CHAPTER VII. ALTERNATIVES FOR IMPLEMENTING SUISUN MARSH SALINITY OBJECTIVES

The 1995 Bay/Delta Plan contains salinity objectives for the channels of Suisun Marsh (Figure VII-1) to protect the beneficial uses of the marsh. This chapter describes the environmental effects of the alternatives for implementing the Suisun Marsh objectives. The chapter is divided into the following sections: (A) background, (B) physical description of existing facilities, (C) alternatives for implementing the objectives, (D) environmental effects of the alternatives and (E) summary.

A. BACKGROUND

The background discussion is divided into two sections: (1) regulatory history and (2) historical salinity conditions in Suisun Marsh.

1. Regulatory History

In 1963 the Suisun Resource Conservation District (SRCD) was formed by public and private landowners in Suisun Marsh. The conservation district undertakes administrative, regulatory, and technical functions that include: representing landowner interests, both individually and collectively; obtaining environmental permits for routine maintenance activities; preparing wetland management plans for all private land within the district; enforcing implementation of the management plans; and providing technical expertise on issues related to marsh management. The district includes 52,000 acres of managed wetlands, 6,300 acres of unmanaged tidal wetlands, 30,000 acres of bays and sloughs, and 27,700 acres of upland grasslands. There are 153 privately owned duck clubs in the marsh, and the DFG manages 15,000 acres of the managed and tidal wetlands (DWR 1993).

A review of the issues related to Suisun Marsh resulted in a memorandum of agreement signed by the USBR, USFWS, DWR, and DFG on July 13, 1970. A goal of this agreement was to select a water supply and marsh management plan that would protect and enhance waterfowl habitat.

The California Legislature, recognizing the threat of urbanization to Suisun Marsh, enacted the Nejedly-Bagley-Z'berg Suisun Marsh Preservation Act of 1974. The act required the DFG and the San Francisco Bay Conservation and Development Commission (BCDC) to develop a plan to protect the marsh. In December 1975, the DFG released the Fish and Wildlife Element of the Suisun Marsh Protection Plan, which contains an inventory of fish and wildlife species found in and around the marsh, an interpretation of how the marsh functions, and recommendations for protection of the marsh.

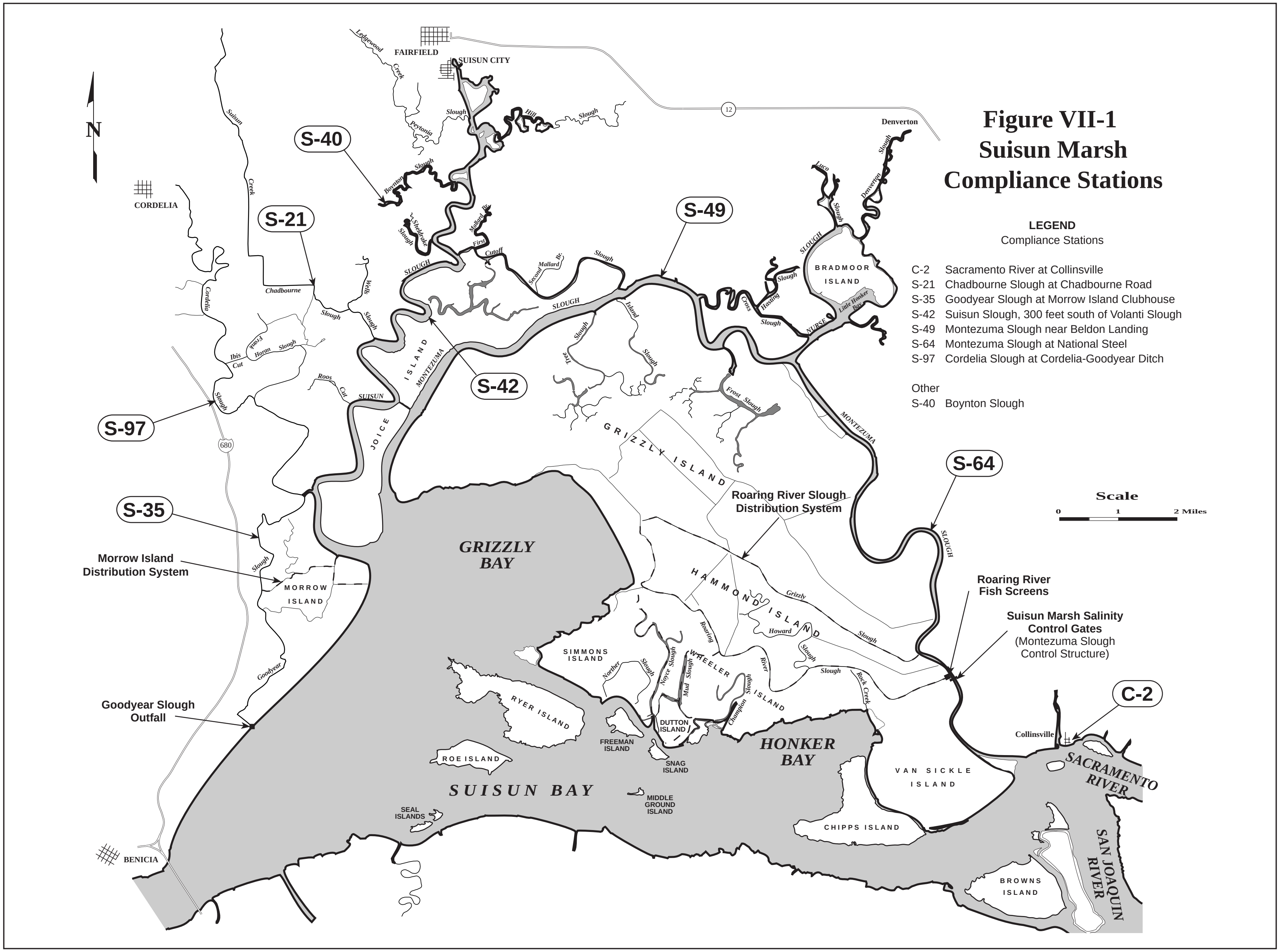


Figure VII-1
Suisun Marsh Compliance Stations

In 1976, the BCDC submitted the Suisun Marsh Protection Plan to the California Governor and Legislature. The Protection Plan divided the marsh into primary and secondary management zones based on land use. Tidal wetlands and diked lands managed as wetlands were placed in the primary management zone; annual and perennial grasslands and vernal pools adjacent to the marsh were classified as the secondary management zone. The purpose of the secondary management zone is to provide a buffer between urban development and wetland areas of the marsh. Under the Suisun Marsh Protection Plan, the BCDC serves as the permitting agency for all major projects within the primary management zone and as an appellate body with limited functions in the secondary management area. The Suisun Marsh Protection Plan recommended that local agencies develop a plan of compliance. It recommended and prioritized the acquisition of properties, proposed a tax assessment plan based on land use, and identified both state and federal sources of funding to achieve its objectives.

In 1977, the California Legislature added the Suisun Marsh Preservation Act of 1977 to the Public Resources Code and implemented the recommended protection measures outlined in the Suisun Marsh Protection Plan. This act emphasized the importance of the marsh as a unique and irreplaceable resource, particularly because of the habitat available for wintering waterfowl.

Salinity objectives for the marsh were first adopted by the SWRCB in 1978. The regulatory history of these salinity objectives is discussed below, including: (1) the 1978 Delta Plan, D-1485, (2) 1985 amendments to D-1485, the Suisun Marsh Preservation Agreement (SMPA), the 1995 Bay/Delta Plan, and (3) Water Right Order 98-09 (WR 98-09).

a. 1978 Delta Plan, D-1485, and the 1985 Amendments. The origin of the 1978 Delta Plan Suisun Marsh salinity objectives can be traced to the DFG's early studies on waterfowl food habits, plant salinity tolerances, and soil salinities. In 1969, the DFG conducted a study to determine waterfowl plant food preferences and the soil and water conditions necessary to support the preferred foods. The study determined that the preferred waterfowl plant food was alkali bulrush seed (*Scirpus robustus*)[1] followed by brass buttons (*Cotula coronopifolia*). The most important factors influencing plant distribution were soil submergence time and soil salinity. Soil salinities during May were found to be critical to September alkali bulrush seed yield. Optimal soil salinity levels were between 7 and 14 parts per thousand (ppt). No seed production resulted when May soil salinity exceeded 24 ppt (Mall 1969).

In 1973, the DFG investigated the relationship between soil salinity and the salinity of applied water. A significant correlation was found to exist between the salinity of applied water and the salinity in the first two feet of the soil. The leaching of marsh soils by alternate flooding and draining with low salinity water was found to be an effective means of reducing soil salinity. Methods of water management were recommended for maintaining suitable soil salinity (Rollins 1973).

1. The species is now determined to be *Scirpus maritimus*.

The DFG and others submitted exhibits during Bay/Delta hearings in 1976 and 1977 which recommended monthly channel water salinity objectives in Suisun Marsh. The salinity objectives adopted in the 1978 Delta Plan were similar to the recommendations of the California Waterfowl Association, which were designed to achieve an average of 90 percent of maximum alkali bulrush seed production and 60 percent seed germination (CWA 1976).

A report by the San Francisco Estuary Project summarizes the studies that have been conducted on food habits of waterfowl in Suisun Marsh (SFEP 1992). Although Mall concluded that alkali bulrush seeds were the most important food item in the diets of dabbling ducks in the marsh (Mall 1969), Swanson and Bartonek demonstrated that analyses of gizzard content inflate the importance of seeds in the diet of ducks (Swanson et al. 1970). Analyses of esophageal contents soon after birds have fed more accurately reflect the diet of waterfowl. More recent studies of waterfowl food habits in the San Joaquin and Sacramento valleys found animal matter constituted a much higher percentage of the diet of wintering waterfowl than previously reported. The percentage of animal matter in the diet was highest in winter, whereas vegetative food items predominated in the fall (SFEP 1992). This finding was confirmed in the Suisun Marsh (Batzer 1993). The 1978 Delta Plan set channel water salinity objectives for the Suisun Marsh from October through May. D-1485 required the SWP and the CVP to develop and implement a plan, in cooperation with other agencies, that would meet all of the salinity objectives by October 1, 1984. Immediate compliance with the objectives was not considered reasonable because such compliance could be achieved only through large increases in outflow, then estimated at as much as two million acre feet annually. The DWR, in cooperation with the SRCD, USBR, DFG, and USFWS, developed the "Plan of Protection for the Suisun Marsh including Environmental Impact Report" (Plan of Protection) in 1984 to meet the D-1485 requirements. The Plan of Protection proposed staged implementation of a combination of activities, including physical facilities, a wetlands management program for marsh landowners, and supplemental releases from SWP and CVP reservoirs. Staged implementation allowed the effect of each action to be evaluated before deciding whether to implement a subsequent action.

At the request of the DWR and the USBR, the SWRCB amended D-1485 in 1985 by changing some of the Suisun Marsh compliance locations and compliance dates. The amended compliance monitoring locations and the effective dates of compliance are listed below in Table VII-1; the compliance monitoring stations are illustrated in Figure VII-1.

b. The Suisun Marsh Preservation Agreement. In 1987, the DWR, USBR, DFG, and SRCD signed the SMPA which is the contractual framework for implementing the Plan of Protection, including controlling channel water salinity. The agreement included proposed normal period and deficiency period[2] salinity requirements that are different from the objectives in the 1978

2. A deficiency period is: (a) the second consecutive dry water year following a critical year; (b) a dry water year following a year in which the Sacramento River Index was less than 11.35: or (c) a critical water year following a dry or critical water year (1995 Bay/Delta Plan).

Table VII-1
Suisun Marsh Compliance Stations and Effective Dates

Station ID	Location	Effective Date
C-2	Sacramento River at Collinsville	October 1, 1988
S-49	Montezuma Slough near Beldons Landing	October 1, 1988
S-64	Montezuma Slough at National Steel	October 1, 1988
S-21	Chadbourne Slough at Chadbourne Road	October 1, 1995
S-97	Cordelia Slough at Ibis Club	October 1, 1997
S-35	Goodyear Slough at Morrow Island Club	October 1, 1997
S-42	Suisun Slough at Volanti Club	October 1, 1997

Delta Plan and D-1485, as amended. A comparison between the SMPA-proposed requirements and the 1978 Delta Plan objectives is provided in Table VII-2.

In 1987, the DWR requested that the SWRCB adopt the SMPA requirements as water quality objectives. The principal concern expressed by the DWR regarding the 1978 Delta Plan objectives was that they are not adjusted during deficiency periods. In response, the SWRCB requested, at the recommendation of the DFG, that the DWR and the USBR prepare a Biological Assessment to determine whether any flow and salinity changes that occur as a result of the actions taken pursuant to the SMPA would jeopardize any rare, threatened, or endangered species. The DWR and the USBR planned to complete a Biological Assessment in 1996. This task was never completed because the 1995 Bay/Delta Plan adopted the SMPA concept of deficiency year objectives, but the deficiency objectives were only applied to stations in the western marsh.

The SMPA called for staged construction of facilities in Suisun Marsh to provide the required channel salinities at a capital cost of $120 million (1985 dollars). The initial facilities (phase 1) were constructed in 1980 including the Roaring River Distribution System, Morrow Island Distribution System, and Goodyear Slough Outfall. The second phase, and most important facility, the Suisun Marsh Salinity Control Gates (SMSCG), were constructed and went into operation in 1988. The gates are used to tidally pump lower salinity water through Montezuma Slough into the central marsh to reduce channel salinities during periods of low to moderate Delta outflow. Operation of the gates restricts the upstream flow of more saline water from Suisun Bay during flood tides while allowing the normal flow of freshwater from the Sacramento River during ebb tides. During full operation, the gates open and close twice each tidal day. Flows past the gates vary from no flow when the gates are closed to several thousand cfs with all three gates open; the net flow through the gates is about 1,800 cfs when averaged over one tidal day. Extended testing established that gate

Table VII-2
1978 Delta Plan Objectives (with 1985 Amendments) and
SMPA Salinity Requirements

Month	Mean Monthly High Tide Electrical Conductivity (mmhos/cm)		
	1978 Delta Plan	SMPA Normal Year	SMPA Deficiency Year
October	19.0	19.0	19.0
November	15.5	16.5	16.5
December	15.5	15.5	15.6
January	12.5	12.5	15.6
February	8.0	8.0	15.6
March	8.0	8.0	15.6
April	11.0	11.0	14.0
May	11.0	11.0	12.5

operation, in conjunction with reasonable outflow levels, results in compliance with the eastern marsh objectives at stations C-2, S-49, and S-64 under most circumstances; however, gate operation can not consistently achieve compliance at the remaining stations in the western marsh. After gate operation began, salinities at the eastern marsh stations were generally below the 1978 Delta Plan objectives and always below the SMPA deficiency standards. Salinities at the western marsh stations were generally below 1978 Delta Plan objectives and SMPA deficiency standards in wetter years or water years following wet periods, such as 1985, 1986, 1987, and 1994. However, during prolonged dry or critically dry periods, salinities in the western marsh were often above both 1978 Delta Plan objectives and SMPA deficiency standards.

In order to comply with the western marsh objectives, the DWR and the USBR began the planning and environmental review process for the Western Suisun Marsh Salinity Control Project in June 1990 (DWR 1991a). This review resulted in the identification of nine individual alternative actions and eighteen combinations of actions that warranted further investigations (DWR 1993). Field tests for one of the more promising actions, flow augmentation in Green Valley Creek, were conducted in 1994 with North Bay Aqueduct water. The DWR and the USBR suspended their planned activities under the Western Suisun Marsh Salinity Control Project after the adoption of the 1995 Bay/Delta Plan in order to reevaluate the needs of the western marsh under the new conditions imposed by the plan.

In August 1995, the parties to the SMPA began discussions to update the agreement (SMPA Amendment III; SMPA 1998) to reflect anticipated future hydrologic and salinity conditions in the Suisun Marsh under the conditions of the 1995 Bay/Delta Plan and Suisun Marsh Salinity Control Gate operation. Execution of Amendment III is pending completion of CEQA/NEPA environmental documentation and the CESA/ESA consultation process. The parties have recommended that the SWRCB consider a series of management actions as the next step in implementing the Bay/Delta Plan rather than focus on the channel water salinities in the western marsh (DWR 1996). The basis for the recommendation is that management actions may provide more appropriate soil salinity conditions in all years on managed wetlands than would strict adherence to the salinity objectives. The Bay/Delta Plan states that the salinity objectives in the channels do not have to be achieved if a demonstration of equivalent or better protection is provided at the location. The recommendation of the parties to the SMPA is considered in this EIR (Chapter VII, section B, Alternative 5).

c. 1995 Bay/Delta Plan. The 1978 Delta Plan Suisun Marsh objectives, as amended, included salinity objectives at the seven compliance points listed above, and flow and salinity objectives at Chipps Island from October through May. During the proceeding leading to adoption of the 1995 Bay/Delta Plan, the signatories to the SMPA (DWR, USBR, DFG, and SRCD) recommended that the SWRCB adopt the SMPA requirements as water quality objectives for the marsh (DWR 1994b, DFG 1994). The following discussion describes the changes made to Suisun Marsh objectives by the adoption of the Bay/Delta Plan and the rationale for the changes.

First, the Chipps Island standards for protection of Suisun Marsh were replaced with the year-round outflow standards for general habitat protection. The new outflow should provide equivalent or better protection for the marsh. Second, the eastern Suisun Marsh salinity objectives (stations C-2, S-64, and S-49) were not changed. These objectives have been met since 1989, with minor exceptions, and operation of the Suisun Marsh Salinity Control Gates, in combination with outflow conditions required by the 1995 Bay/Delta Plan, should be adequate to ensure continued compliance under most circumstances. Recent modeling over the 1987-1992 hydrologic sequence indicates that the objectives at these stations will be met except for the month of February 1991, assuming full-bore[3] operation of the SMSCG and compliance with the Bay/Delta Plan outflow objectives (DWR 1995). Third, the western Suisun Marsh salinity objectives (stations S-21, S-42, S-97, and S-35) were amended to include the SMPA deficiency standards, and the compliance dates for S-97 and S-35 were extended to 1997[4]. The 1978 Delta Plan objectives had not been implemented in the western marsh; therefore, the implementation of the combination of 1978 Delta Plan objectives in average hydrologic conditions and SMPA deficiency standards in dry conditions

3. Full-bore operations consist of tidally pumping water for as long as tidal conditions permit (over the falling tide and into the beginning of the next rising tide) (DWR 1995a).

4 The effective date for compliance at stations S-35 and S-97 was extended by the SWRCB, pursuant to Water Code §1435, on October 30, 1997, August 14, 1998 and April 30, 1999. The Water Code allows for additional 180 day extensions.

should provide lower salinity habitat than existing conditions. Also, there should be a natural gradient of increasing salinity from east to west which is not reflected in the 1978 Delta Plan objectives, but is included in the Bay/Delta Plan objectives when deficiency period objectives are in effect. Fourth, a narrative objective for protection of tidal marshlands was included. This objective is expected to be achieved through compliance with the year-round outflow objectives, but it is added to ensure that the tidal marshlands receive adequate protection. Lastly, the plan recommended that the DWR form a multiagency Suisun Marsh Ecological Work Group (SEW). The principal charge of SEW is to evaluate the scientific basis for the objectives and to identify specific measures to implement the narrative objective, if necessary. The results of this review will be used in the next triennial review of the Suisun Marsh water quality objectives.

d. **SWRCB Order WR 98-09**. In 1995, the DWR and the USBR petitioned the SWRCB to change some of the permit terms and conditions imposed by D-1485 so that they conform with the objectives in the 1995 Bay/Delta Plan and the Principles for Agreement. In D-1485, the SWRCB found that the SWP and the CVP have a mitigation responsibility to protect Suisun Marsh because their operations affect salinity conditions in the marsh. The SWRCB received no new information in the 1995 water quality proceeding relevant to this finding. The SMPA deficiency objectives, as applied in water short years, makes it even more likely that these objectives could have been met absent the CVP and SWP. Therefore, these new Suisun Marsh objectives were incorporated into the water right permits of the SWP and the CVP with the adoption of SWRCB Order WR 95-6. WR 95-6 was a temporary order, expiring on December 31, 1998. On December 3, 1998, the effective term of WR 95-6 was extended until December 31, 1999, when the SWRCB adopted Order WR 98-09. If at that time a new water right decision has not been adopted, D-1485 will once again become effective.

2. Historical Salinity Conditions in Suisun Marsh

The controllable, and most easily measured, water quality parameter in Suisun Marsh is salinity. Salinity influences the types of vegetation that can grow on both managed and unmanaged portions of the marsh, and the types of vegetation in turn influences the occurrence of animal life in the marsh. The following factors affect salinity in the Suisun Marsh:

1. D-1485: the regulatory framework
2. SMPA: the contractual framework
3. Plan of Protection for the Suisun Marsh: facilities planning
4. Suisun Marsh Salinity Control Gate operation (beginning October 31, 1988)
5. Delta outflow
6. Creek inflows
7. Managed wetland operations
8. Fairfield-Suisun Wastewater Treatment Plant effluent inflows into Boynton Slough
9. Precipitation/evaporation conditions
10. Tidal variations, wind, and barometric pressure

Of these factors, facilities planning, the operation of facilities in the marsh, and to an extent, Delta outflows are controlled by the DWR and the USBR. Operations of the private managed wetlands in the marsh are controlled by 153 individual landowners, and the public areas are managed by the DFG. The ultimate destination and discharge of Fairfield-Suisun Sewer District (FSSD) wastewater treatment plant effluent is controlled by the Fairfield-Suisun Sewer District and the Solano Irrigation District (SID), under permits issued by the San Francisco Bay RWQCB. Precipitation, runoff, tidal variations, winds, barometric pressure, and evaporation are natural, uncontrollable factors.

The ER for the 1995 Bay/Delta Plan described the historical salinity conditions in Suisun Marsh for water years 1984-1994 and compared them to D-1485 and SMPA objectives. This description is summarized below. A more detailed description can be found in Chapter VIII of the ER and in a report prepared by the DWR (DWR 1994c).

Mean monthly high tide salinity for water years 1984-1994 for eastern marsh compliance stations C-2, S-64, and S-49 and western marsh compliance stations S-21, S-97, and S-35 are presented in Figures VII-2 and VII-3, respectively (two pages each). Station S-42 is not included in this analysis, but the salinities at this station are very similar to the salinities at station S-21. In some cases, data are not shown for a station in a particular year because either the station was not established or the data did not meet quality assurance/quality control criteria. Mean monthly high tide salinities are presented on each bar chart, one bar per station as indicated on the legend in the upper left-hand corner of the figures. The monthly 1978 Delta Plan (solid line, indicated as D-1485) and SMPA deficiency (dashed line) objectives are also shown on each of the six bar charts (per page) to facilitate comparison of the actual salinities with the 1978 Delta Plan and SMPA deficiency objectives. As described above, the 1995 Bay/Delta Plan objectives are the same as the D-1485 objectives for the eastern marsh stations, and the plan objectives are the same as the SMPA objectives for the western marsh stations in deficiency periods and the same as the D-1485 objectives in other periods. Deficiency periods occurred in 1988, 1989, 1990, 1991, and 1992.

The SMSCG began operating on October 31, 1988. After gate operation began, salinity at the eastern marsh stations was generally below the 1978 Delta Plan standards and always below SMPA deficiency standards. Salinity at the western marsh stations was generally below 1978 Delta Plan standards and SMPA deficiency standards in wetter years or water years following wet periods, such as 1985, 1986, 1987, and 1994. However, during prolonged dry or critically dry periods, salinity in the western marsh is often above both 1978 Delta Plan standards and SMPA deficiency standards. Salinity in northwestern marsh sloughs (e.g., station S-97) is primarily affected by surface water inflows from local creeks and drainage water from the managed wetlands, and is relatively unaffected by SMSCG operations.

Figure VII-2
Suisun Marsh Mean Monthly High Tide Salinity
Specific Conductance in mSiemens
Water Year = 1984-94
Eastern Marsh Sites

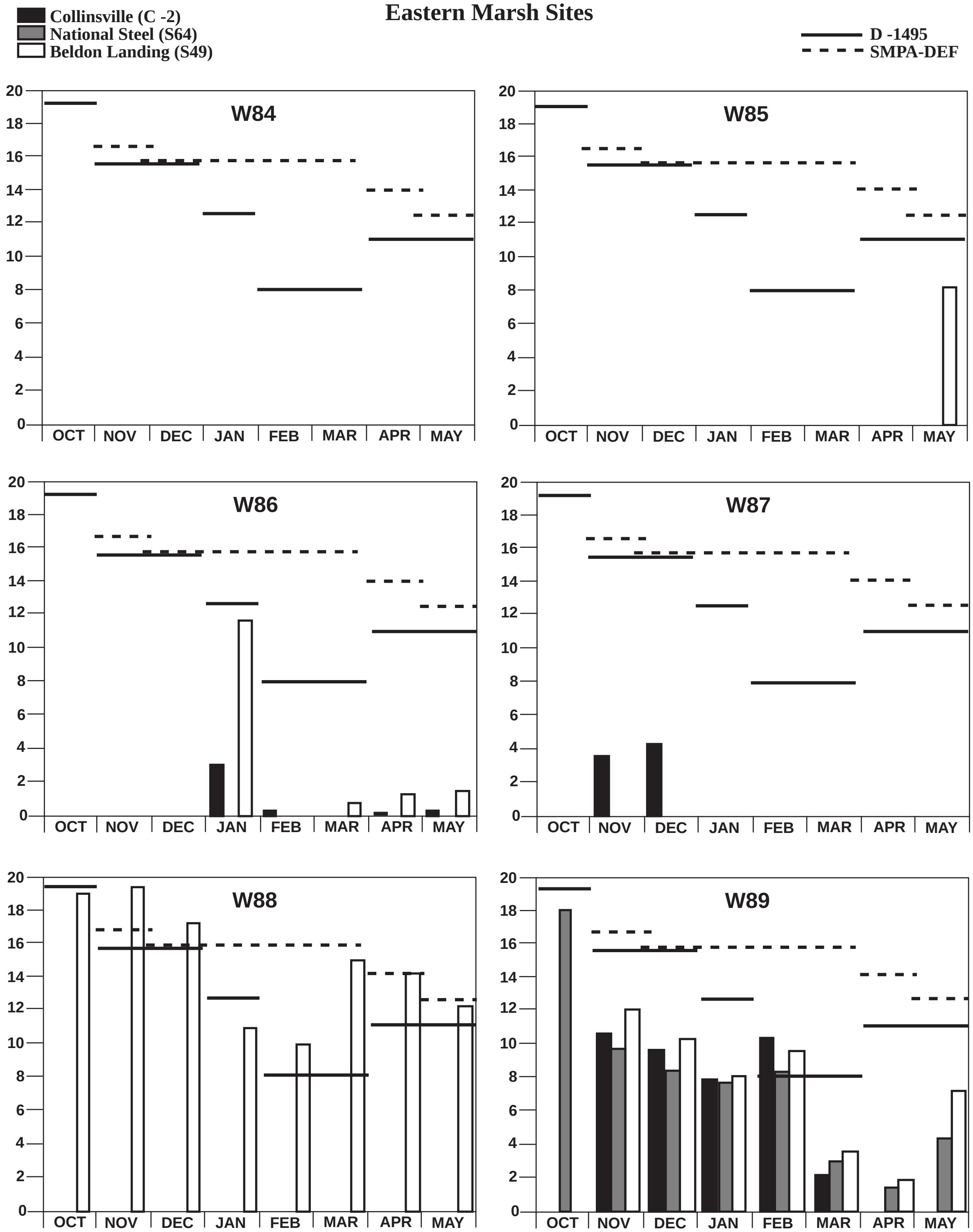


Figure VII-2 (continued)
Suisun Marsh Mean Monthly High Tide Salinity
Specific Conductance in mSiemens
Water Year = 1984-94
Eastern Marsh Sites

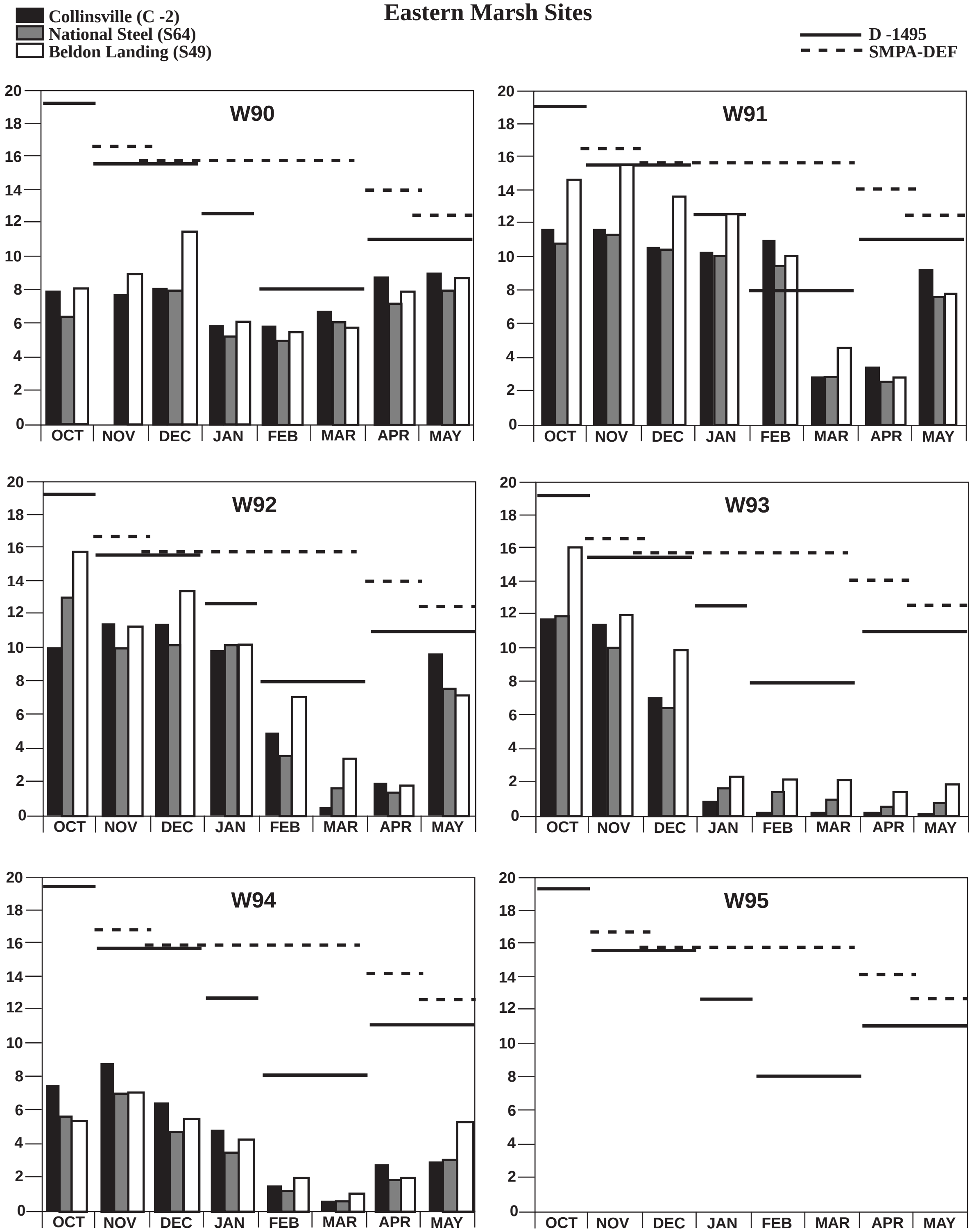
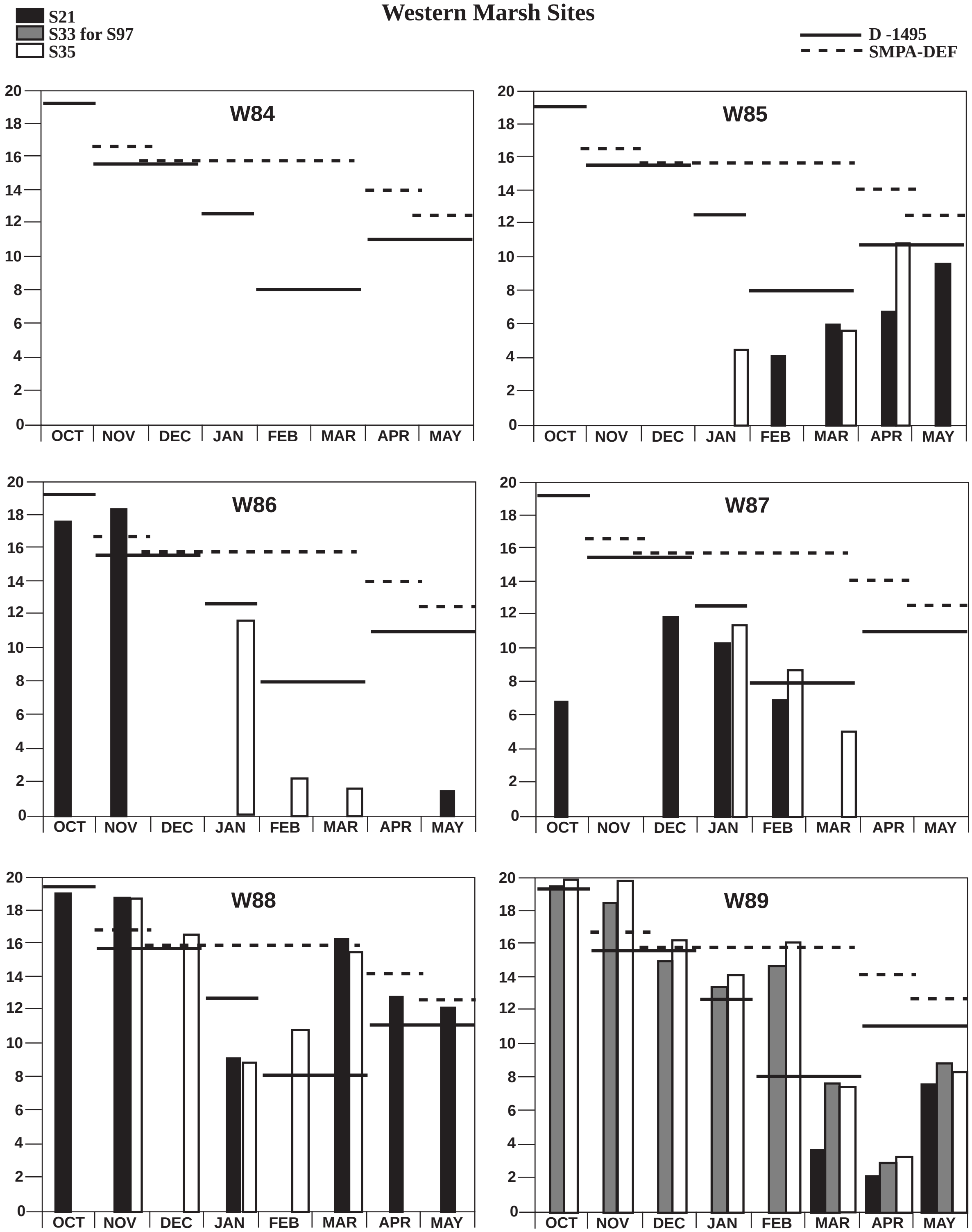


Figure VII-3
Suisun Marsh Mean Monthly High Tide Salinity
Specific Conductance in mSiemens
Water Year = 1984-94
Western Marsh Sites



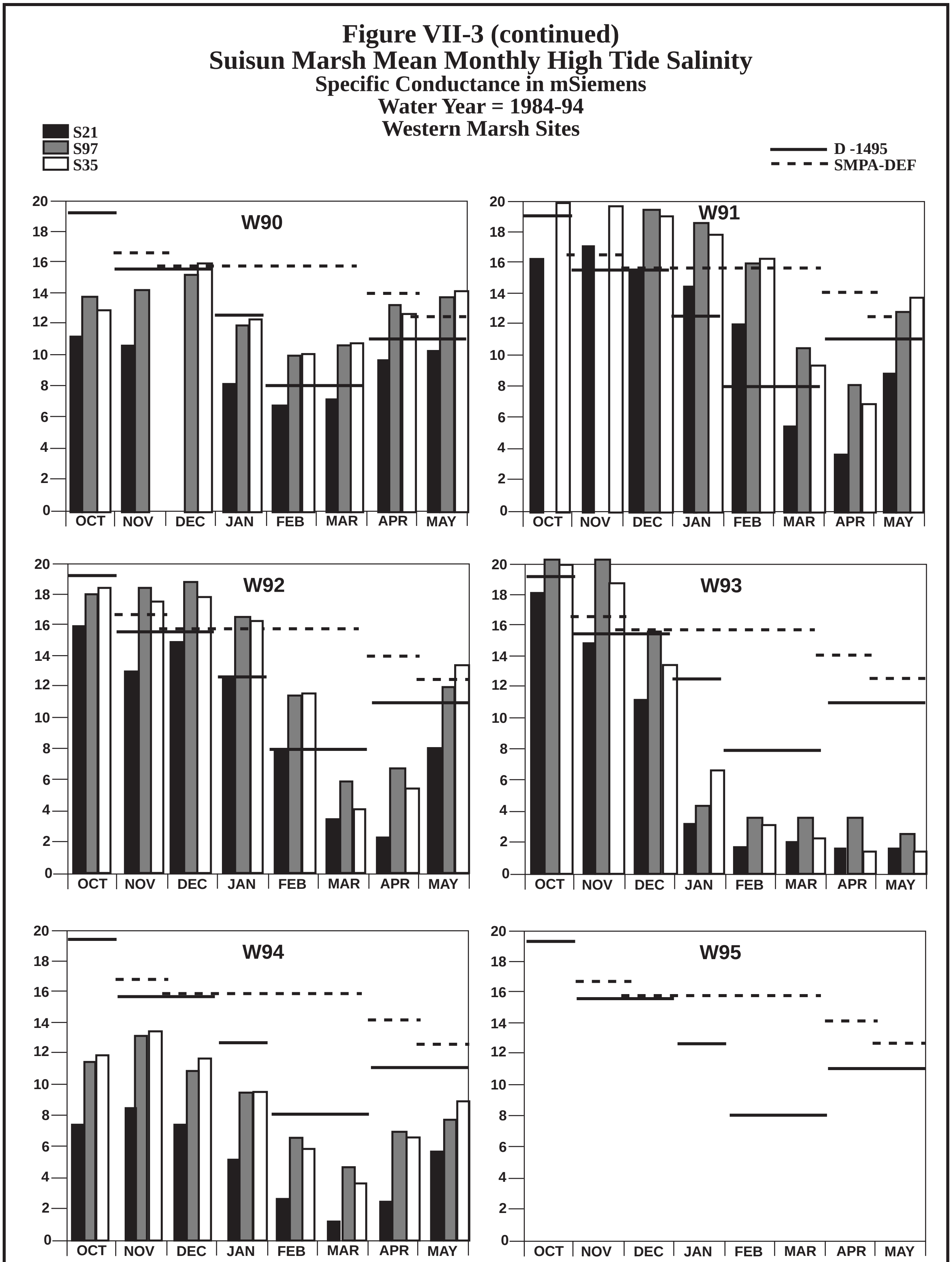


Figure VII-3 (continued)
Suisun Marsh Mean Monthly High Tide Salinity
Specific Conductance in mSiemens
Water Year = 1984-94
Western Marsh Sites
S21
S97
S35
D -1495
SMPA-DEF
W90
W91
W92
W93
W94
W95
OCT
NOV
DEC
JAN
FEB
MAR
APR
MAY
0
2
4
6
8
10
12
14
16
18
20

B. PHYSICAL DESCRIPTION OF EXISTING FACILITIES

This section describes the physical features of the existing facilities that could be used in the implementation of the alternatives. The focus of the descriptions is on the potential role of these facilities to control salinity in the western marsh, so aspects of certain facilities that may not pertain to that specific role are not described. Facilities in other parts of the marsh which are operated for salinity control include the Roaring River Distribution System, Morrow Island Distribution System, Goodyear Slough outfall, and the SMSCG. Operation of these facilities could be modified depending on future actions.

The information on existing facilities was gathered from the DWR and local agencies. Much of the DWR information is contained in a report entitled "Screening Alternative Actions and Describing Remaining Actions for the Proposed Western Suisun Marsh Salinity Control Project" (DWR 1993).

The facilities discussed in this section include: (1) Green Valley Creek and City of Vallejo Reservoirs, (2) the North Bay Aqueduct, (3) the Fairfield-Suisun Sewer District Wastewater Treatment Plant and (4) Lake Berryessa and the Putah South Canal.

1. Green Valley Creek and City of Vallejo Reservoirs

The City of Vallejo owns and operates three reservoirs, two in the Green Valley Creek watershed, Lake Madigan and Lake Frey, and one in the Suisun Creek watershed, Lake Curry (on Gordon Valley Creek tributary to Suisun Creek). The reservoir storage capacities of the three City of Vallejo reservoirs are listed below in Table VII-3.

Table VII-3
Reservoirs that Drain to Suisun Marsh

Reservoir	Capacity (AF)	Watershed Area (mi^2)
Lake Madigan	1,744*	1.5
Lake Frey	1,075	3.1
Lake Curry	10,700	17

* Subject to change due to dam safety concerns

Suisun Creek flows into Chadbourne Slough and can therefore influence salinities at the salinity station S-21 in Chadbourne Slough in the northwestern marsh. At present, no flow augmentation is proposed for Suisun Creek. Green Valley Creek becomes Cordelia Slough less than 0.5 mile downstream (south) of the confluence with an unnamed ditch (the most downstream location affected by tidal action). Green Valley Creek can influence flows into Cordelia Slough, and to a lesser extent Goodyear Slough, and can therefore influence the salinities at stations S-97 and S-35. Releases from the two reservoirs in the Green Valley Creek watershed are considered as a possible way, at least in part, to meet the objectives at these two stations (see Figures VII-4 and VII-5b).

Lake Madigan and Lake Frey are located on Wild Horse Creek, tributary to Green Valley Creek, and were built in 1894 and 1911, respectively. The City of Vallejo claims a pre-1914 water right to divert at Lake Madigan and Lake Frey and has filed a Statement of Diversion and Use with the Division of Water Rights to document its claim. Lake Frey has a capacity of 1,075 AF and Lake Madigan, upstream of Lake Frey, has a capacity of 1,744 AF (see Table VII-3). The operating capacity of Lake Madigan may be reduced in the near future because of concerns regarding the seismic safety of the dam (Exequiel Ganding, City of Vallejo, pers. comm., 11/96). The two reservoirs are operated in conjunction with one another because they are located in close proximity to one another on the same creek. Water from Lake Madigan is released into the stream channel to flow down to Lake Frey, and water is released from Lake Frey to flow into the creek channel. The Green Valley Diversion Dam, downstream of both reservoirs, diverts water into a 14-inch diameter pipeline that goes through the Green Valley Water Treatment Plant and is then distributed by the City of Vallejo. The annual safe yield of the reservoirs is approximately 600 AF per year. Water use information from the City of Vallejo Lakes Water System Master Plan (City of Vallejo 1989, 1994) indicates that the average annual water production from this watershed from 1978 to 1987 was 358 AF. Currently, there are no minimum required instream flow requirements downstream of Lake Frey. The system operates on demand; therefore, only flows in excess of demands and the storage capacity of the reservoirs reach Suisun Marsh.

In 1924, Lake Curry was constructed on Suisun Creek in Napa County. The City has a water right to directly divert 7 cfs year round and to divert to storage 5,400 AF from November 1 to May 1. The total annual water use is not to exceed 5,058.9 AF, and the total amount of water in storage at any one time in Lake Curry may not exceed 10,700 AF. The firm yield of Lake Curry is approximately 3,500 AF. The average annual water production from this watershed from 1978 to 1987 was 705 AF. The water right license does not require releases of water to maintain fish below the dam. The DFG believes that the habitat would be suitable below the dam to support a fishery if water was provided, and releases from the dam for this purpose may be required under Fish and Game Code section 5937 (DFG 1993).

In addition to the three reservoirs, the City also has four additional sources of water: Lake Berryessa, groundwater, treated water from the City's Fleming Hill water treatment plant (sources of water are from Putah-South Canal and the North Bay Aqueduct (NBA)), and treated water from the City of Fairfield (from Putah-South Canal) (City of Vallejo 1994).

2. North Bay Aqueduct

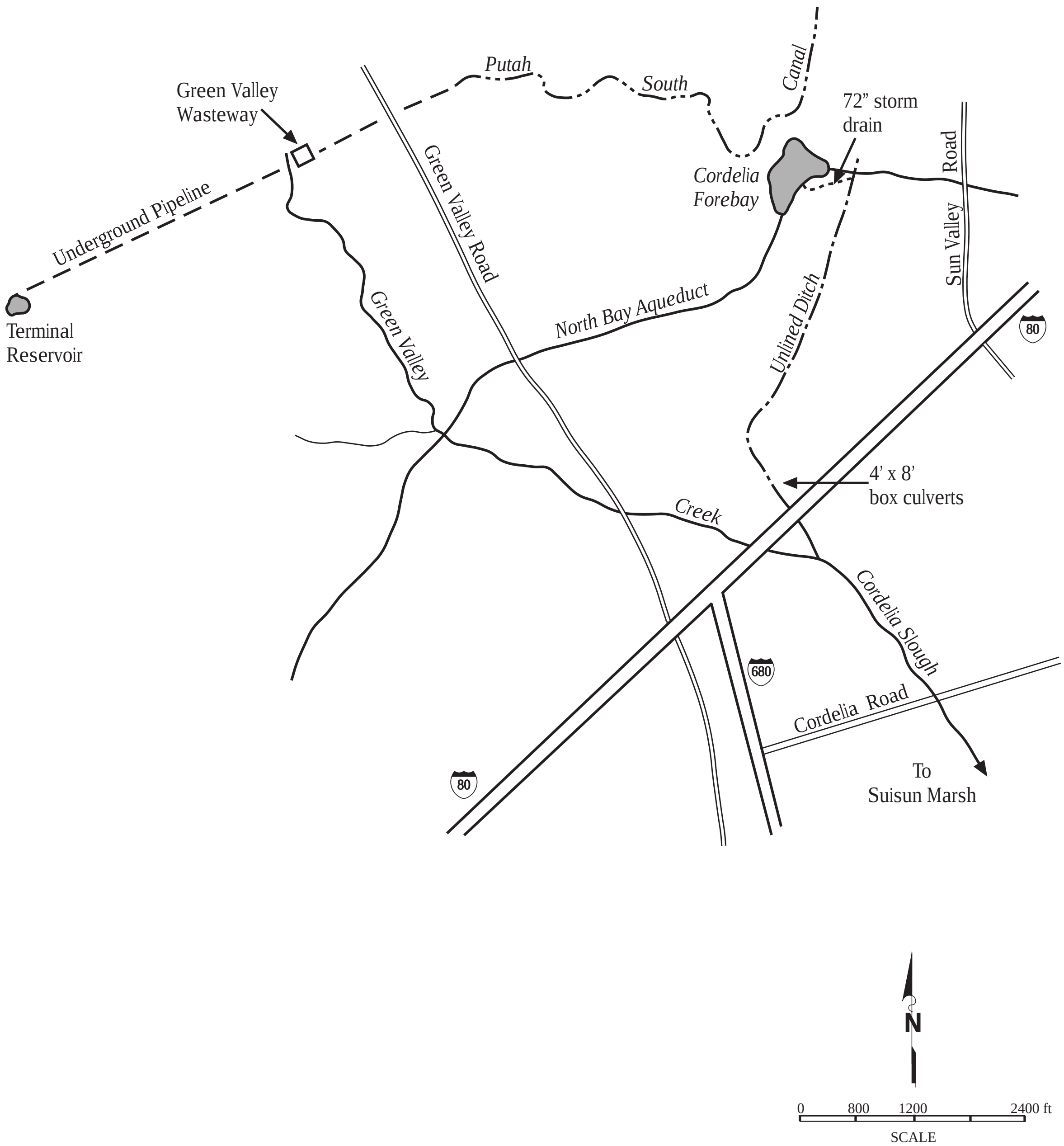
The NBA extends over 27 miles from Barker Slough to the Napa Turnout Reservoir in southern Napa County (see Figure VII-5b). The capacity of the NBA is 174 cfs between Barker Slough Pumping Plant and the Cordelia Forebay. The SWP uses the NBA to meet project entitlements in Napa and Solano counties, including the City of Vallejo (DWR 1994a). Ultimate scheduled allocations are expected to be about 67 TAF annually, with 42 TAF to Solano County Water Agency (SCWA) and 25 TAF to the Napa County Flood Control and Water Conservation District. Pumping from Barker Slough through the NBA averaged 36 TAF in 1990 and 1991 (DWR 1993). At present, deliveries through the NBA are not using the entire capacity of the canal during the Suisun Marsh salinity control season (DWR 1993). Although capacity is currently available in the NBA that could be used for Green Valley Creek augmentation flows, long term availability is not certain.

Supplementing flow in Green Valley Creek from the NBA for salinity control in western Suisun Marsh would require the use of natural channels and the City of Fairfield storm drains. Water would be transported from the intake of the NBA at Barker Slough to the Cordelia Forebay. The water would then flow into an existing 72-inch diameter pipe that connects to a 72-inch City of Fairfield storm drain along Mangles Road. At the outlet of the storm drain, the additional water would flow into an unlined ditch. This ditch, FSSD Treatment Plant and North-Bay Aqueduct constructed by the City of Fairfield, extends southwesterly for about 0.6 mile. It passes under Interstate 80 and adjacent frontage roads through a series of box culverts with cross-sectional diameter of 8 feet wide by 4 feet high and discharges into Green Valley Creek about 50 yards south of Interstate 80 (see Figure VII-4). The ditch is designed to handle maximum flows of 300 cfs (DWR 1993). The City plans to construct a storm drainage retention pond where the ditch is located.

3. Fairfield-Suisun Sewer District Wastewater Treatment Plant

The Fairfield-Suisun Sewer District (FSSD) wastewater treatment plant presently discharges to Suisun Marsh. The DWR investigated the use of effluent from the treatment plants serving the cities of Vacaville, Vallejo, Benicia, and Sacramento to reduce salinity in Suisun Marsh (DWR 1991b). The DWR concluded that the treatment plants in these cities were not able to provide the level of treatment necessary to allow discharge to the marsh. The San Francisco Bay RWQCB requires that any National Pollutant Discharge Elimination System (NPDES) permits issued for Suisun Marsh must meet water quality requirements similar to those specified in the NPDES permit for the FSSD treatment plant, which provides tertiary-level treatment. The concentrations of critical water quality parameters in the effluent from the treatment plants serving the cities of Vacaville, Vallejo, Benicia, and Sacramento exceed the requirements for these parameters in the FSSD's NPDES permit. The discharge from the FSSD treatment plant is, therefore, the only treatment plant discharge considered as a source for water to control salinity in the marsh.

Figure VII-4
Green Valley Creek Detail



The FSSD is located in central Solano County near the southeast corner of the intersection of Cordelia and Chadbourne Roads (see Figure VII-5a). The service area, which includes the City of Fairfield, Suisun City, and Travis Air Force Base, is adjacent to Suisun Marsh. The San Francisco Bay RWQCB Basin Plan prohibits discharge to Suisun Marsh from May 1 to September 21 unless it can be shown that the discharge will provide a net environmental benefit. The FSSD received an NPDES permit to discharge to the marsh through the Basin Plan exemption process. The effluent from the plant has been certified for use on food crops and for nonrestrictive recreational purposes. During the summer months, the treated effluent is reclaimed to the greatest degree possible and used by SID for agricultural irrigation. The remainder of the treated effluent not used for irrigation purposes is discharged to Boynton Slough east of I-680 which is tributary to Suisun Slough and Suisun Bay. During the winter months, the permit allows discharge from the treatment plant to Boynton Slough for management of duck club ponds (FSSD Publication). The locations of the discharge points are Boynton Slough Outfall and Duck Club Turnouts No. 1 and No. 2 (SWRCB WQ Order No. 90-101).

The treatment plant has a dry weather design capacity of 17.5 million gallons per day (mgd). The plant presently has an average dry weather discharge of 11.6 mgd and an annual average discharge of 12.8 mgd. Approximately 40 percent of the annual average discharge is reclaimed and 60 percent is released to Boynton Slough. The reclaimed water is used by SID mainly to irrigate a grass-sod farm because other uses are limited by the high boron content in the water (DWR 1991b). The SID currently has a contract for the use of the first 12 mgd of effluent, except as specified below.

1. From September 22 to December 1, up to one-half of the discharge is available for marsh maintenance and enhancement.

2. From December 2 to March 1, the entire discharge is available for marsh maintenance and enhancement.

3. From March 2 to April 1, two-thirds of the discharge is available for marsh maintenance and enhancement; and

4. From April 2 to May 1, one tenth of the discharge is available for marsh maintenance and enhancement.

In a letter dated January 24, 1997, the DWR and the USBR proposed a collaborative effort with the FSSD to construct a pipeline from the FSSD treatment plant to Green Valley Creek (DWR 1997a). The pipeline would provide the infrastructure needed to discharge surplus treated effluent into the northwestern Suisun Marsh. The letter defines surplus treated effluent as effluent from the FSSD treatment plant that is not now, or in the future, beneficially used by the SID or any other entity in Solano County and is not needed to maintain Boynton Slough salinity within water quality objectives set by the SWRCB. In a letter to the DWR dated April 23, 1997, the FSSD responded that there are too many obstacles to proceed with the proposal at this time (DWR 1997c).

Figure VII - 5a
FSSD Treatment Plant

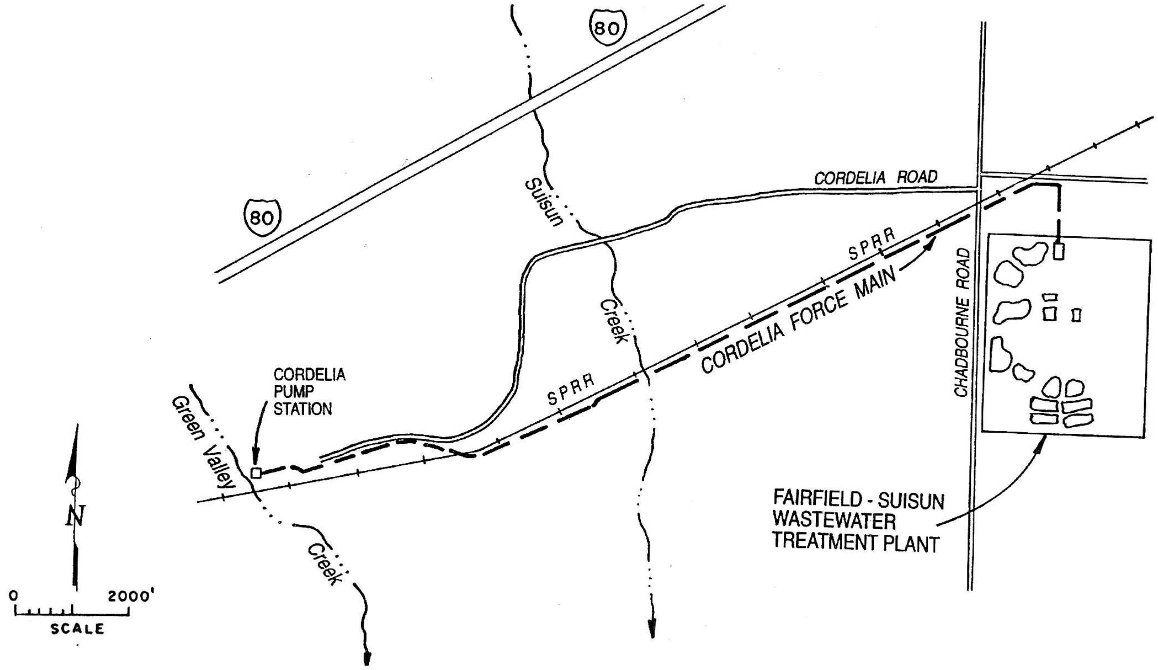
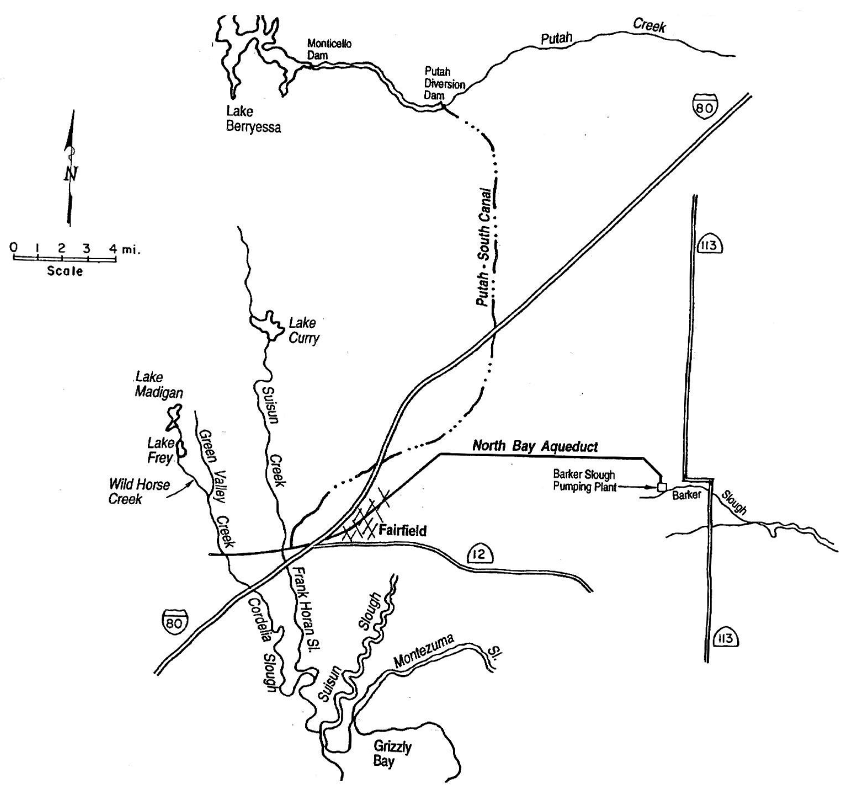


Figure VII - 5b
North Bay Aqueduct and Putah-South Canal



4. Lake Berryessa and Putah-South Canal

Lake Berryessa, formed by Monticello Dam on Putah Creek, and Putah-South Canal are part of the USBR's Solano Project. The storage capacity of Lake Berryessa is 1.6 MAF and the average annual runoff of Putah Creek at Monticello Dam was about 372 TAF between 1958 and 1977. The present long-term contract demand from the project is about 200 TAF (DWR 1993). Water is marketed through the SCWA, of which 73 percent of the supply is allocated to the SID for agricultural purposes. Other purposes of use are recreation, municipal, industrial, and military facilities supply.

Flow augmentation into Green Valley Creek could be accomplished using water from Lake Berryessa (Figure VII-5b). Water dedicated for this purpose would be released from Lake Berryessa into Putah Creek and would flow into Solano Lake about 6 miles below Monticello Dam. Solano Lake, with a capacity of 750 AF, was created by construction of the Putah Diversion Dam on Putah Creek to divert water into Putah-South Canal. The canal is concrete-lined and it has a diversion capacity of 956 cfs, and a terminal capacity of 116 cfs. Water can be released into Green Valley Creek from the Putah-South Canal through the Green Valley Creek Wasteway. The wasteway consists of a concrete conduit, approximately 1.5 miles in length, with a capacity of 14 cfs. The capacity of the wasteway would have to be increased in order to handle the quantity of water required to meet northwestern Suisun Marsh salinity objectives. Another option for increasing the flow capacity into Green Valley Creek would be to divert water from the terminal reservoir on Putah-South Canal to Green Valley Creek through a new pipeline (DWR 1993).

C. ALTERNATIVES FOR IMPLEMENTING THE SUISUN MARSH OBJECTIVES

The alternatives for meeting the Suisun Marsh numerical salinity objectives are based on two principal assumptions: (1) a flow alternative will be adopted that implements the outflow objectives in the 1995 Bay/Delta Plan; and (2) the DWR and the USBR will operate the initial facilities and the SMSCG when Delta outflow alone is not sufficient to achieve the eastern and two of the western marsh objectives (Stations C-2, S-64, S-49, S-21, and S-42). Modeling indicates that, under these conditions, the objectives at these stations and the objectives at the water supply intakes at Chipps and Van Sickle Islands will be met, with limited exceptions. (The modeling results are described in section D.) Consequently, the DWR and the USBR will be held responsible for meeting the numerical objectives at the above stations in all of the alternatives because they operate the salinity control gates. An exception to this responsibility could be made when hydrologic conditions are such that even with gate operation, as described above, the objectives cannot be achieved.

The 1995 Bay/Delta Plan also includes a narrative Suisun Marsh objective that requires conditions sufficient to support a brackish marsh throughout all elevations of the tidal marshes bordering Suisun Bay. The conditions necessary to achieve this narrative objective are not adequately defined at this time. Compliance with the other flow and water quality objectives in the 1995 Bay/Delta Plan may be sufficient to achieve this objective. The SEW is evaluating whether this objective is being achieved, and if not, what actions are necessary for its implementation. This issue will be considered in the next triennial review of the Bay/Delta Plan. This EIR will not, therefore, include specific alternatives to achieve this objective.

Based on the rationale provided above, the alternatives considered in this draft EIR focus on methods to meet the two remaining western marsh objectives (Stations S-35 and S-97). The alternatives include options such as increased flow in Green Valley Creek from various sources, construction of facilities in the western marsh, and management actions to improve soil salinity and habitat conditions without achieving the numerical salinity objectives.

One possible alternative, increased Delta outflow, is not included because available evidence indicates that this alternative would require very substantial increases in Delta outflow. For example, DWR modeling indicates that, with D-1485 standards under 1990 conditions, salinity objectives at S-97 would not have been met with an increase in the Delta Outflow Index from January through May of 2.4 MAF.

The following six alternatives are considered in this EIR.

1. Suisun Marsh Alternative 1

This alternative is the base case and the first No Project alternative. The SWP and the CVP are responsible for meeting D-1485 Suisun Marsh objectives as modified. D-1485 outflow objectives are in effect and the initial facilities and SMSCG are in place and operated to meet objectives at all of the stations, to the extent possible. The DWR and the USBR take no further action to meet the D-1485 western marsh objectives, and the objectives are sometimes not met.

At present, the DWR and the USBR have no firm plans to meet the western marsh objectives under these base case hydrology conditions, and if the SWRCB does not take any action to implement the new Suisun Marsh objectives, this alternative would be in effect as plans are developed and implemented.

2. Suisun Marsh Alternative 2

This alternative is the second No Project alternative and is described in the Western Suisun Marsh Salinity Control Project Screening Report (DWR 1993). The SWP and the CVP are responsible for meeting D-1485 Suisun Marsh objectives as modified. As in Alternative 1, D-1485 objectives are in effect and the initial facilities and the SMSCG are in place and operated to meet objectives to the extent possible. The objectives at the two stations in the western marsh are met, to the extent feasible, through construction and operation of the Cordelia-Goodyear Ditch and an associated tide gate structure, and through flow augmentation in Green Valley Creek with NBA water (DWR 1993).

The modeling of this alternative assumes that the Cordelia-Goodyear Ditch and the Goodyear Slough Tide Gate are operated to meet the objectives at S-35. The flows in Green Valley Creek are supplemented by up to 80 cfs, as necessary, to meet the objectives at S-97.

A preliminary analysis of this action, along with seventeen other actions to meet D-1485 standards, was undertaken by the DWR and the USBR and described in the Western Suisun Marsh Salinity Control Project (DWR 1993). In this EIR, Suisun Marsh Alternatives 2 and 4 assume construction of the Cordelia-Goodyear Ditch, associated tidal gates, and Goodyear Slough Tide Gate (see Figure VII-6). Other methods of complying with the objectives are possible, but construction of these, or similar facilities, are a reasonable assumption. Additional environmental and engineering analyses would be required before these facilities could be constructed; therefore, the analysis of these structures is programmatic.

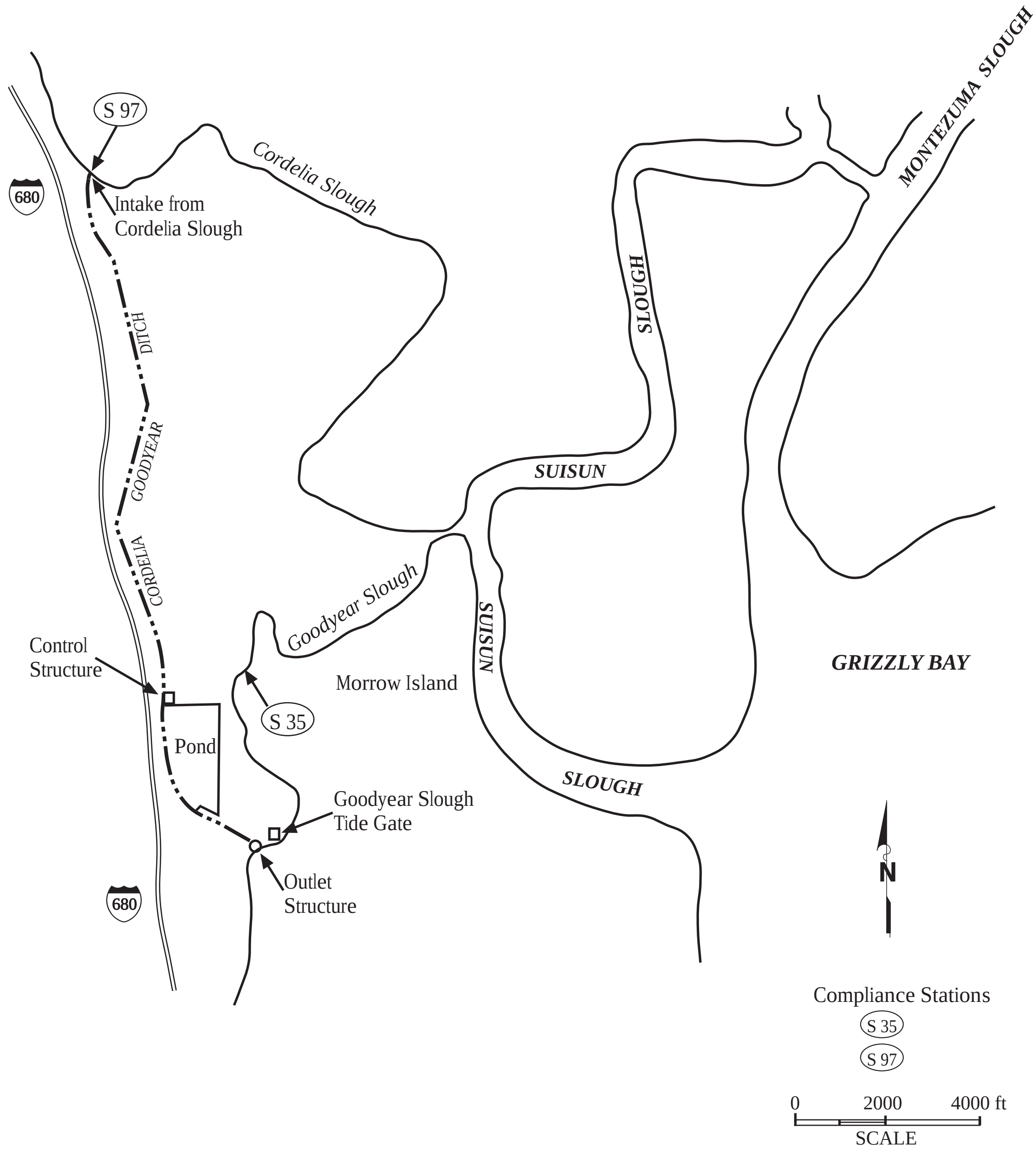
The Cordelia-Goodyear Ditch and associated tidal gates would move lower salinity water from upper Cordelia Slough near the Ibis Club to Goodyear Slough about 0.5 miles north of the intake to the Morrow Island Distribution System. The ditch would be parallel to the eastern side of Interstate Highway 680 (I-680). A pond would be constructed on the Goodyear Slough end of the ditch to increase its holding capacity and to provide public recreation facilities (DWR 1993). The 40-acre pond would be connected to the ditch south of Pierce Lane, between Interstate-680 and the railroad. The pond would be connected to Goodyear Slough about 0.2 miles upstream (south) of Pierce Harbor, with buried pipes and open channel about 0.1 mile long. The pipes would pass beneath the railroad.

The inlet tide gate on Cordelia Slough would use tidal action to move lower salinity water from Cordelia Slough southward through the Cordelia-Goodyear Ditch. The outlet tide gate on Goodyear Slough, just south of Pierce Harbor, would use tidal action to move lower salinity water from the Cordelia-Goodyear Ditch's peaking pond into Goodyear Slough. The inlet and outlet gates would be operated in conjunction. The gates would be designed to move up to 225 cfs net flow over a tidal cycle, with a maximum flow of 625 cfs.

The Goodyear Slough Tide Gate would prevent higher salinity water from entering the upstream (southern) end of Goodyear Slough during flood tide from Suisun Slough near Grizzly Bay. The tide gate would be on Goodyear Slough just downstream (north) of the proposed outlet of the Cordelia-Goodyear Ditch. This tide gate would only be considered in conjunction with the Cordelia-Goodyear Ditch (DWR 1993).

The proposed site for the Goodyear Slough Tide Gate is shown on Figure VII-6. The tide gate would be designed to move up to 250 cfs net flow over a 25-hour tidal cycle, with a maximum flow of 675 cfs. The downstream (northern) end of Goodyear Slough is connected to Suisun Slough and its upstream end is connected to Suisun Bay via the Goodyear Slough Outfall culvert pipes. The intake of the existing Morrow Island Distribution System is connected to Goodyear Slough and the outlet for the proposed Cordelia-Goodyear Ditch would be on Goodyear Slough about 0.2 mile

Figure VII-6
Cordelia-Goodyear Ditch and Goodyear Slough Tide Gate



upstream (south) of Pierce Harbor. Boat passage facilities would be required, should this facility be constructed (DWR 1993).

The tide gate would be in place all year, but would probably only be operated from October through May when necessary to meet the objectives.

3. Suisun Marsh Alternative 3

This alternative is the same as Alternative 1 except that the 1995 Bay/Delta Plan outflow objectives are in effect.

4. Suisun Marsh Alternative 4

This alternative is the same as Alternative 2 except that the 1995 Bay/Delta Plan outflow objectives are in effect.

5. Suisun Marsh Alternative 5

The 1995 Bay/Delta Plan outflow objectives are in effect and the SMSCG is operated to meet objectives to the extent feasible. Compliance stations S-35 and S-97 in the northwest corner of the marsh will become monitoring stations. The following management actions, as recommended by the parties to the SMPA Amendment III, are implemented as described in the "Demonstration Document" (DWR 1997c).

1. *Water Manager Program* - SRCD will institute a Water Manager Program and employ support staff to coordinate and improve water management practices throughout the marsh.

2. *Joint-Use Facilities Program* - A joint-use facility is a structure used by two or more properties, and can include levees, ditches, and water control structures. In coordination with the Water Management Program, this program is to provide more efficient and cooperative use of water delivery and leaching systems to managed wetlands in order to produce better waterfowl habitat.

3. *Portable Pumps for Diversions and Drainage Program* - This program will be coordinated with the Water Management Program. The Water Manager, under the SRCD's direction, will use twenty diesel-powered portable pumps to improve salinity conditions in managed marshes. The pumps are for the benefit of managed wetlands to provide lower salinity water during low tide diversions and better removal of soil salts during drainage. The pumps will be moved throughout the marsh as appropriate to maximize their effectiveness. The Water Manager will be responsible for assuring that any pumps for diverting water from the exterior sloughs have appropriate fish screens attached.

4. *Updating of Existing Management Plans* - The SRCD will prepare updated Individual Ownership Management Plans to provide landowners with information needed to improve salinity conditions on their property.

5. *Operate the SMSCG in September to Meet October Salinity Objectives* - The DWR and the USBR will operate the SMSCG in September when the 7-day running average mean daily high tide salinity in September at any compliance station, or at the S-35 Monitoring Station is 17.0 mmhos/cm or greater. The running averages for September 1-6 will be determined using salinity data from the last six days of August. The purpose of September gate operation is to improve wetland habitat management in the fall and improve leaching efficiency the following spring.

6. *Managed Wetland Improvement Fund* - This action provides for $2,000,000 (plus any remaining funds from the original agreement) to be utilized between two cost share programs for improvements on private managed wetlands.

7. *Drought Response Fund* - This fund would compensate landowners within the marsh, including the Department of Fish and Game, that apply higher salinity channel water to their managed wetlands because of prolonged drought conditions. Funds would be used for activities to offset the effects of the higher salinity water.

Other provisions of the SMPA Amendment III address responsibilities of parties, funding, coordination, criteria, and contingencies. (SMPA 1998)

Not all of the actions in this alternative can be modeled, such as the water manager activities and operation of the portable pumps. Under this alternative, the numerical salinity objectives in the western marsh will not always be met, but the intent is to provide equivalent protection to the managed wetlands through management actions that achieve soil salinities necessary to produce suitable vegetation for waterfowl. The 1995 Bay/Delta Plan states that the salinity objectives in the channels do not have to be achieved if "a demonstration of equivalent or better protection is provided at the location."

6. Suisun Marsh Alternative 6

Multiple parties are responsible for full implementation of the 1995 Bay/Delta Plan western marsh objectives through flow augmentation in Green Valley Creek. The additional sources of water will come from: (1) the FSSD; (2) upstream reservoirs (Lake Madigan and Lake Frey); and (3) if needed, water will be released from Lake Berryessa (see Figure VII-5b).

Lake Berryessa is part of the USBR's Solano Project, and it stores water from Putah Creek, a tributary of the Sacramento River. Lake Berryessa water can be released into the western marsh by diversion into the Putah-South Canal and then to Green Valley Creek. Under this alternative, Lake Berryessa water will be repaid to the Solano Project by the DWR and the USBR through the NBA, unless the Solano Project has an obligation to the Delta under the outflow alternatives, in which case that obligation will be met by releasing water into the western Suisun Marsh. In the past, the SCWA has agreed to provide water to agencies, including the DWR (SCWA Agreements 1992 and 1995); however, no water was actually transferred under these agreements. In the future, the NBA is expected to be operating closer to its full capacity for delivery of SWP supplies, so repayment of water used for the Suisun Marsh will have to be made during times when excess capacity exists.

Arrangements could probably be agreed upon among the involved parties, for sale or exchange of Lake Berryessa water between November and March, including arrangements for the annual cleaning of the canal. A requirement for water from the Putah Creek basin would need to be consistent with SWRCB Order WR 96-002[5]. In addition, it would need to be consistent with the Sacramento County Superior Court Judgment in the case of *Putah Creek Council* v. *SID and SCWA,* filed August 23, 1996. The court ruled, in part, that the SID and SCWA shall release, monitor and record specific instream flows in Putah Creek downstream of the Putah Diversion Dam (lower Putah Creek). The Court's decision is currently under appeal and has been stayed.

D. ENVIRONMENTAL IMPACTS OF THE ALTERNATIVES

This section describes the effects of implementation of the alternatives on: (1) salinity, (2) hydrology, (3) landscape (construction-related impacts), (4) aquatic resources, (5) terrestrial resources, and (6) recreation.

1. Salinity

This section describes the results of the salinity modeling, and the conclusions reached as a result of the modeling studies. In general, the results indicate that Suisun Marsh salinity objectives are met in most months under all alternatives in the eastern and the central marsh. Discussion is therefore focused on the western compliance stations, S-35 and S-97, where a significant number of objective exceedences occur. The hydrodynamic and water quality model DWRDSM (Suisun Marsh Version) was used to analyze the six methods for implementing Suisun Marsh objectives described in section C above. The model simulates the average monthly high tide salinities, expressed in mmhos/cm, for the 1922-1994 time period. Results are reported for all alternatives at compliance monitoring stations C2, S-64, S-49, S-42, S-21, S-35, and S-97 (DWR 1997b, DWR 1999).

5 SWRCB Order WR 96-0025 amended appropriative water rights in the upper Putah Creek watershed filed subsequent to October 29, 1945 which were subject to condition 12 of the USBR's permitted water right Applications 11199, 12578, and 12716.

The SMSCG is operated within the model as needed to meet objectives during the October-May control season. In order to determine when gate operations would be required, two preliminary model runs, without gate operation, were made using D-1485 and 1995 Bay/Delta Plan hydrology. The preliminary model runs are designated as Alternatives 1A and 3A. Though these are not alternatives being analyzed in this EIR, the data is included in the table of results to document the effect that SMSCG operation has on marsh salinity. SMSCG operation is triggered whenever salinity at S-21, S-35, S-49, or S-64 is within 2 mmhos/cm of the applicable monthly objective during the control season (October through May). Based on field test data, SMSCG operation has little or no effect on salinity at S-97, hence S-97 is not used as a trigger for gate operation.

The alternatives were modeled as follows:

Alternative 1 - D-1485 objectives are in effect with SMSCG operation as described above.

Alternative 2 - Same as Alternative 1 plus operation of the Goodyear Slough tide gate, the Cordelia-Goodyear Ditch, and augmentation of Green Valley Creek with up to 80 cfs from the NBA.

Alternative 3 - 1995 Bay/Delta Plan objectives are in effect with full SMSCG operation.

Alternative 4 - 1995 Bay/Delta Plan objectives are in effect with same facilities and SMSCG operation as Alternative 2.

Alternative 5 - Implementation of the SMPA Amendment III (SMPA 1998) is most like modeling of Alternative 3 with the addition of September SMSCG operation, which mostly affects October salinities during dry years. Modeling of Amendment III could not include many management actions, and would understate the net benefit that may be expected from implementation of the alternative.

Alternative 6 - Same as Alternative 3 plus incremental flow augmentation in Green Valley Creek from the FSSD and other unidentified sources until marsh standards are met at both S-35 and S-97.

a. <u>Modeling Results</u>. Results of the salinity modeling are summarized in Table VII-4 and in Figures VII-7 through VII-15. Results of the preliminary runs, Alternatives 1A and 3A, are presented in Table VII-5. The tables list the percentage of time that Suisun Marsh salinity objectives are exceeded at each compliance station for each month of the salinity control season over the 73-year period. As D-1485 does not provide for relaxation of objectives during deficiency periods, (as defined in footnote 2) a straight comparison of exceedence frequencies under the two hydrologies can be misleading. Table VII-6 compares Alternatives 1 and 3 with deficiency years excluded, thus providing a true comparison of the effect that base hydrology has upon marsh salinity.

The figures convey similar information in a graphical "area-frequency" format. The plots are designed to answer two questions: (1) how frequently objectives are exceeded; and (2) by how much objectives are exceeded. Area-frequency plots are prepared by subtracting the monthly salinity standard from the progressive daily mean high tide salinity for the month at each compliance station. The resulting differences are sorted for the entire 73-year period from the largest positive difference (above the objective) to the largest negative difference (below the objective). The sorted differences are normalized from 0 to 100 percent and then plotted. The amount by which an objective is exceeded over the entire 73-year period is estimated by calculating an "exceedence index." The exceedence index is defined as the ratio of the area above the zero difference line to the total area both above and below the same line, expressed as a percent (see Figure VII-7).

Comparison of the exceedence frequencies for Alternative 1 to 1A and Alternative 3 to 3A (Tables VII-4 and VII-5) demonstrates the crucial role that the SMSCG plays in maintaining Suisun Marsh water quality objectives. Without SMSCG operation, only C-2 consistently meets objectives under D-1485 hydrology. The higher outflows in the 1995 Bay/Delta Plan produce compliance in April and May at S-42, S-21, and S-35; otherwise, all stations exceed standards in some months without SMSCG operation. With SMSCG operation, all eastern stations (C-2, S-64, and S-49) and stations S-42 and S-21 in the western marsh either meet, or very nearly meet, objectives under both hydrologies. All stations that meet objectives under D-1485 when the salinity control gates are operating, are marginally freshened with 1995 Bay/Delta Plan hydrology.

Due to the effectiveness in meeting objectives in the eastern marsh and at S-42 and S-21 in the western marsh with SMSCG operation, and the fact that the DWR and the USBR alone have operational control of the gates, there will be no further consideration given to implementation of 1995 Bay/Delta Plan objectives at these stations. The remaining discussion will focus on alternative methods for meeting objectives at S-35 and S-97. The impact of removing treated wastewater from Boynton Slough (Station S-40) under Alternative 6 will also be discussed.

b. Salinity Impacts at S-97. Compliance station S-97 is located on Cordelia Slough at the Ibis Club in the northwestern corner of the marsh. It is located furthest from the SMSCG and therefore is least affected, if at all, by SMSCG operation. Salinities in the northwest marsh are influenced strongly by freshwater inflow from tributary creeks. Green Valley Creek flows have a direct effect on salinity at S-97.

c. Salinity Impacts at S-35. Station S-35 is located in the southwestern corner of the marsh on Goodyear Slough at the Morrow Island Club. Like S-97, S-35 benefits from the increased outflow required by the 1995 Bay/Delta Plan. The flow augmentation proposed in Alternatives 2 and 4 benefits S-35 considerably less than S-97. Salinity control at S-35 is achieved primarily through operation of the Cordelia-Goodyear Ditch and the associated tide gates. Exceedence frequencies are reduced by 5.8 percentage points when Alternatives 2 and 4 are compared, but remain significant at 12.7 percentage points under Alternative 4. The exceedence index is reduced

Table VII-4
Percentage of Time Suisun Marsh Salinity Objectives Would be Exceeded by Station and by Month

Alternative 1

	Station	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Exceedence Index
East	C-2	0.0	0.0	0.0	0.0	0.0	5.5	0.0	0.0	0.1
	S64	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	S49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
West	S42	0.0	0.0	0.0	0.0	9.6	2.7	0.0	0.0	0.2
	S21	0.0	0.0	0.0	0.0	11.0	4.1	0.0	0.0	0.3
	S35	53.4	38.4	23.3	12.3	15.1	8.2	6.8	9.6	6.1
	S97	64.4	71.2	30.1	34.2	56.2	63.0	9.6	16.4	35.5

Alternative 2

	Station	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Exceedence Index
East	C-2	0.0	0.0	0.0	0.0	0.0	4.1	0.0	0.0	0.0
	S64	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	S49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
West	S42	0.0	0.0	0.0	0.0	6.8	1.4	0.0	0.0	0.1
	S21	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0
	S35	57.5	41.1	5.5	4.1	26.0	8.2	5.5	0.0	4.4
	S97	24.7	4.1	0.0	0.0	15.1	8.2	0.0	0.0	0.6

Alternative 3

	Station	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Exceedence Index
East	C-2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	S64	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	S49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
West	S42	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0
	S21	0.0	0.0	0.0	0.0	5.5	0.0	0.0	0.0	0.0
	S35	49.3	39.7	12.3	6.8	5.5	0.0	0.0	0.0	3.5
	S97	56.2	57.5	28.8	20.5	38.4	42.5	0.0	5.5	18.6

Alternative 4

	Station	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Exceedence Index
East	C-2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	S64	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	S49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
West	S42	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	S21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	S35	49.3	30.1	4.1	1.4	16.4	0.0	0.0	0.0	2.2
	S97	20.5	2.7	0.0	0.0	12.3	0.0	0.0	0.0	0.2

Alternative 5

	Station	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Exceedence Index
East	C-2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	S64	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	S49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
West	S42	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0	0.0
	S21	0.0	0.0	0.0	0.0	5.5	0.0	0.0	0.0	0.0
	S35	47.9	39.7	11.0	6.8	5.5	0.0	0.0	0.0	3.0
	S97	50.7	47.9	15.1	15.1	37.0	38.4	0.0	5.5	12.4
Other	S40	0.0	0.0	0.0	0.0	6.8	6.8	0.0	0.0	0.2

Alternative 6

	Station	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Exceedence Index
East	C-2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	S64	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	S49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
West	S42	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	S21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	S35	8.2	2.7	4.1	0.0	1.4	0.0	0.0	0.0	0.1
	S97	6.8	4.1	0.0	0.0	13.7	13.7	0.0	0.0	0.1

Table VII-5
Percentage of Time Suisun Marsh Salinity Objectives Would be Exceeded by Station and by Month Without Suisun Marsh Salinity Control Gate Operation

Alternative 1A

	Station	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Exceedence Index
East	C-2	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.0
	S64	21.9	57.5	45.2	37.0	24.7	19.2	13.7	13.7	22.8
	S49	65.8	69.9	47.9	43.8	42.5	31.5	9.6	13.7	32.8
West	S42	65.8	71.2	47.9	41.1	47.9	32.9	8.2	13.7	32.3
	S21	65.8	71.2	45.2	41.1	46.6	34.2	8.2	13.7	31.4
	S35	65.8	54.8	39.7	26.0	26.0	12.3	8.2	15.1	16.3
	S97	68.5	76.7	49.3	46.6	58.9	65.8	19.2	35.6	50.9

Alternative 3A

	Station	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Exceedence Index
East	C-2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	S64	13.7	56.2	43.8	37.0	27.4	15.1	11.0	12.3	18.8
	S49	56.2	64.4	47.9	42.5	41.1	30.1	8.2	2.7	28.3
West	S42	56.2	63.0	45.2	39.7	32.9	12.3	0.0	0.0	20.0
	S21	56.2	63.0	42.5	38.4	31.5	17.8	0.0	0.0	19.3
	S35	56.2	50.7	37.0	20.5	12.3	0.0	0.0	0.0	10.0
	S97	58.9	63.0	45.2	38.4	42.5	50.7	8.2	16.4	32.0

Table VII-6
Percentage of Time Suisun Marsh Salinity Objectives Would be Exceeded by Station and by Month With SMPA Deficiency Years Excluded

Alternative 1

	Station	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Exceedence Index
East	C-2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	S64	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	S49	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
West	S42	5.0	0.0	0.0	0.0	1.7	0.0	0.0	0.0	0.1
	S21	5.0	0.0	0.0	0.0	3.3	0.0	0.0	0.0	0.1
	S35	43.3	25.0	13.3	1.7	5.0	1.7	1.7	3.3	3.4
	S97	51.7	61.7	18.3	21.7	46.7	58.3	1.7	8.3	24.3

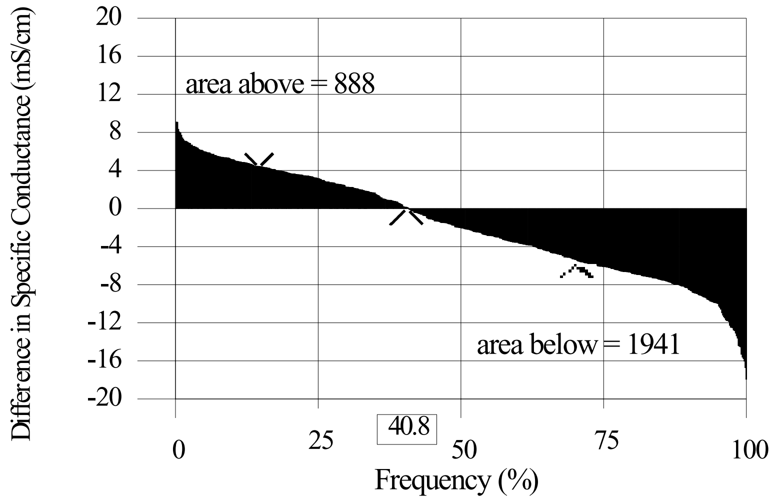
Alternative 3

	Station	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Exceedence Index
East	C-2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	S64	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	S49	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
West	S42	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	S21	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	S35	40.0	25.0	8.3	5.0	3.3	0.0	0.0	0.0	2.3
	S97	46.7	46.7	16.7	18.3	36.7	43.3	0.0	3.3	13.6

SMPA deficiency years excluded are: 1925, 1926, 1930, 1931, 1932, 1933, 1934, 1977, 1988, 1989, 1990, 1991, and 1992.

Figure VII-7

Example of Area-Frequency Analysis Plot and Table for Site X



Site	Frq. Above Std. %	Exceedence Index %
X	40.8	31.4

Objective of Area-Frequency Plots:

Area-frequency plots are prepared to indicate how often and to what extent salinity at a particular location was either above or below standards or target salinity.

Definition of Frequency and Exceedence:

Frequency above standards: Defined to be where the area frequency plot crosses the zero line.

Exceedence Index: Defined to be the area above the zero line divided by the sum of the areas above and below the the zero line, and multiplied by 100 to convert to a percentage. The equation and an example calculation are shown below:

$$\text{Exceedence Index} = [\text{AreaAbove} / (\text{AreaAbove} + \text{AreaBelow})] \times 100$$
$$31.4\% = [888 / (888 + 1941)] \times 100$$

Area-Frequency Preparation:

To prepare the area-frequency plots, the standards (normal or deficiency) were subtracted from the respective mean monthly high tide salinities for the control season. The differences were then assigned to each month and sorted from the largest positive difference (above the target standard) to the greatest negative difference (below the target standard). The sorted differences were then normalized from 1 to 100 percent and plotted.

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Figure VII-8

Salinity Area-Frequency Analysis
Sacramento River at Collinsville (C-2)
October Through May of Water Years 1922-1994

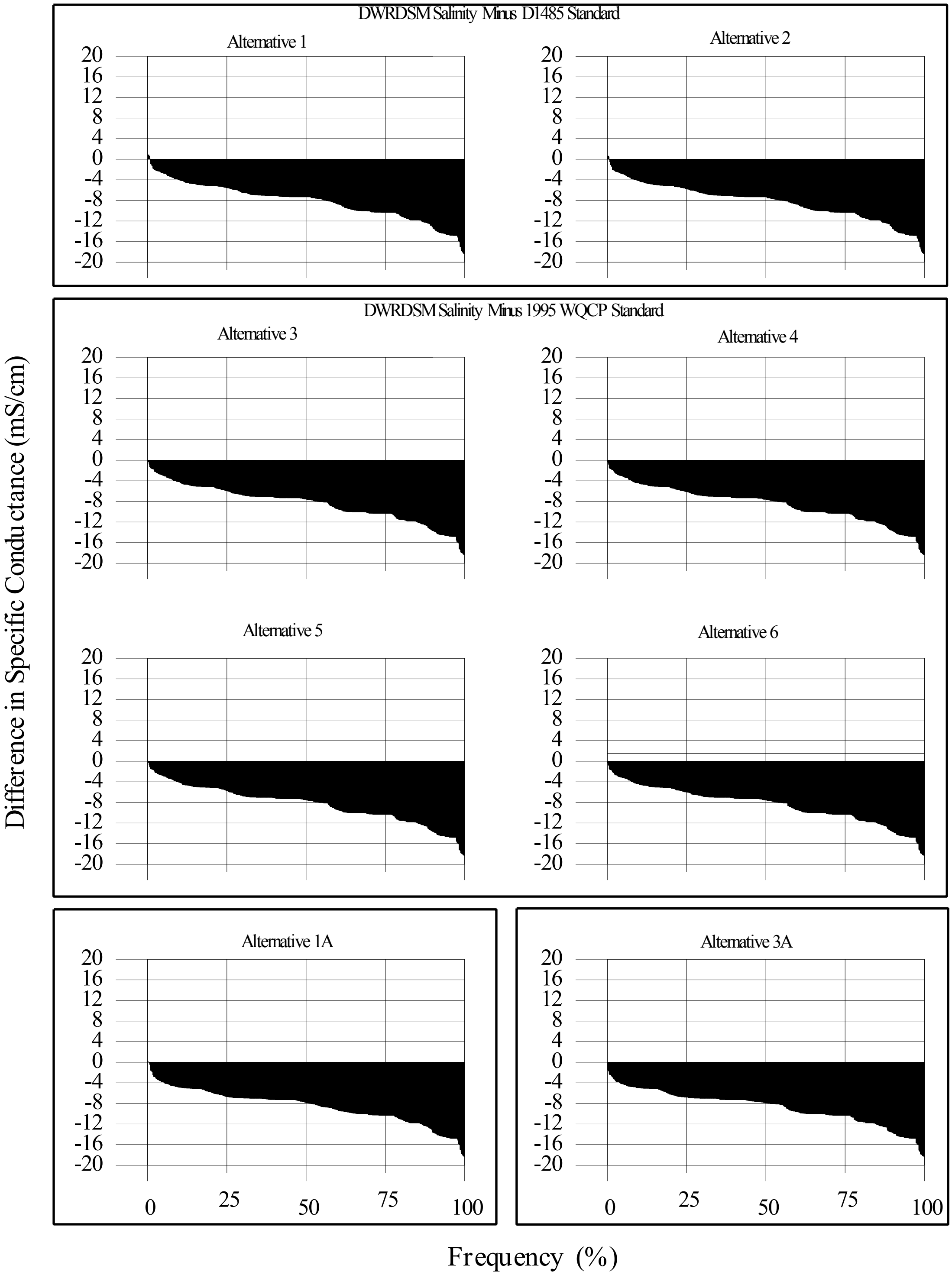

Figure VII-9

Salinity Area Frequency Analysis
Montezuma Slough at National Steel (S64)
October Through May of Water Years 1922-1994

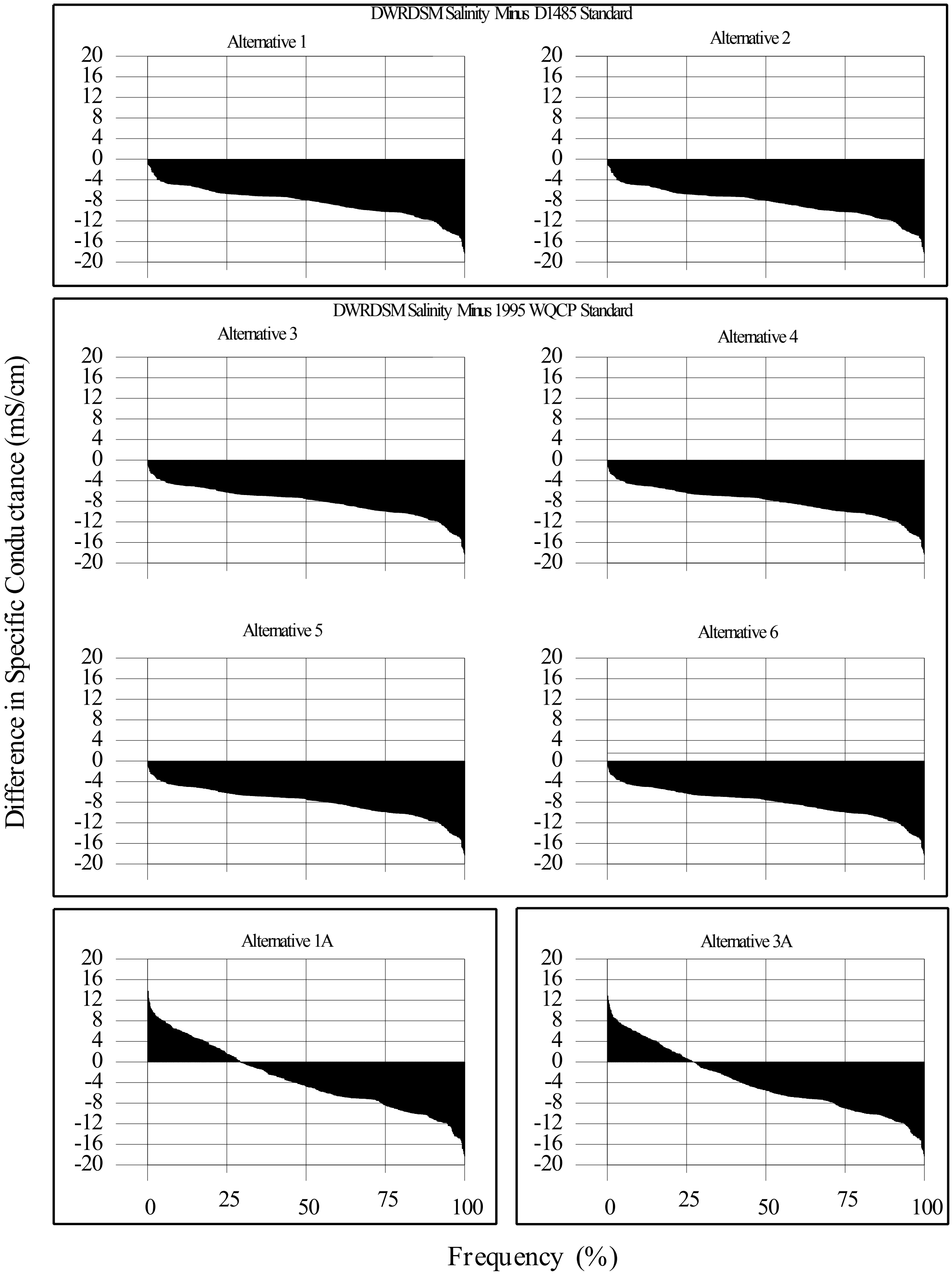

Figure VII-10

Salinity Area-Frequency Analysis
Montezuma Slough near Boldon Landing (S-49)
October Through May of Water Years 1922-1994

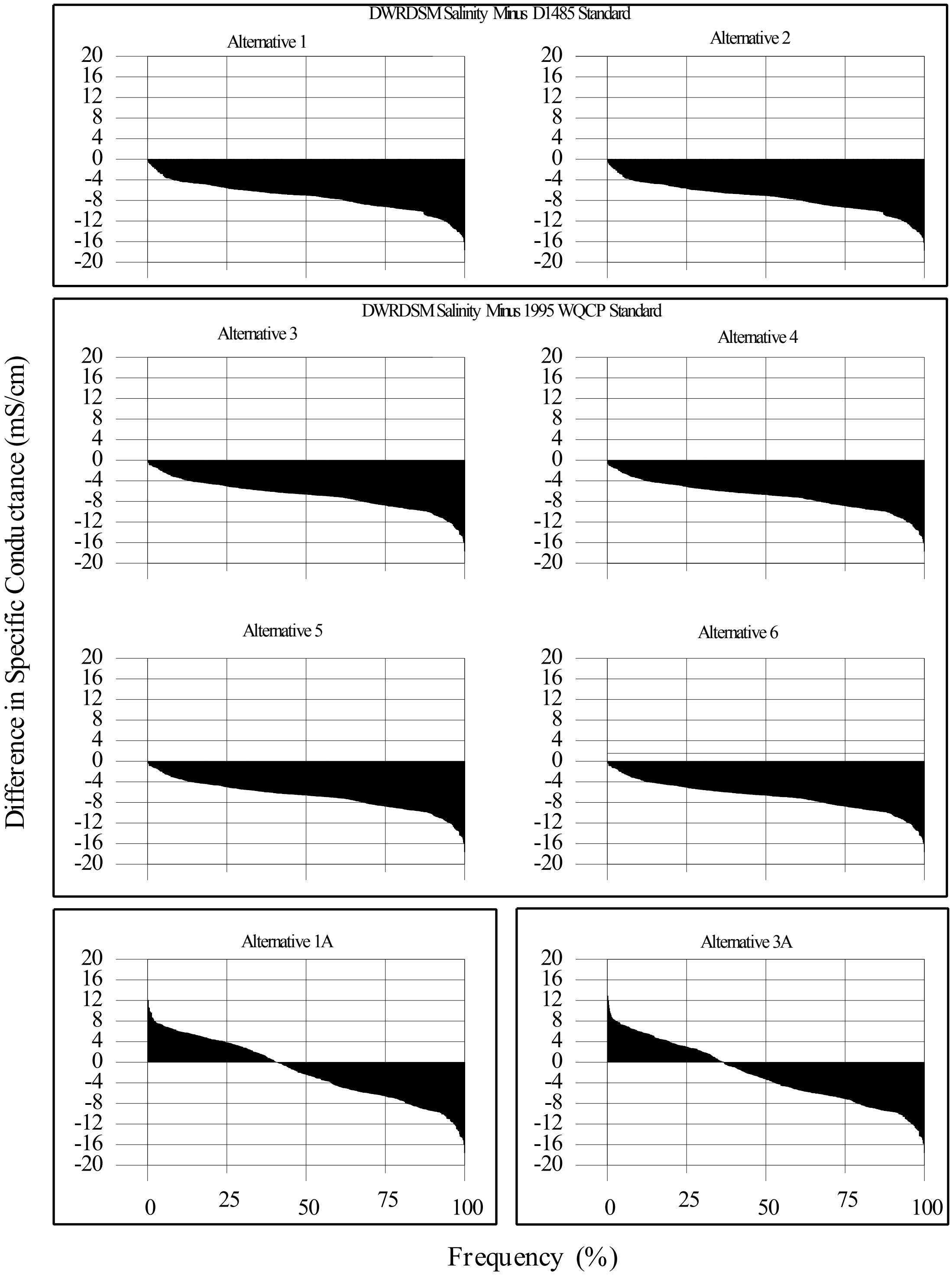

Figure VII-11

Salinity Area Frequency Analysis
Suisun Slough South of Volanti Slough (S-42)
October Through May of Water Years 1922-1994

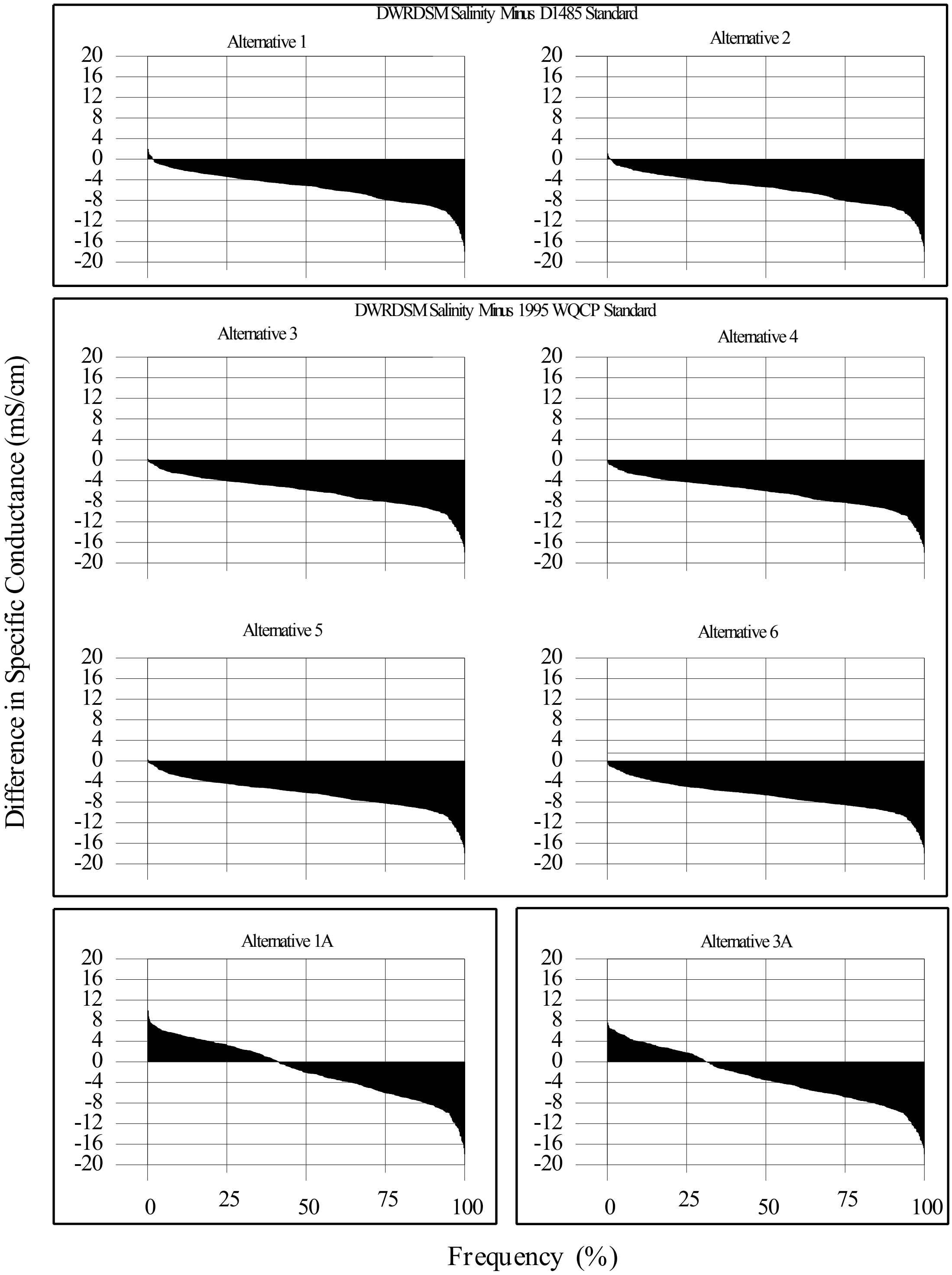

Figure VII-12

Salinity Area-Frequency Analysis
Chadbourne Slough at Chadbourne Road (S-21)
October Through May of Water Years 1922-1994

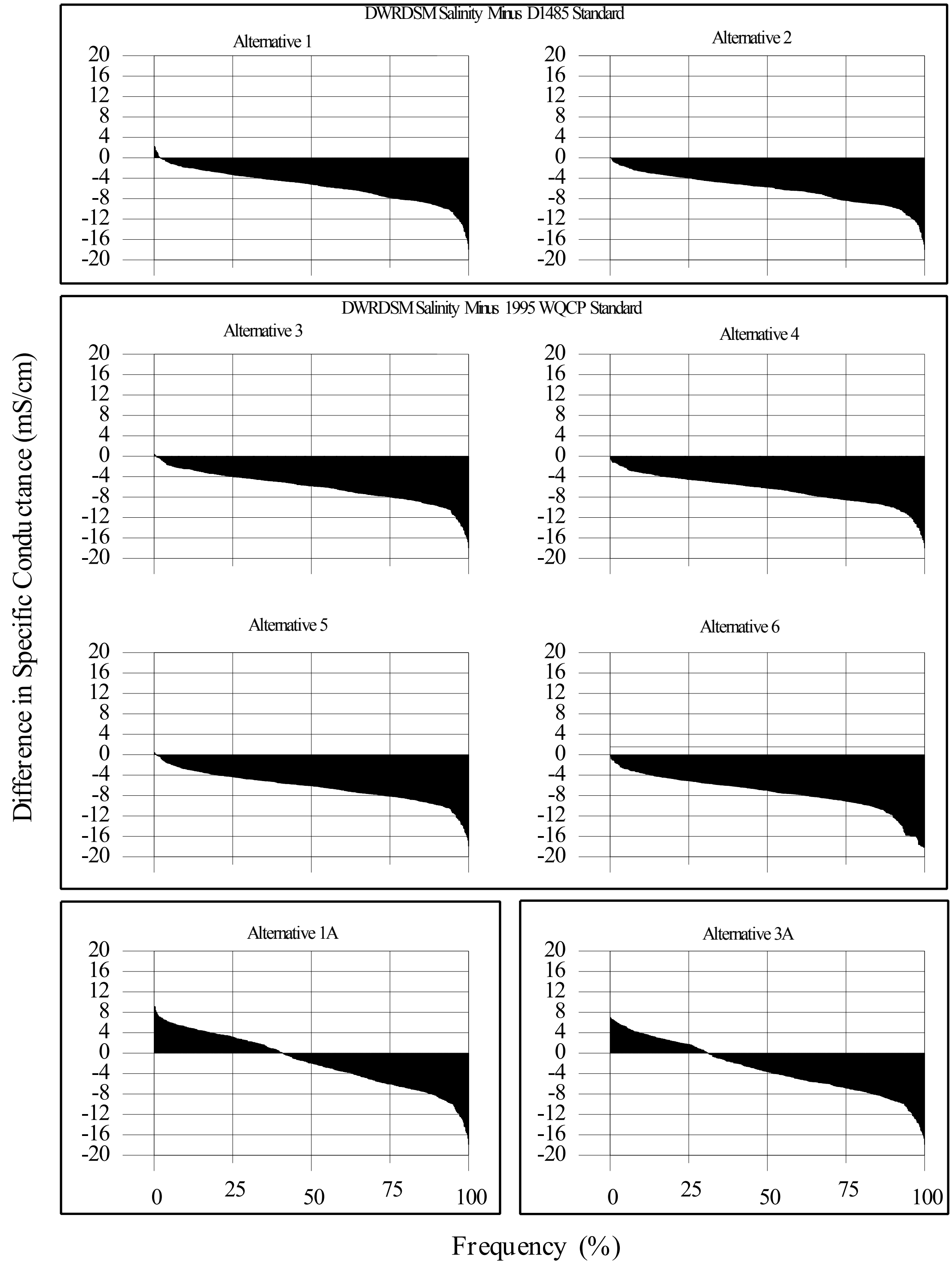

Figure VII-13

Salinity Area-Frequency Analysis
Goodyear Slough at Morrow Island Clubhouse (S-35)
October Through May of Water Years 1922 - 1994

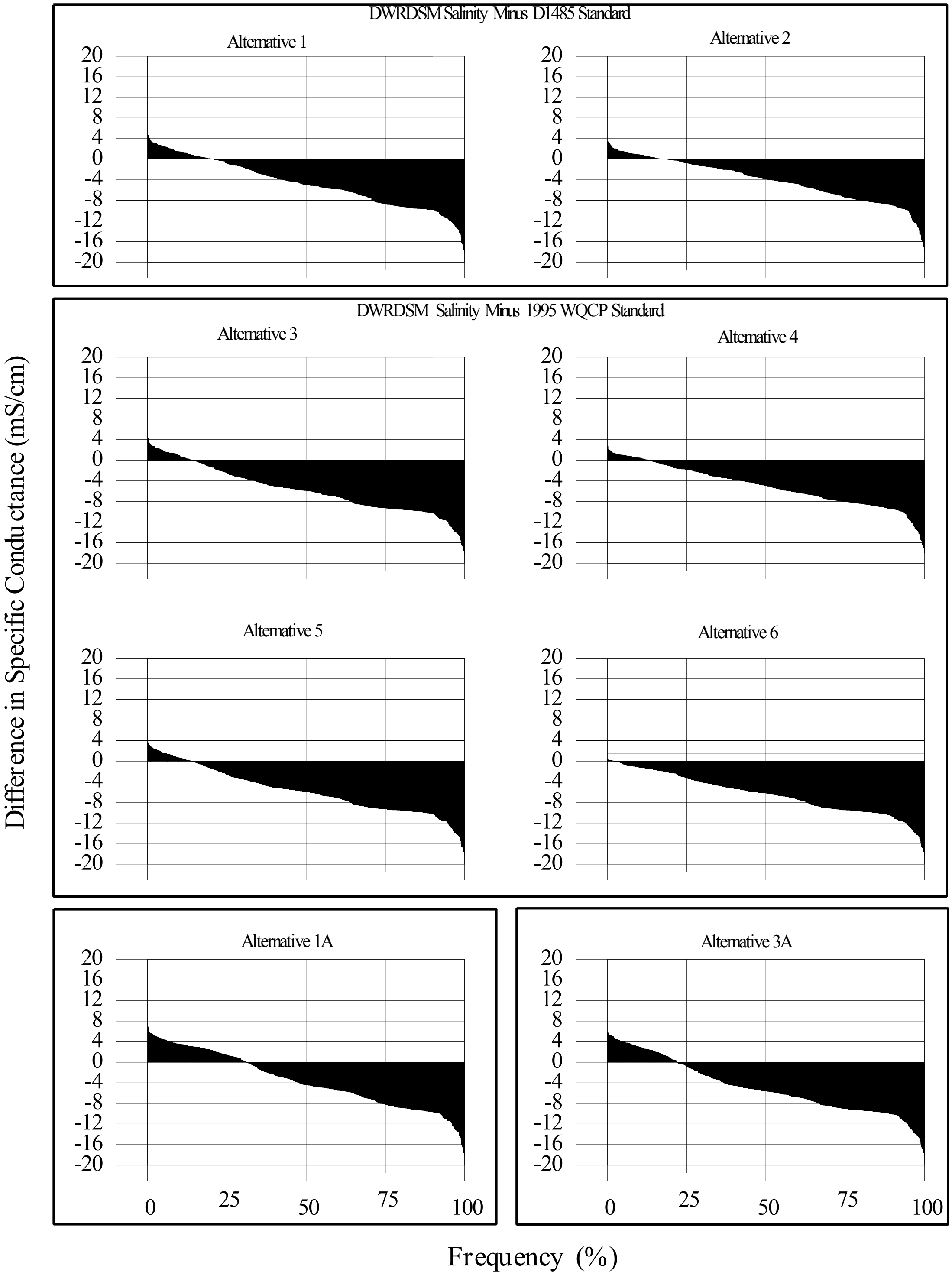

Figure VII-14
Salinity Area-Frequency Analysis
Cordelia Slough at Cordelia Goodyear Ditch (S-97)
October Through May of Water Years 1922-1994

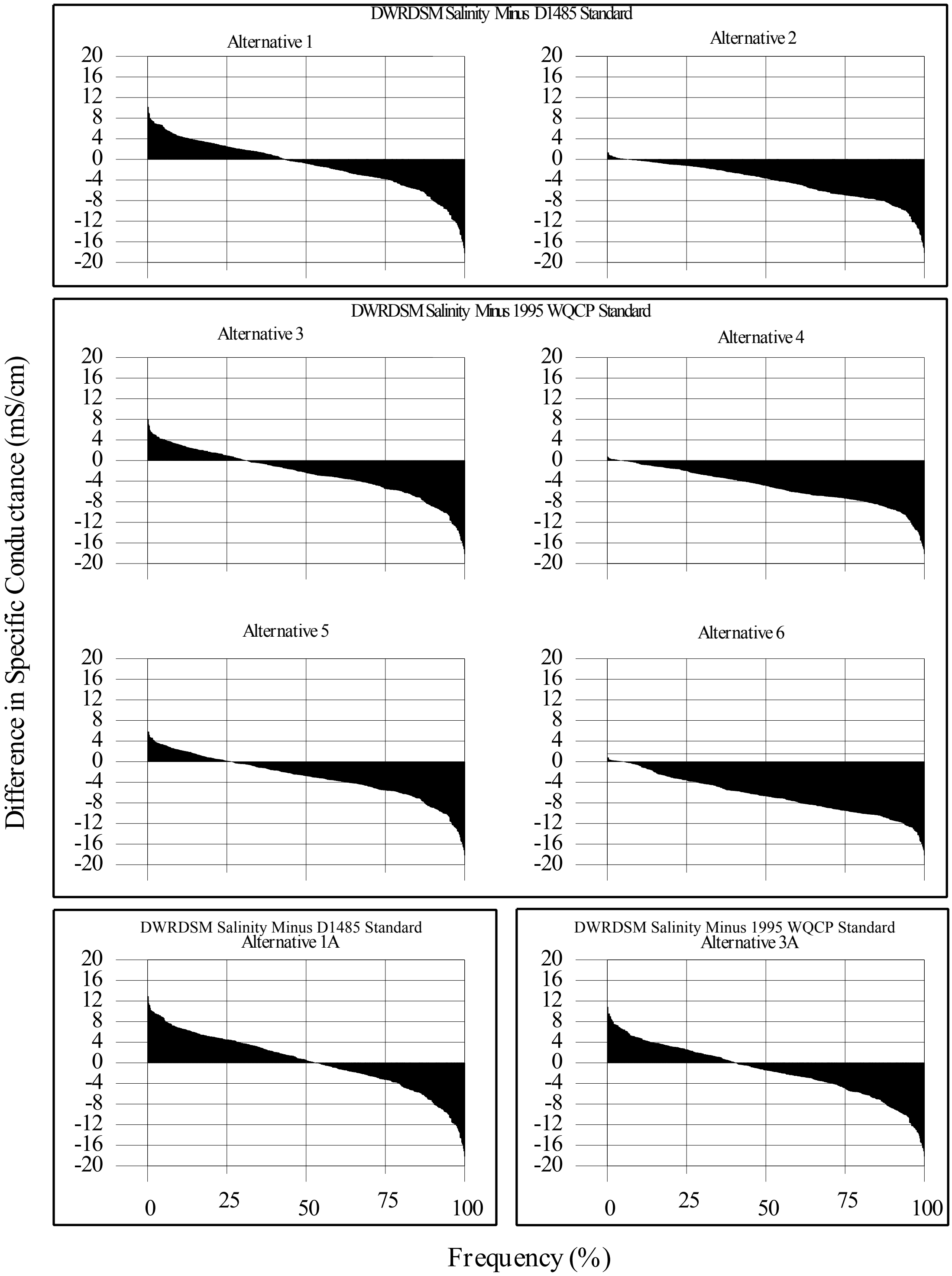

Figure VII-15

Salinity Area-Frequency Analysis
Boynton Slough (S-40)
October Through May of Water Years 1922 - 1994

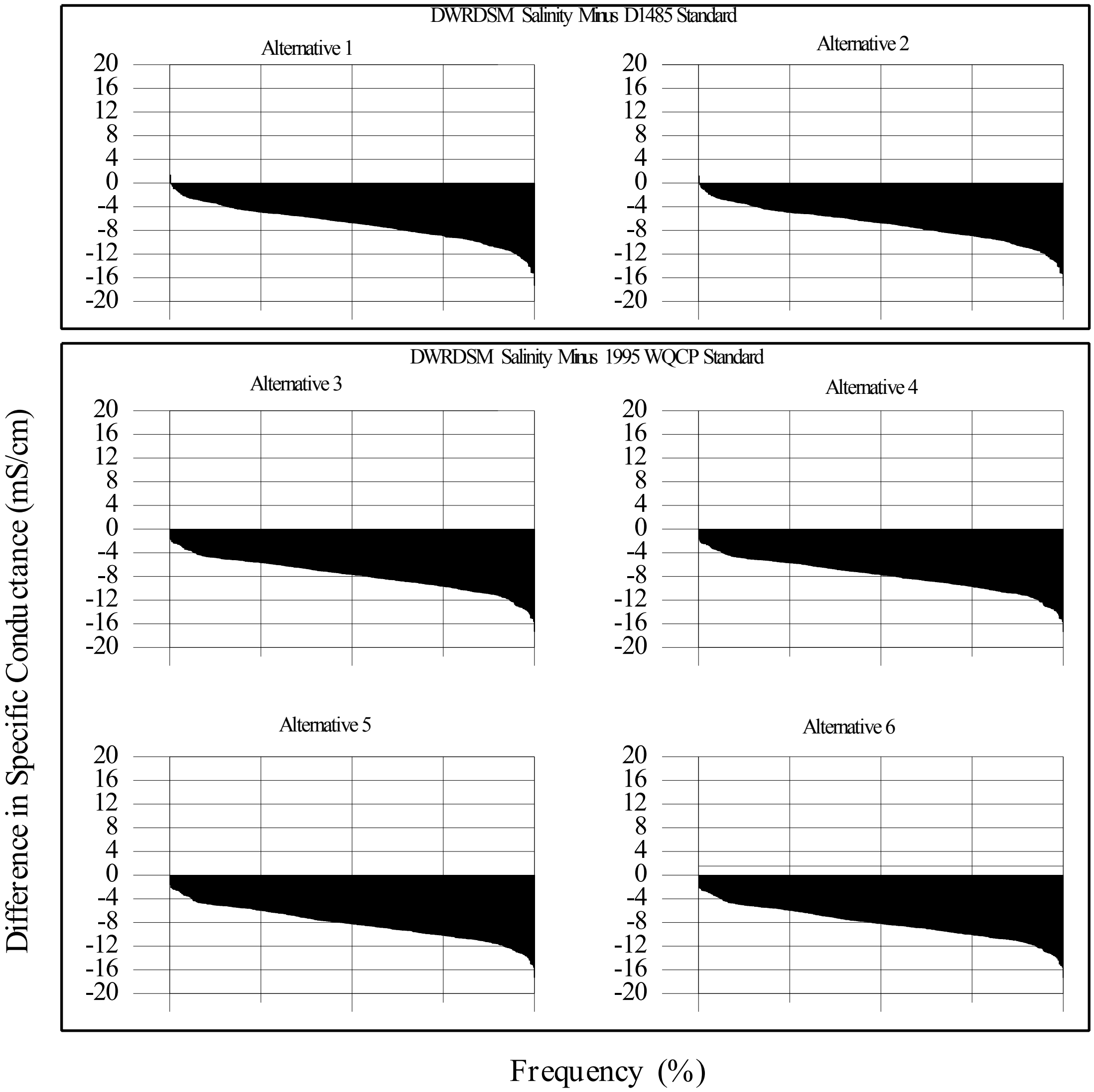

Table VII-7
Estimated Monthly Flow Augmentation
Required for Suisun Marsh Alternatives
Water Years 1922-1994 (TAF)

Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Total
Wet Years									
Alt 2	1.7	0.1	0	0	0	0	0	0	1.8
Alt 4	0.9	0	0	0	0	0	0	0	0.9
Alt 6	11.2	0.6	0	0	0.6	0.4	0	0	12.8
Above Normal Years									
Alt 2	2.2	0.5	0	0	0	0	0	0	2.7
Alt 4	0.8	0.2	0	0	0	0	0	0	1.0
Alt 6	7.1	1.3	0	0	0.3	0.2	0	0	8.8
Below Normal Years									
Alt 2	0.7	0.1	0	0	0.1	0	0	0	1.0
Alt 4	0.3	0.0	0	0	0.2	0	0	0	0.5
Alt 6	4.8	0.5	0	0.3	1.4	0.6	0	0	7.7
Dry Years									
Alt 2	1.4	0.5	0	0.1	1.1	0.1	0	0	3.2
Alt 4	1.4	0.4	0	0.0	0.6	0	0	0	2.5
Alt 6	13.4	2.7	0	0.7	2.8	1.1	0	0	20.7
Critically Dry Years									
Alt 2	3.6	1.4	0	0.7	2.9	0.9	0	0	9.5
Alt 4	2.9	0.9	0	0.1	0.5	0	0	0	4.4
Alt 6	27.9	5.7	0.1	1.2	1.4	0.6	0	0	37.0
73-Year Average									
Alt 2	1.8	0.5	0	0.1	0.7	0.2	0	0	3.4
Alt 4	1.2	0.3	0	0	0.3	0	0	0	1.8
Alt 6	12.8	2.0	0	0.4	1.3	0.6	0	0	17.2
1928-1934 Critical Period Average									
Alt 2	3.7	1.5	0	0.3	3.4	0.9	0	0	10.0
Alt 4	2.6	0.9	0	0	0.4	0	0	0	3.9
Alt 6	23.6	5.7	0	0.3	1.1	0.5	0	0	31.2
Absolute Maximum									
Alt 2	4.9	3.0	0	3.2	4.4	2.0	0	0	15.5
Alt 4	4.9	2.1	0	0.6	2.6	0.4	0	0	7.5
Alt 6	55.3	11.1	0.6	5.0	9.2	3.2	0	0	66.5

Table VII-8
Estimated Monthly Flow Augmentation
Required for Suisun Marsh Alternatives
Water Years 1922-1992 (cfs)

Alternative	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Wet Years								
Alt 2	27	2	0	0	0	0	0	0
Alt 4	14	1	0	0	0	0	0	0
Alt 6	181	11	0	0	10	6	0	0
Above Normal Years								
Alt 2	35	9	0	0	0	0	0	0
Alt 4	14	3	0	0	0	0	0	0
Alt 6	115	21	0	0	6	2	0	0
Below Normal Years								
Alt 2	12	2	0	0	2	0	0	0
Alt 4	5	0	0	0	3	0	0	0
Alt 6	78	9	0	5	25	10	0	0
Dry Years								
Alt 2	23	9	0	1	19	1	0	0
Alt 4	23	6	0	0	11	0	0	0
Alt 6	218	45	0	11	50	17	0	0
Critically Dry Years								
Alt 2	59	24	0	11	51	14	0	0
Alt 4	48	15	0	1	9	1	0	0
Alt 6	454	96	2	19	25	10	0	0
73-Year Average								
Alt 2	30	8	0	2	13	3	0	0
Alt 4	20	5	0	0	5	0	0	0
Alt 6	208	34	0	7	24	10	0	0
1928-1934 Critical Period Average								
Alt 2	61	26	0	5	61	15	0	0
Alt 4	42	15	0	0	8	0	0	0
Alt 6	385	95	0	5	19	9	0	0
Absolute Maximum								
Alt 2	80	50	0	52	79	33	0	0
Alt 4	80	35	0	10	47	7	0	0
Alt 6	899	187	10	81	160	52	0	0

by 2.2 percentage points for the same alternatives. The exceedence frequency for Alternative 5 is midway between Alternatives 3 and 4. Alternative 6 has the lowest exceedence frequency and the lowest exceedence index of the alternatives, but at a very high water cost. The modeling predicts that a peak October augmentation rate of 900 cfs would be needed to meet standards at S-35. The73-year average augmentation rate in October is 205 cfs. Data on augmentation water costs are presented in Tables VII-7 and VII-8. In general, the difference in water cost between Alternative 6 and Alternative 4, 15,200 AF on average, is the additional water required to meet objectives at S-35.

d. Salinity Impacts at Boynton Slough (S-40). Alternative 6 augments Green Valley Creek with effluent from the FSSD treatment plant and other sources. To the extent that this water comes from the treatment plant, there is a potential for impact to salinity in Boynton Slough. Though the maximum rate of FSSD augmentation is 20 cfs, the limited availability of wastewater, and the desirability of maintaining a net downstream flow of 3 cfs in Boynton Slough, results in augmentation rates which are frequently less than 10 cfs. The modeling showed that a slight increase in salinity would occur at the location under Alternative 6. The average exceedence of the objectives on an annual basis increased from no exceedence under Alternative 3 to 1.7 percentage exceedence. This is not considered a significant impact.

e. Suisun Marsh Salinity Control Gate Operation. The SMSCG is operated as needed under all alternatives to help meet salinity objectives. There are three different modes of operation: (1) operation using D-1485 hydrology (Alternatives 1 and 2); (2) operation using 1995 Bay/Delta Plan hydrology (Alternatives 3, 4, and 6); and (3) operation using 1995 Bay/Delta Plan hydrology plus September gate closure (Alternative 5). The frequency with which the SMSCG is operated in the DWRDSM model runs is presented in Table VII-9.

The SMSCG operates less frequently in all months of all water year classifications, especially in the February through May period, under 1995 Bay/Delta Plan hydrology. The western marsh stations S-35 and S-21 are most often responsible for triggering gate operations under both hydrologies. Allowance for SMSCG operation in September reduces the frequency of gate operation in October of Below Normal water years only, due to the fact that carryover of antecedent salinity is generally less than one month. The magnitude of exceedences are reduced with September gate operation. Stations meeting standards without September gate operation are marginally freshened.

2. Hydrology

This section describes changes in flows in natural and constructed channels and changes in reservoir levels as a result of implementing the different alternatives. A comparison of the hydrologic changes, from existing conditions to the various alternatives, is made for the following water bodies and facilities: (a) Green Valley Creek, (b) Lake Madigan and Lake Frey, (c) Sacramento River, (d) NBA, (e) FSSD, (f) Putah-South Canal, and (g) Lake Berryessa. A description of the physical facilities needed to implement the different alternatives precedes this discussion in section C.

Table VII-9
Suisun Marsh Salinity Control Gate Operation Frequency (%)

Alternatives 1 and 2 (without September operation)

Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Sept
C	85.7	85.7	85.7	85.7	85.7	85.7	85.7	92.9	0.0
D	71.4	85.7	85.7	78.6	92.9	92.9	64.3	64.3	0.0
BN	50.0	70.0	50.0	50.0	70.0	70.0	30.0	30.0	0.0
AN	54.5	81.8	72.7	63.6	54.5	54.5	27.3	27.3	0.0
W	68.0	68.0	36.0	21.0	28.0	10.0	16.0	16.0	0.0
Avg	68.5	78.1	63.0	56.2	61.6	65.8	42.5	43.8	0.0

Alternatives 3, 4 and 6 (without September operation)

Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Sept
C	83.3	91.7	83.3	91.7	91.7	75.0	16.7	50.0	0.0
D	56.3	75.0	68.8	62.5	75.0	56.3	0.0	6.3	0.0
BN	50.0	57.1	50.0	50.0	42.9	21.4	0.0	0.0	0.0
AN	45.5	45.5	27.3	9.1	0.0	0.0	0.0	0.0	0.0
W	47.6	52.4	9.5	9.5	4.8	0.0	0.0	0.0	0.0
Avg	56.2	64.4	45.2	42.5	41.1	28.8	2.7	9.6	0.0

Alternative 5 (with September operation)

Water Year Type	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Sept
C	83.3	91.7	83.3	91.7	91.7	75.0	16.7	50.0	100.0
D	56.3	75.0	68.8	62.5	75.0	56.3	0.0	6.3	100.0
BN	50.0	57.1	50.0	50.0	42.9	21.4	0.0	0.0	0.0
AN	45.5	45.5	27.3	9.1	0.0	0.0	0.0	0.0	0.0
W	47.6	52.4	9.5	9.5	4.8	0.0	0.0	0.0	0.0
Avg	53.4	64.4	45.2	42.5	41.1	28.8	2.7	9.6	38.4

Year Types are based on the Sacramento 40-30-30 Index, as defined in the 1995 Bay/Delta Plan

The modeling used to determine salinity impacts within the marsh also produced estimates of monthly flow augmentation required by various alternatives. Monthly estimates for different water year classifications are presented in Tables VII-8 and VII-9. The annual Green Valley Creek augmentation frequency is presented in Table VII-10.

a. <u>Green Valley Creek</u>. Flow augmentation in Green Valley Creek could be accomplished in four ways: (1) releasing water from the two City of Vallejo reservoirs in the upper watershed; (2) pumping tertiary-treated effluent from the FSSD treatment plant into lower Green Valley Creek; (3) transporting water from Barker Slough on the Sacramento River via the NBA; and (4) releasing Lake Berryessa water into Putah-South Canal then into lower Green Valley Creek.

The source and method of transportation of the water would dictate where it was released into Green Valley Creek and would influence the biota in the creek downstream of the release point. The release of water from the reservoirs would enhance the flows throughout the length of Green Valley Creek, whereas the flow augmentation with water from either the FSSD, the NBA, or Putah-South Canal would enhance the flows only in the lower portion of the creek. The effect on the marsh, downstream of Green Valley Creek, would be slightly different due to the differences in water quality from the different sources; however, the major influence on the marsh would be the amount of fresh water input rather than the source.

Table VII-10
Frequency of Green Valley Creek Flow Augmentation

Percentage of Months with Average Flow Greater than the Value (cfs)

Alternative	>0	>5	>15	>40	>75	>150
Alt 2	17.3	17.0	13.7	7.2	3.8	0.0
Alt 4	12.5	11.0	8.0	3.4	0.7	0.0
Alt 6	26.2	25.2	21.6	13.7	10.3	6.0

To conduct the modeling studies, the hydrology of Green Valley and Suisun creeks was synthesized from local rainfall data. The calculated flows were calibrated against available historic data for the creeks. Knowledge of creek base flow is needed in order to calculate the additional flow needed to meet objectives. The information suggests that Green Valley Creek experiences peak flows of about 200 cfs.

Alternatives 2, 4, and 6 require augmentation of Green Valley Creek flows (see Tables VII-8 and VII-9). The highest augmentation rates occur in October, followed by November, February and March. The modeling studies suggest that under Alternative 6, average monthly augmentations of greater than 150 cfs would be required 6 percent of the time, up to a maximum of 900 cfs. Maximum annual water cost of the alternative would be 66.5 TAF. Nearly full compliance with salinity standards at S-97 can be achieved with a maximum release into Green Valley Creek from the NBA of 80 cfs under Alternatives 2 and 4. The difference between the Alternative 6 and Alternative 4 augmentation rates represents the additional amount of freshwater inflow needed to meet objectives at S-35. The general effect of Alternative 6 in the vicinity of S-97 would be to produce salinities significantly lower than the historic condition. Green Valley Creek flow would not be augmented from June through September, nor during periods of high natural flow.

The resources potentially impacted by flow augmentation in Green Valley Creek are aquatic and terrestrial habitats discussed in sections 4 and 5 below. Unmanaged tidal wetlands downstream of Green Valley Creek might also be affected. The extent of the impact would be influenced by: (1) the source of water used for flow augmentation; (2) when it is released; and (3) where the flow is released into the creek.

b. Lake Madigan and Lake Frey. Lake Madigan, Lake Frey, and Lake Curry together constitute the City of Vallejo's Lakes Water System. Over time the system has evolved from the primary water source for the city to a source that provides less than 5 percent of the average City demand. As the city continues to grow, the Lakes System will supply even less. It is, however, the sole drinking water source for over 700 connections in unincorporated Solano County.

The production records for the Lakes Water System reveal that average annual raw water use during the 1977-1988 period was 358 AF and 1,757 AF for the Green Valley Creek reservoirs and Lake Curry, respectively (City of Vallejo 1989, 1994). The capacities of the reservoirs exceed the average annual use, as indicated in Table VII-3. Releases from Lake Curry flow into Suisun Creek and then Chadbourne Slough in the northwestern marsh, influencing salinity in the general vicinity of S-21. At present, no flow augmentation is proposed for Suisun Creek because the objectives are generally met at S-21. Therefore, Lake Curry will receive no further consideration.

Lake Madigan and Lake Frey have a combined capacity of 2,819 AF. If 700 AF were reserved for municipal use, and the reservoirs had no minimum pool, then a maximum of 2,119 AF of water might be available on an annual basis. In Alternative 6, the average annual augmentation quantity is 17.2 TAF. Hence, even under ideal circumstances, these lakes could supply no more than 8 percent of the average annual water requirement. If a bypass flow of 1 cfs from October through May was required pursuant to Fish and Game Code section 5937, about 480 AF per year would be needed, representing nearly 80 percent of the safe yield of the system. Such a bypass flow would clearly have a beneficial impact on riparian habitat in the upper Green Valley Creek watershed. By itself, it would have little impact on salinity at S-97, and none at S-35.

c. Sacramento River. Water is pumped from the Sacramento River at Barker Slough into the NBA to supplement flows in Green Valley Creek under Alternatives 2, 4 and 6. The DWR modeling assumes that the NBA has 80 cfs of available capacity. Thus, in any given month a maximum of 4.9 TAF could be pumped. This amount of water represents 0.6 percent of the average October flow at Freeport on the Sacramento River, an insignificant reduction in Sacramento River flow. Increased pumping could have a significant impact on aquatic resources in Barker Slough, particularly delta smelt. This issue is discussed further in section D.5 of this chapter.

d. North Bay Aqueduct. The NBA has a capacity of 174 cfs from Barker Slough pumping plant to Cordelia Forebay. The modeling assumes that there is 80 cfs of available capacity in the aqueduct during the October-May salinity control season. Under Alternatives 2 and 4, the full capacity would be utilized less than one percent of the time. However, about six percent and three percent of the time, respectively, additional pumping capacity would be needed to fill the pipeline. If the NBA were to be used to help augment Green Valley Creek flow under Alternative 6, there is sufficient capacity to meet the requirement in 90 percent of months. The maximum annual amount of water conveyed for augmentation purposes would be 22 TAF. The average annual amount would be 6 TAF.

Environmental impacts of increased NBA conveyance take place at the point of diversion and downstream of the point of discharge.

e. FSSD Wastewater Treatment Plant. Alternative 6 assumes that up to 20 cfs of treated wastewater from the FSSD could be available for dilution flow in Green Valley Creek during the December to March period and lesser amounts in other months. The modeling further assumes that a minimum discharge of three cfs would be maintained in Boynton Slough to prevent stagnation. The maximum annual amount of water transferred from the FSSD to Green Valley Creek is 4.3 TAF; the 73-year average amount is 1.2 TAF. A significant impact to the hydrology of Boynton Slough or Green Valley Creek is unlikely.

f. Putah-South Canal. The Putah-South Canal could be used in Alternative 6 to augment flow in Green Valley Creek. The canal is concrete lined and has a capacity of 116 cfs in the vicinity of Green Valley Creek. Water could be released through the Green Valley Wasteway, having at present a capacity of 14 cfs, or it could be released from the terminal reservoir through a new pipeline. Water diverted into the canal is derived mainly from release of water stored in Lake Berryessa.

Data supplied to the SWRCB by SCWA indicates that diversion into the Putah-South Canal in October averages about 210 cfs and that October agricultural demand is about 150 cfs, leaving about 50 cfs of available capacity in the terminal reach of the canal. If augmentation flows in Alternative 6 came from the Putah-South Canal alone, there would be sufficient capacity to meet the augmentation requirement in 88 percent of months. If augmentation flows in Alternative 6 came from both the NBA and the Putah-South Canal, there would be sufficient combined capacity to meet the augmentation requirement in 93 percent of months. The maximum annual water cost of using the Putah-South Canal alone to meet the Alternative 6 augmentation requirement would be 14.8 TAF. The average annual cost would be 4.4 TAF.

Environmental impacts of increased Putah-South Canal conveyance would occur mainly at the point of release into Green Valley Creek. Commitments to provide instream flow below Putah Creek diversion dam would remain unchanged.

g. Lake Berryessa. The water supply for Lake Berryessa is derived from the 568 square mile drainage basin above the dam. The elevation of the basin ranges from 182 feet at the dam to 4,772 feet at the upper end of Putah Creek, with most of the basin lying below 1,500 feet. There are four principal creeks that flow into Lake Berryessa: (1) Capell Creek; (2) Pope Creek; (3) Eticuera Creek; and (4) Putah Creek, the main drainage in the basin. Lake Berryessa has a storage capacity of 1.6 MAF at an elevation of 440 feet. The average annual inflow to the reservoir is 369 TAF; the annual firm yield is 201 TAF. A release of 22 TAF is required annually to meet prior downstream water rights along Putah Creek. An upstream reservation of 33 TAF was established by the SWRCB to provide water for future development of the area above Monticello Dam. The USBR has appropriated 7.5 TAF of the reservation to provide for future development around the lake. The reservoir water level may fluctuate from 455 feet to a minimum elevation of 253 feet. A water level of 309 feet is considered dead storage elevation. During the severe drought of 1977 the level was lowered to 388 feet (USBR 1992).

The average annual amount of water that might be required from Lake Berryessa would be 4.4 TAF, or 2.2 percent of the average project safe yield, if this were the sole source of augmentation flow. The maximum annual water cost would be 14.6 AF. Though the impact on water surface elevation might appear small when compared to the maximum reservoir capacity, it becomes potentially significant under dry conditions and could affect the yield of the Solano Project.

3. Landscape (Construction-Related) Impacts

Some of the alternatives for implementing the Suisun Marsh salinity objectives involve impacts due to construction. If an alternative is chosen that results in construction impacts, detailed site-specific environmental documentation will need to be completed by the agencies charged with carrying out the alternative. The following discussion is programmatic in nature. A detailed description of specific construction actions is contained in the DWR/USBR publication "Screening Alternative Actions and Describing Remaining Actions for the Proposed Western Suisun Marsh Salinity Control Project" (DWR 1993). The potential impacts to terrestrial resources (plants and animals) are described in section 4 below.

a. Alternatives 1 and 3. Alternatives 1 and 3 require no new facilities and therefore would not result in construction-related impacts. Any impacts to terrestrial resources would be a result of changes in channel water salinity that could affect the unmanaged tidal marshes. Any changes in terrestrial resources on the managed marshes would primarily be a result of water management practices on the private and state lands.

b. Alternatives 2 and 4. Alternatives 2 and 4 require identical facility modification and new construction. Green Valley Creek flow augmentation would require minor reconstruction of the NBA to accommodate sustained releases to the creek. The Cordelia-Goodyear Ditch and the Goodyear Slough Tide Gate would require major amounts of construction in the vicinity of S-35.

Therefore, implementing either of these alternatives would result in potentially significant construction-related impacts, depending on the projects ultimately approved.

North Bay Aqueduct. Water transported in the NBA could be released from the Cordelia Pumping Plant to an unlined ditch tributary to Green Valley Creek. The ditch is owned by the City of Fairfield and is not available on a long-term basis. A long-term solution would require minor modification of the emergency spillway at the Cordelia Forebay to accommodate sustained releases.

Cordelia-Goodyear Ditch. The approximately 6,300 foot-long ditch would be 100 feet wide and require excavation of 225,100 cubic yards of material. The sixteen foot wide levee roads on either side would require the placement of 61,800 cubic yards of fill. Construction would be required for access/haul roads, pile-supported bridges, the inlet and outlet tide gates, and placement of culverts. Construction related impacts would be significant. Operation and routine maintenance of this facility could result in continuing impacts to endangered species in the area. Detailed site investigations and further environmental documentation would have to be completed prior to construction.

Goodyear Slough Tide Gate. The Goodyear Slough Tide Gate would be similar in construction to the SMSCG, featuring two radial gates, a flashboard structure, and a boat lock. Modules would be constructed in a dry dock facility and floated to the site. On-site modifications include the construction of setback levees to accommodate the structure, channel dredging, access and haul roads, and a control building. Construction related impacts would be significant. Operation and routine maintenance of the tide gate could result in continuing impacts to endangered species. Detailed site investigations and further environmental documentation would have to be completed prior to construction.

c. **Alternative 5**. The actions in Alternative 5 are water management activities that would not result in construction related land disturbance. Environmental documentation for the SMPA Amendment III actions has been prepared jointly by the DWR, USBR, DFG, and the SRCD.

d. **Alternative 6**. Alternative 6, which emphasizes flow augmentation in Green Valley Creek, would require moderate construction to accommodate additional flow through existing waterways. If the NBA were used to convey the water, the construction impacts would be the same as described for Alternatives 2 and 4 above. If the Putah-South Canal were used to convey Lake Berryessa water into Green Valley Creek, then modification to the existing Green Valley Wasteway would be needed to transport the water on a long-term basis. Alternatively, a pipeline of about 0.3 mile in length could be constructed between the Putah-South Canal terminal reservoir and the creek. This work could be completed in about 15 working days and would have minor construction related impacts (DWR 1993). If Alternative 6 were chosen, detailed site investigations and further environmental documentation would have to be completed prior to construction.

This Alternative might also require modification of the FSSD facility to provide flow augmentation to Green Valley Creek. The FSSD could pump treated effluent, in reverse of the usual direction, through an existing 27-inch force main. This action would require a new pump, the replacement of an existing pump, 1,200 feet of new pipeline, and a concrete energy dissipater adjacent to Green Valley Creek. Construction impacts would occur mainly within the existing FSSD treatment plant boundary.

4. Potential Impacts to Terrestrial and Wetland Resources

The Suisun Marsh alternatives will result in channel water salinity slightly different from historic conditions. This may either indirectly affect terrestrial habitat or directly affect wetland habitat within the marsh. Some of the alternatives, if implemented, may significantly disturb limited areas of the marsh habitat. Others will cause minor disturbances to areas near the marsh. In this section, the general effects of changes in channel water salinity are discussed first, then the effects specific to an alternative are considered. The following discussion is programmatic with regard to construction related impacts; detailed site-specific environmental documentation will be developed by the agency responsible for the construction if an alternative is chosen that necessitates construction.

Hydrology is the most important factor for establishment and maintenance of specific types of wetland habitat. Hydrologic conditions affect many abiotic factors including, but not limited to, channel water salinity. These factors, in turn, determine the flora and fauna that develops in the wetlands. The three Suisun Marsh wetland types that may be influenced by salinity are: undiked tidal wetlands, diked seasonal wetlands, and diked permanent wetlands (DWR 1994d).

When Europeans first arrived, the Suisun region was an expanse of continuous tidal marsh. Diking of the historic marsh proceeded over time from the late 1870's through the 1970's, though by the 1930's nearly 90 percent of the total area had been diked. Now, less than eight percent of the original area remains. Tidal brackish marsh occurs where salt water from San Francisco Bay is diluted by freshwater runoff from the interior rivers. A delicate and highly fluctuating interaction exists between saline and freshwater conditions on a diurnal, seasonal, and interannual cycle. These dynamic factors produce a mix of saline and freshwater species that varies locally due to soil salinity, moisture, organic content, inundation, evaporation, and plant competition. Biodiversity is high within the brackish marshes as a result of this convergence (SEW 1997). Many wetland experts believe that retaining, to the extent possible, the full range of hydrologic conditions is essential for long term maintenance of this diversity.

The primary wetland type in Suisun Marsh is diked seasonal wetland managed for wintering waterfowl habitat. Diked wetlands are areas of historic tidal marsh which have been isolated from tidal influence. Plant communities in the diked wetlands can vary widely from site to site. The diversity of species, and the overall quality of the habitat, is strongly influenced by land use and water management practices. Though the managed wetlands also support a wide variety of plants and animals, they usually have fewer native species than natural tidal plant communities, and often a larger component of exotic species.

A small percentage of the managed waterfowl habitat is permanently flooded; the amount of this habitat is limited due to mosquito abatement regulations. A number of special status animal and plant species occur in Suisun Marsh wetland habitats. A listing of the sensitive terrestrial species known from the area is included in Table VII-11. Of the species listed in the table, about fifty percent occur in habitat that may be influenced by changes in the channel water salinity resulting from implementation of the Suisun Marsh water quality objectives (DWR 1994d).

Under D-1485, the DWR and the USBR were responsible for meeting the salinity standards in the marsh. Compliance dates at various stations were met over time as the DWR and the USBR built facilities to achieve the standards. As part of the planning effort to determine how best to meet the salinity objectives in the western marsh, the two agencies proposed the Western Suisun Marsh Salinity Control Test (WSCT). The test provided for augmentation of Green Valley Creek with flow from the NBA and was to be conducted from September 1994 through May 1995.

The DWR, in compliance with the Endangered Species Act (ESA), requested informal consultation with, and approval from, the USFWS to conduct the WSCT. In October 1994, the USFWS approved the September 1 to November 14 portion of the test; however, they expressed a concern that continuation of the test for the remainder of the year would have an adverse affect on listed endangered species. The USFWS was also concerned that achieving the western marsh objectives through flow augmentation might have a long-term negative impact on fish and wildlife habitat (USFWS 1994).

The salinity objectives in D-1485 were designed to satisfy the water quality requirements of waterfowl food plant species. Alkali bulrush, fathen, and brass buttons were thought, when the D-1485 objectives were established, to be the preferred food for migratory waterfowl using the marsh. The salinity objectives did not attempt to enhance the physical environment for pickleweed and other more salt tolerant plant species used by the endangered California clapper rail, the salt marsh harvest mouse, and other species as refuge and nesting habitat. The objectives failed to provide a salinity gradient from the eastern marsh to the western marsh reflective of the natural gradient that would exist under natural conditions. The USFWS concluded that as the D-1485 objectives sought to maintain an artificial regime, they do not enhance habitat appropriate for fish and wildlife species currently residing in the area. Furthermore, the objectives may cause conditions that decrease or eliminate suitable tidal marsh habitat used by federally listed terrestrial species, thus perpetuating their decline.

a. <u>Alternatives 1 and 3</u>. The modeling of Alternative 1 assumes that the salinity objectives at all stations would be complied with, to the extent possible, with SMSCG operation and Delta outflow. There would be slight changes from historical salinity conditions, and the western marsh stations would be made as fresh as possible, given existing facilities.

Table VII-11
Special Status and Sensitive Plant and Wildlife Species Known from the Suisun Marsh Area

Species Which May Be Influenced by Changes in Salinity Gradients

Common Name	Scientific name	Federal Status	California Status	Occur in Freshwater Marshes	Occur in Brackish Marshes	Occur in Salt Marshes	Not Present in Affected Habitats
Birds							
California black rail	*Laterallus jamaicensis coturniculus*	SC	T	X	X	X	
California clapper rail	*Rallus longirostrus obsoletus*	E	E		X	X	
Suisun song sparrow	*Melospiza melodia maxillaris*	SC	SC		X		
Mammals							
Salt marsh harvest mouse	*Reithrodontomys raviventris*	E	E		X	X	
Suisun ornate shrew	*Sorex ornatus sinuosus*	SC	SC		X	X	
Plants							
Mason's lilaeopsis	*Lilaeopsis masonii*	SC	R	X	X		
Soft-haired bird's beak	*Cordylanthus mollis spp. mollis*	E	R		X	X	
Suisun Slough thistle	*Cirsium hydrophilum spp. hydrophilum*	E	-		X		
Delta tule pea	*Lathyrus jepsonii jepsonii*	SC	-	X	X		
Suisun aster	*Aster lentus*	SC	-	X	X		

Species Which Are Not Likely to be Influenced by Changes in Salinity Gradients

Common Name	Scientific name	Federal Status	California Status	Occur in Freshwater Marshes	Occur in Brackish Marshes	Occur in Salt Marshes	Not Present in Affected Habitats
Birds							
American peregrine falcon	*Falco peregrinus anatum*	E	-	X	X	X	
Bald eagle	*Haliaeetus leucocephalus*	T	E				X
Saltmarsh common	*Geothylpis trichos sinuosa*	SC	SC	X	X	X	
Reptiles and Mammals							
Northwestern pond turtle	*Clemmys marmorata marmorata*	SC	SC	X	X	X	
California tiger salamander	*Ambystoma californiense*	C	SC				X
Western spadefoot toad	*Scaphiopus hammondi*	SC	SC				X
Plants							
Antioch dunes evening primrose	*Oenothera deltoides ssp. howellii*	E	E				X
Contra Costa wallflower	*Erysimum capitatum ssp. angustatum*	E	E				X
Tiburon indian paintbrush	*Castilleja affinis ssp. neglecta*	E	T				X
Colusa grass	*Neostapfia colusana*	PT	E				X
Contra Costa goldfields	*Lasthenia conjugens*	PE	-				X
Hispid bird's beak	*Cordylanthus mollis spp. hispidis*	SC	-				X
Heartscale	*Atriplex cordulata*	SC	-				X
Legenere	*Legenere limosa*	SC	-				X

(DWR 1994d)

E = Federal or State Endangered; PE= Proposed Endangered; R = California Rare Plant Species; C =Federal Candidate Species
SC= Federal or State Species of Concern; PT= Proposed Threatened; T = Federal or State Threatened Species; - = No Status

As stated above, the USFWS has concerns that meeting the D-1485 salinity standards would result in too much freshwater in the northwestern marsh and therefore reduce brackish and salt-water habitat. Because implementation of this alternative would be achieved only with outflow and operation of the SMSCG, standards are not met in all years. No construction would be required to meet the objectives in Alternative 1.

Alternative 3 assumes 1995 Bay/Delta Plan hydrology and is otherwise identical to Alternative 1. The differences between D-1485 and the 1995 Bay/Delta Plan objectives in the western marsh are presented in Table VII-4. Salinity throughout the marsh is lower under Alternative 3. The DWR has prepared a report on Sensitive Plant and Wildlife Resources in Suisun Marsh (DWR 1994d). The report states that there are several species of birds, mammals and plants that could be influenced by changes in estuarine salinity gradients resulting from the Suisun Marsh salinity objectives or higher outflows under the 1995 Bay/Delta Plan. The degree to which the objectives would influence terrestrial resources has not been determined with certainty. It is important to note, however, that salinity is only one factor influencing brackish marsh vegetation patterns. Other factors, such as depth and duration of flooding and plant competition, may be of equal or greater importance. The SEW is addressing this and related issues at the present time, and will submit a report to the SWRCB prior to triennial review (SEW 1997).

b. Alternatives 2 and 4. Implementation of Alternative 2 could have a number of different significant impacts to terrestrial and wetland habitats within the marsh. The alternative includes flow augmentation in Green Valley Creek plus construction of the Goodyear-Cordelia Ditch and the Goodyear Slough Tide Gate to meet the D-1485 salinity objectives.

Water for augmentation of Green Valley Creek would come from the NBA. Modification of the Cordelia Forebay spillway would be needed for long-term implementation. The impact of this action to terrestrial resources would be minor and transitory. Flow augmentation would introduce substantial quantities of low salinity water to northwestern marsh. The impact to species requiring brackish or salt marsh habitat is potentially significant.

Construction of the Goodyear-Cordelia Ditch and the Goodyear Slough Tide Gate would result in a significant disturbance of marsh habitat. The ditch and its associated inlet/outlet tide gates would require construction on both private and state lands. The ditch inlet would be located on Cordelia Slough at the Tule Belle Duck Club and run south through the DFG West Family Property. A 40-acre pond on the south side of Pierce Lane would be connected to the system to increase the holding capacity of the ditch. There would be another ditch crossing private land from the pond to the outlet tide gates. Several years ago, the DFG trapped salt marsh harvest mice in the proposed site. At the point where the ditch would enter Cordelia Slough on the Tule Belle lands, there is habitat suitable for sensitive plant species, such as the Delta tule pea and Suisun aster. There is also a possibility that soft haired bird's beak (*Cordylanthus mollis* ssp. *mollis*) may be present in the area as well (Brenda Grewell, DWR, pers. comm. 12/96). Prior to construction of these facilities, it would be necessary to survey the affected habitats for plants and animals of concern, and to complete a site-specific CEQA document.

c. Alternative 5. Alternative 5 includes local water management actions on managed wetlands in the marsh. The water management actions are designed to use available channel water more effectively, while maintaining soil salinity within limits acceptable for production of waterfowl food plants. Under this alternative, the 1995 Bay/Delta Plan the numeric salinity objectives at S-35 and

S-97 need not be met. The DWR and the USBR may demonstrate that equivalent or better protection will be provided by actions in lieu of the numeric objectives.

The implementation of Alternative 5 will most likely improve the quality of the managed wetland habitat. The DFG recognizes that the lack of active water management by many landowners in the marsh has resulted in the degradation of managed wetland habitat. The parties negotiating SMPA Amendment III have endorsed the concept of a water manager to oversee individual property owner water management plans and to insure consistent and efficient water management practices critical for the long term maintenance of seasonally flooded wetland. Data generated from eight years of monitoring in the seasonal wetlands of Suisun Marsh indicate that current waterfowl habitat management objectives can be achieved with the implementation of the SMPA Amendment III actions (DWR 1997b). The DWR, USBR, DFG, and the SRCD are preparing the needed environmental documentation.

Channel water salinity conditions under this alternative will fluctuate more widely than Alternatives 2 and 4 and be nearly indistinguishable from Alternative 3. Species and habitats adapted to brackish or variable salinity conditions will benefit accordingly.

d. **Alternative 6**. In Alternative 6, multiple parties may be responsible for full implementation of the Suisun Marsh objectives using flow augmentation in Green Valley Creek. In this alternative, alterations to the NBA and the Putah-South Canal at the point of discharge into Green Valley Creek would be required.

If flow augmentation were derived, at least in part, by releases from the upstream reservoirs, riparian habitat along Green Valley Creek stream corridor could benefit. The largest quantity of augmentation flow is needed in October and November. A large pulse of water, followed by no additional release from the upstream reservoirs would be of less value to Green Valley Creek riparian habitat than a smaller release made over a longer period of time. A small continuous release, however, would have only a slight freshening effect at S-97, and no effect at S-35.

If FSSD effluent is used for flow augmentation, additional habitat surveys and environmental documentation will need to be prepared.

5. Aquatic Resources

The Suisun Marsh alternatives result in slightly different channel water salinities which may directly affect aquatic habitat in the marsh and possibly the distribution and abundance of resident and migratory aquatic species. The alternatives that involve construction would physically disrupt areas of aquatic habitat. Other potential sources of impact to aquatic resources include: (1) the importation of water from the Sacramento River to Green Valley Creek through the NBA; (2) the use of Lake Berryessa water and effluent from the FSSD; and (3) the operation of the SMSCG for salinity control. The following discussion is divided into three sections: (a) status and trends of aquatic resources in Suisun Marsh; (b) effects of SMSCG operation; (c) affects of Green Valley Creek flow augmentation; and (d) effects of the alternatives.

a. Status and Trends of Aquatic Resources in Suisun Marsh. Long term aquatic sampling programs have been conducted in the marsh since the late 1970's. Short term sampling programs to evaluate the effect of SMSCG operation on aquatic resources have either been completed, or are currently underway. The following section describes the sampling that occurs in the marsh and the trends in abundance and distribution of the various aquatic species.

Since 1979, the DWR has contracted with the University of California at Davis to monitor fish populations in Suisun Marsh. The study is designed to track trends in diversity, abundance and habitat requirements of marsh fishes before and after installation of the SMSCG. Monthly samples are taken year-round with an otter trawl. The study has 21 stations throughout Suisun Marsh, including two in Montezuma Slough (Matern 1995). Six of the stations are east of Cutoff Slough. Moyle et al (1986) analyzed data from 1979 to 1983 and concluded that declines in fish abundance and species diversity were related to temporary perturbations. The structure of the fish assemblage was considered fairly consistent. The decline in abundance was attributed to higher than average outflows and weak year classes of striped bass, splittail, threespine stickleback, tule perch, prickly sculpin, yellowfin goby, Sacramento sucker, and common carp (DWR 1995a).

An analysis from 1979 to January 1992 reached conclusions different from Moyle's five-year study (Meng et al 1993). With data from a 14-year period, Meng concluded that the declines in abundance and species diversity are long-term rather than temporary conditions. The declines were correlated with decreases in outflow and increases in salinity, with the exception of 1986, when downward trends in abundance and species diversity were attributed to high outflows.

The report states that since 1986, the decline in abundance has steadily continued. The abundance of native fish (prickly sculpin, Sacramento splittail, Sacramento sucker, three-spine stickleback, tule perch) was consistently lower than the abundance of introduced species (shimofuri goby, common carp, striped bass, and yellowfin goby) over the 14-year period in the marsh. Abundance indices for seasonal species (delta smelt, longfin smelt, staghorn sculpin, starry flounder, and threadfin shad) fluctuated from 3 to 21 from 1979 to 1985, but remained at or below 4 from 1985 to 1992. Fish abundance, number of species, and the seasonal species index were negatively correlated with salinity. Fish abundance, number of species, introduced species, and native species were positively correlated with Delta outflow, and outflow was negatively correlated with years.

The Meng report also states that the distribution of fish within the marsh has changed over time. In the 1986 study, introduced species were found throughout the marsh but were captured most often in the larger sloughs. In the 1993 analysis, introduced species had become less abundant in the larger sloughs and more abundant in the dead-end sloughs. As in the 1986 study, native species were still found more often in dead-end sloughs, but over time, they were less abundant in those sloughs (DWR 1995a).

The summary of sampling from January 1992 through December 1993 is reported by Matern et al (1994). The abundance of few species increased in response to the wet 1993 water year, but overall, long-term declines in fish abundance were observed between 1983 and 1993. The trend in species in Suisun Marsh continued toward a less diverse assemblage of fish dominated by introduced species. A summary of the U.C. Davis fish sampling follows:

- Total catch of delta smelt has declined since 1983. Of the 443 delta smelt captured since 1979, only 20 have been captured since 1983.

- Total catches of longfin smelt have declined since the late 1980's. An increase in total catch in 1990 consisted of high number of longfin smelt fry. Low numbers of adults and fry were captured in subsequent years, and therefore, the prolific spawn in 1990 did not alter the overall decline.

- Young-of-year striped bass was the most abundant species caught in all years except 1988, 1990 and 1993. Overall, the catch of young-of-year striped bass declined since the early 1980's. Catches of adult striped bass have declined and fluctuated at low levels since 1981. Otter trawling is not an efficient way to catch adult striped bass because the adults can avoid the net, consequently these catch results may not be a good indication of the population abundance in Suisun Marsh.

- Catches of adult and young splittail have declined since 1980. High numbers of young-of-year were caught between 1980 and 1982 and in 1986; young-of-year catches dropped off until 1991, when there was a slight increase in abundance. The catch reached an all time low in 1993.

- Catches of yellowfin gobies have had two major peaks since 1980. The first peak of an average of 6 fish/trawl was in 1984. After 1984, catch levels fluctuated from 1 to 4 fish/trawl. The average catch per trawl of yellowfin gobies reached its highest ever in 1993 with a peak of 16 fish per trawl.

- The population of shimofuri goby peaked in 1989 with 1,348 captured. In 1993, only 118 were captured. Sampling in the spring of 1994 revealed high numbers of juvenile gobies which may result in another increase in the population.

- Prickly sculpin populations respond strongly to changes in Delta outflow. High outflow years produced peak numbers of 1,137, 362 and 242 in 1983, 1986 and 1993, respectively. From 1980 to 1983, catch levels were at their highest. The lowest catch was in 1990 and rose slightly from 1991 to 1993, however, overall, the population has declined since 1983.

- Tule perch is usually one of the most abundant fish in Suisun Marsh. It is considered a year-round resident of the marsh. Tule perch are captured most often in smaller sloughs, possibly a result of the higher otter trawl efficiency in small sloughs. Tule perch abundance peaked between 1980 and 1982 and again in 1987 and 1988. Since 1988, the catches have been below the 1983 levels. Total catch for 1993 was the lowest on record.

- Introduced species have moved from large sloughs to dead-end sloughs, mixing with the native species. Fish assemblages in the Sacramento-San Joaquin Estuary are shifting from an assemblage dominated by striped bass and native fishes to one dominated by exotic species. These changes are likely tied to overall decreases in Delta outflow, increases in salinity and introductions of exotic species (Meng et al 1993 in DWR 1995a).

The DFG conducts *Neomysis mercedis* and zooplankton field sampling twice a month from April through October. Due to naturally low winter abundance of *N. mercedis*, sampling is normally not done from November to March. Phytoplankton are the base of the aquatic food web in Suisun Marsh. *Neomysis* feed on phytoplankton and are, in turn, an important dietary component for many marsh fishes. Phytoplankton respond quickly to major alterations in their environment, and alterations in phytoplankton abundance can affect the *Neomysis* population and consequently many fish species. (Field studies indicate *Neomysis* abundance decreases in salinity above 7.2 parts per thousand (ppt) and are least abundant when salinity exceeds 18 ppt.) Data from March 1974 to November 1993 indicate *Neomysis* abundance and phytoplankton production, as measured by chlorophyll a, are usually higher in Suisun Slough than in western Montezuma Slough. No phytoplankton bloom occurred in Montezuma Slough in 1992, a critical water year, which is consistent with the lack of a phytoplankton bloom recorded during the 1977 drought. By reducing marsh salinity during periods of low Delta outflow, operation of the salinity control gates could help create more favorable conditions for *Neomysis*. Operation of the control gates produces a saltwater/freshwater interface in the marsh, a preferred *Neomysis* habitat, probably similar to the entrapment zone in the larger channels and bays of the estuary (DWR 1995a).

The DFG striped bass egg and larval survey provides an abundance index of developing striped bass every fourth day through the spawning season. In years prior to 1991, the survey was initiated early enough to collect eggs and larvae from early spawning. Spawning is triggered by water temperatures, so survey dates varied from year to year within the months of April, May, June and July. The striped bass egg and larval survey was conducted in Montezuma Slough from 1984 to 1988 and then resumed in 1993. The Montezuma Slough index comprises a small proportion of the total 6-14 mm larval abundance estimated by the survey. However, any area suitable for rearing larval striped bass is important to the Estuary's low population. A 1987 DFG study concluded that the SMSCG would have a minimal effect on striped bass eggs and 3-6 mm larvae (Raquel 1988).

The DFG striped bass tow-net survey results are used to produce an abundance index of the year-class strength for striped bass when their average size is 38.1 mm. When the striped bass are this size, the sampling gear is most efficient. Due to variations in environmental conditions, survey dates vary from year to year within the months of June, July and August. Spring and summer conditions affect spawning time and larval growth and therefore the time when the young become vulnerable to the sampling gear. In 1993, three stations in Montezuma Slough downstream of the control structure were sampled during three surveys. Increased abundance during this wet year seems to indicate that Montezuma Slough remains a relatively small but important habitat for juvenile striped bass. It is difficult to determine whether changes in abundance are caused by the installation and operation of the SMSCG (DWR 1995a).

b. **Effects of Suisun Marsh Salinity Control Gate Operation**. The use of the SMSCG changes the net direction of flow in Montezuma Slough and could cause outmigrating juvenile chinook salmon to use the slough more than normal as a migratory route. This change in migratory route could delay their migration and cause an increase in losses due to predation. In low outflow years, the net flow of water between Montezuma Slough and the Suisun Bay area tends to be from west to east within the slough, from Grizzly Bay towards Collinsville. However, operation of the SMSCG in drier years changes the net circulation pattern, and flow moves from east to west, as in wet years.

In 1987 and 1992, the USFWS sampled in Montezuma Slough to estimate the use of the slough by outmigrating salmon, and losses of salmon as a result of predation upstream and downstream of the salinity control gates. The trawling surveys were conducted in April and May. Concurrent sampling in Montezuma Slough and Chipps Island in 1987 and 1992 showed that a small, yet equal percentage of the outmigrant salmon leaving the western Delta were diverted into Montezuma Slough both with (1992) and without (1987) the salinity control structure in place. In both years, between 0 and 2.72 percent of the fish leaving the western Delta passed through Montezuma Slough. These fish could have lower survival, since their migration would be delayed or the distance to the ocean increased. However, operation of the control structure did not change the percentage of fish diverted into Montezuma Slough during those critically dry water years (DWR 1995a). Little information is available on how conditions in the Suisun Bay area and the marsh may specifically affect winter-run salmon. The extent to which Montezuma Slough is used as a migration route as opposed to Suisun Bay, is unknown. There is no reason to assume that the use of Montezuma Slough by the winter-run salmon would be different from the other outmigrating races.

Since April 1987, the DFG has conducted sampling to determine the presence of predators near the salinity control gates. There is concern that the structure will increase the predation rate for migrating juvenile fishes such as Chinook salmon, striped bass and American shad. From 1987 to 1992, adult fish were collected at about two-week intervals during May and June. Stomach contents of potential predators (striped bass and Sacramento squawfish) were examined for remains of salmon, striped bass and other prey. Three sites were sampled, one upstream and one downstream of the SMSCG and another reference station (added in 1993) two miles upstream of the salinity control gates.

Before initial operation of the gates in October 1988, the primary prey species in stomach samples were threespine stickleback, shimofuri goby, and sculpins. Gobies, bigscale logperch, and striped bass were also found. With the structure in place, threespine stickleback was the primary fish species consumed by squawfish and striped bass from 1988-1990. In 1991, shimofuri goby was the primary prey species consumed by Sacramento squawfish. There was some evidence of predation on juvenile salmon in 1987, 1991, and 1992 but only one or two salmon were found each year. No salmon were found in 1993. No striped bass prey were found in 1990-1993. Predation on American shad was evident in 1989, 1990 and 1992, but not in 1988, 1991 or 1993.

During the U.S. Army Corps of Engineers (USCOE) permitting process, concerns were raised about the potential effect of the control structure on adult salmon migration. To determine impacts on migrating adult Chinook salmon, a sonic tracking study was conducted in the fall of 1993 and 1994. Fall-run adult salmon were captured, tagged and monitored during three SMSCG operational phases:

- While the gates were open and the flashboards were not in place;
- While the gates were open and the flashboards were in place; and
- While the gates were operating.

The preliminary results in 1993 indicated that salmon passage times were significantly increased when the flashboards were in place, regardless of control gate status. The study also indicated that 85 percent of the fall-run chinook migrated through the gates on a flood or high tide. When the gates are operating, there is only a 20-minute period at the beginning of the flood tide when the gates are open and salmon can migrate upstream. However, fish did migrate through the gates on low tide when the gates were operating (DWR 1995a).

Preliminary results from the study suggested that placement of the flashboards and operation of the salinity control structure delayed and prolonged the upstream migration of fall-run salmon. The study was repeated in 1994 and no significant differences were found in passage times. When data for the two years were combined, the overall trends of decreasing passage numbers and increasing passage time with installation of the flashboards were consistent between years. Results from these studies suggest that the SMSCG has the potential to delay the upstream migration of adult salmon. The biological significance of this delay, however, is uncertain and is the subject of ongoing study (DWR 1997d).

All studies except the DFG predation sampling and the water quality profiling continued in 1994 (DWR 1995a). The predation sampling was discontinued because of the remote possibility of finding salmon in the stomachs of predators and the difficulty in determining when the increase in striped bass numbers in Montezuma Slough was significantly different from other areas in the marsh, or the Delta. The 1994 USFWS delta smelt biological opinion requires development of a predation rate on delta smelt at the salinity control structure. Difficulties encountered in detecting predation on salmon will likely be repeated when trying to assess effects on delta smelt.

c. **Effects of Green Valley Creek Flow Augmentation**. The DWR and USBR, in an effort to implement the D-1485 salinity objectives in the western marsh conducted the WSCT (see section 4). The WSCT proposal was to augment flow in Green Valley Creek up to 50 cfs between September 1, 1995 and May 31, 1995. This water would be diverted from Barker Slough via the NBA in the fall and spring, and from Lake Berryessa via Putah-South Canal between November 15 and the first week in March.

When the DWR proposed the WSCT in 1994, the USFWS expressed concerns about the adverse effects on fish during the November 15 through May 30, 1994 portion of the test. They also were concerned about the long-term effect that Green Valley Creek flow augmentation would have on marsh habitat. They felt that implementation of the standards may lead to attraction flows and diversions in environmentally sensitive areas, thus perpetuating the decline of federally-listed aquatic species. The USFWS stated that an analysis should be done to develop new quantifiable standards that provide suitable habitat and appropriate flows to protect and sustain viable populations of federally listed species (USFWS 1994).

The USFWS was concerned that the delta smelt may be attracted by fresh water flow into Green Valley Creek seeking potential spawning habitat. Spawning in the creek may lead to spawning failure and increased entrainment of the young from diversions along Cordelia Slough. This effect could take place regardless of the source of the augmenting flow.

The USFWS was also concerned that the augmentation flow coming from the NBA might entrain delta smelt at the NBA Barker Slough intake. Delta smelt adults migrate upstream from Suisun Bay and spawn in Barker Slough on the Sacramento from February through May. Larval delta smelt have been sampled in Barker Slough from early March to early June. Entrainment of larval delta smelt at the Barker slough intake in 1993 and 1994 was estimated by DWR to be 8,289 and 22,489, respectively. The effectiveness of the screened intake at Barker Slough for juvenile and adult delta smelt is not known.

The USFWS concluded that diversion of water from Barker Sough for flow augmentation in Green Valley Creek might decrease water available for transport and habitat maintenance flows in the Sacramento River. These flows move delta smelt larvae and juveniles to suitable rearing habitat in Suisun Bay and maintain that habitat downstream of the "zone of influence" of the State and federal pumping plants. Any diversion that removes water from the Sacramento River drainage has an incremental effect in these flows (USFWS 1994).

The NMFS also commented on the WSCT, focusing their attention on the January through May period (NMFS 1994). The NMFS concluded that the 1994 proposal would provide only minimal attracting flows to upstream migrating adult winter-run chinook salmon. However, they were concerned that using Sacramento River water to augment flows on a long-term basis, particularly during critically dry years, could adversely impact upstream reservoir cold water storage and the ability to control upper Sacramento River water temperatures for winter-run chinook salmon spawning and egg incubation. Modeling studies for critical water year 1990 indicate up to 80 cfs of additional flow would be required in Green Valley Creek from January through May to effectively lower channel water salinity. Larger diversions and discharges of Sacramento River water in future years will increase the risk of attracting winter-run chinook adults into the western Marsh.

The NMFS also had concerns regarding the appropriateness of the D-1485 objectives. They suggested it would be prudent to evaluate the recent actions pertaining to the proposed 1995 Bay/Delta Plan and review management practices/objectives within Suisun Marsh prior to implementing long-term actions that may adversely affect listed species such as the winter-run chinook salmon.

As part of the WSCT, fishery monitoring was conducted. Following release of NBA water into Green Valley Creek, on November 14, 1994, DFG and DWR biologists conservatively estimated that 80 adult fall-run chinook salmon migrated up Green Valley Creek into the City of Fairfield unlined ditch toward the Cordelia Forebay (DWR-ESO 1996). As a result of observing the fall-run chinook salmon, and concern that NBA water released into the northwestern marsh would attract endangered winter-run salmon, the DWR and the USBR reinitiated informal consultation with the USFWS, NMFS and DFG for the remainder of 1994-1995 WSCT. To continue the WSCT, the regulatory agencies required the DWR and the USBR to develop and implement a fisheries monitoring program to address concerns for winter-run chinook salmon, steelhead trout, splittail, delta smelt, longfin smelt and tidewater goby.

The DWR monitored for winter-run chinook salmon, steelhead trout and splittail from February through May, 1995. A false weir, essentially a fence across the creek with a single opening leading to a box with a one-way entrance, was installed on Green Valley Creek. The DWR staff checked the holding box for fish four days per week, eight hours per day. Staff also checked for spawning salmon and redds twice per week at four locations.

The DWR sampled for delta smelt and longfin smelt by electrofishing twice per month at three sites within Green Valley Creek. Electrofishing was conducted from December 1994 through May 1995. Minnow traps were also tested as a method for capturing these species. The traps were set once a week for eight hour periods.

A survey was conducted to determine if suitable tidewater goby habitat was present in Green Valley Creek. Because of the configuration of the creek bed and the extreme fluctuations in the tidal elevation, no suitable habitat was found. Consequently, no sampling for tidewater gobies was required.

While no winter-run chinook salmon, splittail, Delta or longfin smelt were captured, the presence of fall-run chinook salmon and rainbow trout, possibly steelhead, was documented. An additional

14 fish species were also found during the sampling. Complete results and analysis from the fisheries monitoring will be presented in a report detailing water quality, hydrodynamic and biological effects of the 1994-1995 WSCT.

d. Effects of the Alternatives. This section examines the general effect that the alternatives may have on aquatic resources in Suisun marsh. The alternatives could affect aquatic resources by: (1) changing channel water salinity; (2) operation of the SMSCG; (3) augmentation of Green Valley Creek flow; and (4) by construction of new facilities. Impacts to aquatic resources that arise as results of construction activities are programmatic with respect to this EIR, and would require further analysis and CEQA documentation

Alternative 1. In Alternative 1, the DWR and the USBR are responsible for meeting the D-1485 salinity objectives. The alternative assumes compliance at all monitoring stations, regardless of effective compliance date. The SMSCG is operated as needed to meet objectives and no new facilities are constructed. Under this alternative, objectives are frequently not met at S-35 and S-97 in the western marsh. Impacts to aquatic resources would result from changing salinity and SMSCG operation.

Alternative 2. Alternative 2 seeks to meet D-1485 objectives by a combination of flow augmentation and construction of new facilities. SMSCG operation and salinity in the eastern and central marsh are the same as Alternative 1; salinity in the western marsh would be lower than Alternative 1. Species that may have declined due to the increasingly saline conditions observed in the marsh should benefit.

The introduction of Sacramento River water into Green Valley Creek via the NBA could significantly impact chinook salmon, delta smelt, and other aquatic resources in Barker Slough and in the western marsh. Construction of the Goodyear-Cordelia Ditch and the Goodyear Slough Tide Gate could impact aquatic resources through dredging and related activities. Operation of the Tide Gate could also impact the movement of delta smelt within the slough, increase the number of predatory fish in the area, and thus increase predation near the gate.

Alternative 3. The impact of Alternative 3 to aquatic resources would be similar to Alternative 1. Overall, channel water throughout the marsh is less saline under this alternative due to the higher Delta outflow requirement in the 1995 Bay/Delta Plan. When compared to Alternative 1, species that may have declined due to the increasingly saline historic conditions should benefit. The SMSCG is operated less frequently under 1995 Bay/Delta Plan hydrology. Therefore, impacts due to SMSCG closure should be reduced.

Alternative 4. This alternative is similar to Alternative 2. The hydrology associated with the 1995 Bay/Delta Plan creates less saline conditions throughout the marsh and less frequent SMSCG operation. Impacts due to construction and flow augmentation are identical to Alternative 2.

Alternative 5. Channel water salinity, and the corresponding impacts to aquatic resources under Alternative 5 are similar to Alternative 3.

Some of the management actions proposed in the SMPA Amendment III negotiations may impact aquatic resources. September operation of the SMSCG may increase the impact to aquatic resources over that in Alternatives 3, 4, and 6. Portable pumps are to be used to facilitate the movement of water onto and off of managed wetland areas. Fish screens will be an integral part of the pump design, thereby minimizing fish entrainment. All management actions that are part of the SMPA Amendment III are being analyzed in an environmental document prepared jointly by the SMPA parties.

Alternative 6. The highest Green Valley Creek augmentation rates and quantities are required under Alternative 6. If the NBA were used up to its full available capacity for flow augmentation, the average annual amount of pumping would increase from 1.8 TAF to 6.1 TAF when compared to Alternative 4. The maximum NBA pumping would increase from 7.5 TAF to 22 TAF. Impacts to delta smelt and chinook salmon associated with Alternatives 2 and 4 would be magnified under this alternative. If augmentation water were to come from local sources (Lake Frey, Lake Madigan, or Lake Berryessa), impacts at Barker Slough could be avoided.

In an effort to meet objectives in all months, the modeling predicts that very high augmentation rates would on occasion be needed. The difference in the amount of water needed for augmentation between Alternative 6 and Alternative 4 is the additional amount of water needed to meet objectives at S-35. This large input of freshwater would create conditions at S-97 far less saline than the historic condition, or under any of the other alternatives. Aquatic species in the western marsh preferring brackish conditions would tend to be displaced in favor of freshwater species.

SMSCG operation under this alternative is the same as Alternatives 3 and 4. Construction activities would not impact aquatic resources.

6. Recreation

Diked seasonal wetlands occupy 88 percent of Suisun Marsh. The DFG and a number of private landowners manage this area primarily as waterfowl habitat. Waterfowl hunting is presently the major economic and recreational use of the marsh. The Suisun Marsh channel water salinity objectives adopted by the SWRCB in D-1485 were established to protect waterfowl food plants growing in the managed wetlands. Assuming that the salinity objectives provide the desired level of protection to managed wetland areas, the alternatives that are most effective in achieving the objectives would also be most protective of the major recreational uses in the marsh.

Alternative 6 fully meets the Suisun Marsh objectives. Objectives are exceeded at stations S-35 and S-97 under Alternatives 2 and 4, and with increasing frequency under Alternatives 5, 3, and 1. Among these alternatives, Alternative 6 is presumed to be most protective for marsh waterfowl hunting interests.

Research by the DWR suggests that landowner water management practices are critical for maintaining soil salinity suitable for the growth of desired plant species (DWR 1997c). Carefully timed flooding, drawdown, and leaching cycles have allowed some properties in the western marsh, where channel water salinity has historically been highest, to achieve lower soil salinity than neighboring properties, or similar properties in the eastern marsh using higher quality irrigation water. Therefore, the management actions under Alternative 5 are thought to be equally protective of recreational beneficial use. Recreational pursuits such as bird watching, canoeing, hiking, and wildlife observation are becoming increasingly popular in the tidal marsh areas. Educational programs are conducted in the tidal marshes at Rush Ranch and DFG's Peytonia Slough Ecological Reserve. The Napa-Solano Audubon Society volunteers conduct Christmas bird counts and breeding season surveys in Suisun Marsh. Recreational boating has increased within the marsh with the improvements to the Suisun City waterfront and harbor facilities.

Although current land use in the marsh is predominantly diked seasonal wetland, three major Estuary-wide resource agency planning efforts are calling for extensive tidal marsh restoration to facilitate the recovery of endangered species and sensitive wetland habitat values[6] (Goals Project 1999). Therefore, the recreational use of the marsh may be expected to change over time.

a. Green Valley Creek. Alternatives 2, 4, and 6 require varying degrees of flow augmentation in Green Valley Creek. The largest flows would occur in October and to a lesser extent in November and February. As the Suisun Marsh salinity control season occurs during a period of generally lower recreational use, there would be little beneficial impact to recreation in the lower section of the creek.

b. Lake Frey, Lake Madigan and Lake Berryessa. The City of Vallejo prohibits public access to Lake Frey and Lake Madigan. Therefore, there would be no impact to public recreation at these facilities.

Water from Lake Berryessa could be used for Green Valley Creek flow augmentation under Alternative 6. As stated in section 2.g above, if there were 50 cfs of available capacity in the Putah-South Canal and water from the Putah Creek watershed was the sole source of augmentation flow, then the maximum annual demand placed on Lake Berryessa would be 14.8 TAF. The average annual demand would be 4.4 TAF. Considering the large size of Lake Berryessa, reducing the volume by the above amounts would have an insignificant impact on the lake's surface area, and its potential for water based recreational activities.

E. SUMMARY

The 1995 Bay/Delta Plan establishes numeric salinity objectives at seven stations within the Suisun Marsh from October through May and a narrative objective pertaining to brackish tidal marshes. These objectives replace those adopted in 1978 in Decision 1485 (D-1485), and later amended in 1985. The purpose of these objectives is to make irrigation water available for the managed

6 The San Francisco Bay Area Ecosystem Goals Project, the CALFED Ecosystem Restoration Program Plan, and the USFWS Tidal Marsh Recovery Plan call for extensive tidal marsh restoration.

wetlands that will bring soil salinity into a range capable of supporting plants characteristic of a brackish marsh.

In 1977, the California legislature adopted the Suisun Marsh Preservation Act. Recognizing the unique nature of the resource, the act implemented the Suisun Marsh Protection Plan, developed previously by the DFG and the San Francisco Bay Conservation and Development Commission. The SMPA was adopted in 1987, and continues to serve as a contractual framework between the DWR, the USBR, the DFG, and the SRCD to carry out the Protection Plan. The SMPA calls for the staged construction of facilities to provide required channel water salinity. The initial facilities (phase 1) included the Roaring River distribution system, the Morrow Island distribution system, and the Goodyear Slough outfall. The SMSCG was constructed in 1988 as the second phase of the SMPA. The SMSCG began regular operation in October 1988; since that time, salinity in the eastern marsh (see Figure VII-1) has been below current 1995 Bay/Delta Plan objectives, with minor exceptions in water year 1991. During prolonged dry or critically dry periods, however, salinity in the western marsh often exceeds objectives. Salinity in the northwestern and far western marsh are affected primarily by surface water inflows from local creeks and drainage water from managed wetlands, and are relatively unaffected by SMSCG operation.

In order to comply with the western marsh objectives, the DWR and the USBR began in 1990 the planning and review of the Western Suisun Marsh Salinity Control Project. Field testing for one of the more promising alternatives, flow augmentation of Green Valley Creek, was conducted in the fall of 1994. The test was not carried out for the entire salinity control season as planned due, in part, to concerns expressed by the USFWS and the NMFS regarding potential impacts to resident or migratory endangered species, and because hydrologic conditions were such that augmentation was not needed to meet standards.

In D-1485, the SWRCB found that the SWP and the CVP have a mitigation responsibility to protect Suisun Marsh because their operations affect salinity conditions in the marsh. In 1995, the DWR and the USBR petitioned the SWRCB to change some of the permit terms and conditions imposed by D-1485 so that they conform to the objectives in the 1995 Bay/Delta Plan. In response to the petition, the SWRCB incorporated the 1995 Bay/Delta Plan's Suisun Marsh objectives temporarily into the water right permits of the SWP and the CVP through SWRCB Order WR 95-6. The order expired December 31, 1998.

Upon adoption of Order WR 95-6, parties signatory to the SMPA began discussions to amend the agreement. The draft SMPA Amendment III reflects anticipated future hydrologic and salinity conditions in the marsh under 1995 Bay/Delta Plan hydrology and SMSCG operation. The parties have recommended that the SWRCB consider a series of management actions as the next step in implementing the 1995 Bay/Delta Plan rather than focus on the channel water salinity in the western marsh. Strict adherence to the numeric objectives is not required if it can be demonstrated that other actions will provide equivalent or better protection to the managed wetlands. The DWR and the USBR petitioned the SWRCB to extend the compliance date for S-35 and S-97 to enable the

SMPA parties to finalize Amendment III. The SWRCB granted a 180 day extension on October 30, 1997, and renewals of the extension on August 14, 1998 and April 30, 1999.

In the water right proceeding to implement the 1995 Bay/Delta Plan, the SWRCB focused on alternatives to meet water quality objectives at the two western stations, S-35 and S-97. Because the DWR and the USBR control operation of the gates, the SWRCB will not consider at this time assigning responsibility for meeting objectives at the eastern stations to other parties.

Six alternative methods for implementing the Suisun Marsh objectives are analyzed in this draft EIR. The alternatives assume SMSCG operation as needed to meet objectives and Delta outflow conditions based either on D-1485 hydrology or 1995 Bay/Delta Plan hydrology. To meet objectives at S-35 and S-97 different combinations of physical facilities and Green Valley Creek flow augmentation are employed. The alternatives are summarized in Table VII-12.

Table VII-12
Summary of Suisun Marsh Alternatives

Alternative	Regulatory Condition	New Facilities	Green Valley Creek Flow Augmentation	Other Actions
1	D-1485	None	None	None
2	D-1485	Cordelia-Goodyear Ditch and Goodyear Slough Tide Gate. Minor construction on NBA	Up to 80 cfs as needed from NBA to meet S-97	None
3	1995 Bay/Delta Plan	None	None	None
4	1995 Bay/Delta Plan	Cordelia-Goodyear Ditch and Goodyear Slough Tide Gate. Minor construction on NBA	Up to 80 cfs as needed from NBA to meet S-97	None
5	1995 Bay/Delta Plan	None	None	SMPA Amendment III management actions plus September SMSCG operation as needed
6	1995 Bay/Delta Plan	Minor construction on Putah-South Canal and NBA	As needed from all sources until objectives are met at S-97 and S-35	None

The alternatives were modeled using the water quality and hydrodynamic model DWRDSM (Suisun Marsh Version). Average monthly salinities at the seven compliance stations were simulated for the 1922 to 1994 period. Important observations and conclusions based on the modeling results are as follows:

1. Preliminary model runs demonstrate the importance of the SMSCG in achieving the Suisun marsh objectives. Without gate operation, objectives are violated in all months at all compliance stations under D-1485 hydrology. The increased Delta outflow under the 1995 Bay/Delta Plan reduces the exceedence frequency significantly. However, objectives are still exceeded in most months at most stations, though by lesser amounts.

2. The SMSCG operates significantly less frequently under alternatives with 1995 Bay/Delta Plan base hydrology. Therefore, impacts to anadromous fish passage related to gate operation should be reduced compared to Alternatives 1 and 2.

3. With SMSCG operation and 1995 Bay/Delta Plan outflow, objectives are very nearly met in all months at stations C-2, S-64 and S-49 in the eastern marsh and stations S-21 and S-42 in the western marsh. Objectives can not be met with 1995 Bay/Delta Plan outflow and SMSCG operation at stations S-35 and S-97.

4. Green Valley Creek flow augmentation is an effective means of controlling salinity in the northwestern marsh in the vicinity of S-97 under Alternatives 2 and 4. The Cordelia-Goodyear Ditch and the Goodyear Slough Tide Gates provide marginal benefits in the vicinity of S-35.

5. The frequency with which objectives are exceeded under Alternative 5 is midway between Alternatives 2 and 4. Many of the SMPA Amendment III management actions which are part of the alternative can not be modeled. Therefore, the modeling results understate the net benefit that may be expected from the alternative.

6. Alternative 6 meets objectives at all stations using Green Valley Creek flow augmentation as needed. The October augmentation rates range from a 73-year average of 205 cfs to maximum of 899 cfs. Flows greater than 150 cfs would be required in 6 percent of months during the simulated period. The difference in augmentation rates between Alternative 6 and Alternative 4 is the additional freshwater input required to dilute salinity at S-35. If the entire available capacity of the North Bay Aqueduct and the Putah-South Canal were used along with water stored in the City of Vallejo lakes (lakes Frey and Madigan), the maximum flow rates could not be achieved.

Significant environmental impacts may occur as a result of implementing certain of the above alternatives. Comments received from the USFWS and the NMFS on the DWR and USBR proposal to augment Green Valley Creek flow suggests that importing water from the Sacramento River may attract spawning salmon and delta smelt into areas of unsuitable habitat. Supplying augmentation flows by releases from the North Bay Aqueduct would result in additional pumping at Barker Slough and thereby potentially result in increased entrainment of delta smelt at the pump intakes. Introducing additional fresh water into the western marsh will reduce the salinity gradient now present in the area. The salt marsh harvest mouse and the California clapper rail, both terrestrial endangered species requiring saline marsh conditions for their continued survival, could be impacted by this additional freshwater input. Alternative 6 would be particularly detrimental in this regard. Alternatives 2 and 4 would also potentially impact these species, though to a lesser extent. There is no flow augmentation from sources outside the marsh in Alternatives 1, 3 and 5. Alternative 5, however, contains management actions proposed in SMPA Amendment III designed to provide equivalent protection to managed wetland areas. Therefore, Alternative 5 is the environmentally preferred alternative.

No significant impacts of implementing Alternative 5 are identified in this document. The final determination on this matter must await completion of the CEQA/NEPA process by the SMPA parties.

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