TABLES

TABLE II-1

SUMMARY OF RESTORATION ALTERNATIVES

Alternative	Areas Enhanced or Restored (acres)					Area of Jurisdictional Wetlands Converted by Restoration (acres)	Net Increase in Wetland Area (acres)	Qualitative Impacts								Excavation Volume (cubic yds)
	Tidal Lagoon	Freshwater Pond	Freshwater Wetlands	Transitional Riparian/Upland	Total			Anadromous Fish*	Freshwater Fish	Amphibians*	Birds*	Wetlands Plants	Wetland Dependent Wildlife	Upland Wildlife	Flooding	
A. No Action	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
B. Historic Wetland	0	5.2	6	5	16.2	13.9	2.3	+	+	++	++	++	+	-	++	120,000
C. Historic Wetland that Preserves Existing Riparian Habitat	0	4.6	4.5	3	12.1	9.8	2.3	+	+	++	++	++	+	-	++	100,000
D. Backwater Pond and Wetland	0	2.2	2.9	2.8	7.9	6.2	1.7	0	+	+	+	+	+	-	+	50,000
E. Enlarge Tidal Lagoon to Historic Size; Restore Dunes	0.8	0	0	0	0.8	0.8	0	+	0	0	+	-	0	0	0	3,600

Notes

+ indicates a beneficial impact
- indicates a negative impact
0 indicates no impact
* includes special status species

Table III - 3 continued

COMMON NAME	SCIENTIFIC NAME	LIFE	HABITAT						
			riparian	aquatic	dsturbd	pasture	marsh	dune	upland
Creeping spike rush	*Eleocharis macrostachya*	p		A		A			
Curly dock	**Rumex crispus*	p		O	O	A	O		
Cut-leaved geranium	**Geranium dissectum*	a		O					A
Cut-leaved plantain	**Plantago coronopus*	ab		O	O				
Dallis grass	**Paspalum dlatatum*	p			O				
Davy's manna grass	*Glyceria leptostachya*	p		O					
English ivy	**Hedera helix*	v	A						
English plantain	**Plantago lanceolata*	p		O					D
European beach grass	**Ammophila arenaria*	p						A	
European hair grass	**Aira caryophyllea*	a							O
Farmer's foxtail	**Hordeum murinum ssp. leporinum*	a			A	O	O		
Fennel	**Foeniculum vulgare*	p			O		O		
Fescue	**Vulpia myuros var. m.*	a							O
Field mustard	**Brassica rapa = B. campestris*	a			A				
Forget-me-not	**Myosotis latifolia*	p	O						
French broom	**Genista monspessulana*	s	O		O				
Garden nasturtium	**Tropaeolum majus*	ap		O					
German ivy	**Senecio mikanioides*	v	A		A				
Giant horsetail	*Equisetum telmateia*	p		O	O				
Harding grass	**Phalaris aquatica = P. tuberosa*	p			O	O			A
Hedge bindweed	*Calystegia sepium*	v	O		O				
Hedgehog dogtail	**Cynosurus echinatus*	p			O				O
Himalayan blackberry	**Rubus discolor*	s			C				
Hoary nettle	*Urtica dioica ssp holosericea*	a	A						
Horseweed	*Conyza canadensis*	a			O				
Hottentot fig	**Carpobrotus edulus*	p						O	
Hyssop loosestrife	**Lythrum hyssopiflolium*	a		O		O			
Iris-leaved rush	*Juncus xiphioides*	p		O					
Italian ryegrass	**Lolium multiflorum*	a		O	O	D	O		O
Jaumea	*Jaumea carnosa*	p					O		
Jubata grass	**Cortaderia jubata*	p			O		O		
Kikuyu grass	**Pennisetum clandestinum*	p	O	O	D	O	D	O	
Knotgrass	*Paspalum distichum*	p		D		O			

Table III - 3 continued

COMMON NAME	SCIENTIFIC NAME	LIFE	HABITAT						
			riparian	aquatic	dsturbd	pasture	marsh	dune	upland
Lady fern	*Athyrium felix-femina*	p	A						
Leafy bent grass	*Agrostis pallens*	p				O			O
Little quaking grass	**Briza minor*	a							O
Lizard tail	*Eriophyllum staechadifolium*	p						O	O
Low barley	*Hordeum depressum*	a				O			
Low club rush	*Scirpus cernuus*	a		A					
Lupine	*Lupinus rivularis*	s			O				
Marsh pennywort	*Hydrocotyle ranunculoides*	p	A			O			
Meadow barley	*Hordeum brachyantherum*	p				O			
Meadow chickweed	*Cerastium arvense*	p							O
Meadow foxtail	**Alopecurus pratensis*	p			O	A			
Melic	*Melica sp.*	p							O
Milk thistle	**Silybum marianum*	ab			O				O
Miner's lettuce	*Claytonia perfoliata*	a		O					
Monterey pine	**Pinus radiata*	t	O		O				
Morning glory	*Calystegia purpurata ssp. p.*	v	O						
Myoporum	**Myoporum laetum*	t			O				
New Zealand spinach	**Tetragonia tertragonioides*	a			O				
Nightshade	**Solanum sarrachoides*	a	O						
Orchard grass	**Dactylis glomerata*	p				O			O
Pacific grindelia	*Grindelia stricta*	p					O		
Pacific sanicle	*Sanicula crassicaulis*	p							O
Pacific silverweed	*Potentilla anserina ssp. pacifica =P. egedii*	p		O		O	D		
Pennyroyal	**Mentha pulegium*	p	O	O	O	A			
Pineapple weed	**Chamomilla suaveolens*	p			O	O			
Poison hemlock	**Conium maculatum*	a			D	O	O		A
Poison oak	*Toxicodendron diversilobum*	s			O				A
Prarie bulrush	*Scirpus robustus*	p		A					
Prickle-fruited buttercup	**Ranunculus muricatus*	ab				O			O
Prickly sow thistle	**Sonchus asper*	a			O	O	O		
Purple needlegrass	*Nassella lepida*	p							A
Purple sand spurry	**Spergularia rubra*	ap			O	O			
Rabbit's foot grass	**Polypogon monspeliensis*	a			A	D	A		

Table III - 3 continued

COMMON NAME	SCIENTIFIC NAME	LIFE	HABITAT						
			riparian	aquatic	dsturbd	pasture	marsh	dune	upland
Red alder	*Alnus rubra*	t	D	D			A		
Red elderberry	*Sambucus racemosa var. r.*	s	O		O				
Redwood sorrel	*Oxalis oregana*	p	O						
Rescue grass	**Bromus catharticus*	p			O				
Ripgut brome	**Bromus diandrus*	p			C	O	O	O	
Rough cat's ear	**Hypochaeris radicata*	p	O		O		O		O
Salsify	**Tragopogon porrifolius*	b	O		O		O		
Salt grass	*Distichlis spicata*	p			O		O	A	O
Salt marsh sand spurry	*Spergularia marina*	a						O	
Salt rush	*Juncus leseurii*	p	O	O	O		D		
Scarlet pimpernel	**Anagallis arvensis*	a		O	O	O	O		
Sea rocket	**Cakile maritima*	p					O	A	
Sedge	*Carex spp.*	p	O						
Sheep sorrel	**Rumex acetosella*	p			O				O
Shining/yellow willow	*Salix lucida ssp. lasiandra*	t	D			O	O		
Shore pine	*Pinus contorta var. c.*	t			O				
Six-week's fescue	**Vulpia bromoides*	a			O				O
Slender wild oat	**Avena barbata*	a			A		O		O
Small-fruited bulrush	*Scirpus microcarpus*	p	O	O					
Smaller duckweed	*Lemna minor*	p		A					
Smooth cat's ear	**Hypochaeris glabra*	a			O				
Sneezeweed	*Helenium puberulum*	p		O					
Soap plant	*Chloragalum pomeridianum*	p							O
Soft chess	**Bromus hordeaceous = B. mollis*	a		O	O	O			O
Sourclover	**Melilotus indica*	a		O	A		O		
Spear oracle = Fat hen	*Atriplex triangularis = A. patula*	a					O		
Stinging phacelia	*Phacelia malvifolia*	a							O
Sweet-scented bedstraw	**Galium triflorum*	p	O						
Tall cyperus	*Cyperus eragrostis*	p		A		O	O		
Tall fescue	**Festuca arundinacea*	p		O	O		O		
Thimbleberry	*Rubus parviflorus*	s	O		O				
Three square	*Scirpus americanus*	p		D		O	O		
Toad rush	*Juncus bufonius*	a	O	O		A			

Table III - 3 continued

COMMON NAME	SCIENTIFIC NAME	LIFE	HABITAT						
			riparian	aquatic	dsturbd	pasture	marsh	dune	upland
Water buttercup	*Ranunculus aquatilus*	p		O		O			
Water cress	*Rorippia nasturtium-aquaticum*	p	O	A					
Water parsley	*Oenanthe sarmentosa*	p	O	A		O	O		
Water plantain	*Alisma plantago-aquatica*	p	O	O		O			
Water smartweed	*Polygonum punctatum*	a,p	O	O			O		
Waterpepper	*Polygonum hydropiperoides*	p	O	O					
Weedy cudweed	**Gnaphalium luteo-album*	a				O			
Western sword fern	*Polystichum munitum*	p	A						
White clover	**Trifolium repens*	p		A	O	D			
White sweetclover	**Melilotus alba*	ab			O				
White-stemmed filaree	**Erodium moschatum*	a			A				O
Whorled dock	**Rumex conglomerartus*	p		O	O	A	O		
Wild oat	**Avena fatua*	a			O				
Willow herb	*Epilobium ciliatum = E. watsoni*	p		O	O				
Wood groundsel	**Senecio sylvaticus*	a	O		O	O			
Yellow bush lupine	*Lupinus arboreus*	s			O				O
Yellow sand verbena	*Abronia latifolia*	p			O			A	
Yellow trefoil	**Medicago lupulina*	a			O				O
TOTAL SPECIES		**181**	**51**	**54**	**89**	**58**	**46**	**16**	**52**
ER CENT ALIEN SPECIES		**45%**	**31%**	**43%**	**54%**	**59%**	**57%**	**38%**	**52%**

Table III - 1

Historic occurrences of amphibians and reptiles in Marine County, California. Current observations from Big Lagoon, 1993.

COMMON NAME	SCIENTIFIC NAME	OBSERVATIONS Historical	Current *
Amphibians			
Arboreal Salamander	*Aneides lugubris*	•	
California Newt	*Taricha tarosa*	•	•
California Slender Salamander	*Batrachoseps attenuatus*	•	•
Ensatina	*Ensatina eschscholtzi*	•	•
Pacific Giant Salamander	*Dicamptodon ensatus*	•	
Pacific Tree Frog	*Pseudacris regilla*	•	•
Red-legged Frog	*Rana aurora draytonii*	•	•
Rough-skinned Newt	*Taricha granulosa*	•	•
Western Toad	*Bufo boreas*	•	•
Yellow-legged Frog	*Rana boyleii*	•	
Reptiles			
Common Garter Snake	*Thamnophis sirtalis*	•	
Gopher Snake	*Pituophis melanoleucus*	•	
Northern Alligator Lizard	*Elgaria coeruleus*	•	
Ringneck Snake	*Diadophis punctatus*	•	
Rubber Boa	*Charina bottae*	•	
Southern Alligator Lizard	*Elgaria multicarinata*	•	
Western Aquatic Garter Snake	*Thamnophis couchi*	•	
Western Fence Lizard	*Sceloporus occidentalis*	•	•
Northwestern Pond Turtle	*Clemmys marmorata marmorata*		•
Western Skink	*Eumeces skiltonianus*	•	
Western Terrestrial Garter Snake	*Thamnophis elegans*	•	
Yellow-bellied Racer	*Coluber constrictor*	•	

* Reptile sitings at Big Lagoon do not include upland habitats.

Table III - 2

Terrestrial mammals occurring historically or currently within the Big Lagoon wetland and riparian areas and adjacent habitats. I = introduced from North America; A = alien, introduced from outside North America; P = potentially present; E = extirpated; CSC = California species of special concern; 2 = Federal candidate for listing. (From Jameson and Peeters 1988, Ingles 1965, Zeiner et al 1990.)

Common name	Scientific name	Note
MARSUPIALS		
Oppossums (Didelphidae)		
Oppossum	*Didelphis marsupialis*	I
INSECTIVORES		
Shrews (Soricidae)		
Ornate Shrew	*Sorex ornatus*	
Pacific Shrew	*Sorex pacificus*	
Trowbridge Shrew	*Sorex trowbridgei*	
Vagrant Shrew	*Sorex vagrans*	
Moles (Talpidae)		
Shrew Mole	*Neurotrichus gibbsii*	
California Mole	*Scapanus latimanus*	
BATS		
Evening bats (Vespertilionidae)		
Pallid Bat	*Antrozous pallidus*	CSC
Big Brown Bat	*Eptesicus fuscus*	
Red Bat	*Lasiurus borealis*	
Hoary Bat	*Lasiurus cinereus*	
Pacific Western Big-eared Bat	*Plecotus townsendiii townsendi i*	2
Western Pipestrelle	*Pipistrellus hesperus*	
California Myotis	*Myotis californica*	
Long-eared Myotis	*Myotis evotis*	
Little Brown Myotis	*Myotis lucifugus*	
Fringed Myotis	*Myotis thysanodes*	
Long-legged Myotis	*Myotis volans*	
Yuma Myotis	*Myotis yumanensis*	
Silver-haired Bat	*Lasionycteris noctivagans*	
Free-tailed Bats (Molossidae)		
Brazilian Free-tailed Bat	*Tadarida brasiliensis*	
Greater Western Mastiff Bat	*Eumops perotis californicus*	2
CARNIVORES		
Ursidae		
California Grizzly	*Ursus arctos*	E
Weasels (Mustelidae)		
Long-tailed Weasel	*Mustela frenata*	
Short-tailed Weasel	*Mustela erminea*	
Mink	*Mustela vison*	

Table III - 2 continued

Striped Skunk	*Mephitis mephitis*	
Spotted Skunk	*Spilogale putorius*	
Badger	*Taxidea taxus*	CSC
River Otter	*Lutra canadensis*	
Racoons (Procyonidae)		
Ringtail	*Bassariscus astutus*	
Raccoon	*Procyon lotor*	
Dogs (Canidae)		
Coyote	*Canis latrans*	
Gray Fox	*Urocyon cinereoargenteus*	
Red Fox	*Vulpes fulva*	P,A
Cats (Felidae)		
Mountain Lion	*Felis concolor*	
Bobcat	*Lynx rufus*	
RODENTS		
Mountain beavers (Aplodontiidae)		
Point Reyes Mountain Beaver	*Aplodontia rufa phaea*	2
Squirrels (Sciuridae)		
Yellow-cheeked chipmunk	*Tamias ochrogenys*	
Sonoma chipmunk	*Tamias sonomae*	
Douglas' Squirrel	*Tamiasciurus douglasii*	
California Ground Squirrel	*Spermophilus beecheyi*	
Western Gray Squirrel	*Sciurus griseus*	I,P
Gray Squirrel	*Sciurus carolinensis*	
Fox Squirrel	*Sciurus niger*	I,P
Pocket gophers (Geomyidae)		
Pocket Gopher	*Thomomys bottae*	
Pocket mice (Heteromyidae)		
California Kangaroo Rat	*Dipodomys californicus*	P
Native rats and mice (Cricetidae)		
Deer Mouse	*Peromyscus maniculata*	
Piñon Mouse	*Peromyscus truei*	
Western Harvest Mouse	*Reithrodontomys megalotis*	
Dusky-footed Wood Rat	*Neotoma fuscipes*	
California Vole	*Microtus californicus*	
Red Tree Vole	*Arborimus longicaudus*	CSC
Western Red-backed Vole	*Clethrionomys californicus*	
Muskrat	*Ondatra zibethica*	I
Old world rats and mice (Muridae)		
House Mouse	*Mus musculus*	A
Norway Rat	*Rattus norvegicus*	A
Black Rat	*Rattus rattus*	A
Jumping mice (Zapodidae)		
Point Reyes Jumping Mouse	*Zapus trinotatus orarius*	2 ,CSC

Table III - 3

Plants observed at Big Lagoon and their estimated relative abundance within each habitat ty] .

LIFE CYCLE AND GROWTH FORMS: annual (a), biennial (b), perennial (p), shrub (s), tree (t), vine (v).
HABITAT: Dominant (D), Abundant (A), Occassional (O).
* Alien species

COMMON NAME	SCIENTIFIC NAME	LIFE	HABITAT						
			riparian	aquatic	dsturbd	pasture	marsh	dune	upland
Alkali heath	*Frankenia salina = F. grandifolia*	p					O		
Alkali rye grass	*Leymus triticoides*	p			O		O	A	
American brooklime	*Veronica americana*	p	O	O		O			
American dogwood	*Cornus sericea ssp. s. = C. californica*	s			O				
American dune grass	*Leymus mollis*	p						D	
American water fern	*Azolla filiculoides*	a		O		O			
Annual bluegrass	**Poa annua*	a				O			
Arroyo willow	*Salix lasiolepis*	t	A						
Beach bur	*Ambrosia chamissonis*	p					O	D	
Bermuda grass	**Cynodon dactylon*	p				O			
Birdfoot trefoil	*Lotus corniculatus*	p			A				
Black cottonwood	*Populus balsamifera var. trichocarpa*	t			O				
Black mustard	**Brassica nigra*	a	O		A	O	O	O	O
Blue dicks	*Dichelostemma captitatum*	p							O
Blue wildrye	*Elymus glaucus*	p							A
Blue-eyed grass	*Sisyrinchium bellum*	a							O
Bluegrass	*Poa sp.*	p				O			O
Bog rush	*Juncus effusus var. brunneus*	p	O	O		O			
Bracken	*Pteridium aquilinum*	p							O
Brass buttons	**Cotula coronopifolia*	p		O		O	O		
Bristly ox-tongue	**Picris echioides*	ab		O	O		A		O
Broad-leaved cat-tail	*Typha latifolia*	p	D		O	O			
Brome	*Bromus carinatus var maritimus*	p							
Brome	*Bromus vulgaris*	p	O						
Bull mallow	**Malva nicaeensis*	ap			O				
Bull thistle	**Cirsium vulgare*	a			A	O			O
Bush morning glory	*Calystegia occidentalis ssp. o.*	v	O						

Table III - 3 continued

COMMON NAME	SCIENTIFIC NAME	LIFE	HABITAT						
			riparian	aquatic	dsturbd	pasture	marsh	dune	upland
California blackberry	*Rubus ursinus*	s	O		O	O			O
California buckeye	*Aesculus californica*	t			O				
California burclover	**Medicago polymorpha = M. hispida*	a		O	A	O			O
California canary grass	*Phalaris californica*	p			O				
California figwort	*Scrophularia californica*	p	O	O	O		O	O	
California horkelia	*Horkelia californica ssp. c.*	p							O
California man-root	*Marah fabaceus*	p	O						
California mugwort	*Artemisia douglasiana*	p	O		O			A	A
California oat grass	*Danthonia californica*	p							O
California poppy	*Eschscholzia californica*	p				O			O
California rose	*Rosa californica*	s	O						
California sagebrush	*Artemisia californica*	s			O				A
Calla lily	**Zantedeschia aethiopica*	p	O				O		
Canada thistle	**Cirsium arvense*	b			O	O			O
Capeweed	**Arctotheca calendula*	p							O
Charlock	**Sinapsis kaber*	a			O				
Cheeseweed	**Malva parviflora*	a			O				
Chick lupine	*Lupinus microcarpus var. m.*	a			O				
Coast clover	*Trifolium wormskioldii*	p		A	A	A			
Coast hedge nettle	*Stachys chamissonis*	p	O				O		O
Coast tarweed	*Madia sativa*	a			O	A			
Common monkey flower	*Mimulus guttatus*	a,p		O		O	O		
Common plantain	**Plantago major*	p		O		A	O		
Common rush	*Juncus patens*	p	O						
Common snowberry	*Symphoricarpus albus*	s	O						
Common sow thistle	**Sonchus oleraceus*	a			O		O		
Common tule	*Scirpus acutus*	p		O					
Common velvet grass	**Holcus lanatus*	p		O	O	O	O		
Common vetch	**Vicia sativa*	a	O	O	A	O			O
Common yarrow	*Achillea millefolium*	p			O				A
Cow parsnip	*Heracleum lanatum*	p			O				
Coyote brush	*Baccharis pilularis*	s			O		O		D
Creeping bent	**Agrostis stolonifera*	p		O		O			

TABLE IV-1

MEAN MONTHLY RAINFALL AND EVAPORATION

Month	Mean Precip (in)	Mean Evap (in)	Mean PET (in)	Available Water (in)
OCT	2.49	2.39	1.67	0.82
NOV	6.24	0.98	0.69	5.55
DEC	4.74	0.53	0.37	4.37
JAN	5.73	0.39	0.27	5.46
FEB	5.62	0.84	0.59	5.03
MAR	5.68	2.68	1.88	3.80
APR	2.39	3.71	2.60	0.00
MAY	0.39	5.53	3.87	0.00
JUN	0.26	6.42	4.49	0.00
JUL	0.20	7.30	5.11	0.00
AUG	0.16	5.68	3.98	0.00
SEP	0.53	3.91	2.74	0.00
TOTAL	**34.43**	**40.36**	**28.25**	**25.03**

Notes

Precipitation data from Muir Woods daily records

Evaporation Data from Lagunitas Reservoir Pan

Potential Evapotranspiration (PET) Computed from Pan Evaporation using a pan coefficient of 0.7

TABLE IV-2.

HISTORICAL FLOW DATA ON REDWOOD CREEK AND GREEN GULCH

Date	Location	Agency	Conditions	Instantaneous Flow (cfs)
02/13/62	Redwood Creek at Frank Valley Road	USGS	Annual Storm Peak	880
10/13/62	Redwood Creek at Frank Valley Road	USGS	Annual Storm Peak	800
01/20/64	Redwood Creek at Frank Valley Road	USGS	Annual Storm Peak	100
01/06/65	Redwood Creek at Frank Valley Road	USGS	Annual Storm Peak	410
01/04/66	Redwood Creek at Frank Valley Road	USGS	Annual Storm Peak	1300
01/21/67	Redwood Creek at Frank Valley Road	USGS	Annual Storm Peak	295
01/30/68	Redwood Creek at Frank Valley Road	USGS	Annual Storm Peak	630
12/15/68	Redwood Creek at Frank Valley Road	USGS	Annual Storm Peak	1040
01/21/70	Redwood Creek at Frank Valley Road	USGS	Annual Storm Peak	1780
08/74	Lower Redwood Creek	NPS	Dry Weather	0.56
09/74	Lower Redwood Creek	NPS	Dry Weather	0.31
01/31/86	Redwood Creek at Muir Woods	USGS	Winter	51
01/31/86	Redwood Creek at Pacific Way	USGS	Winter	86
01/30/86	Green Gulch Creek	USGS	Winter	9.9
06/26/86	Redwood Creek at Muir Woods	USGS	Summer	0.77
06/26/86	Redwood Creek at Pacific Way	USGS	Summer	0.66
06/25/86	Green Gulch Creek	USGS	Summer	0.01
02/13/87	Redwood Creek at Muir Woods	USGS	Winter	114
03/13/87	Redwood Creek at Pacific Way	USGS	Winter	30
03/13/87	Green Gulch Creek	USGS	Winter	1.2
06/10/87	Redwood Creek at Muir Woods	USGS	Summer	0.62
06/12/87	Redwood Creek at Pacific Way	USGS	Summer	0.68
06/12/87	Green Gulch Creek	USGS	Summer	0.01
01/05/88	Redwood Creek at Muir Woods	USGS	Winter	42
01/05/88	Redwood Creek at Pacific Way	USGS	Winter	73
03/23/88	Green Gulch Creek	USGS	Winter	0.04
06/07/88	Redwood Creek at Muir Woods	USGS	Summer	0.7
06/07/88	Redwood Creek at Pacific Way	USGS	Summer	0.78
06/02/88	Green Gulch Creek	USGS	Summer	0.01
09/04/88	Redwood Creek at Frank Valley Road	NPS	Dry Weather	0.06

TABLE IV-3

MONTHLY REDWOOD CREEK FLOW VOLUMES, 1992-1993

Month	Flow Volume (ac-ft)	PET Losses by Wetland Plants (ft)	PET Losses by Wetland Plants (ac-ft)
Mar. 92	875	0.20	1.00
Apr	213	0.28	1.38
May	56	0.40	2.00
Jun	72	0.46	2.31
Jul	17	0.54	2.69
Aug	7.3	0.41	2.06
Sep	2.7	0.29	1.44
Oct	7.1	0.18	0.88
Nov	1.5	0.08	0.38
Dec	927	0.04	0.19
Jan 93	3892	0.03	0.13
Feb	2246	0.06	0.31
Mar	787	0.20	1.00
Apr	514	0.28	1.38
May	146	0.40	2.00
Jun	220	0.46	2.31
Jul	37	0.54	2.69
Aug	22	0.41	2.06
Sep	7	0.29	1.44
Aug-Oct 1992 (excluding 10/28 storm)	10.5	0.9	4.38
Aug-Sep 1993	28.9	0.7	3.50

TABLE IV-4
SUMMARY OF LAGOON CONDITIONS, 1992-1993

Period	Lagoon Conditions	Lagoon Elevations (ft. NGVD)	Max. Tide Range (ft. NGVD)	Berm Height (ft. NGVD)	Maximum Salinity (ppt)	Peak 6 hr. Avg. Wave Power (ft-lbs/ft-s)	Wave Steepness (h/l)	Mean Inflows (cfs)	Peak Inflows (cfs)	Comments
5/01 - 5/26/92	Open, Tidal on Spring Tides	3.0 - 4.8	-3.7 +3.9	3		2866	0.017	1	1.2	
5/27 - 6/08/92	Lagoon gage out	?	-3.8 +4.5	?		3540	0.02	0.71	0.71	
6/08 - 6/24/92	Open, Tidal on Spring Tides Closing on High Tide	3.0 - 4.6	-3.9 +3.7	3		2627	0.023	0.56	NA	Closes on higher highs, fills for about 1-day, and breaches on low tide
6/24/92	**Closure Event**	**4.0 - 4.2**	**-1.0 +2.9**	**6**		**2600**	**0.006**	**0.5**	**0.5**	
6/24 - 6/29/92	Fully Closed	3.0 - 5.5	-3.2 +4.2	6		1142	0.005	0.44	NA	Rapid filling due to early summer inflows
6/29 - 7/04/92	Open, Tidal on Spring Tides	3.0 - 5.0	-3.8 +4.4	3		2394	0.02	3.5	15	1.4" storm on 29th and 30th breaches lagoon
7/05 - 7/08/92	Open, Tidal on Spring Tides Closing on High Tide	3.0 - 4.5	-2.5 +3.6	3		1920	0.023	0.35	0.35	Similar to early June behavior
7/08 - 10/29/92	Fully Closed	5.5 - 2.0	-3.3 +4.3	6	6.0 - 15.0	3100	0.018	0.1	0.30	Closed lagoon; losses exceed inflows
10/29/92	Open, Tidal on Spring Tides	3.5 - 6.0	-2.5 +4.1	3.5		5400	0.026	3.3	20	First winter storm (2")
10/30 - 12/01/92	Closed, temporary breaches	3.2 - 5.5	-3.8 +4.4	3.2 - 6	16.5	5300	0.016	0.02	0.2	
12/02 - 12/10/92	Transitional breaching	3.1 - 5.8	-3.4 +4.7	3.1	0.2	11503	0.021	40	160	First major winter storms
12/11/92 - 2/4/93	Open, Partially Tidal	1.3 - 5.5	-4.1 +5.1	1.3 - 3.3	0	6700	0.02	39	400	Tidal lagoon with periods of high storm flows Beach berm is severely eroded
2/04 - 3/08/93	Lagoon gage out	NA	-3.3 +4.9		0	10580	0.019	34	130	Beach berm builds rapidly during this period
3/93	**Closure Event**	**NA**	**-1.8 +2.6**	**4.5**		**8000**	**0.01**	**17**	**18**	
3/08 - 6/16/93	Open, Nontidal	4.5 - 3.0	-3.6 +4.0	3.5	0 - 18.5	NA	NA	7.2	70	High inflows, only highest tides enter lagoon
6/16 - 6/29/93	Open, Tidal on Spring Tides	3.0 - 4.5	NA	3		NA	NA	1.6	2	
6/30 - 7/31/93	Open, Tidal on Spring Tides Closing on High Tide	3.4 - 5.6	NA	3.4	31	NA	NA	0.62	1	Temporary closures, lasting as long as 2-days Closures appear to occur on higher high tides
8/1/93	**Closure Event**	**5.0**	**-3.7 +3.3**	**6**		**NA**	**NA**	**0.4**	**0.4**	
8/1 - 9/15/93	Fully Closed	5.5 - 2.8	NA	6		NA	NA	0.29	0.4	Rapid decline in water level

TABLE IV-5

SUMMARY OF WATER QUALITY DATA FOR REDWOOD CREEK AND GREEN GULCH

Proj #925, Redwood Creek Wells
Compilation of Water Quality Data

Location	Date	Q (cfs)	Conduct. (us/cm)	pH	Temp. (C)	D.O. (mg/l)	Fecal Colif. (#/100ml)	NO2&3 (mg/l)	Phos (mg/l)	Turb. (NTU)	NH3	Data Source
Muir Woods	01/31/86	51.00	136	7	12	10.4	77	<.1	0.01			USGS
Muir Woods	06/26/86	0.77	212	7.3	14	9.8	290	<.1	0.01			USGS
Muir Woods	02/13/87	114.00	118	7.9	12.5	10.4	46	0.14	0.08			USGS
Muir Woods	06/10/87	0.62	215	7.5	14	8.7	5	<.1	<.1			USGS
Muir Woods	01/05/88	42.00	148	7.8	10	11.1	27	0.22	0.01			USGS
Muir Woods	06/07/88	0.70	225	7.9	13.5	9.2	34	0.1	<.1			USGS
Above Banducci	11/14/90			7.5	9		30	<.05		0.7		MBCC
Above Banducci	12/11/90			7.6	9		23	<.05		3		MBCC
Above Banducci	01/22/91			7.8	6			0.1		0.2		MBCC
Above Banducci	02/05/91			7.8	9		130	0.55				MBCC
Above Banducci	02/20/91			7.8	10		4	0.32		0.9		MBCC
Above Banducci	03/04/91			7.7	10		110	0.35		13		MBCC
Above Banducci	03/13/91			7.7	9		30	0.23		9.5		MBCC
Above Banducci	03/27/91			7.5	9		30	0.32		16		MBCC
Above Banducci	08/31/93						23	<.012	<.01		<.05	PWA
Above Banducci	08/31/93						33	<.012	<.01		<.05	PWA
Above Banducci	08/31/93						49	<.012	<.01		<.05	PWA
Below Banducci	08/31/93						240	0.011	<.01		<.05	PWA
Below Banducci	08/31/93						140	<.012	<.01		<.05	PWA
Below Banducci	08/31/93						540	0.021	0.094		<.05	PWA

TABLE IV-5 (continued)

Location	Date	Q (cfs)	Conduct. (us/cm)	pH	Temp. (C)	D.O. (mg/l)	Fecal Colif. (#/100ml)	NO2&3 (mg/l)	Phos (mg/l)	Turb. (NTU)	NH3	Data Source
Pacific Way	01/31/86	86.00	155	7.2	12	10.2	870	0.19	0.01			USGS
Pacific Way	06/26/86	0.66	226	7.4	14	8.8	110	<.1	0.01			USGS
Pacific Way	03/13/87	30.00	178	7.3	11.5	10.7	8000	0.1	<.01			USGS
Pacific Way	06/12/87	0.68	228	7.8	12.5	8.6	280	<.1	<.01			USGS
Pacific Way	01/05/88	73.00	176	7.5	10.5	10.8	50	0.58	0.02			USGS
Pacific Way	06/07/88	0.78	242	7.9	12	9.4	110	0.39	<.01			USGS
Pacific Way	08/31/93						>2400	0.021	0.013		<.05	PWA
Pacific Way	08/31/93						>2400	0.015	<.01		<.05	PWA
Pacific Way	08/31/93						920	<.012	<.01		<.05	PWA
Upper Green Gulch	01/30/86	9.90	202	7.2	12.5	10.1	370	1	<.01			USGS
Upper Green Gulch	06/25/86	0.01	463	7.4	15.5	7.4	13	<.1	0.02			USGS
Upper Green Gulch	03/13/87	1.20	261	7.4	14	10.2	500	0.68	<.01			USGS
Upper Green Gulch	06/12/87	0.01	518	7.4	13.5	6.4	23	0.54	<.01			USGS
Upper Green Gulch	03/23/88	0.04	434	7.6	12.5	7.5	10	0.82	<.01			USGS
Upper Green Gulch	06/02/88	0.01	461	7.6	13	6.3	3	<.1	<.01			USGS
Lower Green Gulch	08/31/93						240	<.012	<.01		<.05	PWA
Lower Green Gulch	08/31/93						110	<.012	<.01		<.05	PWA
Lower Green Gulch	08/31/93						130	<.012	0.02		<.05	PWA

TABLE IV-6

NITROGEN AND PHOSPHORUS LEVELS (mg/l) IN REDWOOD CREEK WATERSHED IN 1992 AND 1993

Site	Date		N as NO	N as NH3	P as PO4
Beach Footbridge	17 Jun 92		0.8	--	0.15
	23 Jul 92		ND	ND	0.1
	4 Jun 93		ND	ND	0.1
	4 Jun 93	rain	0.5	0.3	0.2
	9 Jun 93		0.7	0.2	0.1
	24 Jun 93		1.7	ND	0.1
	19 Aug 93		0.7	ND	0.1
Backwater above Delta	17 Jun 92		ND	--	0.1
	4 Jun 93		ND	0.2	0.2
	9 Jun 93		2.6	0.2	0.1
	24 Jun 93		1.1	ND	0.1
	19 Aug 93		0.5	0.2	0.1
Culvert from Green Gulch	17 Jun 92		ND	--	0.3
	4 Jun 93		1.2	0.2	0.03
Green Gulch Channel	17 Jun 92		ND	--	0.1
	23 Jul 92		ND	0.2	0.15
	4 Jun 93	rain	1.1	0.2	0.3
	9 Jun 93		1.1	0.6	0.1
	24 Jun 93		ND	ND	0.2
	19 Aug 93		1.6	ND	0.1
Road Bridge @ Muir Beach	17 Jun 92		1.0	ND	1.5
	23 Jul 92		ND	0.2	0.15
	4 Jun 93	rain	1.6	0.3	0.1
	9 Jun 93		0.1	ND	0.05
	24 Jun 93		1.8	ND	0.1
	19 Aug 93		0.4	ND	0.1
Downstream of Diversions	24 Jun 93		ND	ND	0.1

Table IV - 7

Aquatic insects found at Big Lagoon from September 1992 through July 1993.

Order	**Common Name**	**Family**
Coleoptera	Predaceous water beetle	Dytiscidae
Coleoptera	Whirligig water beetle	Gyrinidae
Coleoptera	Scavenger water beetle	Hydrophilidae
Coleoptera	Crawling water beetle	Haliplidae
Coleoptera	Round sand water beetle	Omophronidae
Hemiptera	Backswimmer	Notonectidae
Hemiptera	Water boatman	Corixidae
Hemiptera	Giant water bug	Belostomatidae
Hemiptera	Waterscorpion	Nepidae
Hemiptera	Water Strider	Gerridae
Ephemeroptera	Small mayfly	Baetidae
Odonata	Dragon flies	Aeshnidae
Odonata	Damsel flies	
Trichoptera	Caddis flies	Leptoceridae
Plecoptera	Stone flies	
Diptera		Dixidae
Diptera		Chaeoboridae
Diptera	Midge	Chironomidae
Diptera		Ceratopagonida
Diptera	Mosquito	Culicidae
Collembola	Springtail	Poduridae

Table IV- 8

Bird survey dates, times, and station coverage at Big Lagoon, May 29, 1992 to August 9, 1993.

	Date	5/29/92	7/28/92	10/22/92	11/25/92	1/20/93	2/5/93	4/13/93	5/5/93	6/10/93	7/11/93	8/9/93
	Time	1100-1410	0700-1030	0840-1205	0740-1110	0840-0930	0845-1100	0715-0935	0820-1115	0810-1115	0750-1100	0740-1030
STATION												
1		●	●	●	●		●	●	●	●	●	●
2		●	●	●	●		●	●	●	●	●	●
3			●	●	●		●	●	●	●	●	●
4		●	●	●	●		●	●	●	●	●	●
5		●	●	●	●		●	●	●	●	●	●
6		●	●	●	●		●	●	●	●	●	●
7			●	●	●		●	●	●	●	●	●
8		●	●	●	●	●	●	●	●	●	●	●
9								●	●	●	●	●
10		●	●	●	●		●	●	●	●	●	●
11			●	●	●		●	●	●	●	●	●
12		●	●	●	●	●	●	●	●	●	●	●
13		●	●	●	●	●	●	●	●	●	●	●
14						●						
20		●	●	●	●		●	●	●	●	●	●
30		●	●	●	●							

Bird species recorded at Big Lagoon on 1992-1993 surveys and as incidental sitings. **Table IV- 9**

Numbered species were recorded during 10-min. station counts, arranged here in decreasing order of total abundance.

= total n all sightings * observed at qualititatively surveyed beach station • observed outside bird station boundaries or on non-survey day

Terrestrial Associates

Feeding on terrestrial vegetation/associated insects

Brewer's Blackbird	188	Audubon's Warbler	7	Black-throated Gray Warbler	•
Red-winged Blackbird	110	Swainson's Thrush	6	Brown Creeper	•
Pine Siskin	89	American Crow	5	California Quail	•
Song Sparrow	52	Hermit Thrush	5	Cedar Waxwing	•
House Finch	48	Northern Flicker	4	Downy Woodpecker	•
Chestnut-backed Chickadee	35	Black-headed Grosbeak	3	Olive-sided Flycatcher	•
Rock Dove	25	Purple Finch	3	Steller's Jay	•
American Goldfinch	21	Fox Sparrow	2	Townsend's Warbler	•
White-crowned Sparrow	21	Marsh Wren	2	Tri-colored Blackbird	•
Anna's Hummingbird	18	American Redstart	1	White-breasted Nuthatch	•
Wilson's Warbler	17	Hairy Woodpecker	1	Yellow Warbler	•
Golden-crowned Sparrow	17	House Wren	1	Bushtit	•
Mourning Dove	15	Lesser Goldfinch	1		
Scrub Jay	15	Pygmy Nuthatch	1		
European Starling	12	Rufous-sided Towhee	1		
American Robin	11	Bewick's Wren	1		
California Towhee	10				
Ruby-crowned Kinglet	10				

Aerial Insect Feeders

Tree Swallow	39				
Barn Swallow	38				
Northern Rough-winged Swallow	37				
Black Phoebe	10				
Cliff Swallow	10				
Violet-green Swallow	10				

Raptors

		Turkey Vulture	3	American Kestrel	•
		Red-tailed Hawk	1	Black-shouldered Kite	•
				Cooper's Hawk	•
				Great-horned Owl	•
				Northern Harrier	•
				Peregrine Falcon	•
				Red-shouldered Hawk	•

Wetland Associates

Benthic invertebrate feeders

Killdeer	21			Black Oystercatcher	*
Western Gull	7			Marbled Godwit	*
Herring Gull	3			Ring-billed Gull	*
Lesser Yellowlegs	1			Whimbrel	*
Spotted Sandpiper	1			Willet	*
Mew Gull	•			Brown Pelican	*
Wandering Tattler	•			California Gull	•
				Common Snipe	•

Piscivores

Great Blue Heron	8			Double-crested Cormorant	1
Snowy Egret	7			Horned Grebe	1
Black-crowned Night Heron	4			Green-backed Heron	•
Belted Kingfisher	2			Osprey	•
Great Egret	2				

Feeding on aquatic vegetation/ associated invertebrates

Mallard	119			American Coot	•
American Wigeon	105			Cinnamon Teal	•
Common Yellowthroat	3			Brant	•
American Green-winged Teal	1			Canada Goose	•
Barrow's Goldeneye	1			Common Merganser	•
Common Goldeneye	1			Eurasian Wigeon	•
Red-necked Phalarope	1			Virginia Rail	•
				Bufflehead	•

Number of bird species and individuals recorded at 15 stations in Big Lagoon, 1992-1993.

Table IV-10

No.	STATIONS Locations	Approx. Size (m2)	TOTAL OBSERVED (total all surveys) species	indiv.	# SURVEYS	AVERAGE #/SURVEY species mean	sd	individuals mean	sd	AVERAGE #/m2 (x.001) species rank	mean	sd	individuals rank	mean	sd
1	Lagoon	2000	26	97	10	2.6	3.20	9.7	7.45	10	1.3	1.60	10	4.9	3.73
2	Riparian Footpath	600	24	159	10	2.4	2.66	15.9	22.9	4	4.0	4.43	4	26.5	38.17
3	above bridge	600	15	45	9	1.7	1.39	5.0	2.5	8	2.8	2.32	9	8.3	4.17
4	above bridge	600	20	88	10	2.0	2.49	8.8	6.86	7	3.3	4.14	6	14.7	11.43
6	Redwood Creek	450	16	54	10	1.6	1.26	5.4	4.45	6	3.6	2.81	7	12.0	9.89
7		450	15	44	9	1.7	1.80	4.9	4.73	5	3.7	4.01	8	10.9	10.51
5	Riparian Vegetation	250	18	119	10	1.8	1.52	11.9	15.28	3	7.2	6.10	2	47.6	61.11
9		250	12	37	5	2.4	1.22	7.4	4.28	2	9.6	4.90	3	29.6	17.11
8	Pasture	2500	20	130	11	1.8	0.83	11.8	10.34	12	0.7	0.33	11	4.7	4.14
12		2500	17	83	12	1.4	1.45	6.9	5.01	13	0.6	0.58	13	2.8	2.00
13		2500	14	115	13	1.1	1.37	8.8	17.80	14	0.4	0.55	12	3.5	7.12
10	Dense willows	150	15	73	10	1.5	1.62	7.3	16.48	1	10.0	10.80	1	48.7	109.86
11	Kikuyu meadow	1600	13	277	9	1.4	1.59	30.8	75.23	11	0.9	0.99	5	19.2	47.02
20	Beach (qualitative)	n/a	10	142	10	1	1.5	14.2	16.78						
30	Chaparral	500	4	5	4	1.0	0.82	1.3	0.96	9	2.0	1.63	14	2.5	1.91

Table IV - 11

Sensitive bird species recorded at Big Lagoon according to federal, state or county listings.*

SPECIES	STATUS			
	Federal	State	Audubon	Marin County
I All Life Stages Considered Sensitive				
American Peregrine Falcon	Endangered	Endangered		
Black Oystercatcher				•
California Brown Pelican	Endangered	Endangered		
Common Merganser				•
Common Yellowthroat, Saltmarsh subspecies	Candidate 2	Special Concern		
Green-backed Heron				•
Olive-sided Flycatcher	Management Concern			
Red-shouldered Hawk			•	
Tricolored Blackbird	Candidate 2	Special Concern		
Virginia Rail				•
Yellow Warbler		Special Concern	•	
II Only Nest Sites/Rookeries Considered Sensitive				
Barrow's Goldeneye		Special Concern (breeding)		
Black-crowned Night Heron		NDDB** listing (rookeries)		•
Black-shouldered Kite		NDDB listing (nesting)		
California Gull		Special Concern (nesting colony)		
Cooper's Hawk		Special Concern (nesting)	•	
Double-crested Cormorant		Special Concern (rookery)		
Great Blue Heron		NDDB listing (rookeries)		•
Great Egret		NDDB listing (rookeries)		•
Northern Harrier		Special Concern (nesting)	•	
Osprey		Special Concern (nesting)		
Snowy Egret		NDDB listing (rookeries)		•

* California Department of Fish and Game. 1993; California Department of Fish and Game. 1992a; California Department of Fish and Game. 1992b; Tate, J. 1986; Shuford, W. D. 1993. ** Natural Diversity Data Base

TABLE IV-12

DENSITY ESTIMATES (number of fish per 100 feet) FOR COHO AND STEELHEAD COLLECTED ON REDWOOD CREEK IN 1992 AND 1993

(*Data for site 5 are actual capture totals, not density estimates).

Site	Sample Date	Habitat Types Sampled				Length Sampled	Density		
							Coho	Steelhead	
		Pool	Glide	Run	Riffle	(feet)		0+	½+
1. Muir Woods	20 Aug 92	30%	53%	12%	5%	302	84	19	8
	24 Jun 93	45	23	22	9	233	91	52	4
2. 3rd Bridge	19 Sep 92	60	15	7	19	166	30	16	7
	19 Aug 93	63	12	10	15	253	30	26	5
3. Downstream of Diversions	19 Sep 92	19	37	dry		250	13	6	1
						129 wet			
	14 Nov 92					250	4	6	0.4
	24 Jun 93	55	29	9	7	210	25	90	3
	10 Sep 93	51	34	9	6	221	16	72	4
4. 1st Bridge	23 Jul 92	39	56	2	4	314	54	49	1
	14 Aug 92								
	14 Nov 92	39	56	2	4	314	33	29	2
	8 Jun 93	27	35	32	5	255	39	55	4
	10 Sep 93	26	49	16	9	271	14	34	1
5. *Pools Above Delta	23 Jul 92	70	30			200	59	22	3
	14 Aug 92	70	30			200	6	2	3
	14 Nov 92	70	30			200	0	0	0
	4 Jun 93	99				50	29	14	4
	8 Jun 93	70	30			200	17	6	2
	19 Aug 93	70	30			200	6	16	0
	10 Sep 93	70	30			200	4	9	0

TABLE IV-13

DISSOLVED OXYGEN (mg/l) IN THE POOL UPSTREAM OF THE FOOT BRIDGE ON REDWOOD CREEK AT MUIR BEACH IN 1992 AND 1993.

	1992 Dates								
Depth (m)	**17 Jun 11:10** Cloudy	**23 Jun 11:30** Fair	**16:50**	**14 Aug 10:15** Overcast	**16:50**	**19 Sep 9:20** Overcast	**17:20**	**14 Nov 9:30** Fair	**14:35**
Surface	9.9	8.6	10.2	6.8	9.5	4.3	4.7	8.9	9.3
0.25	9.7	8.4	10.2	6.4	9.4	4.2	4.5	8.6	9.1
0.5	9.7	8.2	10.3	5.4	9.0	4.0	4.5	8.4	8.9
0.75	9.7	8.6	10.3	4.5	6.1	3.8	4.5	8.3	7.7
0.8						3.8	4.3		
1.0	9.8	18.0		20+	4.2	4.2		6.2	6.3
1.1	9.9							6.0	5.9
1.15		20+	17.3						
1.2				1.9	2.7				

	1993 Dates					
Depth (m)	**4 Jun 9:45** Rain	**9 Jun 17:00** Fair	**24 Jun 18:30** Fair	**19 Aug 9:00/17:15** Fair by 10:00		**10 Sep 9:40** Overcast
Surface	9.2	10.0	9.2	5.9	8.8	6.5
0.25	9.1	9.9	9.2	5.9	8.5	6.2
0.5	9.0	9.8	9.0	5.9	9.1	4.7
0.75	9.0	9.8	9.0	6.0	9.3	4.7
1.0	9.0	9.8	8.8	6.1	9.1	5.0
1.15			8.6	5.8	9.5	
1.2						4.2
1.25	8.8	8.2				
1.35	3.6					

TABLE IV-14

SALINITIES OF REDWOOD CREEK LAGOON IN 1992 AND 1993

Depth	1992 Dates				
(m)	17 Jun*	23 Jun	14 Aug	19 Sep	14 Nov
Surface	0.0	0.6	5.3	5.4	3.6
0.05	1.0				
0.15	1.0				
0.2	6.6				
0.25	13.3	0.6	5.3	5.5	3.9
0.5	19.9	0.6	5.3	5.6	18.1
0.65				5.6	
0.75	21.5	0.6	5.3		21.8
0.8			5.3		
1.0		0.6			26.6
1.05		2.3			
1.15		4.2			26.6

Depth	1993 Dates				
	4 Jun*	9 Jun*	24 Jun*	19 Aug	10 Sep
Surface	0.6	0.2	0.1	0.5	0.7
0.25	2.6	0.2	0.1	0.6	0.7
0.3	9.3				
0.5	16.3	0.2	0.1	0.6	0.7
0.55		0.1			
0.65					0.7
0.7		0.2			
0.75				1.1	
0.8	19.0				
0.9	19.3			3.6	
1.0				6.7	
1.2				7.6	

* sandbar was open.

888/888muir.tbl/1/13/94

TABLE IV-15

WATER TEMPERATURES IN REDWOOD CREEK LAGOON IN 1992 AND 1993

	1992 Dates							
Depth	**17 Jun***	**23 Jun**		**14 Aug**		**19 Sep**	**14 Nov**	
(m)	**14:00**	**10:50**	**18:10**	**10:50**	**17:10**	**10:00**	**9:55**	**15:05**
Surface	16.9	20.1	23.5	18.4	21.2	15.6	11.7	16.0
0.05	17.6							
0.15	17.4							
0.2	17.4							
0.25	18.8	19.8	23.7	19.0	21.3	15.8	11.4	15.6
0.5	20.1	19.6	23.8	19.4	21.3	15.8	16.0	17.3
0.65				16.3				
0.75	20.5	19.7	23.8	19.4	21.3		20.3	20.4
0.8		19.4	21.3					
1.0		19.7	23.8				21.3	21.7
1.05		19.8						
1.15		19.8	23.7				22.2	22.4

	1993 Dates					
Depth	**4 Jun***	**9 Jun**	**24 Jun***	**19 Aug**		**10 Sep**
(m)	**12:05**	**18.05**	**19:35**	**10:10**	**17:45**	**10:15**
Surface	14.6	16.4	19.7	16.6	20.8	18.4
0.25	14.6	17.3	19.8	17.0	21.3	18.3
0.3	14.7					
0.5	15.4	17.0	19.6	16.9	21.3	18.6
0.55			19.6			
0.65						18.6
0.7		16.6				
0.75	16.4			16.9	21.4	
0.8	16.4					
0.9				18.6	21.4	
1.0				20.2	23.1	
1.2				20.6	23.1	

TABLE IV-16

NUMBER OF FISH OF DIFFERENT SPECIES COLLECTED BY SEINE IN THE LAGOON/ESTUARY AT MUIR BEACH IN 1992 AND 1993

Species	1992			1993	
	23 Jul	14 Aug	14 Nov	4 Jun	19 Aug
Steelhead		24			16
Coho				21	
Threespine Stickleback	1000+	+	+	1000+	500+
Staghorn Sculpin	3	4		7	
Striped Bass	5	65	21		3
Yellowfin Goby					1
Starry Flounder		1			

Table IV - 17

Special species recognized by CNPS (Smith and Berg 1988) which may have historically occurred at Big Lagoon. Code is the status recognized by the CNPS: larger number indicates greater problem concerning: rarity - endangerment - distribution.

Scientific Name	Common Name	Code	Habitat
Alopecurus aequalis var. *sonomensis*	Sonoma alopecurus	3-3-3	marsh
Elymus californicus	California bottlebrush grass	1-1-3	forest
Calamagrostis crassiglumis	Thurber's reed grass	3-3-1	marsh
Campanula californica	Swamp harebell	1-2-3	marsh
Cordylanthus maritimus var. *palustris*	Point Reyes bird's beak	2-2-2	salt marsh
Erysimum franciscanum	San Francisco wallflower	1-2-3	dunes
Grindelia humilis	Marsh gumplant	1-1-3	salt marsh
Layia carnosa	Beach layia	3-3-3	dunes
Lupinus tidestromii var *layneae*	Point Reyes lupine	3-3-3	dunes
Pleuropogon refractus	Nodding semaphore grass	1-2-1	forest
Polygonum marinense	Marin knotweed	3-3-3	salt marsh

TABLE IX-1

WATER BALANCE FOR ALTERNATIVE B -- HISTORIC WETLAND

Month	Inflow Volume (ac-ft)	Open Water Evaporation Losses (ft)	Open Water Evaporation Losses (ac-ft)	PET Losses by Wetland Plants (ft)	PET Losses by Wetland Plants (ac-ft)	Total Losses (ac-ft)	Drop in Water Level (ft)	Turnover Frequency (per period)
Mar. 92	875	0.16	0.80	0.20	2.24	3.04	0.0	68.4
Apr	213	0.22	1.10	0.28	3.08	4.18	0.0	16.7
May	56	0.32	1.60	0.40	4.48	6.08	0.0	4.4
Jun	72	0.37	1.85	0.46	5.18	7.03	0.0	5.7
Jul	17	0.43	2.15	0.54	6.02	8.17	0.0	1.4
Aug	7.3	0.33	1.65	0.41	4.62	6.27	0.0	0.6
Sep	2.7	0.23	1.15	0.29	3.22	4.37	0.3	0.2
Oct	7.1	0.14	0.70	0.18	1.96	2.66	0.0	0.6
Nov	1.5	0.06	0.30	0.08	0.84	1.14	0.0	0.1
Dec	927	0.03	0.15	0.04	0.42	0.57	0.0	72.4
Jan 93	3892	0.02	0.10	0.03	0.28	0.38	0.0	304.0
Feb	2246	0.05	0.25	0.06	0.70	0.95	0.0	175.5
Mar	787	0.16	0.80	0.20	2.24	3.04	0.0	61.5
Apr	514	0.22	1.10	0.28	3.08	4.18	0.0	40.1
May	146	0.32	1.60	0.40	4.48	6.08	0.0	11.4
Jun	220	0.37	1.85	0.46	5.18	7.03	0.0	17.2
Jul	37	0.43	2.15	0.54	6.02	8.17	0.0	2.9
Aug	22	0.33	1.65	0.41	4.62	6.27	0.0	1.7
Sep	7	0.23	1.15	0.29	3.22	4.37	0.0	0.5
Aug-Oct 1992 excluding 10/28 storm)	10.5	0.7	3.50	0.9	9.80	13.30	0.6	0.8
Aug-Sep 1993	28.9	0.6	2.80	0.7	7.84	10.64	0.0	2.3
Annual Total						44.84		

TABLE IX-2

WATER BALANCE FOR ALTERNATIVE C --
HISTORIC WETLAND, PRESERVE EXISTING RIPARIAN HABITAT

Month	Inflow Volume (ac-ft)	Open Water Evaporation Losses (ft)	Open Water Evaporation Losses (ac-ft)	PET Losses by Wetland Plants (ft)	PET Losses by Wetland Plants (ac-ft)	Total Losses (ac-ft)	Drop in Water Level (ft)	Turnover Frequency (per period)
Mar. 92	875	0.16	0.74	0.20	1.50	2.24	0.0	78.1
Apr	213	0.22	1.01	0.28	2.06	3.07	0.0	19.0
May	56	0.32	1.47	0.40	3.00	4.47	0.0	5.0
Jun	72	0.37	1.70	0.46	3.47	5.17	0.0	6.5
Jul	17	0.43	1.98	0.54	4.03	6.01	0.0	1.5
Aug	7.3	0.33	1.52	0.41	3.09	4.61	0.0	0.7
Sep	2.7	0.23	1.06	0.29	2.16	3.21	0.1	0.2
Oct	7.1	0.14	0.64	0.18	1.31	1.96	0.0	0.6
Nov	1.5	0.06	0.28	0.08	0.56	0.84	0.0	0.1
Dec	927	0.03	0.14	0.04	0.28	0.42	0.0	82.8
Jan 93	3892	0.02	0.09	0.03	0.19	0.28	0.0	347.5
Feb	2246	0.05	0.23	0.06	0.47	0.70	0.0	200.5
Mar	787	0.16	0.74	0.20	1.50	2.24	0.0	70.3
Apr	514	0.22	1.01	0.28	2.06	3.07	0.0	45.9
May	146	0.32	1.47	0.40	3.00	4.47	0.0	13.1
Jun	220	0.37	1.70	0.46	3.47	5.17	0.0	19.7
Jul	37	0.43	1.98	0.54	4.03	6.01	0.0	3.3
Aug	22	0.33	1.52	0.41	3.09	4.61	0.0	2.0
Sep	7	0.23	1.06	0.29	2.16	3.21	0.0	0.6
Aug-Oct 1992 (excluding 10/28 storm)	10.5	0.7	3.22	0.9	6.56	9.78	0.0	0.9
Aug-Sep 1993	28.9	0.6	2.58	0.7	5.25	7.83	0.0	2.6
Annual Total						32.98		

TABLE IX-3

WATER BALANCE FOR ALTERNATIVE D -- BACKWATER POND AND WETLAND

Month	Inflow Volume (ac-ft)	Open Water Evaporation Losses (ft)	Open Water Evaporation Losses (ac-ft)	PET Losses by Wetland Plants (ft)	PET Losses by Wetland Plants (ac-ft)	Total Losses (ac-ft)	Drop in Water Level (ft)	Turnover Frequency (per period)
Mar. 92	875	0.16	0.35	0.20	1.82	2.17	0.0	125.0
Apr	213	0.22	0.48	0.28	2.50	2.99	0.0	30.5
May	56	0.32	0.70	0.40	3.64	4.34	0.0	8.0
Jun	72	0.37	0.81	0.46	4.21	5.02	0.0	10.3
Jul	17	0.43	0.95	0.54	4.89	5.84	0.0	2.5
Aug	7.3	0.33	0.73	0.41	3.75	4.48	0.0	1.0
Sep	2.7	0.23	0.51	0.29	2.62	3.12	0.2	0.4
Oct	7.1	0.14	0.31	0.18	1.59	1.90	0.0	1.0
Nov	1.5	0.06	0.13	0.08	0.68	0.81	0.0	0.2
Dec	927	0.03	0.07	0.04	0.34	0.41	0.0	132.5
Jan 93	3892	0.02	0.04	0.03	0.23	0.27	0.0	556.0
Feb	2246	0.05	0.11	0.06	0.57	0.68	0.0	320.8
Mar	787	0.16	0.35	0.20	1.82	2.17	0.0	112.4
Apr	514	0.22	0.48	0.28	2.50	2.99	0.0	73.4
May	146	0.32	0.70	0.40	3.64	4.34	0.0	20.9
Jun	220	0.37	0.81	0.46	4.21	5.02	0.0	31.4
Jul	37	0.43	0.95	0.54	4.89	5.84	0.0	5.3
Aug	22	0.33	0.73	0.41	3.75	4.48	0.0	3.1
Sep	7	0.23	0.51	0.29	2.62	3.12	0.0	1.0
Aug-Oct 1992 (excluding 10/28 storm)	10.5	0.7	1.54	0.9	7.96	9.50	0.0	1.5
Aug-Sep 1993	28.9	0.6	1.23	0.7	6.37	7.60	0.0	4.1
Annual Total						32.04		

TABLE X-1

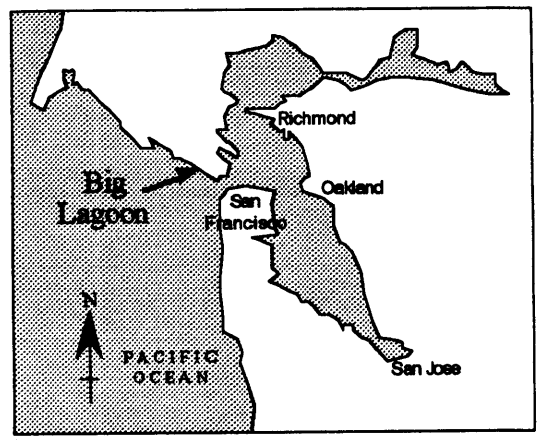
SUMMARY OF POTENTIAL DREDGE DISPOSAL LOCATIONS

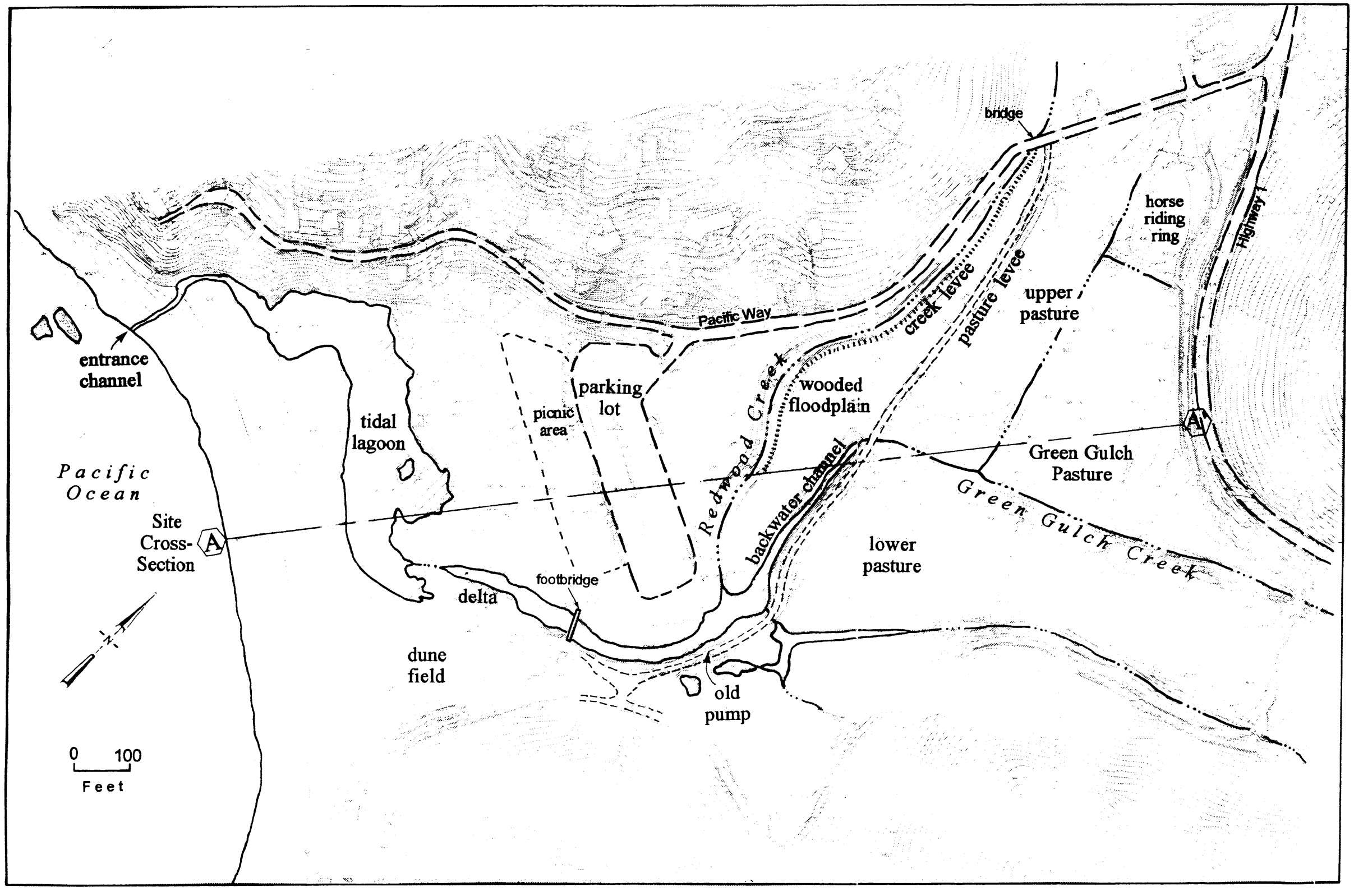
Location	Capacity (cy)	Average Disposal Depth (feet)	Maximum Truck Haul (feet)
Green Gulch Fields 6 and 7	24000	4	1300
Banducci Fields	80,000-120,000	2-3	5800
Riding Ring and State Park Land	24,000-36,000	2-3	7500
Former Ballfield	18,000-27,000	2-3	3000
On-site Uplands Near Hwy 1	20000	8	1000

FIGURES

FIGURE I-1

Big Lagoon Site Location



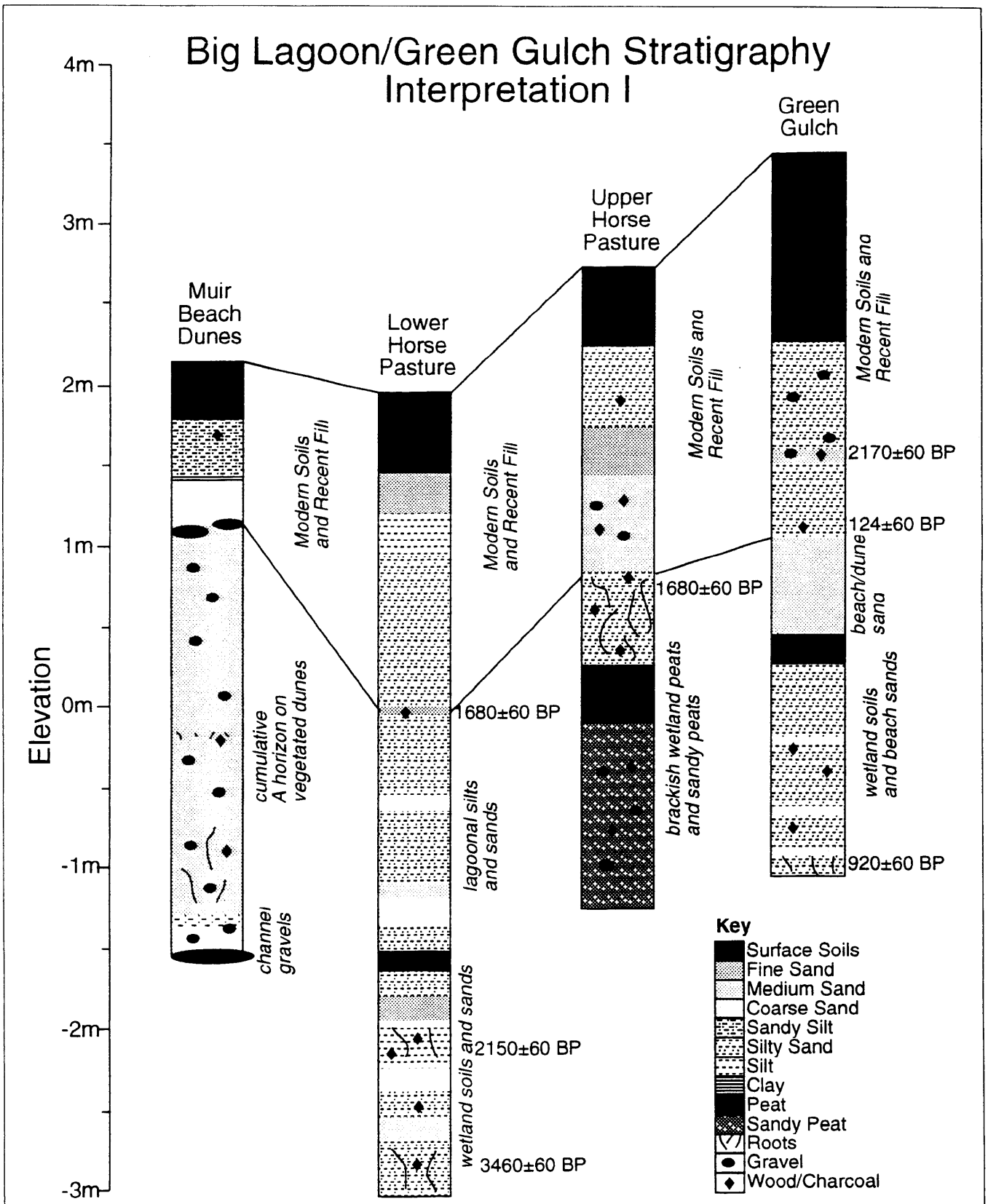


Original Topography by CalTrans,
Photograph Date: 12-20-91

Revised by
Philip Williams & Associates, Ltd.: April, 1993

Scale: 1" = 200'

Philip Williams & Associates, Ltd.



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Soil Corings Profile

Figure
III-2

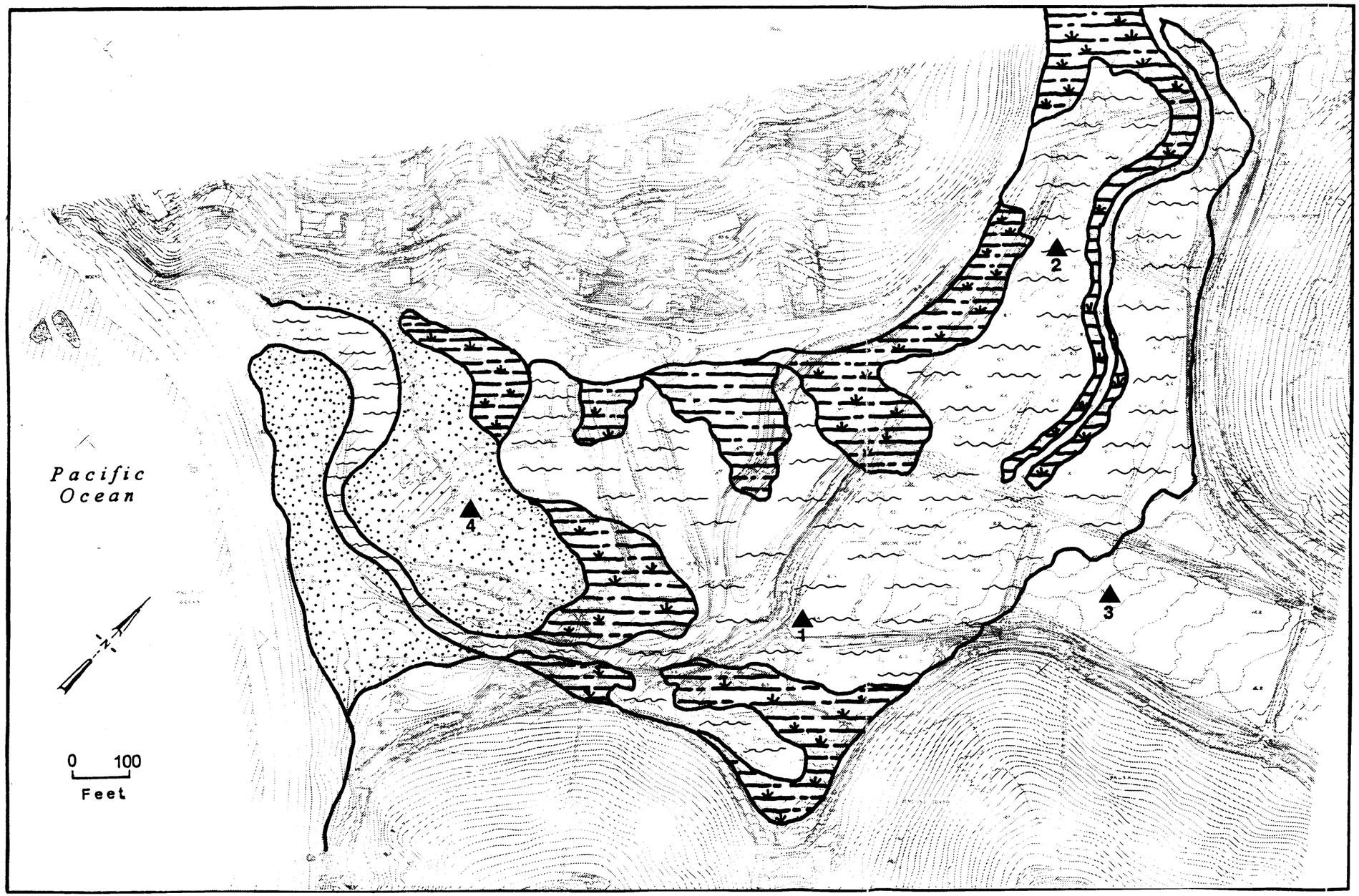

FIGURE III-1

Historic Map of
Big Lagoon, 1853

Source: U.S. Coast and Geodetic Survey, 1853.

LEGEND

- dunes and beach
- wetlands
- open water
- soil corings

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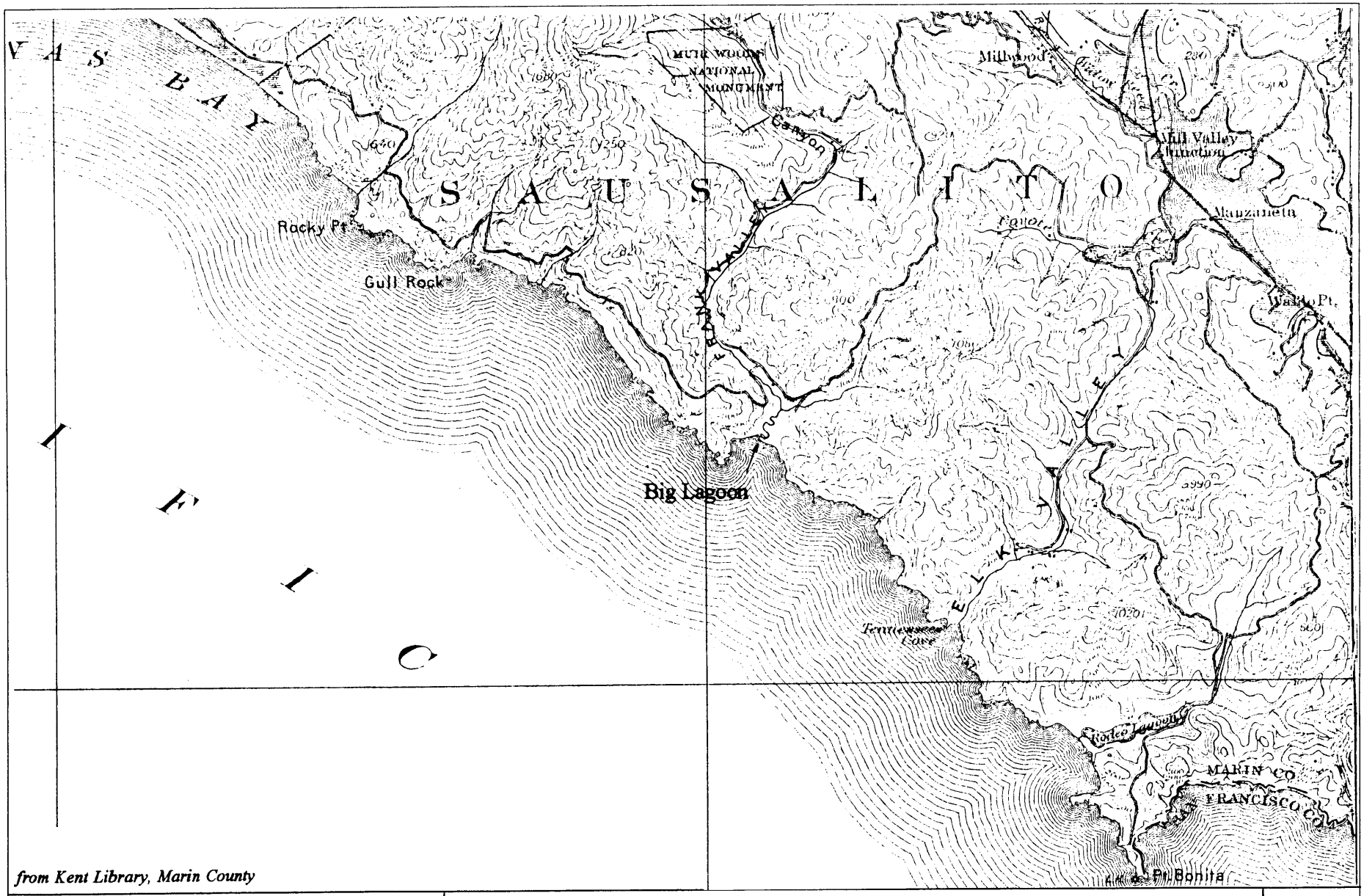

from Kent Library, Marin County

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Lagoon as Shown on 1894 USGS Quadrangle

Figure
III-3

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1946 Aerial Photo
of the Big Lagoon Area

Figure
III-4

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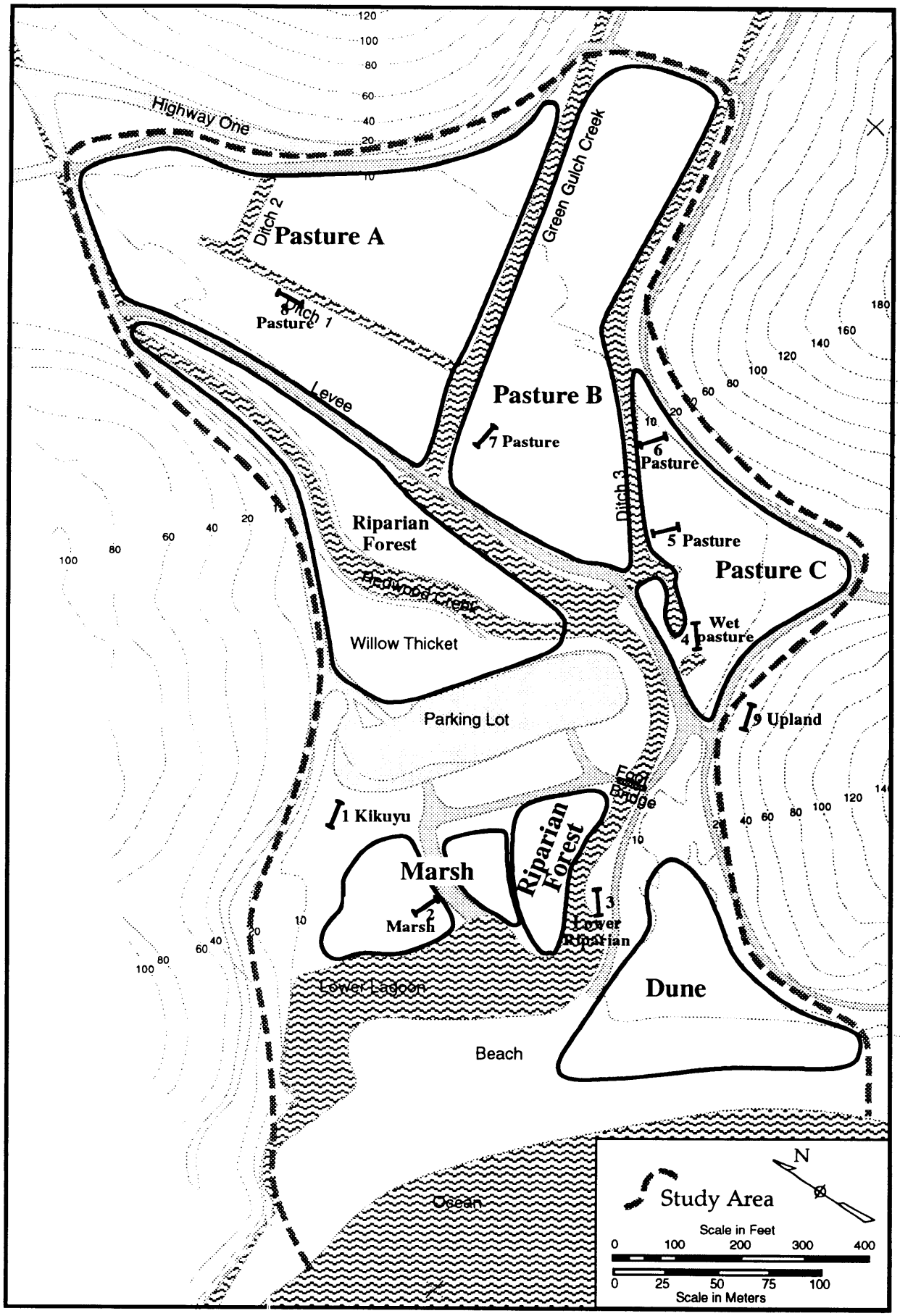
1965 Aerial Photo
of the Big Lagoon Area

Figure
III-5

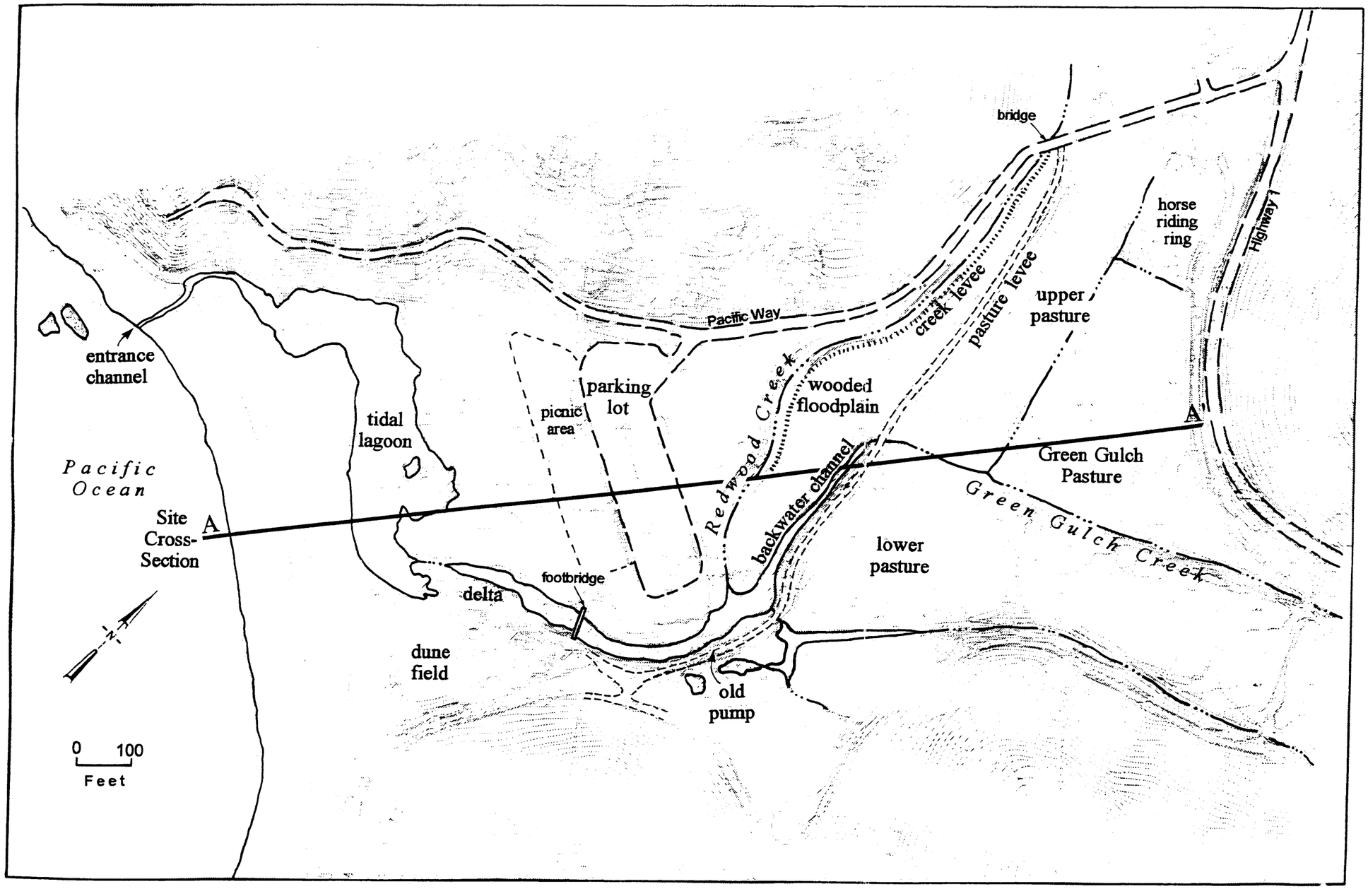


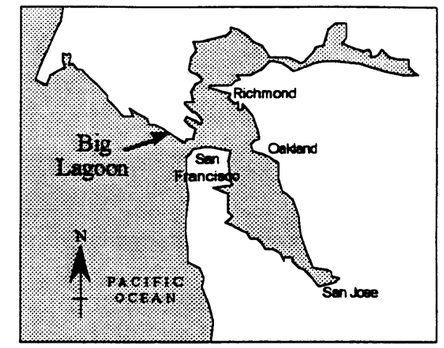
Vegetation types at Big Lagoon.

Figure III-6

FIGURE IV-1

Big Lagoon Site Location



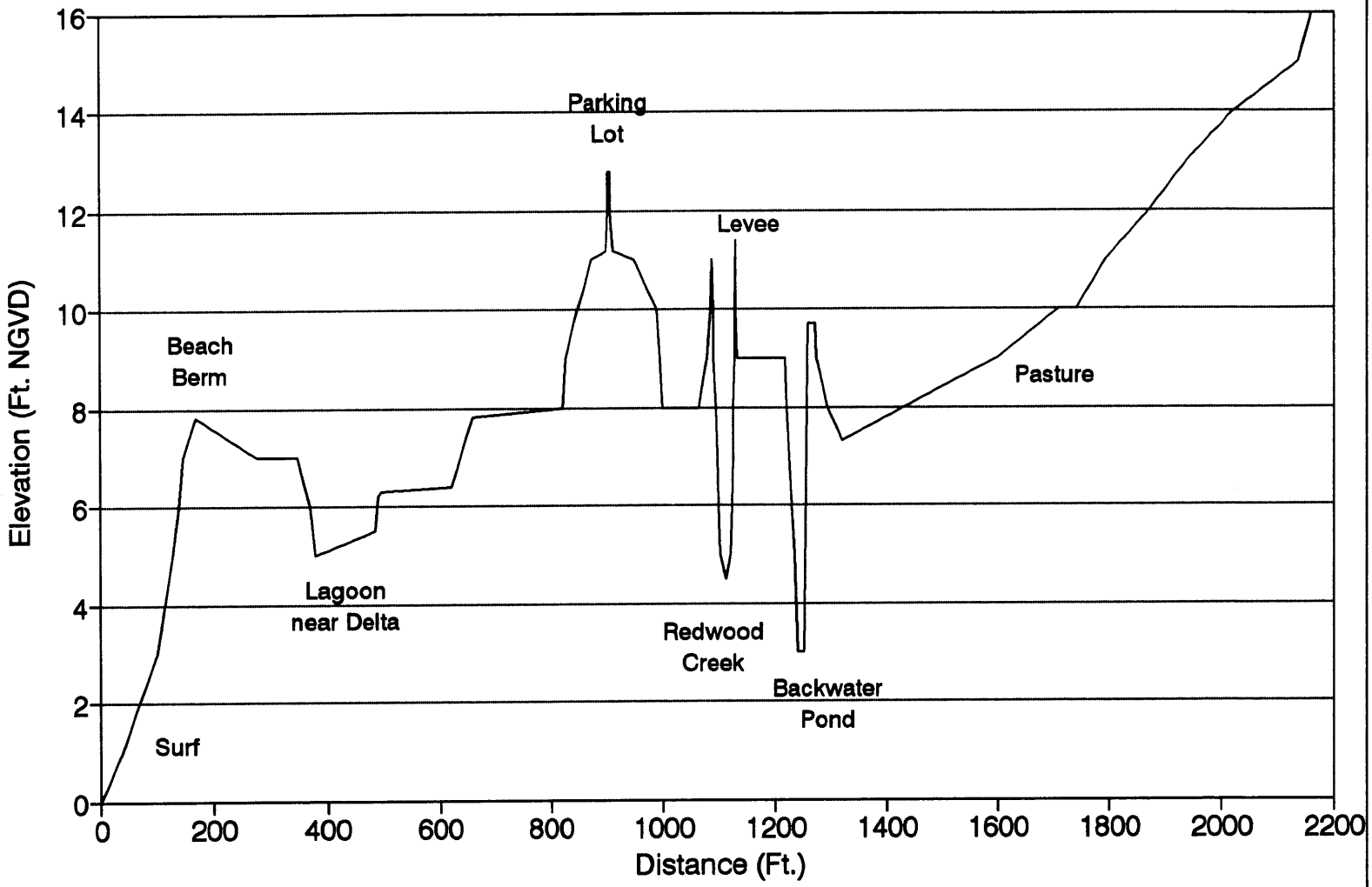


Original Topography by CalTrans, Photograph Date: 12-20-91

Revised by Philip Williams & Associates, Ltd.: April, 1993

Scale: 1" = 200'

Philip Williams & Associates, Ltd.



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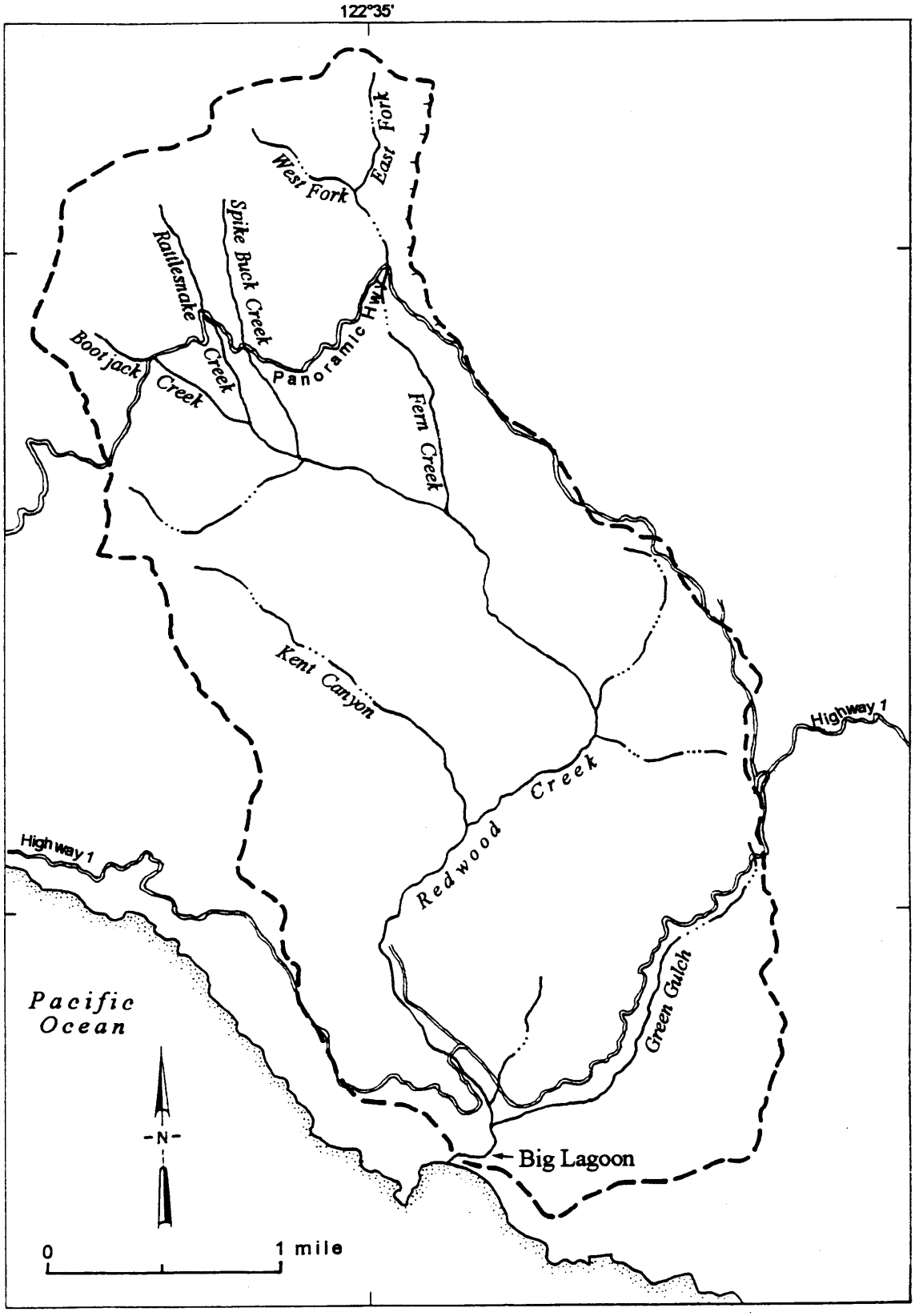
Cross Section of Site (A-A')

Figure
IV-2



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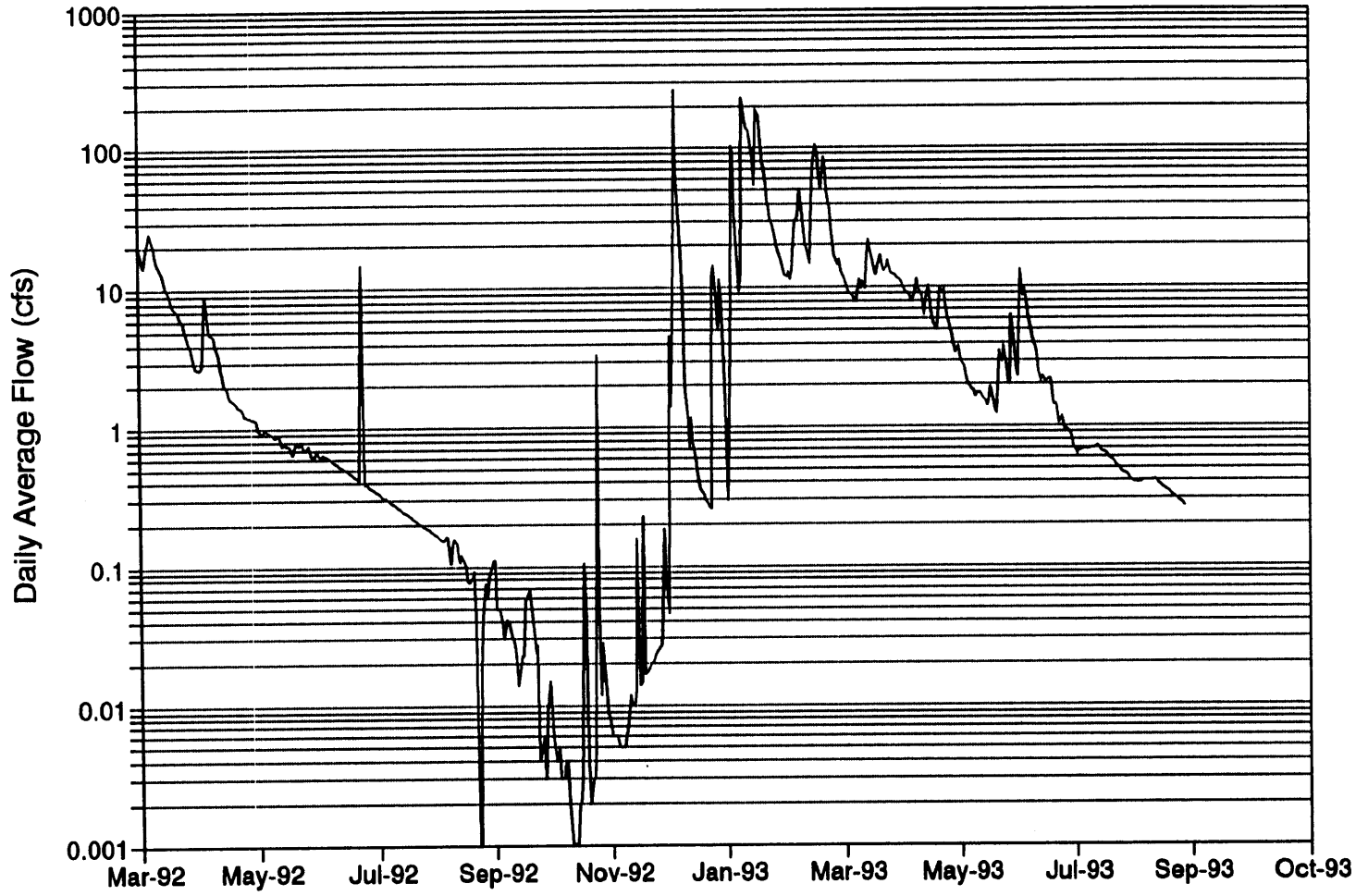
Redwood Creek
Watershed Map

Figure
IV-3



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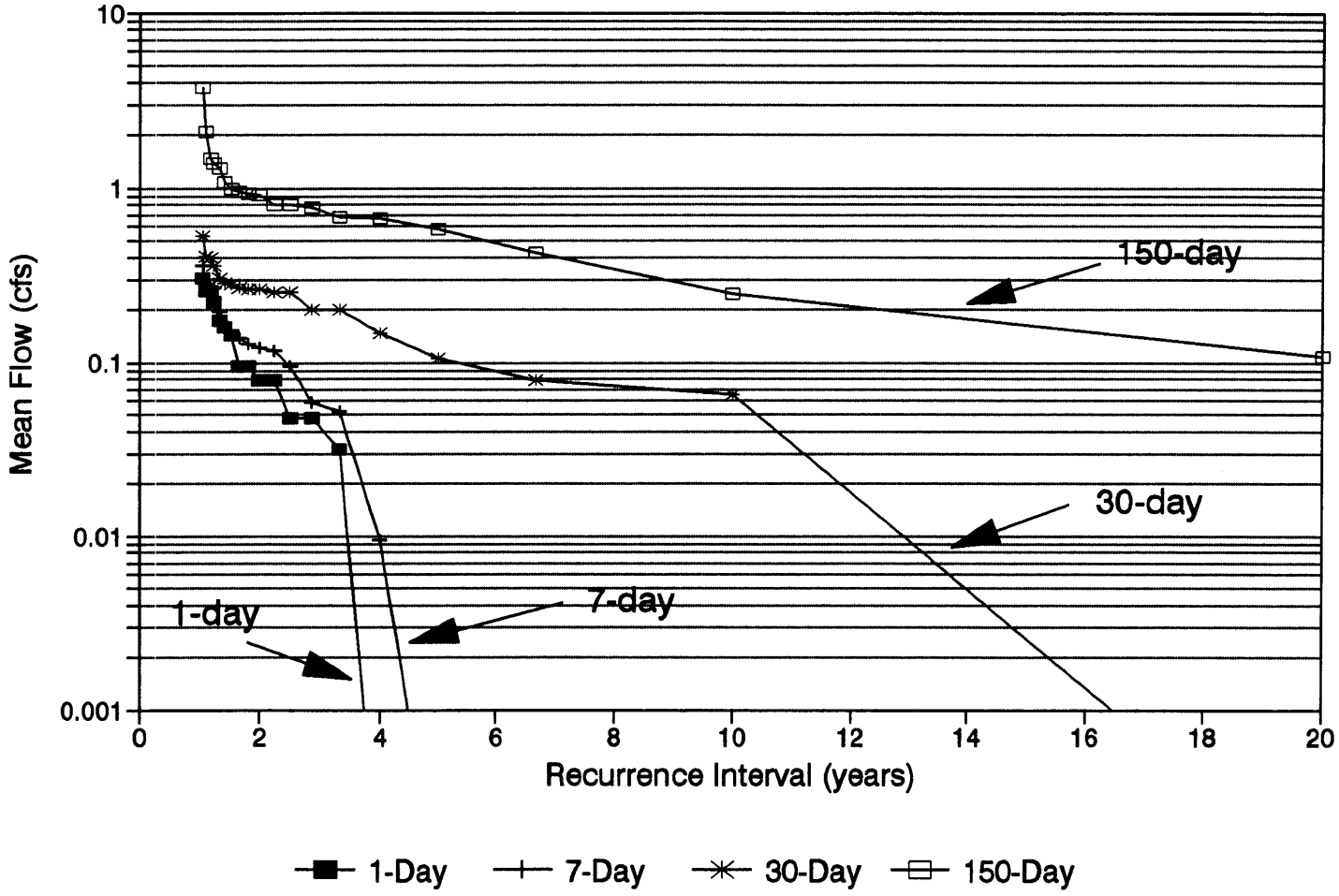
Daily Average Flows in Redwood Creek
1992-1993

Figure
IV-4



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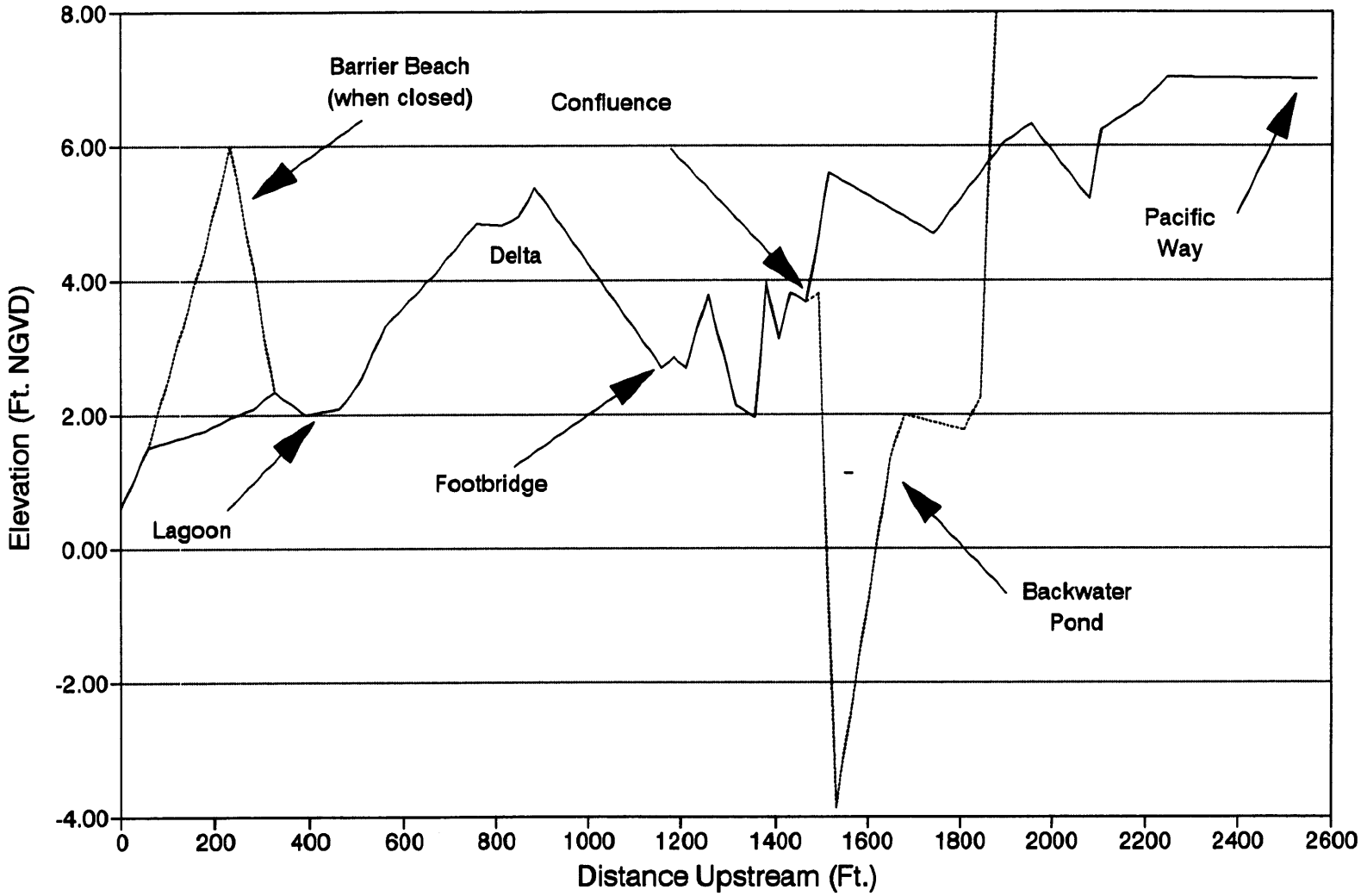
Flow Duration Curve for Redwood Creek
Derived from Arroyo Corte Madera Data

Figure
IV-5



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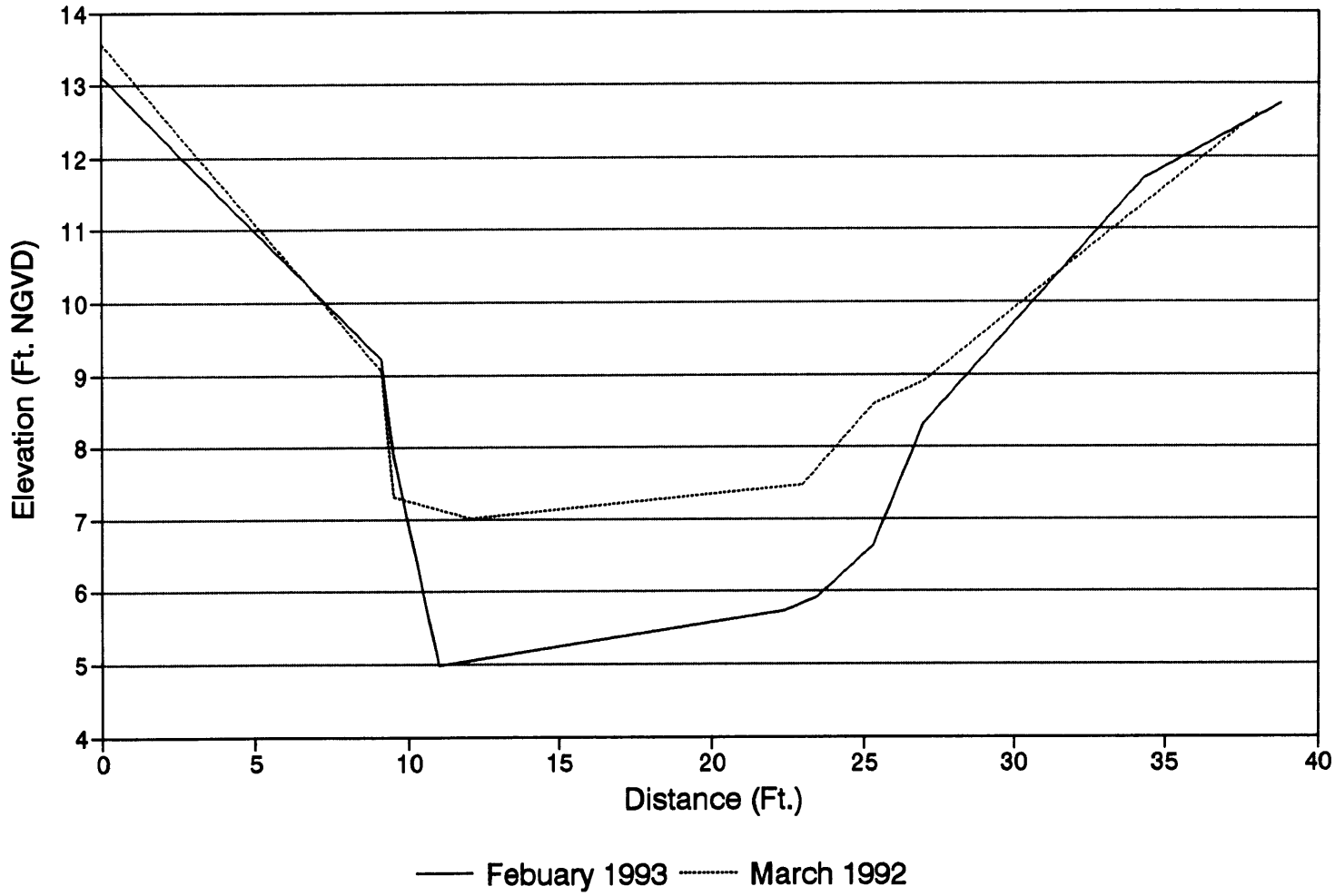
Profile of the Redwood Creek Bed

Figure
IV-6



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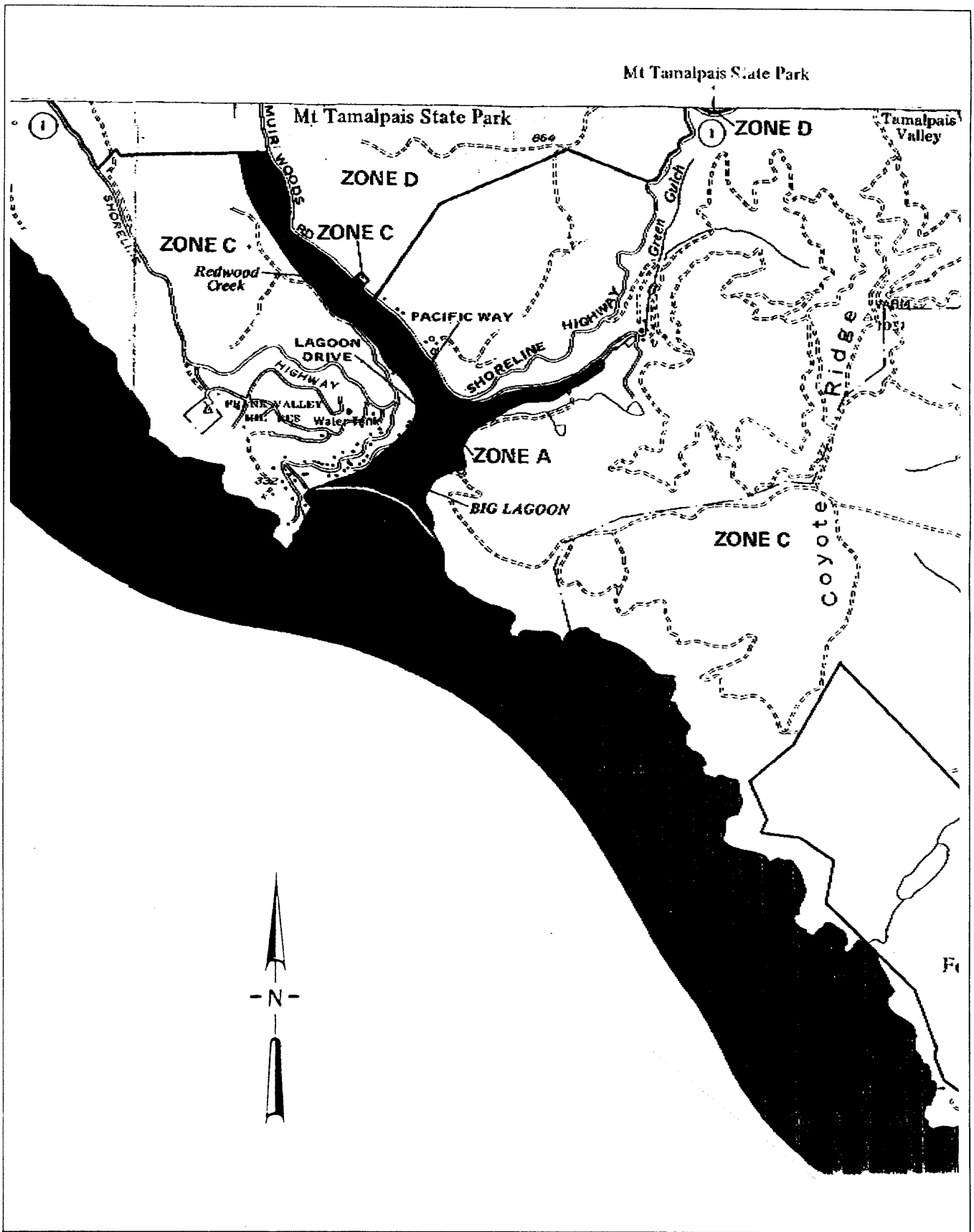
Cross Section of Redwood Creek
Upstream of Pacific Way

Figure
IV-7



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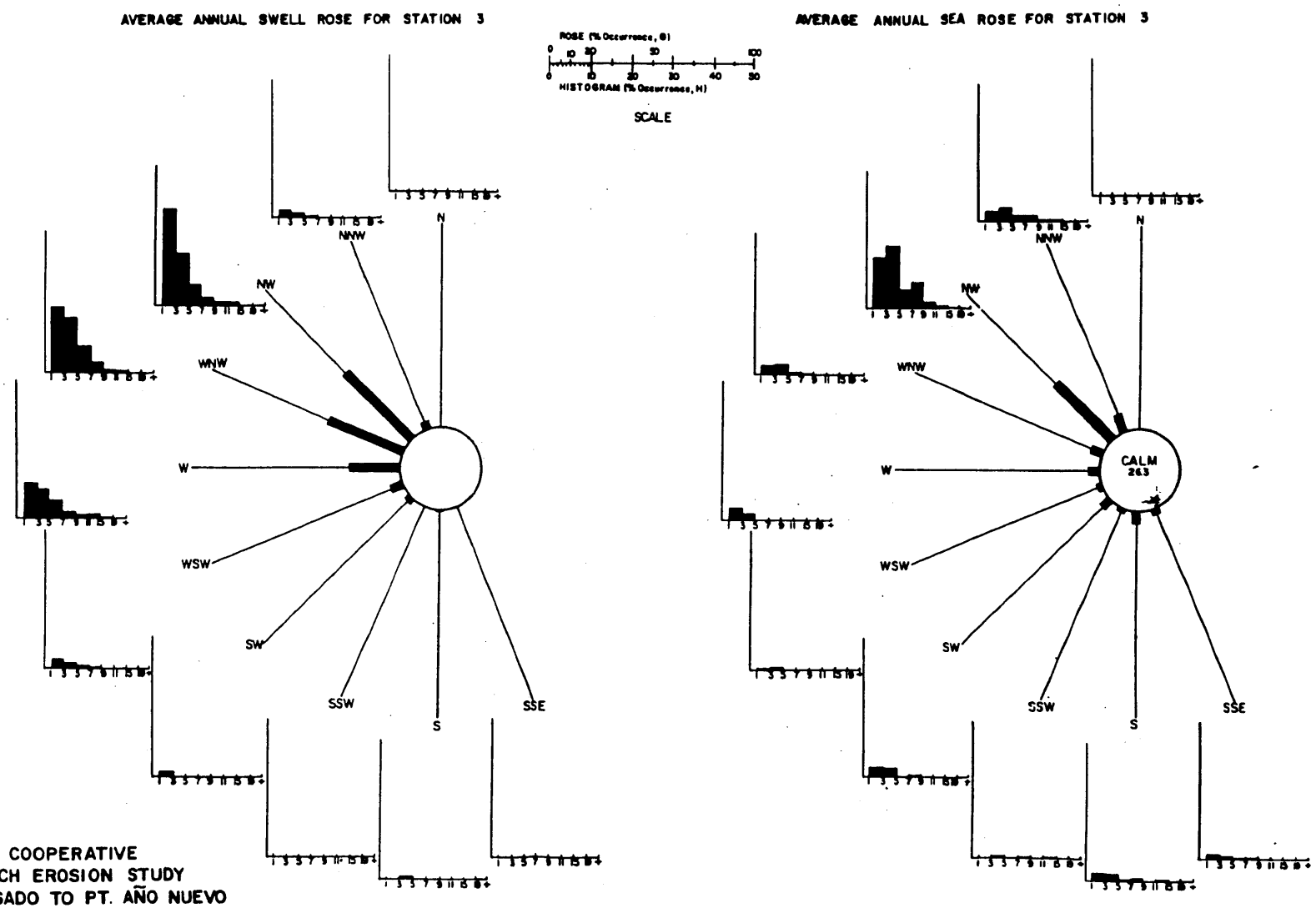
FEMA 100-Year
Floodplain Boundaries

Figure
IV-8



COOPERATIVE
BEACH EROSION STUDY
PT. DELGADO TO PT. AÑO NUEVO
CALIFORNIA

FILE NO. 16-51-34 PLATE 5

Histograms show percent occurrence of differing wave heights. Data collected 1956 - 1958.
Source: San Francisco District US Army Corps of Engineers, 1960

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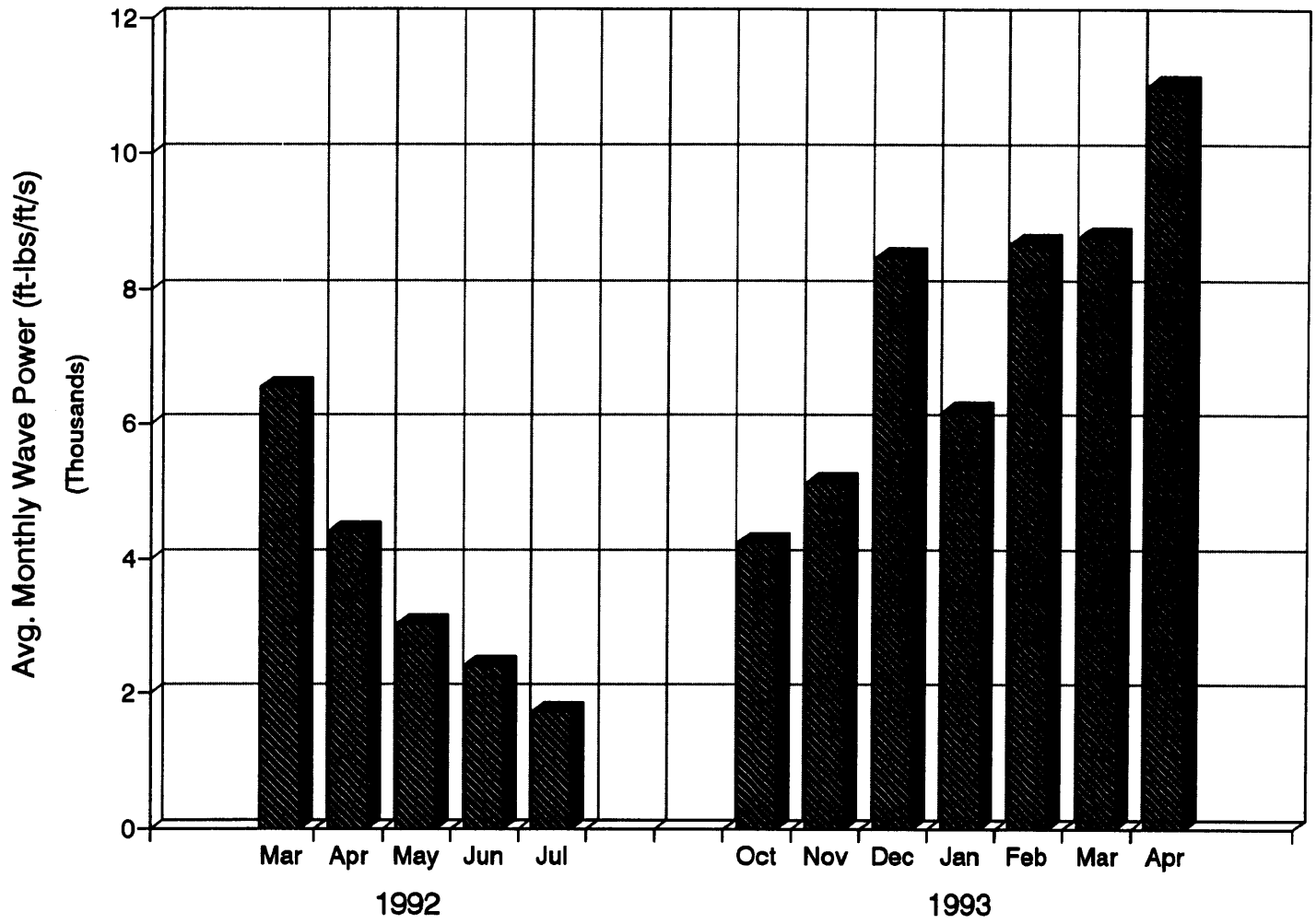
Wave Direction Rose for the COE San Francisco Hindcast Station

Figure
IV-9



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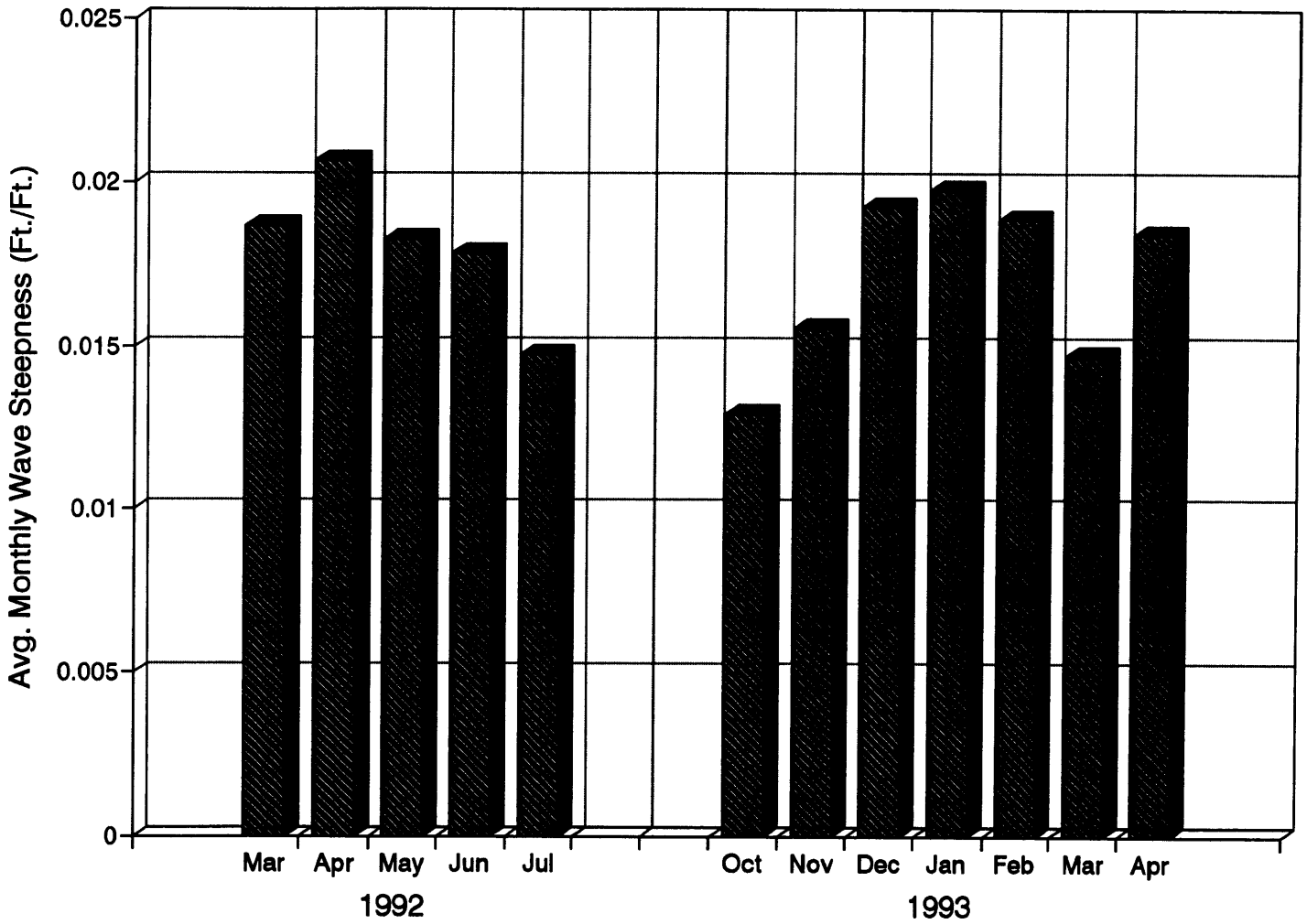
Monthly Average Wave Power for the
San Francisco Deep Water Wave Bouy, 1992-93

Figure
IV-10



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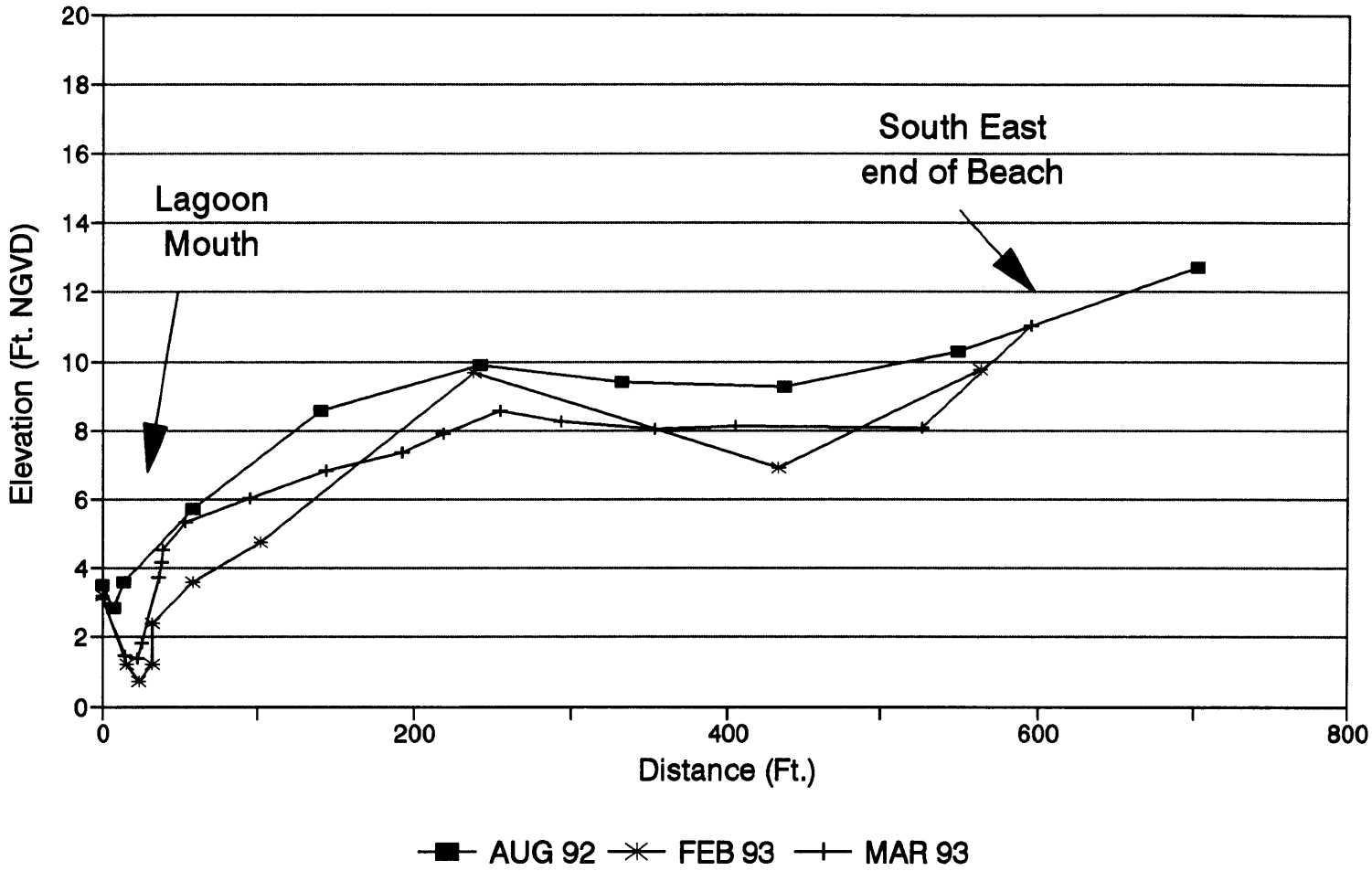
Monthly Average Wave Steepness for the San Francisco Deep Water Wave Buoy, 1992-93

Figure IV-11



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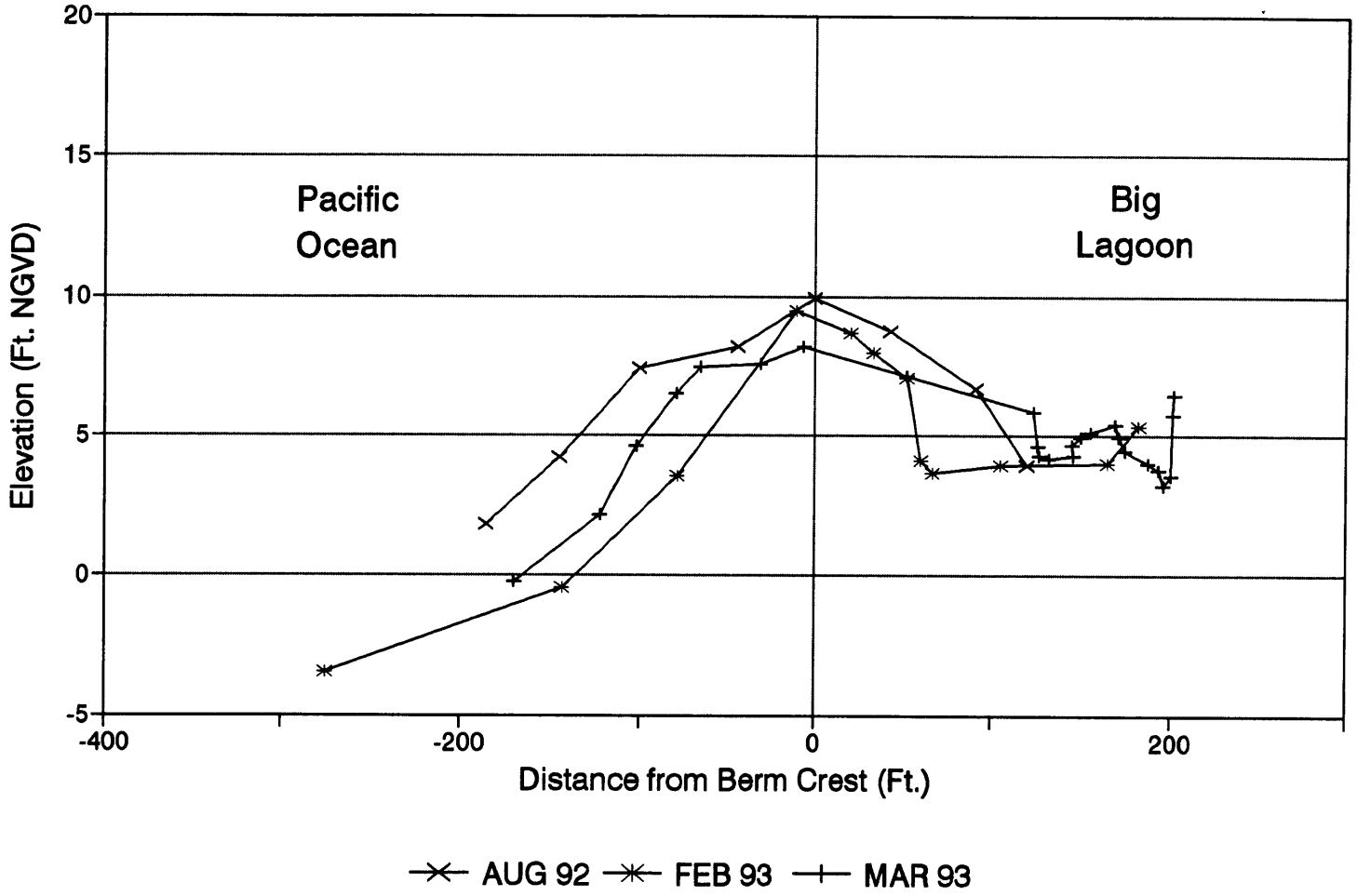
Comparison of Winter and Summer
Beach Crest Profiles

Figure
IV-12



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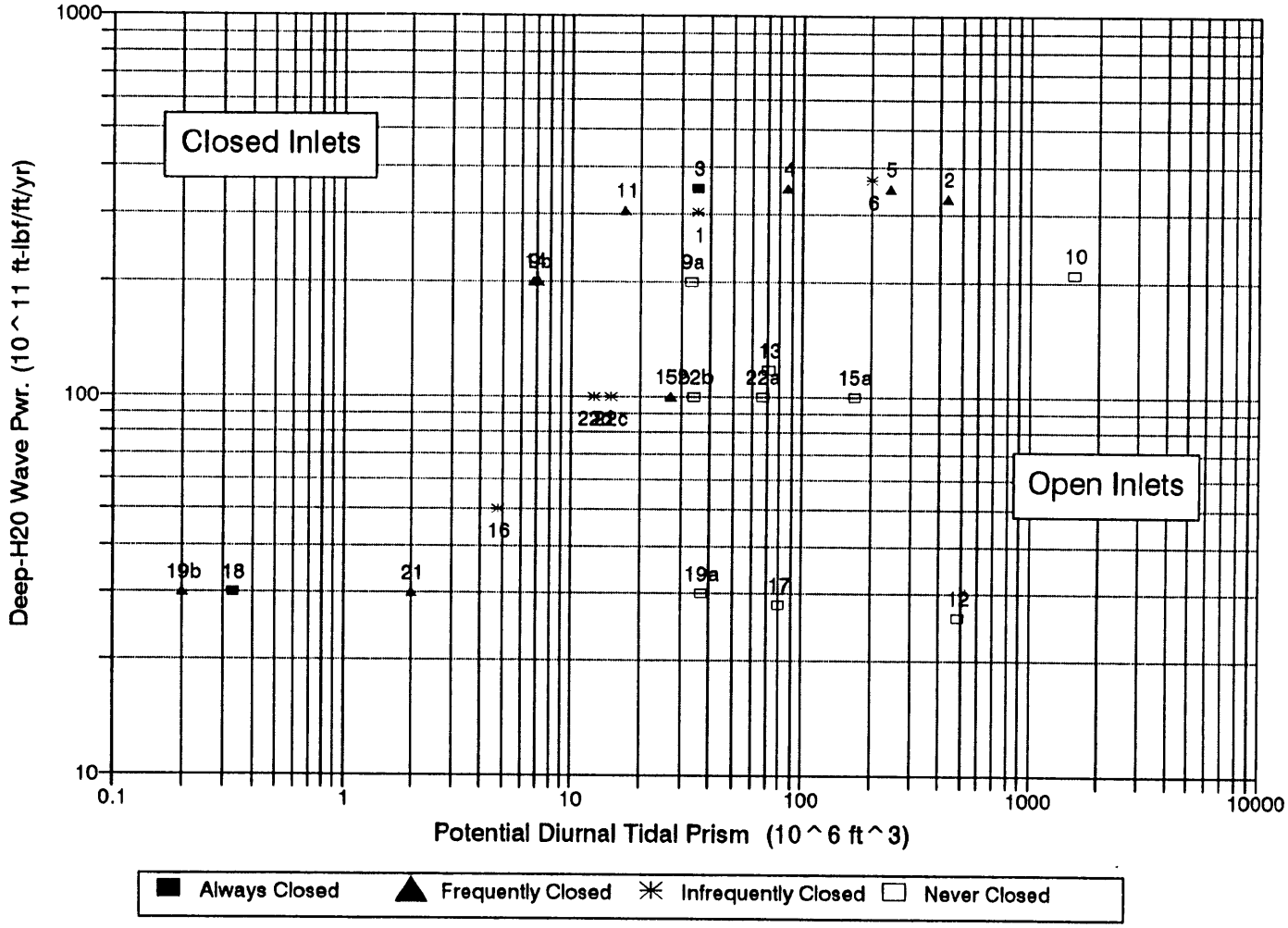
Comparison of Winter and Summer Beach Transects

Figure IV-13



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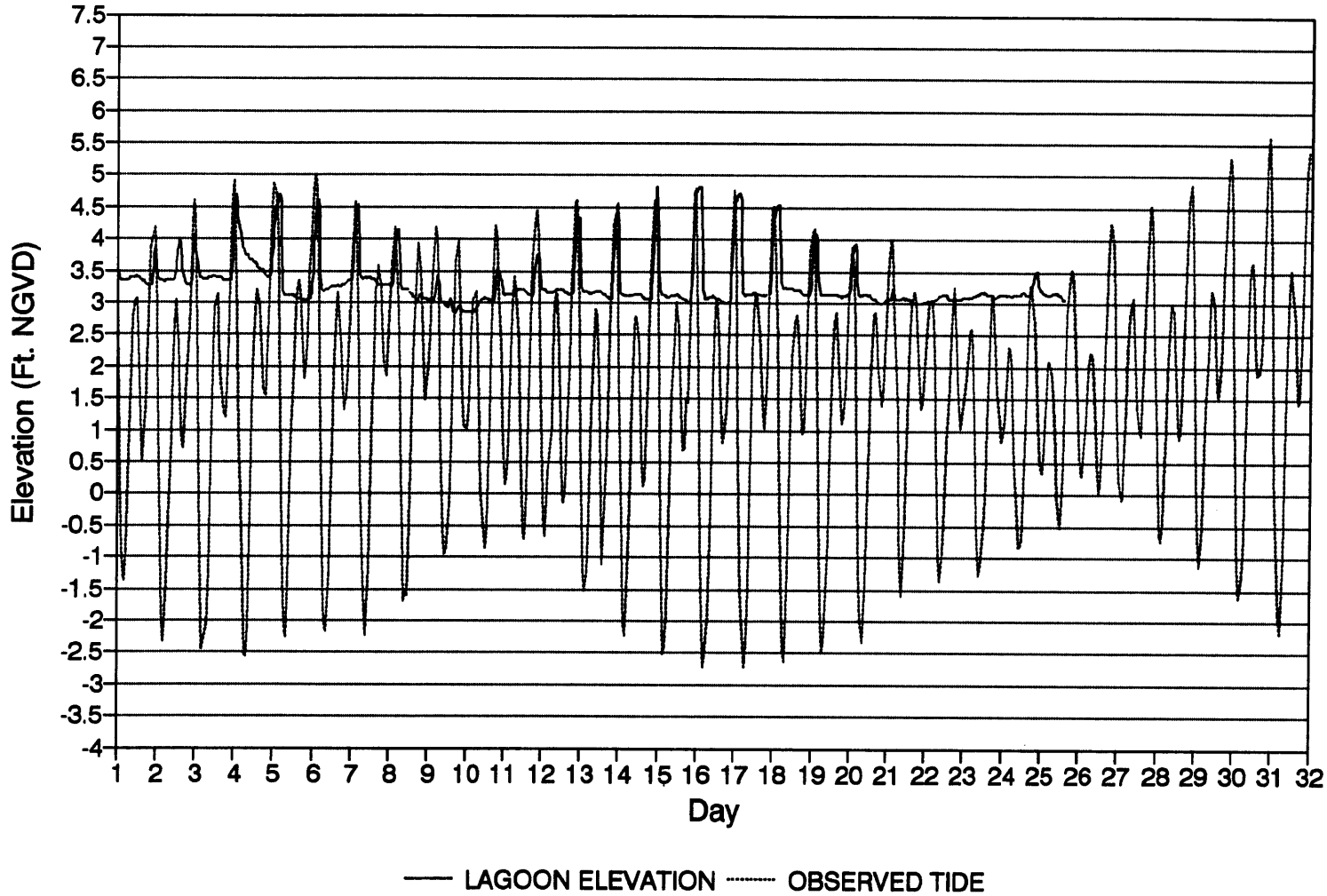
Johnson Criteria for Lagoon Closure

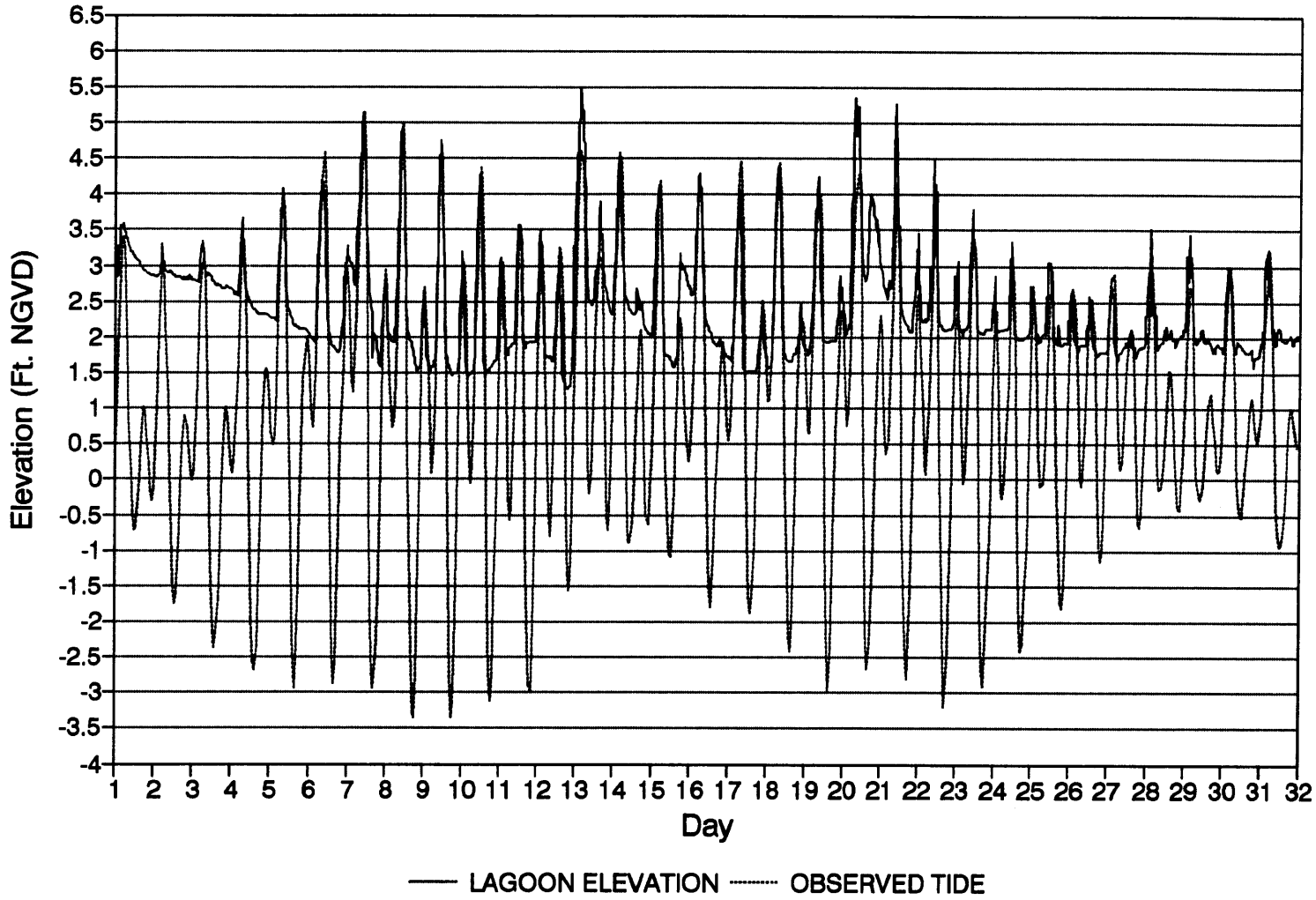
Figure
IV-14



Philip Williams & Associates, Ltd.
Consultants in Hydrology

Lagoon Water Levels, May 1992

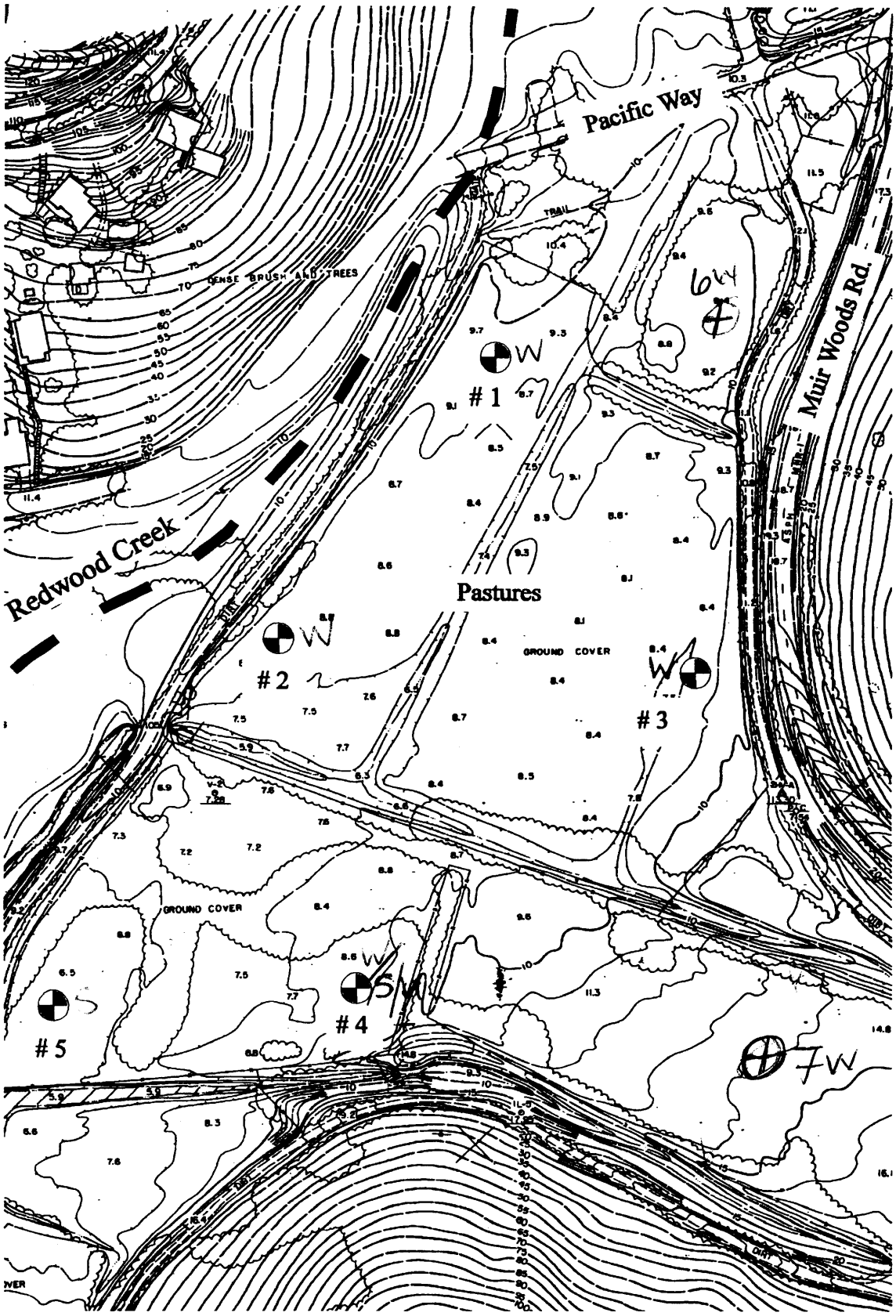
Figure
IV-15



Philip Williams & Associates, Ltd.
Consultants in Hydrology

Lagoon Water Levels, January 1993

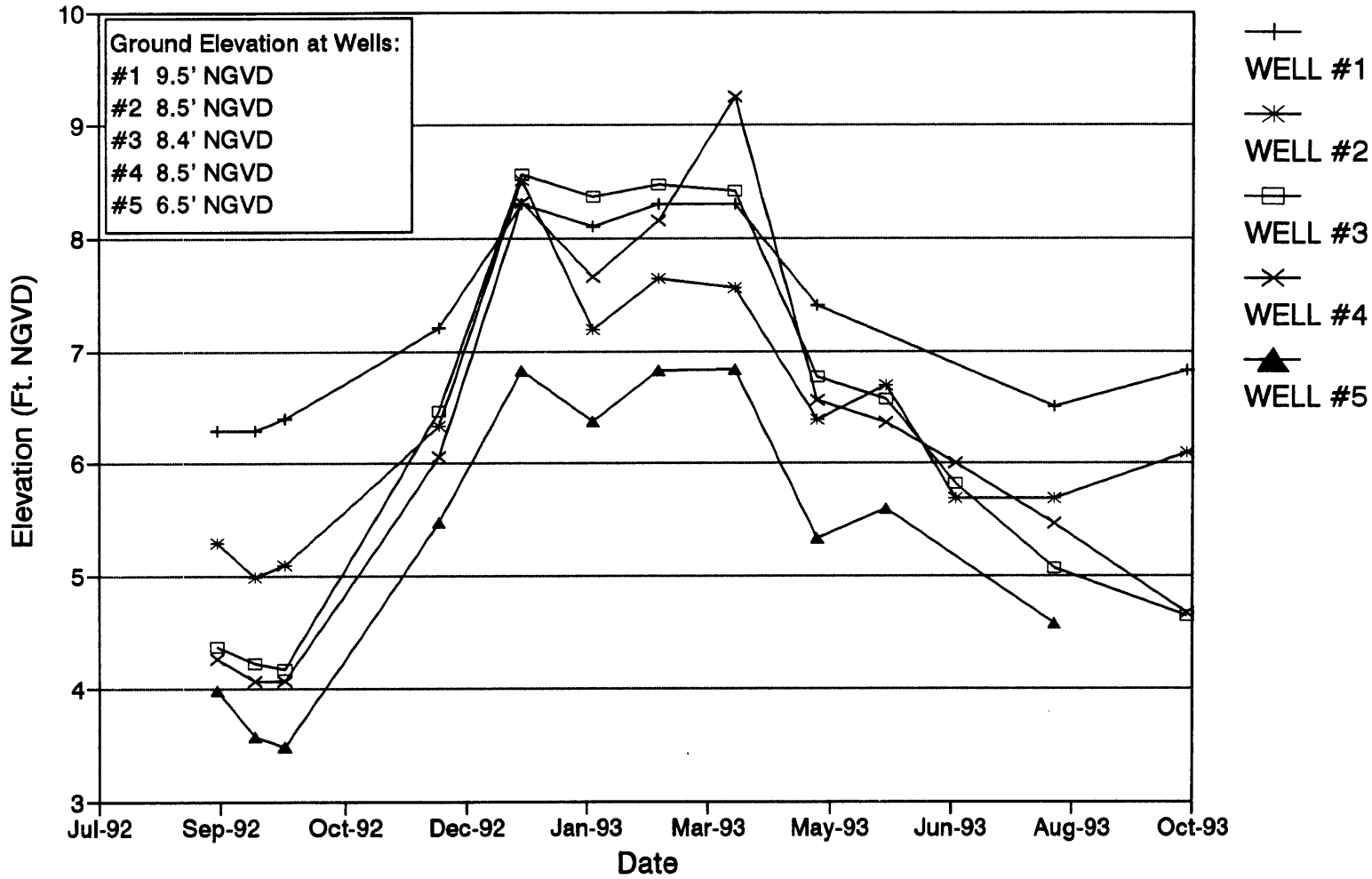
Figure
IV-16



Philip Williams & Associates, Ltd.
Consultants in Hydrology

Location of Monitoring Wells

Figure
IV-17



Philip Williams & Associates, Ltd.
Consultants in Hydrology

Monthly Water Levels in Monitoring Wells
1992-1993

Figure
IV-18

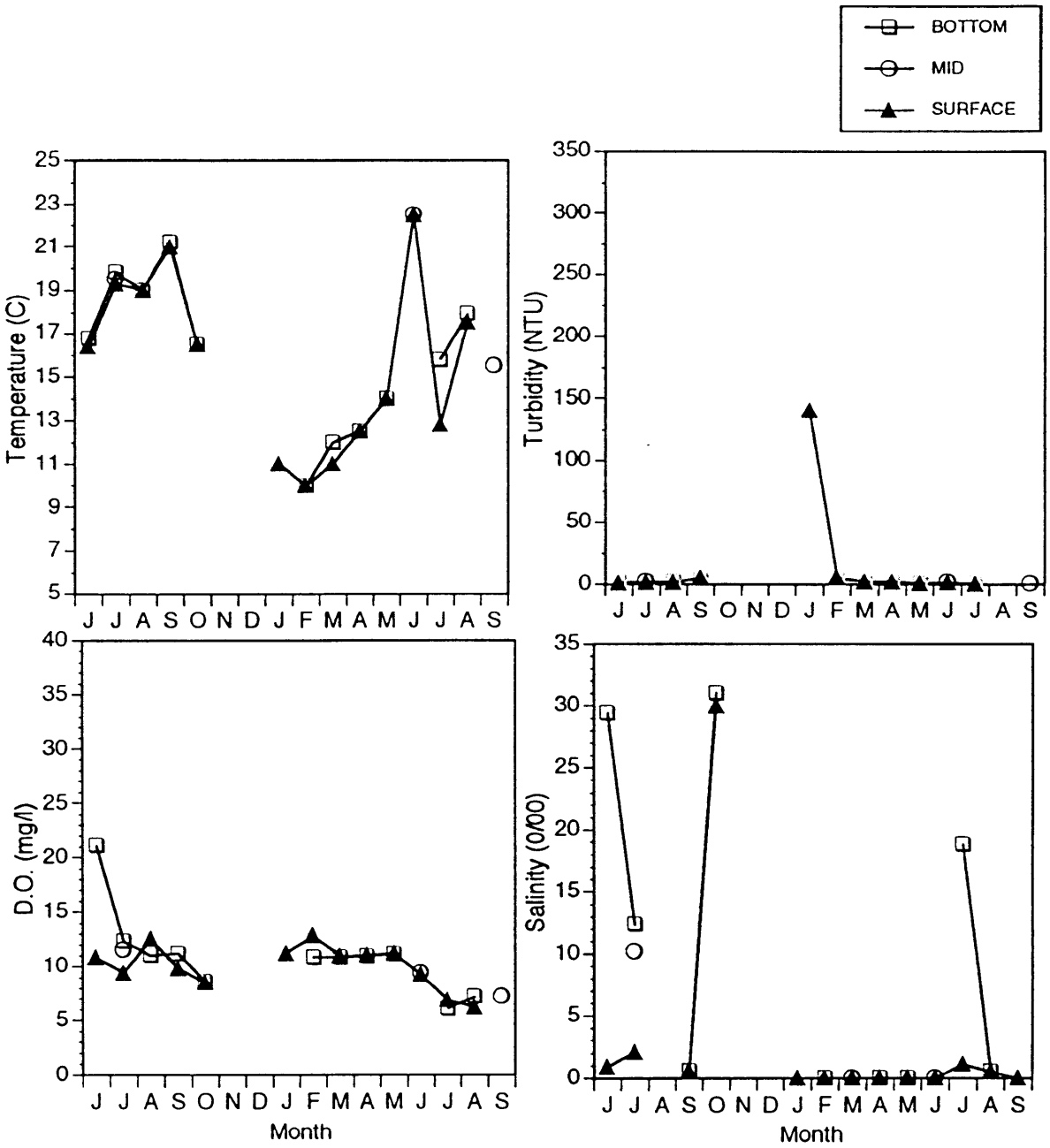


Figure Water quality data for Muir Beach station 1 for the period of June 1992 thru September 1993. Data are from three water column depth strata : near bottom, mid column and at the surface. Salinity at this station has a higher incremental range than for the other stations due to its proximity to the ocean.

Philip Williams & Associates, Ltd. Consultants in Hydrology	Water Quality Data in the Tidal Lagoon	Figure IV-19

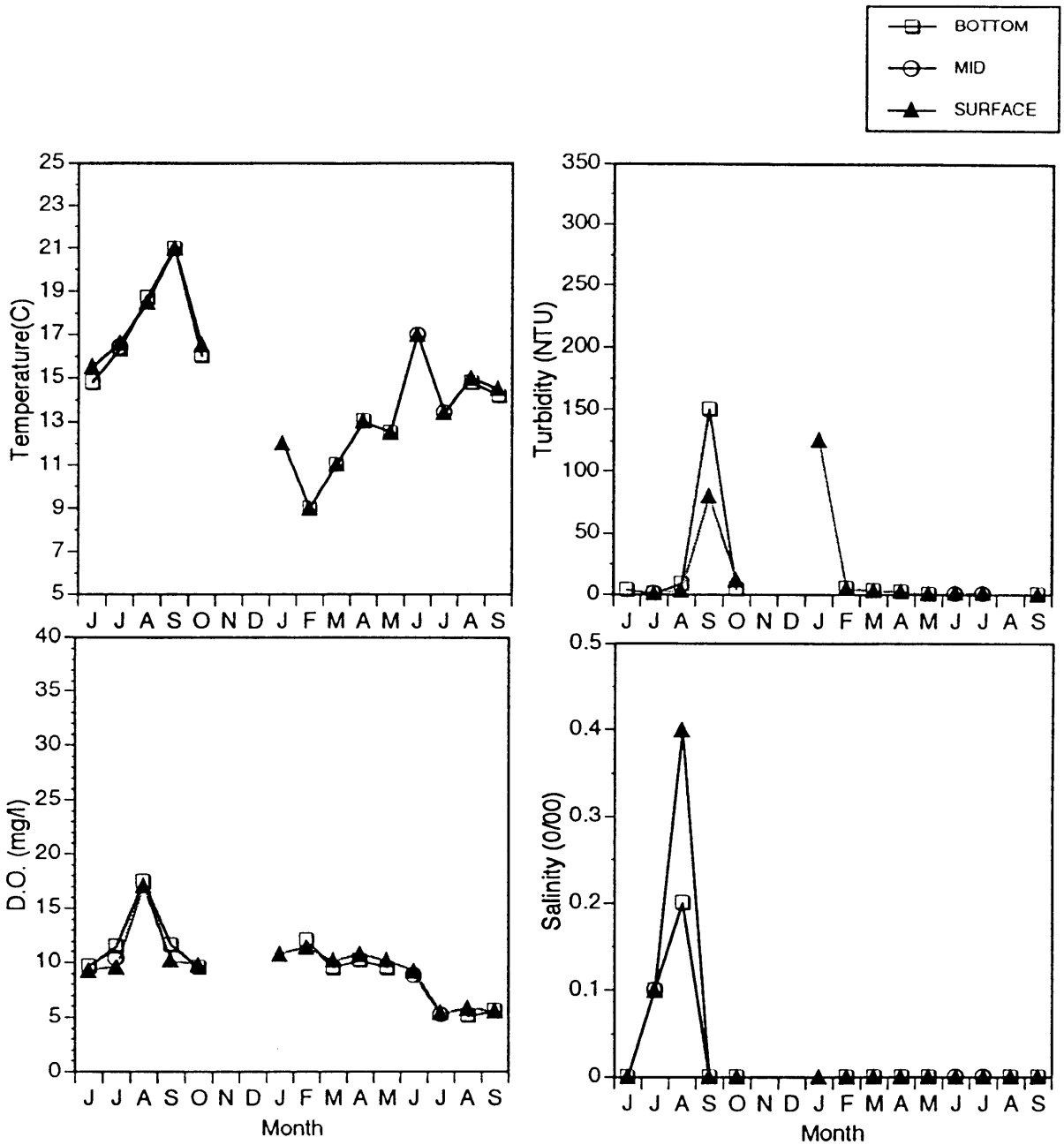


Figure Water quality data for Muir Beach station 2 for the period of June 1992 thru September 1993. Data are from three waterr column depth strata: near bottom, mid column, and at the surface.

Philip Williams & Associates, Ltd. Consultants in Hydrology	Water Quality Data in Redwood Creek at the Footbridge	Figure IV-20

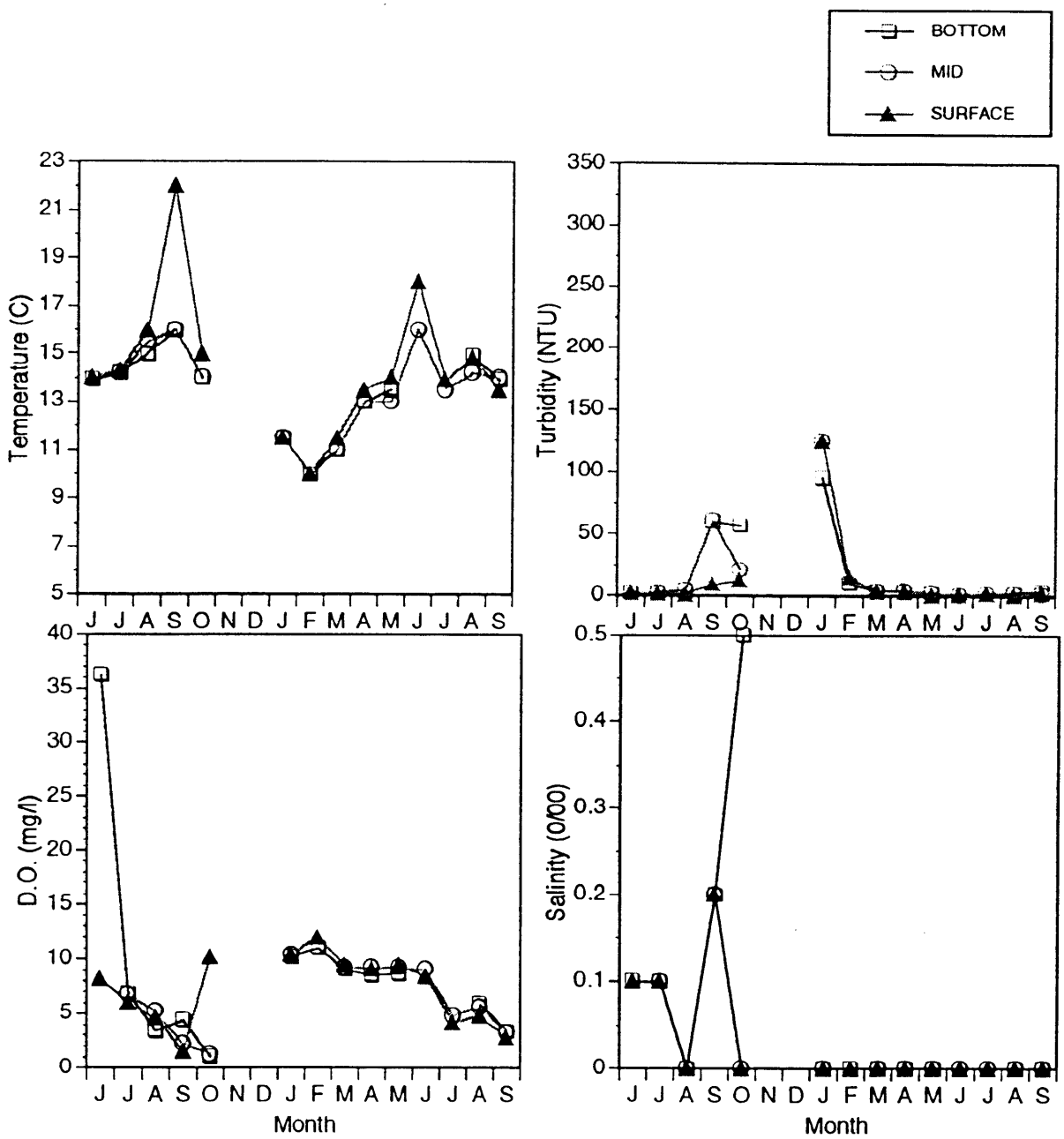
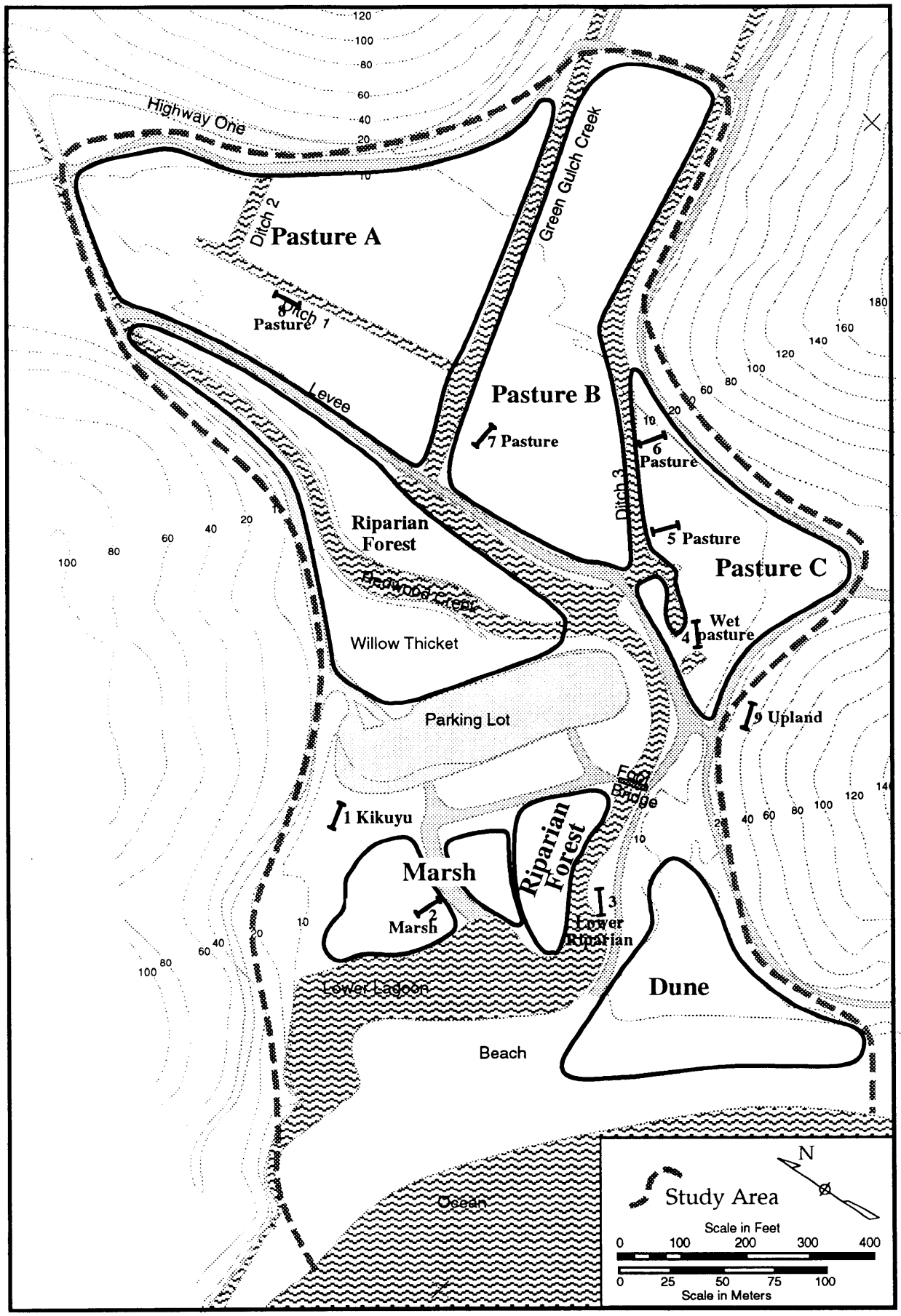


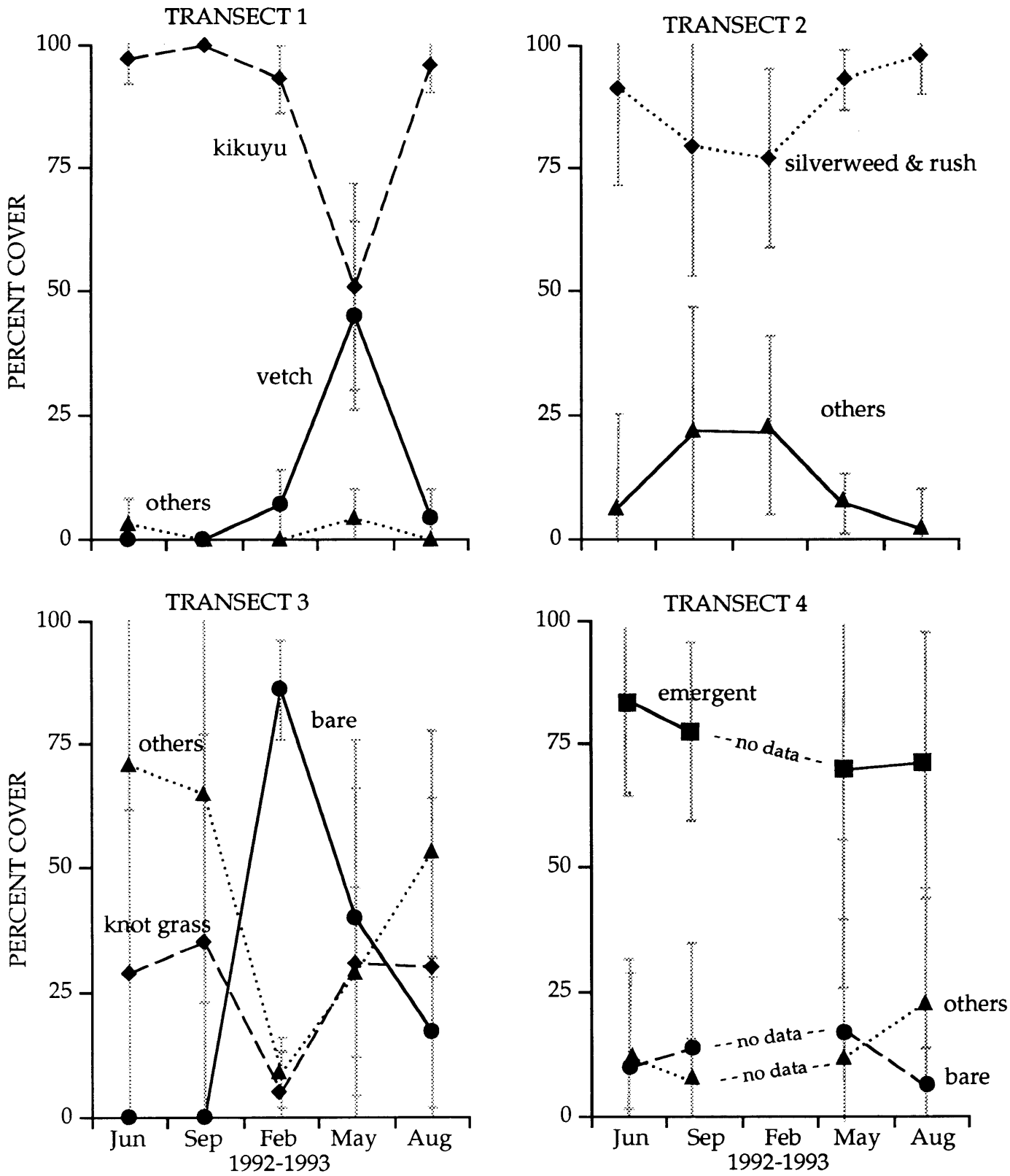
Figure Water quality data for Muir Beach station 3 for the period of June 1992 thru September 1993. Data are from three water depth stata: near bottom, mid column, and at the surface.

Philip Williams & Associates, Ltd. Consultants in Hydrology	Water Quality Data in Redwood Creek at the Backwater Channel	Figure IV-21



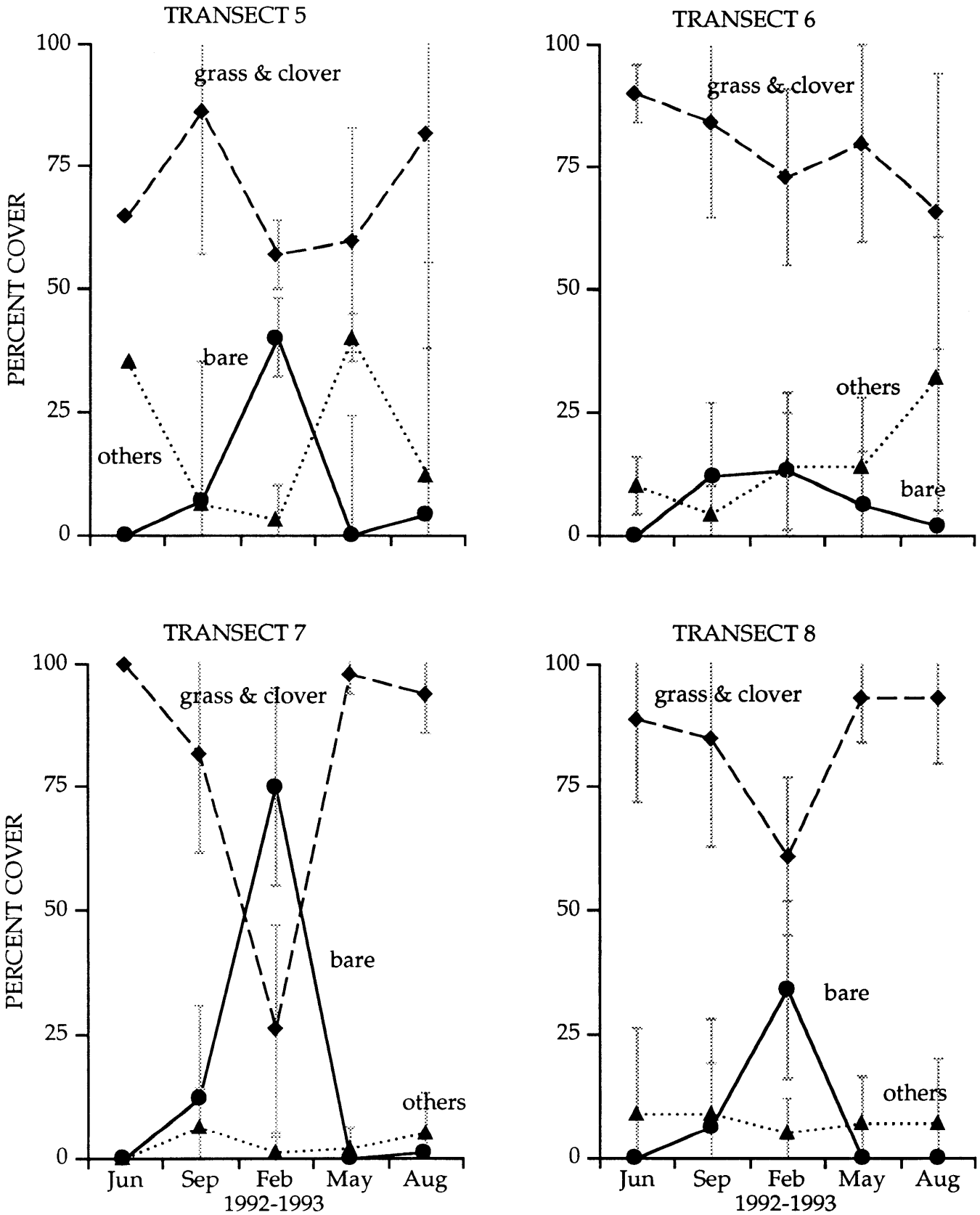
Location of the nine vegetation transects.

Figure IV - 22



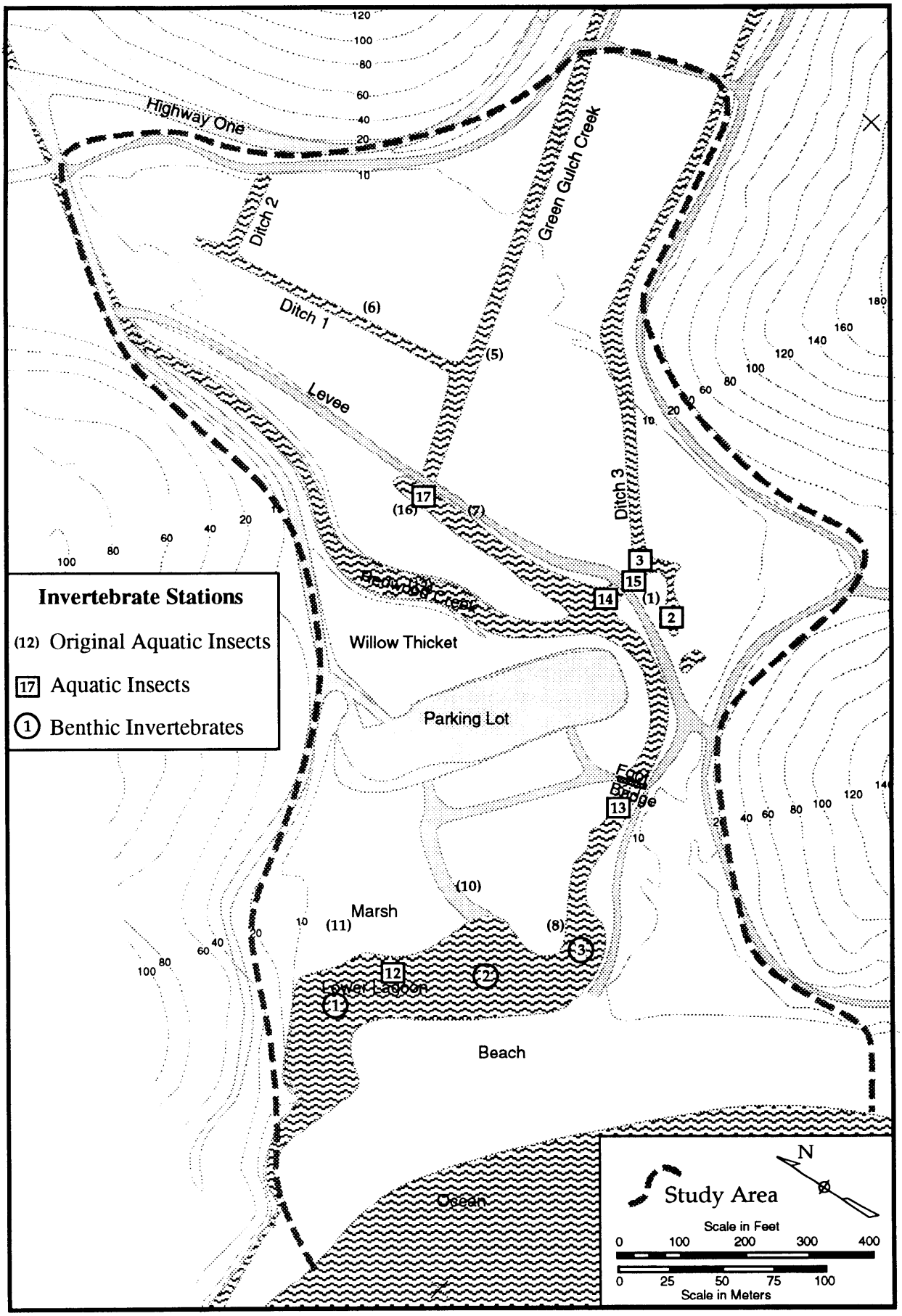
Vegetative cover along four habitat types: disturbed (transect 1), salt marsh (transect 2), aquatic (transect 3), and pasture aquatic (transect 4). Mean percent cover, standard deviation (vertical line), n=10. Transect 4 was flooded during February, hence no data.

Figure IV-23



Vegetative cover along pasture transects: mean percent cover, standard deviation (vertical line), n=10. Note dominance of pasture vegetative type and winter increase of bare soil.

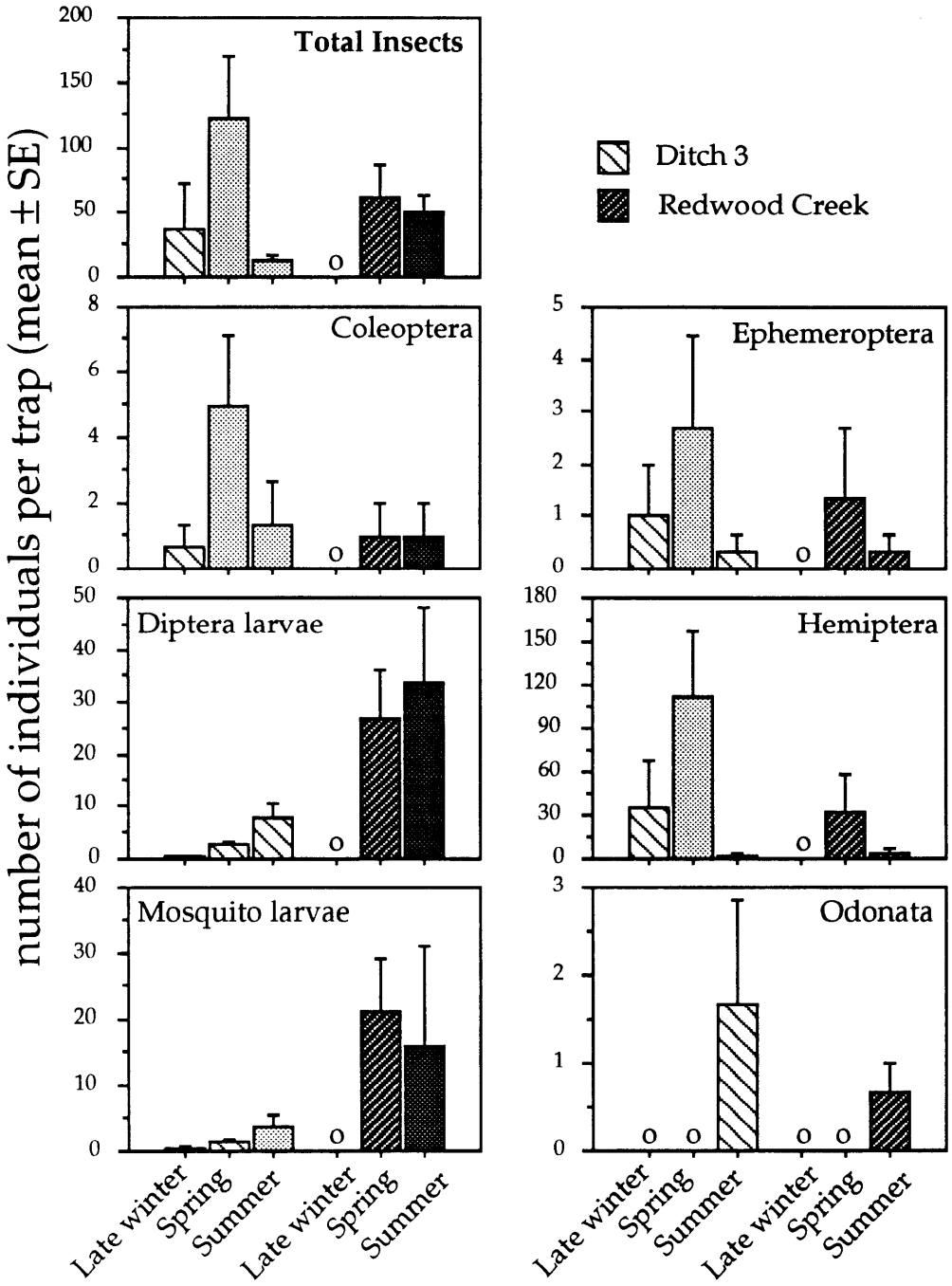
Figure IV-24



Locations of aquatic insect (boxed) and benthic invertebrate (dotted) survey stations in Big Lagoon.

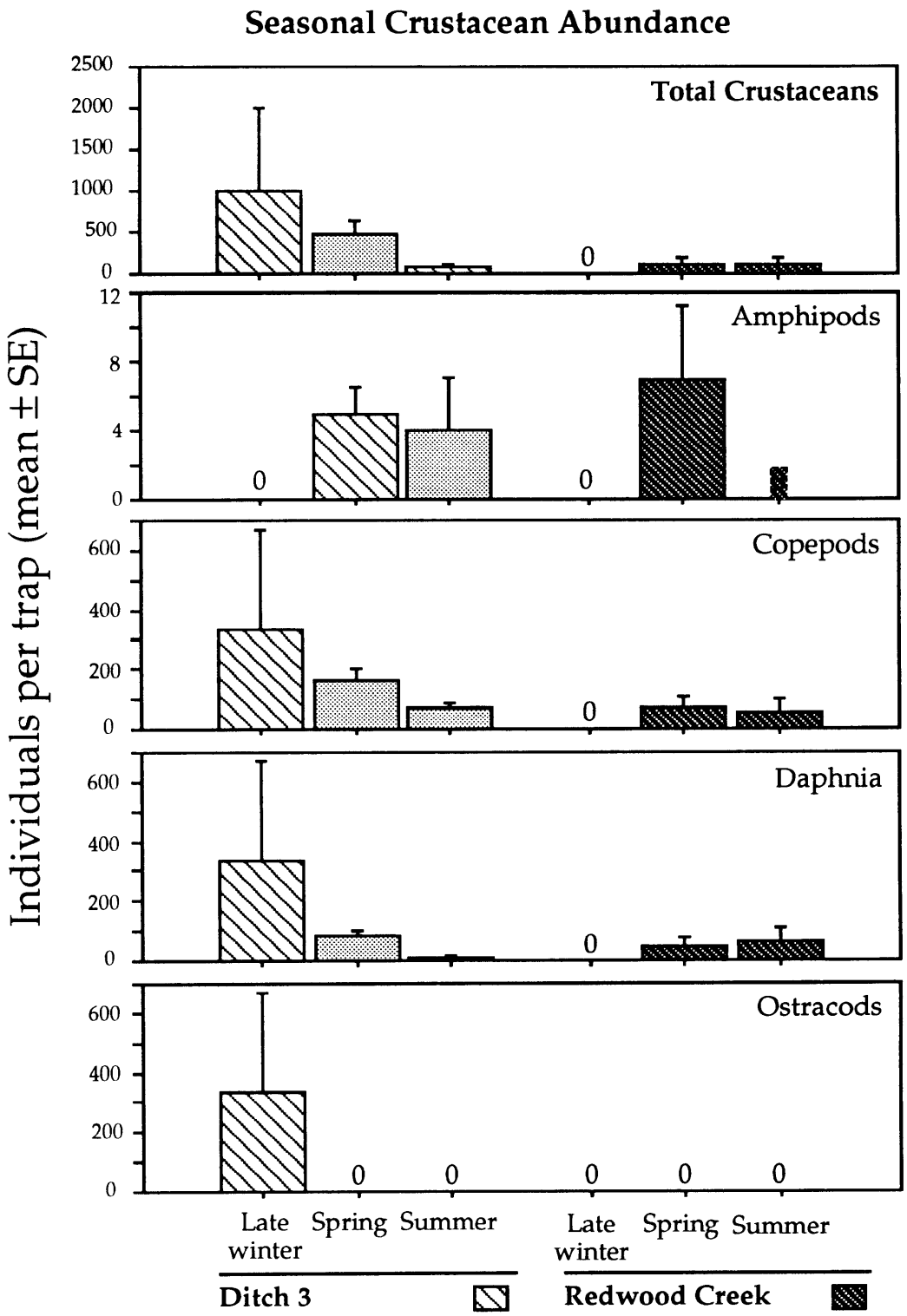
Figure
IV-25

Seasonal Aquatic Insect Abundance



Seasonal abundance of major groups of aquatic insects found in night traps at the horse pasture pond (ditch 3) and Redwood Creek sampling sites (N = 3 per site). Zeros indicate no individuals captured. Note different scales.

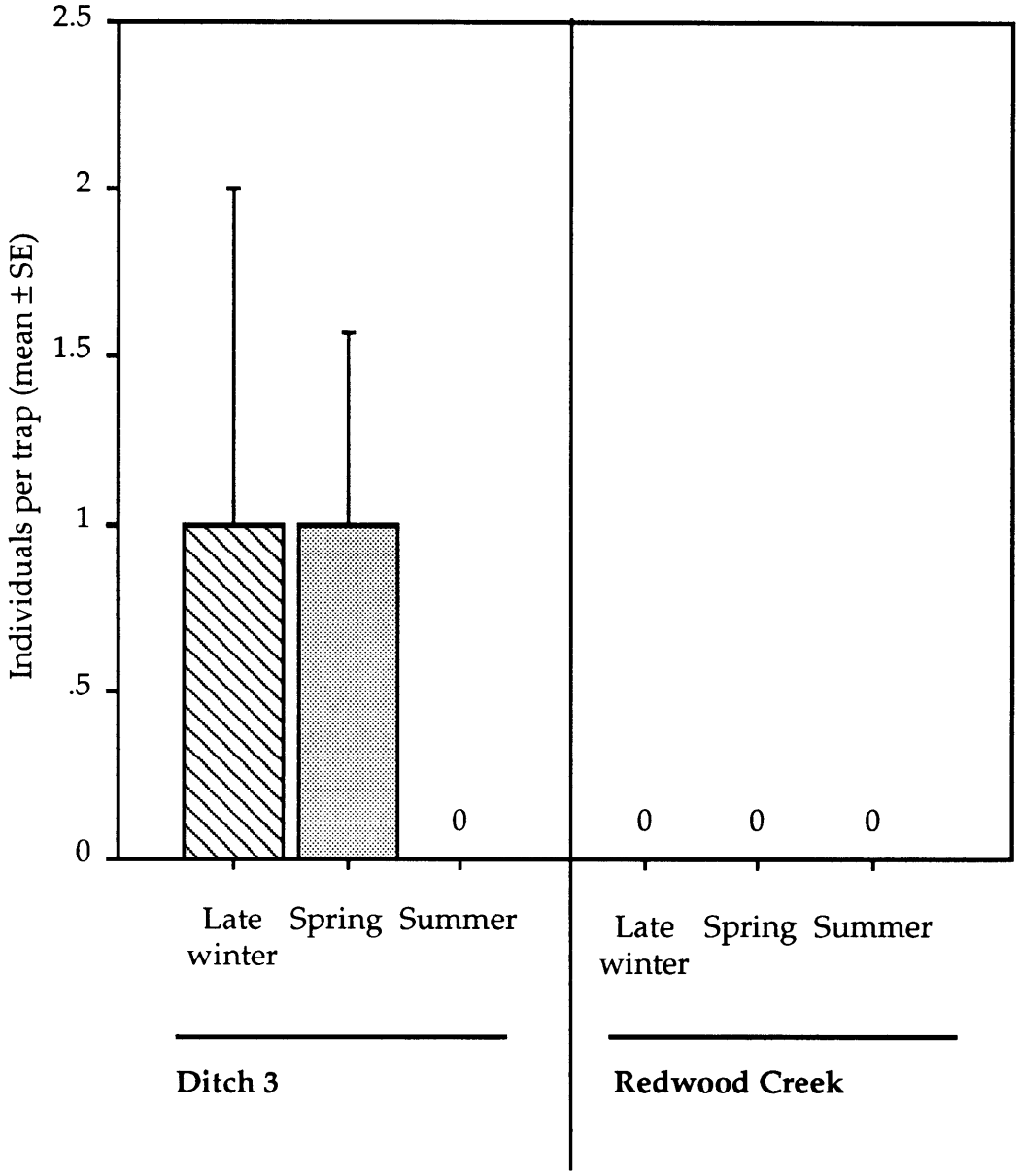
Figure
IV-26



Changes in the seasonal abundance of major aquatic crustacean groups found in nocturnal traps at the horse pasture pond (ditch 3) and Redwood Creek sampling sites (N = 3 per site). Zeros indicate no individuals captured.

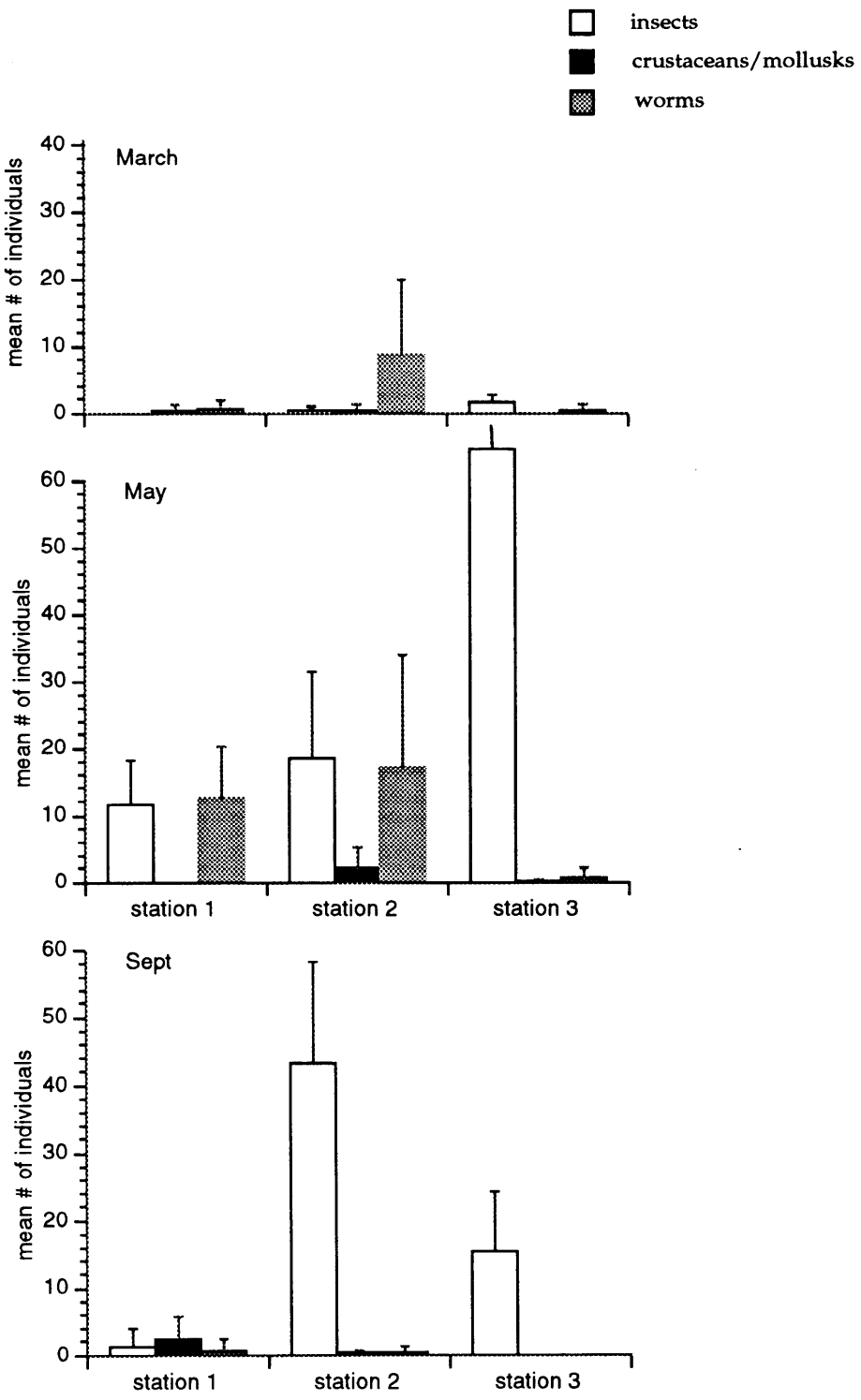
Figure
IV-27

Seasonal Amphibian Larvae Abundance



Seasonal abundance of amphibian larvae found in nocturnal traps at the horse pasture pond (ditch 3) and Redwood Creek sampling sites (N = 3 per site). Zeros indicate no individuals captured.

Figure
IV-28



Benthic invertebrates and insect larvae abundances during 1993 seasons at Big Lagoon. Mean number of individuals of each group per core and standard deviation, n = 6. Station 1 was the most marine; station 3 the least saline.

Figure
IV-29

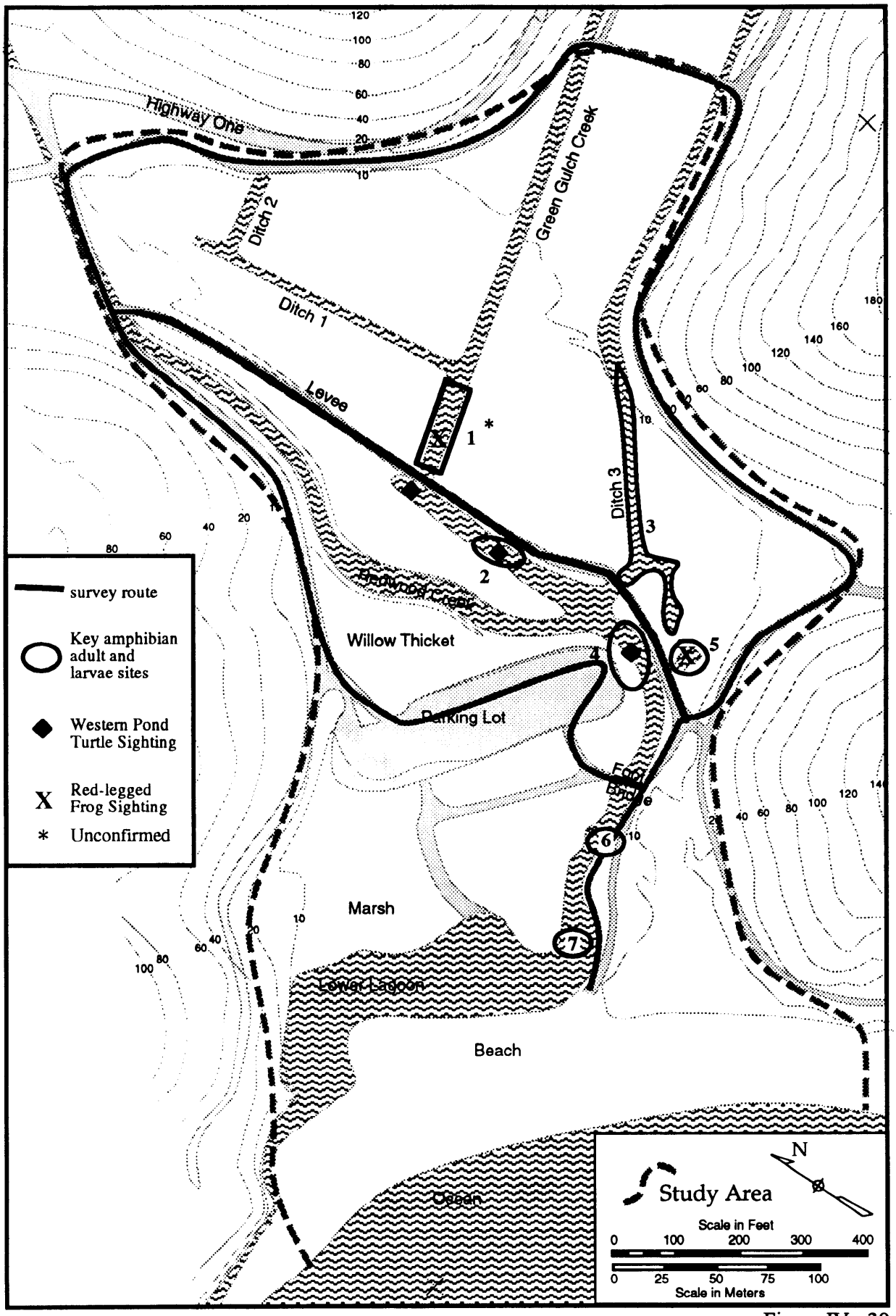
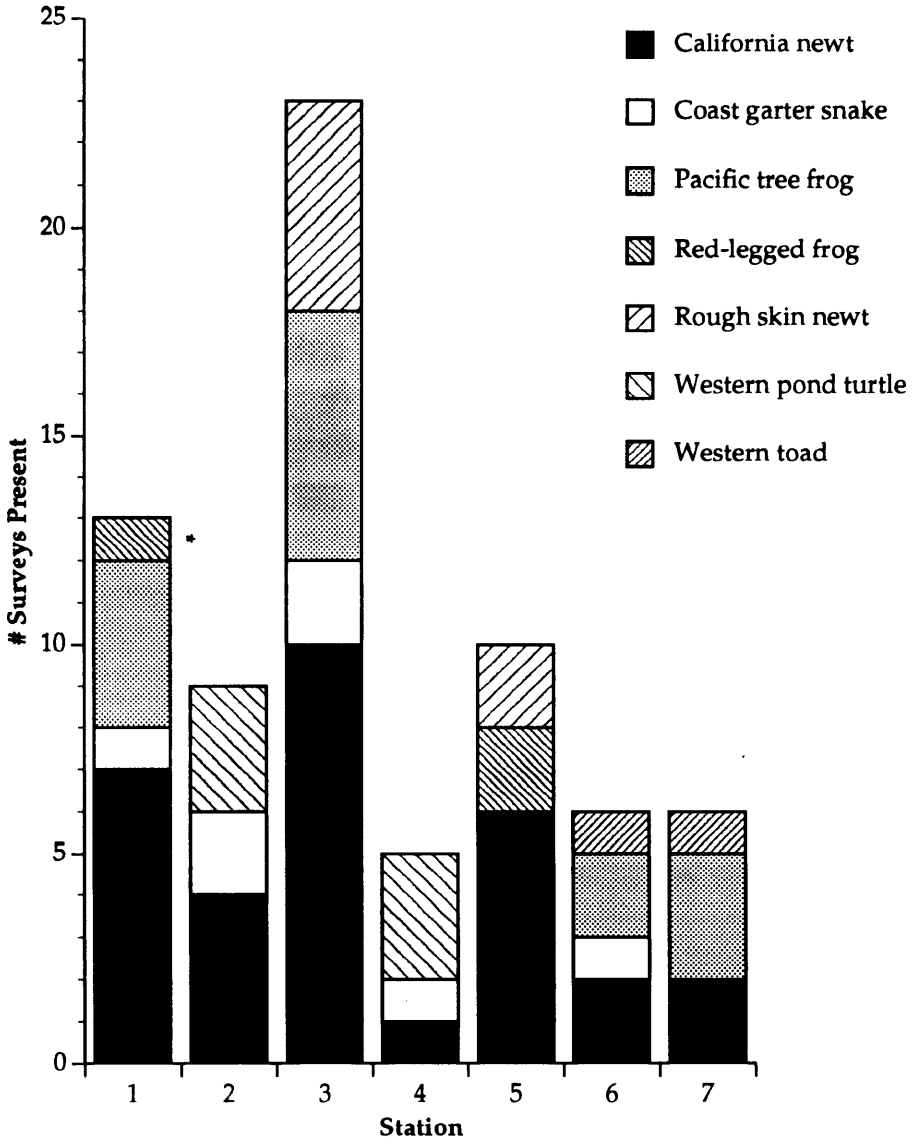


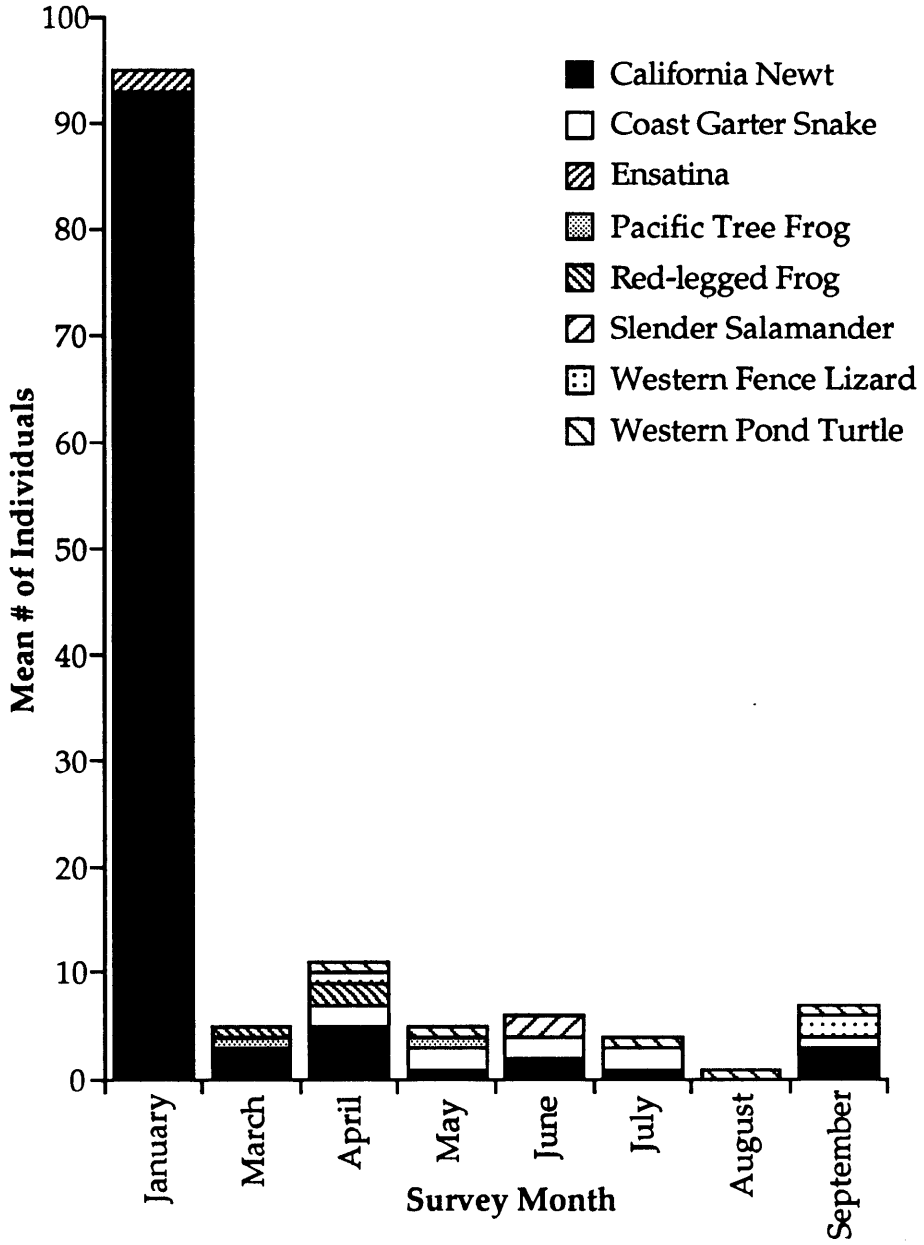
Figure IV - 30

Survey route and locations of critical amphibian and reptile habitats in Big Lagoon.

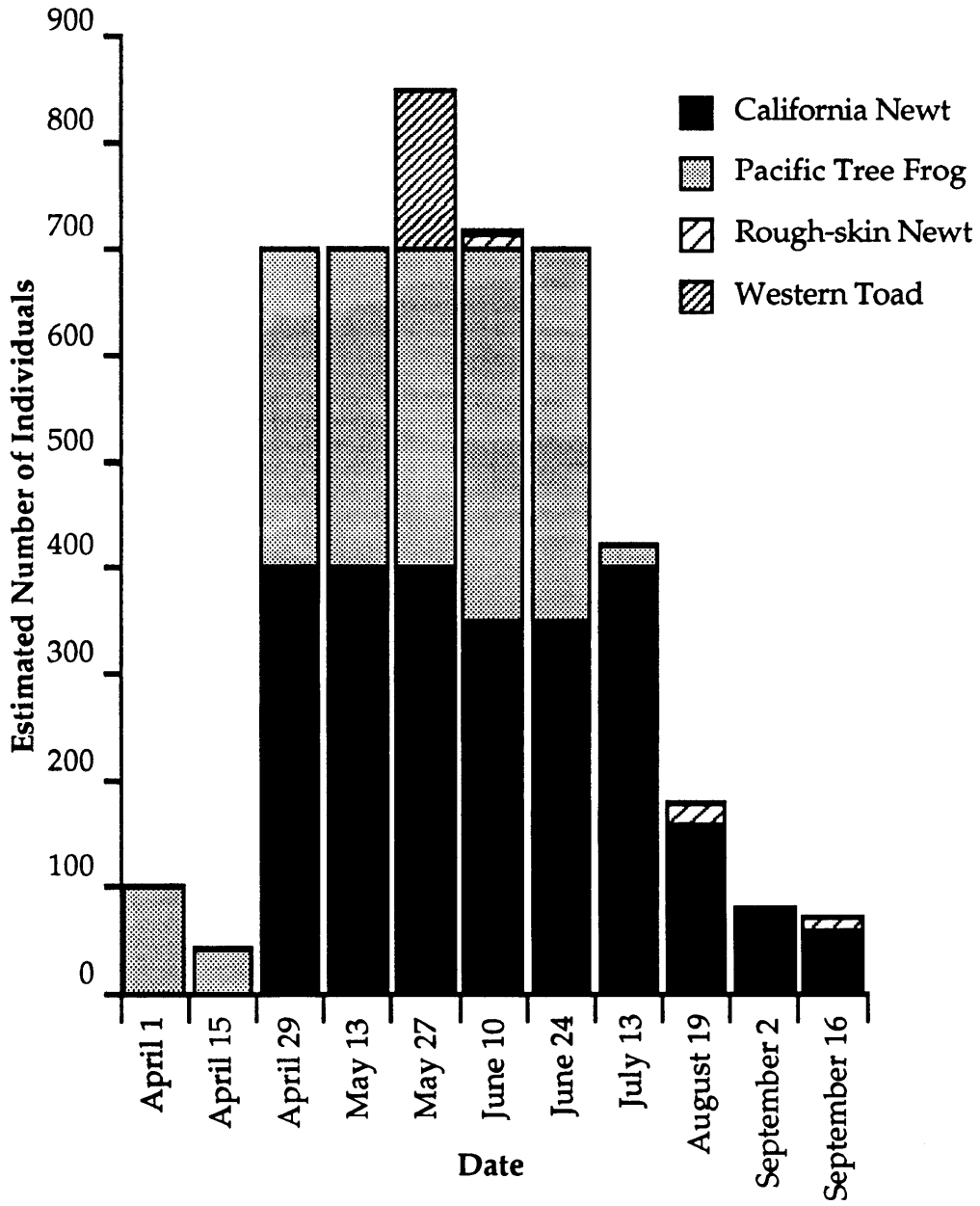


Total number of times (frequency) of occurrence of each species of amphibian and reptile at Big Lagoon, 1993.
*Unconfirmed observation.

Figure IV - 31



Mean number of adult amphibians and reptiles observed at Big Lagoon station during 1993.



Estimated abundance of amphibian larva at Big Lagoon station during 1993.

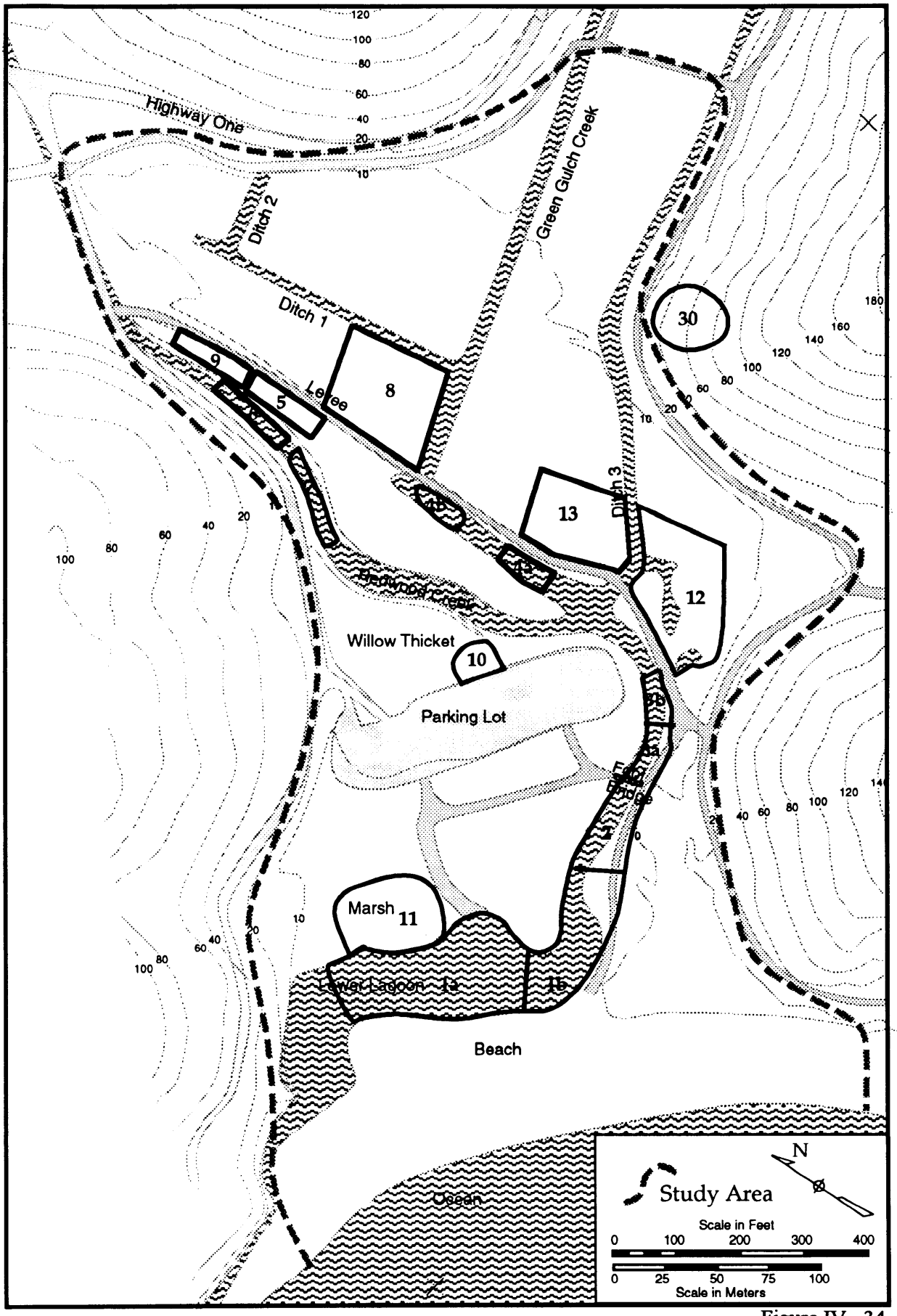
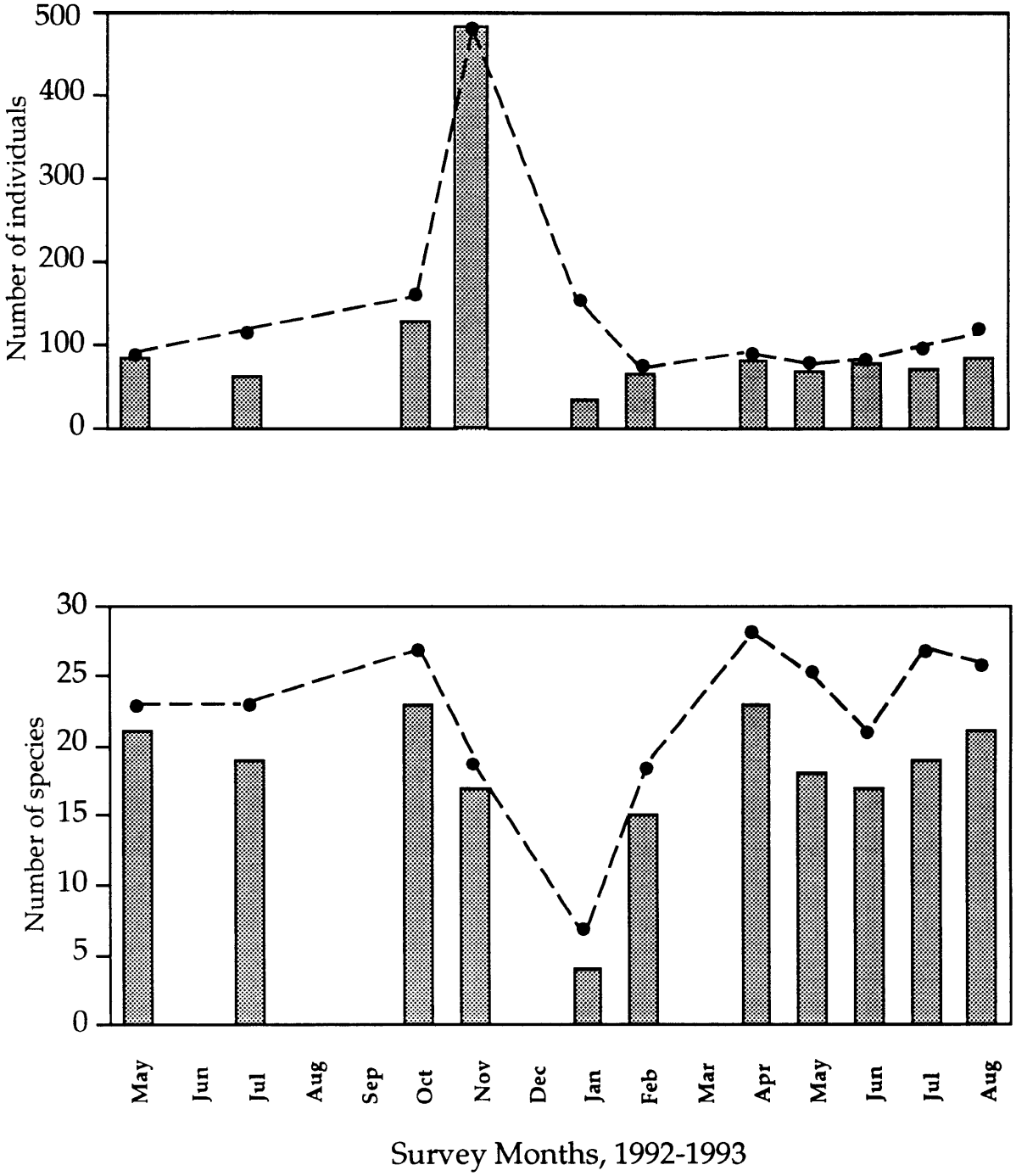


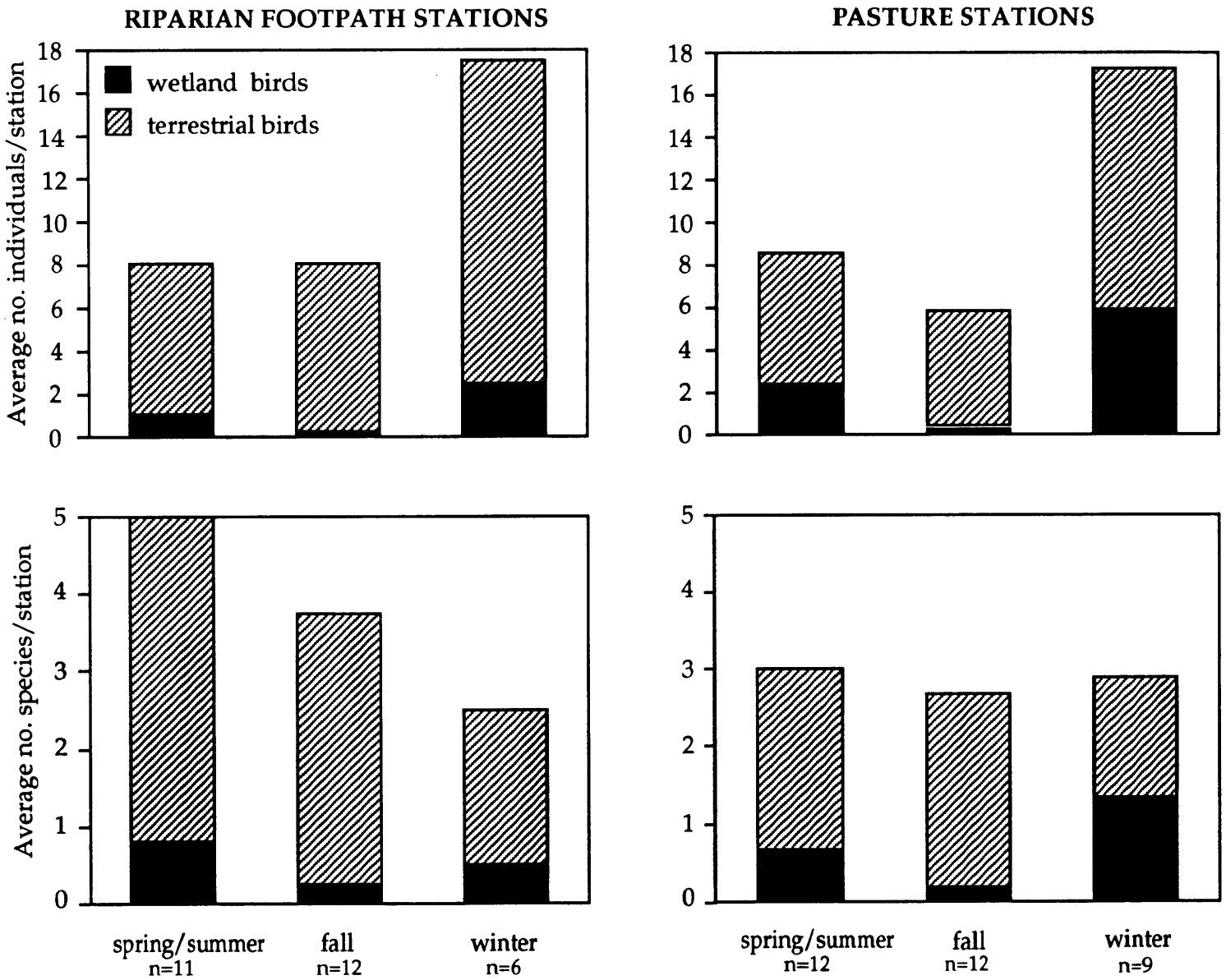
Figure IV - 34

Locations of bird survey stations at Big Lagoon. Station areas are roughly delimited by polygons. See IV B.1. Methods and Appendix B Bird Methods.



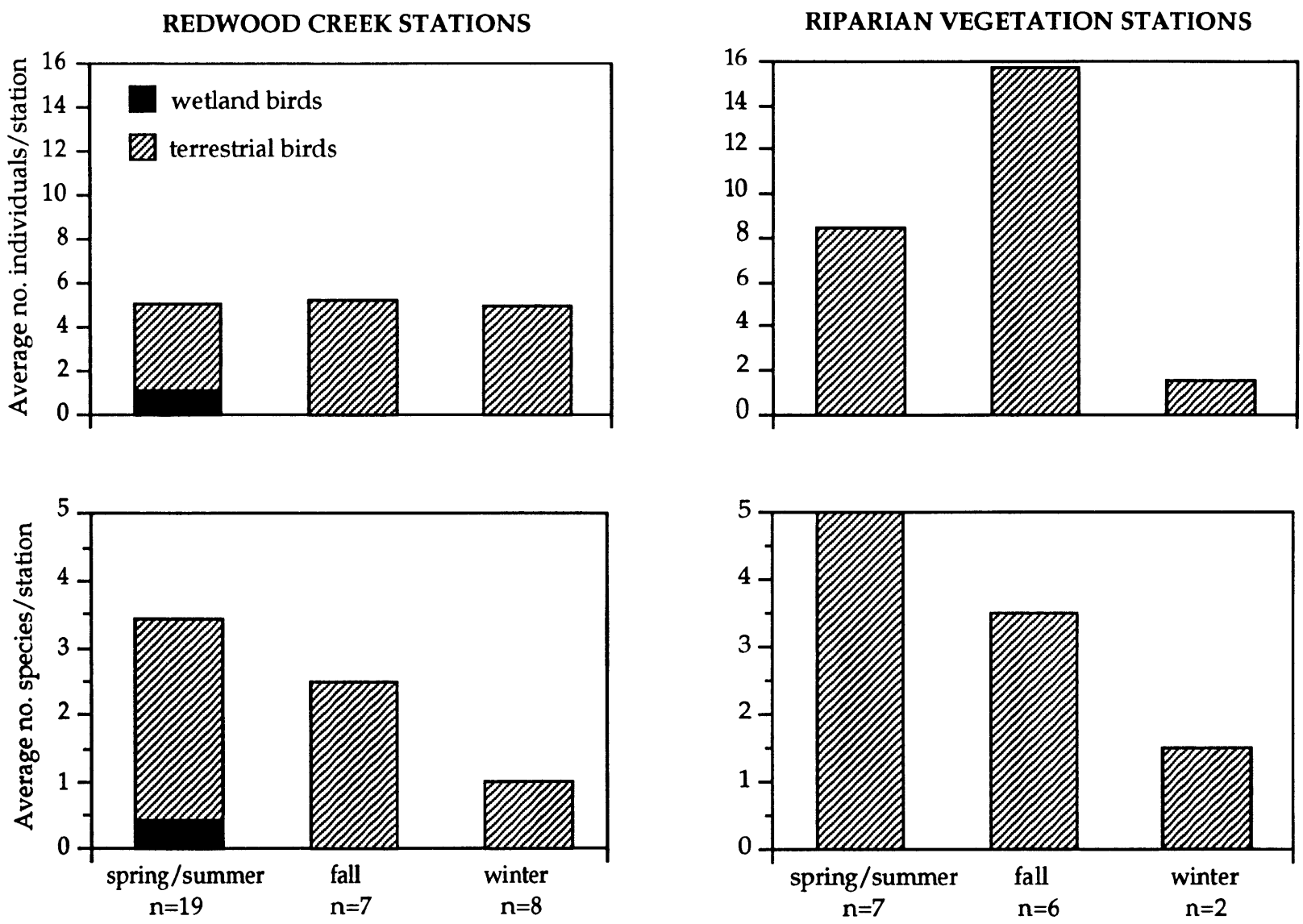
Total number of individuals and species of birds counted during 11 surveys at Big Lagoon, May 29, 1992 to August 9, 1993. Dotted line is summed for 12 stations. It includes sums from four additional stations surveyed less than 9 times, or only qualitatively

Figure
IV-35



Average number of bird species and individuals at Riparian Footpath Stations and Pasture Stations during spring/summer, fall, and winter seasons. Bars represent sum of wetland species and terrestrial species; see Table X.

Figure IV - 36



Average number of bird species and individuals at Redwood Creek Stations and Riparian Vegetation Stations during spring/summer, fall, and winter seasons. Bars represent sum of wetland species and terrestrial species.

Figure IV - 37

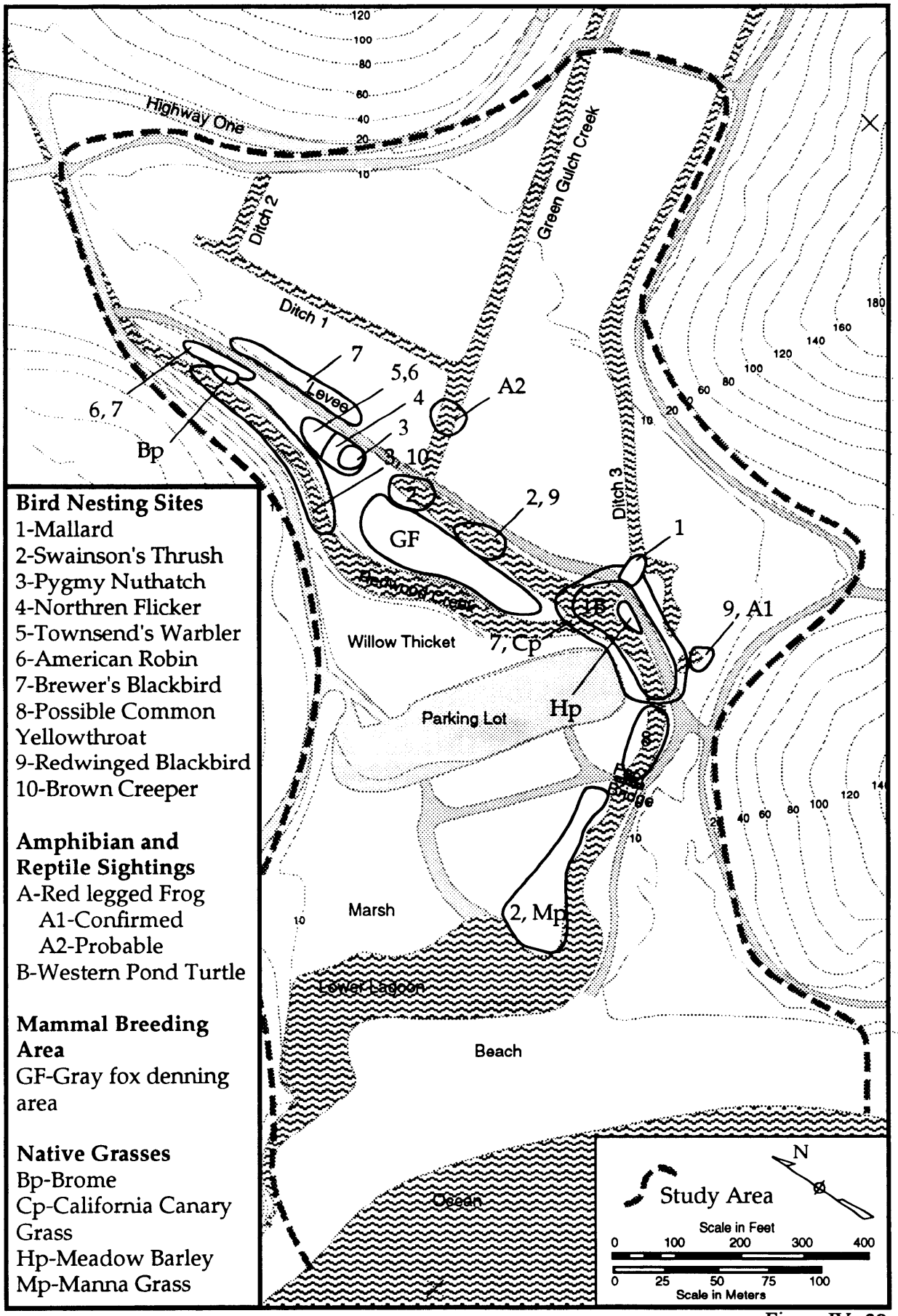
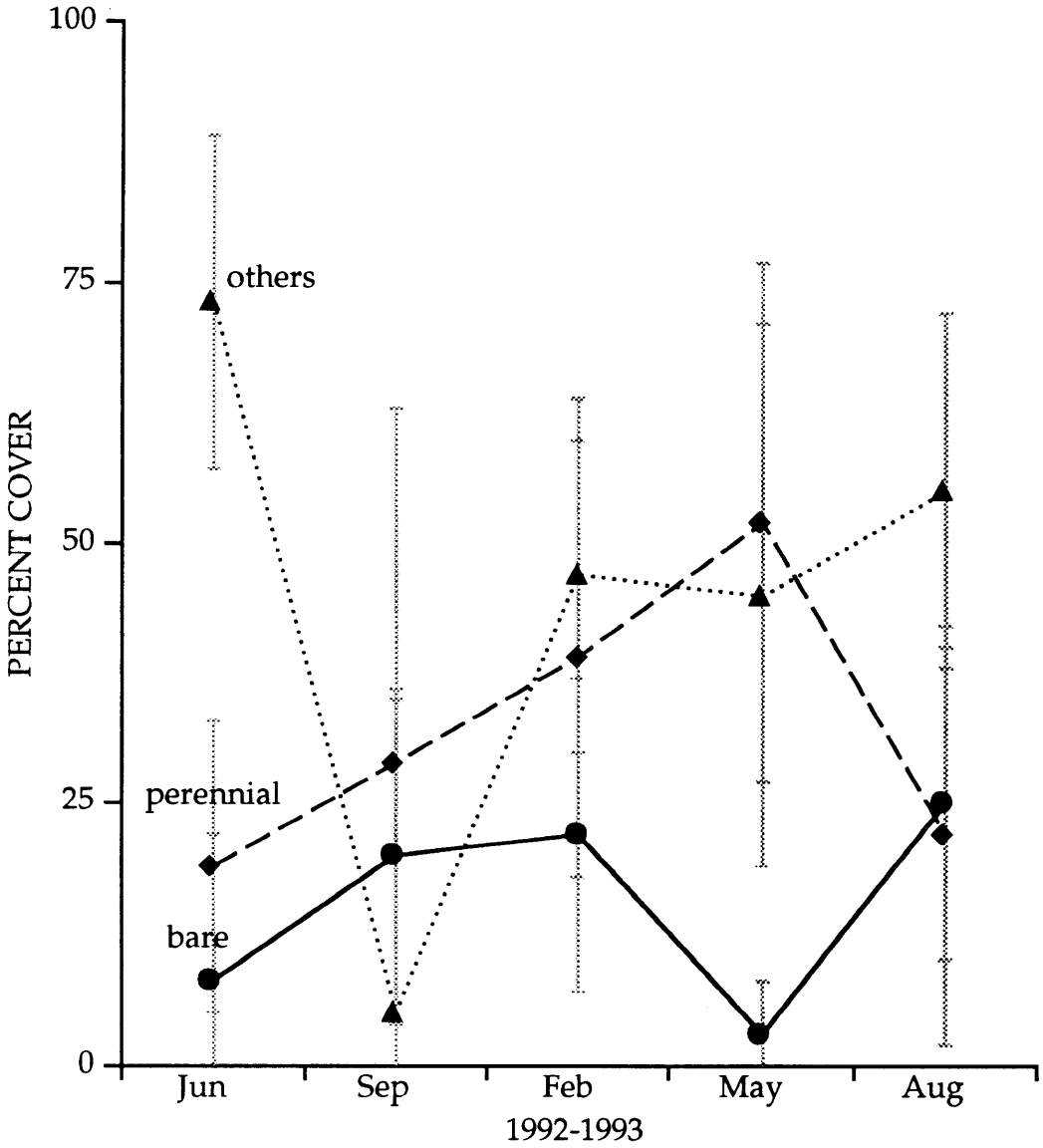


Figure IV -38

Locations of bird and mammal nest sites, red-legged frog, Western pond turtle and . antive grasses at Big Lagoon.



Vegetative cover along upland habitat transect. Mean percent cover, standard deviation, n=10.

FIGURE VIII-8

Restoration Alternative E
Enlarge Tidal Lagoon and Restore Dunes

LEGEND

Restored Lagoon

Dunes

Philip Williams & Associates, Ltd.

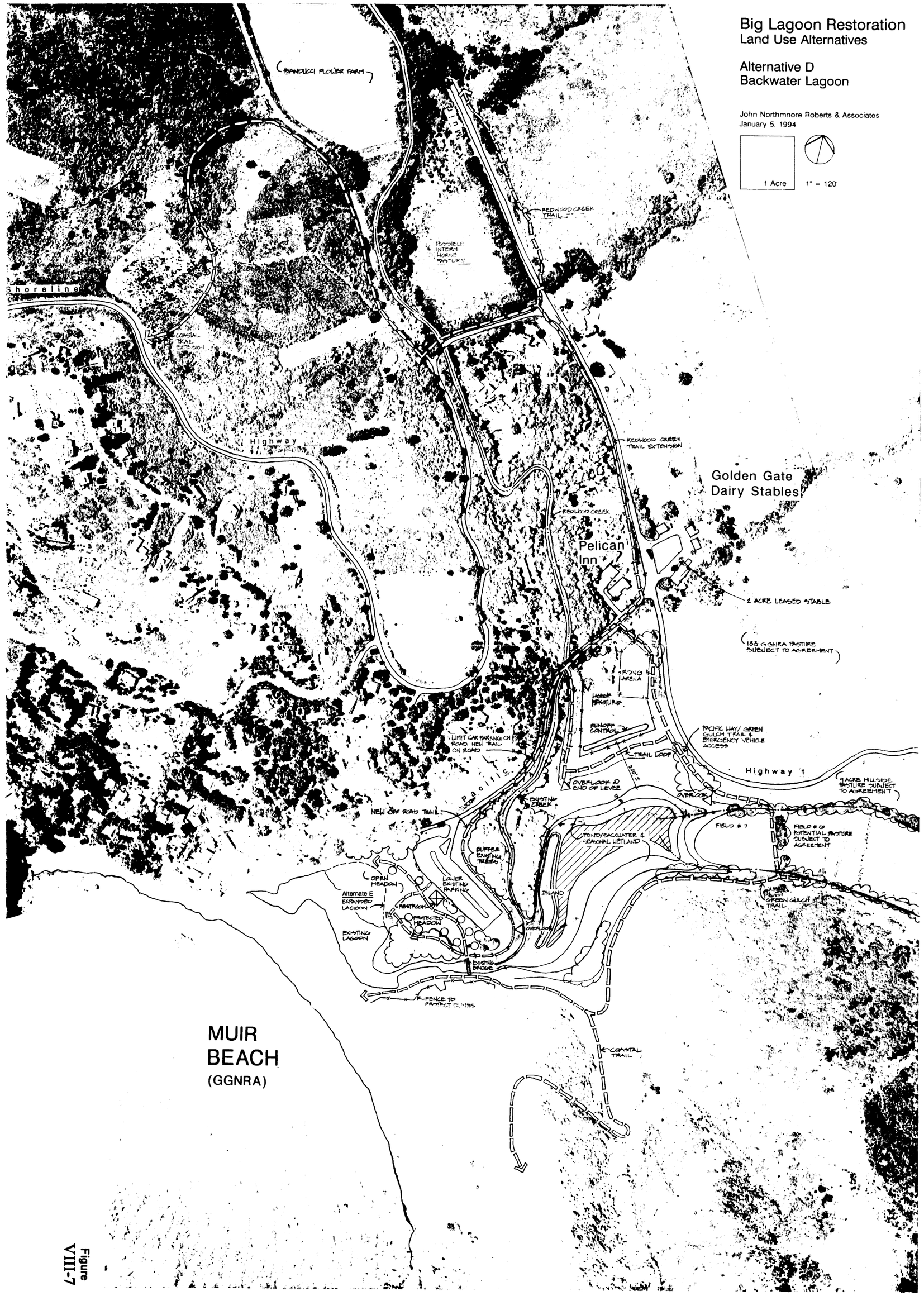
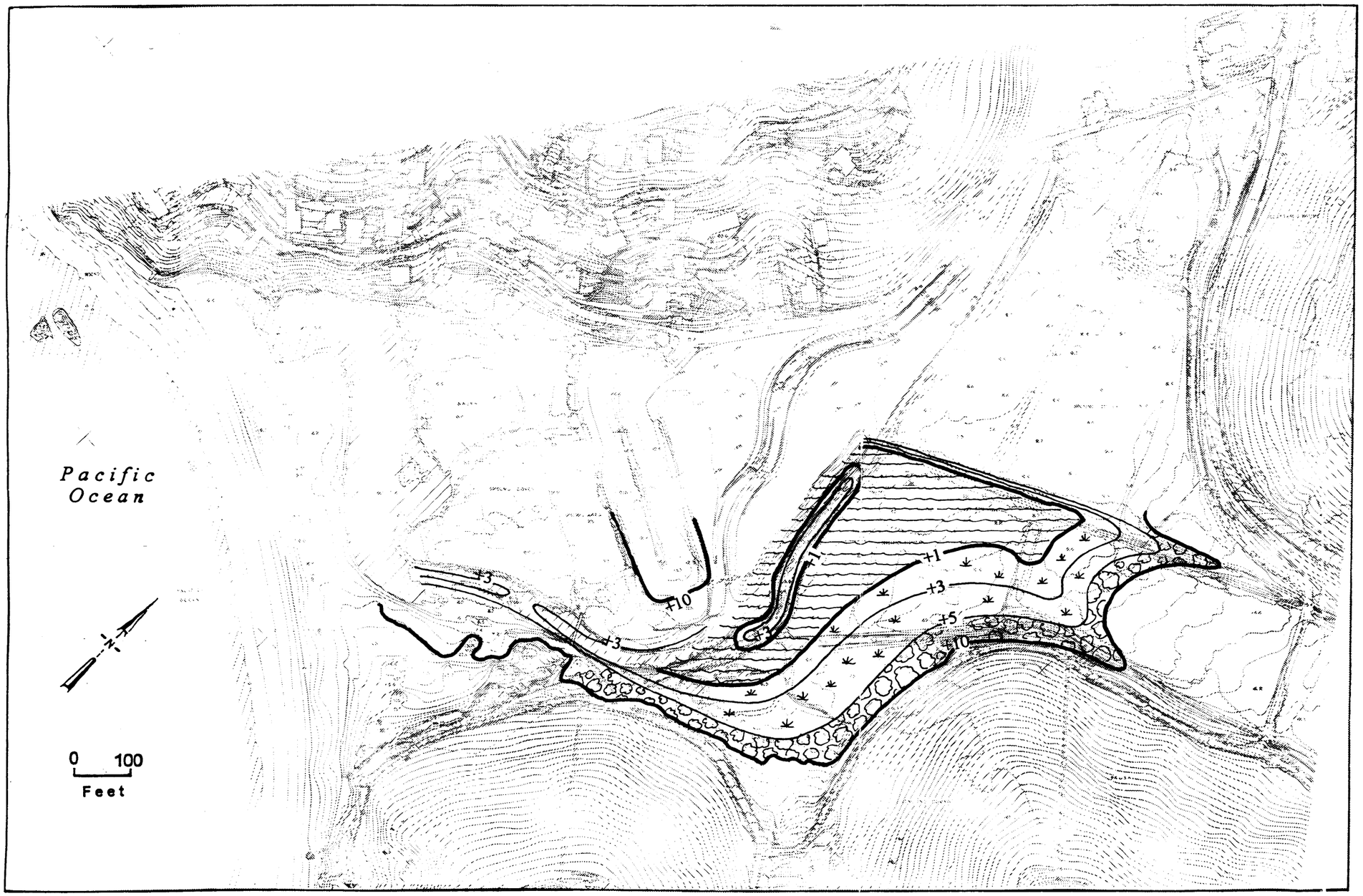


Figure VIII-7

FIGURE VIII-6

Restoration Alternative D
Backwater Pond and Wetland



LEGEND

- Open water
- Wetland
- Transitional Riparian / Upland

Philip Williams & Associates, Ltd.

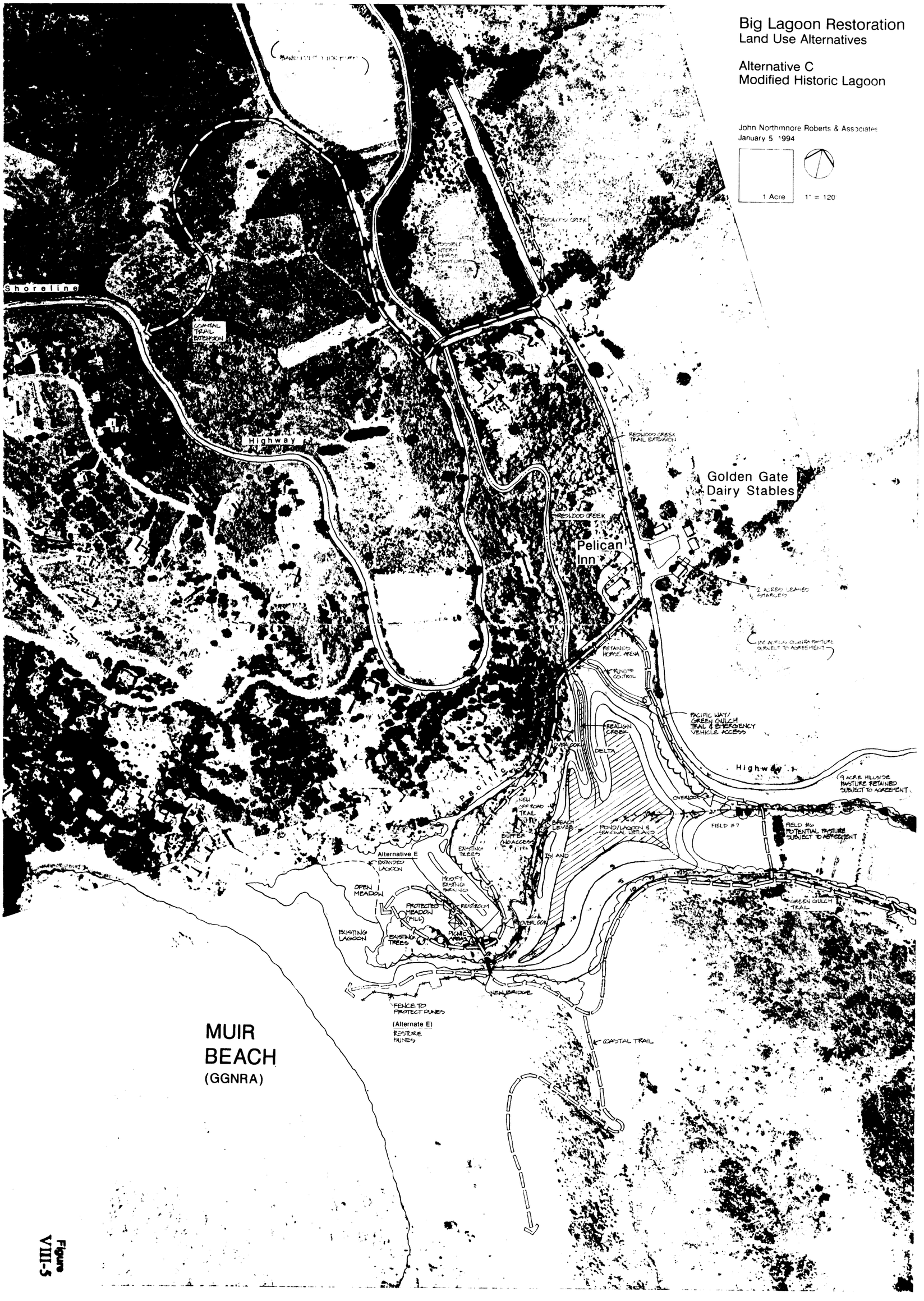
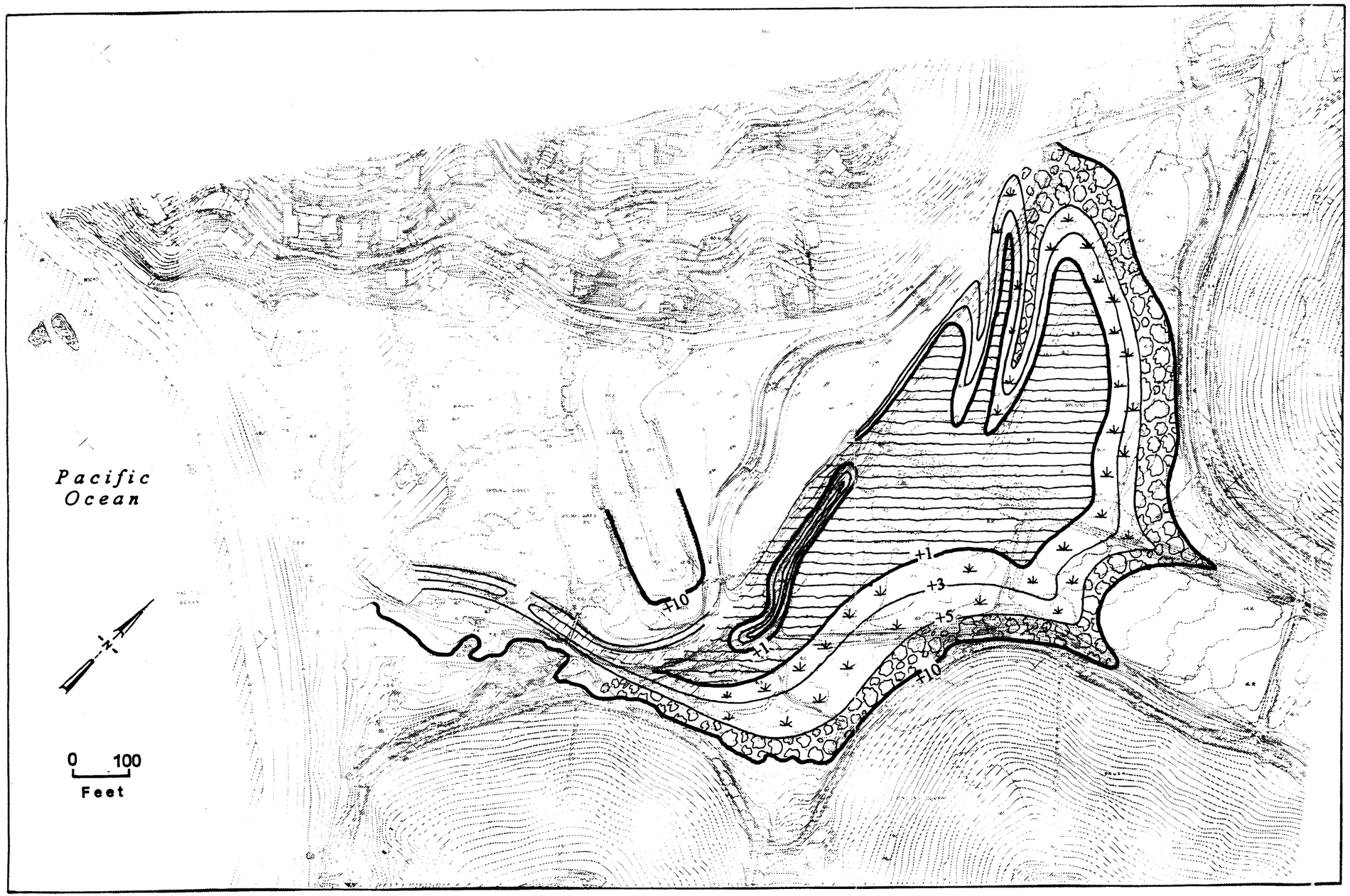


Figure VIII-5

FIGURE VIII-4

Restoration Alternative C Historic Wetland that Preserves Riparian Habitat



LEGEND

- Open water
- Wetland
- Transitional Riparian / Upland

Philip Williams & Associates, Ltd.

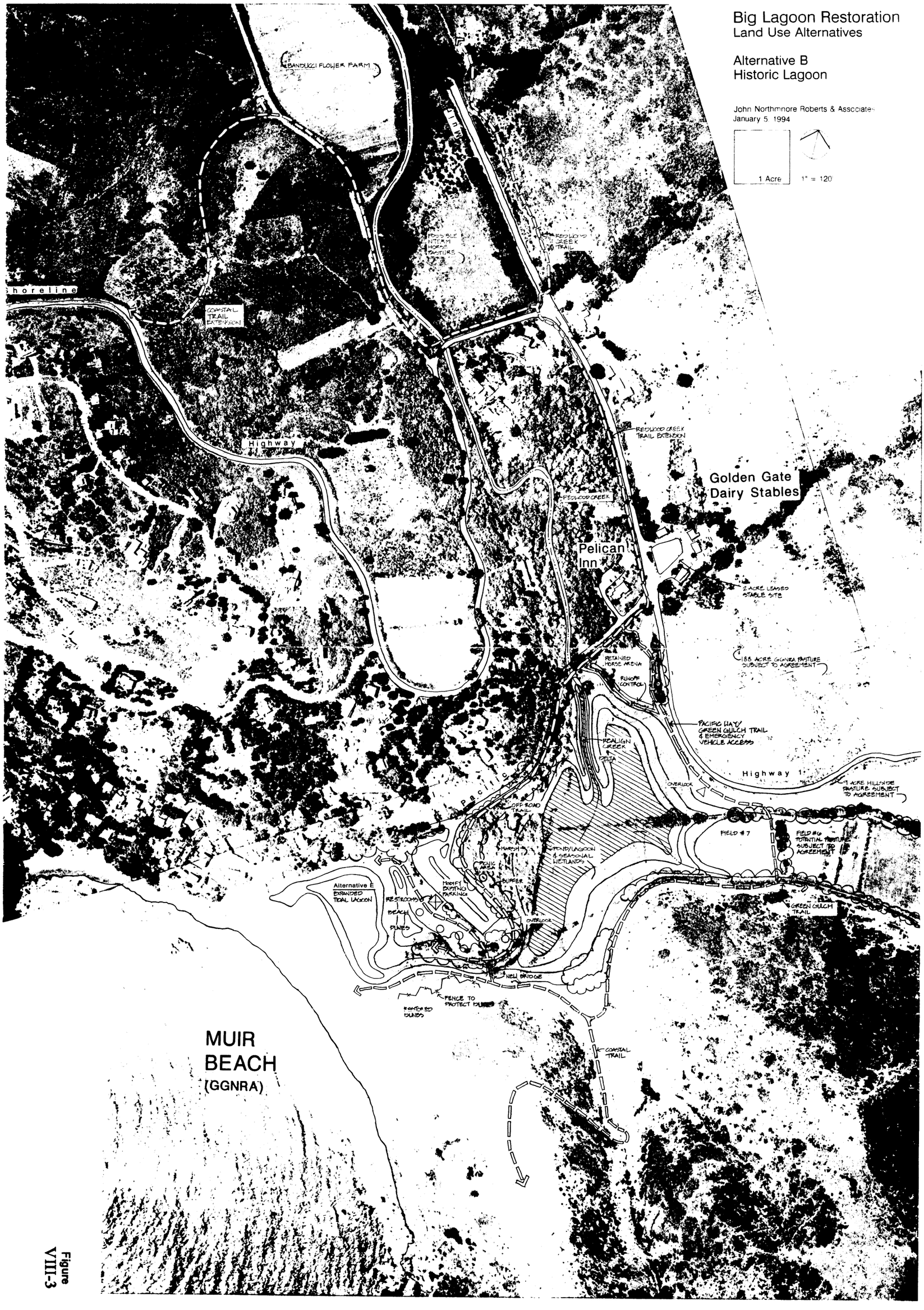
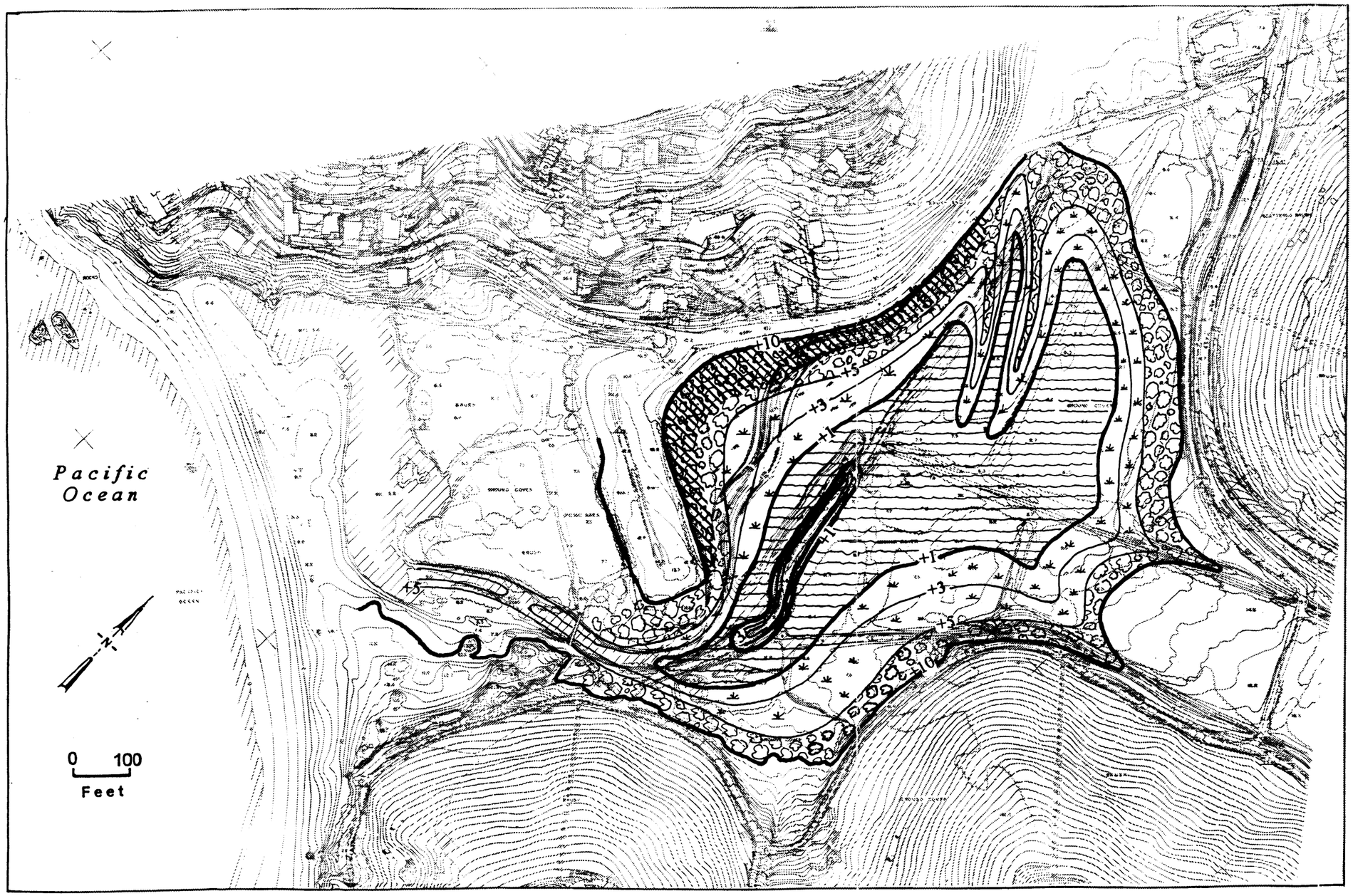


Figure VIII-3

FIGURE VIII-2

Restoration Alternative B
Historic Wetland



LEGEND

- Open water
- Wetland
- Transitional Riparian / Upland
- Existing Riparian Area (habitat enhancement only-no grading)

Philip Williams & Associates, Ltd.

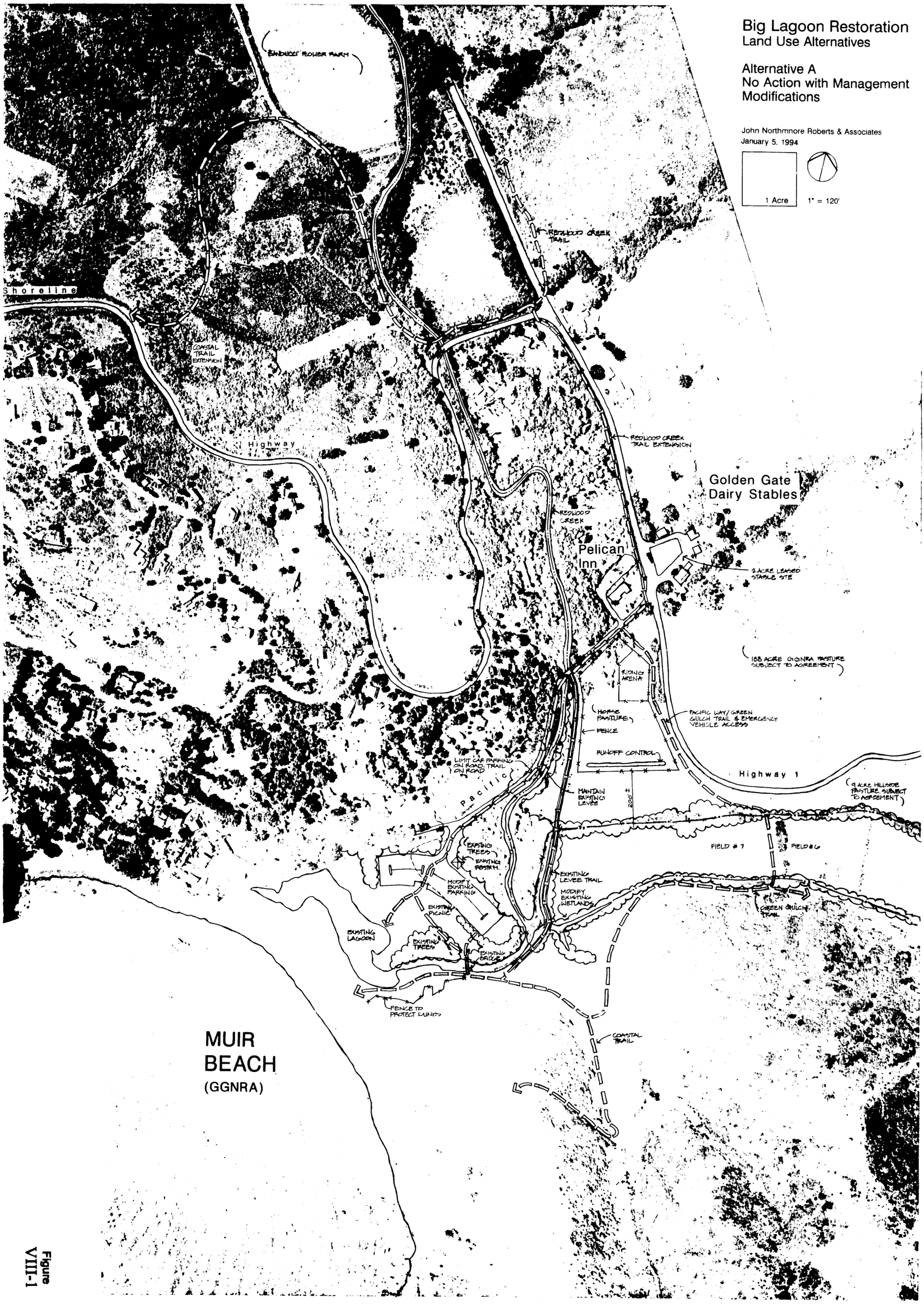


Figure VIII-1

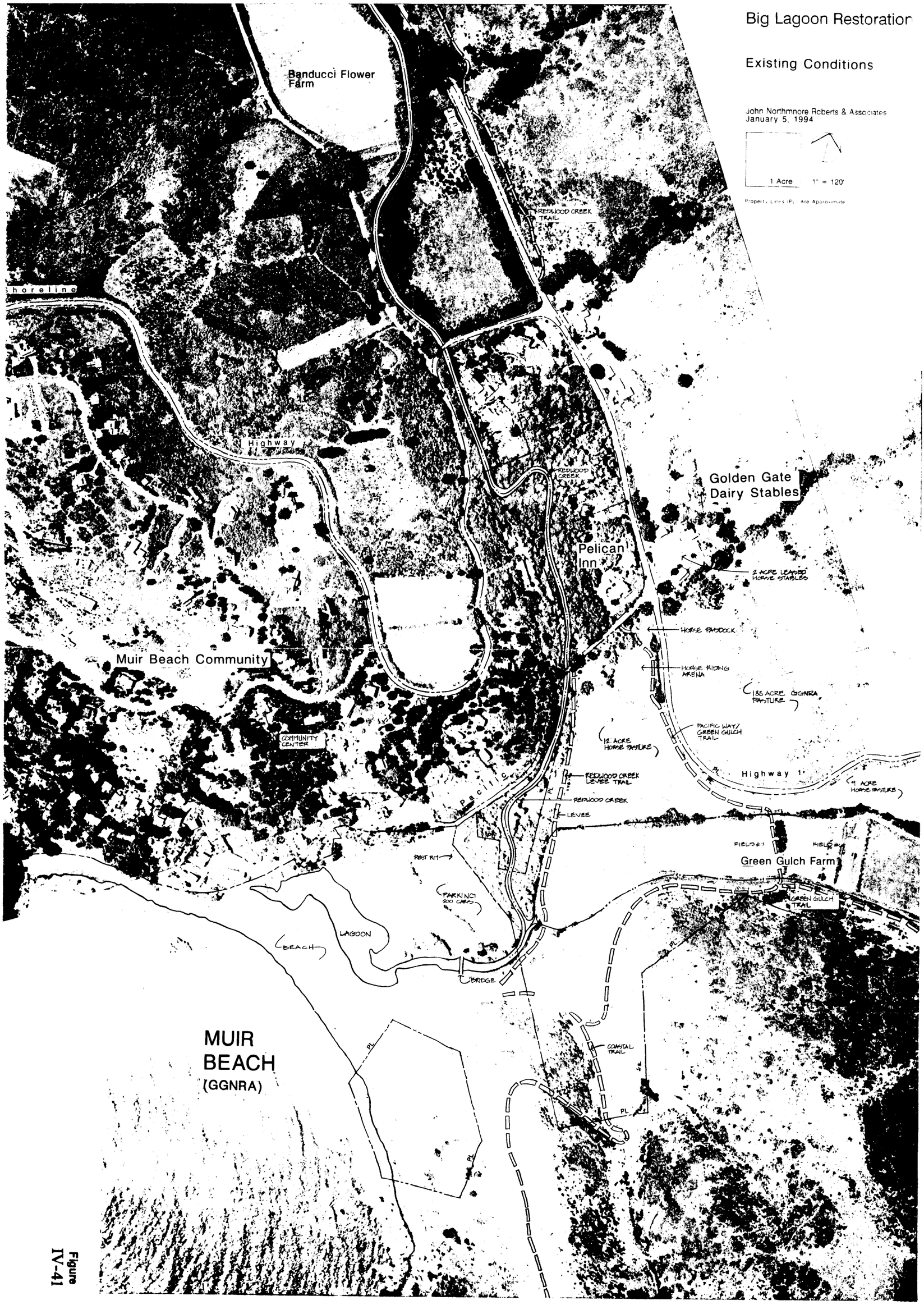

Big Lagoon Restoration
Existing Conditions
John Northmore Roberts & Associates
January 5, 1994
1 Acre
1" = 120'
Property Lines (PL) Are Approximate
Banducci Flower Farm
REDWOOD CREEK TRAIL
Shoreline
Highway
REDWOOD CREEK
Golden Gate Dairy Stables
Pelican Inn
2 ACRE LEASED HORSE STABLES
HORSE PADDOCK
HORSE RIDING ARENA
Muir Beach Community
COMMUNITY CENTER
1.85 ACRE GGNRA PASTURE
PACIFIC WAY/ GREEN GULCH TRAIL
12 ACRE HORSE PASTURE
REDWOOD CREEK LEVEE TRAIL
Highway 1
9 ACRE HORSE PASTURE
REDWOOD CREEK
LEVEE
FIELD #7
FIELD #6
Green Gulch Farm
REST RM
PARKING (100 CARS)
GREEN GULCH TRAIL
LAGOON
BEACH
BRIDGE
COASTAL TRAIL
MUIR BEACH (GGNRA)
PL

Figure IV-41

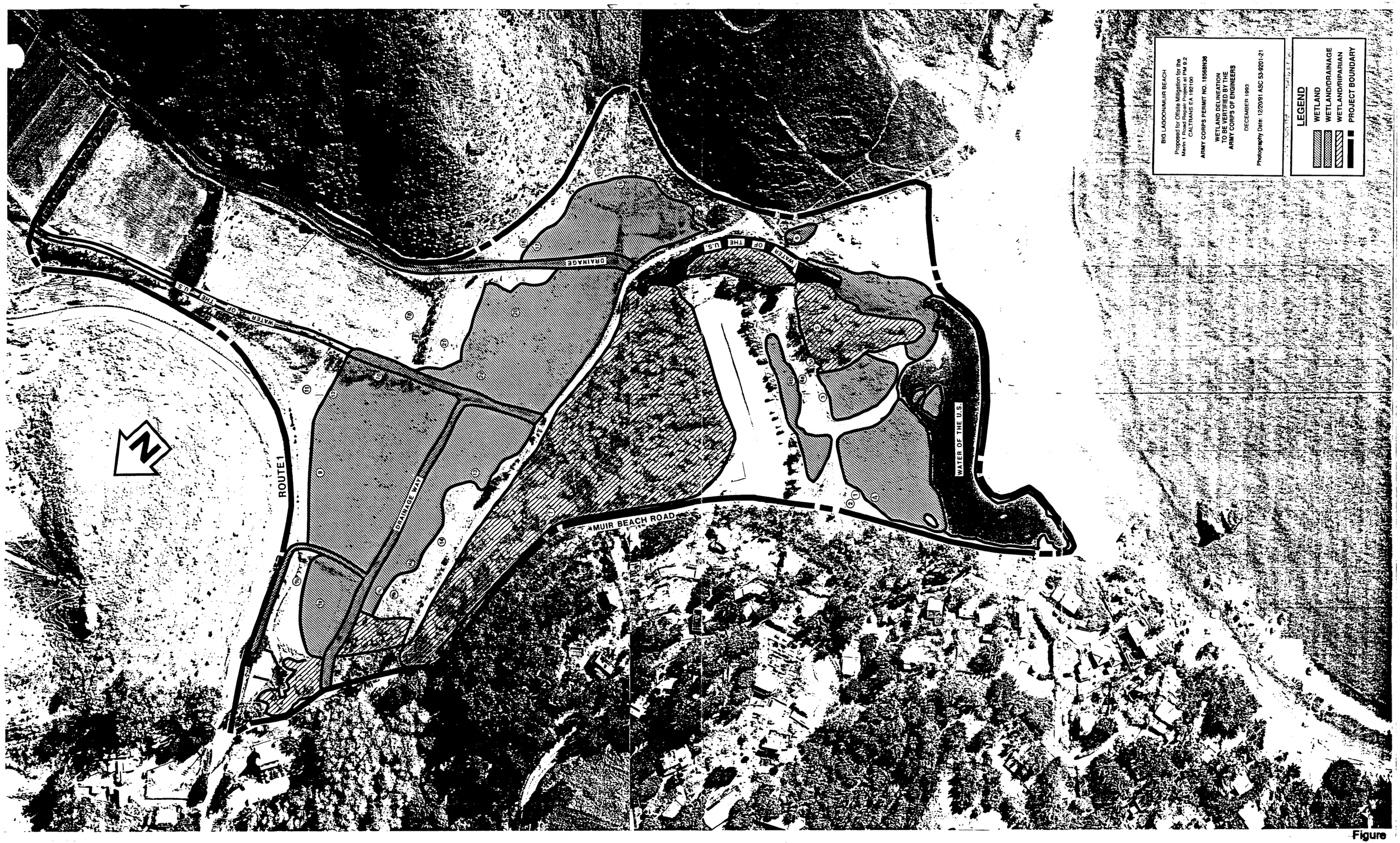
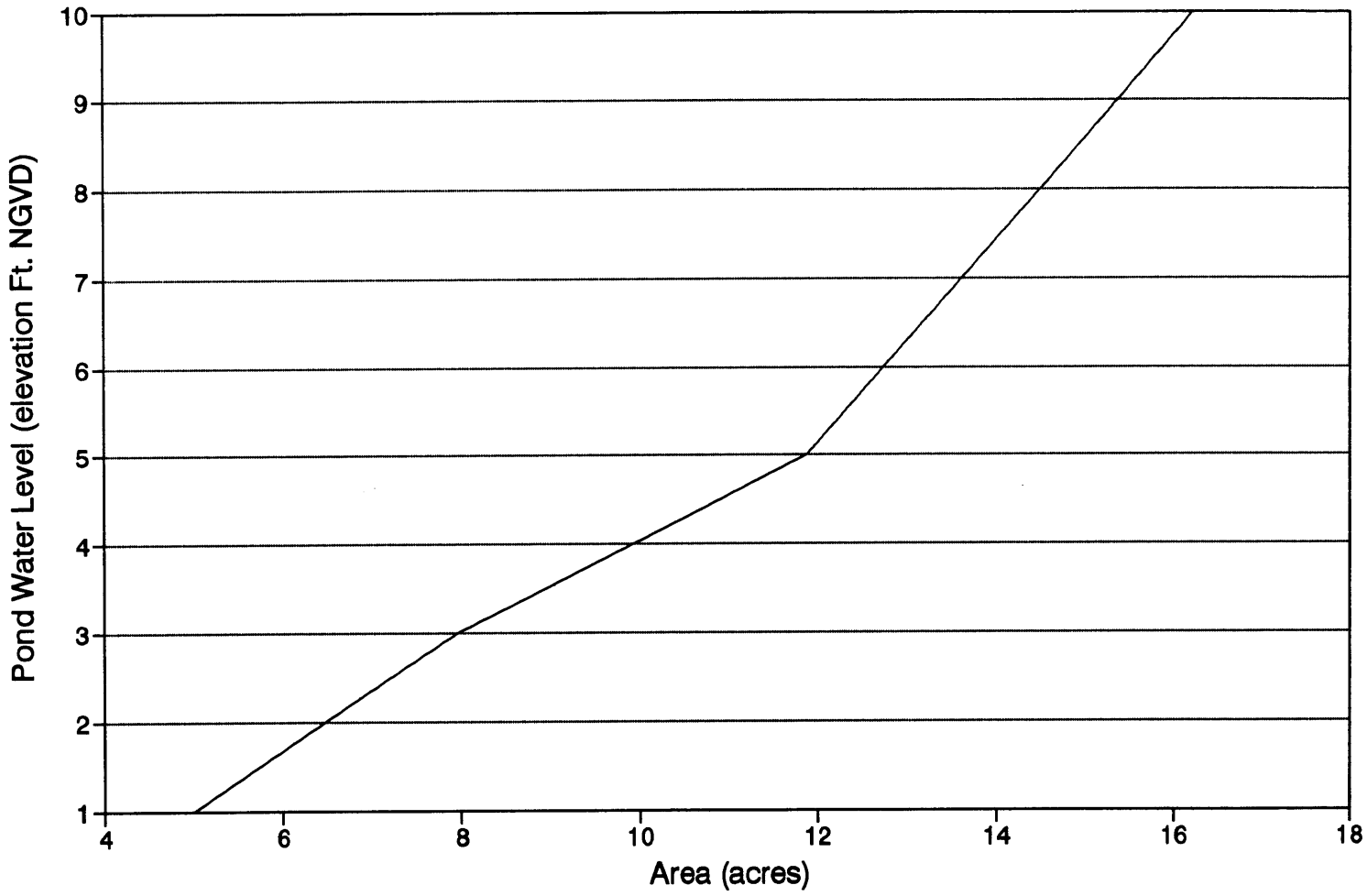

BIG LAGOON/MUIR BEACH
Proposed for Offsite Mitigation for the
Marin Tiburon Project at PM 9.2
CALTRANS EA 1B2100
ARMY CORPS PERMIT NO. 18568N36
WETLAND DELINEATION
TO BE VERIFIED BY THE
ARMY CORPS OF ENGINEERS
DECEMBER 1993
Photography Date: 12/20/91 ASC 53-9201-21
LEGEND
WETLAND
WETLAND/DRAINAGE
WETLAND/RIPARIAN
PROJECT BOUNDARY
N
ROUTE 1
DRAINAGE WAY
WATER OF THE U.S.
DRAINAGE
WATER OF THE U.S.
MUIR BEACH ROAD
WATER OF THE U.S.

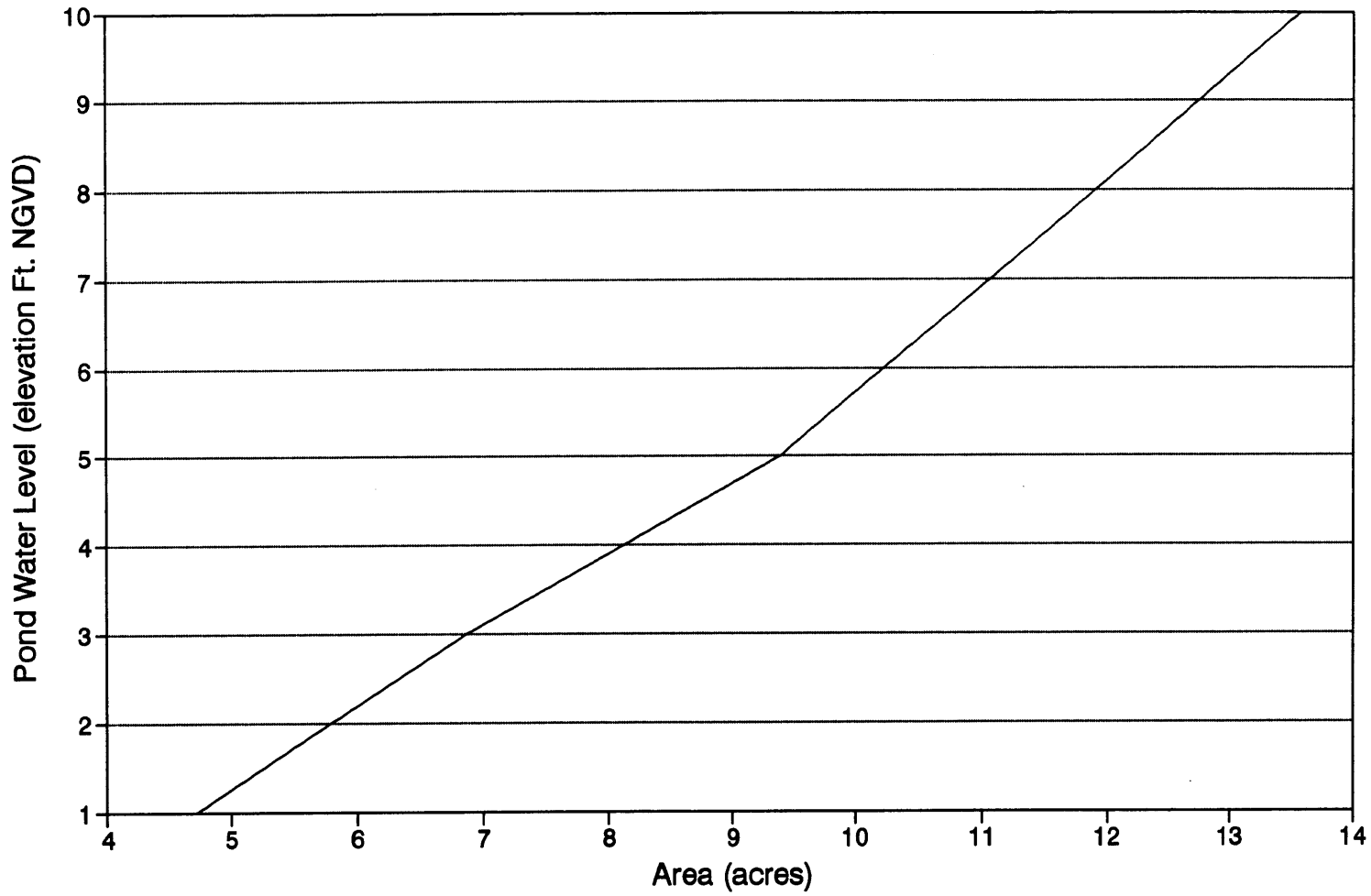
Figure
IV-40



Philip Williams & Associates, Ltd.
Consultants in Hydrology

Stage-Area Curve for Alternative B

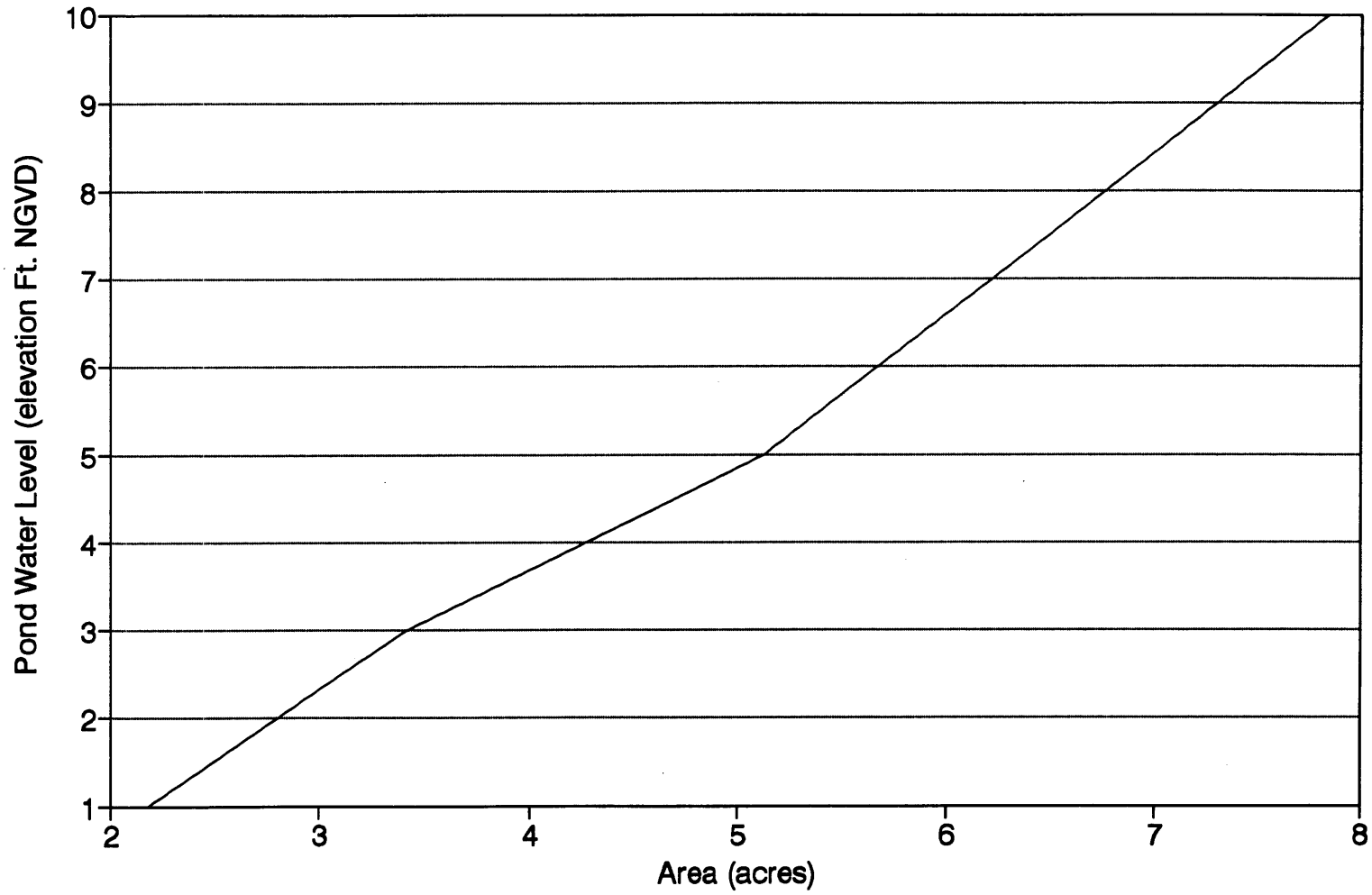
Figure
IX-1



Philip Williams & Associates, Ltd.
Consultants in Hydrology

Stage-Area Curve for Alternative C

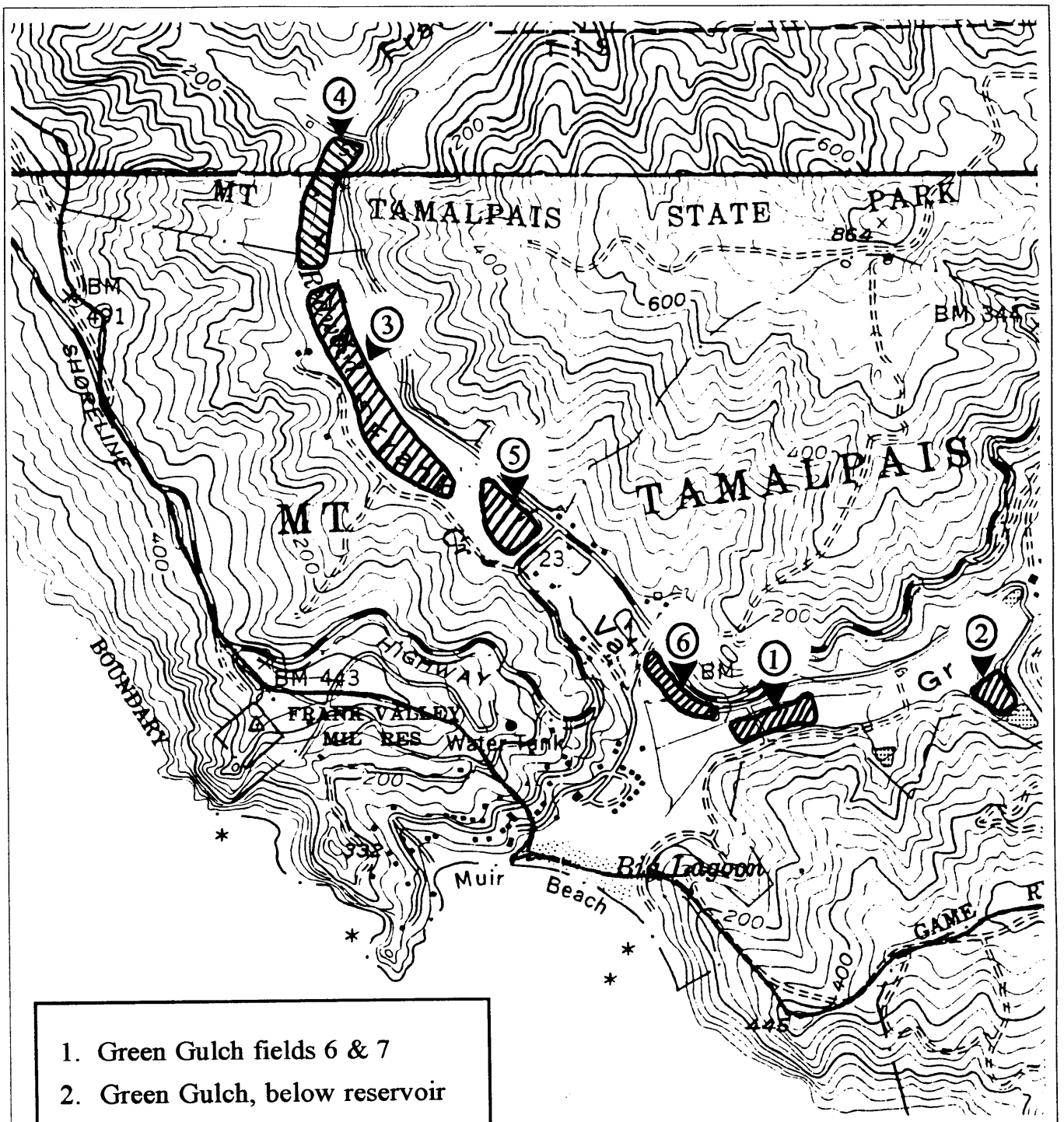
Figure
IX-2



Philip Williams & Associates, Ltd.
Consultants in Hydrology

Stage-Area Curve for Alternative D

Figure
IX-3



1. Green Gulch fields 6 & 7
2. Green Gulch, below reservoir
3. Banducci fields
4. Riding ring and State Park land
5. Former ballfield
6. Onsite uplands near Highway 1

Philip Williams & Associates, Ltd. Consultants in Hydrology	Locations of Potential Disposal Sites	Figure X-1

APPENDIX A

Interpretation of Soil Corings

UNIVERSITY OF CALIFORNIA AT BERKELEY

BERKELEY • DAVIS • IRVINE • LOS ANGELES • RIVERSIDE • SAN DIEGO • SAN FRANCISCO SANTA BARBARA • SANTA CRUZ

DEPARTMENT OF GEOGRAPHY
EARTH SCIENCES BUILDING
BERKELEY, CALIFORNIA 94720
FAX: (415) 642-3370

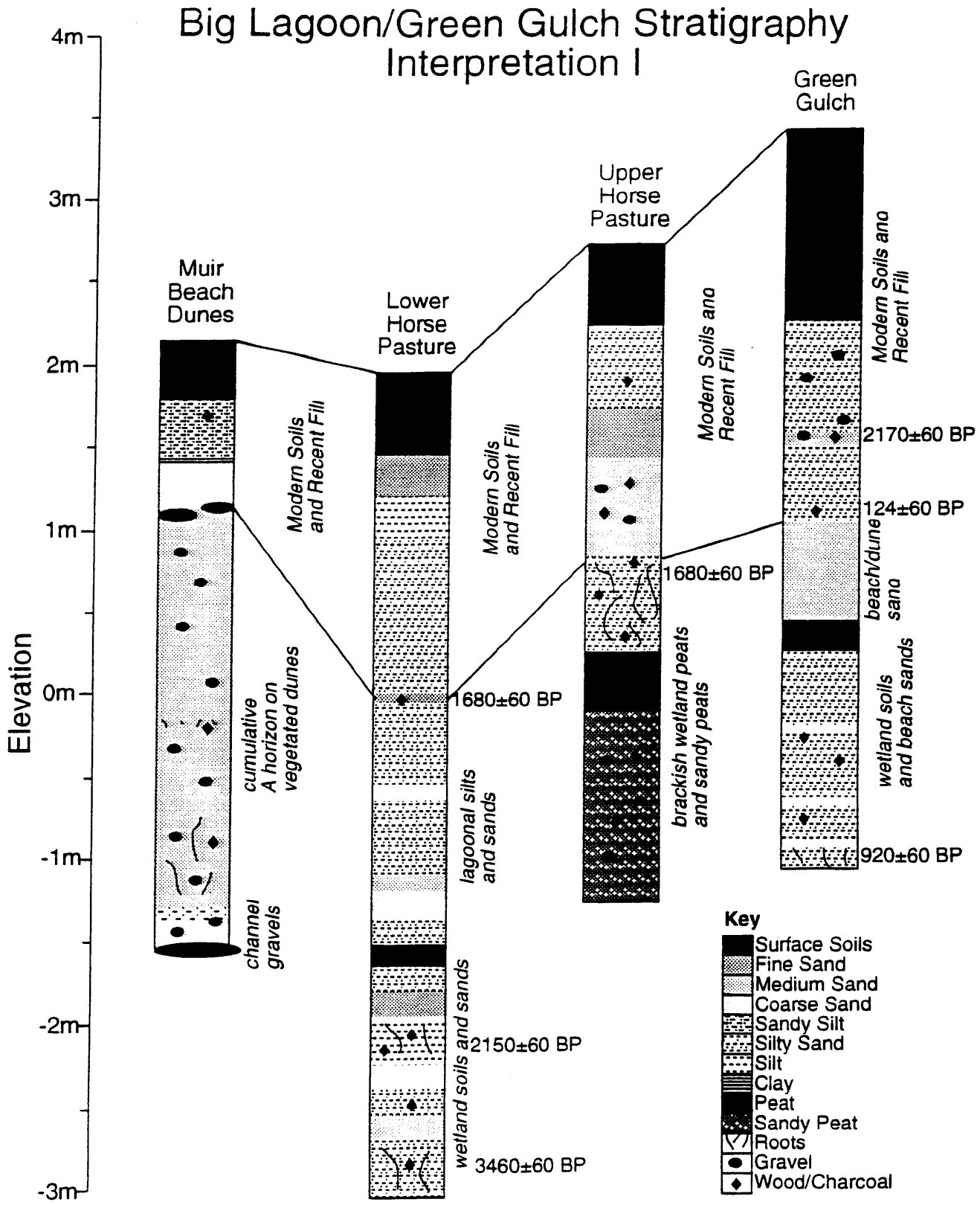
January 7, 1994

To: Rob Schonz
Phil Williams and Associates
Pier 35, The Embarcadero
San Francisco California

From: Dr. Lisa E. Wells
1376 Hearst Ave
Berkeley CA 94702-1419
FAX/Phone: 510/849-9512

As per our discussion yesterday, I would like to clarify the differences between my original and final interpretation of the marsh sediments. I attach two diagrams (Interpretation I and II) which illustrate the alternative interpretations. The original interpretation (I) was based mainly on stratigraphic arguments. A clear discontinuity in all the cores marks the base of what was interpreted to be modern deposits. This stratigraphic discontinuity is a change in sedimentation with a increase of organic matter and fine grained sediment into the lagoon. Subsequent radiocarbon dating of this discontinuity yielded two ages of 1680 BP on detrital charcoal within the fine grained sediment layer. Based on this radiocarbon age I revised my interpretation (II) and moved the stratigraphic boundary for the base of modern deposits to shallower depths. However, one must keep in mind that the material for the radiocarbon dates was detrital charcoal which can have a very long lifetime in the environment. Since we see older charcoal incorporated into the modern deposits in Green Gulch it is reasonable to assume that older charcoal may have been deposited into the lagoon as well. If this is the case then my original interpretation may be the correct one.

It is difficult to choose a best interpretation with the data available. The fact that the discontinuity in both the lower and upper horse pasture yielded identical radiocarbon dates lowers the probability that these are very old charcoal samples. Alternatively, the elevation of the discontinuity and the stratigraphy would suggest that the dates are indeed to old. Resolution of this dilemma requires additional radiocarbon dating.



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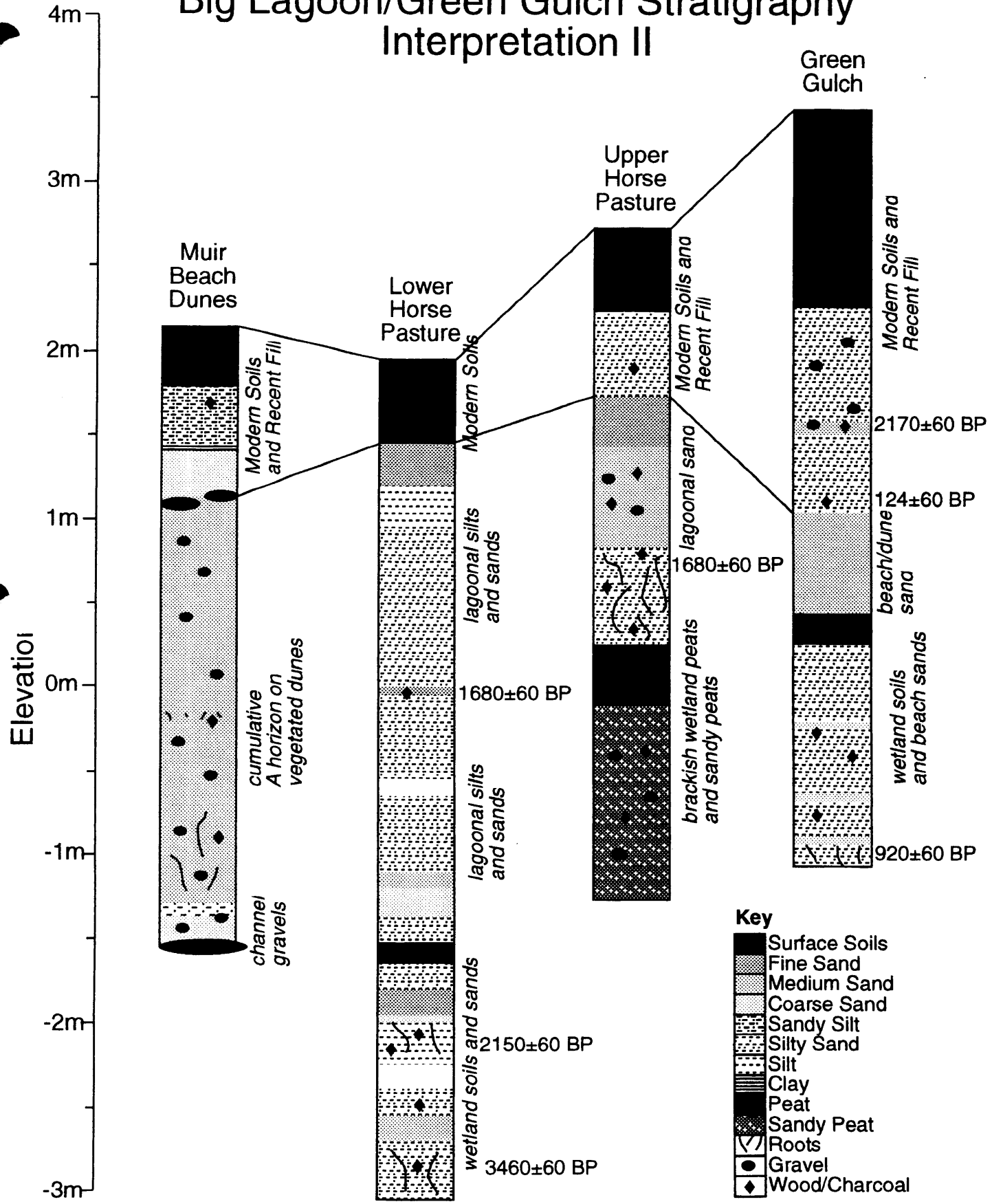
Soil Corings Profile

Figure III-2

Big Lagoon/Green Gulch Stratigraphy Interpretation II



Sedimentation History at Big Lagoon/Green Gulch

A report for Philip Williams and Associates

By Lisa E. Wells Ph.D.

17 December 1993

Summary: Big Lagoon formed in the lower Muir Creek drainage basin as the result of later Holocene sea level rise. Sediments in this area record the gradual flooding the basin and a transition from a brackish wetland to a brackish/salty lagoon. Open water lagoonal conditions existed from just after 2000 BP until at least 1853 AD and wetland since about 3500 BP. Foraminifera from wetlands on the upstream end of the lagoon indicate that early during the lagoons formation (c. 1680 BP) it was a brackish environment with frequent fresh water flushing by Muir Creek. As the area was drowned during sea level rise and the lagoon extended farther inland the area probably became increasingly saline with freshening events during with winter storms. About 125 years ago the edge of the lagoon, marked by a sandy beach, was located at the mouth of Green Gulch. The presence of interbedded wetland soils and lagoonal sands below the beach deposits suggests that the lagoon fringe was located here since at least 900 years ago. About 250 cm of organic rich sand just west of the parking area indicate that the lagoon was ponded by a vegetated dune. Channel gravels at the base of this deposit are indicative of the channel which once drained the lagoon.

Four holes were drilled into the surface sediments in Muir Beach-Green Gulch Area. The location of the drill holes are as follows (refer also to accompanying map): 61193) Muir Beach Dunes drill site was located in the vegetated dune area between the picnic tables and the tidal channel at the Muir Beach Recreation Area; 92692A) Lower Horse Pasture drill site was located in the lowermost horse pasture on the Green Gulch Farms property just east of Muir Creek; 92692B) Green Gulch drill site was located within the horse pasture which extends into Green Gulch proper; and 72393) Upper Horse Pasture drill site was located farther upstream along Muir Creek within the horse pasturage. Materials were described in the field and samples have been archived in the Kesseli Laboratory at the University of California, Berkeley. Samples from below 2 m depth in the Lower Horse Pasture were analyzed for grain size distribution, moisture and organic content. Radiocarbon analysis was done on samples from the Upper and Lower Horse Pasture site and the Green Gulch site.

All sites are capped by modern soils on a layer of recent fill. The fill depth ranges from about 1 m at the Muir Beach Dunes site to 2. 4 m at the Green Gulch site. These surface deposits are comprised of pebbly silty sands and sandy silts, with modern roots extending through the upper few decimeters.

At the Muir Beach Dunes site a gravel layer marks the base of the modern fill deposits. Two samples from these upper sediments at the Green Gulch drill site were analyzed for radiocarbon content. Soil organic matter at a depth of 192.5 cm yielded a radiocarbon date of 2170 ± 60 BP and wood at a depth of 230 cm yielded a radiocarbon date of 124 ± 60 BP. The old date from the shallower sediment is interpreted here to reflect soil organic material released when the hillsides around Green Gulch were plowed. The younger date at the base probably reflects that age of the soils at this site prior to human intervention.

At the Muir Beach site a thick sand layer with common pebbles and some organic materials underlies the modern fill. This material represents a vegetated dune complex into which occasional storm events washed coarser gravel. Root material from the lower part of this section, about 3 m depth, appear to be the same *Juncus* species that is growing on the surface today. Penetration at the site stopped at 3.7 m depth when a very large rock was encountered. The pebbly coarse sand above the rock and the rock itself represent an old tidal channel at this location.

The two drill sites in the horse pasture were drilled directly into the location of the Muir Beach Lagoon. The sediments at these sites result from sea level rise and the gradual flooding of the lower Muir Creek drainage basin, except the upper few decimeters which are clearly modern soils. Below the modern soil the sediments are interbedded sands, silty sands, silts and peats. At the Lower Horse Pasture site the low organic content of the sediment between 0.5 and 3 m depth suggests that they are open water lagoonal deposits . Between 3 and 5 m depth the frequency of roots increases suggesting that at these levels the sediments were deposited into a wetland environment with standing vegetation. The vegetated wetland was present from at least 3500 BP to some time after 2000 BP based on two radiocarbon dates from this material (Table 1). The sedimentation rate increased in the open water lagoon as indicated by the radiocarbon date of 1680 ± 60 from wood at a depth of 197 cm. At some time subsequent to the deposition of this wood the sedimentation rate dropped significantly and the modern soil began to form.

The clean fine to coarse sands between 100 and 200 cm depths at the Upper Horse Pasture site depths were deposited in an open water lagoon. Below these lagoonal deposits a sandy peat (200-250 cm) marks the transition from wetlands to lagoon. A radiocarbon date on wood from the top of this transitional layer indicates that the open water was flooding this site subsequent to 1680 ± 60 BP. The lowermost sediments (250-400 cm) are wetland peats and sandy peats. The agglutinated foraminifera *Trochammina inflata* was found in the peats between 250 and 285 cm. *Trochammina* is common today in the brackish mud flats of the San Francisco Bay and Carquinez Straits. This agglutinated foraminifera makes its shell by cementing sand grains together with calcium carbonate. At Green Gulch the *Trochammina* shells have largely dissolved, leaving the organic interiors and

some thin crystallization on the outer chambers. This habit indicates an environment with common fresh water flushing that would dissolve the carbonate shell.

At the Green Gulch site the lagoonal deposits are buried by 240 cm of modern fill. This thick layer of modern fill resulted from human-induced erosion of the surrounding hill sides. The sands below the modern fill (240-300 cm depth) at the Green Gulch site are most likely a beach or dune deposit. They marked the inland edge of the open water lagoon and may have resulted from storm deposition. Sediments below 3 m depth have a higher organic content and obvious root materials suggesting that vegetated wetlands interfingered with beach sediments here prior to the lagoon. A wood fragment from the base of the wetland sediments yielded a radiocarbon date of 920 ± 60 BP suggesting that the mouth of Green Gulch marked the eastern edge of the open water lagoon for at least 900 years.

Table 1: Radiocarbon Dates

Location	Sediment Type	Material	Depth	Radiocarbon Age yr BP
Lower Horse Pasture	Sand	charcoal	197 cm	1680 ± 60
	Peat	soil organics	405 cm	2150 ± 60
	Silty Clay	soil organics	478 cm	3460 ± 60
Upper Horse Pasture	Sand	charcoal	200 cm	1680 ± 60
Green Gulch	Sand	soil organics	192 cm	2170 ± 60
	Silty Sand	wood	230 cm	124 ± 60
	Silty Sand	wood	442 cm	920 ± 60

Table II. Core Logs, depth in cm:

92692A, Lower Horse Pasture

0-50	loam, oxidize silty clay
50-75	f. sd
75-100	silt
100-130	silty f. sd
130-175	silty vf sd, water table at 150 cm
175-178	silty vf sd
178-180	c sd
180-195	silty vf sd
195-200	vf sd, wood fragment
200-210	silty vf sd, liquid
210-250	silty vf sd w/ f sd layers
250-260	no recovery
260-305	silty vf sd
305-315	m-f sd
315-332	m-c sd
332-347	silty sd
347-360	red, root rich silty sd w/ woody fragments
360-375	silty vf sd
375-390	f-vf sd, liquid
390-395	m-c sd
395-420	silt w/ abundant roots, sulfer smell
435-450	silty vf sd, mottled, oxidized root fragments
450-465	f-m sed, liquid
460-468	silty f sd
468-470	m-c sd
470-500	silty vf sd, mottled, organic fragments

92692B, Green Gulch

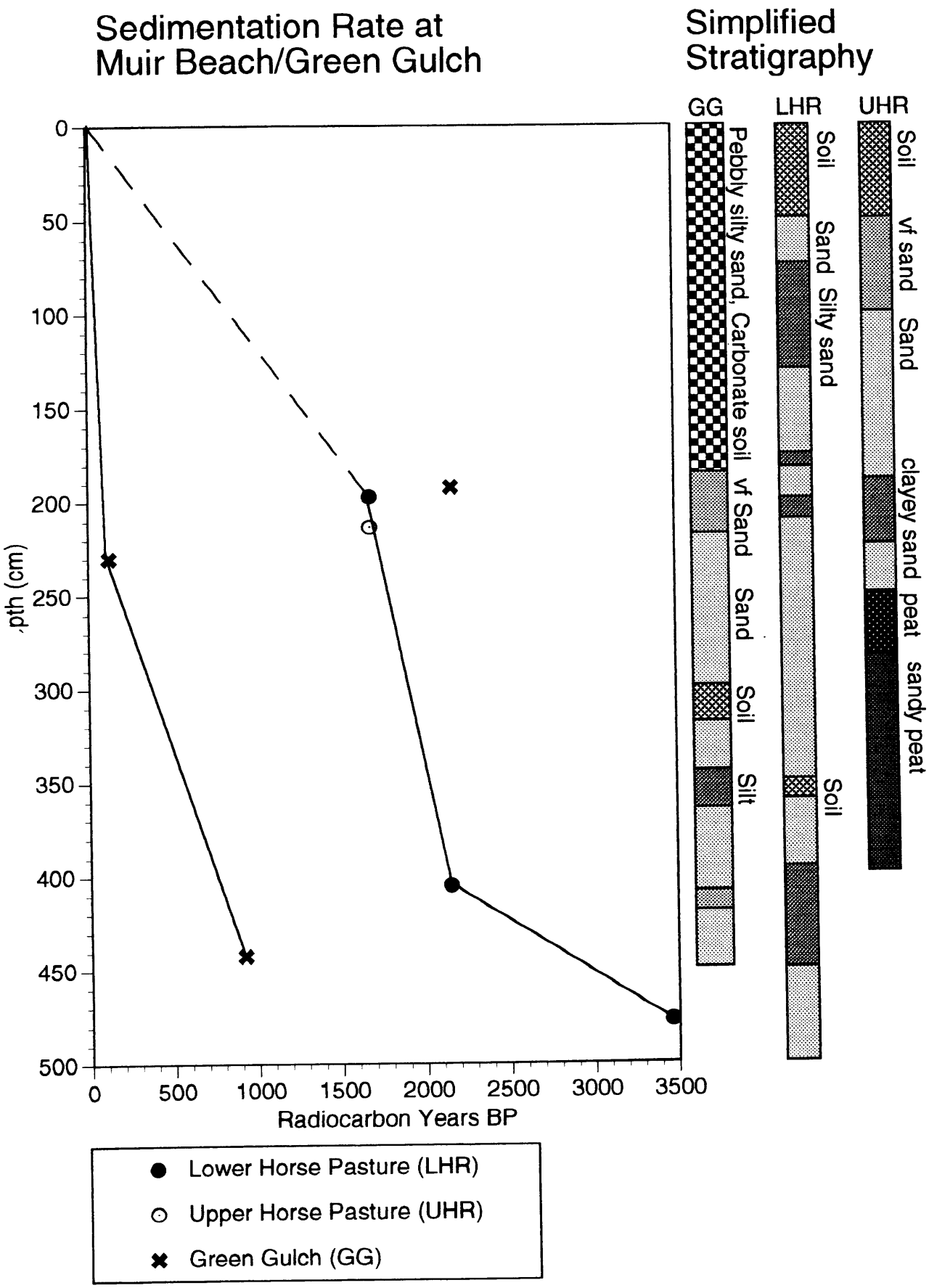
0-100	pebbly silty sd, carbonate
100-120	pebbly silty sd
120-185	pebbly silty sd, water table at 120
185-195	pebbly m-c sd
195-220	silty f sd
220-240	silty f sd, large organic fragments
240-300	f-c sd, liquid
300-320	buried soil, organic silty sd, mottled black with many f-vf roots
320-345	silty f-m sd
35-365	sandy silt
365-370	m-c sd
370-380	silty sd, many organic fragments
380-385	f-m sd, liquid
385-400	silty sd, abundant organic fragments
400-410	organic silty sd
410-420	m-f sd, liquid
420-430	organic silty sd
430-435	m-c sd, liquid
435-450	silty m-c sd, long roots, abundant organic fragments

92692 Muir Beach

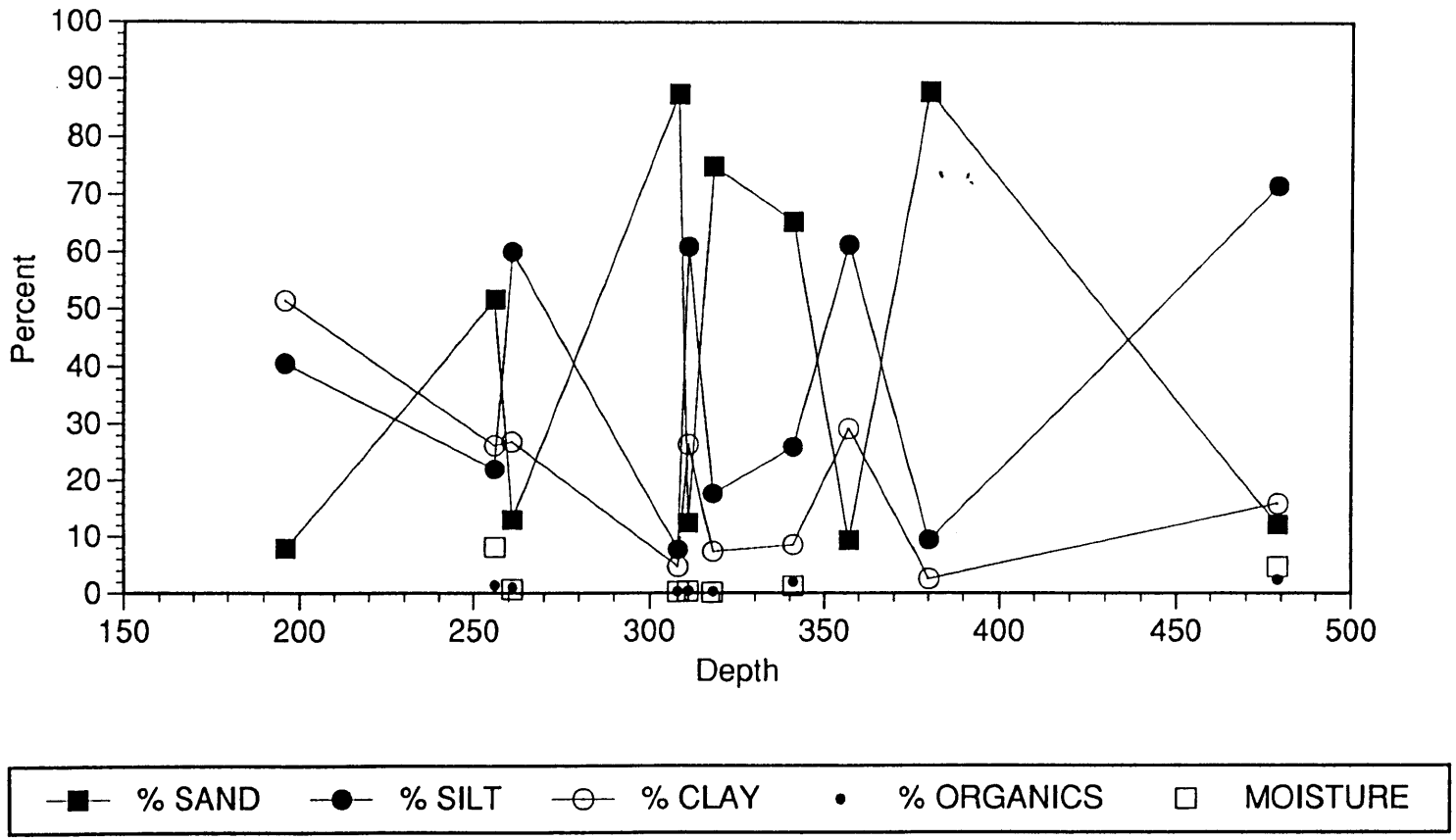
0-35	soil, red with live roots
35-36	m-c sd
36-45	silty sd, soil, charcoal and small oxidized soil particles
45-70	silty sd
70-71	clay
71-90	m-c sd
90-100	coarse gravel
100-229	f-m sd, few rounded pebbles
229-235	f-m sd, oxidized roots
235-287	f-m sd, few rounded pebbles
287-330	f-m sd, *juncus* roots, subangular pebbles
330-342	pebbly sd, small grass fragments
342-350	plastic pebbly sd, anoxic clay
350-367	pebbly c-vc sd, poorly sorted
370	v. large rock

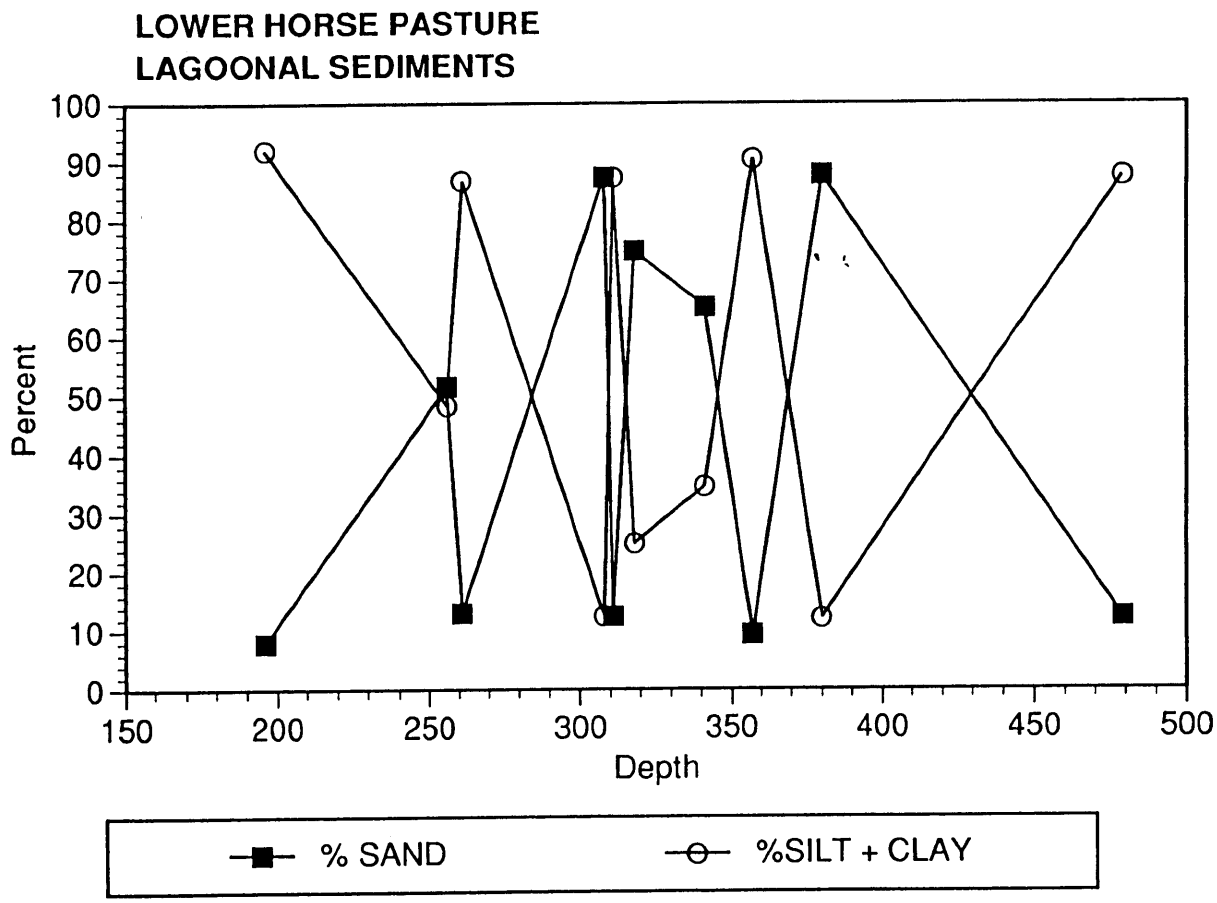
72693 Upper Horse Pasture

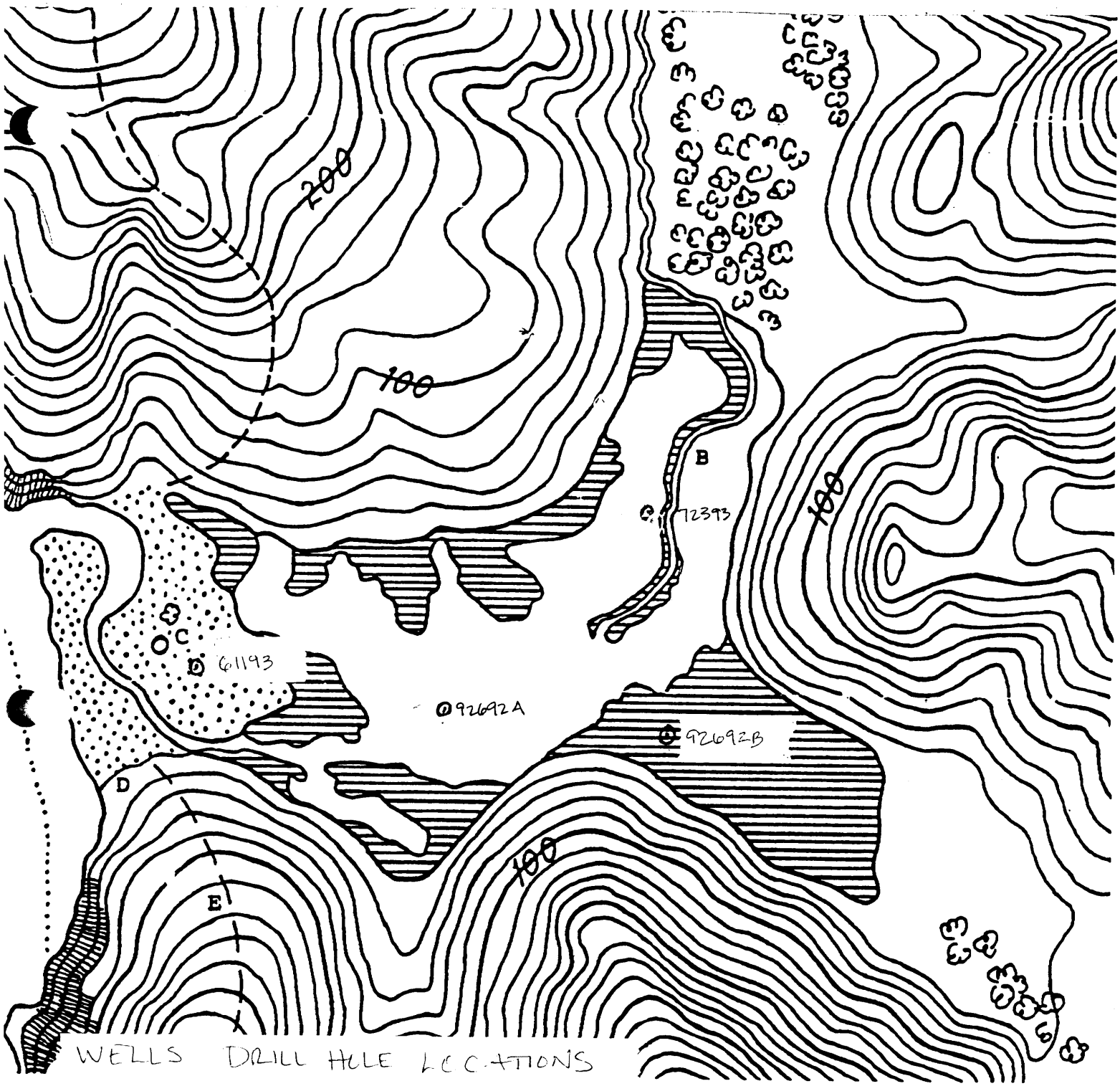
0-50	pebbly silty clay, blk w/ organics
50-100	silty f sd, small charcoal fragments and thin c. sd stringers
100-130	f-vf sd
130-140	m-cos sd, small wood fragment
140-165	pebbly m-cos sd, rounded and angular pebbles, small wood fragment
165-180	pebbly m-c sd,
180-189	pebbly m-c sd, organic fragments, wood
189-194	m-c sd, base is clay w/ rootlets
194-220	pebbly silty clayey sd, abundant charcoal
224-238	silty f-vf sd, few pebbles, fine organic material
238-250	pebbly silty f-vf sd, fine roots, fine organic material
250-285	peat
285-315	sandy peat, pebbles, very wet and disturbed
315-400	sandy peat, pebbles, very wet and disturbed, very poor recovery


Sedimentation Rate at
Muir Beach/Green Gulch
Simplified
Stratigraphy
GG
LHR
UHR
Pebbly silty sand, Carbonate soil
vf Sand
Sand
Soil
Silt
Soil
Sand
Silty sand
Soil
Soil
vf sand
Sand
clayey sand
peat
sandy peat
0
50
100
150
200
250
300
350
400
450
500
pth (cm)
0
500
1000
1500
2000
2500
3000
3500
Radiocarbon Years BP
Lower Horse Pasture (LHR)
Upper Horse Pasture (UHR)
Green Gulch (GG)

LOWER HORSE PASTURE - LAGOONAL SEDIMENTS




LOWER HORSE PASTURE
LAGOONAL SEDIMENTS
Percent
100
90
80
70
60
50
40
30
20
10
0
150
200
250
300
350
400
450
500
Depth
% SAND
%SILT + CLAY



SECTION OF 1853 U.S. COAST SURVEY MAP T-400, MUIR BEACH AREA

Traced from copy of original drawing by James M. Morley in March 1993.
Originally mapped at 1:10,000 scale; enlarged here to 1:4,000 scale.

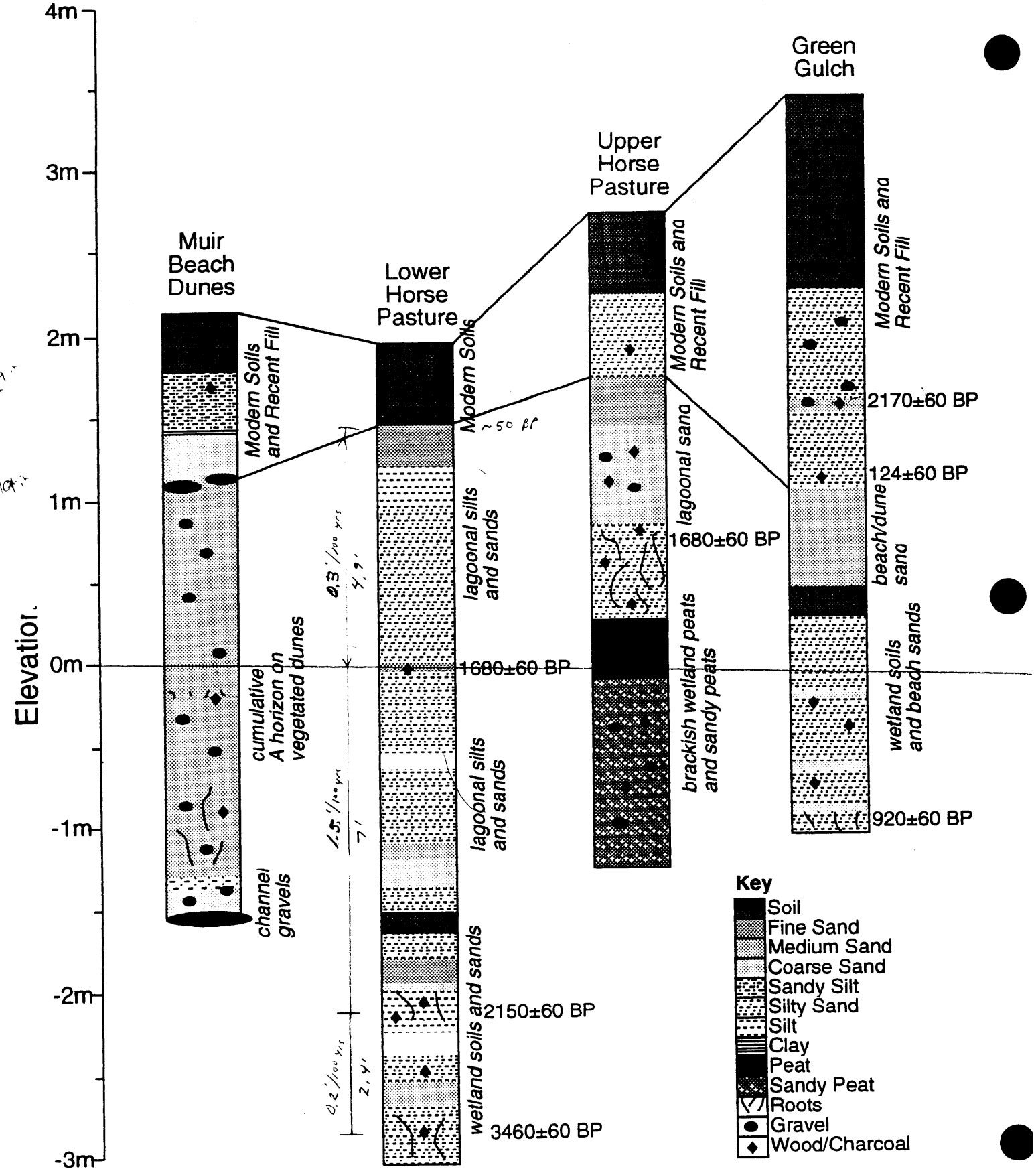
CONTOUR INTERVAL 20 FEET

0 500 feet 0 200 meters

Cliffs | Sand | Woodland | Foreshore line | Trail | Wetland (see notes page)

A - Triangulation station named "Frank's Lagoon". B - No wetland feature on this side of stream, but something must have existed to contain the channel. C - Possible tree and circle that most likely are accidental marks on the original drawing. D - This line appears to represent the base of the slope. It is not a contour nor could it reasonably be the lagoon shoreline. There is no corresponding line on the north side of the beach. E - Probable trail here; trail symbol coming from the south on the manuscript fades out as it starts down the hill to the beach. This would be a logical connection to the trail on the north side of the beach.

Big Lagoon/Green Gulch Stratigraphy



APPENDIX B

Biologic Sampling Methods

XII. APPENDIX- METHODS

A. Methods

Physical

Grain Size

Field Methods:

Sediment samples for grain size analysis were collected from three stations within the lower lagoon. Lagoon stations were roughly equally spaced, with station one near the lower end (the "mouth", when open to tidal flow), station two in the middle, and station three near the upstream end of the lagoon. Samples were collected using stainless steel implements. An approximately 80g subsample from the top 2cm of the sediment surface was placed in a zip-lock bag for grain-size analysis. Samples were labeled with an external label on the bag with an additional internal label.

Laboratory methods:

Sample Preparation

The samples were analyzed whole; no subsampling or splitting was performed. All weights in all analyses were read and recorded to the nearest 0.01g. The samples were placed into numbered pre-weighed beakers and were dried at less than 55°C to prevent collapse of the clays. Samples were allowed to cool for at least one hour to equilibrate to the atmosphere, then weighed. After the sample was dried, the debris was removed, with any sediment adhering to the debris being washed into the sample container. The debris/shell fragments were dried, weighed, and listed on the data sheet, but not included in the computation of sediment size statistics. The stock container (50g/l) of 'Calgon' dispersant was stirred to ensure homogeneity, and 100 ml added to each beaker to prevent flocculating. Lumps were broken up using a rubber-tipped probe, then the sample beakers placed in an ultrasonic cleaner for 15 minutes for disaggregation. Samples were then wet-sieved through a No. 230 4 phi (0.0625 mm) stainless-steel sieve. Silts, clays, and colloidal material passing through the sieve were not retained and were allowed to flow down the drain. The coarse fraction was placed into a pre-weighed beaker, dried at 55°C, allowed to acclimate, then weighed. Analysis of March 1993 sediments was limited to this rough percent fine/percent coarse characterization. The preponderance of coarse sediments in samples from all three stations (see below) suggested that further analysis of the

coarse fraction was necessary. In accordance, the coarse fraction from the May and September 1993 sampling dates were analyzed by sieve analysis using a mechanical shaker for 15 minutes and the following sieves: No. 10 (2.0 mm), 18 ((1.0 mm), 60 (0.25 mm), 80 (0.177 mm), 120 (0.125 mm), and 170 (0.088 mm). After shaking, each sieve was inverted onto a large piece of paper and tapped 5 times to free stuck particles. The sieve fractions were added cumulatively to a pre-tared weighing dish, and the cumulative weight after each addition determined to 0.01g. Each sample was returned to its original beaker and saved until the sample computations were completed and checked for errors.

Data Analysis

Fractional weights and percentages of fine (silt, clay, and colloidal, particle size < 63 μm) and coarse (coarse sand, medium/fine sand, and pebbles/gravel, particle sizes ≥ 63 μm) fractions, as well as Folk & Ward parameters (mean and median grainsize, sorting coefficient, skewness, and kurtosis were calculated using custom software on a Macintosh 2 computer.

Ecological Methods

Vegetation

Five major plant associations were recognized on the lowlands. They were identified by visual survey of the site from the ground and by a supplemental overview inspection looking down from the adjacent hills. They were pasture, marsh, disturbed, riparian and dune. Upland habitat of modified coastal scrub grew adjacent to the site on the surrounding hills. Eight permanent transects were established for quantitative sampling (Figure 2).

Vegetation was also assessed qualitatively and semiquantitatively. Regional distribution of species and approximate cover were noted by walking over the entire study site. The whole area was generally searched to locate all species, including those of the dense riparian woodland. Since the upland was peripheral to the study it was not surveyed thoroughly and only species that occurred along the transect or were important components were included in the species list. Seasonal changes in species composition and reproductive state of plants were noted. Aerial photographs were used to assess general seasonal trends in plant composition and cover over the area. Aerial photographs and recorded oral histories provided the basis for review of probable historical conditions and subsequent changes.

IV-22

Quantitative plant surveys to measure per cent cover by species were conducted a total of 5 times, approximately quarterly, along 20 m transects (Figure 3). An additional transect was put in the upland. Transects were positioned through the most typical, homogenous, sections of each habitat. Transects were marked by a small pvc stake at each end and visual lineups were established to facilitate finding the stakes. Generally the habitats were small relative to the length of the transect consequently, transects generally ran through the middle of each area. Lists of species in each habitat type were generated from quantitative transect surveys as well as qualitative evaluations. Habitat types graded into each other or were bordered by disturbed areas with many weeds, and species were often recorded from the edges of habitat types. Dune habitat was sampled by semiquantitative assessment of the community remnants on individual sand mounds.

Quantitative sampling was carried out by stretching a 20m tape between each pair of stakes and placing a quadrat of a quarter meter square area at each of ten points along the tape. The points had been selected each sampling period using a table of random numbers. The random point-quadrat method was employed. The quadrat was covered with a grid dividing it into 100 equally spaced intersects and it defined the sampling area. Ten intersects were chosen each sampling period using a table of random numbers. Data were obtained by recording the species which occurred under each of the ten selected intersect points. The raw quantitative data are archived at Moss Landing Marine Laboratories and may be used for long-term comparisons.

Scientific and common names are the most current according to Hickman (1993). Long-recognized common and scientific names that have been replaced are noted in parentheses in Table 3.

Freshwater Aquatic Invertebrates

Although we initially sampled insect fauna at 17 stations in seven habitat types (Figure 5), we have refined our study to concentrate on aquatic species because they will be most profoundly affected by the proposed mitigation. Our approach, therefore, has been to compare and contrast insect families found in the ditches with those associated with Redwood Creek as a means of evaluating how increasing pond habitat at Muir Beach will influence the relative abundance and composition of aquatic insect and crustacean fauna.

We have adopted this approach because it is in the horse pasture stations that the most dramatic changes will occur following the creation of the proposed

freshwater pond. Sampling of the existing stations and new stations to be established after the creation of the mitigation pond, will enable us to compare the stream habitats with the more stagnant ditch wetlands, and to document the insect colonization sequence in the pond when created.

We have also entered into an informal collaboration with Ray Peterson, an entomologist and resident naturalist at the Audubon Canyon Ranch (ACR), a few miles from the Muir Beach restoration site. Ray has been documenting aquatic insect recolonization patterns following the creation of a small pond at ACR, and has agreed to share his data, technology, species lists and taxonomic expertise with us if the mitigation pond is created. Our ultimate goal will be to evaluate the success of the Muir Beach restoration project by comparing the recolonization sequence and temporal insect community patterns in the newly created pond with those of the more "natural" and already established pond at ACR. This inter-study comparison will be possible because we have adopted Ray's highly effective nocturnal trapping technique for the remainder of the Muir Beach project.

Seasonal changes were tracked via quarterly, qualitative and quantitative sampling at these sites. Qualitative sampling was done during the day by sweeping through the water with a $0.01m^2$ insect net at 7 aquatic stations (Figure 5). Quantitative sampling was done using three replicate, lighted, nocturnal traps placed in Redwood Creek at station 14 and in Ditch 3 at station 15. These two stations used for quantitative sampling were chosen because they offered the best comparison of a quiet stream habitat (#14) with the most persistent of the seasonal "ponds" at the Muir site (#15). Both sites supported emergent vegetation, but the #14 Redwood Creek Backwater site is more directly influenced by the physical dynamics and ecology of the creek than the ditch at #15 which is separated from the creek by a culvert. Insects were preserved in 75% isopropyl alcohol, sorted and identified to family (Powell and Hogue 1979, Borror and White 1970, Lehmkuhl 1979).

Qualitative monitoring only was done on 29 May and 24 September, 1992. Qualitative and quantitative monitoring were done in late winter (6 March 1993), spring (2 May, 1993), and summer (9 July, 1993).

Tidal Lagoon Invertebrates

Since there is a gradient of fresh and salt water mixing in lower Big Lagoon, we selected three stations along the salinity gradient from the mouth to the head of this lagoon area (Figure 5). Quantitative samples were taken during three seasons

from the three stations. Six replicate cores were collected from each station to describe the benthic infaunal communities in the lagoon. Sediment was sampled to measure changes in grain size. Cores were 0.0072 m^2 in area (the same standard core used in the Lone Tree marine monitoring). Cores were washed over a 0.5 mm screen. Screen residues were preserved in 4% formaldehyde solution and later transferred to 70% propanol. Animals were sorted from residues, identified to lowest taxon, and counted.

Amphibians and Reptiles

Visual encounter surveys were conducted on foot primarily at night and approximately twice a month from December 1992 to February 1993. Monthly surveys were conducted after that time. Surveys followed an established route designed to encounter the primary wetland and riparian habitats at Big Lagoon (Figure 10). Surveys were scheduled during and immediately after rainfall to coincide with periods of greatest herpetological activity. Animals were located using flashlights, identified and counted. Locations of sightings were marked on topological maps. Larvae were identified by sampling with a dip-net and counted.

Qualitative observations on the species composition and relative abundance of reptiles were made on each monthly amphibian survey in the late afternoon. In addition, three longer morning surveys of the same amphibian survey route (Figure 10), as well as the major habitats for plant sampling (Figure 3), were made to look for reptiles.

Birds

Birds at Big Lagoon were quantitatively surveyed on eleven dates between 29 May 1992 and 9 August 1993 (Table 5). Birds were originally surveyed by a primary observer and an occasional assistant observer every two months. Beginning April 93, a local birder and long-time Muir Beach resident was contracted to conduct monthly surveys[1].

Permanent stations were established in all wetland and former wetland habitats (Figure 14); boundaries for each station were set using existing landmarks. Though most stations were visited on all sampling dates, some changes were made during the 11/4-year sampling period to enhance coverage of the most

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[1]Note that results are presented only through the end of the most recent full quarter completed prior to this report (June-August 93), but monthly surveys are continuing.

important habitats (Table 5). Surveys of the single upland station (Station 30) were discontinued after November as it was deemed far more useful to increase coverage of habitats in the lowland areas which might be impacted by restoration efforts. Station 9 was added in April 93 to sample a riparian area which a local birder had observed supporting large numbers of birds over several years of observations (O. Onorato, pers. comm.). Station 14 was created in response to the complete inundation of Station 13 in January 93. This station site included a 10 m swath to the north and east of Station 13. In January 93 it was heavily utilized by sitting and wading waterfowl, though the middle of the pond (i.e. Station 13) was devoid of birds. Station 14 will be used to enhance qualitative observations of bird wetland edge preferences when Station 13 is inundated; previous qualitative observations indicate nominal use (at best) of Station 14 during drier times of the year.

During surveys, each station was visited for 10 minutes. During this period, all birds were identified to species and counted; if possible, behavior was also recorded. At most stations, the observer consistently made all observations from a single location. However, due to the long, narrow shape of the riparian habitat being surveyed, Stations 6 and 7 were surveyed by slowly walking along the vehicle road from north to south.

Qualitative observations were made incidental to regular surveys to supplement the bird species list and to better document breeding use of areas within Big Lagoon. However, these were not the primary focus of the field work, and should therefore be considered supplementary to more comprehensive surveys conducted specifically for these purposes. All species names used in text and figures are accepted common names established by the American Ornithologists' Union (1983,1985).

Grainsize characteristics of sediments from three stations in the lower lagoon area of Muir Beach during March - September, 1993. Fractional percentages of four grainsize categories are shown. Due to type of analysis used, data for only the percentage of fine sediment (<0.063mm particle diameter) was obtained for March 1993 samples (see results discussion). n = 1 in all cases.

FRACTIONAL PERCENT

Date	Station	Pebbles/ Gravel (>1.0mm)	Coarse Sand (0.500mm)	Medium/ Fine Sand (0.063mm)	Medium/Coarse Fine Silt (<0.063mm)
March-4	1	-	-	-	0.54
	2	-	-	-	0.11
	3	-	-	-	0.51
May-13	1	0.04	1.02	98.66	0.29
	2	50.34	20.94	28.30	0.42
	3	69.56	8.52	21.59	0.33
September-3	1	10.30	18.15	71.11	0.43
	2	0.13	13.33	86.37	0.18
	3	10.51	5.10	84.07	0.32

Grainsize characteristics of sediments from three stations in the lower lagoon area of Muir Beach during March - September, 1993. Folk and Ward statistics are shown. Due to type of analysis used, no Folk and Ward statistics could be calculated for March 1993 samples (see results discussion). n = 1 in all cases.

FOLK & WARD STATISTICS (phi)

Date	Station	Mean	Median	Sorting
March-4	1	-	-	-
	2	-	-	-
	3	-	-	-
May-13	1	3.37	3.99	0.80
	2	0.14	-0.02	1.16
	3	-0.24	-1.05	1.15
September-3	1	1.42	1.69	0.89
	2	1.82	1.92	0.39
	3	1.78	2.01	0.78

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	2	0.14	-0.02	1.16
	3	-0.24	-1.05	1.15
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	2	1.82	1.92	0.39
	3	1.78	2.01	0.78

APPENDIX C

Water Quality Data Collected During Fish Surveys

APPENDIX A: Muir Beach lagoon water water temperatures, salinities and dissolved oxygen in 1992 and 1993.

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17 June 1992 Weather: overcast Lagoon open

Site: 20 m downstream of riffle leading into lagoon

	13:40		
Depth	Temp.	Salin	DisO2
Sur	16.4	0.0	12.4
0.25m	22.4	0.0	11.6

Site: Deepest part of lagoon, near concrete blocks

	14:00		
Depth	Temp.	Salin	DisO2
Sur	16.9	0.0	10.0
0.05m	17.6	1.0	
0.1	17.6	1.0	
0.15	17.4	1.0	
0.2	17.4	6.6	
0.25	18.8	13.3	10.1
0.5	20.1	19.9	10.0
0.75	20.5	21.5	9.4

23 July 1992 Weather: Fair, warm, windy Lagoon closed

Site: Deepest part of lagoon

	10:50		18:10	
Depth	Temp.	Salin	Temp.	Salin
Sur	20.1	0.6	23.5	0.6
0.25m	19.8	0.6	23.7	
0.5	19.6	0.6	23.8	
0.75	19.7	0.6	23.8	
1.0	19.7	0.6	24.0	
1.05	19.8	2.3		
1.15	19.8	4.2	23.7	2.2

14 August 1992 Weather: overcast morning; partial clearing at 16:30 Lagoon closed

Site: Upper part of lagoon

	11:00		17:30	
Depth	Temp.	Salin	Temp.	Salin
Sur	18.5	5.2	22.4	5.0
0.25m	18.5	5.6	22.4	5.9
0.35	18.8	5.6	22.6	6.0

Site: Deepest part of lagoon

	10:50			17:20		
Depth	Temp.	Salin	DisO2	Temp.	Salin	DisO2
Sur	18.4	5.3	8.3	21.2	5.3	12.7
0.25m	19.0	5.3	8.1	21.3	5.3	12.2
0.5	19.4	5.3	8.0	21.3	5.3	12.2
0.75	19.4	5.3	7.8	21.3	5.3	12.1
0.8	19.4	5.3	7.5	21.3	5.4	10.9

secchi depth 0.6m

19 September 1992 Weather: Breezy, cool, overcast
Lagoon closed

Site: Deepest part of lagoon

	10:00		
Depth	Temp.	Salin	DisO2
Sur	15.6	5.4	8.9
0.25m	15.8	5.5	8.7
0.5	15.8	5.6	8.6
0.65	16.3	5.6	4.8

14 November 1992 Weather: fair, cool, windy
Lagoon reclosed after storm

Site: Deepest part of lagoon

	9:55			15:05		
Depth	Temp.	Salin	DisO2	Temp.	Salin	DisO2
Sur	11.7	3.6	10.6	16.0	4.2	10.4
0.25m	11.4	3.9	10.6	15.6	4.2	10.3
0.5	16.0	18.1	10.2	17.3	16.6	10.4
0.75	20.3	21.8	9.9	20.4	21.4	10.9
1.0	21.3	26.6	4.7	21.7	24.4	8.1
1.15	22.2	26.6	1.3	22.4	25.0	7.4

decaying kelp on bottom

4 June 1993 Weather: rain by 9:45 Lagoon open

Site: Upper part of lagoon

	12:00	
Depth	Temp.	Salin
Sur	15.8	0.2
0.25m	15.8	0.2
0.3	14.6	0.2
0.35	14.7	1.0
0.4	15.0	10.6
0.5	16.4	16.3
0.65	17.3	17.3

Site: Deepest part of lagoon
12:05

Depth	Temp.	Salin	DisO2
Sur	14.6	0.6	10.0
0.25m	14.6	2.6	10.8
0.3	14.7	9.3	
0.5	15.4	16.3	9.0
0.75	16.4	19.0	8.8
0.8	16.4	19.3	8.6

Site: Outflow

Depth	Temp.	Salin
0.1m	15.4	0.5

9 June 1993 Weather: Fair, warm
Lagoon open, mouth cut down from 4 June storm

Site: Deepest part of lagoon
18:05

Depth	Temp.	Salin	DisO2
Sur	16.4	0.2	10.5
0.25m	17.3	0.2	10.5
0.5	17.0	0.2	10.5
0.7	16.6	0.2	10.5

24 June 1993 Weather: Fair, warm Lagoon open

Site: Deepest part of lagoon
19:35

Depth	Temp.	Salin
Sur	19.7	0.1
0.25m	19.8	0.1
0.5	19.6	0.1
0.55	19.6	0.1

19 August 1993 Weather: Overcast until 10:00, windy
Lagoon closed but subject to tidal overwash

Site: Deepest part of lagoon

	10:10			17:45		
Depth	Temp.	Salin	DisO2	Temp.	Salin	DisO2
Sur	16.6	0.5	8.8	20.8	0.4	9.7
0.25m	17.0	0.6	8.6	21.3	0.4	9.7
0.5	16.9	0.6	8.6	21.3	0.4	9.7
0.75	16.9	1.1	8.6	21.4	0.4	9.8
0.9	18.6	3.6	10.0	22.2	3.0	10.4
1.0	20.2	6.7	10.1	22.7	5.3	19.9
1.2	20.6	7.6	8.0	23.1	5.6	20+

10 September 1993 Weather: Clear by 11:15 Lagoon closed

Site: Deepest part of lagoon
10:15

Depth	Temp.	Salin	DisO2
Sur	18.4	0.7	6.7
0.25m	18.3	0.7	6.7
0.5	18.6	0.7	6.7
0.65	18.6	0.7	5.3

Site: Scour hole upstream of main lagoon; immediately downstream of ford
10:30

Depth	Temp.	Salin	DisO2
Sur	16.3	0.3	8.4
0.25m	16.0	0.6	6.5
0.5	17.0	1.4	5.6
0.75	18.5	2.6	5.0
1.0	20.3	10.4	3.8
1.15	20.8	12.7	1.0

Appendix B: Water temperatures and dissolved oxygen at Redwood Creek sites in 1992 and 1993.

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15 June 1992 Weather: cloudy, breezy

Site: Muir Beach footbridge
14:30

Depth	Temp.	DisO2
Sur	15.4	10.2
0.25m	15.5	10.2
0.5	15.0	10.2
0.75	14.9	10.1
0.9	14.7	9.4

17 June 1992 Weather: overcast
Streamflow @ Bridge = approx. 1/2 cfs

Site: Tail of pool at footbridge, Muir Beach
10:35

Depth	Temp.	DisO2
Sur	14.0	10.5
0.2m	13.8	10.0

Site: Footbridge
11:00

Depth	Temp.	DisO2
Sur	13.7	9.1
0.25m	13.7	8.9
0.5	13.8	8.8
0.75	13.6	8.8
0.9	13.6	9.0

Site: Deepest portion of pool upstream of footbridge
11:10

Depth	Temp.	DisO2
Sur	13.6	9.9
0.25m	13.4	9.7
0.5	13.4	9.7
0.75	13.4	9.7
1.0	13.4	9.8
1.1	13.4	9.9

Site: Mouth of stream at side channel pool
11:45

Depth	Temp.	DisO2
Sur	13.3	9.3
0.25m	13.3	9.1
0.5	13.1	9.4
0.75	13.0	9.4
1.0	13.0	9.3
1.15	12.9	9.2

Site: 10 m upstream of stream mouth in side channel
11:50

Depth	Temp.	DisO2	
Sur	13.8	7.1	
0.25m	13.8	6.4	
0.5	13.5	8.4	
0.75	13.3	9.4	some algae on bottom
1.0	13.2	8.2	
1.25	13.1	8.2	
1.5	13.1	8.5	
1.6	13.1	8.3	secchi depth = 1.6m

Site: Edge of floating plants in side channel
12:00

Depth	Temp.	DisO2	
Sur	13.9	8.8	
0.25m	13.9	8.4	
0.5	13.4	8.4	
0.75	13.2	8.5	
1.0	13.2	7.6	
1.25	13.1	5.6	
1.3	13.1	4.0	surface fully covered with floating plants upstream

23 July 1992

Weather: sunny, warm
Streamflow @ Bridge = approx. 1/4 cfs

Site: Footbridge

	11:30		16:50	
Depth	Temp.	DisO2	Temp.	DisO2
Sur	18.6	9.7	22.6	9.5
0.25m	18.0	8.3	20.8	9.7
0.5	16.9	7.8	19.8	10.3
0.75	16.6	8.2	19.5	10.1
0.85	16.5	9.0	19.0	9.0

Site: Pool upstream of footbridge

	12:00		17:00	
Depth	Temp.	DisO2	Temp.	DisO2
Sur	17.0	8.6	19.4	10.2
0.25m	17.0	8.4	19.4	10.2
0.5	17.0	8.2	18.6	10.3
0.75	16.6	8.6	18.3	10.3
1.0	16.4	18.0	17.8	20+
1.15	16.1	20+	1.15	17.3

Site: Mouth of stream at side channel

	17:05	
Depth	Temp.	DisO2
Sur	16.4	11.0
0.25m	16.4	10.4
0.5	16.0	10.2
0.75	15.8	9.6
1.0	14.8	8.6
1.15	15.0	8.2

Site: Side channel Pool

	17:10	
Depth	Temp.	DisO2
Sur	17.0	8.8
0.25m	16.6	8.6
0.5	16.5	8.1
0.75	16.4	8.0
0.85	16.3	7.2

Site: Streamflow at Bridge

	17:40	
Depth	Temp.	DisO2
Sur	16.2	14.8

14 August 1992 Weather: overcast and cool; slight clearing at 16:30

Site: Footbridge

	10:10		16:40	
Depth	Temp.	DisO2	Temp.	DisO2
Sur	17.8	7.8	19.9	8.4
0.25m	17.4	7.7	19.8	8.2
0.5	17.4	7.6	19.4	7.0
0.75	17.4	6.5	18.6	7.0
0.9	17.3	5.6	18.4	7.0

Site: Pool upstream of footbridge

	10:15		16:50		
Depth	Temp.	DisO2	Temp.	DisO2	
Sur	16.5	6.8	19.7	9.5	
0.25m	16.6	6.4	18.6	9.4	
0.5	16.4	5.4	18.2	9.0	
0.75	16.3	4.5	17.4	6.1	secchi depth = 0.6m
1.0	16.0	4.2	16.7	4.2	
1.2	16.0	1.9	16.6	2.7	

Site: Mouth of stream at side channel

Depth	10:30 Temp.	10:30 DisO2	17:00 Temp.	17:00 Diso2
Sur	15.8	4.6	16.4	8.0
0.25m	15.8	4.6	16.4	6.2
0.5	15.6	4.2	15.7	6.2
0.75	15.5	4.0	15.6	5.3
1.0	15.4	3.4	15.4	1.8
1.15	15.4	1.8	15.0	1.4

Site: Side channel

Depth	10:30 Temp.	10:30 DisO2	17:00 Temp.	17:00 DisO2
Sur	15.8	6.5	17.6	7.4
0.25m	15.9	6.4	16.8	7.2
0.5	15.9	6.0	16.6	7.8
0.75	15.8	4.2	16.4	1.4
0.8	15.8	1.2	16.4	1.0

Site: Streamflow at Bridge

Depth	17:45 Temp.	17:45 DisO2
Sur	15.6	9.4

19 September 1992

Weather: breezy, overcast
Streamflow @ Bridge: approx. 0.01 cfs
approx. 0.2 cfs @ city pump
approx. 0.25-0.3 at bridge upstream

Site: Footbridge

Depth	9:15 Temp.	9:15 DisO2	17:15 Temp.	17:15 DisO2
Sur	15.4	8.0	16.4	11.8
0.25m	15.4	7.5	16.6	11.3
0.5	15.4	6.6	16.8	10.3

Site: Pool upstream of footbridge

Depth	9:20 Temp.	9:20 DisO2	17:20 DisO2
Sur	13.8	4.3	4.7
0.25m	14.2	4.2	4.5
0.5	14.3	4.0	4.5
0.75	14.2	3.8	4.5
0.8	14.2	3.8	4.3

Site: Mouth of creek at side channel

Depth	9:35 DisO2	17:25 DisO2
Sur	2.6	2.7
0.25m	2.4	2.2
0.5	2.2	1.4
0.75	2.0	1.2

Site: Side channel

Depth	9:40 DisO2	17:25 DisO2
Sur	3.4	3.2
0.25m	3.0	2.2
0.5	2.4	2.4
0.6	2.4	1.6

Site: Streamflow @ Bridge

Depth	10:20 Temp.	DisO2
Sur	13.4	7.0

14 November 1992 Weather: Fair, windy, cool

Site: Footbridge

Depth	9:20 Temp.	DisO2	14:30 Temp.	DisO2
Sur	11.0	11.1	13.9	11.4
0.25m	10.3	10.0	13.4	11.4
0.5	10.2	9.8	13.1	10.4
0.75	10.2	9.7	13.0	10.0
0.85	10.2	6.4	12.8	7.1

Site: Pool upstream of footbridge

Depth	9:30 Temp.	DisO2	14:35 Temp.	DisO2
Sur	11.4	8.9	13.6	9.3
0.25m	10.8	8.6	13.4	9.1
0.5	10.8	8.4	11.9	8.9
0.75	10.7	8.3	11.9	7.7
1.0	10.6	6.2	11.4	6.3
1.1	10.6	6.0	11.4	5.9

Site: Creek mouth at side channel

Depth	9:35 Temp.	DisO2	14:45 Temp.	DisO2
Sur	10.8	7.0	12.7	7.5
0.25m	11.2	7.0	12.7	7.0
0.5	11.0	5.8	12.4	4.8
0.75	11.0	4.4	12.4	4.4
1.0	12.3	3.4	13.0	3.6
1.1	12.7	1.7	13.2	1.4

Site: Side channel

Depth	9:35 Temp.	DisO2	14:45 Temp.	DisO2	
Sur	11.6	8.2	13.8	7.8	
0.25m	11.2	7.4	13.6	7.6	
0.5	10.9	7.2	12.9	4.4	abundant detritus on
0.75	10.8	3.6	12.9	3.0	bottom
0.95	12.0	1.7			
1.0			14.0	1.8	

Site: Streamflow @ Bridge
15:30

Depth	Temp.	DisO2
Sur	13.6	9.7

4 June 1993 Weather: Heavy overcast, rain by 9:45

Site: Footbridge
9:25

Depth	Temp.	DisO2	
Sur	13.9	8.9	
0.25m	13.8	9.0	
0.5	13.7	9.1	
0.75	13.7	9.0	
1.0	13.7	9.7	algae on bottom

Site: Pool upstream of footbridge
9:45

Depth	Temp.	DisO2	
Sur	13.6	9.2	
0.25m	13.6	9.1	
0.5	13.6	9.0	
0.75	13.6	9.0	
1.0	13.7	9.0	
1.25	13.7	8.8	
1.35	13.7	3.6	detritus on bottom

Site: Mouth of stream at side channel
9:55

Depth	Temp.	DisO2
Sur	13.6	9.2
0.25m	13.6	9.2
0.5	13.6	9.2

Site: Side channel
9:50

Depth	Temp.	DisO2	
Sur	13.8	7.4	
0.25m	13.8	8.2	
0.5	13.6	8.2	
0.75	13.6	8.4	
1.0	13.6	8.2	
1.1	13.6	8.2	detritus on bottom

9 June 1993 Weather: Fair, warm

Site: Footbridge
16:45

Depth	Temp.	DisO2
Sur	16.2	10.6
0.25m	15.3	10.5
0.5	14.9	10.3
0.75	14.8	10.3
1.0	14.8	10.3
1.05	14.8	10.3

Site: Pool upstream of footbridge
17:00

Depth	Temp.	DisO2
Sur	14.9	10.0
0.25m	14.8	9.9
0.5	14.7	9.8
0.75	14.6	9.8
1.0	14.6	9.8
1.25	14.5	8.2

Site: Mouth of stream at side channel
17:05

Depth	Temp.	DisO2
Sur	14.3	9.8
0.25m	14.2	9.7
0.5	14.1	9.7
0.6	14.1	9.6

Site: Side channel
17:10

Depth	Temp.	DisO2
Sur	14.6	9.4
0.25m	14.3	9.4
0.5	13.7	9.3
0.75	13.6	8.3
1.0	13.4	8.1

24 June 1993 Weather: Fair and warm
Streamflow @ bridge: approx. 1.5 cfs

Site: Footbridge
18:15

Depth	Temp.	DisO2	
Sur	17.1	9.4	
0.25m	16.4	9.4	
0.5	16.0	9.2	
0.75	16.1	9.2	
1.0	16.1	3.2	site disturbed by 4 dogs in 10 min.

Site: Pool upstream of footbridge

	18:30	
Depth	Temp.	DisO2
Sur	16.4	9.2
0.25m	16.4	9.2
0.5	15.6	9.0
0.75	15.6	9.0
1.0	15.4	8.8
1.15	15.4	8.6

Site: Stream mouth at side channel

	18:45	
Depth	Temp.	DisO2
Sur	15.2	8.4
0.25m	15.2	8.4
0.5	15.2	8.5

Site: Side channel

	18:40		
Depth	Temp.	DisO2	
Sur	15.1	9.8	
0.25m	14.7	9.8	
0.5	14.5	10.1	
0.75	14.3	10.4	
1.0	14.3	9.3	algae and pondweed over bottom

Site: Streamflow @ Bridge

	19:15	
Depth	Temp.	DisO2
Sur	15.2	7.9

19 August 1993 Weather: Overcast mourning, full sun by 10:00
Streamflow @ Bridge: 0.4-0.45 cfs

Site: Footbridge

	8:45		17:05		
Depth	Temp.	DisO2	Temp.	DisO2	
Sur	13.7	6.4	17.2	9.3	
0.25m	14.0	6.3	17.0	9.6	
0.5	14.0	6.3	16.3	9.7	
0.75	14.0	6.3	16.2	10.0	
0.9	14.0	6.4	15.9	9.9	algae on 1/2 of bottom

Site: Pool upstream of bridge

	9:00		17:15	
Depth	Temp.	DisO2	Temp.	DisO2
Sur	14.1	5.9	16.6	8.8
0.25m	14.0	5.9	16.4	8.5
0.5	14.0	5.9	15.6	9.1
0.75	14.0	6.0	15.4	9.3
1.0	14.0	6.1	15.3	9.1
1.15	13.9	5.8	15.3	9.5

Site: Stream mouth at side channel

	9:10		17:25	
Depth	Temp.	DisO2	Temp.	DisO2
Sur	14.3	5.0	15.1	7.8
0.25m	13.6	5.0	14.9	7.6
0.5	13.6	5.7	14.8	7.5

Site: Side channel

	9:05		17:20		
Depth	Temp.	DisO2	Temp.	DisO2	
Sur	13.9	6.5	15.3	7.9	
0.25m	13.8	6.4	14.9	7.9	
0.5	13.6	7.8	14.6	8.3	top of algae
0.75	13.6	7.8	14.6	8.4	
0.95	13.6	7.3	13.9	8.4	

Site: Streamflow @ Bridge

	9:45	
Depth	Temp.	DisO2
Sur	13.4	8.4

10 September 1993

Weather: overcast morning, clear 11:15
Streamflow @ Bridge: approx 0.2-0.25 cfs

Site: Footbridge

	9:30	
Depth	Temp.	DisO2
Sur	15.3	7.6
0.25m	15.3	7.7
0.5	15.1	5.9
0.75	15.1	5.9
0.85	15.3	5.3

Site: Pool upstream of footbridge

	9:40	
Depth	Temp.	DisO2
Sur	15.1	6.5
0.25m	15.1	6.2
0.5	14.7	4.7
0.75	14.6	4.7
1.0	14.6	5.0
1.2	14.5	4.2

Site: Mouth of stream at side channel

	9:55	
Depth	Temp.	DisO2
Sur	14.3	4.9
0.25m	14.1	4.9
0.5	14.0	4.5

Site: Side channel
9:45

Depth	Temp.	DisO2	
Sur	14.4	5.6	
0.25m	14.3	5.6	
0.5	14.3	5.2	in algae
0.75	14.3	4.5	
0.9	14.3	1.2	