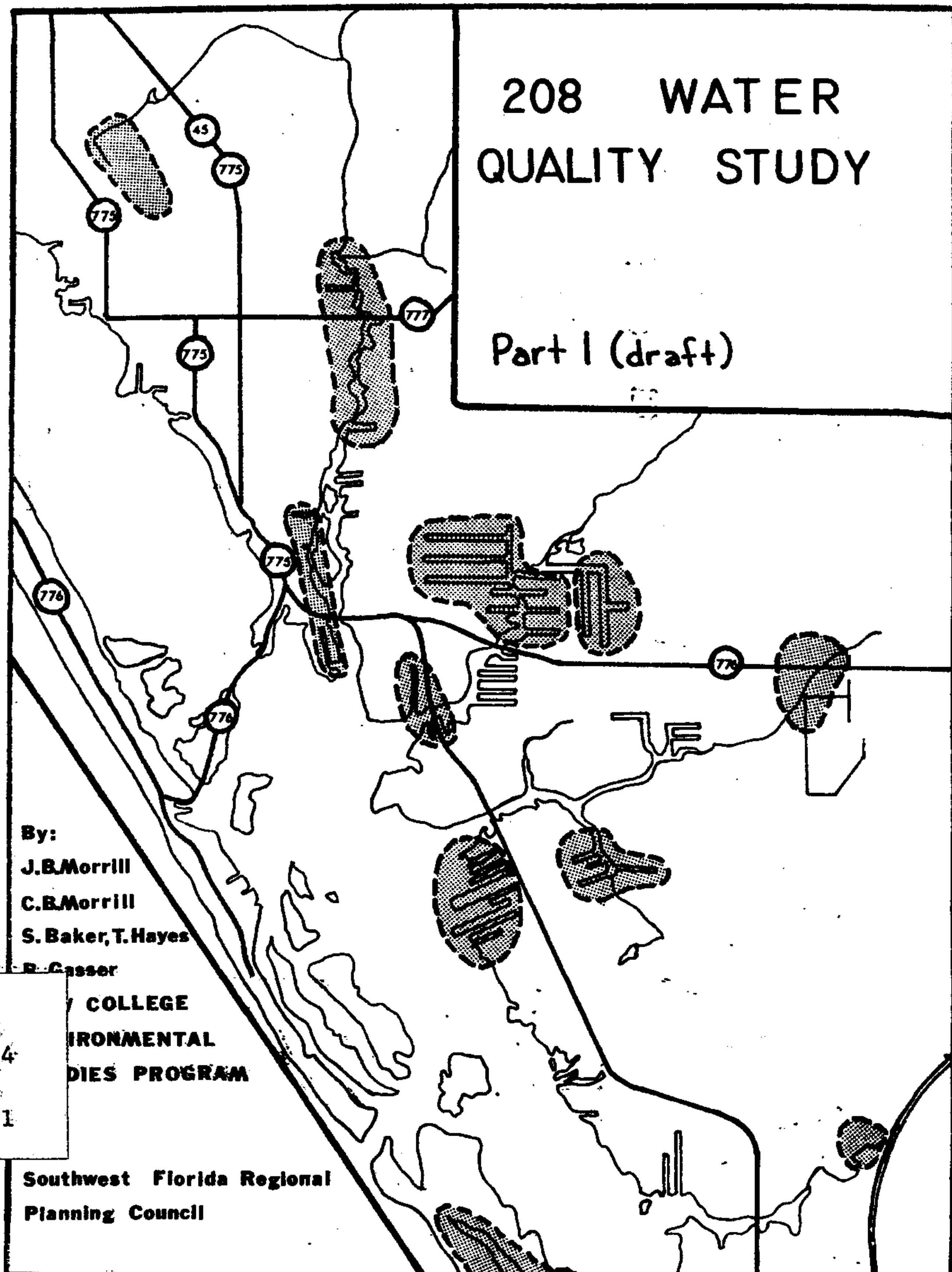
208 WATER QUALITY STUDY

Part I (draft)



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Southwest Florida Regional Planning Council

FINAL REPORT ON THE 208 PROGRAM WATER

QUALITY STUDY OF THE

LEMON BAY COMPLEX STUDY AREA

prepared for:

Southwest Florida Regional Planning Council

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INTRODUCTION

In recent years the people of the Lemon Bay area have experienced an apparent decline in water quality and fishing in the Bay. Traditional clam and oyster beds have been closed. The scallops have all but disappeared. From the 1960's to the present local fish kills and Winter-Spring blooms of blue green algae have caused public concern as have wet season periodic reports of coliform/fecal coliform contamination of surface water in road-side ditches in residential-commercial areas. Beginning in the early 1960's the area has also experienced a steady increase in resident and tourist populations. These and other environmental concerns for human health, safety and welfare led to the inclusion of the Lemon Bay Area in the SWFRPC 208 Water Quality Study Program.

The overall concerns, goals and priorities for the Lemon Bay Complex ~~part~~ of the regional 208 Program were summarized in the Basin I Priorities Workshop, Coastal Sarasota Basin 208 Advisory Committee, April 22, 1976 after a series of public meetings and two technical summaries of existing information and water quality problems by SWFRPC consultants.

The potential environmental hazards of malfunctioning onsite wastewater systems caused by improper installation and maintenance, soil drainage, and flooding conditions, initially directed the focus of the Lemon Bay Complex Study toward septic tanks and their non-point source contributions to nutrient and pollutant loading and lowered water quality in the receiving waters of the Lemon Bay area. In addition, upland runoff and surface-subsurface drainage patterns were to be examined for their contribution to the wasteload entering the receiving waters. Finally, the wasteload budget and transport for the entire area were to be determined. However, the originally over-designed water quality study was underfunded and had to be redesigned several times before and during the study proper as additional facts and concerns became known. The work scope of the study is outlined in Appendix A.

In the following sections of this report, we have collated and summarized a variety of information on the existing and historical environmental conditions in the Lemon Bay Area; future trends are included. The various environmental parameters associated with non-point sources of nutrients and pollutants are discussed. Finally, recommendations and topics for further consideration and study are suggested for onsite wastewater systems, land uses, and regional planning.

While most of the information presented in this report was gleaned from reports by local, regional, and state agencies and their consultants, we will not review such reports. Rather our plan is to utilize these and other data to develop a baseline analysis of existing non-point pollution sources, land use, and water quality. This analysis includes the following: geographical setting, climate, physical features, demographic and land use overviews, a synopsis of existing water quality and hydrographic information, the 208 Water Quality Study, and recommendations.

GEOGRAPHICAL SETTING

The general location of the Lemon Bay 208 Complex is shown in Figures 1 and 2, and Maps I&II.The Complex includes the following coastal Sarasota segments: Segment I-3, Lemon Bay; Segment I-9, Gottfried Creek drainage basin; Segment I-2, Ainger and Oyster Creek drainage basins; and Segment 1-8, Buck Creek drainage basin. The Forked Creek basin at the northern end of Lemon Bay was not included because a tidal current study in 1974 reported that tidal nodes occurred south of Forked Creek and at Palm Island Cut (The Narrows) at the southern end of the Bay.

Lemon Bay is a 15 mile long narrow embayment separated from the Gulf of Mexico by two barrier islands, Manasota Key and Knight Island. It is directly connected to the Gulf of Mexico by Stump Pass between these islands. Secondary connections with the Gulf are via Placida Harbor and Gasparilla Pass to the south and the Venice By-Pass Canal of the Intracoastal Waterway to the north. Historically there were three additional passes in the Lemon Bay area - Blind Pass on Manasota Key; Bocillia Pass between Knight and Don Pedro Island, and Little Gasparilla Pass between Don Pedro and Little Gasparilla Island.

Over the last 100 years the uplands bordering the Bay evolved into several unincorporated communities - Englewood, Grove City, and Englewood Beach. In addition scattered resorts and homes occur only on the margins of the Bay and its tributaries. Although still unincorporated with the north half in Sarasota County and the southern half in Charlotte County, the Englewood-Lemon Bay area has a degree of geographic cohesiveness because of the quasi-governmental unit, the Englewood Water District (EWD). The area serviced by the EWD (Figure 3) with few exceptions encompasses the developed areas within the Lemon Bay Complex. In addition to the EWD, the Englewood Chamber of Commerce and various civic groups have played key roles in maintaining

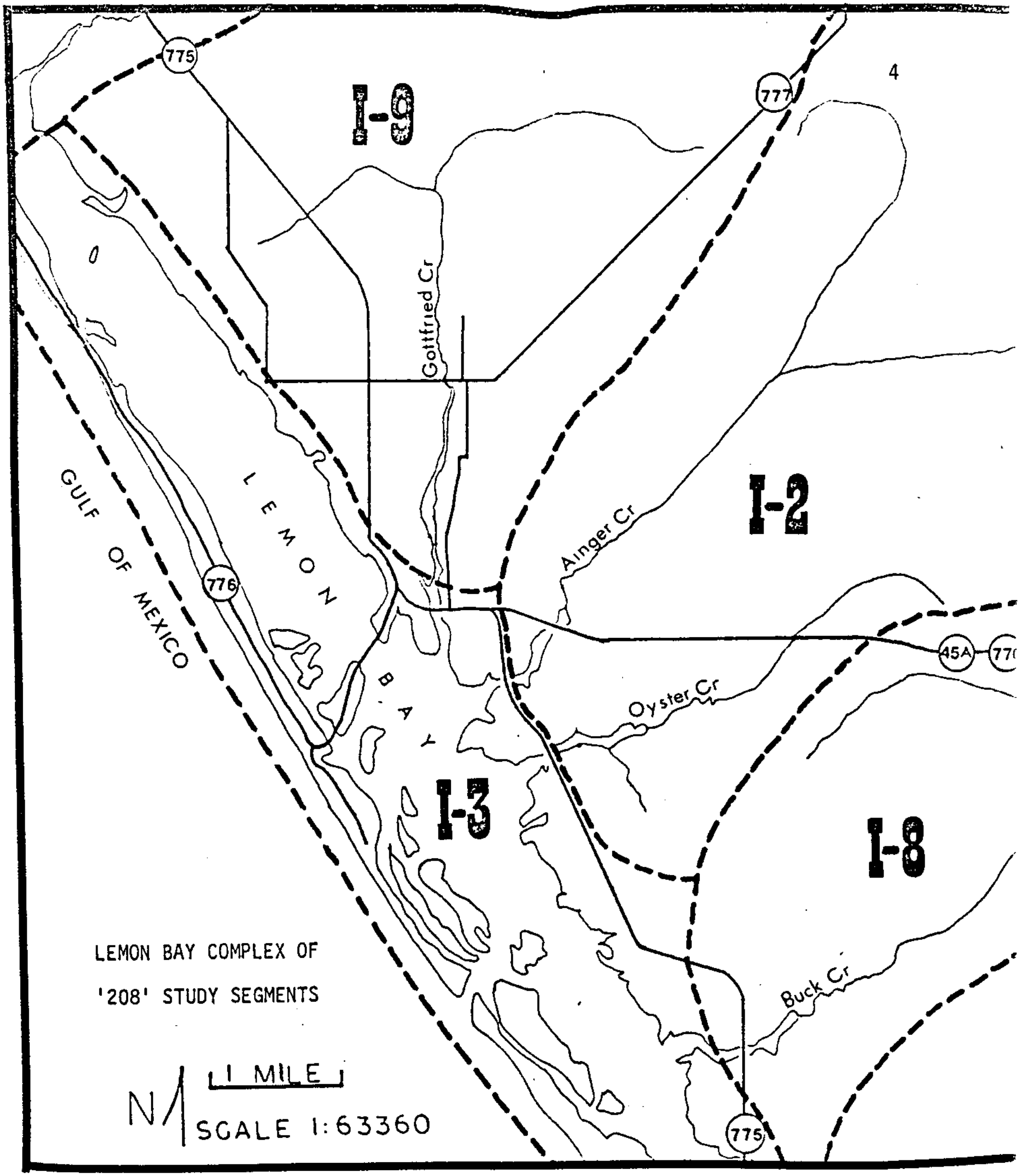
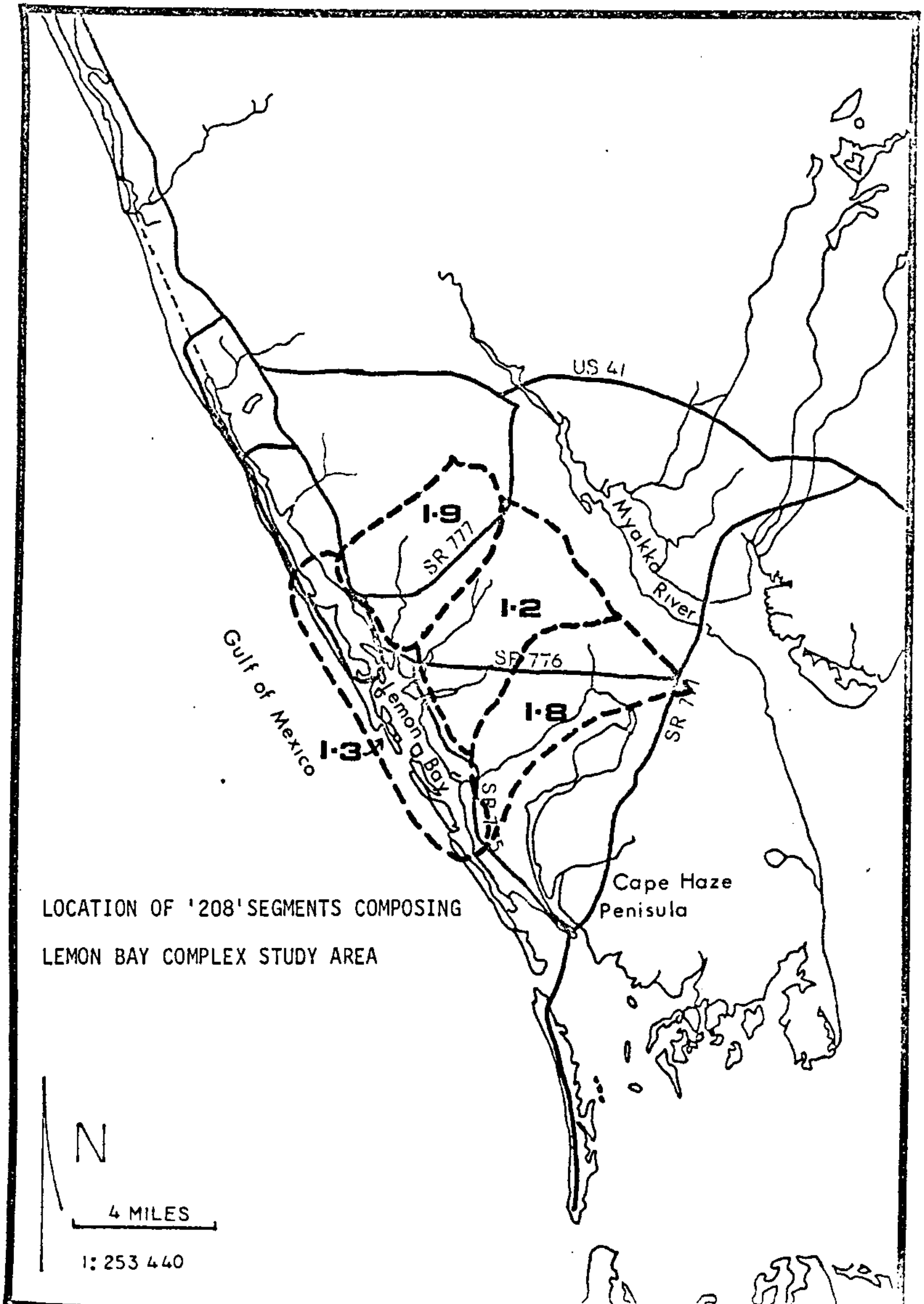


Figure 1. Lemon Bay Complex of '208' study segments(I-2, I-3, I-8, I-9).

Figure 2. Location of "208" study segments (I-2, I-3, I-8, I-9) composing Lemon Bay Complex study area.



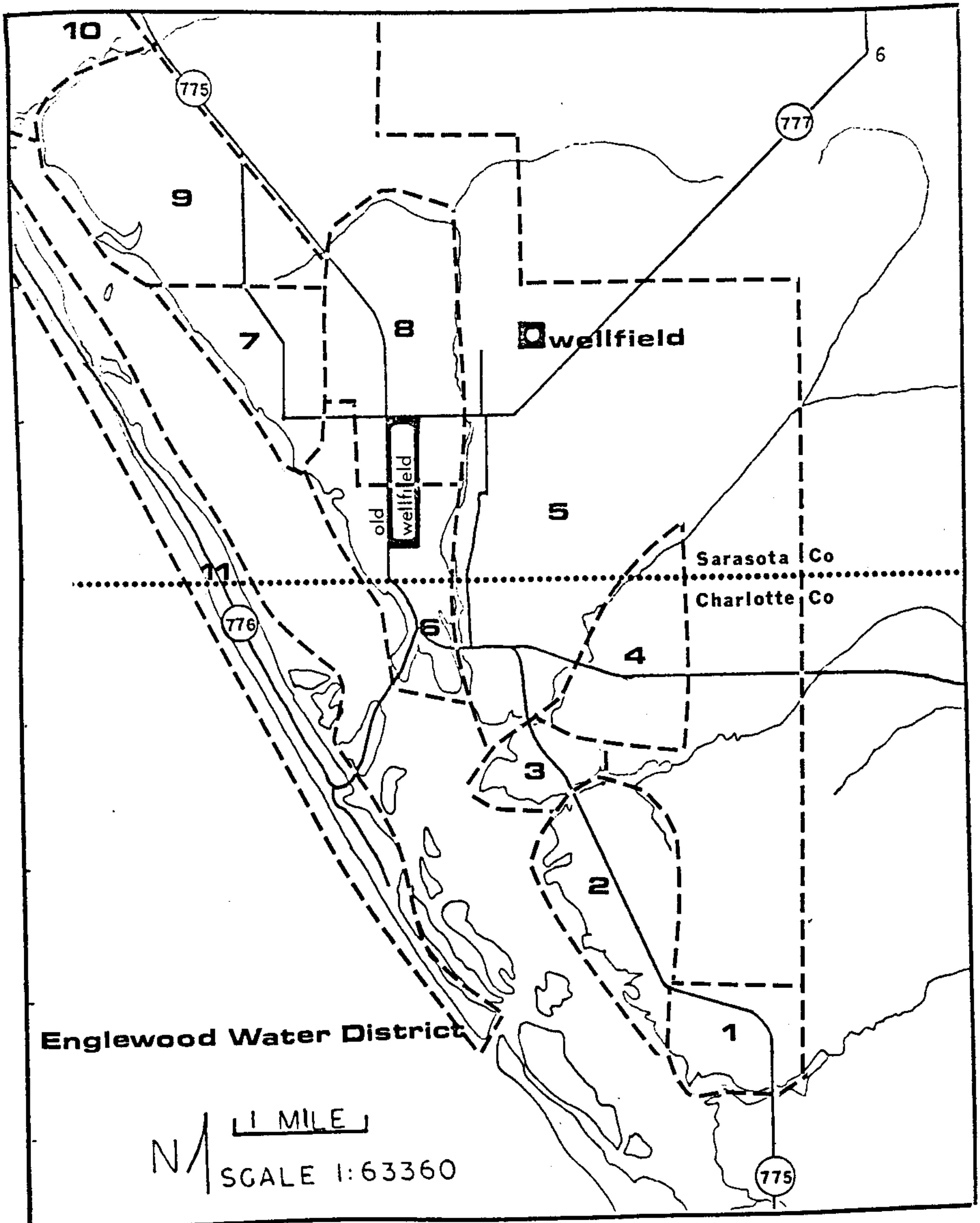


Figure 3. Geographical limits of Englewood Water District, subdistricts, and locations of well fields. Note: subdistricts 10 and 11 extend northward to the Manasota Key Bridge.

it as a single community.

History.

Early in the study we realized that the origins of the present water quality problems and concerns in the Lemon Bay area had a history of over 100 years of changing land use practices. In order to give the present day situation in proper perspective we have summarized some of the historical events in Table 1.

The archeological sites of the pre-modern settlements in the area are located on relatively high ground on promitories on the eastern shore of Lemon Bay and near the mouths of Gottfried, Ainger, and Buck Creeks. The only modern settlements are also located on relatively high ground with well drained soils in Englewood and Grove City. However, since the 1940's building and earth moving technologies have allowed the original communities to extend into areas that were once less suitable for homesites.

With the early modern settlements in the 1850's came the first "woods cows" and razorback hogs whose increasing numbers contributed to changes in the nutrient and sediment budgets of the creeks. During the 1880's a major fishing industry developed along the waterfront of Lemon Bay and inland agricultural activities increased. Following the clear cutting of the pine flat woods on the Cape Haze Peninsula by the Manasota Lumber Company and other lumber companies in the early 1900's, the uplands became open range land for cattle until 1948 when the Fence Law was enacted.

The combination of clear cutting and cattle contributed their share to the nutrient-pollutant and sediment loads of the creeks and Bay. Although the actual numbers of cattle are not known, it is interesting to note that between 20 and 35 acres are required per steer on unimproved pasture land in this area and that the 150 gms solid waste per day of one steer is equivalent

Table 1. Historical sketch of certain events leading to present day land use and water quality conditions in the Lemon Bay area.

Date	Event	Estimated Resident Population
1850-1870	First settlers bring "woods cows" and razor back hogs	
1850-1900	Woods cows in herds roam Englewood area.	
1866	Grove City first laid out in woodlands.	
1870	Goff family raised rice in slough at head waters of Oyster Creek.	
1883	Hamilton Disston purchased 600 acres of Grove City area for 25¢/acre. Subsequently land went through eight different owners.	
1886	January freeze one of the worst known.	
1894-95	Freezes on December 29-30, 1894 and February 9, 1895 after 2-3 weeks of rain.	
1896	Lemon Bay Company filed a plat for town of Englewood. 2000 acres, 24 city blocks and 96 ten acre "grove" lots. Residential lots were 1 acre (two city lots). Before this,area called Vineland.	
1903	Summer rainy season, ground between Englewood and Venice covered with water, especially in the area called Woodmere.	
1911	June, 14 days of rain, Myakka River was 10 feet higher than ever recorded, high water line on trees 10-20 feet above ground.	
1890-1919	Englewood had a small sawmill and turpentine stills.	
1917-18	Englewood road (S.R. 775) to Sarasota built with local rock from Deer (Gottfried) Creek used on the 34 milelong road.	
1918	Manasota Lumber Company established a mill town near junction of S.R. 775 and U.S. 41 and clear cut the pine flat woods of Cape Haze peninsula.	
1921	In the hurricane of that year the water in Lemon Bay reached the second story of the present-day Tate Buchanan House and flooded for blocks inland	
1926	Hurricane-storm resulted in extensive flooding.	
1926	Englewood incorporated as a 13 square mile tract, 12 miles of water frontage of which 4 miles were on Gulf	300
1928	The Tamiami Trail (Highway 311) passed through Englewood.	

Sources: Josephine O. Cortes. 1976. The History of Early Englewood. Mr. Beryl Chadwick, Englewood, Dr. Stewart Springer, Placida. Newspaper articles on file in public libraries of Grove City and Englewood.

Date	Event	Estimated Resident Population
1930's-1940's	The deforested Cape Haze Peninsula became open range cattle land. Tamiami Trail (U.S. 41) re-routed to by-pass Englewood.	
1939	Local red tide with thousands of fish washed ashore in Englewood.	
1940	Grove City, over 1000 acres acquired by Grove City Land Realty Corp, Samuel Spinosa, President. Between then and early 1950's, small lots (many with 30 foot frontage) were consolidated and the whole area was replatted into 100 x 100 foot lots.	
1948	Florida Fence Law abolished open range land.	
1948	West Branch of Gottfried Creek with drainage ditch as far as S.R. 775. Subsequently the sloughs of north and east branch linked to creek by drainage ditches.	
1948-1952	Sloughs at head waters of Ainger Creek connected by drainage ditch. Subsequently a drainage ditch linked sloughs of Buck Creek basin to Ainger Creek.	
1951	E. Vanderbilt purchased 54 mile square tract (35,000 acres) on Cape Haze peninsula.	
1952	E. Vanderbilt opened Two V Ranch with 1,000 certified cattle. At one time an estimated 5,000 head of cattle roamed this ranch land. Vanderbilt also purchased land along Lemon Bay (Cape Haze) and on Manasota Key. He and his family were instrumental in promoting the area for seasonal residents.	
1954	Residential restrictrictions placed on development in Grove City.	
1955	Following this year canals and electric lights added to Grove City area.	
1956	Population reported to double in winter tourist season.	1,400
1960		5,000
1961	Lemon Bay hardshell clam industry had been declining for 15 years because of gradual silting.	
1963-68	Englewood Water District and central water established.	
1963-65	Intracoastal waterway dredge and dredge spoil placed on mangrove islands, submerged grass flats, fringe mangrove shores and uplands the length of Bay. Residents determined not to have spoil islands in the Bay but willingly accepted spoil on submerged lands adjacent to shores.	

Date	Event	Estimated Resident Population
1964	Paulson Point (Furbeck's Point), Englewood, site of Indian Mounds. Diked and filled with dredged spoil.	7,500
	Blind Pass Island, Manasota Key. 30 acres of flat created by placing spoil on grass flats and 17 acres of mangroves.	
	In the Manasota Key section south of Manasota Key Bridge a dike of spoil parallel to Waterway outlined proposed future shoreline of the Key an area of grass flat to be filled with spoil thereby doubling the width of the Key.	
1965(?)	Venice Cut opened linking the waters of Lemon Bay with Roberts Bay and Venice Pass. The result was a marked change in tidal circulation and seasonal salinity gradients in upper Lemon Bay.	
1965-67	Rotunda West began to be developed intercepting Buck Creek and Canal Creek drainage basin systems.	
1968	Buck Creek and west branch of Canal Creek intercepted by a segment of proposed circular canal with overflow wiers placed on each creek.	10,000
1969		12,000
1970		13,000
1971	Rotunda West Circular Canal or River partially completed.	14,000
1972		15,864
1972-73	Oyster Creek channelized between S.R. 45A (776) and Sarasota Charlotte County line with drainage basin north of county line intercepted by an east-west canal and spoil dike.	
1973		17,906
1974	Gasparilla Pines Golf Course intercepted Lemon Creek drainage basin east of S.R. 775. Control wier and dike across creek just east of S.R. 775.	
1975	Spring, large outbreak of blue-green algae. GDC received D.E.R. permit to place a wier on the upper reaches of Ainger Creek.	18,803
1976		18,880
1977	Cape Cave Corporation received D.E.R. permit to dike Buck Creek and construct two retention ponds and grassy filters in pine flatwoods along Buck Creek, west of Rotunda West.	

to the wastes of 16 people (Wadleigh, 1967). Furthermore, the amount of nutrients produced per cow per year is estimated at 17.6 kilograms total phosphorous and 57.5 kilograms total nitrogen (Omernik, 1976). In 1961 a shellfish survey report (Woodburn, 1962) noted that the productivity of commercial clams had been declining for 15 years because of siltation. By the early 1960's non-urban land use practices in the watersheds of the creeks had already colored, if not altered the waters of the Bay.

With the mid 1960's the originally hoped for progress in the area began to intensify both on the uplands and in the Bay. The dredging of the Intra-coastal Waterway and the ensuing runoff from the non-confined spoil areas contributed their share of silt. The opening of the Venice By Pass Canal altered the tidal flow regimes and the historical seasonal salinity patterns in the northern part of the Bay - patterns that were essential to the fame of the Lemon Bay oyster. However, the altered tidal regimes in Lemon Bay north of Forked Creek may have relieved the central region of Lemon Bay of certain water quality problems caused by upland developments and wastewater practices in the Alligator Creek basin.

The settlement of the eastern side of Lemon Bay was accompanied by alterations in surface drainage patterns by roads and drainage ditches. The early roads and trails depicted on pre 1940 maps tended to run along drainage and subdrainage basin ridge lines. After World War II more and more roads transected parts of the creek drainage basins. The historical flood plains in the pastured areas of Gottfried, Ainger, and Oyster Creeks were partially channelized by drainage ditches. More recently the historical flood plains of Lemon, Buck, Oyster, and Ainger Creeks are being eliminated by urban land development. These alterations and the lesser drainage and filling activities associated with minor land developments have contributed to the nutrient-

-sediment load of Lemon Bay and its tributaries; particularly during the period of construction when surface and subsurface soil horizons were exposed to rains and surface runoff.

The final chapter involves the changes in the original shorelines. Although Lemon Bay has been spared the water quality consequences of dead end finger canals along its shores, the Charlotte County sections of Gottfried, Ainger, and Oyster Creeks have not. Most of the finger canals on these creeks were constructed in the 1960's before people were aware of their impact on water quality.

In conclusion, while onsite wastewater systems in the Lemon Bay have contributed to the wasteload of the Bay and its tributaries, these systems have been preceded and accompanied by an array of other non-point sources of nutrients and pollutants.

Present Geography and Land Uses.

The Lemon Bay Complex has several geographical areas other than the 208 Sarasota coastal segments and the tidal creek drainage basins. In order to orient the reader these geographical areas are described below. Land use patterns are detailed elsewhere in this report. Map IV shows the names and locations of the major geographic features and sites.

Manasota Key. The Key is a long narrow peninsula separating the northern three-fourths of Lemon Bay from the Gulf of Mexico. The south end of the Key is at Stump Pass. The southernmost one and one-half mile section of the Key is an undeveloped State park. From the north end of the Park a two lane road runs northward up the middle of the Key past Manasota Bridge. The Charlotte County end of the Key is wide enough to allow the development of secondary roads and multi-family resort and apartment units. Over 60% of the developed land is residential land. A small business center is located in Englewood

Beach at the junction of SR 776 and Beach Road. North of the county line large single family residential lots prevail. Many of these properties extend from the Gulf to Bay with the homes located in the higher land west of Manasota Key Road.

In addition to the undeveloped lots north of Englewood Beach proper, there are three county parks on the Key at Englewood Beach, Blind Pass, and Manasota Key Bridge.

Knight Island and Thornton Key. These keys form part of a barrier island system south of Stump Pass. At the present, Thornton Key is undeveloped and Knight Island has only a few single family units. However, development plans for residential units on both islands are under way.

Englewood. The town of Englewood proper may be considered that area bounded by Lemon Bay on the west and Gottfried Creek on the east. This area corresponds to the EWD Subdistricts 6, 7, and 8 (Figure 3). The area is divided into NE, SE, NW and SW quarters by SR 775 and 777. Commercial development is located along both of these roads. The remainder of the developed sections of the town includes single family residential units, several trailer/mobile home parks, churches, and one school.

EWD Subdistrict 5. The developed sections of this area (Figure 3) are located along Gottfried Creek and Ainger Creek in the delta-shaped upland area between the creeks. Commercial strip development occurs along SRs 776 and 775 at the southern end of the area. Elsewhere single family developmental units prevail in the area between the two creeks north to SR 777.

The rest of the land area in Subdistrict 5 consists of former unimproved and improved pasture land that is in the planning stages of urban development. However, for the present these lands which include sections of the upper reaches of Gottfried, Ainger, and Oyster Creeks are designated open land since most of the area is not platted.

The eastern boundary of Subdistrict 5 forms a definitive human geographic boundary separating the present and future land development in the Englewood area from the platted land developments of Rotunda (Cape Cave Corp.) and General Development Corporation's Myakka Estates in Sarasota County and their tract developments north and south of SR 776 in Charlotte County.

EWD Subdistrict 3. This small area between Ainger and Oyster Creeks (Figure 3) is transected by SR 775 with its commercial strip. The developed land consists of single family residential units, a church and a junior high school. Interestingly, more than 80% of this area is undeveloped. The only waterfront development is located on two pre 1950 end canals on Ainger Creek.

EWD Subdistrict 4. This is a triangular shaped area (Figure 3) bounded by Ainger Creek on the west, undeveloped lands of Subdistrict 5 on the east, and Subdistrict 3 on the south. The area is traversed by SR 776 with its commercial strip. A few small light industries occur in the San Casa Road area south of SR 776. From SR 776 north to the county line most of the area consists of single family and mobile home park units in the uplands and the deadend canals off of Ainger Creek. South of SR 776 additional single family and mobile home park units occupy most of the existing platted land. A small area of unplatted, undeveloped land exists between SR 776 and Oyster Creek; the remaining undeveloped land in this subdistrict occurs north of the county line.

Grove City, EWD Subdistrict 2. This area is bounded by Lemon Bay on the west, Oyster Creek on the north, and the wetlands of the south branch of Oyster Creek on the east. Nearly all of the entire area except for the commercial strip along SR 775 has been platted for single family units. At the present time less than 50% of the platted land is developed.

Placida Church, EWD Subdistrict 1. This area is bounded by Buck Creek on the south and Rotunda on the east. At the present time about 50% of the area is platted and has secondary roads. Less than 50% of the platted area is developed.

Buck Creek, Lemon Creek Area. This small area bounded by Lemon Bay on the west and Rotunda on the east is undeveloped except for the following: Gasparilla Pines Golf Course east of SR 775, a small finger canal development, at the mouth of Lemon Creek and a marina on Lemon Bay south of Lemon Creek.

The Englewood Water District. The Englewood Water District encompasses approximately 7,040 acres which include the Forked Creek drainage basin. Within this area there is an estimated population of 16,000 to 18,880 residents. Tourists visit the area mainly between January and April. Of the resident population an undetermined number are not in residence between June and September.

The wastewater facilities servicing this population consist of twenty-two onsite package plants and onsite septic tank systems. Since the majority of the population is serviced by septic tank systems, the geographic distribution and location relative to seasonal watertables, ground water gradients and proximity to bodies of water of the septic tanks systems are important elements in assessing their roles as non-point sources of pollution. However, any objective assessment of the impact of septic tank systems on water quality in the Lemon Bay area should include a detailed analysis of individual systems including their installation and maintenance.

CLIMATE

With respect to non-point sources of pollution the most important climatic factors are precipitation and evapotranspiration. The latter is affected by wind, relative humidity and temperature. These factors, in turn, are involved directly and indirectly with the volume of water that enters the Bay and its tributaries via run-off and groundwater movements. Figure 4 outlines the complexities of these relationships.

A casual review of various environmental and planning reports indicates that the "normally pleasant" subtropical climate in the Lemon Bay area is a major factor in attracting retirees and tourists to the area. However, closer examination of monthly and yearly climate data shows that the "normally pleasant" summaries are punctuated with "unpleasant" short-term events (i.e., winter freezes, subtropical storms and occasional intense dry season rains) that affect both the water quality of the receiving waters and the hydrological cycles in the area. Thus land planning and evaluation programs will have to incorporate more and more the 1 in 5, 10, 25, 50 and 100 year climatic events for the area.

In addition to official weather station records from Sarasota and Punta Gorda, the Lemon Bay area is fortunate to have several unofficial weather stations that have recorded daily temperature and rainfall for various lengths of time. These weather stations which will play increasingly important roles in future local climate and land use run-off studies are as follows:

Englewood Water District Water Plant, west side of Gottfried Creek, rain gauge and daily records since 1972

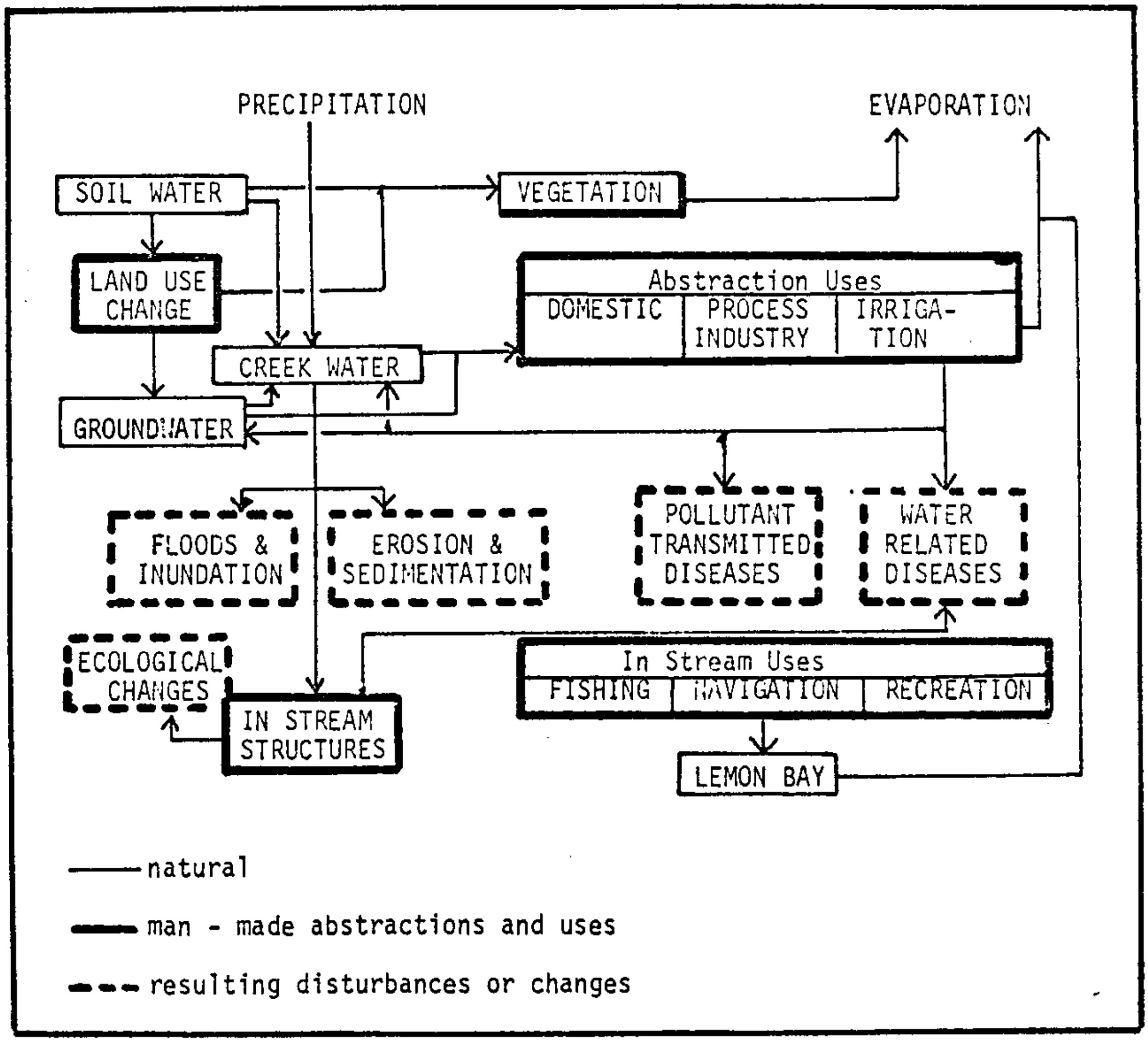


Figure 4. Simplified scheme illustrating man's interaction with water sources and resources of Lemon Bay.

Adapted from: Falkenmark, 1977.

Mr. Parmalee, The Englewood Weather Man, east side of Gottfried Creek, rain gauge and maximum/minimum thermometer since 1964

Cape Haze Water Plant Rotunda, weekly rain gauge records

Mr. Norman Thomas, Englewood Beach, recording temperature gauge and rain gauge

Mr. Robert Murphy, Englewood Beach, non-recording anemometer.

Precipitation. Although the average rainfall for the Lemon Bay area is approximately 50 inches, Figure 5 shows that the total annual rainfall from 1967 to 1976 has varied from 42 to 90 inches. This figure also shows that heavy rains accompanying cold fronts occur during the "dry season" months of November, January and March.

The rainfall patterns for the Lemon Bay area differ from those of nearby North Port Charlotte and the Punta Gorda Areas (Figure 6). Furthermore, the EWD water plant daily rainfall records show that daily rainfall events have been different for each month for the years 1972-1976. The water plant records also reveal that marked fluctuations in the amounts of water pumped by the plant are correlated with rainfall events. Figure 7 illustrates these fluctuations for 1976. The rainfall pattern for this particular year differs considerably from the average monthly summaries. To further illustrate the uniqueness of rainfall events in the last 4 years we have graphed in Figure 8 the number of days having rainfall greater than 0.9 inches. This graph shows that the majority of excessive rains have occurred between June and October when the resident-tourist population and household water consumption are the lowest for the year. Thus rainfall intensity-duration-frequency curves may have to be developed for the Lemon Bay area if such curves are to be used in land use-run-off equations.

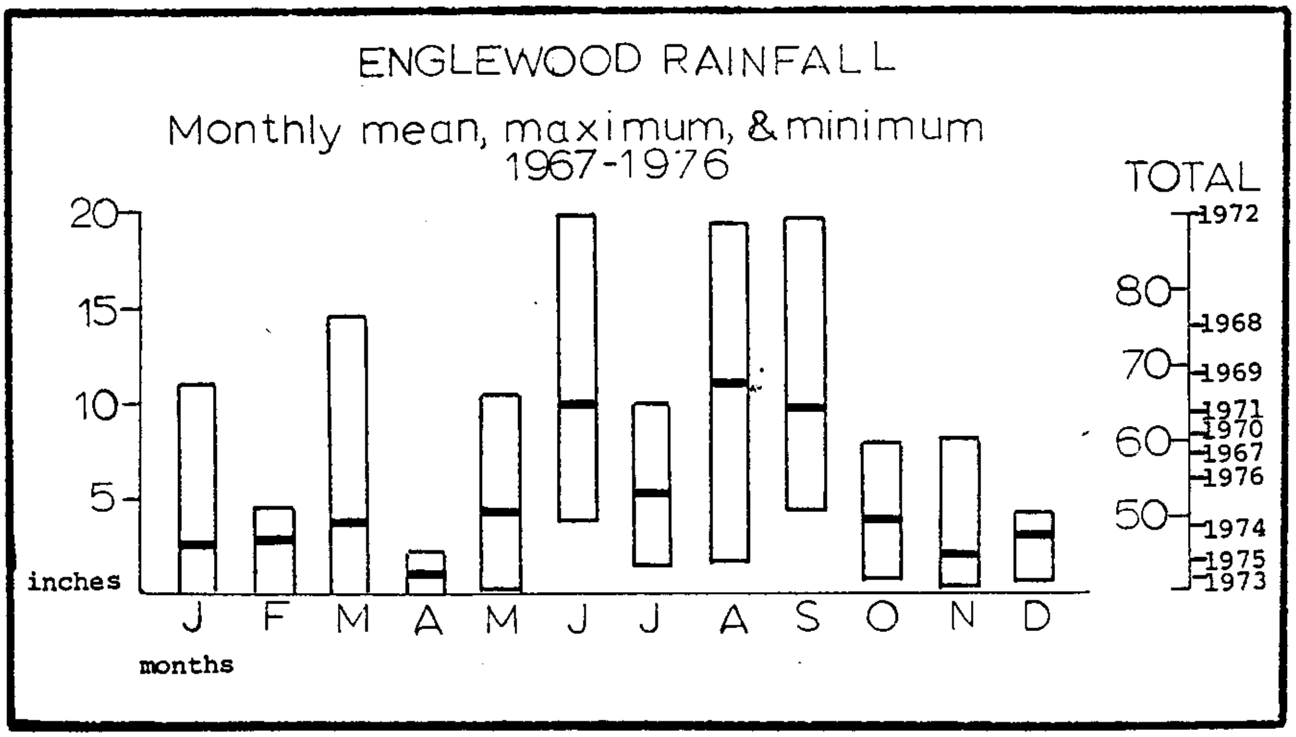


Figure 5 Mean annual rainfall in Englewood, FL, from 1967 to 1976. Mean monthly rainfill over that ten year period is indicated by heavy horizontal line; maxima and minima for each month during that ten year period are indicated by the bars extending above and below the means. Data from: Mr. Olin Parmalee, Englewood, FL.

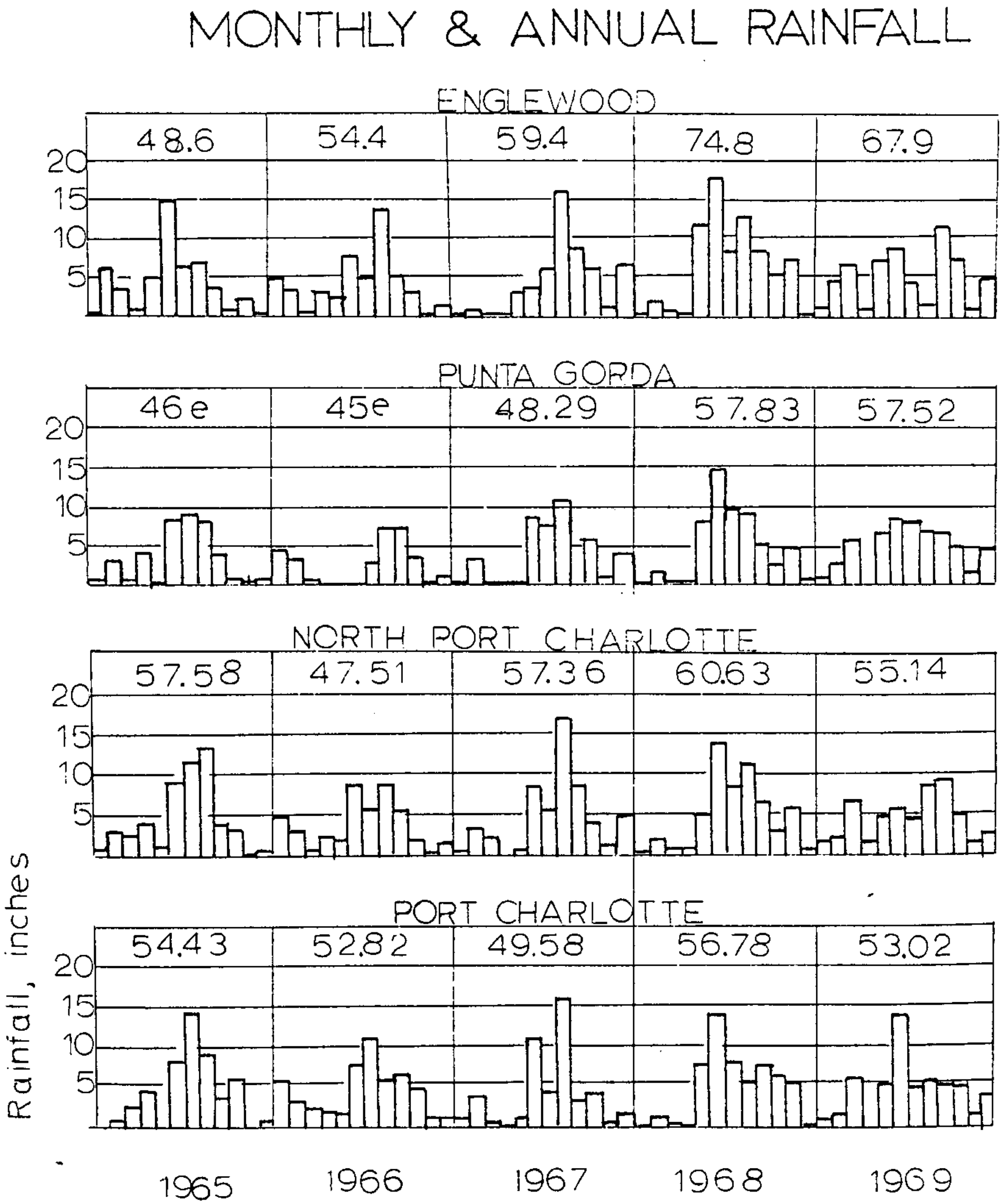


Figure 6. Monthly (bars) and annual (in inches at top of columns) rainfall in Englewood, Punta Gorda, North Port Charlotte and Port Charlotte, 1965 to 1969. Englewood data from Mr. Olin Parmalee. Other data from: Sutcliffe, H., 1973, Appraisal of the Water Resources of Charlotte Co., U.S.G.S.

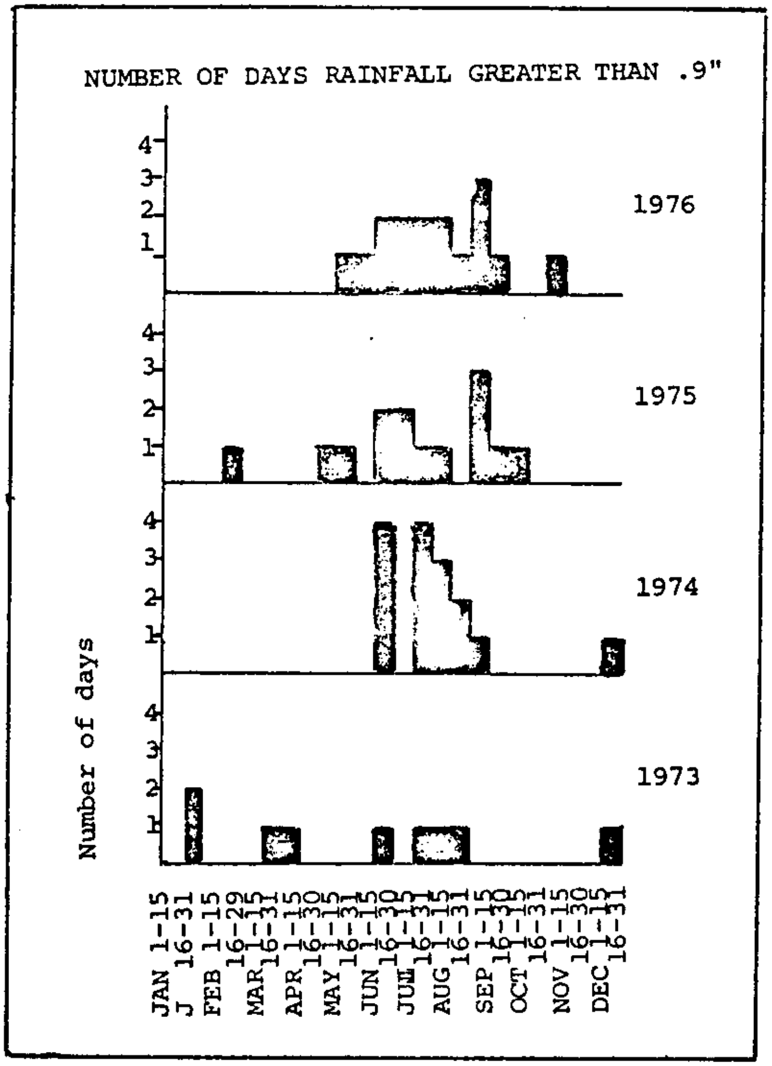


Figure 8. Summary of number of days of rainfall greater than 0.9 inches for the years 1973 to 1976. From: EWD Water Plant Records.

Periods of excessive summer rain have caused and continue to cause local flooding in topographic depressions. Such periods of rain also result in elevated ground water tables to above the ground surface in such depressions. However, both flooding and elevated ground water tables have been reduced by drainage ditch networks in recent years. Most of these networks in the Lemon Bay area consist of vegetated swales. Field observations during the summer of 1977 indicate that standing water in the ditches is rare except in low places and where the ditches are improperly graded.

Even though the Lemon Bay 208 Complex is a small geographical area, not all of the area experiences the same amount of rainfall in a particular 24-hour period. This is particularly true in the summer when the rainfall is from convective showers that produce more than 1.0 inches of rain and have sharp rain gradients. In such storms the rainfall decreases to one-half the core maximum within 2 miles of the core's center, implying a mean rain gradient of 0.5 percent of the rain falls in 10 to 20 percent of the time for a rainfall event. About 50 percent of the rain volume is contained in 10 to 20 percent of the rainfall area (Woodley, et al, 1974). At the present time there is no information on the local distribution of rainfall events in the Lemon Bay area.

Rainfall events also contribute variable amounts of nutrients either directly or indirectly to the land and water surfaces. Although this contribution has not been studied in the Lemon Bay area, a number of studies indicate that rainfall could be an important source of nutrients and pollutants. Significant amounts of ammonia, nitrate and phosphate inputs from rainfall have been reported for other areas (i.e., Brezonik et al, 1969; Federico, 1977; Reimold and Daeber, 1969; Turner, 1972; Denmead et al, 1974;

Haines, 1976; and Gasser, 1975). In a preliminary study of nutrient content in rainwater in northern Sarasota County, Gasser found that rainwater from single rain events in August 1975 contained 20-80 μg/l total phosphorous, 11-20 μg/l nitrite, 80-260 μg/l nitrate, and 100 to 210 μg/l ammonia.

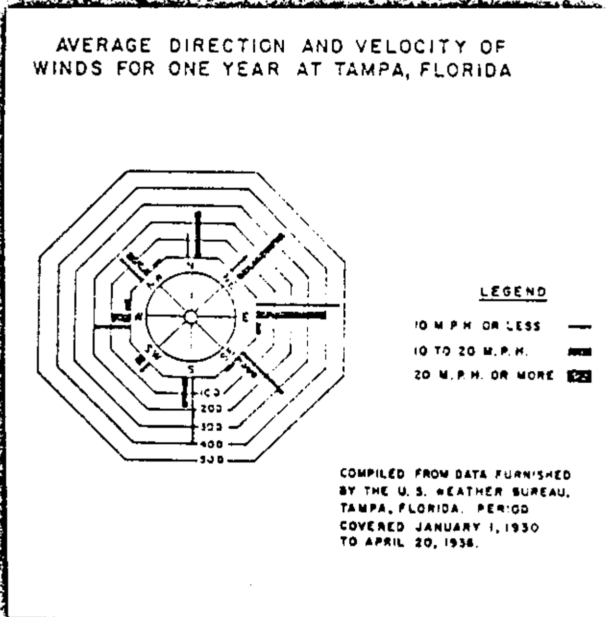
In addition to dissolved nutrients rain events also scavenge submicroscopic aerosols and particles present in the air (i.e., Sievering, 1976). Finally, nutrients and pollutants deposited on surfaces of vegetation through rainfall and dry fall out may be concentrated and carried to ground via rainwash and through fall through the vegetation (i.e., Reiners, 1972).

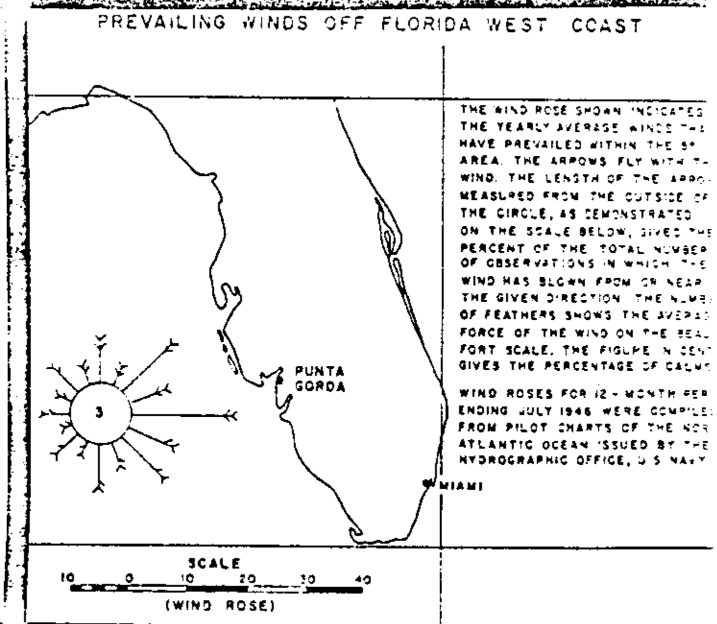
These sources of nutrient inputs might be miniscule in the Lemon Bay area were it not for the fact that the land use practices on the Cape Haze Peninsula have included large tracts of unimproved and improved pasture land and since the late 1960's extensive urban land developments have exposed hundreds of acres of bare ground. The wind erodability of the bare soils in such areas is considerable (Table 6). In addition, the prevailing winds are frequently from the east (Figure 9). Thus dry fall out and precipitation may contribute significantly to the wasteload of Lemon Bay.

Short Term Climatic Events.

There are two short term climatic events that affect the water quality of Lemon Bay and its tributaries - hurricanes and winter freezes.

Hurricanes. The hurricanes that have passed within 100 miles of Lemon Bay are listed in Table 2. Of the twenty-nine known hurricanes or subtropical storms fourteen were classified as being of hurricane intensity. The relative frequency of hurricanes in the area for the period 1900-1976 is 1 in 5 years. The relative frequency for hurricanes and tropical disturbances combined is 1 in 2.5 years.





Wind Directions

Direction	Percent Offshore area	 Shore area	 Tampa area
North	8	16	11
Northeast	17	11	14
East	22	20	24
Southeast	17	9	13
South	13	13	16
Southwest	7	8	3
West	6	11	9
Northwest	7	11	9

Figure 9. The percentage of time and velocity that the winds blow from different directions in the offshore, shore, and Tampa areas.

From: Department of the Army, Corps of Engineers, 1976.

TABLE 2.

CHRONOLOGICAL LIST OF HURRICANES PASSING WITHIN 100 MILES OF STUMP PASS SINCE 1900

from: Reynolds, 1976.

1900	September 5-7
1901	August 10-17
1903	September 10-16
1910	October 11-13 Direct Hit
1911	August 9-14
1912	September 11-23
1915	September 4
1921	October 21-31
1925	November 1
1926	September 6-22 Direct Hit
1928	September 16-22
1929	September 22- October 4
1932	August 24- September 4
1933	July 25- August 4
1935	August 31- September 8
1936	July 27- August 1
1941	October 4-12 Direct Hit
1944	October 13-21
1945	September 15-20
1946	October 7-9
1947	September 11-19
1948	September 19-25
1950	September 1-7
1950	October 15-19
1951	September 30- October 7 Direct Hit
1953	October 8-10 Direct Hit
1960	September 3-13
1966	June 4-14
1972	June 15-22

Sources: Storm Tides in Florida as Related to Coastal Topography, Bulletin N. 109, Florida Engineering and Industrial Experiment Station.

Hurricane Experience Levels of Coastal County Populations, National Oceanic and Atmospheric Administration.

The major environmental impacts of such storms are direct tidal flooding and indirect flooding from the excessive rain over a 2 to 4 day period. The highest tides recorded in the general area are given below.

Date of Storm	Height of Storm Tide in Feet Above Near Sea Level
Oct. 1921	9.3
Sept. 1926	11.5
Oct. 1944	6.5
Sept. 1960	6.4

Source: U. S. Army Corps of Engineers, 1976.

It has been estimated that the height of the tide occurring in the area in a 1 in 100 year storm would be 11.5 feet. Such a storm would inundate the barrier islands as well as most of the areas of the tidal creek basins in the Lemon Bay area.

Since 1972 State and Federal regulations and guidelines have played increasingly important roles in minimizing flood impacts on new land developments. Yet little has been done to remedy tidal and rainfall flood hazards created by elevated, diked roads, and construction of buildings on or close to historical flood prone areas.

Flood tides, lowland flooding, and the accompanying surge in surface water run-off have and will continue to have a direct effect on the nutrient budget and water quality of Lemon Bay. Historically the flushing action of storm tides and the "flush out" of upland nutrients and sediments contributed to the Bay's balanced productivity; but we do not know if these events continue to play a positive role in the Lemon Bay ecosystem.

Winter Freezes. Periodically the equitable annual temperature cycle (Figure 10) for the Lemon Bay region is punctuated by short periods of "abnormally" low temperatures in December, January and February. During these periods air temperatures drop below freezing resulting in fish kills and frost damage to the terrestrial vegetation. Table 3 lists the major recorded winter freezes in the region.

The effects of such freezes on water quality of the Bay and its tributaries are twofold. First dead fish tend to accumulate along the shores and in depressions in the bottoms of the bodies of water. Those that are not consumed by other animals decompose thereby contributing to the nutrient and BOD loads of the waters. Fish not directly killed by the low water temperatures may be indirectly killed by anoxia after seeking the warmer subsurface water in dead end canals.

The second major effect is the frost damage to the mangroves along the creeks and shores of the Bay. Following a cold period like that of January 1977, mangroves in the Lemon Bay area die back almost to ground level. Although new growth resumes later in the year, large amounts of dead leaves are released from the trees during late spring and early summer rains thereby adding to the nutrient and BOD load of the Bay during the early part of the wet season.

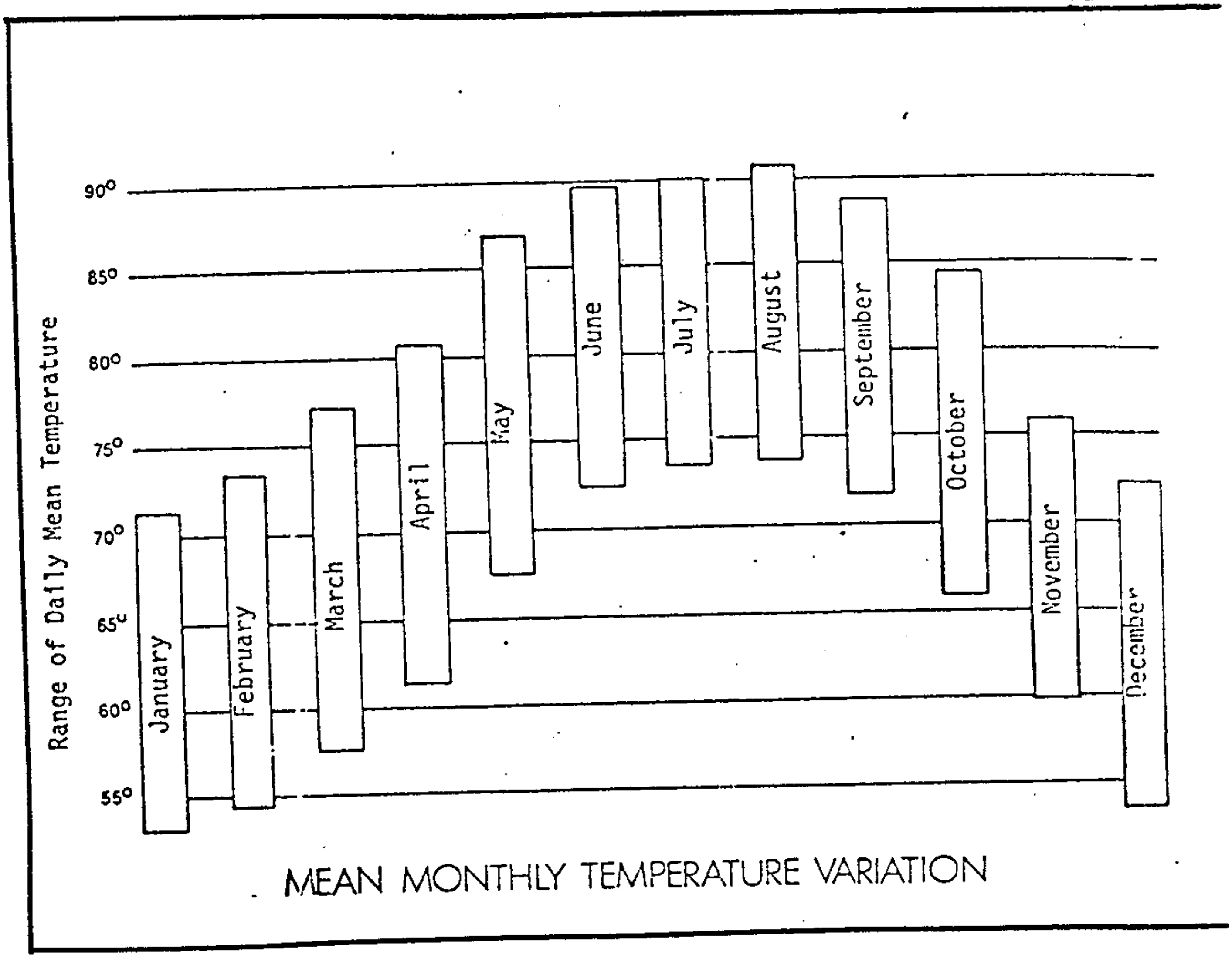


Figure 10. Mean monthly temperature variation in Sarasota, Florida. From: Smalley, Welford, and Nalvin, 1976. Sarasota County 201 Report.

Table 3 Chronology of Winter Freezes and Fishkills in the Lemon Bay Area[1]

Date	
1886	January freeze one of the worst known for southwest Florida.
1894-95	Two freezes as far south as Sanibel on December 29-30, 1894 and February 9, 1895. Lemon Groves of Englewood area destroyed. In Sanibel area vast quantities of shallow water fishes were killed. Young mangroves killed and older mangroves killed to main limbs.
1898	January 3. Temperatures on Sanibel as low as 26°F. Crops were destroyed. Fish mortality was high
1899	February 14. Official Ft. Myers temp. was 28°F. Fish were numbed but not many killed
1905	January 26-27. Ft. Myers temp. was 27°F. Plants more than fish severely damaged.
1915-1916	In this winter freeze water oaks on the Myakka River were killed.
1917	January-February. A month of frosts and near freezing temperatures resulted in "countless numbers of snappers washed into potholes---and lined up in rows in the creeks." 400 to 1000 pounds of numbed snook per boat were transported to the Sanibel fish houses. "Everywhere quantities of dead fish washed ashore and the stench on the beaches was awful."
1924	Remembered in the Englewood area as one of the coldest in Florida.
1928	January. In this one to two day freeze killed and numbed fish were washed ashore everywhere around Sanibel.
1934	December 12. The temperature dropped on Sanibel to 30°F within a few hours. Calm weather and heavy frost resulted in damage to island vegetation, but while many fish were paralyzed few were killed. "Fishermen dipped 2270 pounds of mangrove snapper from the creeks alone."
1962	December 13. This freeze killed the seagrapes on Manasota Key as well as fish in Lemon Bay.
1977	January 13. This freeze numbed and killed fish in the Creeks and Canals as well as killing back the mangroves along the shores of the Bay and Creeks.

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1. Information on freezes for 1886 to 1937 from Stanley and Gudger, 1936.

PHYSICAL FEATURES OF THE LAND

At the base of on-site wastewater systems are soils, subsoils, seasonally fluctuating water tables, and subsurface drainage patterns. Variations in the movements of ground water in these elements are related to vegetation, evapotranspiration rates, topography, and types of land use. Proximity of septic tank systems to surface waters of the Bay, creeks, natural sloughs, wet prairies and marshes, and man-made ditches, canals and real estate ponds is particularly critical when the ground water level is higher than the septic tank system or is higher than the level of the nearby open surface waters.

In the Lemon Bay area the historical topography, drainage basins and subbasins have been measurably altered during the last 70 years. Man-made drainage networks in the form of roadside ditches have been introduced. These networks as well as stream channelization in the agricultural areas and land filling in the developed areas have affected ground water patterns.

In contrast to a wealth of information on the alterations of the land is a paucity of information on the original and altered topography, soils, ground water tables, surface runoff patterns and stream flow. Only lower Gottfried Creek has been mapped to the one foot contour interval. While the soils in the Sarasota County part of the Lemon Bay area have been mapped in detail, those in Charlotte County have not. Information on ground water levels is scattered among well log records and septic tank permit applications. Stream flow data on the tidal creeks are non-existent. The vegetational patterns have only been described in relation to major soil types. Thus the descriptions of the physical features that follow must be viewed as preliminary sketches for more detailed studies.

Drainage Systems.

Basins and Topography.

The western portion of the Cape Haze Peninsula bordering Lemon Bay is divided into five drainage basins (Forked, Gottfried, Ainger, Oyster and Buck Creeks)(Map III). Historically the position of the divides between adjoining basins and other drainage basins to the east was somewhat arbitrary since the area drained by sheet flow and shallow marshes and swamps formed the headwaters of the neighboring basins. Furthermore, the entire creek drainage basins are characteristically composed of the semi-bounded subdrainage basins of the shallow marshes and swamps whose waters eventually flow into the creeks (See Map IV).

While Buck, Oyster and Ainger Creeks flow southwesterly into Lemon Bay, Gottfried Creek flows in a southerly direction. As a result Gottfried, Ainger, and Oyster Creeks converge on the eastern shore of Lemon Bay opposite Englewood Beach. At one time the sediment loads from these creeks probably contributed to the accretion of the southern end of Manasota Key. The sediment loads of Buck Creek may have contributed in a similar way to the growth of Knight Island and Thornton Key.

When the 5 foot contour interval lines are plotted as shown on Map V several interesting topographic features related to past and present land uses emerge. First the early settlements of Grove City and Placida Church between Oyster and Buck Creekswere on an upland island bounded by Lemon Bay on the west and wetland extensions of Oyster and Buck Creek on the east. The community of Englewood proper was also located on an upland island bounded by the west branch of Gottfried Creek and Lemon Bay.

In general the land slopes from elevations of 11 to 14 feet along the ridge lines of the basins toward the flood plains and wetland depressions formed by the 5 and 10 foot contour lines in each of the basins. In the lower reaches of each creek the 5 foot contour line not only delineates the flood plain proper, it also marks the upstream limits of mangrove and juncus marshes and normal salt water and tidal influences. The 10 foot contour line delineates the flood plains in the upper reaches of each basin where it is reflected by the strips of Sabal palms between the wetlands and the margins of the pine flatwoods. The patterns of upland runoff and erosion of the sandy soils and the irregular distribution of the more erosion resistant near-surface marl deposits and limestone have created islandic and peninsular shaped upland areas of pine flat woods with scattered seasonably wet depressions. Historically the upper reach of each of the four creek drainage basins functioned like a hydrological sponge.

When the seasonal and permanent wet areas shown in aerials flown in December-January for 1951-52 and 1976 were mapped (Maps V and VI) the distribution of permanent wet areas were still similar for the Gottfried Creek basin even though the major branches of the creek's drainage system had been partially channelized by drainage ditches. However, the other three drainage basins have been slightly altered since 1952. A drainage ditch in the Ainger Creek flood plain plus a second drainage ditch extending eastward from Ainger Creek across the upper reaches of the Oyster Creek basin wetlands to North Port have helped to "dry out" the pasture land of the Flying A Ranch. Minor drainage ditches have begun to appear in the uplands west of Ainger Creek since 1970 (Map VI). Further modifications of the surface and ground water regimes in the Ainger Creek basin will occur when a tidal wier and flood control structure is installed on the creek and a storm water retention system is developed for Myakka Estates. If this happens the limits of the Ainger Creek Basin will have to be redefined. One possible future basin configuration is shown on Map VII.

At the present time the tidal reaches of Oyster Creek basin have been altered slightly by channelization and dead end canals. However, marked changes have occurred in the basin east of San Casa Road and between SR 776 and the Sarasota-Charlotte County Line. In this area the historical creek has been channelized. The northern section of its drainage basin has been severed at the County line by a segment of the proposed Waterford Waterway that may eventually extend eastward and connect with Butterford Waterway of South Gulf Cove (See Map VII). When this proposed waterway system is completed it may be possible to go by small boat from the Myakka River to Lemon Bay via Oyster Creek. What may be more important to the ecology of Lemon Bay is that the upper half of the Oyster Creek basin is no longer a functional part of the Creek's basin.

In discussing the present status of the Buck Creek and Lemon Creek basins we have a picture of the ultimate futures of Oyster and possibly Ainger Creeks. With the platting of Rotunda and construction of tidal wiers on the west branch of Coral Creek and Buck Creek where the proposed circular Rotunda River would intersect the creeks, the future of the Buck Creek basin was sealed. The sheet flow through its flood plain ceased. Although water continued to flow over the partially constructed wier it was not the same water. Now as the Rotunda River enters its last phases of permitted construction a temporary/permanent dike in the creek has transformed the creek into a small finger of Lemon Bay.

South of Buck Creek lies Lemon Creek with its historic 0.9 mi. sq. drainage basin. Today the creek has been severed by a dike of the Gasparilla Pines Golf course just east of SR 775. What remains of the creek basin is a short segment between SR 775 and the Bay.

In summary, the original topography and drainage patterns of the lower reaches of the creeks have been altered by roads, landfilling, and dead end canals. These elements undoubtedly contribute to the "wasteload" of the creeks and Bay as did former agricultural activities in the upper segments of the basins. The impacts of highways and roads on the hydrogeolic environment are reviewed by Parizekri (1971). However, other recent land development activities are "drying out" areas in the basins. Flood control structures are adversely affecting historic wet season nutrient laden runoff. Thus the historical, annual, freshwater nutrient and sediment inputs to Lemon Bay have been replaced by a new complex of inputs.

The remaining undeveloped flood plain and flood prone areas in the Lemon Bay area that have been delineated by various agencies, including the Coastal Coordinating Council, the U. S. Army Corps of Engineers, Gee and Jensen, Inc. should be developed carefully. Wherever possible the flood plain and wetland vegetation along the creeks should be left undisturbed and any future channelization of the creeks should be prohibited. The natural vegetation of the flood plains is not only an important conservation element; it also plays a critical role as a biological filter for pollutants and a reservoir of nutrients and surface water in the ground water recharge system of the Hawthorne aquifer used by the Englewood area. In particular, the drainage network of Gottfried Creek north of SR 777 should be developed and managed carefully for its multiple roles in the conservation of the quality of the downstream surface waters and the subsurface aquifer recharge system.

Future land development of the creek basins that is compatible with the natural topographic and drainage patterns will be difficult for the following reason$. The islandic areas of developable land above the 10 foot contour line are irregularly shaped. Superimposed upon these irregularities are the traditional rectilinear, real estate patterns which usually yield to some form of the Jeffersonian gridiron pattern of roads and lots. While the patterns of the natural landscape and land development practices are currently incompatible, the undeveloped, unplatted area between Lemon Bay and North Port and Rotunda offer a challenge for the creation of new land development practices.

Sub-Urban Drainage.

Accompanying land development within the EWD of the creek basins, the construction of real estate lakes and ponds, and roadside drainage swales and ditches and the alteration of natural shorelines along the creeks and shores of Lemon Bay have affected drainage patterns and ground water tables in their immediate vicinity. These elements may also affect the ground water movement of pollutants in nearby septic tank systems. Accordingly,real estate lakes, drainage ditches and shoreline alterations deserve brief reviews.

Artificial Lakes. In their survey of the artificial lakes of Sarasota County Snow and Sipe (1975) described the location and ownership of the lakes, the type of and density of development near the lakes, the type of sewage disposal in the developments, and whether the lakes were located in a rural or developed area. The results of their survey for the Lemon Bay Complex area are detailed in Table 4. The number of lakes in the area are as follows: Englewood Coastal Basin, 4; Godfrey Creek Basin, 19; Ainger Creek Basin, 21; Oyster Creek Basin, 1. Of the 45 lakes in the area 34 were surrounded by rural or sub-urban developments that had private package treatment plants. The remaining 12 lakes had septic tank fields in their vicinity, but had either only one single family residence near the lake or no development. Thus while they do not appear to be affected by septic tank systems, these lakes do receive surface runoff. In addition, the lakes effectively lower the ground water table in the approximately 200 foot wide border of adjacent uplands.

In the Charlotte County section of the Englewood Water District there are 11 artificial lakes in the Ainger Creek Basin, 5 in the Oyster Creek Basin and 7 in the Buck Creek Basin. Altogether there are approximately 93 artificial

Table 4. Inventory of Artificial Lakes in the Sarasota county Section of the Englewood Water District.

Englewood, Coastal, Godfrey Creek, Ainger Creek and Oyster Creek Drainage Basins

KEY: SA, surface area; SL, shoreline length
SD, shoreline irregularity index of lake
N, no development
SFR, single family, following number denotes number of residences
Tp, trailer park
SEW, private package plant
ST, septic tank
R, road; NR, no road
ER, extremely rural; R, rural; S, suburban

ENGLEWOOD DIRECT COASTAL DRAINAGE

LOCATION T-R-S HALF SECTION PAGE	PARCEL # OR LAKE NAME	NAME OF SUBDIVISION PLAT BOOK #/PAGE #	OWNER/ADDRESS	SL	SA	SD	TYPE & DENSITY OF DEVELOPMENT	SEWAGE	ACCESS	GENERAL NATURE
40-19-23 492/493	726	Englewood Gardens, Unit 3 4/45-47	Nelson, James R. & Sandra 1041 Bayshore Dr. Englewood, 33533	600	.3	1.4	N dev uc	SEW	R	R
	759 760	Englewood Gardens, Unit 3 4/45-47	Totten, Margaret R. 1125 Larchmont Dr. Englewood, 33533 and Dignam, Thomas M. & Laverne A. 1151 Larchmont Dr. Englewood, 33533	500	.6	1	SFR-2	SEW	R	R
	787A	Englewood Gardens, Unit 7 4/74,75	Kroh Bros. Fla. Prop.,Inc. Englewood Isles Pkwy. Englewood, 33533	1300	.7	2.1	N	ST	NR	SU
40-19-25 496/497	75F	Replat of Plat of. Englewood	Whiteaker, G.H.& Bessie Box 418 Englewood, 33533	800	1.0	1.1	N	ST	R	SU

Table 4, continued.

GODFREY CREEK

LOCATION T-R-S HALF SECTION PAGE	PARCEL # OR LAKE NAME	NAME OF SUBDIVISION PLAT BOOK #/PAGE #	OWNER/ADDRESS	SL	SA	Sb	TYPE & DENSITY OF DEVELOPMENT	SEWAGE	ACCESS	GENERAL NATURE
40-19-24 494/495	Unnamed lake	Artist Acres 6/5 Englewood A/29	joint ownership by adjacent residents	1600	3.1	1.2	SFR-4	SEW	R	R
	100		Clark, Katherine D. 4020 Casey Key Rd. Nokomis, 33533	150	.1	1.0	N	SEW	R	R
	202A		Weaver, Elbert C. & Shirley M. Rt. 1, Box 524A Englewood, 33533	750	.7	1.2	N dev uc	SEW	R	R
	400		Daniels, Ruth K. P.O. Box 185 Englewood, 33533	1100 300 800	.9 .2 .5	1.5 1.0 1.5	N	SEW	R	R
	10012	Third Addition of Bay Vista Blvd. Section of Englewood 2/37	Cavallaro, Raymond & Theresa 4026 Yorba Linda Royal Oak, MI. 48072	550	.3	1.3	SFR-6	SEW	R	R
	11009	Third Addition of Bay Vista Blvd. Section of Englewood 2/37	Daniels, Ruth K. P.O. Box 185 Englewood, 33533	600	.6	1.1	N dev nb	SEW	R	R
40-19-25 496/497	29A, 29B	Plat of Englewood A/29	joint ownership by adjacent residents	600	.5	1.2	SFR-2	SEW	R	R

Table4, continued.

GODFREY CREEK

LOCATION T-R-S HALF SECTION PAGE	PARCEL # OR LAKE NAME	NAME OF SUBDIVISION PLAT BOOK #/PAGE #	OWNER/ADDRESS	SL	SA	SD	TYPE & DENSITY OF DEVELOPMENT	SEWAGE	ACCESS	GENERAL NATURE
40-19-25 496/497	Candlewood Lake 31B	Plat of Englewood A/29	Byers, Clyde L. & Doris 777 Englewood Rd. Englewood, 33533	1200	.9	1.3	SFR-4	SEW	R	SU
	40	Town Center 5/5	Fiandaca, Angelo, Jr. & Caroline O.F. Rte. 3 Moorehead, MI. 56560	700	.8	1.0	SFR-1	SEW	R	SU
	46A	Plat of Englewood A/29	Hocker, Frederick W. & Edella E. Hocker, Frederick, Trustee P.O. Box 67 Placida, 33946	1200	2.2	1.1	N	SEW	NR	R
	54A, 54B, 54C	Plat of Englewood A/29	Joint ownership by adjacent residents	750	.9	1.1	SFR-1	SEW	R	R
	55	Artist Acres 6/5	Tracy, Harry H. & Lois 580 Artist Ave. Englewood, 33533	800	.4	1.8	SFR-1	SEW	R	SU
	56	Plat of Englewood A/29	Englewood Volunteer Fire Dept., Inc. P.O. Box 515 Englewood, 33533	1050	2.5	1.0	COMM	SEW	R	R
	58B	Plat of Englewood A/29	Englewood Trucking Co., Inc. P.O. Box 1661 Highland, IND. 46322	450	.3	1.1	COMM.	SEW	R	R

Table 4, continued

GODFREY CREEK

LOCATION T-R-S HALF SECTION PAGE	PARCEL # OR LAKE NAME	NAME OF SUBDIVISION PLAT BOOK #/PAGE #	OWNER/ADDRESS	SL	SA	SD	TYPE & DENSITY OF DEVELOPMENT	SEWAGE	ACCESS	GENERAL NATURE
40-19-25 496/497	67	Plat of Englewood A/29	Anderson, Marvin, Sr. Rt. 1, Box 107 Orange Park, 32073	850	1.0	1.1	N	SEW	NR	R
	71-75	Artist Acres 6/5	joint ownership by adjacent residents	1100	.6	2.0	SFR-5	SEW	R	SU
	71A	Plat of Englewood A/29	Joyce, Josephine Galvin 470 Elm St. Englewood, 33533	650 100	.2 <.1	1.8 1.0	SFR-1	SEW	NR	R
	74B	Plat of Englewood A/29	Curtis, Sherman L, & Wanda L. P.O. Box 666 Englewood, 33533	700	.4	1.5	N dev nb	SEW	NR	R
40-19-31 853/854	666	Englewood Gardens, Unit 2 4/36	Uhlick, Frank Y. & Florence H. 180 S. Oxford Dr. Englewood, 33533	450	.3	1.0	SFR-1	SEW	R	SU

Table 4, continued.

AINGER CREEK

LOCATION T-R-S HALF SECTION PAGE	PARCEL # OR LAKE NAME	NAME OF SUBDIVISION PLAT BOOK #/PAGE #	OWNER/ADDRESS	SL	SA	SD	TYPE & DENSITY OF DEVELOPMENT	SEWAGE	ACCESS	GENERAL NATURE
40-20-21 833/834	100		Venetia, Inc. 100 Wall St. 15th Floor N.Y., N.Y. 10005	1800	2.4	1.6	N	ST	R	ER
40-20-28 817/818	200		JOZ, Inc. P.O. Box 342 Englewood, 33533	225 450 225	.3 .2 .2	1.0 1.4 1.0	N dev uc	SEW	R	ER
40-20-31 853/854	13-23	Long Lake Estates 11/28	joint ownership by adjacent residents	2250	.6	4.0	SFR-17	SEW	R	SU
40-20-32 855/866	2	Wellington Acres 20/1,1A	Keefer, Arthur J. & 4880 Ramsey Rd. Oxford, MI. 48051	675	.9	1.0	N	ST	R	ER
	3	Wellington Acres 20/1,1A	Vasbinder, Gleason A. & Dorothy L. 1000 Crestwood Rd. Englewood, 33533	700	.4	1.4	SFR-1	ST	R	ER
	4	Wellington Acres 20/1,1A	Scott, Robert, Jr. & Monica R. 1400 Crestwood Rd. Englewood, 33533	200	.1	1.0	SFR-1	SR	R	ER
	4a	Wellington Acres 20/1,1A	Bayer, Raymond A. & Marion J. P.O. Box 5081 Grove City Rural Station Englewood, 33533	600	.5	1.2	SFR-1	ST	R	ER

Table 4, continued.

AINGER CREEK

LOCATION T-R-S HALF SECTION PAGE	PARCEL # OR LAKE NAME	NAME OF SUBDIVISION PLAT BOOK #/PAGE #	OWNER/ADDRESS	SL	SA	SD	TYPE & DENSITY OF DEVELOPMENT	SEWAGE	ACCESS	GENERAL NATURE
40-20-32 855/856	7	Wellington Acres 20/1,1A	Newton, M.W. & Nan H. 741 Perry St. Englewood, 33533		.1	1.0	N	ST	NR	ER
	15	Wellington Acres 20/1,1A	Johnston, Kingsmore, Jr. & Janell H. P.O. Box 194 Boca Grande, 33921	400	.2	1.2	SFR-1	ST	R	ER
	303		Wagoner, Frank L. & Mary P.O. Box 653 Englewood, 33533	300	.2	1.0	SFR-1	SEW	R	ER
	524	Englewood Gardens, Unit 6 4/74,75	First Independent Baptist Church 611 E. Dearborn St. Englewood, 33533	225	.1	1.2	SFR-1	ST	R	ER
	562	Englewood Gardens, Unit 6 4/74,75	Romans, Richard T. 475 Crestwood Rd. Englewood, 33533	800	.6	1.5	SFR-1	SEW	R	ER
	565	Englewood Gardens, Unit 6 4/74,75	Johnson, Marlyn L. & Bertha 733 Crestwood Rd. Englewood, 33533	900	.6	1.6	SFR-1	SEW	R	ER
	568	Englewood Gardens, Unit 6 4/74,75	Bass, Jackson C. & Maureen E. Crestwood Rd. Englewood, 33533	550 450	.3 .5	1.0 1.1	SFR-1	SEW	R	ER
	579	Englewood Gardens, Unit 6 4/74,75	Hartnell, Donald E. 375 No. Pine Englewood, 33533	200	.2	1.0	SFR-1	SEW	R	ER

Table 4, continued

AINGER CREEK

LOCATION T-R-S HALF SECTION PAGE	PARCEL # OR LAKE NAME	NAME OF SUBDIVISION PLAT BOOK #/PAGE #	OWNER/ADDRESS	SL	SA	SD	TYPE & DENSITY OF DEVELOPMENT	SEWAGE	ACCESS	GENERAL NATURE
40-20-32 855/856	580	Englewood Gardens, Unit 6 4/74,75	Fulford, C. Alex & Mary H. 710 Morningside Dr. Englewood, 33533	225	.1	1.1	SFR-1	SEW	R	ER
	581	Englewood Gardens, Unit 6 4/74,75	Sharpe, George A. & Barbara W. 720 Morningside Dr. Englewood, 33533	100 200	.1 <.1	1.0 1.0	SFR-1	SEW	R	ER
	584	Englewood Gardens, Unit 6 4/74,75	Williams, David R & Dorothy A. P.O. Box 563 Englewood, 33533	400	.3	1.0	SFR-1	SEW	R	ER
	588	Englewood Gardens, Unit 6 4/74,75	Babington, John W. & Hazel P.O. Box 493 Englewood, 33533	250 100	.1 <.1	1.1 1.0	SFR-1	SEW	R	ER
	618	Englewood Gardens, Unit 6 4/74,75	same as above	450	.5	1.0	SFR-1	SEW	R	ER
	620	Englewood Gardens, Unit 6 4/74,75	same as above	675	.7	1.1	SFR-1	SEW	R	ER

OYSTER CREEK

LOCATION T-R-S HALF SECTION PAGE	PARCEL # OR LAKE NAME	NAME OF SUBDIVISION PLAT BOOK #/PAGE #	OWNER/ADDRESS	SL	SA	SD	TYPE & DENSITY OF DEVELOPMENT	SEWAGE	ACCESS	GENERAL NATURE
40-20-26 813/814	100		Gen. Dev. Corp. 1111 So. Bayshore Dr. Miami, 33131	900	1.8	1.0	N	ST	NR	ER

lakes in the District, including 25 lakes in the Forked Creek Basin.

Because of building code regulations that set minimal elevations of residential and other structures, more real estate ponds and lakes are expected in the area since they are an important source of fill for building pads. If past practices continue these borrow pits will be constructed in wet depressions in the uplands.

The ensuing lakes with or without overflow pipes will function as surface water catchment basins and will require appropriate management to maintain their water quality. Elsewhere in major land developments, natural drainage ways and wet depressions will probably be converted into storm water retention systems similar to that proposed for Myakka Estates in the upper reaches of Oyster and Ainger basins. The effects of these systems on the ground water, aquifer recharge system and nutrient regimes of the Bay and creeks are not known but should be considered in future land use programs.

Storm Water Drainage Systems.

Since the early 1970's numerous studies have shown that storm water runoff in urban/suburban areas is a major non-point source of pollution for the receiving waters. Urban storm water drainage systems are actually man made drainage networks draining artificial sub-basins. Their discharge points into creeks, rivers, bays, etc. thus may be viewed as minor tributaries of the overall drainage system. For these reasons we undertook a study of drainage networks in the developed areas along the creeks and Lemon Bay in the EWD.

Individual networks were mapped and their discharge points recorded on 1" to 200' zoning maps. The on-site field survey included locations, direction and extent of drainage, character of areas drained, type of drainage swale, ditch, curbed gutter, cement culverts, storm sewers and surfaces of roads. Based on potential runoff the drainage ways were classified as: 1. grass swales ranging from 6 inches to 4 feet deep with less than 1:3 sloping sides; 2. non-vegetated, bare soil ditches frequently box-cut and kept free of vegetation by a maintenance program; 3. cement culverts located mainly where roads intersected the roadside ditches and at drainage outfalls along the banks of the creeks; and 4. cement curbed gutters which occurred in only one subdivision on Ainger Creek. The distribution and character of the roadside drainage networks for the developed areas of Englewood west of SR 775, Gottfried, Ainger, Oyster and Buck Creeks are shown in Figures 11, 12, 13, 14, and 15. Since the maps in these figures are on a 1 inch to 600 foot scale, they may be compared directly with Redi Real Estate Atlas photos.

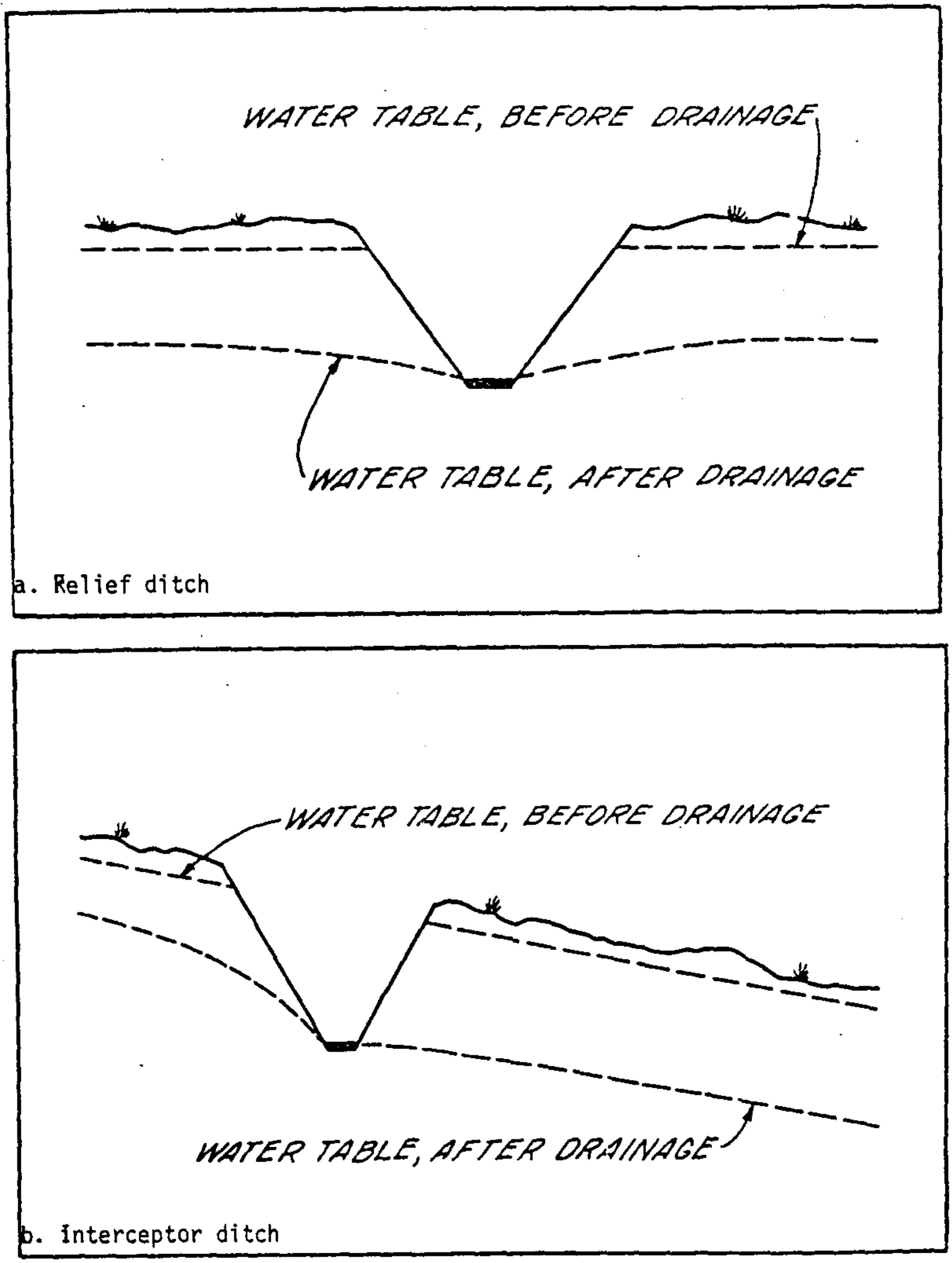
The longest and deepest drainage ditches are those along SR's 775, 776 and 777. These elevated roads function as subdrainage basin dikes or ridges. These engineered ditches grade from basin and sub-basin ridges to discharge points at the bridges over Gottfried, Ainger, Oyster and Buck Creeks. At intervals lateral ditches from nearby residential roads join these major ditches. Throughout most of their length these major ditches are vegetated. Even in the wet season during July and August standing water was minimal and mainly in those areas where the diked roads traverse historical wet depressions.

Theoretically the major highway ditches and the main ditches or residential networks discharge most of the storm water runoff they receive into the creeks and the Bay. Actually, because they are vegetated and have low drainage grades, most of the water entering these ditches is not discharged but is dispersed by evapotranspiration and movement into the subsurface ground. The presence of freshwater emergent and submerged wetland vegetation in the deeper cuts of the major ditches as well as the mowed grasses and forbs in the shallower cuts reduce the downgrade velocity of the water in the ditches during and following storm events thereby aiding the settling out of sediment, silt and other particulates before the water is discharged into the receiving waters. Thus the storm water discharged from the 111 observed outlets of the surface drainage networks in the area is markedly lower than if the surface water runoff were collected by curbed gutters and storm sewers.

The 111 storm water discharge points in the area are distributed as follows: 24 on Lemon Bay, 29 on Gottfried Creek, 34 on Ainger Creek, 15 on Oyster Creek and 9 on Buck Creek. Only 21 of the 111 discharge points are located in areas not receiving an effective tidal flushing. Most of these 21 points occur in the dead end canals along Ainger (9) and Oyster (5) Creeks.

With few exceptions the drainage swales in the residential areas are shallow (6 to 12 inches deep), and vegetated with mowed grass. Their drainage grade is minimal. Furthermore, these drainage swales are interrupted by small culverts under driveways. The drainage swale networks inland of the first road paralleling the shores of a creek or the Bay frequently have no connecting links under the roads to the drainage area immediately adjacent to the creeks or Bay. In most of the residential areas the immediate sub-basin of each creek is defined by a ridge formed by the first roads that parallel the creek proper and the dead ends of the finger canals that branch off from the creeks. It is the storm water and ground water discharges from these sub-basins that constitute the most important sources of non-point source pollution from developed areas at the present time.

Before we describe the land uses in these sub-basins, several general comments are in order. First, in the residential areas buildings are usually elevated slightly on graded building pads. Thus the individual lots and rows of lots have one or more drainage divides. The major divide results in water from the front yard moving "down hill" toward the adjoining roadside drainage swale or ditch and toward the adjoining shore if the lot is on a creek, canal or the Bay and toward a backyard drainage swale if the lot is on an interior upland "block" bounded by roads. The direction of movement of ground water from individual septic tank fields will depend on whether the field is in the front yard or the backyard. The degree and rate of lateral and downward movement of the ground water depends on a variety of local drainage factors, including the character of the subsurface soils, the water table level, and the hydraulic gradient. As shown in Figure 16 swales and ditches either function as relief ditches or interceptor ditches thereby lowering the water table in their vicinity. Thus the reported occurrences of the presence of septic effluent in the wet season



a. Relief ditch

b. Interceptor ditch

Figure 16. Diagram of effect of relief and interceptor ditches on ground water table.

From: Beville, 1973.

in standing water of certain drainage ditches in the Englewood-Grove City area may be traced to low topographical relief, improperly graded ditches and proximity of the ditches to septic tank fields.

The potential and actual movement of ground water from backyard septic tank fields on waterfront lots into the creeks, canals and bays again will vary with local soil, ground water table levels, and hydraulic conditions of ground water. It also will vary with the distance between the field and the shore and with the character of the shore proper. Whether the shore is non-vegetated or stabilized by vegetation, rip rap or seawalls will affect the rate and route of entry of nearby ground water. Finally, any measurable impact of ground water from waterfront lots will depend in part on the patterns of housing density along the shores relative to the various processes involved in mixing, dilution and assimilation by the soils, the receiving waters and their biota.

Shoreline Survey.

As a first step in the assessment of the potential and actual impact of development along the shores of the creeks and Bay, we surveyed the shorelines recording outfalls, types of shores, presence of excessive growths of green and blue green benthic algae (indicators of local sources of nitrogeneous substances). The shoreline survey was done from canoes during July and August, 1977. Information from the field notes and maps were transcribed on to 1 inch to 600 foot maps and aerial photos. Each of the creeks and Lemon Bay were divided into sections (Figure 17) and the total length of each of five types of shoreline were determined for each section using a fine metal chain and calipers to measure distances on the maps.

The five types of shorelines included:

1. Natural shorelines - undisturbed and vegetated by fringes of mangroves and black rush with upland pine flatwoods;

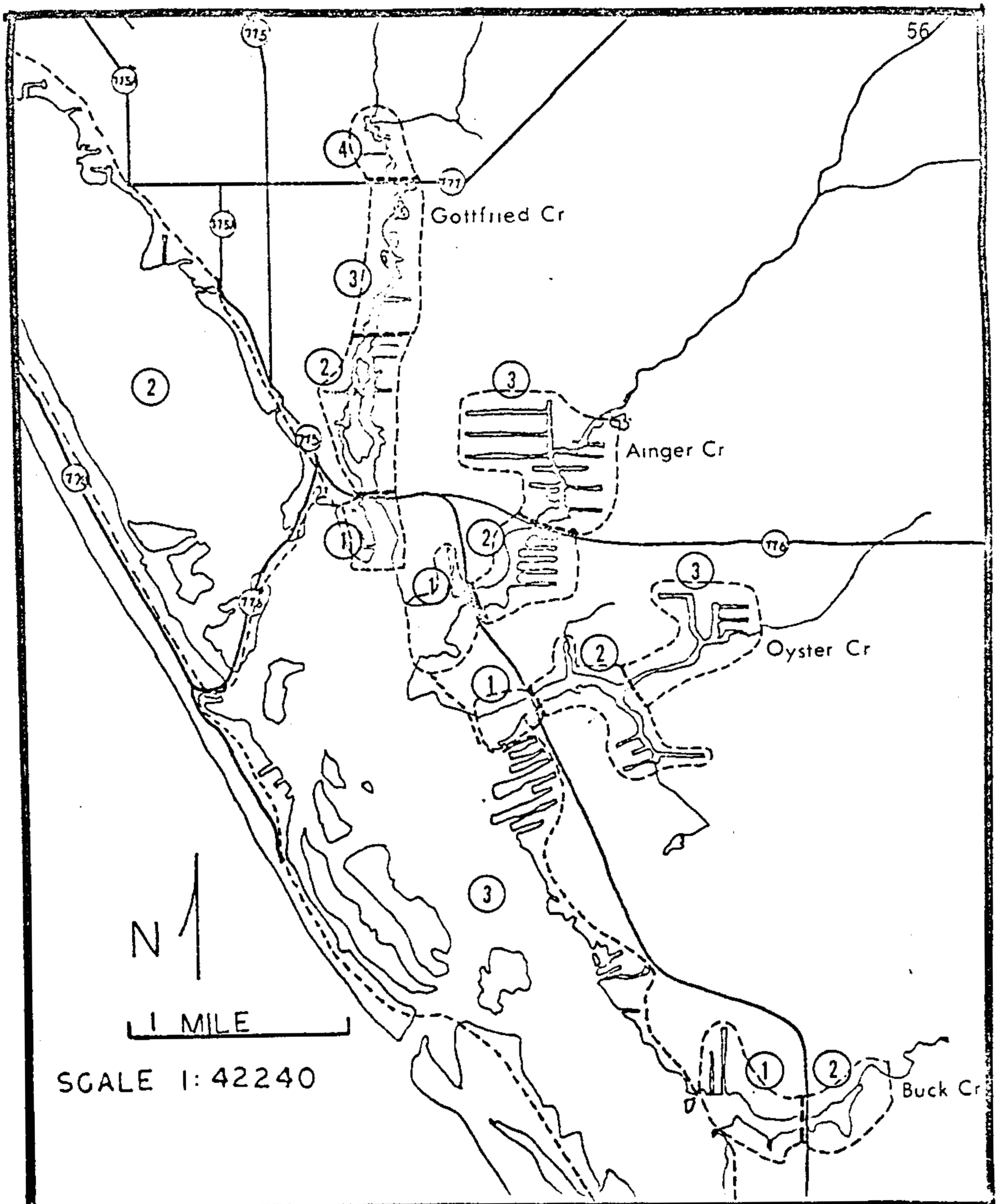


Figure 17. Locations of tidal creek suburban sections in the Lemon Bay 208 Study Area, July 1977. Lemon Bay section 2 extends northward to Manasota Key Bridge. Lemon Bay section 1 extends from Manasota Key Bridge to Alligator Creek. See Table for summary of linear feet of types of shoreline.

2. Disturbed shorelines which have become revegetated by native and/or exotic species such as Brazilian pepper and Australian pine, following upland development or are presently unvegetated and not stabilized;
3. Cultivated shorelines that have mowed lawns or exotic shrubs;
4. Rip rap shorelines where the banks are semi-stabilized by everything from Chlorox bottles, tires, and construction rubble to rock boulders;
5. Seawalled shorelines; vertical, altered shoreline adjacent to dredged waterways.

With respect to their effectiveness in preventing direct seepage of ground water into the receiving waters, the five types of shoreline are ranked as follows: seawall > natural > cultivated > disturbed > rip rap. With respect to their effectiveness as biological filters of sediments and nutrient runoff and seepage, the shorelines are ranked as follows: natural > cultivated > disturbed = rip rap > seawall.

Table 5 summarizes the linear feet of the five types of shorelines in the study area. The total miles of shorelines and the percent of each type of shoreline are included in Table 5. Within this study area there is a total of 63.9 miles of shoreline of which 35 miles border on Lemon Bay and 29 on the four creeks. Approximately 17 miles (27%) of shoreline are still natural; the rest is altered.

Of the various altered shores, rip rapped and disturbed shorelines offer the greatest potential for nutrient/pollutant enriched surface and ground water to enter the creeks and Bay. That these two shorelines combined constitute more than 40% of the total shoreline of Lemon Bay and Gottfried, Ainger and Oyster Creeks may be a major factor associated with the water quality in these areas. The presence of 26 miles (17% of the total shoreline) of seawalled shorelines in the study area are found mostly in the creeks where they form a major element in the dead end canal shorelines. Although sea walls reduce ground water seepage rates, they either border artificial channels dug along former natural shores

Table 5. Shoreline Character of Lemon Bay and Sub-Urban Sections of the Four Tidal Creeks in the Lemon Bay 208 Study Area, July, 1977 (See Figure 17 for locations).

		Linear Feet of Shoreline					Total shoreline in miles
Creek	Section	Natural[1]	Disturbed[2]	Cultivated[3]	Rip Rap[4]	Seawall[5]	
Gottfried	I	0	1825	0	475	4200	1.23
	II	1325	5075	400	1100	5150	2.47
	III	3875	1050	0	2875	1550	1.77
	IV	2250	3900	1075	525	900	1.64
Total No. Feet		7450	11,850	1475	4975	11,800	7.11
Percent Total Shore		22.0	35.3	4.4	14.8	23.2	
Ainger	I	1300	2130	0	1240	3300	1.51
	II	1200	7700	280	4250	1940	2.91
	III	4080	16,190	280	1960	4850	5.18
Total No. Feet		6580	26,020	560	7450	10,090	9.60
Percent Total Shore		11.8	46.6	1.0	13.4	27.2	
Oyster	I	2400	600	0	175	475	0.69
	II	5575	4800	0	1225	3650	2.89
	III	9100	10,600	0	0	2875	4.28
Total No. Feet		17,075	16,000	0	1400	7000	7.86
Percent Total Shore		41.2	38.5	0	3.4	16.9	
Buck	I	7140	0	0	1560	1710	1.97
	II	11,400	0	0	0	600	2.27
Total No. Feet		18,540	0	0	1560	2310	4.24
Percent Total Shore		82.7	0	0	7.0	10.3	
Lemon Bay	I	10,500	19,200	1950	3900	3750	7.44
	II	19,658	40,500	3525	4200	22,050	17.03
	III	11,910	9180	0	2160	33,090	10.67
Total No. Feet		42,060	68,880	5475	10,260	58,890	35.14
Percent Total Shore		22.7	37.1	3.0	5.5	31.7	
Grand Totals of Shoreline in Miles		17.37	23.25	1.42	4.86	17.06	63.95
% Total		27.2	36.3	2.2	7.6	26.7	100

and/or upland finger canals. Since emergent and submerged vegetation are absent, biological filtration is minimal and local water quality is frequently lowered due to non-optimal flushing of the adjoining channels. Since 73% of the shorelines and their adjoining uplands and submerged lands in the Lemon Bay area have been altered, shoreline development becomes an important factor in equations to determine non-point source pollution in this area.

The distribution of housing units and their septic tank systems on different types of shorelines is important as in the age and functional quality of individual septic tank systems. Because of operational constraints we could study these parameters only by observing the distribution and relative age of housing units along the shores of the creeks and bays, past and present.

Figures 18, 19, 20, and 21 show that in 1976 the majority of the housing units on the four creeks were located along the dead end finger canal branches. A similar pattern can be seen in Figures 22 and 23 for the shorelines of Englewood City and Englewood Beach. The units along the Englewood City shoreline are, like those along the creeks, single family residences. The units along the Englewood Beach shoreline include multi-family and resort units. Most of these canals were built after 1960. Many houses on the canals were built after 1972 when new septic tank regulations were enacted.

Since the water quality of dead end canals and the efficiency of septic tank fields decrease as they age, we determined the approximate number of housing units present in the Lemon Bay area from aerial photographs taken in different years. The results are summarized in Table 10for the Charlotte County region and Table 11 for the Sarasota County region of the Lemon Bay area.

Of the 3,185 housing units in the Lemon Bay area in 1972, about 45% (1,434 units) were on waterfront lots. By 1976 there were more than 8,400 housing units in the area which included 861 waterfront units built between 1972 and 1976. In 1976 the total number of waterfront units were 2,295 for the Lemon Bay area. Future "witch hunts" for faulty septic tank systems could be narrowed by determining the approximate age of waterfront housing units built prior to

1970 with the aid of aerial photos and 1970 U. S. Census data. By using U.S.D.A. Soil Conservation Service aerial photos one could determine the approximate age and location of units built prior to 1972 and the modern septic tank regulations. These units are the ones likely to have faulty septic tank systems unless the original systems have been replaced and/or repaired. The 1970 census data on housing units in Census Tract 26 (Englewood area) of Sarasota County show that of 1,869 units existing at the time of the census 101 were built before 1939. The rest of the units built between 1939 and 1970 are as follows: 160 between 1940-49, 655 between 1940-1959, 444 between 1960-64, 358 between 1965-68 and 158 between 1969-70. The utility of this type of information was not known or appreciated until the end of this project. Thus our synoptic shoreline survey failed to show any major sources of ground water pollution. Although we did find individual sites along rip rapped and non-vegetated shorelines of dead end canals that had growths of algae, we could not determine if these growths were caused by nutrients from septic tank systems or by nutrients leached from the exposed soils of the banks of the canals. In general our findings are similar to those of Story et al (1975) in their Sanitary Survey of Lemon Bay. We agree with their conclusions: "Shoreline reconaissance of this area (shores of Lemon Bay proper) disclosed no evidence of any sources of pollution other than surface runoff from habitations and sewage treatment plants".

Dye Tracer Study.

The most direct method for detecting which waterfront housing units may have faulty septic tank systems is to put a dye or other tracer into the system and determine if and when the tracer enters the nearby water of the canal, creek or Bay. The relatively simple design and execution of such an experiment are complicated by several factors including: a tracer which actually simulates the movement of viruses, bacteria and nutrients, finding appropriate systems and then enlisting the cooperation of the homeowners, and installing a series of test wells between the septic tank system and the shore to monitor ground water levels and contents before and during the experiment. What this means is an experimental program similar to that conducted by Missimer (1976) on Sanibel Island. Even then the results may be questioned.

An alternative first cut approach to the basic question would be to put a fluorescent dye tracer into every septic tank system along the shores of sections of waterways suspected of having faulty septic tank systems. The entry of the dye to the systems should be keyed to a period of maximum elevation of ground water level during a spring ebb tide. Such periods typically occur twice a month in July and August during the wet season. By using a set of ten to twenty systems along either side of a creek or canal a neighborhood pattern could be generated. At the same time personal interviews with the occupants of the houses coupled with the septic tank permit records would complete the factual picture.

A major problem with this second approach is obtaining the cooperation of everyone in the waterway neighborhood,providing their house is in use during the experimental period. Interestingly,many of the residents of the Lemon Bay area begin to leave the area beginning in April and do not return until September and October. From our shoreline survey during July we estimated that 30 to 50% of the waterfront houses were vacated as evidenced by deserted boat davits, boarded windows and the absence of autos and yard activity. Our observations were supported by the wet season records of the EWD water plant. Qualitatively these observations indicate that the potential wasteload from septic tank systems along waterfronts may be reduced 30 to 50% because of absenteeism. Thus the neighborhood wet season approach did not appear feasible.

In August, 1977 we returned to a modification of the first approach using a single dye tracer and voluntary cooperation of waterfront homeowners. An article explaining the proposed study and asking for volunteers was prepared and printed in the Englewood Press by the editor, Mr. Lytle. Readers were assured that the results on each test site would be kept confidential. Following the appearance of the article, three homeowners volunteered their septic tank systems for the tracer study. In each case the system did not seem appropriate for the study. Lengthy conversations with two homeowners, however, were quite informative.

One home was located on a canal with excellent tidal exchange with Lemon Bay. Their septic tank drain field is 30 feet from the canal. The home also has a private well with the well point 80 feet below the surface. The other home was located several hundred feet back from the shore of Lemon Bay and had two septic tank systems; one in the backyard, dating from the 1930's but "repaired" 3 years ago, and a second system in the front yard. Neither homeowner had ever experienced trouble from flooding with his system. Both understood and maintained their systems.

In conclusion, the water quality bacteriological surveys of the Sarasota and Charlotte County Health Departments and our own observations indicate that unknown amounts of seepage from faulty septic tank systems may contribute to the wasteload of the waters of the creeks and Bay. Faulty systems include those which 1. were improperly installed prior to 1972, 2. are located within 50 feet of the shore, 3. have not been inspected periodically and have not been properly maintained. There is no overt evidence of instances where leaching fields that fail to function have been by-passed by pipes from the septic tank proper or where leaching fields have a sub-field French tile drainage system.

Soils.

The properties of soils and the movement of water and other substances over, into and through the soil are equally complex. At the same time the erosion of the soil by wind and surface water as well as its dissolution and stabilization by biogenic and chemical activities is also complex. On the one hand soils may function as pollutant filters and on the other they may become pollutants contributing to the wasteload of the receiving waters. Most local areas are lacking detailed information on these various elements. The Lemon Bay 208 Study Complex is no exception. Only the soils in the Sarasota County section have been mapped in any detail (U.S.D.A. S.C.S. Widdermuth and Powell, 1959).

Drainage Properties of Soils.

If one were to follow the numerous guides (by the Soil Conservation Service and planning departments) on soils suitable for construction of septic tanks the population of the EWD area of Lemon Bay would be limited to one major area in Englewood proper and scattered sites above the historical 10 foot line between the mouths of Gottfried, Ainger, Oyster and Buck Creeks. Elsewhere in the area, including the barrier islands, the degree of soil limitation for building construction and septic tank drainage fields is listed as severe or very severe. Yet the majority of the housing units and on-site wastewater systems in the area are located on or over soils with these limitations. One can only conclude that soil limitations have played a minor role regarding decisions as to where to build houses and on-site wastewater systems.

Similarly, numerous technical reports describe and prescribe soil characteristics which are optimal for the removal of pollutants such as bacteria and viruses to organic molecules and inorganic ions. Such factors as soil permeability, clay/sand content, pH, base saturation, texture, cation/anion exchange capacities, waterlogging, sub-surface layer hard pans, runoff potentials, etc., are involved in characterizing a particular soil's potential. However, in siting a wastewater system the complex equations generated by the interplay of these factors are solved by three practical elements - the classical percolation test, the minimal allowable depth above the highest level of the ground water table, and a proper setback distance from the nearest permanent or seasonal surface waters.

Even though soil association maps are included and discussed in reports of various local, regional, and state planning agencies, the available maps were too small or too complex for the purposes of the present study. Accordingly, we prepared our own soil association map whose scale is that of the detailed maps of Wildermuth and Powell. As Map XIII shows we classified the various soils into five associations based on their suitability for septic tank drainage fields. The soil patterns for Sarasota County were traced directly from Wildermuth and Powell's map. The soil patterns for Charlotte County were estimated from 1951-52 S.C.S. aerial photos and a preliminary ground truth survey of the existing vegetation.

Of our five associations the local St. Lucie, Lakewood Pomello fine sand association has the best drainage. It dominates the triangular area formed by Lemon Bay and Gottfried Creek. It is not surprising that the early settlers chose this area above the 10 foot contour line to build their homes and that later the town of Englewood was platted here. It is peculiar that a considerable portion of this area lacks homesites as do the other occurrences of this association along SR 775 between Gottfried Creek and Buck Creek.

Over the years the population has spread from the well drained soil association to the Myakka, Immokalee, Adamsville and Ona fine sand association which is the dominant soil association above the 10 foot contour line in this part of the Cape Haze Peninsula. These soils typically form a flat topography and are underlain by organic hard pans, and are poorly drained and subject to flooding by elevated ground water tables. However, because of their proximity to the drainage ways of the creeks and the shores of the Bay and because of local topographic patterns, these soils have come to be occupied by homesites, first along the Bay, then along the lower reaches of the creeks and now inland from the margins of the creeks. The degree of drainage limitations is reflected in the sizes of the roadside drainage ditches with the most recent ditches in the upland area between SR 777 and Ainger Creek being the deepest and widest. If future land developments spread into the interior of island-like areas of this association in the creek basins we predict a continuation of the surface water wasteload from drainage ditches associated with the developments at least during their periods of construction.

The remaining three soil associations - Broward fine sand, Keri fine sand and a complex of poorly drained soils over shallow organic and marly hard pans form the soils of the historical flood plains of the creeks and the major historical seasonal and permanent depressions in the more elevated areas. In the past people appear to have had enough sense not to build on these soils because of their susceptibility to flooding. More recently subdivisions have begun to encroach on these soils via the construction of borrow pits/real estate lakes and graded land filling. It is clear from our soils map that future land development in the upper basin of Gottfried Creek will face significant constraints as far as suitable soils and adequate drainage. That such constraints may be overcome or overlooked is evidenced by the present condition of the upper part of the Oyster Creek basin.

We emphasize again the need to conserve and to understand the multiple roles these poorly drained soils and their associated wetland vegetation play in the seasonal freshwater-nutrient budget of the Bay. Before these wetland areas are irreparably altered their hydrogeological roles should be clarified since these areas may be a significant part of the aquifer recharge system in the EWD.

Erosion Properties of Soils.

Because bare soils are eroded by wind and water, soil erosion can become a major factor in the nutrient-pollutant-silt wasteload in nearby open bodies of water. Most technical studies on soil erosion are oriented toward non-urban situations (i.e., pasture, row crops, lumbering, etc.). However, in large land developments extensive areas of the existing vegetation are removed and the bare soils are exposed, particularly during the initial phase of development when the road and drainage systems are constructed. In large projects such asby the Rotunda and General Development Corporation in drainage basins of the Lemon Bay Complex the initial phase of land development may continue for years. In the local case study area these two land developments have been in process for more than 5 years.

Runoff from the exposed bare soils of the drained uplands, and the diked spoil and banks of the drainage ditches in these two land developments has continued to contribute an unrecorded wasteload to the surface waters of the creeks and Bay. At the same time the large acreages of the original soil surfaces and new, graded soil surfaces have been subjected to wind erosion. The wind erodability of the major soil types in this region is summarized in Table 6. The major tract developments in the Lemon Bay area are on Myakka, Immokalee, Adamsville, and Ona soils east and southeast of the area within the EWD. The wind erodability index for these soils ranges from 86 to 134 tons per acre per year. Since the prevailing winds and convective storms in this region are from the east, the total contribution of wind eroded soils in the area to the non-point source nutrient-sediment wasteload since 1970 may be a significant element in the annual wasteload budget. However, this is but an academic hypothesis because there are no air quality monitoring stations in the immediate area.

Table 6. Wind Erodability of the major non-flood plain/wet soils in the Uplands of the Lemon Bay Area.

Soil Series	Code	K Factor	T Factor Ton/AC/Yr	Wind Erodability Group	*Wind Erodability Index T/AC/YR
Adamsville	Aa-Ab	0.10	5	2	134
Immokalee	IA	0.15	5	1-3	134-310
Lakewood FS	Lb	0.15	5	2	134
Leon/Myakka		.20	3-5	2-3	86-134
Ona	Ia/Ka	.20	3-5	2-3	86-134
Pomello	Pf	0.17	3-5	1-3	86-310
St. Lucie	SL	0.18	5	1	310

K Factor - Susceptibility to wind erosion. Soil surface roughness for wind erosion. When surface is smooth K is I or 100 percent.

T Factor - Computed soil loss by wind erosion from bare soil.

Wind erodability group.

1. Very fine, fine, and medium sands; dune sands.
2. Loamy sands; loamy fine sands.
3. Very fine sandy loams.
4. Silty clays; silty clay loams.
5. Non-calcareous loams and silt loams.

* Wind Erodability Index - average annual soil loss from a smooth, wide and bare field at Garden City, Kansas.

Source: USDA, SCS. Gainesville, 1974. Envionmental Planning Handbook for Urban Areas, Florida.

Hydrogeology.

The base of the limited knowledge of the hydrogeology of the Lemon Bay area is a report by H. Suttcliffe (1975) - An Appraisal of the Water Resources of Charlotte County, Florida. Supplemental data are available from various well logs, the water level gauges in the EWD well field and other data compiled by the Southwest Florida Water Management District. Information in Sutcliffe's report and personal communications and memoranda from Sutcliffe have been reworked,summarized and interpreted in various recent reports (i.e., Gorelick, 1975; Smalley, Welford and Nalven and Russell and Axon, 1976; Tri-County Engineering, Inc., 1974, 1975).

Groundwater Resources in Englewood Area.

Unlike most local, coastal areas in the Charlotte-Sarasota County region, Englewood and the surrounding region within the EWD is blessed with good quality water from a non-artesian aquifer in the Tamiami limestone formation above the green clay layer of the Hawthorne formation which lies less than 100 feet below the surface. According to Suttliffe a major portion of the aquifer's annual recharge is from percolation of local surface and ground water through the overlying sands and other strata. Given that the average yearly rainfall in the Englewood area between 1965 and 1974 was 60.4 inches (Parmalee, P.C.) and that 73% of the rainfall is lost by evapotranspiration and a variable amount is lost via runoff, it has been estimated that of the remaining retained volume of water only 33% is available for consumption (Smalley, Wellford and Nalven, 1963). Thus we agree with the statement in the recent Sarasota County 201 Facilities Plan that "all efforts must be made to encourage conservation of the area's ground water systems. Such efforts should further encourage the reutilization and recycling of treated sewage effluent whenever possible." While one can argue about the quality of treated sewage by on-site wastewater systems, such systems are contributing to the recycling of water to the aquifer in the Englewood area, particularly in areas with deep, well drained sands and in the "dry season" (January-April) when the total resident/non-resident population is at its annual maximum.

Water Usage in Englewood Water District.

Although as many as 30% of the housing units in the area may be on private wells, the EWD water plant's pumpage and monitoring well records from December 1963 to 1977 form the basis of the following discussion.

As expected with the increase in population between 1964 and 1977 there have been marked annual and seasonal increases in pumpage rates from the EWD well field. The total annual pumpage has increased from 68.7 MG in 1964 to 362.2 MG in 1976. The total for March 1977 was 44.6 MG. Monthly variations in pumpage rates reflect seasonal changes in the population level, while daily maxima and minima pumpage rates are related to dry periods and rainfall events (Figure 7). When the daily fluctuations are smoothed by connecting maximal pumpage days and then minimal pumpage days, the resulting annual curves (Figure 7) reflect the total amount of water pumped to individual units on the water system and the relative amounts of water that pass through the units (lower curve) and around the units via irrigation activities (the area between the lower and upper curve).

In order to compare the annual and seasonal changes in amounts of water passing through the housing units in the EWD, we smoothed the low daily pumpage rates for the years 1972 to 1976. The resulting curves are shown in Figure 24. The curves in this figure reflect the annual increases and seasonal patterns of both the permanent and non-permanent resident populations. This figure also shows that between 1972 and 1974 there was a measurable increase in through unit water

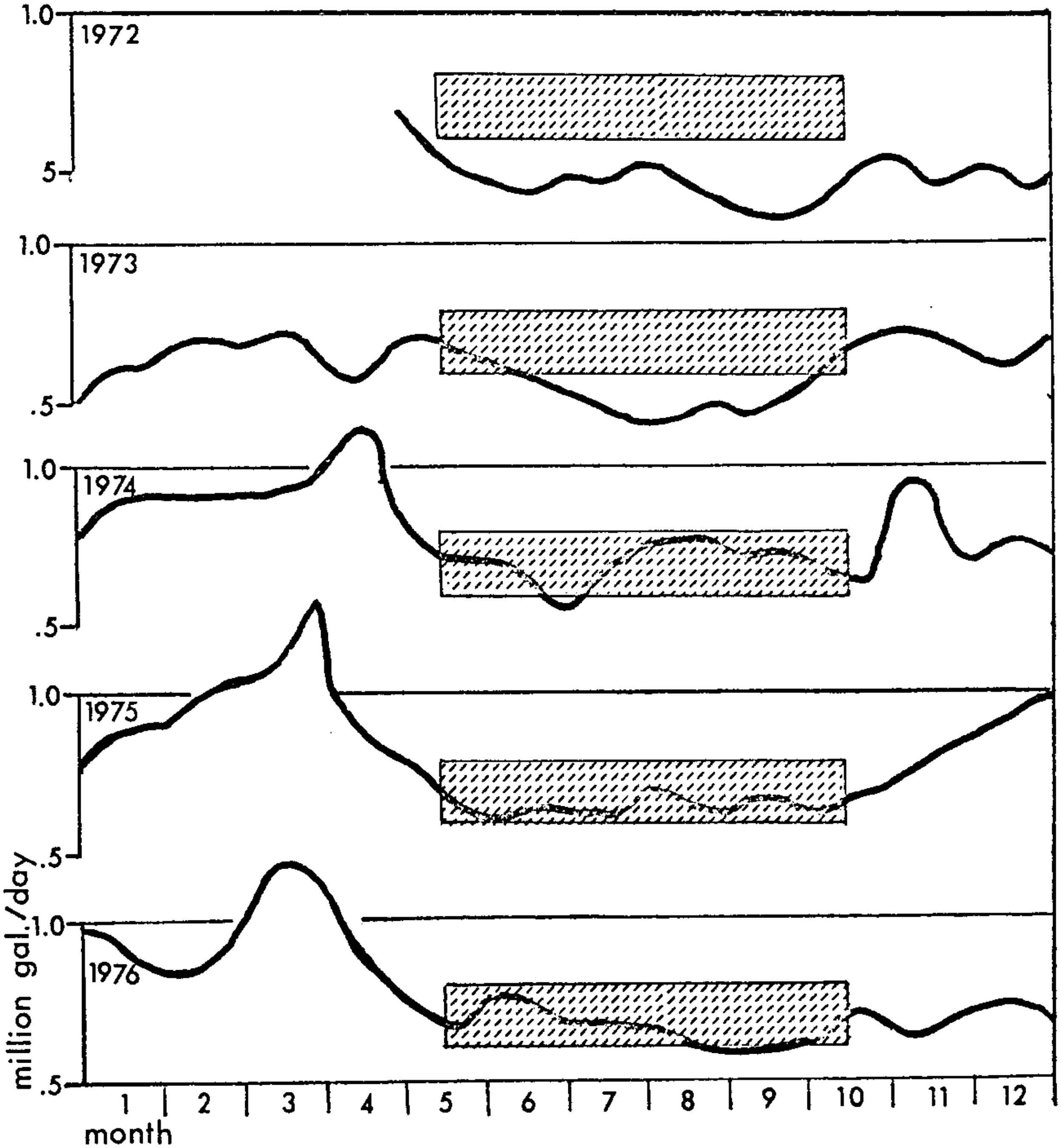


Figure **24** Seasonal fluctuations in low daily pumpage rates by Englewood Water District Water Plant, 1972-1976. These curves represent through - household water use. The shaded rectangles represent 0.6 to 0.8 MGD from May 15 to October 15.

use in the wet season (May 15 to October 15). However, in 1975 and 1976 through unit water use declined in the wet season. These annual and seasonal trends and variations indicate that objective assessments of the impact of through unit-on-site wastewater systems on the ground water and receiving waters may require more detailed analyses.

In addition to total daily and seasonal variations in water pumpage from the EWD water plant there are variations in the amount of water pumped on different days in different seasons. These variations are illustrated in Figure 25 for Sunday and Monday in March, August and September, 1976. The daily pumpage records in this figure reflect the following daily water use patterns. Regardless of the season the water use day begins around 6:30 AM with the early risers. There is a general peaking of water use around 9 to 10:00 AM when through unit and irrigation uses are maximal. The Monday morning through unit washing activities are nicely illustrated by the chart for Monday, September 6, which was in a period of three days of rain. After 10:00 AM water use declines until 12:00 PM in March (the tourist season) and 10:00 to 11:00 PM in August and September. Only a small non-recorded volume of water is pumped between midnight and 6:00 AM. According to the experienced EWD water plant operators (Mr. Halpin and Mr. Colpetts) additional information is contained in these daily pumpage records. For instance, a minor but discernible peak occurs in the peak population season immediately following the 11:30 PM news.

Septic Tank Water Usages in Englewood Water District.

These daily water pumpage records and the variations in their patterns raise several questions related to the assessment of septic tank systems and their efficiency in processing wastewater. Typically a household septic tank system in the Lemon Bay area receives a maximum volume of grey water (tank-toilet) and black water (toilet water) over several hours in the morning, a

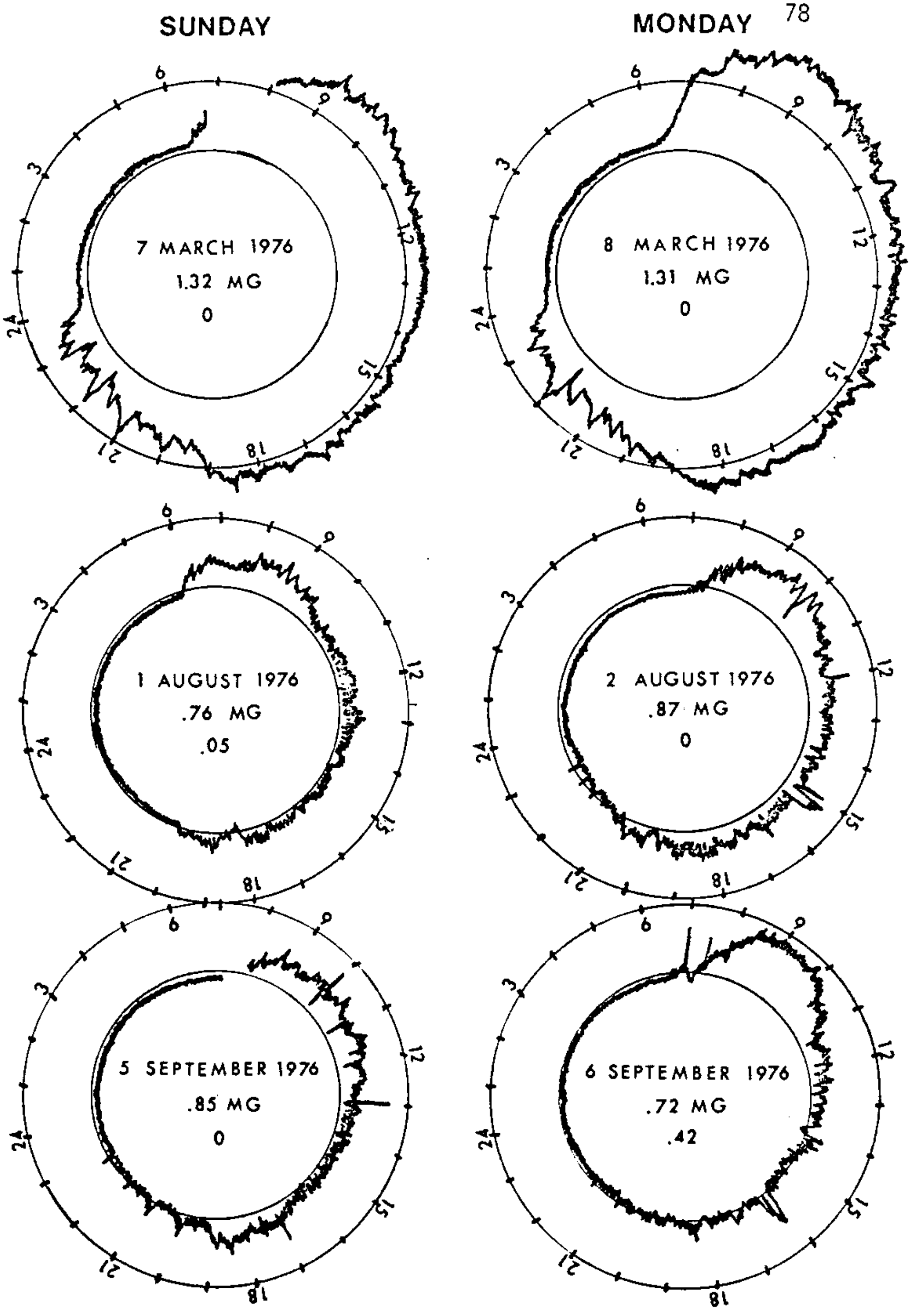


Figure 25. Daily water pumpage records from Englewood Water District comparing seasonal (March to August and September) patterns and weekend (Sunday) to weekday (Monday) patterns. Numbers around outer circle indicate time; inner circle contains date, total amount of water pumped on millions of gallons, and amount of rainfall in inches on that day.

Source: Englewood Water District.

second but smaller volume of grey and black water in the early evening and a third even smaller volume of black water in late evening. Since the inlet and outlet pipes of a typical septic tank are at the same level, the volume of water that enters the tank during a particular period should result in a similar volume of water passing into the leaching field. Thus the efficiency of the leaching field is related directly to its capacity to assimilate and process pulses of different volumes of wastewater and the length of the intervals between the pulses.

Since most of the septic tank systems in the Lemon Bay area service small single family dwelling units, an estimated 100 gal. of wastewater may be generated per unit per day when the units are occupied. Between May 15 to October 15, 1976 the low level daily pumpage of the EWD water plant was 0.45 to 0.50 MGD. By dividing these values by 100 gal/day/hourly unit, we estimated that the number of units using through-house water to be 4,500 to 5,000. By adding an estimated 1,536 units with private wells we arrive at an estimated through-house flow of 0.60 to 0.65 MGD in the EWD. The EWD pumpage records and our own field observations show that a significant percentage of the dwelling units are vacated during the wet season for varying lengths of time. Furthermore, of the 73% of the annual precipitation lost by evapotranspiration more than 50% is lost between May and October. These factors combined with the artificial surface water drainage systems and artificial ground water gradients in the developed areas tend to reduce the impact of septic tank systems on the surface waters. One final factor to be considered in impact equations is that an unknown number of household units in the area have two septic tank systems.

Seasonal Fluctuations of Ground Water Table Levels.

One of the last elements in the hydrogeological picture is the seasonal fluctuations of the ground water table. Information on ground water table elevations in the Lemon Bay area are recorded primarily in septic tank permit applications on file at the County Health Departments. Additional information is available in various test well records. The limited data we obtained on ground water levels during our survey are summarized in Figure 26. The additional data on this element should be analyzed in detail.

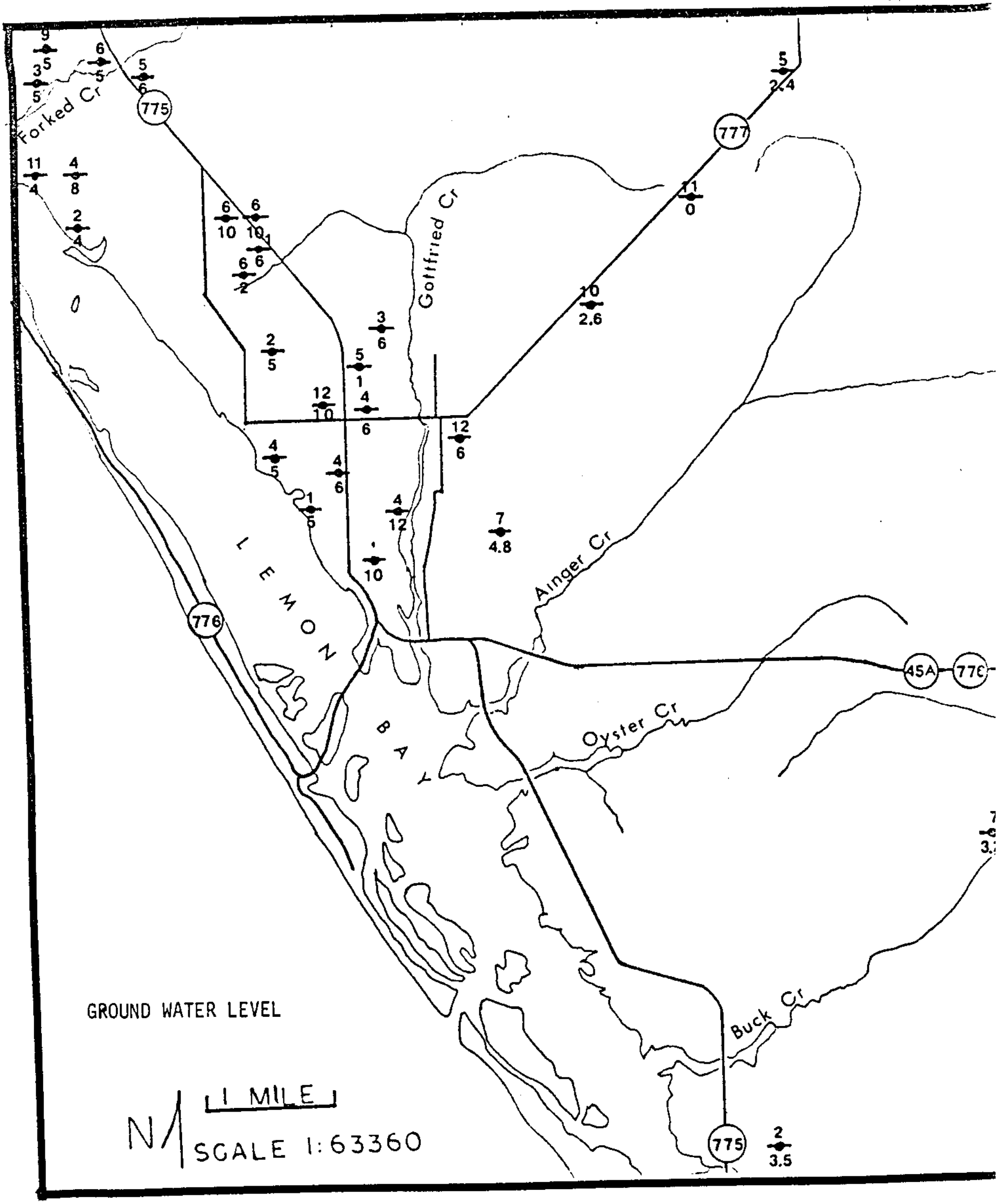


Figure 26. Ground water level in test well records for the Lemon Bay area. Dot is location; number above line, month; number below line, water table level in feet below surface. From: U.S. Geological Survey, Sarasota, FL.

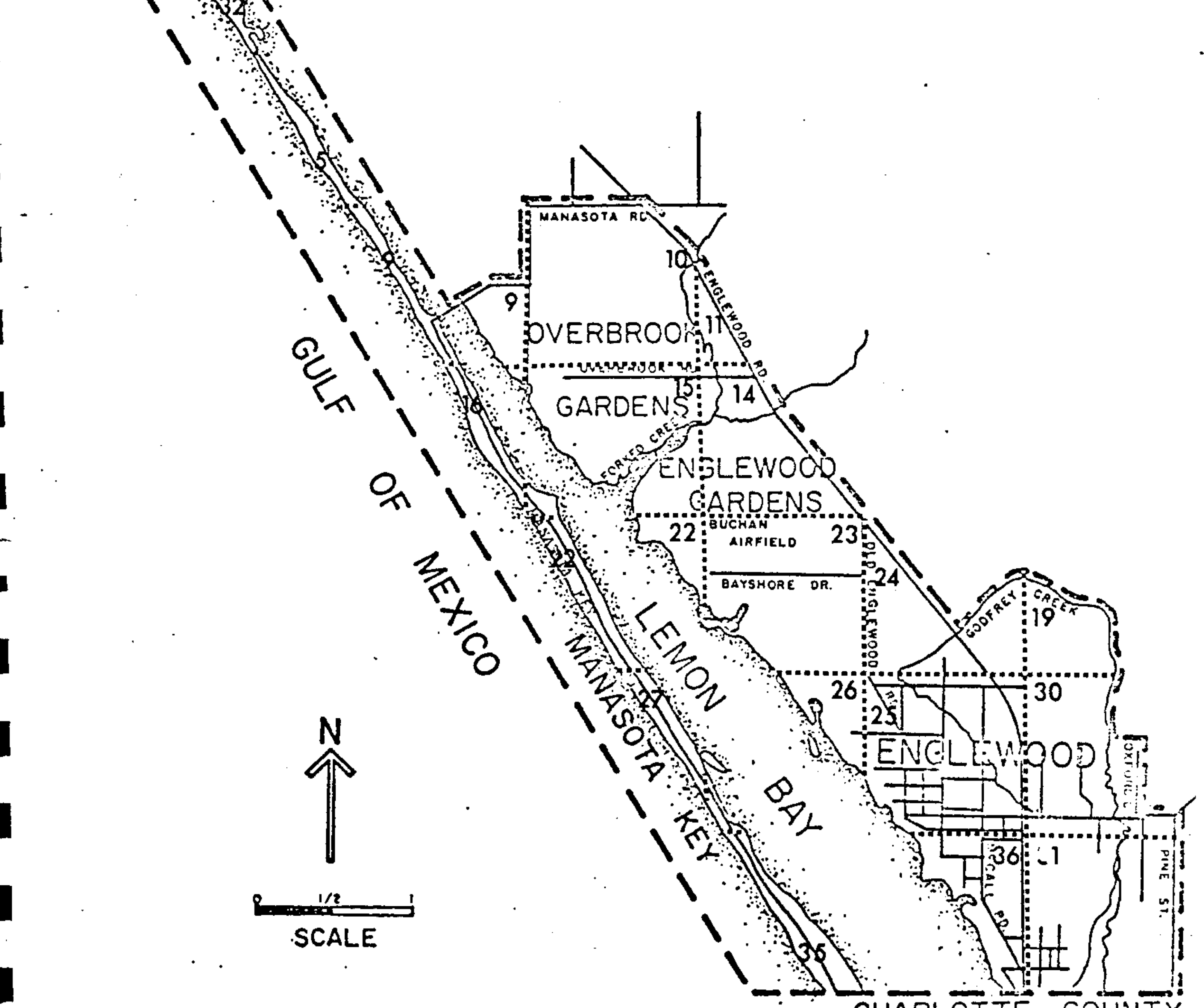
DEMOGRAPHIC AND LAND USE PATTERNS

Any summary of the past and present populations and land use patterns in the Lemon Bay area is hindered by the fact that the area straddles two counties. The part of the Lemon Bay area that lies within the Lemon Bay 208 Complex of our study is for practical purposes the 7,040 acres of the Englewood Water District. At the same time part of the Complex occupies part of Census Tract 26 of Sarasota County (Figure 27); part of the Complex lies in Charlotte County in Township 31S and Ranges 19 and 20 East. In various planning reports by and for the two counties additional demographic and land use areas have been used. For example, the Sarasota County 201 Facilities Plan (1976) incorporates Census Tract 26 and the EWD into one area; The Charlotte County Regional Sewer and Water Comprehensive Plan (1974) provides statistics for the Charlotte County Section of the EWD and designates this section as Area 1 (Figure 28).

An additional complication is that estimates of the growth of the population in the area use different bases and different multipliers, possibly for different reasons. The only firm population data for the area are those of the 1970 U. S. Census data of Census Tract 26. Elsewhere number of housing units (HU's) estimated from aerial photographs, number of mail boxes, number of electrical meters have been used with multipliers ranging from 2.5 (Englewood Area Chamber of Commerce) 2.25,2.19 (Sarasota County 201 Facilities Plan) to 2.0 to 1.7. We have chosen 2.0 as a convenient multiplier for converting HU's to people in the present study.

In the sections on demographic and land use patterns we have culled data for the Lemon Bay area from various county and regional reports and supplemented these data with our own housing unit studies.

Boundaries: southern limit of Venice City, Red Lake, Lemon Bay, 5th St., Manasota Rd., Englewood Rd. (S.R. 775), Godfrey Creek, unnamed dirt road, Oxford Dr., Dearborn Ave., Pine (Westover Rd.) County line, Gulf of Mexico.



CENSUS TRACT 26

Figure 27 Geographical limits of Sarasota County Census Tract 26. Small dashed line demarcates sections; section numbers indicated. Source: Sarasota Co. Planning Dept.

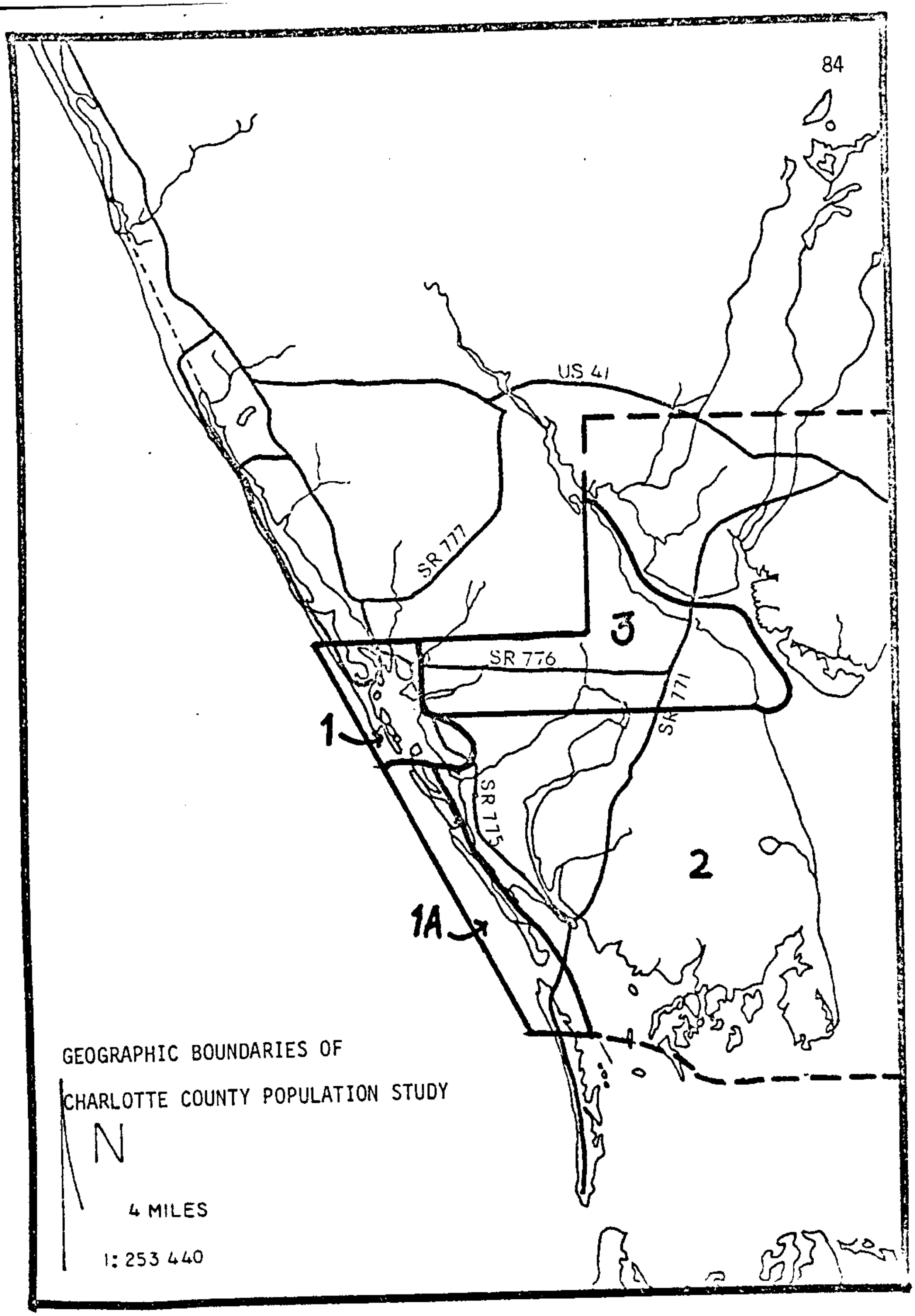


Figure28 Geographic boundaries of Charlotte County population study; areas 1, 1A, 2, and 3 in the Lemon Bay Area.
Source: Charlotte County Regional Sewer and Water Comprehensive Plan, 1974.

Demographic Patterns.

No population study would be complete without a graph summarizing population growth and projected growth. Accordingly, Figure 29 summarizes in a general way the population growth for the Englewood area. The most interesting feature in this graph is the apparent plateauing of the population estimated by the Englewood Area Chamber of Commerce compared to the projected steady increase in the Sarasota County 201 Plan. The estimated present and future growth in Area 1 of Charlotte County is summarized in Table 7 ; one estimate of future increases in the population in Census Tract 26 is shown in Table 8 . The increase in number of housing units in Census Tract 26 from 1958 to 1975 is summarized in Table 9 .

While preparing Table 9 we realized that intra-area distribution patterns of the local population and housing units in the Lemon Bay Complex area might be important in the analysis of residential density limitations of on-site wastewater systems. One residential density classification is given below:

Rural Density	1.0 or fewer residential units per acre
Low Density	1.1 to 4.5 units per acre
Moderate Density	4.6 to 13 units per acre
Medium Density	13.1 to 18.0 units per acre

Source: Smalley, Wellford and Nalven and Russell and Axon, 1976.

In particular, we were interested in the extent and distribution of rural, sub-urban, suburban and urban densities. The number of housing units per half-section (320 acres) were determined for the years 1957, 1972 and 1976, using aerial photos and U.S.G.S. 7-1/2 min. quadrangle maps. The results (Tables 10 and 11) reveal that as of January, 1976 only six half-sections had a housing unit density greater than 1 unit per acre. Since in the geographic sections

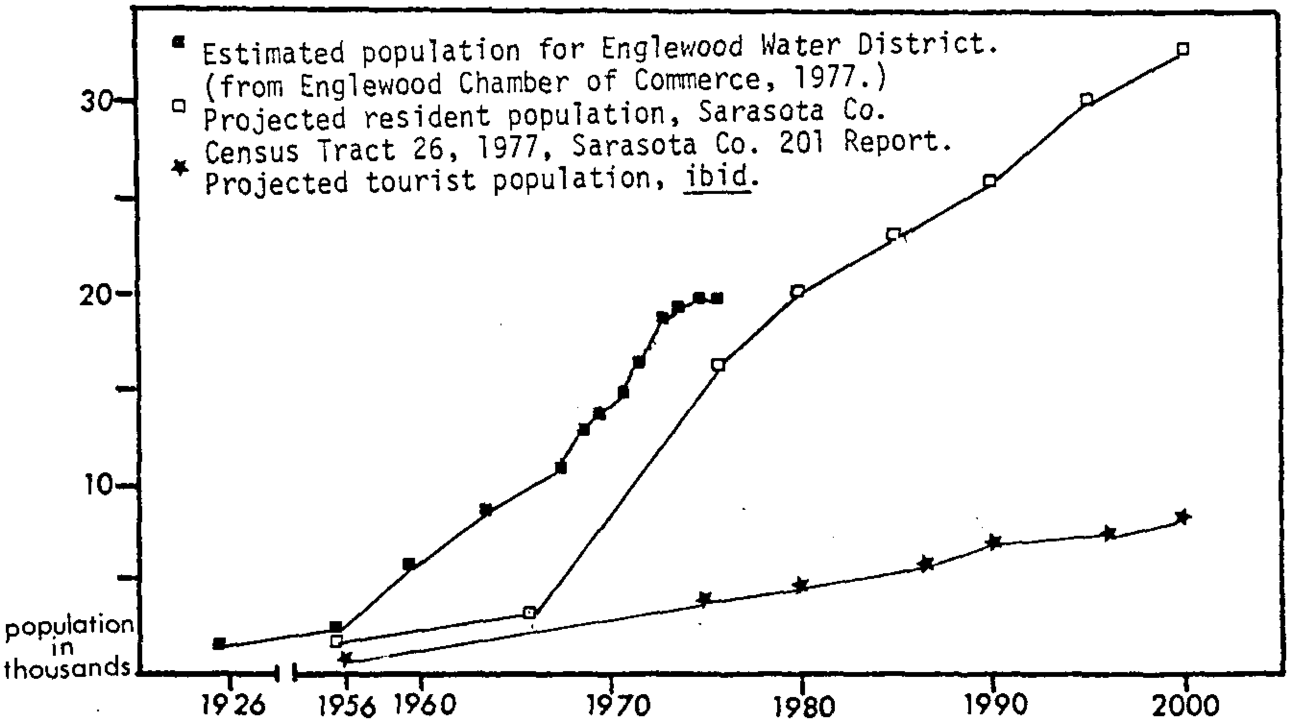


Figure 29 Resident and tourist population of Englewood Water District and Sarasota County Census Tract 26--past, present and estimates of future.

Table 7. Estimated Holding Capacity of Charlotte County with Lemon Bay Area. See Figure 28 for boundaries of study areas. Source: Tri-County Engineering, Inc. 1974.

STUDY AREA IDENTIFICATION	LAND AREA IN ACRES PLATTED	NONPLATTED	TOTAL	RESIDENTIAL ZONE LANDS GROSS AC	NET AC	HOLDING CAPACITY POPULATION PLATTED	NONPLATTED	TOTAL	EXISTING POPULATION	MAXIMUM POP. POTENTIAL
1-A	401	701	1102	1102	747	4095	21440	35545	19	25516
1	3073	1389	4462	2824	2666	27918	10372	38290	6875	31413
2	16211	20531	36742	21974	18871	211594	68028	279622	1839	277783
3	9040	3164	12204	8878	7378	82367	-0-	82367	562	81805

Table __ Estimated Resident and Peak Populations of Charlotte County in the Lemon Bay Area. See Figure __ for boundaries of study areas. Source: Tri-County Engineering, Inc. 1974.

STUDY AREAS	1973 RESIDENT	PEAK	1978 RESIDENT	PEAK	1983 RESIDENT	PEAK	1988 RESIDENT	PEAK	1993 RESIDENT	PEAK
1*	5515	6342	6613	7604	7732	8891	8921	10259	10152	11374
2	1471	1618	5546	6100	11689	12857	18252	20077	27038	29941
3	450	471	743	758	1041	1093	1358	1493	1686	2054

*Study area 1 and 1A have been combined.

Table 8 Generalized Land Use Projection of Census Tract 26 (Englewood), Sarasota County, 1972.

	1972	1975	1980	1985	1990	1995	2000
Total Population	3,504	5,100	7,300	10,000	13,400	16,800	21,200
Total Acres							
Developed Land	785	1,112	1,562	2,114	2,809	3,504	4,404
Single Family	478	675	946	1,277	1,694	2,111	2,651
Multi-Family	--	33	78	133	203	273	363
Mobile Homes	34	67	112	169	238	307	397
Residential	512	775	1,136	1,579	2,135	2,691	3,411
Commercial	47	79	124	179	250	321	411
Industrial	3	19	41	68	102	136	181
Other Uses	223	239	261	288	322	356	401
Residential Density (D.U./Acre)	3.10	2.99	2.92	2.87	2.85	2.83	2.82

Minor Civil Division Total Area[1] 5,635

Source: Tampa Bay Regional Planning Council, 1973

1. Total acres in 1972, 5,635 acres.
   Total vacant and open rangeland in 1972, 4,741 acres.

Table 9. Summary of total number of household units by section in Census Tract 26 (Englewood-Manasota Key), Sarasota County 1958 to 1975. Data from Sarasota County Planning Department Reports.

Township	Section	1/2 Section NS	1958*	1959	1960	1961	1966	1968	1969	1975
40S/19E	5							21	21	22
	9	N						18	18	18
		S					8	38	51	51
	10	N					6	10	10	14
		S					8	14	17	20
	11	S						4	3	3
	14	N					[1]49	[5]188	201	203
		S					[2]4	[6]98	104	125
	15	N					46	155	165	172
		S					12	45	47	54
	16	N					18	45	45	46
		S								
	22	N	8	10	11	13	16	32	36	37
		S	9	10	10	11	12	23	24	24
	23	N					2	21	23	25
		S	9	9	10	10	10	[9]20	26	30
	24	S	15	15	21	21	29	[8]91	98	101
	25	N	39	40	42	44	49	[9]104	121	127
		S	237	245	248	252	[3]256	[10]496	551	512
	26	N	6	7	8	8	13	48	51	53
		S	4	4	4	4	6	12	12	12
	27	N	2	3	4	4	4	18	18	19
	35	N	14	14	15		3	10	13	13
		S					22	28	32	33
	36	N	196	208	213	219	[11]239	321	346	347
		S	115	118	121	125	131	[12]192	192	192
40S/20E	30	S	46	65	76	95	127	226	228	232
	31	N	27	30	33	36	56	148	173	185
		S	88	98	101	111	[4]134	319	323	329
Subtotal Dwelling Units			815	876	911	969	1070	2055	2167	2999
[13]Grand Total							1279	2726	2923	3712

Table 9, continued

*1958 figures present total growth to December 31, 1958. Other figures reflect total growth between each recorded year.

1) Oak Grove Mobile Home Park (40)

2) Brook to Bay Mobile Home Park (60)

3) Shady Haven Mobile Home Park (150)

3) Willow Lake Mobile Home Park (20

4) Deer Creek Mobile Home Park (50)

5) 20 duplex units

6) 20 Oak Groves Mobile Home Park and 22 apt. units

7) 4 Apts. and 3 duplex units

8) 6 duplex units

9) 16 duplex units

10) 300 Shady Haven Mobile Home _____ 124 Willow Lake Trailer Park Units; 72 duplexes

11) 41 duplex units

12) 17 duplex and 20 apt. units

13) The grand total includes 232 duplex; 87 multi, and 194 mobile home units.

Table 10 Number and Geographic Distribution of Household Units Present in 1972 and 1976 in the Lemon Bay Study Area of Sarasota County from the Sarasota-Charlotte County Line North to Forked Creek.

Geographic Location	Township	Range	Section No.	Half Section	Units Built Prior to 1957	Units Built 1957-1972	Units Built 1972-1976	Total 1972 Units	1972 Waterfront	1972 Interior	Total 1976 Units	1976 Waterfront	1976 Interior
Pasture Golf Course	40S	19E	13	/S	-	2	-	2	-	2	2	-	2
Residential-Trailer Forked Creek	40S	19E	14	/S	7	51	346	58	17	41	404	56	348
Mouth of Forked Creek	40S	19E	15	/S	2	25	36	27	14	13	63	28	35
Manasota Key	40S	19E	16	/S	12	13	7	25	18	7	32	24	8
Manasota Key	40S	19E	21	N/	-	2	3	2	2	-	5	5	-
Manasota Key	40S	19E	22	N/S	6	37	47	43	33	10	90	61	29
Mainland					5	8	14	13	7	6	27	18	9
Pasture	40S	19E	23	N/S	-	11	18	11	-	11	29	-	29
Buchan Landing Field					6	12	21	18	-	18	39	-	39
Pasture-Residential	40S	19E	24	N/S	-	-	-	-	-	-	-	-	-
N. Englewood					15	39	64	54	-	54	118	-	118
Pasture-Residential	40S	19E	3	N/S	20	45	20	-	20	65	-	65	
Woodmere					15	21	15	-	15	36	-	36	
Residential Trailer	40S	19E	4	N/S	35	51	35	-	35	86	-	86	
					15	309	15	-	15	324	-	324	
N. Manasota Key	40S	19E	5	N/S	6	4	6	6	-	10	10	-	
Mainland					14	7	14	14	-	21	21	-	
N. Manasota Key	40S	19E	8	N/S	2	-	2	2	-	2	2	-	
					-	-	-	-	-	-	-	-	
Manasota Beach	40S	19E	9	N/S	39	34	39	16	23	73	19	54	
					40	14	40	13	27	54	16	38	
Pasture	40S	19E	10	N/S	11	11	11	-	11	22	1	21	
East Manasota					8	15	8	-	8	23	1	22	
Pasture	40S	19E	11	N/S	17	2	17	-	17	19	-	19	
Gulf Pines Memorial					13	7	13	-	13	20	1	19	
Pasture	40S	19E	13	N/	-	1	-	-	-	1	-	1	
Residential Forked Creek	40S	19E	14	N/	92	225	92	35	57	317	46	271	
Residential Forked Creek	40S	19E	15	N/	98	84	98	37	61	182	61	121	
Manasota Key	40S	19E	16	N/	18	16	18	17	1	34	27	7	
Pasture	40S	20E	28	N/S	-	-	2	-	-	-	2	-	2
					-	-	3	-	-	-	3	-	3

BLE 10 (continued)

.eographic Location	Township	Range	Section No.	Half Section	Units Built Prior to 1957	Units Built 1957-1972	Units Built 1972-1976	Total 1972 Units	1972 Waterfront	1972 Interior	Total 1976 Units	1976 Waterfront	1976 Interior
'asture	40S	20E	29	N/S	-	2	2	2	-	2	4	-	4
					-	4	3	4	-	4	7	-	7
East Englewood	40S	20E	30	N/S	-	-	-	-	-	-	-	-	-
					14	51	189	65	11	54	254	20	234
Englewood	40S	19E	25	N/S	16	23	105	39	-	39	144	19	125
					*	*	*	*	*	*	410	48	362
:nglewood Manasota Key	40S	19E	26	N/S	1	18	11	19	-	19	30	-	30
					3	-	36	3	2	1	39	30	9
lanasota Key	40S	19E	27	N/S	1	12	1	13	13	-	14	14	-
					-	-	-	-	-	-	-	-	-
Manasota Key	40S	19E	35	N/S	4	9	2	13	13	-	15	15	-
					7	24	9	31	21	10	40	24	16
Englewood	40S	19E	36	N/S	*	*	*	*	*	*	311	38	273
					118	2	43	120	36	84	163	46	117
:nglewood Godfrey Creek	40S	20E	31	N/S	16	35	148	51	16	35	199	23	176
					80	88	178	168	22	146	346	47	299
'asture :ast Englewood	40S	20E	32	N/S	1	6	24	7	-	7	31	-	31
					-	2	-	2	-	2	2	-	2
Pasture	40S	20E	33	N/S	-	-	1	-	-	-	1	-	1
					1	6	3	7	-	7	10	-	10
			Totals		758	1328	1759	937	528	1861	4123	721	3402

* Number of HU's not shown on Source Map.

Table 11 Number and Geographic Distribution of Household Units Present in 1957, 1972, and 1976 in Lemon Bay Study Area of Charlotte County from the Sarasota-Charlotte County Line South to the West Branch of Coral Creek.

Geographic Location	Township	Range	Section No.	Half Section	Units Built Prior to 1957	Units Built 1957-1972	Units Built 1972-1976	Total 1972 Units	1972 Waterfront	1972 Interior	Total 1976 Units	1976 Waterfront	1976 Interior
Pasture	41S	20E	1	N/S	-	-	-	-	-	-	-	-	-
(Oyster, Buck Creek)					2	-	-2	2	-	2	-	-	-
Pasture	41S	20E	2	N/S	-	-	-	-	-	-	-	-	-
(Oyster, Buck Creek)					-	-	-	-	-	-	-	-	-
Pasture-Residential	41S	20E	3	N/S	-	-	-	-	-	-	-	-	-
(Oyster, Buck Creek)					2	-	-2	2	-	2	-	-	-
Pasture	41S	20E	4	N/S	-	-	225	-	-	-	225	94	131
Trailer-Residential (Ainger, Oyster Creek)					1	16	229	17	-	17	246	47	199
Mouth of	41S	20E	5	N/S	4	277	93	281	185	96	374	263	111
Ainger Creek					9	207	52	216	70	146	268	95	173
Point of Pines, New Point Comfort,	41S	20E	6	N/S	66	193	136	259	34	225	395	73	322
Mouth of Godfrey Creek					79	84	18	163	101	62	181	119	62
Manasota Key	41S	19E	1	N/S	7	30	19	37	17	20	56	24	32
					17	31	18	48	28	20	66	31	35
Manasota Key	41S	19E	2	N/S	17	28	55	45	22	23	100	31	69
					-	-	-	-	-	-	-	-	-
Punta Gorda	41S	19E	12	N/S	29	67	197	96	42	54	293	72	221
Beach					67	45	40	112	52	60	152	59	93
South	41S	20E	7	N/S	9	6	-	15	11	4	15	11	4
New Point Comfort					-	-	-	-	-	-	-	-	-
Mouth of Ainger Creek	41S	20E	8	N/S	25	5	6	30	25	5	36	30	6
North Grove City					8	203	59	211	101	110	270	211	59
Pasture Trailer-Residential	41S	20E	9	N/S	-	7	143	7	1	6	150	7	143
(Oyster Creek)					-	-	31	-	-	-	31	-	31
South	41S	20E	17	N/S	16	211	56	227	56	171	283	66	217
Grove City					19	57	144	76	9	67	220	49	171
S. Punta Gorda Beach	41S	20E	18	N/S	6	32	13	38	26	12	51	36	15
S. Manasota Key					-	-	-	-	-	-	-	-	-

TABLE 11 (continued)

Geographic Location	Township	Range	Section No.	Half Section	Units Built Prior to 1957	Units Built 1957-1972	Units Built 1972-1976	Total 1972 Units	1972 Waterfront	1972 Interior	Total 1976 Units	1976 Waterfront	1976 Interior
South Punta	41S	19E	13	N/S	21	48	13	69	25	44	82	28	54
Gorda Beach					-	-	-	-	-	-	-	-	-
N. Knight Island	41S	20E	20	N/S	2	-	5	2	1	1	7	5	2
W. Placida Church					-	-	-	-	-	-	-	-	-
Placida Church	41S	20E	21	N/S	16	89	153	105	3	102	258	7	251
Mouth of Buck Creek					4	6	6	10	7	3	16	13	3
Buck Creek	41S	20E	22	N/S	-	-	-	-	-	-	-	-	-
Rotunda					-	12	112	12	7	5	124	49	75
Rotunda	41S	20E	23	N/S	-	-	-	-	-	-	1	-	1
					-	3	88	3	-	3	91	21	70
Rotunda, West Branch	41S	20E	26	N/S	-	6	-	6	-	6			
Coral Creek					-	17		17	11	6			
Pasture	41S	20E	27	N/S	-	48	86	48	14	34	134	37	97
					-	18	44	18	17	1	62	25	37
S. Knight Island	41S	20E	28	N/A	-	-	-	-	-	-	-	-	-
Mouth of Lemon Creek					6	31	4	37	24	13	41	28	13
Knight Island	41S	20E	29	N/S	-	-	6	-	-	-	6	6	-
					-	6	9	6	6	-	15	15	-
South	41S	20E	32	N/S	1	-	-	1	-	1	1	1	-
Knight Island					-	-	-	-	-	-	-	-	-
Don Pedro	41S	20E	33	N/S	5	22	25	27	9	18	52	21	31
Island					1	-	-	1	-	1	1	-	1
Pasture, (Lemon. West	41S	20E	34	N/S	-	-	7	-	-	-	7	-	7
Branch Coral Creek)					-	-	3	-	-	-	3	-	3
Pasture, West	41S	20E	35	N/S	-	-	-	-	-	-			
Branch Coral Creek					-	4		4	2	2			
Pasture (West Branch	41S	20E	36	N/S	-	-		-	-	-			
Coral Creek,					-	-		-	-	-			
Drainage Basin)													
			Totals		439	1809	2092	2248	906	1342	4313	1574	2739

that included parts of Lemon Bay, the actual land area was less than the half-section and since certain sections had areas of both high (trailer and mobile home parks) and low (single family units) housing unit densities, we subdivided each half-section into areas as follows: 0 units/acre, 1-2 units/acre, 2-3 units/acre, 3-4 units/acre and 5 or more units/acre. The resulting distributional pattern is shown on Map IX. The total number of acres for the five housing unit density classes is given below:

Units/Acres		Total Acres
0-1		3,342
1-2		2,567
2-3		899
3-4		104
5 or more		85
	Total acreage	7,997

Those areas with more than 3 units/acre are limited to trailer and mobile home parks and condominiums.

Other land use studies for Charlotte and Sarasota Counties have described the total acreages devoted to different types of activities (i.e., single family, multi-family, mobile homes, commercial, industrial, etc.). The data from these studies for the Lemon Bay area are summarized in Tables 8, 12, 13, and 14.

Both Map IX and the tables above show that 86% of the developed lands in the Lemon Bay area have a housing unit density of 2 or less per acre. Our data do not show which housing units are multiple family units. Nevertheless, nearly all of the housing units fronting on the creeks and Bay are single family units. It is these which are the most important relative to the potential contribution

TABLE 12. Existing Land Use, 1974 for Township 41S-19E, Charlotte County.
Source: Tri-County Engineering, Inc.
June 1975, LUMP.

Type of Use	Number of Uses	Acreage	% of Developed Area	% Total Acreage
Agr. or Open	---	148.14	---	15.0
Residential:				
Single Family	297	74.25	33.4	7.5
Two Family	78	19.50	8.7	2.0
Multi-Family	(25) 363	39.91	17.9	4.1
Mobile Home	3	0.75	0.3	---
Mobile Home Park	(3) 119	12.34	5.6	1.3
Commercial	10	2.50	1.1	0.3
Semi-Public	1	0.23	0.1	---
Park or Recreation	1	26.52	11.9	2.7
Roads	---	46.86	21.0	4.7
Total Developed Area	872	222.86	100.0	22.6
Total Land Area		371.00		37.6
Total Water Area		614.00		62.4
Total Area		985.00		100.0

TABLE 13 Existing Land Use, 1974, for Township 41S-20E, Charlotte County. Source: Tri-County Engineering, Inc. June, 1975, LUMP.

Type of Use	Number of Uses	Acreage	% of Developed Area	% of Total Acreage
Agr. or Open:	---	14,957.61	---	74.6
Residential:				
Single Family	2,218	554.50	25.4	2.8
Two Family	72	18.00	0.8	0.1
Multi-Family	(27) 308	33.68	1.6	0.2
Mobile Home	30	7.50	0.3	---
Mobile Home Park	(14) 852	379.94	17.5	1.9
Commercial	112	72.78	3.3	0.4
Industrial	4	4.99	0.2	---
Warehouse & Storage	3	21.18	1.0	0.1
Public	7	13.88	0.6	0.1
Semi-Public	3	8.44	0.4	---
Park or Recreation	7	493.00	22.6	2.4
School	1	20.20	0.9	0.1
Roads & Railroads	---	553.30	25.4	2.8
Total Developed Area	3,617	2,181.39	100.0	10.9
Total Land Area		17,139.00		85.5
Total Water Area		2,906.00		14.5
Total Area		20,045.00		100.0

Table 14 Generalized Land Use of Census Tract 26 (Englewood Water District) - Sarasota County, 1975, 1985, 2035. Adapted from Smalley, Welford and Nalven, Inc. and Russell and Axon, Inc., 1977

Appendix
Water Resource Merger Study, 1976

Applicable LUDA Levels LEVEL I/ LEVEL II	1975 Area (Acres)	1975 Percent	1985 Area (Acres)	1985 Percent	2035 Area (Acres)	2035 Percent
URBAN OR BUILT-UP						
Residential	2,982	52.9	3,262	57.9	3,782	67.1
Commercial and Services	242	4.3	242	4.3	242	4.3
Industrial	3	0.1	3	0.1	83	1.5
Transportation, Communications and Utilities	121	2.1	121	2.1	121	2.1
Industrial and Commercial Complexes						
Mixed Urban or Built-up Areas	52	0.9	52	0.9	52	0.9
Other Urban or Built-Up Areas	150	2.7	150	2.7	150	2.7
AGRICULTURAL LAND						
Cropland and Pasture						
Orchards, Groves, Vineyards, Nurseries, and Ornamental Horticultural Areas						
Other Agricultural Land						
RANGELAND	1,280	22.7	1,000	17.7	400	7.1
FOREST LAND	730	13.0	730	13.0	730	13.0
WATER						
WETLAND						
BARREN LAND						
Strip Mines, Quarries and Gravel Pits						
Other Barren Land	75	1.3	75	1.3	75	1.3
CENSUS TRACT/DIVISION TOTAL	5,635	100.0	5,635	100.0	5,635	100.0
Percentage of County Area		1.42		1.42		1.42

of septic tank systems to the wasteload of the nearby waterways. A second direct wasteload source includes waterfront marinas and power boats reviewed in the next section.

Marinas and Power Boats.

The impact of small boat marinas and recreational boating on water quality has received more and more attention in recent years (i.e., Roy Mann and Assocs., 1974; Nixon et al., 1973). Mann and Assocs. found that marina facilities ranked high for the following potential environmental impacts: filling/spoil disposal, channelization and poor circulation, anti-fouling toxins, gas and oil spillage, sewage disposal, trash and debris, and fish cleaning. Power boat activities ranked high for the following environmental impacts: sediment resuspension, turbidity, and disturbances to the littoral, benthic and marine fauna and the submerged vegetation.

Since the present study was in part a baseline survey of potential sources of pollution, we surveyed the marinas in Lemon Bay and the number of power boats present in the area in July 1977. The locations of the twelve marinas in Lemon Bay are shown in Figure 30. Information available on individual marinas is summarized in Table 15. At the time of the survey 423 boats were in dry storage and 301 were in boat slips. The number of boats on private waterfront lots were as follows: Lemon Bay, 124; Gottfried Creek, 71; Ainger Creek, 107; Oyster Creek, 42. The total number of boats observed was 1068.

Because of the shallow waters of the creeks and bays most of the power boats in the area are 16 to 24 foot boats with 2-cycle engines. These and other boats that enter the area via the Intracoastal Waterway or by boat trailer are fueled in part by an estimated 24,000 gals. of fuel per month by the local marinas. As the population of the Cape Haze Peninsula increases in the future the activities and expansion of the Lemon Bay marinas will continue to increase. Not all of the marinas on Lemon Bay have toilet facilities. However, marinas that do have

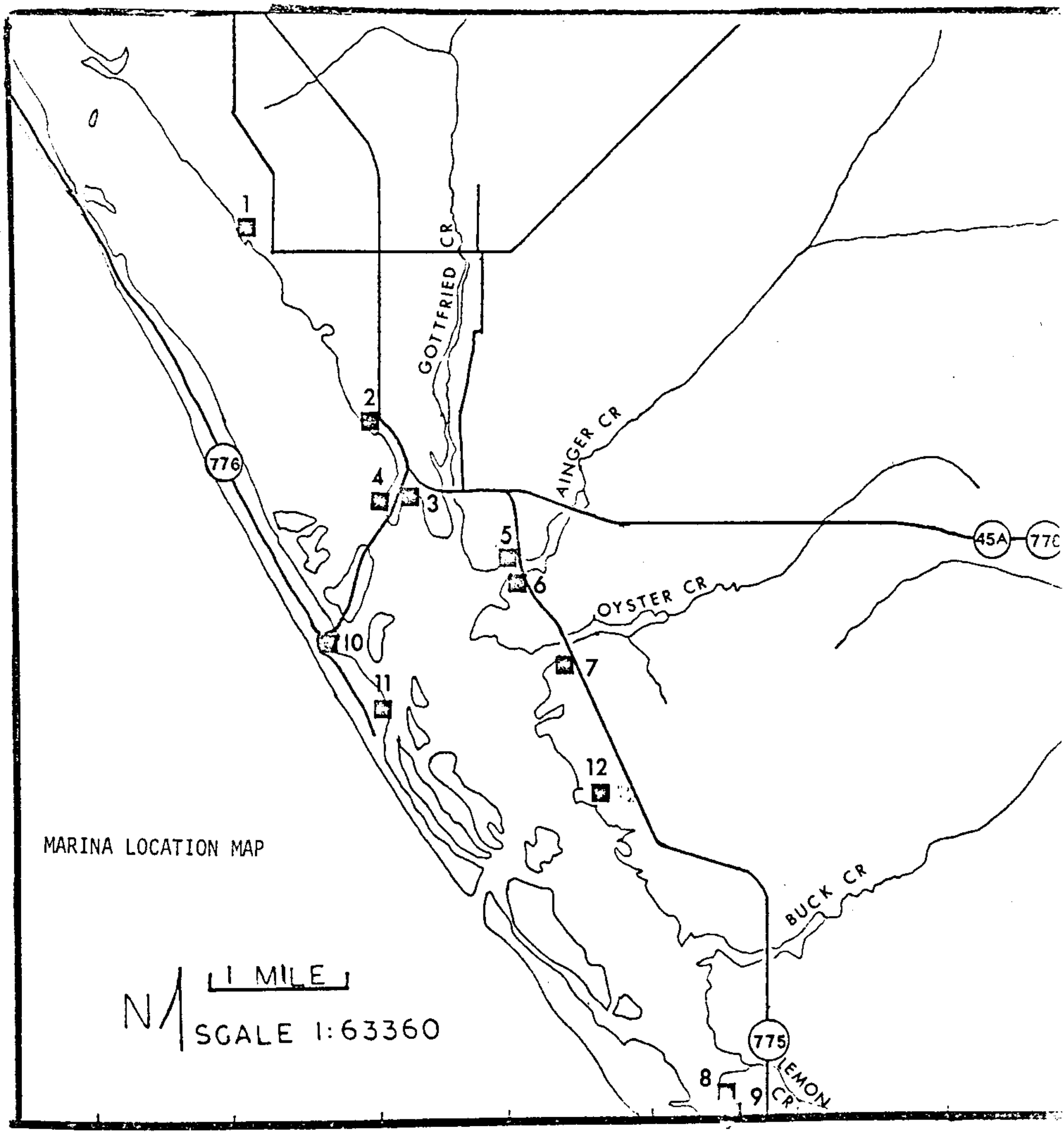


Figure 30 Marina location map. Legend as in Table 15

Table 15 LEMON BAY MARINA INVENTORY

Marina Map Location Number	1	2	3	4	5	6	7	8	9	10	11
Name of Marina	Lemon Bay Marina	Englewood Boats & Motors	Denny's Englewood Marina	Pato Patique	Chucks' Marina Ainger Creek	Norm's Landing Ainger Creek	Grove City Marina Oyster Creek	Sea Gull Marina	Palm Marina	Captain's Club	Weston's Fish & Fun Marina
Type of Marina	C	C	C	C	C	C	C	C	C	P	P
No. Boat Slips	100	-	29	32	15	22	86	70	45	-	-
No. Dry Storage	150	150	12	-	25	-	200	115	120	23	21
No. Boats in D.D.	55	140	16	-	25	-	100	77	110	-	-
No. Boats Wet	75	-	26	32	9	22	42	14	45	20	16
Marine gas/oil sales	+	+	-	+	+	+	+	+	+	-	
Dockside Fuel Pump	+	+	-	+	+	+	+	+	+	-	+
Dockside Diesel Fuel	+	-	-	-	-	-	-	+	-	-	-
No. Gals. Gas/Month	10,000	N/A	0	5,000	800	N/A	N/A	3,000	6,000	-	N/A
Water Hook Ups	+			+	-	-	-	+	+	-	-
Electricity to Slips	+	-	-	+	-	-	-	-	-	+	+
Sewage Facilities	+	-	-	-	-	-	-	-	-	-	-
Live Aboard Boats	2	-	-	-	-	-	-	-	-	3	4
Fish Cleaning	-	-	-	-	-	-	-	+	-	+	-
Grocery Sales	-	-	-	+	-	-	-	-	-	-	-
Restaurant	-	-	-	-	-	-	-	+	+	-	+
Laundromat	+	-	-	-	-	-	-	-	-	-	-
Rest Rooms	+	-	-	-	-	-	-	+	+	+	+
Peak Months	Steady	Steady	Steady	May-Oct	Nov - May	Apr-Oct	Nov-Apr				Summer
Least Active Months				May-Oct							May, Sept, Oct

toilet facilities may be expected to generate large amounts of wastewater during certain days of the week depending on the season.

Marinas with toilet facilities are comparable to schools, churches and waterfront parks. Thus their wasteload budgets differ from those of residential multiple family and tourist housing units and commercial units. In general when the combined wasteload of activities of any of these types of units exceeds the capacities of the on-site septic tank system (S), the next step is to develop on-site neighborhood package type sewage facilities.

Sewage Systems.

Although most of the Lemon Bay area is serviced by on-site septic tank wastewater systems, there are notable exceptions. These exceptions include a variety of small treatment plants with different design capacities. Extended aeration, retention ponds and sand filters are common elements in the processing of treated effluent. The location and character of the 22 treatment plants in the area are summarized in Tables 16 and 17. The locations of the plants are shown in Figure 31. This figure and Map IX show that every area with more than 3 units/acre is presently serviced by a sewage treatment plant with the possible exception of the Redfish Lodge area on Lemon Bay. As the open space in the less densely populated areas is filled with housing units additional areas will require central sewage systems. The filling in of existing developed areas has been slow relative to the expansion of new developments into undeveloped areas. Thus forecasts of the population and waste flow in the Lemon Bay area exemplified by Table 18 may need to be supplemented with additional data on population, zoning and land ownership patterns as well as types of development and the ever increasing array of alternative on-site wastewater systems.

Table 16 Charlotte County, Large Independent Sewer Systems in Lemon Bay Area, 1973.
Source: Tri-County Engineering, Inc., June 1974 (See Figure 31 for locations.)

NAME, ADDRESS LOCATION	COLLECTION SYSTEM AGE MAX. NO. HOOK-UPS SIZE AREA SERVICED COMMENTS	TREATMENT SYSTEM TYPE OF TREATMENT TYPE PLANT & BRAND FINAL DISCHARGE POINT (CAPACITY)	CAPACITY (GPD) DESIGN SUMMER WINTER	EXPANSION FEASIBILITY ON SITE
1. Admiralty Villas N. Beach Road Englewood, Fla.	2 Years NA NA New System	Aeration Defiance Drain Field	50,000 3,386 7,640	NA
2. Englewood Beach Condominium Manasota Key	5 Years 66 Homes 2 Restaurants 1 Public Beach 37	Aeration Environmental Control Sys. Polishing Pond (5,600'^{2})	50,000 19,000 30,000	YES
3. Gasparilla Pines Englewood	Under Construction 320 Units (proposed) 750 Acres	Aeration Marolf Polishing Pond (1 Acre) Golf Course Irrigation	43,000 (Phase 1) 100,000 (Phase 2) Not in Use Yet	NO
4. Holiday Inn Trav-L-Park Fla 776 Englewood	1 Year 112 Hook-Ups 3 Buildings 20 Acres (12 Acres Already Developed)	Aeration Defiance Retention Lake (8,670'^{2})	15,000 2,193 5,110	YES
5. Holiday Mobile Estates Fla 776 Englewood	1/2 Year 413 Connections NA	Aeration Marolf Retention on Pond (2 Acres)	300,000 100,000	YES Plant is Expandable to 1,000,000, part under construction
5A Rotunda West I and II Rotunda West	2 Years--Present 275 Connections	Aeration 1 Clow 1 Davco Polishing Pond (Golf Course Irrigation	70,000 49,000 NA	YES

continued.

Table 16/Charlotte County, Small Independent Sewer Systems in Lemon Bay Area, 1973.
Sources: Tri-County Engineering, Inc. (See Figure 31 for locations)

NAME, ADDRESS LOCATION	COLLECTION SYSTEM AGE MAX. NO. HOOK-UPS SIZE AREA SERVICED COMMENTS	TREATMENT SYSTEM TYPE OF TREATMENT TYPE PLANT & BRAND FINAL DISCHARGE POINT (CAPACITY)	CAPACITY (GPD) DESIGN SUMMER WINTER	EXPANSION FEASIBILITY ON SITE
6. Bay Vista Rest. 1177 McCall Englewood, Fla	12 Years 1 Restaurant NA NA	Aeration Defiance Drain Field (500'^{2})	5,000 NA NA	NO
7. El Galeon Motel Gulf Blvd. Manasota Key	1 Year 13 Apts. NA	Aeration NA Drain Field (1,200'^{2})	3,300 960 1,300	NO
8. Gulf to Bay Trailer Park Manasota Key	10 Years (Modified 1 Year) 20 Hook-Ups	Aeration NA Drain Field	3,000 NA NA	NO
9. Lemon Bay School Fla 775 Englewood	12 Years 479 People	Aeration NA Drain Field (2,000'^{2})	9,000 NA NA	YES
10. Oakwater Cove Condominium N. Beach Road Manasota Key	Under Construction 18 Units 1.32 Acres	Aeration Marolf Drain Field (2,000'^{2})	6,000 NA	NO
11. Palm Plaza Shopping Center Fla 775 Englewood	4 Years 15 Stores	Aeration NA Drybed (6 Runs of 70')	10,000 6,000 12,900	NO
12. Sea Horse Apts. Gulf Blvd. Manasota Key	6 Years 25 Apts.	Aeration Defiance Drain Field (35,000'^{2})	7,200 1,390 4,697	NO
13. Tiki Apartments N. Beach Road Manasota Key	2 Years 32 Apts.	Aeration Defiance Sprinkling System	5,000 1,310 3,580	NO

Table 17 Sarasota County, Independent Sewage Systems in Lemon Bay Area, 1976. Source: Sar. Co. 201 Plan Rpt. 1977. See Figure 31 for locations

Location Symbol	Facility	Address	Design Capacity/ Ave. Daily Flow	Treatment	Disposal
14	Brook to Bay Trailer Park	1891 Englewood Road (State Road 775) Englewood	20,000/Not Reporting	Extended Aeration	Drain Field Sand filter to stream to Forked Creek
15	Deer Creek Trailer Park	201 Horton Englewood	16,000 GPD/9,538 GPD	Extended Aeration	Drain Field
16	Englewood Golf Condominium	1601 Englewood Rd. Englewood	25,000 GPD/2,075 GPD	Extended Aeration	Perc. Pond
17	Englewood School	250 W. Perry Englewood	10,000 GPD/2,439 GPD	Extended Aeration	Drain Field
18	Englewood Shopping Center	Englewood Shopping Center	10,000 GPD/5,400 GPD	Extended Aeration	Drain Field
29	Oak Grove Trailer Park	1800 Englewood Road Englewood	22,000 GPD/7,400 GPD	Extended Aeration	Drain Field to Forked Creek
20	Quail Run Condo Apartments	State Road 777 and Selma Avenue Englewood	75,000 GPD/Just Starting UP	Extended Aeration	Perc. Pond
21	Shady Haven Mobile Home Park	150 Englewood Road Englewood	6,000 GPD/3,590 GPD	Extended Aeration	Drain Field to Lemon Bay
22	Wash House Laundromat	Dearborn Street and State Road 775 Englewood		Open Sand Filter	Drain Field to ditch to Godfrey Creek

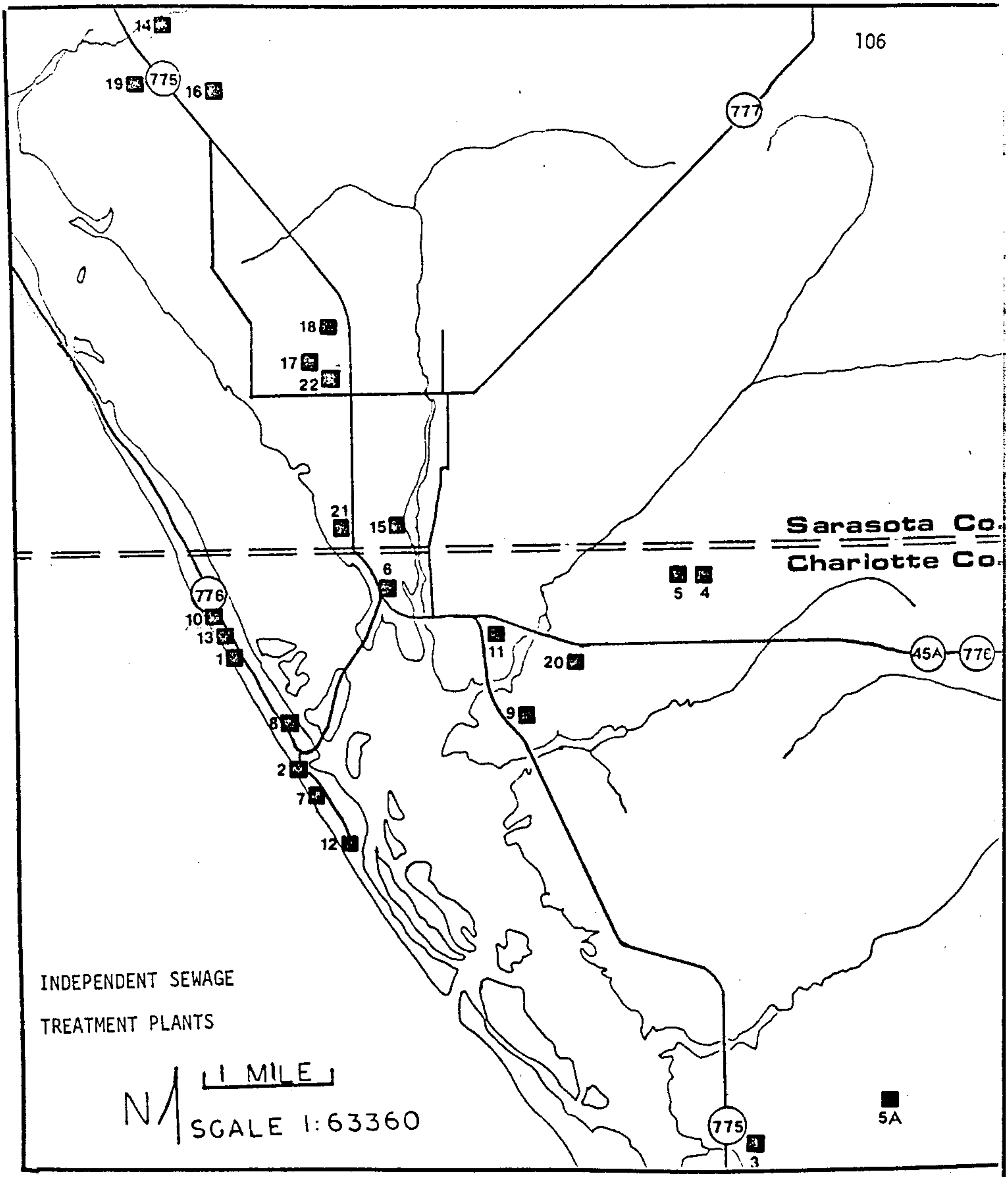


Figure 31. Locations of large and small independent sewage treatment systems in the Lemon Bay Area. See Tables 16 & 17 for descriptions of each system.

Table 18 Forecast of Population and Waste Flow in Englewood Water District Area.
Source: Smalley, Wellford & Nalven and Russell and Axon, Sar. Co. 201 Rept. 1977

	1975	1980	1985	1990	1995	2000
Resident Population	16,122	19,830	23,201	26,449	29,888	32,877
Tourist & Occasional	4,030	4,957	5,800	6,612	7,471	8,218
Total Population	20,152	24,787	29,001	37,161	37,359	41,095
Waste Flow (MGD)[1]	0.75[2]	2.48	2.90	3.31	3.73	4.11
BOD_5 and Susp. Solids (pounds per day)		4,133	4,833	5,517	6,217	6,850

1. Projected flow based on an average flow rate of 100 gals per capita per day.
2. This value is estimated from through-house flow of water derived from Englewood Water District Records.

Land Ownership.

From the present day and future land use planning and zoning vantage point it will be necessary to understand the fine points that lie behind the privately owned lands in the Lemon Bay area. Except for Charlotte Beach State Park, the local county parks, schools and airport, and two or three nature preserves, the lands in the Lemon Bay area are privately owned by individuals or corporations. Some of the private lands have been subdivided and are platted; others are for the present not platted. Tables 19 and 20 summarize the distribution of land ownership and subdivisions. Map X shows the spatial distribution of platted lands.

Since nearly all of the platted lands have been developed or are in the process of being developed, these areas allow little leeway in the location of roads and number of housing units except where the originally platted lots are sold in units of two or more lots. In general the roads and lots in the platted areas conform to rectilinear shaped parcels of land ownership and not to the subtle variations in the topography, soils and natural drainage ways.

Open Spaces.

The platting and development of the unplatted lands along the creeks and Bay must be compatible with the maintenance and improvement in the water quality of the surface waters. At the present time a significant percent of the shorelines on the creeks and Bay in the suburban area are still in a natural state (Table 5 Lemon Bay, 22%; Gottfried Creek, 22%; Ainger Creek, 11.8%; Oyster Creek, 41%; Buck Creek, 82%). These shorelines, their adjoining uplands and shallow submerged lands as well as the mangrove islands in the lower reaches of the creeks and in the Bay must be preserved. Not only do they constitute the region's major environmental conservation elements but they are critical in the overall biological, tertiary treatment and assimilation systems for wasteloads from numerous upland sources, including ground water seepage from improperly located septic tank leaching fields of existing waterfront homesites. Accordingly, we recommend that for the existing unplatted lands in the suburban areas of the creeks and the mainland side of Lemon Bay that a road and building lot setback line be established 100 feet for all natural shorelines. This 100 foot wide zone must be left in its natural state (See Figures 18, 19, 20, 21, 22, and 23). This mandate may require that these lands be acquired as well as regulated by the public.

These "natural" lands in the suburban sections of Lemon Bay and the creeks plus the flood plains that remain in the sections of the creeks beyond the suburban areas are all that remains of the original hydro-biological-nutrient system that once made Lemon Bay a famous fishing and shellfishing resort. In other words, these shorelines and wetlands are major elements in the maintenance and restoration of the chemical, physical and biological integrity of the local waters.

TABLE 19 KEY TO LANDUSE - OWNERSHIP MAP--CHARLOTTE COUNTY SECTION

LAND USE - OWNERSHIP 1976,
TABLE OF PARKS AND SUBDIVISIONS
CHARLOTTE COUNTY

Geographic Location	Township	Range	Section	Subdivision Number	Subdivision Name
Manasota Key	41S	19E	2	1	Ainger's Sub
				2	Pelican Shores
	41S	19E	1	3	Lemon Bay Estates, Inc. #1
				4	Gulf Ridge
				5	Lemon Bay Estates, Inc. #2
	41S	19E	12	6	Chadwick's Sub
				7	Holiday Isles Sub #1
				8	Chadwick's Beach
				9	Chadwick's Sub #2
	41S	19E	19	10	Englewood Shores
	41S	19E	18	11	Holiday Shores
	41S	20E	20	12	New Pass Haven
				13	Sar. Bank & Trust & N. Widris
	41S	20E	29	14	Hellewah Isles
				15	W.C.I.N.D.
				16	Palm Island Estates
N. of Grove City	41S	20E	5,6,7,8, 9 & 20, 21,28	17	Grove City Land Co.
	41S	20E	4	18	G.R. Mobile Homes, Inc.
				19	Holiday Mobile Estates
				20	Mobile Gardens
				21	Gulfwind
				22	San Casa
				23	Lemon Bay Roof Co., Inc.
				24	Sunrise Enterprise Co.
Grove City	41S	20E	8	25	Messer & Dunwody #1
	41S	20E	9	26	Messer & Dunwody #2

	Twnsh	Range	Sect	Subd No.	Subdivision Name
S. of Grove City	41S	20E	16	27	Lemon Bay Holding Co.
				28	General Development Corp
				29	L.R. Drake & Lemon Bay Holding Co.
				30	Hensley Broward Employees Profit Sharing Trust
				31	James E. Messer et al
				32	Dunwody & Messer
	41S	20E	2,3,10, 11	33	Port Charlotte
	41S	20E	14,15,22, 23,26,29	34	Rotunda

PARKS

Geographic Location	Township	Range	Section	Park Letter	Park Name
Manasota Key	41S	20E	12	A	Englewood Beach Park, Chtte Co.
East of Manasota Key	41S	20E	7	B	Dunwoodie Island, Federally Owned
				C	Rookery Island, Nature Conservancy Owned
	41S	20E	18	D	Fla Key, State Owned
				E	Buttonwood Island, Nature Conservancy Owned
S. of Manasota Key				F	
				G	
				H	Charlotte Beach State Parks
				I	
	41S	20E	20	J	Grove City Island, State Owned
				K	Spoil Island, Federally Owned (W.C.I.N.D.)

GOLF COURSE: East of 774 at Lemon Creek (41S/20E/Section 28)

SCHOOL & YOUTH CENTER: East of 774 between Ainger & Oyster Creeks (41S/20E/Sec.8)

TABLE 20 KEY TO LANDUSE - OWNERSHIP MAP--SARASOTA COUNTY SECTION

LAND USE - OWNERSHIP 1976,
PARKS AND SUBDIVISIONS, SARASOTA COUNTY

eographic ocation	Township	Range	Section	Subdivision Number	Subdivision Name
anasota Key	40S	19E	35	1	Gnarled Oak Estates
	40S	19E	27	2	Blind Pass Estates
				3	Carrolland
est of Gottfried Creek	40S	19E	36	4	H.E. Subdiv.
				5	Brucewood Bayou
				6	Palm Grove
				7	Pine Haven
				8	Allenwood
				9	Paulson Place
				10	Englewood Pk.
				11	Englewood Platts
Gottfried Creek	40S	20E	31	12	Horton Estates
				13	Riverview
				14	Englewood Gardens Sub.
				15	Long Lake
				16	Deer Creek Mobile Home Pk.
				17	Burns Wood
				18	Pineland
				19	Orchard
				20	Deer Creek Cove
				21	Bay View Manor
				22	Englewood Gardens Sub
				23	Smithfield Subdiv.
				24	Prospect Park Sub.
				25	Condominium
				26	Prospect Park Sub
				27	Deer Creek Park
				28	Englewood Gardens Sub
ast of Gottfried Creek	40S	20E	32	29	Aldersgate Foundation, Inc.
				30	Prospect Park Sub
	40S	20E	33	31	Englewood Water District
				32	Key Agency, Inc.
			33,34,35	33	Myakka Estates #3
est of SR 775A	40S	19E	26	34	Lemon Bay Park Sub
				35	Bay Vista Blvd 1st Add't'n
				36	Englewood Home Acres

	Twnship	Range	Section	Subdiv. No.	Subdivision Name
E[illegible] of SR 775A	40S	19E	25	37	Southwind Harbour
				38	Lamp Winds Sub
				39	Town Center Sub
				40	Songrest Sub
				41	Englewood Sub
				42	Lasbury Pine Acres Sub
				43	Harter Sub
				44	Jones Addition
				45	Englewood Vie Sub
				46	Englewood Sub
				47	Artists Acres Sub
[illegible]ast of SR 775	40S	20E	30	48	Englewood Gardens
				49	Englewood Gardens
				50	Creek Lane Estates Sub #1
				51	" " " " #2
				52	Coral Lane
				53	Lakeview Terrace
				54	R.E.B.A.
				55	Resteiner Heights
				56	Deer Creek Estates
				57	Carroll Wood Estates
				58	Lake Holly
				59	Englewood Heights
				60	Lemon Wood Inv.
				61	U.S. Home Mobilife Corp.
				62	O'Day Enterprises, Inc.
[illegible]R 777, East of [illegible]ottfried Creek	40S	20E	29	63	Englewood Gardens Sub
				64	Gemot Inc.
				65	Dayton Airport Inc.
	40S	20E	28	66	Joz, Inc.
[illegible]est of 775A	40S	19E	23	67	Gulf Coast Park
				68	Bay Vista Road
				69	Englewood Gardens
	40S	19E	22	70	Lemon Bay Sunset Sub
East of 775A	40S	20E	24	71	Englewood Sub
[illegible]R 777	40S	20E	21	72	F.P.L. Co.
East of SR 777	40S	20E	11,14,22, 23,26,27	73	General Development Corp
[illegible]est of SR 775	40S	19E	15	74	Englewood Gardens 3
[illegible]long SR 775	40S	19E	14	75	Overbrook Gardens Sub
				76	Kroh Bros. Fla. Prop., Inc.
				77	Englewood Isles
				78	Englewood Golf Club Villas
				79	S. Ridge Development Corp
				80	Bartlett Sub
[illegible]R 775 & 777	40S	20E	7,8,9, 10,15,17, 18,19,20, 21	81	Venetia, Inc.
West of 775	40S	19E	9	82	Manasota Gardens 1st Sub
	40S	19E	10	83	Manasota Land & Timber Co.

	Twnship	Range	Section	Subdiv. No.	Subdivision Name
				84	Thomas Heasles Sub
				85	Blue Dolphin Estates
				86	Manasota By The Sea
				87	Manasota Manor
				88	Manasota Acres
East SR 775	40S	19E	11	89	Gulf Coast Groves
	40S	19E	12	90	Claysota Corp.

PARKS

eographic Location	Township	Range	Section	Park Letter	Park Name
East of Gottfried Creek	40S	20E	31	A	Deer Creek Park (BCC)
est of Gottfried Creek	40S	19E	36	B	Paulson Pk Indian Mound (BCC)
Between 775 & 775A	40S	19E	25	C	County Park: "Englewood" (BCC)
anasota Key East of 776	40S	19E	26	D	Sarasota County Pk.
Manasote Key at 776 Turnoff	40S	19E	9	E	Sarasota County Pk.
East of 45A, North of Forked Creek	40S	19E	11	F	Gulf Pines Memorial Pk.

IRPORT - Buchanan Airport, BCC (40S/19E/Section 23)

GOLF COURSE - Golf Club of Englewood, Inc. (40S/19E/Section 13)

CHOOL - Englewood Elementary School, BPI (40S/19E/Section 25)

HYDROGRAPHY

Among the various environmental elements involved in the water quality of Lemon Bay are the following physical hydrographic features: bathymetry (area, depth, volume, shoreline length), tides, tidal flushing and tidal currents. Although the information available on these features is fragmentary and even contradictory, it does provide a baseline for future studies.

Lemon Bay Bathymetry.

Figure 31a shows the outline of Lemon Bay as it appeared on the 1944 U.S.C. & G.S. Topographic Map of Englewood and vicinity. The map itself is based on aerial photographs taken December, 1939. Figure 31a also shows the major areas that have been dredged and filled since 1939.

According to McNulty et al (1972) the total surface area of the Bay at mean high water is 6,042 acres and the volume is 36,410 acre feet. Some 2,145 acres of submerged vegetation occur between mean low water and the 3 foot contour line. The 30 mile long shoreline has 971 acres of mangroves and 331 acres of tidal marshes. From the map in Figure 31a we determined that in 1939 there were 0.89 sq. mi. of mangroves along the shore of the Bay. Subsequent to that date 0.27 sq. mi. (30.3%) have been filled. The area of the Bay that is less than 3 feet deep is 4.94 sq. mi. or approximately 61.4% of the total area of the Bay. This shallow region of the Bay is divided into sub areas by an array of tidal channels, artificial channels and the Intracoastal Waterway.

The original profile of the bottom of the Bay along the route of the Intracoastal Waterway is shown in Figure 32. The profile of the underlying sediments is shown in Figure 33. This last figure reveals that much of the material removed from the waterway cut consisted of silt, organic silt and "fat silt." Between Alligator Creek and the Manasota Key Bridge the surficial (3 ft thick) sediments were dominated by organic silt, probably derived from Alligator Creek.

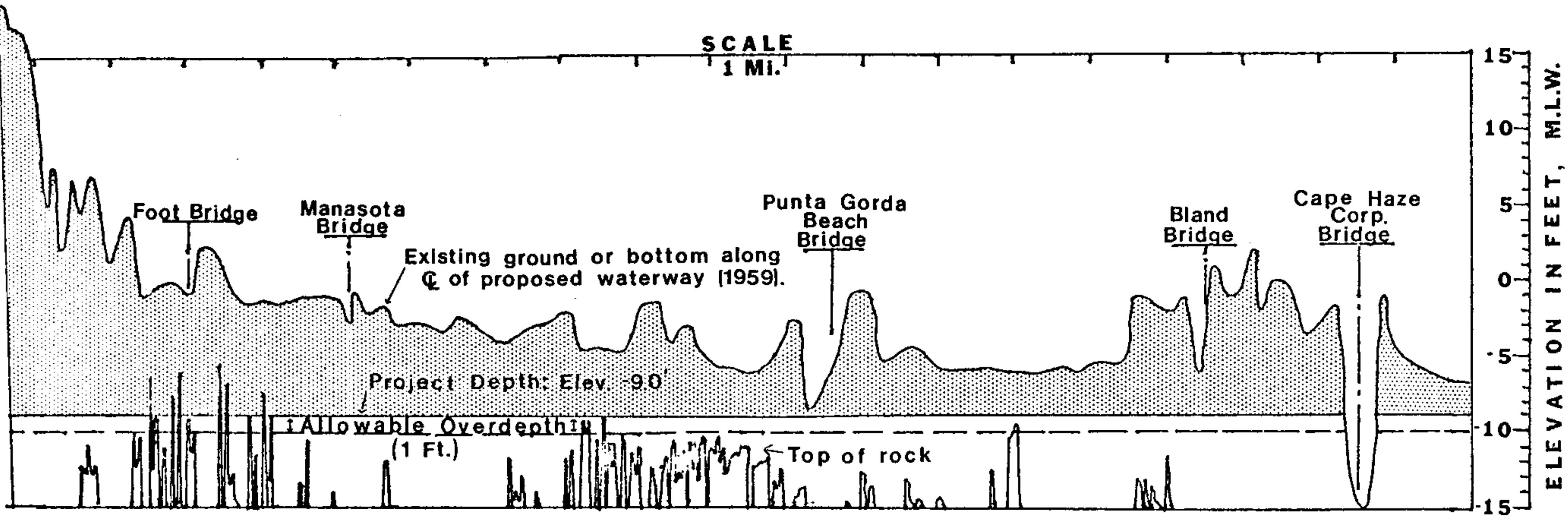
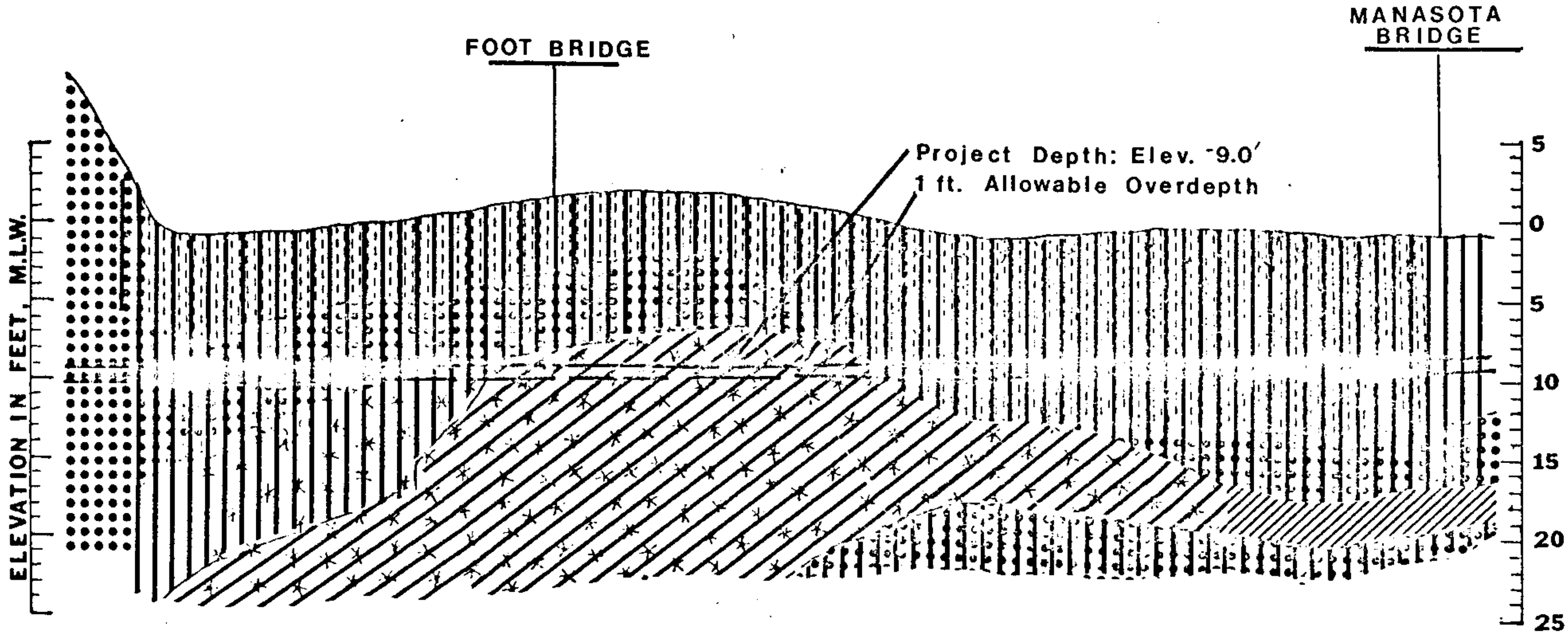


Figure 32 Bottom profile of Lemon Bay along the Intracoastal Waterway and elevation of subsurface rock.

From: U.S. Army Corps of Engineers, 1959, Intracoastal Waterway Caloosahatchee River to Anclote River, Florida.



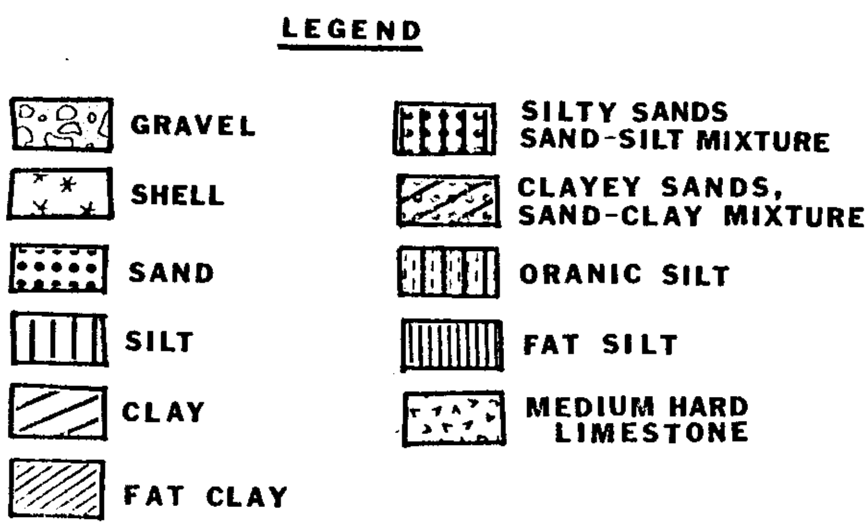


Figure 33 Geologic section of sediments of Lemon Bay along the Intracoastal Waterway from North to South.

Adopted from: U.S. Army Corps of Engineers, 1959, Intracoastal Waterway Caloosahatchee River to Anclote River Florida.

Figure 33 , part 2

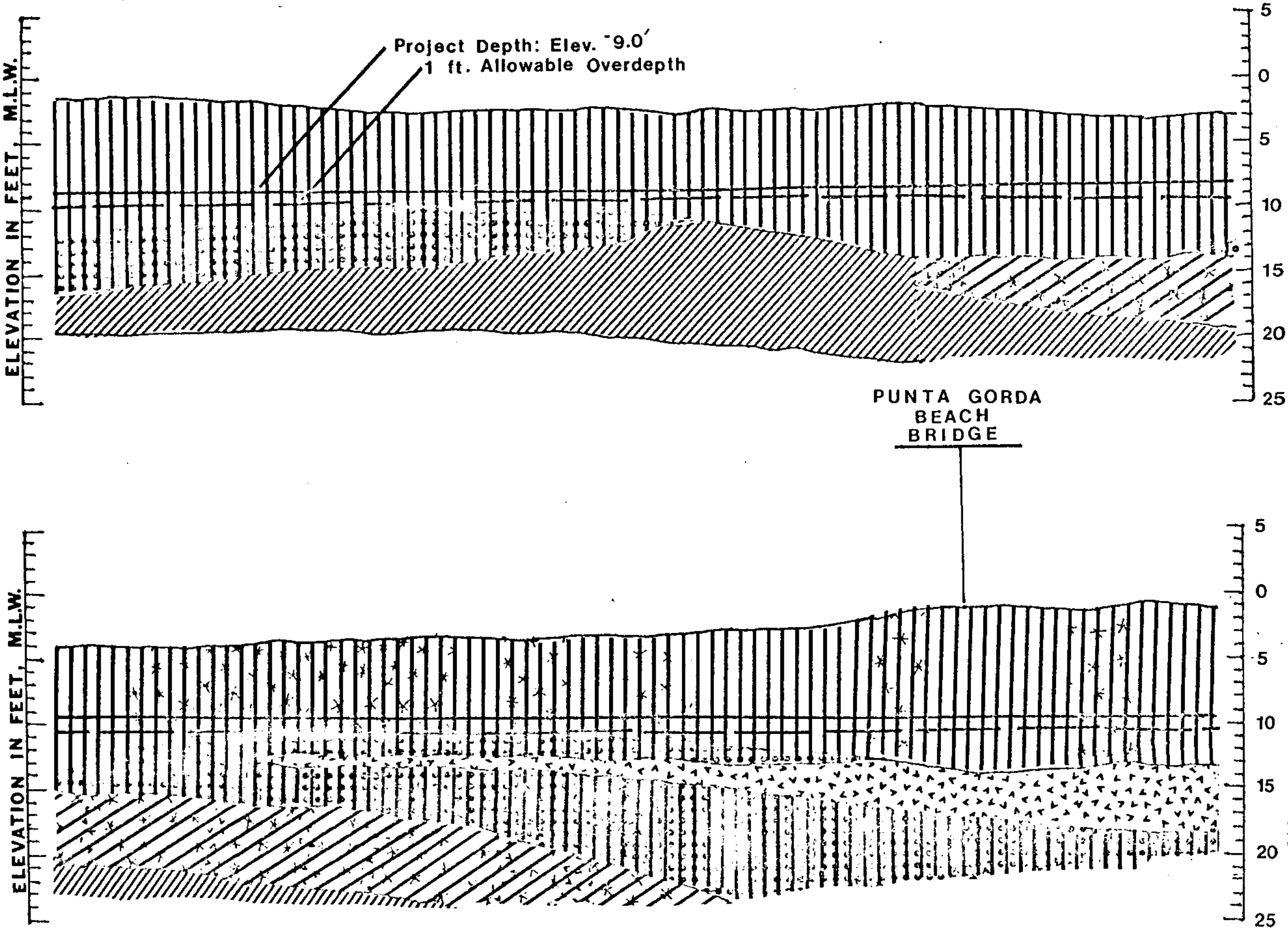
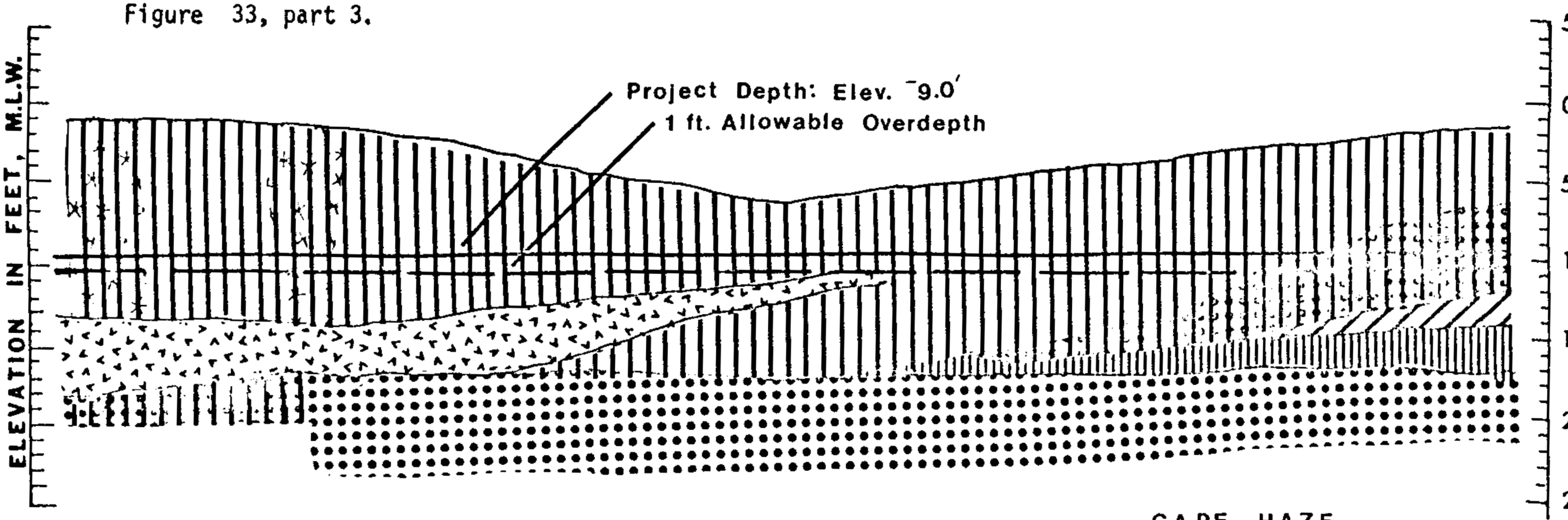
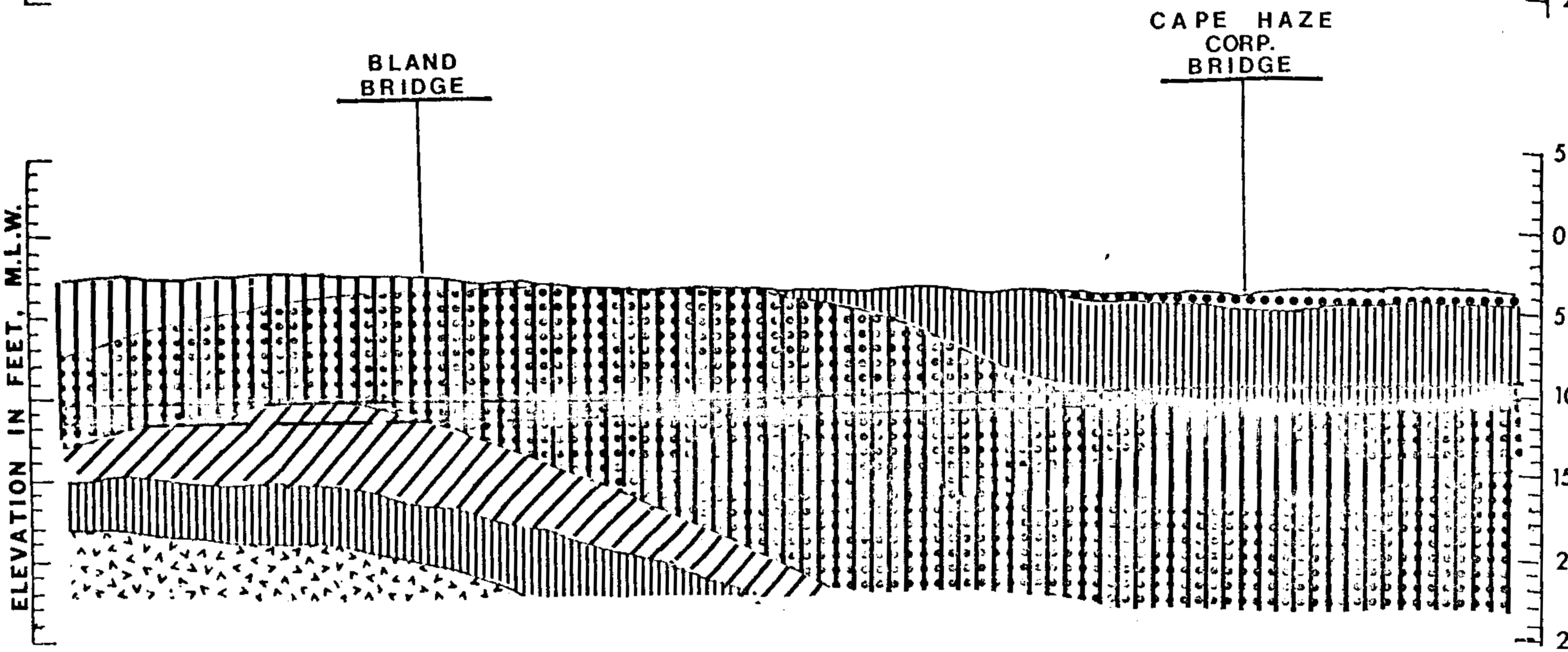


Figure 33, part 3.





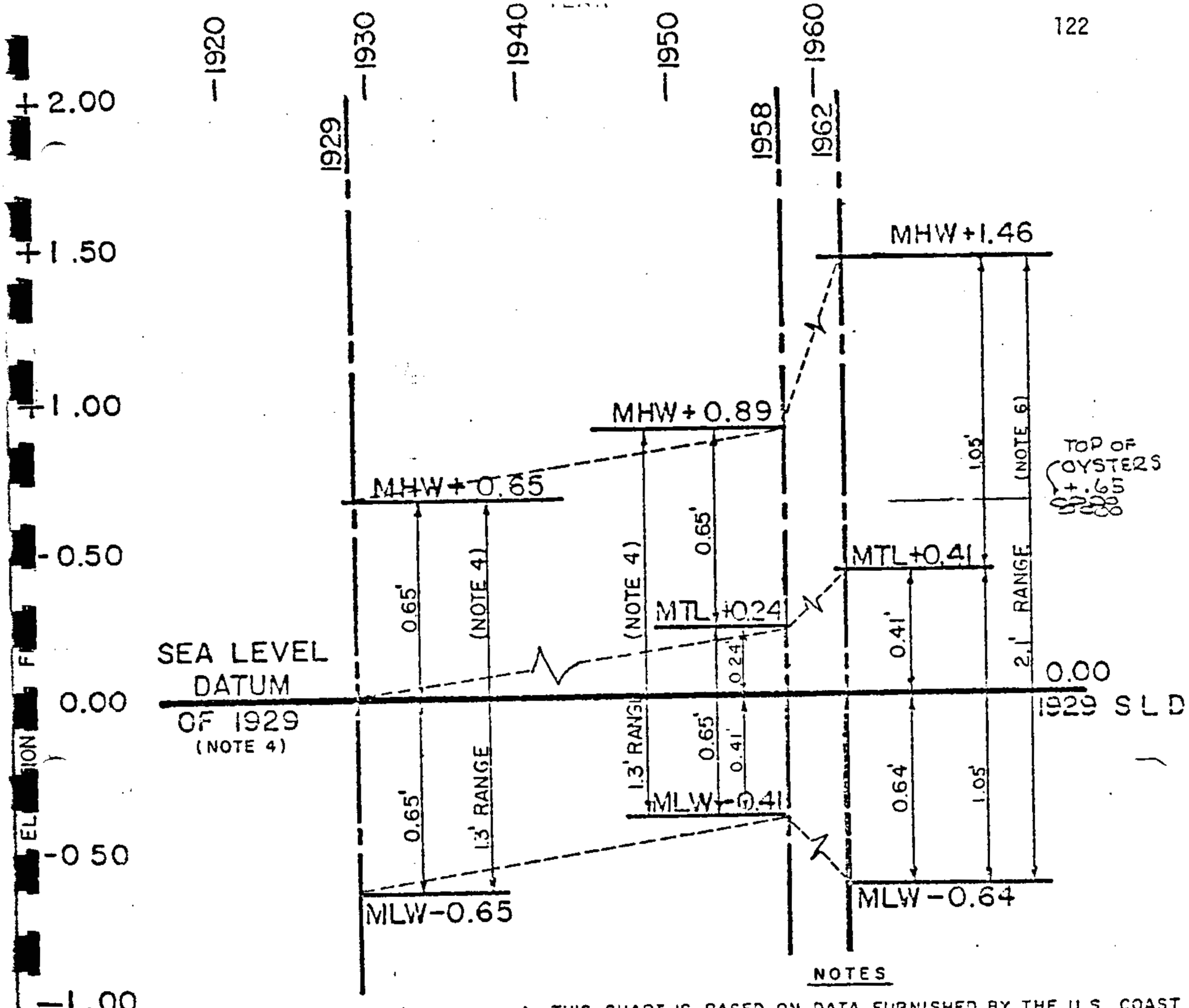
Between Manasota Key Bridge and Bland Bridge at the present day Palm Island Cut the surficial sediments were characterized as fine silt.

Tidal Current and Tidal Flushing.

Lemon Bay. The mean tidal range is 1.3 ft; the mean diurnal tidal range is 2.0 ft; the estimated highest average tide is 3.3 ft and the mean sea level is 0.7 ft above mean low water (U. S. Army Corps of Engineers, 1976). However, the mean sea level has been rising in this region of Florida since 1929 (Figure 34). The maximal velocity of the incoming tide at Stump Pass is 1.1 knots and the maximum ebb tide velocity is 0.6 knots. Unfortunately there appears to be no tidal velocity data prior to dredging of the Intracoastal Waterway.

Tidal current studies by Story et al (1974) indicate that a tidal node occurs in the constriction between Lemon Bay and Placida Harbor at the south end of the Bay and a second tidal node occurs at the northern end of the Bay near Forked Creek. The general ebb and flood current conditions reported in this study are shown in Figure 35. In addition, dye tracer studies by Story et al showed that dye released at SR 775 on Ainger Creek "passed through Stump Pass within one tidal ebb" and that water from Forked Creek flowed northward on both ebb and flood tides. A preliminary dye tracer study in the Englewood area indicated that water in the vicinity of Furbeck Point, Englewood passes southward beyond the Tom Adams Bridge on ebb tide and then flows northward toward Englewood (Figure 36). These results suggest that the area of Lemon Bay north of the Tom Adams Bridge and south of Forked Creek is incompletely flushed during one or more tidal cycles. Contrarily, water entering the Bay from Gottfried, Ainger and Oyster Creeks during the early phase of an ebbing tide probably pass out of the Bay on the same ebb tide.

In the early phases of the present study, people in the Englewood area expressed overt concern over the possiblity that low quality water from the Red Lake-Alligator Creek region north of Lemon Bay entered the Bay and thereby was a major cause of degraded



NOTES

1. THIS CHART IS BASED ON DATA FURNISHED BY THE U.S. COAST AND GEODETIC SURVEY, AND ON "SHORE AND SEA BOUNDARIES" BY SHALOWITZ (PUBLISHED BY U.S.C. & G.S.)
2. LOCAL MSL SHOULD NOT BE CONFUSED WITH SEA LEVEL DATUM OF 1929 AS LISTED UNDER ITEM 4 SINCE IT IS AN ADJUSTED DATUM BASED ON SEA LEVEL OBSERVATIONS AT SELECTED LOCATIONS.
3. M.T.L. IS THE PLANE MIDWAY BETWEEN M.H.W. AND M.L.W.
4. OFFICAL DESIGNATION OF THE EXISTING BENCH MARK NETWORK AT 0.00 ELEVATION IS "SEA LEVEL DATUM OF 1929."
5. AVAILABE DATA INDICATES THAT THE SEA LEVEL (REPRESENTED ABOVE BY CHANGE IN M.T.L.) HAS RISEN ABOUT 0.4 FT. IN THIS AREA BETWEEN 1929 AND 1962, AVERAGING ABOUT 0.012 FT. (0.15 IN.) PER YEAR.
6. PRIOR TO 1962 U.S.C. & G.S. COMPUTED TIDAL RANGE AS A "MIXED TIDE", AVERAGING ALL HIGHS FOR M.H.W. AND ALL LOWS FOR M.L.W. U.S.C. & G.S. NOW CLASSIFIES THIS GULF COAST TIDAL AREA AS DOMINANTLY DIURNAL, AND COMPUTES M.H.W. FROM ONLY HIGHER-HIGHS AND M.L.W. FROM LOWER-LOWS.

ABBREVIATIONS

MSL = MEAN SEA LEVEL (NOTE 2)
MTL = MEAN TIDE LEVEL (NOTE 3)
MHW = MEAN HIGH WATER (NOTE 6)
MLW = MEAN LOW WATER (NOTE 6)
SLD = SEA LEVEL DATUM (NOTE 4)

Figure 34.

TIDE LEVELS AT SARASOTA BAY

SMALLY, WELLFORD AND NALVEN — CONSULTING ENGINEERS

9-14-67

DWG. A-25-66
REV. 10-25-67

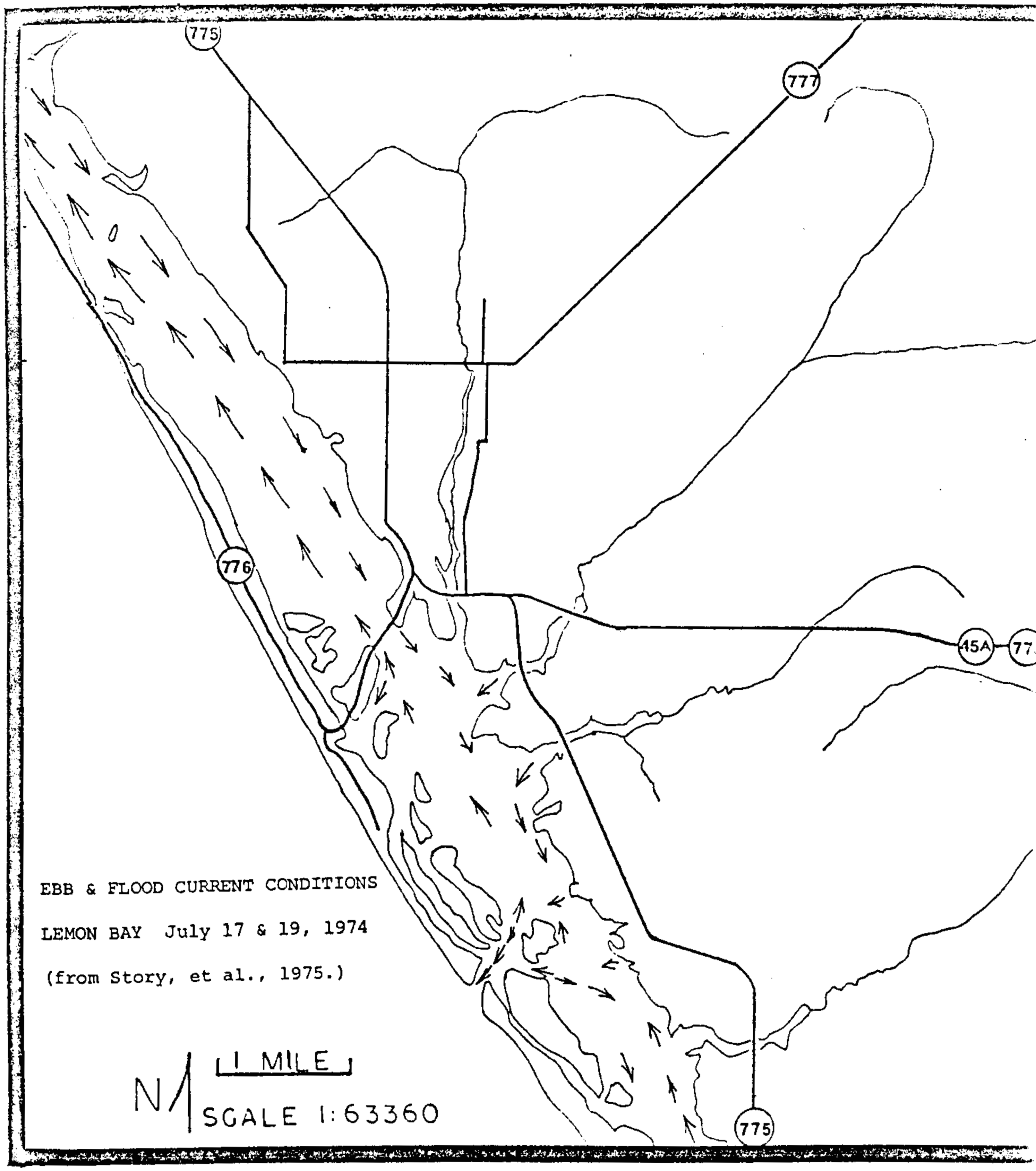


Figure 35. Current conditions in Lemon Bay, July 17 and 19, 1974.

Source: Story, et al., 1975.

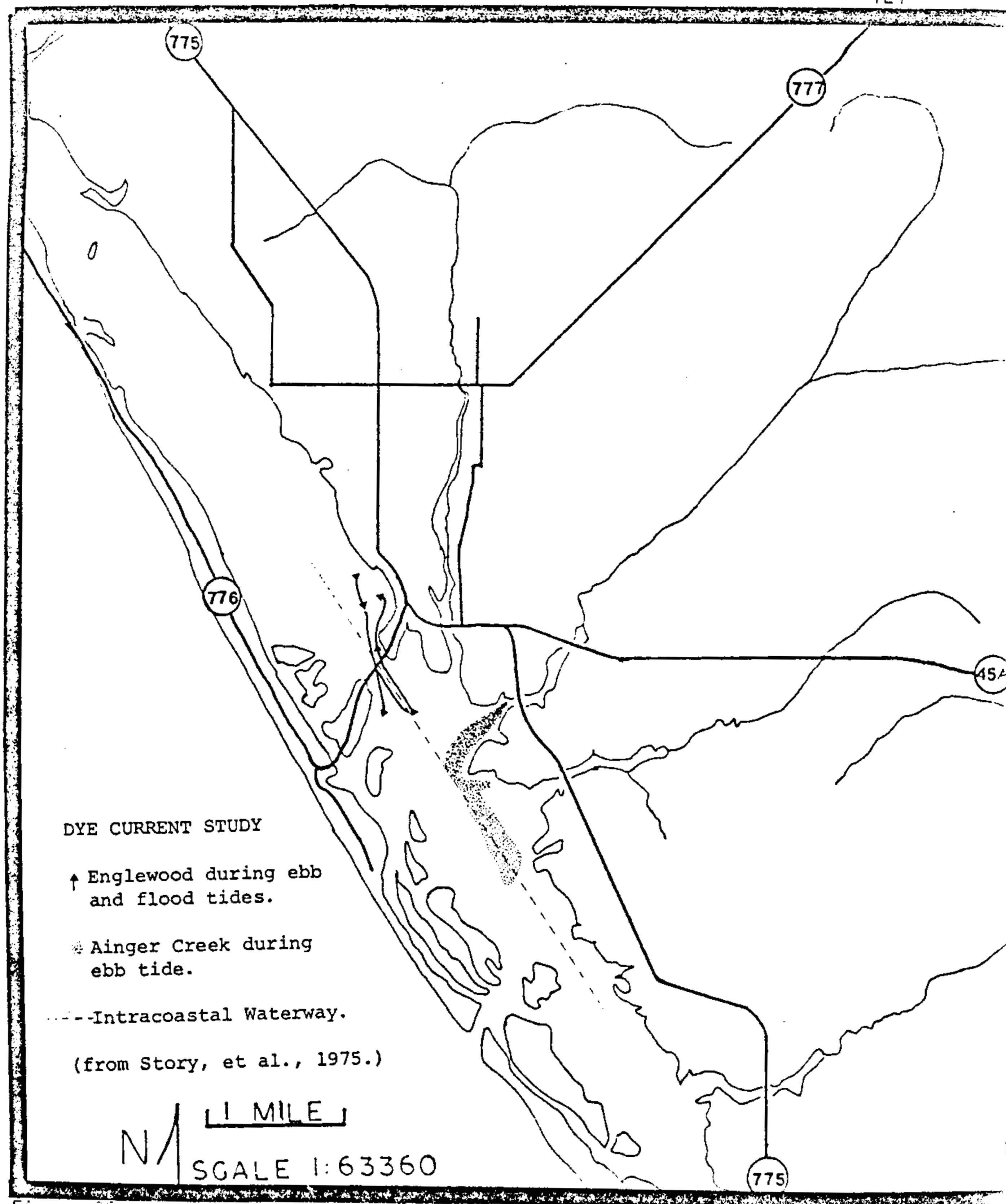


Figure 36. Dye current study by Englewood and Ainger Creek, Lemon Bay.

Source: Story, et al., 1975.

water quality in the Bay. Accordingly, we conducted a current drogue study in the Forked Creek-Alligator Creek area of Lemon Bay on July 25-26, 1977. As seen in Figure 37, current drogues were initially released in the Intracoastal Waterway off of the mouths of the two creeks after the beginning of a short ebb tide (8 hrs., 21.1 ft drop) and were tracked until low slack water. The drogues released at Alligator Creek flowed northward as far as the Venice Avenue Bridge. The drogues released at Forked Creek also flowed northward for almost two miles during the same period.

When the tide turned and began to flood the drogues were again released at their original release points off the mouths of the two creeks and again tracked during the flooding tide (16 hrs., 2.2 ft rise) and the following ebb tide (8.5 hrs, 2.4 ft drop). Throughout this flood-ebb regime the drogues off Forked Creek flowed northward. However, the drogues off Alligator Creek flowed south toward Lemon Bay during the first 6 hours of flood, then flowed northward during the next 4 hours, and then flowed southward for 6 hrs., during the last phase of the flood tide. When the tide again ebbed the drogues flowed steadily northward toward Venice and Roberts Bay.

The results of this tidal current study corroborate those of Story et al in that the water in Lemon Bay near Forked Creek moves northward out of the Bay on both ebb and flood tides. Our study also shows that water in the Red Lake-Alligator Creek area does not flow into Lemon Bay. The combined results of our study and that of Story further indicate that the area of the Bay between Furbeck Point in Englewood and Forked Creek is the most poorly flushed segment of Lemon Bay. Consequently the water quality in this segment of the Bay should be lower than that in the segment south of the Tom Adams Bridge. This expectation is supported by our water quality data patterns for March, 1977.

To learn more about the temporal relations of the directions and velocities of tidal flow and flushing in Lemon Bay, we installed recording current meters and tide staffs at Stump Pass, the Palm Island Cut and the Manasota Key Bridge. Current measurements, hourly changes in water level and direction of surface current were made over a complete tidal cycle on April 6-7, 1977. Although the data are still being analyzed, they clearly show that the tidal flow throughout this particular tidal cycle was toward the north at the Manasota Key Bridge and toward the south at Palm Island Cut. This means that during a flooding tide the Bay receives water from the Gulf only through Stump Pass. Part of the flooding water passes northward beyond the Tom Adams Bridge forcing the water in this segment of the Bay northward. Part of the flooding water flows toward Palm Island Cut forcing the water in the Bay in the vicinity of Buck Creek and Lemon Creek to move south into Placida Harbor. During the ebb tide that follows, Lemon Bay water at the south end of Lemon Bay continues to flow into Placida Harbor. At least this is the tidal pattern that occurs during the combination of mixed tides of April 6-7, 1977 (7 hrs., 1.6 ft rise; 3.75 hrs., 0.2 ft fall; 7.25 hrs., 1.4 ft rise). Under other tidal regimes the tidal flow pattern in Lemon Bay may be different.

During the tidal regime on April 6-7, the maximum flood tide velocity at Stump Pass was 0.88 to 1.08 knots and the maximum ebb tide velocity was 0.42 knots. The maximum flood tide velocity recorded at Stump Pass on March 26, 1977 was only 0.45 knots.

Tidal Creeks. During the water quality study (March 26-27, 1977), water levels at each of the water sampling stations on Gottfried, Ainger, Oyster and Buck Creek were measured with tide staffs over two tide cycles in order to determine the tidal influence along the length of the creeks. Figure 38 shows the recorded changes in water level at Stations 1 and 3 (Station 2, Buck Creek). The locations of the stations are shown in Figure 39 and described in Table 20.

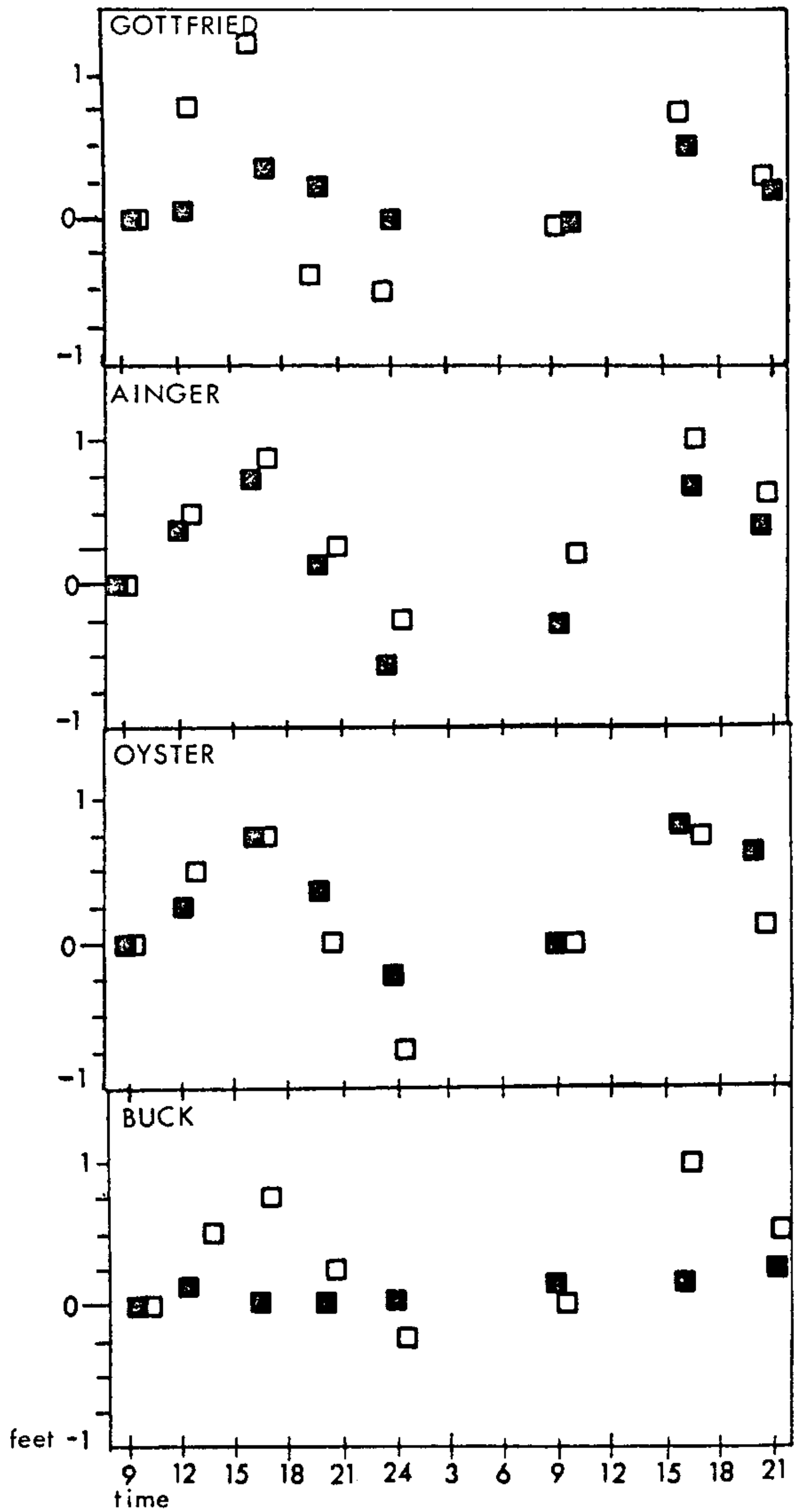


Figure 38. Water levels (measured with tide staffs) at stations 1 (open squares) and 3 (solid squares) over two tide cycles, March 26-27, 1977 on the four tidal creeks in the Lemon Bay Complex Study. See Figure 39 and Table 20 for location of stations.

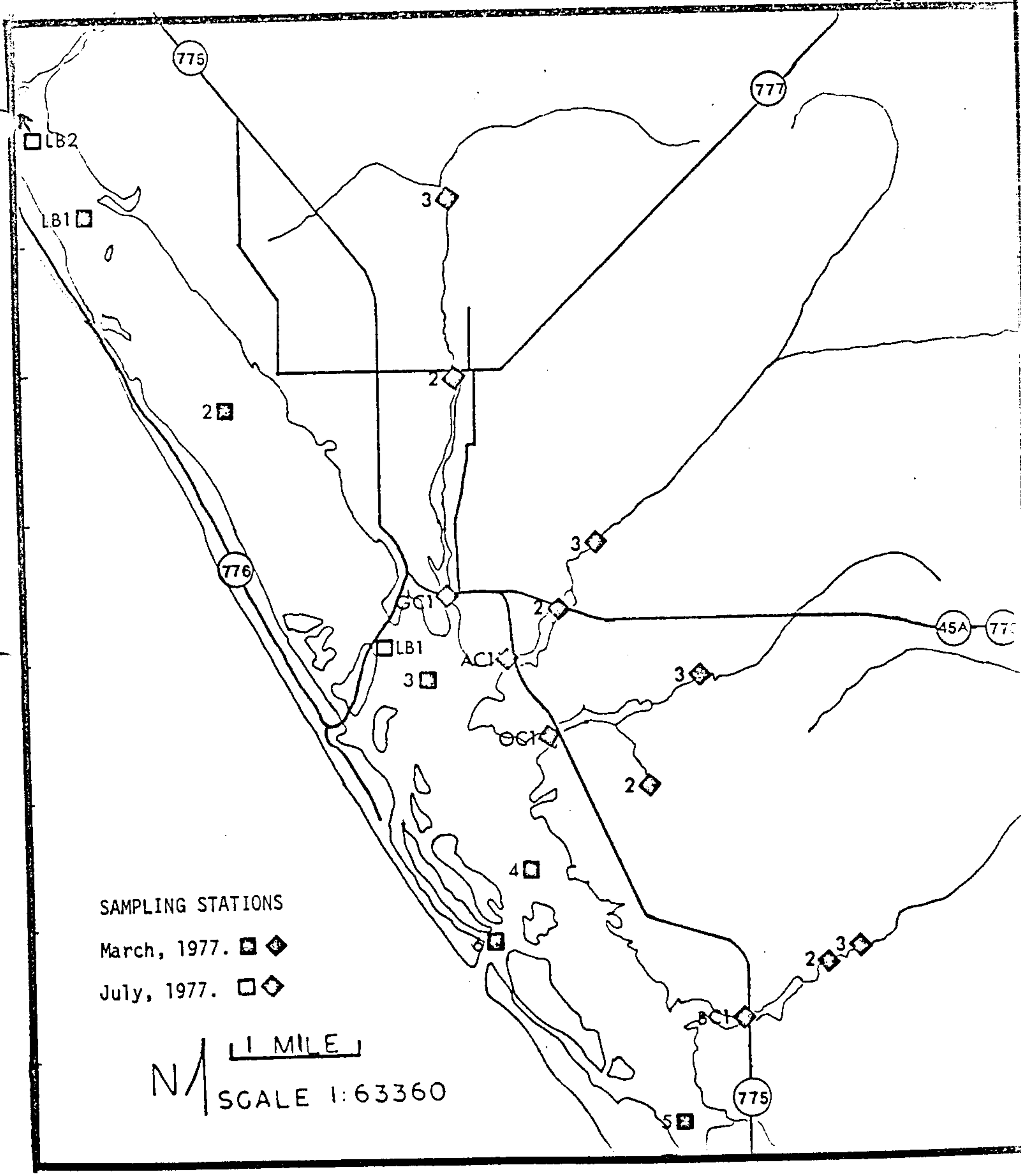


Figure 39. Locations of water sampling stations for Lemon Bay '208' Study, 1977. LB, Lemon Bay; GC, Gottfried Creek; AC, Ainger Creek; OC, Oyster Creek; BC, Buck Creek.

TABLE 20a

LOCATION OF STATIONS FOR LEMON BAY COMPLEX DRY SEASON

WATER QUALITY STUDY. MARCH 26 - 27, 1977.

LEMON BAY -

LB-1 - Intracoastal Waterway marker 33

LB-2 - Intracoastal Waterway marker 28

LB-3 - Intracoastal Waterway marker 23

LB-4 - ¼ mile southwest of Intracoastal Waterway marker 18, at the east end of the north channel of Stump Pass

LB-5 - Intracoastal Waterway marker 9

LB-6 - Stump Pass, 100 yards east of the Gulf of Mexico

BUCK CREEK -

BC-1 - State Road 775 bridge

BC-2 - 100 yards downstream from the Rotunda wier

BC-3 - Just upstream from the Rotunda wier

OYSTER CREEK -

OC-1 - State Road 775 bridge

OC-2 - Brookwood Drive

OC-3 - San Casa Road bridge

AINGER CREEK -

AC-1 - State Road 775 Bridge

AC-2 - State Road 776 bridge

AC-3 - Seahorse Lane

GOTTFRIED CREEK -

GC-1 - State Road 775 bridge

GC-2 - State Road 777 bridge

GC-3 - Between Sarasota Sections 19 and 30, just downstream from culverts

Station 1 was near the mouth of the creek and Station 3 at the furthest upstream sampling point.

The data on changes in the water level at these stations could be interpreted as follows. In Gottfried Creek the streamflow in the section of the creek upstream of Station 2 at SR 777 is minimally influenced by the tides. In Ainger Creek streamflow is affected by the tides as far upstream as the county line. In Oyster Creek, streamflow is affected by the tides upstream as far as San Casa Road. Because the Buck Creek streamflow is affected by a wier at Rotunda West, the section of the creek between the wier and the Bay is comparable to a long dead end canal. Thus the slight changes in water level at Station 2 just downstream of the wier compared to Station 1 are due to the tidal damping effects in this dead end waterway.

These water level data plus the low streamflow during the March study indicate that in the dry season the urbanized downstream regions of the creeks are poorly flushed by the tides. Beyond a certain point upstream of the mouth of the creek wasteloads received by the creek remain in the creek for several tidal cycles or for longer periods. During such periods a wasteload will be assimilated, dispensed and diluted.

The patterns of water level changes at the sampling stations in the four creeks indicate that the upstream-downstream movement of water masses and the degree of flushing during a tidal cycle differed for each creek. Recording current meter records (March 26-27) from Station 1 on each creek support this indication. In Gottfried Creek during the flooding tide the water flowed upstream at velocities ranging from 0.19 knots at the beginning and end to velocities of 0.34 knots during the middle of flood tide. Ebb tide velocities varied from 0.19 knots at the beginning and end to 0.32 knots during the middle of the tide. Thus in Gottfried Creek the tidal flushing pattern was dominated by the tide.

Contrarily, the flushing pattern of Ainger and Oyster Creeks was the result of stream flow and the tides. In these two creeks the downstream current flow attained velocities of 0.70-0.85 knots during the ebbing tide. When the tide turned and began to flood current velocities dropped below 0.15 knots (0.25 ft/sec) and the meter no longer recorded direction of flow. Although the water level at the stations in these creeks rose on a flooding tide, it was not accompanied by a measurable upstream current which indicates that upstream tidal current flow was equalized by a fresh water downstream flow. Thus the net tidal movement of water in these creeks during the tidal cycle is downstream.

The tidal currents in Buck Creek were too low to be recorded by the current meter. Circulation in this creek appeared to be dominated by daily wind and density generated currents.

In July, 1977 the ebb tide current flow of the four creeks was measured by tracking small current drogues released at two points upstream of Station 1 on each creek (Figure 40) shortly before flood slack water. The movements of the drogues were plotted on maps (1 in to 200 ft). Each creek was divided into sections (Figure 41) and the length of time for a drogue to move through a particular creek section was calculated. The length of the section divided by the passage time of the drogue yielded a mean rate of flow through a particular creek section of a water mass simulated by the drogue (Table 21).

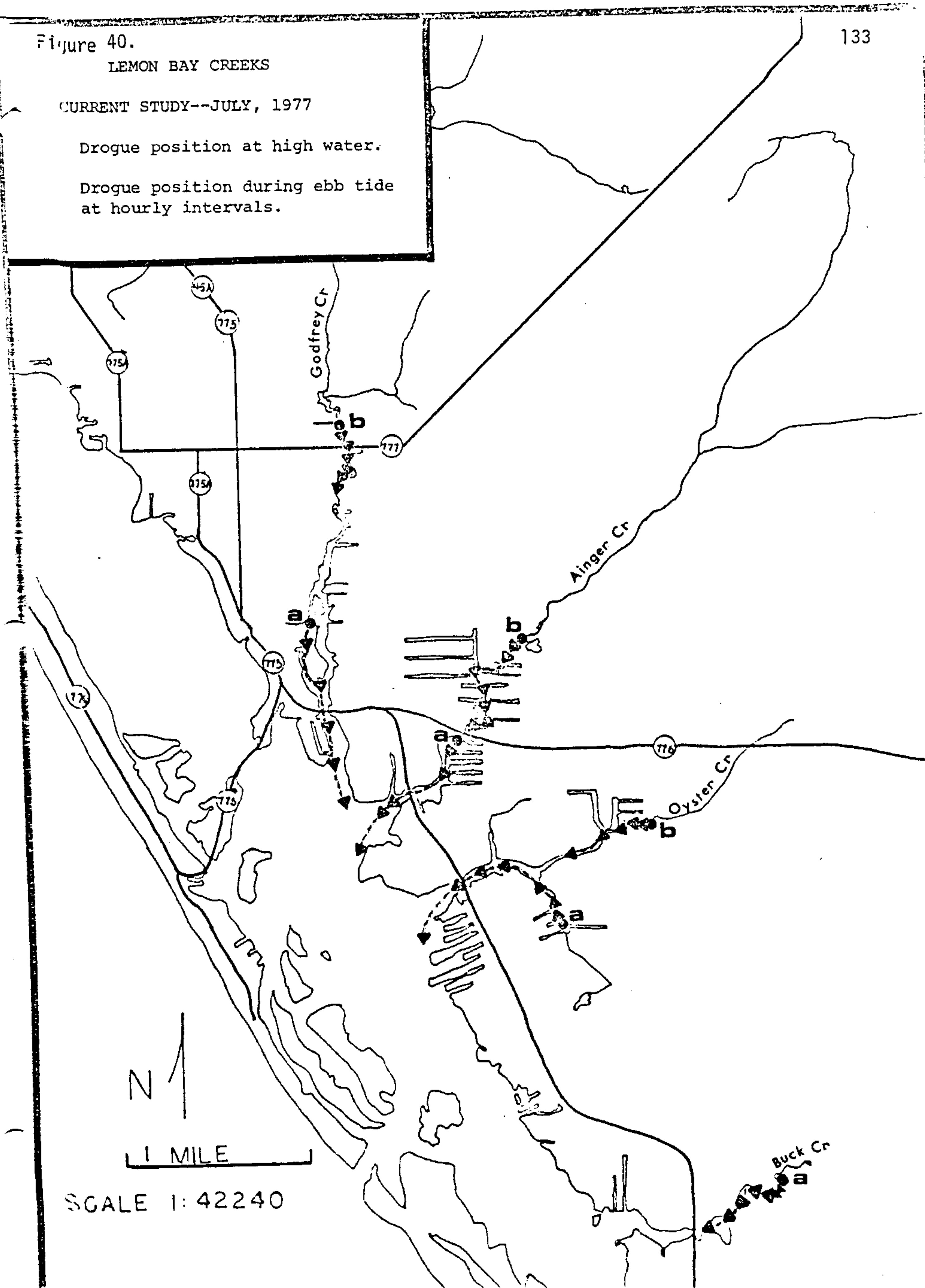
The distances above the creek mouth of the starting points of the drogues on each creek were as follows:

Figure 40.
LEMON BAY CREEKS

CURRENT STUDY--JULY, 1977

Drogue position at high water.

Drogue position during ebb tide at hourly intervals.



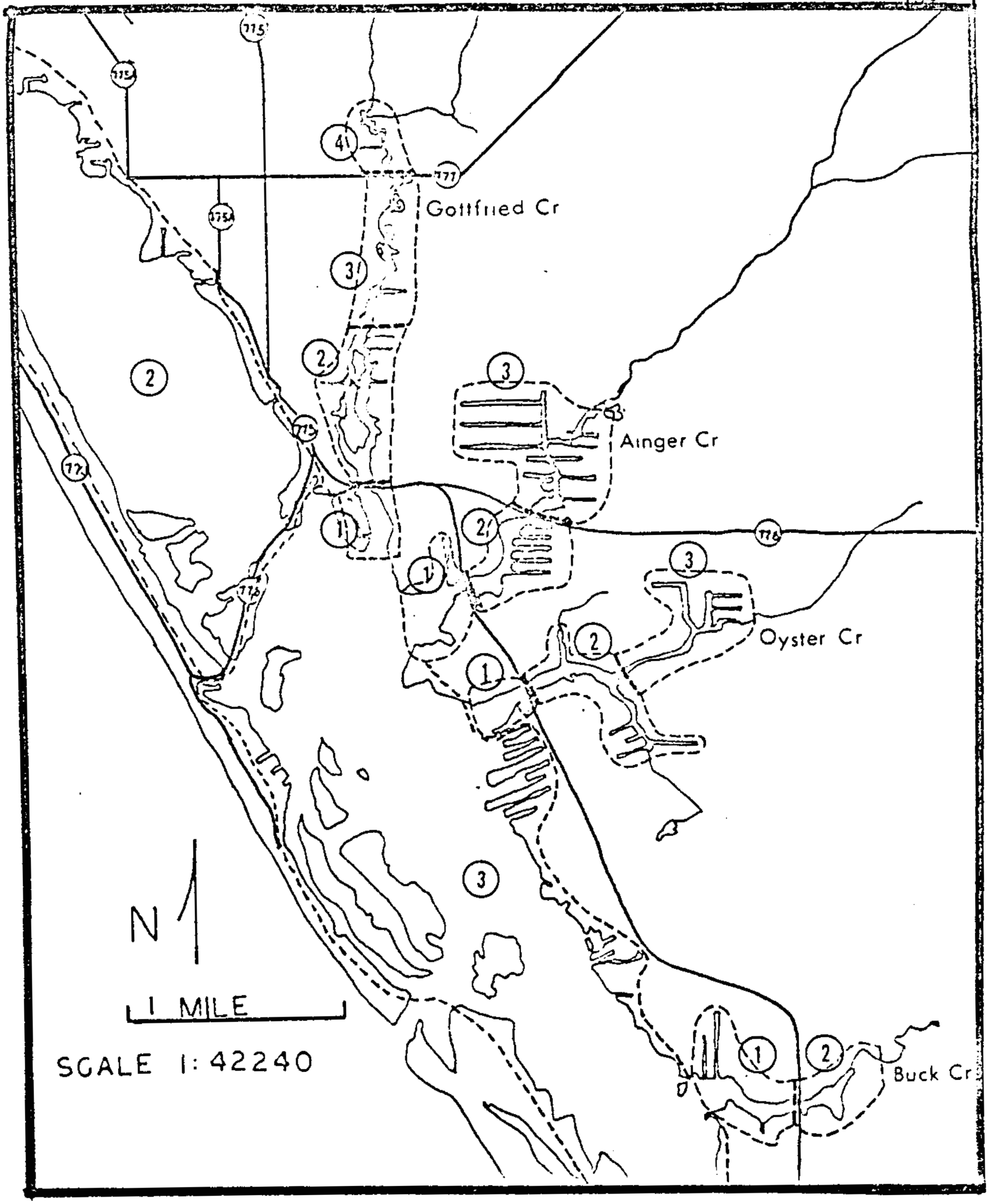


Figure 41. Locations of tidal creek suburban sections in the Lemon Bay 208 Study Area, July 1977. Lemon Bay section 2 extends northward to Manasota Key Bridge. Lemon Bay section 1 extends from Manasota Key Bridge to Alligator Creek. See Table for summary of linear feet of types of shoreline.

Table 21. Results of ebb tide current drogue experiment, July, 1977 in subdivision sections of the tidal creeks in the Lemon Bay 208 Study Area.

Creek	Section Number	Travel Distance in Feet	Time in Minutes	Rate Ft/Min	Rate MPH	Date 1977	Ebb Tide Length Hrs.	Ebb Tide Fall in Ft.
Gottfried	1	1800	75	24.0	0.27	7-13	7.0	2.4
	2	4351	230	18.9	0.21			
	3	2302	240	9.6	0.11			
	4	575	160	3.6	0.04			
Ainger	1	3200	71	45.2	0.51	7-15	7.8	2.5
	2	2851	280	10.2	0.12			
	3	4800	405	11.6	0.13			
Oyster	1	1251	40	31.3	0.35	7-14	8.0	2.4
	2	4599	255	18.0	0.20			
	3	4800	400	12.0	0.14			
Buck	1	2250	390	6.5	0.07	7-11	7.5	2.0

Creek	Starting Point in Miles Above the Creek Mouth	
	A	B
Gottfried	3/4	1-3/4
Ainger	3/4	1-1/2
Oyster	3/4	1-1/4
Buck	3/4	-

As Figure 40 shows, drogues released at a point (3/4 mi. above the mouth) at the beginning of ebb tide on Gottfried, Ainger and Oyster Creek flowed out of the creeks into Lemon Bay within the 7 to 8 hour ebb tide period. On reaching the Bay, the drogues did not flow toward the Intracoastal Waterway in the navigation channels. Rather they flowed south over the shallow grass flats along the eastern shore of the Bay. These results indicate that the wasteloads as far upstream as the Deer Creek Trailer Park on Gottfried Creeks, the bridge at SR 776 on Ainger Creek, and Brookwood Drive on the south branch of Oyster Creek are flushed out of the creeks in one tidal cycle, at least on those tides with a 2.4 foot fall over a 6 to 8 hur period. Furthermore, on reaching the Bay the channelized water of the creeks is dispersed, diluted and mixed by wind generated waves as it sheet flows over the shallow grass flats which function as a biological filter.

The drogues released further upstream at point B on each creek did not pass beyond the downstream end of Section 3 on each creek. This indicates that the water in the vicinity of the SR 777 bridge on Gottfried Creek, Seahore Lane on Ainger Creek, and San Casa Road on Oyster Creek have a relatively long residence time in the creeks. The length of time the masses of waters in these suburban sections remain in a creek will depend in part on the flow volume of fresh water from the upstream watershed.

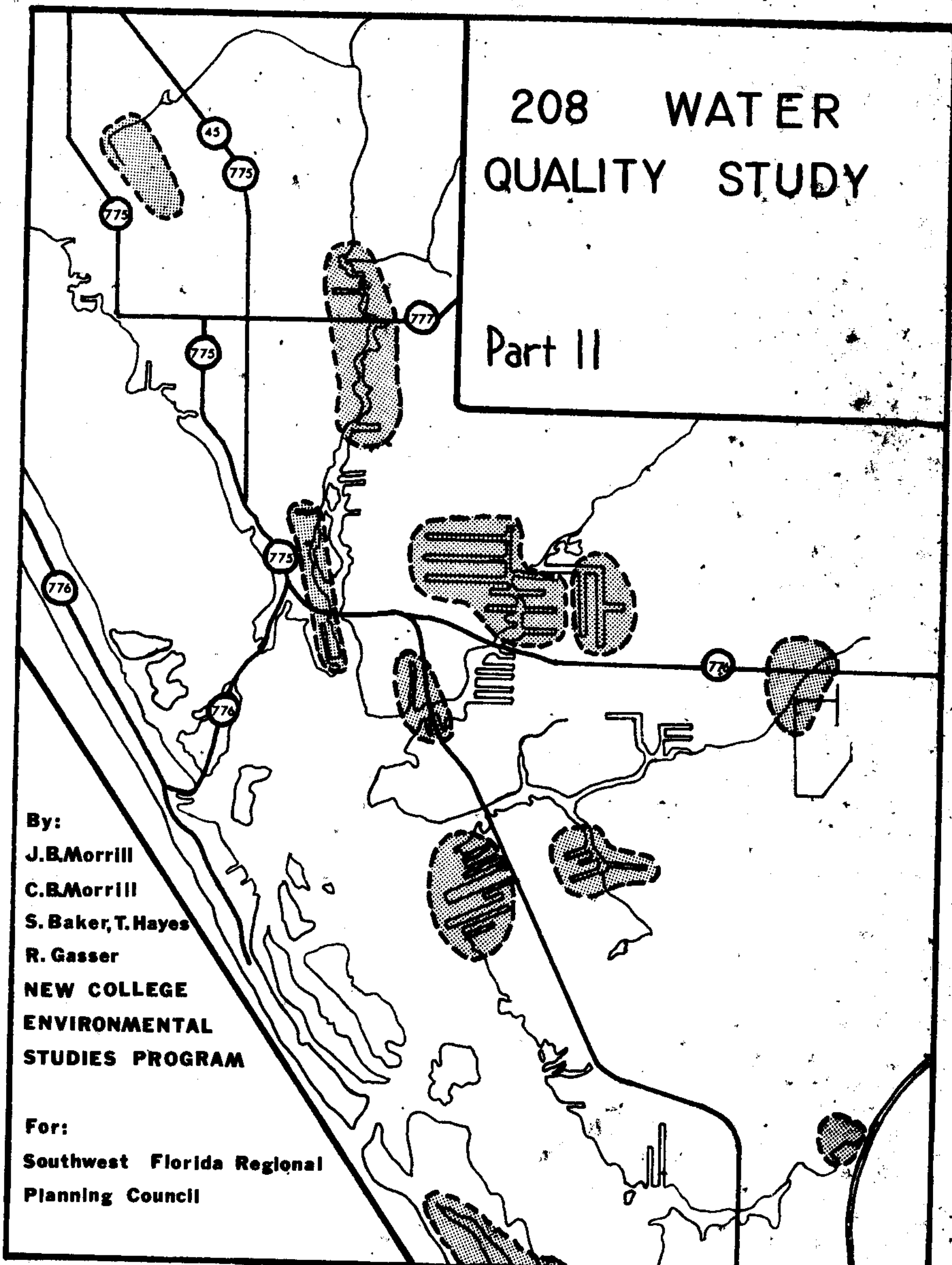
The spread of suburban and urban development into upper watersheds of these creeks will be accompanied by flood control structures such as wiers and retention ponds that reduce stream flow. If these structures caused further reductions in stream flow, Lemon Bay could be spared from additional wasteloads from these tidal creeks; but certain upstream sections of the creeks could receive excessive amounts of wasteloads.

At the present time the existing dead end canals at right angles to the main-stream flow in Sections 2 and 3 of these creeks (Figure 41) are dead end back water areas off the creeks proper. Tidal and even wind generated circulation is minimal. Most of these canals are the typical pre 1970 box cut variety - 6 to 9 feet deep throughout their length with a sill or lip 4 to 5 feet at m.l.w. at their entrances off the creeks. Our depth soundings revealed that most of these canals have organic rich sediments 4 to 12 inches thick along their center lines. Interestingly, such sediments are rare in the channelized parts of the creeks and nonexistent in the non-channelized shallow areas of the creeks from Section 3 to the creeks's mouth.

It is not improbable that with future flood control development and urbanization that the water quality in segments of the creeks proper will approach that of the dead end canal systems. This possibility may already be developing on Buck Creek. At the time of our tidal current studies the creek had a flood control wier at the intersection of the creek and the Rotunda River and an earthen dam downstream from the wier. Even though the release point of the drogue was only three-fourths of a mile from the mouth, it took 6 hours for the drogue to move one-half mile on an ebb tide with a 2 foot fall. Downstream of the earthen dam the creek and its immediate watershed are in a relatively natural condition. Were this segment (Sections 1 and 2, Figure 41) preserved, it could be used as a control or base for comparison for future water quality studies of the creeks and canals in the Lemon Bay area.

208 WATER QUALITY STUDY

Part II



By:
J.B.Morrill
C.B.Morrill
S. Baker, T. Hayes
R. Gasser
NEW COLLEGE
ENVIRONMENTAL
STUDIES PROGRAM

For:
Southwest Florida Regional
Planning Council

WATER QUALITY STUDIES--REVIEW OF PUBLISHED AND UNPUBLISHED REPORTS

A respectable amount of water quality information exists for Lemon Bay even though it is a minor embayment in the Southwest Flroida 208 Study Area. Data on several water quality parameters are available for the late 1950's in the Florida State Board of Conservation red tide report of Dragovich et al (1961) and the U.S. Army Corps of Engineers' Intracoastal Waterway project report (1958). In addition, bacteriological water quality analyses of the surface waters of the ponds and creeks on the Vanderbilt ranch in the western half of the Cape Haze Peninsula were conducted by the State Board of Health for a number of years beginning in the early 1950's. The records from this study were until recently on file at the Cape Haze Water Plant. Various studies in the Sarasota-Charlotte County area provide an array of water quality data for the waters of Lemon Bay following the alteration of its tidal circulation pattern by the Intracoastal Waterway. Most of the existing data have been summarized in the U.S. Army Corps of Engineers' environmental impact statement for a maintenance dredging project of the Waterway (1975). However, this summary does not discuss the details of the various physical and chemical parameters. Accordingly, in the following review we have included as much information as possible from the various water quality studies to complete the baseline inventory and assessment of the water quality in Lemon Bay and its tributaries.

Physical and Chemical Parameters - Lemon Bay

Temperature and Salinity.

The most complete data on water temperature and salinity are from Breder (1968) and the Florida State Board of Conservation (1967). Between 1961 and 1964

Breder recorded daily surface water temperatures for various months from a dock just south of Blind Pass on Manasota Key. The results of Breder's study (Figures 42 and 43 and Table 22) illustrate the seasonal variation in surface water in the shallow areas of the Bay. With respect to water quality, the May-September wet season period is when the mean water temperatures are highest and the 100% D.O. saturation level of the Bay's waters is lowest. Figure 43 illustrates the effect that rain and cloud cover have on the surface water temperature of the Bay.

The surface and bottom water temperature and salinity readings (Table 23) from the Florida State Board of Conservation (1967) show that slight but measureable temperature/salinity gradients occur in the waters moving in and out of the Bay through Stump Pass. Such gradients coupled with the wind are involved in the mixing, dispersion processes in the Bay. Further, prior to the opening of the Venice By Pass Canal at the north end of the Bay, marked surface salinity gradients occurred between Alligator Creek and Stump Pass (Figure 44). Even before the By Pass Canal the area of the Bay north of Forked Creek probably experienced little tidal flushing. This and less detailed studies (i.e., Woodburn, 1962) indicate that the fluctuations in the low salinities in the Alligator-Forked Creek area were accompanied by rainfall-runoff events. Thus the available information on the historical salinities, the sediments and the distribution of productive oyster bars in the Bay indicate that water quality in the upper reaches of Lemon Bay was below present day standards for Class II marine/freshwater.

Turbidity.

Woodburn (1962) in his shellfish survey noted that the water of the Bay was particularly turbid north of Englewood and in the vicinity of the Palm Island Cut as compared to the water in the central region of the Bay and at Stump Pass. More recently, in a plankton survey along the Intracoastal Waterway, Ayer and deNarvaez

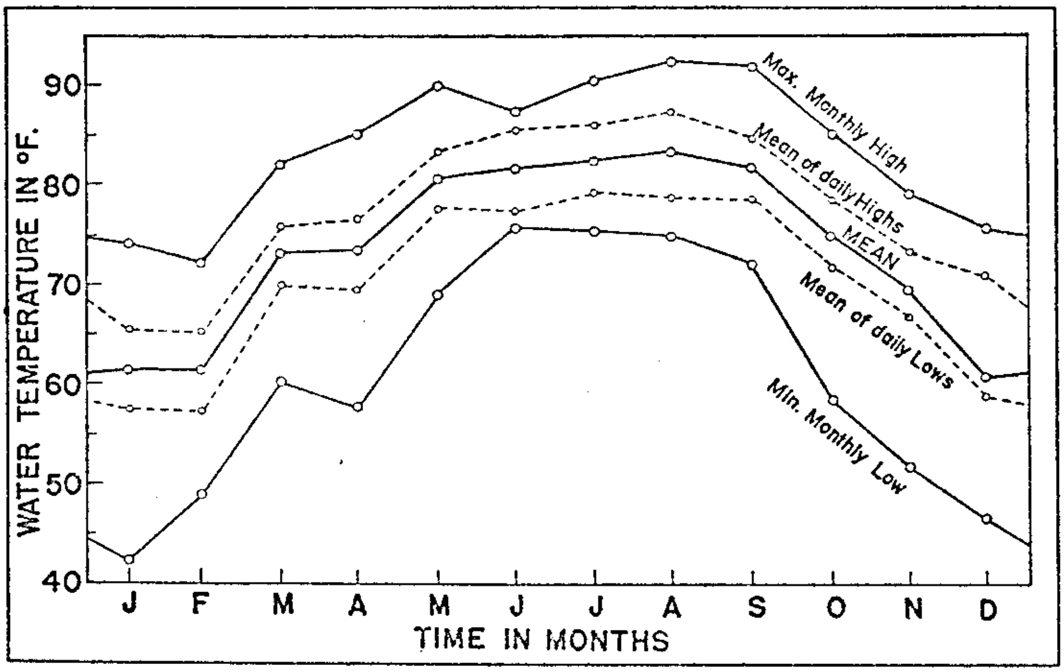


Figure 42. Annual variation in the temperature of the water at the end of a dock in Lemon Bay, with means and extremes, by months for the years 1961 through 1964; based on data in Table 22.

Source: Breder, 1968.

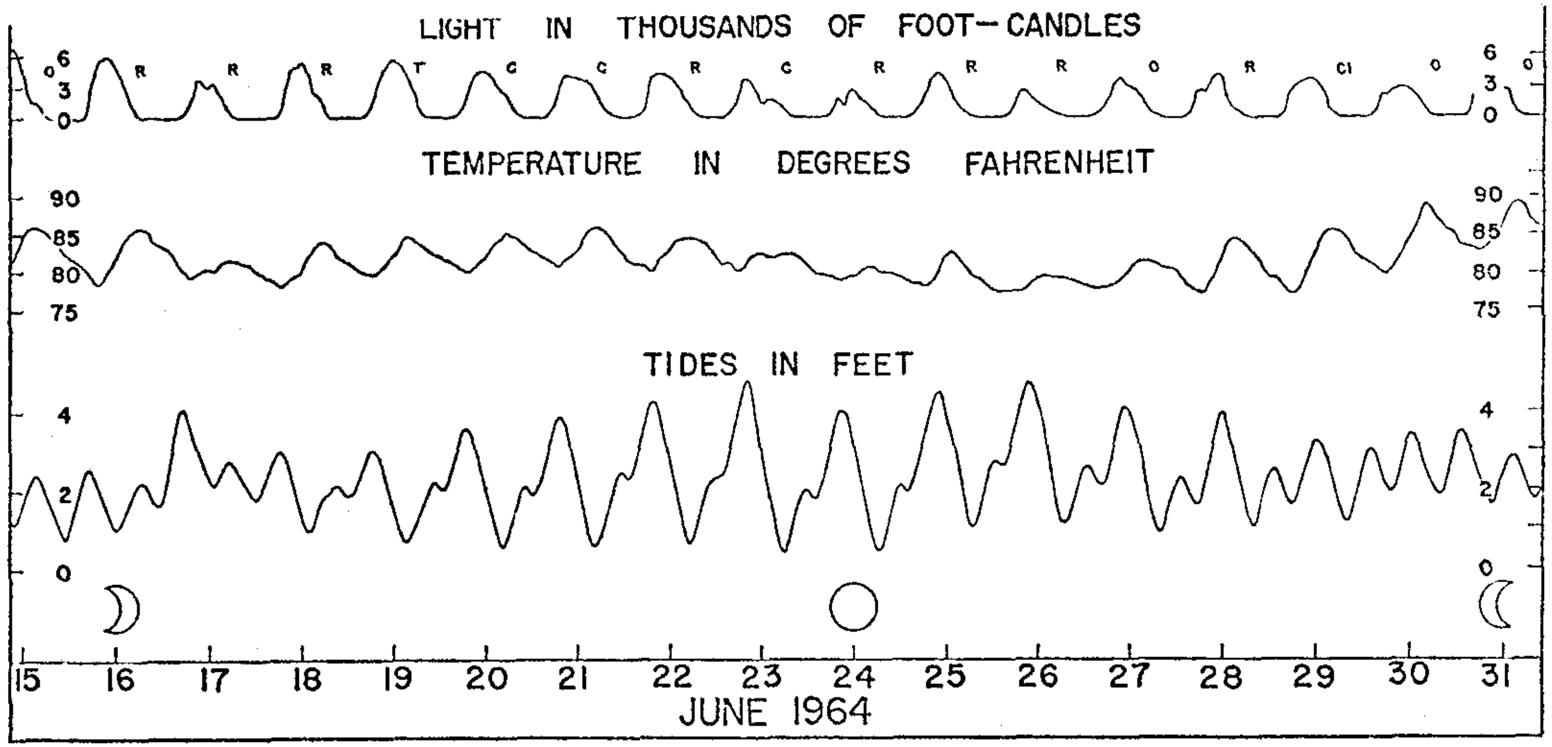


Figure 43. Sample of basic data, indicating the complexity of the tides and surface water temperatures.
Symbols: C, cloudy; Cl, clear; O, overcast; R, rain; T, thunderstorm.

Source: Breder, 1968.

TABLE 22

WATER TEMPERATURES (IN DEGREES FAHRENHEIT) BY MONTHS, INCLUDING MAXIMA, MEANS, MINIMA, MEANS OF DAILY HIGHS AND LOWS, LOWEST HIGH, AND HIGHEST LOW

Year and Month	Max.	Mean	Min.	Mean Highs	Mean Lows	Lowest High	Highest Low	No. of Days
1961								
March	82.5	74.1	63.0	77.1	71.1	66.0	80.0	29
April	86.0	74.3	61.0	77.2	77.3	73.5	82.5	30
Oct.	88.0	76.1	63.0	79.2	73.0	71.0	81.5	21
Nov.	81.0	73.2	59.0	76.4	70.0	70.0	76.0	30
1962								
April	84.5	72.1	54.0	76.0	68.2	70.0	79.0	30
May	90.0	80.5	69.0	83.4	77.8	74.0	85.0	31
June	85.5	81.7	77.5	84.2	79.2	83.0	81.0	3
Nov.	79.0	66.9	52.0	71.0	62.1	61.0	70.0	15
Dec.	80.0	61.4	43.0	67.2	55.7	45.0	69.0	31
1963								
Jan.	77.0	61.3	41.0	67.3	55.2	58.0	67.0	31
Feb.	74.0	61.1	46.0	66.3	55.9	55.0	66.0	24
June	89.5	81.3	74.0	85.7	76.9	80.5	80.0	17
July	91.0	82.1	73.0	86.4	77.7	83.0	87.0	31
Aug.	92.5	83.1	75.0	87.4	78.7	84.0	83.0	31
Sept.	92.0	81.7	72.0	84.8	78.6	76.5	82.5	30
Oct.	82.0	73.6	54.0	77.4	69.9	71.0	76.0	28
Nov.	76.0	67.6	44.0	71.1	64.1	60.0	73.0	30
Dec.	71.0	60.0	50.0	62.3	57.7	57.0	67.0	31
1964								
Jan.	71.5	61.8	43.5	64.0	59.6	52.0	67.0	31
Feb.	70.5	61.9	52.0	64.9	59.6	58.5	66.0	29
March	82.0	71.8	57.5	74.8	68.8	61.5	57.5	25
July	90.0	83.1	78.0	85.7	80.6	80.0	84.5	31
Combined years								
Jan.	77.0	61.5	41.0	65.6	57.4	52.0	67.0	62
Feb.	74.0	61.5	46.0	65.5	57.4	55.0	66.0	53
March	82.5	73.2	57.5	76.0	70.0	61.5	80.0	54
April	86.0	73.2	54.0	76.6	69.7	70.0	82.5	60
May	90.0	80.5	69.0	83.4	77.8	74.0	85.0	31
June	81.7	81.4	74.0	85.5	77.2	80.5	81.0	20
July	98.5	82.6	84.2	86.0	79.1	80.0	87.0	62
Aug.	92.5	83.1	75.0	87.4	78.7	84.0	83.0	31
Sept.	92.0	81.7	72.0	84.8	78.6	76.5	82.5	30
Oct.	88.0	74.7	77.4	78.2	71.2	71.0	81.5	49
Nov.	81.0	69.7	44.0	73.2	66.1	60.0	76.0	75
Dec.	80.0	60.7	43.0	64.6	59.0	45.0	69.0	72
All	*92.5*	*72.3*	*41.0*	*75.9*	*68.7*	*45.0*	*87.0*	*589*

Source: Breeder, 1968.

Table 23 Biweekly Water Temperature and Salinities, Station WS-9, Stump Pass Channel (3-17 feet deep) January-October, 1964. Source: Florida State Board of Conservation, 1967.

	Water Temperature °C		Salinity ppth	
Month	Surface	Bottom	Surface	Bottom
January	14.0	13.8	35.0	35.1
	18. 4	18.0	36.3	36.4
February	15.5	15.2	31.6	33.4
	19.0	17.8	35.9	35.9
March	20.7	20.7	34.6	34.3
	22.6	22.5	36.8	36.6
April	20.5	20.3	36.3	36.0
	27.2	27.2	37.6	37.4
May	26.1	25.6	36.9	36.9
	28.7	28.0	38.5	39.4
June	29.0	28.7	37.5	37.9
	33.7	32.1	39.1	39.3
July	28.6	32.5	37.5	37.7
	30.0	31.2	39.2	39.2
August	30.2	28.9	35.7	35.9
	37.7	31.4	35.8	36.3
September	27.3	27.4	35.7	37.0
	30.1	29.9	37.6	37.2
October	21.3	21.1	34.4	35.2
	28.4	28.4	36.1	36.1

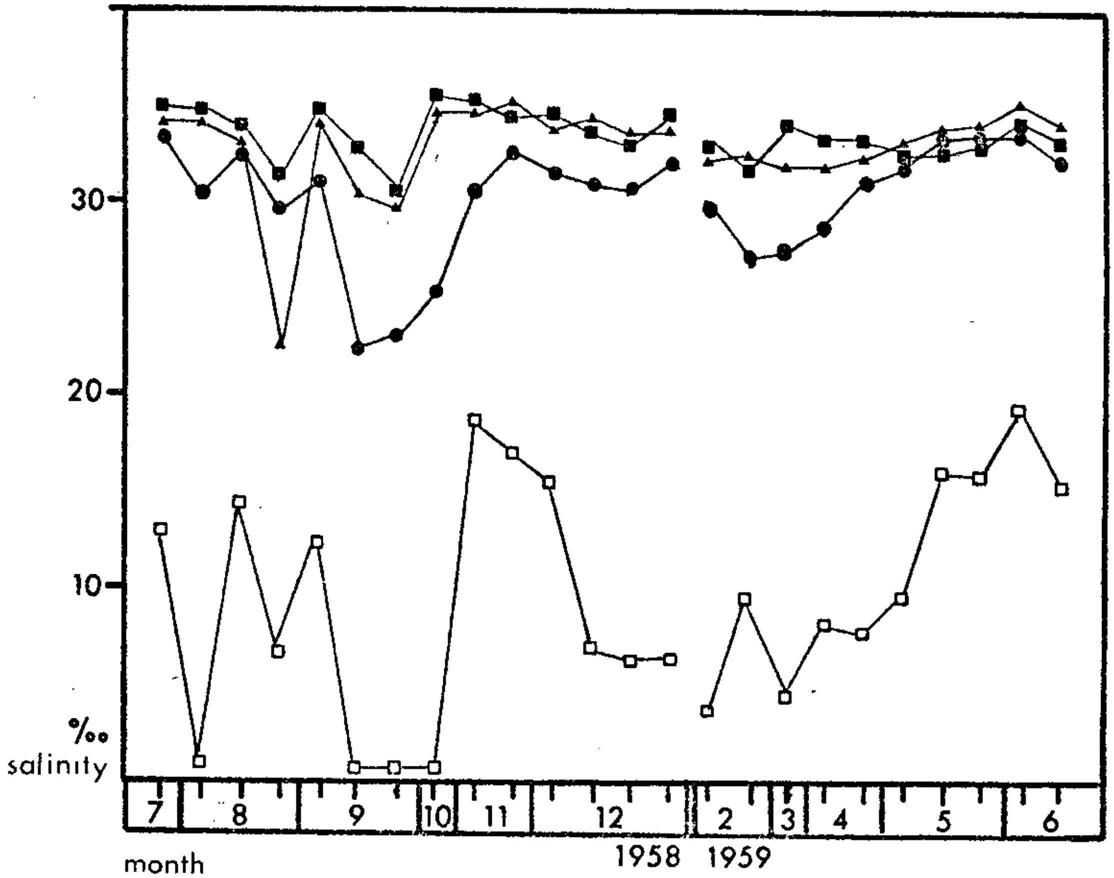


Figure 44. Seasonal patterns of surface water salinity in Lemon Bay between July 1958 and June 1959. Open squares, Alligator Creek; solid squares, Stump Pass; solid circles, Tom Adams Bridge in Englewood; solid triangles, Palm Island Cut ("The Narrows").

Source: Dragovich, Counts of Red Tide Organisms and Associated Oceanographic Data from the Flofida West Coast. 1957 - 1959. U.S.B.C.F. St. Petersburg.

(unpublished) recorded salinity, temperature and turbidity (Secchi disc) at 11 stations in the Lemon Bay area. Table 24 summarizes their water quality data. Figure 45 shows the Secchi disc depth readings for an ebbing tide (Nov. 1971) and a flooding tide (Mar. 1972). The Secchi disc depths in the vicinity of Alligator and Forked Creeks were lower (2.0-3.5 ft) than in any other part of Lemon Bay. The other Lemon Bay stations had Secchi disc readings of between 3.5 and 6.0 feet. Since the distance below the surface at which the black/white pattern on the surface of an 8 inch disc becomes blurred measures water transparency directly and turbidity indirectly, the Secchi disc values in Figure 45 reflect relative turbidities of the water caused by wind and tidal currents.

Ammonia, Nitrate/Nitrite and Phosphate.

Available data for these parameters are limited to "one-time" samples by Alberts et al (1970), the Tampa Bay Regional Planning Council (1971) and the Environmental Quality Laboratory (1975). Alberts et al in their study of the hydrography of Charlotte Harbor measured total dissolved phosphorous at five stations in Lemon Bay in August, 1969. The concentrations of phosphorous in ppm in surface samples at these stations were as follows:

Location	Station No.	Total-P(ppm)	Salinity(%)
Tom Adams Bridge	1	0.024	30.7
Intracoastal Waterway	2	0.020	31.2
Stump Pass	3	0.016	32.6
Waterway off Buck Creek	4	0.018	32.4
Palm Island Cut	5	0.016	29.2
Gasparilla Sound	6	0.020	30.4

The Citizen Water Sampling Project of the T.B.R.P.C. (1971) included three stations (16,17,18) in the Intracoastal Waterway in Lemon Bay (Figure 46). The data for this segment of the study are shown in Table 26. Although the

Table 24 Water quality data from Ayer & deNarvaez, November, 1971 and March, 1972. See Table 24 for station location

Station	Date	Time	Tide	Temp (°C)	Salinity (%)	D.O. (ppm)	Secchi (ft.)
22	11/1	1420	E	27.0	20.4	6.2	3
23	11/1	1435	E	28.0	29.1	7.3	2
24	11/1	1500	E	28.0	28.6	8.8	2
25	11/1	1510	E	28.0	27.6	-	3
26	11/1	1520	E	27.5	32.2	-	6
27	11/1	1530	E	28.0	33.7	-	5
28	11/1	1540	E	27.0	33.8	-	5
29	11/1	1600	E	27.5	36.3	-	7
30	11/1	1610	E	27.5	21.3	-	10
31	11/2	1620	E	27.5	35.8	-	8
32	11/2	1600	E	27.5	36.4	-	11
22	3/21	1330	F	23.0	34.5	6.4	4.5
23		1320	F	24.5	32.9	7.1	4.0
24		1310	F	25.0	31.9	7.3	3.0
25		1250	F	23.5	33.1	6.7	3.5
26		1235	F	22.5	35.9	6.2	5.0
27		1150	F	22.0	36.6	6.8	4.5
28		1130	F	21.5	36.8	6.7	5.0
29		1120	F	21.5	36.8	6.8	8.0
30		1105	F	22.7	36.7	6.2	4.5
31		1045	F	22.5	37.0	6.6	3.5
32		1028	F	22.0	37.1	5.9	4.5

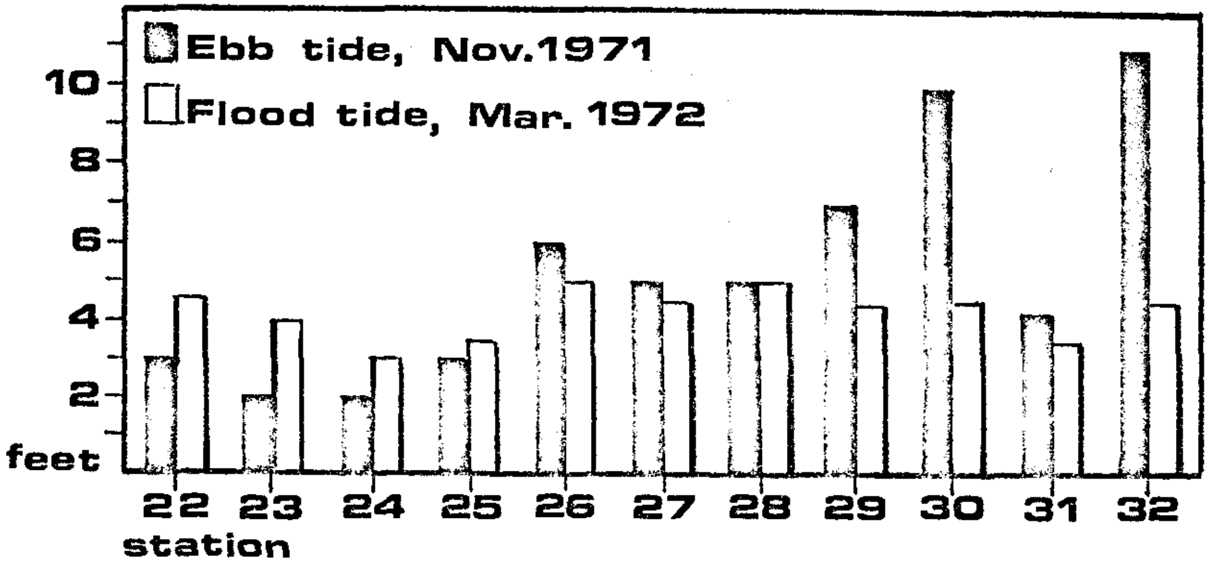


Figure 45 Secchi disc readings. See table below for locations.
Source: Ayer, 1971 - 1972.

Table 25 Station locations for water quality data from Ayer (1971-72) in Figure 45.

Station	Location
22	Venice By Pass Canal, 100 yards north of Red Lake Creek
23	Mouth of Red Lake Creek
24	Mouth of Alligator Creek
25	Mouth of Forked Creek
26	Marker 26, Lemon Bay
27	Marker 23, Lemon Bay
28	Channel, between Pederson Island and Chadwick's Landing, Manasota Key
29	Stump Pass Channel
30	Marker 9, Lemon Bay
31	Marker 25, Placida Harbor
32	Marker 14, Gasparilla Sound

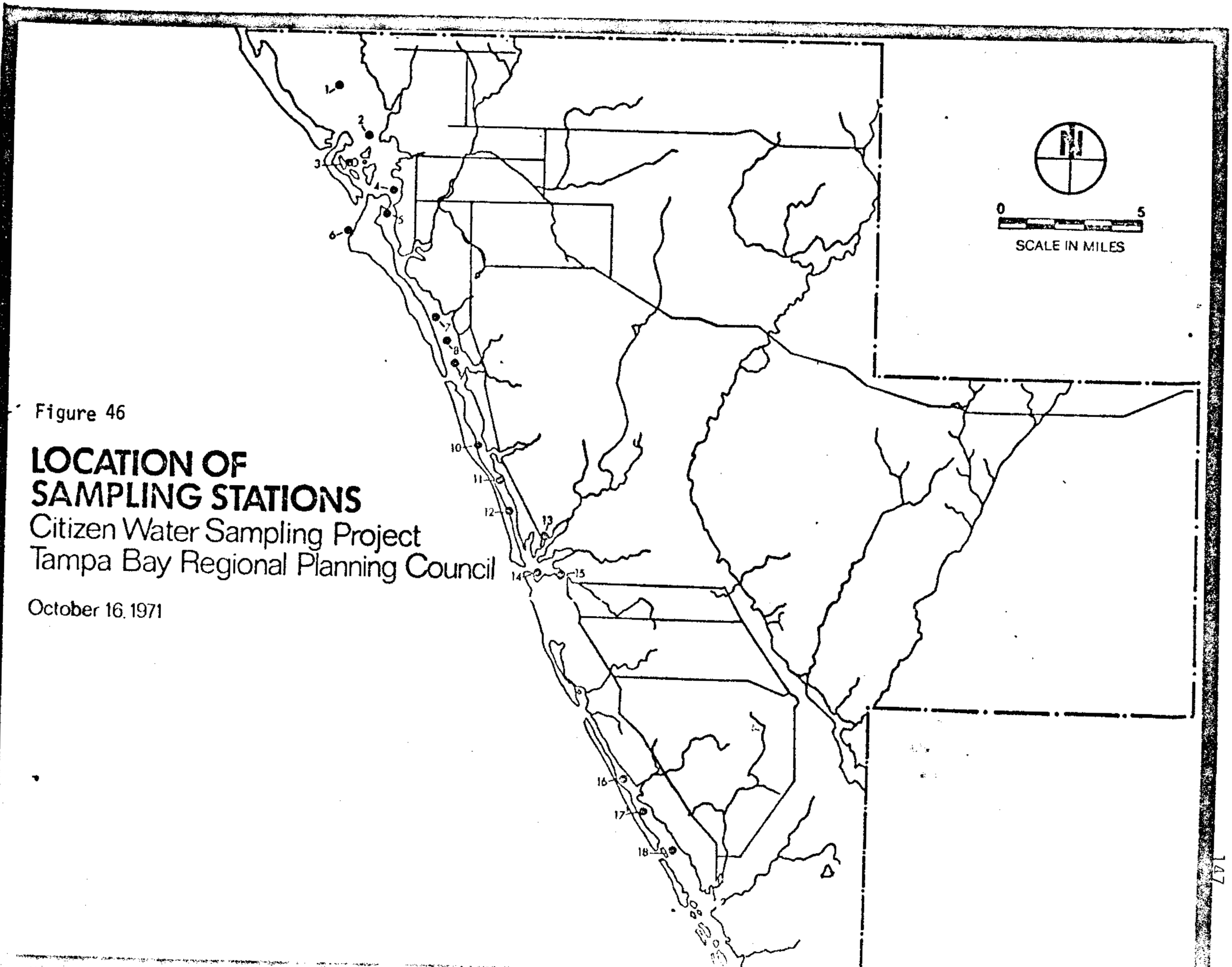


Figure 46

LOCATION OF SAMPLING STATIONS

Citizen Water Sampling Project
Tampa Bay Regional Planning Council

October 16, 1971

Table 26 Water quality data for Lemon Bay stations from Tampa Bay Regional Planning Council Study, October 16, 1971. (See Figure 46 for station locations).

Station	Time	Temp °C	Salinity	Water Color	ppm NO_2	ppm NO_3	ppm SiO_2	ppm PO_4	ppm NH_3
14	1230	29.0	12.0	.74	0.011	0.023	2.88	0.287	0.031
15	1230	29.0	17.4	.71	0.006	0.001	2.18	0.315	0.014
16	-	-	28.2	.19	0.004	0.003	0.56	0.330	0.028
17	1230	29.5	32.2	.10	0.002	0.004	0.29	0.099	0.019
18	1230	29.0	32.5	.10	0.003	0.003	0.09	0.072	0.019
Mean ($\overline{X}$) for Stations 1-18 in Sarasota Bay System		28.9	29.0	.20	0.004	0.005	0.732	0.185	0.028

nitrate-nitrite values were similar at the Lemon Bay Stations and the Roberts Bay Stations(14,15), the phosphate and ammonia values differed significantly. The water at Stations 14,15, and 16 had over 3 times as much phosphate as that at Stations 17 and 18. The ammonia values for Stations 17 and 18 were significantly lower than those for Stations 14 and 16. The values for phosphate, ammonia and silicon dioxide at Stations 17 and 18 in Lemon Bay south of Forked Creek were significantly lower than the mean values for the eighteen stations (Table 26) in the Sarasota Bay system.

Since the main body of Lemon Bay experiences tidal mixing and flushing by the inshore waters of the Gulf of Mexico, we included the phosphate and nitrate data from Dragovich et al (1961) for the surface and bottom water at an inshore station north of Venice Pass (Figure 47). Although this station lies beyond the immediate vicinity of Stump Pass, seasonal variations in concentration of nitrate and phosphate are probably similar to those for waters off Stump Pass prior to the mid 1960's. Similarly, the seasonal variations in ortho, organic and total phosphate for a station in Charlotte Harbor for 1949-1950 (Graham et al, 1954) provides clues to ranges in values of these parameters for Lemon Bay prior to the 1960's (Table 27).

The information in the studies above constitutes the major portion of the historical water quality data base for the Lemon Bay area. Beginning in the late 1960's additional water quality data have been collected at various intervals by various local, state, and federal agencies. Most of these data are recorded in the STORET data bank.

Chemical Analyses of Sediments.

Data on the chemical nature of the sediments in Lemon Bay are limited to a single report by the U. S. Army Corps of Engineers (1975). Table 28 summarizes

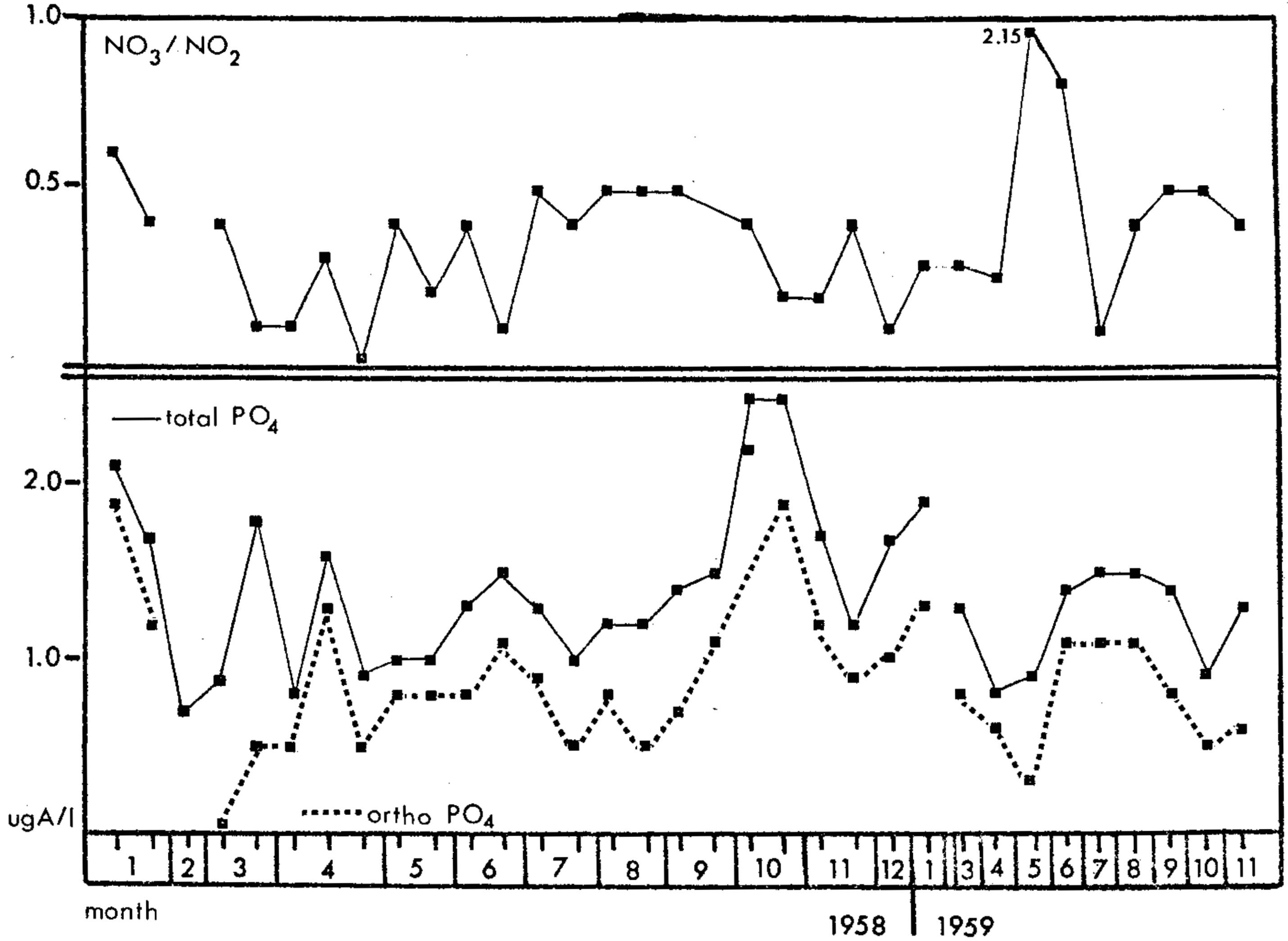


Figure 47. Concentrations of total phosphate, orthophosphate and nitrate/nitrite in the surface water at Gulf Station B5A north of Venice Pass off Casey Key (depth 27 feet, 27°06' N, 82°19.1' W.).

Source: Dragovich et al. (1961).

Table 27 Concentrations of Ortho,Organic and Total Phosphorus at Station 3 in the Center of Charlotte Harbor, May 10, 1949-Aug 22, 1950. Source: Graham et al, 1954

		Phosphorus-μgA/liter		
Year	Month	Ortho	Organic	Total
1949	May 10	0.10	0.20	0.30
	June 7	0.25	0.55	0.80
	June 20	0.25	1.70	1.95
	July 11	0.20	0.55	0.75
	Aug 1	0.90	1.35	2.20
	Aug 30	3.20	1.20	4.40
	Oct 10	1.20	0.65	1.85
	Nov 7	0.60	0.65	1.25
	Dec 5	0.60	0.25	0.85
1950	Jun 9	0.40	0.25	0.65
	Feb 13	0.35	0.25	0.60
	Mar 6	0.20	0.40	0.60
	Apr 3	0.25	0.50	0.75
	May 1	0.10	0.35	0.45
	June 12	0.05	0.70	0.75
	July 12	0.20	0.65	0.85
	Aug 22	0.30	0.95	1.25

Table 28 Chemical analysis of sediments at stations in the Intracoastal Waterway Channel from the Venice By Pass Canal to Placida Harbor (From U. S. Army Corps Eng., April 1975.

Geographic Location	Venice By Pass Canal, North of Venice Airport	Between Alligator Creek and Manasota Key Bridge	South of Forked Creek	South of Englewood Causeway	Off Buck Creek	Cape Haze, South End of The "Narrows"
Intracoastal Waterway Nav. Mark	MSA-31A	48	32	22A	14	35
Sample Station	34	35	36	37	38	39
Volatile Solids	0.35%	10.30%	1.14%	0.76%	6.35%	2.79%
Total Organic Carbon	400 ppm	4750 ppm	735 ppm	675 ppm	910 ppm	1760 ppm
C.O.D.	0.18%	9.10%	0.91%	0.35%	5.31%	1.57%
Kjeldahl Nitrogen	150 ppm	2365 ppm	385 ppm	315 ppm	1125 ppm	625 ppm
Nitrate Nitrogen	1.8 ppm	1.3 ppm	0.73 ppm	6.5 ppm	5.5 ppm	1.2 ppm
Nitrite Nitrogen	0.40 ppm	0.39 ppm	0.19 ppm	0.14 ppm	0.23 ppm	0.19 ppm
Ammonia Nitrogen	29 ppm	*10 ppm	48 ppm	88 ppm	73 ppm	101 ppm
Total Phosphorus	1309 ppm	9150 ppm	1331 ppm	37 ppm	294 ppm	1583 ppm
Ortho Phosphorus	1.6 ppm	12 ppm	5.0 ppm	5.0 ppm	3.7 ppm	4.8 ppm
Arsenic	0.19 ppm	4.3 ppm	0.75 ppm	*0.01 ppm	*0.01 ppm	1.2 ppm
Cadmium	*0.01 ppm	0.83 ppm	*0.01 ppm	*0.01 ppm	0.27 ppm	0.26 ppm
Chromium	2.4 ppm	33 ppm	4.6 ppm	1.9 ppm	9.9 ppm	6.4 ppm
Copper	4.6 ppm	7.7 ppm	6.2 ppm	1.3 ppm	3.0 ppm	1.4 ppm
Lead	5.3 ppm	23 ppm	1.9 ppm	1.9 ppm	8.3 ppm	10 ppm
Mercury	38 ppb	248 ppb	177 ppb	10 ppb	204 ppb*	10 ppb
Nickel	*0.10 ppm	11 ppm	0.27 ppm	0.14 ppm	4.0 ppm	0.65 ppm
Zinc	2.8 ppm	29 ppm	4.5 ppm	2.6 ppm	6.0 ppm	4.2 ppm
Chloride	0.31%	2.06%	0.38%	0.22%	1.17%	0.96%

* ANALYSIS ON DRY BASIS

Denotes "Less Than"

the data in this study for 6 stations in the Intracoastal Waterway in the Lemon Bay Area. This table shows that the highest values for every chemical parameter assayed were from the Alligator Creek-Manasota Key Bridge area. The stations south of Forked Creek had the lowest values. These sediment data further substantiate the hypothesis that the area between Alligator and Forked Creek is a wasteload depositional area with "poor water quality". In the area of the Bay south of Forked Creek and north of Buck Creek, sediment deposition and accumulation in the Waterway and probably the tidal channels is minimized by relatively strong tidal currents.

Comparative Water Quality of Embayments and Estuaries.

How does the water quality of Lemon Bay compare to that of other estuarine and coastal systems? As an introduction to answering this question, we include here several summary tables (Tables 29, 30, and 31) from Turner (1972). Additional comparative summaries may be found in Morrill et al (1974) and the "Estuaries" DRI. Locally the best data for purposes of comparing water quality values are the data for Dona and Roberts Bay, Venice, Florida (Lincer, 1975), unpublished reports by the Environmental Quality Laboratory, Port Charlotte, and unpublished data of the Lee County Environmental Quality Laboratory for Pine Island Sound. The inshore water quality data for four stations, March 22, 1977, in Charlotte Harbor, near the undisturbed area of the McCall Sand Flats on the eastern side of the Cape Haze Peninsula are particularly relevant to the present project. While data from these and other stations in the vicinity have been collected quarterly since 1976, we include here only the data for March 22, 1977 (Table 32 and Figure 48) since they were collected at about the same time as our dry season sampling program in Lemon Bay.

In addition to data in STORET, limited water quality data for Ainger Creek and Alligator Creek are in unpublished reports by the Environmental Quality

Area	Source	NO_3-N μg-at/l	NH_3-N μg-at/l	Sampling period
Coastal and Offshore Waters				
Forty miles east of Miami, Florida	Corcoran & Alexander, 1963		0.0-1.0-NH_3	All seasons
Sargasso Sea	Menzel & Spaeth, 1962		0.78-NH_3(s)	All seasons
Sargasso Sea	Riley, 1957	0.5		All seasons
Cape Sable, Florida	Williams, 1954	0.13		
Key West, Florida	Williams, 1954	0.0		
Yucatan Channel	Williams, 1954	0.135		
Estuaries				
Tributaries of Apalachee Bay, Florida	Donnelly *et al.*, 1966	1.8		July-August
Chesapeake Bay	Patten, *et al.*, 1963	1.17		All seasons
Narragansett Bay	Pratt, 1965	1.68		Dec.-January
Hillsborough Bay, Florida	Hillsborough Bay Technical Assistance Project 1961	17.72-48.0		All seasons

Table 29. A comparison of nitrate-N and ammonia-N in Tampa Bay with concentrations in other estuarine, coastal, and offshore water of Florida, the Gulf of Mexico, and the northwestern Atlantic. Source: Turner, 1972.

Area	Source	NO_3-N μg-at/l	NH_3-N μg-at/l	Sampling period
Anclote River, Florida	Humm *et al.*, 1972	0.61(s)		October
Anclote Anchorage, Florida	Humm *et al.*, 1972	0.25(s)		October
Anclote-Gulf of Mexico	Humm *et al.*, 1972	1.32(s)		October
Waccasassa River, Florida	Saville, 1966	0.63(s)		
Biscayne Bay, Florida (Card Sound)	Segar *et al.*, 1971	0.22(s)		May
Tampa Bay	Williams, 1954	0.1		
	present investigation	2.305(s)		All seasons (1969-1970)
			12.52-NH_3(s)	All seasons (1970-1971)
		0.369(s)		All seasons (1970-1971)
			1.159-NH_3(s)	All seasons (1970-1971)

(s) Surface samples only

Table 29. continued.

Area	Source	Orthophosphate-P µg-at/l	Sampling period
Coastal and Offshore Waters			
Gulf of Mexico	Collier, 1958	0.2	
Forty miles east of Miami, Florida	Corcoran and Alexander, 1963	0.0-0.3	All seasons
Naples, west coast of Florida	Dragovich *et al.*, 1963	1.2	
Three and one half miles offshore from Tampa Bay	Dragovich and Kelley	0.8 minimum	March
Florida west coast	Finucane and Dragovich, 1959	0.3	
Florida strait	Williams, 1954	0.11	August and May
Cape Sable	Williams, 1954	0.03	March and May

Table 30. A comparison of orthophosphate-P in Tampa Bay with concentrations in other estuarine, coastal, and offshore water of Florida, the Gulf of Mexico, and the northwestern Atlantic. Source: Turner, 1972.

Area	Source	Orthophosphate-P µg-at/l	Sampling period
Estuaries			
Tributaries of Apalachee Bay, Florida	Donnelly et al., 1966	0.48	July and August
Chesapeake Bay	Patten et al., 1963	0.27	All seasons
Narragansett Bay	Pratt, 1965	1.22	Fall and Dec.-Mar.
Lower Narragansett Bay	Smayda, 1957	1.25	June-February
Anclote River, Florida	Humm et al., 1972	0.03(s)	October
Anclote Anchorage		0.03(s)	October
Anclote-Gulf of Mexico		0.01(s)	October
Waccasassa River, Florida	Saville, 1966	0.01(s)	
Biscayne Bay, Florida (Card Sound)	Segar et al., 1971	0.002(s)	May
Tampa Bay (near the Little Manatee River)	Dragovich and Kelley, 1964	29.8 maximum	March
Tampa Bay Area	Dragovich et al., 1968	20.1 rivers 20.07 bays	All seasons
Tampa Bay	Williams, 1954	6.33	June and January
Tampa Bay System	present investigation	29.16(s)	All seasons (1969-1970)
		24.42(s)	All seasons (1970-1971)

(s) Surface samples only

Table 30 continued.

Area	Source	Cells x 10^6/1	Sampling period
Coastal and Offshore Waters			
Northwest Atlantic:			
Continental Shelf	Hulburt, 1963	0.092 (10m)	All Seasons
Bermuda to Continental Shelf	Hulburt, 1963	0.027 (10m)	May-August Dec.-March
Off Jacksonville, Florida	Hulburt, 1967	0.052 (s)	April
Off southeastern coast of U.S. between Gulf Stream and Sargasso Sea	Hulburt, 1967	0.013 (s)	April
Block Island Sound	Riley, 1952	0.325	All seasons
Sargasso Sea	Riley, 1957	0.001-0.003	All seasons
Offshore between St. Petersburg & Ft. Meyers, Florida	Saunders & Glenn, 1969	0.008-0.069	All seasons
Estuaries			
Long Island Sound	Conover, 1956	2.430	All seasons
St. Andrew Bay, Florida	Hopkins, 1966	0.846 (s) (mostly diatoms)	All seasons
Four New England estuaries	Hulburt, 1963	63.475	All seasons
Lemon Bay, Florida	Lackey, 1967	2.209 (dinoflagellates)	June

Table 31. A comparison of phytoplankton abundance in Tampa Bay with that in other estuarine, coastal, and offshore waters in the Gulf of Mexico and northwestern Atlantic.
Source: Turner, 1972.

Area	Source	Cells x 10^6/l	Sampling period
Lower Chesapeake Bay	Patten et al., 1963	0.938 (s)	All seasons
Narragansett Bay	Pratt, 1959	6.117	All seasons
Narragansett Bay	Pratt, 1965	1.52-7.62 (s)	Dec.-June
Apalachee Bay, Florida	Saunders and Wahlquist, 1966	0.0407 0.227 0.314	July-Aug. November February
Gulf coast of Florida, Tampa Bay to Caxambas Pass	Saunders et al., 1967	0.802 (diatoms)	All seasons
Gulf of Mexico (inshore) between St. Petersburg and Ft. Meyers, Florida	Saunders and Glenn, 1969	1.096 (diatoms)	All seasons
Lower Narragansett Bay	Smayda, 1957	6.7 (s-2ft.)**	June-Jan.
Beaufort Channel, N. C.	Williams & Murdoch, 1966	2.0 (s)	All seasons
Tampa Bay System	present investigation	1.454 (s)	All seasons (1969-70)
		0.78 (s)	All seasons (1970-71)

*Samples taken only at 10 m. depth

**Samples taken from surface to 2 feet

(s)Samples taken at the surface only

Table 31, continued.

Table 32 Surface water quality data, March 22, 1977, from four water quality stations in Charlotte Harbor adjoining the natural mangrove shore line on the east side of the Cape Haze peninsula. From: Environmental Quality Laboratory, Inc., April, 1977. Results of the Department of Environmental Regulation's Compliance Monitoring Program for General Development's South Gulf Cove Project. (See Figure 48 for station locations).

Station No. surface water samples	BOD_5 ppm	D.O. ppm	Temp ^oC	Cond. umho/cm	Calculated Salinity %	NH_3 mg/l	NO_3+NO_2 mg/l	TKN mg/l	O-PO_4 mg/l	T-P mg/l
9	0.92	7.8	26.0	30	18.6	0.10	0.01	2.85	0.12	0.16
10	1.71	7.5	26.0	28	17.3	0.07	0.01	3.17	0.13	0.25
11	1.43	7.6	26.0	37	23.5	0.07	0.01	1.89	0.12	0.37
12	1.23	8.3	26.0	38	24.2	0.08	0.01	2.67	0.12	0.21

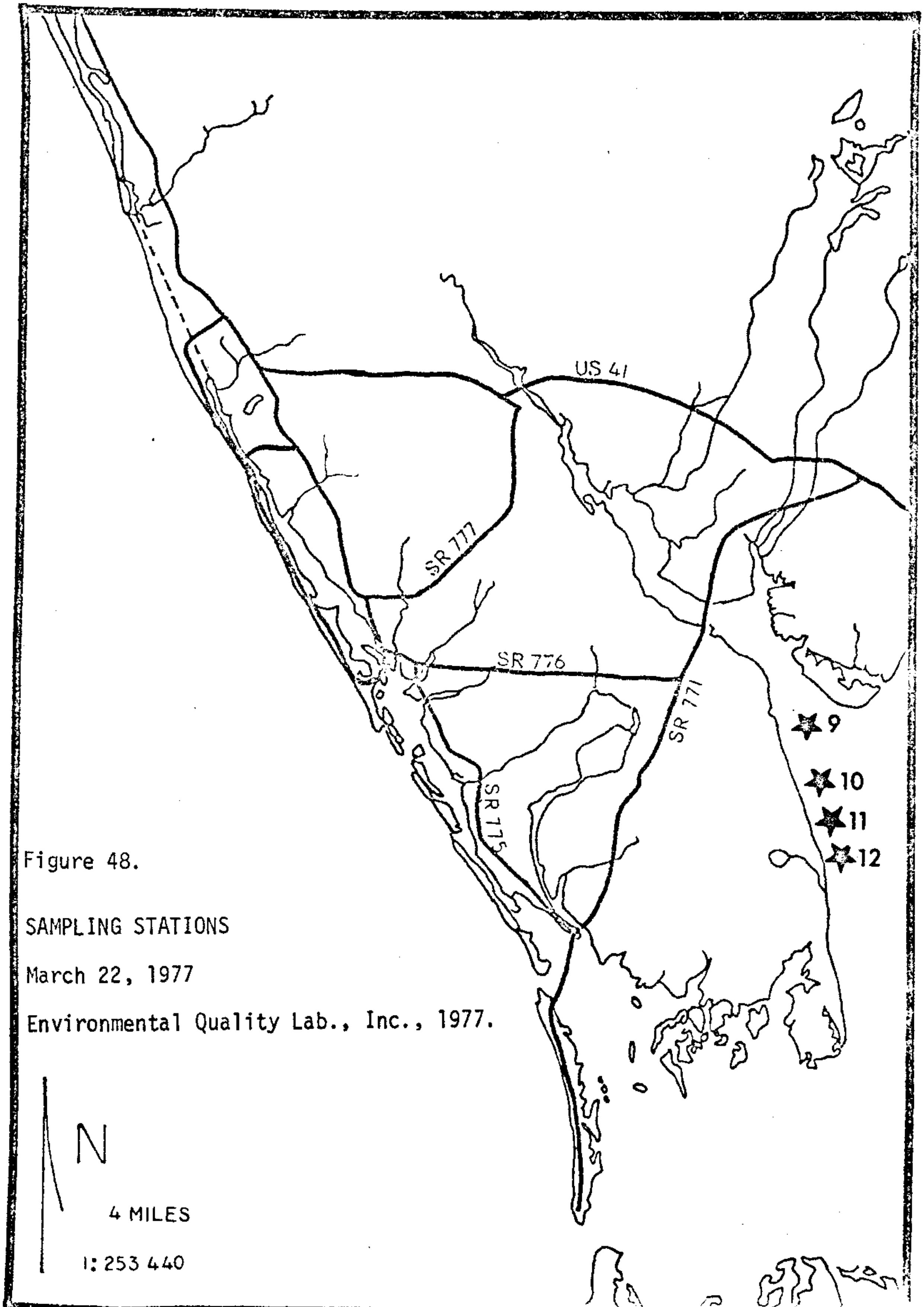


Figure 48.

SAMPLING STATIONS

March 22, 1977

Environmental Quality Lab., Inc., 1977.

Laboratory (1975) and Smolker et al (1977). Figure 49 shows the locations of the sampling stations in the Ainger Creek study; Table 33 summarizes the data for this study. In their study of the tidal creeks of Southwest Florida Smolker et al surveyed the water quality of 10 tidal creeks on two "one-time ebb tide sampling events", February 15-17 and April 15-17, 1977. Three of the creeks were in the region of Lemon Bay: Alligator, Coral, and Whidden Creeks. We include here their data from Whidden Creek whose entire watershed is relatively natural and undeveloped (Figure 50 & Tables 34 & 35) and from Alligator Creek whose watershed is extensively developed (Figure 51 & Tables 34 & 35). In addition, we include a polygonal graph of the EPA criteria for minimum allowable water quality (Figure 52).

Finally, we include here a summary of the water quality data for the west and east branches of Coral Creek from the February sampling run (Figure 53). Since the west branch of Coral Creek receives runoff water from a developing suburban area and the east branch drains a non-urban area, the water quality profiles for the sample stations in these two branches illustrate the potential differences in water quality in upstream segments of two sub-drainage basins of a tidal creek.

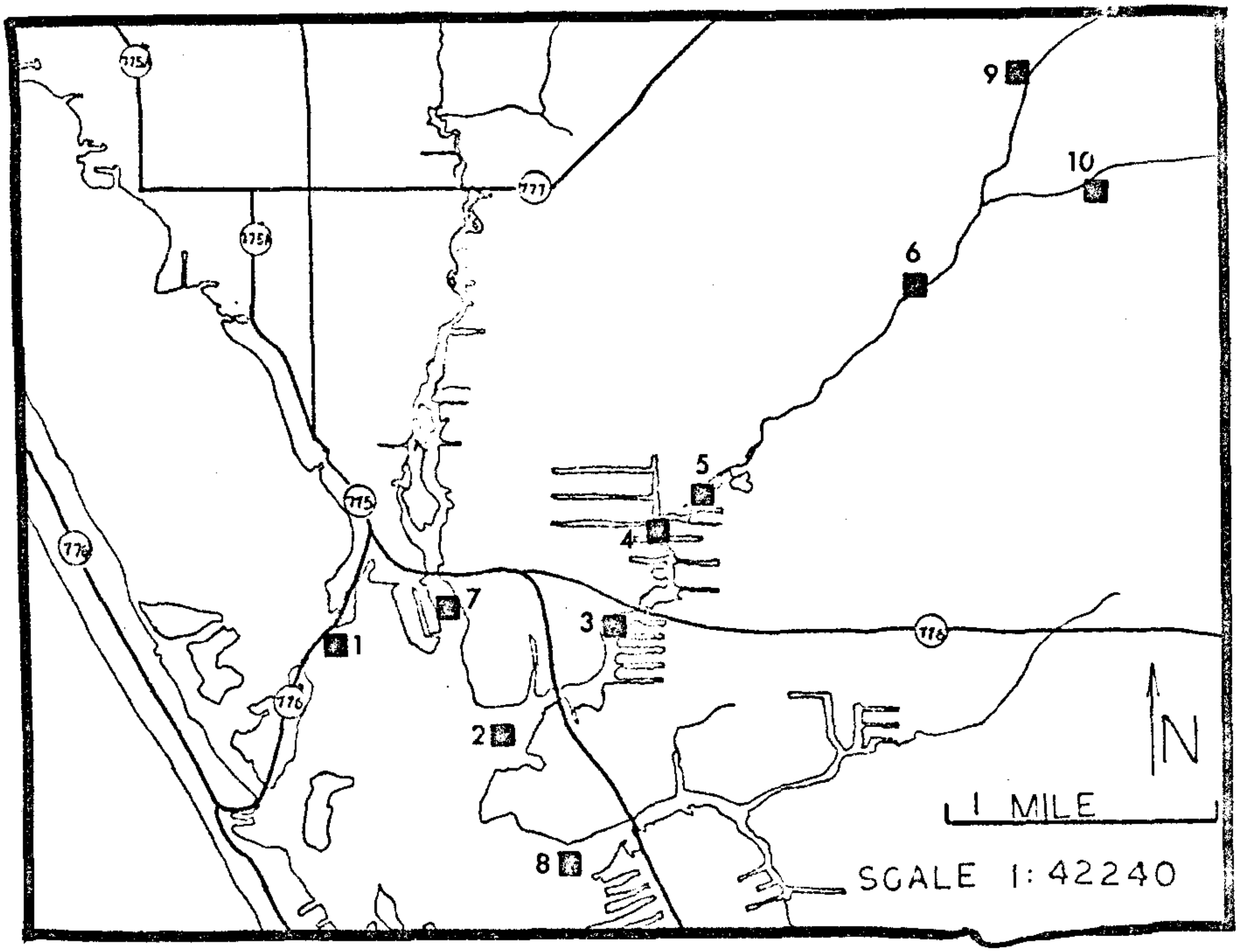


Figure 49. Map showing water quality station locations from: Environmental Quality Laboratory, Inc., Water Quality of Ainger Creek, 1975.

Table 32a. Station descriptions for Figure 49.

1. Lemon Bay at the S. R. 776 bridge.
2. Ainger Cr., approximately 200 M. downstream of S. R. 775 bridge.
3. Ainger Cr., approximately 200 M. downstream of S. R. 776 bridge.
4. Ainger Cr., downstream of junction with last main residential subd.
5. Ainger Cr., downstream of the junction with mobile home subd. canal.
6. Ainger Cr., at the end of the navigable section and upstream of any major development.
7. Gottfried Cr., approximately 300 M. downstream of S. R. 775 bridge.
8. Oyster Cr., approximately 200 M. downstream of S. R. 775 bridge.
9. Agricultural drainage ditch on the Flying "A" Ranch, Myakka Estates.
10. Second agricultural drainage ditch on the Flying "A" Ranch.

Table 33 WATER QUALITY DATA FOR AINGER CREEK AND SURROUNDING AREAS, CHARLOTTE AND SARASOTA COUNTIES, FLORIDA
December 1974 to August 1975
(All nutrient data are reported as milligrams per liter.)

Station Number	Depth	Date	Time (EDT)	Tide	Color (APHA)	Turbidity (NTU)	Salinity (PPT)	o-P (as P)	NH_3 (as N)	NO_3 (as N)	NO_2	SiO_2 (as Si)	Total P	Total N	Total Organic C	Total dissolved solids (mg/l)	B.O.D. (mg/l)	Total Coliforms (per 100 ml)	Fecal Coliforms (per 100 ml)	Fecal Streptococci (per 100 ml)	Fec. Colif/ Fec. Strep. Ratio
10	Surf	6 Dec'74	1358				2.5	ND[a]	0.02	0.16	0.01		0.03	1.44		5,223	1.0				
9	Surf	6 Dec'74	1330					0.02	0.02	0.18	ND		0.05	1.32		6,459	2.2				
11	Surf	6 Dec'74	1240					0.09	0.22	0.21	ND		0.21	2.78		4,432	4.8				
3	Surf	6 Dec'74	1445				29	0.04	0.13	0.04	ND		0.07	1.09		32,260	1.2				
9	Surf	20 May'75	0900					0.48	0.90	ND[a]	ND		0.50	9.9				(1200)[b]	1120	1057	1.1
3	Surf	20 May'75	1000					0.48	0.26	ND	ND		0.21	3.99				130	(48)	100	(.48)
10	Surf	20 May'75	0915					0.03	0.38	ND	ND		0.35	4.65				NA[d]	360	140	2.50
11	Surf	23 Jul'75	1110					0.12	0.11	ND	ND	1.86	0.66	4.65	27.8	284		NA	420	130	3.4
9	Surf	23 Jul'75	1140							ND	ND		0.34	4.59	30.0	2,430		NA	310	300	1.0
10	Surf	23 Jul'75	1145							ND	ND	4.30	0.42	4.20		1,885		100[-e]	(25)	510	(0.05)
3	Surf	23 Jul'75	1230	Out				0.04	1.15	ND	ND	0.55	0.15	3.81	15.6	32,000		(53)	(17)	57	(0.30)
2	Surf	23 Jul'75	1240	Out				0.04	1.23	ND	ND	0.26	0.34	4.65	8.59			(53)	1⁻	(23)	1
1	Surf	16 Aug'75	0925	Out[f]	5	2.5	35	0.06	2.82	ND	ND	0.31	0.27	3.51				1⁻	1⁻	1⁻	1
1	Bot	16 Aug'75	0920	Out	5	2.0		0.04	1.99	ND	ND	0.23	0.21	5.45							
2	Surf	16 Aug'75	0955	Out	11	1.7	34	0.05	1.26	ND	ND	0.38	0.25	5.33				1⁻	1⁻	1⁻	1
2	Bot	16 Aug'75	0955	Out	12	2.4		0.05	1.31	ND	ND	0.31	0.70	3.17							
3	Surf	16 Aug'75	1010	Out	15	1.5	32	0.05	1.03	ND	ND	0.76	0.09	4.04				(17)	(6)	(9)	(.77)
3	Bot	16 Aug'75	1010	Out	15	1.4		0.05	0.90	ND	ND	0.67	0.14	4.31							
4	Surf	16 Aug'75	1200	Out	30	2.2	28	0.06	0.53	ND	ND	0.67	0.30	4.31				(40)	(15)	(16)	(1.0)
5	Bot	16 Aug'75	1037	Out	40	3.1		0.07	0.51	ND	ND	0.46	0.40	4.94							
5	Surf	16 Aug'75	1035	Out	45	3.3	26	0.07	0.33	ND	ND	0.43	0.18	3.05				(20)	(11)	(16)	(.68)
6	Surf	16 Aug'75	1130	Out	60	3.6	21	0.05	1.77	ND	ND	0.34	0.22	2.96				(100)	(62)	44	(1.5)
7	Surf	16 Aug'75	0940	Out	14	1.5	34	0.06	0.85	ND	ND	0.63	0.18	3.75				(20)	(9)	(4)	(2.3)
7	Bot	16 Aug'75	0935	Out	14	1.2		0.06	0.79	ND	ND	0.55	0.22	4.32							
8	Surf	16 Aug'75	1250	Out	16	2.8	35	0.05	0.95	ND	ND	0.32	0.20	2.76				1⁻	1⁻	1⁻	1
8	Bot	16 Aug'75	1250	Out	12	2.5		0.03	2.09	ND	ND	0.29	0.29	3.65							

[a] Not Detected.
[b] Parenthetical values calculated from non-ideal plate counts.
[c] Values reported from two separate determinations.
[d] Not available
[e] "less than"
[f] Tide was high at 0900 EDT in Lemon Bay, on 16 Aug 1975.

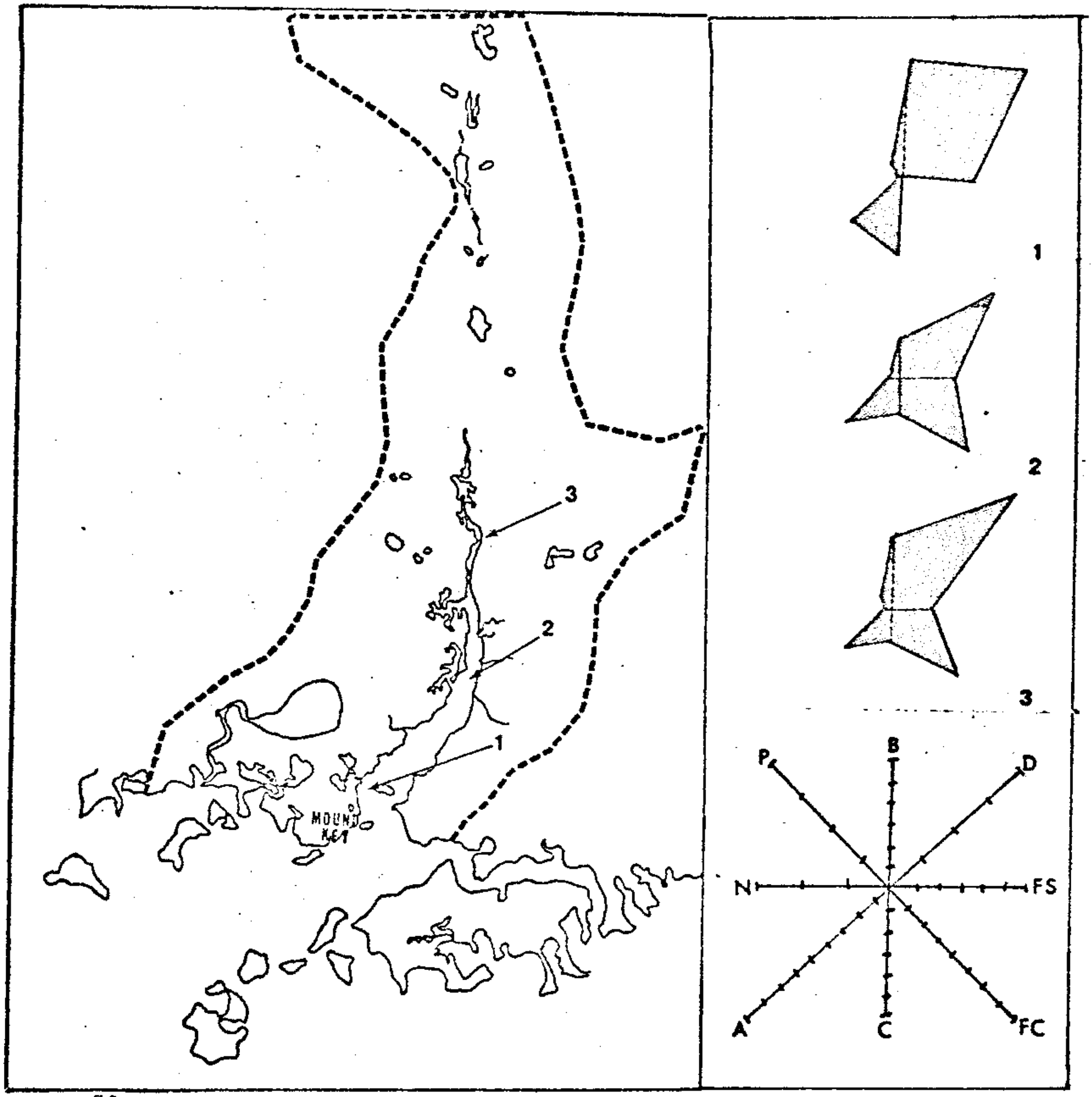


Fig. 50 : Drainage basin map and sample station locations for Whidden **Creek.** Graphs at right may be used as a basis for comparison (for **discussion** see text). " ▲ " indicates package treatment plant; △ **indicates** collection system treatment plant.

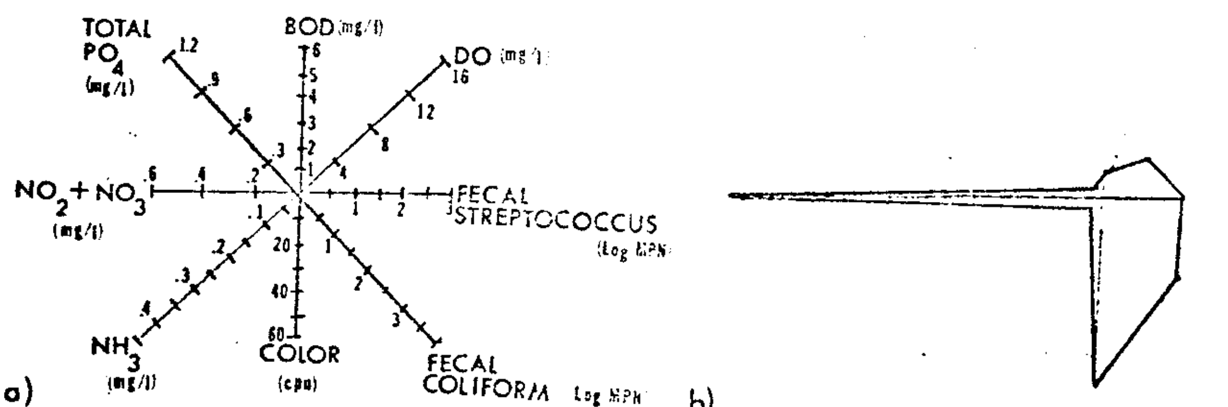


Fig. 52: a) Key to polygonal graphs showing parameters and concentrations used. b) Polygonal graph showing EPA criteria for minimum allowable water quality to be used as a basis for comparison (see text).

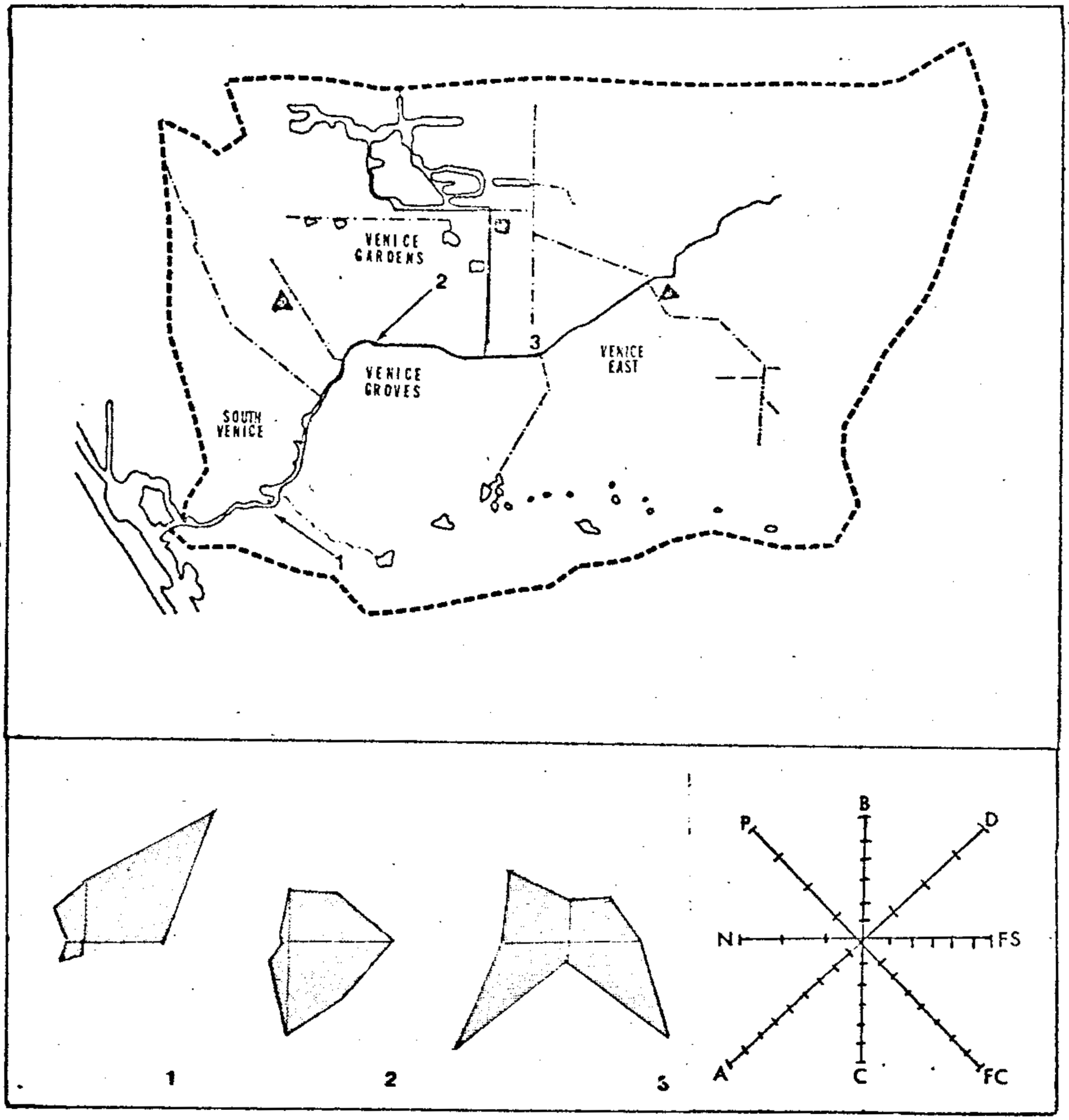


Fig. 51 : Drainage basin map showing sample station locations for Alligator Creek (Sarasota County). Polygonal graphs at bottom are for comparative purposes. " ▲ " indicates package treatment plants; △ indicates collection system treatment plants.

CREEK	STATION	WATER TEMP	pH	SALINITY	COLOR	Turbidity SUSPENDED SOLIDS JTV	DISSOLVED OXYGEN	BOD	TOTAL COLIFORM	FECAL COLIFORM	FECAL STREP	AMMONIA NH_3	NO_3+NO_2	TOTAL KJELDAHL NITROGEN	$o\text{-}PO_4$	TOTAL PO_4	CHLOROPHYLL a
		°C		o/oo	CPU	mg/l	mg/l	mg/l	MPN /100 ml	MPN /100 ml	MPN /100 ml	mg/l	mg/l	mg/l	mg/l	mg/l	mg/m^3
Whidden	1	29		42.7	25	2.4	8.63	3.77	0	6	0	0.09	0.01	3.53	0.02	0.24	
	2	29		42.3	40	1.9	8.06	3.01	1300	0	50	0.14	0.01	3.34	0.01	0.09	
	3	30		44.7	50	3.0	7.83	5.95	1700	0	232	0.43	0.01	5.45	0.02	0.13	
(S) Alligator	1	25	8.1	34.8	15	4.5	6.22	1.67	100	600	2	0.23	0.02	2.26	0.23	0.34	
(s) Alligator	2	26	8.2	31.9	35	3.0	7.25	4.70	900	800	10	0.11	0.01	2.26	0.22	0.27	
	3	25	8.0	3.2	60	1.8	12.70	3.63	0	308	260	0.09	0.01	0.70	0.08	0.01	

Table 34 - Water Quality data for sample run on April 15 - 17. For a discussion of these results, see text. Source: Smelker, et al., 1977.

Table 35 - Water quality data for sample run on February 15 - 17. For a discussion of these results, see text. Source: Smolker, et al., 1977.

CREEK	STATION	WATER TEMP	pH	SALINITY	COLOR	SUSPENDED SOLIDS	DISSOLVED OXYGEN	BOD	TOTAL COLIFORM	FECAL COLIFORM	FECAL STREP	AMMONIA NH_3	NO_3+NO_2	TOTAL KJELDAHL NITROGEN	$o\text{-}PO_4$	TOTAL PO_4	CHLOROPHYLL a
		°C		o/oo	CPU	mg/l	mg/l	mg/l	MPN /100 ml	MPN /100 ml	MPN /100 ml	mg/l	mg/l	mg/l	mg/l	mg/l	mg/m^3
Whidden	1	17	8.40	37.6	35	28.0	15.30	5.37	0	0	50	.15	.01	1.07	.01	.07	0
	2	18	8.00	32.0	15	22.4	12.10	1.65	0	300	20	.14	.01	.99	.01	.01	0
	3	18	7.80	28.6	15	20.8	15.45	3.00	0	200	10	.14	.01	1.01	.02	.05	0
(S) Alligator	1	19	8.25	10.8	6	19.2	18.17	2.82	600	0	100	.05	.01	.71	.16	.24	0
(S) Alligator	2	19	8.10	4.8	5	9.8	11.21	2.57	600	100	170	.12	.04	1.53	.12	.17	2.136
	3	20	7.80	3.4	10	22.0	6.05	1.77	100	3300	60	.39	.30	1.31	.44	.60	1.922

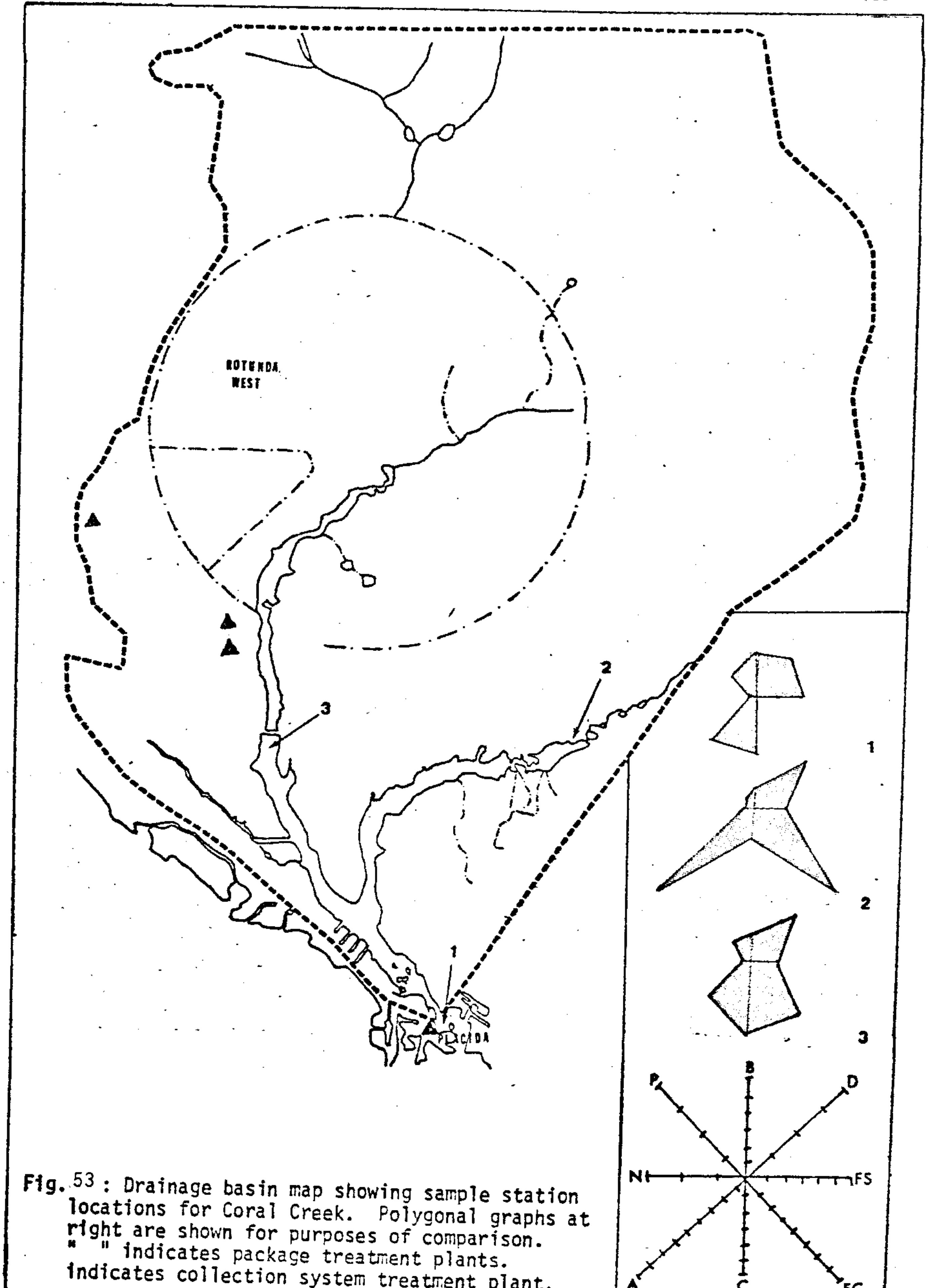


Fig. 53 : Drainage basin map showing sample station locations for Coral Creek. Polygonal graphs at right are shown for purposes of comparison. " " indicates package treatment plants. indicates collection system treatment plant.

Physical and Chemical Parameters - Lemon Bay Tributaries---Predictions

A 1974 report by the Tampa Bay Regional Planning Council included the 1972 and projected runoff volume and loads for the Lemon Bay tributaries. These data summarized below were derived from land use patterns and stream flow in 1972 and a computer program based on data from Tulsa, Oklahoma.

Creek	1972				2000			
	MGD	B.O.D. lb/d	TN lb/d	TP lb/d	MGD	B.O.D. lb/d	TN lb/d	TP lb/d
Gottfried	14.0	323	134	4	17.7	1573	179	11
Forked	12.9	417	113	4	16.3	1610	159	12
Alligator	10.2	426	90	4	13.6	1654	140	12
Ainger	3.3	0	20	1	3.3	0	20	1
Oyster	5.1	0	30	1	5.1	0	30	1

Bacteriological Studies.

Because of occasional shellfish poisoning and wet season incidents where human waste water occurred in roadside ditches, the Lemon Bay area has experienced several bacteriological and water pollution surveys since the early 1960's. The major surveys are briefly described below.

Year	Survey
1966	Sanitary Survey of Sarasota and Lemon Bays: The study's emphasis is on shorelines. Most of the sampled stations in Lemon Bay are located in the Intracoastal Waterway. This was not a continuous monitoring program. Rather, it was a spot check carried out to comply with the requirements of the National Shellfish Sanitation Program.
10/1969-9/1975	Charlotte County Health Department conducted a number of water quality surveys of selected bathing and recreational areas in Charlotte County including areas in Lemon Bay. The conclusions drawn from these surveys by Robert Corno (Dir. Env. Health) were that 1) septic tanks are seemingly the cause of high fecal coliform counts in some areas (Oyster Creek at Mississippi Avenue and the canal at the southwest end of Manor Road at the mouth of Ainger Creek), although a marina at the Manor Road station could also contribute to high fecal coliform readings; 2) the immediate Lemon Bay Watershed contributes to the pollution of Lemon Bay, especially during periods of heavy rainfall.

Year	Survey
1970	Sarasota County Health Department conducted a survey of the ditches and waterways of Englewood. Conclusions drawn by David Crane (Dir. Sar. Co. Health) from the results of this study were that fecal contamination of the ditches and waterways occurs after periods of rainfall with the most probable source being septic tank effluent. The mouth of Gottfried Creek was noted for the high numbers of fecal coliforms.
1974	Sanitary Survey of Lemon Bay: The Florida Department of Health and Rehabilitative Services carried out a survey to reevaluate the classification of Lemon Bay with regard to shellfish harvesting. The study consisted of shoreline analysis, hydrographic studies and bacterial analysis (See Figure 54 for station locations). Results of the bacterial analyses (Table 36) indicated that waters adjacent to areas of high population showed evidence of fecal pollution, although not sufficient to require closing the Bay to shellfish. Further study during the wet season was recommended when the effects of fecal pollution are suspected to be greater.
1975-77	Bacteriological Water Pollution Survey: State of Florida Department of Health and Rehabilitative Services. Twenty-nine stations located throughout Lemon Bay and in adjacent tidal creeks were surveyed at 2 week intervals from December 1975 through the present. Figure 55 shows the locations of the stations and Table 37 describes the vicinity of each station. The Charlotte County segment of this pollution survey provides a most complete bi-weekly, monthly, and seasonal pattern of total coliform and fecal coliform bacteria. It is important to note that the Charlotte County Health Department

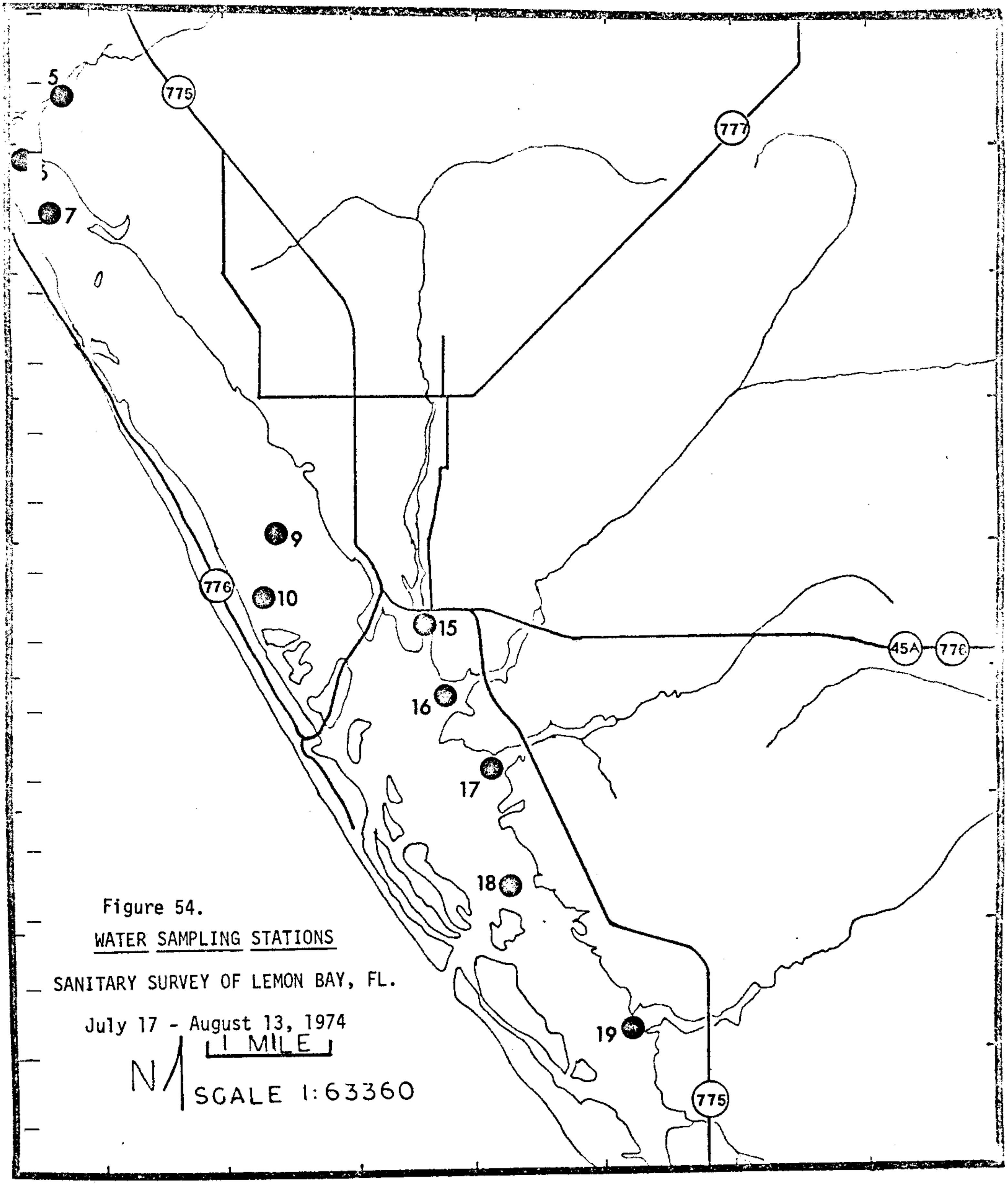


Figure 54.
WATER SAMPLING STATIONS
SANITARY SURVEY OF LEMON BAY, FL.
July 17 - August 13, 1974

Table 36 Total coliform (T.C.) and fecal coliform (F.C.) levels at 10 stations in Lemon Bay from Sanitary Survey of Lemon Bay, Florida, July 15-26, 1974

Station No.		5	6	7	9	10	15	16	17	18	19	Inches of Rain on Sample Day
Location		Forked Creek	Mouth, Forked Creek, Lemon Bay	Lemon Bay	Lemon Bay	Lemon Bay, Manasota Key	Mouth, Godfrey Creek	Mouth, Ainger Creek	Mouth, Oyster Creek	Lemon Bay	Mouth, Buck Creek	
Date	Type											
7/17	T.C.	46	49	8	4	17	79	17	33	5	11	
	F.C.	5	7	2	2	8	17	13	13	2	<5	0.0
7/18	T.C.	-	130	17	11	920	350	350	240	8	-	0.5
	F.C.	-	2	4	<2	17	130	130	130	8	-	
7/19	T.C.	34	27	8	2	4	170	79	79	2	8	0.0
	F.C.	9	<2	5	<2	4	79	22	49	<2	<2	
7/31	T.C.	430	<1.8	<1.8	-	-	-	-	-	-	-	1.9
	F.C.	180	<1.8	<1.8	-	-	-	-	-	-	-	
8/01	T.C.	920	2	6.8	-	-	-	-	-	-	-	1.6
	F.C.	920	2	4.5	-	-	-	-	-	-	-	
8/06	T.C.	2400	<1.8	<1.8	<1.8		79	49	<1.8	2	<1.8	0.0
		540	<1.8	<1.8	<1.8		49	33	<1.8	<1.8	<1.8	
8/08	T.C.	-	-	-	-	-	4.5	4.5	4.5	9.3	7.8	1.1
	F.C.	-	-	-	-	-	4.5	4.5	2.0	<1.8	2.0	

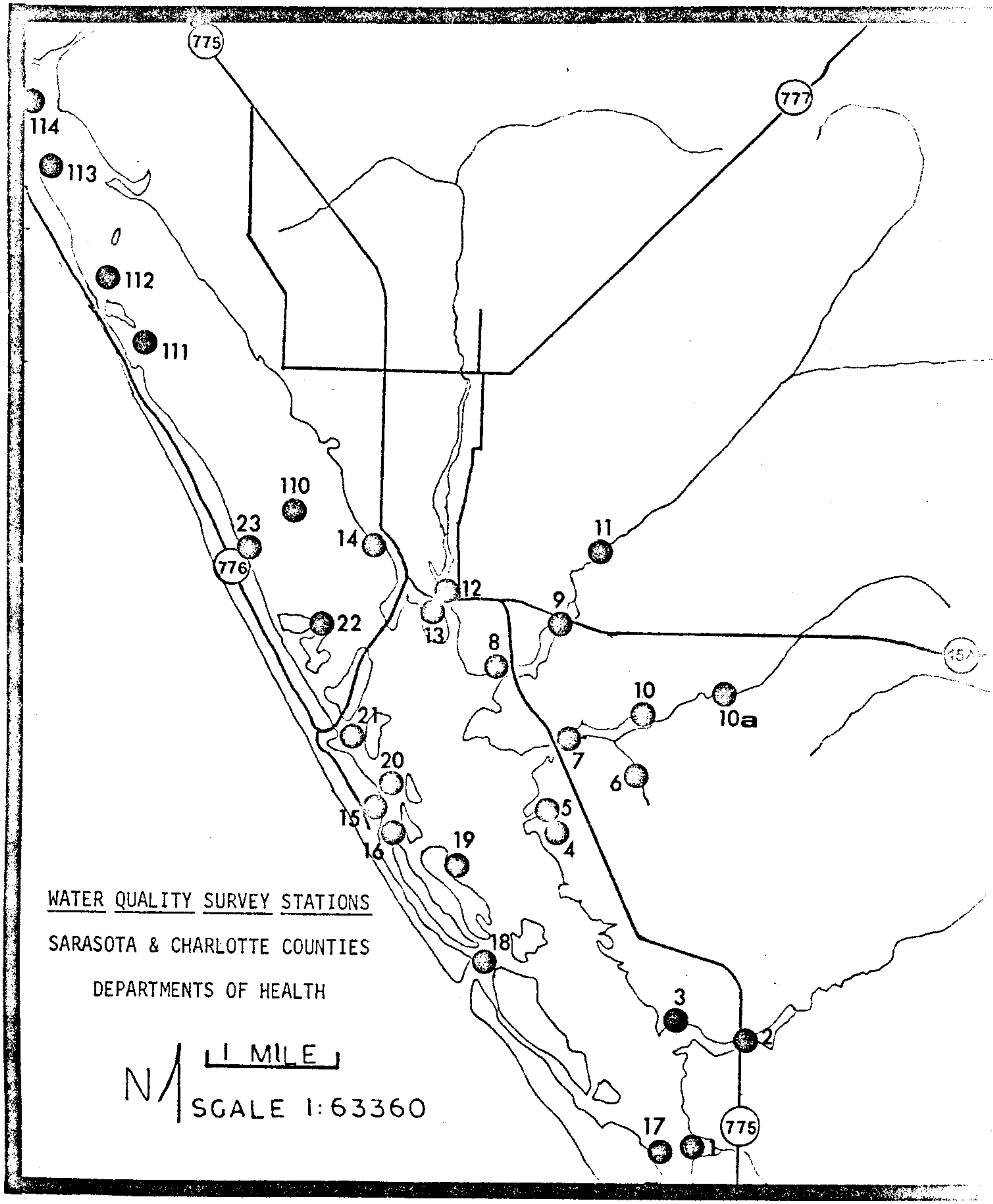


Figure 55 Locations of water quality survey stations of the Charlotte County and Sarasota County Departments of Health for the 1975 - 1977 water quality surveys. See Table 37 for description of station locations.

Table 37 Description of Locations of Biweekly Sampling Stations of the Charlotte County Health Department's Water Quality Survey, 1975-1977.

1. End of Boyette Street at the mouth of Lemon Creek. This point would include the runoff of Palm Point S/D which is on septic tanks. It will also include the new S/D of Gasparilla Pines which has no homes yet. It does have an 18 hole golf course which is in operation. A part of the Rotunda area is also included in this watershed.

2. Buck Creek at Highway 775. Almost completely unsettled wild pineland. Upper reaches of drainage area include some clearing and grading done by Rotunda.

3. Canal South End of Pine Cove Drive. Small S/D of Pine Cove, canal lots about 40% of which have homes on them - all on septic tanks.

4. Canal, Lemon Bay end of Massachusetts Avenue, Grove City. Almost completely built up area of residences, all on septic tanks.

5. Canal, Lemon Bay end of Pennsylvania Avenue, Grove City. Almost completely built up area of residences - all on septic tanks.

6. Bridge at Oyster Creek on Mississippi Avenue. Includes runoff from small older S/D of mobile homes on Brookwood Drive. It also includes drainage of an area of older homes in Grove City.

7. Oyster Creek at Highway 775.

8. Canal at Southwest end of Manor Road. Watershed includes drainage from an area of about 9 square blocks of older homes, all on septic tanks.

9. Rock Creek Bridge at Highway 776. Drainage includes roughly 2 square miles of 75% developed residential area. It also includes a recently developed Clintwood Acres in an older S/D called Breezewood. Both are questionable areas for septic tanks. Canal homes on Edgemere, South and North Lanes are older developments in the area. An unknown acreage of range land is included.

10. Canal at South End of Via Cala. Encompasses drainage of most of Mobile Gardens, an older S/D of mobile homes on septic tanks.

11. Canal at West End of Kingfisher Drive. Drainage area includes most of Holiday Mobile Estates, Holiday Trav-L Park, an addition of Holiday Mobile Estates now being developed.

12. Gottfried Creek at Highway 775. The watershed involved extends into Sarasota County for approximately 2 miles.

13. North End of Canal at Junction of Lemon Bay and Deer Creek Drives. Older homes in Point of Pines S/D all on septic tanks.

Table 37 (continued)

14. Canal at end of Edgewater Street, behind Englewood Boats and Motors. This may include effluent from an older 36 space motor home park all on septic tanks. The runoff from the marina also is discharged into this canal.

15. Boat Basin at Ainger's Resort. Area completely developed, all on septic tanks.

16. Canal at end of Holiday Lane. Completely developed area, all on septic tanks.

17. Palm Island - East side - Channel Marker #9

18. Stump Pass.

19. Whidden Key - East side - opposite Channel Marker #19.

20. Manasota Key - East side - opposite Ainger's Resort and west of Channel Marker #22.

21. South of Kesselring's Wastewater Treatment Plant - Manasota Key - East side.

22. Manasota Key - East side - opposite Ponce De Leon Drive, and Southwest of Channel Marker #24.

23. Manasota Key - East side - opposite Oakwood Cove Condominiums and West of Channel Marker #25.

24. San Casa Drive - Bridge by County Mosquito Control Office.

has continued this survey beyond the project period and has incorporated the survey into its major water quality program.

Rather than review the data on an individual sampling station basis, we submerged the data by determining the average total and fecal coloform counts for all sampling stations on the creeks and dead end canals for each sampling day. The results, graphed in Figure 56, show the general bacterial levels for these tributaries of Lemon Bay throughout the year. With the exception of a few sample days, the average total coliform level was higher than the fecal coliform level and both exceeded federal EPA permissible levels of 70 MPN/100 ml (Total Coliform) and 14 MPN/100 ml (Fecal Coliform) for shellfish harvesting waters.

The data from individual stations and the averages from all the stations (Table 38) were then compared with total rainfall, rainfall events, ebb and flood tides on sample days and seasonal variations in estimated total and tourist populations. These comparisons showed high bacterial levels and appear to be positively related to both rainfall events (Figure 7) and seasonal fluctuations in the local population. On only five sample days were the samples collected on an ebbing tide; on four of these days high bacterial levels were positively correlated with the tide. Peak levels of bacteria from flood tide samples were quite variable.

In the next phase of the analysis of the data, we graphed the averages of all the stations on a particular creek or set of canals and Lemon Bay for each sample day. The sample day patterns throughout the year were examined for possible correlations between bacterial levels and rainfall, population fluctuations and phase of the tide.

Table 38 Yearly total and fecal coliform averages (MPN) for each station in the Lemon Bay bacteriological survey (1976-1977). Averages for each segment of the Bay and for each creek are also included.

Segment	Station #	1976		1977	
		Total	Fecal	Total	Fecal
Lemon Cr.	1	162.7	79.5	124.7	59.6
	Average	162.7	79.5	124.7	59.6
Buck Cr.	2	158.4	105.4	101.9	55.5
	3	116.0	88.1	52.5	35.3
	Average	137.2	96.9	77.2	45.4
Grove City	4	150.2	34.2	585.9	469.8
	5	219.4	66.1	549.6	367.7
	Average	184.8	50.2	556.7	418.8
Oyster Creek	6	844.5	331.0	608.0	341.0
	7	353.5	245.8	390.3	253.4
	10	526.3	165.3	454.1	85.2
	10A	988.8	291.7	1000.7	179.6
	Average	678.3	258.5	613.3	214.8
Ainger Cr	8	474.5	377.8	278.1	228.7
	9	219.8	52.6	306.3	171.5
	11	488.1	224.7	229.7	52.1
	Average	394.1	216.7	271.4	150.8
Gottfried Cr	12	330.9	108.7	134.5	59.7
	13	718.2	262.8	237.3	30.4
	Average	524.6	185.8	185.9	45.0
Lemon Bay Canals	14	80.8	27.8	128.2	38.9
	15	427.7	219.5	265.7	226.2
	16	323.5	136.0	382.7	211.0
	Average	277.3	127.8	258.9	158.7
South Lemon Bay	17	4.5	2.8	7.2	4.6
	18	3.0	2.6	3.9	3.3
	19	2.3	2.2	3.9	3.9
	20	4.7	3.5	9.2	5.0
	21	16.9	25.0	56.8	26.1
	21a	128.7	33.3	366.8	211.0
	Average	26.7	11.6	74.7	42.3

Table 38 (continued)

Segment	Station #	1976		1977	
		Total	Fecal	Total	Fecal
North Lemon Bay	22	6.8	3.2	9.1	8.2
	23	2.7	2.0	5.6	2.9
	110	2.1	2.0	3.6	2.4
	111	3.3	2.8	5.5	2.8
	112	5.3	4.7	2.7	2.0
	113	3.1	2.7	2.0	2.0
	114	24.9	15.7	4.8	3.3
	Average	7.6	4.7	4.8	3.4

Lemon Bay. Figures 57 and 58 show the bacterial counts for the Lemon Bay stations north of the Tom Adams Bridge and the Bay stations south of the bridge. The low bacterial levels at these stations could be due to tidal flushing and dilution, reduced viability of coliform bacteria in sea water and the distance of the stations from the shore. However, Lemon Bay Stations 21 and 21a did exhibit high bacterial counts in December, 1976 and January, 1977. Interestingly, these stations are located close to Englewood Beach which receives an influx of winter tourists. The Bay stations north of the Tom Adams Bridge generally had lower bacterial counts than the stations south of the bridge and were located off-shore of low density single family units and the natural shoreline.

Buck Creek and Lemon Creek. Although these two creeks have few waterfront houses, both creeks have additional potential sources of bacteria. Immediately south of Lemon Creek are two marinas. The Gasparilla Pine's Golf Course until recently drained into Lemon Creek. Water from the Rotunda River partially overflowed into Buck Creek. The marked rise in total and coliform bacterial levels in Lemon Creek between September 1976 and February 1977 (Figure 59) could be partly due to seasonal activities at the nearby marinas and the groundskeeping program at the Gasparilla Pines Golf Course. The irregular pattern of bacterial counts for Buck Creek (Figure 60) may reflect rainfall-runoff and land development activities in Rotunda West, and/or the activities of a small commercial fishery upstream of the SR 775 bridge. Interestingly, the bacterial levels at the Buck Creek station decreased abruptly in April 1977 after the damming of the creek below the Rotunda River.

Oyster Creek, Ainger Creek and Gottfried Creek. Total and fecal coliform bacterial levels in these three creeks (Figures 61, 62 and 63) were higher than the maximal acceptable average levels for Class II waters throughout most of the year. The lowest levels occurred in April after the tourist-winter resident

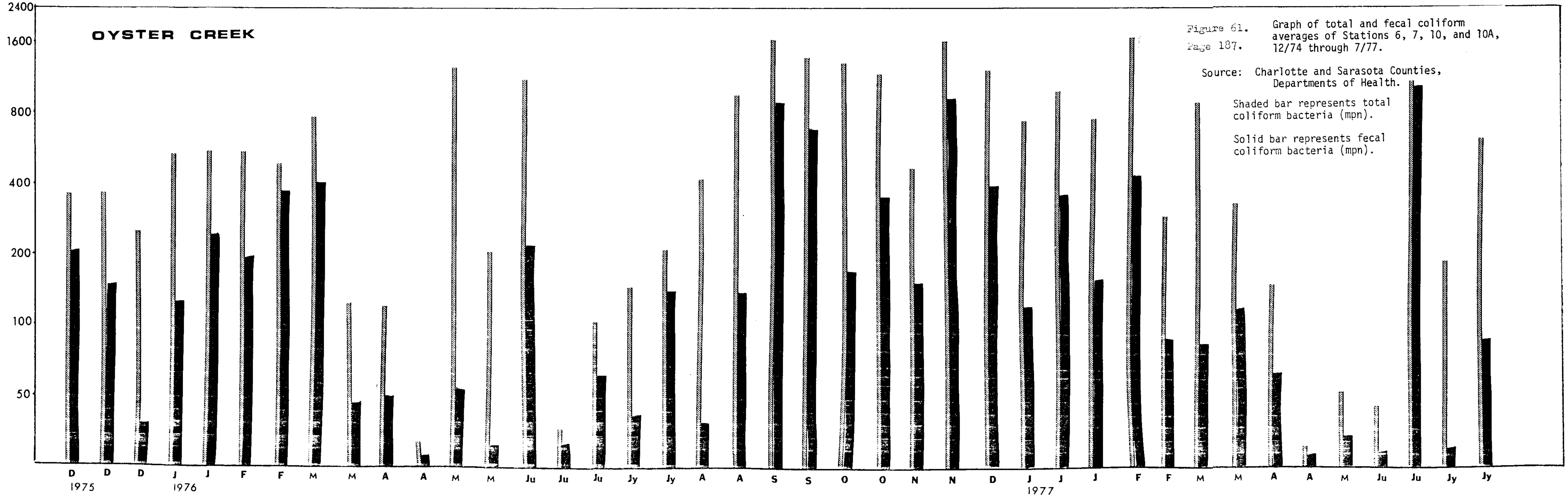


Figure 61. Graph of total and fecal coliform averages of Stations 6, 7, 10, and 10A, 12/74 through 7/77.
Page 187.

Source: Charlotte and Sarasota Counties, Departments of Health.

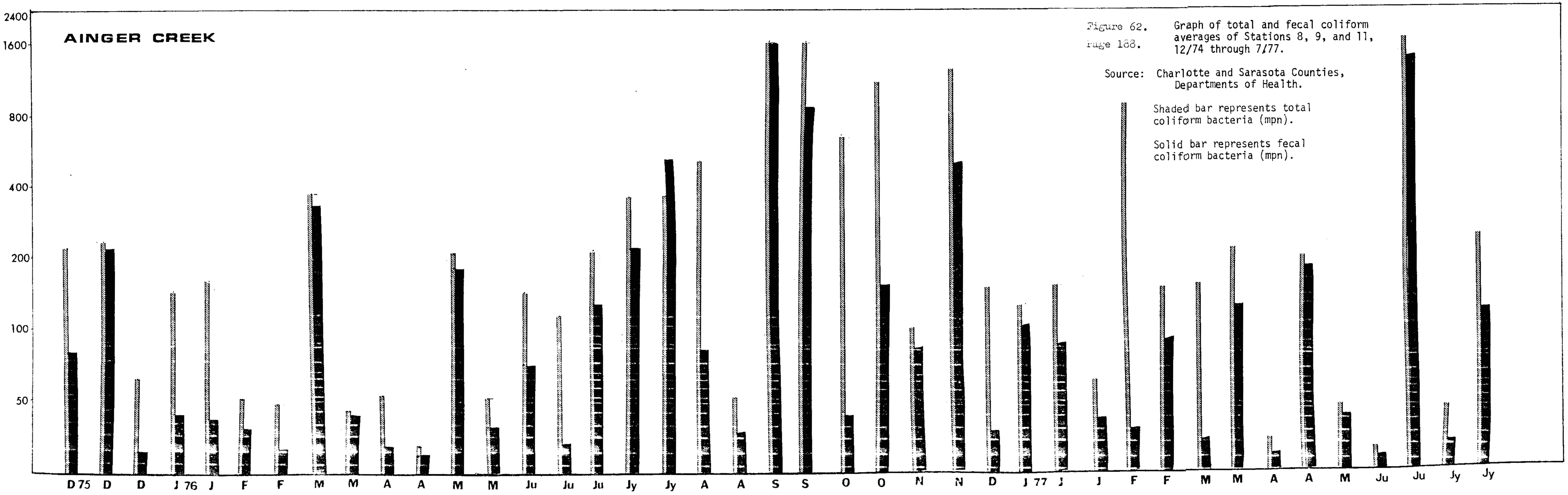


Figure 62. Page 188. Graph of total and fecal coliform averages of Stations 8, 9, and 11, 12/74 through 7/77.

Source: Charlotte and Sarasota Counties, Departments of Health.

Shaded bar represents total coliform bacteria (mpn).

Solid bar represents fecal coliform bacteria (mpn).

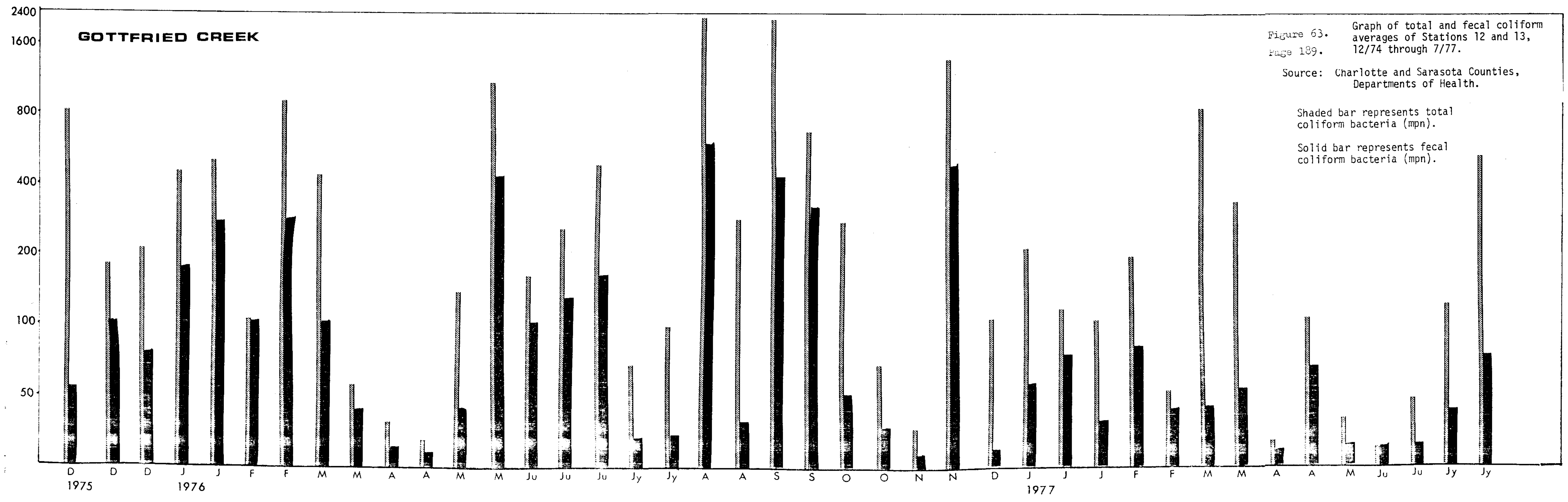


Figure 63. Graph of total and fecal coliform averages of Stations 12 and 13, 12/74 through 7/77.

Page 189.

Source: Charlotte and Sarasota Counties, Departments of Health.

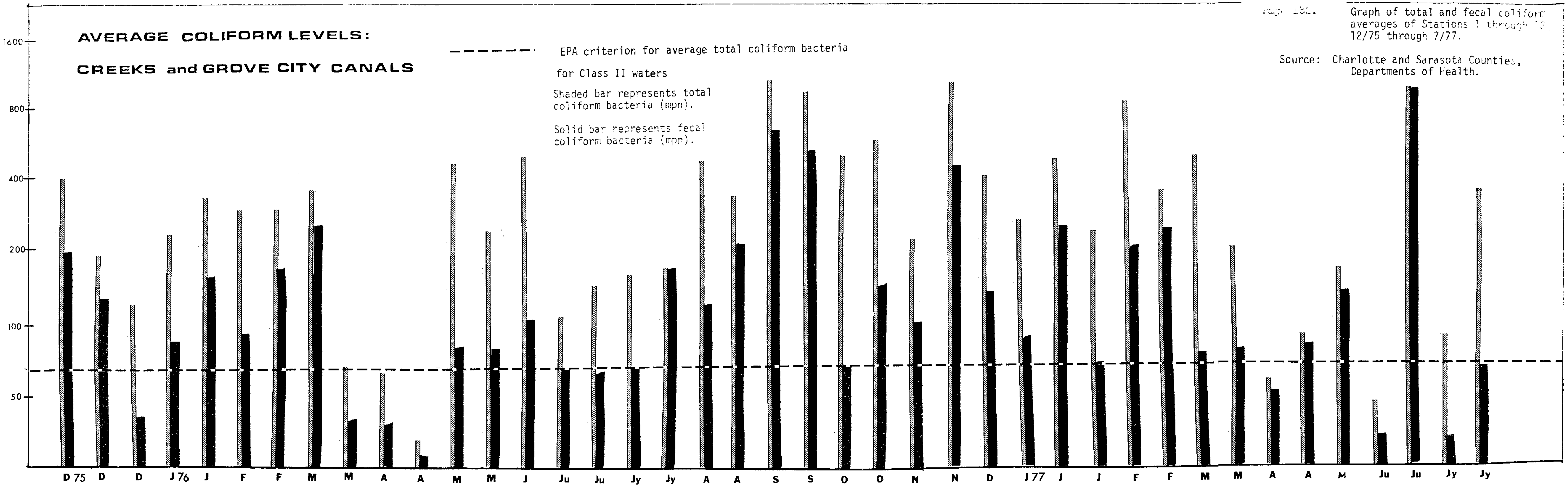


Figure 56.

Page 182. Graph of total and fecal coliform averages of Stations 1 through 13, 12/75 through 7/77.

Source: Charlotte and Sarasota Counties, Departments of Health.

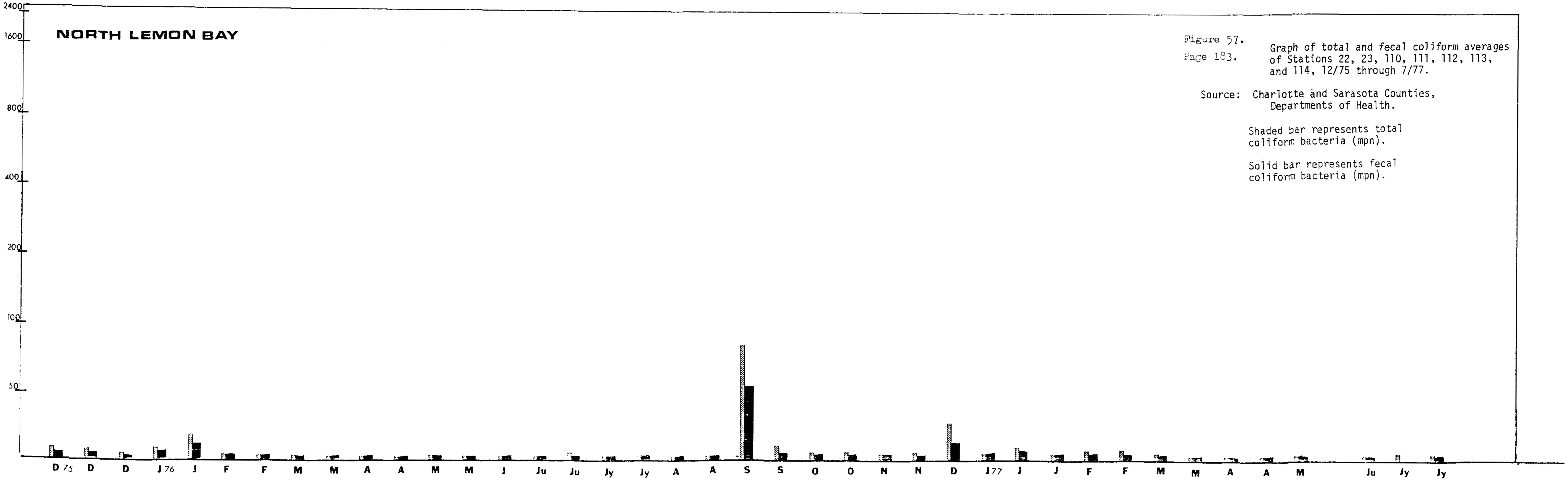


Figure 57. Graph of total and fecal coliform averages of Stations 22, 23, 110, 111, 112, 113, and 114, 12/75 through 7/77.

Page 183.

Source: Charlotte and Sarasota Counties, Departments of Health.

Shaded bar represents total coliform bacteria (mpn).

Solid bar represents fecal coliform bacteria (mpn).

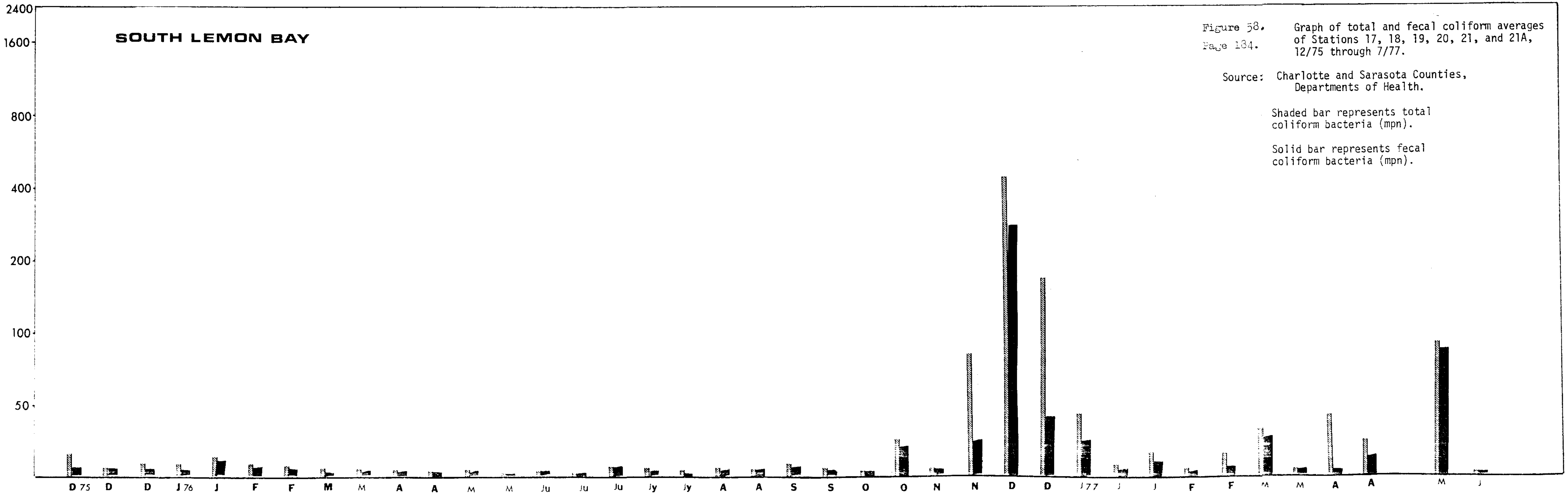


Figure 58. Page 184. Graph of total and fecal coliform averages of Stations 17, 18, 19, 20, 21, and 21A, 12/75 through 7/77.

Source: Charlotte and Sarasota Counties, Departments of Health.

Shaded bar represents total coliform bacteria (mpn).

Solid bar represents fecal coliform bacteria (mpn).

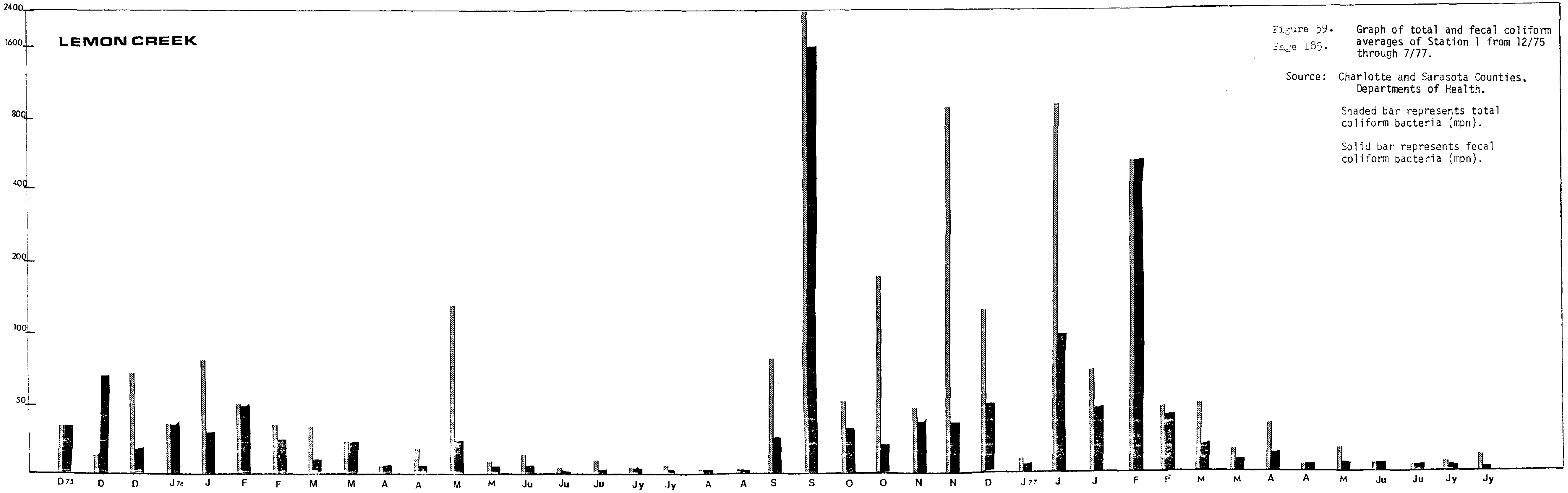


Figure 59. Graph of total and fecal coliform averages of Station 1 from 12/75 through 7/77.

Page 185.

Source: Charlotte and Sarasota Counties, Departments of Health.

Shaded bar represents total coliform bacteria (mpn).

Solid bar represents fecal coliform bacteria (mpn).

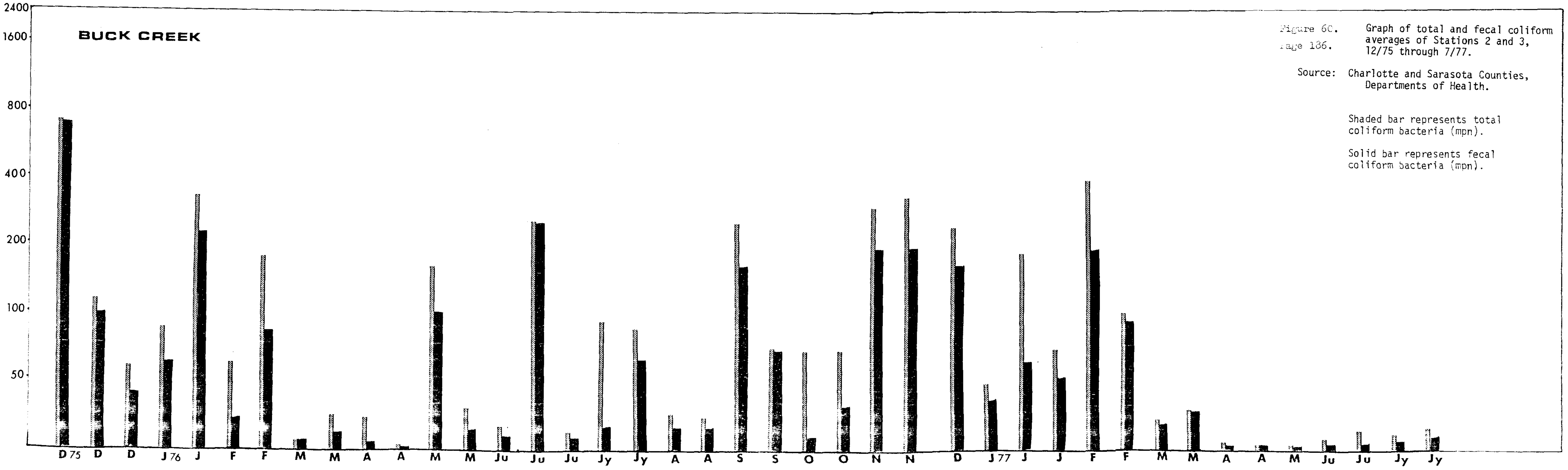


Figure 6C. Graph of total and fecal coliform averages of Stations 2 and 3, 12/75 through 7/77.

Page 186.

Source: Charlotte and Sarasota Counties, Departments of Health.

Shaded bar represents total coliform bacteria (mpn).

Solid bar represents fecal coliform bacteria (mpn).

season and before the summer wet season.

Oyster Creek had consistently higher levels of total coliform bacteria than any other segment of the study area. Station 10a at San Casa Road upstream from the suburban sections of the creek had the highest average total coliform counts of any station in the study area. This may be due to extensive "land scraping and ditching and improved pastures upstream of this station. The downstream sample stations in Oyster Creek had the highest fecal coliform counts in 1976 and second highest in 1977. The waterfront units on the dead end canals of the south branch and the large wetland area drained by this branch of the creek appear to be the two major possible sources of coliform bacteria.

Ainger Creek. Figure 62 shows the fluctuations in bacterial counts for the three stations on Ainger Creek. The conditions and possible sources of bacteria are similar to those for Oyster Creek - pasture and land development activities upstream of the suburban area with its dead end canals and two marinas and 3 dead end canals dating from the 1940's near the mouth of the creek.

Gottfried Creek. The average bacterial counts for the bacterial levels in this creek consist of counts from two stations, one at the SR 775 bridge and one in a dead end canal where the creek flows into the Bay. While the high counts at the bridge station may reflect bacteria entering the creek upstream of this station, the high counts also reflect more directly nearby downstream sources of bacteria since most of the sample days were on a flooding tide. Therefore, this station has three possible major sources - the small commercial fishery on the east side of the creek south of the bridge, the seawalled development along the west side of the creek south of the bridge, and the seawalled waterfront units on the dead end canal of Point of Pines where the creek enters the Bay proper.

Grove City Dead End Canals. Two canals on the Grove City side of Lemon Bay were monitored during the study period. As Figure 64 shows, coliform counts

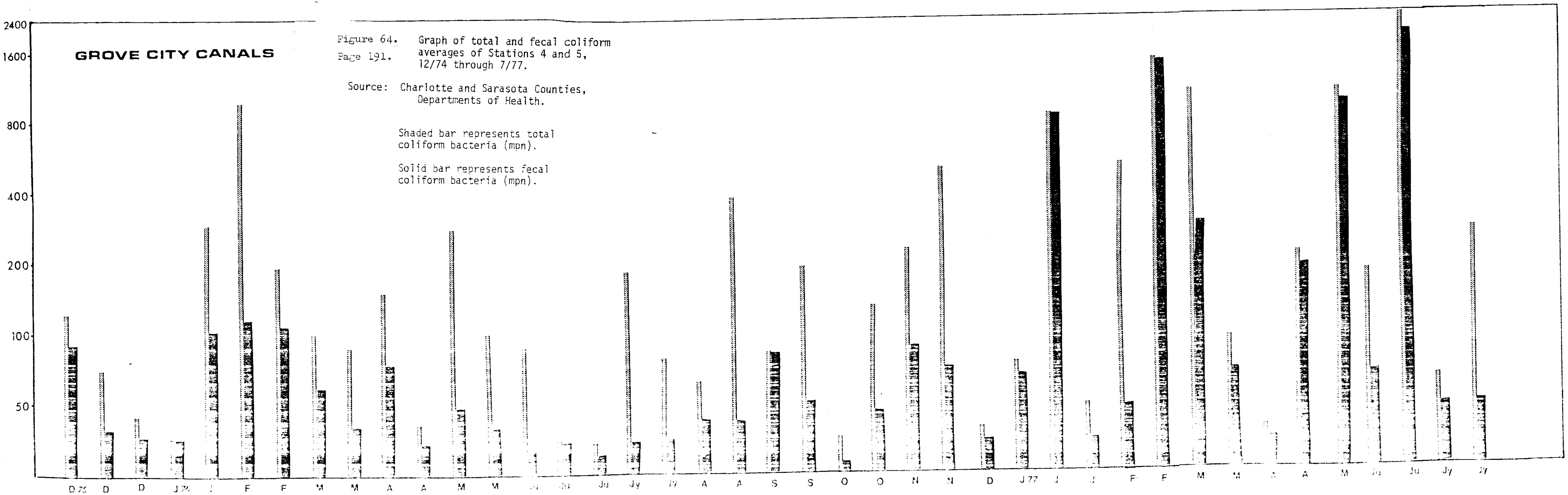


Figure 64. Graph of total and fecal coliform averages of Stations 4 and 5, 12/74 through 7/77.
Page 191.

Source: Charlotte and Sarasota Counties, Departments of Health.

Shaded bar represents total coliform bacteria (mpn).

Solid bar represents fecal coliform bacteria (mpn).

dropped during the summer of 1976 but then underwent a dramatic increase in 1977. The fecal coliform counts during 1977 were higher than for any other stations in the study area. Interestingly, the uplands bordering these canals as well as the Point of Pines Canal consist in part of dredged spoil from the Intracoastal Waterway and mangrove soils of the historical shoreline.

Lemon Bay Canals. Bacterial counts from the dead end canals at South Englewood Beach exhibited seasonal peaks in the winter tourist season (Figure 65) but had low counts during other months in the dry season and during the summer wet season.

Conclusions.

It is obvious from the above study that throughout much of the year the water in the suburbanized downstream segments of the tidal creeks does not meet EPA bacterial standards for Class II shellfishing water. Furthermore, the inshore waters of the Bay, particularly in the vicinity of the dead canals, also does not meet these standards. However, this and other studies do not show what the natural background levels of bacteria were prior to the present land use along the shoreline. Nor have studies in the Lemon Bay area distinguished whether the fecal coliform bacteria arise from human or non-human warm blooded animal sources because they have not measured the level or concentration of fecal streptococci in the water samples.

That high fecal coliform counts accompanying high total coliform counts are due to non-human sources is illustrated in the results of the Environmental Quality Laboratory's Water Quality Study of Ainger Creek (Table 33). The data on bacterial levels from Stations 9 and 10 in May and July 1975 show that at these stations in the head waters, and pastured areas of Ainger Creek, high total and fecal coliform counts were accompanied by high fecal streptococcus counts. Furthermore, the ratio of fecal coliform counts to fecal streptococcus counts was less than 4:1

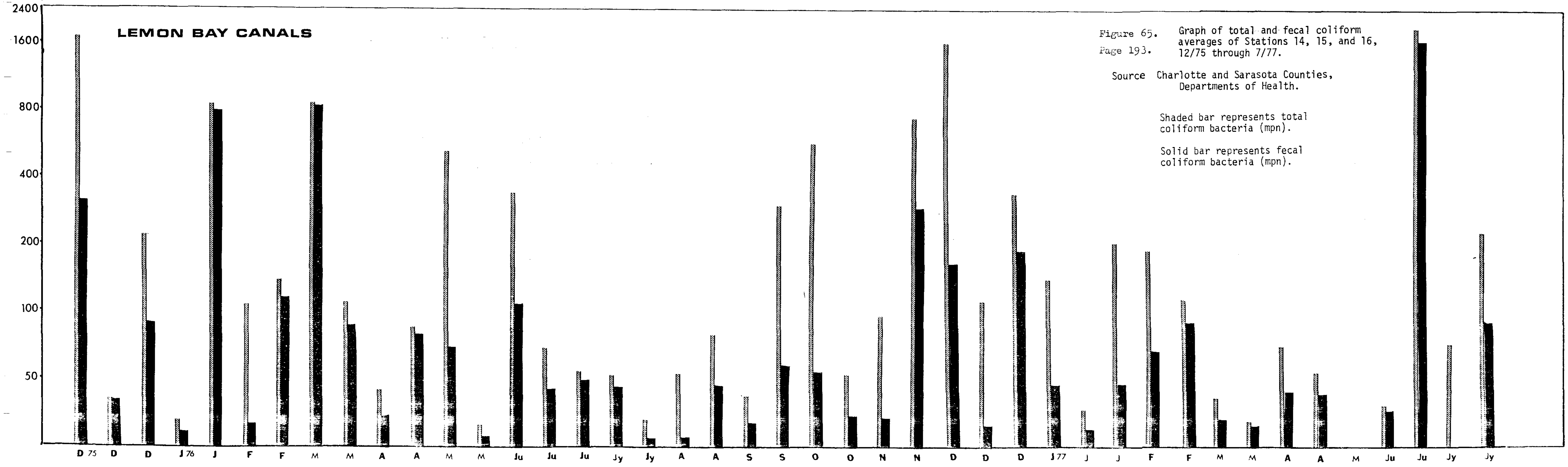


Figure 65. Graph of total and fecal coliform averages of Stations 14, 15, and 16, 12/75 through 7/77.
Page 193.

Source Charlotte and Sarasota Counties, Departments of Health.

Shaded bar represents total coliform bacteria (mpn).

Solid bar represents fecal coliform bacteria (mpn).

which strongly indicates that the bacteria in the samples were of a non-human origin - cattle in this case.

In regard to public health, the origins of fecal bacteria may be of secondary significance, but the origins do become important in regulatory programs directed at maintaining and improving water quality. The example cited above and our dry and wet seasons sampling program in 1977, which included fecal strep. tests, indicate that the tidal creeks are receiving considerable amounts of total coliform and fecal bacteria from non-on-site wastewater/treatment sources. The casual relations of the wasteloads from these sources and water quality of the surface waters in the Lemon Bay area demand more study before firm conclusions and decisions are made regarding the impacts of on-site wastewater systems on the surface waters.

THE LEMON BAY 208 COMPLEX "DRY SEASON" WATER QUALITY CASE STUDY - MARCH 26-27, 1977

In keeping with the other segments of the 208 Water Quality Program of the Southwest Florida Regional Planning Council, the initial design of the water quality study of the Lemon Bay Complex included both wet season, storm event, and dry season sampling regimes. The ultimate goals were two-fold: to develop a pollutant loading or mass balance equation for nutrients and other pollutants in Lemon Bay and to determine the actual contribution of septic systems to the pollutant load. As the work scope of other segments of the 208 Program expanded, both funding and time available for the Lemon Bay Complex Study dwindled. In addition, the keen local concern over septic tank systems being a source of pollution, helped to modify the strategies and goals of the Lemon Bay Program.

An intensive 2-day, dry season, network sampling program was designed primarily to determine the potential contribution of septic tank systems without interference or masking by surface runoff and other ground water non-point sources. The rationale was that in the dry season, pollutant loading of the Bay and its tributaries should be primarily from septic tank systems of waterfront housing units. The major criticism of this rationale has been that in the dry season the groundwater table is low and lateral movement from septic fields is reduced. However, the data from the Charlotte-Sarasota County Water Quality Survey, 1976-1977 show that peak levels of coliform bacteria occur in the creeks and inshore waters of the Bay during this season when the local population is at its maximum. This means that during the dry season and particularly in March 1977 more well water was used by households for through-house activities and for irrigation than any other time of the year. Thus the choice of the sampling period on March 26-27 coincided with the peak residential-tourist population, a three week period of only 0.8 in. total rainfall, and a weekend of intensive boating activity and sport shrimping activity in Stump Pass. Finally, the tides were of the mixed diurnal variety with a short flood tide followed by a long ebb-flood tide.

The results that follow should represent the current "worst case" conditions of dry season water quality for the area and the maximum dry season levels of pollutant-nutrient loads of the tidal creeks and Lemon Bay.

Materials and Methods

Sampling Stations. The "dry season" water sampling program was conducted on March 26-27, 1977 with water samples being collected at six stations on Lemon Bay and three stations on each of the four main tidal creeks - Gottfried, Ainger, Oyster and Buck. The station locations are shown in Figure 66 and described in Table 39. The rationale for the locations of the stations is as follows:

The five Lemon Bay (LB) stations along the Intracoastal Waterway represented water conditions in the open bay. LB-1 was south of Forked Creek at the northern end of the Bay; LB-5 was opposite Lemon Creek at the south end of the Bay. These two stations were located near the apparent tidal nodes in the bay system. LB-2, north of the Tom Adams bridge, was opposite Englewood proper. LB-3 was opposite the mouths of Gottfried and Ainger Creeks. LB-4 was in the channel north of Grove City Island through which most of ebb flow from GC, OC, and AC passed. LB-6 was in the Stump Pass channel between the tips of Manasota Key and Knight Island.

Three stations were chosen for each creek to represent points downstream, upstream, and in the middle of the suburban area of the creek drainage. The stations were also located relative to the degree of tidal flushing in the stream segments. The downstream station for each creek (GC-1, AC-1, OC-1, BC-1) were at SR 775 bridges. Ainger-2 and Oyster-2 were in the middle of suburban segments while Gottfried-2 was near the upstream end of the suburban segment. Gottfried-3, Ainger-3 and Oyster-3 were upstream of the suburban area but downstream from the agricultural/abandoned agricultural/tract land development segments of the three drainage basins.

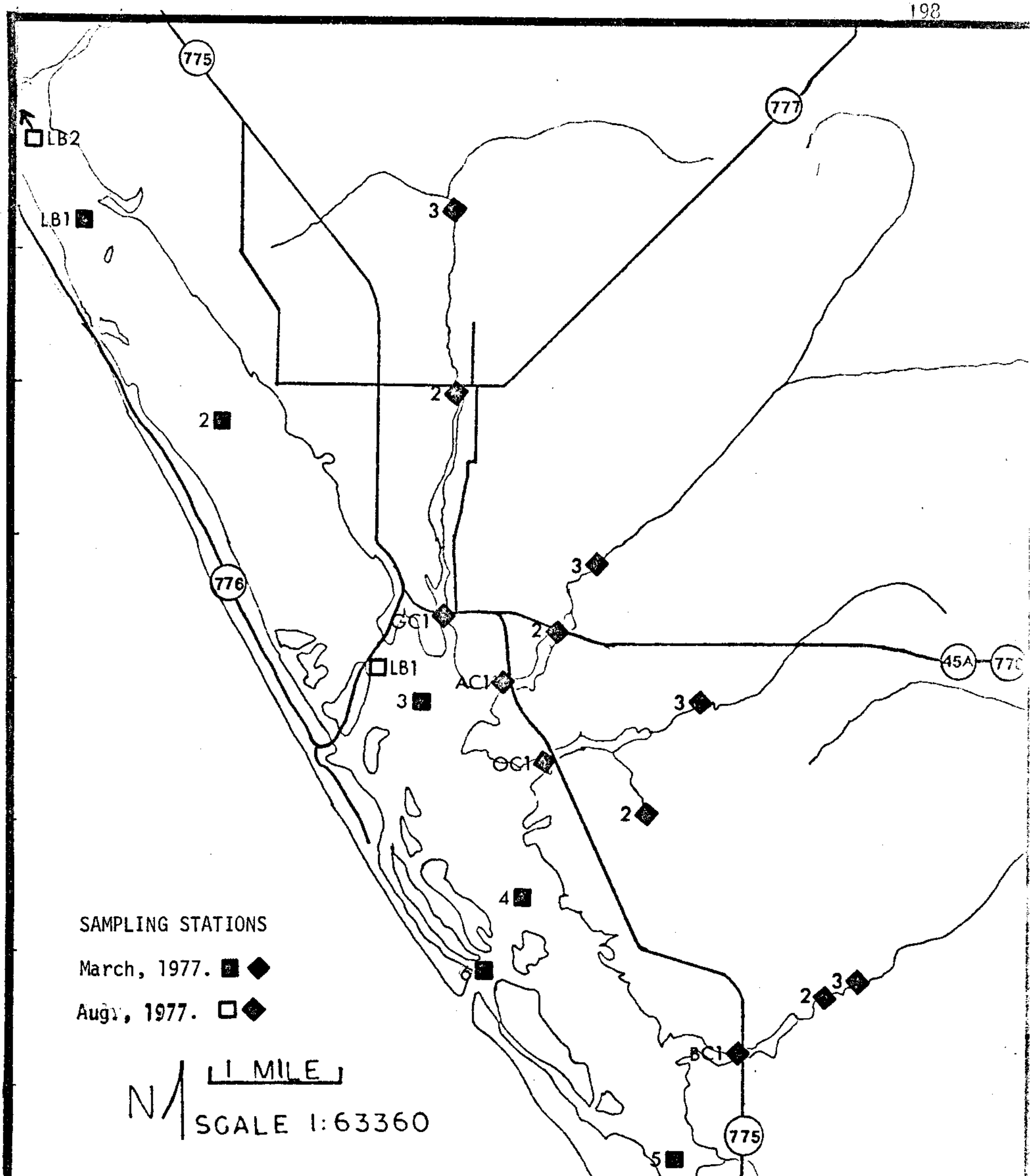


Figure 66 Locations of water sampling stations for Lemon Bay '208' Study, 1977. LB, Lemon Bay; GC, Gottfried Creek; AC, Ainger Creek; OC, Oyster Creek; BC, Buck Creek.

TABLE 39

LOCATION OF STATIONS FOR LEMON BAY COMPLEX DRY SEASON

WATER QUALITY STUDY. MARCH 26 - 27, 1977.

LEMON BAY -

LB-1 - Intracoastal Waterway marker 33

LB-2 - Intracoastal Waterway marker 28

LB-3 - Intracoastal Waterway marker 23

LB-4 - ¼ mile southwest of Intracoastal Waterway marker 18, at the east end of the north channel of Stump Pass

LB-5 - Intracoastal Waterway marker 9

LB-6 - Stump Pass, 100 yards east of the Gulf of Mexico

BUCK CREEK -

BC-1 - State Road 775 bridge

BC-2 - 100 yards downstream from the Rotunda wier

BC-3 - Just upstream from the Rotunda wier

OYSTER CREEK -

OC-1 - State Road 775 bridge

OC-2 - Brookwood Drive

OC-3 - San Casa Road bridge

AINGER CREEK -

AC-1 - State Road 775 Bridge

AC-2 - State Road 776 bridge

AC-3 - Seahorse Lane

GOTTFRIED CREEK -

GC-1 - State Road 775 bridge

GC-2 - State Road 777 bridge

GC-3 - Between Sarasota Sections 19 and 30, just downstream from culverts

Buck Creek was unique in that there was little residential development between its mouth and a wier on the circular Rotunda River which intercepted its historical drainage basin. Thus BC-2 was "downstream" of the wier and BC-3 in the freshwater Rotunda River. Buck Creek represents a creek system without pollutant loadings from developed residential areas. However, water quality values at the Buck Creek stations do reflect the land development activities associated with the construction of the Rotunda River and its adjoining uplands.

General Field and Laboratory Procedures

Grab water samples were collected for sampling runs over a 48-hour period and each sample was analyzed for 18 water quality parameters (Table 40). Since on each sample run all stations were sampled as a network with all samples collected within a 1 to 1.5 hour period it was necessary to develop a team approach to analyze the samples according to the guidelines and procedures described by the EPA.

Prior to the definitive sampling program both the field collectors/ recorders and the laboratory technicians were instructed as to proper procedures. Each laboratory analytical procedure was performed by a single team of one or two persons to minimize operator error. Accuracy and reproducibility of each analytical operation were tested and evaluated with EPA and internal unknown standards. Each of the four field teams consisted of two persons of which one collected all samples and the other served as a recorder. The field and laboratory team members are listed in Tables 40 and 41.

Four days before the March 26-27 sampling period a single trial run was performed to familiarize all personnel with their operations and to determine the real time involved in sample collection, transport of sample

Table 40 Laboratory Methods and Personnel

Parameter	Method	Filtered Water	Analysis
pH	Meter (EPA)	-	Evarts, Jon
Turbidity	Meter (EPA)	-	Sauers, Steve
Color	Platinum-Cobalt (EPA)	-	Drummond, Rick
Residue,total	Gravimetric (EPA)	-	Willen, Claudia
Conductance	Meter (EPA)	-	Dietrich, Valerie
D.O., B.O.D.	Winkler-Azide (EPA)	-	Hayes, Therese
NO_2-N, NO_3-N	Cadmium Reduction (EPA)	+	Draper, Lonnie
PO_4-P, Ortho	Ascorbic Acid (EPA)	+	Marmaro, Jeff
PO_4-P, Total	Ascorbic Acid (EPA)	-	Marmaro, Jeff
NH_3-N	Phenolhypochlorite (Solorzano)	+	Gasser, Raymond
Kjeldahl N	Phenolhypochlorite (Solorzano)	-	Gasser, Raymond
Filtration	Membrane Filter, 0.45 μM (EPA)		Greenfield, Edward
Bacteria	Millipore, Membrane Filter		Pfeuffer, Richard Romano, Lorraine
T.O.C.	Carbon Analyzer (EPA)	-	Lee County Environmental Laboratory

Table 41. List of Field Personnel

NAMES	STATIONS	SAMPLER/ RECORDER
Morrill, Claudia	Lemon Bay	R
Levy, Robert		S
Evans, Mark		S
Smolker, David	Buck Creek	S
Hoffman, Lori		R
Baker, Scott	Oyster Creek	S
Plotkin, Steven		R
Hunt, Helen		R
Harvey, Judd	Ainger Creek	S
Morrill, Sandy		R
Dils, Laurie		R
Evans, Rhonda	Gottfried Creek	S
Mytinger, Linda		R
Morrill, John	Supervisor	Courier

from Lemon Bay to the laboratories in Englewood and Sarasota and analyses of the samples. On this run tide staffs were installed at Stations 1, 2, and 3 on each creek to record changes in water level during the definitive sampling period.

The creek stations were reached by auto and the grab samples taken by sampling from the channel proper. The Lemon Bay stations were sampled from a 16 foot Boston Whaler. Field data included air/water temperature and salinity determined by the hydrometer method. All stations were sampled in a systematic order as follows: creeks (3→2→1), Lemon Bay (6→5→4→3→2→1). The trial run showed that all stations could be sampled in less than 1.5 hours. The samples from the trial and each subsequent run were picked up at the end of the run by a courier who delivered the bacteriological samples to the Englewood Medical Laboratory and the other samples to the ESP Laboratory, Sarasota. The interval between the collection of the first samples and arrival at the laboratories was 3 to 3.5 hours.

On arrival at the ESP Laboratory, aliquots of water for certain tests were immediately filtered through pre-washed 47 mm, 0.45 μM millipore filters and distributed to the NO_3, NO_2, N analysts and the Phosphate analysts. Other unfiltered aliquots were immediately distributed to other analysts for determination of pH, total residue, conductivity, color, total P & N, and turbidity. BOD_5 samples were incubated at 20^{o}C; total organic carbon samples were frozen until further analysis. The interval between arrival at the laboratory and the processing of all samples from a given run was 3 hours.

Data from each field team and each laboratory analysis were recorded in separate notebooks. At the end of the sampling study one person, Mr. Gasser, in charge of the data program, transcribed all field and laboratory data on the Florida State D.E.R. Storet Forms (Appendix B). Although this method was not the most convenient way of summarizing the data, it was consistent with the goals of the overall program.

A. Field Sampling Methods.

1. General. All grab samples were taken in pre-numbered bottles at a depth of approximately 0.3 M and iced until arrival at the laboratory.

2. D.O and BOD_5. Samples were taken in acid rinsed BOD bottles with a displacement sampler to eliminate possible air bubbles D.O. samples were fixed immediately. All samples were stoppered, water sealed, capped and transported in a cool box.

3. Total Organic Carbon. Samples were taken after three on site rinses in 100 or 200 ml acid washed glass bottles.

4. Bacteria. Samples were taken in sterile 200 ml glass bottles leaving a 2.5 cm air space.

5. Chemical Analysis. New, unused half-gallon (2 liter) hard plastic juice bottles were soaked for one week in two changes of deionized water to leach water soluble contaminants. Bottles were then acid washed and rinsed in glass distilled water. Bottles were rinsed three times on site, completely filled, and immediately iced.

6. Temperature. Air/water temperatures were taken with armored Mercury thermometers.

7. Specific Gravity. On site specific gravity measurements were taken with calibrated salinity hydrometers.

8. Phytoplankton. A one liter subsurface grab sample was added to a bottle contaning 100 ml of 37% formaldehyde. This procedure fails to preserve the majority of naked dinoflagellates but does preserve diatoms, armored dinoflagellates, blue green and green micro algae.

B. Laboratory Procedures.

1. pH. pH was measured at 25°C with a Corning expanded scale laboratory pH meter and Markson probe. Meter was standaridized three times during each set of 18 samples.

2. Turbidity. A Hach Model 2100A nephelometric turbidimeter was used for this test. It was standaridized after each sample.

3. Color. Color was determined by visual comparison of a centrifuged sample with standards in the range 0-70 platinum-cobalt units prepared from Hach standard color solution. Comparisons were made using matched 50 ml tall form Nessler tubes.

4. Total Residue. 50 ml aliquots were dried at 98°C in tared 120 ml porcelain evaporating dishes and finished at 105°C.

5. Specific Conductance. Conductivity was measures on a YSI Model 31 conductivity bridge at 25°C.

6. Dissolved Oxygen. 300 ml samples were fixed and acidified as per EPA procedures and titrated with Hach 0.0375 N phenylarsine oxide.

7. Biochemical Oxygen Demand. Samples were incubated for 5 days at 20°C. All bottles were water-sealed and capped during incubation. Titrations were performed as dissolved oxygen as above.

8. Nitrate and Nitrite Nitrogen. Determination of nitrate nitrogen was made by the cadmium reduction method. Columns were made by joining inverted 250 ml Erlenmeyer flasks to 25 cm, 3 mm I.D. glass tubes. Samples were introduced through a hole in what was the bottom of the flask. Approximately 18 cm of copperized cadmium filings were introduced to the column. Final flow rates were about 6 ml per minute. Samples were analyzed as per EPA procedures. Absorbances were measured in matched 2 cm cells ona Bausch and Lomb Spectronic 20. Nitrite samples

were handled similarly with the omission of the dilution and reduction steps.

No column was exposed to more than 35 samples (including standards and testing) and periodic checks showed no decrease in column efficiency.

9. Total Phosphorous and Dissolved Orthophosphate Phosphorous.

The manual, single-reagent ascorbid acid method as described in the EPA manual was used for both phosphorous determinations. An ammonium persulfate-sulfuric acid digestion was used for the total phosphorous test. All glassware was thoroughly washed with 1:1 HCl. Absorbances were measured in matched, acid-washed 1 cm tubes on a Bausch and Lomb Spectronic 20 colorimeter with red filter.

10. Ammonia Nitrogen. Due to the large number of samples (36 plus 8 standards, including the Kjeldahl nitrogen ammonia determination) per sampling run and limited time (typically 3-1/2 to 4 hours) between runs, the standard Nessler Method with its time consuming distillation was deemed inappropriate. An alternative was found in Solorzano's phenol-hypochlorite method, as reviewed by Zadorojny, et al (1973). One alteration was made, that being the addition of a 0.05 M borate buffer to stabilize the pH around 9.2. This proved necessary for preventing precipitation in the digested Kjeldahl samples and was included in the NH_3-N samples for consistency. The method described here uses sample and reagent volumes which are one-half those described in Zadorojny, et al, as this was more convenient in terms of space, glassware, and chemicals. Half-volumes were used only for the NH_3-N test, however. For the Kjeldahl test, full volumes (twice those listed here) proved more convenient.

The Method

Reagents.

1. Phenol-alcohol solution (10%) - dissolve 10 g phenol in 100 ml of 95% denatured alcohol 5% propanol.
2. Sodium nitroprusside (0.5%) - dissolve 1 g in 200 ml H_2O. Stable for one month in an amber bottle.
3. Citrate solution - dissolve 100 g trisodium citrate and 5 g NaOH in 500 ml H_2O.
4. Sodium hypochlorite - commercial chlorine bleach, 5.25% hypochlorite.
5. Oxidizing reagent - 100 ml citrate solution (#3) + 25 ml hypochlorite solution (#4). Use same day.
6. Borate buffer, 0.05 M - (not in original procedure) - dissolve 4g NaOH and 12.4g boric acid (H_3BO_3) in 1 liter H_2O.

Procedure.

To 25 ml sample add 1 ml phenol solution (#1) and 1 ml nitroprusside solution (#2). Mix. Concurrently add 2-1/2 ml oxidizing reagent (#5) and 5 ml borate buffer (#6) and mix. Read at 640 mm after 1 hr. and before 24 hrs. Syringes are quite handy for delivering reagents.

Interferences.

Interferences from sea salts, amino acid-N and most common metals appear minimal at levels commonly found in natural waters.

Samples were measured in matched 1 cm tubes on a Bausch and Lomb Spectronic 20 with red filter.

11. Total Kjeldahl Nitrogen. Kjeldahl nitrogen was digested to $(NH_4)_2SO_4$ with a standard Kjeldahl digestion reagent (EPA manual) on a micro-Kjeldahl digestion rack. The digestate was neutralized to a

pH of about 3.5 with 8 N NaOH and adjusted to 50 ml. Ammonia was then determined as above, using twice the sample and reagent volumes listed.

Although this is not a standard method, it is similar to the EPA automated phenate method. While it was not exhaustively tested, it produced near linear standard curves and accurate determinations of unknown standards in this laboratory.

12. Total Organic Carbon. TOC was analyzed by the Lee County Environmental Quality Laboratory with a Beckman carbon analyzer.

13. Bacteriology. Total and fecal coliforms and fecal streptococci were assayed at the Englewood Medical Laboratory using membrane filter techniques as described in Millipore Application Manual AM-302. Dilutions were as follows: total coliform- 5 ml; fecal coliform - 10 ml; fecal streptococci - 10 ml.

C. Tidal Currents

Tidal current velocities in Stump Pass and near Station 1 on Gottfried, Ainger, Oyster and Buck Creeks were measured with four recording current meters (General Oceanics Model 2011), leased from Continental Shelf, Inc. The meters placed in the creeks were tethered to eye bolts in 2 foot square "popcorn" cinder blocks. The meter in Stump Pass was suspended from a stand off arm attached to a 4 foot long swivel post anchored to the bottom. Thus current velocities within 3 feet of the bottom were recorded. The meters were set so that their internal 8 mm camera recorded the direction and inclination of the meter at approximately 15 minute intervals. The developed Tri-X recording film was analyzed and the deflections in degrees were converted to velocities in cm/sec. according to standard procedures and calibration curves.

Meters were placed at their stations in Stump Pass and Gottfried, Ainger, and Oyster Creeks near mid-channel on the evening of March 25. It was not possible to place the meters in mid-channel because of the narrowness of the channels and boat traffic. Even so the meters were overturned in Stump Pass and Ainger Creek by boats during the first sampling day, March 26. Subsequently the meter in Ainger Creek was relocated in Buck Creek for the remainder of the 2 day water quality study.

Measurements of tidal current velocities in Stump Pass were not resumed until April 7 and 8 when a second tidal current study occurred. In this study the current meters were located at Stump Pass, Manasota Key Bridge, and Palm Island Cut.

D. Weather Conditions.

During and preceding the 2 day sampling period, March 26-27, 1977, Mr. Norman Thomas of Englewood Beach recorded air temperatures with a recording guage on the Lemon Bay side of Manasota Key. He also maintained a rain guage station. During the sampling period, wind direction and velocity were recorded with an anemometer located on the Gulf side of Manasota Key. Cloud cover was estimated by field personnel.

During the sampling period Lemon Bay area air temperatures ranged from 61^{o}F (16^{o}C) to 84^{o}F (29^{o}C). No rain fell during this period. However, 0.2 inches (0.51cm) were recorded on March 25. Prior to the sampling period a total of 2.8 inches (7.1cm) rainfall occurred in 1977. A total of 5.1 cm for eight rainfall events occurred in January; 1.3 cm for two storms in February; and 0.8 cm for two storms in March.

Winds were moderate and from East or Southeast except during the late afternoon and evening of March 26 when they were light and variable. Cloud cover was minimal on the morning of March 26 but increased throughout the day until 80 to 90% cover occurred on Run D (2000). By 2400, March 26, there was 0% cloud cover. On the 27th, cloud cover was minimal during Run F (0900), increased to 20 to 50% by Run G (1600) and decreased to 0 to 10% by Run H (2000).

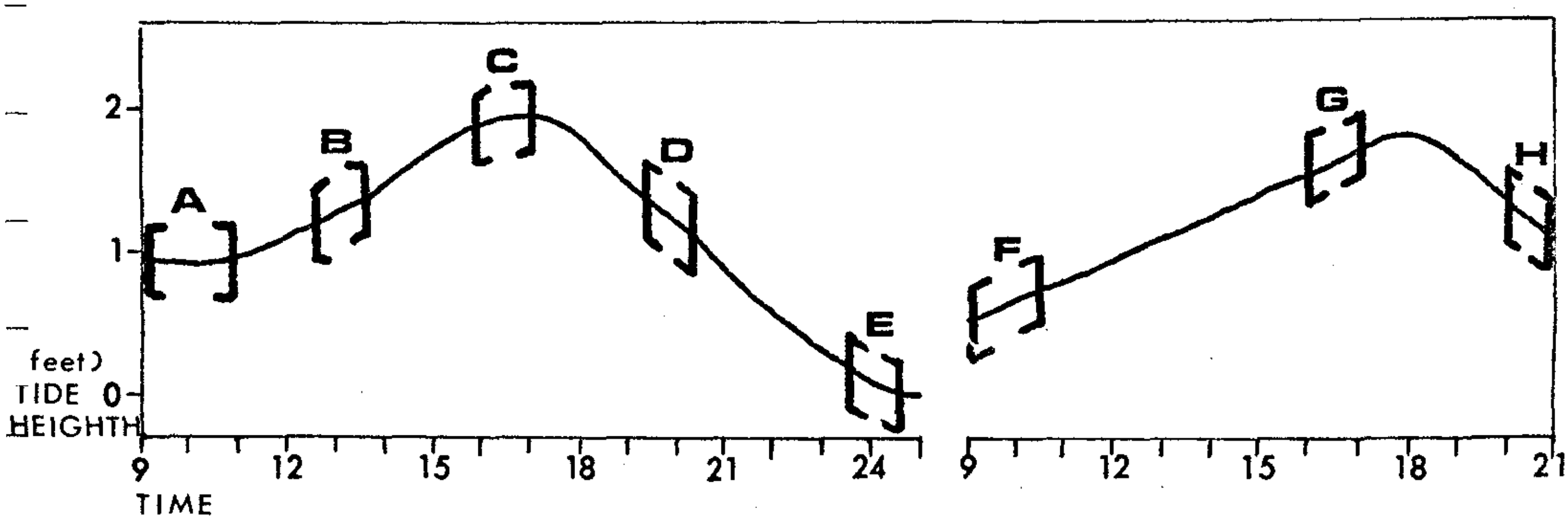
E. Tides.

The first sample run began at 0900, March 26, shortly before low slack water at 0930. On this date the predicted tide rose one foot (0.3M) until high slack water at 1640 and then fell 1.9 feet (0.58M) until 0052, March 27. The tide then rose 1.8 feet (0.55M) over a period of 17 hours until high slack water at 1745, March 27. The tide then fell 1.8 feet (0.55M) over a 7 hour period with low slack water at 0208, March 28. Table 42 and Fig. 67 show the times of the sampling runs relative to stages of the tide.

Table 42 Time and Stage of Tide for the Eight Sample Runs, March 26-27, 1977.

Date	Sample Run	Time	Tide Stage
3-26-77	A	0845-1150	Low slack to Rising
3-26-77	B	1230-1415	Rising
3-26-77	C	1545-1730	Rising to High Slack
3-26-77	D	1900-2100	Falling
3-26-77	E	2300-0100	Falling to Low Slack
3-27-77	F	0850-1050	Rising
3-27-77	G	1530-1720	Rising
3-27-77	H	1915-2115	Falling

Figure 67. Water quality sampling times in relation to tidal cycle and heighth.



Results

The water quality data of the 8 sample runs for the 18 station network for March 26-27, 1977 in APPENDIX B may be described and analyzed in various ways. For the purposes of this report we summarized the most pertinent water quality data from four sample runs (A, C, E and G) in four Tables 43, 44, 45, and 46. Runs A and E were near the end of a ebbing tide and Runs C and G were near the end of a flooding tide. With respect to nutrient-pollutant loading of Lemon Bay by creek waters,Runs A and E represent the worst situation and Runs C and G represent the best. With respect to dissolved oxygen Run A represents the worst situation and Runs C and G the best.

In the sections that follow each water quality parameter in these four tables will be discussed independently. Then the results of the algal bioassay study will be presented followed by pollutant mass budget calculations for selected conservative and non-conservative parameters. The bacteriological data from all runs will then be described followed by a discussion of preliminary results on phytoplankton patterns from one run.

In addition to the March water quality data we include in APPENDIX C water quality data from Aug 1-2, 1977 for the Bay and creeks. Unfortunately, not all water quality parameters could be assayed in this wet season study.

Table 43 Results of Water Quality Study, Lemon Bay Complex, March 26, 1977.
Run A; Time, 0900-1000; Low slack water after 0.1 foot ebb tide.

Samples Stations

Test	Units	LB1	LB2	LB3	LB4	LB5	LB6	GC1	GC2	GC3	AC1	AC2	AC3	OC1	OC2	OC3	BC1	BC2	BC3
Salinity	PPTH	35.3	36.1	36.9	37.7	37.7	37.7	35.1	30.3	1.2	34.4	35.3	29.5	35.3	34.4	34.4	35.7	1.1	0.9
Turbidity	FTU	4.3	6.5	4.4	4.2	5.1	1.9	1.7	2.6	0.8	2.9	2.0	1.9	2.4	3.8	4.0	1.8	1.7	3.0
pH	Units	8.3	8.2	8.1	8.1	8.2	8.1	7.8	7.7	8.0	8.0	7.8	7.7	8.0	7.7	7.7	7.9	7.6	7.9
D.O.	mg/l	8.3	8.0	7.7	7.8	7.5	8.1	4.1	4.5	5.3	4.6	4.0	5.6	5.5	4.0	2.5	4.8	5.1	5.3
B.O.D.	mg/l	3.7	3.4	1.6	1.3	2.5	1.6	2.2	3.2	0.7	1.8	1.5	3.2	1.8	4.0	2.5	1.4	0.9	1.9
$O-PO_4-P$	mg/l	.009	.005	.005	.005	.005	.005	.013	.050	.102	.008	.010	.006	.005	.012	.011	.005	.006	.005
Tot. PO_4-P	mg/l	.016	.010	.005	.005	.008	.010	.025	.106	.125	.022	.020	.012	.027	.056	.032	.007	.112	1.41
NO_3-N	mg/l	.013	.011	.005	.005	.011	.006	.013	.006	.005	.011	.013	.013	.006	.013	.013	.014	.009	.015
TKN	mg/l	1.04	1.05	.61	.80	.56	.76	1.11	1.91	1.38	.90	1.25	1.65	.72	1.47	1.68	1.42	1.77	1.45
NH_3-N	mg/l	.001	.001	.001	.001	.001	.001	.048	.109	.018	.049	.068	.024	.036	.042	.046	.038	.088	.019
TOC	mg/l	13	23	9.5	7	12	9	14	17	27.5	15.5	14.5	17.5	12.5	16	14	13	18.5	31
Total Coli	#/100ml	0	20	0	0	0	0	0	80	440	0	100	40	40	180	100	40	1160	1700
Fecal Coli	#/100ml	10	0	0	0	0	0	0	0	160	30	0	0	0	140	0	10	20	30
Fecal Strep	#/100ml	10	0	0	0	0	0	10	30	540	0	40	0	10	140	70	120	30	30

Table 44. Results of Water Quality Study, Lemon Bay Complex, March 26, 1977. Run E; Time, 2330-2430; Tide, end of ebb tide, 1.9 foot fall over 7 hours

Samples Stations

Test	Units	LB1	LB2	LB3	LB4	LB5	LB6	GC1	GC2	GC3	AC1	AC2	AC3	OC1	OC2	OC3	BC1	BC2	BC3
Salinity	PPTH	34.4	36.1	36.1	35.7	36.1	36.1	34.4	38.7	1.2	34.3	32.8	28.4	35.3	33.6	32.8	36.5	0.9	0.7
Turbidity	FTU	2.9	4.6	6.4	4.4	3.2	6.4	1.7	2.6	1.2	2.4	2.7	2.7	2.4	3.3	3.7	1.8	1.7	2.5
pH	Units	7.9	8.1	8.1	8.1	8.0	8.1	7.7	7.7	8.0	7.7	7.7	7.7	7.8	7.7	7.6	7.8	7.8	7.9
D.O.	Mg/l	7.8	7.8	7.8	8.5	6.9	7.7	5.3	5.9	1.7	5.6	5.5	5.6	4.4	5.2	5.0	5.0	6.6	6.0
B.O.D	Mg/l	3.7	3.4	2.4	1.6	1.8	1.9	1.5	1.9	1.1	1.4	1.4	1.6	1.4	3.1	3.7	2.0	0.9	2.2
O-PO_4-P	Mg/l	.013	.008	.005	.005	.005	.005	.019	.049	.082	.010	.008	.005	.008	.013	.013	.005	.005	.005
Tot. PO_4-P	Mg/l	.031	.017	.005	.005	.005	.005	.019	.056	.084	.011	.012	.008	.011	.021	.021	.005	.005	.005
NO_3-N	Mg/l	.005	.007	.013	.005	.005	.005	.005	.007	.013	.006	.015	.006	.011	.011	.005	.013	.020	.006
TKN	Mg/l	.85	.57	1.05	1.00	.75	.80	.71	1.17	1.28	.80	.92	.77	1.02	1.05	.89	1.01	1.36	1.24
NH_3-N	Mg/l	.001	.001	.001	.001	.001	.001	.071	.015	.023	.028	.030	.001	.048	.001	.001	.062	.099	.001
TOC	Mg/l	13	12.5	-	12.5	9	11	13	15	33	13.5	13	14.5	11	15	15	15.5	-	27.5
Total Coli	#/100ml	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fecal Coli	#/100ml	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Fecal Strep	#/100ml	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 45 Results of Water Quality Study, Lemon Bay Complex, March 26, 1977. Run C; Time 1600-1700; High tide, slack water, after 1 foot rise over 7 hours.

Samples Stations

Test	Units	LB1	LB2	LB3	LB4	LB5	LB6	GC1	GC2	GC3	AC1	AC2	AC3	OC1	OC2	OC3	BC1	BC2	BC3
Salinity	PPTH	35.3	35.3	36.1	36.1	36.1	35.3	35.3	31.0	1.2	36.8	33.6	30.3	36.2	34.4	34.4	36.5	1.0	0.7
Turbidity	FTU	3.9	5.0	3.1	4.0	2.7	1.9	2.3	3.0	2.7	2.4	2.2	2.6	3.2	2.1	3.5	2.1	2.2	2.1
pH	Units	8.1	8.1	8.1	7.9	8.1	7.9	8.1	7.7	8.7	8.2	7.9	7.8	8.0	7.7	7.8	8.0	8.1	8.1
D.O.	Mg/l	9.8	9.7	8.6	8.4	7.5	8.6	9.4	6.1	14.8	10.0	7.2	8.3	7.8	6.3	5.2	9.6	7.6	7.5
B.O.D.	Mg/l	4.3	4.0	1.3	1.7	2.0	1.8	2.6	3.5	2.2	2.0	1.2	4.0	1.2	3.1	3.8	1.9	1.4	-
O-PO_4-P	Mg/l	.012	.005	.005	.005	.005	.005	.006	.036	.076	.005	.008	.006	.035	.014	.012	.028	.007	.005
Tot. PO_4-P	Mg/l	.030	.005	.005	.005	.005	.005	.012	.170	.082	.012	.016	.012	.037	.018	.029	.034	.007	.013
NO_3-N	Mg/l	.005	.005	.011	.005	.005	.005	.034	.013	.030	.005	.012	.005	.005	.007	.005	.007	.022	.005
TKN	Mg/l	1.00	.77	.97	.56	.77	1.02	.81	1.04	1.42	.56	1.23	1.34	.79	.96	.95	.69	1.38	1.30
NH_3-N	Mg/l	.001	.001	.001	.020	.001	.045	.015	.035	.018	.015	.056	.015	.078	.046	.078	.036	.098	.079
TOC	Mg/l	12.5	7.5	7.	10.5	9.5	10.5	13	15	-	10.5	14	19.5	12.5	17	16	11.5	28.5	35.5
Total Coli	#/100ml	0	0	0	0	0	0	20	60	1280	0	420	60	20	160	180	40	360	760
Fecal Coli	#/100ml	0	0	0	0	0	0	10	20	0	0	110	0	60	0	100	0	10	-
Fecal Strep	#/100ml	10	0	0	0	0	10	10	70	260	160	60	70	50	3030	260	20	200	150

Table 46 Results of Water Quality Study, Lemon Bay Complex, March 27, 1977.
Run G; Time, 1600-1700; near end of flood tide (1.8 foot rise over 17 hours).

								Samples Stations											
Test	Units	LB1	LB2	LB3	LB4	LB5	LB6	GC1	GC2	GC3	AC1	AC2	AC3	OC1	OC2	OC3	BC1	BC2	BC3
Salinity	PPTH	35.4	36.1	36.5	36.6	36.8	36.8	36.5	32.8	1.4	36.9	35.3	32.8	36.5	33.6	34.4	38.5	1.3	0.9
Turbidity	FTU	5.7	6.1	7.2	5.0	9.0	9.5	2.2	4.7	1.9	3.6	2.4	2.7	3.4	2.7	2.8	2.8	1.7	2.4
pH	Units	8.1	8.2	8.1	8.0	8.1	8.1	8.1	7.8	8.6	8.3	8.1	7.9	8.3	8.0	7.9	8.2	8.0	8.0
D.O.	mg/l	7.9	8.7	8.0	7.9	7.7	7.5	8.1	8.1	15.2	12.8	8.1	8.2	9.5	8.5	7.1	11.2	8.8	7.7
B.O.D.	mg/l	3.1	2.4	1.1	1.1	1.7	1.0	2.1	3.6	1.6	3.8	1.2	3.2	1.5	3.3	2.7	2.7	1.1	1.8
O-PO_4-P	mg/l	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tot. PO_4-P	mg/l	.031	.036	.005	.006	.005	.002	.013	.046	.104	.010	.006	.022	.008	.022	.016	.005	.006	.005
NO_3-N	mg/l	.032	.029	.032	.029	.040	.031	.040	.041	.034	.040	.042	.033	.039	.048	.040	.047	.046	.040
TKN	mg/l	.89	.85	.046	.49	.51	.36	.94	1.36	1.34	.80	.66	.76	.55	1.14	1.13	.79	.63	.64
NH_3-N	mg/l	.001	.001	.001	.001	.001	.001	.055	.001	.015	.020	.026	.015	.026	.001	.010	.015	.057	.010
TOC	mg/l	12.5	12.5	9.5	12	10	12	14.5	17.5	-	16	15.5	19	11	16	15.5	16.5	30	30.5
Total Coli	#/100ml	0	0	0	0	0	20	-	60	1920	260	280	40	160	60	120	120	1160	TNTC
Fecal Coli	#/100ml	10	0	0	0	0	0	0	30	90	50	100	10	40	10	30	10	40	30
Fecal Strep	#/100ml	0	0	0	0	0	0	0	10	140	20	100	20	50	80	160	0	40	10

Individual Water Quality Parameters.

Salinity. Salinities in Lemon Bay ranged from a high of 37.3% at Stations LB-4, 5 and 6 on the first ebb tide to 34.4 at LB-1 on the second ebb tide. The salinities (36.9-35.3) at Station 1 on each of the creeks on flood tide were similar to that of the Bay stations; wheras on ebb tide they were about 2.0% (35.7-34.3) less than the salinities at the Bay stations and Stump Pass.

The salinities at Station 2 on Gottfried Creek ranged from 28.7% on ebb tide to 32.8% on flood tide, indicating that in the dry season this segment of the creek receives some freshwater from upstream and that the water in this segment is mixed with and slowly flushed by the higher salinity water of Lemon Bay. At GC-3 the salinities were consistently low (1.2-1.4%) which shows that the water at this station upstream of the suburban area is essentially that of the freshwater stream flow.

On Ainger and Oyster Creek the lower ebb tide salinities (28.4 and 32.8%) at Station 3 show some freshwater flow upstream of these stations. However, the salinity in the section of these creeks between their mouths and Station 3 appeared to be minimally affected by freshwater stream flow in the dry season.

The salinities in Buck Creek were remarkable. At Station 1 salinities ranged from 35.7% on an ebb tide to 38.5% on a flood tide, while those at Station 2 downstream of the Rotunda River Wier ranged from 0.9-1.3%. These data and those from the current drogue study indicate that the wier had altered both the historical salinity and flushing regimes in this creek. The low salinity in the tidal area below the wier in March was caused by freshwater from the spill-over at the wier. Interestingly, when we sampled Station 2 in August, 1977 after the creek had been dammed the salinity at this station was 34-35%.

Turbidity. Turbidity values were low throughout the study area, ranging from a high of 9.5 JTU in Stump Pass to 1.7-4.7 JTU in the creeks. Turbidity levels were also low in August except at Buck Creek Station 2 where on one sample run the turbidity was 22 JTU, reflecting the runoff from land development activities in the immediate area. In the July shoreline and tidal current studies Secchi disc readings on the creeks and dead end canals ranged from 4-6 ft in the creek channels to 1.5-2.0 ft in the dead end canals where blooms of phytoplankton were evident.

The significance of turbidity as a single water quality parameter is limited unless the character of the suspended materials is determined. In the dead end canals turbidity is caused by phytoplankton. Turbidity in areas receiving runoff from disturbed, bare soils is caused by a mixture of organic and inorganic silts. Turbidity in the open bay is caused by combinations of plankton and resuspended organic and inorganic silts from the shallow areas of the Bay. Finally, the turbidity at Stump Pass reflects a combination of tidal scouring and flushing.

pH. In the March study the laboratory pH of the water samples was higher for the bay stations and Station 1 on the creeks than for Stations 2 and 3 on the creeks. The pH of the former stations ranged from 7.9 to 8.2 while the pH of the latter stations ranged from 7.6 to 8.1 on ebb tide. Slightly lower values were obtained with the August samples with one exception at Buck Creek Station 2 where the pH was 6.9. This sample also had a high turbidity value and no dissolved oxygen. Again the permitted land development activities in the immediate area were probably the causative agent.

Dissolved Oxygen. Regardless of the tide or time of day, the D.O. values for the Lemon Bay stations in March exhibited little fluctuation, ranging from 6.9 to 9.8 mg/l. As might be expected, the D.O. values for the creek stations with the exception of GC-3 and OC-3 had lower D.O. values (4.0-6.6 mg/l) on ebb tides.

The D.O. values at GC-3 varied from 1.7 to 15.2. Similarly, at OC-3 the D.O. values varied from 2.5 to 7.8 on the same two tides. Both stations, located upstream of the suburban area, apparently are receiving freshwater low in oxygen and high in nutrients from upstream pastured areas.

The D.O. values of the August study show that on the post dawn, ebb tide RUN A, the water at both bay and creek stations had less than 3.3 mg/l D.O. In fact, most of the stations had D.O. values less than 2.5 mg/l which is considerably less than the acceptable minimal levels for Class II waters. However, the D.O. values in the samples from RUN B at dusk were above 4.0 mg/l except at GC-3 which still had a D.O. of less than 2.0 mg/l.

Obviously the seasonal and daily patterns of the D.O. levels in the Lemon Bay merit a lengthy discussion and explanation because of the importance placed on this as a water quality parameter. For the present let us assume that the values for certain stations in the Bay and the creeks represent natural background patterns against which other patterns may be evaluated.

<u>B.O.D.: Biochemical Oxygen Demand</u>. This empirical test of the amount of oxygen consumed by microbial systems over a 5 day in bottle incubation period has a limited value in surface water measurements since the in-bottle environment differs from the original surface water environment. Nevertheless, the test if commonly used and incorporated into surface water classification criteria. It does in a crude way reflect the amount of oxygen that could be consumed by microbes under a particular organic-inorganic nutrient regime. In the present study the recorded B.O.D values represent the amount of oxygen consumed by the organisms in the bottle over a 5 day incubation period.

On the ebb tide runs in March the highest B.O.D. values were at Lemon Bay, Stations 1 and 2, GC-2, AC-3, and OC-2 and 3. On the flood tides the highest values were at Lemon Bay, Stations 1 and 2, GC-2, AC-1 and 3, and OC-2 and 3. This B.O.D. pattern is consistent with tidal current, nutrient and bacteria patterns in the system. The August wet season B.O.D. patterns were similar to the March dry season patterns.

Ortho and Total Phosphate. The concentration/ and distribution of phosphate in Lemon Bay had an interesting pattern. Lemon Bay, Stations 3, 4, 5 and 6 had low phosphate levels (0.005-0.011 mg/l) on both ebb and flood tide. Contrarily, Lemon Bay Station 1 had relatively higher levels of total phosphate (0.016-0.031 mg/l on both ebb and flood tide). Station LB-2 had phosphate levels intermediate between those of LB-1 and LB-3 on ebb tide but similar to LB-3 on flood tide. Of the total phosphate at LB-1 more than 50% was organic phosphate.

In general the ortho and total phosphatelevels in creek samples were higher than in the Bay samples. Total phosphate levels were highest at GC-2 (0.17 mg/l), GC-3 (0.125 mg/l), BC-2 (0.112 mg/l) and BC-3 (1.41 mg/l). The high total phosphate at BC03 was accompanied by a low orthophosphate (0.005mg/l) again indicating runoff wasteloading of the Rotunda River by 1 and development activities. Elsewhere, medium to high levels of total phosphate were generally accompanied by similar increases in levels of orthophosphate except for Gottfried Creek, Station 2 where on both a flood and ebb tide organic phosphate was the major component of total phosphate.

TKN, Total Kjeldahl Nitrogen. TKN values ranged from 0.56 mg/l at Lemon Bay stations to 1.91 mg/l at GC-2 during the first ebb tide. Typically, higher values occurred at GC-3, AC-3, OC-3, BC-2, and BC-3. Since these stations are upstream of the suburban area, it appears that higher TKN values in the waters at the time of the study may be due to surface runoff from irrigation and the rain event on March 25. That surface runoff is the major source of TKN is also seen in the wet season data for Ainger Creek (Table 33).

<u>NH_3-N</u>, Ammonia. In general the NH_3-N levels were very low and at the limits of the assay with the exception of RUN E which was on an ebb tide at 2400 when twenty or more sport shrimping boats were anchored in Stump Pass near Station LB-6. On the creeks the higher NH_3-N values occurred at GC-1, AC-2, OC-1, OC-2, and OC-3. The highest values occurred at BC-2 and BC-3 which suggests that NH_3-N is not necessarily a good diagnostic parameter of human waste flow from upland sources. However, the wet season data for Ainger Creek (Table 33) indicate this parameter may yet be useful.

<u>T.O.C., Total Organic Carbon</u>. The T.O.C. concentrations ranged from 9-12 mg/l at Lemon Bay, Stations 4, 5 and 6 to 35.5 mg/l at Buck Creek Station 3. BC-2, BC-3, and GC-3 were the only stations at which the T.O.C. levels were consistently high. Thus it would appear that the waters of Rotunda River and Gottfried Creek upstream of Station 3 were the major sources of the T.O.C in the upstream segments of these creeks. These results and the limited data from the wet season on Ainger Creek (Table 33) suggest further that the T.O.C. load of the creeks is to a certain degree derived from surface runoff.

<u>Nitrate and Nitrite</u>. Nitrite levels were uniformly low and at the resolving limits of the assay test. Nitrate levels were also low but variable at the creek stations, ranging from 0.005 to 0.013 mg/l.

In general, under the dry season conditions at the time fo the March water quality study, nitrate levels in the Bay and creeks were low enough to limit potential growth of phytoplankton and microbes. This conclusion is fully discussed in the next section on Limiting Nutrient Algal Assays of Lemon Bay, Florida by Craig Dye.

LIMITING NUTRIENT ALGAL ASSAYS OF LEMON BAY, FLORIDA*

INTRODUCTION

Limiting nutrient algal assays were performed on water samples from six stations in Lemon Bay for the Southwest Florida Regional Planning Council. Water samples were collected on 26 March 1977 by personnel of the University of South Florida at Sarasota. Chemical analysis of the water samples were performed by USF personnel, while algal assays were conducted by DER's Biology Lab in Tallahassee

METHODS (ALGAL ASSAYS)

High and low tide water sample series were collected for the six stations in Lemon Bay. The samples were placed in plastic containers and transported on ice in the dark to Tallahassee. Chemical samples were analyzed at the USF lab in Sarasota.

Algal assays were performed according to methods outlined in the Marine Algal Assay Procedure - Bottle Test (U.S. EPA, 1974). Marine samples were innoculated with the marine green alga *Dunaliella tertiolecta*. Assay samples were incubated for 12 days and aliquots withdrawn on days 1 through 7 and also day 12 for algal cell counts. Cell counts, to determine growth response, were performed on an electronic particle counter (Coulter Model ZBI) with mean cell volume attachment.

The following nutrient spikes were added to control samples to determine the effect nitrogen and phosphorus additions would have at the stations that were sampled:

*Note: Table and Figure numbers within the report and on the figures are retained as given by the author. Numbers in parentheses on the table and figures are used in the lists of tables and figures for the entire report.

control + 0.05 mg/l P

control + 0.10 mg/l P

control + 0.10 mg/l N

control + 0.50 mg/l N

control + 0.05 mg/l P + 0.10 mg/l N

control + 0.10 mg/l P + 0.50 mg/l N

RESULTS

Table 1 summarizes the chemical and algal assay results for the six stations sampled on 26 March 1977. A paired t test performed on the 12th day dry weight values for the algal assays revealed no significant difference between nutrient limitation at high tide (samples series c) and low tide (sample series e). However, inspection of the data from Station LB-2 revealed an interesting difference between high and low tide samples spiked with the highest nitrogen concentration. This inconsistency will be discussed later.

Water samples from Stations LB-1 and 2 produced significant growth of test algae (above that of the control) with the addition of nitrogen alone (Figs. 1-8). Thus, assay results from these stations suggest that, at the time of sampling, nitrogen was the primary nutrient limiting phytoplankton growth.

LB-1 was strongly nitrogen limited since single nitrogen spikes produced the greatest amount of growth; even more than the combination nitrogen and phosphorus spikes (Figs. 1-4). Assay data from LB-2 suggests that, although nitrogen was initially limiting, when enough nitrogen was available, phosphorus became the limiting nutrient (Figs. 5-8).

Stations LB-3, 4, 5, and 6 exhibited significant algal growth (above that of the control) with addition of phosphorus alone (see Figs. 9-24).

However there was generally an even more significant growth increase in the samples that were spiked with both nitrogen and phosphorus. These data suggest that, at the time of sampling, algal populations at the above stations were initially limited by phosphorus but when sufficient amounts of phosphorus were available, nitrogen became limiting.

DISCUSSION

Recent evidence has suggested nitrogen to be the primary limiting nutrient in estuaries and coastal marine waters (Goldman et al., 1973; Thomas et al., 1973; Dunstan, 1975; Goldman, 1976). It has also been shown, however, that phytoplankton populations of the nutrient poor surface waters of the open ocean are often phosphorus limited (Collier, 1970; Ryther and Dunstan, 1971).

It is therefore surprising to find phosphorus limited areas of Lemon Bay, an area that could certainly be classified as coastal marine water. Several facts about Lemon Bay and the eastern Gulf of Mexico may serve to explain this unusual nutrient limitation and suggest the role tidal exchange may play in the nutrient regime of Lemon Bay.

Lemon Bay is a narrow, shallow embayment approximately 15 miles long (see map). The principal exchange of water between Lemon Bay and the Gulf occurs through Stump Pass located near the southern terminus of the bay. Therefore, any influence waters from the Gulf might have on Lemon Bay would presumably be noticed in the southern part of the bay first. Additionally, hydrographic conditions in the eastern Gulf this spring have allowed open Gulf water to be brought in close to the Southwest Florida coast (personal communication, Dr. John Morrill).

The nutrient limitations (i.e., phosphorus) observed at Stations LB-3, 4, 5, and 6 on both tides suggest that, at the time of sampling, open Gulf water was significantly influencing the southern part of Lemon Bay. The location of these stations (south of Englewood Causeway, close to Stump Pass) and the chemical results (i.e., extremely low phosphorus values) tend to support this conclusion.

Conversely, Station LB-1 (6 miles north of Stump Pass and north of the Englewood Causeway) was nitrogen limited even at high tide. These data suggest that water from Stump Pass was not reaching too far north in Lemon Bay.

Assay data from Station LB-2 indicate that either nitrogen or phosphorus could have been limiting during the high tide sampling (Fig. 6) suggesting that open Gulf water may have extended north into the vicinity of LB-2. However, low tide assay data (Fig. 7, 8) show strong N limitation similar to that of LB-1. Chemical data from this station and LB-1 support nitrogen limitation since total phosphorus values were significantly greater than those found at the other marine stations.

The maximum dry weight yield of the control samples for each station are indicative of the capacity of that station for supporting algal growth. These data (Table 1) suggest that, at the time of sampling, the waters at Stations LB-3, 4, 5, and 6 were capable of supporting only reduced algal growths. Data from Stations LB-1 and 2 indicated these areas were capable of sustaining moderate phytoplankton populations at the time they were sampled.

Additionally, it is interesting to note that control yields were highest in the low tide samples while they were lowest for high tide samples. These data suggest that the more productive and nutrient rich waters of northern Lemon Bay were influencing the southern reaches of the Bay during low tide; but that on the ensuing flood tide the less productive open Gulf waters were evidently affecting northern portions of the Bay.

The implication of the algal assay data is that limiting nutrients may vary within Lemon Bay depending on a number of factors, particularly tidal exchange. Although only one assay was performed, we suspect that seasonality will also play a significant role in determining the nutrient limiting primary productivity in Lemon Bay. Recent research has shown these two factors have figured prominantly in determining the limiting nutrients of other marine areas as well (Thayer, 1974; Specht, 1975).

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U.S. Environmental Protection Agency. 1974. Marine algal assay procedure: Bottle Test. U.S. EPA, Corvallis, Oregon. 43 pp.

TABLE 1 - Lemon Bay Algal Assay and Chemical Analyses

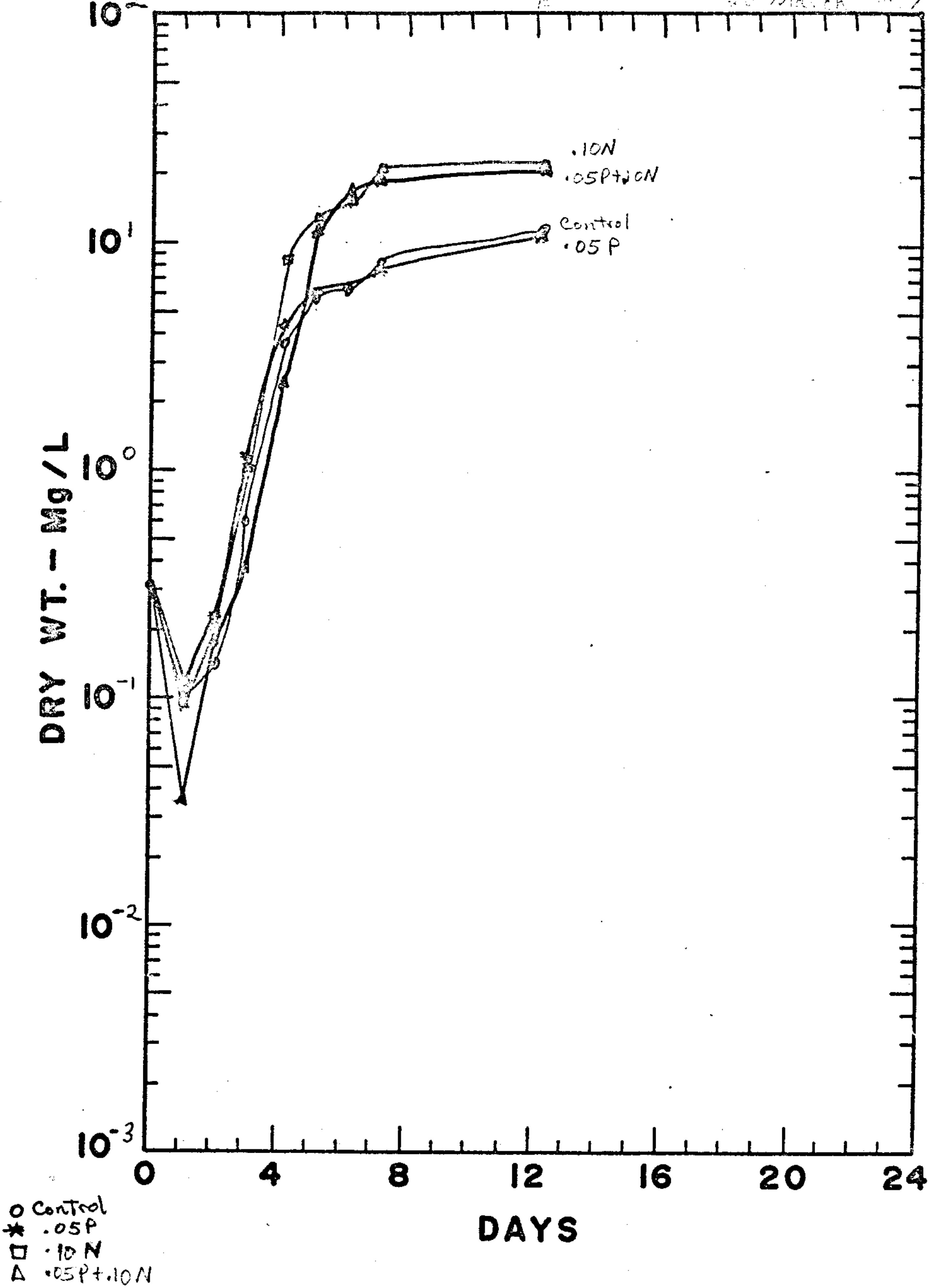
(47)

tation	P-ortho diss (mg/l)	P. total (mg/l)	N-inorganic (mg/l)	N-organic (mg/l)	N-total (mg/l)	TN:TP	inorg.N:oPO$_4$	Primary Limiting Nutrient	Control max. dry wt. yield (mg/l)
B-1$_c$	0.002	0.021	0.015	1.253	1.268	60.3	7.5	N	11.9
B-2$_c$	0.001	0.028	0.015	1.100	1.115	39.8	15.0	N-P	13.8
B-3$_c$	0.001	0.008	0.015	0.642	0.657	82.1	15.0	P	0.6
B-4$_c$	0.001	0.001	0.015	0.531	0.546	546.0	15.0	P	0.3
B-5$_c$	0.001	0.001	0.015	1.424	1.439	1439.0	15.0	P	0.4
B-6$_c$	0.001	0.001	0.015	0.461	0.476	476.0	15.0	P	0.2
B-1$_e$	--	0.032	0.042	0.892	0.934	29.2	α42.0	N	17.2
B-2$_e$	--	0.038	0.039	0.854	0.893	23.5	α39.0	N	20.3
B-3$_e$	--	0.001	0.042	0.465	0.507	465.0	α42.0	P	7.7
B-4$_e$	--	0.001	0.039	0.493	0.532	532.0	α39.0	P	3.5
B-5$_e$	--	0.001	0.050	0.517	0.567	567.0	α50.0	P	1.5
B-6$_e$	--	0.021	0.041	0.361	0.402	19.1	α41.0	P	0.6

Dunaliella tertiolecta
22 Apr - 2 May, 1977

Lemon Bay
Station LB-1-C
26 March 1977

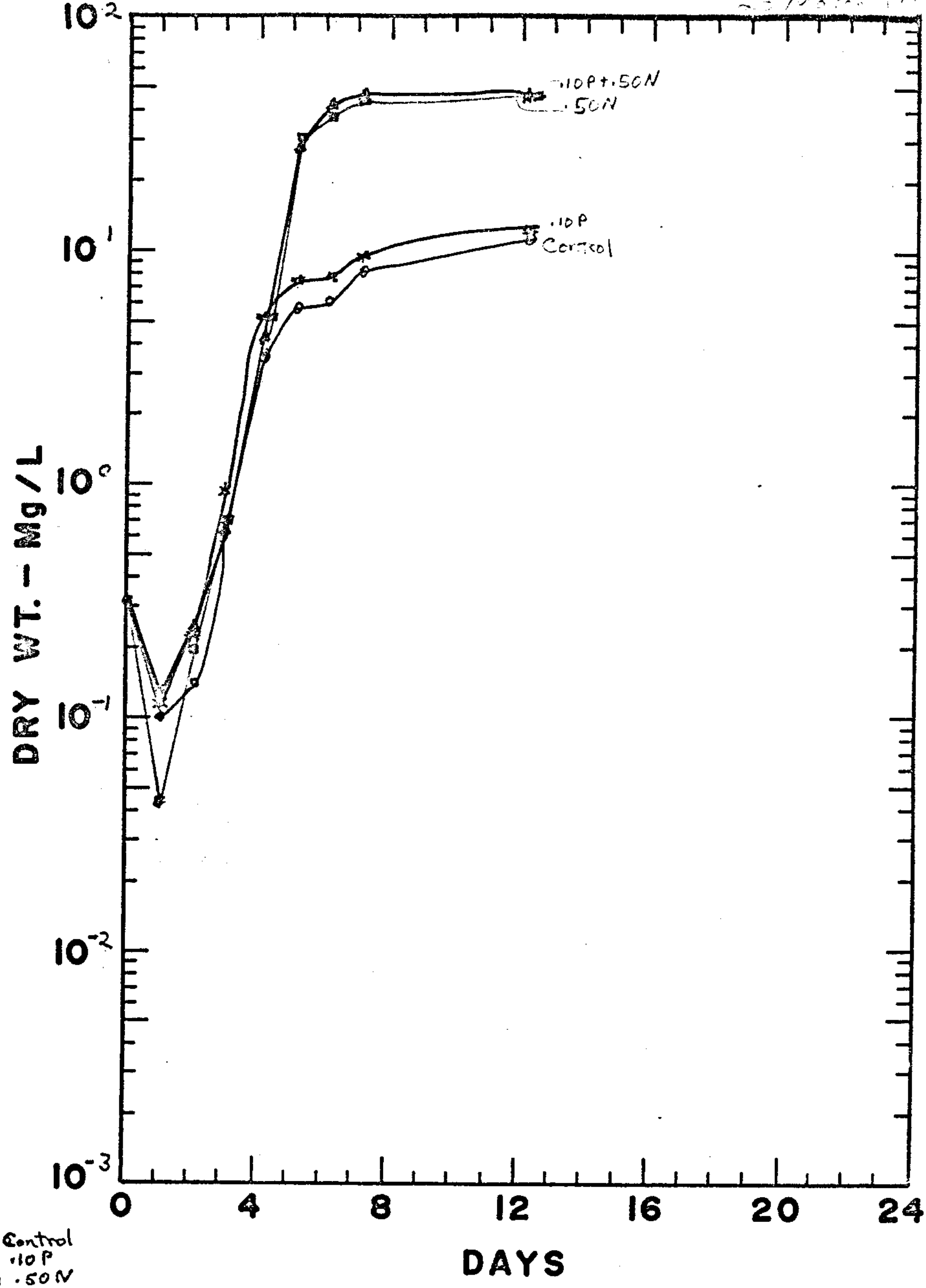
Fig 1 (68)



Dunaliella tertiolecta

Lemon Bay
Station

Fig. 2 (69)



o Control
✱ .10P
□ .50N
Δ .10P+.50N

Fig. 5 (70)

Lemon
Station LB-1-

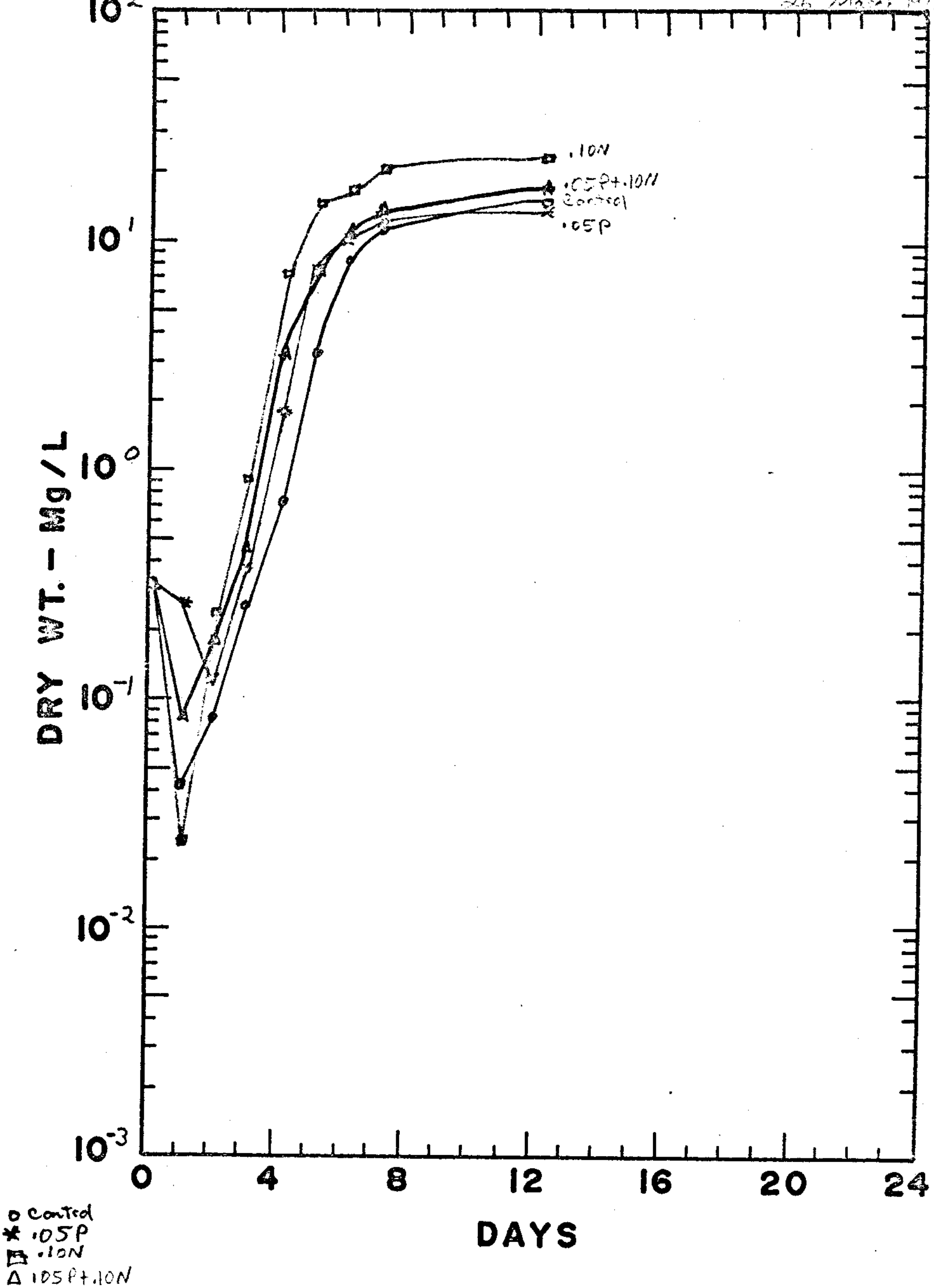
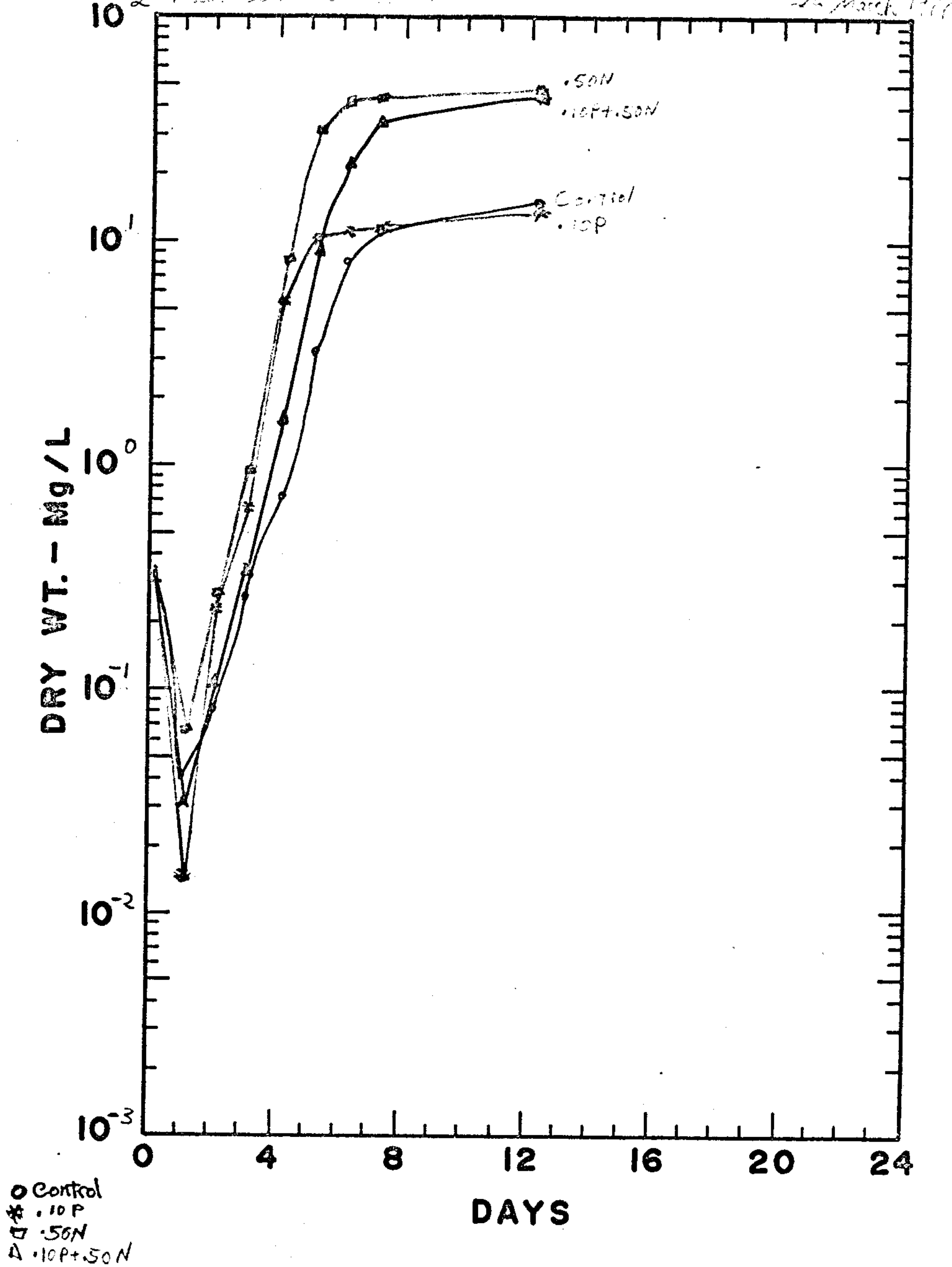


Fig. 4 (71)


DRY WT. - Mg/L
DAYS
10^2
10^1
10^0
10^{-1}
10^{-2}
10^{-3}
0
4
8
12
16
20
24
.50N
.10P+.50N
Control
.10P
o Control
* .10P
□ .50N
Δ .10P+.50N

Lemon Bay 233
Station
26 March 1977

Fig. 5 (72)

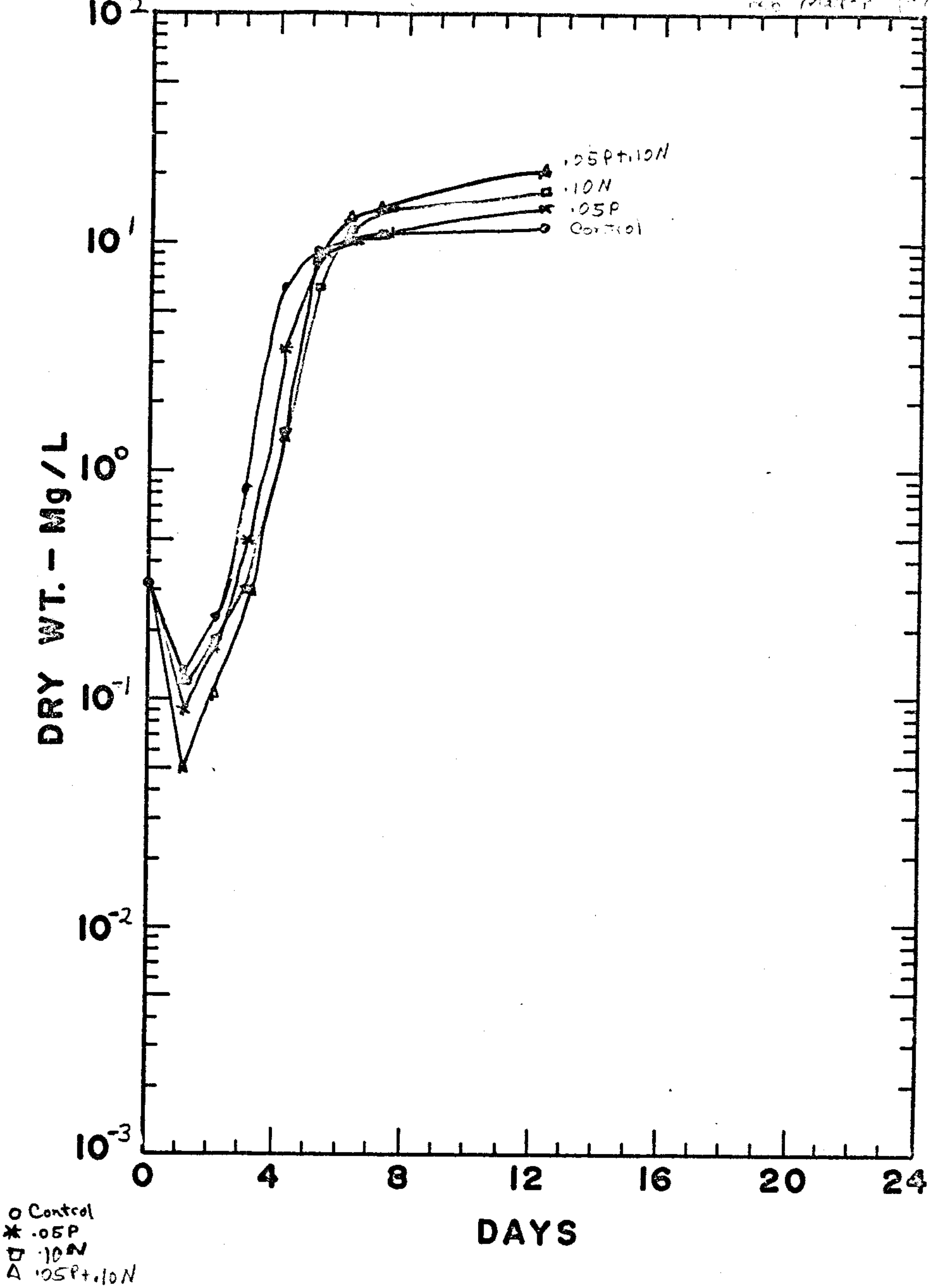
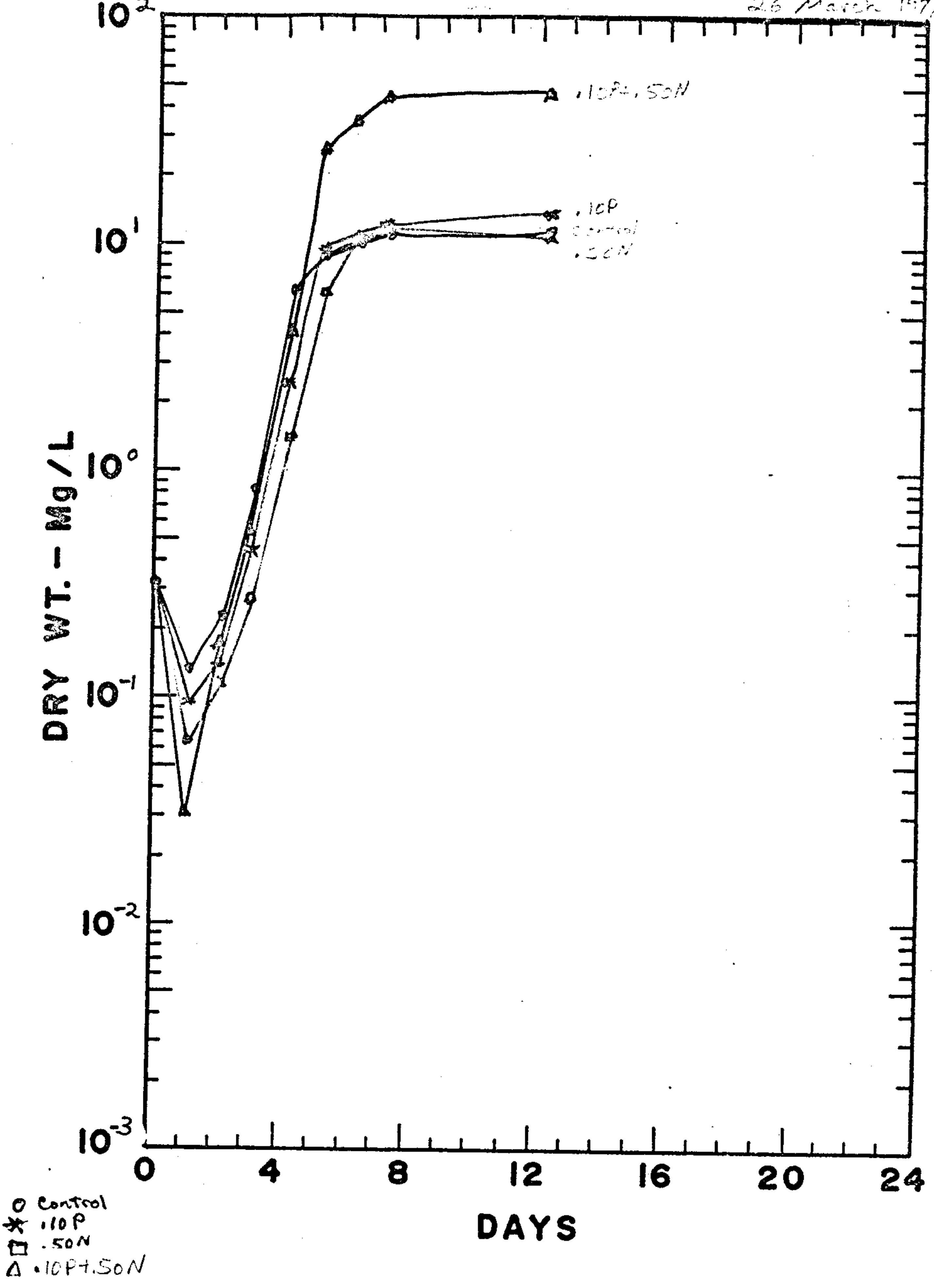


Fig 6 (73)

Lemon Bay 234

26 March 1977

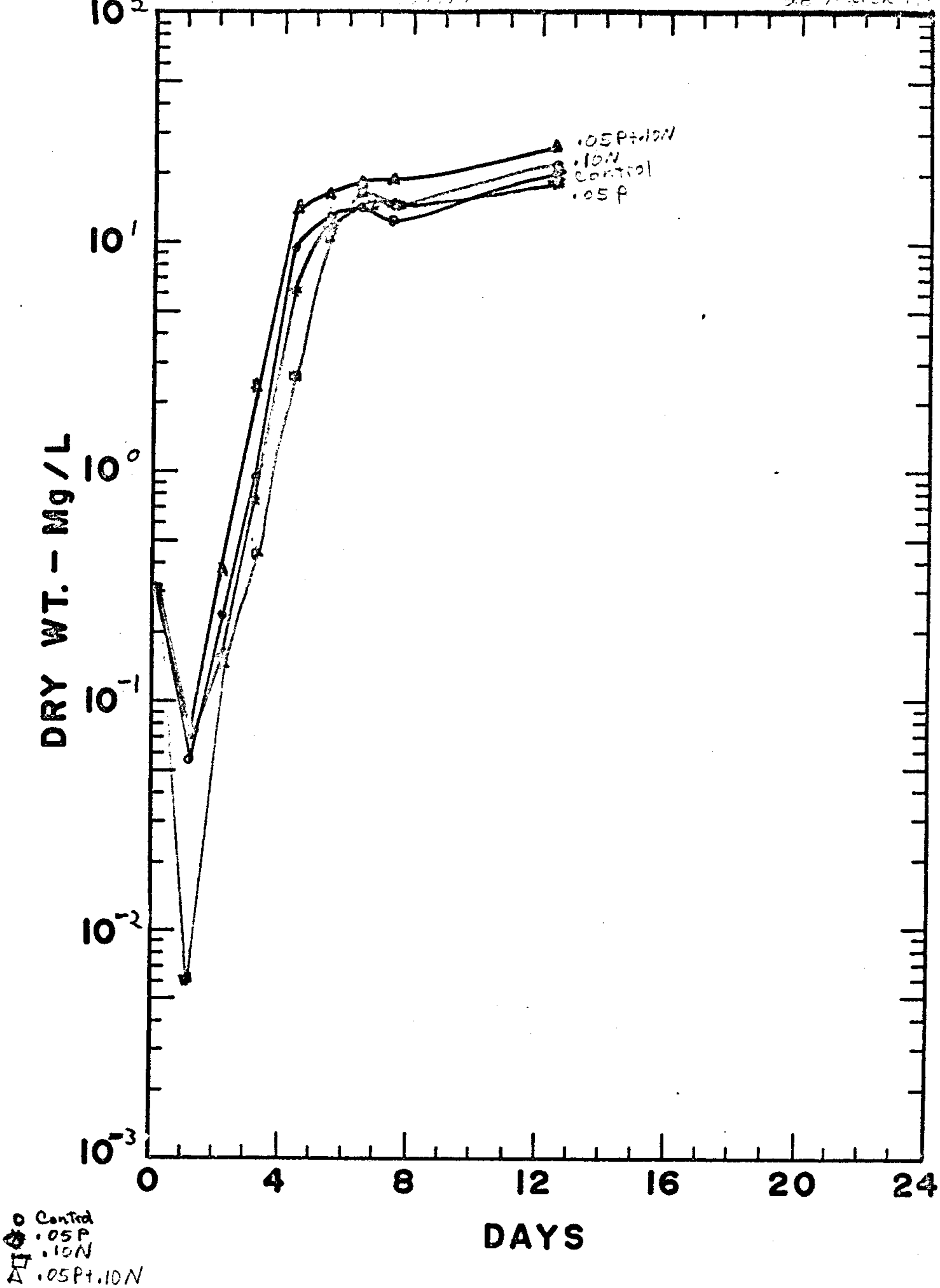


Dunaliella tertiolecta

Assay ... May 1977

Fig 7 (74)

Lemon Bay
Station LB
26 March 1977



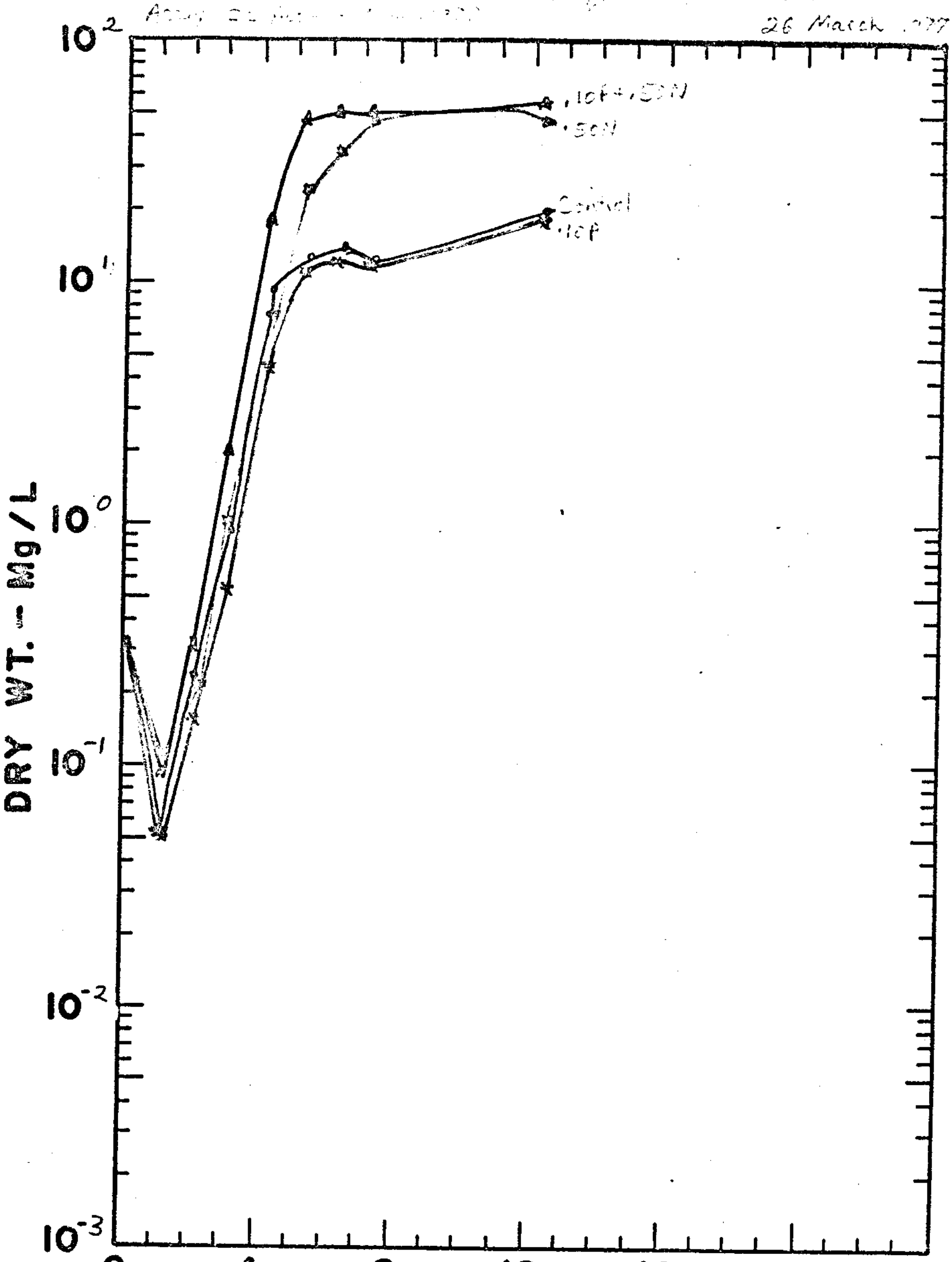

DRY WT. - Mg/L
DAYS
.10P+.50N
.50N
Control
.10P
0 Control
✱ .10P
☐ .50N
Δ .10P+.50N

Fig. 9 (76)

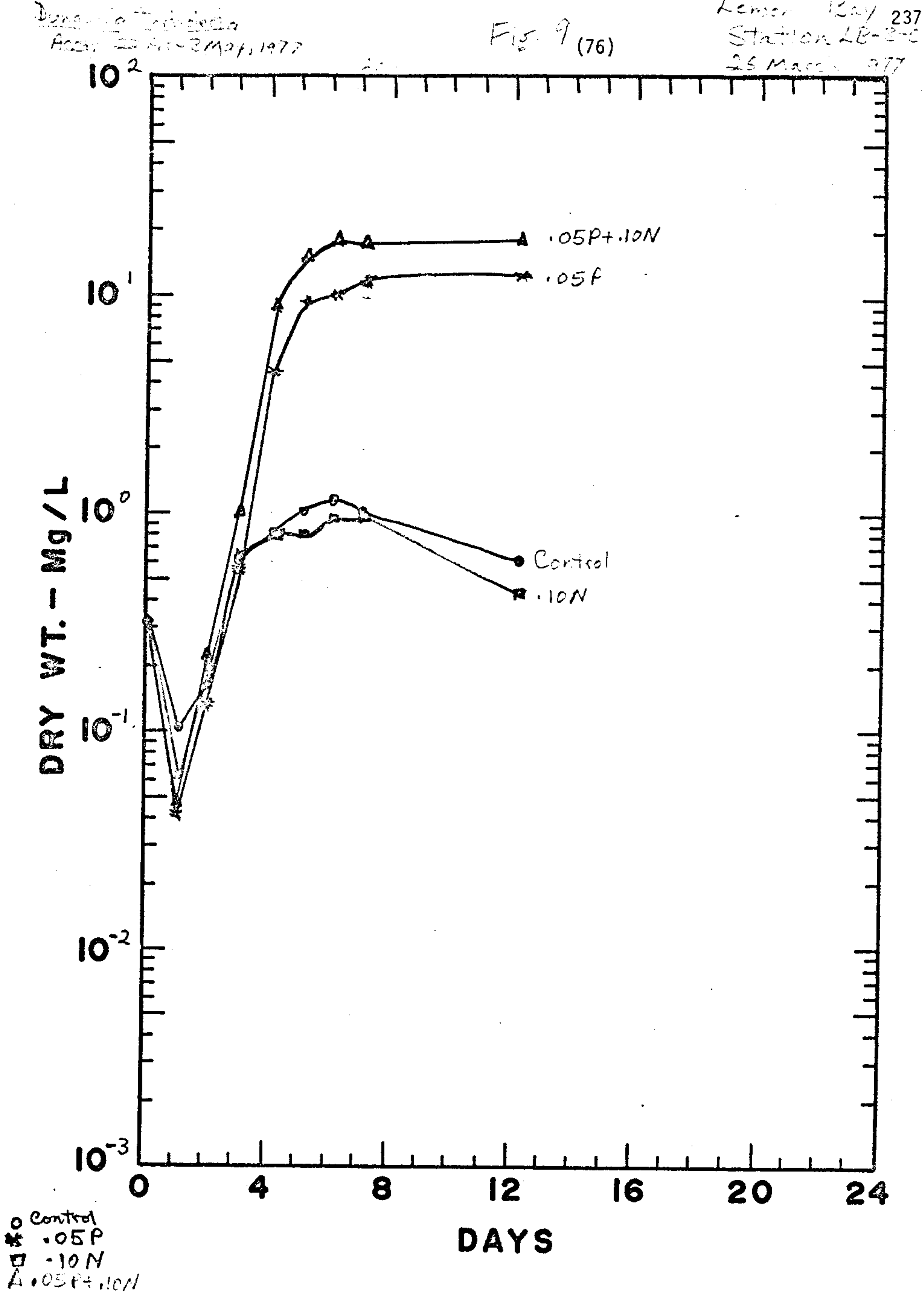

Dunaliella tertiolecta
Lemon Bay
Station LB
25 March 1977
10^2
10^1
10^0
10^-1
10^-2
10^-3
DRY WT. - Mg/L
0
4
8
12
16
20
24
DAYS
.05P+.10N
.05P
Control
.10N
o Control
* .05P
□ .10N
Δ .05P+.10N

Fig. 10 (77)

Lemon Bay 238.
Station LB-3-C
26 March 1977

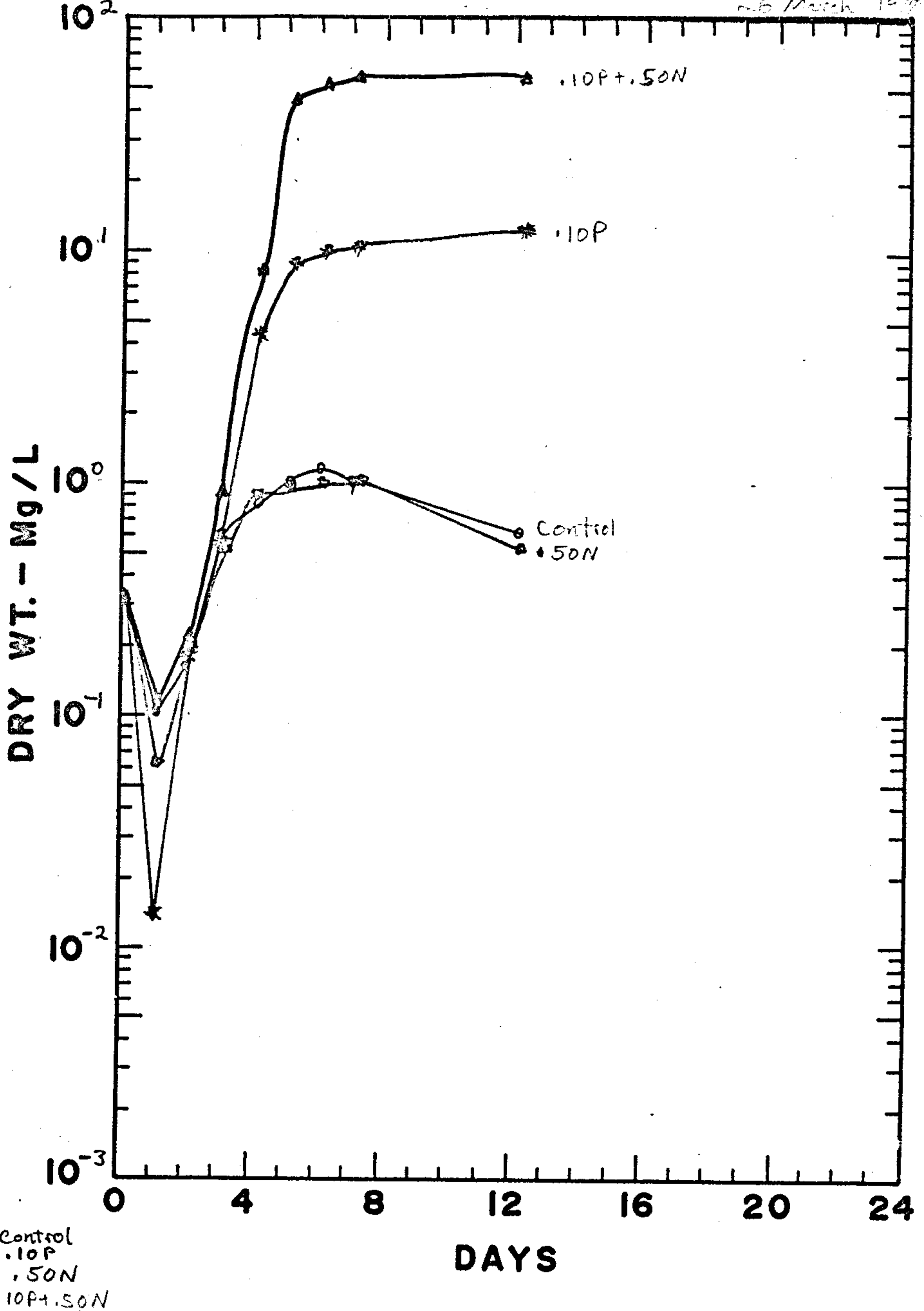


Fig. 11 (78)

239

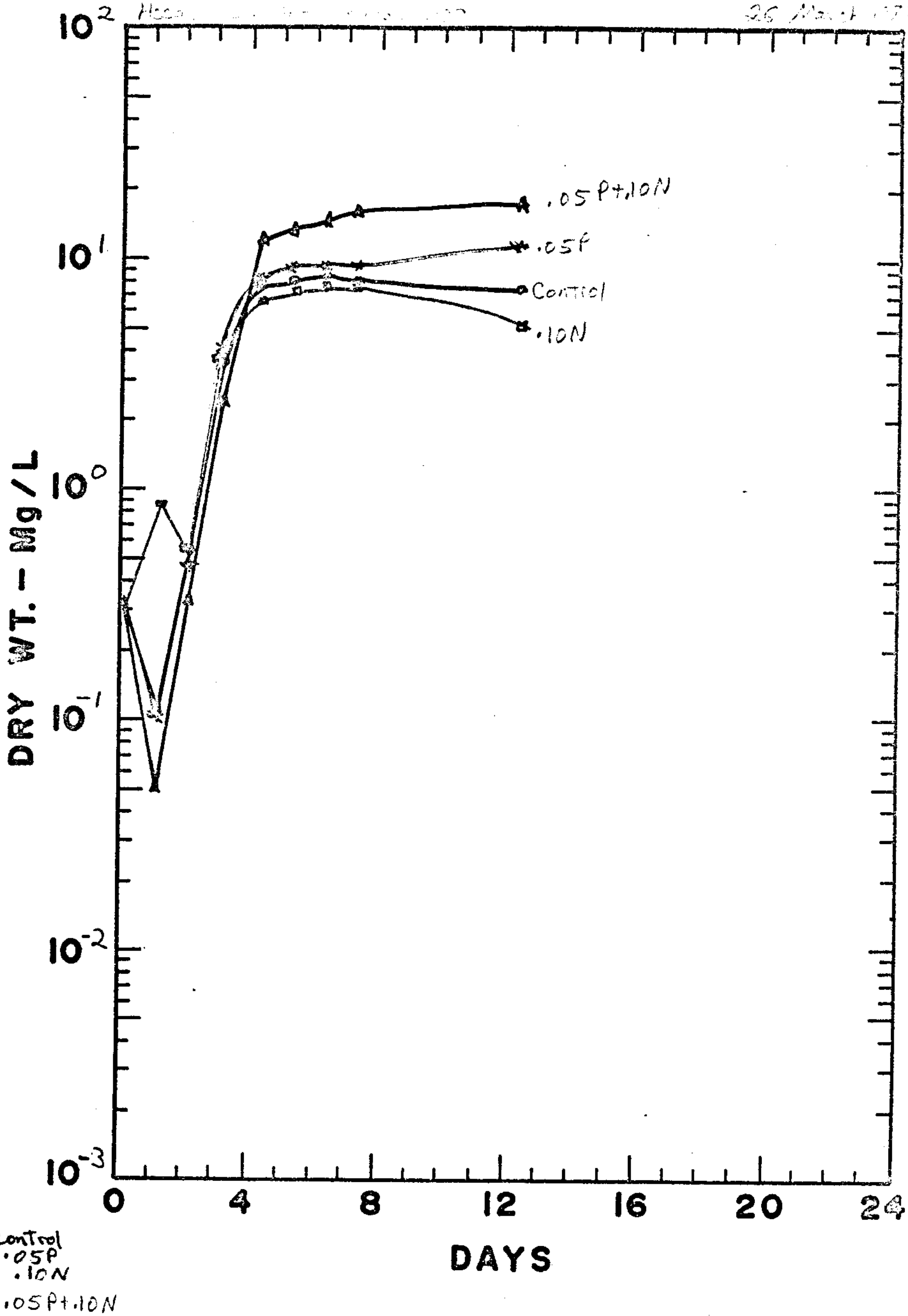

DRY WT. - Mg/L
DAYS
.05P+.10N
.05P
Control
.10N
o Control
* .05P
□ .10N
Δ .05P+.10N

Fig 12 (79)

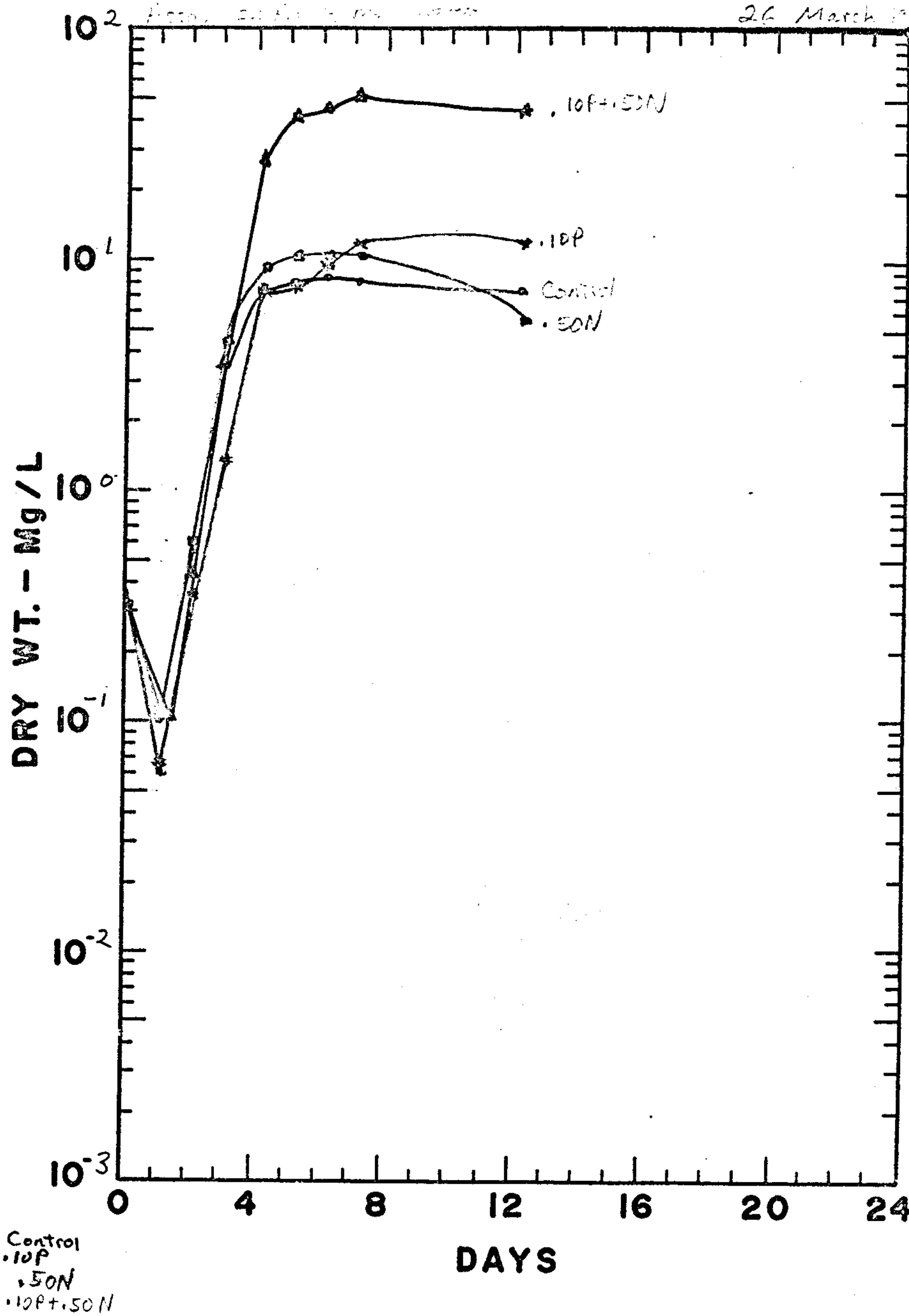
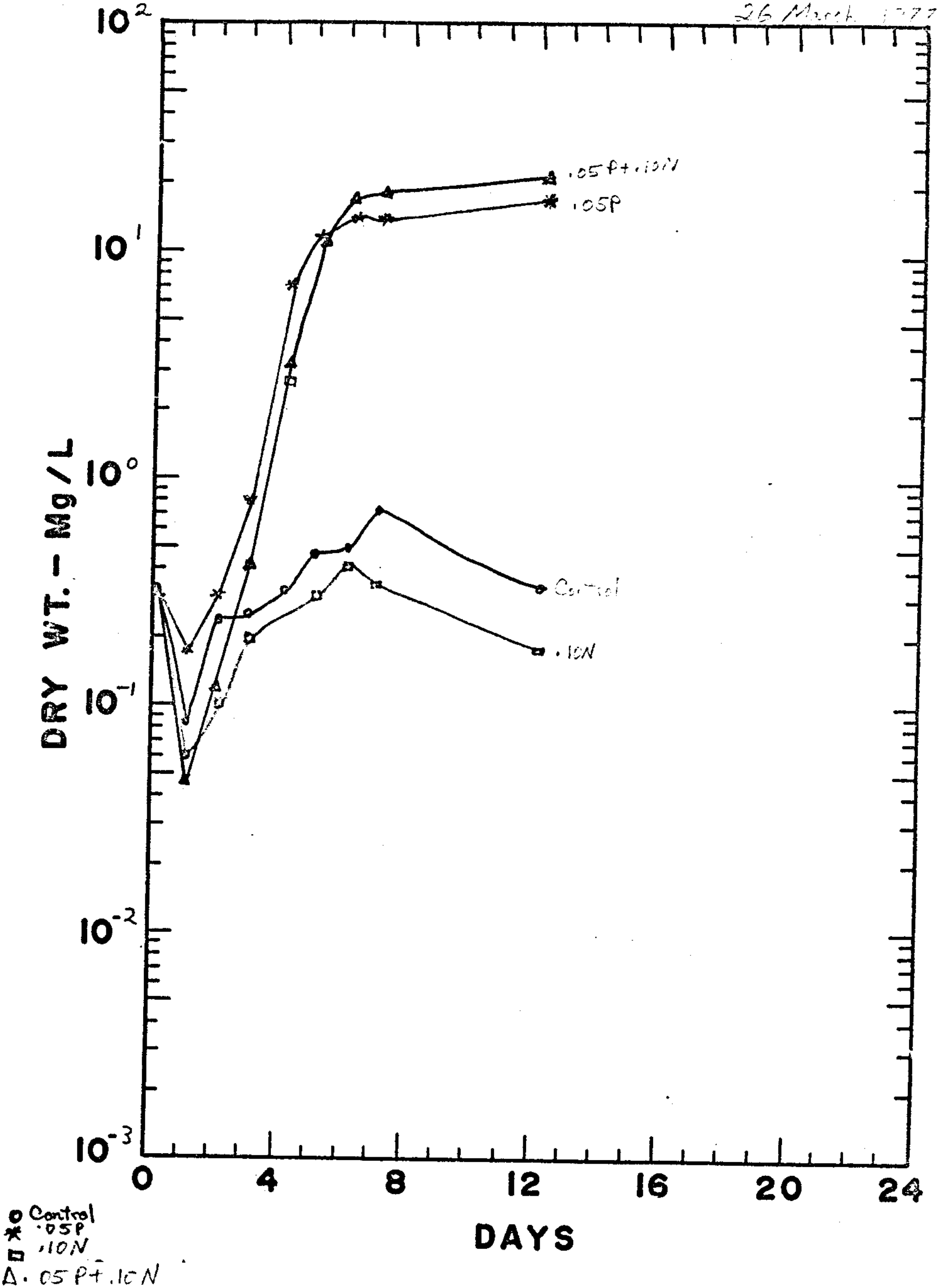

DRY WT. - Mg/L
DAYS
.10P+.50N
.10P
Control
.50N
o Control
* .10P
□ .50N
Δ .10P+.50N

Fig 13 (80)

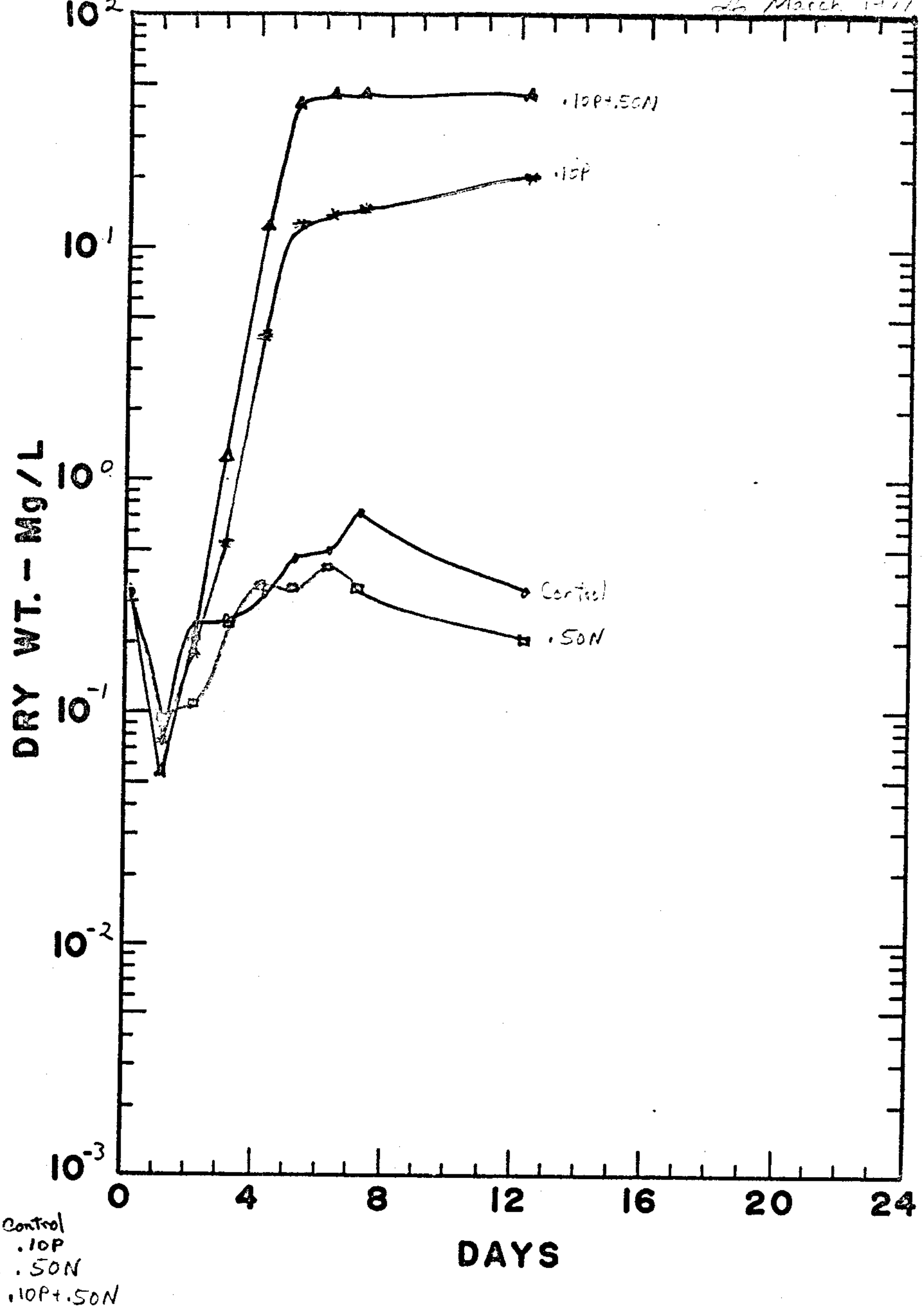
Lomer Bay
Station LB-4-C
26 March 1977



Dunaliella tertiolecta

Fig. 14 (81)

Lemon Bay
Station LB-4-C
26 March 1977



Lemon Bay 243
Station 23-4-e
26 March 1977

Fig. 15 (82)

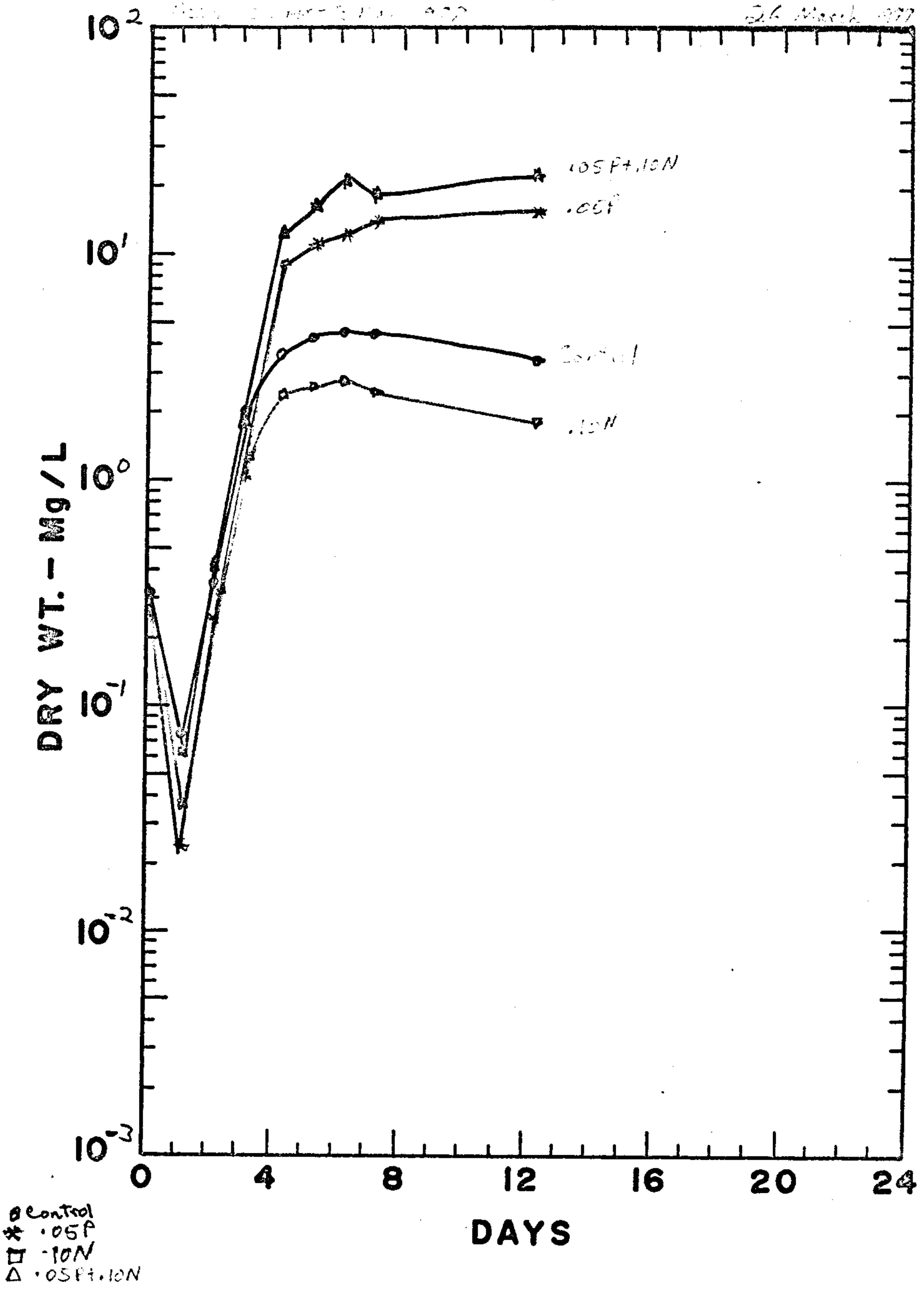
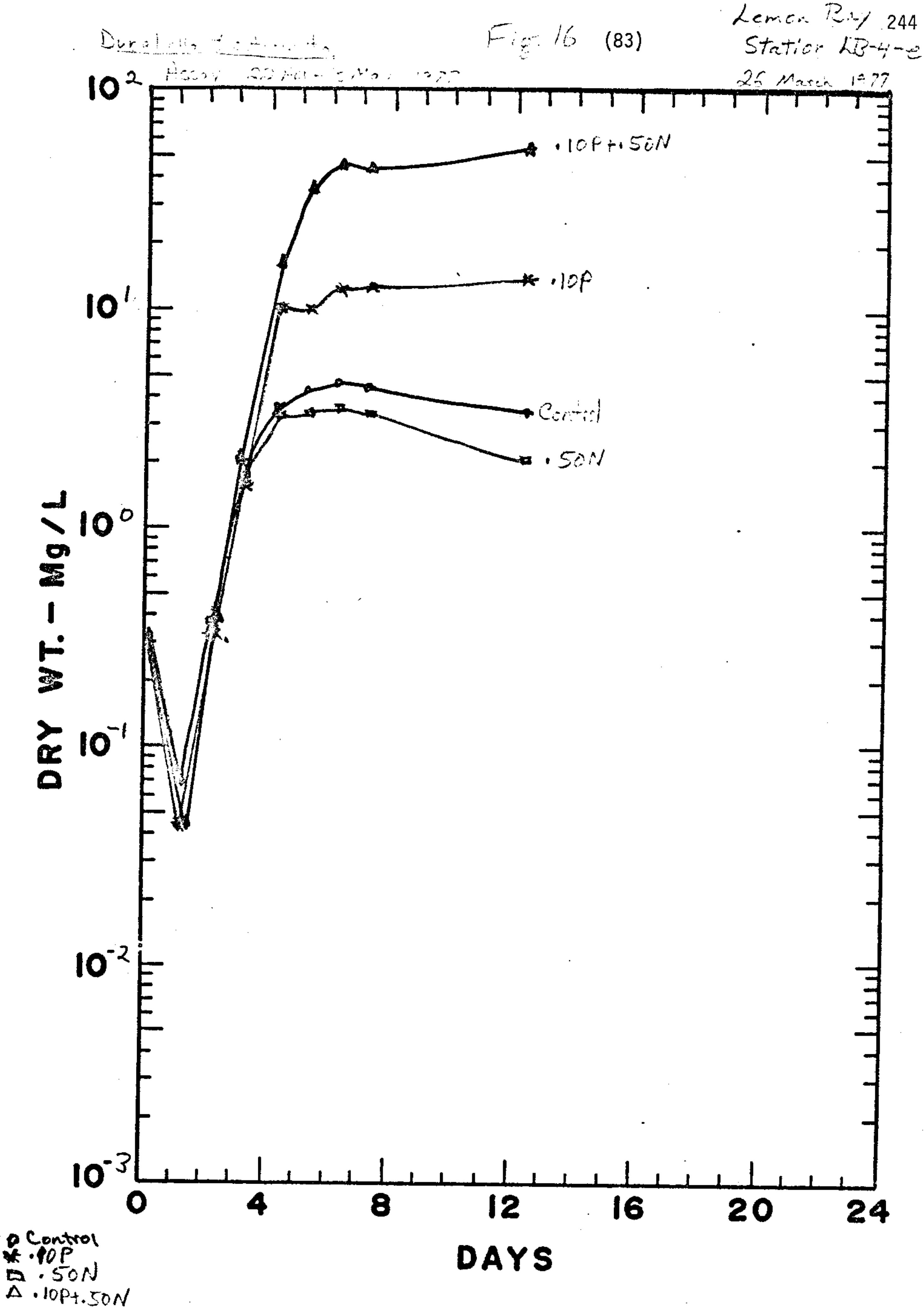


Fig. 16 (83)


Lemon Bay
Station LB-4-e
26 March 1977
.10P+.50N
.10P
Control
.50N
DRY WT. - Mg/L
DAYS
10^2
10^1
10^0
10^-1
10^-2
10^-3
0
4
8
12
16
20
24
o Control
* .10P
□ .50N
Δ .10P+.50N

Lemon Bay
Station LB-5-C
26 March 1977

Fig 17 (84)

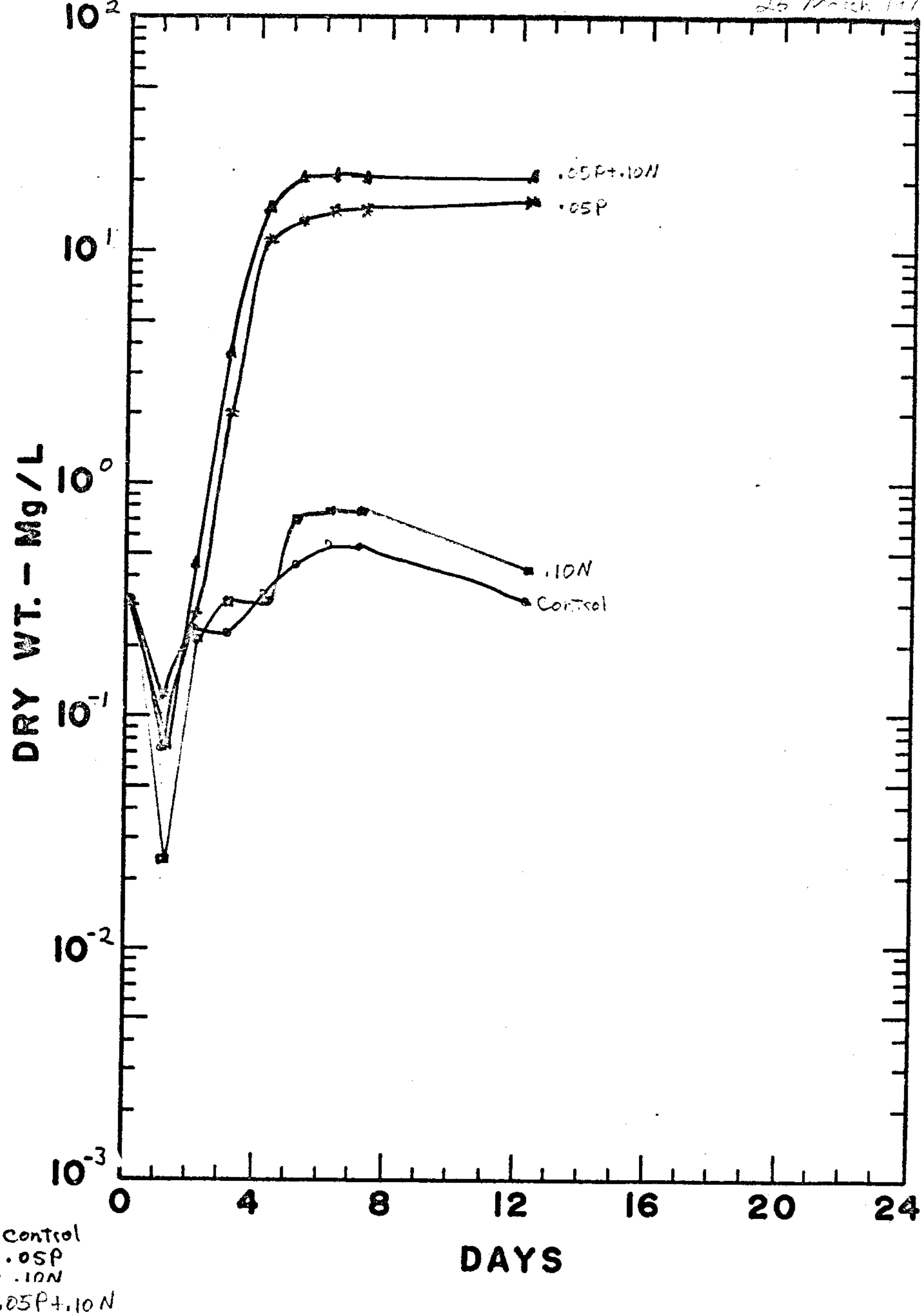
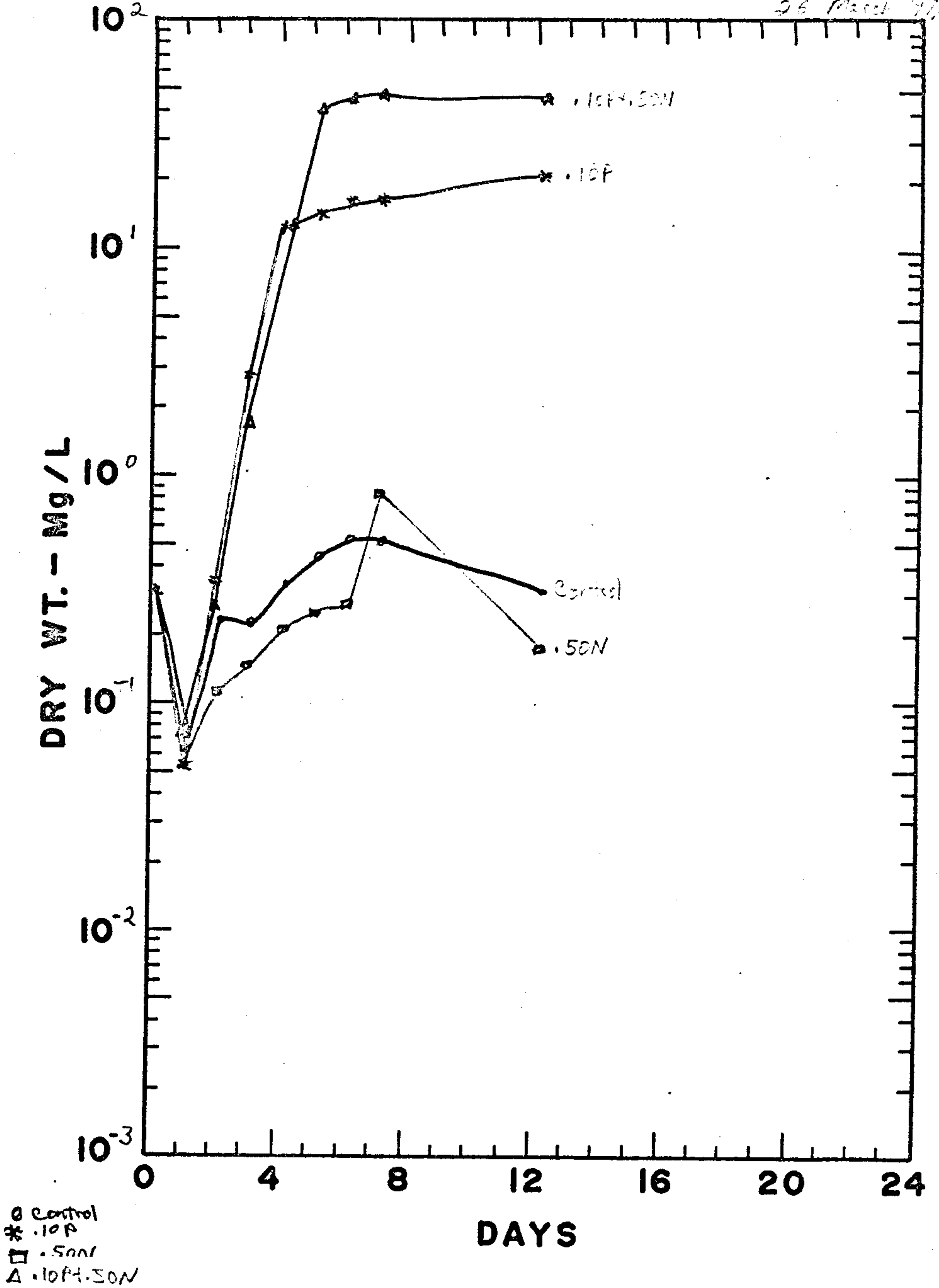


Fig. 18 (85)

246



DRY WT. - Mg/L
10^2
10^1
10^0
10^{-1}
10^{-2}
10^{-3}
0
4
8
12
16
20
24
DAYS
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.50N
.10P
Control
.10P
.50N
.10P+.50N

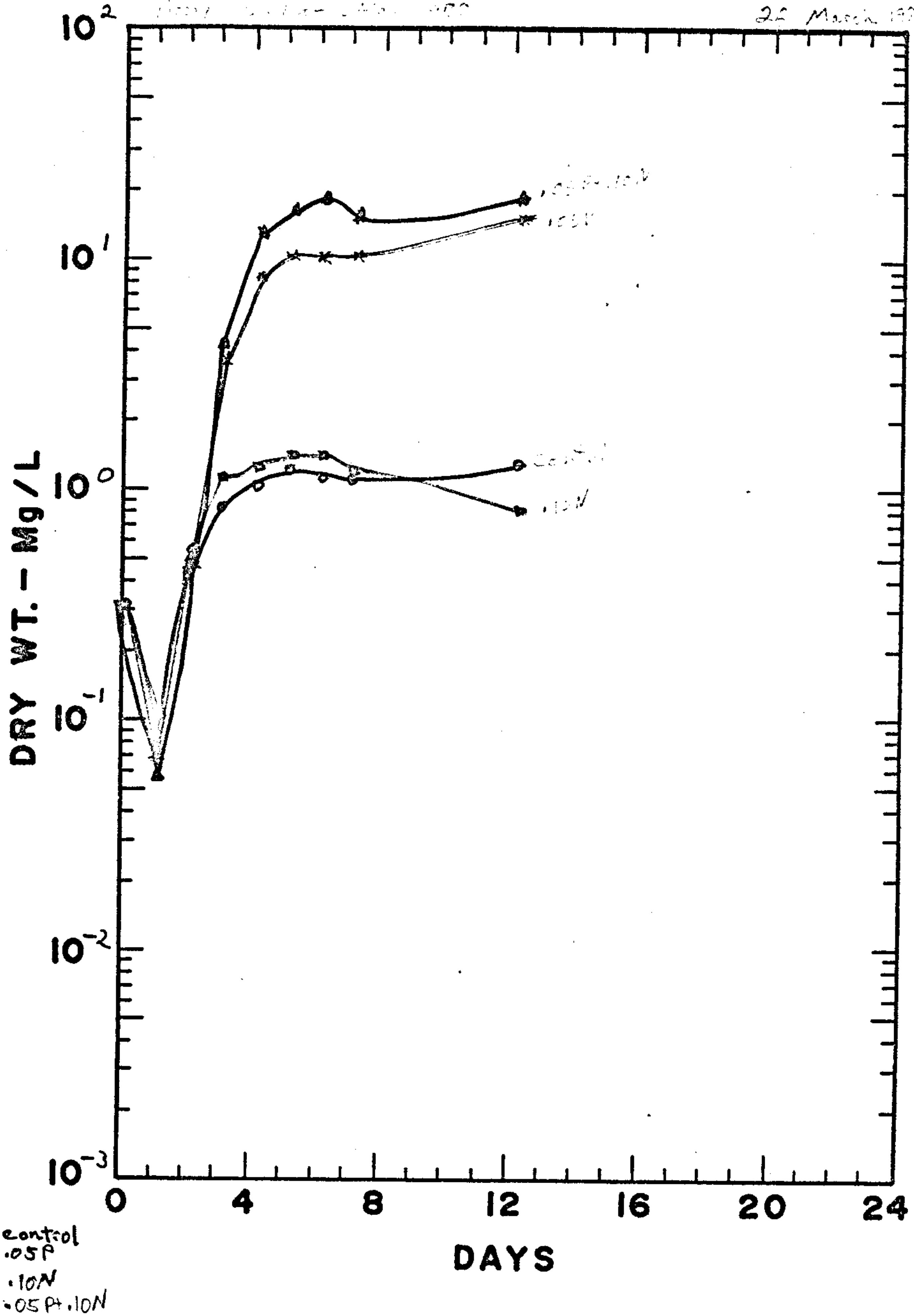
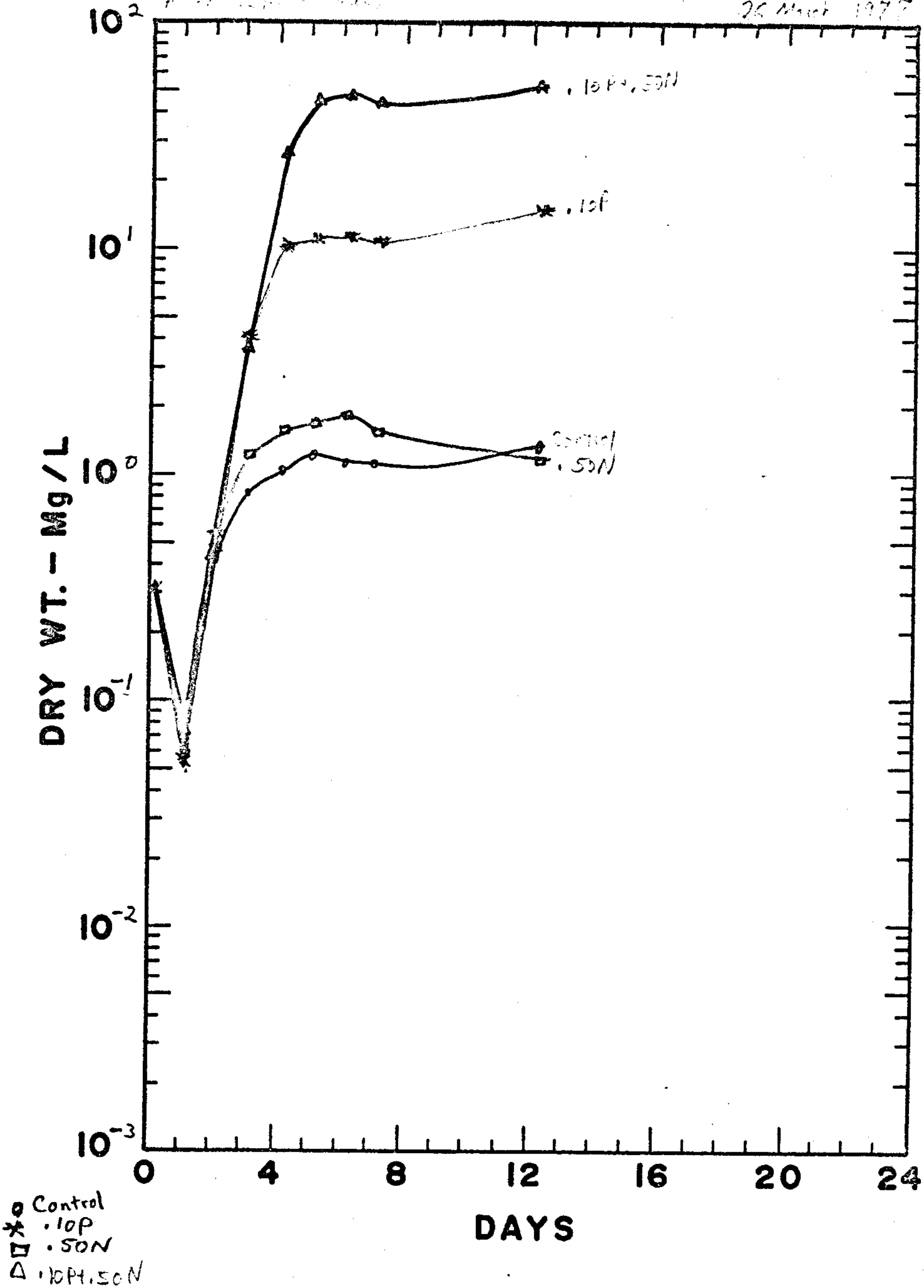

10^2
10^1
10^0
10^{-1}
10^{-2}
10^{-3}
DRY WT. - Mg/L
0
4
8
12
16
20
24
DAYS
o control
* .05P
▽ .10N
Δ .05P+.10N

Fig 20 (87)

Lemon Bay 248
Station LB-5-C
26 March 1977



Dunaliella tertiolecta

Station LB-5-C

21 March

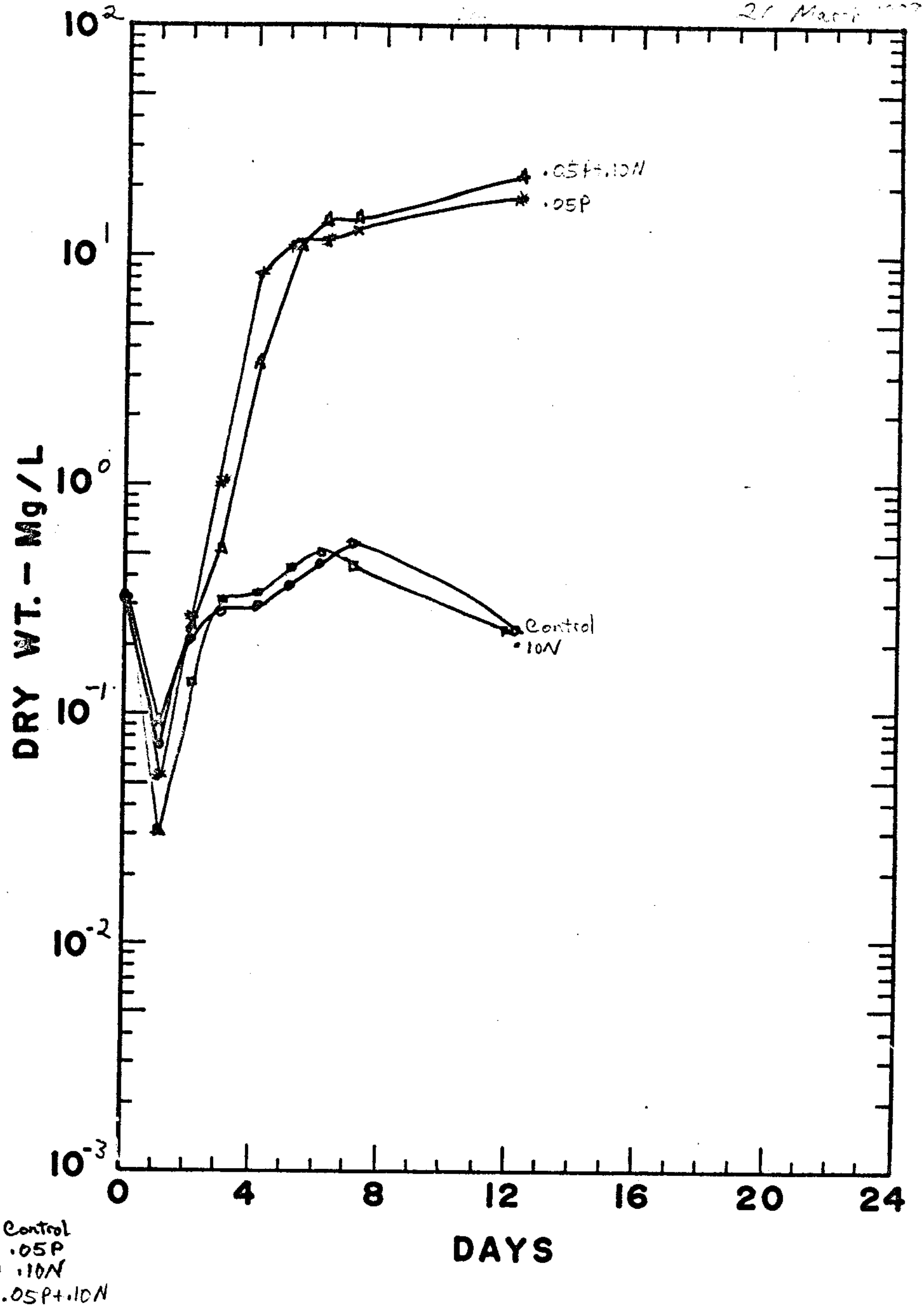


Fig. 21 (88)

Fig. 22 (89)

Lemon Bay
Station LB-6

26 March 1977

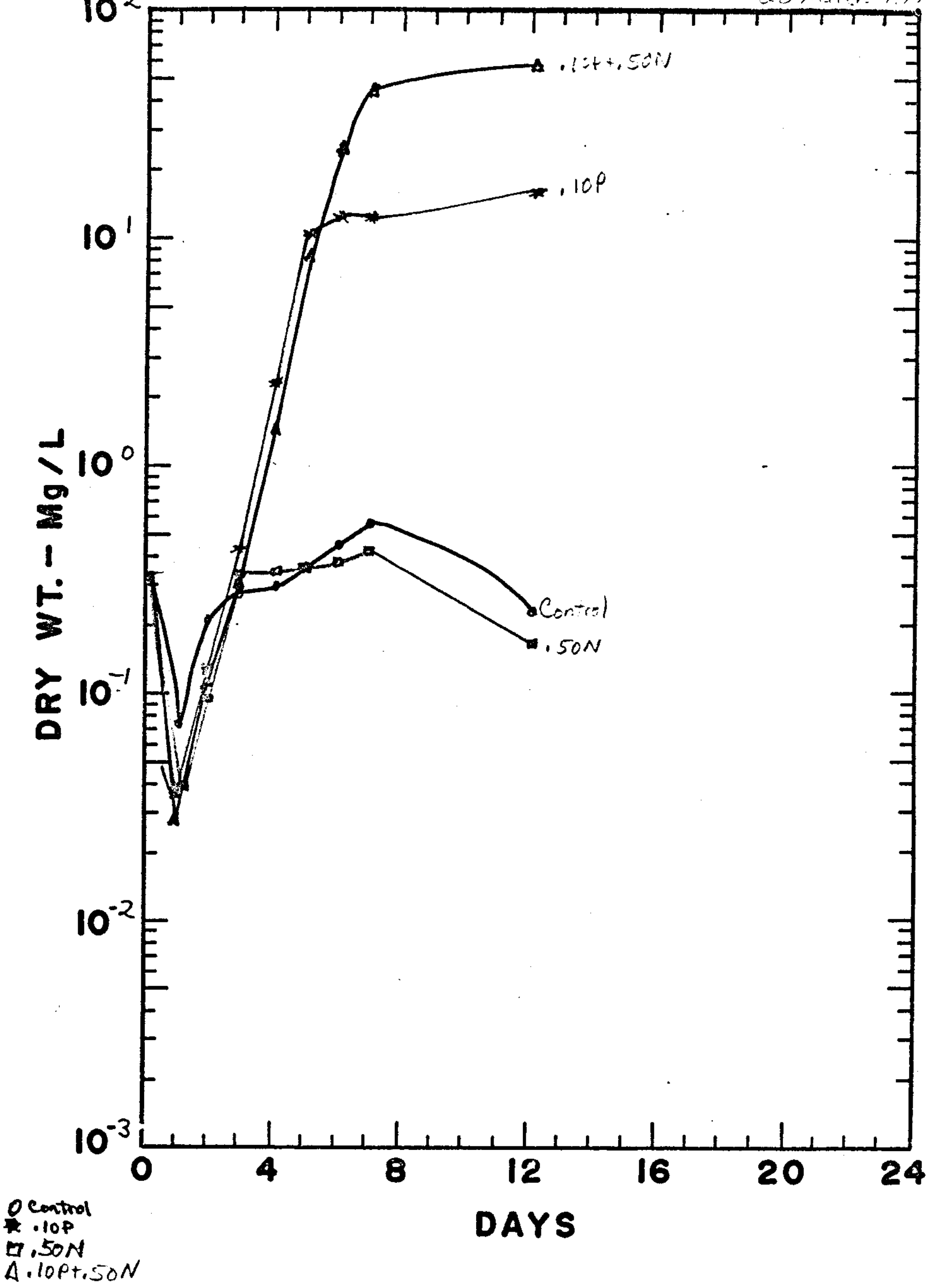
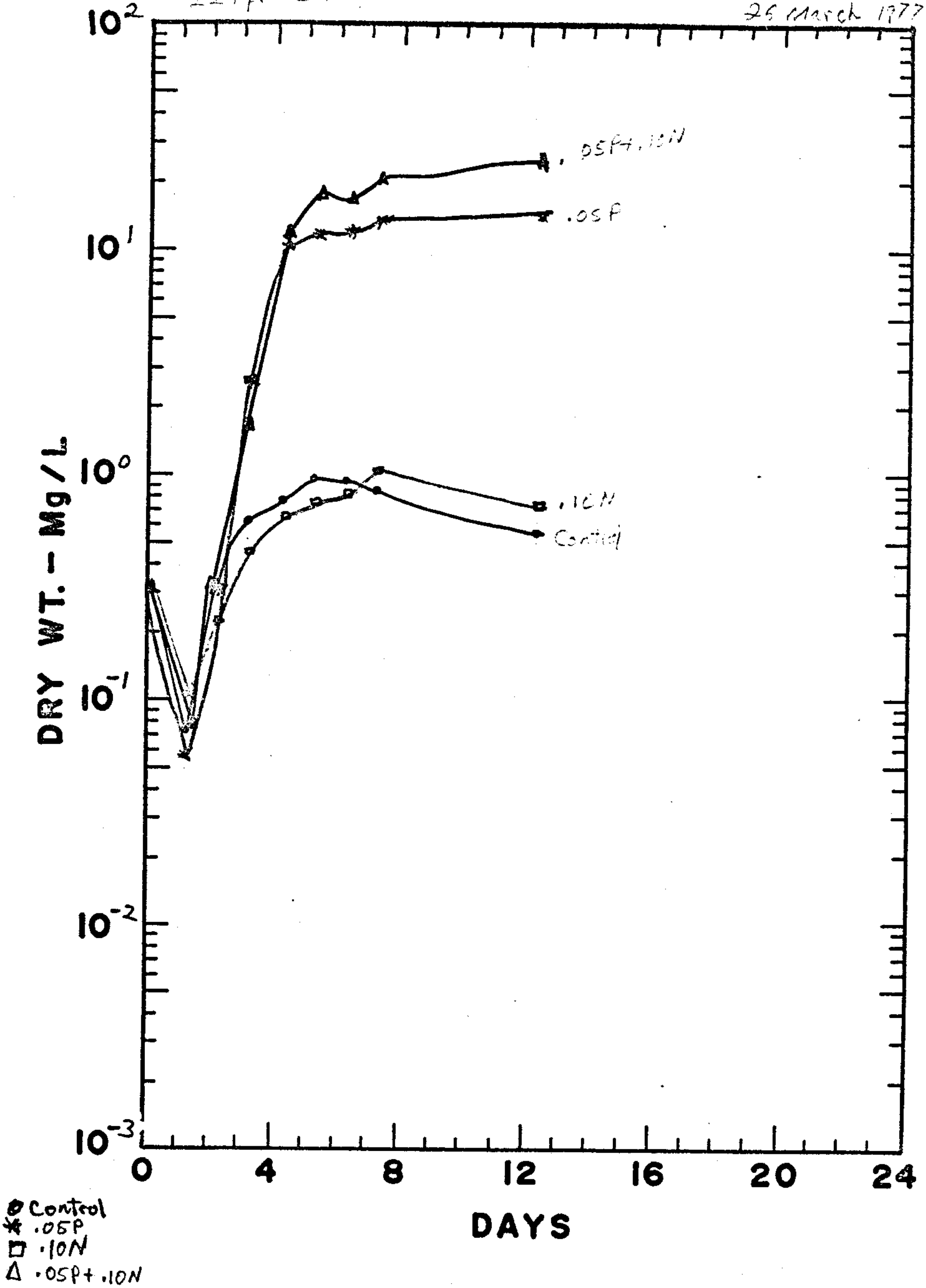


Fig 23 (90)

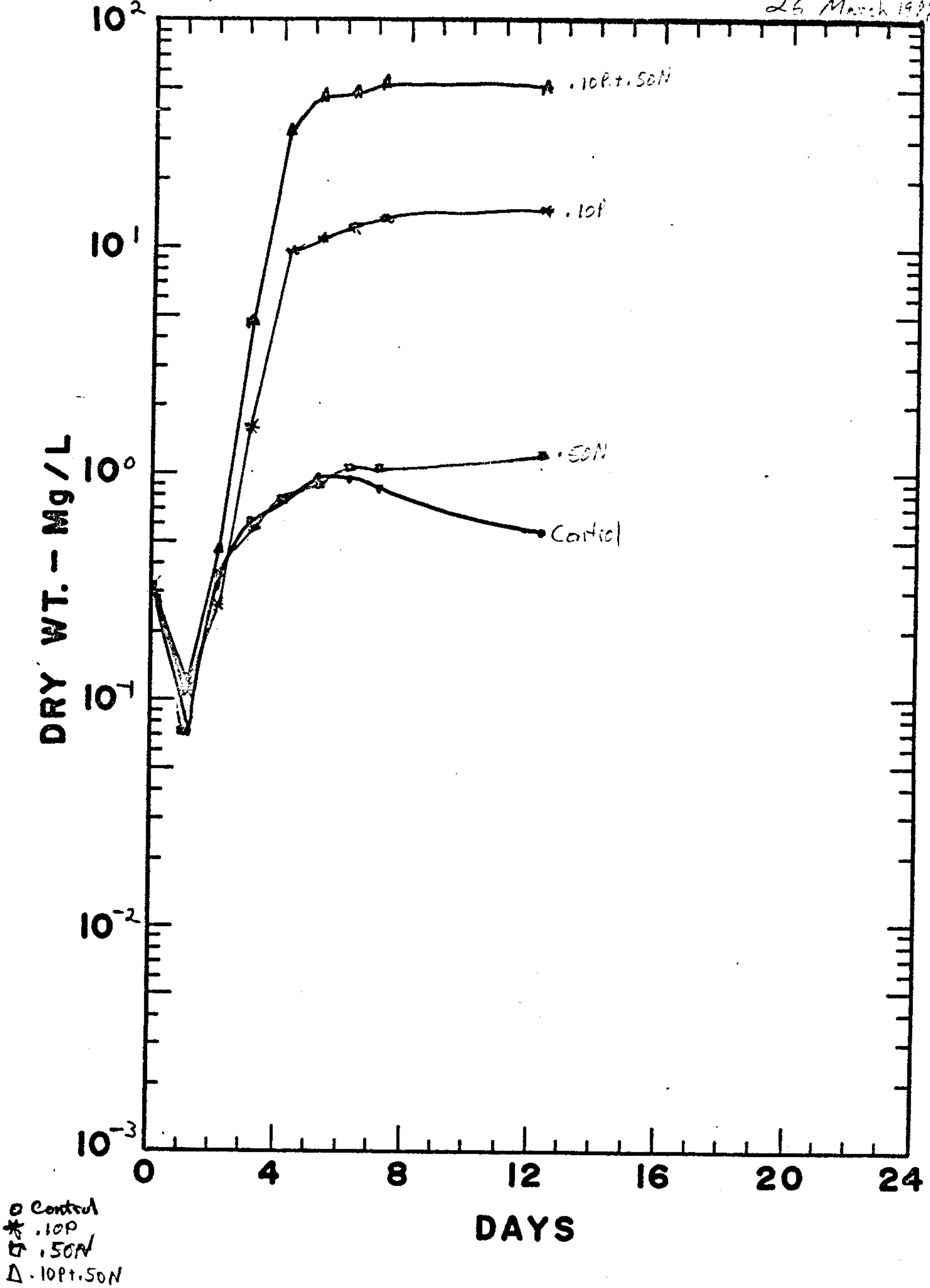
Lemon Bay 251
Station LB-6-C-L
26 March 1977



Dunaliella tertiolecta
Assay 22 ppt - 2 May 1977

Fig. 24(91)

Lemon Bay 252
Station
26 March 1977



Nutrient Loading.

The nutrient load on a system is considered to be the total mass of that nutrient delivered into the system from all sources, including point sources, runoff, ground water and rainfall. During the dry season the predominant sources of loads are point sources, such as the creek mouths, and ground water influx. Ground water loads that pass directly into the Bay are very difficult to estimate and such estimation was not attempted here.

Flow rates at the creek mouths were determined by analyzing data from current meters located at the downstream stations. Net downstream flow rates were figured by subtracting tidal influences. No corrections were made for tidally induced dispersion of the creek water outside their mouths. Flow volumes were calculated by multiplying net rates by approximate cross-sectional areas at the meter sites and appropriate conversion factors for time and volume unit differences. Average values of the various parameters at the downstream stations, as determined from the March sampling runs, were multiplied by flow volumes to give approximate dry season loadings from each creek.

Flow data from Buck Creek were at or below the limits of detection of the meters, so no load data are available. However, with such low flows it is not expected that Buck Creek would make a significant contribution to the system.

The stream flow from Gottfried, Ainger, and Oyster Creeks during the dry season is almost exclusively from ground water. The total flow was determined to be approximately 160 MGD. Contribution by human water usage (through-house or lawn watering) could not exceed the total pumped by the Englewood Water District: which was less than 2 MGD in March.

The nutrient/pollutant loads from the three creeks (Table 48) appear to be quite minimal and should be easily assimilated by the system, especially when

TABLE 48 Estimated Pollutant Loads to Lemon Bay from Gottfried, Ainger, and Oyster Creeks

	Flow Rate[1]	Flow Volume[2]		Total PO_4P		Kjeldahl N		NO_3-N		B.O.D.$_5$		Organic C	
Creek	Ft/Sec	MGD	MLD	LB/Day	KG/Day	LB/Day	KG/Day	LB/Day	KG/Day	LB/Day	KG/Day	LB/Day	KG/Day
Gottfried	.093	27	102	4.2	1.9	210	96	0.9	0.4	450	204	3150	1430
Ainger	.364	53	200	6.6	3.0	340	153	3.4	1.6	880	400	6070	2760
Oyster	.364	82	312	11.7	5.3	540	246	4.6	2.1	1030	468	8510	3870
Total		162	614	22.5	10.2	1090	495	8.9	4.1	2360	1072	17,730	8060

Estimates made on dry season pollutant and flow data using the following formula:

LOAD = (FLOW VOLUME) X (POLLUTANT CONCENTRATION AVERAGE)

[1]Net Downstream Rate Calculated from Current Meter Data at the furthest downstream stations over one tidal cycle, March 26 and 27, 1977.

[2]Flow Volume = (Flow Rate) X (Cross Sectional Area) X (Conversion Factors for Time and Volume) Results in Million Gallons Per Day and Million Liters Per Day.

considering that water from at least as far north as the mouth of Ainger Creek is flushed out of the Bay on a typical ebbing tide (Story, et al., 1975).

The bioalgal assays done on Bay samples collected during the March runs showed that the Bay was both PO_4 and NO_3 limited in different areas. Phosphate and nitrate loads were very small.

In the lower bay stations (LB-3 - LB-6) both B.O.D. and organic carbon levels were quite low, indicating that loads from these parameters are in no way excessive. Loads affecting the northern, more poorly flushed areas of the Bay may be somewhat more critical. Stations LB-1 and LB-2 showed generally higher B.O.D. and carbon values.

It also seems that the northern end was experiencing a bloom of Asterionella japonica (1.63 and 1.35 million cells/liter, respectively) with decreasing, but still somewhat high numbers with increasing distance from the north end (.576 to .177 million cells/liter). The A japonica concentrations in the lower bay were probably due to current transport and are probably not indicative of the ability of the water to support blooms.

Storm runoff in the summer months can be expected to greatly increase stream flow and nutrient and B.O.D. loads to the system, but study of runoff was outside the scope of this project.

Bacteria.

The bacteriological data from the March 26-27 study are summarized in Table 49. The data for the four tidal creeks are graphed in Figure 92 in order to display the relationships of the total concentration of total coliform, fecal coliform, and fecal streptococcus bacteria at the three sample stations on each creek. These figures allow quick visible estimates of fecal coliform and fecal streptococcus ratios. An estimate of the sources of the bacteria may be made if one accepts the assumption that a fecal coliform: fecal strep ratio of less than 4:1 is indicative of non-human sources.

The results of our study agree with those of previous studies as far as the bacterial levels along the Intracoastal Waterway. Bacterial levels at the open water Lemon Bay stations were below detectable levels except for RUN D. In contrast, bacterial levels from the creek stations exhibited a variety of spatial and temporal patterns. Although we will discuss each creek separately, the general patterns are clearly evident in Table 49 .

Gottfried Creek. From a water quality vantage point the water in the vicinity of GC-3 could be classified as polluted if not outright "rotten". The high levels of fecal strep and the fecal coli/fecal strep being less than 4:1 demonstrates that the downstream freshwater flow above this station is carrying pasturage runoff. Although the bacterial levels were lower at GC-2 at the SR 777 bridge, the levels were still above acceptable levels. From what we know about the tidal current, circulation, and nutrient levels in this segment of the creek, it appears that the degraded water quality in this segment is due primarily to upstream surface water runoff. In each instance a relatively high fecal coliform count was accompanied by a proportionally high fecal streptococcus count. The lower bacterial counts at GC-1 also indicate that at least during this study that non-human sources were contributing to the bacterial levels in the water.

Table 49. Summary of bacteriological data from 208 water quality study, March 26-27, 1977 for total coliform, fecal coliform, and fecal streptococcus with millipore filter method. Results expressed as colonies per 100 ml. LB - Lemon Bay; GC - Gottfried Creek; AC - Ainger Creek; OC - Oyster Creek; BC - Buck Creek. See Figure 66 for station locations.

			Stations																	
Test	Run	Time	LB1	LB2	LB3	LB4	LB5	LB6	GC1	GC2	GC3	AC1	AC2	AC3	OC1	OC2	OC3	BC1	BC2	BC3
Total coli	A	26-0900	0	20	0	0	0	0	0	80	440	0	100	40	40	180	100	40	1160	1700
	B	-1230	0	20	0	0	0	0	40	360	320	20	20	20	0	20	0	0	1000	920
	C	-1600	0	0	0	0	0	0	20	60	1280	0	420	60	20	160	180	40	360	760
	D	-1930	20	120	100	0	40	60	580	960	TNTC*	320	400	300	340	380	540	0	TNTC	TNTC
	F	27-0900	0	0	60	40	0	0	120	140	TNTC	340	160	180	80	800	1200	180	TNTC	TNTC
	G	-1600	0	0	0	0	0	20	-	60	1920	260	280	40	160	60	120	120	1160	TNTC
	H	-2000	-	-	-	-	-	-	200	120	1020	120	80	80	360	300	100	80	1760	2200
Fecal coli	A	26-0900	10	0	0	0	0	0	0	0	160	30	0	0	0	140	0	10	20	30
	B	-1230	0	0	0	0	0	0	0	80	200	0	10	10	0	0	0	0	10	20
	C	-1600	0	0	0	0	0	0	10	20	0	20	100	0	60	0	100	30	0	20
	D	-1930	0	0	0	20	0	0	430	170	0	0	110	0	150	210	-	0	10	-
	F	27-0900	0	0	0	0	10	0	40	10	70	20	30	0	10	0	20	0	0	20
	G	-1600	10	0	0	0	0	0	0	30	90	50	100	10	40	10	30	10	40	30
	H	-2000	-	-	-	-	-	-	10	20	130	0	50	0	80	70	70	20	100	30
Fecal strep	A	26-0900	10	0	0	0	0	0	10	30	540	0	40	0	10	140	70	120	30	30
	B	-1230	0	0	0	0	0	0	0	30	90	10	20	20	0	40	20	10	10	10
	C	-1600	10	0	0	0	0	10	10	70	260	160	60	70	50	3030	260	20	200	150
	D	-1930	10	0	0	0	0	0	150	80	410	20	90	490	30	120	240	30	60	250
	F	-0900	0	0	0	0	0	0	50	70	140	0	30	50	10	480	40	0	60	30
	G	-1600	0	0	0	0	0	0	0	10	140	20	100	20	50	80	160	0	40	10
	H	-2000	-	-	-	-	-	-	0	0	290	60	60	110	70	230	50	10	10	30

* TNTC Too numerous to count; non-ideal plates.

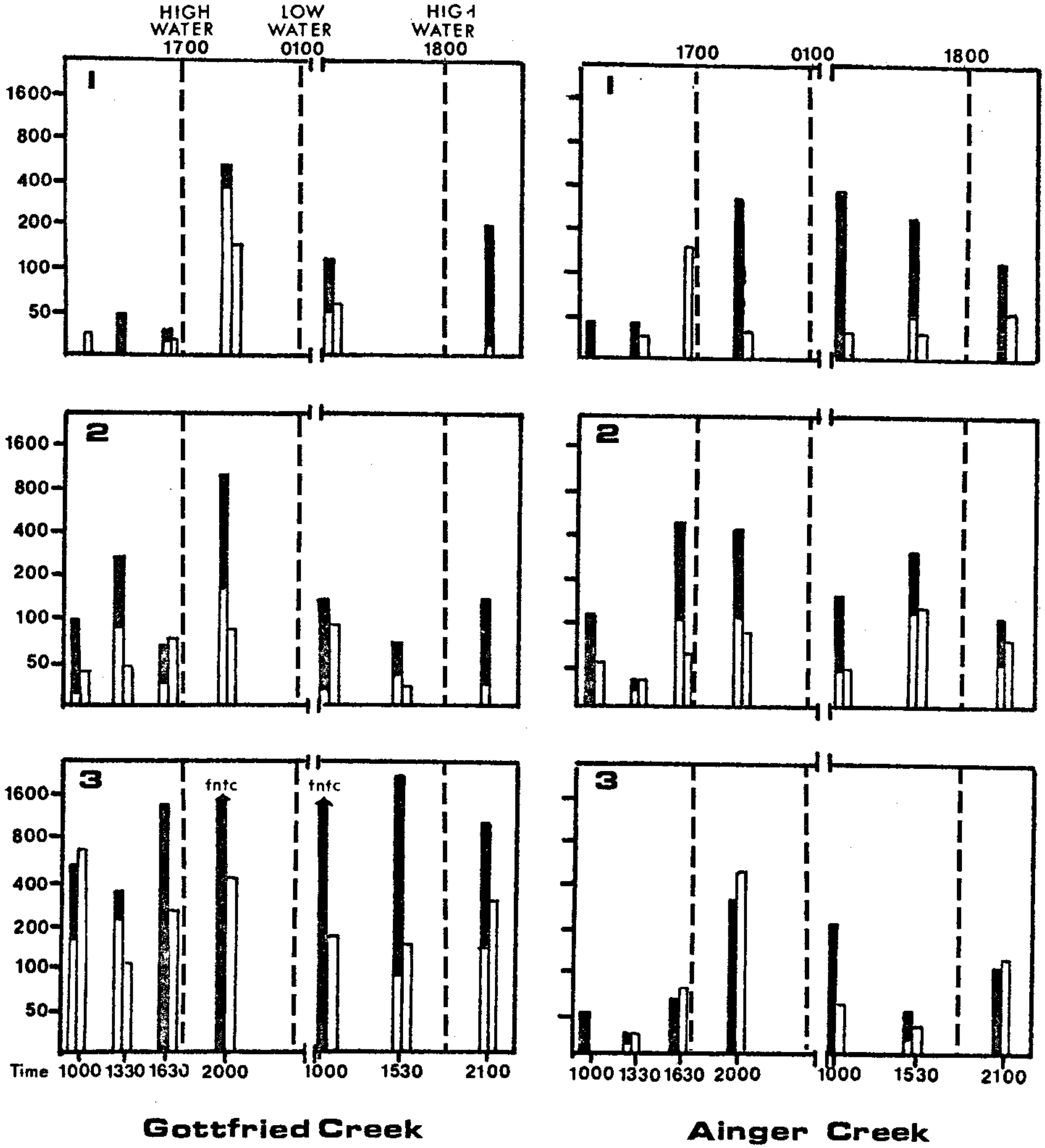


Figure 92. Total coliform (solid bar), fecal coliform (open bar underlying solid bar when present) and fecal strep (open bar on right side of time marks) concentrations (colonies/100 ml) for seven of the water quality sample runs, March 26 - 27, 1977. Sample station numbers on each creek indicated by number in upper left corner.

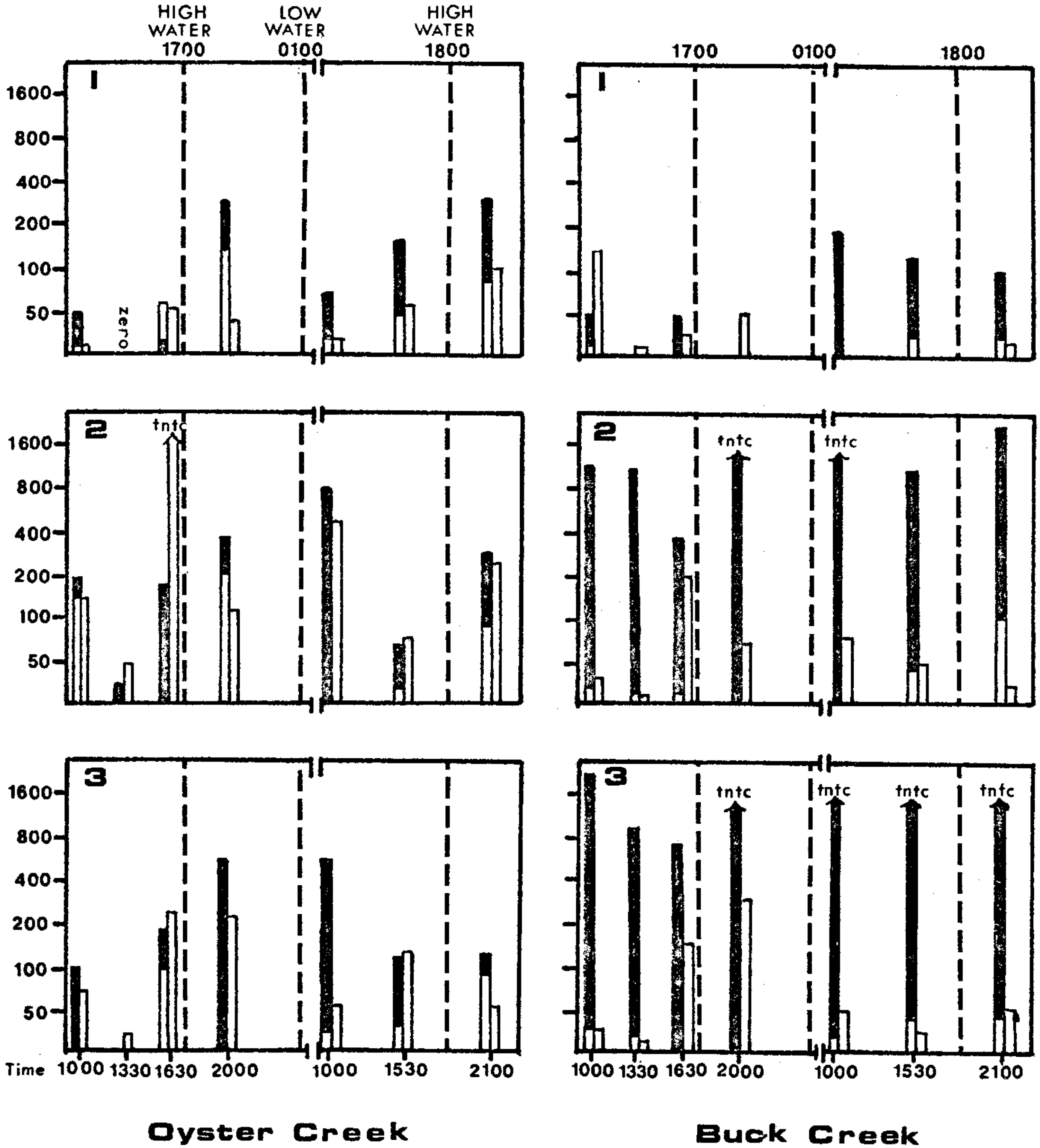


Figure 92,continued.

Ainger Creek. From Table 49 and Figure 92 one can see that even though high counts of total coliforms occurred at all three stations, they were generally lower than counts at GC-2 and GC-3. Furthermore, fecal strep. counts generally equalled or exceeded fecal coliform counts, and in two cases (AC-3, Runs D and H) exceeded the total coliform counts. Again the major sources of the bacteria in the creek during this study do not appear to be human wastewater.

Oyster Creek. In contrast to Gottfried and Ainger Creek, Oyster Creek had peculiar bacterial patterns at all three sample stations. The data in Table 49 and Figure 92 show that, depending on the tide and/or time of day, the fecal bacteria of segment 1 (OC-1) of the creek had a high fecal coliform/fecal strep. ratio. In segments 2 and 3 (OC-2 and OC-3) high fecal coliform counts were accompanied by higher fecal strep. counts. Thus it appears that the major sources of bacteria in the samples from these stations lie upstream of the suburban area. While we suspected this to be the case for OC-3 at the San Casa Road bridge, we did not anticipate this conclusion for the water in the vicinity of OC-2. Apparently runoff and drainage from the wetland region upstream of OC-2 on the south branch of Oyster Creek is a major element contributing to the lowered water quality in this segment of the creek.

Buck Creek. The extremely high total coliform counts accompanied by low fecal bacterial counts and low fecal coliform/fecal strep. ratios were at first both dramatic and unexplainable. However, as the pieces of the water quality and land use patterns of the Buck Creek watershed fell into place, it became clear that the causative factors were the land development activity in the vicinity of the Rotunda River and surface runoff from the light rain on March 25, the day before our water quality study. The patterns of the bacterial counts at BC-1 and BC-2 further illustrate the sluggish nature of the tidal circulation in this creek prior to the recent dam at BC-2. In conclusion the high bacterial counts at the

Buck Creek stations indicate that the creek proper is not impacted by on-site wastewater systems. However, this may not be true for the two dead end canals at the mouth of the creek.

This raises important questions about the water quality in the dead end canals in the Lemon Bay area which were outside the work scope of this study. The general design of these canals, their orientation relative to tidal flushing, and the fact that a majority of waterfront housing units occur on canal margins leads us to suspect that their overall water quality is low and quite possibly a health hazard. Since the exchange of the waters in these canals with the tidal waters of creeks is relatively slow and the downstream assimilative capacities of the shallow areas of the creeks and eastern shores of Lemon Bay relatively high, the impact of waters from the canals is minimized for the present.

Wet Season Bacteriological Study. One immediate criticism of the results above is that the study was conducted during the dry season when the ground water table was low and ground water flow from on-site wastewater systems was minimal. Accordingly, on August 16, 1977 we sampled the tidal creek stations and two Lemon Bay stations at dawn and dusk. The results of this study (Table 50) show that the fecal coliform/fecal strep. ratio was less than 4:1 for every station, indicating that the bacteria in the waters of the creeks at the times of sampling were of non-human origin. Interestingly, the total coliform counts at Stations GC-3, BC-2 and BC-3 were measurably lower than the counts at the stations in the March study. In the case of GC-3 it appears that the runoff from the pastured watershed upstream of the station between the two sampling dates had removed most of the upland surface material prior to the August study.

Table 50 Summary of Bacteriological Data from 208 Water Quality Study in Lemon Bay Complex, August, 1977. Total coliform, fecal coliform and fecal streptococcus with millipore filter method. Results expressed as colonies per 100 ml. See Figure 66 for locations of stations.

			STATIONS													
Test	Run	Time	LBA	LBB	GC1	GC2	GC3	AC1	AC2	AC3	OC1	OC2	OC3	BC1	BC2	BC3
Total Coli	A	0730	10	40	280	680	1200	100	200	180	80	640	800	60	240	140
	B	1800	0	30	270	160	730	20	30	30	40	60	450	20	60	200
Fecal Coli	A	0730	0	10	190	120	200	10	0	30	60	40	110	10	10	10
	B	1800	0	30	200	40	110	0	20	0	30	0	80	20	10	0
Fecal Strep	A	0730	30	10	220	590	640	100	80	20	20	100	590	40	90	0
	B	1800	50	10	150	120	240	30	40	20	30	100	470	0	30	0

MF colonies per 100 ml

Validity of the Bacteriological Results. A second serious criticism of the bacterial data is that the millipore filter method was used rather than the fermentation tube method. Thus, while the values we obtained with the millipore filter method may not be optimal values, they do provide a base for comparing relative levels of bacteria in the water sampled at the several stations. The serious student of bacterial contamination of surface waters may wish to compare our results with the total and fecal coliform data for water samples collected on March 28 and August 15, 1977 by the Charlotte County Health Department.

Phytoplankton. Next to water temperature, phytoplankton is perhaps the easiest water quality parameter to sample but the most laborious to analyze. Although the determination of chlorophylls is frequently the preferred approach to determining the abundance of phytoplankton and the relative degree of "eutrophication", our laboratory was unable to analyze 144 samples for chlorophyll within the time constraints of the 48 hour March sampling program. At the same time it appeared that more could be learned about the water quality patterns in the sampling network by determining the number of cells of different species of phytoplankton.

Although only the samples from RUN B have been analyzed, the results disclosed some interesting and disturbing phenomena. Table 51 shows that at the time of sampling, Lemon Bay was experiencing a "bloom" of the diatom, *Astrionella japonica*.

While segments of this bloom extended up the creeks, particularly Oyster Creek, other "less desirable" species of phytoplankton were present at several creek stations (Table 52). In particular, the relatively high counts of *Gonyaulax* in Ainger and Gottfried Creeks indicate that resident populations of this dinoflagellate in the tidal creeks should be monitored regularly, since species of *Gonyaulax* are the major causative agents of shellfish poisoning. Likewise the bloom of the blue green alga *Anabena* in Buck Creek (BC-2, BC-3) represents a second potential source of shellfish poisoning. However, this particular species of Anabena is probably killed by the high salinity waters of the Bay.

Future water quality programs in the Lemon Bay area might incorporate phytoplankton and fecal streptococcus assays on a routine basis.

Table 51 Phytoplankton at Lemon Bay, Stations 1-6, Run B. March 26, 1977

	Cells Per 10 milliliters					
	LB-1	LB-2	LB-3	LB-4	LB-5	LB-6
Melosira sulcata	133	75	67	75	100	-
Skeletonema costatum	16	-	383	392	400	217
Asterionella japonica	16316	13508	5758	3117	3092	1775
Charactocerus spp.	417	142	625	125	292	150
Nitzschia longissima	42	25	8	25	33	17
N. closterium	-	8	158	42	117	100
Gyrosigma spp.	92	42	100	200	58	167
Pleurosigma spp.	117	8	50	17	17	17
Amphora spp.	158	117	50	125	150	58
Navicula spp.	-	75	50	108	183	100
Grammatophora sp.	42	-	267	183	225	117
Rhizosolena spp.	16	-	58	67	8	58
Tagellavia sp.	33	-	-	-	-	-
Actinastrum sp.	33	-	-	-	-	-
Peridinium sp.	-	92	-	8	8	-
Biddulphia sp.	-	50	42	-	-	-
Ceratium sp.	-	8	-	-	-	-
Ceratium hirundenella	-	8	-	8	-	-
Stephanoxyii sp.	-	-	17	83	-	58
Triceratium sp.	-	-	-	33	17	-
Thallasosira sp.	-	-	-	50	42	-
Scenedesmus sp.	-	-	-	-	42	-
Oscillatoria sp.	-	-	-	-	-	-
Tropidoneis spp.	-	-	-	-	-	-

Table 52 Phytoplankton at Tidal Creek Stations 2 and 3, Run B, March 26, 1977

	Cells Per 10 milliliters							
	AC-2	AC-3	OC-2	OC-3	BC-2	BC-3	GC-2	GC-3
Gonyaulax sp.	1700	1292	338	-	-	-	2758	88
Euglena (Gyrosigma)	17	3033	25725	-	33	33	317	-
Peridinium sp.	42	-	-	-	-	-	-	-
Navicula spp.	17	-	163	13	50	8	183	213
Asterionella japonica	175	-	388	10075	-	-	17	-
Skeletonema costatum	92	3467	1813	4138	-	-	-	-
Gymnodinium sp.	-	817	-	-	75	-	-	-
Gymnodinium splendens	25	25	-	-	-	-	258	-
Pleurosigma spp.	8	-	88	113	17	-	67	13
Gyrosigma spp.	-	8	38	25	-	-	-	-
Amphora spp.	8	-	225	100	8	-	633	2188
Nitzschia closterium	17	8	150	163	8	-	17	-
Grammatophora sp.	-	-	100	138	-	8	50	13
Nitzschia longissima	-	-	75	75	-	-	-	-
Tropidoneis spp.	-	-	38	13	-	-	-	-
Fragilloria sp.	-	-	-	13	-	-	-	-
Chaetocerous spp.	-	-	-	1838	-	-	-	-
Rhizosolena spp.	-	-	-	313	-	-	-	-
Melosira sulcata	-	-	-	138	-	-	-	-
Pediastrun sp.	-	-	-	-	17	-	-	-
Ceratium hirundenella	-	-	-	-	83	158	-	-
Anabena sp.	-	-	-	-	5417	38542	-	-
Oscillatoria	-	-	-	-	-	117	-	-
Cocconeis sp.	-	-	-	-	-	-	17	-

HOT SPOTS

The review and analysis of the water quality of Lemon Bay, and the potential impact of septic tank systems on the water quality of the bay and its tributaries would not be complete without red flagging potential "hot spot", non-point source pollutant areas. From our field studies and laboratory analyses and other water quality studies, we have mapped (Map XI) 12 areas in the Lemon Bay complex whose upland activities are contributing, or may contribute, to the apparent decline in the water quality in Lemon Bay. Table 53 summarizes the potential causitive element(s) for each area. However, each area deserves a brief explanation because not everyone may agree on certain areas.

Area 1. Lemon Bay from Forked Creek north to Alligator Creek. The water quality in this area has and will probably continue to be low due to the variety of non-point sources and wasteloads entering the Bay. These wasteloads remain in this narrow segment of the bay for a relatively long time because of the poor tidal flushing. Furthermore, the ability of the bay to assimilate the wasteloads is low, because of a relative lack of marine grass beds north of Manasota Key Bridge.

Area 2. Artist's Avenue Subdivision Area of Englewood. The soils, the topography and the drainage along the historical west branch of Gottfried Creek make this area below the 11 to 12 foot contour line a high risk area for siting septic tank systems even if the system is elevated above the natural ground level. Future developments in this area between Edwards Street and Wentworth Street should be compatible with the existing drainage and wet season flooding constraints. Construction of a series of real estate lakes and improvement of the stream flow in the west branch of

TABLE 53

KEY FOR WATER QUALITY HOT SPOTS MAP

NO.	LOCATION	PROBABLE OR POTENTIAL CAUSES OF LOWERED WATER QUALITY
1.	Lemon Bay, northwards from south of Forked Creek	poor tidal circulation
2.	Artists Avenue area	area unsuitable for septic tanks because of poorly drained soils
3.	Gottfried Creek, northern section	poor flushing
4.	Gottfried Creek, southern section	undetermined
5.	Ainger Creek, mid-section	poor flushing
6.	Ainger Creek, eastern canals	poor flushing
7.	Ainger Creek, mouth	poor flushing of canals; marinas
8.	Oyster Creek, south fork	poor flushing
9.	Oyster Creek by S.R. 776	land development
10.	Buck Creek near Rotunda	land development
11.	Don Pedro Island	area unsuitable for septic tanks because of poorly drained soils
12.	Dead end canals on Lemon Bay, Grove City	poor flushing

Gottfried Creek could improve the existing situation. However, such a program would require proper forethought, design and individual landowner cooperation.

Area 3. North Section of Gottfried Creek. North of the Deer Creek Trailer Park, Gottfried Creek is poorly flushed. At the same time, major roadside storm water outfalls occur at SR 777 and north of SR 777. At the same time, nutrient-bacterial enriched fresh water flows into this area from the upstream pastured and partially channelized segments of the creeks. To a certain degree the low water quality in this area is a natural historical phenomenon. Therefore, before further channelization and a flood control program like that developed by Smalley, Wellford and Nalven for the Board of County Commissioners, Sarasota County, 1965, occurs, serious consideration should be given to the roles the upper watersheds of Gottfried Creek play in the nutrient regime of the downstream surface waters and the groundwater-aquifer recharge system.

Area 4. Southern Section of Gottfried Creek. The data from our study as well as other water quality studies indicate that somewhere in the vicinity of the mouth of the Creek there exists one or more significant wasteload sources. Because of the tidal circulation patterns at the mouth of the Creek, it appears that onsite waste water systems and irrigation runoff, plus ground water seepage from one or more waterfront units on the Point of Pines are contributing measurably to the wasteload in this area.

Area 5. Midsection of Ainger Creek. The water quality in the long, deadend canals perpendicular to the streamflow and tidal currents in section 2 of Ainger Creek will continue to deteriorate as the lots along the canals are filled with housing units. Even where there is a central sewage system, the water quality will deteriorate unless the canals are redesigned or receive the proper maintenance. The same is true for other dead end canals in the Lemon Bay 208 Study Complex.

Area 6. Eastern Canals of Ainger Creek. The long and deep dead end canals in section 3 of Ainger Creek will experience water quality problems resulting from surface water runoff from waterfront lots and the roadside drainage networks.

Area 7. Mouth of Ainger Creek. All of the evidence to date indicates that water from the three dead end canals in the vicinity of the bridge at S.R. 775 is the primary contributor to the unacceptable levels of nutrients and pollutants in section 1 of the Creek. Both the canals and some of the waterfront housing units date from the late 1940's. The water quality in this area could be improved if improperly located septic tank systems were resited and if the canals were scoured to remove some 30 years' worth of sediments rich in organic matter.

Area 8. South Branch of Oyster Creek. From the results of previous water quality studies and the local geography, one could conclude that the low water quality in this section of Oyster Creek is due to the waterfront housing along the Creek and in particular along the Brookwood Road Canal. However, the results of our bacteriological studies demonstrate that drainage from the wetland areas upstream of the suburban development on this section of the Creek is the major source of the wasteload.

Area 9. Oyster Creek, Northeast of San Casa Road. At the present time the surface water entering the Creek in this area has a relatively high nutrient-sediment-pollutant wasteload derived from nearby land development activities and an improved pasture. The character of this wasteload will undoubtedly change in the future.

Area 10. Buck Creek, Downstream of Rotunda River. At the present time the waters of Buck Creek are receiving high amounts of nutrients, sediment and fine silt via surface runoff from nearby land development activities. In the future, surface runoff from the developed land will continue to be the major non-point source of pollution for Buck Creek.

Area 11. Don Pedro and Knight Island. Until now, the contribution to the wasteload of the southern segment of Lemon by land development and the seawalling of historical dead end tidal channels on the bayside of these islands has been minimal. However, platted land sales and homesite construction are increasing. Septic tank system permits are being issued. If, and when, the islands are connected to the mainland by a bridge, land development and waterfront homesite activities will become major elements in the wasteload budget in this area. However, a major portion of this wasteload will probably flow south out of Lemon Bay and into Placida Harbor.

Area 12. Grove City Dead End Canals on Lemon Bay. The 1975-1977 water quality data of the Charlotte County Health Department indicate that the waters in these canals are receiving significant wasteloads from waterfront housing units. Although the origins of the wasteloads have not been identified, ground water drainage through the dredged spoil soil of some of the lots on the canals is probably a major contributing factor. Spoil soil is one of the few soils in the area for which there is little or no information on the soil's characteristics. Since building sites on the filled sections of these and other dead end canals are underlain by this type of soil, this soil merits immediate study.

Other areas with dead end canal systems with spoil soil from submerged lands include New Point Comfort, the mouths of Buck and Lemon Creeks, and the bay side of Don Pedro Island.

SEPTIC TANK SYSTEMS

An Introduction to their Problems, Maintenance, Improvement, and Alternatives

Not all on-site septic tank wasteater systems are bad. Some are better than others. Contamination of surface and ground water by a septic tank system begins with the permitted platting and zoning of a housing unit or subdivision and ends with the overt symptoms of failure of the system to function properly. Usually the first sign of failure is a sluggish toilet, one week to two months before the system dies.

Six causes for failure may occur from the time of the initial site evaluation to construction. Where one or more of these occur, failure of the system may occur within three years. The six causes or problems are as follows:

1. Poor evaluation of the site for the tank treatment field by the installer.
2. Failure of the regulatory agency to reject applications with poor siting or design.
3. Design specifications not followed during construction and construction not inspected.
4. Poor construction procedures used by the installer.
5. Mistakes overlooked and errors in judgment during the site inspection by the regulatory agency.
6. System overloading beyond design specifications due to increased wastewater volume following installation.

Early failure is avoided when the system is designed and installed with close cooperation between the installer, regulatory agency and soil scientist (Otis et al., 1977). Once the housing unit is occupied the burden of responsibility for the proper operation and maintenance becomes that of the housing unit user(s).

The best and most readily available introduction to septic tank systems and their maintenance is the Manual of Septic Practice, Public Health Service, Publ. No. 526, U. S. Department of Health, Education and Welfare, Public Health Service, available either from the local County Health Department or the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C., 20201 at a cost of 35 cents. Two other up-to-date and readable manuals on septic tank and other on-site systems are Manual of Grey Water Treatment Practice, J. H. T. Winneberger (ed) (1974) and Individual On-site Wastewater Systems, Nina I. McCelland (ed) (1977). All three manuals should be in every local library if not on every household coffee table or bathroom reading rack. At the local level the best counsel is that of the most experienced and reliable septic tank installation and servicing firms.

From the beginning of occupancy of the dwelling a chart should be displayed in an appropriate place in the dwelling served by the system. The chart should show the location of each septic tank and the treatment field. The chart (s) should include the data on the original permit(s), brief instructions for proper inspection and maintenance programs, and records of the dates of inspection, cleaning, symptoms of failures, flooding, etc. If one or more generation of occupants have occupied the site, the present occupant should obtain a copy of the original permit and records of any maintenance program. This can in some instances become equivalent in time and effort to a title search on the property itself.

In the Lemon Bay area and southwest Florida in general, septic tank systems were often improperly installed and improperly sited. Prior to 1972 treatment fields might be as close as 10 feet to edges of waterways; treatment fields in poorly drained soils or fields that failed to function were not infrequently by-passed by sewer pipe or underlain by a French tile subfield drainage system. However, following April 25, 1972 when the present day septic tank regulations began, fields had to be located at least 50 feet from the edge of open water. Systems installed after 1972 have been subject to closely supervised permitting regulations. Furthermore, the local health departments have been directly involved in site inspections, percolation tests, and checking on the system during construction.

In the Lemon Bay area septic tank systems installed since 1972 have been required to be 39 inches above the highest ground water level. If necessary, the system has been built above ground level and buried under a landscaped mound. This was not always true in older systems which cannot be corrected without building a completely new system and sometimes even elevating the house.

The following list of DO's and DO NOT's may help the homeowner and, in turn, help the local community maintain and improve the quality of the local surface waters.

1. DO have septic tank manholes and inspection holes within 8 inches of the ground surface to simplify maintenance and cleaning.
2. DO have the soil absorption system inspected immediately if it is older than 15 years.
3. DO inspect the septic tank once a year for the accumulation of sludge and surface scum.
4. DO have the septic tank pumped and properly cleaned if the bottom of the surface scum is within 3 inches of the tank's outlet pipe. Detergent and other scums clog the soil absorption field, shortening its potential life.

5. DO have the sludge in the tank pumped every 3 to 5 years. The cost is nominal, about $30.00. More frequent pumping destroys proper bacterial action. Biodegradable soaps and occasional addition of yeast help keep the tank's bacterial system "healthy". A small residual amount of sludge should be left in the tank.
6. DO NOT add proprietory"septic tank cleaning" compounds to the system. Many contain caustic soda (sodium hydroxide) which interferes with bacterial digestion. Further, the resulting alkaline effluent from the tank will damage the soil structure of the absorption field.
7. DO NOT use a kitchen garbage disposal, if possible. Garbage disposal units are a cultural convenience that unnecessarily burden the septic tank system. If one insists on using this mechanical device, the septic tank should be pumped every two years. In the BOD_5 of household grey water 70% comes from the kitchen garbage disposal unit.
8. DO NOT pipe roof drains, foundation drains, and other drainage that produces large intermittent or constant volumes of water into the septic tank or absorption area.
9. DO NOT flush toilet paper substitutes, paper towels, newspapers, rags, etc., or tampons into a septic tank or your flush toilet will soon become rather sluggish due to inlet/outlet clogging.
10. DO have the absorption field properly sited, designed, constructed, and located within 24 inches of the soil surface since the highest concentration of soil bacteria is found above this depth.
11. DO NOT irrigate or water the vegetation in the immediate vicinity of the absorption field. This may increase the drainage load on the field.

12. DO consider two absorption fields when the first one fails and has to be rebuilt. With two fields and a diversion valve the two fields may be used alternately thereby prolonging the life of both fields.

13. DO route black water from toilets to one septic tank system and household grey water to a second septic tank system if there is one. This will increase the length of time black water wastes remain in the tank for digestion.

14. DO consider using modern waste flow reduction and water saving devices. A recent report by Cohen et al. (1974) entitled "Demonstration of Wasteflow Reduction From Households" is available from the U. S. Environmental Protection Agency, Cincinnati, Ohio and reviews the costs and effectiveness of various wastewater conserving devices such as shallow trap toilets, toilet tank inserts, flow limiting shower heads and wash water (grey water) reuse systems for lawn sprinkling. The water reuse systems would be most appropriate in southwest Florida where large volumes of water are used for lawn sprinkling during the peak population, dry season, causing a marked draw down of water levels in artesian wells. At the same time reuse of grey water would reduce the wasteload of on-site wastewater systems.

15. DO undertake a neighborhood dye tracer test program to identify faulty septic tank systems in the various waterfront developments. Local groups throughout the country, particularly resort homeowner associations on small northern lakes, have begun to conduct dye tracer tests with the aid of local public health departments. A "grass roots" initiation and participation test program is the best approach for the strongest position in the septic tank controversy at the local level.

16. DO become as well informed as possible about the rapidly evolving alternatives for planning waste treatment for small communities as well as communities having low densities of housing units spread over a large area as in the Englewood Water District.

Every small community needs to be informed of the recent directives defining the new Federal EPA policies on wastewater treatment systems for small communities. In particular the information in the EPA's Construction Grants Program Requirements PRM #76 on the "Eligibility of septic tanks, and other small treatment systems" and the technical booklets from the March 7-9, 1977 seminars on small wastewater treatment systems should be aired publicly at the local level.

Additional information may be obtained from the office of

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17. DO consider as a community more stringent guidelines and regulations at the local level with respect to waterfront developments. In the last 10 years the public has become increasingly informed of conclusions from an ever increasing number of research reports on rates and distances of travel of bacteria, viruses, and nutrients in different types of soils. It now appears that for many types of sandy soils the minimum safe distance from the absorption field to water courses is at least 100 feet (i.e., Motts, 1976). Where the depths of platted lots and roads do not allow such a setback line, then a local alternative waste treatment system should be used. This will require planning for appropriate space and location of such a system in the

subdivision or neighborhood.

18. DO remember the following statements in a memorandum, dated December 30, 1976, from Russell E. Train, Director of the U. S. Environmental Protection Agency to the agency's regional administrators "The (wastewater) facility plans with some recent exceptions, generally did not analyze the alternative of non-sewered systems for small communities even where potentially cost-effective---This alternative appears to have been overlooked in part because it is not in the facility planner's vocabulary of solutions."

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FINAL REPORT ON THE 208 PROGRAM WATER QUALITY STUDY OF THE LEMON BAY COMPLEX STUDY AREA

prepared for:

Southwest Florida Regional Planning Council

By:

Dr. John B. Morrill, Raymond Gasser, Dr. Claudia B. Morrill, Scott Baker, and Therese Hayes, Environmental Studies Program, New College

and

Craig Dye, Florida State Department of Environmental Regulation, Tallahassee

In Collaboration with:

Mark Evans, Bert Luer, and Katy Swain, Environmental Studies Program; Richard Pfeuffer, Englewood Medical Laboratories; and the Lee County Environmental Laboratory

August 31, 1977

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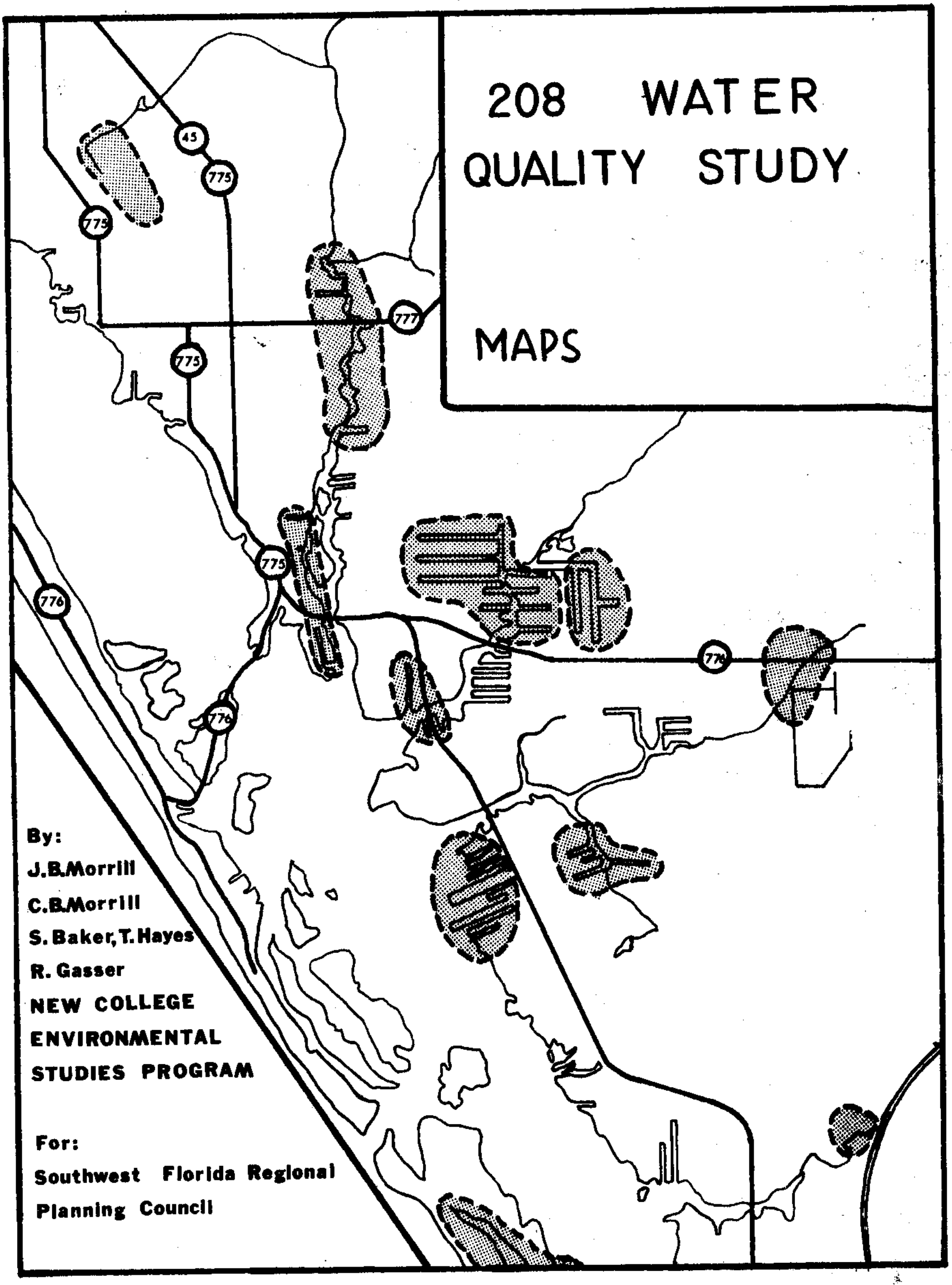
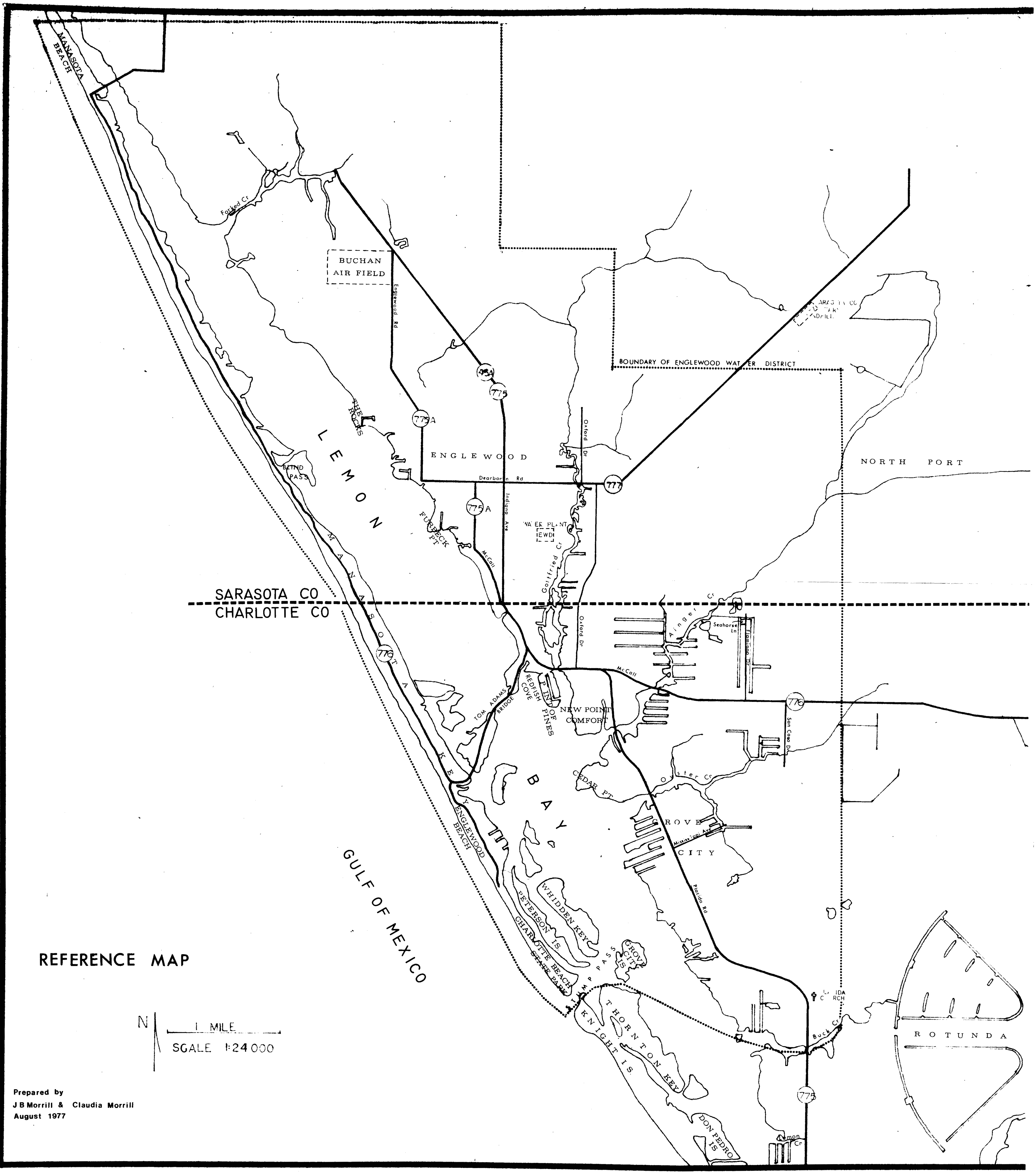
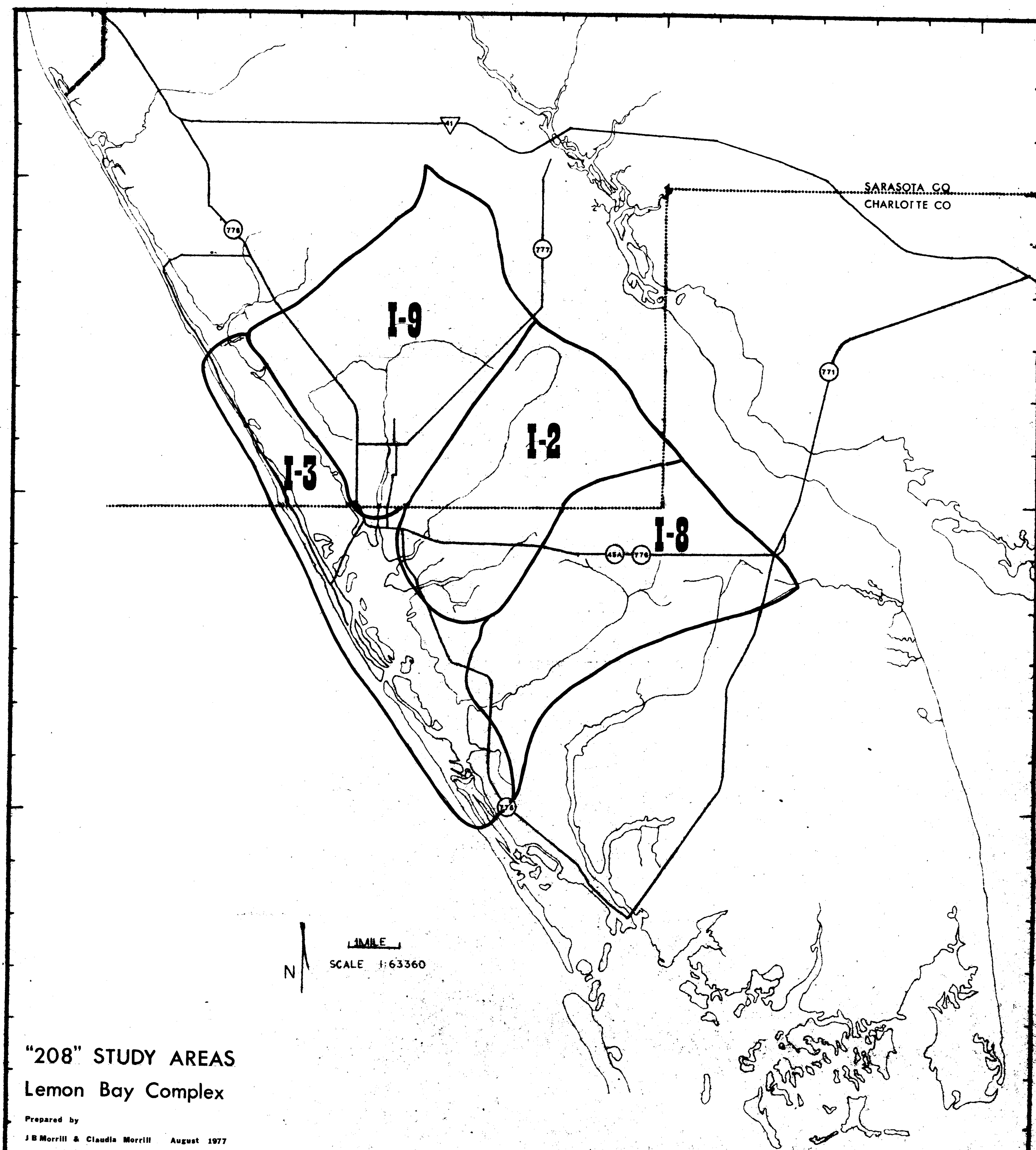


By:
J.B.Morrill
C.B.Morrill
S. Baker, T. Hayes
R. Gasser
NEW COLLEGE
ENVIRONMENTAL
STUDIES PROGRAM

For:
Southwest Florida Regional
Planning Council

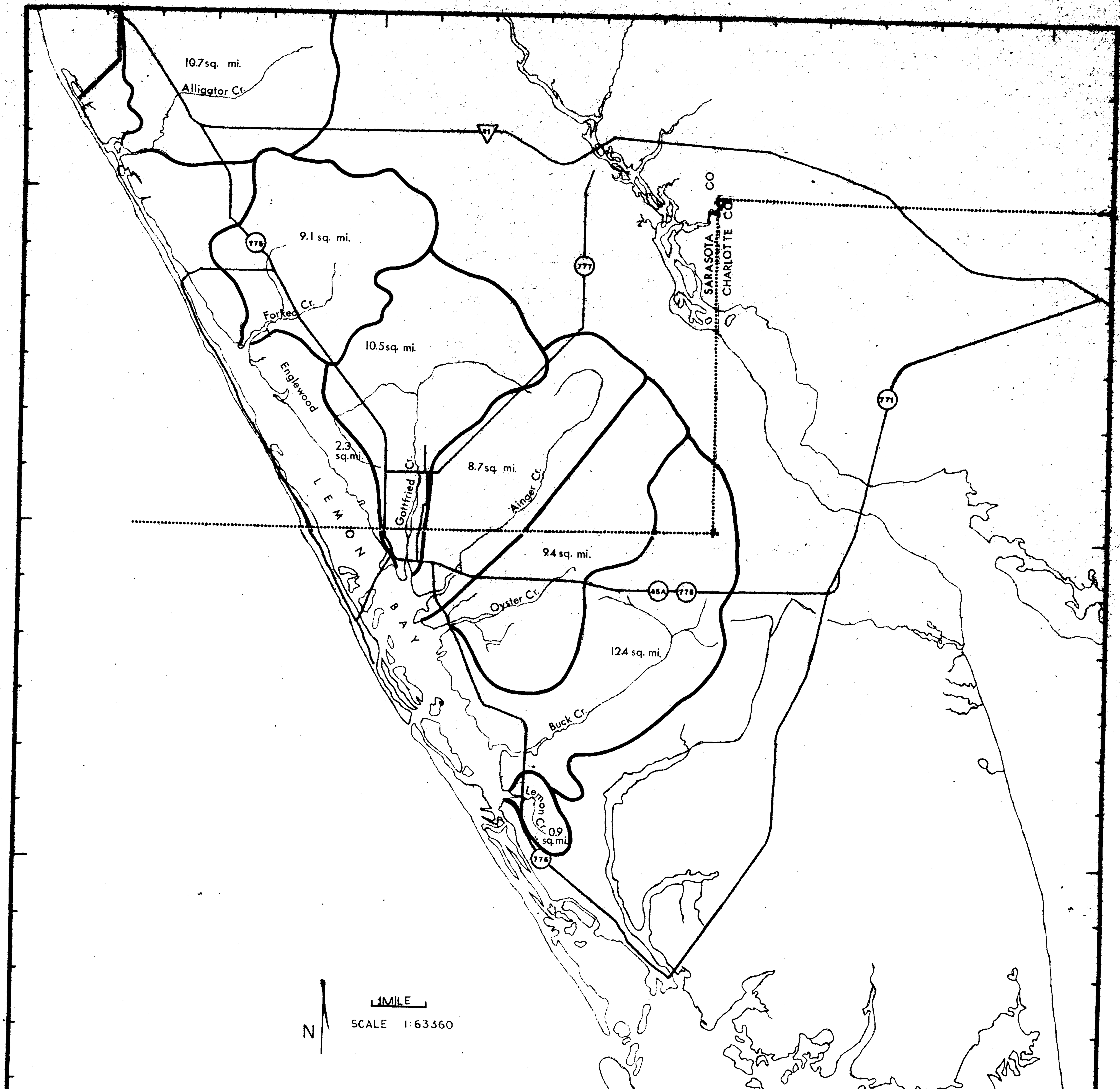

MANASOTA BEACH
Forked Cr
BUCHAN AIR FIELD
Englewood Rd
775A
775
776
777
BOUNDARY OF ENGLEWOOD WATER DISTRICT
THE ROCKS
BLIND PASS
LEMON
ENGLEWOOD
Dearborn Rd
Indiana Ave
Oxford Dr
NORTH PORT
FURBECK PT
McCall
WATER PLANT
EWD
Gottfried Cr
SARASOTA CO
CHARLOTTE CO
MANASOTA KEY
Ainger Cr
Seahorse Ln
Flamingo Dr
TOM ADAMS BRIDGE
REDFISH COVE
PT. OF PINES
NEW POINT COMFORT
San Casa Dr
BAY
CEDAR PT
Oyster Cr
GROVE CITY
Mississippi Ave
Placida Rd
ENGLEWOOD BEACH
GULF OF MEXICO
WHIDDEN KEY
PETERSON IS.
CHARLOTTE BEACH STATE PARK
STUMP PASS
GROVE CITY IS.
THORNTON KEY
KNIGHT IS.
DON PEDRO IS.
Buck Cr
Lemon Cr
ROTUNDA
REFERENCE MAP
N
1 MILE
SCALE 1:24 000
Prepared by
J B Morrill & Claudia Morrill
August 1977



"208" STUDY AREAS
Lemon Bay Complex

Prepared by

J B Morrill & Claudia Morrill August 1977



DRAINAGE BASINS

"208" Lemon Bay Study Area

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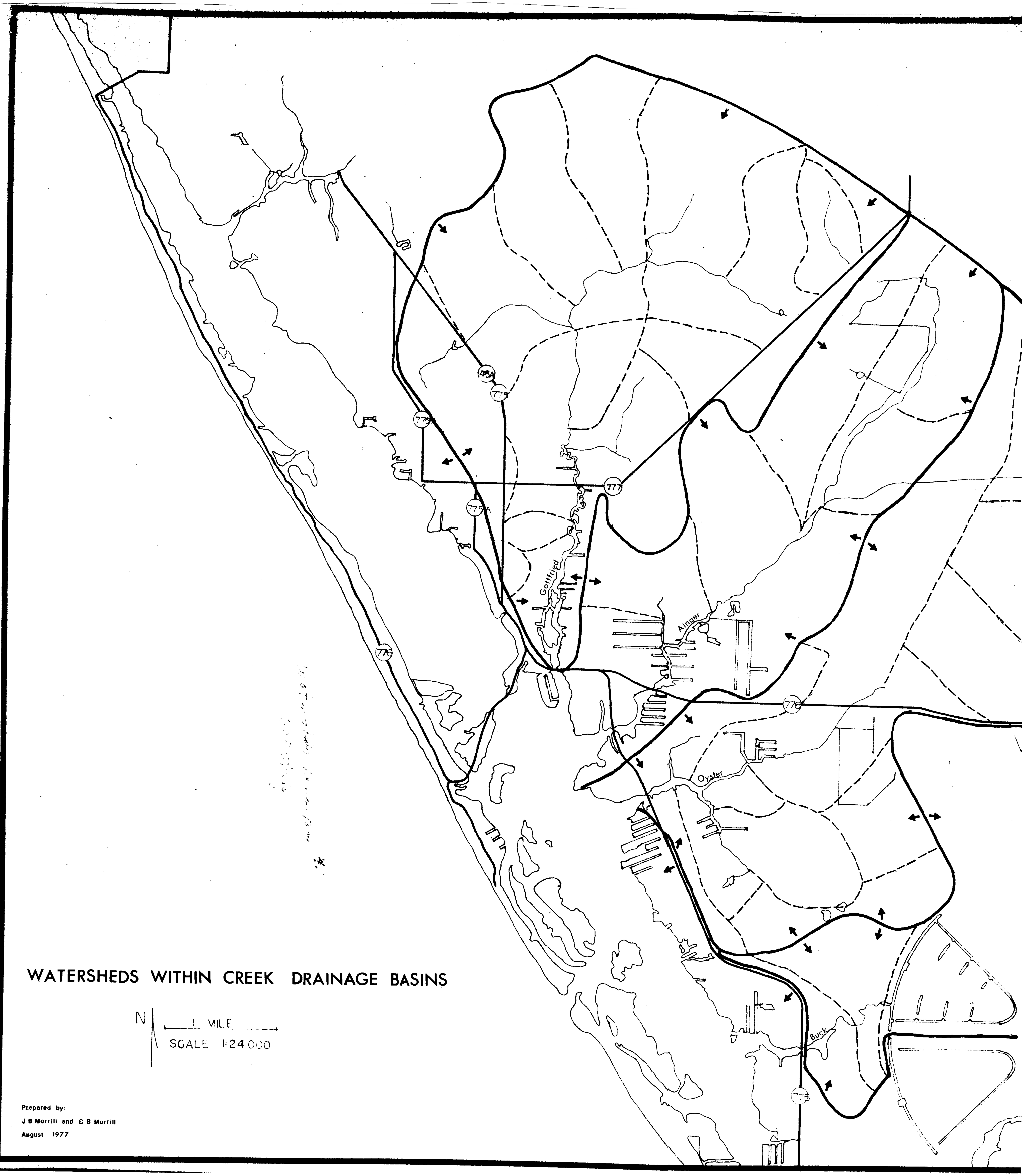
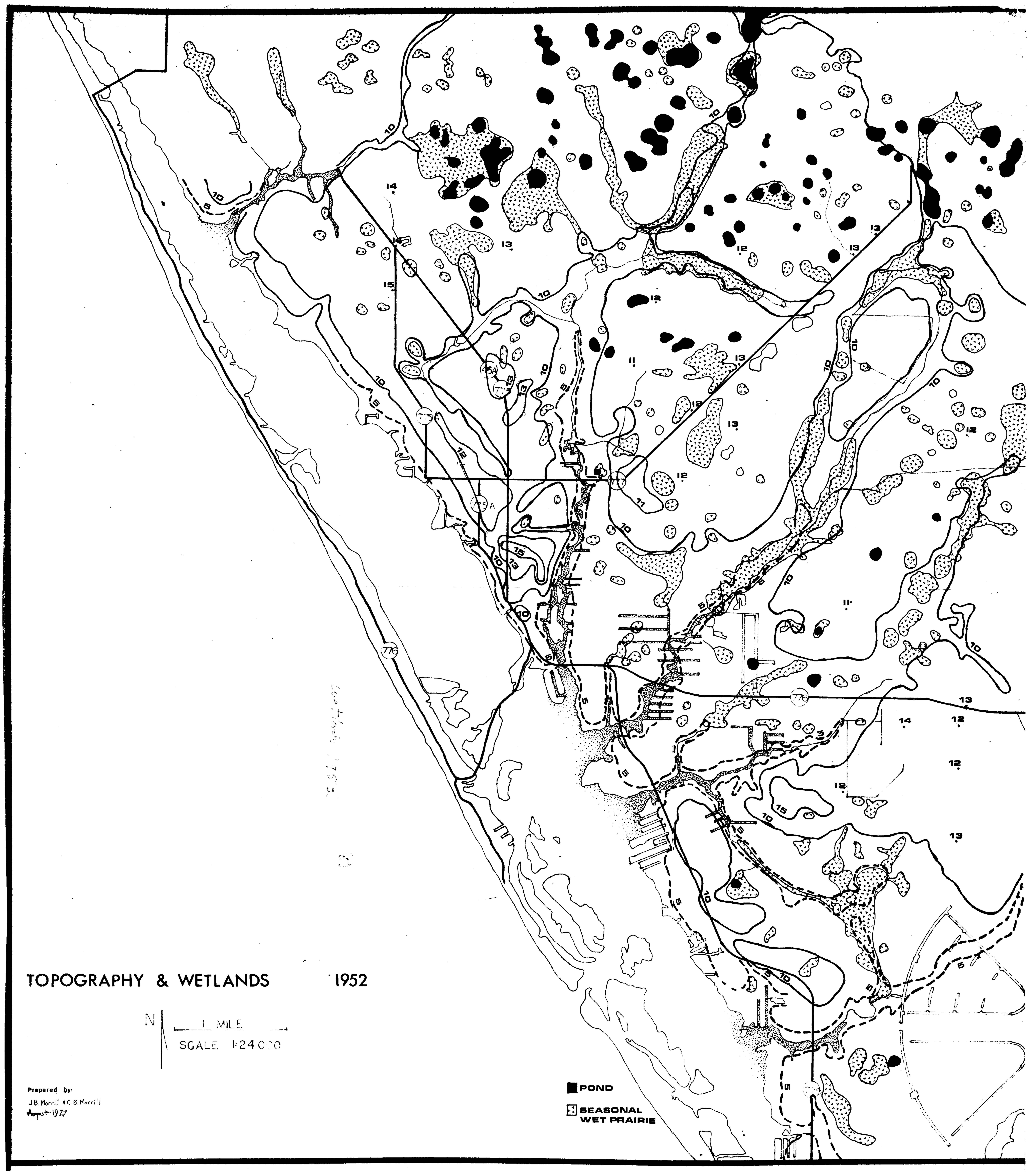
J.B. Morrill & C.B. Morrill August 1977

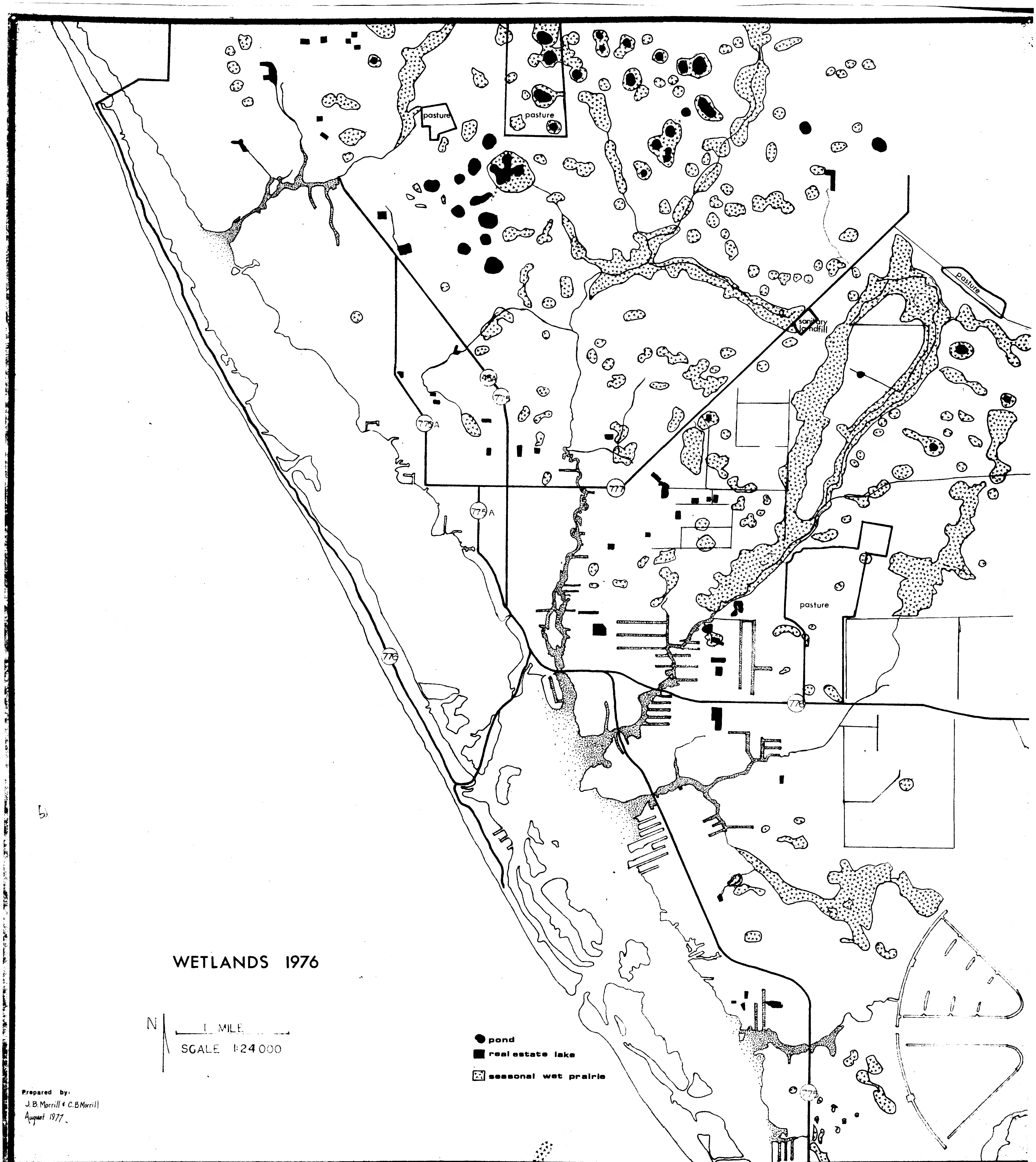


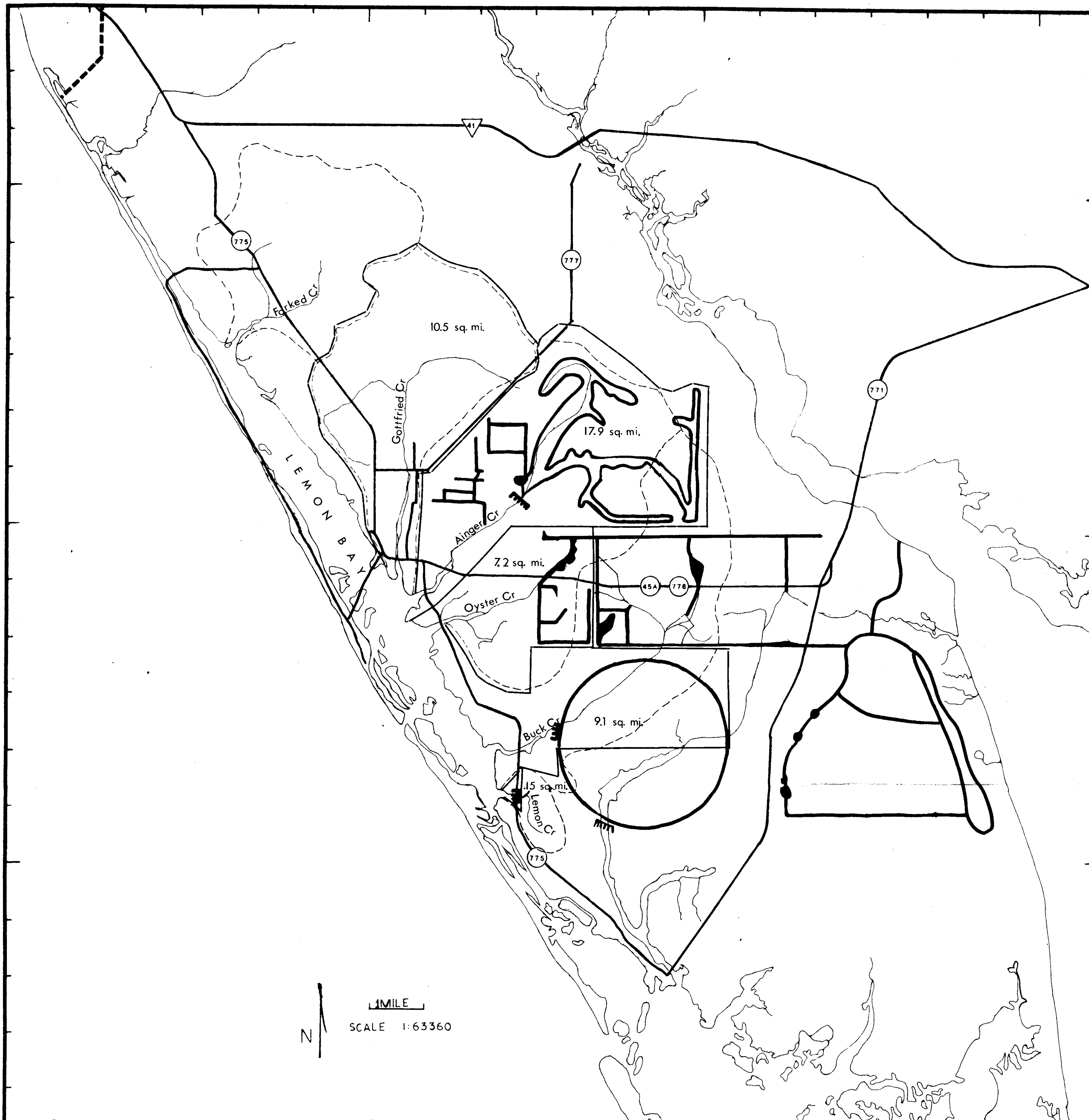
WATERSHEDS WITHIN CREEK DRAINAGE BASINS

Prepared by:
J B Morrill and C B Morrill
August 1977



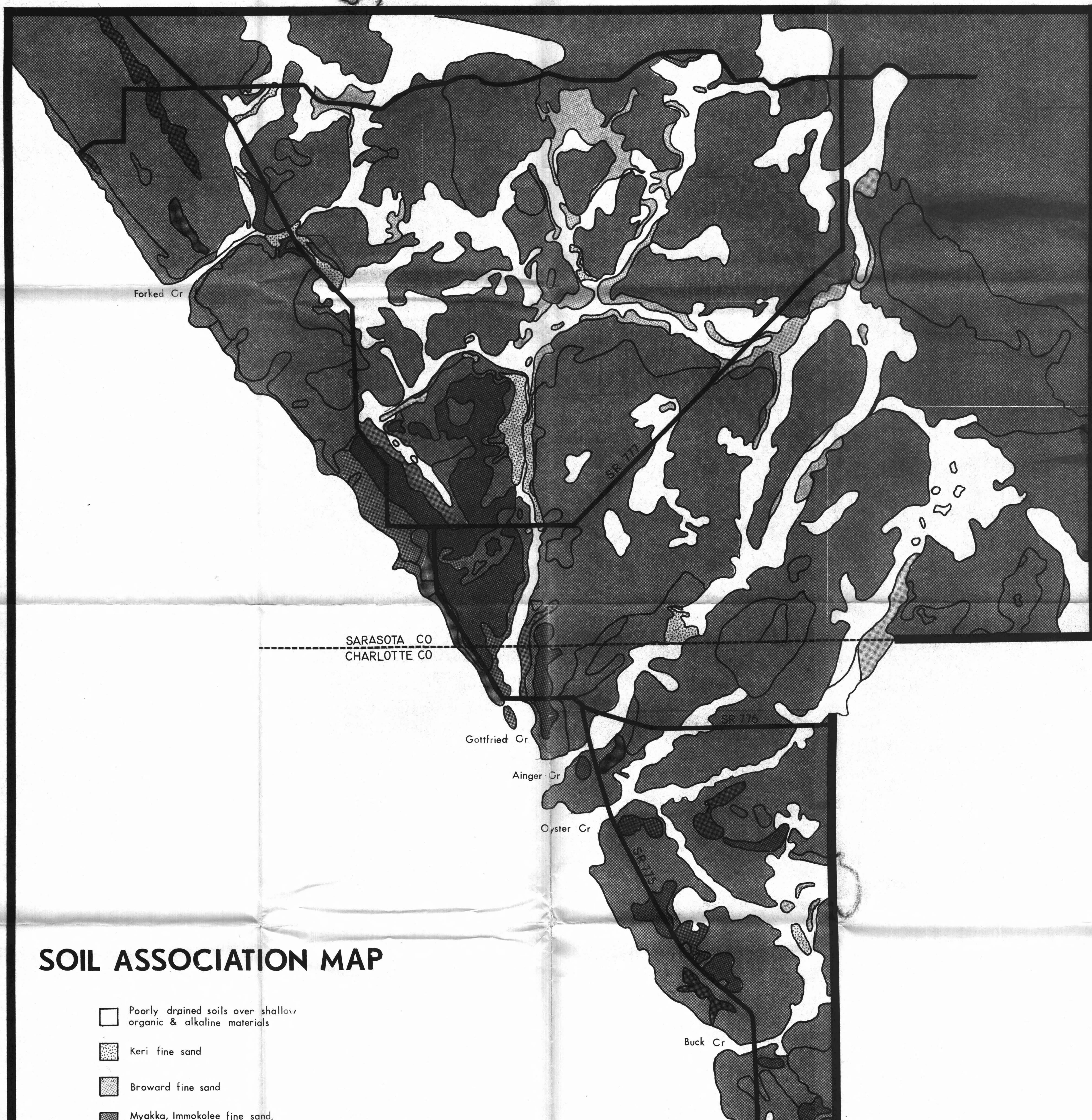
TOPOGRAPHY & WETLANDS 1952
N
1 MILE
SCALE 1:24000
Prepared by:
J.B. Morrill & C.B. Morrill
August 1977
POND
SEASONAL WET PRAIRIE

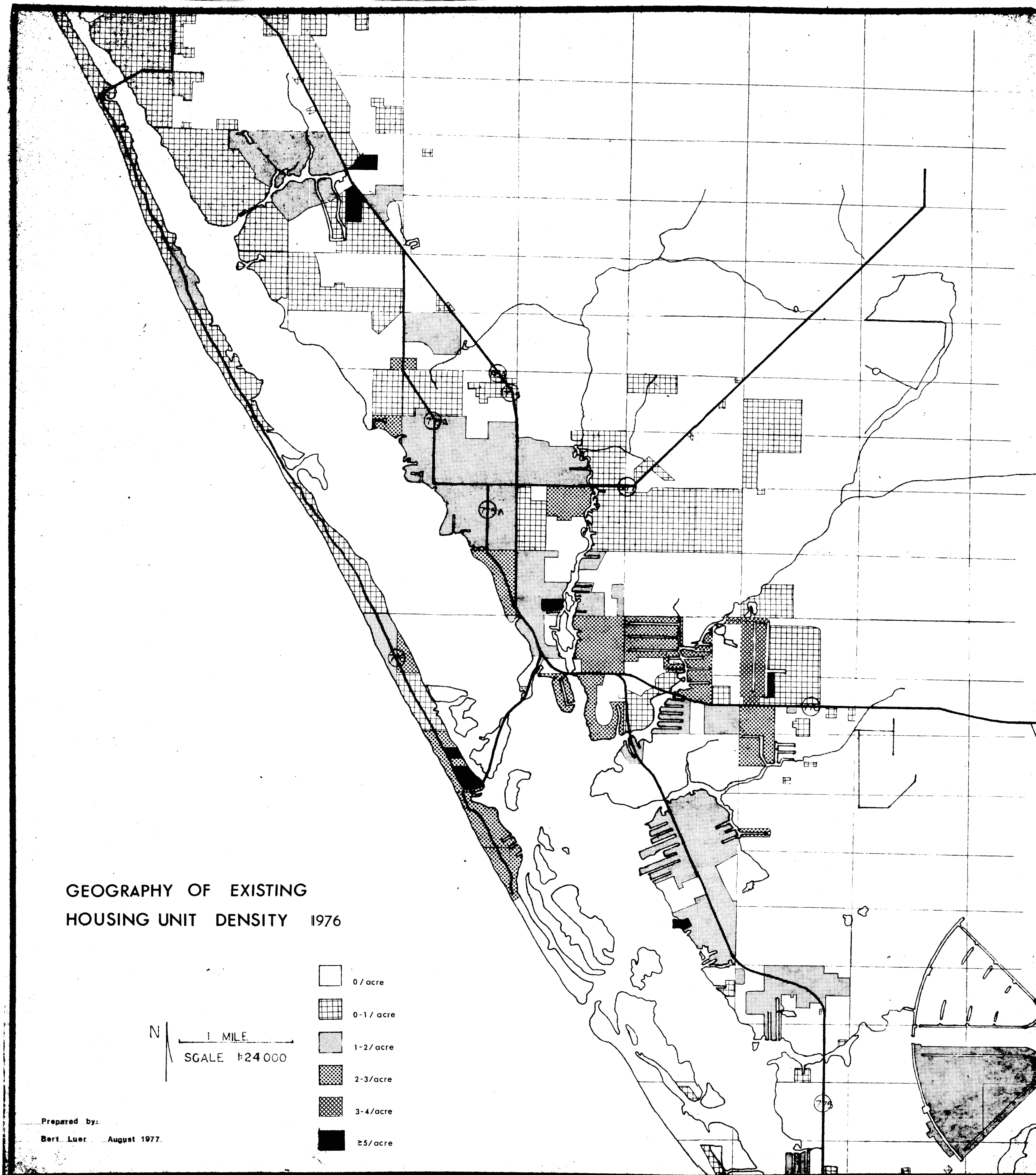

pasture
pasture
pasture
sanitary landfill
pasture
775A
775
775A
777
775A
776
776
775
WETLANDS 1976
N
1 MILE
SCALE 1:24000
pond
real estate lake
seasonal wet prairie
Prepared by:
J.B. Morrill & C.B. Morrill
August 1977

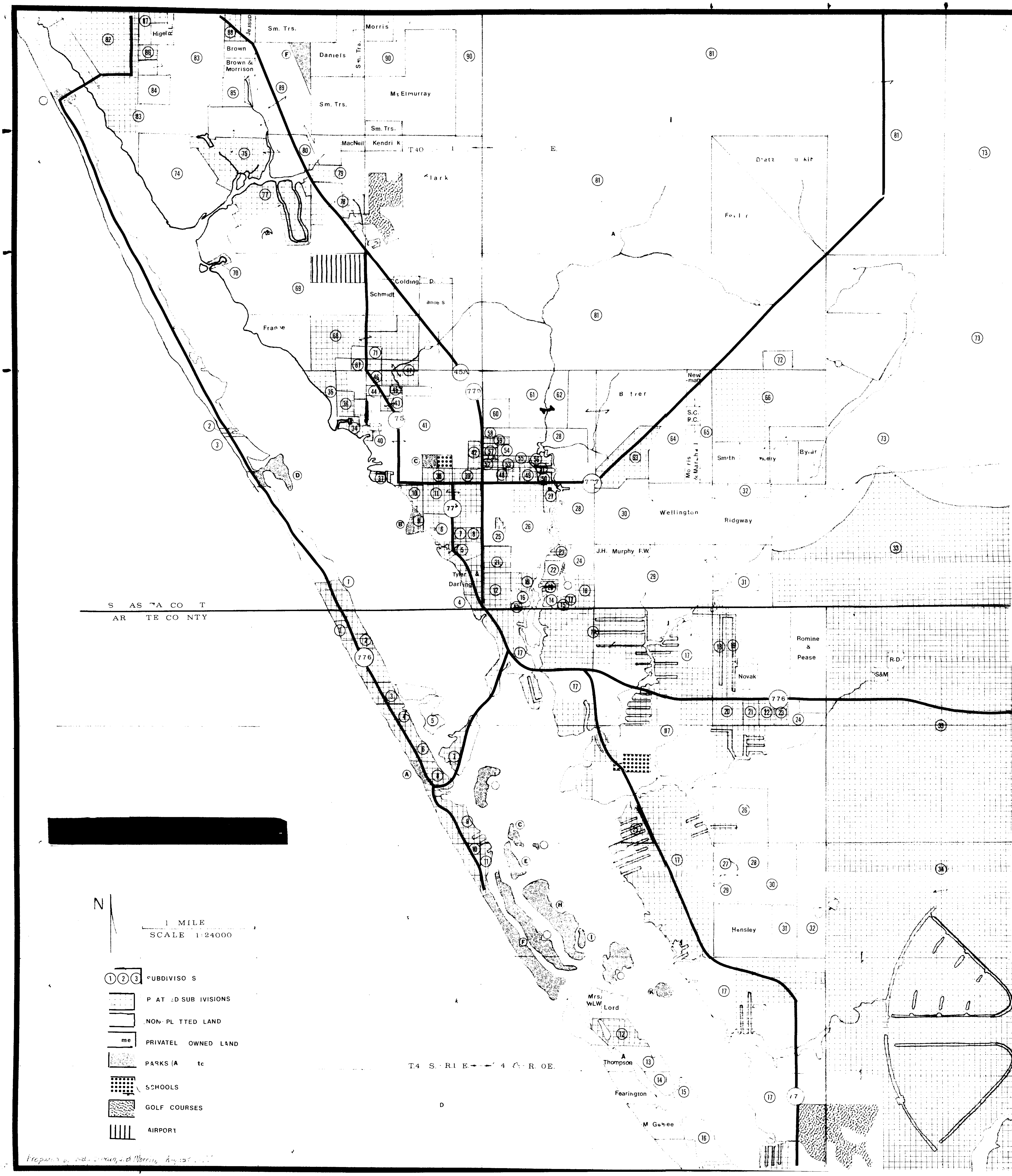


POTENTIAL FUTURE DRAINAGE BASINS

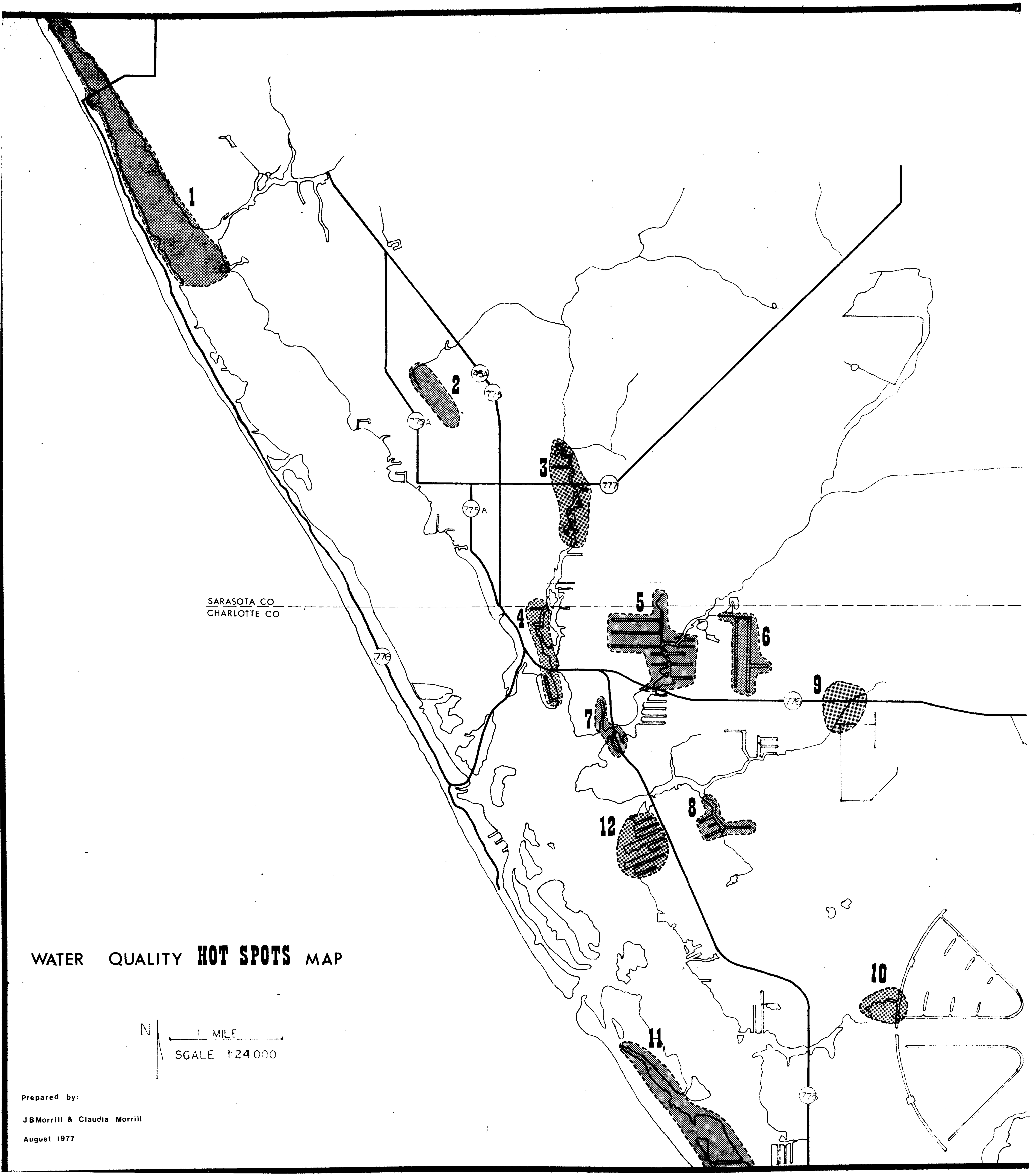
---- Historical drainage basin boundaries
—— Potential future drainage basin boundaries
Man-made canals and lakes
Dikes


Forked Cr
SR 777
SARASOTA CO
CHARLOTTE CO
SR 776
Gottfried Cr
Ainger Cr
Oyster Cr
SR 775
Buck Cr
SOIL ASSOCIATION MAP
Poorly drained soils over shallow organic & alkaline materials
Keri fine sand
Broward fine sand
Myakka, Immokolee fine sand,


GEOGRAPHY OF EXISTING
HOUSING UNIT DENSITY 1976
0 / acre
0-1 / acre
1-2 / acre
2-3 / acre
3-4 / acre
≥5 / acre
N
1 MILE
SCALE 1:24 000
Prepared by:
Bert Luer August 1977



Sm. Trs.
Morris
Higel
Brown
Brown & Morrison
Daniels
Mc Elmurray
MacNeil
Kendrick
Clark
Colding
Schmidt
France
New-man
Butler
Smith
Wellington
Ridgway
J.H. Murphy F.W.
Tyler & Darling
Romine & Pease
Novak
S&M
Hensley
Lord
Thompson
Fearington
1 MILE
SCALE 1:24000
PRIVATEL OWNED LAND
GOLF COURSES
SCHOOLS



WATER QUALITY **HOT SPOTS** MAP

Prepared by:

J B Morrill & Claudia Morrill

August 1977