency" of the releases made to serve the Marsh. To assure that only the facilities needed to achieve the water quality standards are constructed, staging was introduced into the Plan of Protection. The potential for a middle-ground solution to Suisun Marsh water quality problems is expected to be explored during the staging and testing period before construction of further facilities.

The impacts of Decision 1485 standards on flushing flows for San Francisco Bay was discussed in the EIR prepared to support Decision 1485. In that document it was concluded that Decision 1485 standards have negligible impact on the occurrence of flushing flows in San Francisco Bay. The relaxations to Decision 1485 standards proposed in this Plan are also expected to have negligible impacts on flushing flows in the dry and critical years when they apply. The Plan of Protection is proposed as a solution to the problems of Suisun Marsh. Solving the water quality problems of San Francisco Bay is beyond the scope of this proposal.

Comment: Will the Structural (Combination) Plan, if implemented, provide improved water quality in Suisun Marsh? Aside from the use of the Army Corps of Engineers' Bay Model, is there data and/or examples of reasonable success? Are the preliminary structural facilities operating as per expectations? Are there examples of similar structures elsewhere. (Sierra)

Response: The Combination Plan, when completed and operational, will improve water quality to the Suisun Marsh by tidally pumping better quality water from the Sacramento River at Collinsville during dry and critical years.

The Suisun Marsh mathmatical model accurately describes existing flows and water quality conditions within Suisun Marsh. Because the ability of the model to predict future conditions has not yet been proven, the model was developed using conservative assumptions where a change in the flows could result in a range of possible effects. The mathmatical model assumes that the result will occur toward the lower end of the range of the possible effects. Accordingly, actual results of the changes proposed in Suisun Marsh may be far more beneficial than those predicted by the mathmatical model. The staging and monitoring proposed in the plan will allow the Department time to compare predicted results against actual results. DWR believes there is a high degree of certainty that the results will be at least as beneficial as those predicted by the model. The initial facilities at Roaring River (in operation 4 years) and Morrow Island (in operation 3 years) worked as expected.

To our knowledge, this is the only system of its kind.

Comment: Is the loss of 464 acres of marshland avoidable, e.g., by alternative routing of ditches and alternative siting of such facilities as pumping stations.

In the event that the 464 acres of marshland are lost to construction, we agree mitigation is in order. Details of such mitigation (e.g.: Where will new marshland be established? Under what timetable? Using what techniques?) should be incorporated into the final plan. (Sierra, USCE)

Response: In evaluating the individual Overall Facilities, the use of existing channels and ditches was considered. Facility locations were selected to minimize impacts to the greatest extent possible consistent with providing the quality and quantity of water to protect the brackish water nature of the Marsh during dry and critical years. There are no pumping plants, as such, in the Overall Facilities. The pumping referred to in the Plan of Protection and EIR is by tidal action only and it is necessary to locate the structures where tidal conditions are favorable. The final analysis has shown that the Combination Plan, outlined in Chapter 5, will do the job with the least impact on the Marsh wetlands.

Chapter 9 of the EIR presents the reasons for mitigating the impacts of construction and a plan of mitigation recommended by the 4-Agency Suisun Marsh Technical Committee. The EIR also explores options available to DWR for mitigating the loss of wetlands caused by construction of the DWR share of the Overall Facilities. Mitigation for the construction-caused impacts of the USBR share of the Overall Facilities will be examined after the USBR agrees to participate in the Overall Facilities and after it has been determined which of the remaining Overall Facilities will be constructed.

Under the plan recommended by the Suisun Marsh Technical Committee and the options stated in the EIR, mitigation lands may be acquired and developed in selected areas throughout the Marsh. Appendix L is the mitigation plan recommended by the Marsh Technical Committee. This plan will be the basis for detailed development plans that will be prepared by DFG. The choice of mitigation lands will be made by DFG after DWR provides funds for the acquisition. Implementation of the mitigation program is the subject of a Memorandum of Understanding now being worked out between DFG and DWR.

DWR is proposing to stage construction of facilities, with a period of testing between construction of the various facilities. Staging will allow DWR to test and adjust the proposed design of the facilities and to build only those that are needed so that the system constructed will be appropriate to serve the needs of the Marsh with a minimum adverse impact.

Comment: The loss of seasonal and tidal marsh would have an adverse impact on the salt marsh harvest mouse, a species listed by the Federal Government as endangered. The Endangered Species Act (50 CFR Part 402) requires federal agencies to insure that their activities do not jeopardize the continued existence of a species covered by the Act. Section 7 of the Act requires consultation with the appropriate wildlife agency when a federal action may impact a listed species. The EIR does not provide the results of the consultation process nor is it indicated whether the consultation has been performed. The Corps, as a permitting

agency for the project, must insure that the project does not jeopardize the species. Consultation, as required under Section 7, should be initiated by U. S. Bureau of Reclamation as one of the agencies implementing the proposed project. (USCE)

Response: DFG has prepared a biological assessment for the USBR to address impacts on the salt marsh harvest mouse and California clapper rail (Appendix D). A Section 7 consultation memo is attached (Appendix E). Results of this assessment are incorporated in the final EIR. The Plan of Protection will impact the salt marsh harvest mouse and California clapper rail. The plan has been designed to avoid impacts in the Cut-off Slough area, the most probable habitat of the California clapper rail in the Marsh. The salt marsh harvest mouse will be protected by staging the construction of facilities so that disturbed habitat can recover before additional areas of habitat are disturbed. A live trapping program will transfer any salt marsh harvest mice found in areas of construction to undisturbed areas before construction begins. Further, embankments along edges of canals will provide a refuge for the mice during the high spring tides that will inundate most of the marsh and the mouse habitat.

Although there has been consultation with the U. S. Army Corps of Engineers, the U. S. Coast Guard, and the U. S. Bureau of Reclamation, this EIR is being completed by the Department of Water Resources before those federal agencies have either issued their permits or formally decided on how they will participate in this program. As a result, this EIR cannot identify conditions that have not yet been required in permits. DWR expects that the federal agencies will comply with all legal requirements and that adequate protection for rare or endangered species will be required. This EIR describes mitigation options that will adequately protect rare or endangered species.

Comment: There should be some reference to the recent surveys for rare and endangered species. (USBR)

Response: The final EIR refers to the most recent surveys for rare and endangered species (DFG 1980; Harvey 1980; and Shellhammer 1980).

Comment: Page S-1, first two paragraphs, rewrite as follows:

"This report presents a Plan of Protection to mitigate the effects of the Central Valley Project (CVP) and the State Water Project (SWP) on the Suisun Marsh. The State Water Resources Control Board (SWRCB) in Decision 1485 (August 18, 1978) set specific water quality standards for the Marsh. The Department of Water Resources (DWR) is required to implement mitigation measures by October 1, 1984.

The Plan of Protection describes how USBR and DWR propose to maintain the water quality criteria specified in Decision 1485. The major elements of the Plan: Delta outflow, physical facilities, monitoring program, management program, and environmental impact report." (USBR)

Response: The paragraphs have been rewritten to incorporate most of the suggested language.

Comment: Page I-4, second paragraph: To call the Marsh "freshwater" is incorrect because it has always been under the influence of tidal flows. (USBR)

Response: The paragraph has been rewritten.

Comment: Page I-10 through I-15: These figures give a distorted view of the impact of the projects upon the Marsh. They should relate to interior marsh quality. (USBR)

Response: The figures on pages I-10 through I-15 show the salinities of the source water available to the Marsh from two locations, Sacramento River at Collinsville and the mouth of Suisun Slough, under various conditions and for various years. The salinities of the Marsh are related to the source water available. The Plan of Protection is based on these data.

Comment: The document (page V-26) says that up to 32 cfs of Fairfield's waste water will be available for use in the Marsh by the year 2000, yet no indication is given of how the availability of this supply will be assured. Agricultural reuse of the waste water in April, May, and October could preclude marsh reuse unless firm commitments to provide the water to the Marsh are obtained from Fairfield. The final plan and EIR should state what arrangements will be made to assure availability of this supply. Consideration should be given to limited participation in Fairfield's reclamation project as a means of obtaining spring and fall supply. (SFRWQCB)

Response: The treated waste water test program has been conducted by USBR and a decision has been made concerning viability of treated waste water -- its acceptability, the quantity, and the method of use. The agreement between Solano Irrigation and the City of Fairfield, dated January 8, 1974, outlines the rates of delivery of waste water from the Fairfield-Suisun Sewer District treatment plant. This agreement specifies the amount of treated waste water to be made available to Suisun Marsh from September 22 through May 1. Approval by the Regional Water Quality Control

Board and the State Department of Public Health will have to be obtained prior to use in the Marsh. At that time, a contract between DWR and Fairfield-Suisun Sewer District may be necessary to ensure the availability of this supply during the critical months of September through May.

Comment: Fairfield's wastewater flows (22,837 ac-ft/yr or 20.4 mgd, page IV-17), appear to be as much as 50 percent the volume of wastewater flow (60 cfs or 40 mgd, page IX-32) to be conveyed from Boynton Slough to Cordelia Slough. In view of the doubtful availability of the Fairfield waste water, the final EIR should include the results of a computer model run assessing the impact on western marsh salinity in the absence of the Fairfield discharge, especially during dry and critical years. (SFRWQCB)

Response: During dry and critical years, any loss or reduction in treated waste water will be made up by additional diversions from Boynton Slough.

Comment: Similarly, the final EIR should discuss alternative facilities, such as expansion of North Bay Aqueduct, to provide the same salinity reduction as could be achieved with Fairfield waste water. Cost estimates should be included. (SFRWQCB)

Response: The selected North Bay Aqueduct Phase II alignment has its intake on Cache Slough north of Hastings Cut. The pipeline runs west from the intake north of Fairfield to the abandoned Sacramento Northern Railroad right of way. The pipeline then follows the railroad right of way southwesterly to tie into the existing Phase I facilities.

Using the quality water available from the pipeline in the northwestern and western portion of the Marsh would affect vegetation and fish migration. The local change in vegetation near discharge points would be from a brackish water to freshwater vegetation, which would be detrimental for the salt marsh harvest mouse. Because this is Sacramento River water, the upstream migration of fish would be delayed due to confusion of the fish, causing them to stray from normal migration routes.

In addition, because the water comes from Cache Slough, any water used in the Marsh for salinity control would have to be replaced on a one-for-one basis at Rio Vista for Delta salinity control.

Use of the North Bay Aqueduct pipeline for quality water for the Marsh was deemed undesirable for environmental reasons and was rejected.

Comment: The plan and EIR do not state:

(a) What facilities are needed in order to comply with standards of the State Water Resources Control Board's Water Right Decision 1485 (D-1485) at station S-33 or S-32 in Cordelia Slough, but asserts that equivalent protection to the area will be provided by overland facilities.

(b) What volume of water introduced to the north Marsh from the North Bay Aqueduct or equivalent would be needed to assure compliance with D-1485 standards.

(c) What would be the incremental cost of expanding the Aqueduct. (SFRWQCB)

Response:

(a) Water quality at Stations S-33 and S-32 on Cordelia Slough will be provided by water tidally pumped from Boynton Slough through Boynton-Cordelia ditch. The computer model shows that the proposed facilities can be operated to meet Decision 1485 standards at these stations in all months.

(b) If the most southerly route of the North Bay Aqueduct were used, the size of the pipeline would have to be increased from a capacity of 120 cubic feet per second to 450 cubic feet per second to provide the north portion of the Marsh with the same amount of water that Potrero Hills Ditch will provide.

(c) Because use of the North Bay Aqueduct was rejected for environmental reasons and because of its location north of Fairfield, the construction cost for expanding the aqueduct was not calculated.

Comment: The Plan and DEIR (Page IX-9) state that velocities in Montezuma Slough could adversely impact Neomysis populations. The final document should address alternative methods of complying with D-1485 standards without such high velocities, e.g., introduction of larger flows into the northern or western Marsh by overland facilities, thereby reducing the flow rate in Montezuma Slough. (SFRWQCB)

Response: The mathematical model shows that the velocities at the Montezuma Slough Control Structure and in the eastern portion of Montezuma Slough will be lower than originally stated and thus will not be as detrimental as originally feared. Studies have not identified any significant impacts on Neomysis shrimp as a result of the Plan of Protection (Alan Baracco, DFG, October 1980).

Introducing larger flows into the northern and western portions of the Marsh by overland facilities would reduce the velocities required in Montezuma Slough. These larger flows

would, however, cause side effects that would have a more adverse impact on the marsh environment. The flows would cause fish to stray from normal migration routes. The local environment near discharge points would change to that of a freshwater marsh, which would be harmful to the salt marsh harvest mouse. All water used would have to be replaced on a one-for-one basis by project releases if needed to control salinities below Rio Vista. For these reasons, plus the excessive cost of the overland system and the minimal effect of the velocities on the Neomysis, additional alternative methods have not been added to the Plan of Protection.

Comment: Duck club drain water discharges to Boynton Slough have been known to cause localized DO depressions to below 3.0 mg/L. What is the likely impact of projected increase in intensity of duck club management on a real extent, duration, and magnitude of DO depressions? (SFRWQCB)

Response: The depressed dissolved oxygen levels in Boynton Slough are not all attributable to the duck club drain water. They result from a combination of events. Decreased exchange of water in the slough, low wind action, and the low dissolved oxygen occur during December, January, and February, when there is rain with subsequent runoff, fog, and low temperatures.

Boynton Slough will be the intake for the Boynton-Cordelia Ditch. Boynton Slough water will be tidally pumped through the ditch to Cordelia Slough, drawing additional water from Suisun Slough. This circulation pattern will increase dissolved oxygen levels in all of Boynton Slough.

Comment: The contract between SID and Fairfield is incorrectly described. SID has the first right to the waste water for the entire year, not just the summer, except that the following percentages are reserved for marsh use:

| | |
|---|---|
| Sep 22 to Dec 1 | 50% |
| Dec 2 to Mar 1 | 100 |
| Mar 2 to Apr 1 | 67 |
| Apr 2 to May 1 | 10 |
| May 1 to Sep 22 | 0 |

In 1984, none of Fairfield's waste water will be available for marsh use after May 1 and only 10 percent of it during April. Therefore, less water would be available for marsh use than is indicated in the Plan and DEIR. Also, as Fairfield expands its agricultural reuse facilities, waste water flows above 12 mgd may not be available for marsh use, especially in dry years. The second sentence of the second paragraph should be

modified to read: "The remainder of...could be available to the Marsh per year if firm commitment for such use is obtained from Fairfield". (SFRWQCB)

Response: The Plan of Protection has cited the contract between the city of Fairfield and Solano Irrigation District and has used the quantities of treated waste water available, as provided by James M. Montgomery, consulting engineer for the Fairfield-Suisun Sewer District. The percentages cited in the contract match those above and those of the consultant.

Section I, Item D, of the agreement dated January 8, 1974, between Solano Irrigation District and the city of Fairfield, reads as follows:

"D. Rates of Delivery

During the term of this agreement, District shall take during each calendar year at the point of delivery, the following quantities of water, under the following terms and conditions.

1. District shall utilize all wastewater up to a maximum flow of 12 mgd between May 1 and September 21.

2. At the time that the flow rate approaches 12 mgd, City and District shall make arrangements for delivery of waters in excess of 12 mgd.

3. District shall have first right to receive all wastewater up to 12 mgd between September 22 and May 1 except that the following amounts, when those amounts are required for maintenance and enhancement of the Suisun Marsh area during the following periods, will be provided from such waters:

a. September 22 to December 1
Up to one-half of the wastewater flow shall be available for Marsh maintenance and enhancement.

b. December 2 to March 1
Two thirds of the wastewater flow shall be available for Marsh maintenance and enhancement.

c. March 2 to April 1
Two-thirds of the wastewater flow shall be available for Marsh maintenance and enhancement.

d. April 2 to May 1
One-tenth of the wastewater flow shall be available for Marsh maintenance and enhancement."

The only difference in the figures may be in that the total project quantities have increased or the assumptions on how SID will use its water. The lower figures are based on full

compliance with contract, and the higher figures are based on SID using 12 mgd from May 2 through September 21.

Comment: On page V-26, following the first sentence of first pararaph, add "...available. However, waste water reuse for irrigation could reduce or eliminate the availability of waste water for Marsh uses, especially in dry years, unless contractural commitments for Marsh use of the water are obtained. If..." (SFRWQCB)

Response: The model shows that if the treated waste water were not available, additional water could be tidally pumped through Boynton Slough to meet the quality needs.

Comment: On page IX-7, the water quality discussion should be expanded to describe salinity changes with time. Graphical representations similar to Figure V-3 should be made that show monthly salinities at each control station for 1980, 2000, and 2020 conditions, including duck club discharges as inputs to model. Also, Figure V-3 should be redrawn to include all control stations, not just those meeting the standards. (SFRWQCB)

Response: Figure V-3 has been revised to include all stations called for in Decision 1485. To establish salinities for the years 1980 and 2000 under the same criteria would be meaningless because DWR has met Decision 1485 standards under the worst conditions.

Comment: The following potential adverse impacts should be considered prior to completion of final EIR.

1. Interruption of access to our facilities for maintenance, repair, and operation.

2. Unsafe operating clearances for both overhead and underground facilities due to project development.

3. Costs associated with project-related relocations of any of our existing facilities on private and/or public property.

4. The constraints affecting the construction of new service lines. (PGandE)

Response: All items will be handled by relocation agreements, as discussed in the EIR. These are economic impacts that will be given careful attention as the plan is implemented. These are not significant effects on the environment needing detailed analysis in the EIR.

Comment: The proposed project does not achieve the managed wetland soil salinities required to maintain and restore wildlife habitat using the quality of water mandated by D-1485. Unless such facilities are provided, the damages caused by the SWP and the CVP diversions will not be fully mitigated. (SRCD, Coon)

Response: The Plan of Protection will provide the quantity and quality of water required for the Marsh to meet water quality standards. The plan also provides facilities necessary for each club affected by construction to continue to operate as well as they did before construction. In addition, the proposed DWR/DFG/SRCD contract includes a provision for DWR to share in the cost of club facilities needed to operate in conformance with individual management plans.

Comment: On page I-7, the first paragraph acknowledges that both "Equity" and the provisions of the Davis-Dolwig Act obligate the SWP and CVP to mitigate their impacts on the Marsh. (SRCD, Coon)

Response: The Davis-Dolwig Act authorizes the SWP to mitigate its impact on the Marsh but does not obligate DWR to do so. The Act has no effect on the CVP because CVP is controlled by Federal laws. Congressional authority is now being sought to enable USBR to also mitigate adverse marsh impacts caused by operation of the CVP.

Comment: The following comments are related and are grouped together. On page II-2, the first full paragraph, third sentence, clearly identifies the need for more intensive management practices "in combination with improved drainage and control facilities" (emphasis added) to "reduce the effects of increased salinity levels of the water supplies from Honker, Grizzly and Suisun Bays". On page III-1, second paragraph, this section describes the situation (need for better management) succinctly. On page III-29, last sentence and the first sentence on page III-30, see II-2 above. (SRCD, Coon)

Response: The first paragraph refers to a study made by DFG in relation to preferred waterfowl food plants and the quantity and quality of water available in the Marsh. This study has led to the present Plan of Protection. The third sentence, cited above, reads as follows:

> The studies also showed that more intensive management practices within the duck clubs and State wildlife areas, in combination with improved drainage and control

facilities and a supplemental supply of fresh water, could reduce the effects of the increased salinity levels of the water supplies from Honker, Grizzly, and Suisun bays, and attain the desired management conditions.

When implemented, the Plan of Protection will provide the water for the Marsh to meet applicable water quality standards when the salinity level degrades to a point where better quality water must be tidally pumped from the Sacramento River at Collinsville. It is not the intention of the SWP and its water contractors to improve the Marsh, but to mitigate for impacts of the SWP.

The statement on page III-1, second paragraph, is what the Plan of Protection is all about: to provide the Marsh with quality water "so there will be an improvement in the Marsh's plant community if each club under SRCD will manage its property correctly".

The last sentence of III-29 and the first sentence on page III-30 are quite clear in their intent and meaning. The CVP and SWP will provide the necessary quality water for use by all clubs. It is up to the SRCD and the clubs to see that each club manages its lands correctly to maintain and/or improve the present plant community balances. The CVP and SWP are not responsible or liable for making the clubs in the SRCD better than they are.

Comment: On page III-32, beginning with the second paragraph, the section clearly and specifically points out the major shortcoming of the proposed plan. In order to use the marginal quality water required by D-1485, the managed wetland areas must have the water management facilities necessary to carry out the required leaching cycles. Failure to include these facilities as a part of the plan will not provide full mitigation as required by the Davis-Dolwig Act. (SRCD, Coon)

Response: Page III-32, second paragraph, does not mention marginal quality water, the only statement being "water of the quality indicated by Decision 1485". The marsh clubs have been using brackish water on their lands since the thirties and forties and each spring have leached their fields of the accumulated salts to grow the cover required for the following season. The clubs will continue to receive water of the needed quantity and quality under the Plan of Protection.

DWR recognizes the right of the marsh landowners to divert water of the quality needed to conform with good management practices. The right to divert for reasonable use does not include the right to waste water by failing to follow good management practices. It is appropriate that the landowner bear a

large part of the responsibility for funding facilities needed for good management.

Whether or not additional individual facilities are needed to provide full mitigation, the Davis-Dolwig Act does not require that DWR provide full mitigation. The Act authorizes mitigation for the impacts of the SWP. CEQA requires that DWR mitigate to the extent DWR finds feasible, which is not necessarily full mitigation.

Comment: On page IV-4, the last sentence, plus the first sentence on page IV-5, this language claims that intensive on-club management is part of "the substance of the Combination Plan", but the plan fails to provide the on-club facilities necessary to undertake intensive management. (SRCD, Coon)

Response: The parties to the DWR/DFG/SRCD contract expect that the contract will provide for partial cost reimbursement for on-club facilities necessary to achieve proper management. DWR believes the partial compensation is not needed as part of the mitigation for the impacts of the SWP, but has tentatively agreed to it during the negotiations. In addition, AB-2090 provides a vehicle for reimbursement by the State General Funds of 50 percent of the O&M costs incurred in improving the wildlife habitat.

Comment: On page IX-18, the last paragraph states that consideration should be given to using spoil material to renovate the exterior levees in the Marsh. (SRCD, Coon)

Response: Deterioration of the levees is a problem the district and the individual landowners must resolve. The SWP and CVP have no obligation to maintain or to renovate the exterior levees of the Marsh as their condition is not related to the impacts of the CVP and SWP . Spoil material from construction could be made available to the district or to the individual owners if arrangements are made for reimbursing DWR for any increases in handling costs.

Comment: In Appendix C, pages 26-27, Section 7(a) -- the section of the SWRCB order specifically requires that the Suisun Marsh plan shall include "...physical facilities ... (and assurances) to restore and maintain the Suisun Marsh as a brackish water marsh using best practical management practices". This language clearly requires that the plan include all the facilities necessary to carry out "best practical management practices". (SRCD, Coon)

Response: Section 7(a) reads as follows:

"7. For the protection of Suisun Marsh permittees shall:

(a) Develop a plan for Suisun Marsh by July 1, 1979, in cooperation with other agencies which will ensure that the standards in Table II for full protection of the Marsh are met. Such plan must be satisfactory to the Board and shall include appropriate EIR/EIS documentation, a monitoring network, physical facilities, operating and management procedures, and assurances to restore and maintain Suisun Marsh primarily as a brackish water marsh capable of producing high quality feed and habitat conditions for waterfowl and other marsh-related wildlife using best practical management practices."

The SWP is attempting to comply with this section and will provide facilities that will help restore and keep the Marsh in its brackish water state. These facilities are those required to provide the quantity and quality water to the marsh channels to meet Decision 1485 standards. The language requires that the Plan contain assurances that the Marsh will be restored and maintained as a brackish water marsh, not that DWR provide all on-club facilities necessary to carry out good management practices. It remains the responsibility of SRCD and the clubs to instigate and maintain proper management.

Comment: Within the last two years, the SRCD acting through the U. S. Soil Conservation Service, has developed management plans for 82 of the 168 individual private ownerships within the Primary Management Area of the Marsh. Each of these plans identifies the water management facilities necessary to flood and drain that property within 30 days and estimates the cost of those facilities in 1980 dollars. A copy of this information is attached. Extrapolating this information to cover the balance of the managed wetlands in the Primary Management Area indicates that the total cost of these facilities would be approximately $1 million. Because of the lack of provisions of the required managed wetland facilities, the Suisun Resource Conservation District Board considers the Plan of Protection fundamentally inadequate and strongly opposes its adoption in its present form. (SRCD, Coon)

Response: The Plan directs the SWP to have facilities that will provide quality water to the marsh channels. The clubs have the responsibility to install facilities so they can comply with their management plans and avoid wasting water. Provision for reimbursement of a portion of the cost of installing additional facilities required to fill and drain in 30 days may be included in the contract among DWR, SRCD, and DFG.

Comment: S-3, third full paragraph, the statement that the Goodyear Slough Outfall became operational in October 1979 is not correct. This will not occur until the outfall channel is dredged to the Bay, which should occur in early 1981. (SRCD, Chapin)

Response: The outfall channel has been completed and the statement has been corrected.

Comment: I-4, first full paragraph, lines 9-15, the statements on the lack of success of commercial agriculture during the period from 1870 to 1900 are not correct. Details confirming the high agricultural value of the area are available if desired. This section should be rewritten to read: "Commercial agriculture flourished during the rest of the nineteenth century. The crops grown included various cereal grains, beans, tomatoes, and asparagus supplemented by extensive dairy and beef production". (SRCD, Chapin)

Response: The paragraph has been rewritten.

Comment: In IV-6-21, the section on Alternative Water Sources needs to be reorganized into two sections: one dealing with alternative primary water supplies and written accordingly, the second dealing with potential sources of supplemental water if the quality of the water provided by tidal pumping in Montezuma Slough proves inadequate. (SRCD, Chapin)

Response: Part of Chapter 4 deals with alternatives reviewed as sources of quality water to be used within the Marsh. This review led to the use of water from the Sacramento River near Collinsville, with other alternatives available for backup if needed. The review was not established to achieve a primary water source and potential supplemental water sources, but to identify all sources prior to selecting the best source available.

Comment: In III-32, first paragraph, this sentence doesn't make sense. As pointed out in the fourth paragraph on I-7, CVP and SWP reduce water quality during the critical spring months and between 25 and 50 percent of the time it will not meet D-1485 standards. (SRCD, Chapin)

Response: The paragraph was not needed; it has been deleted.

Comment: Concerning V-28, first two lines, I suggest that this sentence be deleted. In order to comply with

the terms of the proposed 2-Agency Agreement, and in accordance with administration policies, operation of the Montezuma Control Structure is proposed in wetter years whenever it would not adversely impact the yield of the projects and to the extent it does not significantly impact the fishery in the Slough. (SRCD, Chapin)

Response: The statement has been revised to reflect the considerations outlined in the proposed contract among DWR, SRCD, and DFG.

Comment: In IX-3, first paragraph, in various places in the plan, different sets of numbers are used for the various types of habitat in the Marsh. The attached set of figures are the correct ones and should be used throughout. In addition, the last sentence is incorrect. There are approximately 52,300 acres of managed wetlands in the primary management area. The project is intended to serve all of them except for the 1,100 acres (approximately) of offshore islands. (SRCD, Chapin)

Response: The sizes of areas have been corrected.

Comment: Concerning IX-7, last sentence, the meaning of this sentence is not clear. In a critically dry year the facilities are expected to be operating at full capacity 100 percent of the time between the beginning of October and the end of May. Given this situation, the claimed "flexibility" is not existent if the normal operating criteria (i.e., wide open operation) provided is inadequate. (SRCD, Chapin)

Response: The text has been rewritten for clarity.

Comment: In IX-21, second full paragraph, the claim of increased fishing success is incorrect. The access to this structure will be over private property and there will be no public entry provided. (SRCD, Chapin)

Response: Public recreation facilities are proposed for the Montezuma Slough Control Structure. These facilities include public access from the Collinsville Road, parking areas, a fishing platform, and other features as shown in the Recreation Plan, Appendix M. Necessary rights will be acquired. In addition, fishing success by boat anglers may increase.

Comment: In IX-23, third full paragraph, the area of public fishing access along the south levee should be

spelled out. It will not be provided where the levee crosses privately owned lands. (SRCD, Chapin)

Response: Fishing opportunities would only be increased with the increased public access along the south side of the ditch, where the ditch borders the existing county road. Because the area involved is private property, the necessary rights will have to be acquired if this type of recreation is to be provided.

Comment: In IX-28, third paragraph, the manner in which the ditch would reduce private and increase public access should be described (see (4) and (10)). (SRCD, Chapin)

Response: Cygnus Ditch has been eliminated from the Plan of Protection and the EIR.

Comment: In IX-30, fourth paragraph, there will be no increase in public fishing opportunity since all access is over private land. (SRCD, Chapin)

Response: Public fishing opportunity will increase only if access is provided on the west side.

Comment: No arrangements have been made for water drainage of the Laughing Mallard Club (534) or adjoining club lands. We believe that this problem should be addressed in the final plans. (DFG, George)

Response: If the ditch blocks existing drainage facilities, the clubs will be made whole when Grizzly Island Ditch is built.

Comment: In our January 25 letter on the Draft Plan of Protection (Plan) and preliminary Draft Environmental Impact Report (Draft EIR), we stated that a greater attempt should be made to quantify the environmental impacts of alternative actions. The current document shows little evidence of improvement in this regard. While we recognize the difficulty in numerically estimating future environmental changes, we emphasize that this is an important part of any environmental impact analysis. At the very least, an attempt should be made to estimate the unavoidable adverse impacts of the project on important species of fish and wildlife. The estimates should be in terms of percent population reduction or numbers of individuals lost, particularly those considered rare and/or endangered. In the absence of supporting numerical estimates, the use of subjective terms, such as "small", "not significant" or "adverse" does little to help the reader develop a basis for agreeing or disagreeing with the author's conclusions.

The discussion of adverse impacts on fish and wildlife should be modified in the Final EIR to include numerical estimates of changes in population parameters. (SWRCB)

Response: Initial indications are that, with the proposed mitigation, compensation, and enhancement, losses will not occur to wildlife populations, but in most cases populations may be enhanced.

To determine the numbers of the rare and endangered wildlife species that may be lost due to construction of the facilities is next to impossible; to determine a percent of loss would be impractical. Because the exact or even the approximate number of the species is unknown, any number chosen would be a guess and not appropriate for this report.

Before and during construction of the facilities, efforts will be made to minimize any losses to the salt marsh harvest mouse. This will be accomplished by trapping the mice in potential mouse habitat areas for each facility and moving them to other suitable habitat, including recently developed habitat capable of supporting mice but not now doing so. Trapping will take place early in the season to reduce impacts on breeding mice or mice with litters.

Construction crews and equipment will work as closely as possible within the limits and alignments of the project facilities to reduce disturbance to the black rail and the mouse.

The only known location of the California clapper rail in the Marsh is the Cutoff Slough area, which will not be disturbed by construction of the project facilities. There will, therefore, be no losses of this bird due to the project.

Likewise, to determine any numerical or percent losses in fish populations would be impractical, if not impossible, considering the numbers of fish that use the marsh waterways during the year. The best solution is to anticipate some losses and to keep them as small as possible by installing fish screens on facilities where losses could occur.

To give number or percent of losses of the endangered or rare species of wildlife or of the fish that use marsh waterways is not practical because there are no numbers on which to base an estimate.

Comment: The Plan states that the channel islands southwest of Grizzly Island will not be protected from increased salinity. The discussion should reference the plan for mitigating resultant adverse impacts discussed on page IX-36. (SWRCB)

Response: The text has been expanded.

Comment: Concerning pages V-1 and V-26, on page V-1, the Plan states that the 1984 water quality standards for three control points -- S33, S-36 and mouth of Montezuma Slough -- would not be met. Lands in the vicinity of these control points would be serviced by overland facilities rather than directly from the channels. The discussion which follows that statement does not adequately explain which facilities will provide this overland service. Nor does it explain whether lands serviced by such overland facilities will receive protection equivalent to that which would be obtained by meeting the standards at the above mentioned control points. Decision 1485 requires that equivalent protection to lands serviced be demonstrated prior to State Board approval of standards modification. The Plan should be modified to provide this information.

For example, our January 25 letter stated that the discussion of the Cygnus Ditch facility should explain that the facility is designed to provide protection of lands which would otherwise be serviced directly from the channels near Station S-33 (i.e., the State S-33 area). The discussion on page V-26 does not provide this explanation. Furthermore, it appears to misinterpret the term "Station S-33 area" to mean water within Cordelia Slough west of Cygnus rather than lands serviced near Station S-33 as explained above. This should be corrected. (SWRCB)

Response: Decision 1485 standards at Station S-36 and the mouth of Montezuma Slough cannot be met because the vast amount of saline water in Grizzly Bay is too much to dilute. DWR will recommend to the SWRCB that the stations be moved or deleted.

Land near these control points, however, is to be serviced with quality water to meet water quality criteria by overland facilities (the Goodyear-Slough Facilities, in particular the Morrow Island Distribution Facility) rather than directly from the channels. Therefore, the quality of water at these control points does not reflect the quality of water provided to the clubs.

Using the current configurations of the various facilities and the larger amounts of quality water transported to Cordelia Slough, the model now predicts that water quality standards at Station S-33 can be met. Because of this, the Cygnus Ditch has been deleted from the plan.

Comment: On page VI-I, the last sentence states, "DWR will be responsible for the maintenance and management of the major water control structures of the project" (emphasis added). We presume the term "management"

includes procedures for operating these major facilities exclusive of the individual (on club) management procedures which will be under the responsibility of the Suisun Resource Conservation District (SRCD). In our January 25 letter, we stated that DWR's procedures for operating the major water control structures should be detailed in the Plan. The present plan does not include this information as required by Condition 7(a) of Decision 1485. This information should be provided in the Final Plan. In addition, a summary of SRCD's individual (on club) management procedures should also be included. (SWRCB)

Response: General operation procedures of the major facilities are addressed in the Plan. Detailed plans will be provided after the project has been in operation for three years. Individual management procedures for each club will be available through the SRCD.

Comment: Concerning Pages V-23 and V-26, the Plan states that by the year 2000, 32 cubic feet per second of supplemental treated waste water from the Fairfield plant will be available to help meet standards in the western Marsh. If this supply will be needed to meet the standards, the Plan should discuss the basis for assuring that it will be available to the Marsh rather than reclaimed elsewhere. If such assurances cannot be provided, the Plan should specify backup facilities designed to meet the standards without Fairfield waste water. (SWRCB)

Response: The treated waste water that will be made available to the Boynton-Cordelia Ditch is not necessarily needed to provide the quality water for the western portion of the Marsh. If it is found that during a dry or critical year the treated waste water is needed elsewhere for irrigation, water supplied from Boynton Slough would be increased to meet quality standards in the western portion of the Marsh.

Comment: On page VIII-1, in the first line, the words of "SWRCB Decision 1485" should be inserted after "Order No. 7(b)". (SWRCB)

Response: The words have been added.

Comment: On pages IX-8 and IX-36 -- the draft EIR proposes development of a plan to mitigate adverse salinity effects of the project on the channel islands. Additionally, plans to mitigate adverse effects on rare and endangered species (i.e., the California black rail and the salt marsh harvest mouse) are also proposed.

These mitigation plans should be fully detailed in the Final EIR. (SWRCB)

Response: The final Plan of Protection includes general options to mitigate project impacts on the channel islands. Section 7 consultation with the U. S. Fish and Wildlife Service shows specific mitigation, compensation, and enhancement for the endangered salt marsh harvest mouse and California clapper rail (Appendices D, E, and J). Because surveys have been unable to find the black rail (Appendix G), the EIR refers to impacts on potential black rail habitat.

Comment: On page IX-9 the Draft EIR discusses possible adverse effects of the project on anadromous fish survival due to:

1. Changes in migration routes,

2. Increased predation; and

3. Reduction in populations of Neomysis (an important fish food organism).

This discussion should also address the loss of anadromous fish into the duck club ponds attributable to unscreened diversions. Moreover, the resultant population losses due to all of the above factors should be quantified numerically in the Final EIR (see our general comments above).

On page IX-35, the Draft EIR stated: "Effects on anadromous fish would be minimized by tailoring operational procedures and screening intakes as necessary".

This implies that a specific plan will be developed at a later date to mitigate the impacts on the anadromous fishery discussed above. The mitigation plan should be fully detailed in the Final EIR. Such disclosure in the Final EIR will be needed to establish whether proposed mitigation measures are sufficient. (SWRCB)

Response: On page IX-9, the Draft EIR section, Fish, has been replaced with the section of the report by Alan Baracco of DFG (Appendix F), Analysis of Proposed Action (pages 16-20). Sections dealing with the effects of the alternative plan on migration (page 20) have been deleted.

Barraco's report does not address SWRCB comments on numerically estimating the impacts of the project on important species or the resultant population loss due to the project. As stated on page IX-35 of the Draft EIR, some impacts will not be known until after the project has been in operation. Barraco doubts that losses could be quantified even then. The only way to handle the

migration and predation losses would be through artificial propagation or recognition that some loss exists and calling it an unavoidable, adverse environmental impact. He suggests the latter, because the losses are expected to be minimal. Clubs served by Roaring River Slough and Grizzly Island Distribution System will receive water through screened diversions in lieu of unscreened preproject diversions. This may provide sufficient fish benefits to offset the minimal losses from other effects.

Comment: On page IX-16, under the topic of energy, the Draft EIR states that operation of the Montezuma Slough Control Structure would require a small and difficult task(?) to estimate consumption of electrical energy. If the conclusion can be reached that such consumption is "small", then a maximum annual use of energy (assuming continued operation from October through May) can and should be estimated. (SWRCB, SC)

Response: The energy consumption of the Montezuma Slough Control Structure during a season (October to May) will be 60,000 kWh during normal years and 71,000 kWh during critical years. This information has been included.

Comment: The Department of Fish and Game has reviewed the subject plan and DEIR. We believe the DEIR is incomplete, since the plan of mitigation for the loss of existing habitat being developed by the Suisun Marsh Technical Committee (page IX-36) is not available for review along with the subject document. The merits of the plan and DEIR cannot be fully evaluated without the proposed mitigation plan. Further, we believe that the DEIR does not adequately consider the impact of the project on endangered species and that sufficient new information is now available to begin preparation of a supplement to this EIR. Any subsequent environmental documents should include this new information and be available simultaneously for review. (DFG)

Response: The options for mitigating impacts and more details on the endangered species are included.

In preparing this EIR, DWR found that many of the details of the later phases of this project could not be predicted with accuracy. The Department found that many of these later phases depended on a number of policy decisions and interagency agreements being worked out. Recognizing that many of these details would not be worked out until sometime in the future, the DWR coverted this EIR from a normal project EIR, which would describe all parts of the proposed activity in detail, to a program EIR that discusses the overall Plan of Protection generally to the degree that is possible to predict now and provides more detail and certainty on the first few phases of the

Plan of Protection that can be predicted with accuracy at this time. Accordingly, this EIR does not now contain all possible details on future mitigation measures. The EIR is adequate to support a decision to proceed with the access road to the Montezuma Slough control structure and the construction of the control structure itself. Proposed decisions to proceed with future components of the Plan of Protection will be reviewed in the light of this EIR. If the Department finds that this EIR does adequately describe the effects of a proposed later phase of the Plan of Protection, then that Plan could proceed with only consideration of this EIR. If the Department finds that there are new significant effects of a future phase of the plan that had not been discussed in this EIR or that new feasible alternatives or mitigation measures should be considered that were not discussed in this EIR, then a supplement to this EIR will be prepared and circulated before a decision is made to proceed with that future phase.

The Department recognizes that this EIR is not perfect. No EIR, however, will be perfect. DWR believes, however, that this EIR is adequate to support decisions to proceed with the early decisions to implement the Plan of Protection by constructing the access road to the control structure and constructing the control structure itself.

Comment: On page S-3, fish screens may be required with the Goodyear Slough facilities. This point should be discussed in the document and provided for if needed. (DFG)

Response: The information has been included.

Comment: On page II-5, the conclusion that marsh ponds can be flooded with treated waste water has not yet been verified by the pilot study results. Further, discussion of the Fairfield Duck Club Program (page II-6) points out the severe algae problems that have occurred with the use of waste water on typical duck clubs. We know that future studies are planned which will assess the effects of using highly diluted waste water and modified marsh management practices. You should refer to these future studies and identify alternative sources of water in the event the use of waste water is determined to be infeasible. (DFG)

Response: The paragraph has been reworded to include results of the 4-year study program, which has now been completed. USBR has not yet completed the final report, but it will be issued as a Four-Agency Ecological Study Report when it is complete.

Comment: On page III-19, "Scirpus" is misspelled and should be capitalized as a proper name. (DFG)

Response: The correction has been made.

Comment: On page III-20, "Neomysis" should be capitalized as a proper name. American shad and threadfin shad are both present in the Marsh. (DFG)

Response: Corrections have been made.

Comment: On page III-23, the fitted line for "Central Valley" waterfowl stocks does not appear to be valid. The line should be fitted by the best available statistical method. (DFG)

Response: The graph is pictorial. If a statistical method were employed, it would be a three-segment chart, which would be somewhat misleading. This chart was provided by the U. S. Fish and Wildlife Service and was used by USBR in its 1982 report, "Special Report on the Suisun Marsh Management Plan". DWR believes the graph is reasonably accurate and provides an understandable presentation of the information.

Comment: On page III-25, the Rare and Endangered chart is incomplete; it should include the bald eagle, peregrine falcon, and salt marsh harvest mouse under the Department of Fish and Game columns.

The thicktail chub has been declared extinct by the California Fish and Game Commission. (DFG)

Response: The chart has been corrected.

Comment: Concerning page III-26, first paragraph, last sentence, both U. S. Fish and Wildlife Service and Department of Fish and Game consider the mouse endangered. (DFG).

Response: Text has been corrected.

Comment: Concerning page III-28, second full paragraph, last sentence, the conclusion that nature study may become the most important activity in the Marsh is misleading. Nature study may be expected to increase. However, we anticipate that waterfowl hunting and fishing will also increase and continue to be the most important activities in the Suisun Marsh. (DFG)



C—054181

C-054181

Response: Text has been corrected.

Comment: On page III-31, the citation is inadequate. We believe that the mean annual salinities should be:

| | |
|---|---|
| Brass Buttons: | 8.9 - 30.5 PPT TDS |
| Alakli Bulrush | 6.9 - 32.5 PPT TDS |

Response: Correction has been made.

Comment: Concerning page V-20, the Goodyear Slough facilities may require fish screens. This point should be discussed in the document and the installation of screens provided for, if determined necessary. (DFG)

Response: Information has been added.

Comment: On page IX-12, recent surveys do not discount the probability of breeding populations of California clapper rail in the Marsh. (DFG)

Response: Recent surveys (DFG, 1980, and Harvey, 1980) do, in fact, indicate breeding populations of the California clapper rail in the Marsh. The biological assessment prepared by USBR to initiate the Section 7 consultation process addressed the Marsh's value to the rail, potential impacts, and compensation for any impacts.

Comment: Regarding page IX-26, Recreation, potential improvement of fishing and hunting opportunities with construction of the Potrero Ditch should be explained. (DFG)

Response: Section on recreation at Potrero Hills Ditch has been rewritten to include fishing.

Comment: Regarding page IX-29, Wildlife, recent results from salt marsh harvest mouse surveys should be included. (DFG)

Response: The most recent salt marsh harvest mouse survey data have been included in the final EIR.

Comment: On page IX-36, potential impacts on black rail habitat are discussed in most evaluation sections. Impacts on the black rail may not be significant if most of the areas affected are virtually all pickleweed. A DFG report, "California Black Rail Breeding Season

Survey in Central California; 1977", by Timothy D. Manolis, describes the importance of pickleweed and associated vegetation. The Department of Fish and Game has recently completed a survey of marsh habitat affected by the project. The results of this survey should be assessed to determine the probable impacts on black rail. (DFG)

Response: The Plan of Protection will impact the black rail habitat primarily by construction of facilities. The disburances to habitat would be isolated in location and time. Due to the staged construction of the individual Overall Facilities, an area disturbed during the construction of one facility would have time to recover before construction disturbed another area.

The results of the survey mentioned in the comment have been assessed. The report of the surveys found no black rails in the areas expected to be impacted by project construction. Black rails found in a 1976 survey were found in tidal sloughs and other areas that would not be impacted by project construction.

Comment: Regarding page B-7, fish occurrence studies are now in progress, and necessary screening will be concurrent with construction of the facilities. (DFG)

Response: Fish screens may be required on facilities where the loss of fish may occur. DWR believes that the benefits to fish of new screened diversions, which replace old unscreened diversions, will more than offset any fish losses caused by the project.

Comment: Page III-29 states, "During recent years, because of increased upstream depletions, it has been increasingly difficult to maintain the species of brackish marsh vegetation which contribute to the value of the Suisun Marsh as wintering habitat" (emphasis added).

Since the report seems to be saying that such "increased upstream depletions" are the cause of the water quality problems and, hence, the deterioration of the Suisun Marsh, it would seem logical that limitation of such upstream depletions should be discussed as an alternative, at least during extremely dry years. (SL)

Response: Impacts of meeting Marsh water quality standards with outflow are equivalent to those of limiting upstream diversions. Those impacts, discussed in the EIR, were judged too severe for that alternative to be considered further.

During the 1976 and 1977 drought years, there were reductions in upstream water use and in water exported by the SWP. Under the present system of operation, with a repeat of 1976-77 conditions, DWR would once again restrict the amount of water exported. DWR is bound by Decision 1485 and agreements to provide 2 million acre-feet of water to the Delta for municipal and industrial use and to meet water standards for fish and agriculture.

If there are two or more critical years in a row with upstream storage at a low level, it may be necessary for all water users, including Suisun Marsh to absorb a deficiency in supply. The proposed deficiency water quality standards for the Marsh are described on page 49.

Comment: No supporting documentation is given for the statement made repeatedly throughout the report that:

"The aquatic barriers that would be created by the new ditches are not expected to have a significant adverse impact on wildlife".

The Potrero Hills Ditch, which as proposed will be 147 feet wide, will effectively make the Potrero Hills an island. It is not clear that this will have no impact on the migration, predation, and genetic exchange of the plant and animal populations of the Potrero Hills. As you are aware, the Suisun Marsh Plan states that:

> "Existing uses should continue in the upland grasslands and cultivated areas surrounding the critical habitats of the Suisun Marsh...where feasible, the value of the cultivated lands as habitat for marsh-related wildlife should be enhanced".

As we stated in our earlier letter, we believe the Commission will be concerned that the construction of these water barriers, particularly the Potrero Hills Ditch and the Boynton-Cordelia Ditch, will change the nature of the available upland habitats and may adversely affect the ability of the landowner to use these lands for agricultural purposes. We feel that there should be some discussion of these potential impacts. The staff continues to believe that the construction of pipelines using the prescribed guidelines of the Suisun Marsh Protection Plan may have less long-term environmental impacts than the construction of open channels where the channels would traverse long distances, particularly in the secondary management area. (BCDC)

Response: The Boynton-Cordelia Ditch follows the alignment of an existing channel, which is a barrier as defined by San Francisco Bay Conservation and Development Commission. This 50-foot-wide ditch serves as an apparent property line, with agriculture on both sides of the ditch. The existing ditch will be widened to 169 feet and a new drainage ditch will be constructed north of the Boynton-Cordelia Ditch. This will entail the loss of 70 acres of agricultural land in the secondary management area. The new ditches will not have an adverse effect on the landowner's farming operation. It will only affect the amount of farmable land available. The landowner will receive compensation for lands lost. The new ditches will have no more adverse effect on the existing upland habitat and wildlife than now exists.

The Cordelia-Goodyear Ditch will be constructed parallel with Highway 680 along the dividing line between marsh uplands and managed wetlands. As the ditch would be on the dividing line between uplands and wetlands, there would be little or no environmental effect on vegetation and wildlife.

The Potrero Hills Ditch will be constructed across both the primary and secondary management areas, presently used for agriculture. While it is true that the Potrero Hills Ditch could create a barrier to the free movement of land-dependent animals, no adverse effects on animal or plant communities are expected for several reasons. First, no known migration trails cross the ditch alignment, probably because the area is dominated by resident, rather than migratory, animals. Second, the ditch will not represent a barrier to many plants and animals, such as birds, swimming mammals, insects, and wind-borne seeds. Third, bridges with fill approaches are planned for three road crossings. The wide road shoulders will undoubtedly be used as animal pathways.

The belief by BCDC staff that pipelines are preferable to open channels has some merit; however, pipelines are not without adverse impacts. There could be high mortalities as fish are drawn into the pipe. The mortality rate would depend on the length of travel and water quality conditions encountered. The cost of either a 70-foot-diameter pipeline or 49 ten-foot pipelines to convey the volume of water needed would be high relative to that of the open channel. Placing heavy concrete pipe in this area of the Marsh could produce settlement because of the soils in the area. Special bedding and backfill material would be required. The source of this material could have an impact on areas outside the Marsh.

Although they may alter the travel routes of certain animals, open channels have considerable wildlife value, especially when compared to grasslands or agricultural areas. The edge effect and the diversity of wildlife species that prefer water areas and riparian channel banks far outweigh any adverse impacts expected. Because the genetic exchange of plant life is carried out mostly by the transfer of pollen and seeds (by birds, bees, and the

wind), this ditch will have no significant effect in these areas of concern.

Comment: As you are aware, the Commission must also find that no alternative exists to any proposed fill project and that the proposed fill will not have harmful impacts on the Bay. It is not at all clear that other alternatives involving considerably less fill and disturbance of the Suisun Marsh have been sufficiently examined for the Commission to make this finding. It also seems clear that the increased freshwater diversions that approval of this project would permit will significantly impact San Francisco Bay.

As stated in our earlier letter, the staff believes that the proposed water control structures at Goodyear Slough and Montezuma Slough may be in conflict with the McAteer-Petris Act, the San Francisco Bay Plan, and the Suisun Marsh Preservation Act and Protection Plan. The San Francisco Bay Plan Policy on Water Surface Area and Volume states, in part, that:

> "water circulation in the Bay should be maintained, and improved as much as possible. Any proposed fill, dikes, or piers should be thoroughly evaluated to determine their effects upon water circulation and then modified as necessary to improve circulation or at least to minimize any harmful effects".

It is obvious that such proposals may have profound impacts on water circulation of Bay waters, as well as adversely impacting navigation, fish migration, and normal salinity gradients. Therefore, we believe that the impacts of constructing such barriers must be much more thoroughly analyzed and understood before the Commission could approve their construction. (BCDC)

Response: The Plan of Protection is implementing a mandate from the State Water Resources Control Board. The SWRCB has the legal responsibility for approving water appropriations and diversions. SWRCB granted the authority to divert water in Decision 1485. If BCDC takes issue with diversions of water from the Delta, it should petition the SWRCB for reconsideration of Decision 1485. Trying to block implementation of Decision 1485 by refusing to grant permits for a mitigation program mandated in that decision is inappropriate. Governmental agencies should work together to give effect to all the laws and to serve the many, potentially competing, public policies that are reflected in those laws.

The changes caused by the Montezuma Slough control structure during dry and critical years when the structure is operating are:

- In conjunction with the other marsh facilities, prevent the marsh water from exceeding applicable water quality standards.

- Change the flow of Montezuma Slough by changing the net flow of 300 cubic feet per second easterly to 2,095 cubic feet per second westerly, only when the system is operating. This will keep the marsh water quality at a uniform level by using the better quality water available from the Sacramento River at Collinsville. There will be no net effect on the water of San Francisco Bay due to this change, because water diverted at Collinsville returns to the system at Suisun Bay and additional releases will be made to prevent water quality standards from being violated due to the diversion at Montezuma Slough Control Structure. Minimum quality west of Benicia may actually improve due to the additional releases.

- The gates will operate with the tidal cycle. They will be open during incoming tides and closed during outgoing tides.

The gates, flashboard opening, and boat lock, will be open the major portion of the time during normal and wet years, and from May to September in all years, to allow the water to flow unobstructed.

The impact on salinities of the Marsh will be positive rather than adverse. During dry and critical years, the structures will block the easterly flow of saline water and will pump quality water in a westerly direction to maintain the brackish water nature of the Marsh.

There may be an adverse impact on fish migration due to predation that may occur at the structure during dry and critical years or when the structure is operating on the tidal cycle. Due to the presence of the structure itself, minor increases in predation will occur during normal and wet years.

There would not be an adverse impact on navigation, because the lock would be of adequate size to handle recreational craft. It would always be open during the main boating season, May to September, and it would be a hindrance only when the structure was operating from September through May.

Movement of large barges and dredges into Montezuma Slough between the Grizzly Island Bridge and the proposed control structure can be accommodated. When this is required, the 60-foot flashboard opening could be opened to permit passage, or the center section of the bridge could be removed to allow heavy equipment to pass through.

DWR believes the Suisun Marsh Plan of Protection is consistent with the McAteer-Petris Act, the San Francisco Bay Plan, and the Suisun Marsh Preservation Act and Protection Plan. The purpose of the Plan is to maintain water quality in the Marsh by improving water circulation and promoting the flow of high quality water into the Marsh by way of Montezuma Slough. The Plan will result in an increase in water area in the Marsh. It will maintain a salinity gradient to preserve brackish conditions, rather than allowing the increases in salinity that would result from the absence of the plan and project. The project is designed to protect the wetland habitat and, thereby, to protect the rare and endangered species that live in the area. The project will also result in increased public access to the shoreline and water in the Marsh. New public roads and launching ramps will increase the opportunity for fishing, nature watching, and boat launching. Mitigation measures such as fish screens on new diversions will minimize adverse effects on, and possibly enhance conditions for, fish populations.

This EIR will support DWR's applications to BCDC for permits to construct the various project facilities in the Marsh.

Comment: The Plan of Protection estimates that the project will involve excavation of approximately 1,121,000 cubic yards of material, with approximately half of that being used in the construction of project facilities. The report further states that the remaining spoils will be used either in other projects outside the Marsh or disposed of in a manner acceptable to all regulatory agencies. One suggestion to "spread the spoils out on grazing lands in the secondary management zone of the Marsh" would appear to substantially disturb the wildlife habitat and grazing use of the lands and be in conflict with above Suisun Marsh Protection Plan policy. (BCDC)

Response: The statement that spoil disposal would disturb wildlife habitat could be true. Short-term disturbance must be weighed, however, against long-term benefit. DWR believes that spoil can be placed in areas acceptable to regulatory agencies. Spoil could be placed on existing marsh levees or spread on the club ponds that have bottoms with low elevations. This would improve habitat and substantially aid duck clubs in operating their areas in conformity with good water management practices. USCE recently completed a dredging project using this method of disposal, and environmental disturbances were much less than had been anticipated.

Comment: As stated above, the staff does not believe that all alternatives to the proposed Plan of Protection

have been sufficiently studied for the Commission to find that no better alternative to the project exists. Almost all of the selected alternatives are dismissed without any discussion of whether variations of the alternative were considered, or whether the alternative was subject to any degree of model testing. For example, one of the likely routes of the North Bay Aqueduct will be through the northwestern portion of the Marsh. Tapping into the Aqueduct at key locations may eliminate the need for constructing the Potrero Hills and Boynton-Cordelia ditches and may more effectively serve the western portions of the Marsh than the project proposed in the Plan of Protection. Combined with releases of fresh water in the Sacramento River sufficient to attain the water quality goals of Decision 1485 in the eastern sections of the Marsh, this alternative may meet the water quality standards at less environmental and economic costs.

Nor is it clear that 2 million acre-feet of fresh water would be required to provide full protection to the Suisun Marsh in dry and critical years. It is implied that this estimate is based on the assumption that the 2 million acre-feet of water would be released to the Sacramento River and be dispersed naturally throughout the Suisun Marsh. It may be possible to reduce significantly the amount of fresh water necessary to attain sufficient water quality if freshwater (including possible releases from the neighboring sewage treatment facilities) is released at strategic locations throughout the Marsh. (BCDC)

Response: The alignment of North Bay Aqueduct has removed it from being a viable source of quality water for the north portion of the Marsh. The use of this source for the westerly portion of the Marsh would have several negative results that are considered to be greater than the benefits derived.

- The cost of constructing a larger North Bay Aqueduct to transport an additional 212 cubic feet per second is too high for the value received.

- Because the water to be used is Sacramento River water, migrating fish would be confused by the water and be delayed in their migration, with possible adverse effects.

- Placing this amount of quality water into the natural waterway in the westerly portion of the Marsh (Suisun, Green Valley, and McCoy creeks) would freshen the water to a point where the area salinities could be too low. This could lead to the loss of pickleweed, which is the habitat of the endangered salt marsh harvest mouse.

° Water used from the North Bay Aqueduct would have to be replaced on a one-for-one basis to maintain salinity control below Rio Vista; water taken at Collinsville would not.

To fully protect Suisun Marsh in dry and critical years will require 3.8 to 4 million acre-feet of water in addition to that required for fish, agricultural, and municipal and industrial use. Treated waste water is a viable source to supplement some of this, according to USBR testing. The Department of Health Services, which must approve the use of treated waste water, indicates that it will have to be mixed at a 1 to 1 ratio to reduce algae growth that has appeared in test ponds. Treated waste water will be mixed with water from Boynton Slough and used in the westerly portion of the Marsh via Boynton-Cordelia Ditch and Cordelia Slough.

Comment: It is not clear what, if any, public access is proposed as part of the project. As all projects within the Commission's jurisdiction are required to provide maximum feasible public access, we believe that public access, consistent with the policies of the Suisun Marsh Protection Plan (listed on pages 5 and 6 of our earlier letter) should be considered. The Department of Fish and Game, Solano County, and BCDC should be consulted before any public access improvements are finally proposed. (BCDC)

Response: Most of the Marsh is private property, operated by private hunting clubs. Members of these clubs pay a fee to join and are assessed additional fees annually for club maintenance and improvements. Uncontrolled recreation, especially during hunting season, would be detrimental to the operations of these clubs. If recreation is provided, conflicts with hunting must be limited. The areas must also be patrolled for litter and for fire prevention during the dry season.

To avoid possible conflicts with the private hunting clubs in the area, recreational opportunities provided by the project will be limited to activities other than hunting. These activities may include fishing, boating, and nature study. New boating access may be provided at the Grizzly Island Bridge. Public access to the shore of Montezuma Slough may be provided on the road to the Montezuma Slough control structure. Other public recreational opportunities are already provided in the Grizzly Island and Joice Island Wildlife Management Areas, which comprise 13,700 acres. With the potential addition of up to 1,000 acres of mitigation lands, these public lands will provide substantial recreational opportunity for the public.

Comment: We are concerned that the 60-million-dollar estimated cost of the Plan of Protection may not reflect the true cost of the proposed plan. Levees will have to

be continually maintained in order for the Plan of Protection to work, and as stated in the report, "Maintenance of levee systems in the Marsh is a continuous and expensive process" (pages III-33). Already portions of the levee constructed but a year ago as part of the Initial Facilities have subsided and in at least one location, may have to be relocated. Water control structures, tidegates, and fish screens will also have to be maintained, repaired, and replaced. The staff believes that these costs should also be included when evaluating the proposed Plan of Protection. Including these costs will provide a true measure of the cost effectiveness of the proposed Plan of Protection, and it may be that an alternative requiring less physical modification of the Marsh would do a better job for less money. (BCDC)

Response: The implementation schedule on page 121 of the Plan of Protection shows the operation, maintenance, monitoring, and replacement costs for the facilities.

Comment: The proposed Plan of Protection ensures only that good quality water will be available for use but does not ensure that it will be correctly used. The report briefly discusses the fact that the U. S. Soil Conservation Service (SCS), under contract with the Suisun Resource Conservation District, is working to provide individual mangement plans for the various clubs served by the project. We feel that these management programs are an essential element of the Plan of Protection, and the report should include a discussion of how such programs will be implemented. An indication of how many clubs are currently following good water management practices, how many can be expected to do so in the future, and the location of the clubs practicing good water management would be helpful to the Commission. Assisting the clubs to ensure proper management practices may well be a cost effective method for making sure the project has its intended result. (BCDC)

Response: The SCS has developed management plans for 82 of the 168 private ownerships within the Primary Management Area of the Marsh; the plans have been reviewed and certified by BCDC. SCS is working on plans for the remaining clubs. Each of these plans identifies the water management facilities necessary to flood and drain the property within 30 days. DWR will provide adequate quality water to the Marsh for the clubs' use. Assuring proper day-to-day management of the clubs is outside DWR responsibility. This responsibility is assigned to SRCD in the proposed DWR/DFG/SRCD contract. SRCD has acted responsibly in adopting a Marsh Management Program, complete with regulations for the management of the duck clubs. SRCD sponsored legislation, AB 2090, which became effective in October 1982, that granted SRCD

the power to inspect clubs for compliance with SRCD regulations. AB 2090 also provided a vehicle for State reimbursement of 50 percent of the O&M cost incurred in improving the wildlife habitat. The individual management plans prepared by SCS must be approved by the SRCD, reviewed by DFG, and certified by BCDC. DWR believes that this process will better assure good management.

Comment: The project may have several important impacts on fish and wildlife. These are only superficially discussed in the Draft Environmental Impact Report. For example, will operation of the Montezuma Control Structure affect the migration of king salmon, steelhead, and other anadromous fish? The report states that one project impact would be that "in the eastern portion of Montezuma Slough, net velocities would approach or exceed those found limiting for Neomysis. Neomysis populations could be reduced in that area, with a corresponding reduction in fish that depend on Neomysis for food-notably striped bass". (Page IX-9). How significant is this potential impact? Can sizeable reductions in the populations of Neomysis and striped bass be expected? Several endangered plants are found in the Suisun Marsh. Will any of these plants be affected by the construction and/or operation of the project facilities? The report states that "The work of constructing the facilities would have little environmental impact" (Page IX-5). Yet over 1,000 acres of wetlands and uplands habitat will be at least temporarily destroyed during project construction. This is a major and substantial adverse impact; the loss of this amount of wildlife will result in at least some temporary reductions in the population of some of the fish and wildlife species inhabiting the Marsh. Could such losses be significant for any given species? As yet, no fish screen has yet been devised that actually works. How many fish can be expected to be killed during the operation of water control structures without fish screens? How likely is it that an effective fish screen will be available by the time the facilities are in operation? How will the project affect salinity gradients throughout the Marsh? Are these changes in salinity gradients sufficient to disrupt normal behavior of various aquatic animals (including fish) living in the marshes, sloughs, and channels? (BCDC)

Response: Department of Fish and Game publication, "Aquatic Resources of Suisun Marsh with an Analysis of the Fishery Effects of a Proposed Water Quality Maintenance Plan", October 1980, states that implementation of the recommendations found on page 21 of the publication will minimize adverse impacts of the project and avert significant reductions in fish populations. Those recommendations will be instituted as part of the design and operation of the project.

From July to September 1980, Stephen P. Rae, State Plant Ecologist, Department of Fish and Game, periodically visited the area proposed for ground disturbance. Based on his field surveys and review of file information, he has not been able to document the existence of the following plant species within the proposed areas of activity:

Aster chilensis var. lentus (Suisun aster)
Cicuta bolanderi (Water hemlock)
Cirsium hydrophilum var. hydrophilum (Suisun thistle)
Cordylanthus mollis ssp. mollis (Soft haired birds beak)
Lasthenia conjugens (Contra Costa gold fields)
Lathyrus jepsonii ssp. jepsonii (Delta tule pea)
Legenere limosa (Greene's legenere)
Lilaeopsis masonii (Mud Flat quill-plant)

Species of wildlife found within the Marsh are distributed over large areas. Construction activities, while disturbing local areas, will not, therefore, significantly affect any given species. DFG and DWR believe that this is also true for endangered species, such as the salt marsh harvest mouse.

The opinions expressed relative to fish screens are not shared by DWR and DFG. Considerable time, effort, and expense is being and will be spent to design, construct, and operate effective fish screens. None of the preproject diversions to duck clubs in the Marsh were screened. The screening of major diversions, such as Roaring River Slough, Grizzly Ditch, and possibly Morrow Island Ditch, will, therefore, incidentally improve an existing condition that is detrimental to anadromous fish.

Comment: Throughout the report, it is stated that appropriate mitigation for adverse impacts is being studied. The staff believes that the Commission would be reluctant to consider any project of this magnitude without an accompanying mitigation plan which would assure that all project impacts would be effectively mitigated. For example, the Channel Islands, the southern tip of Joice Island, and the Van Sickle-Chipps Island area will not be protected by the facilities proposed in the Plan of Protection. Mitigation for these areas should be provided as part of the project. The project will also involve the "permanent conversion of 464 acres of marsh and 37 acres of upland habitat to 505 acres of water surface and 6 acres of road surface" (page IX-36). First, the report never explains why these figures do not add up. Secondly, although the report indicates that the Department of Water Resources recognizes that these project impacts must be mitigated, the BCDC staff believes that a mitigation proposal will have to accompany any application for the facilities proposed in the Plan of Protection, and that the mitigation proposal should also be discussed in an appropriate

environmental document. We also believe that as the entire project can be viewed as mitigation for adverse impacts caused by the water projects, the Department of Water Resources should consider additional mitigation measures to ensure the success of the Plan of Protection. For example, we believe that the Department of Water Resources should consider assisting in the management of those clubs practicing poor water management. (BCDC)

Response: Up to 437 acres of wetland and 96 acres of uplands, will be altered to new uplands and water surface. If DWR finds it feasible, this change will be mitigated by acquisition and development of new wetlands as is outlined in USBR's Biological Assessment, attached to the EIR as Appendix D. This may lead to a temporary loss in wildlife habitat, but in the long run, it could lead to an improvement for wildlife and, therefore, not represent an adverse impact. To minimize animal loss during construction, DFG proposes to remove endangered species from the construction zone to other habitat areas in the Marsh.

Mitigation reports are included in the final EIR as appendices. The project is mitigation for the adverse impacts caused by the SWP and CVP on the Marsh. The Department of Water Resources does not believe that additional measures, by DWR such as assisting poorly managed clubs, are needed to ensure the success of the Plan of Protection. This is the responsibility of the clubs and of the SRCD.

The SWP has already provided mitigation for the adverse impact caused by construction of the project, and DWR believes that the Plan of Protection for the Marsh, when complete and operational, will satisfy its responsibility to provide quality water to the Marsh, as mitigation for the impacts of the SWP. Ensuring proper management of the individual clubs will be the responsibility of SRCD, whereas the Department's concern is to operate the facilities and provide water to meet water quality standards each year. Van Sickle and Chipps islands do not presently need facilities to meet water quality standards; they may, however, after the year 2000. It is expected that facilities for Van Sickle and Chipps islands would be provided after the need for them had been demonstrated.

Comment: The facilities may affect water quality sufficiently to meet the water quality standards of Decision 1485. But then again, there is no assurance that the facilities will perform as expected. This fact is tacitly admitted on page IV-12 of the report where it is stated that "should the physical facilities prove to be inadequate to meet the D-1485 standards, diversion from Lindsay Slough would have to be reconsidered". Therefore, we believe that the Environmental Impact Report for the Plan of Protection

should include a description of all studies performed to determine the likelihood that the plan will achieve its goal of meeting the water quality standards set in D-1485. In particular, the EIR should include a description of the model used to test the Plan of Protection, including the assumptions made in the model and a detailed analysis of the results of the model tests, including the estimated range of errors. Consideration should also be given to having an independent analysis of the model and its results. We believe that such an analysis is exceedingly important as construction of the facilities proposed in the Plan of Protection involves many risks that the plan will not be adequate to meet D-1485 standards and that the Marsh will be irreversibly altered by the facilities proposed. We believe that the Commission will desire that these risks be thoroughly known and understood, prior to their approval of the Plan of Protection, and that they have some assurance that the potential environmental benefits of the project are worth these risks.

Finally, the magnitude of the work proposed and the modifications of the Suisun Marsh necessary to meet these standards make us uneasy, particularly as no studies have yet been made of the success of the interim facilities approved in BCDC Permit No. 35-78. Projects of this magnitude usually have ramifications that are either poorly understood or were not considered or anticipated. For these reasons, the BCDC staff favors any approach requiring less drastic physical alteration of the Marsh, including the release of additional fresh water. The BCDC staff believes that the Commission would feel considerably more comfortable with the proposed Plan of Protection if it had more concrete assurance that: (1) The proposal were likely to work. (2) That such a structural solution would not necessarily result in long-term adverse impacts on the Marsh. (3) If the final proposed project were in conformance with the Commission's laws and plan policies. (BCDC)

Response: To include copies of all the various reports to the Plan of Protection and EIR is not practical because the material is too voluminous. DWR will make available to BCDC, upon request, copies of the reports it needs. DWR has met with BCDC staff and its computer modeling consultant and has responded to the issues raised in the consultant's report on the marsh model.

DWR believes that staging construction, with a period of testing between construction of the various facilities, will assure that the Plan of Protection will be adequate. Staging construction will allow DWR to test and verify the assumptions made in the Suisun Marsh model to eliminate facilities not needed and adjust the proposed sizing of needed facilities so that their

design will be appropriate to serve the needs of the Marsh with minimum adverse impact.

Roaring River Slough has been in operation 4 years and has delivered the quantity and quality water required by the clubs served by it. Morrow Island Ditch has also proven its operational capabilities during its 3 years of operation. With the quality of water delivered by the Initial Facilities, the clubs in the area serviced have the potential of growing good crops of the preferred duck foods.



C—054196

C-054196

# COPIES of LETTERS

# RECEIVED

# STATE WATER CONTRACTORS AUDIT COMMITTEE

c/o 1109 Whitley Avenue
Corcoran, California 93212

Alameda County Flood Control and Water Conservation District
Alameda County Water District
Antelope Valley-East Kern Water Agency
Castaic Municipal Water District
Castaic Lake Water Agency
Coachella Valley County Water District
Desert Water Agency
Devil's Den Water District
Dublin Ridge Water District
Empire Westside Irrigation District
Kern County Water Agency
Kings County
Lakerock Creek Irrigation District
Mojave Water Agency
Napa County Flood Control and Water Conservation District
Palmdale Water District
San Bernardino Valley Municipal Water District
San Gabriel Valley Municipal Water District
San Luis Obispo County Flood Control and Water Conservation District
Santa Barbara County Flood Control and Water Conservation District
Santa Clara Valley Water District
Solano County Flood Control and Water Conservation District
Tulare Lake Basin Water Storage District

November 20, 1980

Mr. Wayne MacRostie
Chief, Central District
Department of Water Resources
3251 S Street
Sacramento, California 95816

Subject: Report on "Plan of Protection for the Suisun Marsh"

Dear Mr. MacRostie:

Set forth herein are the comments of the State Water Contractors Audit Committee on your September 1980 report "Plan of Protection for the Suisun Marsh, including Draft Environmental Impact Report". The State Water Contractors Audit Committee is, of course, most concerned with the cost of the program which will ultimately be passed on to the State Water Contractors.

Our first area of concern is that any fish and wildlife enhancement resulting from this program and other facilities of the State Water Project be fully reflected in the Project purpose cost allocation. In this connection, we note that while there has been a slight decrease in Pintail Ducks in the Suisun Marsh (see page III-23), there has been a substantial increase at other Project facilities such as Clifton Court Forebay, Bethany Reservoir and San Luis Reservoir (see page III-22). The graph on page III-23 shows that as a result of these facilities and other factors, there has been an increase of more than one million (some 60%) since the early 1960's. We also note that about 74% of the Suisun Marsh area is in private ownership, not accessible to the general public and the enhancement of conditions on these lands must also be taken into account in the cost allocation process and not charged against the State Water Contractors.

An additional item which should be considered in the allocation of costs is that the Project is purportedly required because of a diminution of flow has been caused by not only diversions by the State Water Project but also by diversions by the Central Valley Project and others. The diversion by others includes East Bay MUD

City of San Francisco and other northern California cities, but also irrigators in the Sacramento and San Joaquin Valleys. While the exact relationship is not susceptible to evaluation, we urge that the portion of the Project required to offset the effects of diversions by others be allocated to others than the State Water Contractors.

The other item of concern to the Audit Committee Members are the costs associated with the Project. We note that the capital cost at 1979 price levels are estimated to be $60,000,000 and inflation will undoubtedly push the actual cost incurred well above this amount. We urge that the Department do everything within its power to keep these capital costs at as low a level as is possible. Furthermore, we urge that the Department take all action necessary to keep to a minimum the operating cost of the facilities. In particular, we urge that care be taken to limit the State's operating cost to those necessary for its facilities and not permit its operational activities to extend to facilities of others such as landowners in the Suisun Marsh.

We appreciate having had the opportunity to submit these comments.

Very truly yours,

Robert N. McKinney, Chairman
Suisun Marsh Subcommittee
State Water Contractors Audit Committee

cc: Brent Graham

**SIERRA CLUB**
Northern California/Nevada
Regional Conservation Committee 6014 College Avenue Oakland, California 94618

Mr. Wayne McRostie, Chief
Central District
3251 "S" Street
Sacramento, CA 95814

Nov. 22, 1980

Dear Mr. MacRostie:

Re: Comments by the Sierra Club on the Draft Plan of Protection for the Suisun Marsh and Draft EIR

The importance of Suisun Marsh in preserving many species of endangered wildlife, in supporting migrating waterfowl, in cleansing pollution, and as a unique expanse of semi-wild brackish marshland demands a high priority by all government agencies whose activities impinge on the welfare of the marsh. The Sierra Club actively worked to pass various measures, including the Suisun Marsh Protection Act AB 1717, designed to preserve this unique California resouce.

Water is the "life-blood" of the Suisun Marsh ecology. We have carefully reviewed the Proposed Plan of Protection for the Suisun Marsh and have consulted with the Bay Conservation and Development Commission (BCDC) and California Department of Fish and Game (DFG) in preparing these comments.

Nonstructural vs. Structural Plan

We do not feel that the proposed Plan adequately evaluates the option of the use of increased water releases ("Nonstructural") to safe-guard the water quality of Suisun Marsh. We do not agree that such releases cannot be construed "a reasonable and beneficial use of water" as the Department of Water Resources (DWR) contends (see P. I-8). Consistently, the intent of water use for "reasonable and beneficial" purposes has been interpreted to include protection of ecological and environmental values.

We ask if a "middle ground" solution to Suisun Marsh water quality problems cannot be reached by increasing water releases above those advocated by the Plan, but also providing some structural facillities to increase the "efficiency" of such releases. If feasible, such a solution should be evaluated.

Further, water releases must be seen in the context of benefit downstream, e.g. flushing flows for San Francisco Bay.

We urge that the value of increasing water releases be evaluated by the final Plan in more detail.

Will the Proposed Plan Work?

Of course, a major consideration in addressing the problem is the

feasibility of the solution. Will the Structural Plan, if implemented, provide improved water quality in Suisun Marsh? Aside from the use of the Army Corps of Engineers' Bay Model, is there data and/or examples of reasonable success? Are the preliminary structural facillities operating as per expectations? Are there examples of similar structures elsewhere?

Loss of Marsh Habitat and Mitigation

Is the loss of 464 acres of marshland avoidable, e.g. by alternative routing of ditches and alternative siting of pumping stations, etc?

We understand that DFG has additional data, including completed studies on the endangered Black Rail and San Francisco Salt Marsh Harvest Mouse. We concur with their desire to incorporate this information in the Final Plan.

We agree with the concerns of BCDC as to the disposition of the dredge spoils from construction of ditches -- where will this material be disposed?

In the event that the 464 acres of marshland are lost to construction, we agree mitigation is in order. Details of such mitigation (e.g. where will new marshland be established? Under what time-table? Using what techniques?) should be incorporated into the Final Plan.

Water Law Reform and Conservation

While the issues of water law reform (e.g. instream flows, ground water management) and water conservation ( the Sierra Club supports a state-wide water conservation effort in urban, industrial and agricultural uses) are beyond the scope of the present Plan, we still feel the need to point out the inter=relationships of these concepts. Clearly, human water use patterns will ultimately determine the fate of Suisun Marsh; wise husbanding and conservation of the water resources of our state can safe-guard Suisun Marsh and other wild habitats.

Thank you for your consideration of our comments. We look forward to working with you to develop and implement the best possible Plan for the Protection of the Suisun Marsh.

Sincerely yours,

Mark J. Palmer,
Regional Vice President

cc Jeff Blanchfield, BCDC
Glen Rollins, DFG

DEPARTMENT OF TRANSPORTATION
UNITED STATES COAST GUARD

MAILING ADDRESS:
Commander (oan)
12th Coast Guard District
630 Sansome Street
San Francisco, CA 94126

Suisun Marsh General
16500
28 October 1980

Mr. Wayne MacRostie
Chief, Central District
Department of Water Resources
3251 "S" Street
Sacramento, CA 95816

Dear Mr. MacRostie:

The Coast Guard has reviewed your draft Environmental Impact Report on the Suisun Marsh Protection Plan and has the following comments:

1. The Goodyear Slough control structure will impose a permanent barrier to navigation for approximately four miles.

2. The Montezuma Slough water control structure will pose a significant hindrance to navigation, restricting access to more than 22 miles of waterway.

3. The lock size is smaller than recommended in our letter of 3 APR 80 (copy enclosed). We recommend that the length be increased to 70 feet.

4. The method of operation although not in detail in the DEIR appears reasonable. Will the lock be manned during hours of operation (except when standing open)? Will there be a radio-telephone installed?

5. We still believe that the appropriate mitigation for the waterway obstructions is the elimination of another State owned obstacle to navigation, the Grizzly Island Bridge. A short drawbridge, perhaps even one operated by passing water-craft, could be installed in the existing bridge. This would improve waterway access for some vessels and could offset the effects of the water control structures. A picture of a hand-operated Bascule bridge in Europe is enclosed.

6. Your project may require the construction of access road bridges over tidal waterways. Those will require the prior approval of the Coast Guard. A bridge permit guide is enclosed.

16500
28 October 1980

The opportunity to review this report is appreciated.

Sincerely,

T. V. JOHNSON
Commander, U. S. Coast Guard
Chief, Aids to Navigation Branch
By direction of the District Commander

Encl: (1) My ltr 16500 of 3 APR 80
(2) Bridge Permit Guide
(3) Picture of Hand-Operated Bascule Bridge

Copy: ~~Sacramento~~ SF Corps of Engineers w/encl.
CCGD12 (b)
CCGD12 (dpl)
California Dept. of Boating and Waterways

Commander (oan)
12th Coast Guard District
630 Sansome Street
San Francisco, CA 94126

16500
3 April 1980

Director
Department of Water Resources
Attention: George Spencer
1416 Ninth Street
Sacramento, CA 95814

Dear Mr. Spencer:

Our recommendations for a water control structure on Montezuma Slough are:

1. That the lock be operated on a regular basis (e.g., 6 a.m. - 10 p.m. from 1 May through 31 October; 9 a.m. - 5 p.m. 1 November - 30 April); and

2. That the lock be constructed large enough for the largest vessels that could ordinarily be expected to use it during the life of the lock. We estimate that vessel size to be: LOA - 65', Beam - 18', Draft - 8'. Lock size should be slightly larger to provide maneuvering room, perhaps 70'X20'X9'. The lock should have a radiotelephone installed.

A water control structure on Montezuma Slough would be a significant hindrance to navigation. We believe a suitable mitigation measure would be to replace the California Fish and Game Commission's Montezuma Slough Bridge with a moveable span bridge. We reviewed the Bureau of Reclamation's Draft Suisun Marsh Management Study Appraisal Report in October 1973. At that time we pointed out to them that we have a record of a continuing marine interest in replacing the Montezuma Slough Bridge with a movable bridge. This indicates to us a significant interest in increasing the recreational use of Montezuma Slough. We believe that use of the waterway for recreational boating and fishing should be encouraged.

Sincerely

J. S. BLACKETT
Commander, U. S. Coast Guard
Chief, Aids to Navigation Branch
By direction of the District Commander

Copy to: Corps of Engineers, S. F.
Attn: Skid Hall

MARIPOSA HUNTERS PT. YACHT CLUB
FLOATING REALTORS YACHT CLUB
PARADISE HARBOR YACHT CLUB
BRIDGE MARINA YACHT CLUB
DELTA MARINA YACHT CLUB
LOCH LOMOND YACHT CLUB
PORT SONOMA YACHT CLUB
COYOTE POINT YACHT CLUB
OYSTER POINT YACHT CLUB
BALLENA BAY YACHT CLUB
FORT SUTTER YACHT CLUB
SAN JOAQUIN YACHT CLUB
SAN RAFAEL YACHT CLUB
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RIVER VIEW YACHT CLUB
PENINSULA YACHT CLUB
SPINDRIFT YACHT CLUB
MARIN YACHT CLUB

METROPOLITAN YACHT CLUB
LITTLE VENICE YACHT CLUB
SPORTSMEN YACHT CLUB
NORTH BAY YACHT CLUB
SOUTH BAY YACHT CLUB
PITTSBURG YACHT CLUB
INVERNESS YACHT CLUB
MARTINEZ YACHT CLUB
RICHMOND YACHT CLUB
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GALLINAS YACHT CLUB
DIABLO SAILING CLUB
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ISLAND YACHT CLUB
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# Pacific INTER CLUB Yacht Association

**SAN FRANCISCO, CALIFORNIA**

REGIONAL AFFAIRS SECRETARY
**RICHARD M. BOSWELL**
3505 BROADWAY, SUITE 1000
OAKLAND, CALIF. 94611
PHONE: DAY: (415) 658-8550
DAY OR EVE.: 525-2511

To: Wayne MacRostie, Chief
Central District
Department of Water Resources
3251 "S" Street
Sacramento, California 95816

STATEMENT OF THE PACIFIC INTER-CLUB YACHT ASSOCIATION AT THE PUBLIC HEARING, NOVEMBER 24th, 1980, FOR THE PLAN OF PROTECTION FOR THE SUISUN MARSH AND DRAFT ENVIRONMENTAL IMPACT REPORT (DEIR).

Gentlemen, my name is Richard Boswell, Regional Affairs Secretary and Chairman of the Delta Committee of the Pacific Inter-Club Yacht Association. On behalf of our 72 Member Clubs in the San Francisco Bay - Delta area, with more than 12,000 boating families, I wish to officially go on record that this document does not adequately address the significant hindrance to navigation that the Montezuma Slough Control Structure will pose. It will restrict access to more than 22 miles of waterway, and will be another State-owned obstacle to navigation. The document also does not address mitigation measures for this significant hindrance to navigation. The U. S. Coast Guard has consistently recommended installation of a short draw span in the Grizzly Island Bridge as suitable mitigation for the proposed Control Structure. There is a significant interest in the marine community in increasing the recreational use of Montezuma Slough, a beneficial use of the human environment of this natural resource. Sailboats are energy-efficient recreational craft. They are the ones that will be affected the most by this structure, as they are with the other State-owned obstacle to navigation on Montezuma Slough, the Grizzly Island Bridge.

We are astounded that those responsible for the drafting of this report have totally ignored the Coast Guard's repeated assertions about the Control Structure and Small Craft Lock's adverse impact on navigation

Continued next page

of Montezuma Slough, as well as their mitigation requests. It is Boating's intention to fully support the Coast Guard's position.

This Report ignores the fact that Montezuma Slough is a navigable public waterway, and the existence of the Public Trust over such waterways. There are State and Federal Agencies that guard that trust. No individual or agency has the legal right to block or restrict such a waterway. They may apply for that right to the Corps of Engineers or the Coast Guard, as the case may be. At that time individuals and governmental agencies have the right to state their position, and it would seem prudent to consider the position of the involved agencies.

A case in point was the Coast Guard Public Hearing of April 19, 1979, Re: The Joint Application by the County of San Joaquin and the MacDonald Island Reclamation District #2030, for a Fixed Low-level Bridge over Turner Cut. The Applicants had ignored advance warnings by Coast Guard Staff that approval recommendations were contingent upon inclusion of a draw span in the bridge. At the Hearing, Boating interests certainly justified the Coast Guard's advance warnings.

The Applicant's EIR for the Turner Cut Bridge adversely considered the alternative of a traditional 90ft. drawbridge and the personnel cost of operating the draw. We proposed at that Hearing, that it was time to re-think traditional drawbridge engineering, and to design a low-cost draw span with a 25' to 30' opening for pleasure craft, using automated controls. (The Coast Guard has granted permits for numerous automated bridges across the nation.) The Applicants immediately endorsed that concept. They subsequently designed a hydraulically operated "slide-back" opening span, which the Coast Guard has since approved.

A copy of the Design Engineer's sketch of the Turner Cut Bridge slide opening is enclosed with this statement, along with a reprint of the Federal Register, Vol.43, No.218 of November 9th, 1978, describing the operation of a fully automated R.R. Bridge across the Victoria Channel in Texas. The Coast Guard has also sent you pictures of the narrow draw spans across the waterways in Europe, which are so well counterbalanced that one person can raise them by hand.

continued next page

We are not saying 'no Control Structure'. What we are saying is that the Coast Guard has solid reasons and strong support for their request for an opening span in the Grizzly Island Bridge as a mitigation measure for the Montezuma Slough Control Structure's further detrimental effect on navigation.

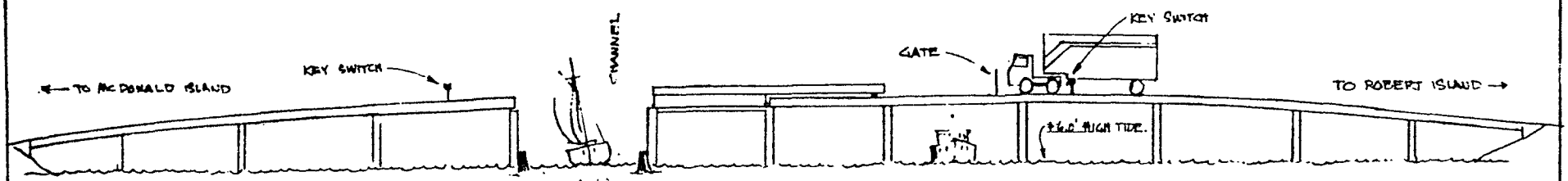
Thank you very much.

* * * * * *

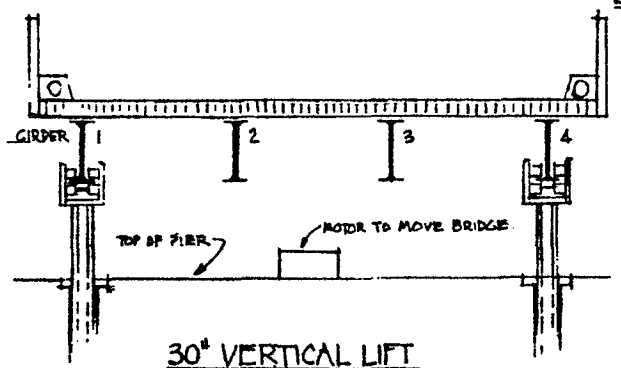
END STATEMENT

Attachments: 2

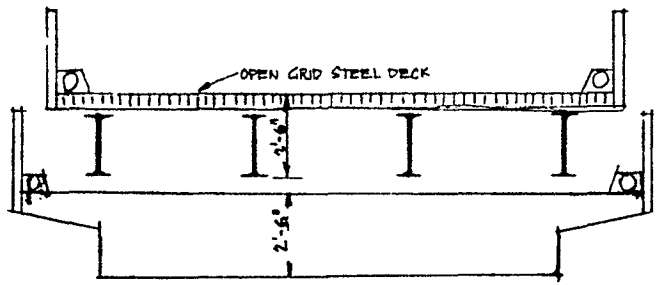
cc: U.S. Coast Guard, 12th District,
Aids to Navigation Branch
San Francisco Corps of Engineers
Department of Boating and Waterways




ELEVATION (OPEN POSITION)




30' VERTICAL LIFT
(FIRST PHASE)




MOVABLE SECTION ON BRIDGE
IN OPEN POSITION.
(SECOND PHASE)

• PROJECT DESCRIPTION

BRIDGE TO BE 470' TOTAL LENGTH CONSISTING OF 10-40' REINFORCED CONCRETE SPANS AND 2-35' STRUCTURAL STEEL SPANS WITH OPEN GRID STEEL DECKING. ALL THE SUPERSTRUCTURE TO BE SUPPORTED BY 2 PILE COLUMN BENTS. THE ROADWAY GEOMETRICS ARE FOR ONE-WAY TRAFFIC. AN 18' ROADWAY WIDTH WAS CHOSEN TO ACCOMODATE OVERWIDTH TRUCKS AND FARM EQUIPMENT.

: THE LOW LEVEL STRUCTURE PROVIDES A VERTICAL CLEARANCE OF 16' AT HIGH TIDE AND 19.5' AT LOW TIDE. THE 16 FOOT VERTICAL CLEARANCE WILL SATISFY THE REQUIREMENTS OF POWER BOATS AND WATER SKIERS.

: A MOVABLE SPAN TO PROVIDE AN OPENING OF 35' AND A CLEAR NAVIGATION SPAN OF 25'. THE DIFFERENCE BEING THE PROTECTIVE FENDER SYSTEM REQUIRED FOR WATER TRAFFIC SAFETY.

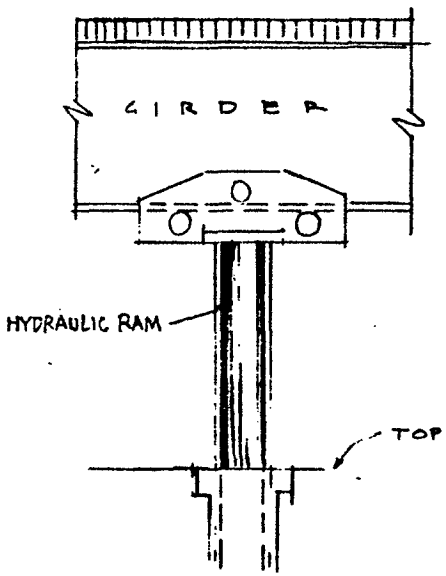
: THE STEEL SPANS ARE THE MOVABLE SECTIONS PLACED IN SPANS 5 AND 6. A HYDRAULIC RAM SYSTEM WILL OPERATE TO RAISE THE STEEL SPANS A VERTICAL HEIGHT OF APPROXIMATELY 2-½ FEET. UPON THE COMPLETION OF THIS CYCLE, A HYDRAULIC SYSTEM WILL BE ACTUATED MOVING THE STEEL SPAN LONGITUDINALLY, WITH SPAN 5 TRAVELING ON AND OVER SPAN 6 A DISTANCE OF APPROXIMATLY 35 FEET THEREBY PROVIDING THE SPAN 5 OPENING FOR SAILBOATS AND SUCH OTHER CRAFT.

THE MOVABLE SPAN IS KEPT IN THE OPEN POSITION. TRUCKS AND OTHER BRIDGE TRAFFIC WOULD CONTROL CLOSING THE SPAN BY A KEY CONTROL BOX LOCATED ON THE APPROACH SPANS.

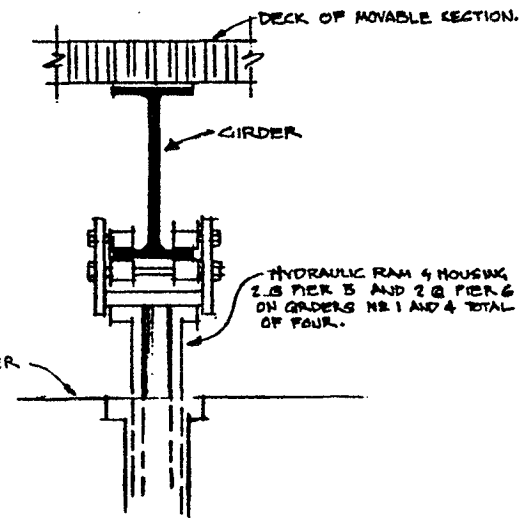
IT IS ESTIMATED THAT APPROXIMATLY FIVE MINUTES WOULD BE REQUIRED TO OPEN OR CLOSE THE BRIDGE SPAN.

— AUXILLARY STANDBY EQUIPMENT WOULD BE PROVIDED.

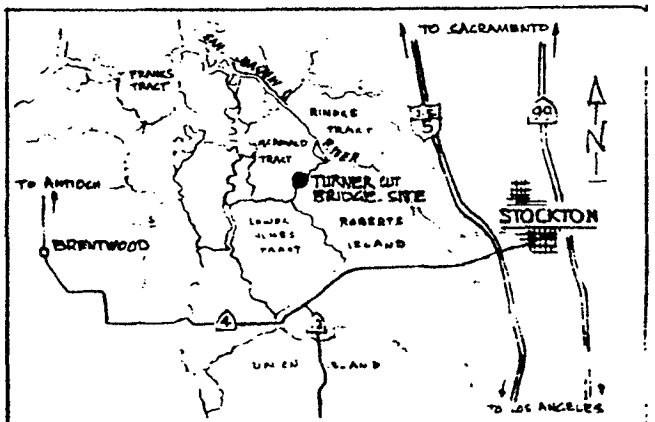
THE SYSTEM WILL ALSO PERMIT OPENING OF THE BRIDGE BY BOAT TRAFFIC.




SIDE VIEW OF JACKING UNIT
IN RAISED POSITION




SKETCH OF JACKING UNIT
AT PIER 6 AND 7




LOCATION MAP

WARREN N. SAMARZICH & ASSOCIATES
CONSULTING CIVIL ENGINEER
1722 J STREET, SACRAMENTO, CA. 95814 (916) 441-3035

• RECLAMATION BOARD 2030 •

• TURNER CUT BRIDGE •

C-054208

C-054208

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FAIRFIELD, CALIFORNIA 94533

COUNTY ADMINISTRATOR
DAVID BALMER
(707) 429-6211

CLERK OF THE BOARD
JOHN BLACKLOCK
(707) 429-6218

November 18, 1980

Mr. Wayne MacRostie
Chief, Central District
Department of Water Resources
3251 "S" Street
Sacramento, CA 95816

Dear Mr. MacRostie:

Re: Plan of Protection for the Suisun Marsh including Draft Environmental Impact Report

Thank you for the opportunity to comment on the Department of Water Resources "Plan of Protection for the Suisun Marsh". As you are well aware, your proposed project lies entirely within Solano County, and the protection of the Suisun Marsh has been of utmost concern to the Board of Supervisors. The County fully supports all efforts to mitigate water quality problems due to increased salinity intrusion into the Suisun Marsh, and we recognize that this project could represent an important step in providing a long-term solution to this situation.

The project does, however, propose substantial alterations to the Marsh environment which are very technical in nature, and, as such, requires considerable review and analysis by all affected agencies. As a result of our preliminary review of the project, and its Draft Environmental Impact Report, the County does have several areas of concern with the report as currently drafted.

The report is somewhat superficial considering the huge public expenditure and the large amount of environmentally sensitive habitat that would be disturbed. It seems that the underlying concept is somewhat theoretical and that there are still many uncertainties as to how efficiently the system will work. There is a major emphasis on monitoring all aspects of the project and continually evaluating its performance which is valuable in assuring the optimum performance of the system but the report gives the impression that it is not really known how well it will work. In some sections, it is actually stated that DOWR does not have any idea what the impacts might be. It seems critical to Solano County that the performance of the project be assured and the impacts thoroughly addressed prior to spending millions of dollars and adversely impacting that much valuable habitat.

Besides a general concern over the lack of detail in addressing the impacts of the project, we do have several concerns over the short-term impacts during construction and the long-term impacts of the project itself. These are outlined below:

Short-Term Impacts

The DEIR begins by stating "the work of constructing the facilities would have little environmental impact". The County believes that construction operations could have an impact and some of these concerns came to light during construction of the initial facilities phase of the project. A major concern is the adverse impact on our local road system of transporting construction materials and heavy equipment. During the construction of the Roaring River Project, damage to Grizzly Island Road was so extensive, it became necessary to formalize an agreement between Department of Water Resources and the County to provide funds for road reconstruction. We assume Department of Water Resources will recognize the same responsibility for the remaining projects and request that prior to awarding of future contracts DOWR meet with County staff to determine a method for preserving local roads. Construction of the project could also result in the temporary closing of existing roads for new bridge construction. What impacts this might have on existing uses in the Marsh and Potrero Hills is not known.

The other area of great concern deals with the dredging and removal of natural materials and the disposal of such spoil materials. The DEIR indicates that 1,121,000 cubic yards of materials is to be excavated. About half would be used for the project facilities but it is not clear how the other half would be disposed of. It explains that half of the excess might be needed by the City of Fairfield. It is not known what it is to be used for or what the composition of such material might be. The remainder is proposed to be used for cover on the Potrero Hills landfill or be spread out over grazing lands in the secondary management area. At one point, it is even proposed that spoils be spread over existing marsh vegetation. Disposal of spoils in this manner is very questionable and must be addressed in greater detail and specific sites considered for disposal need to be identified.

The County is further concerned that the DEIR does not adequately address the problems of noise and dust pollution, increased sedimentatio and turbidity, sources of borrow materials, energy usage, and the location of "staging areas" for storage of materials and equipment. The report should also indicate what type of governmental permits are necessary and what guidelines must be followed. The Suisun Marsh Preservation Act and Protection Plan as well as the County's local component of the Suisun Marsh Local Protection Program specifically

require certain types of construction techniques and provisions for undergrounding of utilities which must be incorporated in the project. A project of this magnitude in an environmentally sensitive area requires greater detail in addressing these problems.

Long-Term Impacts of the Project

The County is deeply concerned about two main long-term impacts of the project. The project would result in a significant loss of habitat and would create several major barriers to wildlife movement in the Marsh. It would seem that the loss of 424 acres of marsh vegetation including important habitat of several rare and endangered species would indeed be significant. The report indicates that the impacts would be small but certainly no information is given to substantiate this claim. The only real mitigation suggested is to compensate the loss by developing and improving habitat elsewhere, most likely within the secondary management area. It should be noted that while taking extensive agricultural lands out of production for use as marsh habitat may help the Marsh, it also impacts upland grazing lands currently in production.

The project also could result in the loss of fish and wildlife to an unknown extent. The report indicates that no wildlife surveys have been done in some sections of the Marsh and that the impacts to fisheries have not been fully evaluated. Increased flows within some waterways could also result in the loss of neomysis shrimp which is the major food source of striped bass. This impact should be further addressed in the report.

The second major area of concern deals with barriers to wildlife movement that will be created by the project. The facilities would create miles of new ditches with very little area provided for wildlife movement. The report states that the Potrero Hills Ditch which runs from Luco Slough to Hill Slough for a distance of 3.5 miles and will be up to 150 feet wide in areas "should not result in significant adverse impacts to wildlife". Besides creating a barrier to wildlife, the ditch could have significant visual impacts due to its proximity to Suisun City and State Route 12. A cross section of the ditch showing levee heights would serve to better evaluate such an impact. The report should also address the potential for use of waters flowing through the ditch for irrigation purposes on adjacent grazing lands, effect on nearby wells, and potential for contamination of marsh waterways from the abutting solid waste facility.

Also of concern is the operation of the Montezuma Slough Control structure. The Collinsville-Montezuma Hills Area Plan and Program provides for the construction of marina facilities in close proximity to the structure near Collinsville. Such a marina facility could increase recreational use of the eastern portions of Montezuma Slough and it is not known what effect the operation on the control structure might have on the recreational use.

We thank you for the opportunity to express our concerns and hope that our comments may help in assuring the best possible design for the project. As we have previously stated, we share your concern over improving water quality within the Suisun Marsh and will cooperate with you to the greatest extent possible. Should you have any questions regarding any of our comments, please feel free to contact the Board or any affected County department.

Very truly yours,

Wallace L. Brazelton

WALLACE L. BRAZELTON
Chairman
Solano County Board of Supervisors

WLB/TLC/jf

KERN COUNTY WATER AGENCY
4114 Arrow Street, P.O. Box 58
Bakersfield, California 93302

Directors:

| | |
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| Phillip H. Maxwell | Division 1 |
| J. Elliott Fox | Division 2 |
| Jack G. Thomson | Division 3 |
| Floyd S. Cooley | Division 4 |
| Robert E. McCarthy | Division 5 |
| Henry C. Garnett President | Division 6 |
| Gene A. Lundquist | Division 7 |

Telephone. 393-6200

Stuart T. Pyle
Engineer-Manager

George E Ribble
Assistant Engineer-Manager

Linda Kildebeck
Secretary

November 3, 1980

Mr. Wayne MacRostie
Chief, Central Division
3251 "S" Street
Sacramento, CA 95816

Dear Mr. MacRostie:

We have reviewed the "Plan of Protection for the Suisun Marsh, Including Draft EIR", dated September, 1980.

We have no specific comments on the above document. We do, however, have comments regarding the apparent high cost of Suisun Marsh fish screens when compared to the benefits received.

We would concur with the State Water Contractors Audit Committee Report dated September, 1980. The report expresses concern with the level of expenditures and operating costs required for the Suisun Marsh fish screens. Such costs are high when compared to the limited number of fish to be affected.

Yours very truly,

Stuart T. Pyle
Engineer-Manager

GB:lk

United States Department of the Interior
WATER AND POWER RESOURCES SERVICE

MID-PACIFIC REGIONAL OFFICE
2800 COTTAGE WAY
SACRAMENTO, CALIFORNIA 95825

IN REPLY
REFER TO:MP-720
123.4

NOV 5 - 1980

Wayne MacRostie, Chief
Central District
Department of Water Resources
P.O. Box 160088
Sacramento, CA 95816

Dear Mr. MacRostie:

We have reviewed your Plan of Protection for the Suisun Marsh including Draft Environmental Impact Report and have found the document in general conformance with our draft report. Our comments on the report are attached.

Sincerely yours,

Darrell D. Mach

Darrell D. Mach
Regional Planning Officer

Attachment

B. Sweeney

Comments on Plan of Protection
for Suisun Marsh

General

1. There are numerous differences in the description of the size of the facilities between our work and your report. We would assume that these differences are based upon additional design work that your agency has performed.

2. There should be some reference to the recent surveys for rare and endangered species.

Specific

1. Page S-1, first two paragraphs: Rewrite as follows:

"This report presents a Plan of Protection to mitigate the effects of the Central Valley Project (CVP) and the State Water Project (SWP) on the Suisun Marsh. The State Water Resources Control Board (SWRCB) in Decision 1485 (August 18, 1978) set specific water quality standards for the Marsh. The Department of Water Resources (DWR) is required to implement mitigation measures by October 1, 1984.

"The Plan of Protection describes how WPRS and DWR propose to maintain the water quality criteria specified in Decision 1485. The major elements of the Plan: Delta outflow, physical facilities, monitoring program, management program, and environmental impact report."

2. Page I-4, 2nd paragraph: To call the Marsh "freshwater" is incorrect because it has always been under the influence of tidal flows.

3. Page I-7: Delete first sentence and "specifically."

4. Page I-10 through I-15: These figures give a distorted view of the impact of the projects upon the Marsh. They should relate to interior marsh quality.

5. Page III-7: The continuous monitor site is at S-48 at Grizzly Island Road.

6. Page III-14, second line: Change "excessive" to "increased" and delete rest of sentence after "algae."

7. Page III-15: Change "21,000" to "21,600."

8. Page IV-19, ninth line: Replace "Sulphur Creek northeast of Benicia Creek" with "Goodyear Slough near Lake Herman Road."

9. Page IV-19, eleventh line: Delete "and industrial purposes."

10. Page V-6, three lines from bottom: One and one-half miles conflicts with page IV-13 where one mile is stated.

11. Page V-6, last line: Insert "for a marsh environment" after "foundation."

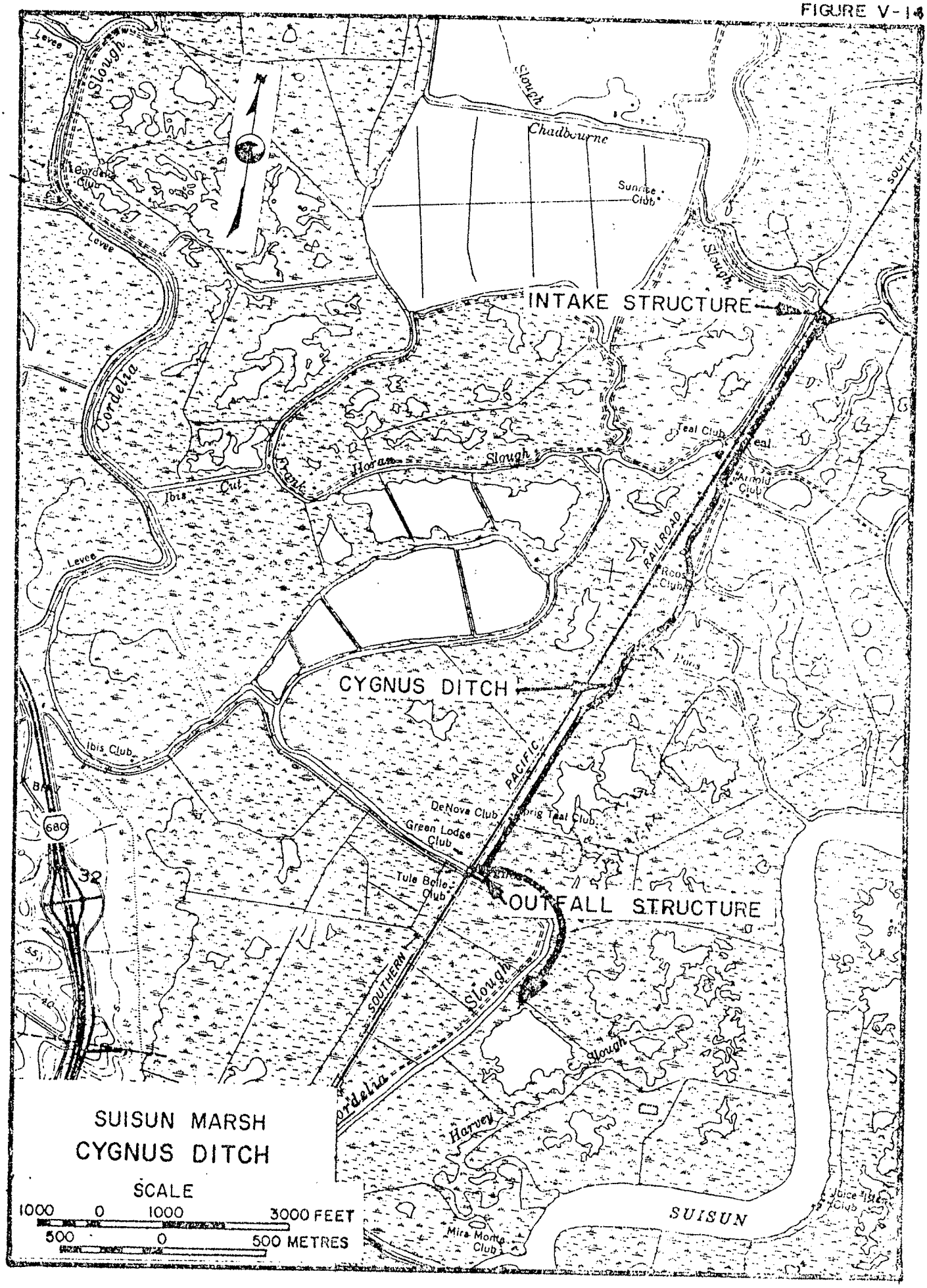
12. Page V-7: Have your designers moved the control structure upstream from its location at the old railroad crossing?

13. Page V-13: It should be more clearly shown in the Plan view that the fish screens are the staged construction.

14. Page V-27: See attachment.

15. Page IX-21: There is a difference in the number of boats from page V-9.

FIGURE V-14






C-054217

C-054217

State of California

The Resources Agency of California

# Memorandum

To : Wayne MacRostie
Chief, Central District
Department of Water Resources
3251 "S" Street
Sacramento, CA 95816

Date: October 31, 1980

File No. 1534.00 (RKM)tmh
2129.2016

From : **San Francisco Bay Regional Water Quality Control Board**
**1111 Jackson Street, Oakland 94607**

Subject: PLAN OF PROTECTION FOR SUISUN MARSH AND DRAFT EIR

Following are comments on the subject document.

1. The document (page V-26) **says that up to 32 cfs of Fairfield's wastewater** will be available for use in the marsh by the year 2000. Yet no indication is given of how the availability of this supply will be assured. Agricultural reuse of the wastewater in April, May and October could preclude marsh reuse unless firm commitment to provide the water to the marsh is obtained from Fairfield. The final plan and EIR should state what arrangements will be made to assure availability of this supply. Consideration should be given to limited participation in Fairfield's reclamation project as a means of obtaining spring and fall supply.

2. Fairfield's wastewater flows (22,837 ac-ft/yr or 20.4 mgd, page IV-17) appears to be as much as 50% the volume of wastewater flow (60 cfs, or 40 mgd page IX-32) of the flow to be conveyed from Boynton Slough to Cordelia Slough. In view of the doubtful availability of the Fairfield wastewater, the final EIR should include the results of a computer model run assessing the impact on western marsh salinity of the absence of the Fairfield discharge especially during dry and critical years.

3. Similarly, the final EIR should discuss alternative facilities, such as expansion of North Bay Aqueduct, to provide the same salinity reduction as could be achieved with Fairfield wastewater. Cost estimates should be included.

4. The Plan and EIR do not state what facilities are needed in order to comply with standards of the State Water Resources Control Board's Water Right Decision 1485 (D 1485) at station S-33 or S-32 in Cordelia Slough, but asserts that equivalent protection to the area will be provided by overland facilities. What volume of water introduced to the north marsh from the North Bay aqueduct or equivalent would be needed to assure compliance with D 1485 standards? What would be the incremental cost of expanding the aqueduct?

5. The Plan and DEIR (page IX-9) states that velocities in Montezuma Slough could adversely impact neomysis populations. The final document should address alternative methods of complying with D-1485 standards without such high velocities, e.g., introduction of larger flows into the northern or western marsh by overland facilities, thereby reducing the flow rate in Montezuma Slough.

6. Duck club drain water discharges to Boynton Slough have been known to cause localized C.O. depressions to below 3.0 mg/l. What is likely impact of projected increase in intensity of duck club management on a real extent, duration and magnitude of D.O. depressions?

7. Page IV-17

The contract between SID and Fairfield is incorrectly described. SID has the first right to the wastewater for the entire year, not just the summer, except that the following percentages are reserved for marsh use:

| | |
|---|---|
| Sept. 22 to Dec. 1 | 50% |
| Dec. 2 to March 1 | 100 |
| March 2 to April 1 | 67 |
| April 2 to May 1 | 10 |
| May 1 to Sept. 22 | 0 |

In 1984, none of Fairfield's wastewater will be available for marsh use after May 1 and only 10% of it during April. Therefore, less water would be available for marsh use than is indicated in the Plan and DEIR. Also, as Fairfield expands its agricultural reuse facilities, wastewater flows above 12 mgd may not be available for marsh use, especially in dry years. The second sentence of the second paragraph should be modified to read: "The remainder of ... could be available to the marsh per year if firm commitment for such use is obtained from Fairfield."

8. Page V-26

Following the first sentence of first paragraph, add: "... available. However, wastewater reuse for irrigation could reduce or eliminate the availability of wastewater for marsh uses, especially in dry years, unless contractural commitments for marsh use of the water are obtained. If ..."

9. Page IX-7

The water quality discussion should be expanded to describe salinity changes with time. Graphical representations similar to Figure V-3 should be made that show monthly salinities at each control station for 1980, 2000, and 2020 conditions, including duck club discharges as inputs to model. Also, figure V-3 should be redrawn to include all control stations, not just those meeting the standards.

FRED H. DIERKER
Executive Officer

cc: Ross Swenerton, SWRCB
Mike Rugg, DF&G

Glenn Rollins
Department of Fish & Game
Environmental Services
1416 Ninth St., 12th Floor
Sacramento, CA 95814

Hobart C. Knapp, staff

PACIFIC GAS AND ELECTRIC COMPANY

PG&E 5555 FLORIN-PERKINS ROAD • P.O. BOX 7444 • SACRAMENTO, CALIFORNIA 95326

October 31, 1980

Plan of Protection of the
Suisun Marsh including Draft
Environmental Impact Report
670

RE: Your letter of October 10, 1980

State of California
Department of Water Resources
3251 "S" Street
Sacramento, California 95816

Attention: Mr. Wayne MacRostie
Chief, Central District

Gentlemen:

The Draft Environmental Impact Report included with the Plan of Protection for the Suisun Marsh, prepared in September 1980 by your department, has been reviewed by PGandE.

Upon review of Chapter IX, we find potential adverse impacts on our existing and new facilities not addressed in the draft.

The following are the potential adverse impacts which PGandE feels should be considered prior to the preparation of the final EIR:

1. Interruption of access to our facilities for maintenance, repair, and operation.

2. Unsafe operating clearances for both overhead and underground facilities due to project development.

3. Costs associated with project related relocations of any of our existing facilities on private and/or public property.

4. The constraints affecting the construction of new service lines.

In order for PGandE to provide accurate comments, maps with more details would be necessary.

If you have any questions concerning this matter, please contact Mr. W. E. Bird at (916) 383-4141, Ext. 256.

Sincerely,

E C Hornof/jac

E. C. HORNOF,
Manager, General Services

WEBird/jli
cc: SABrown
EDLightfoot
JARotlisberger

Suisun Resource Conservation District

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Secretary
555 Veterans Boulevard
Redwood City, CA 94063
(415) 365-3072

November 13, 1980

Mr. Wayne MacRostie,
District Engineer
Department of Water Resources
Central District
3251 "S" Street
Sacramento, CA95816

SUBJECT: PLAN OF PROTECTION FOR THE SUISUN MARSH, SEPTEMBER 1980

Gentlemen:

This letter supplements Mr. Chapin's letter of October 21, 1980 commenting on the proposed plan. On November 12th, the District's Board of Directors held a special workshop to review the plan in detail. In doing so, it identified a major shortcoming of the plan as presented.

The proposed project does not achieve the managed wetland soil salinities required to maintain and restore wildlife habitat using the quality of water mandated by D 1485. Unless such facilities are provided, the damages caused by the SWP and the CVP diversions will not be fully mitigated.

To be more specific (comments of primary importance are *):

*1. Page I-7, 1st paragraph acknowledges that both "equity" and the provisions of the Davis Dolwig Act obligate the SWP and CVP to mitigate their impacts on the Marsh.

2. Page II-2, 1st full paragraph - the third sentence clearly identifies the need for more intensive management practices "in combination with improved drainage and control facilities" (emphasis added) to "reduce the effects of increased salinity levels of the water supplied from Honker, Grizzly and Suisun Bays. ."

3. Page III-1, 2nd paragraph - this section describes the situation succinctly.

continued on -2-

4. Page III-29, last sentence and the first sentence on Page III-30 - see "3" above.

*5. Page III-32, 2nd paragraph - this section very clearly and specifically points out the major shortcoming of the proposed plan. In order to use the marginal quality water required by D 1485, the managed wetland areas must have the water management facilities necessary to carry out the required leaching cycles. Failure to include these facilities as a part of the plan will not provide full mitigation as required by the Davis Dolwig Act.

6. Page IV-4, last sentence plus the 1st sentence on Page IV-5 - this language claims that intensive on-club management is part of "the substance of the Combination Plan", but the plan fails to provide the on-club facilities necessary to undertake intensive management.

7. Page IX-18, last paragraph - consideration should be given to using spoil material to renovate the exterior levees in the Marsh.

*8. Appendix C, page 26/27, Section 7(a) - this section of the SWRCB order specifically requires that the Suisun Marsh plan shall include ". . . physical facilities. . .to restore and maintain the Suisun Marsh as a brackish water marsh. . .using best practical management practices." This language clearly requires that the plan include all the facilities necessary to carry out "best practical management practices."

Within the last two years, the SRCD, acting through the U.S. Soil Conservation Service, has developed management plans for 82 of the 160 individual private ownerships within the Primary Management Area of the Marsh. Each of these plans identifies the water management facilities necessary to flood and drain that property within 30 days and estimates the cost of those facilities in 1980 dollars. A copy of this information is attached. Extrapolating this information to cover the balance of the managed wetlands in the Primary Management Area indicates that the total cost of these facilities would be approximately $1 million.

continued on -3-

Because of the lack of provisions of the required managed wetland facilities, the Suisun Resource Conservation District Board considers the Plan of Protection fundamentally inadequate and strongly opposes its adoption in its present form.

Very truly yours,

William W. Coon

William W. Coon, President
Suisun Resource Conservation District

Encls.

cc: SRCD Board of Directors

SUISUN RESOURCE CONSERVATION DISTRICT
AB 1717 MANDATED CAPITAL IMPROVEMENT COSTS

| OWNERSHIP NO. | NUMBER ACRES | ESTIMATED CAP. IMPROVEMENT COST | AVERAGE COST PER ACRE |
|---|---|---|---|
| 112 | 203.07 | -0- | -0- |
| 113 | 144.95 | $12,060.00 | $ 83.20 |
| 117 | 307.88 | 3,090.00 | 10.03 |
| 122 | 326.23 | 1,460.00 | 4.47 |
| 123 | 300.00 | 5,060.00 | 16.86 |
| 124 | 644.53 | 10,180.00 | 15.79 |
| 126 | 55.17 | 6,000.00 | 108.75 |
| 128 | 251.00 | 4,000.00 | 15.93 |
| 131 | 95.00 | 9,300.00 | 97.89 |
| 133 | 998.20 | 5,330.00 | 5.33 |
| 207 | 251.78 | 29,450.00 | 116.96 |
| 211 | 300.00 | 31,890.00 | 106.30 |
| 212 | 5.04 | -0- | -0- |
| 303 | 516.01 | 3,190.00 | 6.18 |
| 304 | 762.03 | 6,360.00 | 8.34 |
| 318 | 75.09 | 19,400.00 | 258.35 |
| 320 | 89.40 | 5,000.00 | 55.92 |
| 403 | 564.78 | 7,500.00 | 13.27 |
| 407 | 130.00 | 7,600.00 | 58.46 |
| 408/409 | 148.92 | 2,500.00 | 16.78 |
| 410 | 248.90 | 25,360.00 | 101.85 |
| 411 | 195.07 | 7,320.00 | 37.52 |
| 414 | 225.00 | 3,000.00 | 13.33 |
| 416/417/421 | 794.30 | 6,800.00 | 8.56 |
| 417 | 116.76 | 10,000.00 | 85.65 |
| 418 | 164.19 | 11,000.00 | 66.99 |
| 426 | 652.41 | 15,950.00 | 24.44 |
| 502 | 172.76 | 2,000.00 | 115.10 |
| 510 | 192.14 | 4,000.00 | 208.10 |
| 511 | 46.97 | -0- | -0- |
| 513 | 2,259.40 | -0- | -0- |
| 516 | 129.95 | 11,500.00 | 88.49 |
| 517 | 55.41 | 15,000.00 | 270.71 |
| 518 | 150.00 | 1,560.00 | 10.40 |
| 528 | 268.56 | 7,790.00 | 29.00 |
| 530/531/532 | 308.09 | 10,660.00 | 34.60 |
| 605 | 477.00 | 9,030.00 | 18.93 |
| 607 | 75.47 | 6,230.00 | 82.54 |
| 608 | 92.30 | 10,200.00 | 110.50 |
| 619 | 221.50 | 1,000.00 | 4.51 |
| 621 | 117.33 | -0- | -0- |
| 625 | 822.70 | 12,000.00 | 14.58 |
| 701 | 260.22 | 1,180.00 | 4.53 |
| 703 | 139.00 | 120.00 | .86 |
| 704 | 75.00 | -0- | -0- |
| 714 | 295.50 | 22,180.00 | 75.05 |
| 715 | 450.00 | 5,330.00 | 11.84 |
| 717 | 256.28 | 5,180.00 | 20.21 |
| 802 | 1,025.00 | 13,540.00 | 12.23 |
| 803 | 847.00 | -0- | -0- |
| 804 | 537.00 | 7,800.00 | 14.52 |
| 805/806 | 150.00 | 20,510.00 | 136.73 |
| 807 | 1,041.00 | 6,180.00 | 4.97 |

| OWNERSHIP NO. | NUMBER ACRES | ESTIMATED CAP. IMPROVEMENT COST | AVERAGE COST PER ACRES |
|---|---|---|---|
| 901 | 117.00 | -0- | -0- |
| 902 | 129.07 | 10,900.00 | 84.45 |
| 903 | 129.08 | 5,000.00 | 38.73 |
| 904 | 93.58 | 90.00 | .84 |
| 905 | 474.95 | 11,420.00 | 24.04 |
| 906 | 124.11 | 13,600.00 | 109.58 |
| 907 | 368.75 | 11,330.00 | 30.72 |
| 910 | 460.38 | 3,790.00 | 8.23 |
| 911 | 12.06 | -0- | -0- |
| 912 | 309.45 | 14,000.00 | 45.24 |
| 914 | 243.00 | -0- | -0- |
| 915 | 235.20 | 7,010.00 | 29.80 |
| 916 | 67.96 | 120.00 | 1.76 |
| 917 | 26.41 | 60.00 | 2.27 |
| 923 | 11.72 | -0- | -0- |
| 927 | 47.87 | 120.00 | 2.50 |
| 928 | 68.55 | 60.00 | .87 |
| 929 | 42.65 | -0- | -0- |
| 930 | 65.19 | 2,090.00 | 32.06 |
| 931 | 307.05 | $ 270.00 | $ .87 |
| 932 | 400.00 | 210.00 | .52 |
| 940 | 49.99 | -0- | -0- |
| 941 | 33.20 | 6,620.00 | 199.39 |
| TOTALS | 22,848.51 | $507,480.00 | $ 22.21 |

TOTAL ACRES ON WHICH IMPROVEMENTS ARE MANDATED BY AB 1717 — 43,134.98 x $22.21/avg. per acre cost = $958,028.

Suisun Resource Conservation District

SOLANO COUNTY, CALIFORNIA
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Laura Morgan
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~~2200 Sand Hill Road~~
~~Menlo Park, California 94025~~
~~(415) 854-1880~~

October 21, 1980

Mr. Wayne McRostie,
District Engineer
Central District
Department of Water Resources
P.O. Box 160088
Sacramento, CA 95816

SUBJECT: PLAN OF PROTECTION FOR THE SUISUN MARSH, SEPTEMBER, 1980

Gentlemen:

I have reviewed the subject document on behalf of the Suisun Resource Conservation District Board of Directors, and have the following comments. Additional comments may be provided by members of the Board.

Enclosed is a marked up copy of the Plan containing specific minor suggested changes. In addition, I have the following more substantive comments.

1. S-3, 3rd full paragraph - the statement that the Goodyear Slough Outfall became operational in October, 1979 is not correct. This will not occur until the outfall channel is dredged to the bay which presumably will occur in early 1981.

2. PI-4, 1st full paragraph, lines 9-15 - the statements on the lack of success of commercial agriculture during the period from 1870 to 1900 are not correct. Details confirming the high agricultural value of the area are available if desired. This section should be rewritten to read: "Commercial agriculture flourished during the rest of the nineteenth century. The crops grown included various cereal grains, beans, tomatoes and asparagus supplemented by extensive dairy and beef production."

3. IV-6-21 - this section on Alternative Water Sources needs to be reorganized into two sections; one dealing with alternative primary water supplies and written accordingly; the second dealing with potential sources of supplemental water if the quality of the water provided by tidal pumping in Montezuma Slough proves inadequate.

continued on -2-

4. III-32, 1st paragraph - this sentence doesn't make sense. As pointed out in the 4th paragraph on I-7, CVP and SWP reduce water quality during the critical spring months and between 25 and 50% of the time it will not meet D 1485 standards.

5. V-27, 1st two lines - I suggest that this sentence be deleted. In order to comply with the terms of the proposed 2 Agency Agreement and in accordance with administration policy, operation of the Montezuma Control Structure is proposed in wetter years whenever it would not adversely impact the yield of the projects and to the extent it does not significantly impact the fishery in the Slough.

6. IX-3, 1st paragraph - in various places in the plan different sets of numbers are used for the various types of habitat in the Marsh. The attached set of figures are the correct ones and should be used throughout. In addition, the last sentence is incorrect. There are approximately 52,300 acres of managed wetlands in the primary management area. The project is intended to serve all of them except for the 1100 acres (approximately) of off-shore islands.

7. IX-6, second line from the bottom - see (6) above.

8. IX-7, last sentence - the meaning of this sentence is not clear. In a critically dry year the facilities are expected to be operating at full capacity 100% of the time between the beginning of October and the end of May. Give this situation, the claimed "flexibility" is not existant if the normal operating criteria (i.e., wide open operation) proves inadequate.

9. IX-21, 2nd full paragraph - the claim of increased fishing success is incorrect. The access to this structure will be over private property and there will be no public entry provided.

10. IX-23, 3rd full paragraph - the area of public fishing access along the south levee should be spelled out. It will not be provided where the levee crosses privately owned lands.

continued on -3-

11. IX-28, 3rd paragraph - the manner in which the ditch would reduce private and increase public access should be described (see (4) and (10)).

12. IX-30, 4th paragraph - there will be no increase in public fishing opportunity since all access is over private land.

We appreciate the opportunity of providing these comments and hope that they will be helpful.

Very truly yours,

D. Chapin

D. Chapin

Encls.

cc: SRCD Board of Directors

# SUISUN MARSH FACT SHEET

1. Acreage:

| | | |
|---|---|---|
| Primary Management Area * | 88,138 | acres |
| Secondary Management Area * | 27,897 | acres |
| Total | 116,035 | acres |

2. Primary Management Area Land Forms:

| | | |
|---|---|---|
| Managed wetlands (approximately) | 52,300 | acres |
| Tidal wetlands (approximately) | 6,300 | acres |
| Rivers, bays and sloughs (approximately) | 29,500 | acres |
| Total | 88,100 | acres |

3. Land Ownership (PMA):

(a) State and federal (approximately 56.2%)

| | | |
|---|---|---|
| (i) Rivers, bays and sloughs (approx.) | 29,500 | acres |
| (ii) Tidal wetlands (approximately) | 6,300 | acres |
| (iii) Managed wetlands (approximately) | 13,700 | acres |
| Subtotal (approx.) | 49,500 | acres |

| | | |
|---|---|---|
| (b) Private (approximately 43.8%) | 38,600 | acres |
| Total | 88,100 | acres |

* As defined by the Suisun Marsh Protection Act of 1977.

State of California

The Resources Agency

# Memorandum

To : Don Reese
State Lands Commission
1807 13th Street
Sacramento, California 95814

Date: November 17, 1980

Telephone: ATSS ( 707 ) 425-1604
( 707 ) 425-3828

From : Department of Fish and Game, Harry George

Subject: Proposed Construction of Grizzly Island Distribution System Through Laughing Mallard - Club No. 534 - Parcel 46 - 190 - 23; 148 acres.

Dear Mr. Reese:

We have only one objection to the project proposed by the Central District Plan of Protection for the Suisun Marsh in their report of September 1980 of the Department of Water Resources. Namely: That no arrangements have been made for water drainage of these lands or adjoining club lands. We beleive that this problem should be addressed in the final plans.

The existing buildings are of no value to us and it would be considered an improvement to have them removed with the exception of Cresent School which is a Historical Solano Landmark and will have to be preserved.

All the rest of the plan would benefit this parcel and the other portion of Grizzly Island that it serves.

If you have any further questions give me a call.

Sincerely,

Harry George

Harry George
Manager
Grizzly Island Wildlife Area

c.c. George Spencer
John Parrish

DEPARTMENT OF THE ARMY
SAN FRANCISCO DISTRICT, CORPS OF ENGINEERS
211 MAIN STREET
SAN FRANCISCO, CALIFORNIA 94105

SPNED-EA

Wayne MacRostie
Chief Central District
Department of Water Resources
3251 S Street
Sacramento, California 95816

26 November 1980

Dear Mr. MacRostie:

We have reviewed the Plan of Protection for the Suisun Marsh and the Draft Environmental Impact Report on the Plan(September 1980)and wish to make the following comments:

The proposed construction work discussed in the Plan will require Department of the Army Authorization under Section 10 of the River and Harbor Act and under Section 404 of the Clean Water Act. A copy of our pamphlet "U.S. Army Corps of Engineers Permit Program, A Guide for Applicants," is inclosed. For additional information please contact our Regulatory Functions Branch at (415)-556-5966 .

Approximately 172 hectares of marsh and 14 hectares of upland will be lost as a result of the project. While this area is small in relation to the size of the overall wetland, it is still a significant loss. On page IX-36 it is stated that this loss will be mitigated using the point-scale habitat evaluation procedure used by the Department of Fish and Game; however details of the mitigation plan are not provided. We are therefore unable to comment on the proposal. We request this information be provided so that we may evaluate the adequacy of the plan. We are also not familiar with the Department's point-scale evaluation process and would appreciate information describing the procedure.

As stated in the Draft Report, the permanent loss of 172 hectares of seasonal and tidal marsh would have an adverse impact on the salt marsh harvest mouse, a species listed by the federal government as endangered. The Endangered Species Act (50 CFR Part 402) requires Federal agencies to insure that their activities do not jeopardize the continued existence of a species covered by the Act. Section 7 of the Act requires consultation with the appropriate wildlife agency when a federal action may impact a listed species. The EIR does not provide the results of the consultation process nor is it indicated whether the consultation has been performed. The Corps as a permitting agency for the project, must insure that the project does not jeopardize the species. Consultation as required under Section 7 should be initiated by Water and Power Resources Service as one of the agencies implementing the proposed project.

On page III-19 of the report, it is stated that "...tules (scirpus) are not the food plants preferred by waterfowl,...". This sentence appears to contradict an earlier

SPNED-EA

26 November 1980

Mr.Wayne MacRostie, Chief Central District
Department of Water Resources

statement in the same paragraph which indicates that alkali bulrush, also a scirpus, constitutes a winter food supply for waterfowl. The "tules" in the tidal marsh areas should be further identified to distinguish them from alkali bulrush.

Thank you for including us in your review process.

Sincerely,

JAY K. SOPER
Chief, Engineering Division

STATE OF CALIFORNIA EDMUND G. BROWN JR., Governor

SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION
30 VAN NESS AVENUE
SAN FRANCISCO, CALIFORNIA 94102
PHONE: 557-3686

April 14, 1981

Mr. Wayne MacRostie, Chief
Central District
Department of Water Resources
P. O. Box 160088
Sacramento, California 95816

SUBJECT: Draft Environmental Impact Report - Plan of Protection - Suisun Marsh
BCDC Inquiry File No. SL.PH.7214.1
BCDC Permit No. 35-78

Dear Mr. MacRostie:

I am writing regarding the Draft Environmental Impact Report for the Plan of Protection - Suisun Marsh, dated September 1980. Although the Commission has not had an opportunity to review this document, the staff has examined it in light of the McAteer-Petris Act, the Suisun Marsh Preservation Act, the Suisun Marsh Protection Plan, and the San Francisco Bay Plan, particularly those policies on Water Supply and Quality (pages 13-15) and Land Use and Marsh Management (pages 27-29) in the Suisun Marsh Protection Plan. Many of the following comments were communicated to your staff previously in a courtesy copy of a letter dated January 4, 1980 to Mr. Darrell D. Mach, Regional Planning Officer for the U. S. Water and Power Resources Service.

P1

Construction in Water Areas - Water Control Structures

As stated in our earlier letter, the staff believes that the proposed water control structures at Goodyear Slough and Montezuma Slough may be in conflict with the McAteer-Petris Act, the San Francisco Bay Plan, and the Suisun Marsh Preservation Act and Protection Plan. The San Francisco Bay Plan Policy on Water Surface Area and Volume states, in part, that:

what is stated purpose of this provision? structures are to assist circulation/WQ in Marsh

> "water circulation in the Bay should be maintained, and improved as much as possible. Any proposed fill, dikes, or piers should be thoroughly evaluated to determine their effects upon water circulation and then modified as necessary to improve circulation or at least to minimize any harmful effects."

It is obvious that such proposals may have profound impacts on water circulation of Bay waters, as well as adversely impacting navigation, fish migration, and normal salinity gradients. Therefore, we believe that the impacts of constructing such barriers must be much more thoroughly analyzed and understood before the Commission could approve their construction.

As you are aware, the Commission must also find that no alternative exists to any proposed fill project, and that the proposed fill will not have harmful impacts on the Bay. It is not at all clear that other alternatives

involving considerably less fill and disturbance of the Suisun Marsh have been sufficiently examined for the Commission to make this finding. It also seems clear that the increased freshwater diversions that approval of this project would permit will significantly impact San Francisco Bay.

Water Barriers Created by Proposed Ditches

No supporting documentation is given for the statement made repeatedly throughout the report that:

> "The aquatic barriers that would be created by the new ditches are not expected to have a significant adverse impact on wildlife."

The Potrero Hills Ditch, which as proposed will be 147 feet wide, will effectively make the Potrero Hills an island. It is not clear that this will have no impact on the migration, predation, and genetic exchange of the plant and animal populations of the Potrero Hills.

As you are aware, the Suisun Marsh Plan states that:

> "Existing uses should continue in the upland grasslands and cultivated areas surrounding the critical habitats of the Suisun Marsh...where feasible, the value of the cultivated lands as habitat for marsh-related wildlife should be enhanced."

As we stated in our earlier letter, we believe the Commission will be concerned that the construction of these water barriers, particularly the Potrero Hills Ditch and the Boynton-Cordelia Ditch, will change the nature of the available upland habitats, and may adversely affect the ability of the landowner to use these lands for agricultural purposes. We feel that there should be some discussion of these potential impacts. The staff continues to believe that the construction of pipelines using the prescribed guidelines of the Suisun Marsh Protection Plan may have less long-term environmental impacts than the construction of open channels where the channels would traverse long distances, particularly in the secondary management area.

Spoil Disposal

The Plan of Protection estimates that the project will involve excavation of approximately 1,121,000 cubic yards of material, with approximately half of that being used in the construction of project facilities. The report further states that the remaining spoils will be either used in other projects outside the Marsh or disposed in a manner acceptable to all regulatory agencies. One suggestion to "spread the spoils out on grazing lands in the secondary management zone of the Marsh" would appear to substantially disturb the wildlife habitat and grazing use of the lands and be in conflict with above Suisun Marsh Protection Plan policy.

Alternatives

As stated above, the staff does not believe that all alternatives to the proposed Plan of Protection have been sufficiently studied for the Commission to find that no better alternative to the project exists. Almost all of the selected alternatives are dismissed without any discussion of whether variations of the alternative were considered, or whether the alternative was subject to any degree of model testing. For example, one of the likely routes of the North Bay Aqueduct will be through the northwestern portion of the Marsh. Tapping into the aqueduct at key locations may eliminate the need for constructing the Potrero Hills and Boynton-Cordelia Ditches and may more effectively serve the western portions of the Marsh than the project proposed in the Plan of Protection. Combined with releases of freshwater in the Sacramento River sufficient to attain the water quality goals of Decision 1485 in the eastern sections of the Marsh, this alternative may meet the water quality standards at less environmental and economic costs.

Strategy: This could gain DL approval of NBA thru Marsh considerable $ saving (the costs of NBA would need to be allocated among Solano, Napa & SM.

Nor is it clear that 2 million acre-feet of freshwater would be required to provide full protection to the Suisun Marsh in dry and critical years. It is implied that this estimate is based on the assumption that the 2 million acre-feet of water would be released to the Sacramento River and be dispersed naturally throughout the Suisun Marsh. It may be possible to reduce significantly the amount of freshwater necessary to attain sufficient water quality if freshwater (including possible releases from the neighboring sewage treatment facilities) is released at strategic locations throughout the Marsh.

Will model tests demonstrate amount of fresh water needed? We should pin down more well possibly —

Public Access

It is not clear what, if any, public access is proposed as part of the project. As all projects within the Commission's jurisdiction are required to provide maximum feasible public access, we believe that public access, consistent with the policies of the Suisun Marsh Protection Plan (listed on pages 5 and 6 of our earlier letter) should be considered. The Department of Fish and Game, Solano County, and BCDC should be consulted before any public access improvements are finally proposed.

Project Cost

Are we!

We are concerned that the 60 million dollar estimated cost of the Plan of Protection may not reflect the true cost of the proposed Plan. Levees will have to be continually maintained in order for the Plan of Protection to work, and as stated in the report, "maintenance of levee systems in the Marsh is a continuous and expensive process" (pages III-33). Already portions of the levee constructed but a year ago as part of the Initial Facilities have subsided and in at least one location, may have to be relocated. Water control structures, tidegates, and fish screens will also have to be maintained, repaired, and replaced. The staff believes that these costs should also be included when evaluating the proposed Plan of

Protection. Including these cost will provide a true measure of the cost effectiveness of the proposed Plan of Protection, and it may be that an alternative requiring less physical modification of the Marsh would do a better job for less money.

Management Programs

The proposed Plan of Protection ensures only that good quality water will be available for use but does not ensure that it will be correctly used. The report briefly discusses the fact that the U. S. Soil Conservation Service, under contract with the Suisun Resource Conservation District, is working to provide individual management plans for the various clubs served by the project. We feel that these management programs are an essential element of the Plan of Protection and the report should include a discussion of how such programs will be implemented. An indication of how many clubs are currently following good water management practices, how many can be expected to do so in the future, and the location of the clubs practicing good water management would be helpful to the Commission. Assisting the clubs to ensure proper management practices may well be a cost effective method for making sure the project has its intended result.

Impacts on Fish and Wildlife

The project may have several important impacts on fish and wildlife These are only superficially discussed in the Draft Environmental Impact Report. For example, will operation of the Montezuma Control Structure affect the migration of king salmon, steelhead, and other anadromous fish? The report states that one project impact would be that "in the eastern portion of Montezuma Slough, net velocities would approach or exceed those found limiting for neomysis. Neoysis populations could be reduced in that area, with a corresponding reduction in fish that depend on neomysis for food-notably striped bass" (page IX-9). How significant is this potential impact? Can sizeable reductions in the populations of neomysis and striped bass be expected? Several endangered plants are found in the Suisun Marsh. Will any of these plants be affected by the construction and/or operation of the project facilities? The report states that "The work of constructing the facilities would have little environmental impact" (page IX-5). Yet over 1,000 acres of wetlands and uplands habitat will be at least temporarily destroyed during project construction. This is a major and substantial adverse impact; the loss of this smount of wildlife habitat will result in at least some temporary reductions in the population of some of the fish and wildlife species inhabiting the Marsh. Could such losses be significant for any given species? As yet, no fish screen has yet been devised that actually works. How many fish can be expected to be killed during the operation of water control structures without fish screens? How likely is it that an effective fish screen will be available by the time the facilities are in operation? How will the project affect salinity gradients throughout the Marsh? Are these changes in salinity gradients sufficient to disrupt normal behavior of various aquatic animals (including fish) living in the marshes, sloughs, and channels?

Mitigation

Throughout the report, it is stated that appropriate mitigation for adverse project impacts is being studied. The staff believes that the Commission would be reluctant to consider any project of this magnitude without an accompanying mitigation plan which would assure that all project impacts would be effectively mitigated. For example, the Channel Islands, the southern tip of Joice Island, and the Van Sickle-Chipps Island area will not be protected by the facilities proposed in the Plan of Protection. Mitigation for these areas should be provided as part of the project. The project will also involve the "permanent conversion of 424 acres of marsh and 37 acres of upland habitat to 505 acres of water surface and 6 acres of road surface" (page IX-36). First, the report never explains why these figures do not add up. Secondly, Although the report indicates that the Department of Water Resources recognizes that these project impacts must be mitigated, the BCDC staff believes that a mitigation proposal will have to accompany any application for the facilities proposed in the Plan of Protection, and that the mitigation proposal should also be discussed in an appropriate environmental document. We also believe that as the entire project can be viewed as mitigation for adverse impacts caused by the water projects, the Department of Water Resources should consider additional mitigation measures to ensure the success of the Plan of Protection. For example, we believe that the Department of Water Resources should consider assisting in the management of those clubs practicing poor water management.

General Comments

The facilities may affect water quality sufficiently to meet the water quality standards of Decision 1485. But then again, there is no assurance that the facilities will perform as expected. This fact is tacitly admitted on page IV-12 of the report where it is stated that "should the physical facilities prove to be inadequate to meet the D-1485 standards, diversion from Lindsay Slough would have to be reconsidered." Therefore, we believe that the Environmental Impact Report for the Plan of Protection should include a description of all studies performed to determine the likelihood that the plan will achieve its goal of meeting the water quality standards set in D-1485. In particular, the EIR should include a description of the model used to test the Plan of Protection, including the assumptions made in the model, and a detailed analysis of the results of the model tests including the estimated range of errors. Consideration should also be given to having an independent analysis of the model and its results. We believe that such an analysis is exceedingly important as construction of the facilities proposed in the Plan of Protection involves many risks - that the plan will not be adequate to meet D-1485 standards, and that the Marsh will be irreversibly altered by the facilities proposed. We believe that the Commission will desire that these risks be thoroughly known and understood prior to their approval of the Plan of Protection, and that they have some assurance that the potential environmental benefits of the project are worth these risks.

Finally, the magnitude of the work proposed and the modifications of the Suisun Marsh necessary to meet these standards make us uneasy, particularly as no studies have yet been made of the success of the interim facilities approved in BCDC Permit No. 35-78. Projects of this magnitude usually have ramifications that are either poorly understood, or were not considered or anticipated. For these reasons, the BCDC staff favors any approach requiring less drastic physical alteration of the Marsh, including the release of additional freshwater. The BCDC staff believes that the Commission would feel considerably more comfortable with the proposed Plan of Protection if they had more concrete assurance that: (1) the proposal was likely to work; (2) that such a structural solution would not necessarily result in long-term adverse impacts on the Marsh; and (3) if the final proposed project was in conformance with the Commission's laws and plan policies.

Thank you again for this opportunity to comment on the proposed Plan of Protection. If you have any questions regarding this letter or the Commission's policies, please do not hesitate to contact Bob Batha, the staff member most familiar with the project.

Very truly yours,

MICHAEL B. WILMAR
Executive Director

MBW/pm

Enclosure

cc: Department of Fish and Game, Attn: Glen Rollins
U. S. Water Power Resource Service, Attn: Darrell Mach
Department of Fish and Game, Attn: Dennis Becker
Suisun Resource Conservation District, Attn: Dan Chapin
Department of Water Resources, Attn: George Spencer
U. S. Fish and Wildlife Service, Attn: Bill Sweeney

STATE OF CALIFORNIA

EDMUND G. BROWN JR., Governor

SAN FRANCISCO BAY CONSERVATION AND DEVELOPMENT COMMISSION
30 VAN NESS AVENUE
SAN FRANCISCO, CALIFORNIA 94102
PHONE: 557-3686

January 4, 1980

Mr. Darrell D. Mach
Regional Planning Officer
Water and Power Resources Service
2800 Cottage Way
Sacramento, California 95825

Dear Mr. Mach:

I am writing regarding the preliminary draft of the Solano County Water Project: A Report on the Feasibility of Water Supply Development, dated September, 1979, and received in our office on November 30, 1979. The Commission itself has not had the chance to review the project or the preliminary draft of the study, so these are staff comments only. They are, however, based on the McAteer-Petris Act (the Commission's law) the Commission's San Francisco Bay Plan and Suisun Marsh Protection Plan, and the Suisun Marsh Preservation Act of 1977, which the Commission has primary state responsibility to implement. The plans and acts are also part of the Commission's approved Coastal Management Program under the federal Coastal Zone Management Act of 1972, as amended Our comments on this proposed project are in three parts: (1) comments on substance of the report, (2) apparent conflicts between the project and the Commission's plan policies and laws and (3) the requirement for a consistency determination of the proposed project with the Commission's Coastal Zone Management Program.

1. Report Substance

Our comments focus on the Alternative Plans for the Suisun Marsh, the Marsh Plan and the Environmental Impacts sections of the draft report. Our comments are general because at this stage in the planning process, an actual proposal has not been finalized. We will have very specific comments as the project becomes more refined and the appropriate documents are circulated to our office.

The project alternative evaluated as the most appropriate and effective, "environmental quality," is one of only four options reviewed. Other scales of facilities should be considered. BCDC staff has concerns that the proposed project is "over designed" and will create channels and water management facilities which are out of proportion with the existing facilities, channels and sloughs. We fear the impacts of construction of the huge channels (up to 165 wide), the impacts of the dumping of dredged materials, the destruction of managed wetlands, impacts aquatic life, (such as fish and shrimp) and the impacts on recreation uses of the Marsh waterways may not have been fully evaluated. The plan should more fully evaluate and investigate the use of wastewater from Fairfield, water availability from the North Bay Aquaduct, the possibility of transporting some of the water in buried pipelines, and alternatives to the tide gates across Montezuma Slough.

More specific information about the size of the proposed facilities should be included. For example, the existing channel dimensions along the proposed routes, the amount of material to be removed or dredged (in cubic yards), and the final dimensions of the levees that would be created. This data is sorely lacking in the project proposal and should be available through the computer modeling. Hopefully, creative engineering will help to design smaller, more efficient facilities.

BCDC is very concerned about the large amount of wetland habitat that would be destroyed under the current proposal. The document does not discuss mitigation for this loss, and the loss of additional brackish marsh habitat on the channel islands which cannot be served by the proposed facilities. BCDC has a very strong record of requiring mitigation for wetlands within its jurisdiction. We have required large scale marsh renovation to mitigate for the construction of the Larkspur Ferry Terminal in Marin County and the construction of the Dumbarton Bridge in San Mateo and Alameda Counties.

The project proposes to make portions of the project available for public access. BCDC is also very concerned with public access in the marsh and addressed the issues specifically in the Suisun Marsh Protection Plan. The Commission's position is that public access should be provided on lands administered and managed by public agencies such as Department of Fish and Game. Such land should provide for a variety of uses. The relevant Marsh Plan policies are listed on pages 5 and 6 of this letter. The Department of Fish and Game, Solano County and BCDC should be consulted before any public access improvements are finally proposed.

2. Commission's Laws and Policies

The area within the Suisun Marsh is regulated by the Commission under two pieces of Legislation: the McAteer-Petris Act and the Suisun Marsh Preservation Act, and two plans: the San Francisco Bay Plan and the Suisun Marsh Protection Plan. If there are conflicts between the two plans, the more specific Marsh Plan would apply. The laws and plans contain very specific restrictions and limits on the placing of fill in water areas, such as Montezuma Slough, tidal marshes and managed wetlands. The plans also regulate the installation of pipelines and the provision of public access. The construction and design of the proposed facilities must be in conformance with the Commission policies as set forth below.

a. Construction in Water Areas

Fill, as defined in the Bay Plan, includes earth or any other substance or material placed in the Bay, including piers, pilings and floating structures moored in the Bay for extended periods. Any structure like the tide gates in Montezuma Slough would be considered fill by the Commission. Under the McAteer-Petris Act there are strict restrictions regarding the placing of fill in the Bay. Section 66605(a) of the California Government Code states:

> "further filling of San Francisco bay should be authorized only when public benefits from fill clearly exceed public detriment from the loss of the water areas and should be limited to water-oriented uses (such as ports, water-related industry, airports, bridges, wildlife refuges, water-oriented recreation and public assembly, water intake and discharge lines for desalinization plants and power generating plants requiring large amounts of water for cooling purposes) or minor fill for improving shoreline appearnace or public access to the bay..."

The tide gate proposed would not conform to the categories in the list of water-oriented uses.

Water Surface Area and Volume Policy #2 in the Bay Plan states that:

> "water circulation in the Bay should be maintained, and improved as much as possible. Any proposed fill, dikes, or piers should be thoroughly evaluated to determine their effects upon water circulation and then modified as necessary to improve circulation or at least to minimize any harmful effects."

A tide gate would effect circulation in the Bay and would have to be evaluated under this policy.

The Bay Plan also speaks to the waterways as habitat. Fish and Wildlife Policy #1 states "the benefits of fish and wildlife in the Bay should be insured for present and future generation of Californians..." The effects of any project must protect and enhance aquatic wildlife habitat, as well as terrestrial or wetland habitat.

The Bay Plan also contain specific policies regarding dredging and the disposal of dredged materials. Dredging Policy #1 requires that dredged material be disposed on dry land; as fill in approved fill projects; barged or piped to sutiable disposal sites in the ocean; or dumped at a designated site where tides will carry the material out to sea. Dredging Policy #4, relevant in light of engineering problems in the Initial Facilities, states that "all proposed channels should be carefully designed so as not to undermine the stability of any adjacent dikes and fills."

Environment Policy #2 of the Marsh Plan states that:

> "The Marsh waterways, managed wetlands, tidal marshes, seasonal marshes and lowland grasslands are critical habitat for marsh-related wildlife and are essential to the integrity of the Suisun Marsh. Therefore, these habitats deserve special protection."

b. Construction in Managed Wetland.

The Marsh includes the managed wetlands within the primary management area of the Suisun Marsh. The Marsh Plan sets forth policies to protect the areas within the primary management area. Environment Policy #2 states:

> "The Marsh waterways, managed wetlands, tidal marshes, seasonal marshes, and lowland grasslands are critical habitats for marsh-related wildlife and are essential to the integrity of the Suisun marsh. Therefore, these habitats deserve special protection."

Land Use and Marsh Management Policy #1 states, in part:

> "within the primary management area existing uses should continue and both land and water areas should be protected and managed to enhance the quality and diversity of the habitats."

The proposed project would, however, destroy 378 acres of marshland without mitigation.

The Marsh Plan also addresses the construction of permanent ponds. Land Use and Marsh Management Policy #8 limits the development of such ponds.

The policy states; in part:

> "Permanent ponding, which provides only marginal wildlife benefits should be practiced only in the following situations: (a) in deep ponds that are difficult to drain and manage as seasonally flooded marshes; (b) in limited shallow areas where habitat diversity is desired; (c) in areas of high salinity concentrations..."

c. Construction in the Secondary Management Area

The secondary management area consists of upland area (above the 10 foot contour) and agricultural areas. The Marsh Plan addresses the value of these areas, and proposes appropriate land uses. The Boynton-Cordelia Ditch and the Potrero Hills Ditch would cross such areas. Environmental Policy #3 states:

> "Existing uses should continue in the upland grasslands and cultivated areas surrounding the critical habitats of the Suisun Marsh...where feasible, the value of the cultivated lands as habitat for marsh-related wildlife should be enhanced."

The construction of these ditches would change the nature of the available habitats, and would disrupt the existing agricultural land uses.

Land Use and Marsh Management Policy #10 further defines land uses in the secondary management area. The policy states:

"Agricultural uses consistent with protection of the Marsh, such as grazing and grain production, should be maintained in the secondary management area. The value of the upland grassland and cultivated lands as habitats for Marsh-related wildlife should be maintained and enhanced where possible by planting or encouraging valuable wildlife food or cover plant species."

Any pipelines which may be proposed for construction in the Marsh must be constructed in conformance wih Policy #3 of the Chapter Utilities, Facilities and Transportation (see page 20). All plans for construction must be reviewed by the Department of Fish and Game to assure that construction methods and timing will have a minimal impact on Marsh flora and fauna under Policy #4 of the same chapter. The staff feels the construction of pipelines using the prescribed guidelines may have less long-term environmental impact than the construction of open channels where the channels would traverse long distances especially through the secondary management area.

d. Recreation and Access

The following policies from the Recreation and Access chapter of the Marsh Plan would apply to any public access areas proposed as a part of the project:

"1. Additional land should be acquired within the Suisun Marsh to provide for increased public duck hunting recreational use and additional refuge areas for waterfowl during the hunting season. Acquisition priority should be given to those lands not now operated as managed wetlands.

2. The Fish and Game Commission and the Department of Fish and Game have the ultimate responsibility and authority for management of the fish and wildlife resources of California and the Suisun Marsh. Lands acquired with State funds for the purpose of enhancing and managing wildlife habitat and providing related recreation use, should be administered and managed by the Department of Fish and Game.

3. Land should also be purchased for public recreation and access to the Marsh for such uses as fishing, boat launching, and nature study. These areas should be located on the outer portions of the Marsh near the population centers and easily accessible from existing roads. Improvements for public use should be consistent with protection of wildlife resources.

4. Public agencies acquiring land in the Marsh for public access and recreational use should provide for a balance of recreational needs by expanding and diversifying opportunities for activities such as bird watching, picnicking, hiking, and nature study.

5. Agencies administering land acquired for public access and recreational use should be responsible for maintaining the areas and controlling their use. Signing on roads leading into the Marsh and

maintained litter receptables at major public use areas should be provided by the appropriate local or State agency to prevent littering and vandalism to public and private property.

6. Recreational activities that could result in adverse impacts on the environmental or aesthetic qualities of the Suisun Marsh should not be permitted. Levels of use should also be monitored to insure that their intensity is compatible with other recreation activities and with protection of the Marsh environment..."

In summary, the policies of the policies of the Marsh Plan and the Bay Plan clearly define appropriate activies and construction techniques for the marsh and there are some severe conflicts between the proposed project and these policies. We felt you should be aware of the Commission's policies and the conflicts between the policies and the proposal at this early stage in the actual project development.

3. Consistency Determination

As you know, the Suisun Marsh is a part of the coastal zone and the McAteer-Petris Act, the Suisun Marsh Preservation Act, the Bay Plan and the Marsh Plan are part of BCDC's certified Coastal Zone Management Program prepared under the Coastal Zone Management Act of 1972, as amended. All federal agencies proposing activities within the coastal zone must submit a consistency determination under BCDC's Management Program and the Federal consistency regulations. If the Department sponsors this project in the Marsh, it will be necessary for the Commission to review the consistency determination and either concur or not concur with the findings. If only funding for the project comes from the Department, a consistency determination for the funding would be required.

Thank you for the opportunity to comment on the preliminary draft document. I hope our comments will aid you in the planning of a program to protect the Marsh.

Sincerely,

MARGIT NICKELL
Resource Analyst

MN/lg

cc: George Deatherage, Department of Water Resources
Dennis Becker, Department of Fish and Game
Dan Chapin, Suisun Resource Conservation District

State of California
GOVERNOR'S OFFICE
OFFICE OF PLANNING AND RESEARCH
1400 TENTH STREET
SACRAMENTO 95814

EDMUND G. BROWN JR.
GOVERNOR

November 24, 1980

Mr. Wayne MacRostie
Department of Water Resources
3251 "S" Street
Sacramento, CA 95816

SUBJECT: SCH# 80092322 SUISUN MARSH PLAN OF PROTECTION - OVERALL FACILITIES

Dear Mr. MacRostie,

Several state departments have commented on your draft environmental document. If you would like to discuss the concerns and recommendations in their comments, contact the staff from the agencies whose names and addresses appear on the comments.

The State Lands Commission suggests the limitation of upstream depletions be discussed as an alternative to the deterioration of the Susuin Marsh.

The State Water Resources Control Board has previously reviewed a preliminary draft of the document and finds that several of their concerns have not been addressed. The EIR does not provide adequate quantification of the adverse impacts upon fish and wildlife resources and does not detail the mitigation measures for these impacts. The final plan and EIR will be acceptable to the Board provided the mitigation plans are presented in the final EIR.

You may formally respond to the agencies' comments by writing to them (including the State Clearinghouse number on all such correspondence) When filing the final EIR, you must include all comments and responses (State EIR Guidelines, Section 15146). State review of your draft environmental document will then be complete.

You should attempt to resolve these conflicts before any further action is taken on this project.

Sincerely,

Anna Polvos
State Clearinghouse

Stephen Williamson
State Clearinghouse

Attachments

**UNITED STATES DEPARTMENT OF COMMERCE**
**National Oceanic and Atmospheric Administration**
NATIONAL MARINE FISHERIES SERVICE
Southwest Region
300 South Ferry Street
Terminal Island, California 90731

January 8, 1981

F/SWR33:TY/JJS
F/SWR:FSA

Mr. George Spencer
Department of Water Resources
Central District
3251 "S" Street
P.O. Box 160088
Sacramento, CA 95816

Dear Mr. Spencer:

Subject: Review of the "Plan of Protection" for the Suisun Marsh Including Draft Environment Impact Report"

We have reviewed the subject document and offer the following general comments.

The National Marine Fisheries Service believes that the Suisun Marsh can be protected with Delta outflows and that this means of protection should be the selected alternative. We do not believe that this least environmentally damaging alternative should be rejected without a complete analysis.

We believe that the selected plan is inappropriate and that the alternatives to the plan have been rejected with inadequate substantiation. Suisun Marsh was guaranteed protection under Water Right Decision 1485, a law that was designed to restore and protect resources that had been impacted adversely by operation of the Central Valley Project (CVP) and the State Water Project (SWP). This law provided for Delta salinity standards which were designed to maintain particular population levels of striped bass (and presumably other fishes). The resources of Suisun Marsh were to be protected by structural means, <u>if</u> salinity control by releases of fresh water from CVP and SWP facilities was not feasible. Water Right Decision 1485 assumed certain levels of operations of the CVP and SWP pumping facilities and was to mitigate adverse impacts of these assumed operational levels.

The National Marine Fisheries Service is concerned that protection of Suisun Marsh fisheries resources has not been given equal consideration in the selected plan with the protection of waterfowl habitat, much of which is private. Some reports indicate that waterfowl populations have not declined in absolute numbers because of salinity problems in the Marsh. Instead, the waterfowl have moved eastward into the Delta where salinities allow production of forage (Michny 1979). The National Marine Fisheries Service recognizes that degradation to waterfowl forage has occurred in Suisun Marsh, but we do not think it is wise to sacrifice fisheries habitat values (more than 37 reported species-Moyle and Daniels, 1980), in order to attract ducks back into the managed wetlands of Suisun

Marsh. Implementation of the selected plan will result in blocked fish passage, entrained and diverted fishes, increased predation pressure on young fishes, decreased fish forage, altered salinities and reversed natural flow regimes (Baracco, 1980).

Further, a number of factors that could influence the hydrologic conditions of the San Francisco Bay-Delta estuary were not evaluated adequately in the EIR but should be before selecting a final plan for protection of Suisun Marsh. For example, the CVP is undergoing legislative reauthorization. This could result in substantial quantities of CVP yield being made available for instream uses. In our evaluation of the Draft Environmental Impact Statement to reauthorize the CVP, we calculated that 1.3 to 2.0 million acre-feet could be available from CVP sources alone (National Marine Fisheries Service, 1980). Agricultural water conservation and groundwater management also could provide substantial quantities of water for instream purposes.

The Delta Pumping Plant (one element of the SWP) has not received necessary permits to operate. Its future operation could be at annual levels different than those assumed in Water Right Decision 1485. In addition, the Peripheral Canal (or its alternatives), the San Joaquin Valley Salt Drain, the Sacramento Deep Water Ship Channel (and salt barrier) and the proposed Montezuma power plant at Collinsville each will affect the assumed conditions in the hydrologic model used to formulate the selected plan. All of the aforementioned projects should be interfaced with the hydrologic model for the selected plan and predicted impacts should be evaluated in the Final Environmental Impact Report.

Finally, we are not convinced that the economic consequences of providing Marsh protection with Delta outflows are as severe as presented in the Draft Environment Impact Report. In our economic analysis of providing fishery flows in the Trinity River, we found that the net loss to agriculture in terms of low-income crops (those most likely to be taken out of production if water supplies were reduced) was approximately $3.60/acre-foot of applied water (National Marine Fisheries Service, 1980a). Considering that the CVP has an unallocated yield of 1.3 million acre-feet (not including New Melones Reservoir), and other sources of water (such as water conservation) which would not result in reduced agriculture production, the economic benefits of increasing Delta outflows in terms of increased fishery and waterfowl production could outweigh the costs to agriculture.

Given the above considerations we believe the feasibility of providing protection of the Suisun Marsh with Delta outflows rather than structural means be evaluated further. We look forward to reviewing a revised Final Environment Impact Report and thank you for the opportunity to review the draft.

Sincerely yours,

Floyd S. Anders, Jr.
Acting Regional Director

Enclosure
Bibliography

## Bibliography


Baracco, A., 1980. Aquatic resources of Suisun Marsh with an analysis of the fishery effects of a proposed water quality maintenance plan. California Department Fish and Game, Bay-Delta Fishery Project, Stockton, CA

Moyle, P. B. and Daniels, R. A., 1980. Fishes of Suisun Marsh: Preliminary report to the California Department of Water Resources. Department Wildlife and Fisheries Biol., University of California Davis

Michny, P. J., 1979. Trends of pintails wintering in the Suisun Marsh California based on 20 years of aerial surveys. Division of Ecol. Services, U.S. Fish and Wildlife Service, Sacramento, CA

National Marine Fisheries Service, 1980. Review of Draft Environmental Impact Statement (DEIS No. 8007.21) on the reauthorization of the CVP and coordinated operating agreement for the CVP-SWP. Southwest Region Environmental Assessment Branch, 300 S. Ferry Street, Terminal Island, CA

National Marine Fisheries Service, 1980a. Review of Draft Environmental Statement (DES 80-54) on management of river flows to mitigate the loss of the anadromous fishery of the Trinity River, CA. Southwest Region, Environmental Assessment Branch, 300 S. Ferry Street, Terminal Island, CA


Encl

PEI 11.5

State of California

THE RESOURCES AGENCY

# Memorandum

To : Mr. Huey Johnson
Secretary for Resources
1416 Ninth Street
Sacramento, CA 95814

Attn: Mr. James W. Burns

Date : NOV 3 1980

From : STATE WATER RESOURCES CONTROL BOARD

Subject: PLAN OF PROTECTION FOR THE SUISUN MARSH INCLUDING DRAFT ENVIRONMENTAL IMPACT REPORT (SCH 80092322)

The State Board has reviewed the subject document prepared by the Department of Water Resources (Department).

The State Board previously reviewed a preliminary draft of the subject document dated September 27, 1979, and transmitted detailed comments on that document to the Department on January 25, 1980. While many of the Board's concerns have been addressed in the present document, several have not. Additionally, new concerns have been raised since the preliminary draft was prepared.

The most notable concern is that the Draft Environmental Impact Report (Draft EIR) does not provide suitable quantification of the project's adverse impacts on important fish and wildlife species. This quantification should be in terms of estimated numerical changes in population parameters. The Board recognizes the lack of present knowledge on existing fish and wildlife populations in the Marsh. An attempt, however, should be made in the Final EIR to estimate these population changes when discussing the unavoidable adverse effects of the project on fish and wildlife. The reader must be allowed to determine for himself whether these changes are significant and whether proposed mitigation measures are appropriate.

A second concern is that the Draft EIR proposes measures to mitigate the adverse impacts of the project, but does not detail the mitigation plans. The Board is aware that the plans are still in the developmental stage. Nonetheless, the mitigation plans should be presented in the Final EIR.

Attached are the Board's detailed comments on the Plan and Draft EIR. On the whole, the Department has done an admirable job in preparing this document. The Final Plan and EIR will be acceptable to the Board, provided they are modified in accordance with our comments.

Sincerely,

Michael A. Campos
Deputy Executive Director

Attachment

cc: Hon. Ronald B. Robie, Director (w/attachment)
Department of Water Resources
1416 Ninth Street, Rm. 1115-1
Sacramento, CA 95814

Mr. M. A. Catino (w/attachments)
Acting Regional Director
U. S. Water and Power Resources
Service
2800 Cottage Way
Sacramento, CA 95825

STATE WATER RESOURCES CONTROL BOARD
COMMENTS ON THE
PLAN OF PROTECTION FOR THE SUISUN MARSH
INCLUDING DRAFT ENVIRONMENTAL IMPACT REPORT
SCH 80092322
October 1980

General Comments

In our January 25 letter on the Draft Plan of Protection (Plan) and preliminary Draft Environmental Impact Report (Draft EIR), we stated that a greater attempt should be made to quantify the environmental impacts of alternative actions. The current document shows little evidence of improvement in this regard. While we recognize the difficulty in numerically estimating future environmental changes, we emphasize that this is an important part of any environmental impact analysis. At the very least, an attempt should be made to estimate the unavoidable adverse impacts of the project on important species of fish and wildlife. The estimates should be in terms of percent population reduction or numbers of individuals lost, particularly those considered rare and/or endangered. In the absence of supporting numerical estimates, the use of subjective terms, such as "small", "not significant" or "adverse" does little to help the reader develop a basis for agreeing or disagreeing with the author's conclusions. The discussion of adverse impacts on fish and wildlife should be modified in the Final EIR to include numerical estimates of changes in population parameters.

Specific Comments

1. Pages IV-4 and IV-5

The Plan states that the channel islands southwest of Grizzly Island will not be protected from increased salinity. The discussion should reference the plan for mitigating resultant adverse impacts discussed on page IX-36.

2. Pages V-1 and V-26

On page V-1, the Plan states that the 1984 water quality standards for three control points--S-33, S-36 and mouth of Montezuma Slough--would not be met. Lands in the vicinity of these control points would be serviced by overland facilities rather than directly from the channels. The discussion which follows that statement does not adequately explain which facilities will provide this overland service. Nor does it explain whether lands serviced by such overland facilities will receive protection equivalent to that which would be obtained by meeting the standards at the above-mentioned control points. Decision 1485 requires that equivalent protection to lands serviced be demonstrated prior to State Board approval of standards modification. The Plan should be modified to provide this information.

For example, our January 25 letter stated that the discussion of the Cygnus Ditch facility should explain that the facility is designed to provide protection of lands which would otherwise be serviced directly

from the channels near Station S-33 (i.e., the Station S-33 area). The discussion on page V-26 does not provide this explanation. Furthermore, it appears to misinterpret the term "Station S-33 area" to mean water within Cordelia Slough west of Cygnus rather than lands served near Station S-33 as explained above. This should be corrected.

3. Page VI-1

The last sentence states: "DWR will be responsible for the maintenance and management of the major water control structures of the project" (emphasis added). We assume the term "management" includes procedures for operating these major facilities exclusive of the individual (on-club) management procedures which will be under the responsibility of the Suisun Resource Conservation District (SRCD). In our January 25 letter, we stated that DWR's procedures for operating the major water control structures should be detailed in the Plan. The present plan does not include this information as required by Condition 7(a) of Decision 1485. This information should be provided in the Final Plan. In addition, a summary of SRCD's individual (on-club) management procedures should also be included.

3. Pages V-23 and V-26

The Plan states that by the year 2000 up to 32 cubic feet per second of supplemental treated wastewater from the Fairfield plant will be available to help meet standards in the western Marsh. If this supply will be needed to meet the standards, the Plan should discuss the basis for assuring that it will be available to the Marsh rather than reclaimed elsewhere. If such assurances cannot be provided, the Plan should specify back-up facilities designed to meet the standards without Fairfield wastewater.

4. Page VIII-1

In the first line, the words "of SWRCB Decision 1485" should be inserted after "Order No. 7(b)".

5. Page IX-1

In the last line of the third paragraph, the State Board's mailing address should be shown as P. O. Box 100, rather than P. O. Box 1002.

6. Pages IX-8 and IX-36

The draft EIR proposes development of a plan to mitigate adverse salinity effects of the project on the channel islands. Additionally, plans to mitigate adverse effects on rare and endangered species (i.e., the California black rail and the salt marsh harvest mouse) are proposed. These mitigation plans should be fully detailed in the Final EIR.

7. On page IX-9, the Draft EIR discusses possible adverse effects of the project on anadromous fish survival due to:

1) changes in migration routes;

2) increased predation; and

3) reduction in populations of Neomysis ( an important fish food organism).

This discussion should also address the losses of anadromous fish into the duck club ponds attributable to unscreened diversions. Moreover, the resultant population losses due to all of the above factors should be quantified numerically in the Final EIR (see our general comments above).

On page IX-35, the Draft EIR states:

> "Effects on anadromous fish would be minimized by tailoring operational procedures and screening intakes as necessary."

This implies that a specific plan will be developed at a later date to mitigate the impacts on the anadromous fishery discussed above. The mitigation plan should be fully detailed in the Final EIR. Such disclosure in the Final EIR will be needed to establish whether proposed mitigation measures are sufficient.

8. Page IX-16

Under the topic of energy, the Draft EIR states that operation of the Montezuma Slough Control Structure would require a small and difficult to estimate consumption of electrical energy. If the conclusion can be reached that such consumption is "small", then a maximum annual use of energy (assuming continued operation from October through May) can and should be estimated.

State of California

Kmn

The Resources Agency

# Memorandum

To : 1. Jim Burns, Projects Coordinator
Resources Agency

2. Department of Water Resources
3251 "S" Street
Sacramento, CA 95816

Date: November 7, 1980

From : **Department of Fish and Game**

Subject: SCH 80092322A - Plan of Protection for the Suisun Marsh Including Draft EIR, Department of Water Resources, September 1980

The Department of Fish and Game has reviewed the subject plan and DEIR. We believe the DEIR is incomplete, since the plan of mitigation for the loss of existing habitat being developed by the Suisun Marsh Technical Committee (Page IX-36) is not available for review along with the subject document. The merits of the plan and DEIR cannot be fully evaluated without the proposed mitigation plan. Further, we believe that the DEIR does not adequately consider the impact of the project on endangered species and that sufficient new information is now available to begin preparation of a supplement to this EIR. Any subsequent environmental documents should include this new information and be available simultaneously for review.

In addition to the above general comments, we have the following specific and editorial comments:

Page S-3: Fish screens may be required with the Goodyear Slough facilities. This point should be discussed in the document and provided for if needed.

Page II-5: The conclusion that Marsh ponds can be flooded with treated wastewater has not yet been verified by the pilot study results. Further, discussion of the Fairfield Duck Club Program (Page II-6) points out the severe algae problems that have occurred with the use of wastewater on typical duck clubs. We know that future studies are planned which will assess the effects of using highly diluted wastewater and modified marsh management practices. You should refer to these future studies and identify alternative sources of water in the event the use of wastewater is determined to be infeasible.

Page III-19: "Scirpus" is misspelled and should be capitalized as a proper name.

Page III-20: "Neomysis" should be capitalized as a proper name.

American shad and threadfin shad are both present in the Marsh.

Page III-23: The fitted line for "Central Valley" waterfowl stocks does not appear to be valid. The line should be fitted by the best available statistical method.

Page III-25: The Rare and Endangered chart is incomplete; it should include the bald eagle, peregrine falcon and salt marsh harvest mouse under the Department of Fish and Game columns.

The thicktail chub has been declared extinct by the California Fish and Game Commission.

Page III-26: First paragraph, last sentence. Both U. S. Fish and Wildlife Service and Department of Fish and Game consider the mouse endangered.

Page III-28: Second full paragraph, last sentence. The conclusion that nature study may become the most important activity in the marsh is misleading. Nature study may be expected to increase. However, we anticipate that waterfowl hunting and fishing will also increase and continue to be the most important activities in the Suisun Marsh.

Page III-31: The citation is inadequate. We believe that the mean annual salinities should be:

| | |
|---|---|
| Brass Buttons: | 8.9 - 30.5 PPT TDS |
| Alkali Bulrush: | 6.9 - 32.5 PPT TDS |

Page V-20: The Goodyear Slough facilities may require fish screens. This point should be discussed in the document and the installation of screens provided for if determined to be necessary.

Page IX-12: Recent surveys do not discount the probability of breeding populations of California clapper rail in the Marsh.

Page IX-26: Recreation. Potential improvement of fishing and hunting opportunities with construction of the Potrero Ditch should be explained.

Page IX-29: Wildlife. Recent results from salt marsh harvest mouse surveys should be included.

Page IX-36: Marsh and Upland Habitat. Potential impacts on black rail habitat are discussed in most evaluation sections. Impacts on the black rail may not be significant if most of the areas affected are virtually all pickleweed. A DFG report, "California Black Rail Breeding Season Survey in Central California; 1977", by Timothy D. Manolis, describes the importance of pickleweed and associated vegetation. The Department of Fish and Game has recently completed a survey of marsh habitat affected by the project. The results of this survey should be assessed to determine the probable impacts on black rail.

Page B-7: Fish occurrence studies are now in progress, and necessary screening will occur concurrently with construction of the facilities.

Department of Fish and Game personnel are available to discuss our concerns (and recommendations) in more detail. To arrange a meeting, the project sponsor or applicant should contact Mr. Dennis Becker, Region 3, Department of Fish and Game, P. O. Box 47, Yountville, CA 94599, telephone (707) 944-2443.

Director

State of California

State Lands Commission

# Memorandum

To : James D. Burns, Assistant Secretary
Resources Agency

Date : October 21, 1980

File No.:

Wayne MacRostie
Department of Water Resources
3251 S Street
Sacramento, CA 95816

From : **EXECUTIVE OFFICE**
1807 13th Street, Sacramento 95814

Subject: Comments to DWR's Plan of Protection for the Suisun Marsh Draft EIR - SCH #80092322

The State Lands Commission's staff has reviewed the subject document and offer the following comment.

On page III-29 it states:

> "During recent years, because of increased upstream depletions, it has been increasingly difficult to maintain the species of brackish marsh vegetation which contribute to the value of the Suisun Marsh as wintering habitat." (emphasis added)

Since the report seems to be saying that such "increased upstream depletions" are the cause of the water quality problems and hence the deterioration of the Suisun Marsh, it would seem logical that limitation of such upstream depletions should be discussed as an alternative, at least during extremely dry years.

Ted T. Fukushima

TED T. FUKUSHIMA
Senior Planner

TTF:js

C—054258