ATTACHMENT 5

HYDROLOGIC EVALUATION AND REVISED DESIGN FOR CHANNELS AT THE ELSIE ROEMER MARSH, ALAMEDA

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12/12/05

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Purpose and Scope

The Invasive Spartina Project (ISP) proposes to treat non-native hybrid cordgrass (*Spartina alterniflora x folios*) at the Roemer marsh with herbicide. At present, the marsh supports a healthy population of California clapper rails, due in part to the recent development of the heavy cover of cordgrass. To mitigate for the potential habitat damage from spraying the cordgrass, the ISP has proposed the excavation of small channels through the marsh, with berms on both sides at elevations that will support high marsh plants, especially gum plant (*Grindelia stricta*). The conceptual plan is described in a Preliminary Enhancement Plan (Kerr & Olofson, 2005). The purpose of this report is to propose and quantitatively analyze some channel design alternatives that will ultimately provide rail habitat at the site.

Tides and Tidal Datums

The National Ocean Service (NOS) operates a recording tide gage on a pier at the Alameda Naval Air Station, about 5.2 km NNW of the Roemer Marsh (Figure 1). The tide record and tidal bench marks at NAS were used to derive the tidal datums for this project, relative to MLLW, National Geodetic Vertical Datum (NGVD) and the North American Vertical Datum (NAVD). Table 1 shows the datums.

Figure 1. Location of Roemer Marsh and NAS Tide Gage

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Table 1. TIDAL DATUMS AT ALAMEDA NAS, STATION 9414750

	Datum, m			Datum, ft		
	MLLW	**NAVD**	**NGVD**	**MLLW**	**NAVD**	**NGVD**
MHHW	2.01	1.94	1.12	6.59	6.36	3.66
MHW	1.821	1.75	0.93	5.97	5.74	3.04
MTL	1.083	1.01	0.19	3.55	3.32	0.62
NGVD	0.89	0.823	0.00	2.93	2.70	0.00
MLW	0.345	0.28	-0.55	1.13	0.90	-1.80
NAVD	0.07	0.00	-0.82	0.23	0.00	-2.70
MLLW	0.00	-0.07	-0.89	0.00	-0.23	-2.93

For planning the planting of vegetation, it is also useful to know the frequency of extreme high tides. The lower limit of upland vegetation is determined not the the normal and frequent high tides, but rather by tides that occur a few times per year or less. The available tide gage record for NAS (1996-2005) was used to determine the average exceedence frequency for higher-high waters. Figure 2 shows the average number of times per year that a given HHW is equaled or exceeded. The highest tide of record at NAS was 6.71 ft NGVD, on 12/03/83. Upland vegetation would not thrive below about 5.5 ft NGVD.

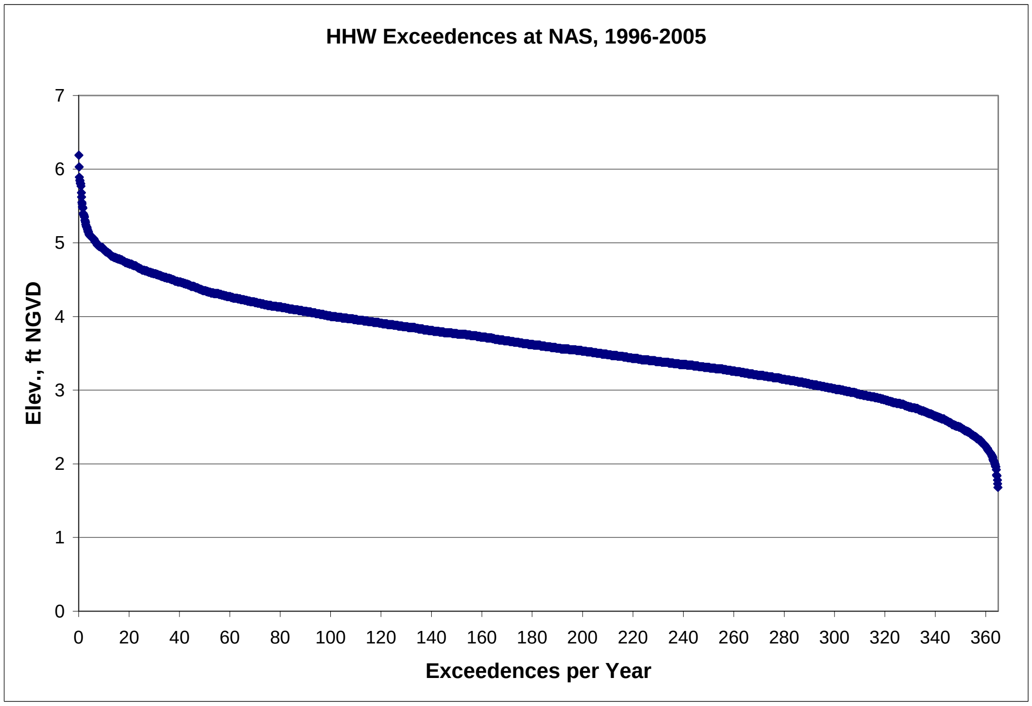

Figure 2. Average number of times per year a given higher high tide on the Alameda shoreline is equaled or exceeded.

Sand Transport and Beach Formation

The substrate material in the marsh is a complex pattern of sand deposits overlain in places by soft bay mud. Aerial photographs from 1973 show a sandy beach along the shoreline, with established clumps of vegetation on the mud/sand flat off shore. By 1981 the vegetation had encroached slightly onto the mud/sand flat, and subtidal dunes were forming around the clumps. During the 1980s a groin was built to protect Crown Beach, to the north. This groin apparently reduced the wave energy at the shoreline,accelerating the accretion of fine sediment and vegetation at the Roemer site.

Figure 3 is an aerial photograph of the site in 2004, with apparent directions of sand migration indicated. The lack of bed-forms near the vegetated margin suggests that the most active transport has been forced off-shore by the groin.

Apparent direction of sand transport, Alameda Shoreline

Figure 3

Strength of the Bed Material

There is considerable uncertainty about the strength of the material into which channels must be cut, and the stability of the side-slope of the channels and the adjacent berms. Figures 4A and 4B are two cross-sections of the drainage channel that crosses the marsh about 800 ft east of the eastern edge of the project area. Note that the maximum side-slopes in these cross sections are 3.2:1 in X-sec. 1 and 2.3:1 in X-sec. 2 (horizontal:vertical). Unfortunately, the slopes in these cross-sections are not supported by a root-mat of vegetation, and the material is somewhat more fine-textured than the material at the site. The surface material at the site is reinforced by a dense mat of roots and rhizomes, and may support a slope of 1:1, at least until the structures decompose. Although the depth of the supported layer is not known, it is likely that excavation will intersect layers of saturated sorted sand. With disturbance, these layers may liquefy.

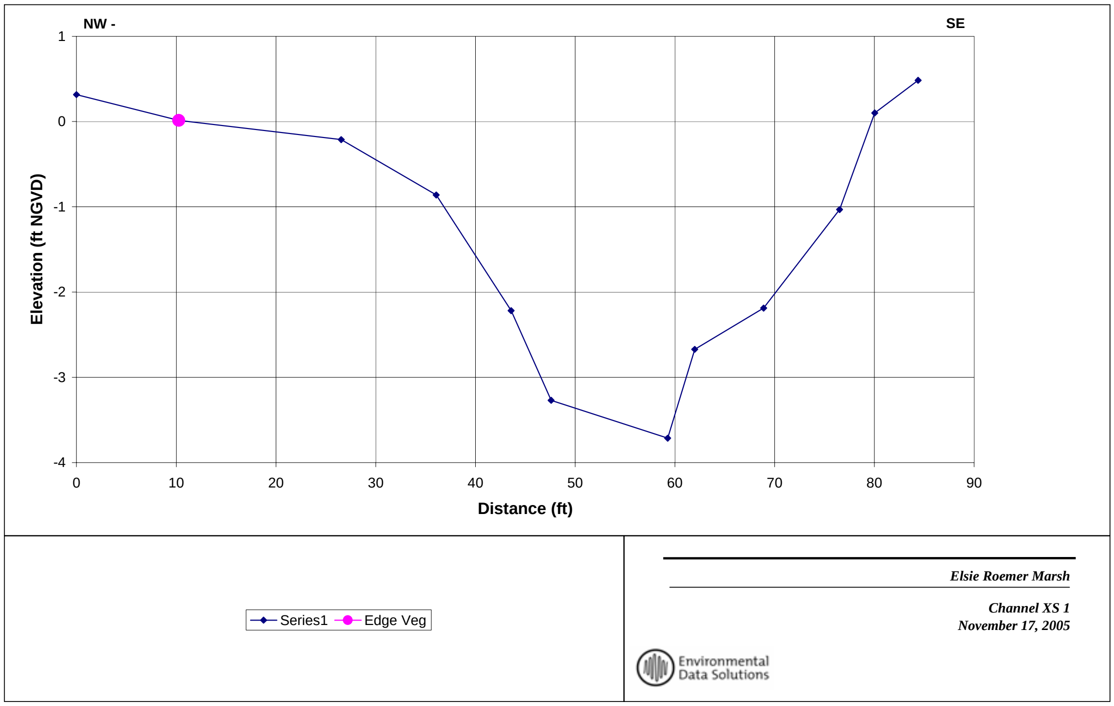

Figure 4A. Cross-section 40 ft downstream of box culverts.

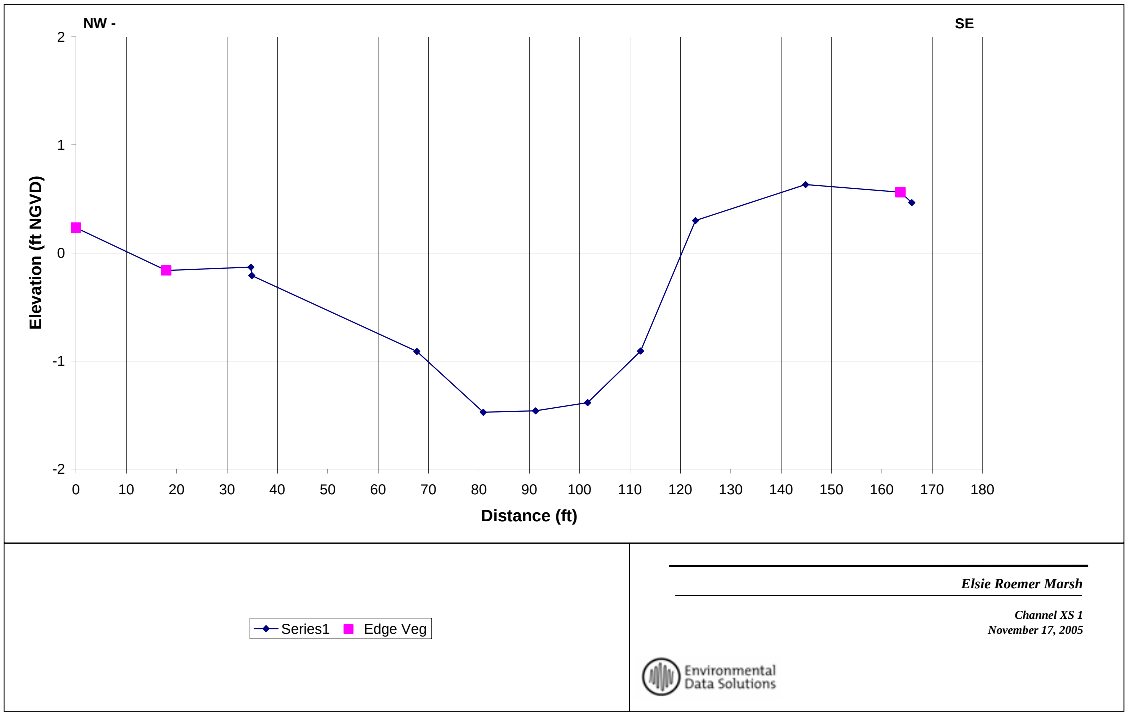

Figure 4B. Cross section 96 ft downstream of the box culverts

A second problem at the site is the possibility of mud waves, resulting from increased loading on the marsh surface, adjacent to the excavated channels. At edge of the vegetated marsh, the berm will be 4 ft high above the existing elevation. With side slopes of 1:1, the base of the berm would be 9 ft wide. It is conceivable that the pressure on the marsh surface of this mass could be relieved by a collapse of the ditch wall, or by a mud wave that would lift the bottom of the ditch.

Channel and Berm Design

Figure 5 shows the plan view of 3 proposed channels superimposed on a topographic map of the marsh. The berms will extend from the high marsh (about 4.0 ft NGVD) out to an elevation of 2.0 ft NGVD. As the marsh elevation decreases, the required berm height and need for material increase. In order to build the berms much beyond the elevation of 2.0 ft, it would be necessary to either widen the channels, or move material from the high marsh to the low marsh.

The sinuosity of the channels is about 1.3, based on averages for 1st and 2nd order channels in San Francisco Bay tidal marshes. Figures 6A-6D show proposed cross-sections at elevations of 4.0, 3.0, 2.5 and 2.0 ft NGVD. The cross-sections assume a channel bottom width of 1.5 ft, channel side slopes of 1:1, berm side slopes of 3:1, a berm top width of 1 ft, and final elevation of 5.0 ft. The total volume of material excavated for Channels 1, 2, and 3 would be respectively 619 yds^3, 328 yds^3, and 402 yds^3. This assumes that the berms are constructed out to the 2 ft contour, but the channels are constructed out to elevation 1.0 ft NGVD.

In order to contain the dredged material and reduce subsidence of the berms, a pad of organic debris (*Spartina* stems) will be laid on the marsh prior to placement of the berm material, and blocks of root-matted surface soils will be placed along berm margins.

Gumplant (*Grindelia*) grows in the high marsh at the Roemer site from elevations of about 4.6 to 5.3 ft NGVD, and it may be capable of growing as low as MHHW (3.66 ft NGVD). Each channel would support about 1,700 ft^2 of space suitable for Grindelia, and with 3 channels, there would be a total of about 5,200 ft^2 of suitable area.

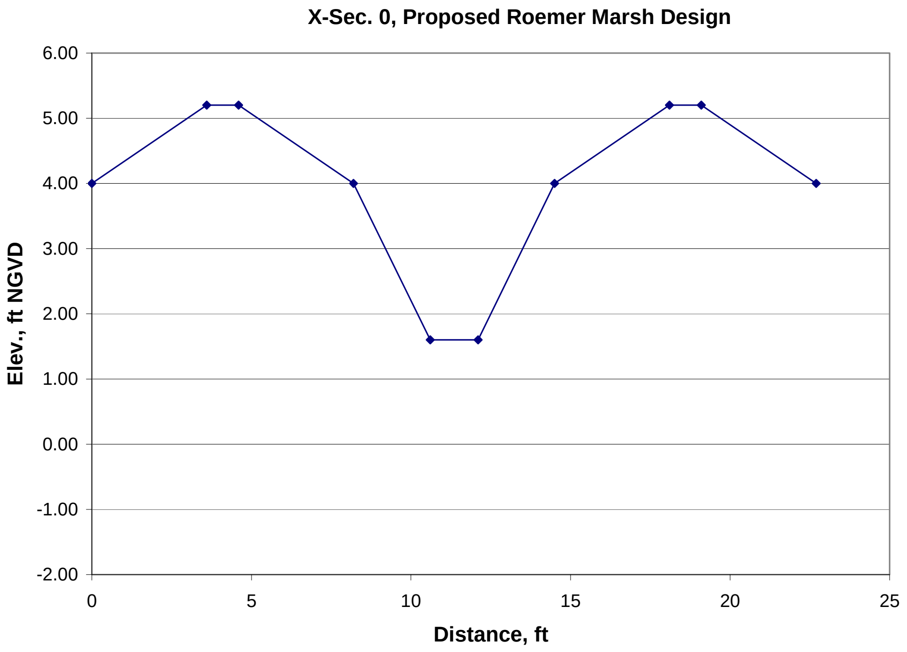

Figure 6A

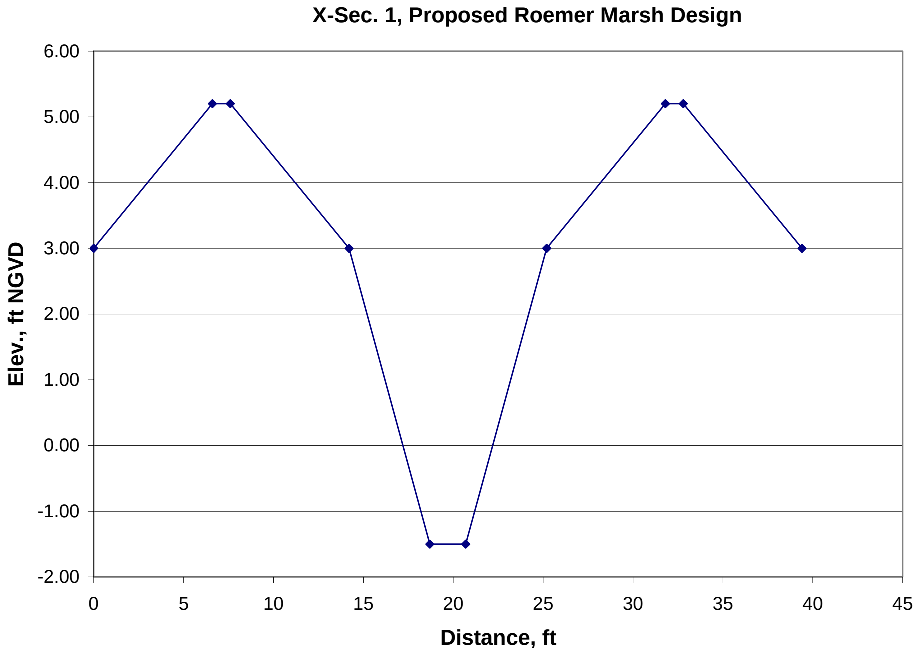

Figure 6B

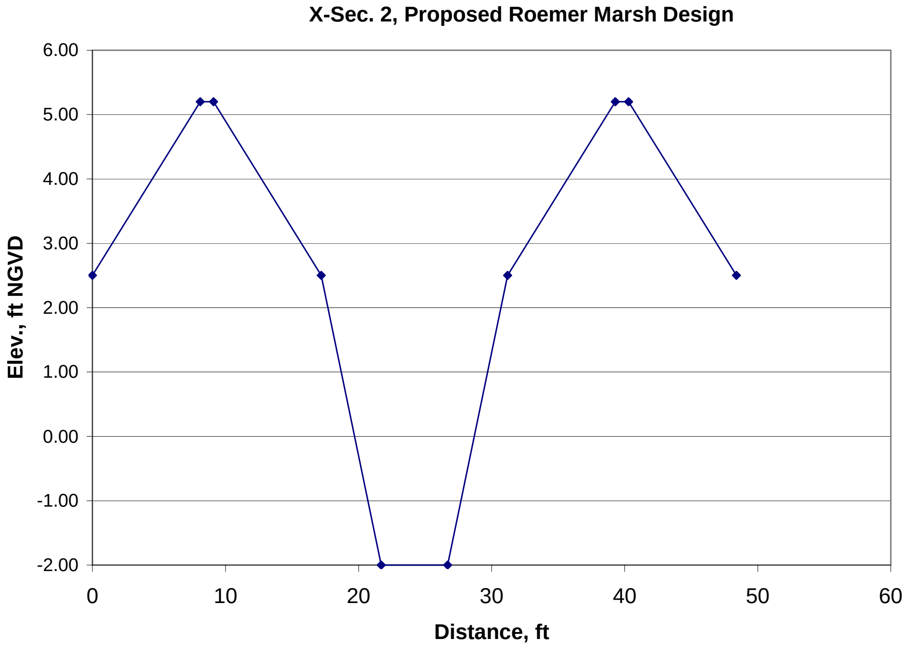

Figure 6C

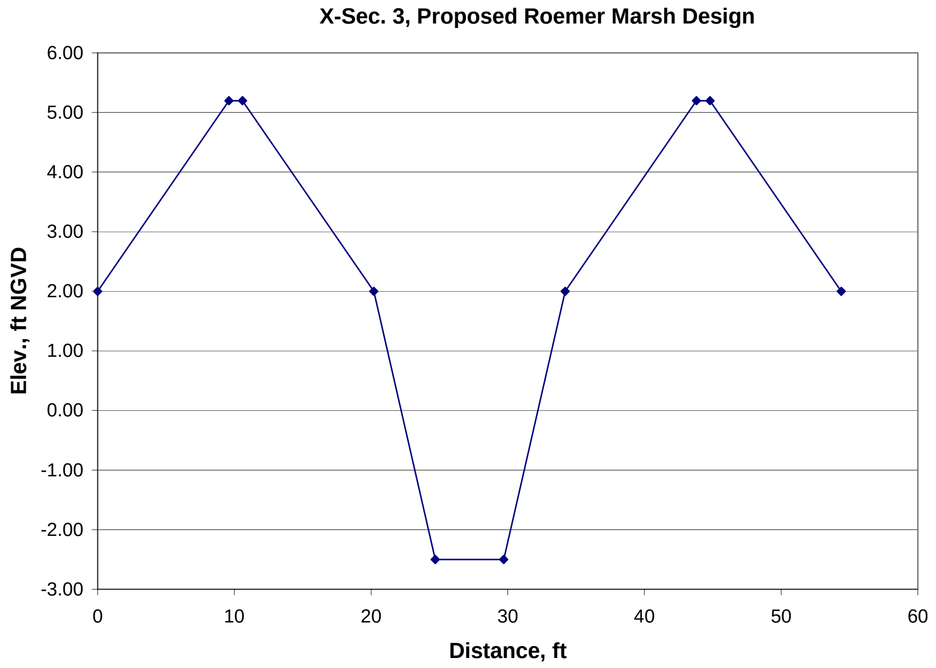
X-Sec. 3, Proposed Roemer Marsh Design
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
Elev., ft NGVD
0
10
20
30
40
50
60
Distance, ft

Figure 6D

Table 2 shows the designed and predicted channel dimensions. The predicted is based on empirical geomorphic relationships for tidal marshes around San FrancisCo Bay (Coats et al., 1995; Williams et al., 2002). Note that the designed channel is over-sized relative to its tidal prism. This suggests that tidal scour will not be sufficient to resuspend sediment deposited from the water column, and that the channel will gradually fill.

Table 2. Designed and Predicted Channel Dimensions, Roemer Marsh

	Designed			Predicted			Percent Difference (100*(designed.-pred)/meas.)		
Cross-Sec.	A, m^2	Depth, m	Width, m	A, m^2	Depth, m	Width, m	A	Depth	Width
0	0.79	0.63	1.71	0.00	0.00	0.00	--	--	--
1	7.13	1.57	4.56	0.31	0.74	0.81	95.61	52.72	82.27
2	9.92	1.73	6.39	1.00	1.02	1.84	89.96	41.01	71.23
3	10.43	1.88	7.30	1.74	1.18	2.74	83.29	36.91	62.54
4	11.45	2.18	9.13	2.16	1.26	3.19	81.10	42.44	65.06
5	9.70	2.03	10.05	2.92	1.36	3.95	69.92	32.88	60.71

REFERENCES

Coats, R. N., P. B. Williams, C. Cuffe, J. B. Zedler, D. Reed, S. Waltry and J. Noller. 1995. Design Guidelines for Tidal Channels in Coastal Wetlands. For the U.S. Army Corps of Engineers Waterway Experiment Station. Philip Williams & Associates, San Francisco. 46 pp.

Kerr, D. and P. Olofson. 2005. Elsie Roemer bird sanctuary *Spartina* control program California clapper rail habitat enhancement preliminary plan. Unpublished. 18 pp.

Pestrong, R. 1965. The development of drainage pattens on tidal marshes. Stanford Univ. Publ. in Geol. Sci. Vol. X, No.2. 87 pp. Palo Alto, CA

Willliams, P.B., M.K. Orr, and J. J. Garrity. 2002. Hydraulic geometry: a geomorphic design tool for tidal marsh channel evolution in wetland restoration projects. Restoration Ecology 10(3):557-590.