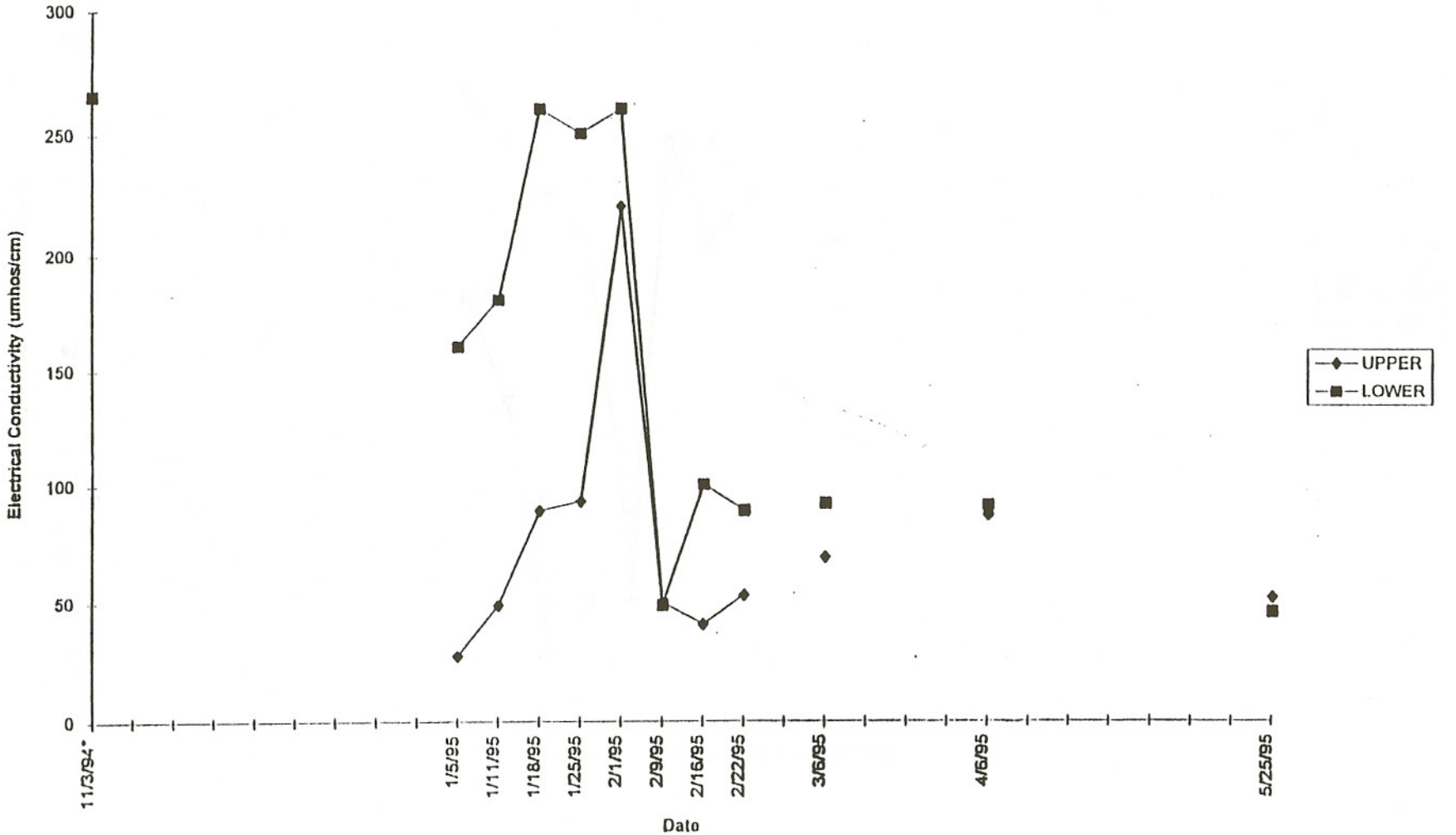
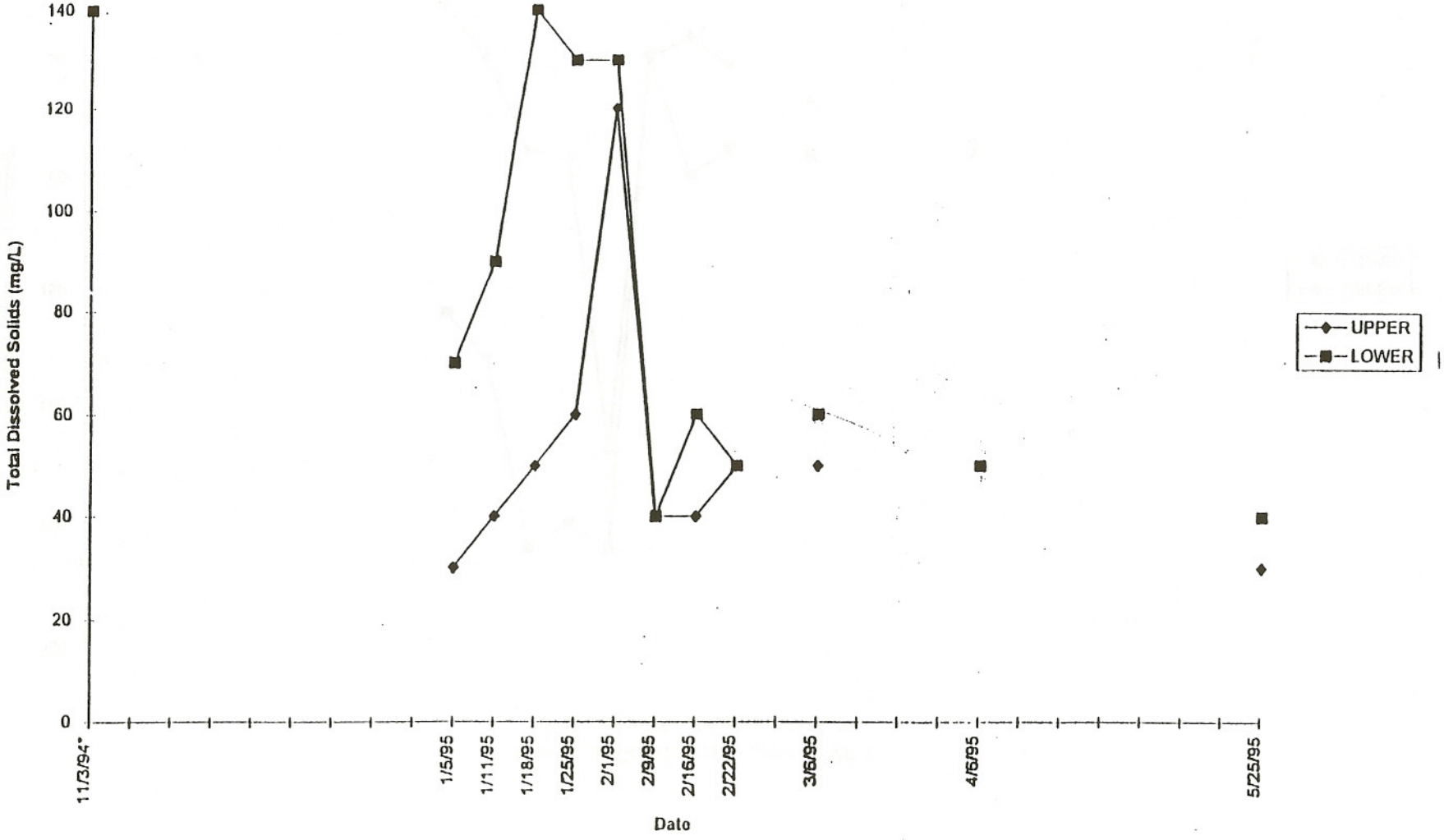
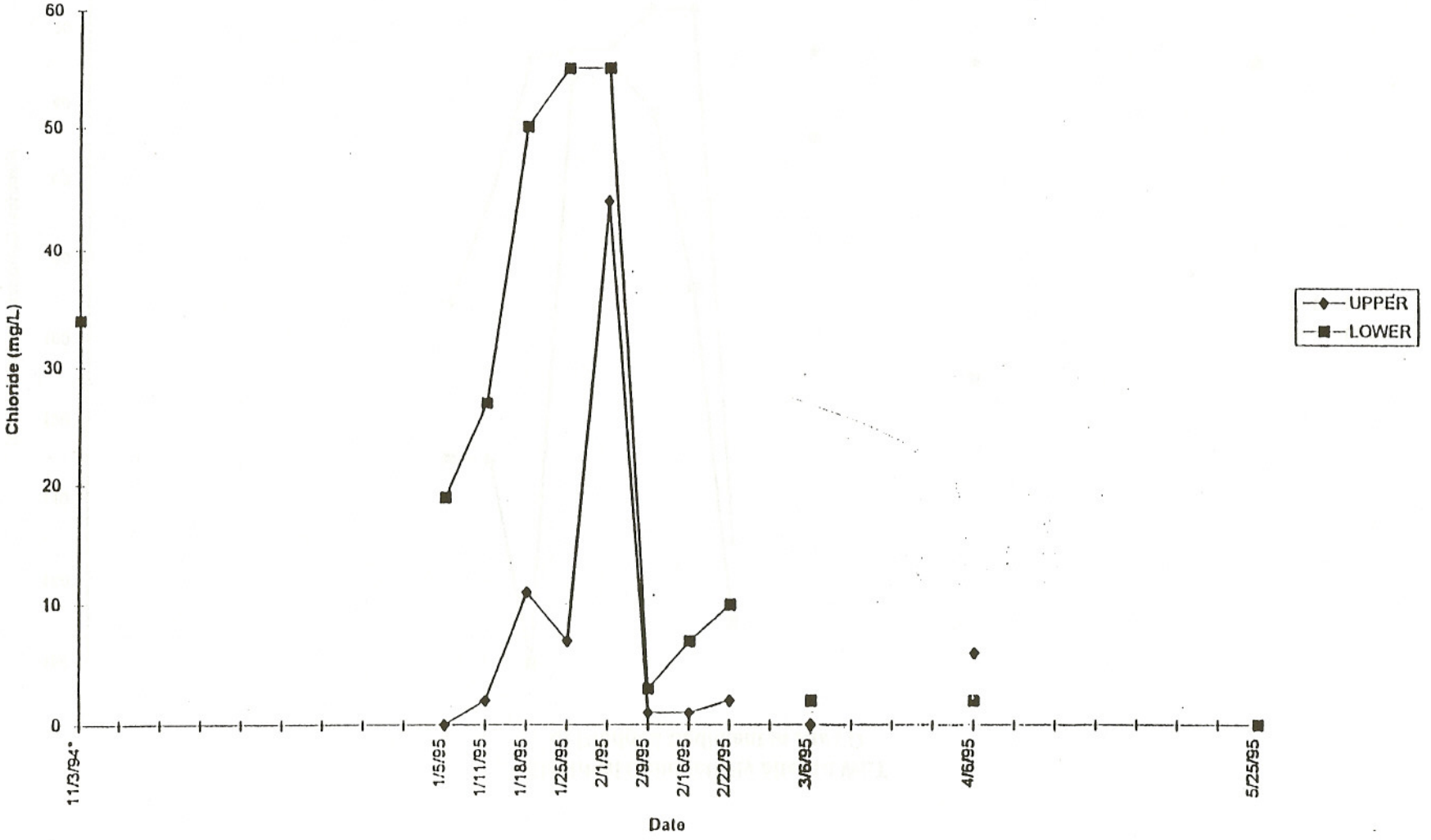
Electrical Conductivity after DI WET of Dredged Sediment in Area B

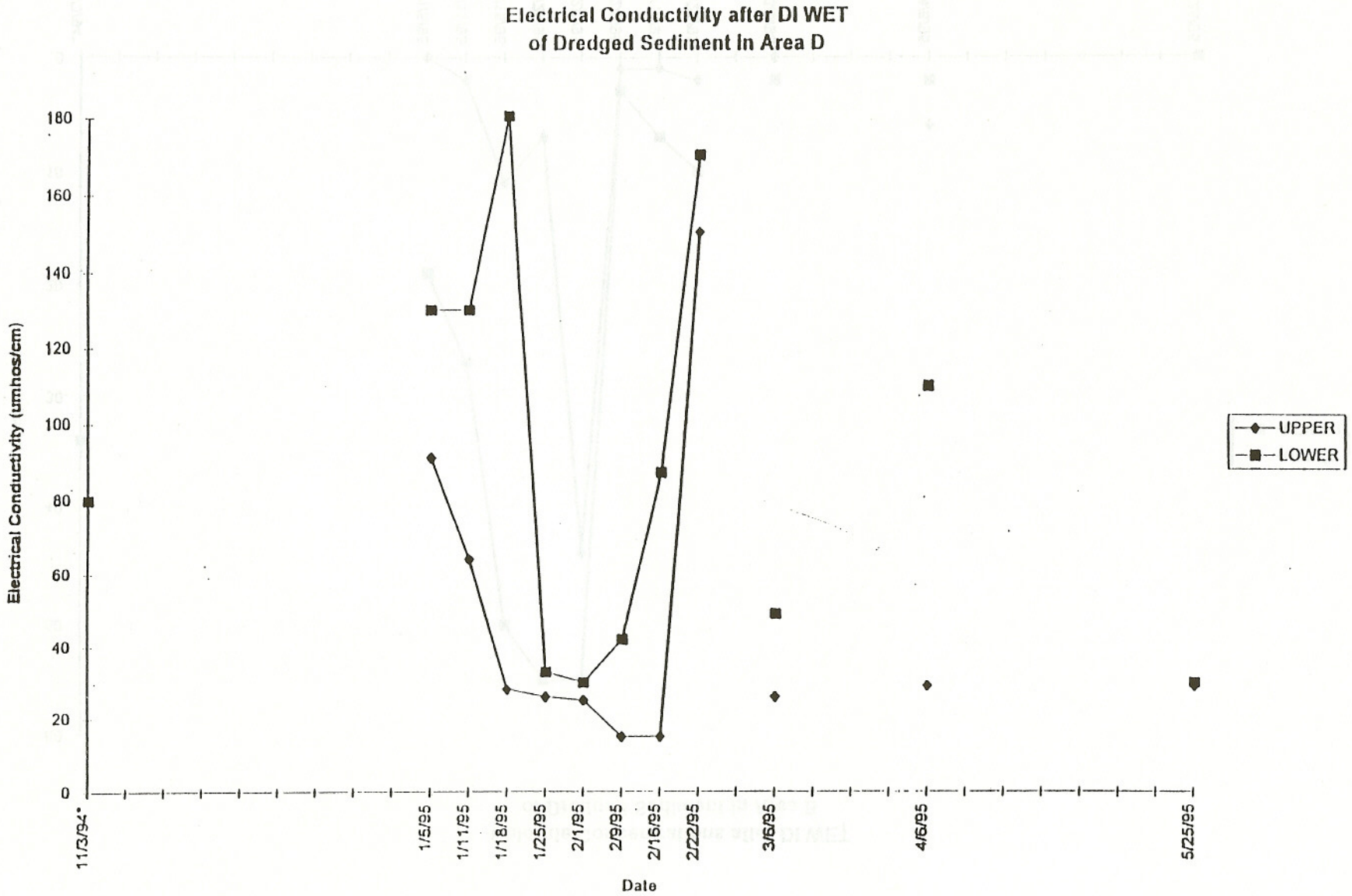


Total Dissolved Solids after DI WET of Dredged Sediment in Area B

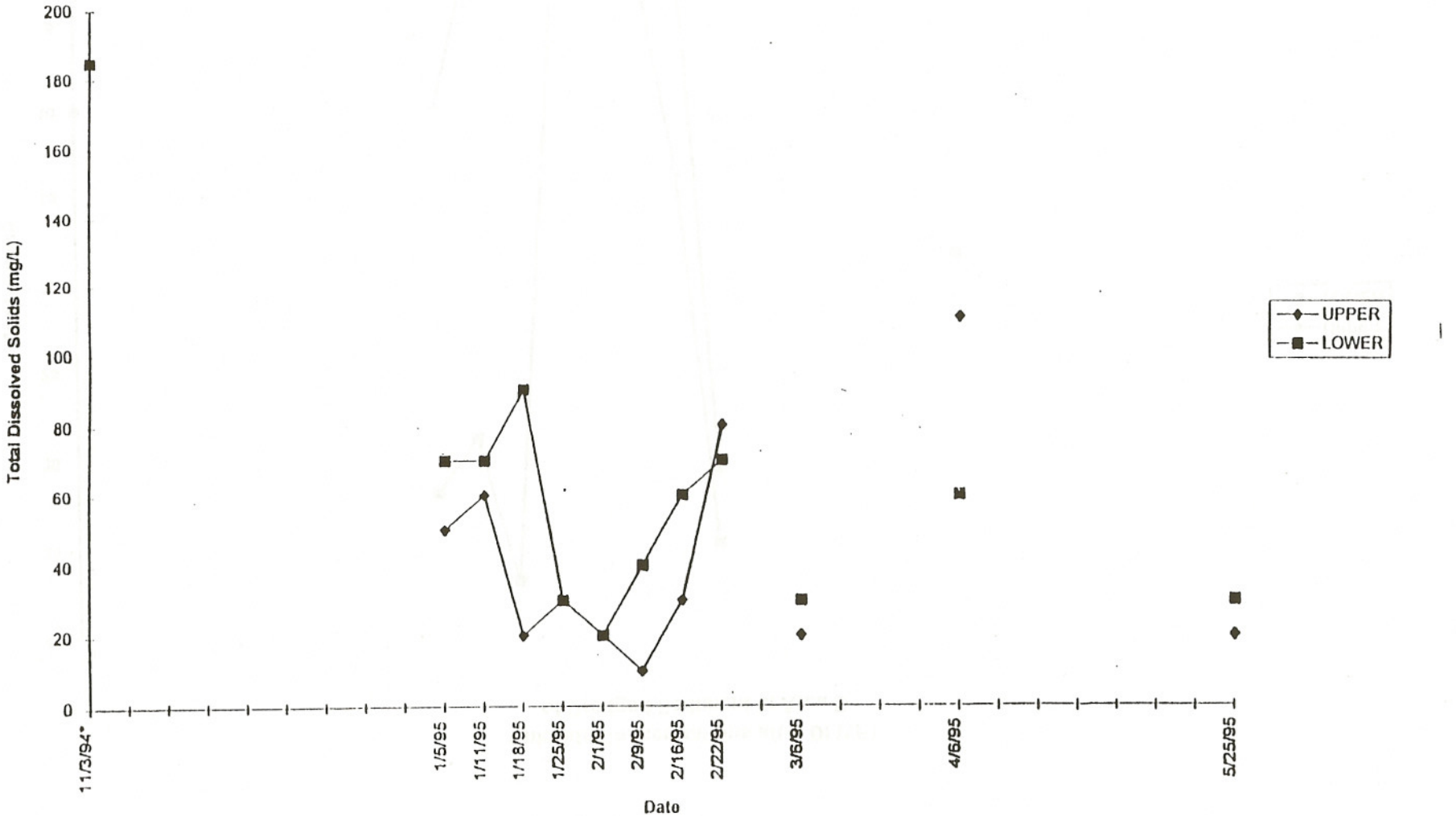


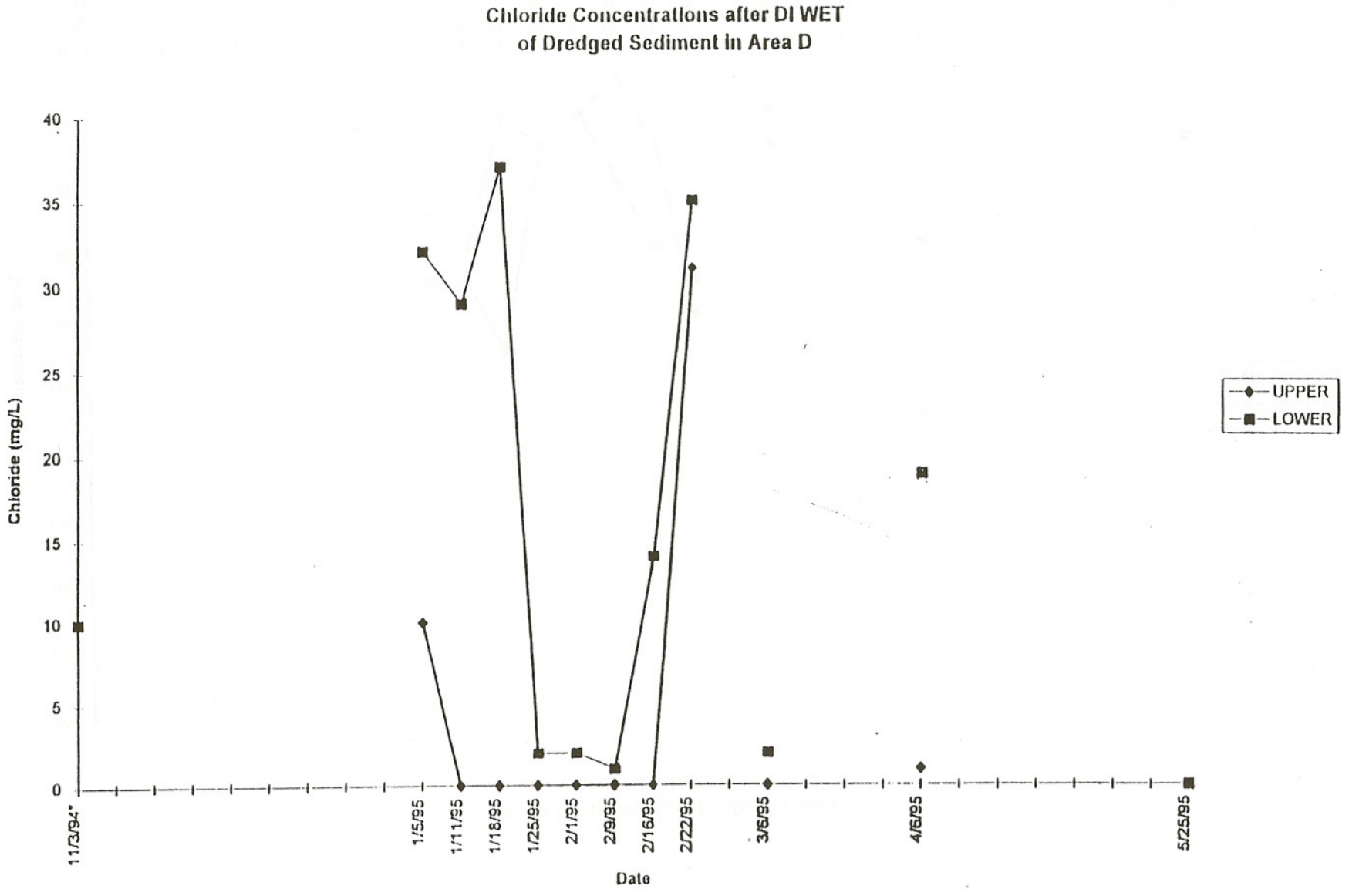
Chloride Concentrations after DI WET of Dredged Sediment in Area B




Electrical Conductivity after DI WET
of Dredged Sediment in Area D
Electrical Conductivity (umhos/cm)
180
160
140
120
100
80
60
40
20
0
11/3/94*
1/5/95
1/11/95
1/18/95
1/25/95
2/1/95
2/9/95
2/16/95
2/22/95
3/6/95
4/6/95
5/25/95
Date
UPPER
LOWER

Total Dissolved Solids after DI WET of Dredged Sediment in Area D




Chloride Concentrations after DI WET
of Dredged Sediment in Area D
Chloride (mg/L)
40
35
30
25
20
15
10
5
0
11/3/94*
1/5/95
1/11/95
1/18/95
1/25/95
2/1/95
2/9/95
2/16/95
2/22/95
3/6/95
4/6/95
5/25/95
Date
UPPER
LOWER

APPENDIX B

COMMENTS SUBMITTED FOR THE JERSEY ISLAND DEMONSTRATION PROJECT

SUBMITTED BY:
California Regional Water Quality Control Board, San Francisco Bay Region, Michael Carlin, Chief Planning Division, Dated March 26, 1996.

STATE OF CALIFORNIA
PETE WILSON, Governor

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
SAN FRANCISCO BAY REGION
2101 WEBSTER STREET, SUITE 500
OAKLAND, CA 94612

Phone: (510) 286-1255
FAX: (510) 286-1380

Rodrick A. Chishom, II
Chief, Planning Branch
U.S. Army Corps of Engineers
211 Main Street
San Francisco, CA 94105

March 26, 1996
File No. 1250.11

RE: Draft Lessons Learned Report for Jersey Island Demonstration Project, February 1996.

Dear Mr. Chisholm:

This letter is to inform you that the Regional Board staff has completed a review of the above document and are furnishing the following comments on the report. The report was submitted by the Corps to the Regional Board, pursuant to Regional Water Board Order Number 90-040, Waste Discharge Requirements (WDR) for discharge of dredged material to the San Francisco Bay. Specifically, provision 6. of the Order, and section III of the self-monitoring program require the Corps to prepare a lessons learned report for the Suisun Bay reuse project.

In general, we found the draft lessons learned report to be well written and feel that it will be a valuable document in dredge material disposal planning and regulation. The draft report is a good faith effort to respond to provision 6. of Order Number 90-040 and that the requirement will be fulfilled after the attached comments are satisfactorily addressed in a final report. Please furnish copies of the final report to staff of the San Francisco Bay and Central Valley Regional Water Quality Control Boards, the State Water Resources Control Board, the Bay Conservation and Development Commission and the US Environmental Protection Agency. Please contact Tom Gandesbery of my staff at (510) 286-0841, if you require more information.

Sincerely,

Michael Carlin, Chief
Planning Division

cc: Thompson Keesling, USACOE Construction Branch
Barney Opton, USACOE Project Management
Steve Goldbeck, BCDC
Erika Hoffman, USEPA
William Croyle, Central Valley RWQCB
James Sutton, SWRCB

COMMENTS

page/paragraph	Comment
1/ 2nd	References to organizations such as "regulatory agencies" should be specific. Describe who or what are constitute the "plethora of responsible agencies...". From the body of the report it would seem that the Corps' budgetary process is as much of a constraint on getting these projects completed as are other agencies (e.g. DWR). An MOU will only help a process if it is already achievable under existing processes and policies.
5/ Figure 2	Label figure.
8/ 4th	Why if nine firms were issued "solicitations for bid" did only one firm actually bid on the job? Is there a lack of competition for dredging activities in the region?
13 / Table A.	A fifth column should be inserted which provides a per-cubic yard figure for each year (column 4/column 3).
15/ 1st	2nd sentence suggest: replace "...is often enough to..." with **can.**
16/3rd	1st sentence: word missing after "time frame"
19/ 2nd	Suggest defining "flagged" and then dropping quotes. Also, 4th line down: is "determination" the same as delineation"?
21/ bottom	A concluding statement seems to be missing from this section. In general, how was the water quality? Were the results inconclusive? Were they what people expected? Chapter 5 ends with a statement about detection limits.
22/ 1item	Is this a major problem (lack of competition)? Is this a common phenomenon in the Bay Area?
22/ 3rd item	How should future projects handle the shallowness of certain access points? How many other "DWR islands" have this problem? Can the material be off-hauled at one point and moved by truck down the levee to areas that are not accessible by barge? How many more miles of levee remain to be bolstered on Jersey Island?

25/ item 24 — missing data on 4th line.

25/ item 29 — What is this statement based upon? Were there inter-agency meetings with FWS, NMFS? We know that BCDC, DWR the RWQCB's and the COE were in approval of the project as planned, but how did those agencies and the resource agencies as well, come to the conclusion that this project was a "success"? (This report should be one major way to convey that message).

26/ 3rd — fifth line down: "DWR will soon own 90%" :....of what? the island, the levees?.

26/ 3rd — We gather that DWR does not have funding authority to assist on the islands listed here? Are these islands in the "delta" or more in Suisun Bay?

26/ 5th — This overlaps with our comment regarding the executive summary. How can agencies give the Corps any more "lead time" if the project is dredged annually?

26/ 7th — Replace "revisited" with a more specific term. Revised, reassessed, re-issued, etc.

26/ 8th — Is the "environmental master plan" a CEQA document? Isn't the Delta Protection Commission or Cal-Fed putting together a "programmatic EIS/EIR" for delta projects?

27/ 1st — Isn't there already an assessment district in Contra Costa county, especially as it relates to the JF Baldwin deepening project?

27/2nd — Provide some more discussion and detail on the content of the proposed MOU.

Appendix A — The Waste Discharge Requirements (WDR) are <u>not</u> included in this appendix, despite the title of the appendix. Please correct this. The first page appears to be a summary of the WDR's prepared by DWR.

A-1, under <u>Dredged Sediment</u> , define what is meant by "specified concentrations" and "designated". There are no references here to the actual WDR's or the regulations.

/coe/wrdprv6

APPENDIX C
RESPONSE TO COMMENTS
THE JERSEY ISLAND DEMONSTRATION PROJECT

California Regional Water Quality Control Board, San Francisco Bay Region, Michael Carlin, Chief Planning Division, Dated March 26, 1996.

Page 1.para. 2	The sentence was revised. Refer to Table A and Section 4.0 for additional information on budgetary process.
Page 5.Figure 2	The figure has been labeled.
Page 8.para. 4	The firms solicited for bids did not proved information concerning lack of response. A possible reason was that the project implementation process required a quick turn around. Also, dredging firms are busy throughout the Western United States which may impact local competition.
Page 13.Table A	A cost per unit column was added.
Page 15.para. 1	Revised as suggested.
Page 16.para. 3	Sentence revised.
Page 19.para. 2	"Flagged" was the process used to delineate the areas in which dredged material was deposited.
Page 21.para.6	A clarifying sentence was added. Conclusions are given in Section 6.
Page 22.item 1	See third response, above, regarding lack of competition.
Page 22.item 3	Additional information was added, regarding accessibility constraints. An inventory of potential repair sites is beyond the scope of this report. Levee repair sites will be identified by a per project basis or as part of a comprehensive plan for dredge disposal, i.e.: Long Term Management Strategy (LTMS).
Page 25.item 24	Information provided.
Page 25.item 29	Statement was revised to reflect available information. The coordination of these agencies is beyond the scope of this report.

Page 26.para. 3	The reference to "DWR will soon own 90%" was deleted.
Page 26.para. 3	DWR may be a future player in dredged material disposal. The island are identified on Figure 1 and Figure 2.
Page 25.para. 5	Statement was rewritten to define possible coordination option to help expedite the implementation process.
Page 26.para. 7	Sentence was revised as suggested.
Page 26.para. 8	It is anticipated that the Long Term Management Strategy (LTMS) will fulfill this need. The LTMS has been developed and reviewed by the different regulatory agencies in the Bay Area.
Page 27.para. 1	The financial return from existing assessment districts is allocated to other purposes.
Page 27.para. 2	Information provided
Appendix A	The word "Summary" was added to the title and a footnote was added, directing users to DWR for additional information.

The Sonoma Baylands Wetland Demonstration Project:
(1) Project Description
(2) Annual Monitoring Report 1997 – Executive Summary
(3) An Adaptive Response Program for Insuring the Evolution of a Vegetated Marsh at Sonoma Baylands (Philip Williams & Associates, 5/20/98)

Sonoma Baylands Wetland Demonstration Project

May 1997

Project History

The Sonoma Baylands project was conceived and planned by the California State Coastal Conservancy, a government agency, and the Sonoma Land Trust, a non-government organization. Using funds provided by the Coastal Conservancy, the Land Trust acquired the project site and completed a restoration plan in 1991. The restoration plan identified the use of dredged material as the best means of restoring tidal salt marsh habitat on the project site.

After the restoration plan was completed, the Coastal Conservancy, Port of Oakland, and local environmental groups began a cooperative effort to encourage the use of dredged material from the deepening of Oakland Harbor to construct the Sonoma Baylands project. The project proponents actively organized political support for the Sonoma Baylands project among maritime industries, fishermen, and civic and labor interests. As a result of those efforts, Congress directed the Corps of Engineers to construct the Sonoma Baylands Wetland Demonstration Project in Section 106 of the Water Resources Development Act of 1992. The Corps of Engineers began detailed design of the project in June 1993. Construction of the project began in June 1994 and is approaching completion.

The Coastal Conservancy is contributing 25 percent of the estimated $7.6 million construction cost, which includes the additional costs of transporting Oakland Harbor dredged material to the Sonoma Baylands site in lieu of ocean disposal.

Project Description

Location. The project is located on 348 acres of diked lands in southwestern Sonoma County, California. The project site is on the northern shoreline of San Pablo Bay (the northern arm of the San Francisco Bay system), east of the mouth of the Petaluma River. Prior to the start of project construction, the site was used to grow oat hay.

Design Concept. The design of the Sonoma Baylands project incorporates experience gained from past tidal marsh restoration projects in San Francisco Bay. Rather than attempting to construct an "instant marsh," the project is designed to allow a tidal marsh system to naturally develop over a relatively short period of time while minimizing construction costs. Dredged material is being used to accelerate the re-establishment of intertidal marsh elevations on diked lands that had subsided about six feet. The final surface of the restored marsh, including the tidal channel system, will be created by the natural deposition of suspended sediment after the site is restored to tidal action.

Site Preparation. The most prominent physical feature of the project is a new 11,600-foot levee along the landward periphery of the restoration area. The existing bayfront levee will be breached to restore the site to tidal action. A new peripheral levee was therefore required to replace the tidal flood protection provided by the existing bayfront levee to the contiguous low-lying lands. The new levee confines the dredged material that has been placed in the 289-acre interior of the restoration area. The lower portion of the bayward levee was constructed at a slope of 1 vertical on 5 horizontal. A slope flatter than that required for levee stability was used to provide a wider wetland-to-upland transition zone and to reduce erosion of the levee by wind-waves.

The project also includes an interior levee on the western portion of the project site. The main purpose of the interior levee is to provide maintenance access to two high voltage electrical transmission line towers. Additional bracing and concrete footings were added to a total of three towers to allow the placement of fills around the bases of the towers. The interior levee also divides the restoration site into two functionally independent areas: the 39-acre pilot unit on the west side of the interior levee, and the 309-acre main unit on the east side of the interior levee.

The project includes a series of low interior berms ("peninsulas") extending throughout most of the marsh restoration area. The main purpose of the peninsulas is to limit the length of wind-wave fetches across the site to 1,000 feet or less. The peninsulas are also intended to direct the formation of major tidal channels away from the toe of the peripheral levee. The peninsulas were designed with a sinuous, branched pattern to mimic tidal marsh channels primarily for aesthetics. Due to concerns regarding potential use of the peninsulas by mammalian

predators, the peninsulas are designed to subside and erode as the marsh develops. It is expected that the peninsulas will remain slightly elevated above the surrounding marsh plain, providing substrate for more diverse vegetation. To further reduce use of the peninsulas as pathways into the restored wetland by mammalian predators, a gap will be created between the levees and each of the longer peninsulas prior to the restoration of tidal action.

The levees and peninsulas were constructed using only material excavated from within the restoration area. About three feet of surface material were excavated throughout most of the restoration area to provide the construction material. As a result, portions of the restoration area were more than seven feet below sea level prior to the placement of dredged material.

Dredged Material. The design elevation for the dredged material fill, after initial consolidation, is two feet above the National Geodetic Vertical Datum of 1929 (NGVD, which is approximately mean sea level). Previous local marsh restoration projects using dredged material have demonstrated that tidal channel development is greatly enhanced if dredged material is placed to an elevation below the ultimate marsh elevation. A complex, sinuous channel system will then evolve as additional sediment is gradually deposited over the dredged material by natural processes. In the case of the Sonoma Baylands project, the restoration area is expected to reach an equilibrium elevation of about +3.4 feet NGVD, based on the elevation of the adjacent natural marsh.

The pilot unit was filled with 207,000 cubic yards of maintenance-dredged material from the Petaluma River navigation channel during October-November 1994. The material was pumped into the site by a small hopper dredge. The pilot unit was opened to tidal action by excavating a breach in the bayfront levee in late January 1996.

The main unit was filled with 1.7 million cubic yards of dredged material from the deepening of Oakland Harbor during May-November 1995. Dredged material was transported to the mouth of the Petaluma River in 994 barge loads and then pumped into the site by a specially-constructed hydraulic unloader. The main unit was restored to tidal action by breaching the bayfront levee on October 25, 1996.

The elevation of the dredged material fill is critical to the success of the project. As dredged material was placed in the site, the elevation and density of the material was monitored using 21 electrical resistivity staffs. Even distribution of the dredged material throughout the site was achieved by moving the pipeline discharge point as necessary. Minor grading was required to remove small mounds of coarse-grain material at some of the discharge points.

Completion of Project. No planting of marsh vegetation is proposed as part of the Sonoma Baylands project. Surveys of previously restored San Francisco Bay tidal salt marshes found that the vegetation structures of the marshes were similar regardless of whether the sites were planted or allowed to revegetate naturally. The adjacent existing marsh will provide abundant propagules for the establishment of vegetation within the Sonoma Baylands site. It was therefore concluded that planting of marsh vegetation would not significantly accelerate the restoration of vegetated marsh and would not be cost-effective. The dominant plant species are expected to be pickleweed (Salicornia spp.) and Pacific cordgrass (Spartina foliosa).

The authorized project includes monitoring of the development of the restored marsh. Current monitoring activities include tidal hydrology, sediment deposition, fish and bird use, vegetation and benthic colonization, water quality, and tidal channel morphology. The first annual monitoring report was distributed in August 1996. The project authorization also includes provisions for remediation if the monitoring results indicate a need for corrective action.

Project Benefits

Approximately 82 percent of the original tidal wetlands of San Francisco Bay have been diked or filled. The Sonoma Baylands project will restore 289 acres of high value tidal salt marsh habitat. An additional 48 acres of active agricultural land on the periphery of the project will be converted to grassland and transitional wetland habitat.

The project is designed to provide habitat for two endangered species: the salt marsh harvest mouse, which exists only in San Francisco Bay, and the California clapper rail, a marsh bird that breeds primarily in the Bay. A large number of other wildlife species, including migratory waterbirds and anadromous fish, will also benefit from the project.

For additional information, contact:

Scott Miner, Ecologist, Planning Branch (CESPN-PE-P), U.S. Army Engineer District, San Francisco
333 Market Street, San Francisco, CA 94105-2197
(415) 977-8552 sminer@smtp.spd.usace.army.mil

Sonoma Baylands Wetland Demonstration Project

May 1997

Project History

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SONOMA BAYLANDS
WETLAND DEMONSTRATION PROJECT

ANNUAL MONITORING REPORT
1997

Prepared by
U.S. Army Corps of Engineers
San Francisco District
333 Market Street
San Francisco, California

In cooperation with
California State Coastal Conservancy
1330 Broadway, Suite 1100
Oakland, California

October 1997

Executive Summary

This report provides monitoring results for the period of May 1996 through February 1997 in accordance with the approved monitoring plan dated October 1996. Some results of monitoring prior to May 1996 and subsequent to February 1997 have also been included in this report to provide more complete results. For a complete record of monitoring data prior to April 1996, refer to the Annual Monitoring Report for 1996.

The monitoring results to date indicate the following:

Tidal exchange between the Bay and both the Pilot and Main Units is continuing to develop. Erosion of the connecting channels between the Bay and both Units is occurring, as is necessary to establish a fully tidal marsh system. Tidal circulation and mixing in the Pilot and Main Units appear to be adequate to maintain good water quality.

The dredged material fill elevations in the Pilot Unit are within the maximum allowable elevation of +2.9 ft. NGVD, as defined by the project design. Approximately 1.8 percent of the Main Unit fill area has remained above the maximum design elevation after consolidation and regrading. The high areas were caused by the mounding of coarse-grained material at some of the dredged material discharge points adjacent to perimeter levees in the Main Unit. With minor exceptions, the high areas are less than one foot above the maximum design elevation.

Marsh vegetation is continuing to colonize the perimeters and the higher elevation areas within both the Pilot and Main Units. Eleven species of estuarine and brackish-water tolerant fish were found in the Main Unit during the report period. As was found in the Pilot Unit last year, fall-run chinook salmon smolts appeared to use the Main Unit for temporary rearing during winter in their gradual passage from spawning areas to the ocean. In addition, the Pilot and Main Units supported large numbers of waterbirds during the report period. The Main Unit supported higher mean densities of shorebirds, waterfowl, and other waterbirds than the tidal flats reference area. The Pilot Unit supported a higher mean density of waterfowl, but lower densities of shorebirds and other waterbirds than the tidal flats reference area.

As discussed in the 1996 monitoring report, the Pilot Unit has met the three success criteria specified in the monitoring plan that were applicable during the first year following the restoration of tidal action to the Pilot Unit. Those three criteria concern initial fill elevations, initial erosion of the exterior tidal channel, and initial establishment of marsh vegetation. Based on the findings in this report, the Main Unit has met three of the four success criteria that are applicable during the first year following the restoration of tidal action to the Main Unit. Those three criteria concern chemical constituents, initial erosion of the exterior tidal channel, and initial establishment of marsh vegetation. The fourth applicable criterion, concerning initial fill elevations, has not been met for the Main Unit. In accordance with the monitoring plan, the Corps of Engineers has initiated a remediation investigation to determine whether there is a need for further corrective action regarding the initial fill elevations.

PWA
PHILIP WILLIAMS & ASSOCIATES
CONSULTANTS IN HYDROLOGY

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AN ADAPTIVE RESPONSE PROGRAM FOR INSURING THE EVOLUTION OF A VEGETATED MARSH AT SONOMA BAYLANDS

Prepared for

California State Coastal Conservancy

Prepared by

Philip B. Williams, Ph.D., P.E.
President

and

Jennifer Fox
Hydrologist

May 20, 1998

PWA Ref. No. 1154

TABLE OF CONTENTS

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1. PURPOSE OF THE REPORT

The design of the 289-acre Sonoma Baylands restoration project was intended to establish vegetated tidal wetland functions as rapidly as possible after breaching the levees. For this reason bay mud dredged material was placed on the subsided site to accelerate the evolution to intertidal mudflats that can be colonized by cordgrass (*Spartina foliosa*). Originally, the site was to have been connected to San Pablo Bay by a 1000-foot channel excavated across the outboard marsh to insure full tidal range in the site immediately after breaching. Later in the design process it was determined that the construction of such a channel would disturb endangered clapper rail that inhabited the channels in the outboard marsh. Accordingly, the design was changed to utilize existing small tidal channels across the outboard marsh and allow for their natural erosion by the increased tidal flow after the levees were breached. Based on experience with other restoration projects, it was estimated that it would take approximately four years for these channels to erode sufficiency to achieve adequate tidal range within the site (COE, 1994). An Army Corps of Engineers (COE) monitoring plan was designed and implemented after breaching in 1996 to track the rates of evolution of wetland functions on the site.

In 1997, concerns were raised by an environmental group and regulatory agencies that the wetland was not evolving rapidly enough. This was because to date most of the site has remained shallow subtidal habitat that precludes the extensive colonization of mudflats by cordgrass. Accordingly at an interagency meeting held in December 1997 the California Coastal Conservancy agreed to retain Philip Williams and Associates, Ltd. (PWA) to undertake an analysis of the monitoring data to determine if the site was evolving as intended, and to identify a potential remedial program to accelerate vegetation colonization if desired. This report describes our findings.

2. HOW THE SONOMA BAYLANDS PROJECT HAS EVOLVED TO MARCH 1998

2.1 THE PILOT UNIT

The 29-acre Pilot Unit was intended to be filled with dredged bay mud to a maximum design elevation of 2.0 feet NGVD. In fact, most of the site had elevations of between 0.3 feet and 1.05 feet NGVD at the time of breaching on January 24, 1996. Tidal action was introduced from the San Pablo Bay through an existing 1800-foot long channel (Figure 1). The upstream reach of this tidal channel was the silted in borrow ditch that ran along the outboard side of the former agricultural levee. The downstream section is the silted in former dredged channel to an abandoned marina. Between these two sections the channel cuts across fill placed for the old marina and receives intermittent discharges from a pump station draining more almost 2000 acres of agricultural land to the north. At the time of breaching the channel was typically about 10 feet wide and 4 feet deep.

Since tidal action was restored to the site the diurnal tidal amplitudes within the site have progressively increased and the minimum tide level has gradually been lowering. Figures 2 and 3 illustrate how the equinox neap tides (the tides whose amplitudes are at their minimum) have increased over 18 months and now typically have about a range of about half a foot. Similarly the tidal amplitude of spring tides have increased with ranges typically to about 1.5 feet as compared to half a foot immediately after breaching. Data for the spring equinox of 1998 shows much larger ranges but is misleading because of El Niño sea level rise and storm surges.

Although the lowest tides now drain to about +1.3 feet this is not low enough to expose significant areas of mudflats. In the 26-month period since the site was breached, some estuarine sedimentation has occurred. Maximum rates of sedimentation would have been limited by the initial small tidal exchange to about 0.1 to 0.2 feet/year, increasing as the tidal range increased. However, the measurements of sedimentation using permanently installed resistivity meters do not appear to be sufficiently accurate to demonstrate clear trends beyond the error band of about 0.5 feet.

Starting in September 1997, detailed elevation transects were surveyed. Figures 4, 5 and 6 show representative transects across the site in September 1997 and March 1998. These transects show the changes that occurred over the Winter of 1997-1998 and indicate a small amount of accretion in the interior of the site where it is protected by wave action by peninsulas that were designed for this purpose, and about 0.2 feet of erosion in the outer part of the site where it was exposed to breaking waves from San Pablo Bay. Because of El Niño conditions during this winter several high tide storm surges of up to 7.6 feet NGVD

occurred. With up to 4 feet water depths over the outboard marsh, wave action during southeast storms in areas not protected by peninsulas would have been appreciable, causing resuspension of deposited sediments.

As of March 1998 low tides in the Pilot Unit will need to drain lower by approximately 1 foot in order to expose significant areas of mudflat to allow for vegetation colonization. At present after two growing seasons two isolated patches of cordgrass have established themselves on the interior perimeter of the Pilot Unit at an elevation of about +2 feet.

The rate of erosion of the outboard slough channel is the controlling factor on the rate lowering of the minimum tide level in the Pilot Unit. With the increase in tidal prism at the end of the slough after the levee was breached the channel started eroding in the same pattern as observed in other restored marshes. First scouring deepens the channel causing the banks to fail in large slump blocks that slowly slide downwards until they erode away, significantly widening the channel and increasing its hydraulic conveyance. Figures 7, 8, and 9 show cross section views of the slough channel and demonstrate this slumping and erosion process is occurring on the Pilot Unit channel.

The main constraint on the level of the minimum tide level is the "thalweg" or bed elevation of the channel. Figure 10 shows a longitudinal profile of the bed elevations along the Pilot Unit slough channel illustrating how the channel has deepened—typically about 1.5 feet after two years. However this profile also shows an anomaly in the pattern of erosion. There is a more erosion resistant "sill" in the bed of the channel where it passes through the area of fill adjacent to the pump station discharge point. In the two years since the breach, the highest point of this sill has eroded only approximately 0.3 feet, significantly restricting low tide drainage of the Pilot Unit.

The increasing trend in depth and channel cross sectional area for the Pilot Unit channel is shown in Figures 11 and 12.

2.2 THE MAIN UNIT

The 260-acre Main Unit was filled with bay mud dredged material to typical elevations of between +1.0 to 1.5 feet NGVD, and was breached on October 25 1996 (Table 1). Tidal flows enter the unit through a 1000-foot long small natural slough channel that flows directly to San Pablo Bay across the outboard marsh. Because of the large tidal prism of the site relative to the small size of this channel, water level fluctuations have been governed by the 14-day spring-neap cycle and amount to about a 1.5 feet range (Figure 13). Diurnal tidal fluctuations are very muted and amount to about 0.1 feet in spring tides and nearly zero during

neaps. Because of the short period of monitoring, 15 months, and the El Niño high water levels it is not yet possible to discern any trends in the tidal amplitudes.

The minimum tide level the site drained down to prior to the El Niño high water levels was +1.8 feet NGVD. This is insufficient to expose extensive areas of mudflat. So far, the small tidal range is insufficient to permit significant amounts of estuarine sedimentation. Monitoring of mudflat transects appears to indicate that the strong wave action and high tide levels encountered in the Winter of 1997-1998 caused up to 0.3 feet of erosion of mudflats in areas not protected by peninsulas, with re-suspended material probably being deposited in sheltered areas (Figures 14 and 15).

As of March 1998, the Main Unit will need to drain about a foot lower at low tide to expose large areas of mudflat for vegetation colonization. At present, pickleweed has colonized scattered portions of the perimeter areas between +2 and +4 feet elevation.

As with the Pilot Unit, the rate of evolution is determined by the rate of erosion of the tidal slough channel leading to the site. Over the last 15 months the same pattern of erosion described for the Pilot Unit channel is observed for the Main Unit channel (Figures 16, 17, and 18). The cross sectional area and hydraulic conveyance of the channel is progressively increasing as shown in Figure 19. Similarly, the bed of the channel is progressively scouring as shown in Figures 20 and 21. Unlike the Pilot Unit channel however, there is no evidence of any less erodible sill retarding the deepening of the channel. In 15 months the bed has lowered about 1.5 feet and its maximum elevation is now -0.7 feet NGVD.

3. PROJECTING THE FUTURE RATE OF EVOLUTION

3.1 THE EXPECTED PATTERN OF TIDAL CHANNEL EVOLUTION

The form or "hydraulic geometry" of estuarine tidal slough channels is largely determined by an equilibrium with the tidal prism—the tidal volume that ebbs and floods in and out of the channel. If the tidal prism is artificially increased in a restoration project like the Sonoma Baylands, the channel will erode; conversely if it is reduced, the channel silts in. This equilibrium has been plotted using field data for many San Francisco Bay marshes (Figures 22 and 23). Because they are out of balance with their tidal prisms, both the Main and Pilot Unit slough channels will continue to deepen and widen. As they grow larger, their hydraulic conveyance increases allowing a greater tidal range within the site. This in turn increases the effective or actual tidal prism scouring the channel, increasing the rate of erosion. This positive feedback mechanism continues until the site drains completely at low tide and the channel dimensions reach an equilibrium with the scouring power of the full or "potential" tidal prism ebbing and flooding from the site.

At first, and currently at the Sonoma Baylands, this tidal prism is larger than occurs in natural marshes because the typical elevation of the placed dredged material is considerably lower than the natural marshplain of about MHHW or +3.5 feet. However, as the tidal range increases, more estuarine sediment is brought in on the tide and deposited as vegetation colonizes the mudflats and creates a new marshplain. This process progressively reduces the tidal prism to a value similar for a natural tidal marsh. Consequently, the channel over time will become smaller again approaching the dimensions of a natural slough channel.

In Table 2, we show a comparison between the actual and predicted equilibrium geometry of the Sonoma Baylands tidal channels and compare them with the evolution of two other evolving channels we have measured at Greenpoint Marsh on the Petaluma River and the Warm Springs Marsh in the South Bay.

In five years the 1,000-foot long Greenpoint marsh channel evolved from a small ditch to close to its equilibrium geometry. Over the last seven years it has stabilized and appears to becoming shallower as the marsh plain forms (Figure 24).

The 300-foot long Warm Springs marsh North Breach channel progressively enlarged from a small 3-foot wide channel at breaching in 1986 to a 12-foot wide and 4 feet deep channel in the Spring of 1990. Then over six months in 1990, rapid erosion occurred increasing the size of the channel to 38-foot wide and 8-foot deep (Abbe, et al., 1991). Figure 25 shows the pace of this rapid erosion.

3.2 PROJECTING THE EVOLUTION OF TIDAL RANGES AT SONOMA BAYLANDS

In order to predict how long it will take for the tidal slough channels to erode large enough to drain the mudflats at low tide, we linearly extrapolated observed rates of erosion into the future, and then modeled the eroded channels hydraulic conveyance for typical spring- neap tides using a simple hydrodynamic model MPOND. The model was calibrated on observed Pilot Unit tidal data. This method is conservative—probably over- predicting the time frame for evolution as it does not recognize the potential positive feedback mechanism that can accelerate erosion of the channel as the actual tidal prism increases.

The main impediment to more effective drainage of the Pilot Unit is the continued presence of a more erosion resistant sill near the pump station discharge point. Upstream and downstream of this point the channel has downcut to at least -2 feet NGVD. Assuming this sill is removed (or eroded out) in 1998 our modeling results project full exposure of the Pilot Unit mudflats, by the Summer of 1999. Figures 26 and 27 show the projected channel depths and cross sectional areas based on continuation of present trends. Figure 28 shows the projected increase in tidal range based on MPOND modeling results.

Assuming linear increases in channel depth and cross sectional area, we project increased drainage of the Main Unit and exposure of mudflats by the Summer of 2000 (Figures 29-31).

Essentially this means that the decision not to excavate the outboard channels has retarded the evolution of the Sonoma Baylands towards a vegetated marsh by three to four years. Nevertheless, it should be noted that monitoring has shown that during this transition period when most of the site is shallow subtidal, monitoring has shown other valuable wetland functions are provided, including habitat for waterfowl and juvenile salmonids (COE, 1997).

Once mudflats are exposed by the diurnal tide the process of vegetation colonization can begin. Monitoring of the nearby restored Carls Marsh that has unrestricted tidal action shows initial perimeter colonization at about +1.7 feet NGVD in the second year followed by expansion to lower elevations down to mean tide level. After four growing seasons independent colonization of interior mudflats has started to occur (Stuart Siegel 1998, personal communication).

4. POTENTIAL REMEDIAL PROGRAM

4.1 PILOT UNIT

Monitoring of the slough channel has shown that the presence of a more erosion resistant sill in the bed of the channel near the pump discharge point has retarded the rate at which the tidal range is increasing in the Pilot Unit. Although this sill is gradually eroding, it appears that it will take about another two years to scour out completely. It may take even longer if the pump continues to discharge sediment into the channel. In a March 1998 survey of the channel, we observed higher channel elevations due to gravel and rocks near pump discharge point.

Removal of this sill to accelerate evolution is simple and could be accomplished by equipment working from the remnant agricultural levee. It would require excavation of an average of approximately one foot of mud from a 6-foot width of the channel bed over approximately 200 feet to an elevation of -2.0 feet. Approximately 44 cy of mud could be spread on the top of the adjacent Sonoma Baylands levee.

With removal of this sill we anticipate that exposure of the mudflats by the diurnal low tide will occur by the Summer of 1999. Once this occurs we anticipate colonization of mudflats within a further four years based on observations from the adjacent Carls marsh.

We therefore recommend that in September 1998, at the end of the clapper rail breeding season, any section of channel bed that has not eroded to -2.0 NGVD be excavated. This will require another channel survey to be carried out at this time to locate and tag the specific section to be deepened.

4.2 MAIN UNIT

Monitoring slough channel erosion rates and modeling the hydraulics indicates that with continuation of the current rates of erosion, significant diurnal mudflat exposure will occur by the Summer of the year 2000. Unlike the Pilot Unit, there is no evidence of any impediment to erosion of this channel and we expect that erosion rates will accelerate. Nevertheless, there are uncertainties in our prediction. If for some undiscovered reason the channel were to stop eroding, or if wind wave erosion were to erode and export sediment from the site significantly lowering mudflat elevations , or if the tidal hydraulics was substantially different than predicted, the evolution of the site could be retarded beyond that predicted.

If continued monitoring and re-analysis of the hydraulics indicate an unacceptable time frame for evolution by natural erosion of the existing channel, a new channel can be excavated. The best location for this channel would be approximately 1500 feet to the east where the outboard marsh is narrowest. Excavation of a new channel would minimize habitat disruption along the existing channel and can be accomplished by excavating from the bayward edge on a temporary haul road. The channel would be excavated to the expected ultimate equilibrium hydraulic geometry of the marsh. Practically, this would be a channel 12 feet deep (approximately -8.5 feet NGVD) with 30 feet bottom width and side slopes at the initial angle of repose of 3:1. This cross section is undersized for the current tidal prism but we would anticipate considerable bank slumping and erosion increasing the channel cross section. Approximately 22,000 cubic yards of mud would have to be removed. The location for disposing this material would have to be investigated further.

5. REFERENCES

Abbe, Tim, and Phyllis Faber, 1991, San Francisco Bay Monitoring Study - Annual Status Report (PWA #677).

Army Corps of Engineers, 1997, Annual Monitoring Report - Sonoma Baylands Wetlands Demonstration Project.

Army Corps of Engineers, April 1994, Final Demonstration Project Report and Environmental Assessment, Sonoma Baylands Wetlands Demonstration Project. p. 31.

Siegel, Stuart, April 1998. Personal communication.

TABLES

TABLE 1:
Main Unit -summary of sediment surface elevation data as measured by resistivity staffs

Staff break point elevation (measure of sediment surface by Bob Corwin, SP Surveys)

Main Unit Staff #	Date Jan-96	Oct-96	Dec-96	Apr-97	May-97	Jun-97	Aug-97	Sep-97	Dec-97	Mar-98
7	2.4	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
8	2.3	0.9	0.9	0.9	0.6	0.6	0.6	0.6	0.6	0.6
9	2.7	1.5	1.7	1.3	1.3	1.3	1.3	1.3	1.4	1.5
10	2.4	1.2	1.2	1.1	0.8	0.8	0.9	0.9	1.1	1.1
11	2.4	2.0	1.8	1.5	1.6	1.7	1.6	1.6	1.7	1.7
12	2.0	1.7	1.5	1.4	1.0	1.0	1.1	1.1	1.4	1.4
13	2.4	1.4	1.4	1.0	1.0	1.0	1.0	1.0	1.4	1.4
14	2.4	1.2	0.8	0.8	0.8	0.4	0.4	0.4	0.6	0.6
15	2.6	1.8	1.8	1.3	1.3	1.3	1.3	1.3	1.3	1.3
16	2.0	1.2	1.2	1.1	0.9	0.9	0.9	0.9	0.6	0.6
17	2.6	1.6	1.6	1.4	1.3	1.3	1.3	1.3	1.2	1.2
18	2.5	1.9	2.3	1.7	1.7	1.9	1.9	1.9	2.0	2.0
19	2.5	1.7	1.9	1.3	1.5	1.5	1.5	1.5	1.3	1.3
20	2.4	1.6	1.8	1.2	0.9	1.3	1.3	1.3	1.2	1.2
21	2.0	1.2	1.4	1.2	0.9	0.9	0.9	0.9	0.6	0.6
Ave	2.4	1.5	1.5	1.2	1.1	1.1	1.2	1.2	1.2	1.2

Elevations estimated by density profile breakpoint by Bob Corwin, SP Surveys.
Elevations do not account for scour around the staffs.

TABLE 2:

Current and Equilibrium Marsh Characteristics for Sonoma Baylands Pilot and Main Units and Greenpoint Marsh

		Marsh Parameters				Depth of Channel Thalweg		Channel Cross-sectional area	
Marsh	Date	Marsh Area	Slough Channel Length	Typical Mudflat Elevation	Potential Diurnal Tidal Prism	Actual depth feet below MHHW	Predicted depth feet below MHHW	Actual area sq feet below MHHW	Predicted area sq feet below MHHW
		acres	feet						
SB Pilot Unit	Jan-96	28	1,700	0.3	87.6	4.0	8.9	40	405
SB Pilot Unit	Mar-98	28	1,700	0.3	87.6	6.0	8.9	65	405
SB Pilot Unit	Ultimate	28	1,700	3.4	19.0	N/A	6.0	N/A	180
SB Main Unit	Oct-96	240	1000	0.9	607.2	4.0	14.9	30	1200
SB Main Unit	Mar-98	240	1000	0.9	607.2	5.0	14.9	42	1200
SB Main Unit	Ultimate	240	1000	3.4	280.0	N/A	12.1	N/A	800
Greenpoint	1991	64	1,010	1.4	129.9	11.0	9.9	385	480
Greenpoint	1998	64	1,010	1.9	97.9	10.0	9.2	374	400
Greenpoint	Ultimate	64	1,010	3.4	55.0	N/A	7.9	N/A	300

Notes: For ultimate conditions, diurnal tidal prism read off of marsh area vs. tidal prism hydraulic geometry relationships (PWA Report 934, Figure 5.2-1)
For existing and historic conditions, diurnal tidal prism = marsh area*diurnal tidal range
Predicted channel depth and channel cross sectional area determined from hydraulic geometry relationship

Assumptions:

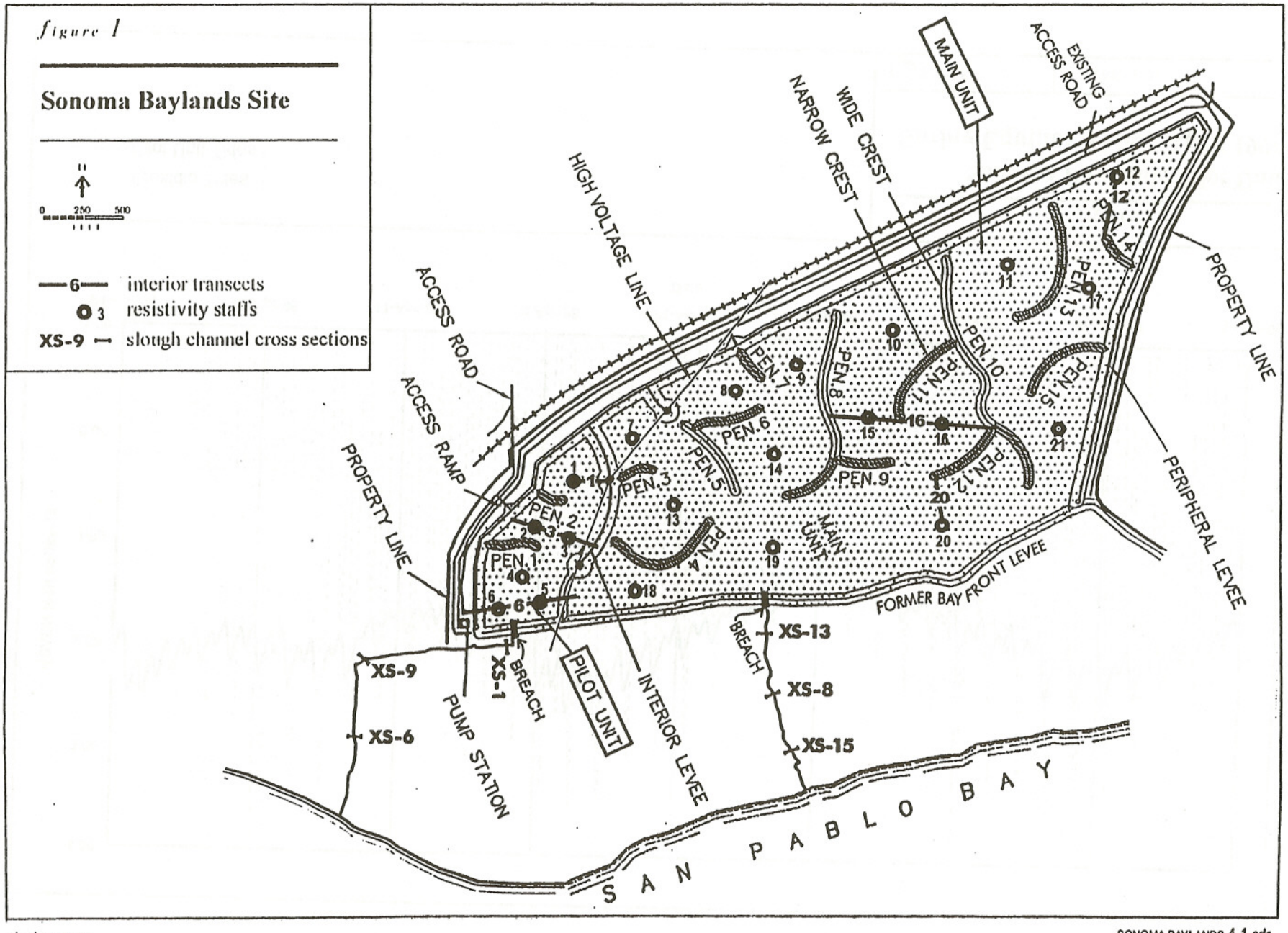
MHHW	3.43	ft NGVD
MLLW	-2.63	ft NGVD
Tidal range	6.06	feet

March 1998 data is preliminary and subject to review.

FIGURES

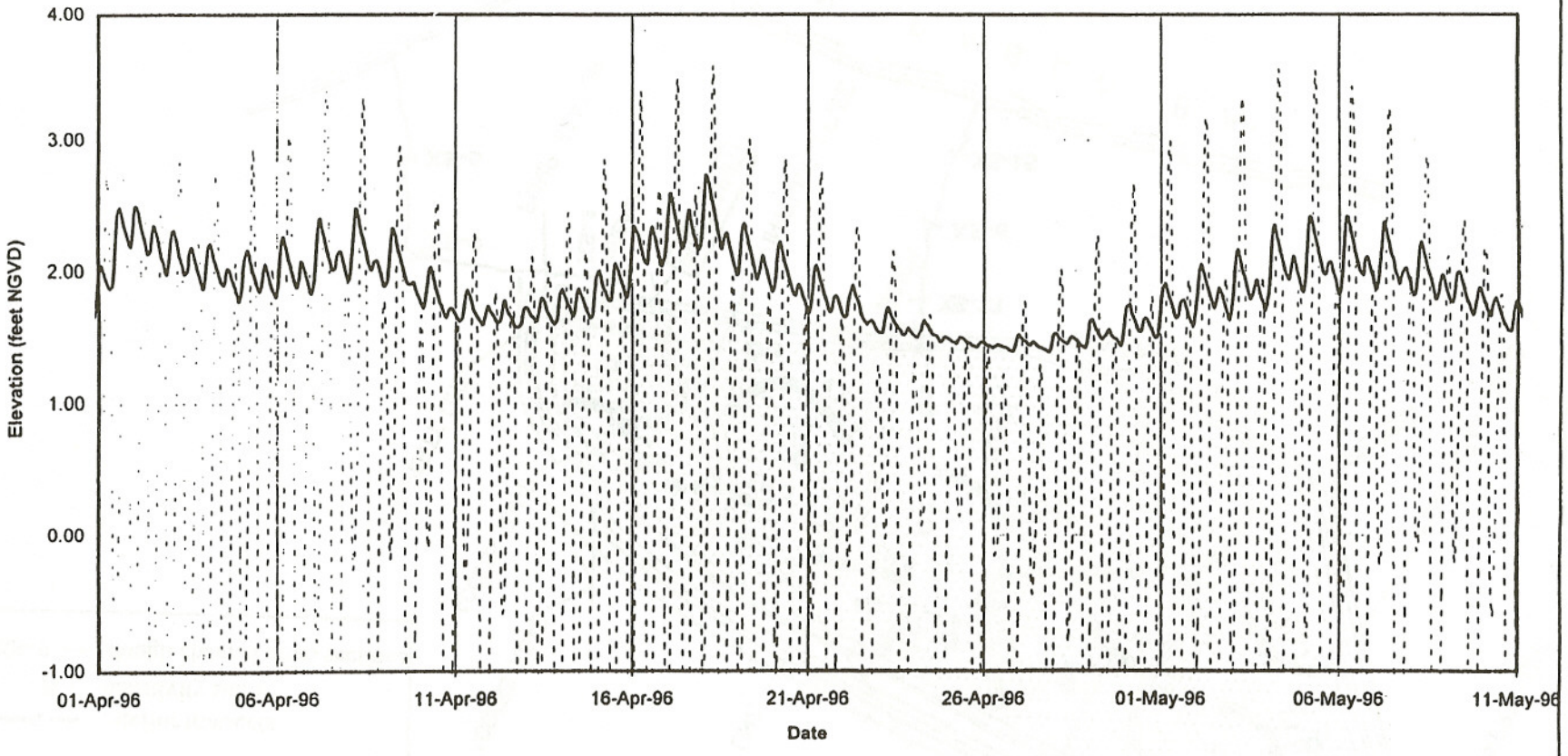
figure 1

Sonoma Baylands Site



PWA

SONOMA BAYLANDS 4-1.cdr



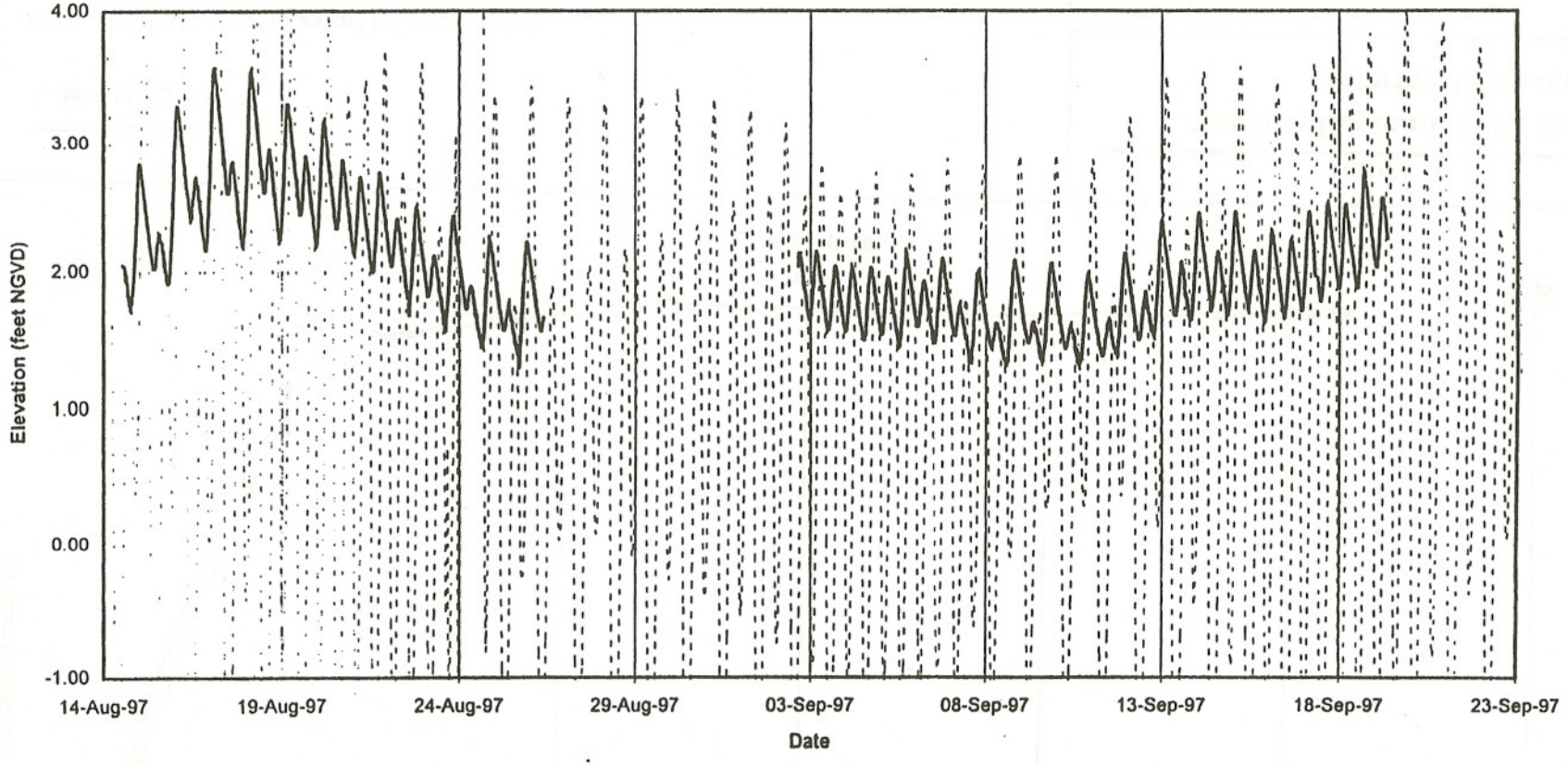
Presidio Tides
Pilot Unit Tides

figure 2

Sonoma Baylands Pilot Unit
Spring Equinox Tides, April 1996

PWA

PWA#: 1154



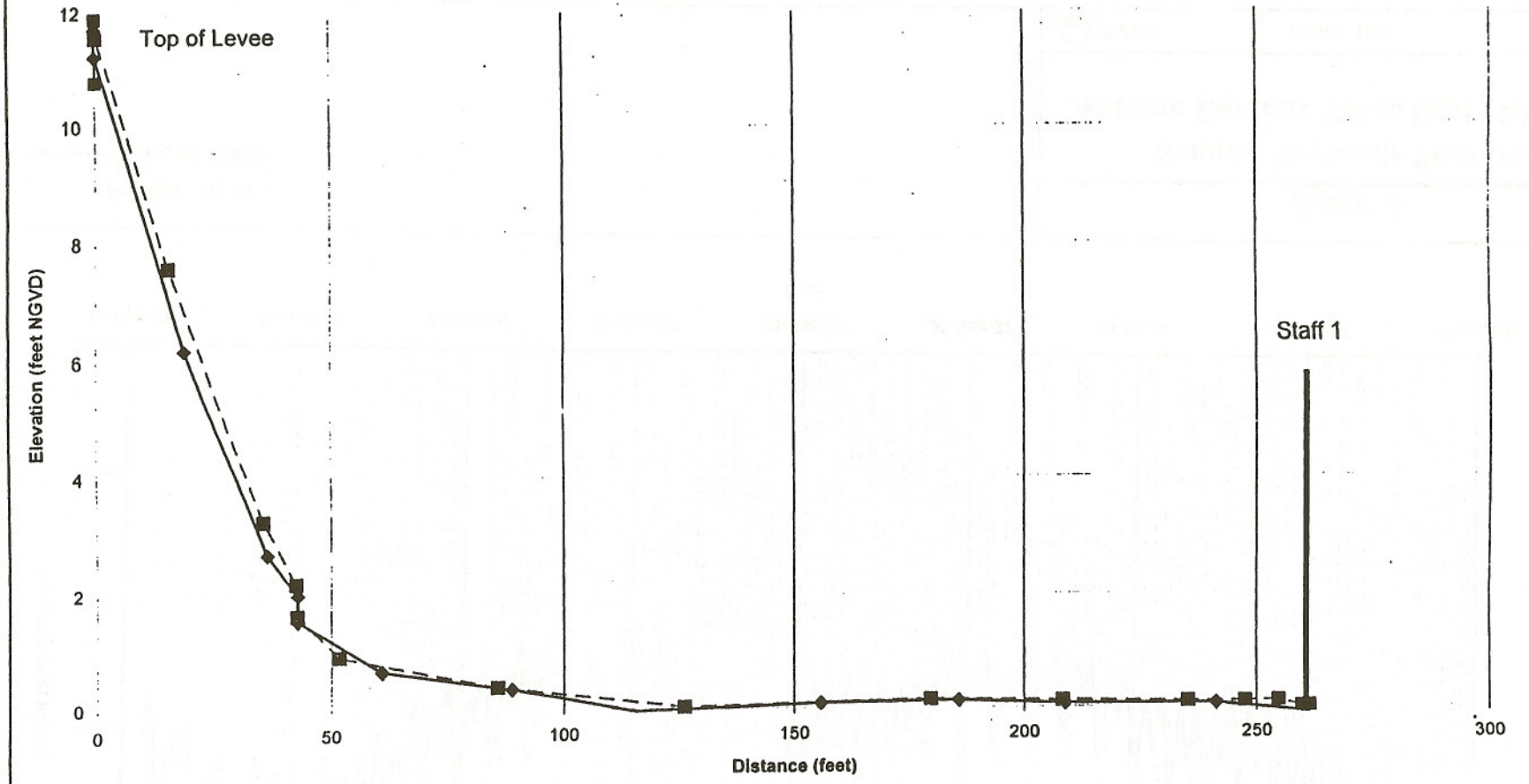
Presidio Tides
Pilot Unit Tides

figure 3

Sonoma Baylands Pilot Unit
Autumn Equinox Tides, Sept 1997

PWA

PWA#: 1154



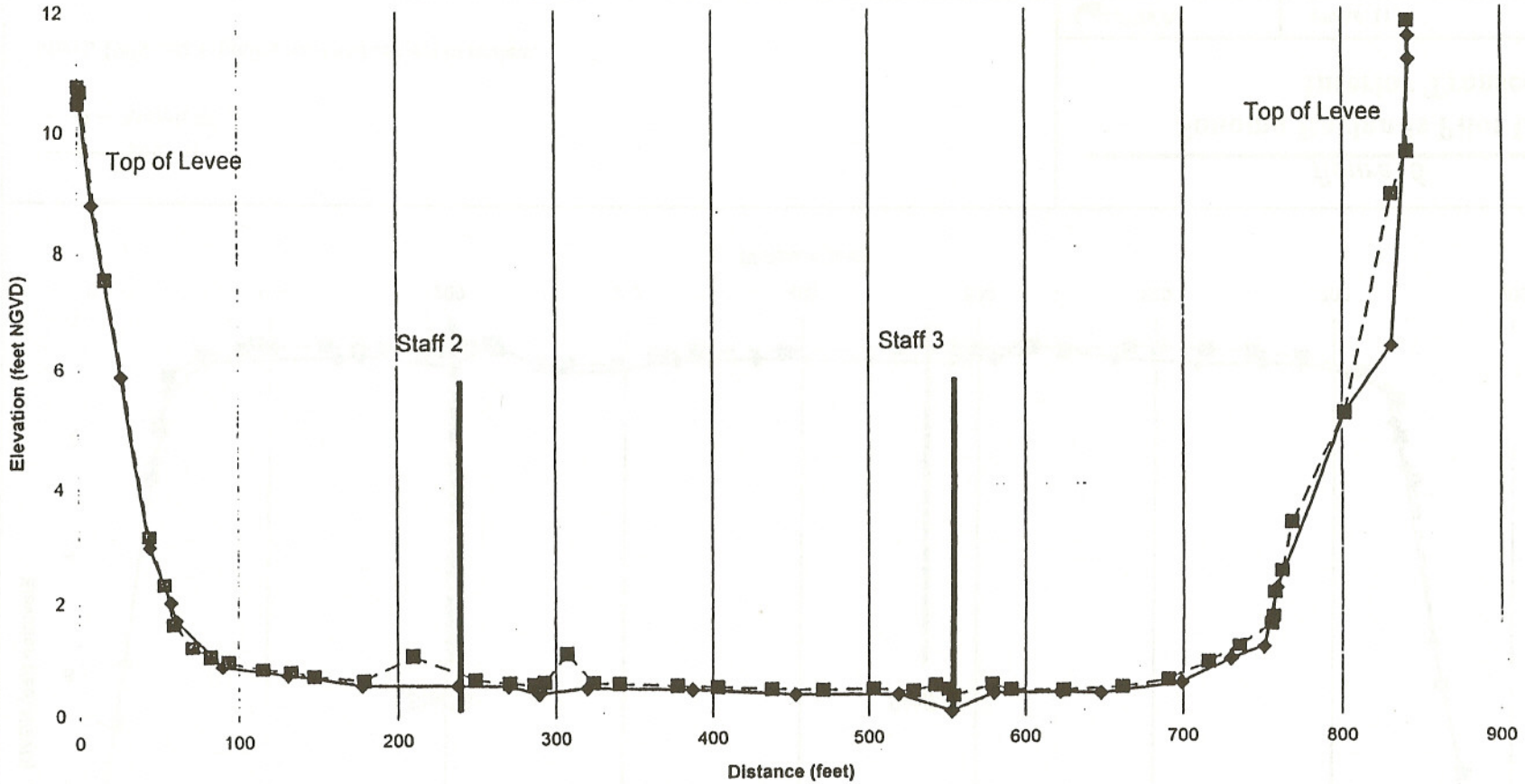
Sept. 97
March 98

March 1998 data is preliminary and subject to review.

figure 4

Sonoma Baylands Pilot Unit
Interior Transect 1

PWA | PWA#: 1154



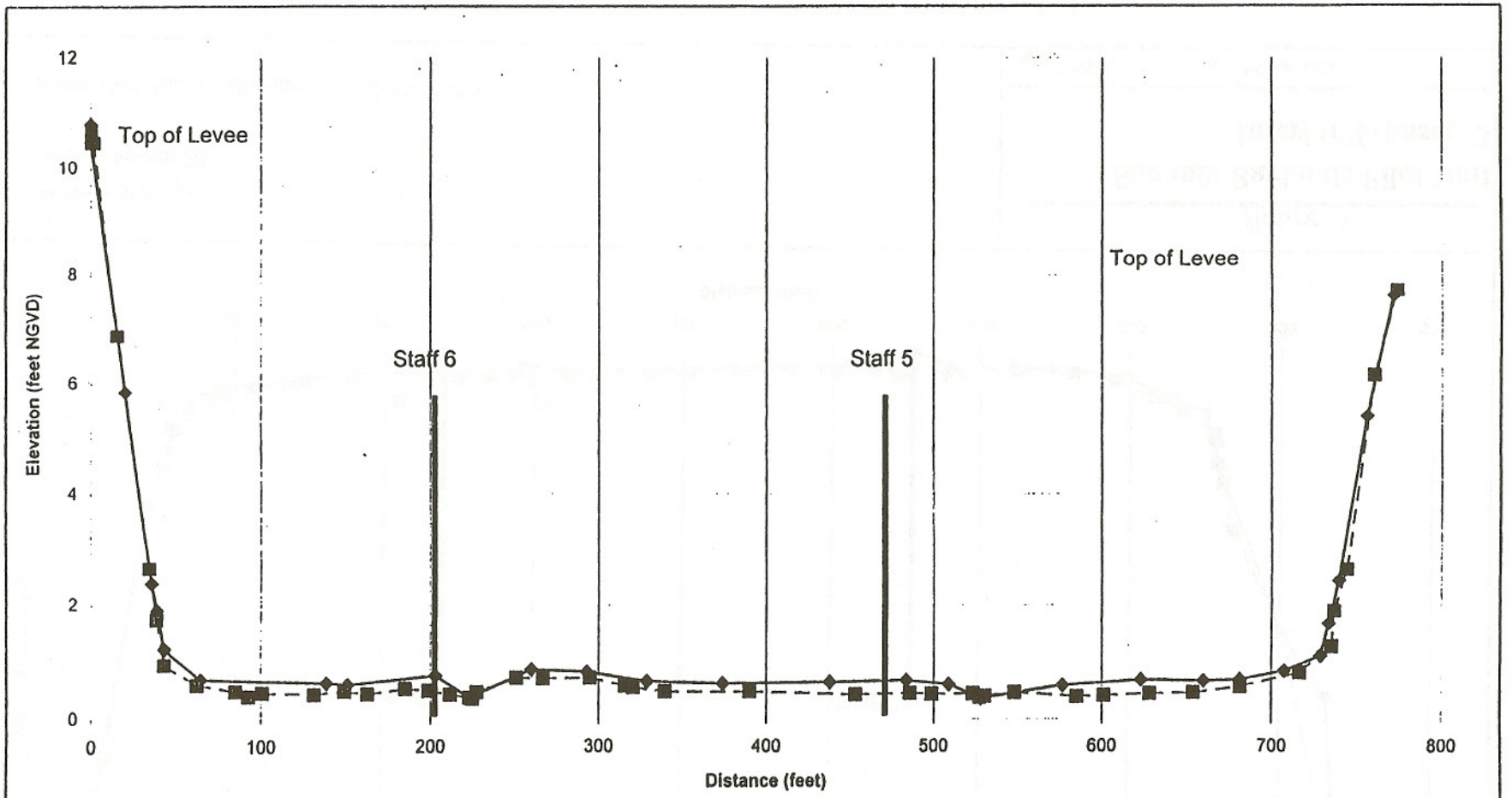
Sept. 97
March 98

March 1998 data is preliminary and subject to review.

figure 5

Sonoma Baylands Pilot Unit
Interior Transect 3

PWA | PWA#: 1154



Sep. 97
March 98

March 1998 data is preliminary and subject to review.

figure 6

Sonoma Baylands Pilot Unit
Interior Transect 6

PWA | PWA#: 1154