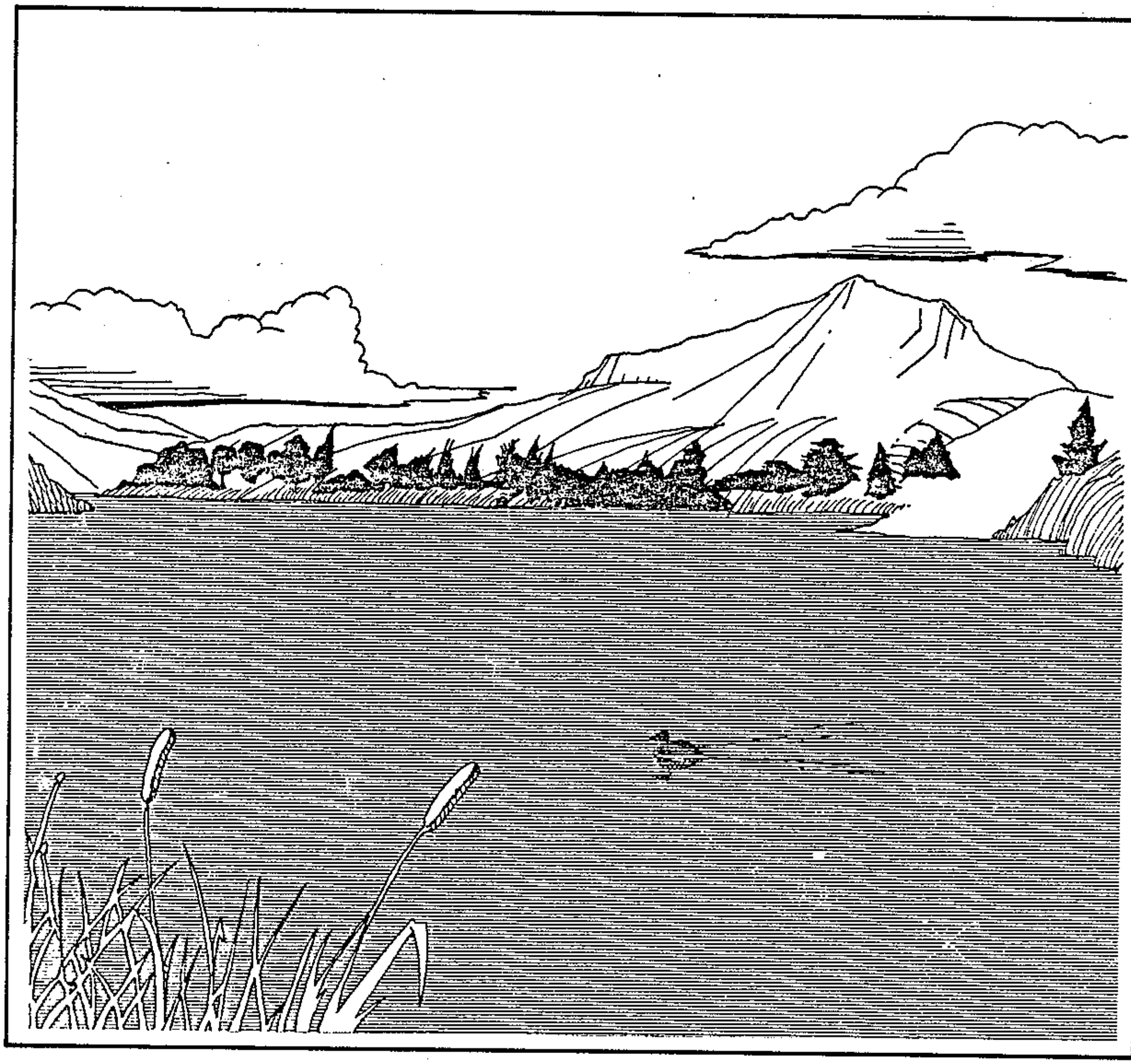
LAGUNA LAKE MANAGEMENT PROGRAM



Technical Appendix

APPENDIX A

LAGUNA LAKE
AVIAN WILDLIFE HABITAT UTILIZATION

LAGUNA LAKE MANAGEMENT STUDY - Job # 59-231-001

Avian Wildlife Habitat Utilization

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source of information: personal observations and field notes covering the period 1970 to present

A. WINTER WATERFOWL HABITAT

Field notes were subdivided according to specific use-areas of the lake since not all portions of it are equal in regard to wildlife utilization. The areas are designated in Fig. 1; verbal descriptions follow.

I. Developed End - that portion of the lake lying SE of a line drawn from the base of the peninsula across the lake to the mouth of Perfumo Creek. The SW shore of this section consists of the back-yards of houses which face Oceanaire Drive. There are numerous docks, and in conjunction with these, considerable human activity. Most of the vegetation is ornamental, though there are isolated stands of bulrushes (*Scirpus*), smartweed (*Polygonum*)and native willow (*Salix*). The NE shore from Madonna Road to the public boat ramp is part of Laguna Lake Park. Shoreside vegetation consists primarily of dense stands of bulrushes, with clear areas which provide fishing access. There is considerable human activity here as well, especially fishing and boating.

II. Center Lake - from the Developed End, as described, northwesterly to a line drawn perpendicularly across the lake from the point of bulrushes NW of the peninsula. The SW shore behind Laguna Junior High School has recently been developed, but lakeside stands of smartweed remain. Along the same shore, to the NW of the developed area, are dense interdigitated beds of bulrushes and smartweed. The NE shore consists of the vegetation along the edge of the peninsula, primarily dense stands of willow and bulrushes, and a nearly pure stand of bulrushes beyond the entrance to the inlet which lies to the NE of the peninsula. The central portion of the lake has been silting in rapidly, and smartweed is becoming established there.

III. Peninsula Inlet - the narrow body of water lying NE of the peninsula. The peninsula shore is mixed willow, bulrushes, and smartweed; the opposite side consists of dense beds of smartweed in deeper water, backed by bulrushes in the shallower spots.

IIIA. Peninsula - the artificial peninsula extending in a northwesterly direction from the public boat ramp. The perimeter is lined with willows, stinging nettle, smartweed, and bulrushes; the central portion, which contains water after the first winter rains, is primarily a dense stand of smartweed, with a few "islands" of bulrushes and, in the winter, some areas of open water.

IV. Northwest End - that portion of the lake lying NW of the Center Lake. It consists of the end of the lake proper, plus two shallow inlets extending from the NE side and one from the SW side. The two NE inlets are surrounded and sheltered in part by dense stands of bulrushes, though much of this vegetation at the NW corner has been removed during the past few years. The NW end of the lake proper consists of smartweed beds backed by bulrushes. The inlet on the SW side is presently fairly heavily choked with smartweed centrally and surrounded by dense stands of bulrushes, which help to screen it from the new development to the SW.

B. WINTER WATERFOWL HABITAT UTILIZATION

I. Developed End. This section of the lake is populated primarily by a large flock of domestic waterfowl, the numbers of which fluctuate from about 50 to over 100. American Coots are the next most abundant, in numbers ranging from about 30 to over 150, followed by Ruddy Ducks (up to 100.) Ring-billed Gulls (up to 50) and occasionally a flock of Mew Gulls also use this portion, especially the area where people feed the domestic ducks. Other species are usually found here only in very low numbers (1 or 2): Western Grebe; Double-crested Cormorant; Eared Grebe; Pied-billed Grebe; Cinnamon Teal; Northern Shoveler; Canvasback. Wading birds (Great Blue Heron, Black-crowned Night Heron, Great Egret, Snowy Egret, American Bittern) use the shoreside areas in very low numbers; again, one is unlikely to find more than 1 or 2 individuals of these species at any one time. A few Soras inhabit the bulrushes, but probably not more than 5 pairs in the appropriate vegetation. From late summer to early winter 2 or 3 terns (Caspian and Forster's) can sometimes be seen fishing over this area.

II. Center Lake. This large, open expanse of water (now becoming choked with smartweed) has provided habitat for those species of waterfowl which need open water rather than cover for security. During winters when they are present, up to 550 Canvasbacks may use this portion of the lake in preference to all others. (But some winters there are none present at all.) Ruddy Duck numbers are second, ranging from about a dozen to over 130, followed by coots, numbering from a few to over 250. This portion of the lake is the prime bathing area for Ring-billed and Mew Gulls, whose numbers vary widely from one or two to several hundred. Double-crested Cormorants, up to a dozen, both bathe and fish here. Other waterfowl likely to be encountered, with approximate numbers indicated in parentheses, include: Western Grebe (1-6); Eared Grebe (1-10); Pied-billed Grebe (1-2); Bufflehead (1-3); Mallard (2-4); Northern Shoveler (2-30); and an occasional Cinnamon Teal, Pintail, Green-winged Teal, American Wigeon, or Ring-necked Duck. Up to 5 Great Blue Herons may be found hunting along the shores, and up to 20 Black-crowned Night Herons roost by day in the dense stand of bulrushes along the NE shore NW of the entrance to the Peninsula Inlet. An occasional Great or Snowy Egret may also forage along the shore, and 6-12 White Pelicans frequently loaf in the center.

Birds of highly seasonal occurrence include Bonaparte's Gulls (up to 20 or so in the spring) and Wilson's and Northern Phalaropes in late summer (July-August). As the smartweed becomes established, avian species composition has been shifting from open-water forms to those species of dabbling ducks which prefer marshy areas with vegetative cover. The edge of the Peninsula, which forms the NE shore of this section, harbors a good population of Soras, with a few Virginia Rails also present in the winter.

III. Peninsula Inlet. This protected body of water provides excellent habitat for dabbling ducks as well as other species which prefer the cover afforded by the adjacent stands of smartweed and bulrushes. Up to 75 Northern Shovelers have used it; 2-20 Cinnamon Teal (most numerous in early spring); wild Mallards (3-6); Green-winged Teal (1-6); Gadwall (0-5); American Wigeon (0-17); Pintail (0-2); Ring-necked Duck (2-20); and American Coot (2-40). These birds are usually well-hidden in the patches of open water which are surrounded entirely by smartweed. The large body of open water adjacent to the Peninsula can have up to 50 Ruddy Ducks, a few Canvasbacks, 1 or 2 Double-crested Cormorants, 1 or 2 Western Grebes, and 1-4 Pied-billed Grebes. The emergent vegetation on the NE side harbors foraging Great Blue Herons (1-3), Great Egrets (0-1), and American Bitterns (1-12), and, roosting in the bulrushes, up to 10 Black-crowned Night Herons. Use of this area by dabbling ducks has been declining as the smartweed fills in the small protected pools.

IIIA. The interior of the Peninsula, when flooded, provides foraging habitat for a few dabbling ducks (Cinnamon Teal, Northern Shovelers, Green-winged Teal) and Pied-billed Grebes. More importantly, with its heavy cover of smartweed, it has served as a night roosting area for up to 300 dabbling ducks (mostly Northern Shovelers, Green-winged Teal, and Pintails.) Birds have been noted in late evening arriving here from other parts of Laguna Lake, as well as from the direction of the City of San Luis Obispo's sewage treatment plant about a mile to the SE. Up to 12 Black-crowned Night Herons roost in the bulrushes during the day.

IV. Northwest End. The open water in this section (at the end of the lake) attracts much the same diversity of birds that the Center Lake does: Canvasbacks, when present (a high count of 730 one year); Ruddy Duck (10-200); American Coot (2-35); and an occasional Bufflehead, Western Grebe, or Pied-billed Grebe. Double-crested Cormorants use this area more than any other (up to 20 individuals) both for sunning and fishing. Dabbling ducks are attracted to areas sheltered by smartweed: 1-65 Pintail; 10-80 Northern Shovelers; 2-12 Cinnamon Teal; 10-20 Green-winged Teal; 0-7 Mallards; 0-6 Gadwalls. Ring-necked Ducks (0-12) may also occur here. The shore area is used moderately by waders: 1-3 Great Blue Herons; 1-14 Black-crowned Night Herons (roosting in bulrushes); 0-2 Great Egrets; 0-4 Snowy Egrets; and an occasional American Bittern. Six to 8 White Pelicans sometimes loaf here.

The three inlets which lead off of the end of the lake proper provide varying levels of protection from disturbance. In the past, that inlet to the SW was the most heavily used portion of the lake by dabbling ducks (50 to over 250 Shovelers; 50-75 Green-winged Teal; 10-75 Pintail; 1-20 Mallards; 1-9 Gadwalls; 10-90 Cinnamon Teal; and a few American Wigeon) as well as Ring-necked Ducks (5-40). In addition the area supported moderate numbers of Ruddy Ducks (5-20), American Coots (30-130), and Canvasbacks (2-15), plus an occasional grebe. Waders used the edges in moderate numbers: 1-2 Great Blue Herons; an American Bittern; 1-2 Black-crowned Night Herons; and up to 8 Snowy Egrets. This section of the lake has undergone a significant decline in waterfowl utilization, primarily because of the dense growth of smartweed which has all but eliminated open water. The new development being established adjacent to it has probably been contributing to this decline, because of disturbance by human activity and heavy equipment operation.

The two small inlets to the NE of this end have, in the past, held moderate numbers of waterfowl (2-15 Cinnamon Teal, 2-20 Northern Shovelers, 2-12 Ruddy Ducks, 1-4 Mallards, 1-5 Pintail, 1-10 Green-winged Teal, 2-30 American Coots, and an occasional Western Grebe, Pied-billed Grebe, Double-crested Cormorant, Eared Grebe, Canvasback, or Bufflehead.) Black-crowned Night Herons use the bulrushes on the periphery as a day roost (2-10 birds), and Great Blue Herons (1-5) and Great and Snowy Egrets (0-2) hunt the water's edge. Soras and Virginia Rails occur in good numbers throughout the emergent vegetation that surrounds these two inlets. Recently the most northwestern of these two inlets has assumed greater importance with the decline in value of the inlet to the SW. Though much of the protective screen of bulrushes has been removed, greater numbers of ducks, as well as 6-20 White Pelicans and an occasional flock of Canada Geese find this an area for undisturbed loafing.

C. AREAS OF WATERFOWL CONCENTRATION

Currently the most important areas of the lake in terms of waterfowl concentrations are as follows:

1. The Center Lake, for gulls and those species which prefer open water (Canvasbacks, Ruddy Ducks, and grebes primarily.)

2. The Peninsula Inlet, especially for moderate numbers of dabbling ducks. The shoreline areas are among the most heavily used by waders (herons and egrets).

3. The Peninsula proper, which provides a fall and winter night roosting area for several hundred ducks.

4. The Northwest End of the lake proper and the two inlets which extend from it to the NE, primarily for dabbling ducks, pelicans, and occasional geese, but also for a small numbers of grebes and, in the main body of the lake, occasionally for a raft of Canvasbacks..

D. NESTING LOCATIONS AND SUITABLE HABITAT FOR AVIFAUNA

I. Developed End. The shoreline of this section provides little in the way of nesting habitat for native waterfowl, though some of the domestic ducks apparently nest in backyards. The bulrushes along the park side provide nesting habitat for 2-3 pairs of Soras, as well as a few pairs of Common Yellowthroats and Red-winged Blackbirds. Song Sparrows are probably the commonest nesting bird along the entire perimeter of this area.

II. Center Lake. The edge of the peninsula provides nesting habitat for several pairs of Common Yellowthroats, and in fact this area probably has the densest concentration of this species anywhere around the lake. Long-billed Marsh Wrens also seem to reach maximum density here, with a pair about every 50m. Song Sparrows nest abundantly, and the presence of 3 or 4 Soras suggests that at least 2 pairs also nest here. Across the lake from the tip of the peninsula, the smartweed beds provide nesting habitat for 2-3 pairs of Pied-billed Grebes, but no other waterfowl are known to nest along the shores of this section.

III. Peninsula Inlet. The edge of the Peninsula provides nesting habitat for Common Yellowthroats (in weeds and smartweed), Long-billed Marsh Wrens (in bulrushes), Soras (probably in smartweed and bulrushes), and Song Sparrows (in weeds and smartweed.) The extensive beds of smartweed on the NE side of the inlet provide prime nesting habitat for Pied-billed Grebes. In fact, this area supports a nesting density of this species higher than any I can find reported in the literature. Total number of pairs present may exceed 15. American Coots (2-5 pairs) also nest in this area, primarily in isolated clumps of bulrushes. In the past, there was one nesting attempt here by American Bitterns. The bulrushes also support a few nesting pairs of Soras and Red-winged Blackbirds; dryer spots contain Song Sparrows and Common Yellowthroats. Nearly every year one Mallard apparently nests in this area, as evidenced by the presence of a hen with ducklings on the inlet.

IIIA. Peninsula. In addition to the species already mentioned to nest on the shores (see paragraphs II and III preceding) the interior of the peninsula, when under water, provides nesting habitat for 2-4 pairs of Pied-billed Grebes and 1-2 pairs of American Coots. The willows which line the edge provide nesting habitat for 2-4 pairs of Yellow Warblers.

IV. Northwest End. The smartweed beds at the far end and in the various inlets provide nesting habitat for up to 5 pairs of Pied-billed Grebes and scattered pairs of American Coots. Soras nest in the bulrushes in unknown numbers (probably not exceeding 10 pairs.) Long-billed Marsh Wrens are very abundant in bulrushes, and Red-winged Blackbirds also nest in this habitat, but in low numbers.

E. ADDITIONAL NOTES FOR CONSIDERATION

I. Cliff, Barn, Tree, Violet-green, and Rough-winged Swallows utilize the entire lake heavily in spring and early summer, catching insects (mostly midges) over the water and vegetation. The insects probably provide an important food source for migrating swallows; in addition, they support a large population of Cliff Swallows (and some Barn Swallows) which nest in or on nearby buildings. In July and August, both Cliff and Barn Swallows bring their newly-fledged young to the lake, where the juveniles sit on the bulrushes (especially around the Peninsula and Peninsula Inlet, and at the Northwest End) waiting to be fed by adults.

II. Most Red-winged Blackbirds nest in vegetation in the drier spots, especially dense stands of hemlock (Conium). Not many pairs actually nest in the bulrushes.

III. Belted Kingfishers in low numbers (1-2) hunt the entire lake.

IV. There is a nesting colony of Great Blue Herons, approximately a dozen pairs, in the eucalyptus stand across Madonna Road from the SE end of the lake. Birds from this colony do about half their foraging at Laguna Lake; they also fly in other directions, probably to farm ponds and streams.

V. White-tailed Kites, known to be rather nomadic and cyclic in population numbers, frequent the lakeside in unpredictable numbers. During the winter of 1974-75, thirty kites roosted each night in the smartweed and bulrushes along the NE side of the Peninsula Inlet.

VI. Marsh Hawks (Northern Harriers) frequently winter at the lake (1 or 2) and hunt the drier perimeter.

VII. The dense stands of bulrushes bordering the Northwest End, and to some extent those bordering the Center Lake, harbor a large winter blackbird roost composed of Red-winged Blackbirds, Brewer's Blackbirds, Brown-headed Cowbirds, and a few Starlings. Numbers may on occasion approach 5 or 6 thousand.

VIII. When the lake level has been extremely low in late summer, exposing extensive areas of mud, large numbers of shorebirds have occurred. They have included Marbled Godwits, dowitchers, Least and Western Sandpipers, Semipalmated Plovers, Dunlins, and occasional Pectoral Sandpipers, Greater and Lesser Yellow-legs, and American Avocets.

NOTE: I have omitted from this report mention of birds which are principally land-oriented, as well as rareties and species whose presence is normally of very short duration. I attach a checklist of Birds of Western San Luis Obispo County, with all species recorded at the lake or in its immediate vicinity checked. The list also provides approximate times the species are present in western San Luis Obispo County (to the nearest half month.)

F. WILDLIFE HABITAT VALUE MAP FOR AVIFAUNA (see Fig. 2)

On the basis of overall value to nesting, migrant, and wintering birds, I rate the lake sections as follows:

1. (most valuable) Peninsula and Peninsula Inlet and adjacent vegetation.

2. Northwest End with its three inlets.

3. Center Lake.

4. (least valuable) Developed End.

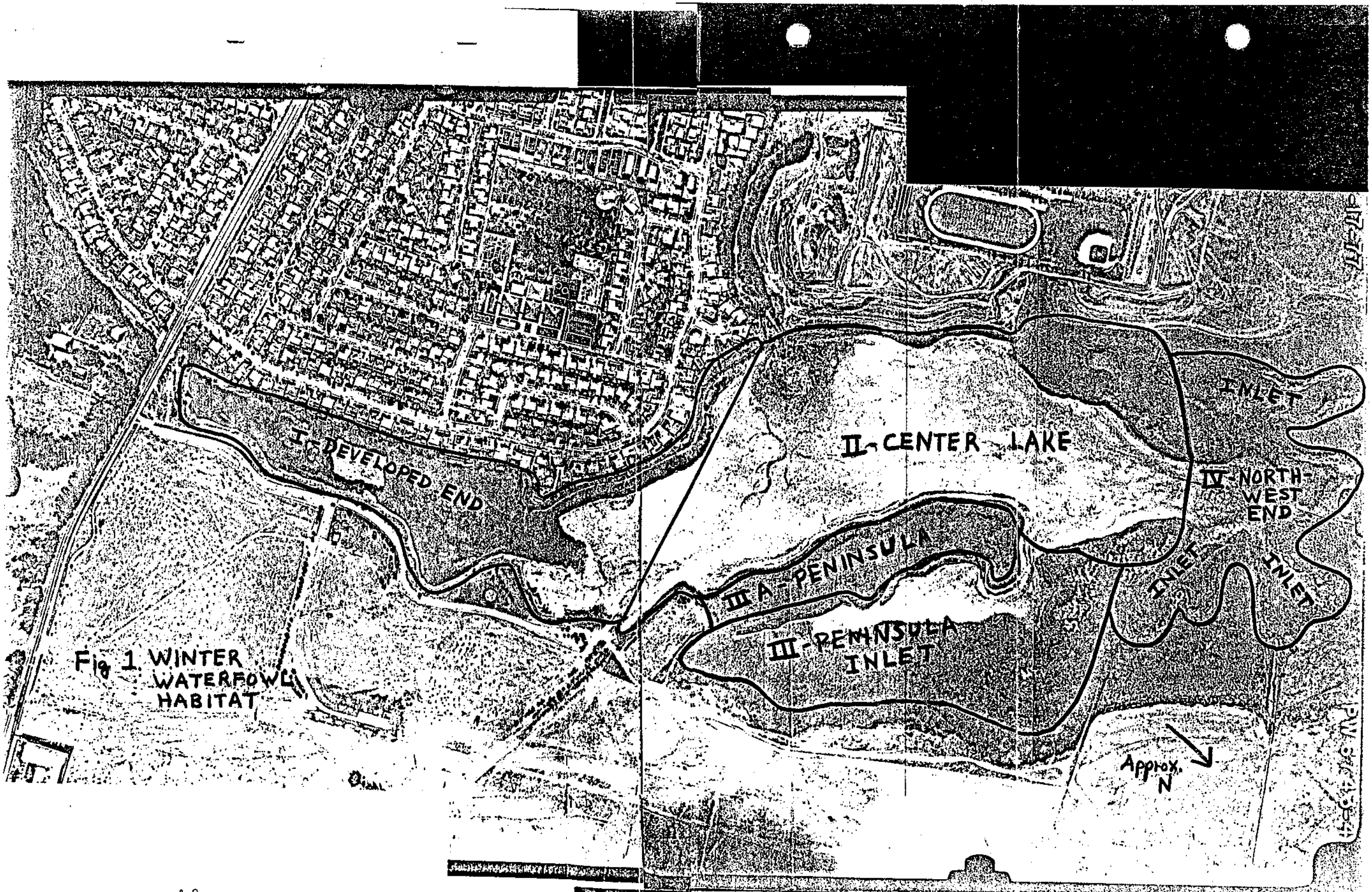


Fig 1 WINTER WATERFOWL HABITAT

BIRDS OF WESTERN SAN LUIS OBISPO COUNTY

Locality Laguna Lake and Vicinity (within 1/4 mile)

Weather ______________ Date 1970-1980

Time begin ________ Time end ________ Hours ________

Habitats ______________

Observers ______________ Total species ________

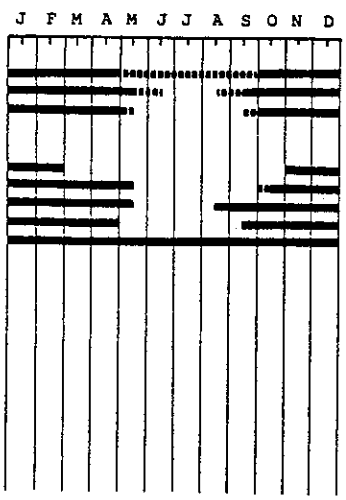
This list includes all species which have been recorded west of the Santa Lucia Mountains. Abbreviations used:

- A -- abundant; can be expected to be seen in substantial numbers
- C -- common; of regular occurrence, but in limited numbers
- O -- occasional; irregular, but a few seen almost every year
- R -- rare; of extremely infrequent occurrence
- Acc -- accidental; outside of its normal geographic range; only a few records

The approximate period when a species is normally present in this area is indicated by a line extending through the appropriate time period. For example, a solid line extending from the beginning of April to the end of September indicates that the species normally arrives during the first half of April and departs during the last half of September.

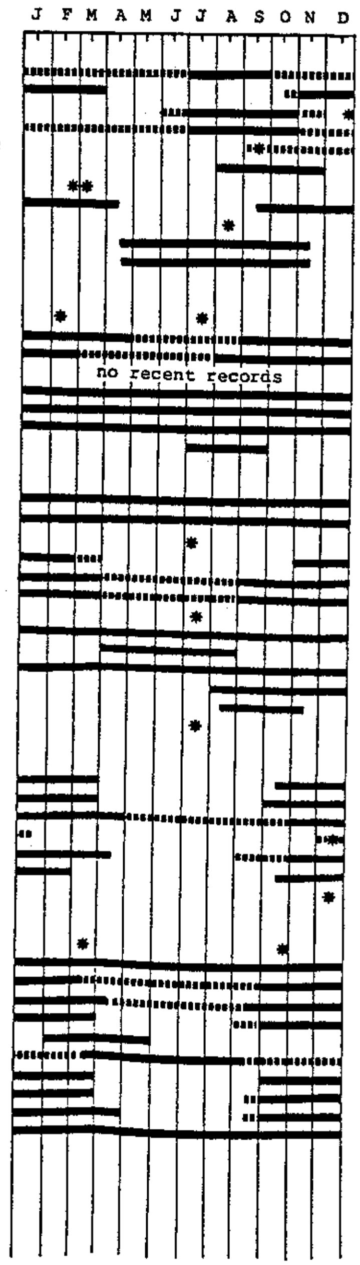
Dashed lines indicate periods when a few individuals are usually present.

Asterisks on the time line are isolated records.



LOONS
- ___ Common Loon--C
- X Arctic Loon--C
- X Red-throated Loon--C

GREBES
- ___ Red-necked Grebe--R
- X Horned Grebe--C
- X Eared Grebe--C
- X Western Grebe--C
- X Pied-billed Grebe--C



TUBENOSES
- ___ Black-footed Albatross--R
- ___ Northern Fulmar--O
- ___ Pink-footed Shearwater--R
- ___ Sooty Shearwater--A
- ___ Short-tailed Shearwater--Acc
- ___ Manx Shearwater--R
- ___ Scaled Petrel--Acc
- ___ Fork-tailed Storm-Petrel--R
- ___ Leach's Storm-Petrel--Acc
- ___ Ashy Storm-Petrel--R
- ___ Black Storm-Petrel--R

PELICANS, CORMORANTS, AND ALLIES
- ___ Red-billed Tropicbird--Acc
- X White Pelican--C
- ___ Brown Pelican--A
- ___ Blue-footed Booby--Acc
- X Double-crested Cormorant--C
- ___ Brandt's Cormorant--C
- ___ Pelagic Cormorant--C
- ___ Magnificent Frigatebird--R

HERONS, EGRETS, AND ALLIES
- X Great Blue Heron--C
- X Green Heron--C
- ___ Little Blue Heron--Acc
- X Cattle Egret--O
- X Great Egret--C
- X Snowy Egret--C
- ___ Louisiana Heron--Acc
- X Black-crowned Night Heron--C
- ___ Least Bittern--R
- X American Bittern--C
- ___ Wood Stork--Acc
- X White-faced Ibis--R
- X Roseate Spoonbill--Acc

SWANS AND GEESE
- X Whistling Swan--O
- X Canada Goose--O
- ___ Brant--A
- ___ Emperor Goose--Acc
- X White-fronted Goose--O
- X Snow Goose--O
- X Ross' Goose--Acc

SURFACE-FEEDING DUCKS
- X Fulvous Whistling-Duck--Acc
- X Mallard--C
- X Gadwall--O
- X Pintail--A
- X Green-winged Teal--C
- ___ Blue-winged Teal--R
- X Cinnamon Teal--C
- ___ European Wigeon--R
- X American Wigeon--C
- X Northern Shoveler--C
- X Wood Duck--R

2

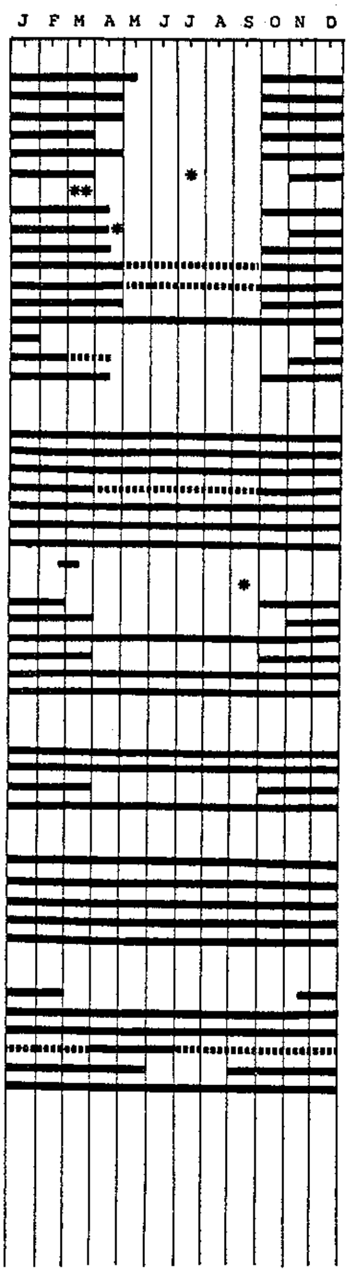
NG DUCKS
_Redhead--Acc
_Ring-necked Duck--O
_Canvasback--A
_Greater Scaup--Acc
_Lesser Scaup--C
_Common Goldeneye--R
_Barrow's Goldeneye--Acc
_Bufflehead--C
_Oldsquaw--R
_Harlequin Duck--R
_White-winged Scoter--C
_Surf Scoter--A
_Black Scoter--R
_Ruddy Duck--A
_Hooded Merganser--R
_Common Merganser--O
_Red-breasted Merganser--C

URES, HAWKS, AND EAGLES
_Turkey Vulture--C
_California Condor--R
_White-tailed Kite--C
_Sharp-shinned Hawk--C
_Cooper's Hawk--C
_Red-tailed Hawk--C
_Red-shouldered Hawk--C
_Broad-winged Hawk--Acc
_Swainson's Hawk--Acc
_Rough-legged Hawk--O
_Ferruginous Hawk--O
_Golden Eagle--O
_Bald Eagle--O
_Marsh Hawk--C
_Osprey--O

ONS
_Prairie Falcon--O
_Peregrine Falcon--O
_Merlin--R
_American Kestrel--C

L, PHEASANTS, AND ALLIES
_California Quail--A
_Mountain Quail--C
_Ring-necked Pheasant--Acc
_Chukar--Acc
_Turkey--C

ES AND RAILS
_Sandhill Crane--Acc
_Virginia Rail--C
_Sora--C
_Black Rail--R
_Common Gallinule--O
_American Coot--A



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OYSTERCATCHERS
_____American Oystercatcher--Acc
_____Black Oystercatcher--C

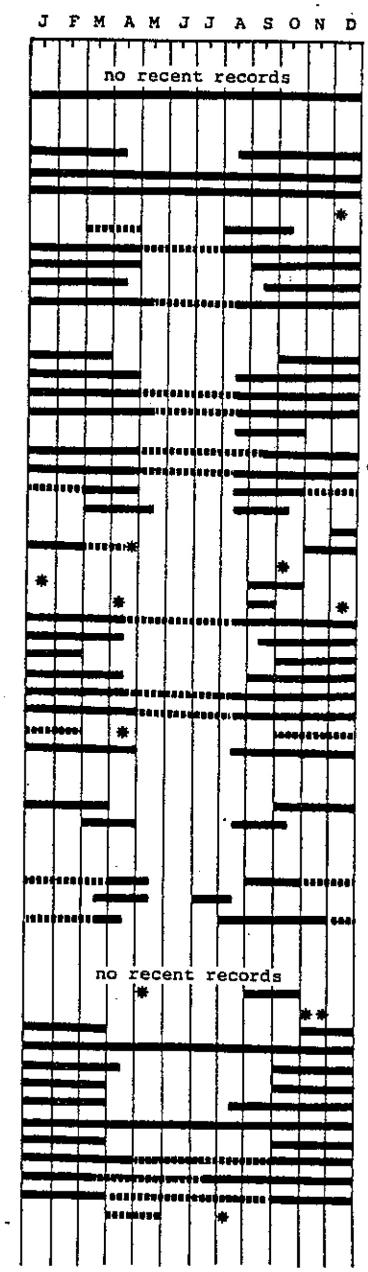
PLOVERS AND TURNSTONES
X Semipalmated Plover--C
_____Snowy Plover--C
X Killdeer--C
_____Mountain Plover--Acc
X American Golden Plover--Acc
X Black-bellied Plover--C
_____Surfbird--C
_____Ruddy Turnstone--O
_____Black Turnstone--A

SANDPIPERS
X Common Snipe--C
X Long-billed Curlew--C
_____Whimbrel--C
X Spotted Sandpiper--C
_____Solitary Sandpiper--R
_____Wandering Tattler--C
_____Willet--A
X Greater Yellowlegs--C
X Lesser Yellowlegs--C
_____Red Knot--R
_____Rock Sandpiper--Acc
_____Sharp-tailed Sandpiper--Acc
X Pectoral Sandpiper--O
_____Baird's Sandpiper--R
X Least Sandpiper--A
X Dunlin--C
X Short-billed Dowitcher--C
X Long-billed Dowitcher--A
X Western Sandpiper--A
X Marbled Godwit--A
_____Ruff--Acc
_____Sanderling--A

AVOCETS AND STILTS
X American Avocet--C
X Black-necked Stilt--O

PHALAROPES
X Red Phalarope--C
X Wilson's Phalarope--O
X Northern Phalarope--C

JAEGERS AND GULLS
_____Pomarine Jaeger--R
_____Parasitic Jaeger--R
_____Glaucous Gull--Acc
_____Glaucous-winged Gull--O
_____Western Gull--A
_____Herring Gull--C
_____Thayer's Gull--Acc
X California Gull--C
X Ring-billed Gull--A
X Mew Gull--A
X Bonaparte's Gull--C
_____Heermann's Gull--A
_____Black-legged Kittiwake--C
_____Sabine's Gull--Acc



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TERNS
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SWIFTS
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HUMMING
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ystercatcher--Acc
tercatcher--C

NSTONES
ed Plover--C
er--C
C
Plover--Acc
olden Plover--Acc
ied Plover--C
C
stone--O
stone--A

pe--C
d Curlew--C
C
ndpiper--C
andpiper--R
Tattler--C

llowlegs--C
llowlegs--C
-R
piper--Acc
ed Sandpiper--Acc
andpiper--O
ndpiper--R
piper--A

ed Dowitcher--C
d Dowitcher--A
ndpiper--A
dwit--A

--A

LTS
vocet--C
ed Stilt--O

rope--C
halarope--O
halarope--C

LS
aeger--R
aeger--R
ull--Acc
nged Gull--O
ll--A
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ull--Acc
Gull--C
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ed Kittiwake--C
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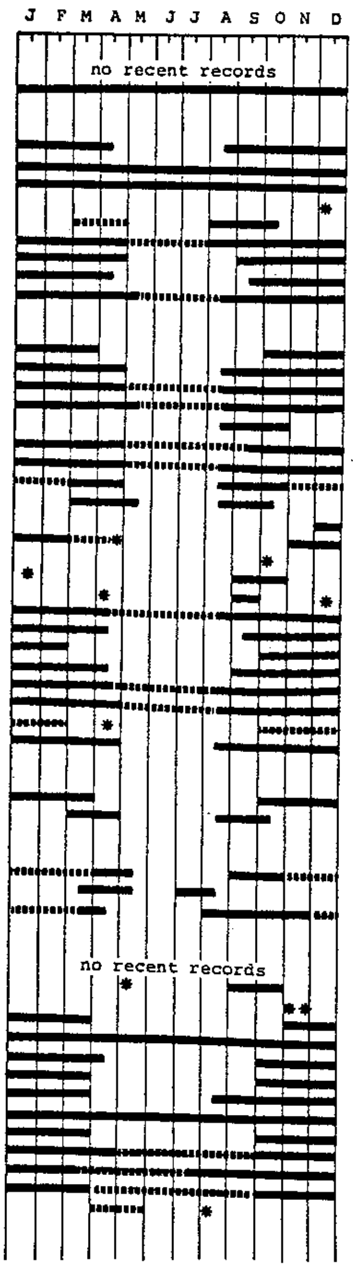


TERNS
X Forster's Tern--C
Common Tern--R
Arctic Tern--R
Least Tern--R
Royal Tern--C
Elegant Tern--C
X Caspian Tern--C
X Black Tern--R

ALCIDS
Common Murre--A
Pigeon Guillemot--A
Marbled Murrelet--R
Xantus' Murrelet--R
Ancient Murrelet--O
Cassin's Auklet--C
Parakeet Auklet--Acc
Rhinoceros Auklet--C
Horned Puffin--Acc
Tufted Puffin--R

PIGEONS AND DOVES
Band-tailed Pigeon--C
X Rock Dove--A
White-winged Dove--Acc
X Mourning Dove--C
Spotted Dove--Acc
Ringed Turtle Dove--Acc

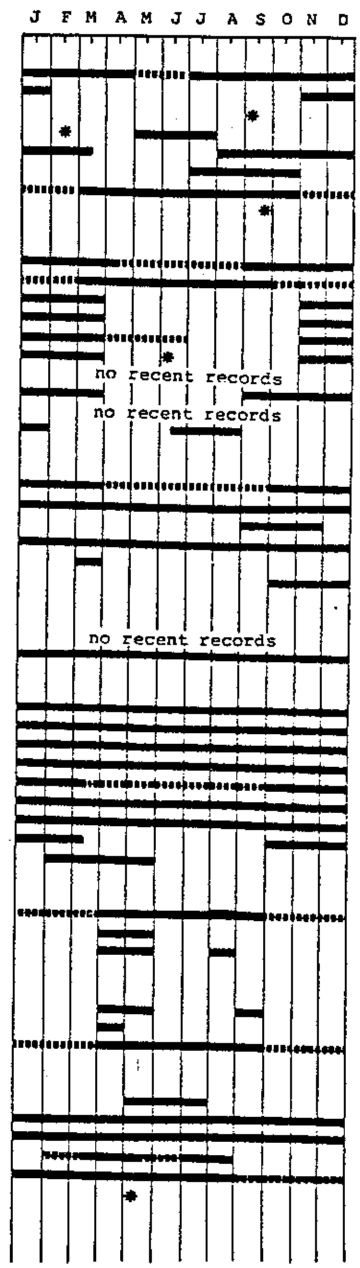
CUCKOOS AND ROADRUNNERS
Yellow-billed Cuckoo--R
Roadrunner--O

OWLS
X Barn Owl--C
Screech Owl--C
X Great Horned Owl--C
Pygmy Owl--R
X Burrowing Owl--C
Spotted Owl--O
Long-eared Owl--R
X Short-eared Owl--O
Saw-whet Owl--R

NIGHTJARS
X Poor-will--C
Common Nighthawk--R
Lesser Nighthawk--R

SWIFTS
Black Swift--R
Vaux's Swift--O
X White-throated Swift--C

HUMMINGBIRDS
Black-chinned Hummingbird--R
Costa's Hummingbird--R
X Anna's Hummingbird--C
X Rufous Hummingbird--C
X Allen's Hummingbird--C
Calliope Hummingbird--Acc



KINGFISHERS
X Beltec

WOODPECKERS
X Commor
X Commor
Acorn
Lewis'
Yellow
Hairy
X Downy
X Nuttal

FLYCATCHERS
Easter
X Wester
X Cassin
X Ash-th
Easter
X Black
X Say's
Willow
X Hammon
Wester
Wester
Olive-

LARKS
X Horned

SWALLOWS
X Violet-
X Tree S
Bank S
X Rough-
X Barn S
X Cliff S
Purple

JAYS, MAGPIE
Steller
Scrub J
Yellow-
Common
X Common
Clark's

TITMICE AND
X Chestnu
Plain T
X Bushtit

NUTHATCHERS
White-b
Red-bre
Pygmy N

CREEPERS
Brown C

NS
__Forster's Tern--C
__Common Tern--R
__Arctic Tern--R
__Least Tern--R
__Royal Tern--C
__Elegant Tern--C
__Caspian Tern--C
__Black Tern--R

'IDS
__Common Murre--A
__Pigeon Guillemot--A
__Marbled Murrelet--R
__Xantus' Murrelet--R
__Ancient Murrelet--O
__Cassin's Auklet--C
__Parakeet Auklet--Acc
__Rhinoceros Auklet--C
__Horned Puffin--Acc
__Tufted Puffin--R

:EONS AND DOVES
__Band-tailed Pigeon--C
__Rock Dove--A
__White-winged Dove--Acc
__Mourning Dove--C
__Spotted Dove--Acc
__Ringed Turtle Dove--Acc

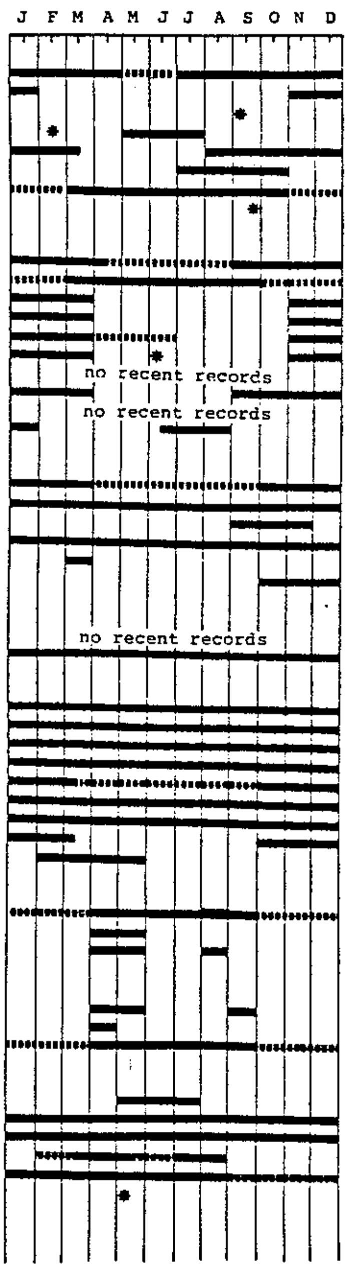
:KOOS AND ROADRUNNERS
__Yellow-billed Cuckoo--R
__Roadrunner--O

.S
__Barn Owl--C
__Screech Owl--C
__Great Horned Owl--C
__Pygmy Owl--R
__Burrowing Owl--C
__Spotted Owl--O
__Long-eared Owl--R
__Short-eared Owl--O
__Saw-whet Owl--R

:HTJARS
__Poor-will--C
__Common Nighthawk--R
__Lesser Nighthawk--R

:FTS
__Black Swift--R
__Vaux's Swift--O
X_White-throated Swift--C

:MINGBIRDS
__Black-chinned Hummingbird--R
__Costa's Hummingbird--R
__Anna's Hummingbird--C
__Rufous Hummingbird--C
__Allen's Hummingbird--C
__Calliope Hummingbird--Acc



KINGFISHERS
_X_Belted Kingfisher--C

WOODPECKERS
_X_Common (Yellow-shafted) Flicker--Acc
_X_Common (Red-shafted) Flicker--C
____Acorn Woodpecker--C
____Lewis' Woodpecker--Acc
____Yellow-bellied Sapsucker--O
____Hairy Woodpecker--C
_X_Downy Woodpecker--C
_X_Nuttall's Woodpecker--C

FLYCATCHERS
____Eastern Kingbird--Acc
_X_Western Kingbird--C
_X_Cassin's Kingbird--O
_X_Ash-throated Flycatcher--C
____Eastern Phoebe--Acc
_X_Black Phoebe--C
_X_Say's Phoebe--C
____Willow Flycatcher--R
_X_Hammond's Flycatcher--O
____Western Flycatcher--C
____Western Wood Pewee--C
____Olive-sided Flycatcher--C

LARKS
_X_Horned Lark--C

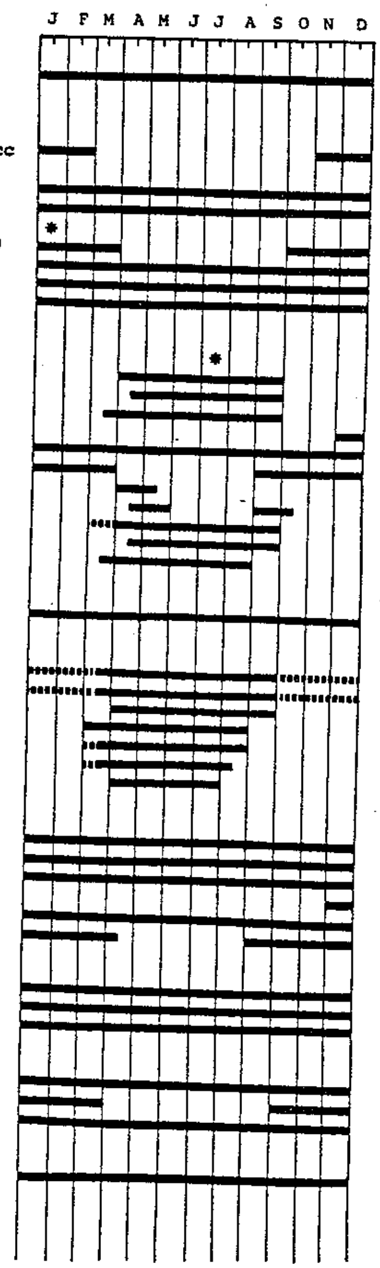
SWALLOWS
_X_Violet-green Swallow--C
_X_Tree Swallow--C
____Bank Swallow--R
_X_Rough-winged Swallow--C
_X_Barn Swallow--C
_X_Cliff Swallow--A
____Purple Martin--R

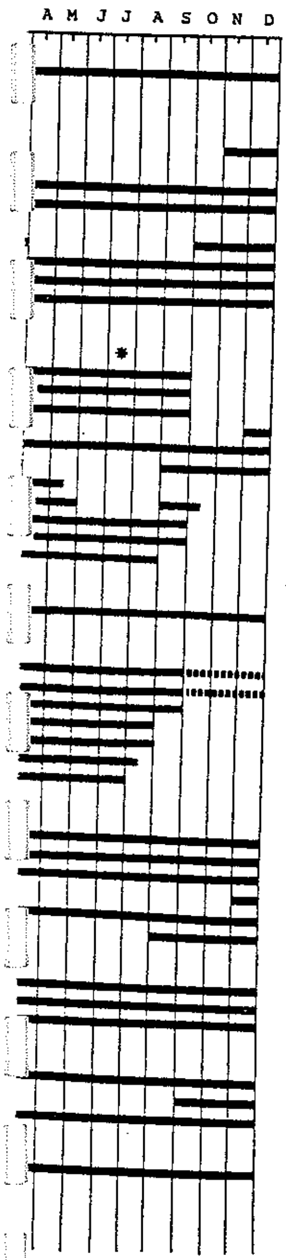
JAYS, MAGPIES, AND CROWS
____Steller's Jay--C
____Scrub Jay--C
____Yellow-billed Magpie--C
____Common Raven--Acc
_X_Common Crow--C
____Clark's Nutcracker--Acc

TITMICE AND CHICKADEES
_X_Chestnut-backed Chickadee--C
____Plain Titmouse--C
_X_Bushtit--A

NUTHATCHERS
____White-breasted Nuthatch--C
____Red-breasted Nuthatch--C
____Pygmy Nuthatch--C

CREEPERS
____Brown Creeper--C





WRENTITS
_____Wrentit--C

DIPPERS
_____Dipper--R

WRENS
_____House Wren--C
_____Winter Wren--O
__X__Bewick's Wren--C
__X__Long-billed Marsh Wren--C
_____Cañon Wren--O
__X__Rock Wren--C

THRASHERS AND MOCKINGBIRDS
__X__Mockingbird--C
_____California Thrasher--C
_____Sage Thrasher--Acc

THRUSHES AND BLUEBIRDS
__X__American Robin--C
_____Varied Thrush--O
__X__Hermit Thrush--C
_____Swainson's Thrush--C
__X__Western Bluebird--C
__X__Mountain Bluebird--O
_____Townsend's Solitaire--O

GNATCATCHERS AND KINGLETS
_____Blue-gray Gnatcatcher--C
_____Golden-crowned Kinglet--C
__X__Ruby-crowned Kinglet--A

PIPITS
__X__Water Pipit--A

WAXWINGS
_____Bohemian Waxwing--R
__X__Cedar Waxwing--A

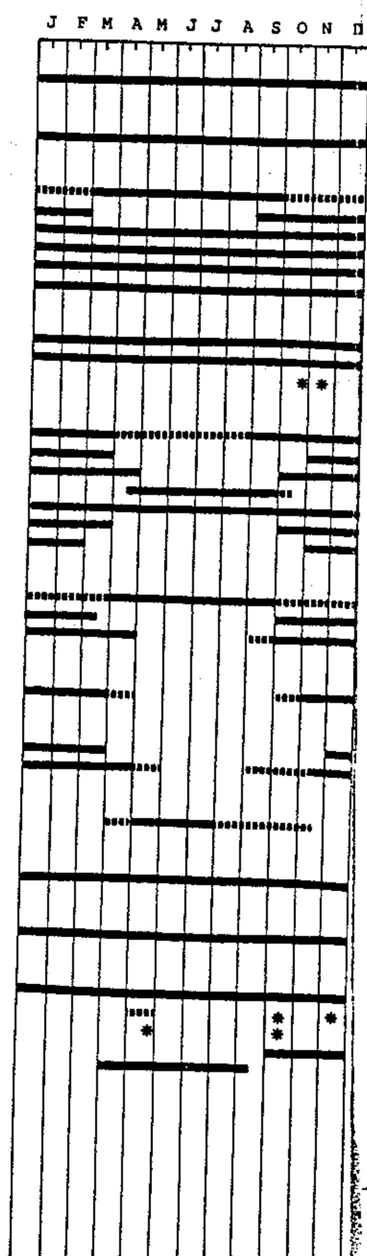
SILKY FLYCATCHERS
_____Phainopepla--O

SHRIKES
__X__Loggerhead Shrike--C

STARLINGS
__X__Starling--A

VIREOS
__X__Hutton's Vireo--C
_____Bell's Vireo--R
_____Yellow-throated Vireo--Acc
_____Solitary Vireo--R
_____Warbling Vireo--C

7



WARBLERS
_____Black-and-white Warbler--Acc
_____Prothonotary Warbler--Acc
_____Tennessee Warbler--Acc
__X__Orange-crowned Warbler--C
__X__Nashville Warbler--O
_____Virginia's Warbler--Acc
__X__Yellow Warbler--C
_____Black-thr. Blue Warbler--Acc
__X__Yellow-rumped (Myrtle) Warbler--O
__X__Yellow-rumped (Audubon's) Warbler--A
_____Black-thr. Gray Warbler--C
_____Townsend's Warbler--C
_____Hermit Warbler--C
_____Blackpoll Warbler--Acc
_____Palm Warbler--Acc
_____Kentucky Warbler--Acc
_____MacGillivray's Warbler--O
__X__Common Yellowthroat--C
_____Yellow-breasted Chat--R
__X__Wilson's Warbler--A
_____American Redstart--Acc

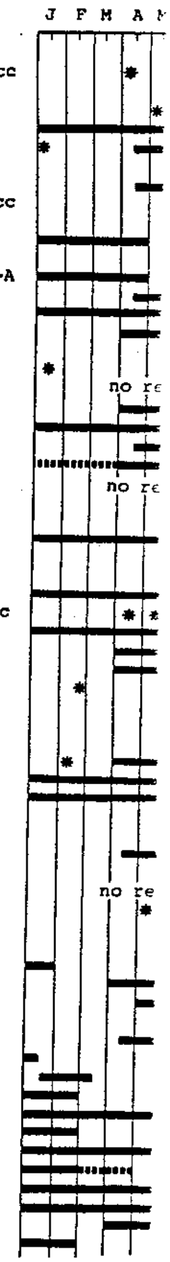
WEAVER FINCHES
__X__House Sparrow--A

BLACKBIRDS AND ORIOLES
__X__Western Meadowlark--A
__X__Yellow-headed Blackbird--Acc
__X__Red-winged Blackbird--A
__X__Tri-colored Blackbird--O
__X__Hooded Oriole--C
_____Scott's Oriole--Acc
_____Northern (Baltimore) Oriole--Acc
__X__Northern (Bullock's) Oriole--C
__X__Brewer's Blackbird--A
__X__Brown-headed Cowbird--C

TANAGERS
__X__Western Tanager--C
_____Scarlet Tanager--Acc
_____Hepatic Tanager--Acc
_____Summer Tanager--Acc

GROSBEAKS, FINCHES, AND BUNTINGS
_____Rose-breasted Grosbeak--Acc
_____Black-headed Grosbeak--C
_____Blue Grosbeak--R
_____Indigo Bunting--Acc
_____Lazuli Bunting--C
_____Painted Bunting--Acc
_____Dickcissel--Acc
_____Evening Grosbeak--R
_____Purple Finch--C
__X__Cassin's Finch--R
__X__House Finch--A
_____Pine Siskin--O
__X__American Goldfinch--C
__X__Lesser Goldfinch--A
_____Lawrence's Goldfinch--C
_____Red Crossbill--R

8



WARBLERS

- Black-and-white Warbler--Acc
- Prothonotary Warbler--Acc
- Tennessee Warbler--Acc
- Orange-crowned Warbler--C
- Nashville Warbler--O
- Virginia's Warbler--Acc
- Yellow Warbler--C
- Black-thr. Blue Warbler--Acc
- Yellow-rumped (Myrtle) Warbler--O
- Yellow-rumped (Audubon's) Warbler--A
- Black-thr. Gray Warbler--C
- Townsend's Warbler--C
- Hermit Warbler--C
- Blackpoll Warbler--Acc
- Palm Warbler--Acc
- Kentucky Warbler--Acc
- MacGillivray's Warbler--O
- Common Yellowthroat--C
- Yellow-breasted Chat--R
- Wilson's Warbler--A
- American Redstart--Acc

WEAVER FINCHES

- House Sparrow--A

BLACKBIRDS AND ORIOLES

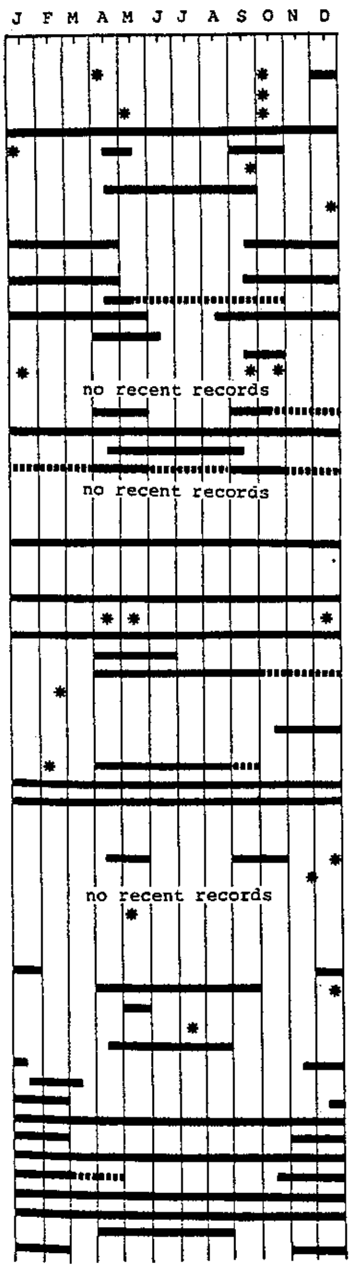
- Western Meadowlark--A
- Yellow-headed Blackbird--Acc
- Red-winged Blackbird--A
- Tri-colored Blackbird--O
- Hooded Oriole--C
- Scott's Oriole--Acc
- Northern (Baltimore) Oriole--Acc
- Northern (Bullock's) Oriole--C
- Brewer's Blackbird--A
- Brown-headed Cowbird--C

TANAGERS

- Western Tanager--C
- Scarlet Tanager--Acc
- Hepatic Tanager--Acc
- Summer Tanager--Acc

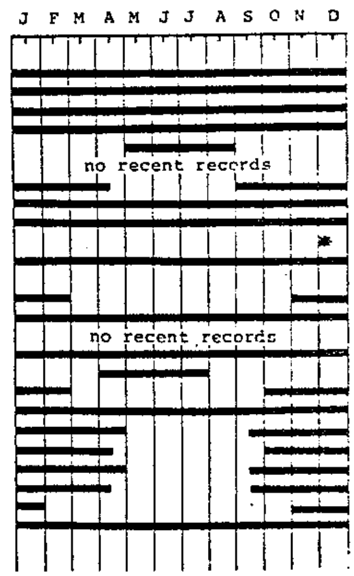
GROSBEAKS, FINCHES, AND BUNTINGS

- Rose-breasted Grosbeak--Acc
- Black-headed Grosbeak--C
- Blue Grosbeak--R
- Indigo Bunting--Acc
- Lazuli Bunting--C
- Painted Bunting--Acc
- Dickcissel--Acc
- Evening Grosbeak--R
- Purple Finch--C
- Cassin's Finch--R
- House Finch--A
- Pine Siskin--O
- American Goldfinch--C
- Lesser Goldfinch--A
- Lawrence's Goldfinch--C
- Red Crossbill--R



TOWHEES, SPARROWS, AND JUNCOS

- Green-tailed Towhee--R
- Rufous-sided Towhee--C
- Brown Towhee--A
- Savannah Sparrow--C
- Grasshopper Sparrow--R
- Sharp-tailed Sparrow--Acc
- Vesper Sparrow--R
- Lark Sparrow--C
- Rufous-crowned Sparrow--C
- Black-throated Sparrow--Acc
- Sage Sparrow--R
- Dark-eyed (Slate-colored) Junco--Acc
- Dark-eyed (Oregon) Junco--A
- Gray-headed Junco--Acc
- Chipping Sparrow--O
- Black-chinned Sparrow--O
- Harris's Sparrow--Acc
- White-crowned Sparrow--A
- Golden-crowned Sparrow--C
- White-throated Sparrow--O
- Fox Sparrow--C
- Lincoln's Sparrow--C
- Swamp Sparrow--Acc
- Song Sparrow--C



NOTES

APPENDIX B

WATER QUALITY ANALYSIS

Part A

PHYSIO-CHEMICAL PROPERTIES
OF LAGUNA LAKE WATERS

by:

Dr. Kingston Leong
Dr. Robert Brown

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INTRODUCTION

Many lake shores in California are being developed into urban communities. These communities take advantage of the lake's natural beauty and recreation such as fishing and sailing as well as the added enjoyment of resident and migratory wildlife that may frequent these lakes. Laguna Lake in San Luis Obispo, California is such a lake whose shores were and are presently being developed for residential homes. This lake is a small shallow eutrophic body of water (ca. 76 hectares) that is enjoyed by the community for many of the aforementioned advantages.

Since residential homes are situated along the shoreline of Laguna Lake, it is not surprising that these homes have had previous insect problems. In 1966 and 1968 midges (non-biting flies) emerging from the lake were so abundant that they caused considerable annoyance to the lake's residents by getting into their eyes, nose, mouth and homes. The County Health Department declared the midge a health nuisance and chemical control was implemented to supress the emerging flies (Stimac and Leong 1977). The insect problem associated with Laguna Lake is not unique but rather, a common occurrence of lake communities (Ali 1978, Anderson et al. 1965, Mulla and Khasawinah 1969, Mulla 1974, Maggy 1968). In addition to annoying insect problems, other lake communities have experienced algal blooms which have resulted in unpleasant odors and fish kills.

The purpose of this report is to describe some of the physiochemical properties of Laguna Lake waters and the influence they have on the biotic community, namely the insect and phytoplankton populations.

METHODS AND MATERIALS

Data used for the analyses are from various studies conducted in Laguna Lake. The physio-chemical parameters of the lake's water during the period of November 1979 to June 1980 were collected and analyzed by Dr. Dieter Heinz and his staff, employed by the City of San Luis Obispo.

Data concerning the interactions among the midge, phytoplankton and water quality were from previous research projects on Laguna Lake (Leong et. al. 1973, Stimac and Leong 1977, Althouse et al. 1978).

The data analyzed using both univariate and multivariate statistical analyses available at the California Polytechnic State University, San Luis Obispo, CA. The multivariate statistical programs, DISANAL and CORANAL used for the analyses were developed by R.A. Pimentel (1979).

RESULTS AND DISCUSSION

The results are presented in four parts. The first is an overall graphic description of Laguna Lake's annual limnological cycle. The second concerns an indepth description and discussion of the water parameters measured and their importance to lake management. The third is the distribution and kinds of midge populations in Laguna Lake and lastly, a discussion of water quality, phytoplankton and insect populations interactions.

I. Description of Laguna Lake's Annual Limnological Cycle

The annual limnological cycle of Laguna Lake is graphically summarized in Figure 1. Figure 1 is a canonical discriminate analysis graph showing that the samples, taken from November 1979 to June 1980, tended to group into three rather discrete groups: fall (A-B); winter (C-F); spring (G-I). The lines extending from a central point (grand centroid) are vectors of individual variables. The vector of a variable in canonical space indicates the direction in magnitude of how a particular variable increases. The pH variable vector, for example, is a long vector directed toward the fall samples. This indicates that the fall samples were more alkaline or another way of phrasing it, as fall approaches, the waters of Laguna Lake become more alkaline.

Referring to Figure 1, therefore, the following is a brief discussion of the lake's water quality cycle. It should be noted, however, that only variables that have significantly large vectors or variation for a time period will be discussed.

As fall approaches, the sago pondweed dies off rapidly and by November much of the vegetative portions of this plant are completely decomposed, resulting in a high concentration of nutrients such as ammonia, nitrate and phosphorus in the lake's waters. The pH and phosphorus variables during fall show the greatest changes in values and therefore are depicted by large vectors.

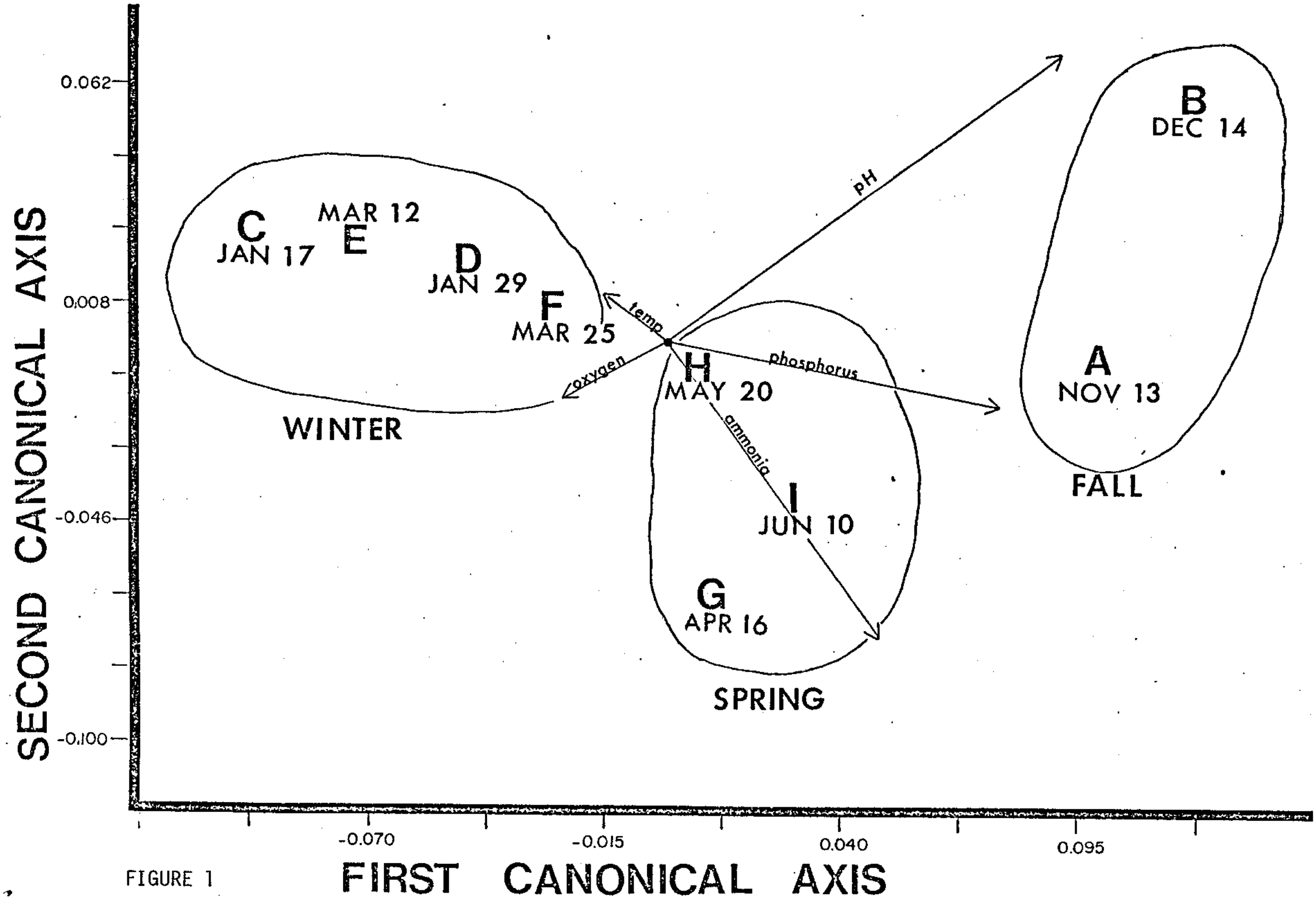

FIGURE 1

Canonical graph showing the grouping of samples into discrete groups; Fall (A-B); Winter (C-F); and Spring (G-I). The vectors extending from a central point (grand centroid) depicts how veriables influence each time period.

When the winter rains occur in January through March, the lake's water level is increased through surface run off and through the emptying of Perfumo creek waters into the lake. Along with the increase in lake depth, there is an increase in oxygen levels, temperatures and turbidity. The oxygen and temperature levels are the main variables separating the winter from the fall and summer groups.

In spring, there is a general warming and clearing of the lake's waters, along with the marked decrease in the lake's free ammonia and nitrate levels. The decrease in the ammonia levels (large vector) reflects the utilization of inorganic nitrogen by green plants, namely phytoplankton and the emerging submerged sago pondweed.

Although samples were not taken during the summer months (mid-June to October) 1980, previous research (Leong et al. 1972; Stimac and Leong 1977) indicates the following trends: the summer months show an increase in temperature, clarity, depth, and depletion of available inorganic nutrients. During these months, the biotic community, such as the pondweed, phytoplankton and insect populations increases almost geometrically through July, reaching a peak in mid-August and slowly decreasing in abundance as summer approaches fall.

II. Discussion of Laguna Lake's Water Quality Parameters Measured from November 1979 to June 1980.

A. Turbidity

Turbidity is the measurement of water clarity, taking into account the amount of suspended material, both organic and inorganic, found in the water column. As turbidity is essentially a measure of light penetration into the lake, it provides an index of the general productivity of phytoplankton species and indicates the depths at which rooted aquatic macrophytes can germinate and grow. Turbidity also indicates the amount of suspended clays and silts in the water; these substances affect the ability of predatory fish to find forage and can also clog their gills.

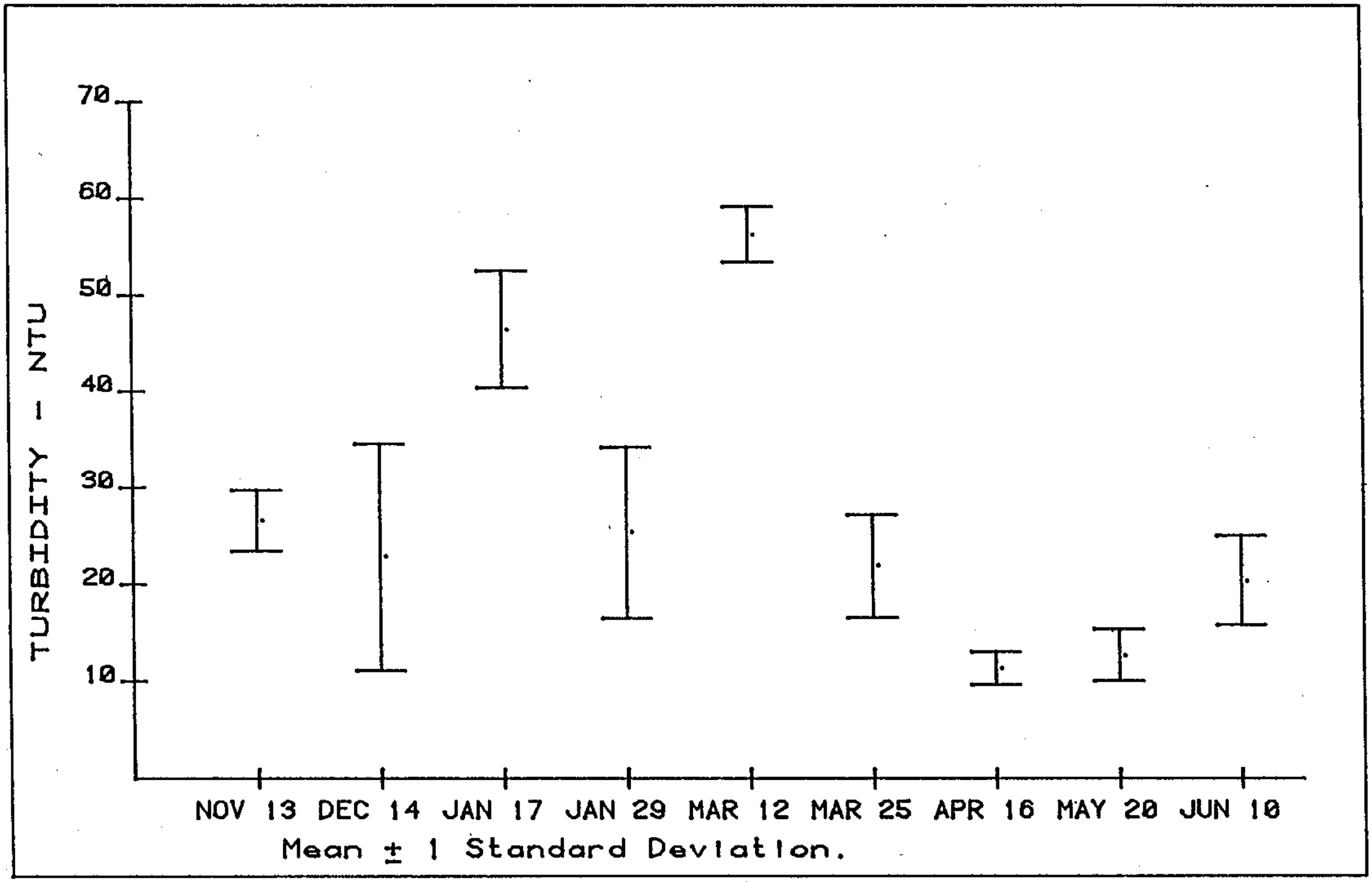

FIGURE 2

Measurements of water turbidity (NTU) for Laguna Lake from November 1979 to June 1980.

NTU=National Turbidity Units

Turbidity is measured in National Turbidity Units (ntu), an index that means that a unit of 1 corresponds to naturally clear water, 10 units indicates light penetration to ten to twenty feet, and 50 units indicates virtually no light penetration (muddy water). As can be seen in Figure 2, turbidity varies widely throughout the year, being greatest after periods of rainfall and windy conditions. During the spring months turbidity drops, particularly on calm mornings, and light penetration is virtually to the bottom of the lake. However, when the wind begins to stir up the water, turbidity increases noticeably as fine clays are resuspended from the bottom into the water column.

B. Temperature

Temperature is an important limiting factor in freshwater systems because many aquatic organisms have narrow tolerance limits to this parameter. In particular, warm water fish can breed only in water that is warm enough for embryo development within the eggs. Trout on the other hand are cold water fish that reach maximum growth at temperatures between 18 and 10 degrees Centigrade, but prefer water temperatures around 15 degrees C. Temperature changes also produce characteristic patterns of circulation and stratification that greatly influence the type and abundance of aquatic life.

Temperature data collected in the water analysis (Figure 3) indicate that Laguna Lake does not have a thermal stratification. This illustrates that wind mixing of the lake waters prevents the formation of a hypolimnion. The data also show a typical response to increasing air temperature characteristic of shallow ponds. While temperatures are optimal for the propagation of warm water fishes, the spring and summer temperature ranges are not optimal for cold water game species, such as trout.

C. Conductivity

Electrical conductivity is the measurement of the water's ability to carry an electrical charge, or conversely, its resistance to an electrical

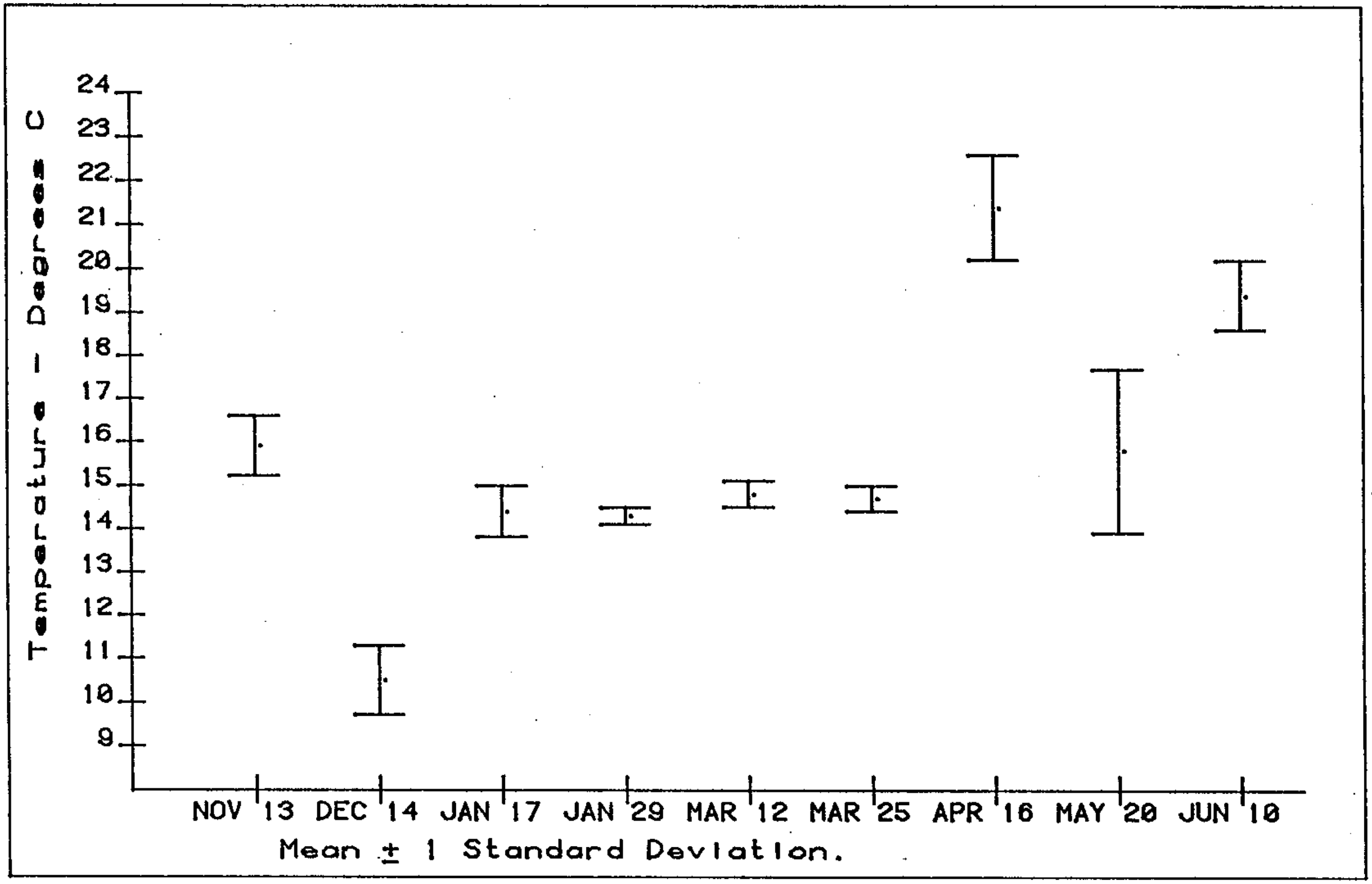

FIGURE 3

Measurements of water temperature (degrees centigrade) for Laguna Lake from November 1979 to June 1980

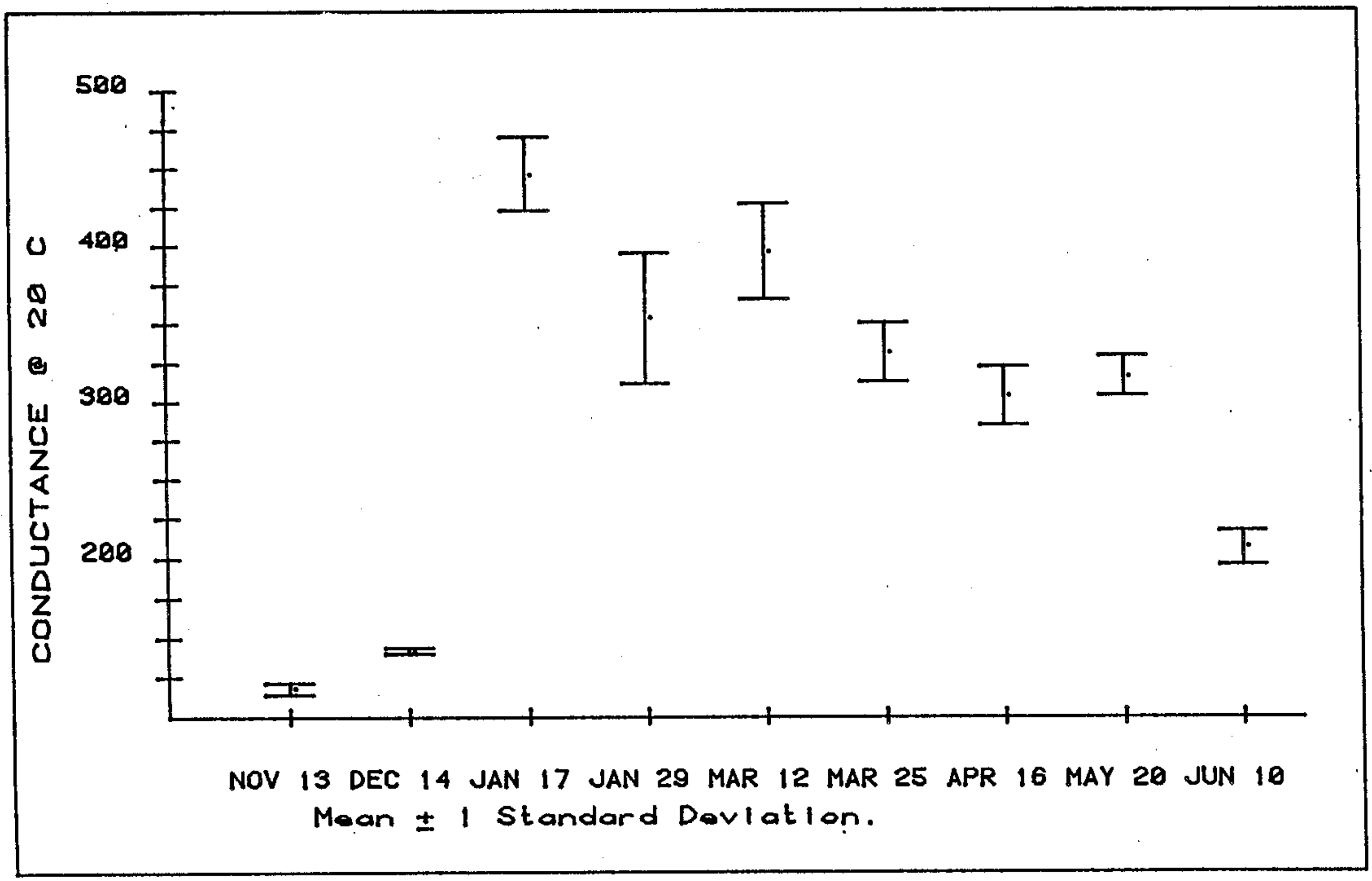

FIGURE 4

Measurements of water conductance for Laguna Lake
from November 1979 to June 1980

current. Since only dissolved ions take part in the conduction of electrical current, conductivity is a measure of salinity, total dissolved solids and the general salinity of the water.

Conductivity at Laguna Lake (Figure 4) exhibits a classical pattern of solids and ion inflow during the rainy season, followed by decreasing levels over the spring and summer as materials are used by the biotic community of the lake and become bound to the sediment.

D. pH

This parameter measures the degree of alkalinity or acidity of the lake water. The acidity of the lake determines the reaction rate at which various chemical reactions occur in the lake. Because of this, it determines in part what concentrations of various nutrients will be available for plant growth. In addition, acidity has a direct effect on aquatic organisms, all of which have varying tolerances to different pH levels. The abundance of midge larvae in Laguna Lake, for example, has been strongly associated with pH levels (Stimac and Leong 1977).

The pH of Laguna Lake is slightly alkaline, as is typical of eutrophic and highly productive water bodies. Figure 5 shows that with the onset of rainfall, which is mildly acidic due to dissolved carbon dioxide and nitrates, the pH value of the lake drops to slightly below neutral. As inputs of nutrients and the biological activity of the lake increases during the spring, the pH increases, with stabilized levels occurring in the summer.

The pH values found for the lake are strong indicators of the overall annual cycling of the lake. The multivariate analysis of the various parameters shows that the lake has distinct seasons correlated to the time of year (Figure 1), with the regular change in pH being one of the most important parameters. This change in seasons will dictate the timing of physical alterations and water inputs to the lake.

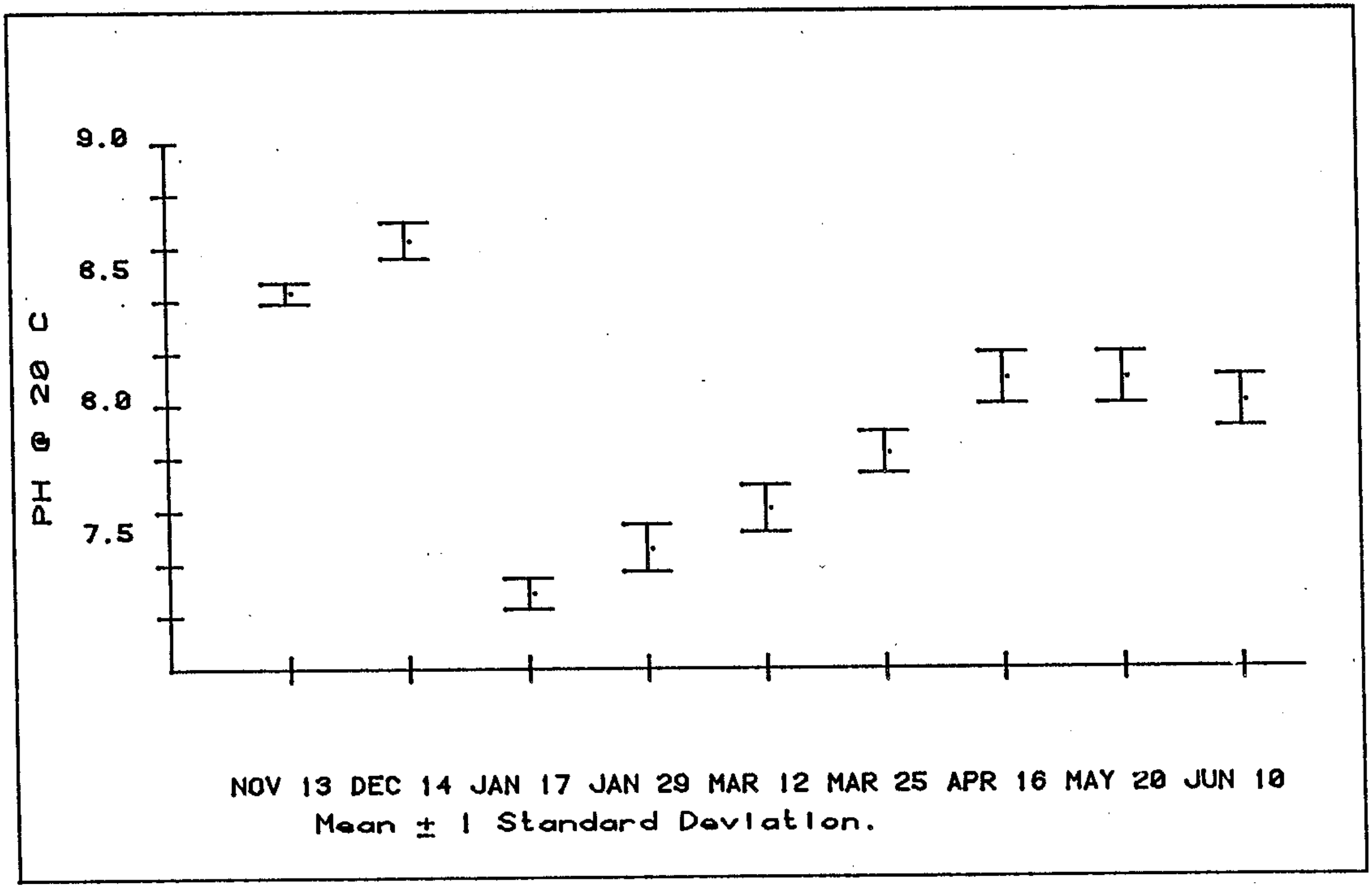

FIGURE 5

Measurements of pH for Laguna Lake from November 1979 to June 1980

E. Dissolved Oxygen

Oxygen is necessary for the respiration of organisms as they metabolize food to obtain energy. In an open air or running stream habitat, oxygen is generally not limiting to the growth and existence or organisms, but in soil and lake environments, it is particularly important in its relationship to the decomposition of organic material; high oxygen supplies enhance aerobic organisms to breakdown organic materials while low oxygen supplies retards or kill these organisms.

At Laguna Lake, oxygen levels are maintained by the constant mixing action of the prevailing winds, particularly during the spring and summer months. Data indicate that oxygen levels are also on a yearly season cycle like pH and conductivity (Figure 6). While levels are generally adequate for the maintenance of animal populations, there is a noticeable decrease in oxygen levels during the late fall. This oxygen depletion is probably related to the decompositon of vegetation and consequent oxygen depletions caused by the growth of bacteria.

Analysis of the oxygen data indicates that Laguna Lake forms a stratified oxygen layer at the bottom during exceptionally calm mornings. This stratification appears to be a temporary phenomena that disappears as breezes increase and promote mixing of the lake. If this condition were to persist for a longer period of time, stratification of the lake bottom waters could create a stagnant hypolimnion.

F. Nutrients - Ammonia, Nitrate, and Total Phosphorus

Inorganic nutrients are the key limiting factors to the growth of plants, with nitrogen and phosphorus generally being the key substances. Variations in the concentration of these parameters within the lake (often changing with seasons) determines the amount and spatial location of plant growth.

In Laguna Lake, nutrient values are generally high, as is typical of eutrophic, highly productive lakes and ponds. The lake area acts as a

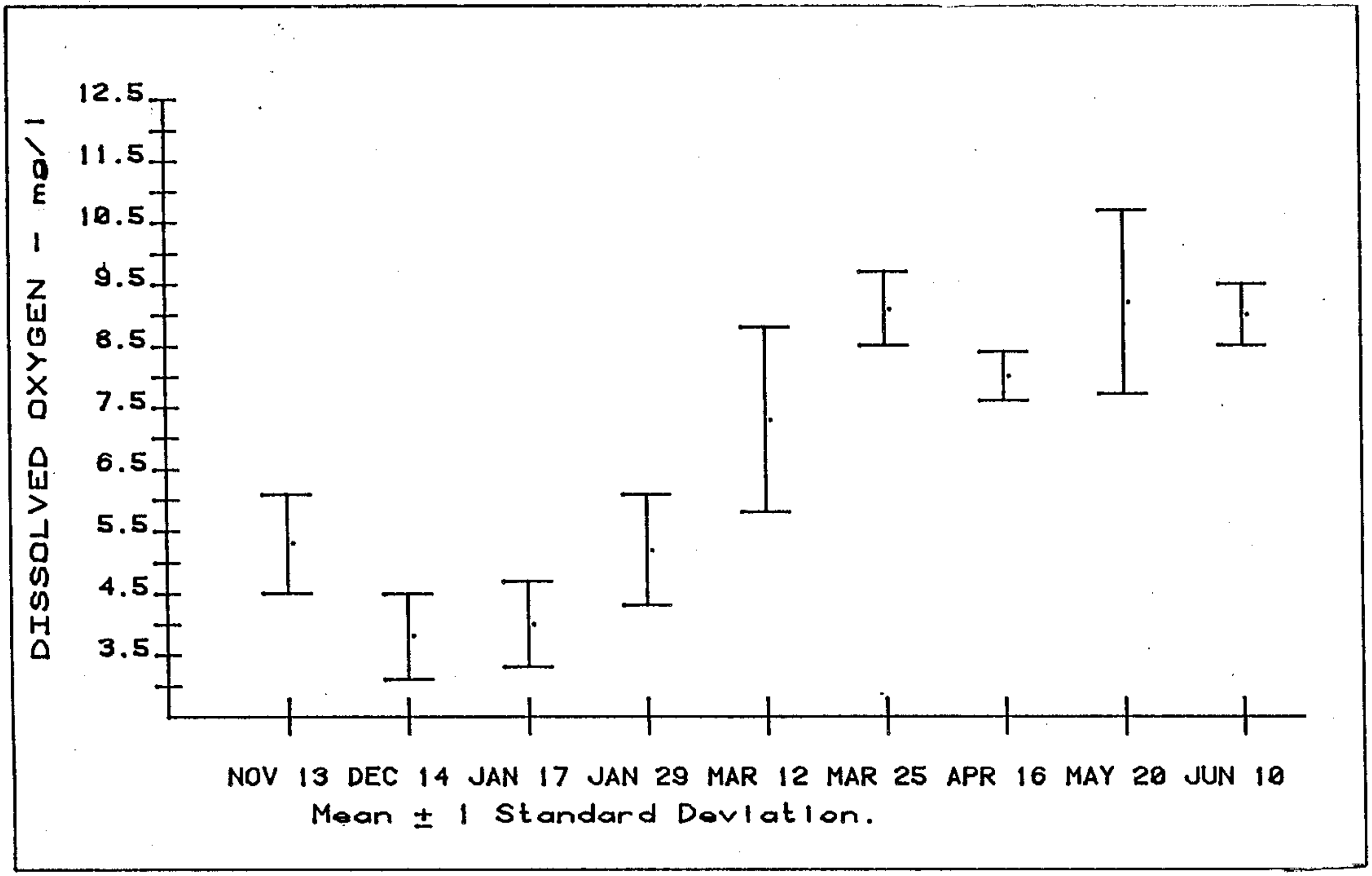

FIGURE 6 Measurements of dissolved oxygen for Laguna Lake November 1979 to June 1980

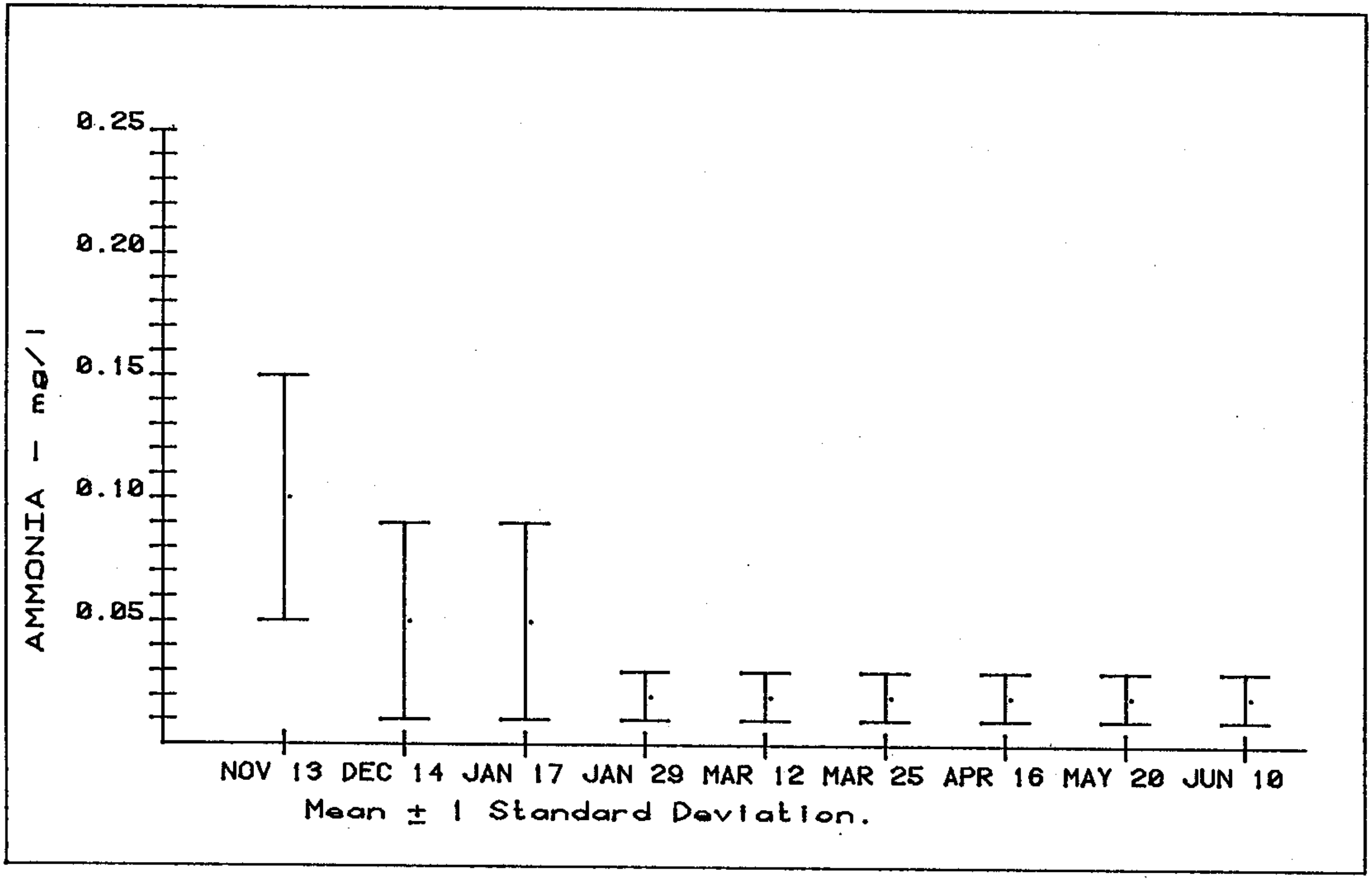

FIGURE 7

Measurements of ammonia levels for Laguna Lake from November 1979 to June 1980

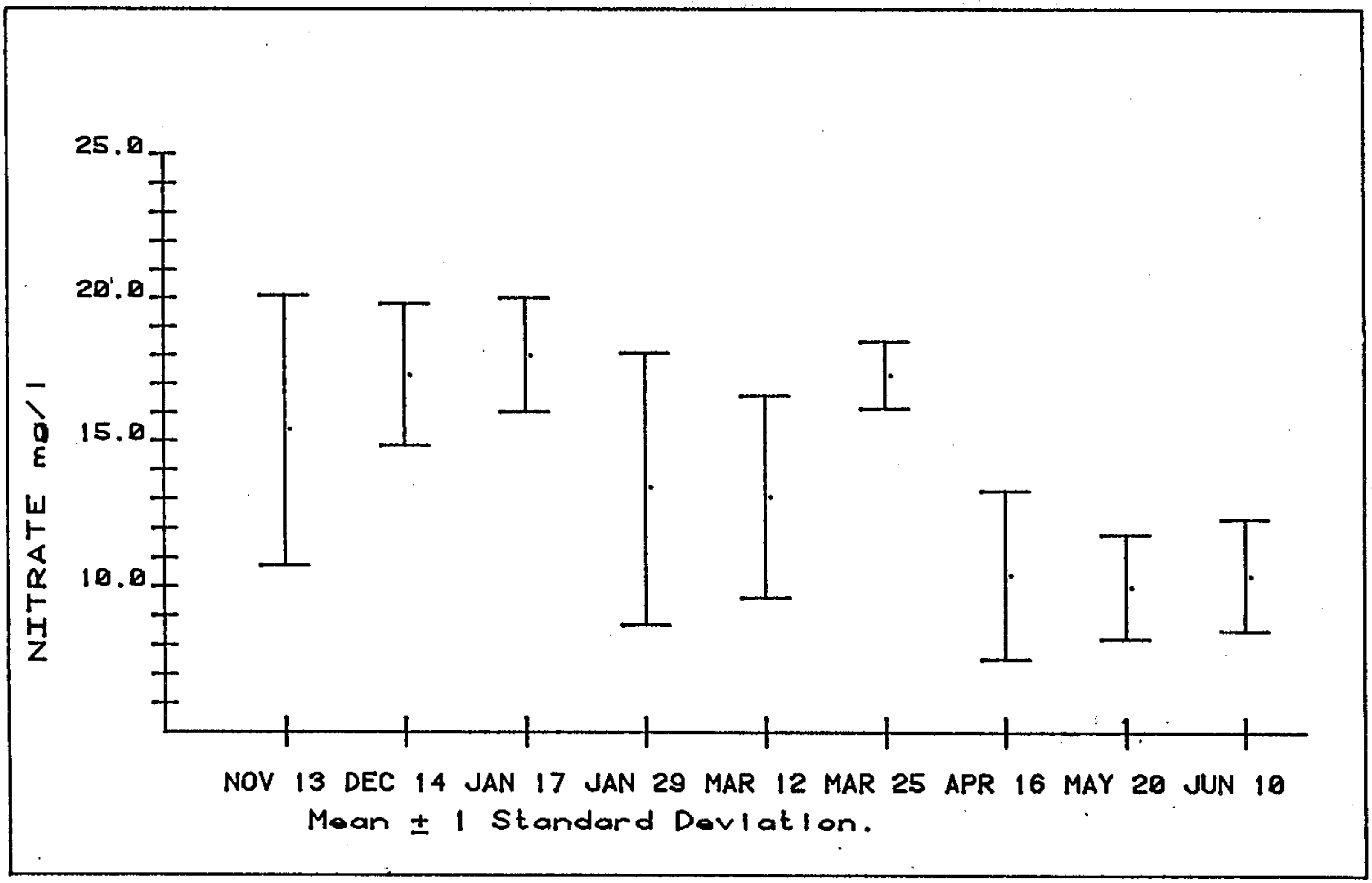

FIGURE 8

Measurements of nitrate levels for Laguna Lake from November 1979 to June 1980

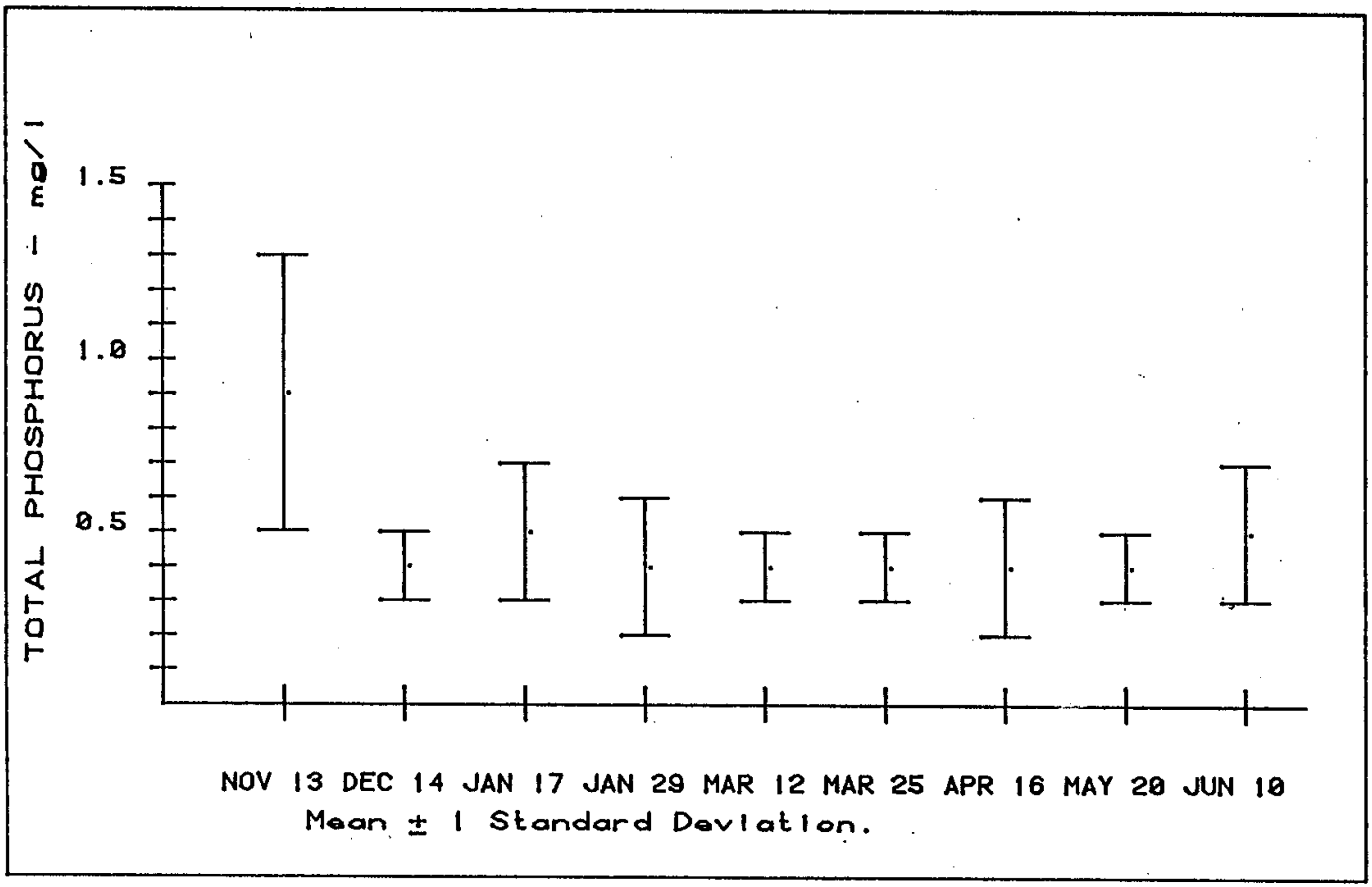

FIGURE 9 Measurements of phosphorus levels for Laguna Lake from November 1979 to June 1980

nutrient trap to material washed out of the watershed, with particularly high nutrient sources occurring on the grazing and agricultural lands. Figures 7, 8, 9 indicate that nutrient levels vary considerably within the lake, but the mean is approximately stable. An exception to this is the high concentration of ammonia and similarly somewhat increased levels of nitrate and phosphorus during the late fall. This appears to be the result of annual vegetation die off, which returns nutrients to the lake waters at a time when they cannot be utilized effectively. An important proportion of this material is probably carried out of the lake during overflow conditions and other portions are probably tightly bound to the clay and silt sedimentation accumulating on the bottom of the lake.

Inputs of additional nutrients, particularly large amounts of phosphorus and nitrates from effluent water, may cause accelerated eutrophication.

III. Distribution and Kinds of Midges in Laguna Lake

The results of this 1971-1972 midge survey in Laguna Lake are summarized in Table 1. As depicted, the greatest variety of midge genera was associated with the seasonal submerged sago pondweed, Potamogeton pectinatus. This weed is an annual plant that germinates in spring from the lake bottom and sends up numerous thin, filamentous branches that reaches the lake surface. In late July and early August, this pondweed forms a thick green filamentous mat over much of the lake. After the seeds are produced in August, the plant dies rapidly and by mid-October, no vegetative stages could be found.

Of the 15 midge genera recovered from the sago pondweed, six genera, Cricotopus, Chironomus, Paralauterborniella, Glyptotendipes, Tanypus and Procladius are considered to be potentially pestiferous in California (Grodhous 1975). The most abundant genus was Corynoneura which averaged 789 larvae per sample in 1972 during peak abundance in August. This genus also had a restricted distribution to the pondweed and its seasonal abundance was closely synchronized with the sago pondweed annual cycle. It is our belief that this genus was the pestiferous species of the 1966 and 1968 midge outbreaks. Lake residents reported that during the midge outbreaks, the midge flies were entering their homes directly through the house screens. Since Corynoneura sp. adults were about 1-1.5 mm in length, it is plausible that they could readily enter homes directly through the house screens. The genus declared a health nuisance by the California Department of Public Health (Magy 1968, Grodhous 1968) was Paralauterborniella but our studies have indicated that this species may not be the principal pest species because it seldom exceeded 15 individuals per sample. The adults of Paralauterboniella were much larger than Corynoneura and could not enter homes through the house screens. The genus, Cricotopus sp. within the pondweed, could also contribute to the 1966 and 1968 outbreaks since it was the second most abundant midge recovered from this habitat. Its populations (counts) often exceeded 63 larvae per sample.

During full growth of the pondweed in early August, we have frequently recovered mosquito larvae, identified to be Anopleles occidentiales and

Table 1. The 1972 distribution of 15 midge genera recovered from 4 habitats in Laguna Lake, San Luis Obispo, CA.

Genera	Pondweed	Bulrushes	Smartweed	Mud
Corynoneura	X			
Cricotopus	X	X	X	
Chironomus	X			X
Cryptochironomus	X			
Einfeldia	X	X	X	X
Dicrotendipes	X		X	
Endochironomus	X			
Paralauterboniella	X			
Psectocladius	X		X	
Glyptotendipes	X	X	X	
Ablabesmyia	X			
Procladius	X			X
Tanypus	X			
Tanytarsus	X		X	
Herterotrissocladius	X	X		

Culex tarsalis, in the weed beds. The presence of mosquito larvae within the weed beds may reflect the sheltering effects or the retarded movements of the lake waters due to the thick summer growth of *Potamogeton*.

Bordering much of the lake are the bulrushes and the smartweed aquatic plants which supported a stable population of midges throughout the year. Unlike the pondweed, these habitats never contained the numbers nor the abundance of midges. They did contain, however, species that Grodhous (1975) listed as potentially pestiferous (*Cricotopus* and *Tanytarsus*).

The mud habitat contained three genera, *Chironomus*, *Procladius*, and *Einfeldia*. The genera, *Chironomus* and *Procladius* were present in the mud samples collected throughout the year while *Einfeldia* was recovered only during the summer months. *Chironomus* and *Procladius* are potentially pestiferous since they have been reported to emerge an nuisance levels in various recreation lakes in California (Ali and Mulla 1977b, Mulla *et al.* 1975, 1976).

IV. Biological Interactions amoung Laguna Lake's Water Quality, Insect, and Phytoplankton Populations

The 1971-72 survey revealed that the bulk of the pestiferous midge populations was associated with the annual presence of the submerged sago pondweed. Stimac and Leong (1977) subsequently, conducted a research project from mid-June to mid-October 1973 to determine the factors associated with midge larval abundances. Their study encompassed the seasonal cycle of the submerged sago pondweed and the insect populations associated with this weed (Table 2). These investigators showed through the use of principal component analyses and information index analyses (Cassie 1972), that the insect predators of five types of chironomid larvae had only a minor to moderate suppressive influence upon midge larval densities and that the availability of the aquatic weed substrate did not have a major influence on the abundance of larval midges. They consequently concluded that the suppressive action of the insect predators alone could not prevent midge outbreaks and that the pondweed must be drastically

TABLE 2. Summary of ranges, means and standard errors of samples for 12 ecological variables measured during the period of June-October 1973. Sample size is n = 48 for each factor within each habitat.

Factors	Untransformed ranges, means and standard deviations of 12 original factors								
	Top			Middle			Bottom		
	Range	Mean	Standard error[1]	Range	Mean	Standard error	Range	Mean	Standard error
Corynoneura	0.0-365.0	118.65	± 16.06	0.0- 66.0	20.52	± 2.81	0.0-119.0	31.40	± 4.92
Cricotopus	16.0-178.0	63.71	± 5.58	0.0- 34.0	4.88	± 0.97	0.0- 44.0	4.44	± 1.11
Microtendipes	0.0- 65.0	11.67	± 2.66	0.0- 8.0	1.08	± 0.28	0.0- 32.0	2.60	± 0.85
Parachironomus	0.0- 5.0	0.42	± 0.16	0.0- 9.0	0.88	± 0.24	0.0- 14.0	2.23	± 0.46
Psectrocladius	0.0- 9.0	1.21	± 0.35	0.0- 1.0	0.40	± 0.11	0.0- 6.0	1.00	± 0.22
Ablabesmyia	0.0- 11.0	0.63	± 0.26	0.0- 9.0	0.70	± 0.25	0.0- 5.0	0.96	± 0.20
Coenagrion	0.0- 20.0	2.81	± 0.60	0.0- 17.0	2.21	± 0.53	0.0- 36.0	2.96	± 0.87
Weed weight (gms)	8.2- 58.1	26.48	± 3.82	0.9- 16.2	4.70	± 0.52	6.5- 59.5	22.39	± 1.48
Water temperature (°C)	17.0- 25.9	21.38	± 0.34	16.8- 21.5	19.60	± 0.17	16.9- 20.9	18.97	± 0.14
Alkalinity (ppm)	226.0-390.0	304.83	± 8.18	224.0-398.0	302.63	± 8.32	224.0-392.0	301.90	± 8.31
pH	7.0- 8.8	8.04	± 0.10	7.0- 8.6	7.98	± 0.08	7.0- 8.4	7.96	± 0.07
Dissolved oxygen(ppm)	3.1- 18.0	9.22	± 0.62	3.2- 15.0	6.69	± 0.52	0.8- 14.7	5.62	± 0.61

[1]Standard error = $s/\sqrt{n}$

reduced to prevent future midge emergence problems. The environmental variable that was associated with the greatest variation in midge population was total alkalinity, a measure of total dissolved carbonates. This association, it was hypotehsized, was an indirect measure of available food supply. Non-predaceous midge larvae are phytoplankton, diatom, and algal feeders. The parameters that limits phytoplankton growth and abundances, therefore would limit midge abundance. Moss (1973) reported that at high pH of 8.6 to 8.8, free CO2 is a limiting factor of oligotrophic phytoplankton. Since Stimac and Leong (1977) encountered many pH measurements greater than 8.6, they hypotehsized that free carbonates was a limiting factor in this system. Reduced levels of free carbonates, therefore, affected the phytoplankton populations and consequently the chironomid larval populations.

The food hypothesis was later investigated by Althouse et al. (1977) for the possible associations among water quality, phytoplankton and midge population abundances. This study, conducted from November 1976 to March 1977, involved eight biotic variables (alkalinity, dissolved oxygen, nitrate, phosphate, ammonia, temperature, pH and lake depth) and four biotic variables (phytoplankton, Procladius, Chironomus larvae and adults). Using canonical correlation analysis, they revealed several interesting relationships and are summarized as follows: 1) Chironomid larval populations were directly associated with alkalinity, nitrate, phosphate, temperature, pH and especially strong with phytoplankton populations; and 2) Low phytoplankton populations were associated with low levels of phosphate and nitrates and high levels of alkalinity and dissolved oxygen. The fact that the chironomid larval populations were strongly associated with the phytoplankton populations which in turn is dependent upon the lake's phosphate, nitrate, and alkalinity levels, indicates a strong interrelationship amoung the midge population, phytoplankton population, and the lake's water quality. The direct and interdependence of these variables are important management considerations since any modification that would increase phytoplankton abundance would surely increase midge populations.

CONCLUSIONS

1. The nutrient levels of Laguna Lake are high and are typical of low elevation, large watershed, eutrophic lakes.

2. The submerged sago pondweed, Potamogeton pectinatus habitat supported the greatest densities and types of midge genera.

3. Midge abundances were directly associated with alkalinity, nitrate, phosphate, temperature, pH and phytoplankton abundances.

4. Phytoplankton abundances were associated with the nutrient levels of the lake, particularly the phosphate and nitrate levels.

RECOMMENDATIONS

Laguna Lake, although eutrophic, is a relatively stable aquatic ecosystem. The midge problems of 1966 and 1968 have not occurred at nuisance levels for more than a decade. Natural mortality factors such as fish predation, insect predators, food (phytoplankton) abundances may be holding the pestiferous midge populations below the nuisance levels. Since there were past problems with midges, any modifications of Laguna Lake should be considered carefully so that factors favoring phytoplankton and midge abundances can be minimized.

We therefore recommend the following:

1. Laguna Lake should be deepended to a minimum of ten feet. A depth of ten feet or greater would discourage the germination and growth of the sago pondweed. This weed supports a high proportion of pestiferous midge genera.

2. Lower the lake's nutrient levels by the periodic harvesting of aquatic plants within and immediately surrounding the lake. Aquatic plants accumulate nutrients during active growth periods (spring and early summer) but contribute these nutrients back to the lake during periods of vegetative die off (late summer and fall). Thus harvesting of vegetation during late summer/early fall, would reduce the level of available nutrients and result in a lowering of overall productivity the following spring.

3. Sewage effluent waters should not be used to increase the lake water levels unless there are appropriate and economic means of lowering the phosphorus and nitrate levels, i.e. tertiary treatment. These nutrients will enhance phytoplankton growth and possibly insect and related problems, i.e. unpleasant odors.

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APPENDIX B

WATER QUALITY ANALYSIS
Part B

The Relationship of Laguna Lake Water Quality
to Management Plan Alternatives

A water quality testing program was conducted from November 1979 to June 1980 to provide a limnological data base from which the effect of management and restoration decisions could be determined. The information gathered was used to eliminate environmentally unfeasible actions and to provide input to the EIR and regulatory permit processes, particularly with respect to the potential introduction of treated wastewater to the lake for the purpose of stabilizing the lake level. The data (Table I at back of appendix) was collected at five locations: #1 in the Peninsula Inlet, #2 in the Northwest inlets, #3 in the Central lake, #4 just outside the Prefumo Inlet, and #5 in the Southeast Arm. Each sampling point was sampled at three depths, surface, 20 inches, and bottom (5 - 8 feet), so that any stratification effects would be noted. The data was analyzed through graphical interpretation and the technique of multi-variate analysis (see Part A of Water Quality Analysis). The purpose of this analysis is to discuss the effect of various lake management decisions as it pertains to water quality.

1. Effect of Lake Size on Lakeshore and Aquatic Habitats

Laguna Lake is shallow, particularly in the northwest end where small changes in water depth results in a substantial change in the extent of shoreline and the amount of aquatic habitat available. If the lake level is increased, thus expanding the lake size, there is a greater amount of habitat available for marsh species, particularly flowering plants (macrophytes). Given that there is basicly a limited supply of total nutrients available for plant growth in the lake water during the growing season, the additional macrophyte uptake will result in a greater decrease in the total nutrient supply. This could result in lower total phytoplankton (microphytes) growth in the open water portion of the lake, leading to a slight decrease in aquatic organisms. This decrease is compensated by an increase in semi-aquatic organisms. The increase in lake size would be somewhat beneficial if treated wastewater is brought to the lake, as the extra nutrients from this source would be utilized by the macrophytes instead of entering the phytoplankton - midge food chain (the consequences of this is detailed in Part A).

2. Effect of Lakeshore Recreation on the Ecological Value of the Lake

Analysis of the water quality data indicates that there is no significant difference between water quality at site #5 in the Southeast Arm, which receives the most intensive recreational use, and the other sites on the lake. This indicates that there has not been any intensive disturbance to the aquatic habitat at this present level of use. If there was, a significant difference would have been noted in turbidity values (shoreline recreation can cause extensive shoreline erosion which would be reflected by high turbidity levels) and dissolved oxygen values (large amounts of trash entering the lake at this point would result in lower dissolved oxygen content).

3. Effect of Water Depth on Lakeshore and Aquatic Habitat

As water depth increases, there is less rooted aquatic growth as the amount of sunlight that can penetrate the water decreases. The ability of sunlight to penetrate the water is dependent on the water clarity, which is determined by the amount of suspended material in the water. As the water becomes more turbid, less light penetrates. Turbidity values in Laguna Lake vary rapidly, depending primarily on the amount of wind which can cause re-suspension of bottom materials. Turbidity values for the lake indicate that on calm mornings, there is light penetration essentially to the bottom of the lake, which allows extensive growth of rooted aquatic weeds which are a detriment to recreational use of the lake and to the ecologic value of the lake if the growth becomes extensive enough to cause stagnation. In order to prevent this growth, lake depth should be increased to at least ten feet (see part A). If such an increase occurs, there will be a shift in growth from the rooted aquatic weeds to the phytoplankton. This can result in improved forage for fish, but might also increase midge populations to nuisance levels. The actual effect would have to be determined by monitoring of midge populations if the depth is substantially increased without removal of the midges breeding substrate (primarily sago pondweed). The probable effect of increased depth is also possibly mitigated if the extent of shoreline habitat is increased.

Another effect of increased water depth is the possibility of thermal and chemical stratification (ie: formation of a hypolimnion). In a shallow, eutrophic lake like Laguna Lake, this would cause a variety of problems. The water quality data indicates that there is no stratification at any depth throughout the lake, with the wind causing essentially total mixing from surface to bottom. However, data taken early in the morning (site #1) indicates that there is a temporary bottom depletion of oxygen. If the lake is deepened and effluent water is introduced, this area of the lake will need to be monitored carefully to ascertain that no long term adverse effects will occur.

4. Effect of Urban Storm Runoff, Natural Discharge, and Effluent Discharge

The primary effects of rainfall discharge to the lake was an increase in conductivity (indicating increased salinity due to the input of dissolved salts from the watershed), a decrease in pH and a slow increase in dissolved oxygen levels and temperature. As there was no significant difference in these parameters between sites located near urban areas and those located adjacent to grazing lands, it appears that input from all sources are rapidly mixed in the lake and no specific concentration points can be identified for control measures on nutrient input. (The input of nitrogen and phosphate from the watershed is the controlling mechanism in the eutrophication process of the lake.) The discharge of effluent to the lake would be as a point source of nutrient inflow. This discharge is regulated by the Regional Water Quality Control Board (Appendix I), but current allowable discharges of nutrients are greater than the lake's ecosystem can handle without substantially increased eutrophication. As a result, if effluent is discharged to the lake, a variety of mitigation measures will be necessary to reduce the impacts of excessive nutrient supply to the lake. These measures are discussed in the text under the effluent water supply alternative.

STUDENT NEUMAN KEULS MULTIPLE RANGE TESTS

FOR MONTHLY MEAN VALUES

TEMPERATURE

DEC 14	10.54
JAN 29	14.27
JAN 17	14.39
MAR 25	14.70
MAR 12	14.76
MAY 20	15.84
NOV 13	15.92
JUN 10	19.39
APR 16	21.39

NH4

MAR 25	0.015
APR 16	0.015
MAY 20	0.017
JUN 10	0.019
MAR 12	0.022
JAN 29	0.024
JAN 17	0.047
DEC 14	0.049
NOV 13	0.096

CONDUCTANCE

NOV 14	117.7
DEC 13	142.4
JUN 10	206.4
APR 16	303.3
MAY 20	315.9
MAR 25	330.6
JAN 29	352.6
MAR 12	396.3
JAN 17	446.4

TURBIDITY

APR 16	11.4
MAY 20	12.8
JUN 10	20.4
MAR 25	21.9
DEC 14	22.9
JAN 29	25.4
NOV 13	26.6
JAN 17	46.5
MAR 12	56.4

NO3

MAY 20	9.95
APR 16	10.42
JUN 10	10.43
MAR 12	13.11
JAN 29	13.36
NOV 13	15.43
MAR 25	17.27
DEC 14	17.29
JAN 17	17.98

PH

JAN 17	7.29
JAN 29	7.46
MAR 12	7.61
MAR 25	7.82
JUN 10	8.10
APR 16	8.10
MAY 20	8.10
NOV 13	8.44
DEC 14	8.63

OXYGEN

DEC 14	3.84
JAN 17	3.98
JAN 29	5.24
NOV 13	5.34
MAR 12	7.30
APR 16	7.97
JUN 10	9.00
MAR 25	9.08
MAY 20	9.18

PHOSPHATE

JAN 29	0.36
MAR 25	0.38
MAR 12	0.40
DEC 14	0.43
MAY 20	0.44
APR 16	0.44
JAN 17	0.49
JUN 10	0.52
NOV 13	0.86

NOVEMBER 13,1979

A = SURFACE   B = 20' DEPTH

TEMPERATURE

4-B	14.98
3-B	15.07
2-B	15.07
1-B	15.46
5-B	16.00
3-A	16.07
4-A	16.12
2-A	16.27
1-A	17.03
5-A	17.08

NH4

2-A	0.047
1-A	0.050
3-A	0.077
3-B	0.077
5-A	0.077
4-B	0.080
4-A	0.090
5-B	0.133
1-B	0.140
2-B	0.200

CONDUCTANCE

5-A	112.67
5-B	113.67
3-B	115.67
4-A	115.67
4-B	116.00
1-A	118.67
2-B	118.67
2-A	121.00
3-A	121.00
1-B	124.00

TURBIDITY

5-A	21.67
1-A	24.33
3-A	24.67
4-A	24.67
4-B	25.00
1-B	27.33
2-A	27.67
3-B	28.33
2-B	28.67
5-B	33.33

NO3

5-A	9.33
4-A	10.67
4-B	11.33
2-A	13.00
3-B	13.67
1-A	14.97
2-B	18.33
3-A	18.67
5-B	20.33
2-B	24.00

PH

3-A	8.37
3-B	8.40
1-B	8.41
2-B	8.43
5-A	8.43
4-B	8.43
4-A	8.45
2-A	8.45
1-A	8.48
5-B	8.49

OXYGEN

5-B	3.83
5-A	4.10
1-B	4.83
2-B	5.07
2-A	5.57
3-B	5.56
3-A	6.03
1-A	6.07
4-A	6.13
4-B	6.17

PHOSPHATE

5-A	0.27
3-A	0.33
3-B	0.53
2-A	0.87
1-A	0.90
5-B	0.93
4-B	1.13
2-B	1.17
4-A	1.17
1-B	1.34

FILTER INDEX

2-A	378.3
4-B	378.3
4-A	390.0
5-B	393.3
3-B	423.3
2-B	446.7
1-A	513.3
5-A	523.3
1-B	570.0
5-B	780.0

DECEMBER 14, 1979

A = SURFACE B = 20' DEPTH C = 40' DEPTH

TEMPERATURE

2-C	9.17
2-B	9.37
1-C	10.07
2-A	10.07
1-B	10.13
3-C	10.13
4-C	10.23
1-A	10.47
3-B	10.47
4-B	10.57
3-A	10.87
5-C	10.87
5-B	11.57
4-A	11.63
5-A	12.47

OXYGEN

3-C	2.83
1-C	2.93
2-C	3.07
4-C	3.17
1-B	3.37
1-A	3.63
2-B	3.67
4-B	3.87
2-A	3.93
3-B	3.93
5-C	4.17
3-A	4.27
4-A	4.33
5-B	4.93
5-A	5.43

NO3

1-B	12.33
5-A	14.67
1-A	15.67
1-C	15.67
2-B	15.67
3-B	15.67
5-C	16.33
4-A	17.00
2-A	17.33
3-A	18.67
5-B	18.67
4-B	19.00
2-C	20.33
3-C	20.67
4-C	21.67

TURBIDITY

1-B	3.27
1-A	3.37
4-A	16.67
3-A	17.33
2-B	17.50
2-A	18.00
1-C	20.33
5-A	20.67
3-B	22.67
4-B	23.33
5-B	23.67
4-C	35.67
5-C	36.33
2-C	40.67
3-C	43.67

NH4

1-B	0.010
2-B	0.010
3-A	0.010
3-B	0.010
4-A	0.010
5-A	0.010
5-C	0.010
5-B	0.043
1-A	0.047
4-B	0.057
2-A	0.060
4-C	0.087
1-C	0.107
3-C	0.107
2-C	0.153

PHOSPHATE

3-B	0.23
5-C	0.30
2-A	0.33
3-A	0.33
4-B	0.37
4-C	0.37
1-A	0.43
1-B	0.43
2-B	0.43
5-A	0.43
5-B	0.43
4-A	0.47
1-C	0.57
3-C	0.60
2-C	0.67

DECEMBER 14, 1979 CONTINUED.

CONDUCTANCE		PH		FILTER INDEX	
5-B	138.33	1-A	8.46	1-B	303.3
1-B	139.33	2-C	8.51	1-A	370.0
2-A	139.33	2-A	8.57	1-C	390.0
2-B	140.33	1-B	8.59	4-A	406.7
3-C	140.67	2-B	8.60	3-A	490.0
4-B	141.67	1-C	8.61	2-B	523.3
3-A	143.00	3-C	8.62	5-A	536.7
1-C	143.33	3-A	8.65	2-A	600.0
4-A	143.33	3-B	8.66	2-C	696.7
5-C	143.33	4-A	8.67	4-B	696.7
2-C	143.67	4-C	8.68	3-B	756.7
3-B	143.67	5-C	8.69	5-B	880.0
5-A	143.67	4-B	8.70	3-C	1146.7
4-C	145.00	5-A	8.70	4-C	1166.7
1-A	147.67	5-B	8.71	5-C	1396.7

JANUARY 17, 1980

A = SURFACE   B = 20' DEPTH   C = BOTTOM

TEMPERATURE

1-C	13.17
5-C	13.87
3-C	13.93
4-C	13.93
2-C	14.07
4-A	14.07
3-B	14.33
1-B	14.37
2-B	14.43
3-A	14.57
5-B	14.57
2-A	15.03
1-A	15.07
4-B	15.17
5-A	15.23

OXYGEN

2-C	3.17
3-C	3.17
1-C	3.23
3-A	3.37
1-B	3.57
2-B	3.60
3-B	3.63
4-C	3.63
1-A	3.83
2-A	3.87
5-C	4.37
5-B	4.87
4-A	4.93
4-B	5.07
5-A	5.33

NO3

1-B	14.33
1-A	15.67
5-B	16.00
2-C	16.67
4-B	16.67
2-A	17.33
3-A	17.33
3-C	18.33
5-A	18.33
1-C	18.67
2-B	19.33
4-C	19.33
5-C	19.33
3-B	20.67
4-A	21.67

TURBIDITY

3-C	31.67
3-B	39.67
1-A	40.33
1-B	40.67
2-A	44.00
2-B	45.67
4-B	47.67
2-C	48.67
5-A	48.67
3-A	49.33
5-C	50.67
4-A	51.67
5-B	52.67
1-C	53.00
4-C	53.00

NH4

1-B	0.010
2-A	0.010
3-A	0.010
3-C	0.010
4-A	0.010
5-A	0.010
2-B	0.040
1-A	0.043
5-C	0.047
5-B	0.057
4-B	0.063
2-C	0.067
1-C	0.077
3-B	0.093
4-C	0.157

PHOSPHATE

5-B	0.30
2-A	0.33
3-A	0.33
1-A	0.40
4-A	0.40
2-C	0.43
3-C	0.43
5-A	0.43
5-C	0.47
3-B	0.53
1-C	0.57
1-B	0.63
2-B	0.63
4-B	0.67
4-C	0.83

JANUARY 17, 1980 CONTINUED.

CONDUCTANCE		FILTER INDEX		PH	
5-B	416.7	4-B	196.7	2-C	7.22
5-C	416.7	2-A	223.3	3-A	7.22
5-A	420.3	5-A	293.3	1-B	7.23
4-A	430.3	1-A	350.0	3-C	7.24
3-B	431.0	4-A	360.0	2-B	7.24
2-C	435.7	2-C	396.7	2-A	7.25
2-B	439.7	3-A	430.0	1-C	7.27
4-C	441.0	2-B	443.3	3-B	7.27
3-C	445.0	1-B	456.7	1-A	7.29
2-A	447.3	5-B	466.7	4-B	7.31
4-B	450.7	3-C	473.3	5-A	7.32
3-A	466.7	3-B	596.7	4-C	7.36
1-C	476.7	5-C	686.7	5-C	7.36
1-B	484.7	1-C	693.3	4-A	7.40
1-A	494.3	4-C	730.0	5-B	7.42

JANUARY 29, 1980

A = SURFACE   B = 20' DEPTH   C = BOTTOM

TEMPERATURE

5-C	13.77
5-B	13.93
5-A	13.97
2-A	14.17
3-B	14.17
4-A	14.17
3-B	14.27
1-B	14.33
2-B	14.33
4-C	14.37
2-C	14.43
1-C	14.47
3-A	14.47
1-A	14.53
4-B	14.63

OXYGEN

5-C	3.63
5-B	3.77
5-A	4.07
1-C	4.87
2-C	4.87
1-B	4.97
1-A	5.13
2-B	5.17
2-A	5.53
3-B	5.53
3-A	5.63
3-C	5.77
4-A	6.37
4-C	6.53
4-B	6.83

NO3

1-A	4.73
1-B	6.10
2-C	9.53
1-C	9.53
2-B	11.37
5-B	11.50
4-B	11.53
4-C	14.53
2-A	14.97
5-B	15.33
4-A	15.53
5-A	16.67
3-B	17.87
3-C	19.73
3-A	21.53

TURBIDITY

1-B	10.3
1-C	15.7
4-C	17.3
4-B	18.7
1-A	19.3
4-A	19.7
5-B	21.3
5-C	23.3
5-A	24.3
2-A	31.7
3-B	33.0
2-B	33.7
3-A	34.0
3-C	38.3
2-C	40.3

NH4

1-C	0.010
4-A	0.010
5-A	0.010
3-C	0.013
5-B	0.013
2-A	0.017
4-B	0.017
1-B	0.023
2-C	0.023
3-B	0.023
2-B	0.033
4-C	0.033
5-C	0.033
1-A	0.037
3-A	0.057

PHOSPHATE

1-A	0.04
1-B	0.05
2-B	0.06
4-A	0.33
2-A	0.37
2-C	0.37
4-C	0.37
5-A	0.37
3-A	0.42
5-C	0.43
3-B	0.47
4-B	0.47
1-C	0.50
5-B	0.53
3-C	0.57

JANUARY 29, 1980 CONTINUED.

CONDUCTANCE

2-A	282.7
5-A	294.3
1-A	299.3
4-A	308.3
3-A	312.0
2-B	351.3
5-B	353.3
4-B	355.0
5-C	371.7
4-C	374.3
3-B	382.3
2-B	386.0
1-C	392.0
3-C	411.7
2-C	414.3

PH

1-B	7.29
1-C	7.30
1-A	7.34
2-A	7.42
3-C	7.44
2-C	7.45
2-B	7.48
3-A	7.48
3-B	7.48
5-A	7.53
5-B	7.53
4-A	7.53
4-C	7.54
5-C	7.55
4-B	7.58

MARCH 12, 1980

A = SURFACE   B = 20' DEPTH   C = BOTTOM

TEMPERATURE

2-C	14.43
3-C	14.43
4-B	14.43
2-B	14.47
3-B	14.60
2-A	14.63
1-C	14.63
4-C	14.70
1-B	14.83
5-B	14.93
5-C	15.00
1-A	15.03
3-A	15.03
4-A	15.03
5-A	15.17

OXYGEN

1-C	4.33
1-B	4.53
1-A	4.67
2-C	7.13
2-B	7.37
3-A	7.67
3-B	7.93
5-B	7.93
3-C	8.07
5-A	8.13
4-B	8.17
5-C	8.23
4-C	8.33
4-A	8.40
2-A	8.67

NO3

1-A	4.73
1-B	8.17
3-C	10.57
4-C	10.93
1-C	11.33
2-B	11.90
4-A	13.10
5-A	14.17
3-B	14.27
2-C	14.67
4-B	14.97
2-A	16.03
5-C	16.30
5-B	16.67
3-A	18.87

TURBIDITY

1-A	51.0
1-C	52.7
2-A	53.0
2-C	54.0
1-B	55.7
3-C	56.3
4-A	56.3
5-A	57.0
4-B	57.3
3-A	57.7
4-C	58.3
5-C	58.3
5-B	59.0
3-B	59.7
2-B	60.3

NH4

2-A	0.010
2-C	0.010
3-A	0.010
4-A	0.010
4-B	0.010
5-A	0.010
5-B	0.010
2-B	0.017
3-B	0.017
5-C	0.027
4-C	0.033
1-A	0.037
1-C	0.037
3-C	0.040
1-B	0.060

PHOSPHATE

5-B	0.23
3-C	0.27
1-A	0.37
1-C	0.37
2-B	0.37
4-B	0.37
1-B	0.43
2-A	0.43
3-A	0.43
4-A	0.43
5-A	0.43
2-C	0.47
4-C	0.47
5-C	0.47
3-B	0.53

MARCH 12, 1980 CONTINUED.

CONDUCTANCE		PH		FILTER INDEX *	
2-A	339.3	1-C	7.41	1-C	61.7
3-A	354.7	1-B	7.51	5-A	68.3
1-A	358.3	2-C	7.52	2-A	87.3
4-A	364.3	2-B	7.54	4-A	88.3
5-A	369.7	3-C	7.55	5-C	90.0
2-B	393.7	3-B	7.60	1-B	91.7
3-B	395.0	2-A	7.61	5-B	91.7
4-B	406.7	5-C	7.64	2-C	100.0
2-C	409.3	3-A	7.65	4-C	106.6
3-C	411.7	1-A	7.66	2-B	111.0
5-B	418.7	4-C	7.66	3-A	116.7
4-C	420.0	4-B	7.67	4-B	116.7
1-C	422.7	5-B	7.69	3-B	121.7
5-C	437.7	5-A	7.69	3-C	128.3
1-B	442.3	4-A	7.77	1-A	816.7

MARCH 25, 1980 (STATIONS 1-4 ONLY).

A = SURFACE   B = 20' DEPTH   C = BOTTOM

TEMPERATURE

3-C	14.40
2-C	14.43
3-A	14.43
4-B	14.43
2-B	14.47
2-A	14.63
3-B	14.63
4-A	14.63
4-C	14.67
1-C	15.03
1-B	15.27
1-A	15.43

OXYGEN

1-A	7.80
1-B	8.22
1-C	8.39
2-C	8.97
3-A	8.97
2-A	9.07
2-B	9.17
3-B	9.27
3-C	9.43
4-B	9.63
4-C	9.80
4-A	9.87

N03

2-C	14.47
2-A	15.93
3-C	16.17
2-B	17.00
4-B	17.03
3-B	17.43
4-C	17.53
1-B	17.63
1-C	18.10
3-A	18.43
4-A	18.47
1-A	18.97

TURBIDITY

1-B	15.0
2-A	15.0
1-A	15.3
1-C	15.3
2-C	20.3
2-B	21.3
4-C	24.3
4-A	25.3
3-A	26.0
3-C	26.0
3-B	27.3
4-B	28.0

NH4

1-A	0.010
1-C	0.010
2-A	0.010
3-A	0.010
3-B	0.010
4-A	0.010
4-B	0.013
1-B	0.017
2-B	0.017
4-C	0.017
2-C	0.027
3-C	0.030

PHOSPHATE

4-C	0.27
2-A	0.30
3-A	0.30
2-C	0.33
3-C	0.33
4-A	0.33
1-B	0.37
2-B	0.43
3-B	0.43
4-B	0.47
1-A	0.50
1-C	0.53

MARCH 25, 1980 CONTINUED.

CONDUCTANCE		PH	
4-C	306.0	1-A	7.69
3-B	308.3	1-B	7.70
3-C	311.0	1-C	7.72
4-B	315.7	2-C	7.79
4-A	319.7	2-B	7.81
3-A	321.0	2-A	7.82
2-C	330.7	3-A	7.84
2-B	344.3	3-C	7.86
1-C	346.0	3-B	7.88
1-A	354.3	4-A	7.89
1-B	356.0	4-C	7.92
2-A	359.3	4-B	7.93

APRIL 16, 1980

A = SURFACE B = 20' DEPTH C = BOTTOM

TEMPERATURE

4-C	19.97
5-C	20.17
3-C	20.33
5-B	20.47
4-B	20.50
3-B	20.67
2-C	20.83
1-C	21.47
5-A	21.47
1-B	21.63
4-A	21.87
3-A	21.97
2-B	22.10
1-A	23.53
2-A	23.97

OXYGEN

1-A	7.33
2-C	7.33
1-C	7.37
1-B	7.53
2-B	7.77
5-C	7.93
3-B	7.97
3-A	8.03
2-A	8.07
3-C	8.10
5-B	8.20
4-A	8.30
5-A	8.40
4-B	8.50
4-C	8.77

NO3

2-A	6.07
3-C	6.63
2-C	7.63
1-C	8.77
5-A	8.93
4-B	9.40
2-B	9.57
1-A	9.77
3-B	9.87
1-B	11.30
4-A	11.47
3-A	12.03
5-C	12.70
5-B	15.97
4-C	16.13

TURBIDITY

4-A	9.0
2-A	10.0
3-A	10.0
4-B	10.0
4-C	10.0
5-A	10.0
1-A	10.3
3-B	11.0
5-B	12.0
2-B	12.3
3-C	12.3
5-C	12.7
1-B	13.0
2-C	13.7
1-C	15.0

NH4

1-B	0.010
2-A	0.010
2-B	0.010
4-A	0.010
4-C	0.010
1-A	0.013
3-A	0.013
3-B	0.013
4-B	0.013
5-A	0.013
5-C	0.013
5-B	0.017
1-C	0.023
3-C	0.023
2-C	0.033

PHOSPHATE

3-B	0.17
5-C	0.17
2-B	0.27
4-B	0.33
1-A	0.37
3-A	0.37
4-C	0.40
4-A	0.43
1-C	0.47
5-B	0.47
1-B	0.53
2-C	0.53
3-C	0.63
2-A	0.73
5-A	0.77

APRIL 16, 1980 CONTINUED.

CONDUCTANCE

5-C	275.7
1-B	284.0
4-C	286.0
2-B	286.3
3-C	293.7
5-A	298.3
2-C	298.7
2-A	302.7
3-A	303.3
1-A	303.7
1-C	306.3
4-A	311.3
5-B	329.7
4-B	330.0
3-B	340.0

PH

2-B	7.92
1-B	7.97
2-C	7.97
1-A	8.00
1-C	8.05
3-C	8.06
5-B	8.09
3-A	8.16
4-B	8.16
2-A	8.16
5-C	8.18
4-C	8.18
3-B	81.9
4-A	8.20
5-A	8.21

MAY 20, 1980

A = SURFACE   B = 20' DEPTH   C = 40' DEPTH   D = BOTTOM

TEMPERATURE

2-B	14.43
1-C	14.63
3-A	14.63
2-C	14.83
4-B	14.83
1-B	14.87
3-D	14.93
4-C	14.93
2-A	15.03
4-A	15.03
1-A	15.06
3-B	15.13
4-D	15.23
3-C	15.37
1-D	15.43
2-D	16.10
5-C	19.43
5-B	19.53
5-D	19.73
5-A	19.80

OXYGEN

2-A	6.37
2-D	7.40
3-C	7.80
2-B	7.83
3-D	8.03
1-D	8.37
2-C	8.40
1-C	8.63
4-C	8.70
1-B	8.93
3-A	8.93
4-B	8.97
3-B	9.30
4-A	9.37
1-A	9.57
4-D	9.63
5-D	10.47
5-C	11.00
5-B	11.47
5-A	12.43

NO3

1-C	8.07
2-C	8.37
4-A	8.43
3-B	8.63
5-B	8.80
2-A	8.93
3-C	9.43
1-B	9.60
5-A	9.63
2-B	9.90
4-B	9.90
3-A	10.07
1-A	11.43
5-C	13.43
2-D	13.63
1-D	14.63
4-C	14.63
3-D	15.83
4-D	19.73
5-D	21.60

TURBIDITY

2-A	9.3
4-B	9.3
5-A	9.7
4-A	10.3
5-C	11.3
4-C	11.6
5-B	11.7
2-C	13.0
3-B	13.3
2-B	13.7
1-A	14.0
1-C	14.7
3-A	14.7
1-B	16.0
3-C	18.7
4-D	19.3
5-D	26.3
1-D	28.7
3-D	37.0
2-D	39.7

NH4

1-A	0.010
1-B	0.010
1-C	0.010
2-C	0.010
3-A	0.010
3-B	0.010
3-C	0.010
4-A	0.010
4-B	0.010
5-B	0.010
5-A	0.017
5-C	0.020
2-A	0.023
1-D	0.033
2-B	0.033
3-D	0.043
4-C	0.060
2-D	0.063
5-D	0.063
4-D	0.090

PHOSPHATE

2-A	0.17
4-A	0.27
1-B	0.33
5-B	0.33
3-A	0.37
1-A	0.40
5-C	0.40
2-C	0.47
3-C	0.47
5-A	0.47
4-C	0.50
1-C	0.57
2-B	0.60
4-B	0.60
3-B	0.63
1-D	0.83
5-D	0.83
2-D	0.93
4-D	0.93
3-D	1.07

MAY 20, 1980 CONTINUED.

CONDUCTANCE

5-B	295.7
4-A	299.3
3-A	305.7
5-C	305.7
1-C	309.3
5-A	310.0
1-A	313.0
3-B	315.7
4-B	315.7
1-D	318.7
4-D	319.3
1-B	319.7
4-C	320.3
3-C	320.7
2-B	328.7
5-D	333.3
2-C	334.3
2-A	344.3
3-D	344.3
2-D	360.7

PH

1-B	7.90
1-C	7.94
2-C	7.99
1-A	8.01
2-B	8.01
2-A	8.08
5-C	8.11
4-C	8.16
5-A	8.16
3-B	8.17
4-B	8.17
5-B	8.18
3-C	8.19
3-A	8.19
4-D	8.20
4-A	8.20
5-D	8.30
2-D	8.31
3-D	8.36
1-D	8.41

JUNE 10, 1980

A = SURFACE B = 20' DEPTH C = 40' DEPTH D = BOTTOM

TEMPERATURE

1-D	17.93
2-C	18.17
1-C	18.37
2-B	18.43
2-A	18.57
1-B	18.60
3-C	19.30
2-D	19.33
4-D	19.37
5-D	19.37
3-B	19.57
5-C	19.60
4-C	19.63
3-D	19.73
1-A	19.80
3-A	19.83
4-B	20.07
4-A	20.17
5-B	20.23
5-A	20.53

OXYGEN

1-D	6.93
4-D	8.10
1-B	8.27
3-C	8.40
4-C	8.43
1-C	8.60
1-A	8.63
3-D	8.83
2-B	8.90
2-C	9.00
3-B	9.03
3-A	9.07
5-B	9.07
2-A	9.20
2-D	9.27
5-C	9.40
5-A	9.57
4-B	9.60
5-D	9.80
4-A	9.83

NO3

5-A	8.40
1-A	8.63
1-B	8.90
4-A	9.00
5-B	9.10
2-A	9.17
3-B	9.57
1-C	9.60
2-B	10.57
3-A	10.63
5-C	10.80
4-B	11.47
3-C	12.07
4-C	14.10
2-C	14.50
1-D	14.63
3-D	16.83
5-D	19.10
2-D	19.13
4-D	23.07

TURBIDITY

1-C	13.7
2-A	14.3
2-C	16.3
5-A	16.7
5-B	18.3
4-B	18.7
2-B	19.0
1-B	19.3
5-C	19.3
5-D	19.3
3-B	21.0
4-A	22.3
4-C	24.0
3-A	26.3
1-A	27.3
3-C	29.3
2-D	33.3
3-D	37.0
4-D	37.0
1-D	40.0

NH4

1-A	0.010
2-A	0.010
2-B	0.010
2-D	0.010
3-B	0.010
3-C	0.010
4-A	0.010
4-B	0.010
5-A	0.010
5-B	0.010
3-A	0.017
1-C	0.027
5-C	0.033
4-C	0.037
4-D	0.037
5-D	0.040
1-B	0.043
2-C	0.043
3-D	0.047
1-D	0.060

PHOSPHATE

4-B	0.33
1-A	0.37
2-A	0.37
3-B	0.37
4-A	0.40
1-C	0.43
3-C	0.43
5-A	0.47
1-D	0.53
1-B	0.57
4-C	0.60
2-B	0.63
3-A	0.63
5-C	0.63
5-B	0.70
3-D	0.83
2-C	0.93
4-D	0.93
5-D	0.93
2-D	1.10

JUNE 10, 1980 CONTINUED

CONDUCTANCE

1-A	190.0
1-B	194.3
3-A	194.3
3-B	197.3
5-A	198.0
3-C	199.3
5-B	200.7
1-C	204.0
5-C	205.3
3-D	207.7
5-D	213.0
2-C	216.3
4-A	216.3
1-D	217.0
2-A	219.0
4-B	219.7
2-B	220.3
4-C	221.3
4-D	233.7
2-D	240.0

PH

1-C	7.89
1-B	7.90
1-A	7.92
1-D	7.95
2-A	8.00
3-B	8.00
2-B	8.03
3-C	8.03
3-A	8.05
3-D	8.05
2-D	8.06
2-C	8.10
4-C	8.21
4-A	8.24
4-B	8.26
5-B	8.26
5-A	8.27
5-C	8.27
5-D	8.28
4-D	8.31

APPENDIX C

VEGETATION OF LAGUNA LAKE

APPENDIX C - VEGETATION OF LAGUNA LAKE

Vegetation of the Shoreline

Raphanus sativus
Potentilla anserina
Spergula arvensis
Salix lasiolepis
Scirpus acutus
Polygonum coccineum
Malva parviflora
Silybum marianum
Brassica campestris
Medicago hispida
Lupinus bicolor
Plantago major
Lotus corniculatus
Lotus purshianus
Mentha arvensis
Polypogon monspeliensis
Polypogon maritimus
Stachys ajugoides
Hemizonia parryi
Sonchus oleraceus
Cirsium edule
Populus fremontii
Erigeron canadensis
Lippia nodiflora
Gnaphalium luteo-album
Lythrum hyssopifolia
Atriplex patula
Baccharis pilularis

Vegetation of the Marsh

Raphanus sativa
Potentilla anserina
*Scirpus acutus
*Polygonum coccineum
Brassica campestris
Medicago hispida
Rumex crispus
Rumex fueginus
Plantago lanceolata
Plantago major
Polypogon maritimus
Cyperus eragrostis
Epilobium watsonii
Sonchus oleraceus
Melilotus indica
Cirsium edule

* Dominant species for this particular habitat.

APPENDIX D

FAUNA OF LAGUNA LAKE AREA

APPENDIX D - FAUNA OF LAGUNA LAKE AREA
(Exclusive of Birds)

<u>Animals of Open Field Area</u>

- Reptiles and Amphibians -
  - Western Fence Lizard
  - Garter Snake
  - Gopher Snake
- Mammals -
  - Cottontail Rabbit
  - Black-tailed Jackrabbit
  - Black-tailed Deer
  - Pocket Gopher
  - California Ground Squirrel
  - Mouse
  - Rat
  - Mole
  - Shrew

<u>Animals of Shoreline Area</u>

- Reptiles and Amphibians -
  - Pacific Tree Frog
  - Garter Snake
  - Alligator Lizard
- Mammals -
  - Opossum
  - Broad-handed Mole
  - Raccon
  - Cottontail Rabbit
  - Mouse
  - Striped Skunk

<u>Animals of Marsh and Open Lake</u>

- Reptiles and Amphibians -
  - Bullfrog
  - Red-legged Frog
  - Western Aquatic Garter Snake
- Mammals -
  - Muskrat

<u>Fish (most commonly found)</u>

Blue Gill	Lepomis macrochirus
Largemouth Bass	Micropterus salmoides
Rainbow Trout	Salmo gairdneri
Black Crappie	Pomoxis nigromaculatus
Brown Bullhead	Ictalurus nebulosus
Brook Trout	Salvelinus fontinalis
Green Sunfish	Lepomis cycinellus
Golden Shiner	Notemigonus crysoleucas
Mottled Sculpin	Cottus bairdi

APPENDIX E

LAGUNA LAKE SEDIMENTATION RATE

LAGUNA LAKE SEDIMENTATION RATE ANALYSIS

The accumulation rates of sediment inflow to various parts of Laguna Lake are important to lake management in that they will determine the location, time interval, costs, and necessity of future dredging that might be required to maintain adequate depth and/or the location and costs of siltation control devices. In this analysis, sedimentation rates were determined primarily by comparing water depths measured by the City in 1956 with lake bottom topography determined from aerial photographs taken in September 1977 when the lake was almost completely dry. This 21-year time span was considered extensive enough to yield reasonably accurate annual sedimentation rates.

Methodology

Use of the 1956 depth data required an estimate of the water level elevation as this datum elevation was not determined and incorporated into the data and the original reference point utilized no longer exists as a result of development adjacent to the lake. Comparison of the lake configuration in the western end of the lake between the 1956 and 1977 photographs and data suggest that the water elevation was at its normal height (+118 feet Mean Sea Level) in 1956 at the time of data collection.

The City of San Luis Obispo had previously attempted to correlate the 1977 topography with the 1956 depth data, and using a different datum estimated that there was approximately 5 feet of uniform siltation throughout the lake during the 21-year time span. Given the shallowness of the lake, the relatively small watershed, the gentle relief in the immediate area of the lake, and the tendency of material to sediment rapidly at the point of entry to a lake and form deltas, it is unlikely that the lake bottom could uniformly rise 5± feet in 21 years and also maintain similar bottom and shoreline configurations.

Other methods of estimating sedimentation within the lake using rainfall data, peak runoff coefficients and bulking factors did not yield reasonable results as compared to the metodology discussed above. This was due primarily to the lack of site specific information about the watersheds.

Analysis

The diversion of Prefumo Creek into the lake in late 1963/ early 1964 must be considered in estimating sedimentation rates. Prior to this diversion, flow into the lake was limited to the eastern Los Osos Valley (7.8± suare miles) and Sycamore Canyon (0.9± sq. mi.). The addition of Prefumo Canyon (3.9± sq. mi.) represented only a moderate increase (45%) in the total drainage area, but a major increase (430%) in the steep sedimentary terrain of the Irish Hills that contributes the larger proportion of sediment to local streams.

Because of water flow patterns, the area westerly of Prefumo Inlet can be assumed to be relatively unaffected by sediment transported by Prefumo Creek. The average change in depth in this part of the lake has been approximately 0.5 feet in the 21-year period, or 0.02 feet/year. This sedimentation would be the result of siltation of fine clays transported to the lake from drainages other than Prefumo Canyon and the accumulation of organic debris on the bottom. These materials can be expected to settle fairly uniformly over the entire open lake bottom.

A greater amount of sedimentation (approximately 1.0 feet in 21 years) occurred easterly of the Prefumo Inlet. As 0.5 feet of this sediment was probably the result of natural lake-filling processes, as seen in the western portion of the lake, the other 0.5 feet was contributed by Prefumo Creek in the 13-year time interval from its diversion to the lake. The rate from this source is about 0.04 feet/year, and the total sedimentation rate within the eastern portion of the lake is about 0.06 feet/year.

Accumulations in the Prefumo Inlet and the adjacent part of the lake have been much more rapid, and a recognizable delta has begun to form in the lake next to the inlet. Depth changes at the delta have averaged approximately 3.3 feet in the 13-year period or 0.25 feet/year. Changes in the inlet are more variable because the coarse sediment (mostly gravel) deposited there is transported primarily during floods. Long-term rates are probably of the order of 0.5 feet/year, but several feet may accumulate in a single season. An approximation of the sedimentation rate within the Prefumo Inlet has been based on a 1973 estimate that 73,000 cubic yards of material would have to be removed to restore this area to its prior configuration (Letter from Paul Landell, Jr., civil engineer for the City, to Richard Miller, 25 September 1973; re: Lake Dredging). This yields an accumulation rate of 8,000 cu. yds./yr. within the inlet (73,000 cu. yds./ 9 years).

The estimated annual sedimentation within Laguna Lake is summarized in Table 1. The relatively low sedimentation rates within the lake can be attributed to the following factors: 1) eroded material entering the lake is composed primarily of clay due to the lithology of the area; 2) the clay particles tend to stay in suspension and would therefore not have the opportunity to be deposited in the lake but rather would be "flushed out" along with the lake outflow; and 3) the gently sloping, densely vegetated terrain that borders the western portion of the lake is likely to result in the removal of a significan quantity of debris from runoff before it reached the deep water part of the lake.

It should be noted that the estimate of sedimentation resulting from the Prefumo Canyon drainage in this analysis is similar to the annual average sediment production from Prefumo Canyon estimated by George S. Nolte and Associates for the purpose of designing a debris basin in the canyon (Flood Control and Drainage Master Plan for the San Luis Obispo Creek Watershed, August 1977). This value was used as a comparison check on the methodologies employed to obtain sedimentation rates in the lake.

Table 1. Summary of Annual Sedimentation within Laguna Lake

	Sedimentation Rate (ft/yr)	Area (acres)	Annual Sedimentation (cu yd)
A. Source			
Natural Drainage	0.02	100	3000
Prefumo Drainage			
1. Easterly Portion of Lake	0.04	60	4000
2. Prefumo Delta (Central Lake)	0.25	1.2	500
3. Prefumo Inlet	--	--	8000
		TOTAL:	15,500
B. Location of Accumulation			
Western Portion	0.02	40	1000
Eastern Portion	0.06	60	6000
Prefumo Delta	0.25	1.2	500
Prefumo Inlet	--	--	8000
		TOTAL:	15,500

APPENDIX F

LAGUNA LAKE SOILS EVALUATION

Central Coast Laboratories
396 BUCKLEY ROAD · 544-3276
SAN LUIS OBISPO, CALIFORNIA 93401

SOIL MECHANICS
FOUNDATION ENGINEERING

June 20, 1980

PROJECT: EVALUATION OF SOILS WITHIN THE UPPER FIVE FOOT PROFILE OF THE LAGUNA LAKE BOTTOM. CC04333

REQUESTED BY: Mr. Don Asquith, Geologist, Envicom Corporation

In accordance with the request of the above named client, there is submitted herewith the results of our laboratory tests and sampling of soils within the Laguna Lake area as depicted on the enclosed site map. It is the intent of this report to generally identify the physical properties of the soils, their suitability for use for agricultural purposes or construction purposes, and to provide general information as to the feasibility of removing these materials from within the lake area.

During the month of May, a total of ten locations were sampled to evaluate the general characteristics of the clays within the lake bottom. In order to adequately sample the soils within the upper profile, it was necessary to gain access to the lake with a wet suit and all samples were obtained with the utilization of hand augers.

After the samples were brought into the laboratory, they were tested for grain size by utilizing methods of mechanical analysis, including washing and sieving as well as hydrometer procedures. A summary of the sample location, depth of sample, soil type, and plastic and grain size characteristics is included within the text of this report of all of the typical materials sampled.

Gradation curves are included in the Appendix of this report which depict the grain size in microns as related to the percent passing the various sizes of sieves. In addition, a direct shear test was performed on one typical sample taken from the north shore to determine the angle of internal friction and the unit cohesion of these materials. This sample was run in a drained condition; and consequently, the angle of internal friction is not particularly applicable insofar as strength characteristics are concerned. The most realistic characteristic of these clay soils would be a value of approximately 20 pounds per square foot of cohesion.

In general, it can be concluded that the clay soils which are substantially away from the mouth of Perfumo Creek are of little value for agricultural purposes or for any utilization insofar as fills are concerned. It should be pointed out that these soils are approximately 90 percent clay sizes, have a plastic index of 63, and a liquid limit of 111. These soils can be expected to expand from a wet to dry condition in the vicinity of 20 to 30 percent, will experience extreme shrinkage cracking when drying, and will probably develop expansion pressures if totally restrained in the vicinity of 10,000 pounds per square foot. Those soils in the vicinity of the river mouth depicted by test areas 4 through 10 are predominately silty sands to sandy silts. These soils would be suitable for possible fill materials, and of some agricultural use. As can be seen, the plastic index is 8 as compared to 63 in the clay soils and the liquid limit is 35 as compared to 111.

Based on this limited study, it appears as if there is no reasonable use for the major portion of the material that may be excavated from the lake with the exception of that area in the vicinity of the mouth of Perfumo Creek. In reviewing the general characteristics of the clays in the vicinity of the lake bottom as is representative over most of the lake area, it becomes apparent that these materials will seek their own level in a period of time, and excavation of the lake bottom adjacent to the existing residences would probably result in land creep of the fill soils which have been placed to construct the residences. The question as to how far from the toe of the existing bank should an excavation be made in order to assure the City that this will not have an adverse effect on the stability of the existing homes and their lots is still not totally clear. The shear strength data and the analysis of this problem is quite complex and it will require a comprehensive study. Based on the very limited data that we have, I would suggest that any excavations be made with a very flat slope (between 5 and 10 percent) and that no slopes be started closer than 30 feet from the existing shorelines where residences are constructed. The reader should be advised that this is only an educated guess at this time; however, I feel that some indication should be given to the committee reviewing this issue so that consideration for further study or a conservative approach can be taken.

Insofar as dredging of the lake is concerned, it should be pointed out that there are various small dredges which can be purchased by a municipality for purposes of maintaining minimal depths of water in impoundments such as this. In general, the area where such dredging is stockpiled or disposed of should be an area which will be not intended for use for any subsequent construction or agricultural purposes.

It has been the intent of this report to basically identify the characteristics which are predominate in the study area and to generally point out any potential hazards which may develop as a result of excavation of the lake itself. Under no consideration should excavation be considered adjacent to the existing lake shore where homes are now built without a very detailed stability study of this issue. In the event that you would wish to pursue this issue in further detail, please feel free to contact this office at your convenience.

Respectfully submitted,

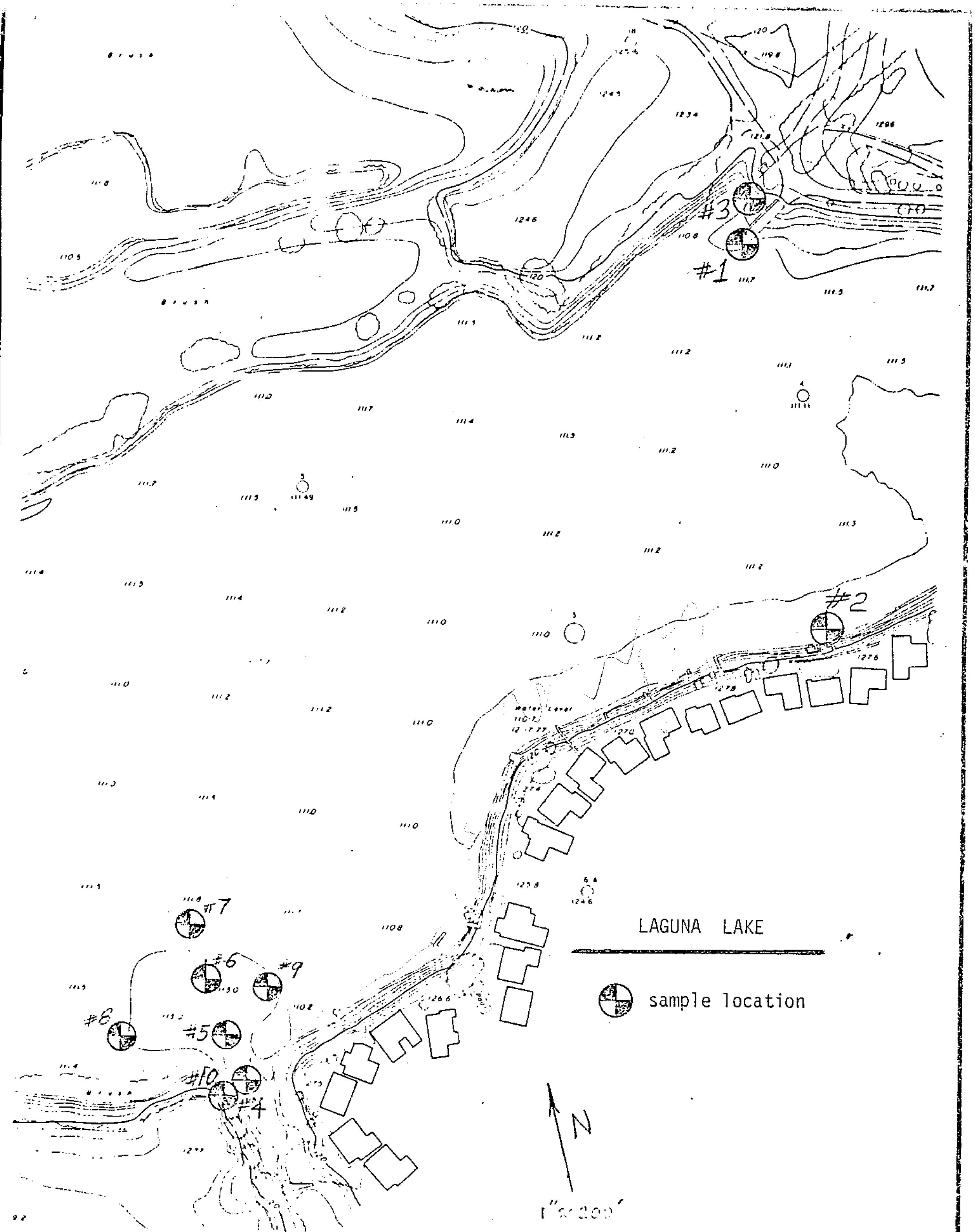
CENTRAL COAST LABORATORIES

Robert E. Williams, Consulting Engineer
Soil Mechanics and Foundations

REW:jak

LAGUNA LAKE SOIL SAMPLES

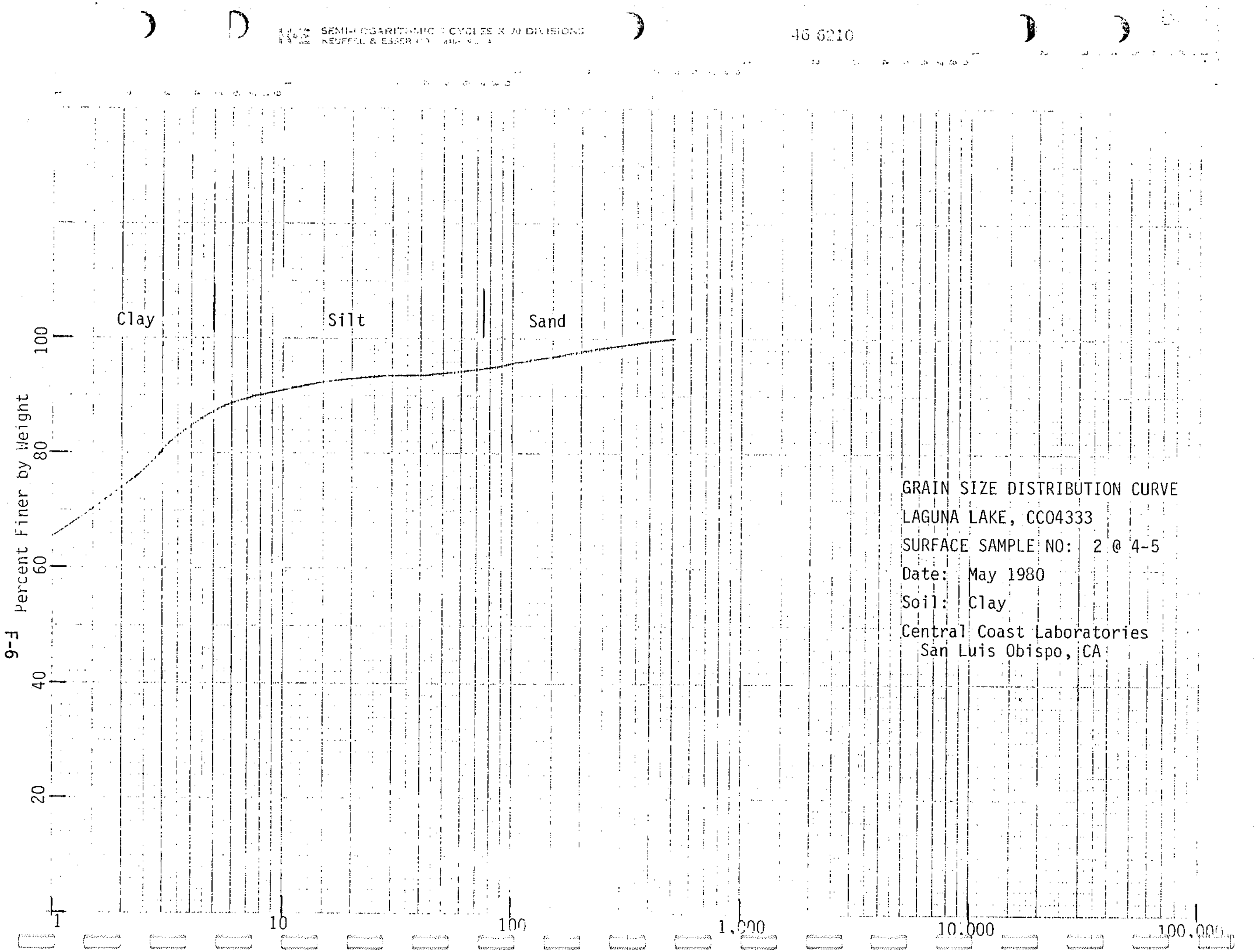
Descriptive Location	Sample No.	Depth Below Lake Bottom	Soil Type	Soil Test Data
North Shore	1	0'-1'	CLAY	-----
South Shore	2A	0'-0.5'	CLAY	-----
South Shore	2B	1'-2'	CLAY	-----
South Shore	2C	3'-4'	CLAY	-----
South Shore	2D	4'-5'	CLAY	3% sand, 7% silt, 90% clay, plastic index = 63 liquid limit = 111 plastic limit = 48
North Shore	3	0'-1'	CLAY	Angle of internal friction Peak: 15° Ultimate: 12° Cohesion, Peak: 30 psf Ultimate: 22 psf
River Mouth	4	0'-1'	SILTY SAND	50% sand, 40% silt, 10% clay
100' North of River Mouth	5	0'-1'	SILTY SAND	46% sand, 44% silt, 10% clay
200' North of River Mouth	6	0'-1'	SANDY SILT	18% sand, 67% silt, 15% clay
300' North of River Mouth	7	0'-1'	SANDY SILT	25% sand, 62% silt, 13% clay
200' Northwest of River Mouth	8	0'-1'	SANDY SILT	-----
200' Northeast of River Mouth	9	0'-1'	SANDY SILT	-----
River Mouth (near shore)	10	0'-1'	SANDY SILT	31% sand, 54% silt, 15% clay Plastic Index = 8 Liquid Limit = 35 Plastic Limit = 27

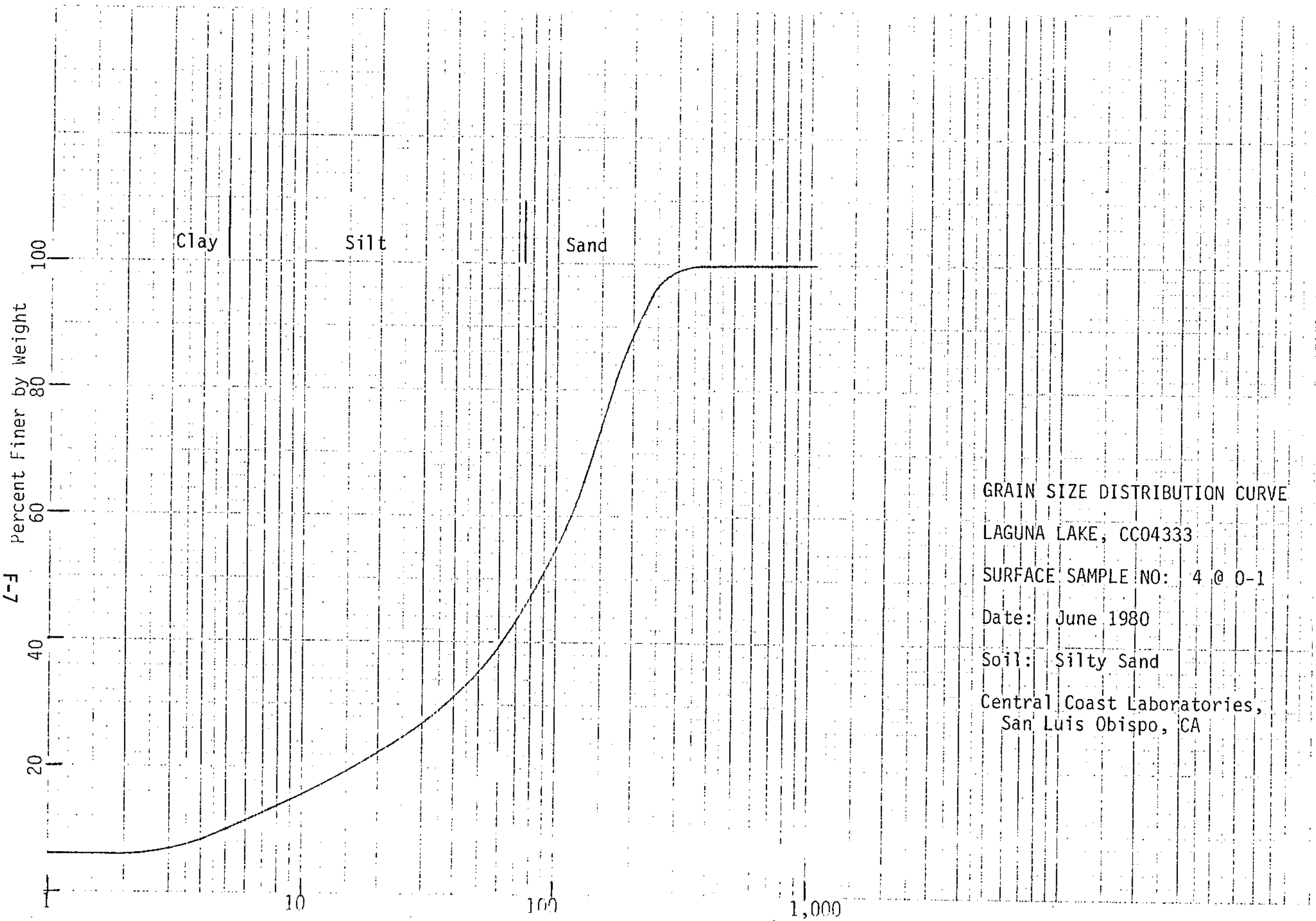


CENTRAL COAST LABORATORIES

SOIL MECHANICS · FOUNDATION ENGINEERING

396 BUCKLEY RD. SAN LUIS OBISPO, CA 93401 / 805-544-3276


SEMI-LOGARITHMIC 5 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO.
46 6210
Clay
Silt
Sand
Percent Finer by Weight
100
80
60
40
20
1
10
100
1,000
10,000
100,000
GRAIN SIZE DISTRIBUTION CURVE
LAGUNA LAKE, CC04333
SURFACE SAMPLE NO: 2 @ 4-5
Date: May 1980
Soil: Clay
Central Coast Laboratories
San Luis Obispo, CA



GRAIN SIZE DISTRIBUTION CURVE

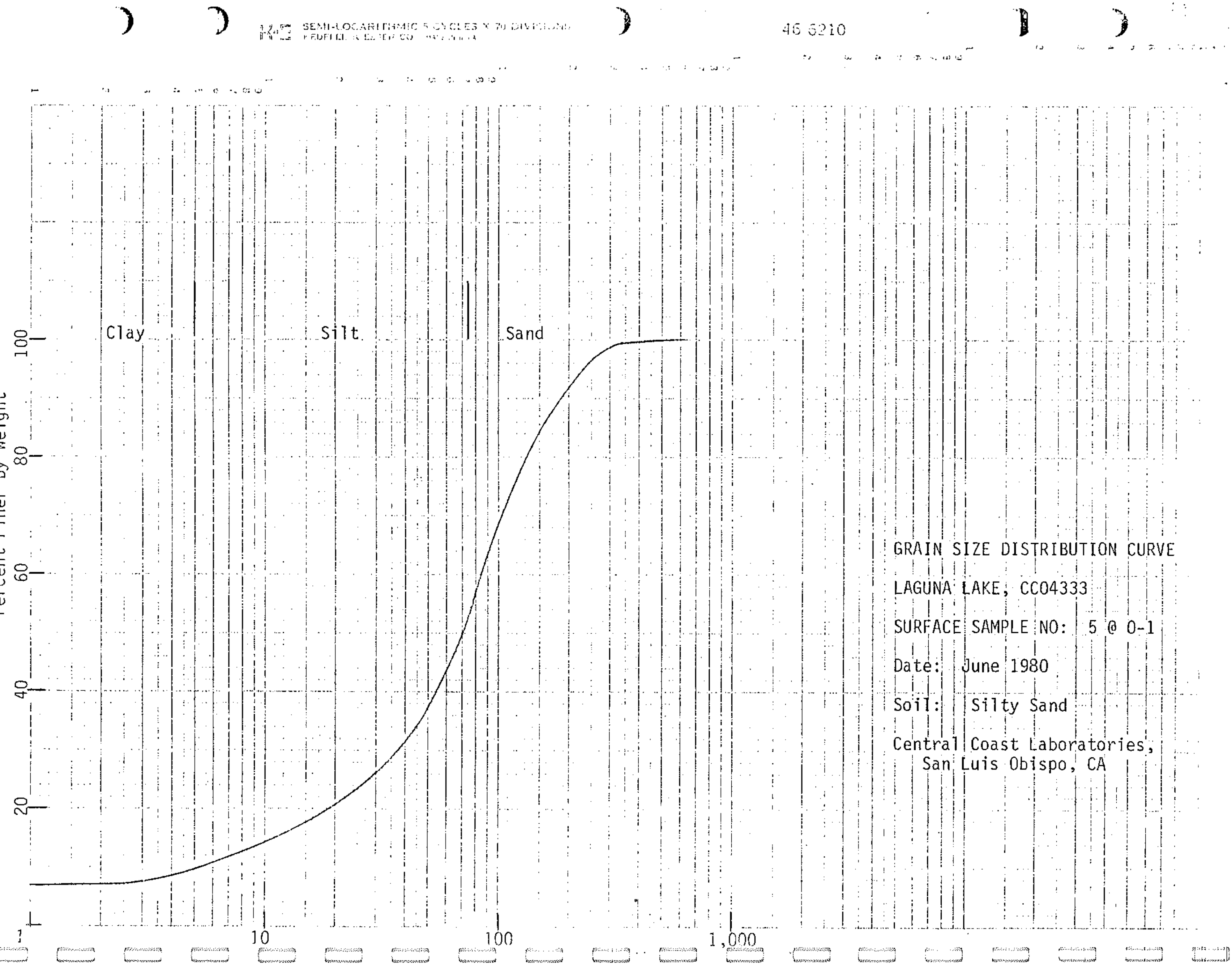
LAGUNA LAKE, CC04333

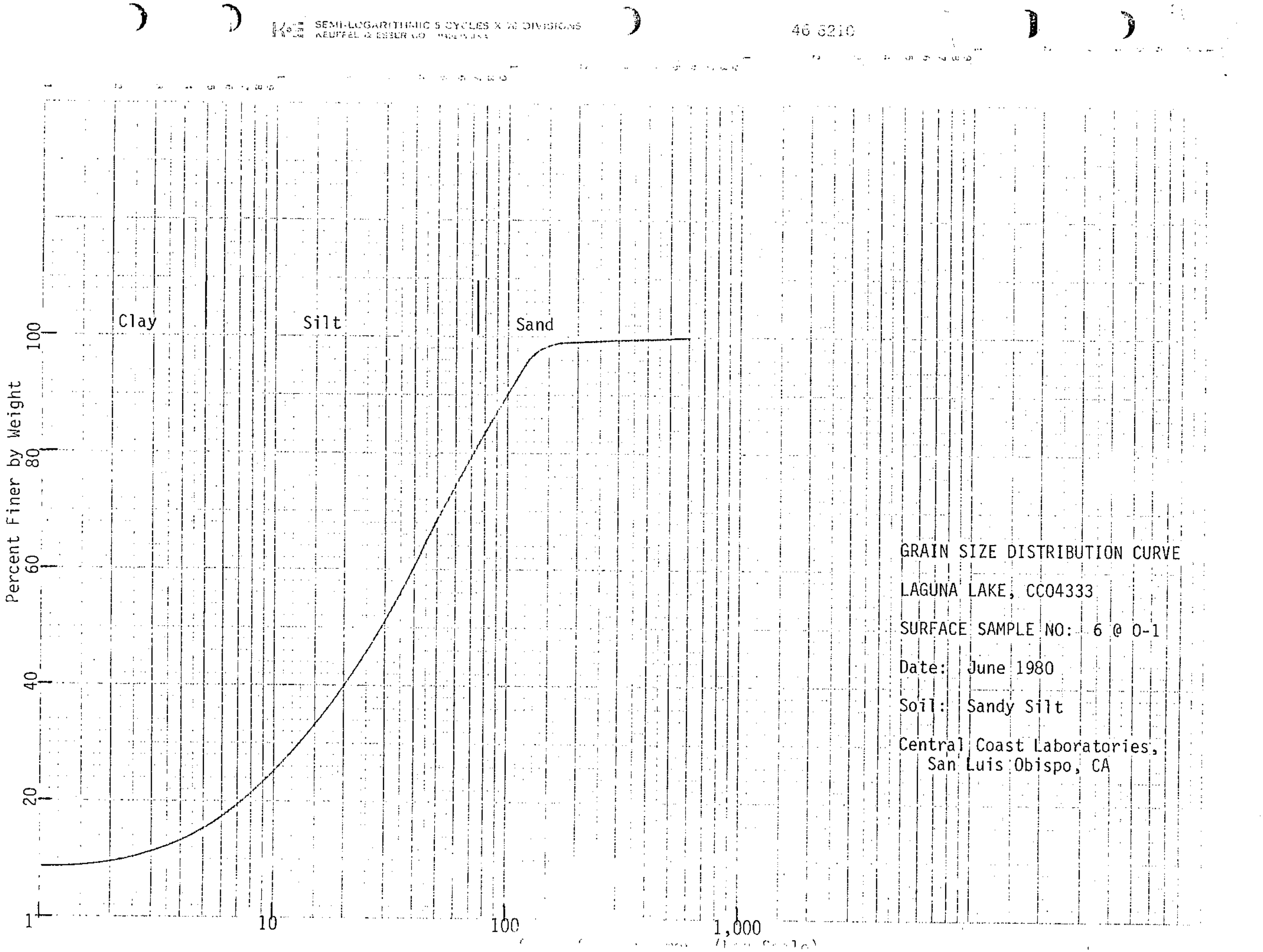
SURFACE SAMPLE NO: 4 @ 0-1

Date: June 1980

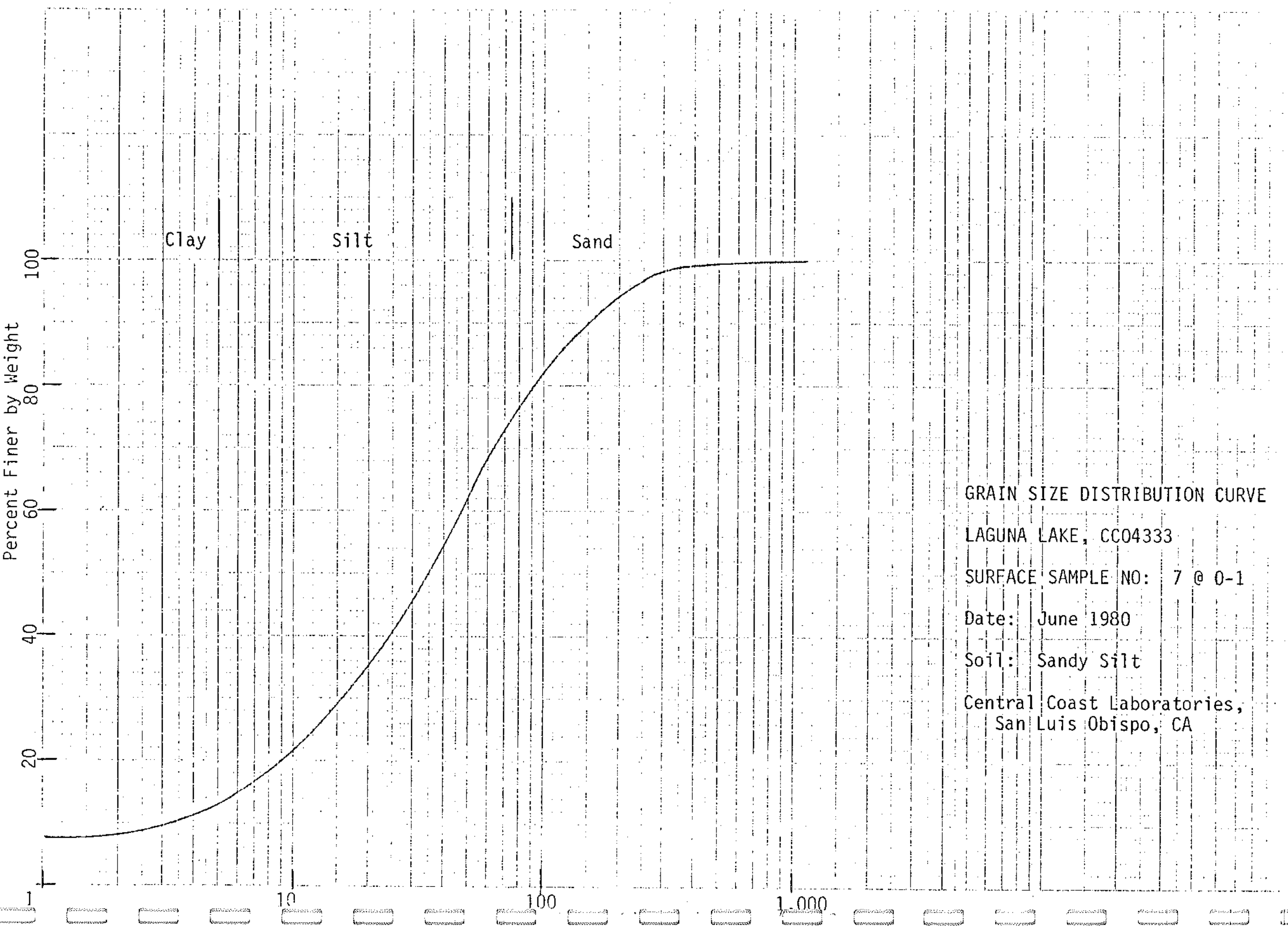
Soil: Silty Sand

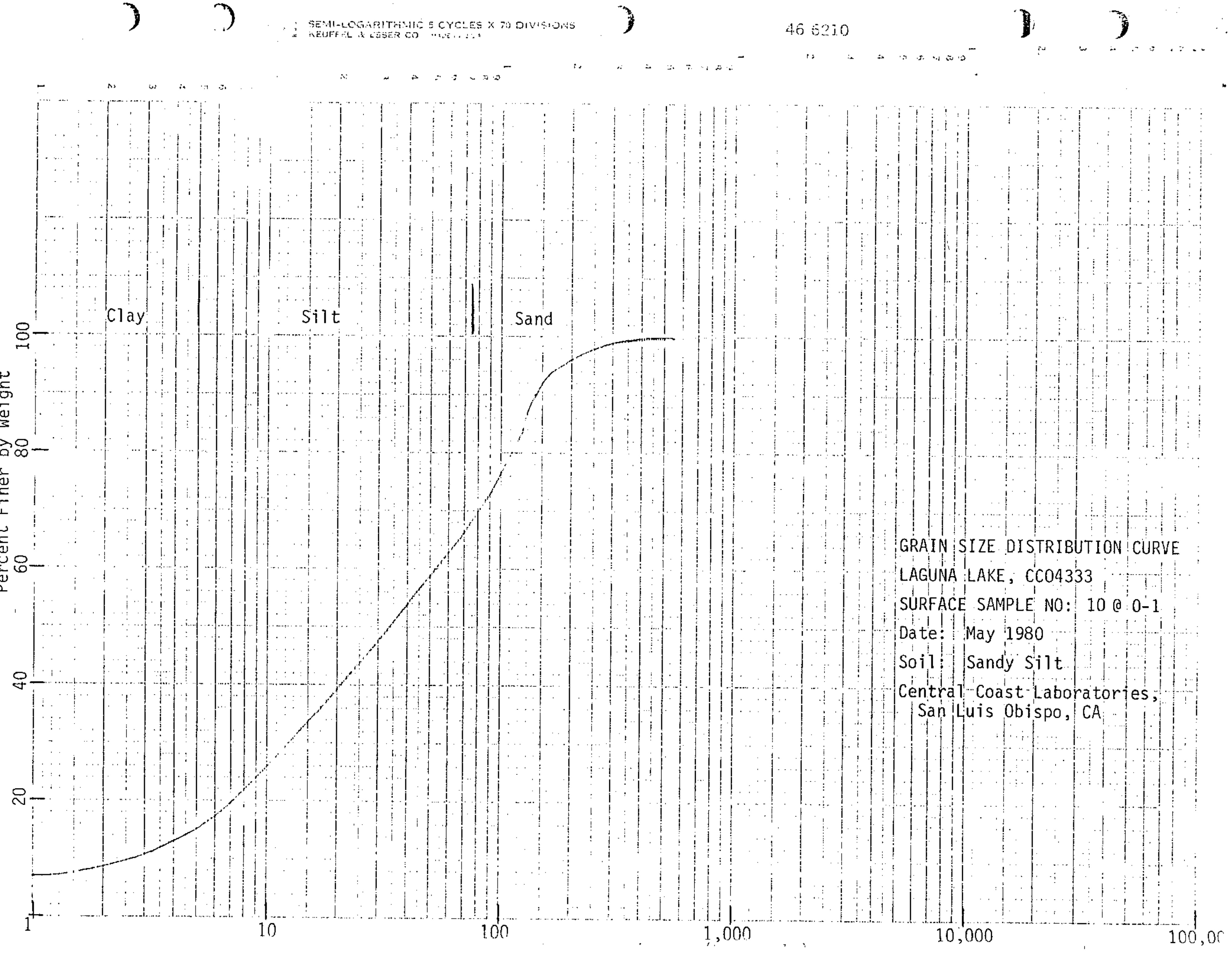
Central Coast Laboratories,
San Luis Obispo, CA

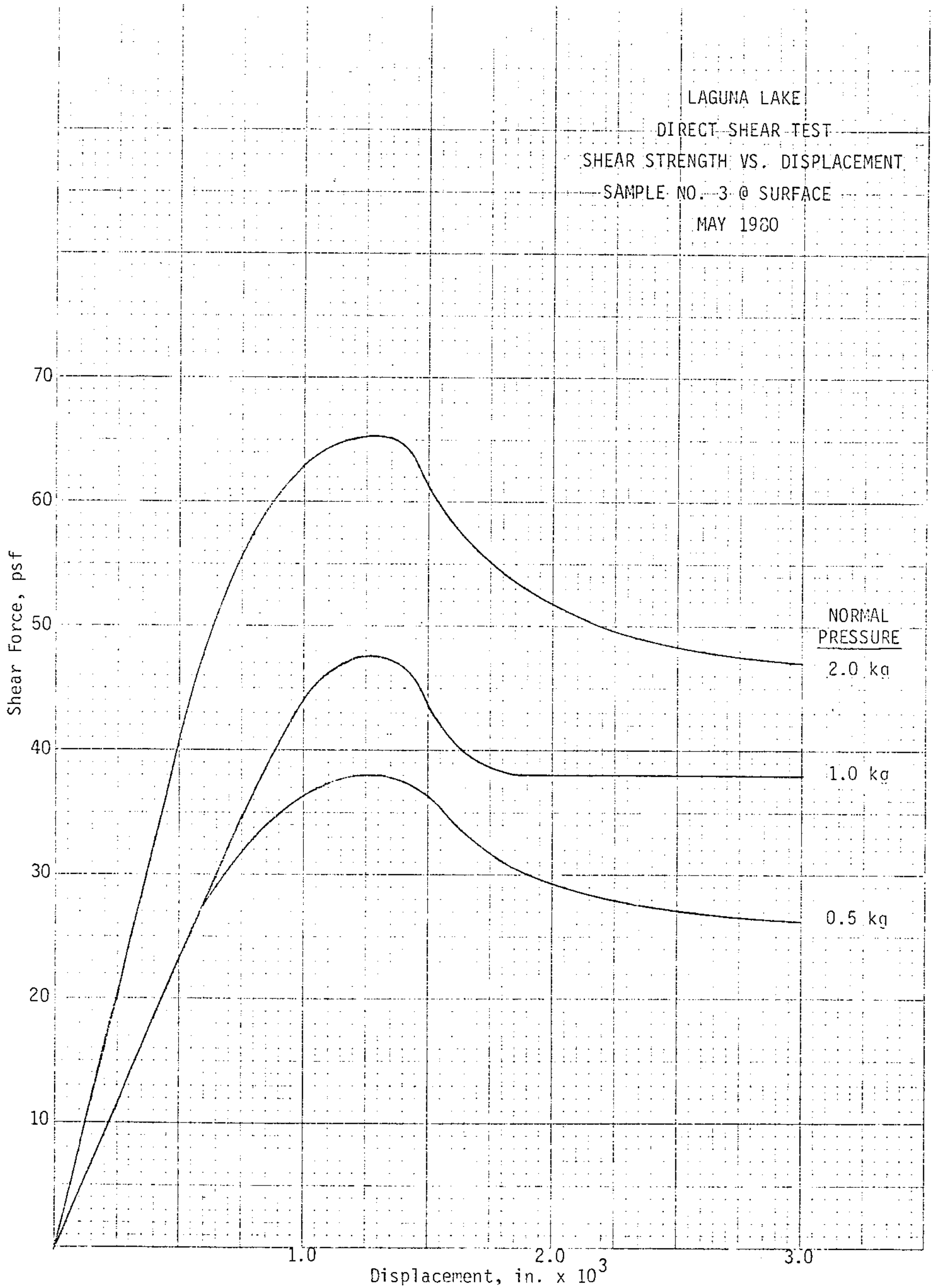

SEMI-LOGARITHMIC 5 CYCLES X 70 DIVISIONS
46 6210
Clay
Silt
Sand
Percent Finer by Weight
100
80
60
40
20
1
10
100
1,000
GRAIN SIZE DISTRIBUTION CURVE
LAGUNA LAKE, CC04333
SURFACE SAMPLE NO: 5 @ 0-1
Date: June 1980
Soil: Silty Sand
Central Coast Laboratories,
San Luis Obispo, CA

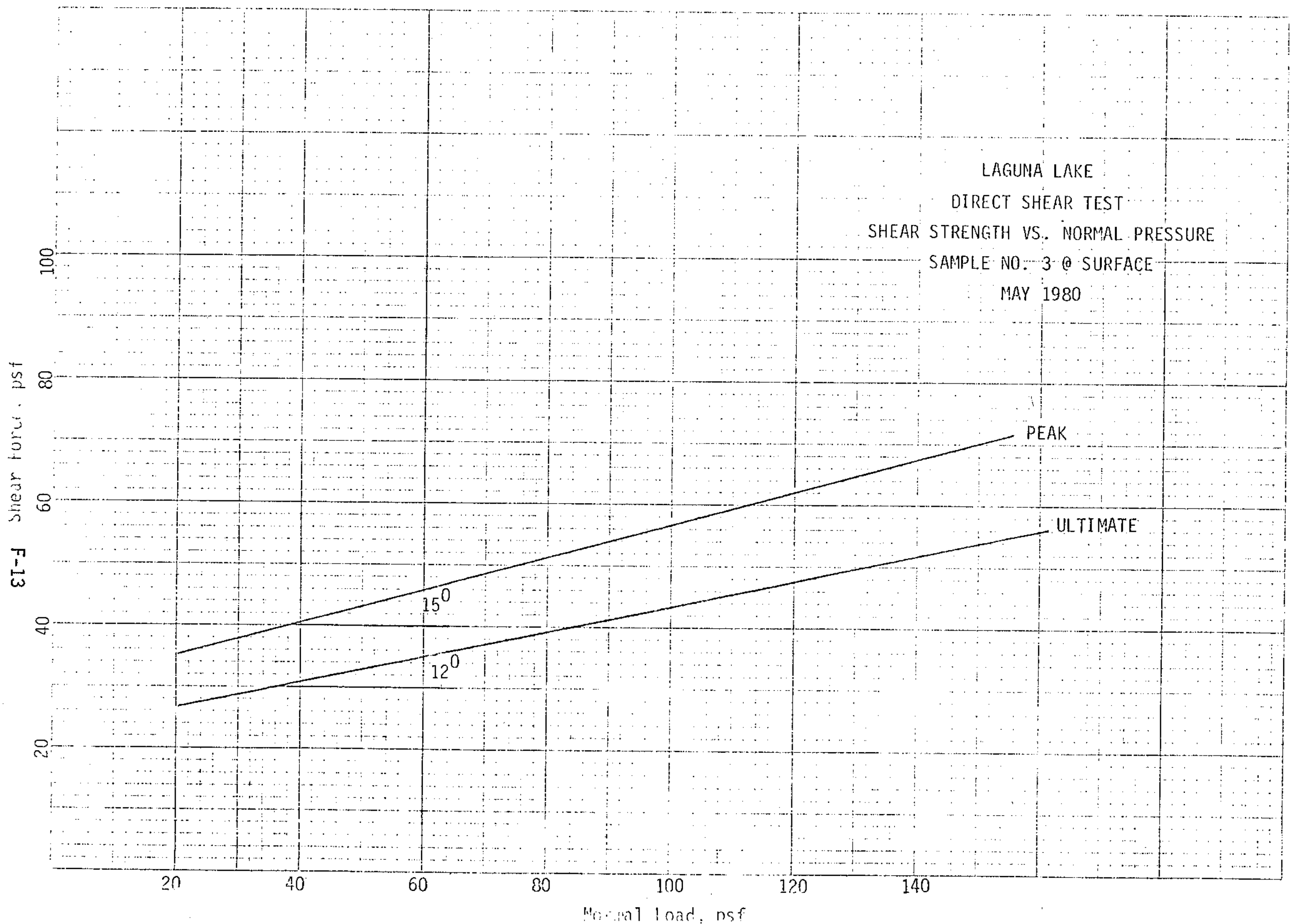

K&E SEMI-LOGARITHMIC 5 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO.
46 6210
Clay
Silt
Sand
Percent Finer by Weight
100
80
60
40
20
1
10
100
1,000
GRAIN SIZE DISTRIBUTION CURVE
LAGUNA LAKE, CC04333
SURFACE SAMPLE NO: 6 @ 0-1
Date: June 1980
Soil: Sandy Silt
Central Coast Laboratories,
San Luis Obispo, CA

46 6210


Clay
Silt
Sand
Percent Finer by Weight
100
80
60
40
20
1
10
100
1,000
GRAIN SIZE DISTRIBUTION CURVE
LAGUNA LAKE, CC04333
SURFACE SAMPLE NO: 7 @ 0-1
Date: June 1980
Soil: Sandy Silt
Central Coast Laboratories,
San Luis Obispo, CA


SEMI-LOGARITHMIC 5 CYCLES X 70 DIVISIONS
KEUFFEL & ESSER CO.
46 6210
Clay
Silt
Sand
Percent Finer by Weight
100
80
60
40
20
1
10
100
1,000
10,000
100,00
GRAIN SIZE DISTRIBUTION CURVE
LAGUNA LAKE, CC04333
SURFACE SAMPLE NO: 10 @ 0-1
Date: May 1980
Soil: Sandy Silt
Central Coast Laboratories,
San Luis Obispo, CA


LAGUNA LAKE
DIRECT SHEAR TEST
SHEAR STRENGTH VS. DISPLACEMENT
SAMPLE NO. 3 @ SURFACE
MAY 1980
Shear Force, psf
70
60
50
40
30
20
10
NORMAL PRESSURE
2.0 kg
1.0 kg
0.5 kg
1.0
2.0
3.0
Displacement, in. x 10^3



LAGUNA LAKE
DIRECT SHEAR TEST
SHEAR STRENGTH VS. NORMAL PRESSURE
SAMPLE NO. 3 @ SURFACE
MAY 1980
PEAK
ULTIMATE
15°
12°
20
40
60
80
100
120
140
Normal load, psf
Shear Force, psf

F-13

APPENDIX G

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL COAST REGION

WASTE DISCHARGE REQUIREMENTS FOR CITY OF SAN LUIS OBISPO
WASTEWATER TREATMENT PLAN

STATE OF CALIFORNIA — RESOURCES AGENCY

EDMUND G. BROWN JR., Governor

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD—
CENTRAL COAST REGION
1102 A LAUREL LANE
SAN LUIS OBISPO, CALIFORNIA 93401
(805) 549-3147

February 13, 1980

City of San Luis Obispo
Post Office Box 321
San Luis Obispo, California 93406

Attention: David Romero, Director
Public Services Department

Gentlemen:

Enclosed are copies of Order No. 80-04, "Waste Discharge Requirements for City of San Luis Obispo Wastewater Treatment Plant, San Luis Obispo County, NPDES No. CA0049224", and an Enforcement Order for Issuance of a Time Schedule, "Order Directing the City of San Luis Obispo to Comply with Requirements Prescribed by the California Regional Water Quality Control Board, Central Coast Region in Order No. 80-04 (NPDES No. CA0049224)", as adopted by this Board on February 8, 1980.

Very truly yours,

CALIFORNIA REGIONAL WATER QUALITY
CONTROL BOARD, CENTRAL COAST REGION

By [signature]
KENNETH R. JONES
Executive Officer

KRJ:nd

Enclosure

cc: U. S. Environmental Protection Agency
State Water Resources Control Board
State Department of Fish and Game, Yountville
State Department of Health Services, Santa Barbara
State Department of Water Resources, Los Angeles
San Luis Obispo County Health Department
San Luis Obsipo County Planning Department
San Luis Obispo County Engineering Department

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL COAST REGION
1102-A Laurel Lane
San Luis Obispo, California 93401

ORDER NO. 80-04
NPDES NO. CA0049224

WASTE DISCHARGE REQUIREMENTS
FOR
CITY OF SAN LUIS OBISPO
WASTEWATER TREATMENT PLANT
SAN LUIS OBISPO COUNTY

The California Regional Water Quality Control Board, Central Coast Region (hereafter Board), finds:

1. The City of San Luis Obispo by application dated November 8, 1979, has applied for waste discharge requirements and a permit to discharge wastes under the National Pollutant Discharge Elimination System.

2. The City of San Luis Obispo (hereafter discharger) discharges treated municipal wastewater to San Luis Obispo Creek (Sec. 10, T31S, R12E, MDB&M) at three discharge locations shown on the enclosed Attachment "A". Effluent is also reused on a nearby 50 ± acre city-owned pasture area.

3. Design capacity of existing secondary treatment facilities is 5.0 million gallons (18,940 m^3) per day. Average flow is 3.7 million gallons per day (MGD).

4. Existing treatment consists of comminution, grit removal, primary and secondary sedimentation, primary and secondary biofiltration, oxidation in ponds, and chlorination. Sludge is anaerobically digested and air-dried for use as soil amendment.

5. During periods of intense rainfall, infiltration and inflow occurs in the wastewater collection system. Peak waste flows of less than 9.0 MGD are treated, disinfected, and discharged to San Luis Obispo Creek at Point 001 and/or the pasture area. Waste flows between 9.0 and 10.0 MGD bypass normal treatment processes, and are discharged at Point 001. Waste flows in excess of 10.0 MGD bypass the entire treatment process and are discharged without disinfection at Point 003.

6. During intense rainfall, the outfall from the chlorine contact pond near Point 001 lacks sufficient capacity for the combination of surface run-off and plant effluent. In order to prevent flooding of the oxidation pond and the treatment plant, it becomes necessary to open a floodgate and discharge a mixture of treated and untreated wastewater at Point 002.

7. The discharger has prepared plans for upgrading the treatment facility in order to provide better wastewater treatment and to prevent bypassing of untreated wastes to San Luis Obispo Creek. Plans are to add aeration,

a biological tower, dual media filters, equalization pond, sludge thickeners, a flocculator-clarifier unit, and a standby generator. Completion of plant upgrading is expected by April 1, 1983. Design capacity will then be 5.23 MGD.

8. Following completion of treatment plant upgrading the discharger proposes to reuse treated wastewater to maintain a constant water level in Laguna Lake and to irrigate a park and a golfcourse. Discharge and reuse locations are shown on Attachment "A" of this Order.

9. The discharge is presently regulated by Order No. 77-49 (NPDES NO. CA0049224) and Enforcement Order No. 77-13, which permit a discharge to San Luis Obispo Creek and the pasture area. Both Orders were adopted on July 8, 1977.

10. On March 14, 1975, the Board adopted a Water Quality Control Plan for the Central Coastal Basin (Basin Plan) establishing water quality objectives for sub-basins within the region. This Order implements that Plan.

11. Present and anticipated beneficial uses of the waters of San Luis Obispo Creek downstream from the City's discharge locations include:

    a. Agricultural supply,
    b. Groundwater recharge,
    c. Water contact recreation,
    d. Non-water contact recreation,
    e. Wildlife habitat,
    f. Cold freshwater habitat,
    g. Warm freshwater habitat,
    h. Fish migration, and
    i. Fish spawning.

12. Present and anticipated beneficial uses of groundwaters recharged by San Luis Obispo Creek downstream from the City's discharge locations include:

    a. Domestic supply
    b. Agricultural Supply

13. The U. S. Environmental Protection Agency and the Regional Board have classified this discharge as a major discharge.

14. Issuance of waste discharge requirements for this discharge is exempt from the provisions of Chapter 3 (commencing with Section 21000) of Division 13 of the Public Resources Code in accordance with Water Code Section 13389.

15. On November 28, 1979, the Board notified the discharger and interested agencies and persons of its intent to revise waste discharge requirements for the discharge and provided a public hearing and an opportunity to submit written views and recommendations.

16. The Board, in a public meeting on February 8, 1980, heard and considered all comments pertaining to the discharge.

IT IS HEREBY ORDERED, pursuant to the provisions of Division 7 of the California Water Code and regulations adopted thereunder, and to the provisions of the Federal Water Pollution Control Act, as amended, and regulations and guidelines adopted thereunder, that the City of San Luis Obispo shall comply with the following:

A. Prohibitions

1. When the influent flow rate is less than 5.0 million gallons per day, discharge of untreated, partially treated, or undisinfected wastewater to San Luis Obispo Creek is prohibited.

2. Effective August 1, 1982, discharge of untreated, partially treated, or undisinfected wastewater to San Luis Obispo Creek is prohibited. [handwritten: specific]

3. Discharge of waste sludge and sludge digester supernatant to any surface waters or drainageways is prohibited.

B. Effluent Limitations

1. The maximum daily dry weather volume discharged shall not exceed 5.0 million gallons (18,930 m^3) until additional capacity is constructed. After completion of plant improvements the maximum daily dry weather volume discharged shall not exceed 5.23 million gallons (19,810 m^3) per day.

2. Effluent discharged to San Luis Obispo Creek shall occur only at Discharge Points 001, 002, and 003 as shown on Attachment "A".

3. Effluent discharged to San Luis Obispo Creek shall not exceed the following limits:

Constituent	Units	30-Day Average*	7-Day Average	Maximum
Settleable Solids	ml/l	0.1		0.3
Biochemical Oxygen Demand, 5-Day	mg/l (kg/day)	10 (190)**	30 (570)**	50 (950)**
Grease and Oil	mg/l (kg/day)	5 (95)**		10 (190)**
Turbidity	NTU	10		20
Total Filtrable Residue	mg/l (kg/day)			800 (15,200)**
Sodium	mg/l (kg/day)			150 (3,000)**
Chloride	mg/l (kg/day)			150 (3,000)**
Sulfate	mg/l (kg/day)			150 (3,000)**

Constituent	Units	30-Day Average*	7-Day Average	Maximum
Boron	mg/l (kg/day)			1.5 (30)**
Toxicity Concentration	TU	0.59		0.87

*For all constituents sampled fewer than four times per month, the average of the four most recent samples analyzed for such constituent shall not exceed the tabular value for that constituent.

**Based upon a design treatment capacity of five million gallons per day.

4. Effluent discharged to San Luis Obispo Creek shall not exceed the following limits:

see Enforcement order (attached)

Constituent	Units	30-Day Average or Mean*	7-Day Average	Maximum
Non-Filtrable Residue (Suspended Solids)	mg/l (kg/day)	10 (200)**	30 (600)**	75 (1,500)**
Ammonia + Ammonium	mg/l (kg/day)	4.0 (80)**		6.0 (120)**
Total Phosphorus	mg/l (kg/day)	1.8 (36)		

*For all constituents sampled fewer than four times per month, the average of the four most recent samples analyzed for each such constituent shall not exceed the tabular value for that constituent.

**Based upon a design treatment capacity of 5.23 million gallons per day.

5. The arithmetic mean of the biochemical oxygen demand (5-Day, 20°C) and suspended solids values, in kilograms per day, for effluent samples collected in a period of 30 consecutive calendar days shall not exceed 15 percent of the arithmetic mean of the respective values, in kilograms per day, for influent samples collected at approximately the same times during the same period (85 percent removal).

6. Effective specific April 1, 1983, effluent discharged to San Luis Obispo Creek shall not have a measurable chlorine residual.

7. Effluent discharged to San Luis Obispo Creek shall be continuously disinfected so the median most probable number (MPN) of coliform organisms does not exceed 2.2 per 100 milliliters, as determined from the last seven days for which analyses have been completed. The maximum number of coliform organisms shall not exceed 2,400 per 100 milliliters.

8. Undisinfected effluent discharged to the pasture area shall be confined to the designated disposal area shown on Attachment "A".

9. Effluent discharged shall not have a pH of less than 6.5 nor greater than 8.3.

10. Effluent discharged to San Luis Obispo Creek and Laguna Lake shall not have a dissolved oxygen concentration of less than 2.0 mg/1.

11. Use of reclaimed water for irrigation and recreational impoundments shall be in conformance with reclamation criteria established in Title 22, Division 4, (Chapter 3), of the California Administrative Code. Uses not addressed in Title 22 and all specific areas of use are subject to prior approval by the Executive Officer. All reclaimed water shall be confined to the approved area of use. The discharger shall not produce or supply reclaimed water for reuse without submittal of an adequate engineering report similar to that required by Section 60323 of Title 22.

12. The discharge shall not contain pesticides in excess of limiting concentrations set forth in the California Administrative Code, Title 22, Chapter 15, Article 4, Section 64435.

13. The discharge shall not contain concentrations of radionuclides in excess of the limits specified in the California Administrative Code, Title 22, Chapter 15, Article 5, Section 64443.

14. The discharge shall not contain substances in concentrations which are toxic to, or which produce detrimental physiological responses in human, plant, or animal (particularly fish or aquatic) life.

15. The discharge shall not contain floating material including solids, liquids, foams, and scum which cause nuisance or adversely affect beneficial uses.

16. The discharge shall not contain taste or odor producing substances that cause nuisance or that adversely affect beneficial uses.

C. Receiving Water Limitations

1. Discharge shall not cause the following limits to be exceeded in San Luis Obispo Creek:

See Enforcement order (attached)

Constituent	Maximum (mg/1, unless otherwise noted)
Aluminum	7.5
Arsenic	0.10
Cadmium	0.005
Chromium	0.05
Copper	0.05
Fluoride	1.5
Iron	7.5
Lead	0.05
Mercury	0.0003
Selenium	0.01

Constituent	Maximum (mg/l, unless otherwise noted)
Zinc	0.30
M.B.A.S.	0.2
Phenols	0.1
Unionized Ammonia (NH_3 as N)	0.025
Algal Biomass	Not more than 20% greater than levels found in San Luis Obispo Creek upstream of Prado Road.
Turbidity	Not more than 20% greater than levels found in San Luis Obispo Creek upstream of Prado Road.

2. The discharge shall not cause the nitrate nitrogen (NO_3 as N) level of groundwaters underlying effluent discharge areas to exceed 10.0 mg/l.

3. The discharge shall not cause the dissolved oxygen concentration of San Luis Obispo Creek to be depressed below 5.0 mg/l at Discharge Point 001, nor cause the dissolved oxygen concentration of San Luis Obispo Creek to be depressed below 7.0 mg/l one-half mile downstream of Discharge Point 001.

4. The discharge shall not cause the dissolved oxygen concentration of Laguna Lake to be depressed below 5.0 mg/l.

5. The discharge shall not cause the color of surface waters to be greater than 15 units of 10 percent above natural background levels, whichever is greater.

6. The discharge shall not cause a violation of any applicable water quality standard for receiving waters adopted by the Board or the State Water Resources Control Board as required by the Federal Water Pollution control Act and regulations adopted thereunder.

D. Provisions

1. The requirements prescribed by this Order supersede the requirements prescribed by Order Nos. 77-49 and 77-13, adopted by the Board on July 8, 1977. Order Nos. 77-49 and 77-13 are hereby rescinded.

2. The discharger shall implement and enforce a source control program approved by the Executive Officer.

3. The discharger shall comply with the attached Monitoring and Reporting Program as ordered by the Executive Officer.

4. The discharger shall comply with all items of the attached "Standard Provisions and Reporting Requirements".

5. All facilities used for the transport or treatment of waste shall be protected against overflow, flooding or washout from a storm or flood having a predicted frequency of once in 100 years.

6. The public shall be excluded from land discharge areas unless bacteriological limits established in Item B.7. of this Order are met.

7. This Order expires February 1, 1985. The discharger must file a Report of Waste Discharge in accordance with Title 23, Chapter 3, Subchapter 9 of the California Administrative Code not later than 180 days in advance of such expiration date as application for issuance of new waste discharge requirements.

This Order shall serve as a National Pollutant Discharge Elimination System Permit pursuant to Section 402 of the Federal Water Pollution Control Act or amendments thereto, and shall become effective February 18, 1980.

I, KENNETH R. JONES, Executive Officer, do hereby certify the foregoing is a full, true, and correct copy of an Order adopted by the California Regional Water Quality Control Board, Central Coast Region, on February 8, 1980.

Executive Officer

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL COAST REGION

MONITORING AND REPORTING PROGRAM NO. 80-04
FOR
CITY OF SAN LUIS OBISPO WASTEWATER TREATMENT PLANT

WATER SUPPLY MONITORING

Representative samples of the municipal water supply shall be collected and analyzed for the following constituents:

Constituent	Units	Type of Sample	Minimum Sampling and Analyzing Frequency
Total Filtrable Residue	mg/l	Grab	Annually (April)
Sodium	mg/l	Grab	Annually (April)
Chloride	mg/l	Grab	Annually (April)
Sulfate	mg/l	Grab	Annually (April)
Boron	mg/l	Grab	Annually (April)

INFLUENT MONITORING

Measurement and sampling at the headworks shall be performed according to the following:

Constituent	Units	Type of Sample	Minimum Sampling and Analyzing Frequency
Daily Flow	mg		Daily
Instantaneous Maximum Flow Rate	mgd		Daily
Maximum Daily Flow	mgd		Monthly
Mean Daily Flow	mgd		Monthly
Biochemical Oxygen Demand, 5-Day	mg/l	24-hr. Composite	Weekly - Monday
Suspended Solids	mg/l	24-hr. Composite	Weekly - Monday

EFFLUENT MONITORING

Constituent	Units	Type of Sample	Minimum Sampling and Analyzing Frequency
Daily Flow	mgd		Daily
Maximum Daily Flow	mgd		Monthly
Mean Daily Flow	mgd		Monthly

Constituent	Units	Type of Sample	Minimum Sampling and Analyzing Frequency
Settleable Solids	ml/l	Grab	Daily
Chlorine Residual	mg/l	Grab	Daily
Chlorine Used	lbs/day		Daily
Dissolved Oxygen	mg/l	Grab	Daily
Turbidity	NTU	Grab	Daily
Non-Filtrable Residue (Suspended Solids)	mg/l	24-hr. Composite	5 Days Per Week
Total Coliform Organisms	MPN/100ml	Grab	5 Days Per Week*
pH	pH units	Grab	5 Days Per Week
Biochemical Oxygen Demand, 5-Day	mg/l	24-hr. Composite	3 Days Per Week (Mon.,Wed.,Fri.)
Grease and Oil	mg/l	Grab	Weekly - Tuesday
Ammonia + Ammonium	mg/l	Grab	Weekly - Tuesday
Total Phosphorus	mg/l	Grab	Monthly
Total Nitrogen	mg/l	Grab	Twice Per Year (October & April)
Total Filtrable Residue (Dissolved Solids)	mg/l	Grab	Twice Per Year (October & April)
Sodium	mg/l	Grab	Twice Per Year (October & April)
Chloride	mg/l	Grab	Twice Per Year (October & April)
Sulfate	mg/l	Grab	Twice Per Year (October & April)
Boron	mg/l	Grab	Twice Per Year (October & April)
Nitrate	mg/l	Grab	Twice Per Year (October & April)
**Toxicity Concentration	TU	Chlor. Grab	Twice Per Year (January & July)
Total Chlorinated Hydro-carbons	mg/l	Chlor. Grab	Once Every Two Years (July)

*Daily when reclaiming effluent at Laguna Lake or irrigating land where public contact is likely (parks, golfcourses, etc.).

**Bioassay tests shall be conducted on the effluent as discharged to the receiving waters and shall meet the following specifications:

Species	Test Temp.	Test Tank Dilutions
Rainbow trout (Salmo gairdnerii)	14 - 17°C	100% 56% 32% 18% 10% and control

RECEIVING WATER MONITORING (SAN LUIS OBISPO CREEK)

Receiving water stations shall be established as follows:

Station No.	Location
1	At Prado Road Bridge.
2	100 Feet Upstream of Discharge Point 001.
3	100 Feet Downstream of Discharge Point 001.
4	At Higuera Street Bridge, near U. S. 101.

Representative samples of the receiving water shall be collected and analyzed for the following:

Constituent	Station No.	Units	Minimum Sampling and Analyzing Frequency
*Aluminum	2, 3	mg/l	Twice per Year (July and October)
*Arsenic	2, 3	mg/l	Twice per Year (July and October)
*Cadmium	2, 3	mg/l	Twice per Year (July and October)
*Chromium	2, 3	mg/l	Twice per Year (July and October)
*Copper	2, 3	mg/l	Twice per Year (July and October)
*Fluoride	2, 3	mg/l	Twice per Year (July and October)
*Iron	2, 3	mg/l	Twice per Year (July and October)
*Lead	2, 3	mg/l	Twice per Year (July and October)
*Mercury	2, 3	mg/l	Twice per Year (July and October)
*Zinc	2, 3	mg/l	Twice per Year (July and October)
*M.B.A.S.	2, 3	mg/l	Twice per Year (July and October)
*Phenols	2, 3	mg/l	Twice per Year (July and October)
Total Phosphorus	1, 3	mg/l	Twice per Year (July and October)
Total Nitrogen	1, 3	mg/l	Twice per Year (July and October)
Color	2, 3	units	Twice per Year (July and October)

Constituent	Station No.	Units	Minimum Sampling and Analyzing Frequency
*Unionized Ammonia (NH_3 as N)	2, 3	mg/l	Quarterly (Jan.,Apr.,Jul.,Oct.)
Algal Biomass	2, 4	mg/l	Quarterly (Jan.,Apr.,Jul.,Oct.)
Turbidity	1, 2, 3, 4	NTU	Monthly
Dissolved Oxygen	2, 3, 4	mg/l	Monthly

*To reduce receiving water monitoring costs, the noted receiving water constituents may initially be sampled in the effluent at Discharge Point 001. If review of effluent analysis shows that a constituent concentration does not exceed the applicable limit, no further sampling is required. However, if review of effluent analysis shows that a constituent concentration exceeds an applicable receiving water limit, then three additional samples (one at Point 001 and one each at receiving water stations 2 and 3) shall be promptly collected within two days of learning a constituent exceeds an applicable limit and promptly analyzed.

RECEIVING WATER MONITORING (GROUNDWATERS)

A groundwater monitoring well shall be established at Well 31S/12E - 10M1 shown on Attachment "A". Depth to groundwater shall be measured prior to pumping. Sampler shall note color and odor when sample is taken.

Well water samples shall be collected after the well is purged of standing water and analyzed for the following constituents:

Constituent	Units	Type of Sample	Minimum Sampling and Analyzing Frequency
Nitrate Nitrogen (as N)	mg/l	Grab	Twice per Year (October and April)
Electrical Conductivity	mg/l	Grab	Annually - October

RECLAMATION MONITORING (LAGUNA LAKE)

A record of the volume of water released to Laguna Lake shall be maintained. Representative samples of lake water shall be collected and analyzed as outlined below:

Station Locations

Station	Location
A	Centerline of Lake, directly offshore of discharge point.
B	Approximate center of Lake.
C	Opposite end of Lake at same depth contour as Station A.

Water Column Sampling

Constituent	Units	Station	Type of Sample	Frequency
Turbidity	NTU	A, B, C (mid-depth)	Grab	Twice per Year (October and April)
Dissolved Oxygen	mg/l	A, B, C (mid-depth)	Grab	Twice per Year (October and April)
Temperature	°C	A, B, C (mid-depth)	Grab	Twice per Year (October and April)
Ammonia	mg/l	A, B, C (mid-depth)	Grab	Twice per Year (October and April)
Nitrate	mg/l	A, B, C (mid-depth)	Grab	Twice per Year (October and April)
Total Phosphate	mg/l	A, B, C (mid-depth)	Grab	Twice per Year (October and April)
Phytoplankton (algal) Biomass	Organisms/ml	A, B, C (mid-depth)	Grab	Twice per Year (October and April)
Fecal Coliform	MPN/100 ml	A, B, C (mid-depth)	Grab	Twice per Year (October and April)

RECLAMATION MONITORING (IRRIGATION)

A record shall be kept of the volumes of water reused for irrigation. For each location of reuse the following information shall be reported at least quarterly:

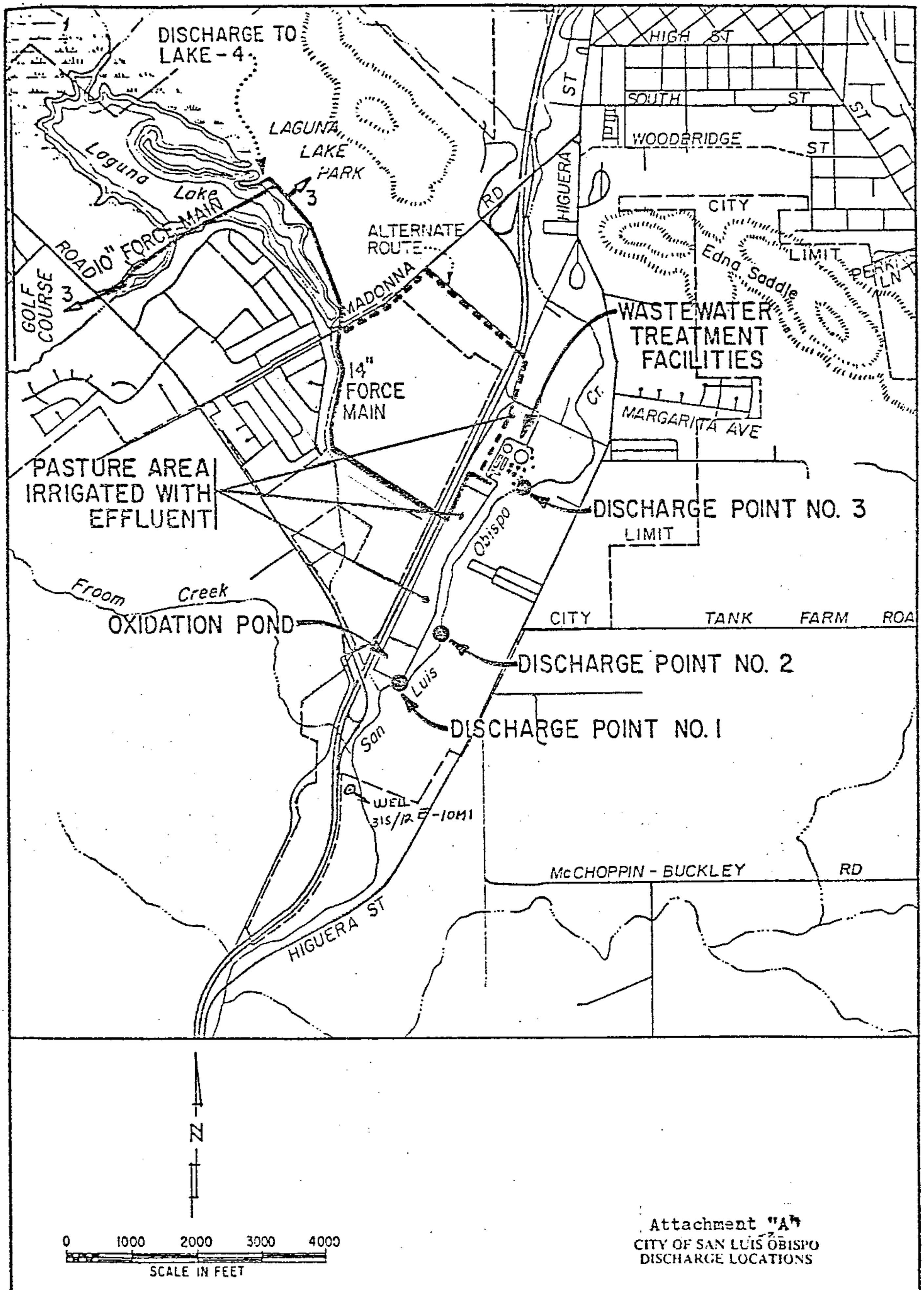
1. Maximum volume of water reclaimed during any one day.
2. Total volume of water reclaimed during the reporting period (month or quarter).
3. Percent of total flow reclaimed.
4. Uses of reclaimed water.

REPORTING

Results of monitoring shall be reported to the Board by the 20th day of the next month. Annual reports (January) shall attest to compliance with General Provision A.5. regarding operator certification.

ORDERED BY [signature]
Executive Officer

February 8, 1980
Date



Attachment "A"
CITY OF SAN LUIS OBISPO
DISCHARGE LOCATIONS

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL COAST REGION

JULY 8, 1977

STANDARD PROVISIONS AND REPORTING REQUIREMENTS

A. General Provisions:

1. Neither the treatment nor the discharge of wastes shall create a nuisance or pollution as defined in the California Water Code.

2. The requirements prescribed herein do not authorize the commission of any act causing injury to the property of another, nor protect the discharger from his liability under federal, state, or local laws, nor guarantee the discharger a capacity right in the receiving waters.

3. The discharger shall permit the Regional Board and the Environmental Protection Agency:

   a. Entry upon premises in which an effluent source is located or in which any required records are kept;

   b. Access to copy any records required to be kept under terms and conditions of this Order;

   c. Inspection of monitoring equipment or records; and

   d. Sampling of any discharge.

4. All discharges authorized by this Order shall be consistent with the terms and conditions of this Order. The discharge of any pollutant more frequently than or at a level in excess of that identified and authorized by this Order shall constitute a violation of the terms and conditions of this Order.

5. The discharger's wastewater treatment plant shall be supervised and operated by persons possessing certificates of appropriate grade pursuant to Chapter 3, Subchapter 14, Title 23, California Administrative Code.

6. The discharger shall maintain in good working order and operate as efficiently as possible any facility or control system installed by the discharger to achieve compliance with the waste discharge requirements.

7. Collected screening, sludges, and other solids removed from liquid wastes shall be disposed of in the manner approved by the Executive Officer of the Regional Board.

8. After notice and opportunity for a hearing, this Order may be terminated or modified for cause, including, but not limited to:

   a. Violation of any term or condition contained in this Order;

   b. Obtaining this Order by misrepresentation, or failure to disclose fully all relevant facts; and

   c. A change in any condition that requires either a temporary or permanent reduction or elimination of the authorized discharge.

9. If a toxic effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is established under Section 307(a) of the Federal Water Pollution Control Act, or amendments thereto, for a toxic pollutant which is present in the discharge authorized herein and such standard or prohibition is more stringent than any limitation upon such pollutant in this Order, the Board will revise or modify this Order in accordance with such toxic effluent standard or prohibition and so notify the discharger.

10. If more stringent applicable water quality standards are approved pursuant to Section 303 of the Federal Water Pollution Control Act, or amendments thereto, the Board will revise and modify this Order in accordance with such more stringent standards.

11. The provisions of this Order are severable, and if any provision of this Order, or the application of any provision of this Order to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this Order shall not be affected thereby.

12. Safeguard to electric power failure:

   a. The discharger shall, within ninty (90) days of the effective date of this permit, submit to the Regional Board and the Regional Administrator of the Environmental Protection Agency (EPA) a description of the existing safeguards provided to assure that, should there be reduction, loss, or failure to electric power, the discharger shall comply with the terms and conditions of this Order. Such safeguards may include alternate power sources, standby generators, retention capacity, operating procedures or other means. A description of the safeguards provided shall include an analysis of the frequency, duration, and impact of power failures experienced over the past five years on effluent quality and on the capability of the discharger to comply with the terms and conditions of the Order. The adequacy of the safeguards is subject to the approval of the Regional Board.

   b. Should the treatment warks not include safeguards against reduction, loss, or failure of electric power, or, should the Regional Board not approve the existing safeguards, the discharger shall, within ninety (90) days of the effective date of this Order or within ninety (90) days of having been advised by the Regional Board that the existing safeguards are inadequate, provide to the Regional Board and the Regional Administrator of EPA a schedule of compliance for providing safeguards such that in the event of reduction, loss, or failure of electric power, the permittee shall comply with the terms and conditions of this permit. The schedule of compliance shall, upon approval of the Regional Board become a condition of this Order.

13. Any diversion from or bypass of facilities necessary to maintain compliance with the terms and conditions of this Order is prohibited, except (a) where unavoidable to prevent loss of life or severe property damage, or (b) where excessive storm drainage or runoff would damage any facilities necessary for compliance with the effluent limitations and prohibitions of this Order. The discharger shall promptly notify the Board and the Regional Administrator of EPA in writing of each such diversion or bypass.

14. Except for data determined to be confidential under Section 308 of the Federal Water Pollution Control Act, all reports prepared in accordance with terms of this Order shall be available for public inspection at the offices of the Regional Water Quality Control Board, and the Regional Administrator of EPA. As required by the Federal Water Pollution Control Act, effluent data shall not be considered confidential. Knowingly making any false statements on any such report may result in the imposition of criminal penalties as provided for in Section 309 of the Act.

15. The discharger shall take all reasonable steps to minimize any adverse impact to receiving waters resulting from noncompliance with any effluent limitations specified in this Order, including such accelerated or additional monitoring as necessary to determine the nature and impact of the noncomplying discharge.

16. In the event of any change in control or ownership of land or waste discharge facilities presently owned or controlled by the discharger, the discharger shall notify the succeeding owner or operator of the existence of this Order by letter, a copy of which shall be forwarded to this Board.

17. The discharger shall ensure compliance with any existing or future pretreatment standard promulgated by EPA under Sections 307 of the Federal Water Pollution Control Act or amendments thereto, for any discharge to the municipal system.

18. The discharge of any radiological, chemical, or biological warfare agent or high level radiological waste is prohibited.

B. Provisions for Monitoring

1. Water quality analysis shall be performed in accordance with the latest edition of "Guidelines Establishing Test Procedures for Analysis of Pollutants," promulgated by the United States Environmental Protection Agency.

Chemical, bacteriological, and bioassay analyses shall be conducted at a laboratory certified for such analyses by the State Department of Health.

2. The laboratory which performs the sample analyses must be identified in all monitoring reports submitted to the Regional Board Executive Officer and the Regional Administrator (EPA).

3. Effluent samples shall be taken downstream of the last addition of waste to the treatment or discharge works where a representative sample may be obtained prior to mixing with the receiving waters.

4. All monitoring instruments and devices used by the discharger to fulfill the prescribed monitoring program shall be properly maintained and calibrated as necessary to ensure their continued accuracy.

C. General Reporting Requirements

1. The discharger shall submit to the Board on or before each compliance report date, a report detailing his compliance or noncompliance with the specific schedule date and task.

   If noncompliance is being reported, the reasons for such noncompliance shall be stated, plus an estimate of the date when the discharger will be in compliance. The discharger shall notify the Board by letter when he has returned to compliance with the time schedule.

2. In the event the discharger does not comply or will be unable to comply with any prohibition, daily maximum effluent limitation, or receiving water limitation of this Order for any reason, the discharger shall notify the Executive Officer by telephone (805-549-3147) as soon as he or his agents have knowledge of such noncompliance, and shall confirm this notification in writing within two weeks. The written notification shall state the nature, time and cause of noncompliance and shall describe the measures being taken to prevent recurrences.

3. This Board requires the discharger to file with the Board, within ninety (90) days after the effective date of this Order, a technical report on his preventive (failsafe) and contingency (cleanup) plans for controlling accidental discharges, and for minimizing the effect of such events. The technical report should:

   a. Identify the possible sources of accidental loss, untreated waste bypass, and contaminated drainage. Loading and storage areas, power outage, waste treatment unit outage, and failure of process equipment, tanks and pipes should be considered.

   b. Evaluate the effectiveness of present facilities and procedures and state when they become operational.

      Describe facilities and procedures needed for effective preventive and contingency plans.

c. Predict the effectiveness of the proposed facilities and procedures and provide an implementation schedule containing interim and final dates when they will be constructed, implemented, or operational. (Reference: Sections13267(b) and 13268, California Water Code)

This Board, after review of the technical report, may establish conditions which it deems necessary to control accidental discharges and to minimize the effects of such events. Such conditions may be incorporated as part of this Order, upon notice to the discharger.

4. Monitoring reports shall be submitted on forms to be supplied by the Board to the extent that the information reported may be entered on the forms. The results of all monitoring required by this Order shall be reported to the Board, and shall be submitted in such a format as to allow direct comparison with the limitations and requirements of this Order. Unless otherwise specified, discharge flows shall be reported in terms of the 30-day average and the daily maximum discharge flows.

5. The discharger shall file with the Board a report on waste discharge at least 120 days before making any material change or proposed change in the character, location or volume of the discharge.

6. The results of any analysis of samples taken more frequently than required at the locations specified in the Monitoring and Reporting Program shall be reported to the Board.

7. The discharger shall file a written report with the Board within ninety (90) days after the average dry-weather waste flow for any month equals or exceeds 75 percent of the design capacity of his waste treatment and/or disposal facilities. The discharger's senior administrative officer shall sign a letter which transmits that report and certifies that the policy-making body is adequately informed about it. The report shall include:

   a. Average daily flow for the month, the date on which the instantaneous peak flow occurred, the rate of that peak flow, and the total flow for the day.

   b. The discharger's best estimate of when the average daily dry-weather flow rate will equal or exceed the design capacity of his facilities.

   c. The discharger's intended schedule for studies, design, and other steps needed to provide additional capacity for his waste treatment and/or disposal facilities before the waste flow rate equals the capacity of present units. (Reference: Sections 13260, 13267(b) and 13268, California Water Code.)

8. If required to have a source control program, the discharger shall send an annual report of the effectiveness of that program to the Regional Board's Executive Officer. This report is a part of the annual report due by January 30 under Reporting Requirements for Monitoring - 2. Such report shall contain at least the information outlined in the State Water Resources Control Board's "Guidelines for Determining the Effectiveness of Local Source Control Programs."

D. Reporting Requirements for Monitoring

1. For every item of monitoring data where the requirements are not met, the discharger shall submit a statement of the actions undertaken or proposed which will bring the discharge into full compliance with requirements at the earliest time, and shall submit a timetable for such corrective actions. The discharger shall submit such information, in writing, within two weeks of becoming aware of noncompliance.

2. By January 30 of each year, the discharger shall submit an annual report to the Board. The report shall contain both tabular and graphical summaries of the monitoring data obtained during the previous year. In addition, the discharger shall discuss the compliance record and the corrective actions taken or planned which may be needed to bring the discharge into full compliance with the waste discharge requirements.

3. The discharger shall maintain records of all sampling and analytical results, including strip charts; the date, exact place and time of sampling; the analyst's name; analytical techniques used; and results of all analyses. Such records shall be retained for a minimum of three years. This period of retention shall be extended during the course of any unresolved litigation regarding this discharge or when requested by the Board. Monitoring results shall be submitted on forms provided by the Board.

4. The discharger shall file with the Board technical reports on self-monitoring work performed according to the detailed specifications contained in any Monitoring and Reporting Program as directed by the Executive Officer.

5. All reports shall be signed by:

   a. In the case of corporations, by a principal executive officer at least of the level of vice president or his duly authorized representative, if such representative is responsible for the overall operation of the facility from which the discharge originates;

   b. In the case of a partnership, by a general partner;

   c. In the case of a sole proprietorship, by the proprietor; and

   d. In the case of a municipal, state or other public facility, by either a principal executive officer, ranking elected official, or other duly authorized employee.

6. The discharger shall mail a copy of each monitoring report on the appropriate form to be supplied by the Board and any other reports required by this Order to:

   a. California Regional Water Quality Control Board
   1102-A Laurel Lane
   San Luis Obispo, California 93401

b. A copy of such monitoring report for those discharges designated as a major discharge shall be mailed to:

Regional Administrator
Environmental Protection Agency
Region IX, Attention: ENCMR
215 Fremont Street
San Francisco, California 94105

F. Definitions:

1. The daily discharge ràte is obtained from the following caloulation for any calnedar day:

$$\text{Daily discharge rate (lbs/day)} = \frac{8.34}{N} \sum_{1}^{N} Q_i \cdot C_i$$

$$\text{Daily discharge rate (kg/day)} = \frac{3.78}{N} \sum_{1}^{N} Q_i \, C_i$$

in which N is the number of samples analyzed in any calendar day. Q_i and C_i are the flow rate (MGD) and the constituent concentration (mg/l) respectively, which are associated with each of the N grab samples which may be taken in any calendar day. If a composite sample is taken, C_i is the concentration measured in the composite sample and Q_i is the average flow rate occurring during the period over which samples are composited.

2. The "30-day, or 7-day, average" discharge is the total discharge by weight during a 30, or 7, consecutive calendar day period, respectively, divided by the number of days in the period that the facility was discharging. Where less than daily sampling is required by this permit, the 30-day, or 7-day, average discharge shall be determined by the summation of all the measured discharges by weight divided by the number of days during the 30, or 7, consecutive calendar day period when the measurements were made.

   If fewer than four measurements are made during a 30, or 7-day, consecutive calendar day period then compliance or noncompliance with the 30, or 7, day average discharge limitation shall not be determined.

   For other than 7-day or 30-day periods, compliance shall be based upon the average of all measurements made during the specified period. If fewer than four measurements are made during the period, compliance shall be based upon the last four consecutive samples.

3. The "daily maximum" discharge means the total discharge by weight during any calendar day.

4. The "30-day, or 7-day, average" concentration, other than for fecal or total coliform bacteria, is the arithmetic mean of measurements made

during a 30, or 7, consecutive calendar day period, respectively. The "30-day, or 7-day, average" concentration for fecal or total coliform bacteria is the geometric mean of measurements made during a 30, or 7, consecutive calendar day period, respectively. The geometric mean is the n^{th} root of the product of n numbers.

If fewer than four measurements are made during a 30, or 7, consecutive calendar day period, then compliance or noncompliance with the 30, or 7, day average concerntration limitation shall not be determined.

5. The "daily maximum" concentration is defined as the measurement made on any single discrete sample or composite sample.

6. A "grab" sample is defined as any individual sample collected in less than 15 minutes.

7. A composite sample is a combination of no fewer than eight (8) individual samples obtained at equal time intervals over the specified sampling period. The volume of each individudal sample is proportional to the discharge flow rate at the time of sampling. The sampling period shall be specified in the monitoring and reporting program ordered by the Executive Officer.

8. An "industry" is defined as any facility identified in the Standard Industrial Classification Manuel, 1972, Office of Management and Budget, as amended and supplemented, under the following divisions:

   a. Division A - Agriculture, Forestry, and Fishing;

   b. Division B - Mining;

   c. Division D - Manufacturing; and

   d. Division I - Services.

   A facility in the Divisions listed may be excluded if it is determined by the Board that it introduces primarily domestic wastes or wastes from sanitary conveniences.

9. "Prohibited wastes" is any of the following wastes, which shall not be introduced into the treatment works:

   a. Wastes which create a fire or explosion hazard in the treatment works;

   b. Wastes which will cause corrosive structural damage to treatment works, but in no case wastes with a pH lower than 5.0 unless the works is designed to accommodate such wastes;

   c. Solid or viscous wastes in amounts which would cause obstruction to the flow in sewers, or other interference with the proper operation of the treatment works; or

   d. Wastes at a flow rate and/or pollutant discharge rate which is excessive over relatively short time periods so that there is a treatment process upset and subsequent loss of treatment efficiency.

CALIFORNIA REGIONAL WATER QUALITY CONTROL BOARD
CENTRAL COAST REGION
1102-A Laurel Lane
San Luis Obispo, California 93401

ENFORCEMENT ORDER FOR ISSUANCE OF A TIME SCHEDULE

Order Directing the City of San Luis Obispo to Comply with Requirements Prescribed by the California Regional Water Quality Control Board, Central Coast Region in Order No. 80-04 (NPDES No. CA0049224)

The California Regional Water Quality Control Board, Central Coast Region, (hereafter Board), finds that:

1. This Board, on February 8, 1980, adopted Order No. 80-04 (NPDES No. CA-0049224) prescribing waste discharge requirements for the City of San Luis Obispo Wastewater Treatment Plant.

2. Several specific requirements contained in Order No. 80-04 cannot be met until treatment facility improvements are constructed.

3. The Environmental Protection Agency (EPA) has advised this Board that the Clean Water Act requires that the City of San Luis Obispo comply with requirements in our Basin Plan by July 1, 1977. EPA further stated that the problem of non-compliance should be addressed via an enforcement mechanism.

4. This enforcement action is being taken for the protection of the environment and as such is exempt from the provisions of the California Environmental Quality Act (Public Resources Code, Section 21000 et. seq.) in accordance with Section 15108, Chapter 3, Title 14, California Administrative Code.

5. The Board, in a public hearing on February 8, 1980, heard and considered all comments pertaining to the discharger's ability to achieve compliance.

IT IS HEREBY ORDERED, that in accordance with Water Code Section 13300, the City of San Luis Obispo shall:

1. Comply immediately with all requirements contained in Order No. 80-04 (NPDES No. CA0049224), except as follows:

   a. Effluent limitation B.4.

   b. Receiving Water limitation C.1. (constituents M.B.A.S., phenols, unionized ammonia, algal biomass, and turbidity, only).

2. In the interim, comply with the following effluent limitations for constituents in paragraph B.4.:

Note: Enforcement order does not change specific dates shown in requirement.

Constituent	Units	30-Day Average	7-Day Average	Maximum
Non-filtrable Residue (Suspended Solids)	mg/l (kg/day)	20 (380)	30 (570)	75 (1420)
Ammonia + Ammonium	mg/l (kg/day)	10 (190)		15 (288)
Total Phosphorus	mg/l (kg/day)	5.0 (95)		

3. On or before April 1, 1983, comply with all requirements contained in Order No. 80-04.

I, KENNETH R. JONES, do hereby certify that the foregoing is a full, true and correct copy of an Order adopted by the California Regional Water Quality Control Board, Central Coast Region, on February 8, 1980.

Executive Officer

February 8, 1980
Date

APPENDIX H

HYDROLOGIC ANALYSIS OF RAISING LAGUNA LAKE STORAGE ELEVATION

STUDY OF PROPOSED RAISING OF LAGUNA LAKE STORAGE ELEVATION

The present three barreled culvert outlet for Laguna Lake permits storing water to elevation 118.0. To pass the 100 year U.S. Corps of Engineers' design storm, the elevation in the lake is 125.98. The design storm has a peak inflow of 7,702 cfs. Due to the storage capacity of the lake the outflow peak is reduced to 2092 cfs. The starting flow rate for the storm outflow hydrograph due to a preceding storm is 456 cfs, requiring a depth at the culvert corresponding to elevation 121.19.

It is proposed to increase the storage depth during the spring, summer and fall as an alternate to dredging the lake to maintain depth. This increase can be obtained by constructing a permanent concrete weir, 120 feet long, 8" thick, with a round crest, to elevation 120.0 in front of the existing culvert. The weir would have essentially a semi-circular shape but modified by construction and topographical conditions. A sluice way at elevation 118.0 would permit draining the lake to the restricting culvert elevation. Any lower elevation could be obtained by pumping.

At this elevation and length, the weir would pass the low flow of 456 cfs at the same upstream water surface elevation as the culvert requires so there would be no effect on the initial condition of the outflow hydrograph used by the Corps of Engineers. At the peak flow of 2,092 cfs, the weir would be submerged six feet and would have negligible effect on the water surface elevation. It would cause a depressed wave over it of a theoretical depth of 0.06 feet.

The proposed permanent weir would create an increased depth of two feet. It is desirable and feasible to further increase the depth using temporary structures--stop logs or inflated tubing--to raise the lake surface an additional two or three feet after the probability of the 100 year storm has become negligible. If raised an additional two feet, to elevation 122.0, the weir is still capable of passing the design 2,092 cfs but not the full 100 year storm volume because of reduced "spillway storage" capacity.

A hydrological and safety study could determine a safe date for raising the crest elevation by implacing stop logs or inflating tubing. It probably would be about mid-March. Additional stream flow after this date would usually raise the lake to an appreciably higher level than the 122.0 initial storage. Seasonal and individual storm forecasting would permit an earlier raising to provide more assurance of a fuller lake. Removal of the stop logs or inflatable tubing should occur in mid-November, the normal commencement of the rainy season.

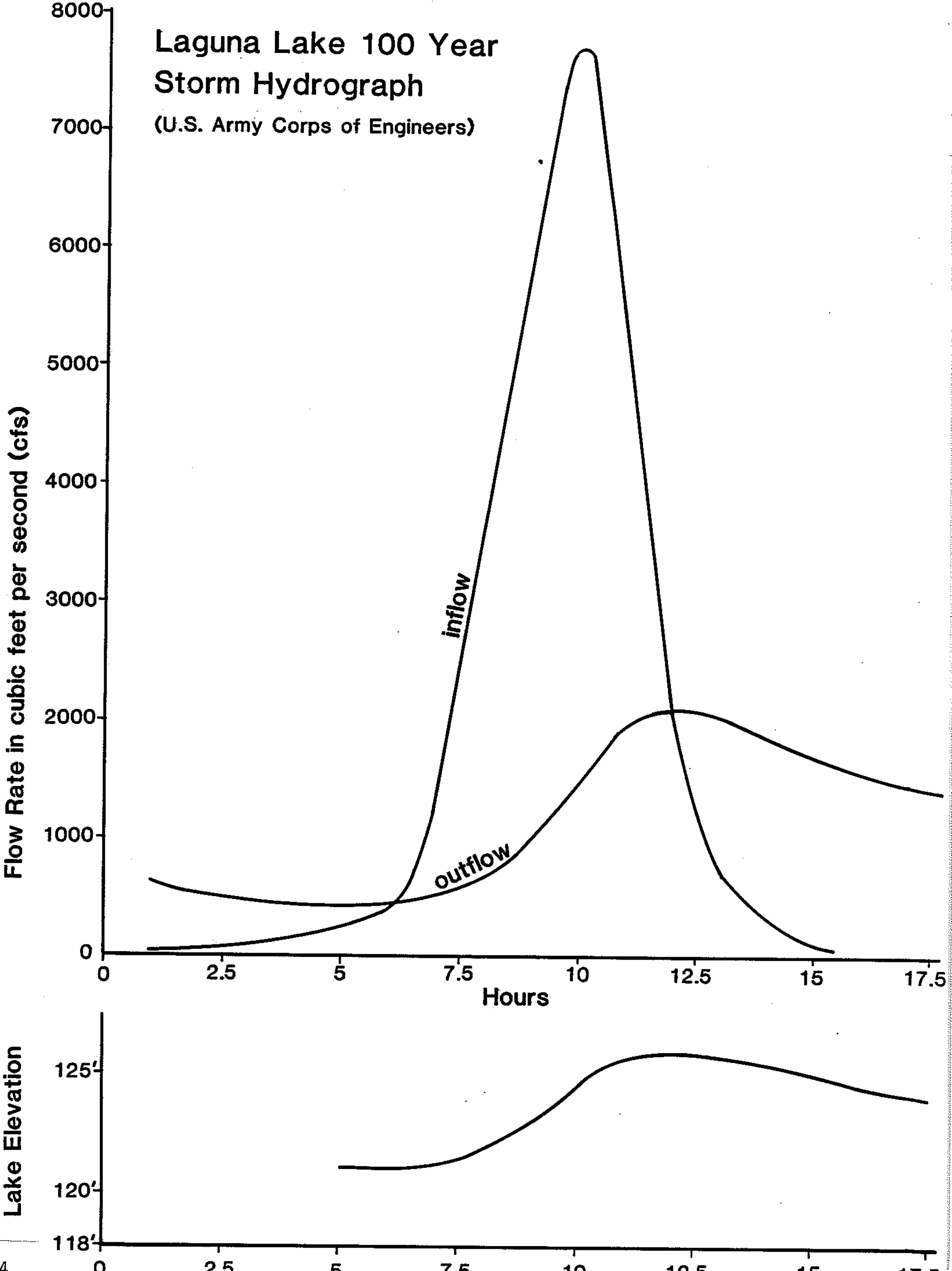
In addition to the desirable increased storage elevation during the recreation season, the increased depth would fill the Prefumo Inlet back to the road culvert. This will cause debris coming down the canyon to drop in the upper part of the inlet where it can more conveniently be removed. The suspended material will still move into the lake, but in reduced amount. The material in the inlet can be removed in the fall when the water level is low; or the level can be lowered earlier to 118.0 by opening the sluice in the weir.

The increased water level during the summer will not raise the maximum flood elevation, 126.0, but will cover much of the marsh land. The maximum seasonal storage level will be a compromise between increased ponded area in the marsh and the enhanced recreational opportunity. Structures adjacent to the lake and which are currently below the new operational level, should be raised. They are already subject to flooding, but not continued submergence.

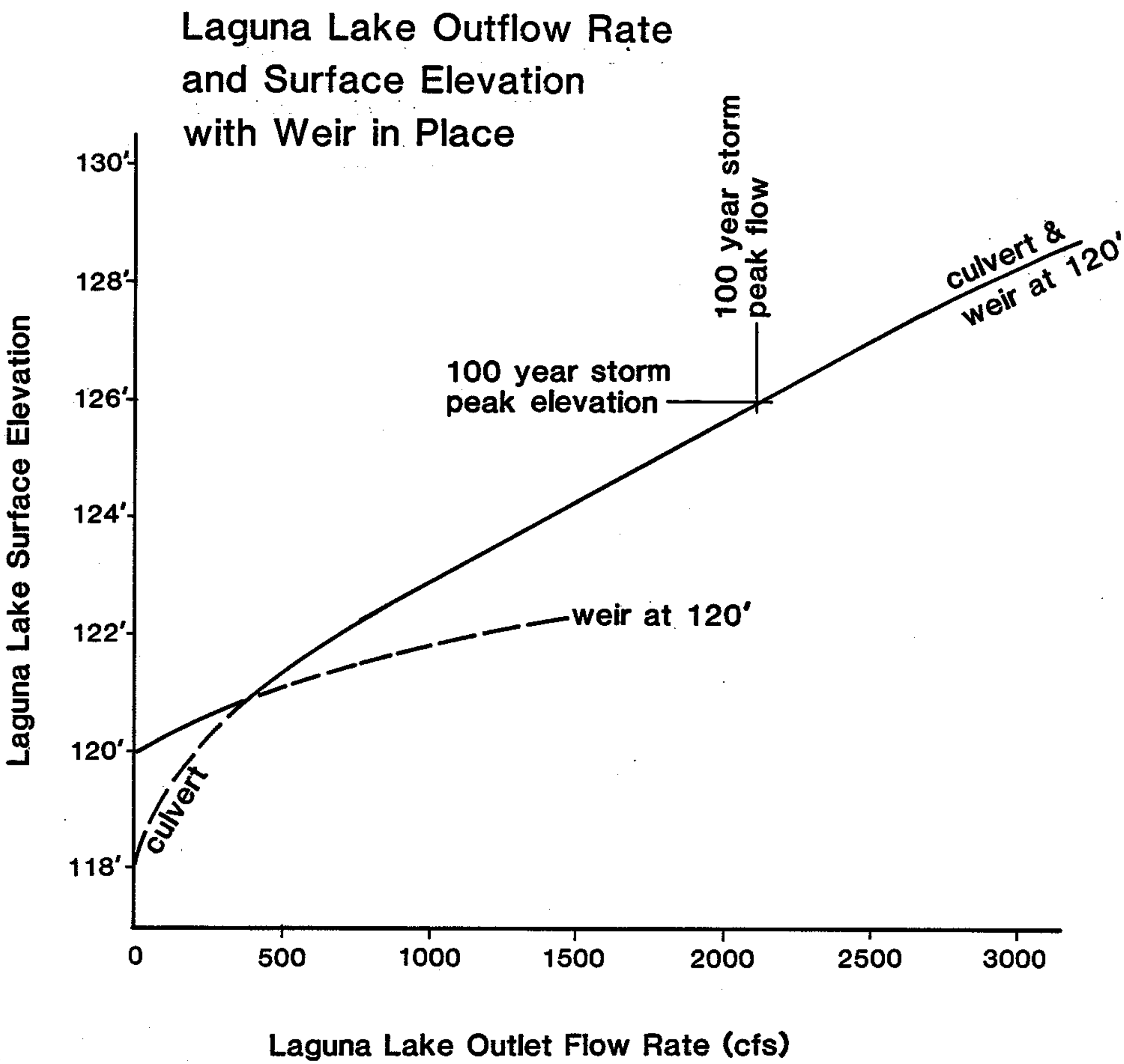
It will be necessary to obtain a water right to impound the additional water. Above the present 118.0 elevation to elevation 120.0, about 450 acre-feet of additional storage will be provided. To elevation 122.0, about 950 acre-feet additional will be obtained.

The cost of the low weir--two feet above present elevation, sluice way, and stop logs should cost less than $15,000.00.

John L. Merriam
RCE 6979



Laguna Lake 100 Year
Storm Hydrograph
(U.S. Army Corps of Engineers)
Flow Rate in cubic feet per second (cfs)
8000
7000
6000
5000
4000
3000
2000
1000
0
inflow
outflow
0
2.5
5
7.5
10
12.5
15
17.5
Hours
Lake Elevation
125'
120'
118'



Note: The curve for the culvert and weir combination is identical to the curve for the culvert alone, after the lake surface elevation reaches 121'.

APPENDIX I

POTENTIAL LAKE MANAGEMENT PROGRAM FUNDING SOURCES

LAGUNA LAKE MANAGEMENT PROGRAM

Inventory of Resource Management Program Funding Sources

The following is a preliminary list of existing Federal and State programs which may be available to provide financing for capital improvements, maintenance, and monitoring of lake conditions as called for in the Laguna Lake Management Program.

1. U.S. EPA Clean Lakes Program

The U.S. Environmental Protection Agency administers a grant program under Section 314 of the Federal Clean Water Act (P.L. 92-500) which is specifically designed to restore and enhance publicly-owned freshwater lakes.

Funding Limits: Limits are established for the Clean Lakes grants in two phases, as follows:

Phase 1: "A Diagnostic Feasibility Study" is the first step, and funds are available for up to 70% of eligible costs with a ceiling of $100,000 for the EPA grant. The study is intended to determine the "best available lake restoration procedures" and their associated costs.

Phase 2: This phase provides unlimited funding on a 50% matching basis to implement specific restoration measures identified in Phase I, including final engineering design, construction of non-point or point source controls, dredging, weed harvesting, algae control, etc.

Eligibility: EPA Clean Lakes grants are made only to States, although States are permitted to delegate the administration of grant agreements to cities (or other substate entities) through interagency agreements. In California, the funds are administered through the State Water Resources Control Board (SWRCB), Division of Planning and Research. San Luis Obispo has already applied to the SWRCB to have Laguna Lake placed on the State's priority list. The Lake is now on the list, but is ranked "second class" in priority, meaning that funding will probably not be available before 1985. This priority ranking might be improved, however, if the City wished to press its case before the Board. The State now receives approximately $3-4 million from EPA for this program.

(90-91) State Contacted 3/1/91 Past two years about $800,000 available for 4 states. Our project not high priority if fundable. - If fundable - study of how to stop sedimentation from reaching lake.

Contact: Jack Youngerman
State Water Resources Control Board
Division of Planning and Research
Surveillance and Monitoring Branch
1416 Ninth Street
Sacramento, CA 95814
(916) 322-4552

Bruce Lery
U.S. EPA Region IX
Water Division
215 Fremont Street
San Francisco, CA 94105

(415) 556-1598

Deadlines: There are no specific deadlines for local agencies to apply for consideration. Generally speaking, a long-term time commitment is necessary to obtain and administer these grants, due to elaborate reporting and analysis requirements.

2. U.S. Department of Agriculture, Agricultural Stabilization and Conservation Service, 1980 Rural Clean Water Program

The U.S. Department of Agriculture published proposed rules for an experimental Rural Clean Water Program (RCWP) in December, 1979. This program provides a mechanism for USDA cooperation with the U.S. Environmental Protection Agency in achieving the goals of Section 208 of the Clean Water Act relating to non-point source pollution control.

Funding Limits: The program is funded at $50,000,000 initially. Maximum payments to any participant (a land owner or agricultural producer) are limited to $50,000, and Federal cost-sharing is limited to 75%.

Eligibility: Funds are available only to private landowners within designated eligible project areas, whose lands contribute significantly to identified agricultural non-point source water quality problems. These problems must be related to non-point source pollutants, including sediment, animal waste, irrigation return flows, runoff, or leachate that contain high concentrations of nitrogen, phosphorous, dissolved solids, toxics, or high pathogen levels. Funds are available to install "Best Management Practices" (BMP's) in accordance with an approved water quality plan for the applicant; these practices might include such measures as revegetation of disturbed areas or buffer zones, construction of sediment ponds, etc. The funds are distributed through three RWCP Coordinating Committees, at the County, State and national levels.

Deadlines: No deadlines or application procedures have yet been established. The program will be administered by the Agricultural Stabilization and Conservation Service, with technical assistance from the Soil Conservation Service.

Contact:

Howard Steudeman
U.S. Agricultural Stabilization and Conservation Service

6750 El Camino Avenue
Atascadero, CA 93442
(805) 466-1551

3. Land and Water Conservation Fund

The State Department of Parks and Recreation annually receives about $12,000,000 from the U.S. Heritage Conservation and Recreation Service, Land and Water Conservation Fund for distribution to local agencies. San Luis Obispo County competes with Monterey, Santa Cruz, San Benito and Santa Barbara County for access to an estimated $600,000 of these funds allocated to District 7.

Funding Limits: There are no limits on the funding of individual items, but applications generally far exceed the monies available. In the last fiscal year, the smallest grant in District 7 was for $50,000 to the City of San Luis Obispo for improvements to Sinsheimer Park.

Eligibility: Typical items funded through the Land and Water Conservation Fund include picnic and camping facilities; playgrounds; riding, hiking and bicycling trails; outdoor sports facilities (non-spectator); and support facilities such as roads, parking lots, interpretive displays, and landscaping. The funds have been used in Santa Cruz County for lake restoration purposes, but these measures should be directly related to outdoor recreation enhancement.

Contact: Ed Navarro, Project Officer for District 7
State Department of Parks and Recreation
P. O. Box 2390 (830 "S" Street)
Sacramento, CA 95811

(916) 322-9578

Deadlines: Applicants must submit materials to the State Clearinghouse by July 1. Following receipt of their comments, the City would apply to the State Department of Parks and Recreation by September 15. Early application is encouraged.

Additional comments: The Land and Water Conservation Fund is a reimbursement program. Local agencies are expected to finance the entire project "up front" and then receive 50% reimbursement after project completion. The City has successfully applied for such funding in several instances in the past.

4. State Urban Grants Program

Under the Urban Open Space and Recreation Program enacted in 1976, the State Department of Parks and Recreation distributes approximately $10,000,000 annually to local agencies. These monies are primarily allocated to urbanized areas and most would not be available to this area; however, 15% of the total appropriation are allocated to non-urbanized areas on the basis of need.

Funding Limits: Need Basis Grants are limited to no more than 10% of the total annual appropriation to non-urbanized areas. Seventy five percent (75%) of project costs may be funded by the grant.

Eligibility: The Need Basis Grants to non-urbanized areas are allocated to "traditional recreation systems" serving functional needs in intensively developed areas. Program criteria appear to emphasize active recreation facilities supporting a variety of users (multiple uses are specifically encouraged) in proximity to urban neighborhoods.

Deadlines: Application may be made at any time, but prior to April 15 for consideration in the subsequent fiscal year. Application materials and procedures are relatively straightforward.

Contact: Barry Jones, Project Officer
Department of Parks and Recreation
830 "S" Street
Sacramento, CA 95811
(916) 322-9578

Jim S. checking on this report 3/11/91

5. Wildlife Conservation Board

The State Department of Fish and Game administers a grant program from State budget and Bond Act appropriations specifically for wildlife and fishing projects. In recent years, approximately \$3 - 3-1/2 million has been available annually.

Funding Limits: There are no funding limits or requirements for matching local monies, except that the WCB will only finance 50% of fishing pier costs. The Wildlife Conservation Board obtains its funding from several earmarked sources, including most recently the Urban and Coastal Park Fund.

Eligibility: The program is open to local agencies for improvements to public access or for other management projects to improve fish and wildlife habitat. The State Board encourages projects of a statewide or regional nature in order to obtain 50% funding from Land and Water Conservation Fund (federal) appropriations. There is one requirement should the City seek a Wildlife Conservation Board grant for Laguna Lake: the State would require a long-term lease or other proprietary interest on the entire lake area to the State, with an accompanying agreement by the City to operate the facilities and guarantee open public access. Fishing piers are a frequent type of Board-approved project; a recent grant was approved, however, to permit dredging for fishing enchancement in Whittier Narrows.

Deadlines: None. The Board, consisting of the President of the State Fish and Game Commission, Director of the Department of Fish and Game, and Director of Finance, meet at irregular intervals to decide grant awards.

Contact:

Al Rutsch, Assistant Executive Officer
Wildlife Conservation Board
1416 Ninth Street
Sacramento, CA 95814
(916) 445-8449

Cooperative

APPENDIX J

LAGUNA LAKE
WATER RIGHTS

LAGUNA LAKE WATER RIGHTS INQUIRY

Situation:

1. The outlet structure (culvert under Madonna) for Laguna Lake has a flow line elevation of 117.8' MSL.

2. The maximum storage capacity of Laguna Lake is 933 acre feet at the normal seasonal high water level of 117.8' MSL.

3. Irrigation pumping contributes to the drawdown of the lake surface each summer along with evaporation; total average seasonal drawdown is approximately 550 acre feet.

4. Average evaporative loss during the "dry" season is approximately 450 a.f.

5. An adjacent land owner/rancher (Alex Madonna) currently irrigates approximately 60 acres of pasture land with water pumped from Laguna Lake during the dry season. It is estimated that he uses about 150 a.f. of lake water for this purpose and that approximately 120 a.f. is lost through consumptive use, the remainder percolating back to the groundwater and Laguna Lake.

6. The total lake water surface area (at 117.8' MSL) is 187 acres. Approximately 157 acres of this area is owned by the City of San Luis Obispo and 30 acres by Alex Madonna.

7. The lake is used as a fish and wildlife preservation area and for public recreation by the City of San Luis Obispo. About $200,000 of improvements have been installed in and around the lake for public recreation.

8. The City would like to minimize the drawdown as much as possible because, toward the end of summer, lake depth is so shallow as to discourage boating and other similar uses, and water weed growth is stimulated.

Questions:

1. Can the City limit the amount of water that Alex Madonna can use to irrigate his land?

2. What process or processes are available to the City to pursue legal limitations to Madonna's water pumping?

3. What is the likelihood that the City could be successful in obtaining the right to limit Madonna's pumping?

Situation:

The City of San Luis Obispo is considering raising the level of Laguna Lake, thereby impounding additional water and inundating land which is in private ownership. The City is considering raising the level from the current normal high of 117.8' MSL to either 119.0' MSL, 120.0' MSL or 122.0' MSL.

1. IF raised to 119.0' MSL:
   - additional water impoundment would be 200 a.f.
   - additional private property inundated would be 12 acres

   IF raised to 120.0' MSL:
   - additional water impoundment would be 400 a.f.
   - additional private property inundated would be 50 acres

   IF raised to 122.0' MSL:
   - additional water impoundment would be 1,000 a.f.
   - additional private property inundated would be 100 acres.

2. Downstream users along Prefumo Creek, which drains Laguna Lake, and along San Luis Creek, to which Prefumo Creek is a tributary, presently and historically draw groundwater and stream water for domestic and agricultural use.

3. There are no known appropriative rights to Laguna Lake, Prefumo Creek, or San Luis Creek water.

4. See Situation A for description of present lake characteristics and ownership.

Questions:

1. If the City wished to raise the lake water level by constructing a weir at the downstream entry to Prefumo Creek, what legal, quasi-legal and permit processes would be required?

2. What, generally, would be required to get through these processes?

3. What is the likelihood of getting approval or at least, what would the City have to do to get approval?

Telephone discussions with Buck Taylor, State Water Resources Control Board, Division of Water Rights (916) 920-6416 and Arthur Shaw, Stuart and Shaw, San Luis Obispo.

LAGUNA LAKE MANAGEMENT PLAN
WATER RIGHTS

1. Can the City impound additional water to raise level of Laguna Lake?

Additional impoundment of water would require application to State Water Resources Control Board, Division of Water Rights. They would require that all land owners affected by the application and the City come to appropriate agreements prior to issuance of the permit.

In specfic, if additional land was inundated by the additional impoundment of water, the City must have agreement with the owners (thru easement or other such entitlement allowing property to be subject to inundation) or City would have to acquire the land through condemnation. Without such agreement or acquisition the City could be subject to inverse-condemnation suit by affected property owners and the State Water Resources Control Board would not approve the permit.

In addition, if the impoundment reduced the waters flowing to downstream riparian users in Prefumo Creek or San Luis Obispo Creek, then those users' water rights would have to be determined. If it was found that the impoundment adversely affected the riparian water use requirements of downstream users then the City might not be allowed to impound additional water or might be required to pay damages for the use of the additional water.

2. Can City exert some control as to how much water may be pumped from the lake by contiguous property owners?

All owners of land which lies along the shore of Laguna Lake or along tributary streams to Laguna Lake have littoral or riparian rights to water which lies within the lake or in the streams. As long as they do not interfere with others' riparian rights to the water, no control can be exerted. If an owner's use of the water began interferring with the common use of the lake or stream, then some division of the rights could be arrived at through adjudication. It might be asserted that pumping water from the lake lowers the lake level and interferes with its recreational use. If such could be shown, then some division of the rights to the water might be adjudicated. However, it might be difficult to show that pumping was the key factor to this interference and not natural occurrences such as evaporation, etc. Not withstanding the above, if this were adjudicated, it is likely that, under California law, the agricultural use would be favored over recreational use of the water in establishing a division of the water rights.

3. Could the City construct a dam structure across the upper end of the lake, creating a bathtub effect which would physically limit water availability to west-end property owners for pumping?

There is no clear answer on this. However, under laws relating to littoral or riparian water rights, the land owners affected could assert that the City had illegally divided the riparian or littoral rights or interest in the lake water. They might also assert that their riparian rights were being limited in order to enhance a public use of the water than thus claim inverse-condemnation of their riparian rights.

D. WATERS TO WHICH RIGHT ATTACHES

§ 93. In General.—There appears to be no decision of an appellate court, and no statute or constitutional provision, definitely limiting the waters to which the doctrine of riparian rights is applicable. But it is clear that the riparian right to use water on adjoining land applies as well to the water of a lake, pond, slough, or other natural body of water, by whatever name it may be called, as to a running stream.[17] Even in the case of a pond or lake caused by overflow, which has no other source of supply and which by reason of seepage and evaporation will soon disappear, the owners of lands riparian to the pond or lake have a right to the reasonable use of the water, both for domestic purposes and for irrigation of adjacent land.[18] Ordinary flood waters,[19] waters from springs,[20] waters from tributaries,[1] navigable waters,[2] waters that have been used by upper owners and allowed to seep back into the stream,[3] and waters that belong to upper diverters with prior rights but have been allowed by them to pass by their point of diversion[4] may all be subject to riparian rights. And riparian rights to water of property adjoining a stream exist independently of any claim of the owner.[5]

The riparian right does not attach to any particular portion of the water until it is diverted from the main stream into the ditches or conduits of the riparian proprietor, or is put to use by him.[6]

17. Turner v James Canal Co. 155 C 82, 87, 99 P 520; Crum v Mt. Shasta Power Corp. 220 C 295, 30 P2d 30.

18. Turner v James Canal Co. 155 C 82, 90, 99 P 520.

19. Miller & Lux v Madera Canal & Irr. Co. 155 C 59, 69, 99 P 502.

20. § 416, infra.

1. Porters Bar Dredging Co. v Beaudry 15 CA 751, 765, 115 P 951.

2. Heilbron v Fowler Switch Canal Co. 75 C 426, 432, 17 P 535.

3. Southern Calif. Inv. Co. v Wilshire 144 C 68, 77 P 767.

4. Barton Land & Water Co. v Crafton Water Co. 171 C 89, 94, 95, 152 P 48.

5. Mt. Shasta Power Corp. v McArthur 109 CA 171, 191, 292 P 549.

6. Palmer v Railroad Com. 167 C 163, 168, 138 P 997; Fresno Canal

water for seasonal storage and subsequent power development does not become a proper riparian use though the public utility diverting it is a large riparian owner on the stream.[17]

Periodic or cyclic storage is not a proper exercise of the riparian right. It is often more damaging to the rights of the lower owners than seasonal storage. The generation of power is a proper riparian use, if the water used for such generation is used in such a manner as not to interfere materially with other riparian users on the stream, but the reservoiring or cyclic use of such waters to the detriment of lower riparian users is not within the rights of the upper riparian.[18] The use of water as motive power imposes the duty on the riparian owner to make a present return of the waters so used to the course of the stream without undue waste or diminution, and in such reasonable amounts as will not work a hardship on the lower riparian user. This means that a riparian owner may not operate machinery by accumulating the water and then discharging it on those below in unusual quantities.[19]

§ 148. **Recreation.**—The courts have consistently refused to recognize, as a proper riparian use, the use of the flow of a stream of water for the purpose of pleasing the eye or gratifying a taste for the beautiful.[20] But the maintenance of the level of a lake in its natural condition, resulting in the existence of attractive surroundings for guests, where a recre-

17. Lodi v East Bay Municipal Util. Dist. 7 C2d 316, 335, 60 P2d 439.

18. Moore v California Oregon Power Co. 22 C2d 725, 734, 140 P2d 798 (storing water in daytime and releasing it at night and on Sundays and holidays).

19. Seneca Const. Gold Mines Co. v Great Western Power Co. 209 C 206, 287 P 93, 70 ALR 210; Moore v California Oregon Power Co. 22 C2d 725, 733, 140 P2d 798.

20. Lux v Haggin 69 C 255, 396, 4 P 919, 10 P 674.

A riparian owner may not insist on the full flow of the stream over his land for the mere pleasure of looking at it as a feature of the landscape. Rose v Mesmer 142 C 322, 330, 75 P 905.

ational business is involved, constitutes a reasonable beneficial use of the water required to maintain the lake.[1] And the maintenance of the recreational opportunities of a lake, on which large business interests of the community have built for the purpose of making those opportunities available to its citizens, is a proper riparian use though it deprives others of water for irrigation.[2] But where the recreational use consumes added quantities of water year after year, thereby depriving a lower riparian of water he formerly used, the court would need to examine the use of water to determine if it was reasonable in view of the requirements of the lower riparian.[3]

The use of waters for recreational purposes is a thing of value. Accordingly, where the waters that maintain the level of a lake used for recreational purposes are taken for public purposes by condemnation, the riparian owner is entitled to substantial damages for being deprived of his rights, and mere nominal damages are not adequate.[4]

§ 149. **Unusual Uses.**—The exercise of the riparian right need not be for usual and ordinary purposes so long as the operation does not interfere with other rights in the stream. In one instance the use of the stream to replace sand and gravel taken for commercial uses from the bed of the stream was held to be a proper and beneficial riparian use.[5] In another, the riparian owner was permitted to impound the waters of the stream temporarily in order to get sufficient water to float logs to the mill, and this was held to be a proper riparian use if it did not interfere with the rights of other users.[6]

1. Los Angeles v Aitken 10 CA2d 460, 473, 52 P2d 585.

2. Elsinore v Temescal Water Co. 36 CA2d 116, 129, 97 P2d 274 (not against public policy).

3. Prather v Hoberg 24 C2d 549, 560, 150 P2d 405.

4. Los Angeles v Aitken 10 CA2d 460, 475, 52 P2d 585.

5. Los Angeles County Flood Control Dist. v Abbot 24 CA2d 728, 76 P2d 188.

6. San Joaquin & Kings River Canal & Irr. Co. v Fresno Flume & Irr. Co. 158 C 626, 631, 112 P 182.