APPENDIX B

Other UNLV Technical Reports

Lake Mead Water Quality History
Limnological Monitoring Program (1979)
Limnological Monitoring Program (1980)
Periphyton Study (1979)
Periphyton Study (1979 to 1980)
Intensive Surveys (1979 to 1980)

LAKE MEAD WATER QUALITY HISTORY

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TECHNICAL REPORT NO. 4

Submitted to

BROWN and CALDWELL

by

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November 1980

Introduction

Concern over the water quality in Lake Mead was first expressed in the late 1960's. At that time increased algal growth accompanied by low water transparency was noted in Las Vegas Bay. A newspaper article entitled "A Story of Pollution and Neglect" (Vincent 1967) revealed the public concern at that time stating that:

> "There is a cancer in Lake Mead. A foul green-brown growth which is eating its way through Las Vegas Wash toward the deep, blue waters of Boulder Basin, the very heart of one of the finest bodies of water in the country".......

The increased algal growth in Las Vegas Bay was attributed to high nutrient loading from Las Vegas Wash (FWPCA 1967) containing secondary treated sewage effluent from the Clark County and Las Vegas sewage treatment plants, and industrial effluent from Basic Management Industries (BMI) in Henderson.

Water Quality in Las Vegas Bay

A report by the Federal Water Pollution Control Administration (FWPCA 1967) was the first to present data documenting the higher algal growth in Las Vegas Bay as a result of the high nutrient loading from Las Vegas Wash. This was followed by a number of short term investigations which substantiated these findings (Hoffman, Tramutt and Heller 1967; FWQA 1970; EPA 1971; Hoffman, Tramutt and Heller 1971). Long term data collected by the University of Nevada, Las Vegas (Deacon and Tew 1973, Deacon 1975, 1976, 1977) added to these findings showing seasonal and yearly variations in algal growth in Las Vegas Bay. Deacon (1975, 1976) noted an improvement in water quality in Las Vegas Bay with a continual decrease in chlorophyll from 1972-1976. This was again shown in a summary report by Goldman and Deacon (1978) which included data from Hoffman et al. (1971).

The decrease in chlorophyll in the inner bay was not related to a reduction in nutrient loading from Las Vegas Wash. Based on U.S. Geological Survey data collected at Pabco Road, sewage effluent discharges increased from 50-70 $ft^3 \cdot sec^{-1}$ over this period (Fig. 1) thus increasing nutrient loading to Las Vegas Wash. Goldman and Deacon (1978) summarized all the available nutrient data at North Shore Road and found that nitrogen loading (in all forms) did not change appreciably and that phosphorus only increased slightly over the period of 1970 to 1977. It is interesting to note that although there was a substantial increase in sewage effluent discharge into Las Vegas Wash, there was only a slight increase in the nutrient load at North Shore Road. This was due to the nutrient stripping capability of the wash which has been reported by FWPCA (1967) and Goldman and Deacon (1978). The factors resulting in the apparent decline in chlorophyll in the inner bay have not been adequately defined, but it was probably related to a decrease in nutrient loading from the Colorado River and/or to increasing water levels in Lake Mead during this time period.

Water Quality in Lake Mead

There have been two major changes or continuation of events which have had, or may have had, an effect on the water quality in Lake Mead and Las Vegas Bay. These were the construction of Glen Canyon Dam forming Lake Powell on the Colorado River upstream of Lake Mead in 1963, and a continual increase in water levels in Lake Mead after the initial filling of Lake Powell.

Physical and chemical characteristics of the Colorado River inflow to Lake Mead were altered as a result of the construction of Glen Canyon Dam (Paulson and Baker 1980). Seasonal fluctuations in the Colorado inflow were stabilized as were seasonal fluctuations in water temperatures with higher winter and lower summer water temperatures. Suspended sediment loads to Lake Mead were also reduced. These physical changes in the Colorado inflow altered the circulation patterns in Lake Mead and completely eliminated the spring overflow of the Colorado River water in Lake Mead. Furthermore, a large percentage of the Colorado River nutrient loads are now being retained in Lake Powell reducing the nutrient load to Lake Mead. These alterations have resulted in an apparent overall reduction in the productivity of Lake Mead (Paulson and Baker 1980).

Also, related to the formation of Lake Powell, was a dramatic reduction in Lake Mead water levels (Fig. 2). Subsequent to the filling of Lake Powell, water levels in Lake Mead continually increased up until 1979 when the lake reached full capacity. The extremely low water levels in the 1960's may have aggravated water quality conditions in Las Vegas Bay and Boulder Basin because of the reduced volume of water in Boulder Basin to dilute the high nutrient load from Las Vegas Wash. As water levels increased from 1964-79, there was an increasingly greater volume of water in Boulder Basin and therefore, a greater dilution of the nutrient load from Las Vegas Wash. This also would tend to reduce algae growth and productivity in Las Vegas Bay and Boulder Basin. The combined effects of reduced nutrient loading from the Colorado River and increasing water levels in Lake Mead have probably resulted in the decline in chlorophyll noted by Deacon (1975, 1976).

Water Quality Conditions, 1977-78 and 1979-80

Phosphorus removal at the sewage treatment plants and alterations in the Las Vegas Wash system have changed the nutrient load to Las Vegas Bay. Comparing nutrient loading at North Shore Road from September-October 1977-78 and 1979-80 we see that there was a reduction in total phosphorus loading with ortho-phosphorus loading remaining at the same level for both time periods (Table 1). There was also a reduction in nitrate loading, but ammonia loading more than doubled resulting in an overall increase in the total inorganic nitrogen load. The increase in ammonia loading was apparently due to a breakdown in the stripping capacity of the Las Vegas Wash system which had previously reduced ammonia concentrations to low levels by the time the effluent reached North Shore Road (FWPCA 1967, Goldman and Deacon 1978). The actual mechanism within the wash that reduced ammonia has not been completely determined at this time.

The change in nutrient loading from Las Vegas Wash was reflected in nutrient concentrations in the inner bay. At Station 3, mean annual ortho-phosphorus concentrations were lower and ammonia concentrations were higher in 1979-80 compared to 1977-78 (Table 2). The annual average N:P ratio increased from 4.7 (1977-78) to 13.5 (1979-80) and indicated a potentially shorter supply of phosphorus for algal growth than in previous years. Although phosphorus concentrations were reduced, chlorophyll concentrations did increase from 9 $\mu g \cdot l^{-1}$ (1977-78) to 16 $\mu g \cdot l^{-1}$ (1979-80). Monthly average chlorophyll and inorganic nutrient concentrations at

Station 3 are shown in Figure 3. Seasonly, chlorophyll was higher in 1979-80 except for the winter period. Nitrate was generally lower except for slightly higher levels in May and June, 1980. Ammonia did not show any type of seasonal pattern for either period but the peaks were much higher in 1979-80. There are any number of factors which may have resulted in the higher chlorophyll concentrations in 1979-80. If it were due to nutrients, all indications would point to the higher ammonia concentrations. The fact that there was higher chlorophyll and lower phosphorus concentrations adds support to the inner bay being nitrogen limited.

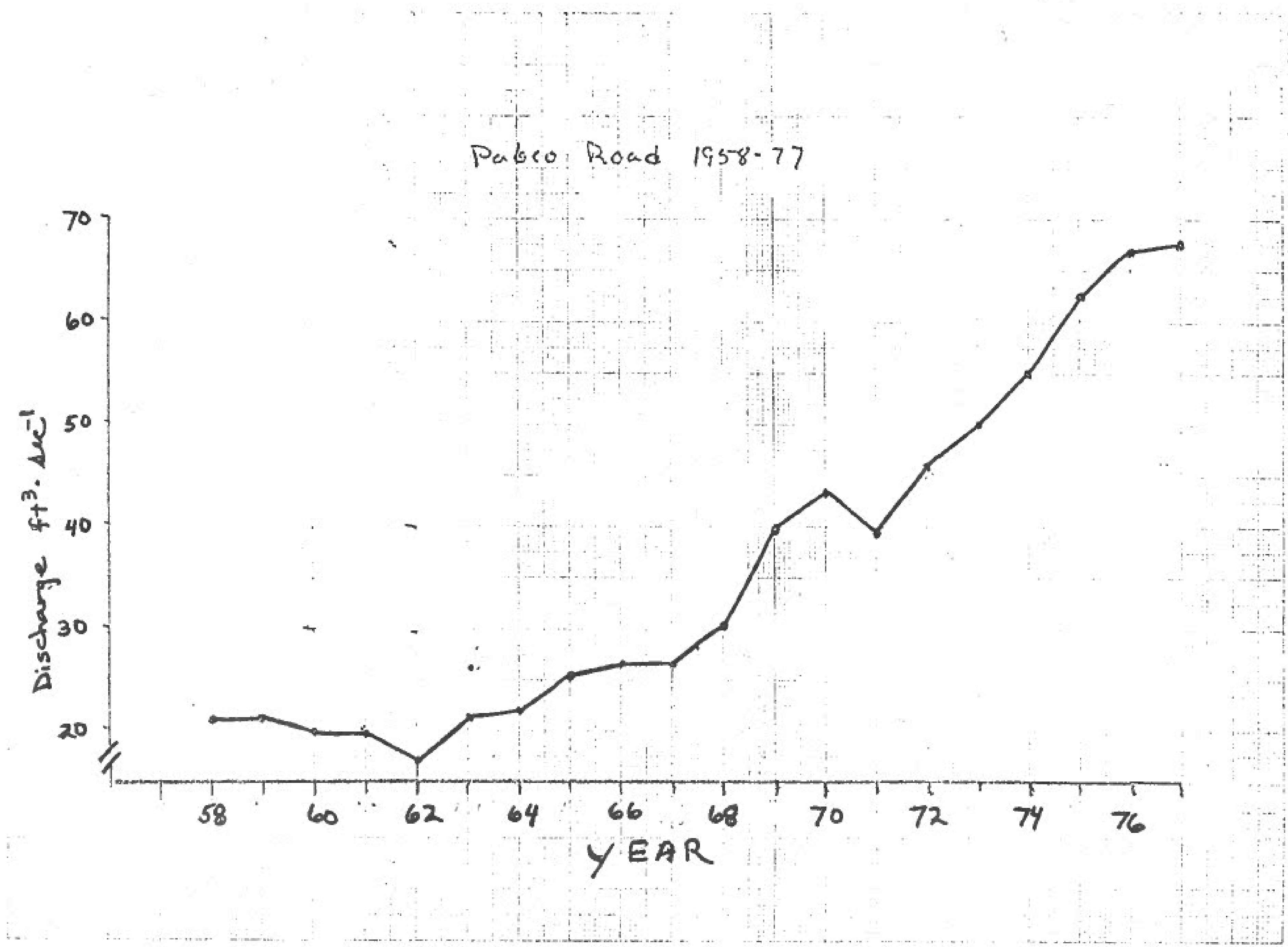

Figure 1. Mean annual discharge at Pabco Road, 1958-77.

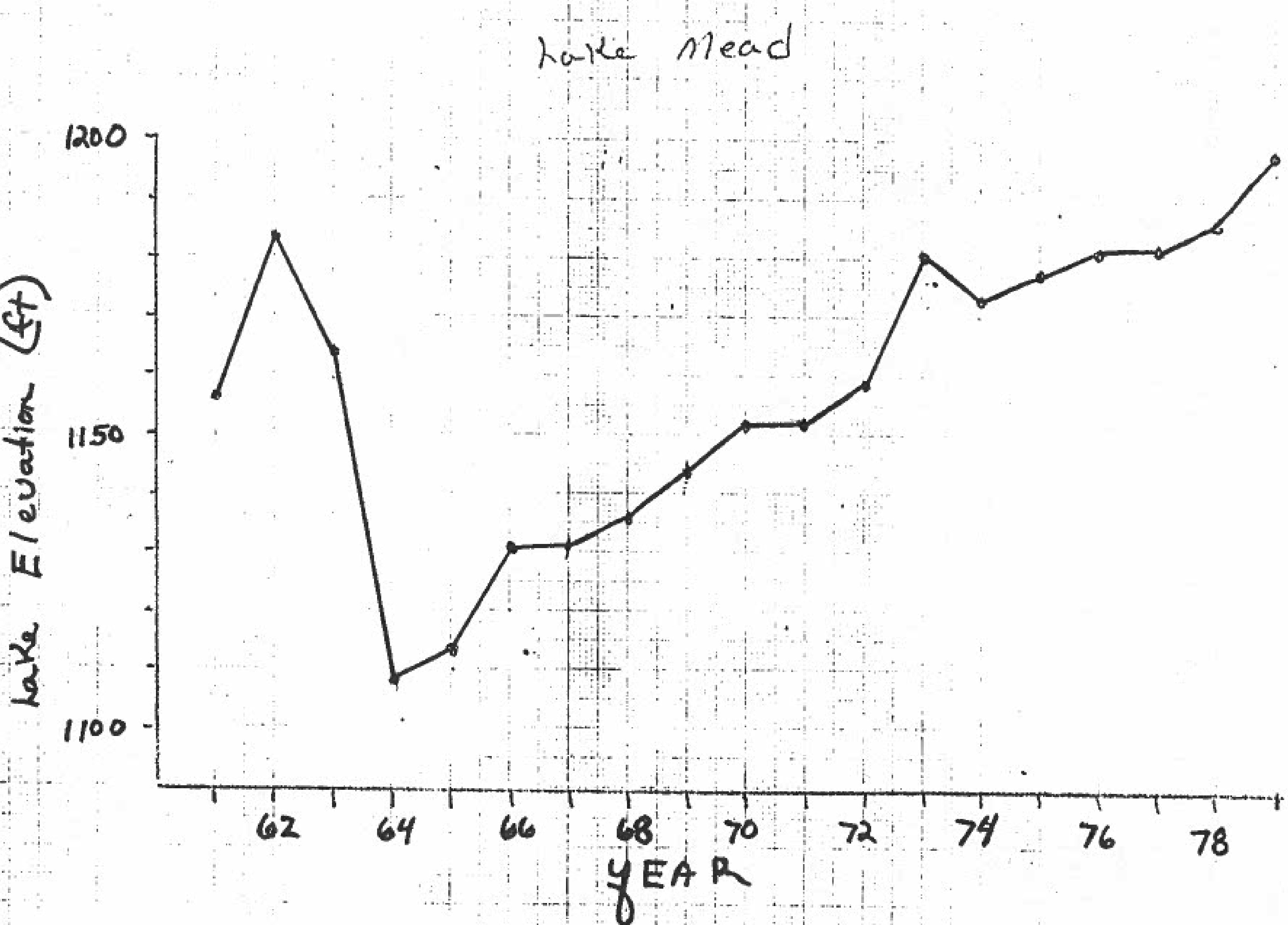

Figure 2. Lake Mead water elevations, 1961-79.

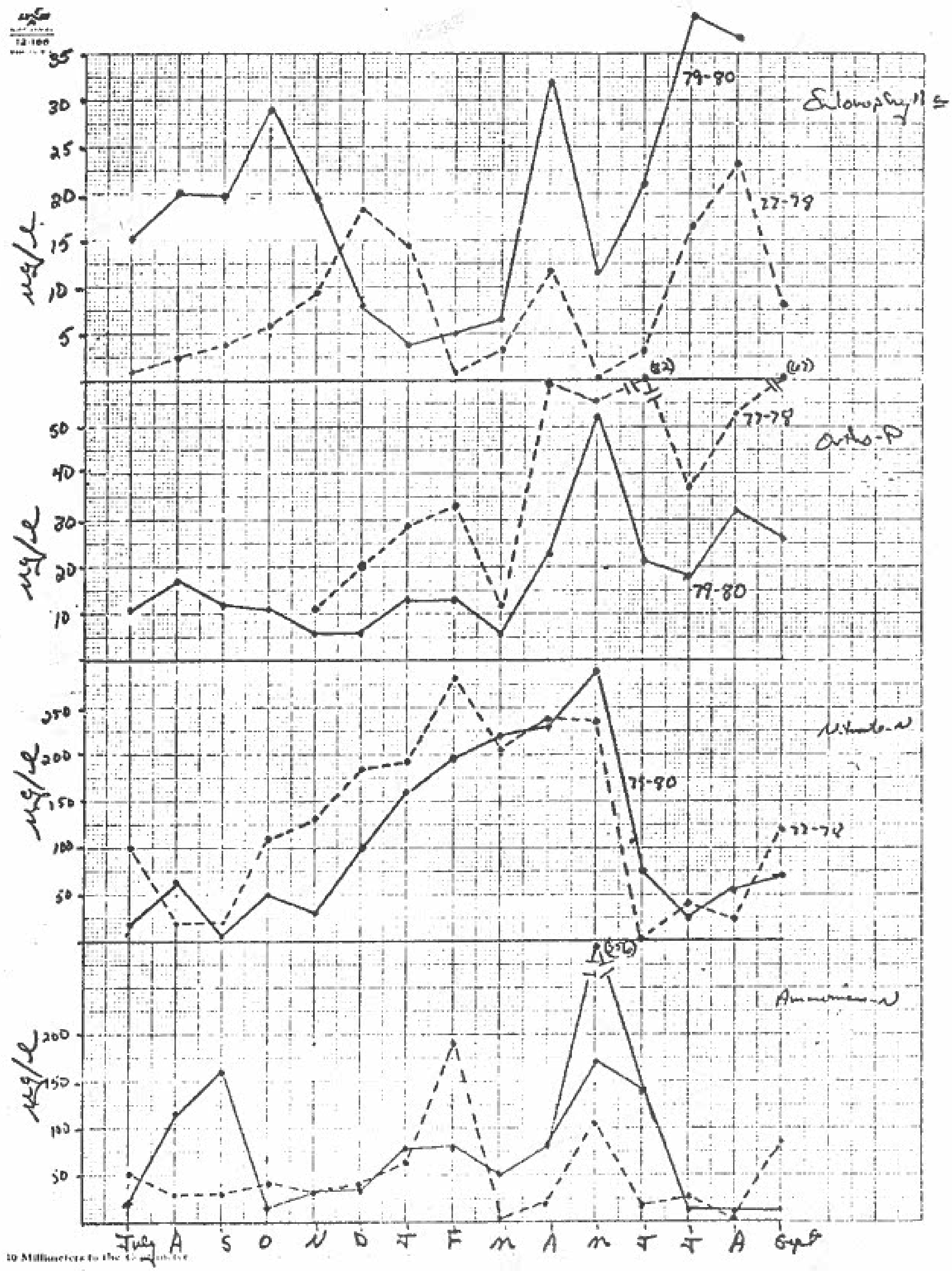

Figure 3. Monthly chlorophyll-a and nutrient concentrations at Station 3. Las Vegas Bay 1977-78 and 1979-80.

Table 1. Las Vegas Wash phosphorus and nitrogen loading at North Shore Road. Measurements from September - October.

	1977-78 $Kg \cdot yr^{-1}$	1979-80 $Kg \cdot yr^{-1}$
Total phosphorus	2.63×10^5	2.15×10^5
Ortho-phosphorus	1.37×10^5	1.37×10^5
Nitrate Nitrogen	3.49×10^5	2.70×10^5
Annonia Nitrogen	3.24×10^5	7.09×10^5
Total Inorganic Nitrogen	6.73×10^5	9.79×10^5

Table 2. Average annual nutrient and chlorophyll-a concentrations in the inner bay (Station 3) 1977-78 and 1979-80.

	1977-78* $\mu g \cdot L^{-1}$	1979-89** $\mu g \cdot L^{-1}$
Ortho-phosphorus	42	16
Nitrate nitrogen	147	120
Ammonia Nitrogen	51	96
Inorganic N:P Ratio	4.7	13.5
Chlorophyll-a	9	16

* Determined from monthly measurements October 1977-September 1978

** Determined from average monthly measurements July 1979-June 1980

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