Metropolitan Dade County, Florida

DEPARTMENT OF ENVIRONMENTAL RESOURCES MANAGEMENT

1986 INTENSIVE CANAL STUDY: Evaluation of Water Quality in the Mowry Canal (C-103)

DERM

Technical Report 89-2

1986 INTENSIVE CANAL STUDY

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EXECUTIVE SUMMARY

Background

The Intensive Canal Study (ICS) was implemented by the Department of Environmental Resources Management in 1980 to monitor the surface water quality of Dade County's canals on an annual basis. The C-103 and the North canals were chosen for the 1986 ICS to (1) determine if any pollution problems exist in the major South Dade canals and (2) obtain baseline data from the canals for use in future studies.

Seven sites along the C-103 Canal and four sites along the North Canal were sampled quarterly for various organic and inorganic parameters during February, May, August and December.

Findings

(1) There was evidence of salt water intrusion at the discharge sites of both canals during the dry season. The effect was more pronounced along the C-103 Canal. The C-103 Canal has a salinity structure (S-20F) located at SW 97 Avenue, approximately two miles east of sampling site L-4. The North Canal drains into the C-103 Canal via the L-31E Canal, located approximately 75 feet west of salinity structure S-20F. The North Canal is effectively blocked off from the bay by the L-31E levee, which reduces salt water intrusion in the North Canal.

(2) Levels of nutrients and other agriculturally-related compounds (such as chlorides and sulfates) were higher in the C-103 and North canals than in historical data levels from other canals in north and south Dade County.

(3) Although most phenol levels in these canals were higher than the 1 ug/l water quality standard, these levels are considered normal for Dade County canals.

(4) All sites had conductivity levels which were at or exceeded the 500 umhos/cm water quality standard. These levels are typical of Dade County canals and most likely result from the intermixing of groundwater (which has typically higher conductivity levels) and surface water.

INTRODUCTION

The Department of Environmental Resources Management (DERM) initiated the Intensive Canal Study (ICS) in 1980 for monitoring the canals which serve Dade County with freshwater conveyance and stormwater management. Since its implementation, the ICS has intensively monitored a different canal system every year:

1980 Snapper Creek Canal
1981 Miami Canal
1982 Tamiami/Dressels Canals
1983 Black Creek Canal
1984 Coral Gables Waterway
1985 Snake Creek Canal

The C-103 system in southern Dade County (figure 1) was selected for the 1986 ICS quarterly monitoring program. A total of eleven monitoring stations were sampled along the C-103 Canal, the C-103S Canal, the C-103N Canal, and the North Canal (which parallels the C-103). These canals flow through agricultural areas, low density residential areas, and a portion of Homestead Air Force Base. Sampling stations and analytical protocol were selected to establish baseline data and assess the impact of proximal land uses on surface water quality.

The topography of the area consists of Miami oolite rock overlain in the western and northern areas by well drained rocky soil and to the southeast by Perrine marl.

Sampling Sites

The ICS monitoring sites are indicated on the map given as figure 1.

The following information specifies station designations, location coordinates, and the immediate land use(s) surrounding the monitoring stations:

STATION	LOCATION	LAND USE
M-5	NORTH CANAL SW 328 ST & 97 AVE	Open land, west of Homestead Bayfront Park.
M-12	NORTH CANAL SW 328 ST & 132 AVE	Corn and potatoes, in area of Homestead A.F.B.
M-13	NORTH CANAL SW 328 ST & 147 AVE	Low density residential, corn and potatoes.
M-14	NORTH CANAL SW 328 ST & 157 AVE	Low density residential.
L-4	C-103 SW 320 ST & 117 AVE	Potatoes, approximately 2 miles west of salinity structure S-20F.

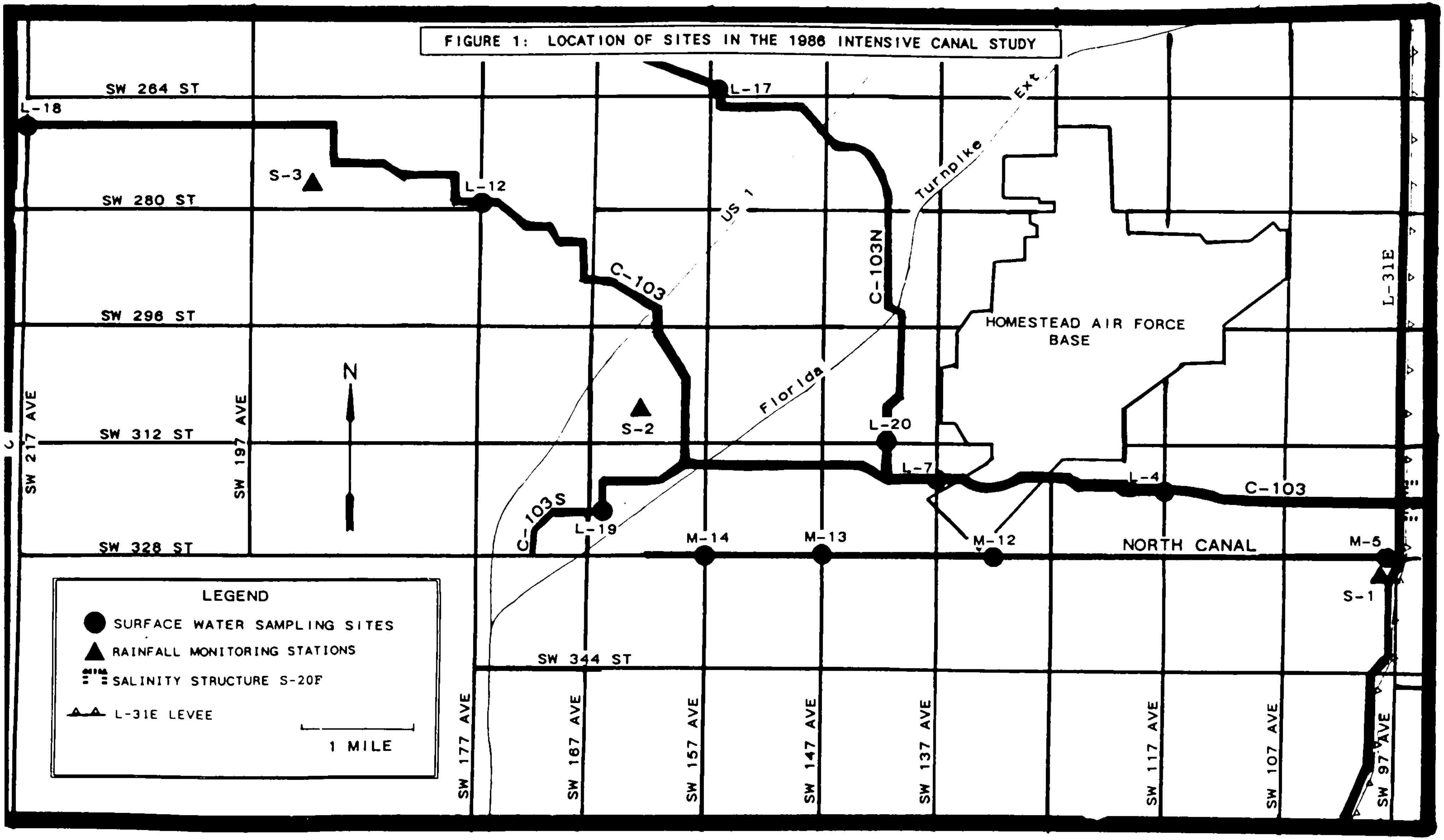


FIGURE 1: LOCATION OF SITES IN THE 1986 INTENSIVE CANAL STUDY
SW 264 ST
SW 280 ST
SW 296 ST
SW 312 ST
SW 328 ST
SW 344 ST
SW 217 AVE
SW 197 AVE
SW 177 AVE
SW 167 AVE
SW 157 AVE
SW 147 AVE
SW 137 AVE
SW 117 AVE
SW 107 AVE
SW 97 AVE
L-18
L-17
L-12
L-20
L-7
L-4
L-19
S-3
S-2
S-1
M-14
M-13
M-12
M-5
C-103
C-103N
C-103S
NORTH CANAL
L-31E
US 1
Florida Turnpike Ext
HOMESTEAD AIR FORCE BASE
N
LEGEND
SURFACE WATER SAMPLING SITES
RAINFALL MONITORING STATIONS
SALINITY STRUCTURE S-20F
L-31E LEVEE
1 MILE

L-7	C-103 SW 320 ST & 137 AVE	Potatoes, malangas, nursery.
L-12	C-103 SW 280 ST & 177 AVE	Low density residential.
L-17	C-103N SW 264 ST & 157 AVE	Nurseries.
L-18	C-103 SW 266 ST & 217 AVE	Lime groves, tomatoes and beans.
L-19	C-103S SW 320 ST & 167 AVE	Residential.
L-20	C-103N SW 312 ST & 142 AVE	Other agricultural crops.

Analytical Parameters

The canals were sampled quarterly for the following parameters:

Physical Properties
- Conductivity
- Turbidity
- Total Filtrable Residue

Trace Elements
- Arsenic
- Copper
- Zinc

Major Inorganics
- Alkalinity
- Chlorides
- Sulfates
- Fluorides

Minerals
- Calcium
- Sodium
- Magnesium
- Potassium

Nutrients
- Ammonia
- Total Kjeldahl Nitrogen
- Nitrates/Nitrites
- Total & Ortho-phosphate

Organic Parameters
- Biochemical Oxygen Demand
- Phenols

This report discusses the analytical results with respect to appropriate surface water standards and surrounding land uses. Standards referred to in Table 1 are those contained in the Metropolitan Dade County Environmental Protection Ordinance, Chapter 24-11; the Environmental Protection Agency (EPA) 1986 Water Quality Criteria Document; the Department of Environmental Regulation (DER) Water Quality Standards, Chapter 17-3.121. In cases where reported levels are at or near the method detection limit, median values are utilized because they are not affected by erratic, extreme values (i.e., median values are robust or resistant to outliers).

TABLE 1 : SURFACE WATER STANDARDS

PARAMETER	UNITS	MAXIMUM ALLOWABLE CONCENTRATION
Alkalinity	mg/l	Not <20 (1)
Ammonia	mg/l	0.5
Biochemical Oxygen Demand	mg/l	Should not exceed a value which would cause dissolved oxygen to be depressed below 4 mg/l
Chlorides	mg/l	500
Conductivity	umhos/cm	500
Fluorides	mg/l	1.4
Nitrates	mg/l	10 (2)
Phenols	ug/l	1
Total Filtrable Residue	mg/l	1000 at any time or 500 monthly average
Turbidity	JTU	50
Arsenic	ug/l	50
Copper	ug/l	400
Zinc	ug/l	1000

Unless otherwise noted, the standards referred to were taken from Dade County Environmental Code, Chapter 24-11.

(1) Department of Environmental Regulation Water Quality Standards, Chapter 17-3.121.

(2) Environmental Protection Agency Surface Water Criteria

Rainfall Data

Rainfall data for 1986 were obtained from three stations in the study area, as shown in figure 1. The average annual precipitation at these stations was 48.07 inches. Typical wet season rainfall consists of heavy, localized convectional showers of short duration. The typical dry season is characterized by widespread light rainfall resulting from frontal activity. The heaviest rainfall occurred in June and September with average total precipitation of 10.64" and 7.57", respectively. In February, the study area had virtually no rainfall prior to sampling. In December, the central portion of the study area had 2" total rainfall prior to sampling whereas the rest of the study area had 0 - 1" during this period. The central area also had the highest total precipitation in June (12.23").

PHYSICAL PROPERTIES

Conductivity

Conductivity is a measure of the ability of an aqueous solution to carry an electric charge. This ability is dependent upon the presence of ions and the mobility, concentration and valence of the ions. Temperature also affects the conductivity measurement.

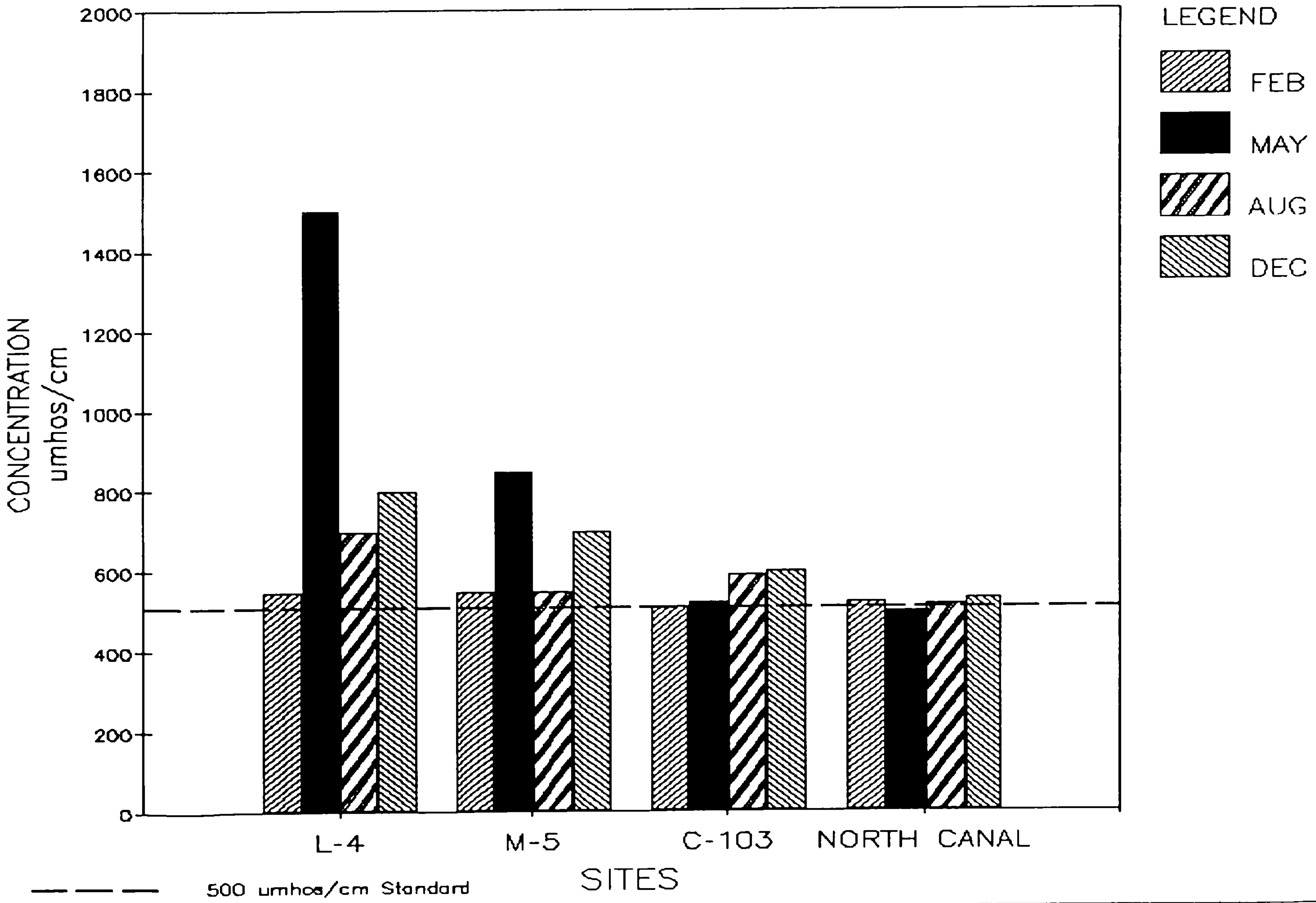
Natural waters contain varying concentrations of ionic and undissociated species, and cannot be considered simple solutions. As a result, conductivity measurement, when applied to natural waters, cannot be directly correlated with ion concentration and dissolved solids. Conductivity measurement does, however, give a general indication of the concentration of dissolved solids.

The average conductivity was 611 umhos/cm at the C-103 Canal and 554 umhos/cm at the North Canal.

Although these values exceed the standard of 500 umhos/cm, they are consistent with data from other canals in the county and may be considered background levels. The highest levels of conductivity occurred at stations L-4 (1500 umhos/cm) and M-5 (850 umhos/cm) during May (with no rainfall 30 days prior to sampling). L-4 is west of salinity structure S-20F and M-5 is blocked off from the bay by the L-31E levee. Both sites may be subject to salt water intrusion (see Chlorides section), as supported by the high levels of chlorides and total filtrable residue obtained during the dry season.

The conductivity levels for sites L-4 and M-5 (figure 2) showed seasonal fluctuations with highest concentrations at the end of

FIGURE 2: 1986 INTENSIVE CANAL STUDY
Conductivity Data



the dry season prior to dilution by rain. Average values for all other sites remained essentially constant throughout the year.

Turbidity

Turbidity is a measure of the capacity of water to absorb or scatter light. It is a measure of the clay, silt and finely divided organic and inorganic matter suspended in the water. Turbidity may interfere with recreational use and aesthetic enjoyment of water.

Application of the water quality standard for turbidity is not appropriate because it is based on outdated methodology measured in Jackson Candle Turbidity Units.

The median turbidity value was <1 Nephelometric Turbidity Units (NTU's) along the C-103 Canal and 1.6 NTUs along the North Canal. These levels are typical of the canals in Dade County and indicate good water clarity. The highest level, 18.5 NTUs, was found at station M-12 following a rainy period in August.

The wet season can be expected to produce increased turbidity levels due to stormwater washing of particulates into the canals. However, no apparent seasonal trend was observed for turbidity since only 60% of the sites had higher values following rainy periods and the remaining 40% had maximum values during dry periods. Two sites, L-4 and L-17, had similar turbidity levels throughout the year.

Total Filtrable Residue (TFR)

Total Filtrable Residue (TFR) is the total concentration of dissolved matter (which is not retained by filtration) in water. High levels of residue may result in water of inferior palatability or may adversely affect the appearance of the water.

The average values obtained were 384 mg/l at the C-103 Canal and 350 mg/l at the North Canal. Both values were below the surface water standard. Above average levels of TFR occurred at sites L-4 (1041 mg/l) and M-5 (583 mg/l), with L-4 being above the 1000 mg/l standard. These levels closely paralleled the high conductivity and chloride levels found at these sites during the dry season (figures 3 & 4) and can be attributed to salt water intrusion.

FIGURE 3: 1986 INTENSIVE CANAL STUDY
Comparison of Chloride, Conductivity and
Total Filtrable Residue for L-4

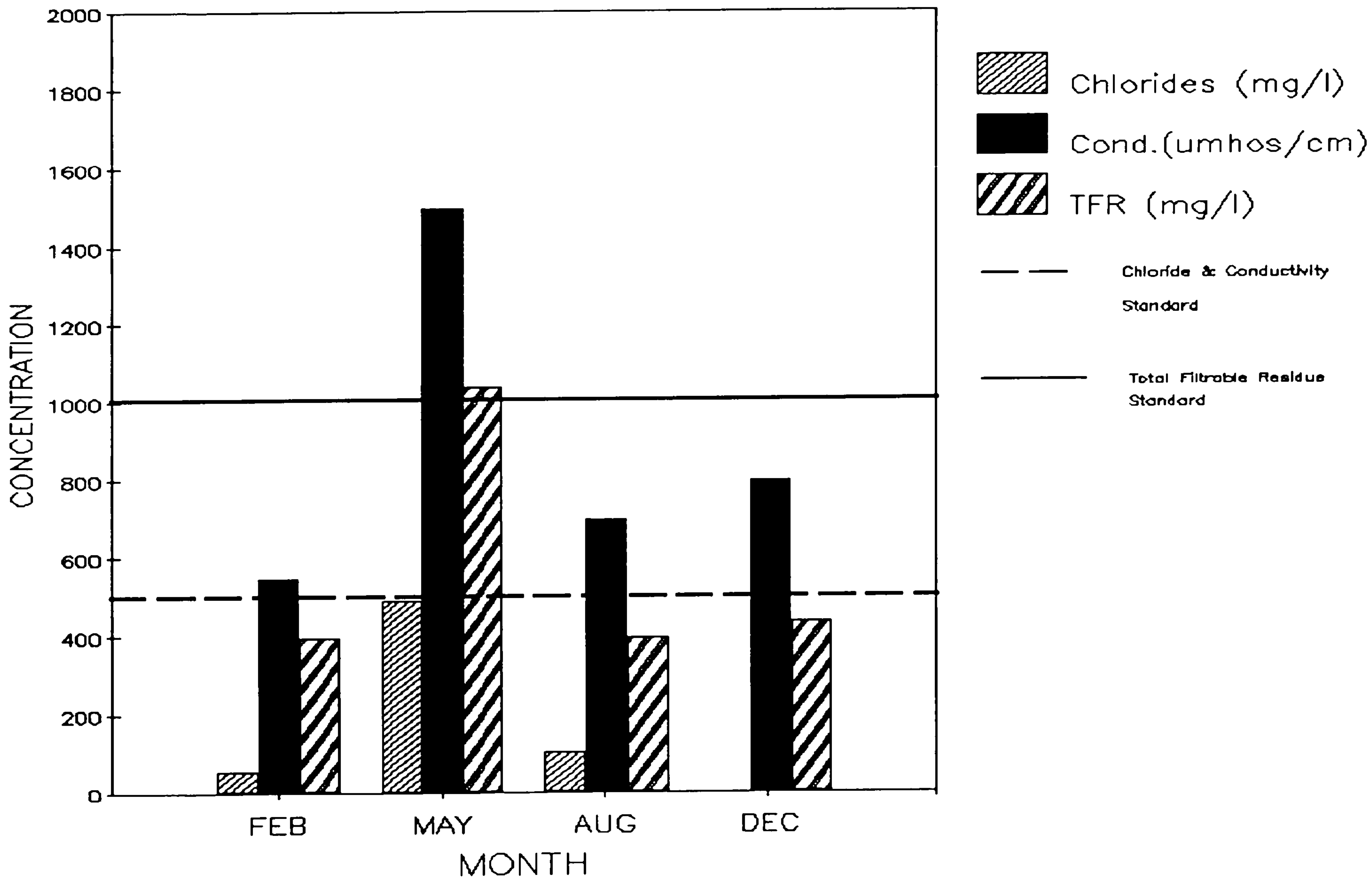
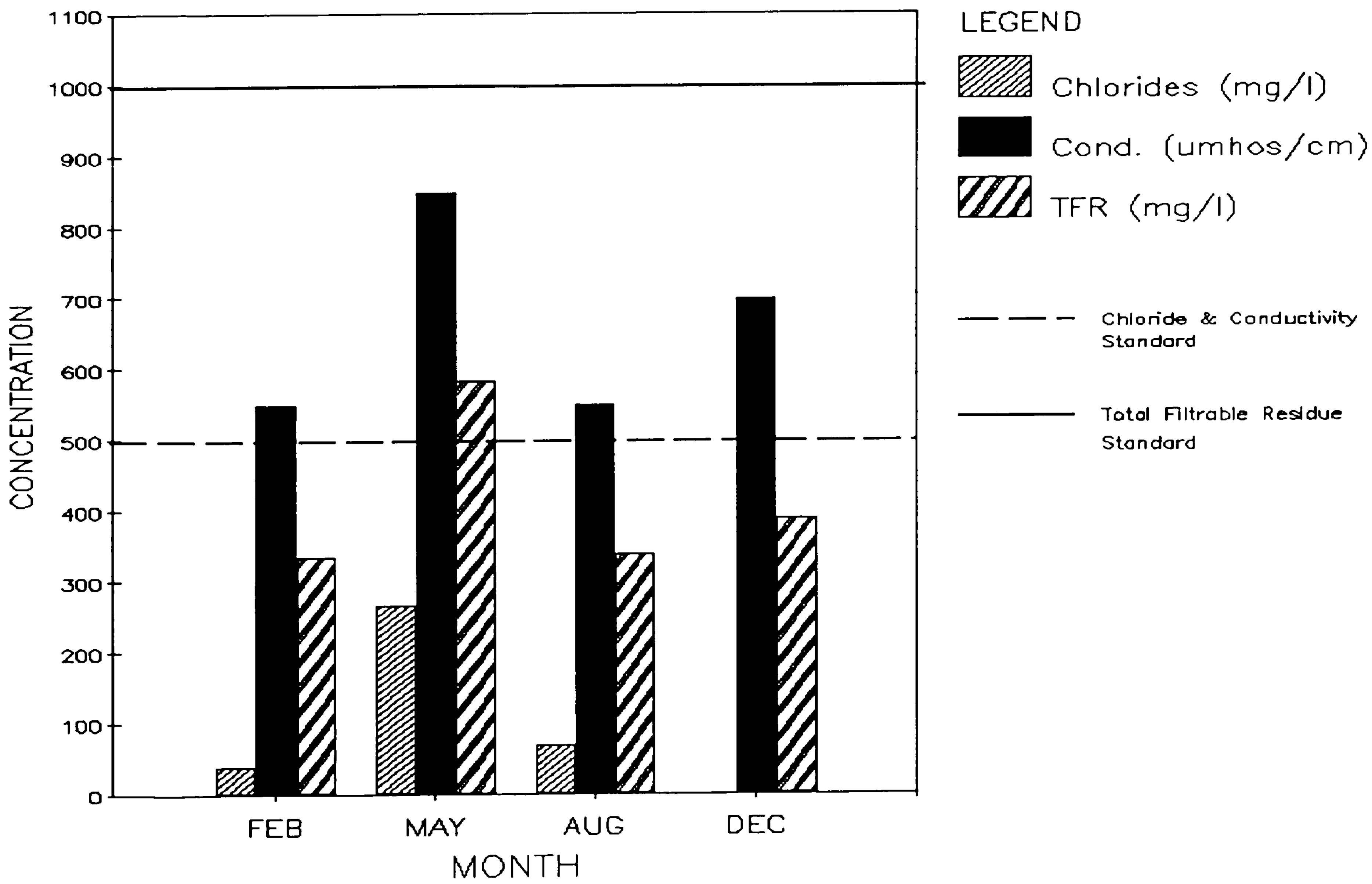


FIGURE 4: 1986 INTENSIVE CANAL STUDY
Comparison of Chloride, Conductivity and Total Filtrable Residue for M-5



MAJOR INORGANICS

Alkalinity

Alkalinity is related to the buffering capacity of water. In Dade County canals, buffering capacity is dependent on the concentration of bicarbonate ions. Alkalinity content is important in surface waters because (1) it is the sum total of buffering components which neutralize the pH-lowering by photosynthetic activity of chlorophyll-bearing species (2) the carbonate or bicarbonate ions form metal complexes with some toxic heavy metals and reduce their toxicity, and (3) excessive alkalinity may cause problems for swimmers by altering the pH of the lacrimal fluid of the eyes.

In general, low levels of alkalinity are more threatening than high levels. The minimum level of alkalinity necessary for the support of aquatic life is 100-120 mg/l. The canal data ranged from 149 - 336 mg/l and averaged 193 mg/l in the C-103 Canal and 205 mg/l in the North Canal. These levels are considered background levels for Dade County and represent water that may be used for a variety of purposes, such as agricultural, recreational and industrial. Levels were fairly consistent along both canal reaches throughout the year. The highest levels occurred at the background sites of both canals (figure 5).

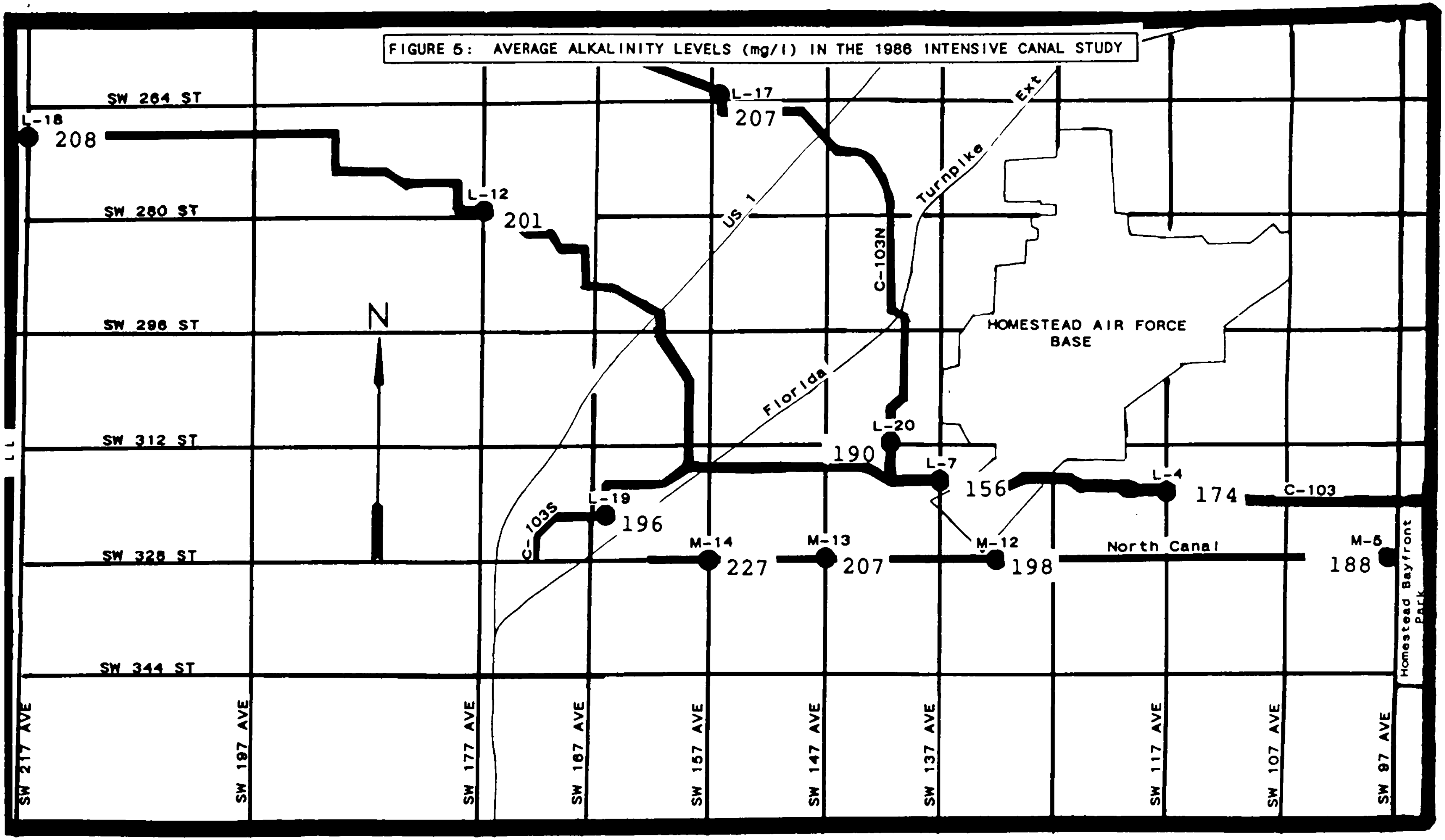
Chlorides

Chlorides in natural waters may be due to (a) natural mineral origin (b) agricultural practices (c) sewage (d) industrial effluent or (e) salt water infiltration. Standards for chloride concentrations are generally based on palatability requirements rather than health effects.

Chlorides were analyzed in February, May and August. There were no exceedances of the surface water standard of 500 mg/l. The maximum levels were 492 mg/l at station L-4 and 268 mg/l at station M-5 in May. Both sites are east of the inland extent of water containing 1000 mg/l of chloride near the base of the Biscayne aquifer, where intermixing of ground and surface water can result in elevated chloride levels (see Salt Water Intrusion map in Appendix I). The proximity of these sites to the bay may also result in the intrusion of salt water at these sites. Elevated levels of conductivity and TFR indicate that salt water intrusion peaked at these discharge sites during the dry season (figures 3 & 4).

By omitting the data from these sites, the overall chloride concentrations averaged 83 mg/l in C-103 and 70 mg/l in the North Canal. The majority of the sites had peak chloride

FIGURE 5: AVERAGE ALKALINITY LEVELS (mg/l) IN THE 1986 INTENSIVE CANAL STUDY



levels following rainy periods (figure 6). These levels may result from the natural leaching of chlorides from rocks or from the increased runoff of residual agricultural compounds such as fertilizers (potassium chloride), fungicides or bactericides applied during the growing season. The areas with the largest wet season increases, L-7 and L-18, were also adjacent to the areas of heaviest agricultural usage.

Sulfates

Sources of sulfates in water include:
a) natural origin (from leaching of gypsum or other common minerals)
b) oxidation of sulfides and thiosulfates
c) oxidation of organic matter in the sulfur cycle
d) industrial discharges
e) agricultural discharges (from the application of ammonium sulfate or potassium sulfate).

Sulfates were analyzed twice during the year (in the second and fourth quarters). Levels ranged from 2.9 - 106.9 mg/l and averaged 32.4 mg/l along the C-103 Canal and 34.9 mg/l along the North Canal. Levels obtained in this study appear to be considerably elevated compared to the 1985 ICS, which obtained values of 4.1 - 16.8 mg/l. It is difficult to attribute elevated sulfate levels to a single source, such as agriculture, because the lowest sulfate values were from monitoring station L-18, which was adjacent to areas of heaviest agricultural use.

The elevated sulfate levels may be attributed to a combination of factors such as salt water intrusion (sites L-4 and M-5), individualized agricultural practices, and the influence of ornamental nurseries (L-17). The sulfate content of surface water data obtained in this study and the sulfate content in historical ground water data (1983-1985) for this area exhibited similar trends. Sulfate levels were one order of magnitude lower in the eastern region than in the rest of the study area for both surface and ground water (figure 7).

Fluorides

Fluoride minerals occur naturally in sedimentary rocks but their solubility is low. Consequently, levels of fluoride are usually low in natural waters.

The median levels obtained were 0.6 mg/l along the C-103 Canal and 0.1 mg/l along the North Canal. The data is consistent with historical canal data; levels remained far below the standard of 1.4 mg/l.

FIGURE 6: 1986 INTENSIVE CANAL STUDY
Variation in Chloride Data

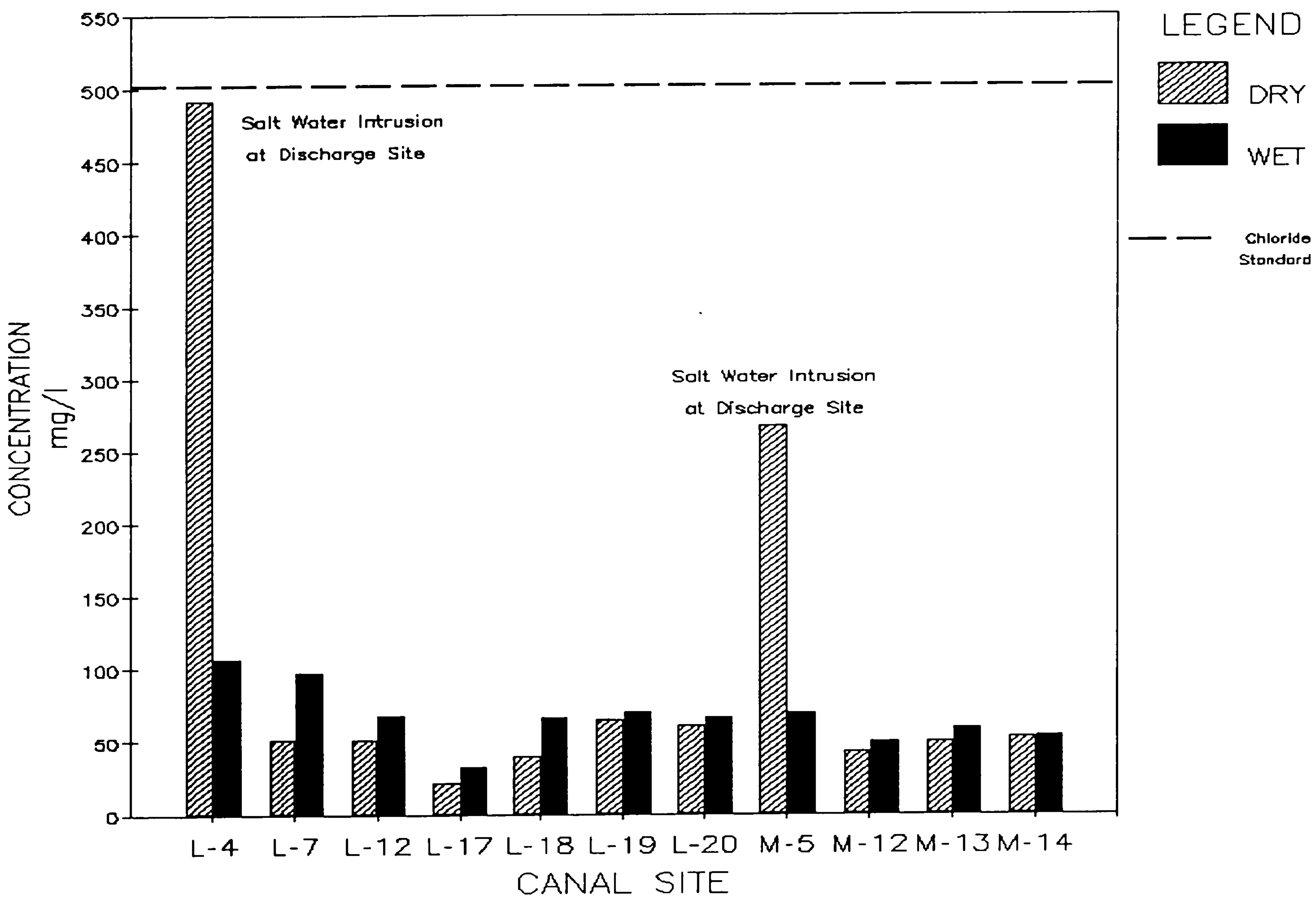
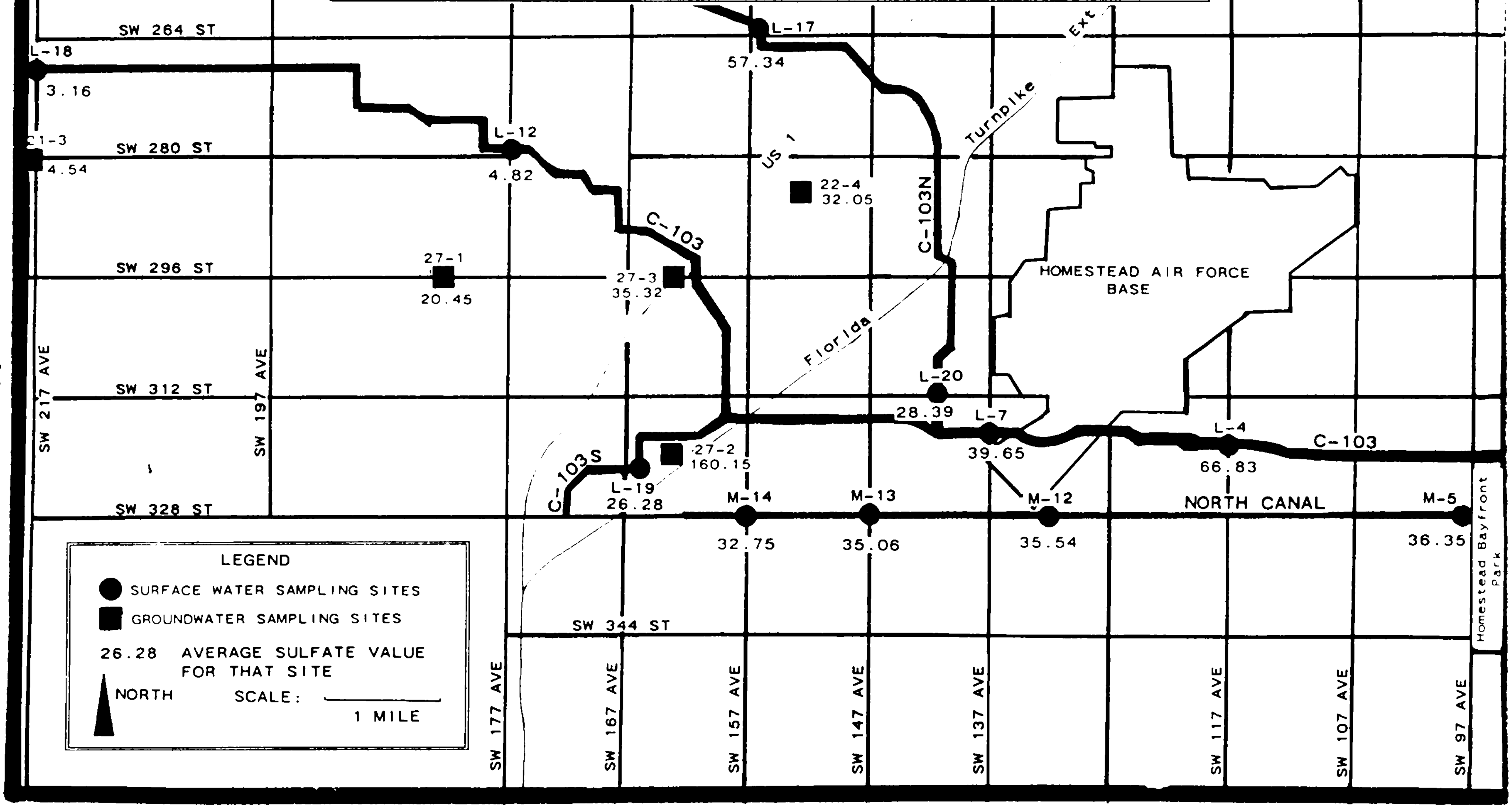


FIGURE 7: AVERAGE SULFATE DATA FOR SITES IN THE 1986 INTENSIVE CANAL STUDY



NUTRIENTS

Chemical fertilizers containing nitrogen and phosphorus are utilized in agricultural practices to supplement soil nutrients. Excessive levels of nitrogen or phosphorus in surface water can result in accelerated eutrophication. Elevated levels of nitrates are toxic to animals and man.

Nitrogen applied to the soil is subject to microbial transformation, direct runoff, erosion and percolation. High solubility nitrate-nitrogen may be carried vertically through the soil by leaching and may then enter surface water streams through the interaction of ground and surface water. Both organic nitrogen and phosphates are attenuated by soil particles and moved by erosion.

Levels of phosphates in surface waters are further lowered by their affinity to complex with limestone substrates. In general, levels of nitrates/nitrites and Total Kjeldahl Nitrogen were lower following rainy periods whereas ammonia remained fairly constant throughout the year.

Nitrates/Nitrites

Nitrates and nitrites were analyzed together as NOx-N. NOx-N levels are normally low in surface waters because nitrites are quickly converted to nitrates by oxidation, which are subsequently converted to organic nitrogen by photosynthetic activity. Nitrates are primarily produced by (1) microbial decomposition of organic matter (2) nitrification of ammonia and (3) nitrogen fixation by algae. High concentrations of NOx-N are indicative of pollution from agriculture, septic tanks, sewage treatment plants and landfills. Acid rain can also make a contribution.

In previous samplings, the C-103 Canal and the North Canal have had levels of NOx-N that were one order of magnitude higher than background levels found in southern canals not affected by agriculture (0.42 mg/l in 1985). NOx-N levels in this study ranged from 0.01 - 4.60 mg/l with median levels of 1.60 mg/l for the C-103 Canal and 1.45 mg/l for the North Canal.

With the exception of sites L-7 and L-17, the sites along C-103 had consistent levels of NOx-N throughout the year. Near the Air Force base, at site L-7, levels were more elevated and peak levels occurred during the growing season (December-February). Site L-17 had the highest NOx-N levels during the first and third quarters, which may be an effect of nurseries in the area (figure 8). In the North Canal, the highest levels occurred during the growing season (figure 9). Although there was no exceedance of the 10 mg/l standard, levels of NOx-N at some sites indicated a significant impact from agricultural land use (2 - 3 standard deviations from the median level).

FIGURE 8: 1986 INTENSIVE CANAL STUDY
Variation in Nitrate Data For The C-103 Canal

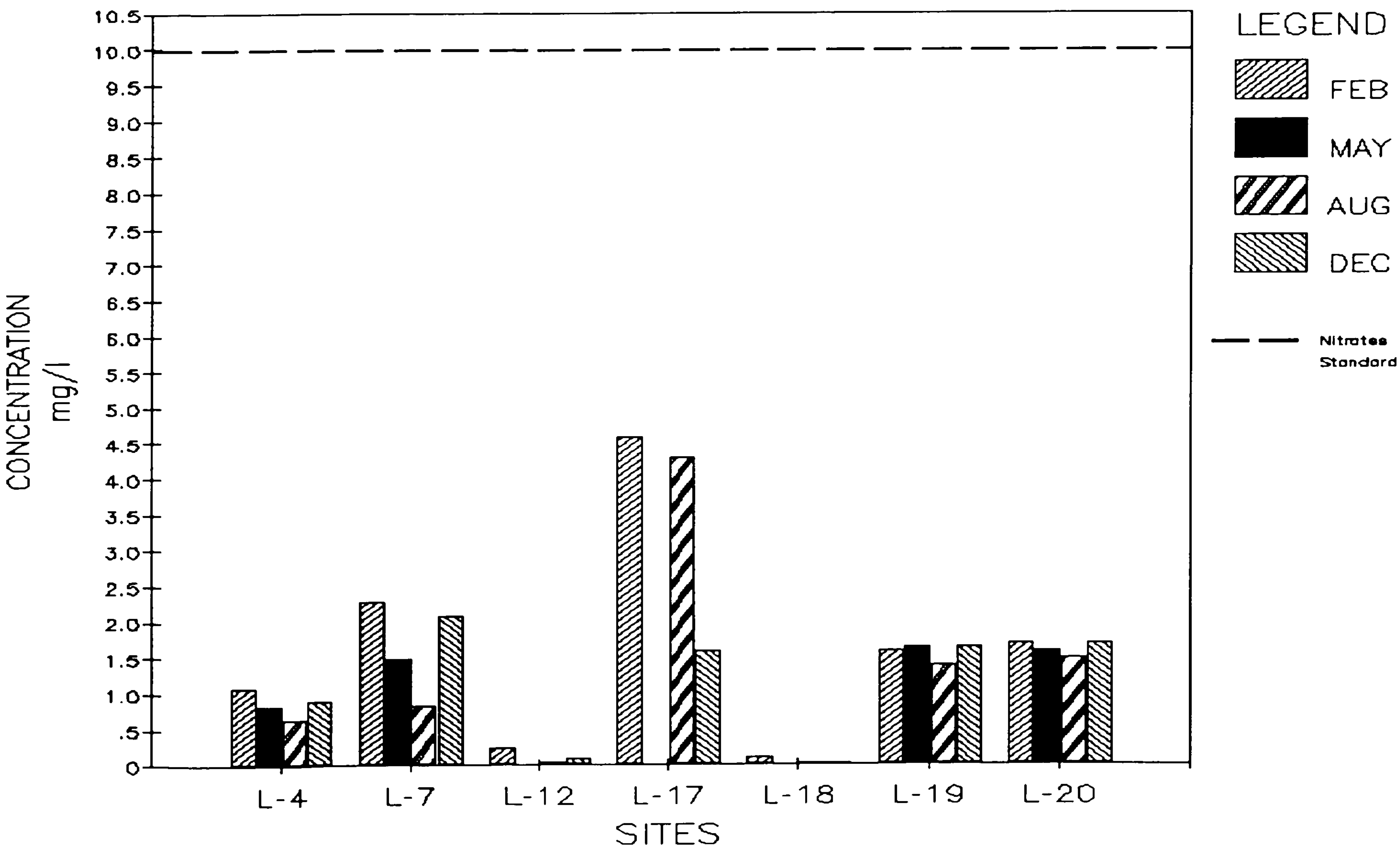
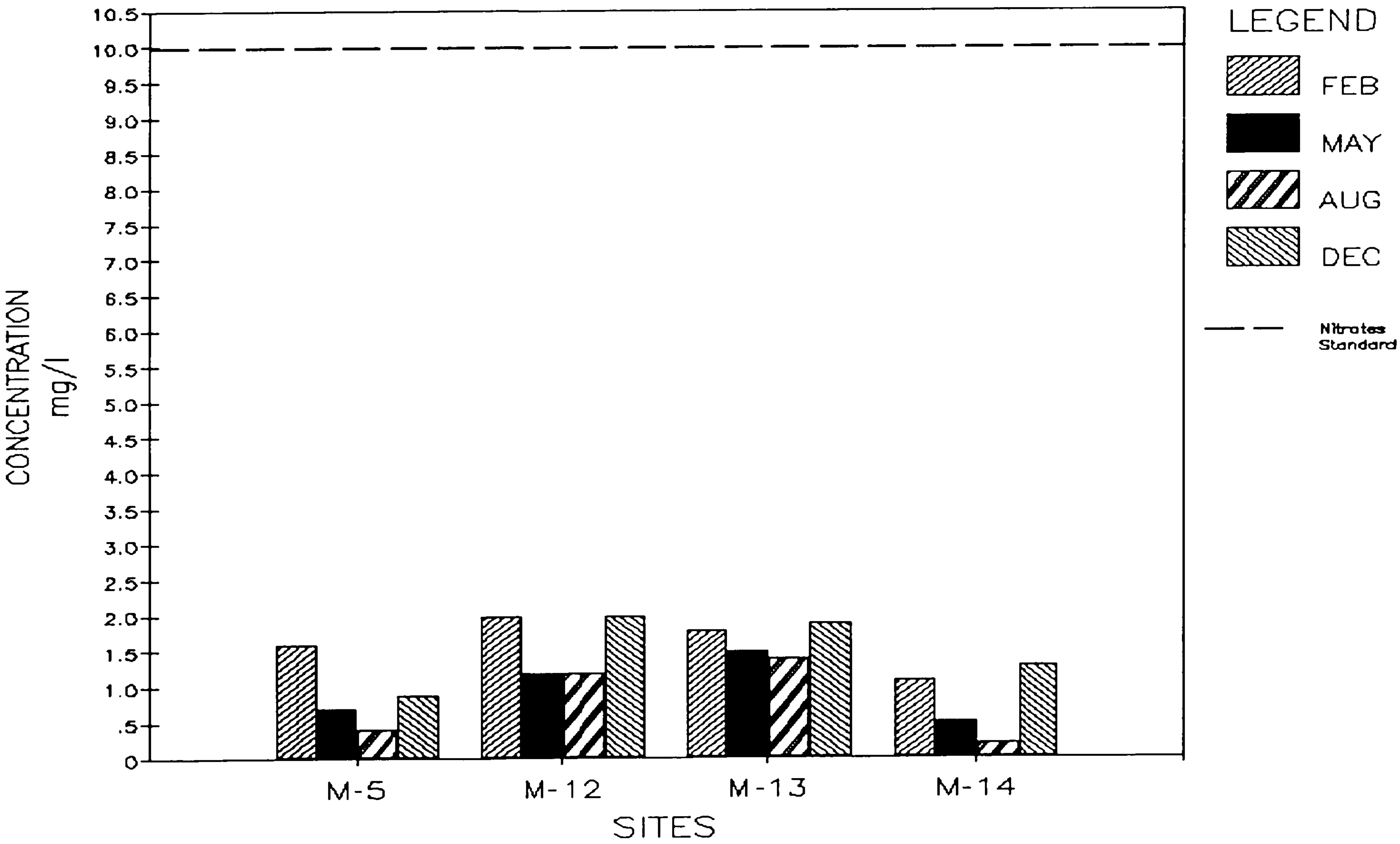


FIGURE 9: 1986 INTENSIVE CANAL STUDY
Variation in Nitrate Data
For The North Canal



Total Kjeldahl Nitrogen (TKN)

TKN is the sum total of the total organic nitrogen and ammonia. It does not include the nitrogen present as nitrates or nitrites.

Levels ranged from 0.2 - 1.70 mg/l and averaged 0.94 mg/l along the C-103 Canal and 0.82 mg/l along the North Canal. These levels were similar to surface water data for 1984 and 1985 (1.0 and 1.51 mg/l, respectively).

Ammonia (NH3-N)

Ammonia occurs naturally in surface waters and wastewaters. Ammonia levels obtained in this study were low; medians of 0.02 mg/l along C-103 and 0.05 mg/l along the North Canal were observed. These values were below typical levels found in Dade canals (0.25 mg/l in 1984 and 1985). The highest level (0.45 mg/l) was at site L-18 and may be due to the presence of septic tanks or water birds in the area. No sampling was conducted during the last quarter. Levels did not exceed the water quality standard of 0.5 mg/l.

In computing overall monthly averages, an interesting similarity is observed in the trends of the TKN and NOx-N data when compared to consistent NH3-N levels (figure 10). These fluctuations in TKN and NOx-N are due to organic nitrate levels and possibly result from agricultural applications. Nitrate in the fertilizers moves with water and is easily leached, whereas ammonia is readily adsorbed by the soil. In addition, levels of nitrates and nitrites are increased as ammonia is readily converted to these nitrogen species by soil microbes.

Total and Ortho-phosphates

The main form of phosphorus in natural waters occurs as phosphate. Total phosphates include ortho-phosphates and organically bound phosphates. Ortho-phosphates are applied to agricultural land and residential lawns. Fertilizer phosphate, applied in soluble ortho-phosphate form, is converted to an insoluble form in the soil. Concentrations of phosphates in surface waters tend to be low because the material is quickly incorporated into plant cell structures via photosynthesis.

Ortho-phosphates ranged from below detection limits to 0.02 mg/l with a median value of 0.01 mg/l for both C-103 and the North Canal. Total phosphates ranged from 0.01- 0.06 mg/l with median values of 0.02 mg/l along C-103 and 0.04 mg/l along the North Canal. While monthly averages of total phosphate levels were as much as one order of magnitude higher than those of ortho-phosphate, both reached their maximum levels during the dry season (figure 11). Levels of total and ortho-phosphates were comparable to data from other canals in the county.

FIGURE 10: 1986 INTENSIVE CANAL STUDY
Comparison of Nitrogen Levels for
C-103 and North Canals

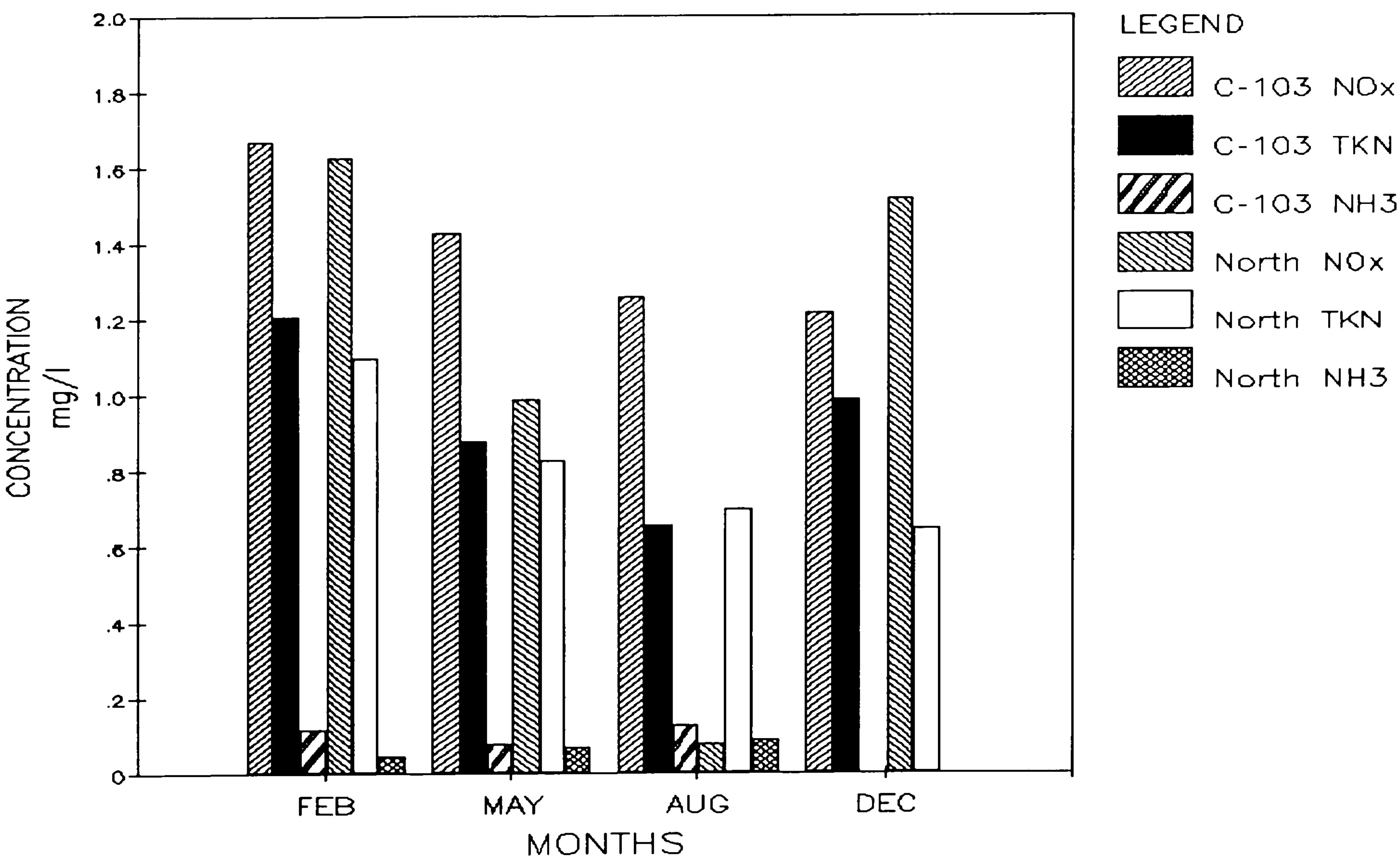
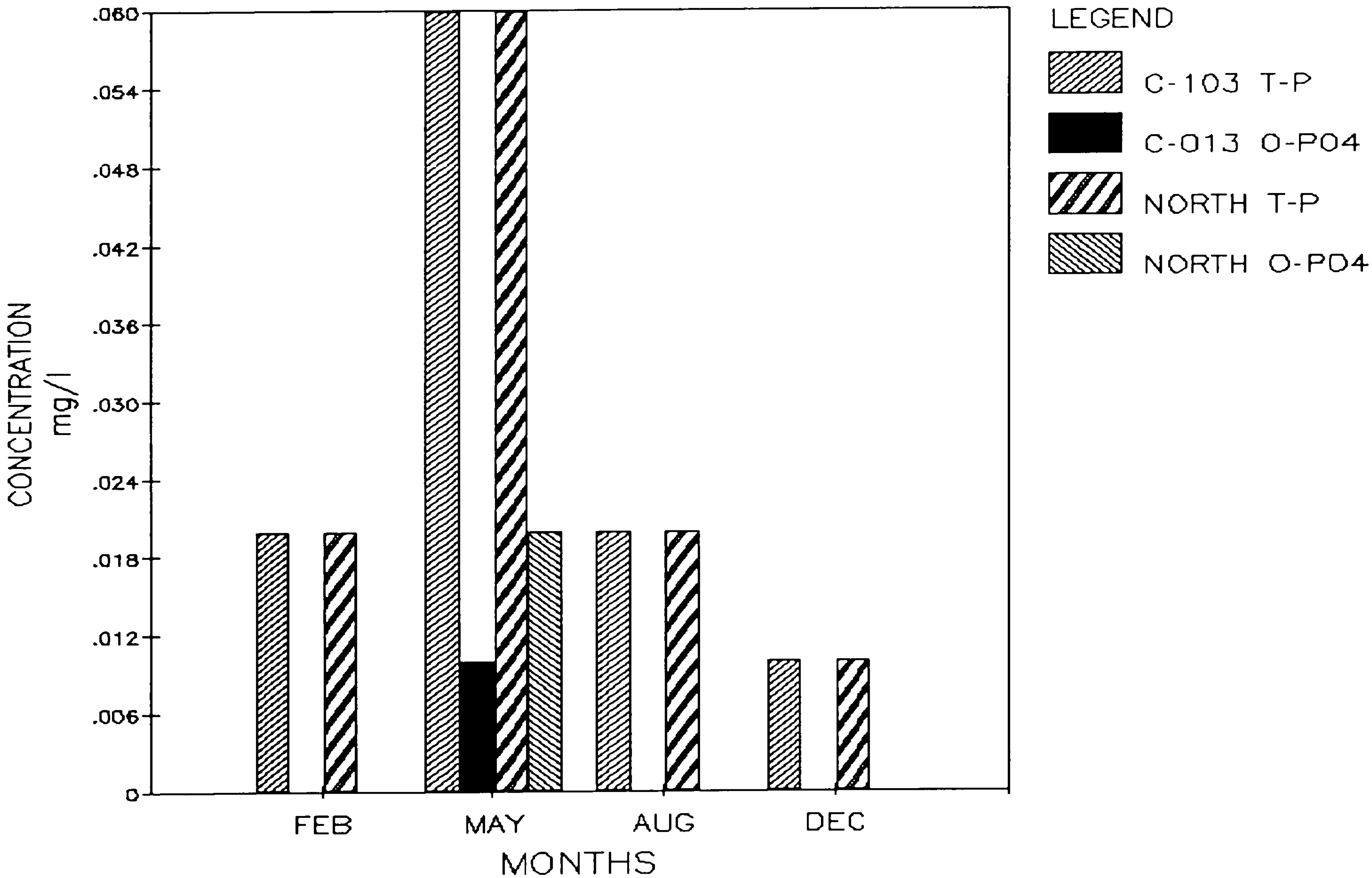


FIGURE 11: 1986 INTENSIVE CANAL STUDY
Comparison of Phosphate Data in the
C-103 and North Canals



TRACE ELEMENTS

Arsenic

Arsenic is used as a wood preservative and in the manufacture of dyes, glassware, ceramics and pesticides. In the past, arsenic formulations were extensively used for agricultural pest control in Dade County. The current standard for arsenic is 50 ug/l and no violations of this standard were detected.

Both the North and C-103 Canals had levels of arsenic below the standard. The average value obtained was <5 ug/l along the C-103 and the North canals. The maximum value was 10 ug/l. The levels are close to the detection limit of the analytical method, so caution must be used when interpreting the data. All positive detections occurred during the first dry season sampling.

Copper

Levels of copper in surface waters are usually very low. Elevated levels may result from industrial pollution or from the use of copper compounds for controlling undesirable plankton. Copper is also extensively used as a fungicide on row crops and grove operations. Concentrations ranged from below the detection limit to 17.0 ug/l with median values of 2.0 ug/l at C-103 and 2.4 ug/l at the North Canal. The highest concentration was detected at site M-14 during the dry season. Though M-14 is located in a low density residential area, the elevated copper levels (10 times background levels) cannot be attributed to a source at this time. All detections were well below the 400 ug/l standard.

Zinc

Zinc is a natural constituent of the aquifer and is usually found at levels much higher than those of other trace elements. Because zinc is ubiquitous and its concentration can vary widely, it is often difficult to determine when background concentrations have been exceeded by anthropogenic contamination.

Levels ranged from below the detection limit to 50 ug/l, with median values of 30 ug/l along C-103 and 25 ug/l along the North Canal. The highest levels were found at sites L-19, L-20 and M-5 during the dry season. All levels were well below the 1000 mg/l standard. Most of the sites had their lowest levels following rainy periods (figures 12 & 13).

Figure 12: 1986 INTENSIVE CANAL STUDY
Zinc levels in the C-103 Canal

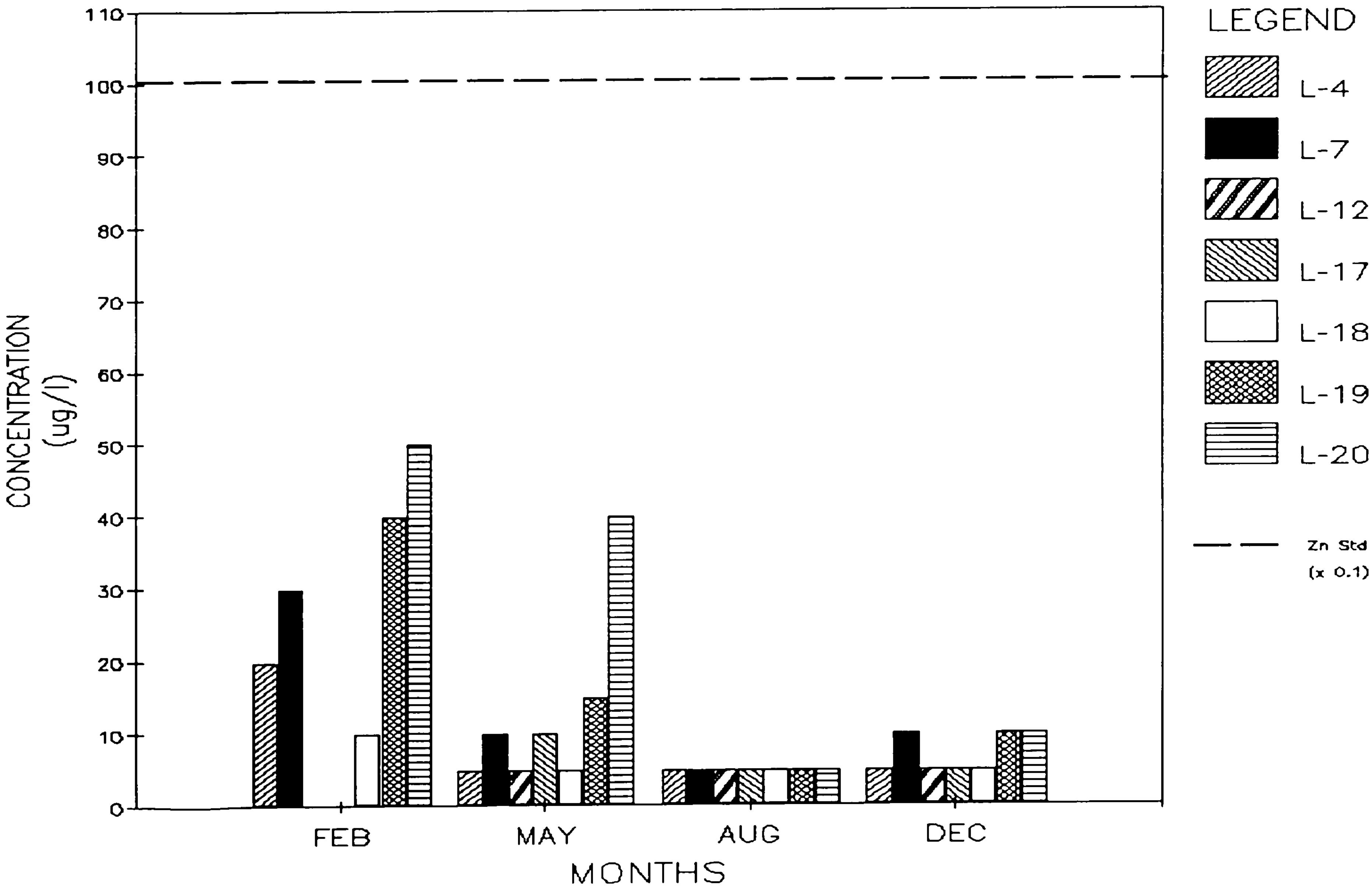
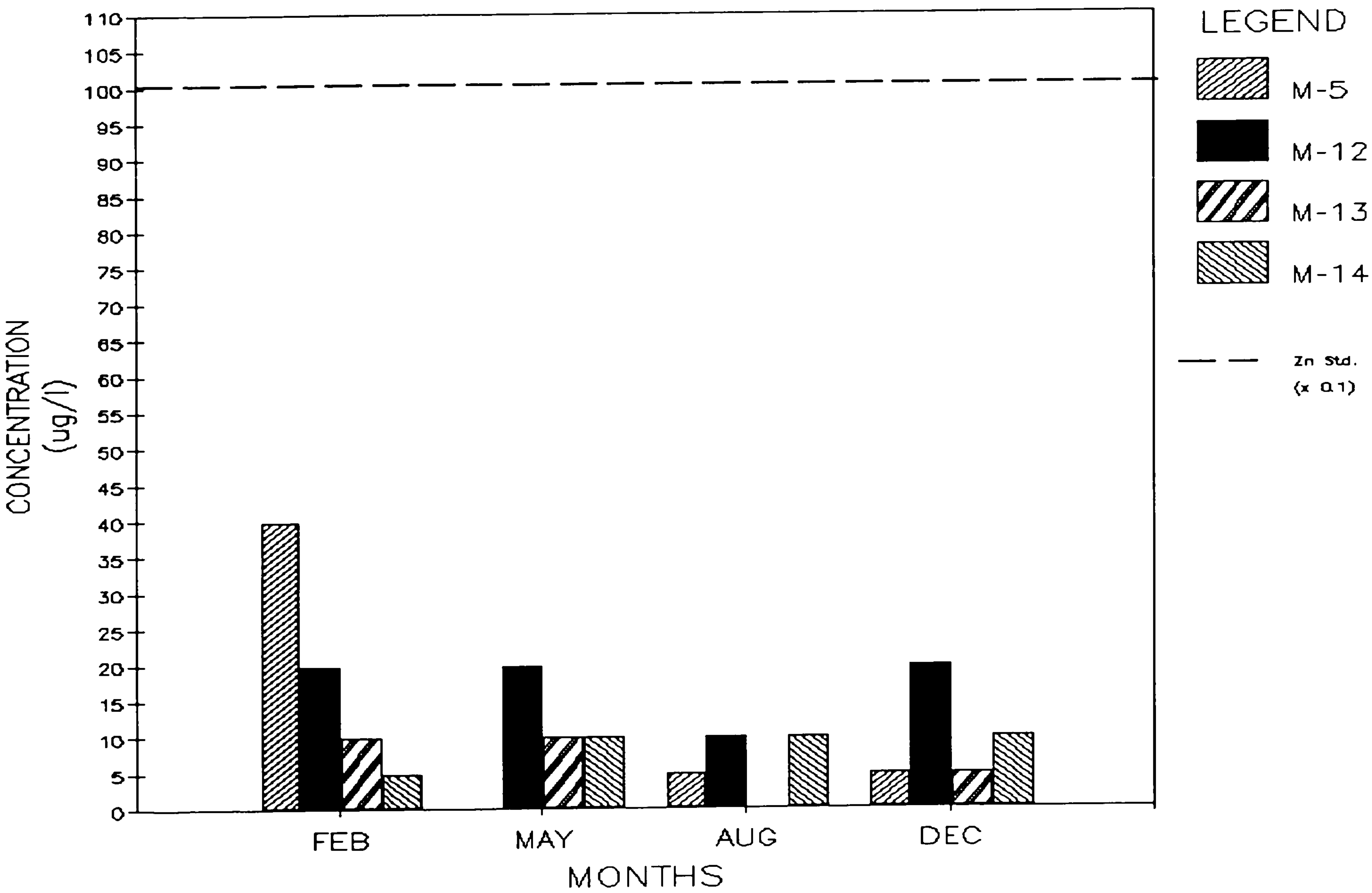


Figure 13: 1986 INTENSIVE CANAL STUDY
Zinc levels in the North Canal



MINERALS

Calcium, sodium, potassium and magnesium content were analyzed only during the last quarter of the year. Therefore, only provisional conclusions may be drawn from the limited data. No water quality standards are available for these parameters.

Calcium

The most common form of calcium present in Dade County surface waters is $CaCO_3$. Because of the preponderance of limestone in Dade County, levels of calcium are expected to be higher than levels of other minerals. Levels ranged from 70.1 to 103.1 mg/l and averaged 84.8 mg/l along C-103 and 88.3 mg/l along the North Canal. This variation is not uncommon in surface waters because calcium solubility depends on carbonate equilibrium (which varies with canal conditions) and is pH-dependent.

Sodium

Sodium is the most abundant mineral. In water, there are no major precipitation reactions that maintain low sodium concentrations similar to the way carbonate precipitation controls calcium concentrations. Sodium, once brought into solution, tends to remain in solution.

Sodium levels averaged 29.7 mg/l along the C-103 Canal and 27.1 mg/l along the North Canal. The highest level occurred at site L-4 (50.4 mg/l). As previously discussed, L-4 is subject to salt water intrusion; data collected during the dry season would probably confirm this.

Potassium

Potassium content in surface waters tends to be lower than sodium content because potassium exhibits a strong tendency to be reincorporated into solid weathering products and living organisms. Potassium levels averaged 5.0 mg/l along the C-103 Canal and 5.8 mg/l along the North Canal. The highest level occurred at site L-17 (8.20 mg/l).

Magnesium

Mg^{2+} is the dominant species of magnesium present in surface waters. Most limestone contains a moderate amount of magnesium.

Magnesium levels averaged 5.8 mg/l along the C-103 Canal and 4.5 mg/l along the North Canal.

ORGANIC PARAMETERS

Biochemical Oxygen Demand (BOD)

Biochemical oxygen demand measures both the oxygen required for biochemical degradation of organic material and the oxygen used to oxidize inorganic material such as sulfides and ferrous iron. Elevated BOD levels are often indicative of sewage pollution. Average BOD values obtained were 1 mg/l along the C-103 Canal and 2 mg/l along the North Canal. The highest value found was 3 mg/l. Results are consistent with data from other canals in the county. The 1985 ICS average value for BOD was 2 mg/l.

Phenols

Phenols are hydroxyl derivatives of benzene and of its condensed nuclei. They are commonly used in disinfectants, in the manufacture of resins, as medical and industrial compounds, and as reagents for chemical analyses. Because of their high solubility in water, phenol concentrations can adversely affect freshwater aquatic life.

Phenol levels ranged from below the detection limit to 5 ug/l and averaged <2.7 ug/l at the C-103 and North canals. Although phenol levels exceeded the 1 ug/l standard at most sites, these are considered background levels for Dade County and do not indicate pollution sources.

SUMMARY

The Intensive Canal Study was conducted in order to (1) determine whether pollution problems exist in the major South Dade canals and (2) obtain baseline data from these canals for use in future studies.

The data confirmed that salt water intrusion occurred at the discharge sites of both the C-103 and North Canals (L-4 & M-5) during the dry periods. Although both discharge sites were affected by salt water intrusion, the effect was greater along the C-103 Canal.

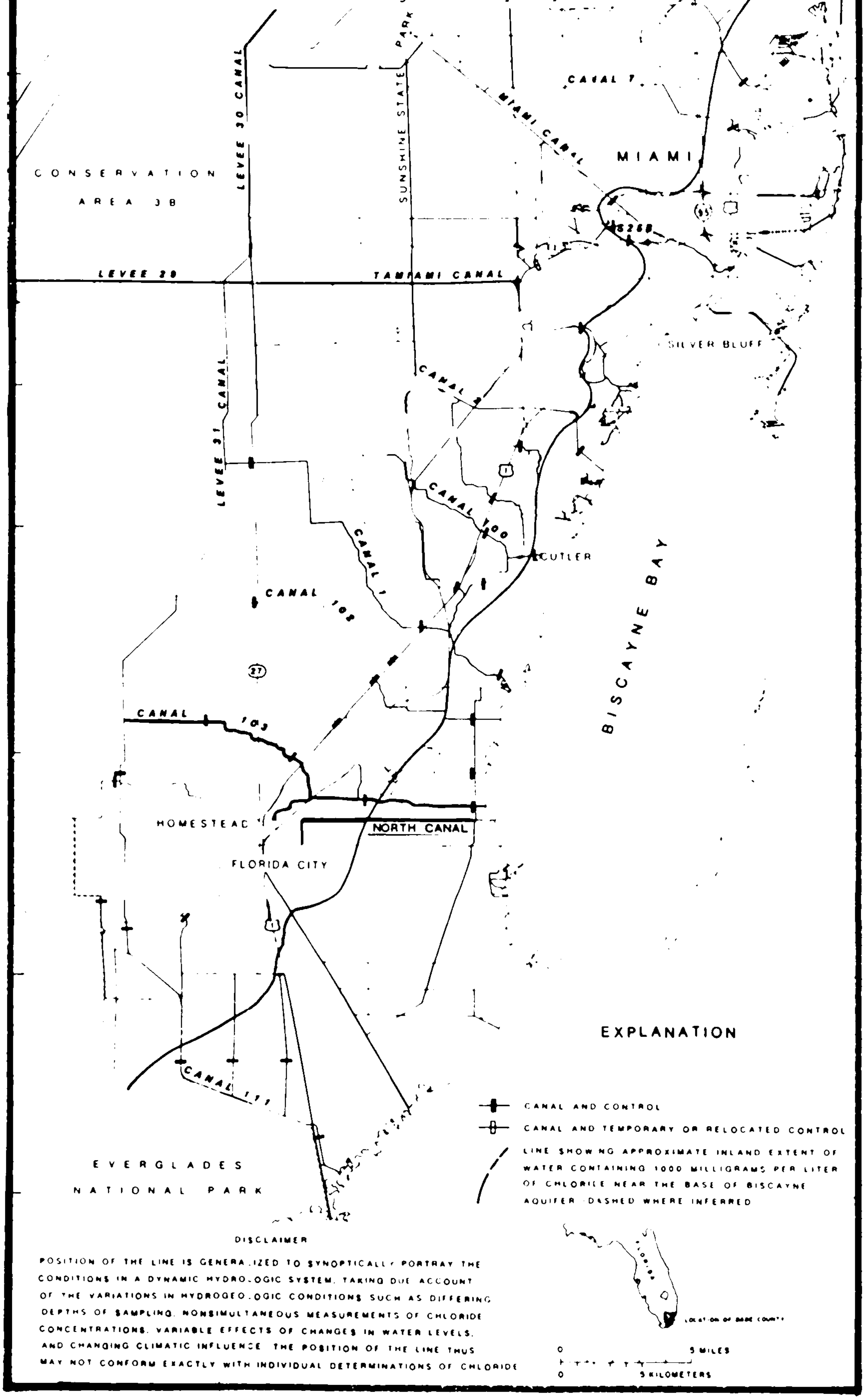
In the C-103 and North Canals, levels of nutrients, chlorides and sulfates were found to be higher than in canals in Dade County which are not in agricultural areas. These indicate that some water quality degradation has occurred which probably resulted from past and current agricultural practices.

Although phenol and conductivity levels exceeded the water quality standards at most sites, these levels are considered normal for Dade County surface water systems.

APPENDIX I

FIGURE SHOWING INLAND EXTENT OF WATER CONTAINING 1000 mg/l OF CHLORIDE NEAR THE BASE OF THE BISCAYNE AQUIFER

(United States Geological Survey, May 1984)



APPENDIX II

1986 INTENSIVE CANAL STUDY C-103 CANAL							
PARAMETER	WATER QUALITY STANDARD	METHOD DETECTION LIMIT	AVERAGE VALUE	MEDIAN VALUE	MINIMUM VALUE	MAXIMUM VALUE	STANDARD DEVIATION
ALKALINITY (mg/l)	Not <20		193		149	218	14
B.O.D (mg/l)	(1)	1	1		1	2	0
CHLORIDE (mg/l)	500		83		22	492	98
TURBIDITY (NTU)	50(2)	1.0	1.3	<1	<1	4.2	1.1
CONDUCT.(UMHOS/CM)	500		611		500	1500	208
FLUORIDE (mg/l)	1.4	0.01	0.16	0.64	0.09	0.64	0.13
T.K.N (mg/l)		0.01	0.94		0.20	1.70	0.40
AMMONIA (mg/l)	0.5	0.01	0.11	0.02	0.01	0.45	0.14
NOX-N (mg/l)	10	0.01	1.38	1.6	0.01	4.60	1.11
O-PO4 (mg/l)		0.01	0.01	0.01	0.01	0.02	0.00
T-PO4 (mg/l)		0.01	0.02	0.02	0.01	0.06	0.02
T.F.R (mg/l)	1000		384		293	1041	130
PHENOLS (ug/l)	1	2.7	<2.7		<2.7	5	1.33
Ca (mg/l)		0.1	84.8		70.1	103.1	11.6
Na (mg/l)		0.1	29.7		11.0	50.4	11.6
Mg (mg/l)		0.1	5.8		3.5	7.3	1.5
K (mg/l)		0.1	5.0		1.8	8.2	2.5
SULFATE (mg/l)			32.4		2.9	106.9	25.6
ARSENIC (ug/l)	50	5	<5		<5	7	<5
COPPER (ug/l)	400	0.1	1.4	2.0	0.1	6.6	1.7
ZINC (ug/l)	1000	10	10	30	<10	50	14

(1) Should not exceed a value which would cause dissolved oxygen to be depressed below 4 mg/l.
(2) Units for the standard are Jackson Turbidity Units (JTU) which are not comparable to Nephelometric Turbidity Units (NTU).

1986 INTENSIVE CANAL STUDY: C-103 CANAL DATA

PARAMETER	L-4				L-7			
	FEB	MAY	AUG	DEC	FEB	MAY	AUG	DEC
ALKALINITY (mg/l)	182	149	177	187	171	181	177	183
B.O.D (mg/l)	1	2	2	1	1	1	1	1
CHLORIDE (mg/l)	58	492	107		45	59	98	
TURBIDITY (NTU)	1.2	2.0	1.7	2.0	1.0	2.0	1.9	<1
CONDUCT(umhos/cm)	550	1500	700	800	550	520	630	600
FLUORIDE (mg/l)	0.13	0.10	0.13	0.13	0.13	0.11	0.11	0.12
T.K.N (mg/l)	1.10	0.80	0.40	0.60	1.10	0.60	0.40	0.70
AMMONIA (mg/l)	0.05	0.05	0.03		0.04	0.04	0.01	
NOX-N (mg/l)	1.10	0.85	0.67	0.92	2.30	1.50	0.85	2.10
O-PO4 (mg/l)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
T-PO4 (mg/l)	0.03	0.05	0.02	0.01	0.02	0.06	0.02	0.01
T.F.R (mg/l)	399	1041	397	437	325	328	394	349
PHENOLS (ug/l)		5	<2.7	<2.7	<2.7	<2.7	<2.7	<2.7
Ca (mg/l)				94.2				85.7
Na (mg/l)				50.4				24.5
Mg (mg/l)				7.3				5.2
K (mg/l)				7.1				5.9
SULFATE (mg/l)	106.90		44.44	49.20	38.05		43.70	37.20
ARSENIC (ug/l)	7.4	<5	<5	<5	<5	<5	<5	<5
COPPER (ug/l)	1.3	1.1	1.9	0.8	1.9	0.2	1.6	0.5
ZINC (ug/l)	20	<10	<10	<10	30	10	<10	10

1986 INTENSIVE CANAL STUDY: C-103 CANAL DATA

PARAMETER	L-12				L-17			
	FEB	MAY	AUG	DEC	FEB	MAY	AUG	DEC
ALKALINITY (mg/l)	206		200	197	211		206	207
B.O.D (mg/l)	1	1	1	2	1	1	1	2
CHLORIDE (mg/l)	52		68		22		33	
TURBIDITY (NTU)	1.0		2.3	1.8	<1		1.0	<1
CONDUCT.(umhos/cm)	500		525		500		650	
FLUORIDE (mg/l)	0.18		0.17	0.15	0.10		0.12	0.62
T.K.N (mg/l)	1.60		1.20	1.70	0.80		0.20	0.80
AMMONIA (mg/l)	0.19		0.34		0.03		0.02	
NOX-N (mg/l)	0.26		0.05	0.10	4.60		4.30	1.60
O-PO4 (mg/l)	0.01		0.01	0.02	0.01		0.01	0.01
T-PO4 (mg/l)	0.02		0.02	0.01	0.02		0.01	0.02
T.F.R (mg/l)	346		339	337	378		396	399
PHENOLS (ug/l)			<2.7	<2.7	<2.7		<2.7	<2.7
Ca (mg/l)				71.9				103.1
Na (mg/l)				30.9				11.0
Mg (mg/l)				7.1				3.5
K (mg/l)				1.8				8.2
SULFATE (mg/l)	3.79		7.08	3.60	53.99		54.32	63.70
ARSENIC (ug/l)	<5	<5	<5	<5	5.0	<5	<5	<5
COPPER (ug/l)	0.6	0.3	1.1	0.05	0.7	0.9	0.7	2.0
ZINC (ug/l)		<10	<10	<10		10	<10	<10

1986 INTENSIVE CANAL STUDY: C-103 CANAL DATA

PARAMETER	L-18				L-19			
	FEB	MAY	AUG	DEC	FEB	MAY	AUG	DEC
ALKALINITY(mg/l)	218		200	206	195	193	193	201
B.O.D(mg/l)	1	2	2	1	1	1	1	1
CHLORIDE(mg/l)	40		67		53	68	71	
TURBIDITY(NTU)	2.3		4.2	2.6	<1	1.0	1.3	<1
CONDUCT.(UMHOS)	500		520		520	550	610	600
FLUORIDE(mg/l)	0.16		0.19	0.11	0.13	0.11	0.12	0.11
T.K.N(mg/l)	1.50		1.20	1.70	1.40	1.00	0.60	0.80
AMMONIA(mg/l)	0.45		0.45		0.05	0.10	0.02	
NOX-N(mg/l)	0.12		0.02	0.01	1.60	1.50	1.40	1.50
O-PO4(mg/l)	0.01		0.01	0.01	0.01	0.01	0.01	0.01
T-PO4(mg/l)	0.03		0.02		0.03	0.06	0.02	0.01
T.F.R(mg/l)	351		325	336	361	366	346	344
PHENOLS(ug/l)	4		<2.7	<2.7		<2.7	<2.7	<2.7
Ca(mg/l)				70.1				84.4
Na(mg/l)				31.6				28.9
Mg(mg/l)				7.1				4.5
K(mg/l)				1.8				4.8
SULFATE(mg/l)	3.58		2.90	3.00	24.44		27.40	27.00
ARSENIC(ug/l)	<5	<5	<5	<5	5.2	<5	<5	<5
COPPER(ug/l)	0.4	0.2	0.5	0.05	2.2	1.2	5.9	6.6
ZINC(ug/l)	10	<10	<10	<10	40	20	<10	10

1986 INTENSIVE CANAL STUDY: C-103 CANAL FIELD DUPLICATES DATA

PARAMETER	L-17 FIELD DUPLICATE DEC	L-18 FIELD DUPLICATE AUG	L-19 FIELD DUPLICATE MAY	L-19 FIELD DUPLICATE DEC
ALKALINITY (mg/l)	204		193	201
B.O.D (mg/l)			1	
CHLORIDE (mg/l)		67	69	
TURBIDITY (NTU)	<1	3.4	1.3	1.0
CONDUCT. (umhos/cm)			520	600
FLUORIDE (mg/l)	0.64	0.18	0.12	0.10
T.K.N (mg/l)			0.80	0.70
AMMONIA (mg/l)			0.07	
NOX-N (mg/l)			1.70	1.80
O-PO4 (mg/l)	0.01		0.01	0.01
T-PO4 (mg/l)	0.02	0.02	0.06	0.01
T.F.R (mg/l)	403	351	364	343
PHENOLS (ug/l)			<2.7	
Ca (mg/l)				
Na (mg/l)				
Mg (mg/l)				
K (mg/l)				
SULFATE (mg/l)				
ARSENIC (ug/l)	<5		<5	<5
COPPER (ug/l)	0.9		1.0	6.0
ZINC (ug/l)			10	

1986 INTENSIVE CANAL STUDY: C-103 CANAL DATA

PARAMETER	L-20			
	FEB	MAY	AUG	DEC
ALKALINITY (mg/l)	193	181	192	193
B.O.D (mg/l)	1	1	1	2
CHLORIDE (mg/l)	56	67	67	
TURBIDITY (NTU)	<1	1.5	1.1	1.0
CONDUCT. (umhos/cm)	500	500	610	
FLUORIDE (mg/l)	0.13	0.10	0.14	0.09
T.K.N (mg/l)	1.00	1.20	0.60	0.90
AMMONIA (mg/l)	0.02	0.15	0.05	
NOX-N (mg/l)	1.70	1.60	1.50	1.70
O-PO4 (mg/l)	0.01	0.01	0.01	0.01
T-PO4 (mg/l)	0.02	0.06	0.02	0.01
T.F.R (mg/l)	358	349	293	386
PHENOLS (ug/l)	<2.7		<2.7	<2.7
Ca (mg/l)				84.0
Na (mg/l)				30.4
Mg (mg/l)				5.9
K (mg/l)				5.2
SULFATE (mg/l)	25.06		29.80	30.30
ARSENIC (ug/l)		<5	<5	<5
COPPER (ug/l)	1.5	0.9	0.4	1.2
ZINC (ug/l)	50	40	<10	10

1986 INTENSIVE CANAL STUDY NORTH CANAL							
PARAMETER	WATER QUALITY STANDARD	METHOD DETECTION LIMIT	AVERAGE VALUE	MEDIAN VALUE	MINIMUM VALUE	MAXIMUM VALUE	STANDARD DEVIATION
ALKALINITY(mg/l)	Not <20		205		163	336	40
B.O.D (mg/l)	(1)	1	2		<1	3	1
CHLORIDE (mg/l)	500		70		32	268	63
TURBIDITY (NTU)	50(2)	1	3	1.6	<1	18.5	4.35
CONDUCT. (UMHOS)	500		554		500	850	95
FLUORIDE (mg/l)	1.4	0.01	0.10	0.10	0.08	0.13	0.01
T.K.N (mg/l)		0.01	0.82		0.30	1.40	0.31
AMMONIA (mg/l)	0.5	0.01	0.07	0.05	0.02	0.24	0.06
NOX-N (mg/l)	10	0.01	1.24	1.45	0.22	2.00	0.56
O-PO4 (mg/l)		0.01	0.01	0.01	0.01	0.02	0.01
T-PO4 (mg/l)		0.01	0.03	0.04	0.01	0.06	0.02
T.F.R (mg/l)	1000		350		290	583	66
PHENOLS (ug/l)	1	2.7	1		<2.7	5	2
Ca (mg/l)		0.1	88.3		87.3	89.5	0.9
Na (mg/l)		0.1	27.1		21.7	37.7	7.2
Mg (mg/l)		0.1	4.5		4.1	5.5	0.7
K (mg/l)		0.1	5.8		5.5	6.1	0.3
SULFATE (mg/l)			34.9		32.0	37.3	1.6
ARSENIC (ug/l)	50	5	<5		<5	10	2.9
COPPER (ug/l)	400	0.1	2.3	2.4	0.1	17.0	4.2
ZINC (ug/l)	1000	10	11	25	<10	40	11

(1) Should not exceed a value which would cause dissolved oxygen to be depressed below 4 mg/l.
(2) Units for the standard are Jackson Candle Turbidity Units (JTU) which are not comparable to Nephelometric Turbidity Units (NTU).

1986 INTENSIVE CANAL STUDY: NORTH CANAL STUDY

PARAMETER	M-5				M-12			
	FEB	MAY	AUG	DEC	FEB	MAY	AUG	DEC
ALKALINITY (mg/l)	206	163	175	206	201	176	211	202
B.O.D (mg/l)	1	1	2	<1	1	2	1	1
CHLORIDE (mg/l)	39	268	70		32	55	50	
TURBIDITY (NTU)	<1	2.5	2.2	<1	1.0	2.0	18.5	1.6
CONDUCT.(umhos/cm)	550	850	550	700	550	500	520	500
FLUORIDE (mg/l)	0.10	0.11	0.11	0.08	0.11	0.10	0.10	0.10
T.K.N (mg/l)	1.00	0.80	0.50	0.70	0.90	0.80	1.40	0.60
AMMONIA (mg/l)	0.04	0.05	0.02		0.04	0.07	0.24	
NOX-N (mg/l)	1.60	0.72	0.43	0.89	2.00	1.20	1.20	2.00
O-PO4 (mg/l)	0.01	0.02	0.01	0.01	0.01	0.02	0.01	0.01
T-PO4 (mg/l)	0.02	0.06	0.02	0.01	0.03	0.06		0.01
T.F.R (mg/l)	336	583	340	389	335	324	290	338
PHENOLS (ug/l)	<2.7	<2.7	<2.7		<2.7	<2.7	<2.7	3
Ca (mg/l)				88.3				89.5
Na (mg/l)				37.7				21.7
Mg (mg/l)				5.5				4.1
K (mg/l)				6.1				5.7
SULFATE (mg/l)	36.25		37.30	35.50	35.22		36.40	35.00
ARSENIC (ug/l)	<5		<5	<5	5.0	<5	<5	<5
COPPER (ug/l)	1.3		1.5	0.3	2.7	0.5	0.9	0.4
ZINC (ug/l)	40		<10	<10	20	20	10	20

1986 INTENSIVE CANAL STUDY: NORTH CANAL DATA

PARAMETER	M-13				M-14			
	FEB	MAY	AUG	DEC	FEB	MAY	AUG	DEC
ALKALINITY (mg/l)	241	188	195	202	336	166	195	209
B.O.D (mg/l)	3	2	1		2	2	2	2
CHLORIDE (mg/l)	43	57	60		48	59	54	
TURBIDITY (NTU)	1.0	2.3	1.6	1.0	5.6	3.0	2.3	3.4
CONDUCT.(umhos/cm)	520	500	530	500	500	500	500	600
FLUORIDE (mg/l)	0.10	0.10	0.13	0.09	0.10	0.12	0.12	0.09
T.K.N (mg/l)	1.20	0.60	0.30	0.70	1.30	1.10	0.60	0.60
AMMONIA (mg/l)	0.04	0.06	0.04		0.07	0.08	0.05	
NOX-N (mg/l)	1.80	1.50	1.40	1.90	1.10	0.52	0.22	1.30
O-PO4 (mg/l)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
T-PO4 (mg/l)	0.04	0.05	0.02	0.01	0.03	0.05	0.03	0.01
T.F.R (mg/l)	352	334	336	343	339	304	319	335
PHENOLS (ug/l)	<2.7	3	<2.7	5		4	<2.7	<2.7
Ca (mg/l)				87.3				88.1
Na (mg/l)				24.6				24.2
Mg (mg/l)				4.2				4.2
K (mg/l)				5.5				5.9
SULFATE (mg/l)	36.29		34.70	34.20	33.25		32.00	33.00
ARSENIC (ug/l)	5.2	<5	<5	<5	9.8	<5	<5	<5
COPPER (ug/l)	2.4	0.5	0.1	0.8	17.0	0.8	1.0	4.2
ZINC (ug/l)	10	10		<10	<10	10	10	10

APPENDIX III

REFERENCES

U.S. Environmental Protection Agency, 1986, Quality Criteria for Water

Florida Department of Environmental Regulation, Water Quality Standards

U.S. Department of Agriculture, Environmental Protection Agency, 1975, Volume I, Control of Water Pollution from Cropland

Dade County Department of Environmental Resources Management, 1984 Ground and Surface Water Monitoring Programs

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