Metropolitan Dade
County, Florida

Department of Environmental Resources Management

Ground and Surface Water Monitoring Programs 1984

DERM Technical Report 88-10

GROUND AND SURFACE WATER

MONITORING PROGRAMS

1984

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PREFACE

Dade County's Department of Environmental Resources Management (DERM) regulates potential pollution sources and utilizes land use controls in an effort to prevent degradation of the County's sole drinking water supply, the Biscayne aquifer. The effectiveness of these measures are monitored by four water quality programs:

1. Ambient Groundwater Network - biannual sampling to quantify a wide variety of parameters which are used to establish a data base as well as to characterize the water's quality.

2. General Canal Monitoring Program - monitors physical and chemical parameters on the majority of the canals throughout the County on a monthly basis.

3. Annual Pollutant Study - incorporates a more extensive range of parameters on a biannual basis and monitors the impact of urbanization along the canals.

4. Intensive Canal Study - highlights one canal per year and extensively monitors it on a quarterly basis.

The total estimated analytical costs for these programs for 1984 was $107,000 which was allocated to each program as follows:

Groundwater Network	17.8%
Canal Monitoring Program	36.2%
Intensive Canal Study	28.8%
Annual Pollutant Study	17.2%

The following report discusses the 1984 analytical results obtained from conducting these programs. The standards referenced throughout this report were obtained from DER Water Quality Standards, Chapters 17-3 and 17-22, Dade County Environmental Code Chapter 24-11, and EPA Water Quality Criteria.

PART I

1984 AMBIENT GROUNDWATER QUALITY MONITORING NETWORK

The groundwater quality monitoring network was initiated in 1981 by DERM to monitor ambient groundwater quality in the Biscayne aquifer. A network of approximately 35 groundwater wells were sampled bi-annually (wet and dry seasons) for routine parameters (field analyses, nutrients, major ions, indicator bacteria when appropriate), and more specific parameters (metals, volatile organics, pesticides and herbicides) on a less frequent basis. The objectives of the program were to:

1. establish baseline ambient groundwater quality associated with general land uses in Dade County, and
2. monitor the long term impact of those land uses on the groundwater supply.

Due to resource limitations, the groundwater sampling took place only once in 1984 instead of the normal biannual sampling of previous years. These analyses were performed:

<u>Physical Properties</u>
Color
Turbidity
Total Filtrable Residue

<u>Major Inorganics Anions</u>
Sulfates
Fluorides
Chlorides
Alkalinity

<u>Nutrients</u>
Total phosphate
Ammonia
Nitrate/Nitrites
Ortho phosphate
Total phosphate

<u>Trace Elements</u>
Arsenic
Cadmium
Chromium
Copper
Iron
Lead
Manganese
Mercury
Nickel
Selenium
Silver
Zinc

<u>Organic Constituents</u>
Phenols
Volatile Organic Carbons(VOC)

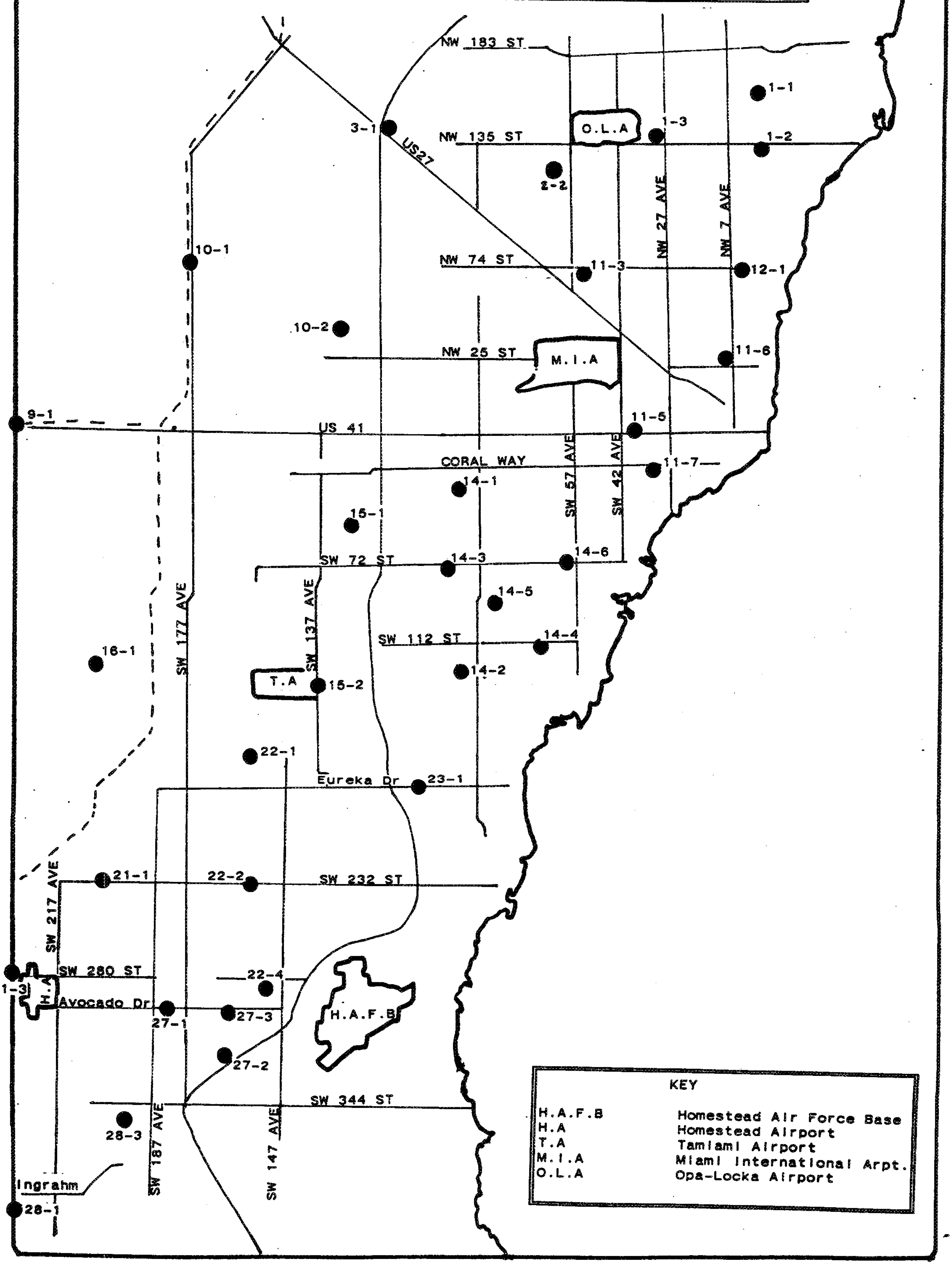
Table 1 lists the locations of groundwater sites involved in the study, Figure 1 maps their location. In the following discussion Dade County is considered to be divided into northern and southern sections by the Tamiami Canal.

TABLE 1: LOCATION AND LAND USE OF SITES IN THE 1984 GROUNDWATER NETWORK PROGRAM

SITE NUMBER	USGS (1) NUMBER	DEPTH (feet)	LAND USE	SEWERED	LOCATION
1-1A	G-1630		Residential	No	NE 2nd Ave & 163 St
B	G-1631	20	Residential	No	NE 2nd Ave & 163 St
C	G-1632	31	Residential	No	NE 2nd Ave & 163 St
D	G-1633	45	Residential	No	NE 2nd Ave & 163 St
1-2	G-430	97	Residential	No	Meml. Hwy & NE 136-7 St
1-3	OPWTP(2)	100	Residential	No	Burlington & Codadad
2-2	GW-4	8	Bus./Resid.	No	W 8th Ave & 74 St
3-1	G-1637	26	R/S(3), Ind.	No	US 27, Opa-Locka W Alrpt
9-1A	G-3202	10	Resid./Bus	No	US 41 at Coopertown
B	G-3203	35	Resid./Bus	No	US 41 at Coopertown
10-1	G-1488	20	R/S	No	NW 177 Ave & 72 St
10-2	G-3103	21	R/S	No	NW 120 Ave & 42 St
11-3	G-1610	10	Resid./Bus	Yes	W 1st Ave & 19th St
11-5	GW-6	10	Residential	Yes	SW 37 Ave & SW 2nd St
11-6		60	Industrial	Yes	NW 11 Ave & 22 St
11-7	F-179	77	Industrial		SW 32 Ave & 24 Terr
12-1	F-46	90	Residential	Yes	NW 5 Ave & 69 St
14-1B	G-1606	20	Residential	Yes	SW 90 Ave & 38 St
D	G-1608	40	Residential	Yes	SW 90 Ave & 38 St
E	G-1609	60	Residential	Yes	SW 90 Ave & 38 St
14-2	G-553	91	Resid./Ind	No	SW 89 Ave & 128 St
14-3	G-3073	20	Resid./Bus	Yes	SW 97 Ave & 72 St
14-4	G-580A	22	Residential	No	SW 67 Ave & 112 St
14-5	G-1604	62	Resid./Bus	No	SW 75 Ave & 105 Terr
14-6	F-319	20	Resid./Bus	Yes	US 1 & SW 72 St
15-1	G-958A	27	Resid./Undev	No	SW 127 Ave & 51 St
15-2	G-858	20	Airport/R/U/I	No	SW 137 Ave & 128 St
16-1B	G-3189	21	R/S		SW 207 Ave & 120 St
21-1	G-3108	15	Resid./Agri	No	SW 202 Ave & 232 St
21-3	G-3177	22	Airport/Agri	No	SW 237 Ave & 280 St
22-1	G-1362	33	Resid./Agri	No	SW 157 Ave & 168 St
22-2	G-614	18	Resid./Agri	No	SW 157 Ave & 232 St
22-4	G-1486	20	Resid./Agri.	Yes	SW 152 Ave & 284 St
23-1	S-182	51	Resid./Bus	Yes	SW 104 Ave & 185 Terr
27-1A	G-1615	12	Resid./Agri	No	SW 182 Ave & 296 St
C	G-1617	36	Resid./Agri	No	SW 182 Ave & 296 St
D	G-1618	45	Resid./Agri	No	SW 182 Ave & 296 St
E	G-1619	61	Resid./Agri	No	SW 182 Ave & 296 St
27-2		27	Residential	Yes	SW 162 Ave & 320 St
27-3		20	Undev./Bus		US 1 & SW 296 St
27-4	IFAS(4)	23	Resid./Agri	No	SW 187 Ave & 280 St
28-1B	G-3180	21	R/S	No	SW 232 Ave & 392 St
28-3	G-864	20	Resid./Agri.	No	SW 192 Ave & 352 St

(1) USGS = United States Geological Survey
(2) OPWTP = Opa-Locka Water Treatment Plant
(3) R/S = Recharge/ Storage
(4) IFAS = Institute of Food and Agricultural Sciences

FIGURE 1: LOCATION OF SITES IN THE 1984 GROUNDWATER MONITORING PROGRAM



RESULTS

The standards referenced in this section are listed in Table 2.

Physical Properties

Color

An aesthetic property, color has no direct chemical significance. Color in water may result from the presence of natural metallic ions (e.g., manganese, and iron), organic humus and peat materials, plankton, weeds and industrial wastes. The numerical value assigned to color has no direct relation to the actual amount of matter producing the color and is entirely empirical. Color values do provide an indirect measure of trihalomethane formation potential of water samples. Trihalomethanes are carcinogenic chemicals which form as a result of the disinfecting process when the water contains organic humus and peat materials.

The average value obtained was 27 platinum-cobalt units (PCU's) and ranged from 5 to 50 PCU's. Higher PCU values occurred in sites north of the Tamiami Canal.

Turbidity

Turbidity is a measure of the capacity of water to absorb or scatter light. Suspended matter such as clay, silt and finely divided organic and inorganic matter results in higher turbidity values. More importantly, turbidity interferes with recreational use and aesthetic enjoyment of water. Excessive turbidity: (1) can signal damage to a groundwater well, (2) can interfere with microbiological determinations, and (3) can interfere with disinfection if the groundwater is for potable use.

Turbidity is measured in nephelometric turbidity units (NTU). The average value obtained for groundwater samples was 10.2 NTU, with

TABLE 2 : STANDARDS*

PARAMETER	UNITS	MAXIMUM ALLOWABLE CONCENTRATION	
		GROUNDWATER	SURFACE WATER
Alkalinity	mg/l	-	Not <20 (3)*
Ammonia	mg/l	0.5	0.5
Chlorides	mg/l	500	500
Conductivity	UMHOS/cm	100%>background	500
Dissolved Oxygen	mg/l	Not less than 4	-
Fluorides	mg/l	1.4	1.4
Nitrates	mg/l	10 (2)	10 (1)
Phenols	ug/l	1	1
Total Filtrable Residue	mg/l	1000/any time 500/monthly average	1000/any time or 500/monthly average
Turbidity	JCU	50	50
Methylene Blue Active Substances(MBAS)	mg/l	0.5	0.5
Oil & Grease	mg/l	15	15
Arsenic	ug/l	50	50
Cadmium	ug/l	10 (2)	1.2 (3)
Chromium	ug/l	50	50
Copper	ug/l	400	400
Iron	ug/l	300	300
Lead	ug/l	50	950
Mercury	ug/l	N.D*	N.D
Nickel	ug/l	-	100 (3)
Selenium	ug/l	10 (2)	25 (3)
Silver	ug/l	50 (2)	0.07 (3)
Zinc	ug/l	1000	1000
Carbon Tetrachloride	ug/l	3.0 (2)	-
1,2-Dichloroethane	ug/l	3.0 (2)	-
Tetrachloroethylene	ug/l	3.0 (2)	-
1,1,1-Trichloroethane	ug/l	200 (2)	-
Trichloroethylene	ug/l	3.0 (2)	-
Vinyl Chloride	ug/l	1.0 (2)	-
Aldrin plus Dieldrin	ug/l	-	0.003 (3)
Chlordane	ug/l	-	0.01 (3)
Endosulfan	ug/l	-	0.003 (3)
Endrin	ug/l	0.2 (2)	0.004 (3)
Heptachlor	ug/l	-	0.001 (3)
Lindane	ug/l	4 (2)	0.01 (3)
Methoxychlor	ug/l	100 (2)	0.03 (3)
Myrex	ug/l	-	0.001 (3)
Toxaphene	ug/l	5 (2)	0.005 (3)
2,4-D	ug/l	100 (2)	-
2,4,5-TP (Silvex)	ug/l	10 (2)	-
Fecal Coliform	MF/100ml or MPN	-	800/any one day 200/monthly avg 400 in 10% of samples (3)
Total Coliform	MF/100ml or MPN	50	1000

* Unless otherwise noted the standards referred to were taken from Dade County Enviromental Code Chapter 24-11.
(1) Environmental Protection Agency Surface Water Criteria
(2) Florida Primary Drinking Water Standards
(3) Department of Environmental Regulation Water Quality Standards Chapter 17-3.121
* N.D = None Detected

levels ranging from 0 to 175 NTU. Site 11-3 displayed 175 NTU which may be indicative of well damage in that previous data on this site were consistently low. Application of the water quality standard is not appropriate because it is based on outdated methodology which is measured in Jackson candle turbidity units (JCU).

Total Filtrable Residue

Total filtrable residue (TFR) is the total concentration of dissolved material in water that is not retained by a glass fiber filter. The principal inorganic anions dissolved in water include carbonates, chlorides, sulfates and nitrates; the principal cations are sodium, potassium, calcium and magnesium. The physiological effects directly associated with TFR include laxative effects (mainly for Na_2S0_4 and $MgS0_4$) and the adverse effect of sodium on certain patients afflicted with cardiac disease. Corrosion and encrustation of metallic surfaces by water containing filtrable residue is well known. Waters with high TFR values are generally of inferior palatability. Dade County's groundwater standards allow an average monthly TFR concentration of 500 mg/l and a maximum value of 1000 mg/l for any single sampling.

TFR concentrations averaged 488 mg/l in the groundwater monitoring network and ranged from 172 to 6193 mg/l. The 1000 mg/l TFR standard was exceeded at site 11-3 (6193 mg/l). Sites which had levels greater than 500 mg/l were: 11-5 (682 mg/l), 11-6 (631 mg/l), 11-7 (831 mg/l) and 27-2 (574 mg/l). Sites 11-6 and 11-7 are clearly the result of salt water intrusion since chloride levels at both sites are high and previous data have established high sodium levels at these sites. Sites 11-3 and 11-5, slightly further north and east of 11-6 and 11-7, have high TFR values and suggest salt water intrusion, but this has not been confirmed by chloride levels nor previous sodium data. Both wells are shallow (10 ft.) and the sites are not deep enough to be affected by salt water. Consequently, high TFR's at sites 11-3 and 11-5 are probably a result of urban activities in the area. The elevated TFR level at site 27-2, was a first occurrence at this site. Future testing should determine if this is due to land use activities.

Major Inorganic Anions

The major anions in groundwater are sulfates, chlorides, bicarbonates and, to a lesser extent, fluorides. Several factors affect the aqueous concentration of these ions: (a) availability of the elements in soil, (b) their solubility and adsorption characteristics, and (c) the sequence in which water comes into contact with the minerals.

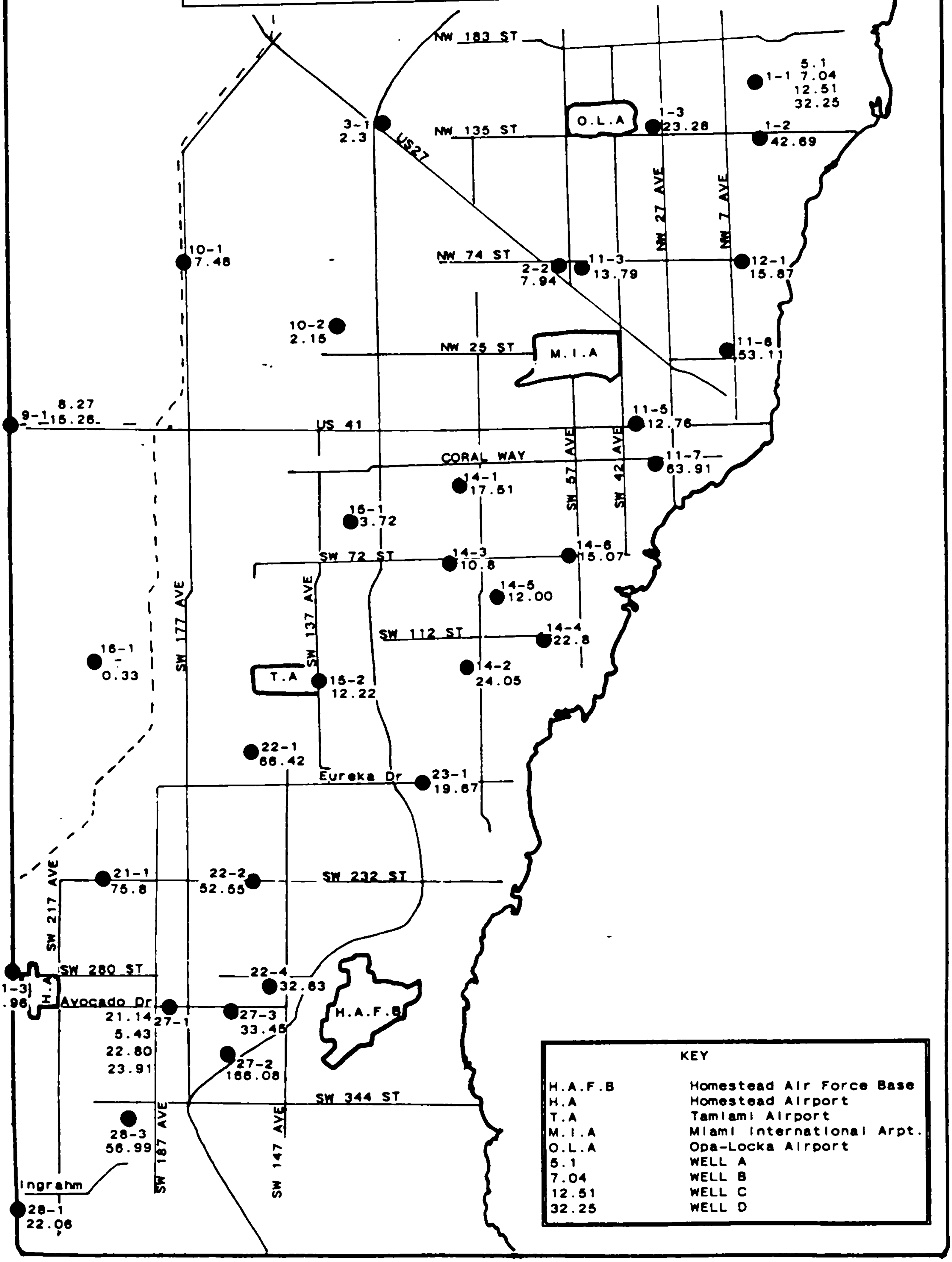
Sulfate

Sulfate is widely distributed in nature and its concentrations in natural waters may vary markedly. Chemical transformation of sulfur ions to sulfate ions or reduction to the sulfide state occurs frequently in groundwater. The reaction is believed to take place in the presence of certain bacteria. Typically groundwater experiencing sulfate reduction has both high bicarbonate and carbon dioxide content and contains hydrogen sulfide. Sulfate levels averaged 26.2 mg/l in the groundwater network and ranged from 0.33 - 166.08 mg/l (Figure 2). Agricultural practices also contributed to elevated sulfate levels in the sites south of the Tamiami Canal as indicated by data from sites 27-2 (166.08 mg/l), 22-1 (66.42 mg/l), 22-2 (52.55 mg/l) and 28-3 (56.99 mg/l). Site 21-1 (75.8 mg/l) was impacted by brackish water pumped from the artesian well at Chekika Hammock State Park that had been pumping mineralized water from the Floridan aquifer since 1944 (until capped in 1985). Sites 11-6 (53.11 mg/l) and 11-7 (63.91 mg/l) had elevated sulfate levels attributable to salt water intrusion.

Chlorides

Chlorides in large concentrations are harmful to metallic surfaces and growing plants. Chloride ions do not readily undergo oxidation-reduction reactions in the ambient environment nor do they form covalently bonded soluble salts to any appreciable extent. Chlorides move through water with little or no retardation. Elevated levels of Chlorides in water may be due to salt water intrusion, landfills,

FIGURE 2: VARIATION OF SULFATE DATA IN THE 1984 GROUNDWATER MONITORING PROGRAM



sewage, or illegal dumping activities.

The average chloride level obtained for the groundwater samples was 63.6 mg/l, almost an order of magnitude below the Dade County standard of 500 mg/l. As seen in Figure 3, salt water intrusion was detected at sites 11-6 (312 mg/l), 11-7 (388 mg/l) and 21-1 (111 mg/l) due to the artesian well influence. Sites 9-1 and 10-1 had elevated levels which were probably the result of recharge of mineralized water which originated from Lake Okeechobee agricultural areas and was transported via the L-67A and Tamiami canals. Elevated chloride levels at site 3-1 (132 mg/l) may also be due to recharge of mineralized surface water originating from the Lake Okeechobee agricultural areas and transported via the Miami Canal.

Alkalinity

The major contributors to alkalinity in Dade County are bicarbonate and carbonate ions. Bicarbonates in water are generally formed by either of two reactions:

a) reaction of carbon dioxide (CO_2) with water:

$$CO_2 + H_2O = H_2CO_3 = H^+ + HCO_3^{2-}$$

b) reaction of organic matter with sulfates:

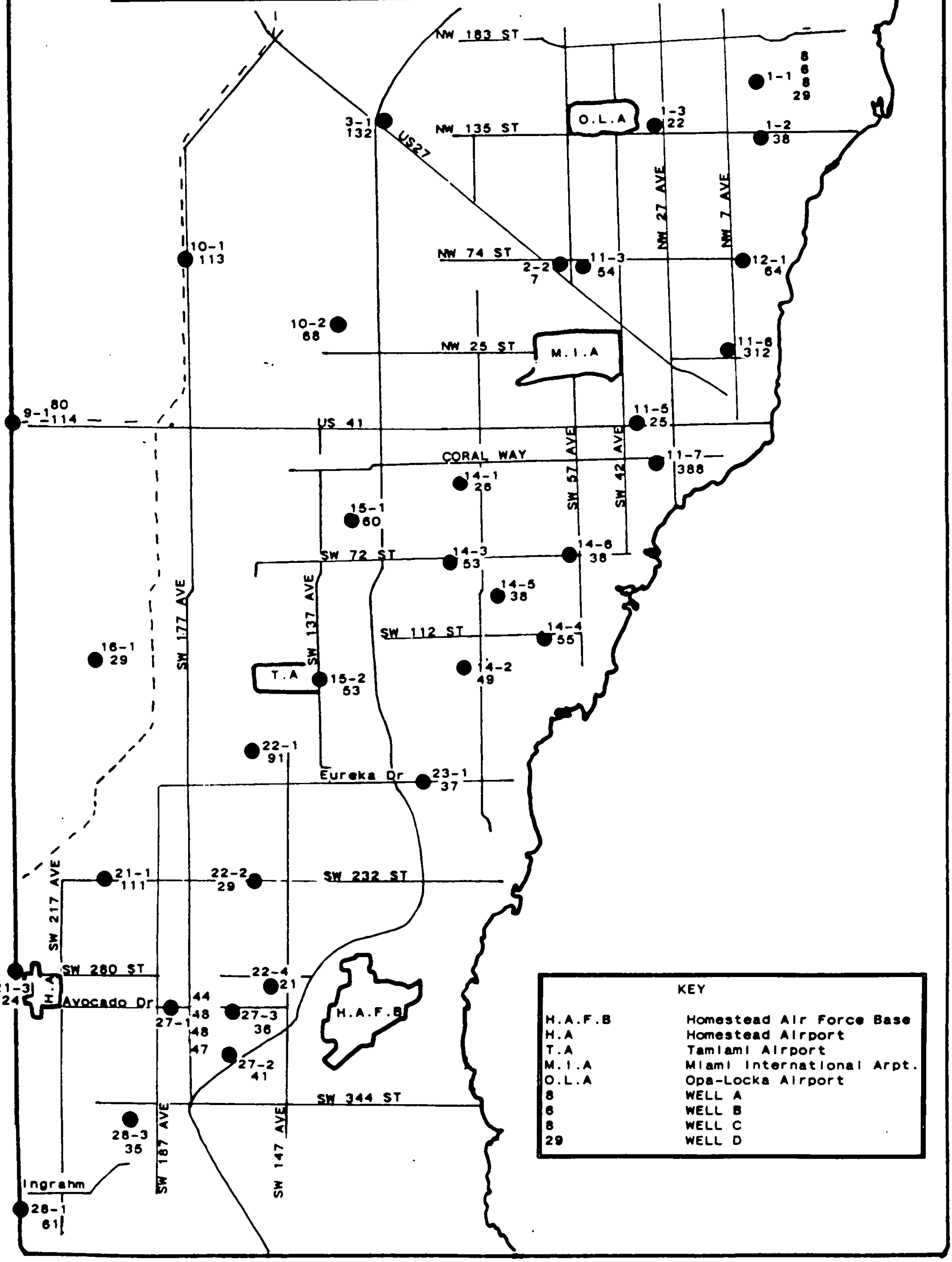
$$2CH_2O + SO_4^{2-} = HS^- + 2HCO_3 + H^+$$

Alkalinity is an indicator of the buffering capacity of water. Its importance cannot be overemphasized because of the impact of pH on organisms which thrive in water and on the toxicity of certain pollutants found in water. The average alkalinity value obtained in this groundwater study was 210 mg/l. Levels ranged from 103 - 429 mg/l.

Fluorides

Fluoride is relatively insoluble, and its concentrations in groundwater are usually quite low. Fluoride ions are usually tied up in rock minerals and only a small portion is in solution. Fluoride

FIG 3: VARIATION OF CHLORIDES IN THE 1984 GROUNDWATER MONITORING PROGRAM



concentrations ranged from 0.08 to 0.49 mg/l and averaged 0.155 mg/l, well below the Dade County standard 1.4 mg/l.

Nutrients

Nutrients are substances which are essential to sustain life. In excessive amounts in drinking water, nutrients can be harmful to human health. Nitrogen and Phosphorus are naturally occurring in the environment and are involved in varied ecological processes as outlined in the nitrogen cycle located in Appendix I. Pollution sources of nitrogen and phosphorus are septic tanks, sewage, fertilizers, dumps, stormwater runoff and illegal dumping activities.

Nitrogen

In groundwater, the most common forms of naturally occurring nitrogen are nitrate (NO_3), nitrite (NO_2) and ammonia (NH_3). Nitrogen species can accumulate in groundwater because a) they are extremely soluble and b) they are usually the end product of decay of organic matter.

Wastes from fertilizer plants and field fertilization are typical anthropogenic sources of nitrates. They may also leach from soils which contain a large amount of animal refuse. Nitrates, at levels above 50 mg/l, can cause methemoglobinemia in infants (blue baby type disease).

The breakdown of urea and proteins in domestic waste from septic tanks and leaking sewer lines is a source of ammonia. Under strictly aerobic conditions, ammonia may be oxidized to nitrite and nitrate through the action of nitrifying bacteria:

$$2NH_4 + 3O_2 = 2NO_2 + 4H^+ + 2H_2O$$
$$2NO_2 + O_2 = 2NO_3$$

The dominant species present depends primarily upon the geology and soils of the area. In the northern part of Dade County (sites north of the Tamiami Canal), reducing conditions prevail and the major species present is ammonia. This is demonstrated graphically in Figure 4 which compares the ammonia and nitrate levels for North Dade. The highly permeable limestone in South Dade County facilitates the rapid percolation of oxygen rich rainwater to the groundwater thereby promoting rapid nitrification of ammonia. This causes the major species to be nitrate (Figure 5). Any nitrite formed is quickly converted to the more stable anion, nitrate. Ammonia concentrations averaged 0.34 mg/l in the groundwater monitoring network and ranged from 0.01 to 2.90 mg/l thereby encompassing very low levels in samples from the southern sites and higher ammonia concentrations from samples from North Dade. The Dade County standard of 0.5 mg/l for ammonia was exceeded at three sites in the north and one site in central Dade County. These were:- 9-1A (1.4 mg/l), 9-1B (1.2 mg/l); 11-3 (2.9 mg/l); 11-7 (1.3 mg/l) and 14-1E (0.88 mg/l). The nitrate values exhibited an inverse relationship with ammonia concentrations, averaging 0.95 mg/l with a high value of 5.00 mg/l in the southern section of the County. These levels did not exceed the Dade County standard of 10 mg/l of nitrates.

Phosphorus

The principal sources of phosphorus in natural waters are probably the apatite minerals, $Ca_3(PO_4)_2.CaF_2$ and $Ca_3(PO_4)_2.\ CaCl_2$ which dissolve in water to yield $H_2PO_4^-$ and HPO_4^{2-}. Phosphorus in groundwater is present as phosphate $(PO_4)^{3-}$.

Although orthophosphates and phosphates in general are utilized in fertilizers, their final concentrations in groundwater are very low.

FIGURE 4
COMPARISON OF AMMONIA AND NOx-N DATA FOR THE NORTHERN SITES IN THE 1984 GROUNDWATER MONITORING PROGRAM

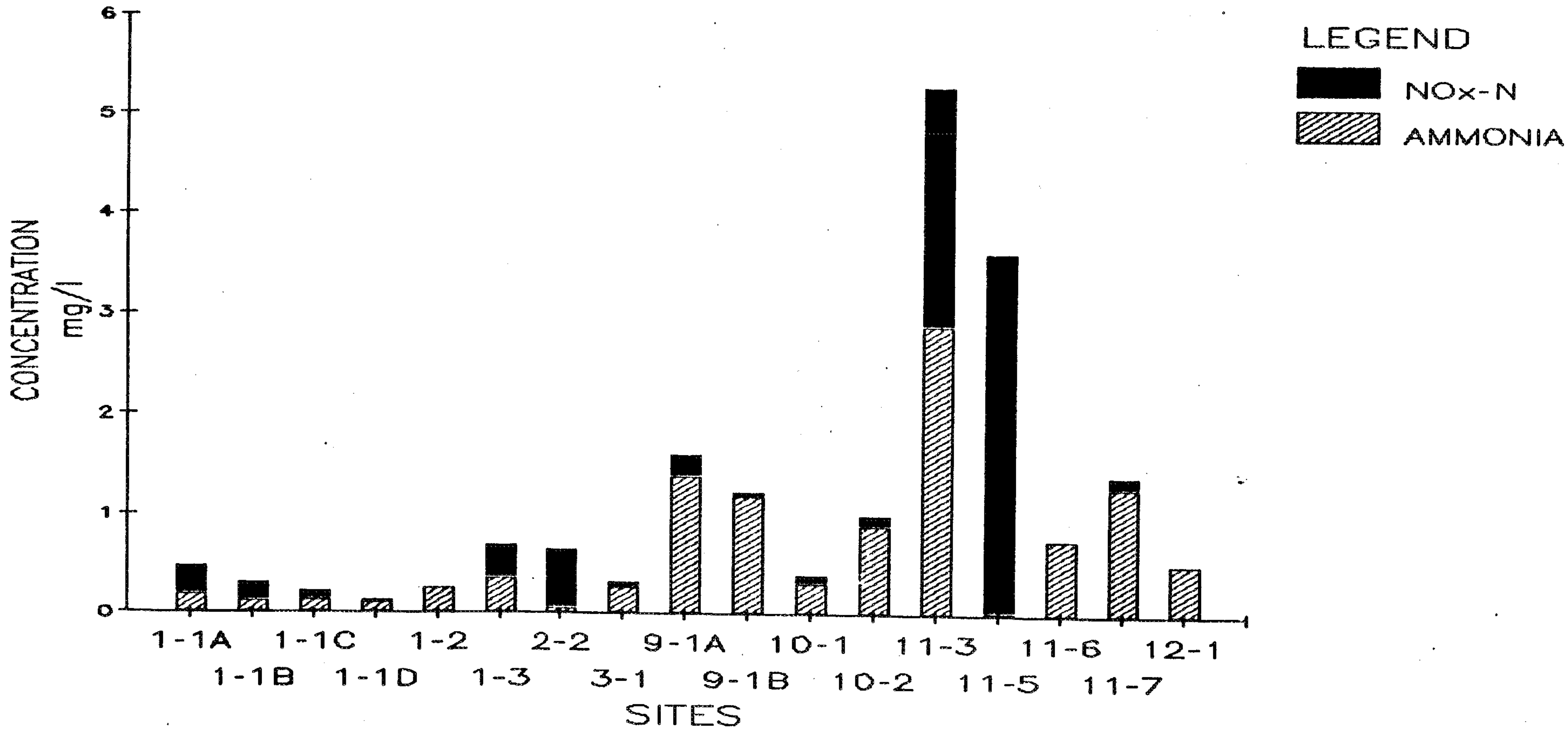
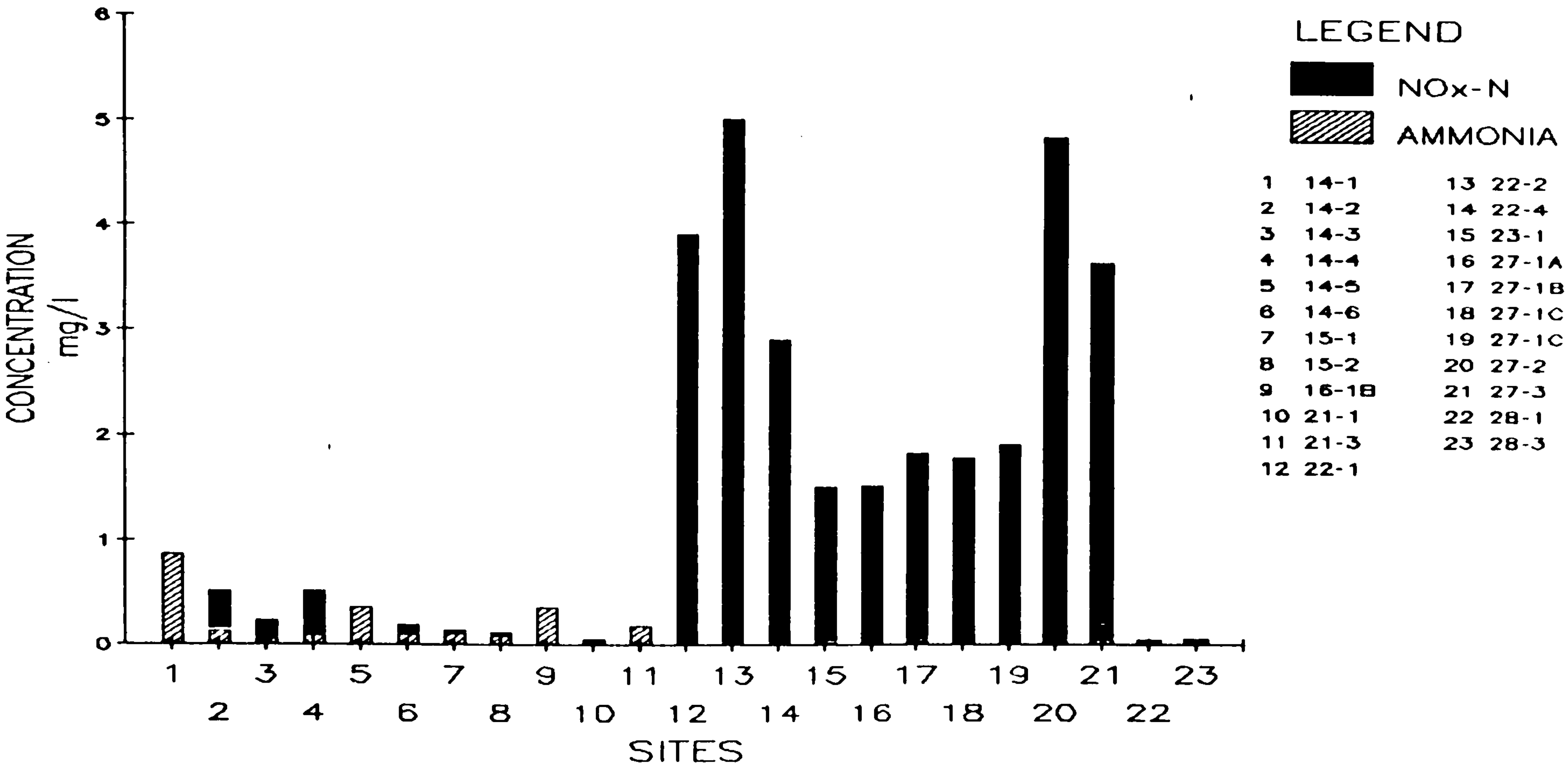


FIGURE 5
COMPARISON OF AMMONIA AND NOx-N DATA FOR THE SOUTHERN SITES IN THE 1984 GROUNDWATER MONITORING PROGRAM



Phosphates are assimilated by plants, adsorbed by soil colloids and combined to limestone substrates. At the same time, since they are released slowly from the decomposition of organic matter, they have low mobility in the groundwater.

Total phosphates include orthophosphate and all other organic and inorganic phosphate species. Orthophosphate concentrations ranged from below the detection limit of 0.001 mg/l to 0.125 mg/l and averaged 0.017 mg/l. Sites 2-2 (0.052 mg/l), 11-3 (0.028 mg/l) and 14-6 (0.125 mg/l) were higher than average. Total phosphate levels ranged from 0.002 to 0.127 mg/l and averaged 0.024 mg/l. Site 14-6 (0.127 mg/l), a business area, was an order of magnitude above the average.

Trace Elements

Trace elements are rarely found in groundwater at concentrations high enough to comprise a significant percentage of the total dissolved solids, but they can occur at levels which exceed the safe limits set for drinking water standards. Concentrations are low mainly because of low solubility of the elements and their salts.

Arsenic

Arsenic is sometimes present in natural waters due to contact with arsenic-bearing minerals such as arsenical pyrites. In heavy doses, arsenic acts as a cumulative poison, probably because of its slow elimination from the human body. Arsenic was historically used in insecticides and this makes it an element of environmental interest. The most stable forms of arsenic, As_2O_5 and As_2O_3 are sufficiently soluble in water to exceed the groundwater standard of 50 ug/l. Arsenic concentrations in the groundwater samples were more than an order of magnitude below the standard, averaging 1.1 ug/l and ranging from below the detection limit of 1 ug/l to a high of 6.8 ug/l.

Cadmium

Cadmium has a high toxic potential when ingested. It accumulates in the soft tissues at all concentration levels down to 100 ug/l in drinking water, resulting in anemia, poor metabolism, possible adverse arterial changes in the human liver, and at higher concentrations, death. Cadmium may become a water contaminant from electroplating plants. It is also a common impurity in zinc used for zinc-galvanized iron and may enter water distribution systems from this source. Cadmium is used in batteries, electroplating, pigments and as a alloy with other metals. The average concentration detected in groundwater samples was 0.2 ug/l, which was below the groundwater standard of 10 ug/l. Site 11-3, a residential/business area, had the highest level, 1.4 ug/l.

Chromium

The salts of hexavalent chromium (Cr^{6+}) in industrial use (chromates and dichromates) are skin irritants and can produce ulcers. Chromium is known to be a carcinogenic agent for man when it is inhaled. Trivalent chromium (Cr^{3+}) is not toxic. Most chromium concentrations (measured as cumulative Cr^{3+} and Cr^{6+}) were below the detection limit of 1 ug/l, and well below the 50 ug/l groundwater standard for chromium. Concentrations ranged from below the detection limit of 1 ug/l to 3.9 ug/l. It is interesting that site 11-3, which had the highest level of cadimum, also had the highest level of chromium, although the value was well below the standard.

Copper

Copper is an insignificant constituent of natural water. It is introduced by dissolution from brass and copper pipes and from the use of copper sulfate as an agricultural fungicide and as an algicide in reservoirs. Copper is of physiological importance as a supplement to iron for hemoglobin regeneration and is an essential constituent of tissue cells. Copper in concentrations in excess of 1000 ug/l may impart a disagreeable taste to water and may precipitate as $Cu(OH)_2$ which will increase turbidity and stain plumbing fixtures. The standard applied to Dade County groundwater is 400 ug/l. The average concentration obtained in the study was below the detection of 1 ug/l, with a high value 10 ug/l. Again, site 11-3 had the highest level of copper, but it did not exceed the standard.

Iron

Iron is essential to plant and animal metabolism and is found in organic wastes and in plant debris. Unlike other trace metals, iron levels in groundwater are high because relatively small shifts in pH can cause great changes in its solubility.

Iron concentrations ranged from 0.02 mg/l to 30.5 mg/l and averaged 2.0 mg/l. These levels, which exceed the 0.3 mg/l standard, may be a function of the well casing erosion in some instances. Site 11-3 had much higher than average iron levels (30.5 mg/l). This is a shallow well in a densely developed commercial area. The elevated iron level in this case may be indicative of pollution.

Lead

Lead taken into the body in quantities in excess of certain low limits is a cumulative poison. The Dade County standard allows a maximum concentration of 50 ug/l. There were exceedances of the standard at site 11-3 (160.3 ug/l) along with higher then baseline levels of cadmium, chromium, copper and iron. As mentioned earlier, 11-3 is in a densely developed area. The elevated lead values suggest groundwater degradation attributable to land use. Site 14-3 (49 ug/l) which approached the standard, is in a less developed area and future monitoring should reveal whether or not the apparent degradation of water quality is a trend. Lead concentrations ranged from below the 1 ug/l detection limit at most sites to a high of 160.3 ug/l, averaging 6.3 ug/l.

Manganese

Manganese precipitates deposits in distribution mains, stains plumbing fixtures and renders water unsuitable for laundering, dyeing, paper making and other manufacturing processes. It is an essential element to both plant and animal metabolism and natural organic cycling can influence its presence in water.

Manganese ranged from below the detection level of 0.1 ug/l to 138 ug/l and averaged 14.5 ug/l. Site 11-3 had the highest level (138 ug/l) and this suggests pollution by waste water (again an indication of groundwater degradation of this densely populated site).

Mercury

Mercury and mercuric compounds may be added to natural water from various industrial sources including marine anti-fouling paints. Because of their density, mercuric contaminants usually settle to the bottom of the water column. Mercury is very toxic and can cause "heavy metal poisoning". All groundwater samples tested below the level of detection (0.2 ug/l), therefore no violations of the standard was evident.

Nickel

Nickel is considered to be relatively nontoxic to man although nickel salts have been shown to be injurious to plants. Average concentration in the groundwater samples was 0.01 mg/l, an order of magnitude below the standard of 0.1 mg/l, and ranged from 0.01 to 0.03 mg/l.

Selenium

Selenium is an essential nutrient and is a minor constituent of the aquifer. Selenium levels were at background concentrations, averaging below the detection limit of 1 ug/l in the groundwater samples analyzed. There were no exceedances of the standard of 10 ug/l.

Silver

The most common manifestation of exposure to elevated levels of silver is argyria, which consists of a permanent blue-gray discoloration of the skin, eyes and mucous membranes of the victim. Most common salts of silver produce argyria when taken orally. Most groundwater samples did not exceed the detection limit of 0.1 ug/l, and none exceeded the standard of 50 ug/l.

Zinc

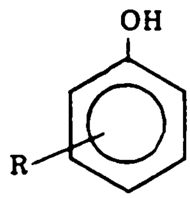
Zinc is a normal constituent of the human body. In drinking water, concentrations up to about 40 mg/l appear to have no health significance, but it does impart an astringent taste to water and will form a milky precipitate of $Zn(OH)_2$ or $ZnCO_3$ in alkaline waters. The groundwater standard for zinc is 1.0 mg/l. Zinc concentrations averaged 0.01 mg/l in the groundwater samples, ranging from below detection limits to 0.08 mg/l.

Organic Constituents

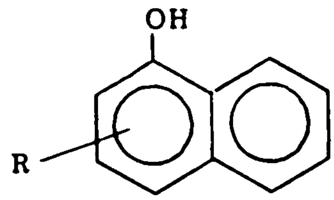
Water absorbs various organic materials when it contacts and enters the soil. These are primarily compounds from humus and peat-rich soil layers with the phenolic characteristic of humic acids. If the soil is polluted by soluble organic wastes to such a degree that its adsorptive retention power is exceeded, the most diverse materials can be released to the water and can then be detected in the groundwater. These may consist of water-soluble components and decomposition products from landfills, pesticide residues from agriculture and synthetic organic chemicals, many of which are not biodegradable. Organic pollutants have unfavorable effects on water. Color and transparency are impaired; undesirable, although unspecific, odor and taste effects become evident; and serious health hazards arise. Especially important to water quality are the synthetic organic chemicals (SOC's). Although many SOC's have low solubilities in water, these compounds are very toxic at low concentration (in some cases carcinogenic). Solubilities often exceed permissible concentration levels.

Phenols

Phenols are hydroxyl compounds of aromatic hydrocarbons, i.e. benzene and homologs, naphthalene and the like (see general structures below). They are frequent pollutants of industrial waste waters, components of important plastics, raw materials for drugs, dyes, and (particularly chlorophenols) are present in weed control agents and other pesticides, making them frequent pollutants of waste effluents of organic syntheses.



benzene homologs



napthalene homologs

where R = any group including H

Phenolic compounds are also components of pulp effluents; and they form during the decomposition of leaves. Phenols of natural origin may be present in detectable concentrations in groundwater. Phenols can be detected in water by odor or taste even in concentrations of 0.01 - 0.1 mg/l. This effect is enhanced by one to two orders of magnitude during chlorine disinfection due to the formation of chlorophenols.

Phenols are toxic to most organisms, especially bacteria. They are increasingly subject to biodegration by phenol-resistant bacterial strains.

Phenols were not detected in any of the groundwater samples (detection limit: 2.5 ug/l).

Volatile Organic Compounds (VOC's)

Volatile organic carbon compounds (VOC's) are chemicals used in industrial and commercial applications as dry cleaning solvents, degreasers, paint thinners, and refrigerants. Most are toxic to humans and many have carcinogenic properties. Table 3 lists the VOC's analyzed in this study, some of their sources, structures and health affects.

VOC's characteristically have low boiling points and high vapor pressures. Under ambient temperatures most are liquids denser than water. A liquid spill of VOC's will tend to sink in any receiving water before dispersion, volatilization, emulsification or solubilization takes place. Chlorinated VOC's of natural origin are very rare, so their presence in groundwater is indicative of urban pollution.

Thirteen sites were chosen from the groundwater survey to be analyzed for VOC's. They were residential sites reflecting industrial/business (54%); agricultural (31%) developments as well as background (15%) locations.

None of the background residential locations had VOC's while 57% of the industrial/business sites had measurable levels. Of the 4 agricultural sites sampled, 50% had VOC's and should be re-examined as demonstrative of possible impacts of land use on groundwater quality.

The following sections discuss the results of individual VOC's. In some cases the analytical technique employed could not differentiate between two or more compounds. For those situations, the discussion of the results is provided together.

Methylene Chloride and Vinylidene Chloride

Methylene chloride (dichloromethane) is used in the manufacture of paint and varnish removers, insecticides and fumigants, solvents, cleaners, fire extinguishers, degreasers, christmas tree ornamental

TABLE 3: VOLATILE HALOGENATED ORGANIC COMPOUNDS, THEIR STRUCTURES, SOME SOURCES AND HEALTH EFFECTS

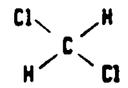
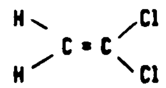
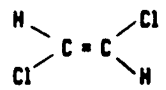
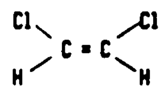
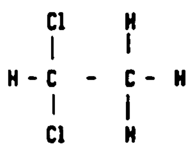
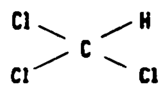
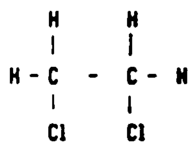
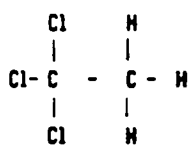
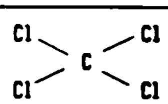
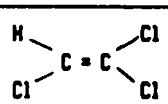
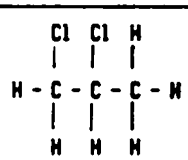
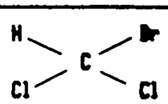
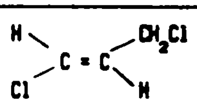
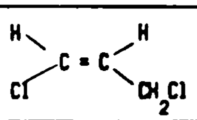
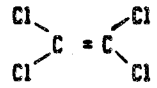
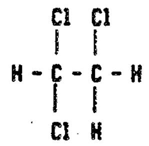
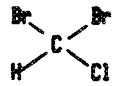
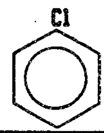
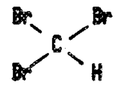
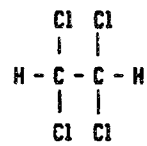
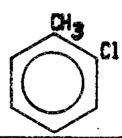
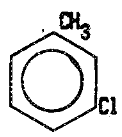
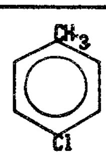
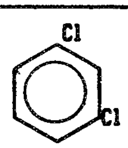
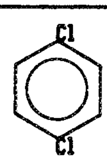
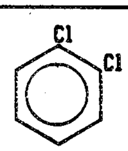
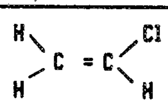
COMPOUNDS	STRUCTURES	POSSIBLE SOURCES	HEALTH EFFECTS
Methylene Chloride		Degreasing and cleaning fluids, as solvent in food processing	Narcotic in high concs.
Vinylidene Chloride		intermediate in production of vinylidene polymer plastics	Narcotic in high concs. Irritant to skin, mucous membranes
trans 1,2-Dichloroethene		Refrigerant, additive to dye and lacquer solutions, constituent of perfumes	Central nervous system depressant.
cis 1,2-Dichloroethene		Solvent for organic fats, phenol, camphor	Similar effect as the trans isomer but less severe
1,1-Dichloroethane		Lab use	Carcinogenic
Chloroform		As a solvent for fats, oils rubber etc., cleansing agent, in fire extinguishers	Large doses may cause hypotension, respiratory depression and death
1,2-Dichloroethane		Production of vinyl chloride Cleaning textiles, manuf. of paints, adhesives and coatings	Toxic to animals, mutagen animal carcinogen
1,1,1-Trichloroethane		Used in cold type metal cleaning, also in cleaning plastic molds.	Irritating to eyes and mucous membranes, narcotic in high concentrations.
Carbon Tetrachloride		As fire extinguisher, for cleaning clothes, insect extermination, solvent	Can be fatal to humans Carcinogenic
Trichloroethylene		In degreasing and dry cleaning, solvent, in manuf. of organic chemicals	High concs. can have narcotic effect, carcinogen for some strains of mice
1,2-Dichloropropane		Dry cleaning fluids, soil fumigant for nematodes, solvent for metal degreasing, fats, oils	Causes liver congestion and hepatic fatty changes
Bromodichloromethane		Fire extinguisher, solvent	
trans 1,3-Dichloropropene		Used in the Telone II mixture as a soil fumigant	Irritating to skin, liver kidney injury to animals
cis 1,3-Dichloropropene		Used in the Telone II mixture as a soil fumigant	Irritating to skin, liver kidney injury to animals

TABLE 3: VOLATILE HALOGENATED ORGANIC COMPOUNDS, THEIR STRUCTURES, SOME SOURCES AND HEALTH EFFECTS

COMPOUNDS	STRUCTURE	POSSIBLE SOURCES	HEALTH EFFECTS
Tetrachloroethylene		Dry cleaning solvent, metal degreasing	Carcinogenic in mice Narcotic in high concs.
1,1,2-Trichloroethane		Solvents for fats, waxes and natural resins	Irritating to eyes, mucous membranes, narcotic in high concs.
Dibromochloromethane		By product of water disinfection with chlorine	
Chlorobenzene		Manufacture of phenol, aniline, DDT, solvent for paints	
Bromoform		Solvent for waxes, greases separating mixtures of minerals	Abuse may lead to addiction
1,1,2,2-Tetrachloroethane		Paint manuf., soil sterilization and weed killer and insecticide formulation	Powerful narcotic, liver poison
o-Chlorotoluene		Solvent, dyestuff intermediate organic synthesis	
m-Chlorotoluene			
p-Chlorotoluene			
m-Dichlorobenzene		No documented usage	
p-Dichlorobenzene		Insecticidal fumigant. Domestic use against clothes moths	Vapors cause irritation to skin, throat and eyes liver injury
o-Dichlorobenzene		Solvent for waxes, gums, resins Insecticide for termites. Fumigant, metal polishes, dyes manuf.	Injury to liver, kidneys High concs. causes CNS depression
Vinyl Chloride		In plastic industry, as refrigerant in organic synthesis	Carcinogen

lights, and in food processing. Methylene chloride readily migrates through soil to the groundwater where it remains for extended periods.

Vinylidene chloride (1,1-dichloroethylene) has been used as a chemical intermediate and in the manufacture of polyvinylidene copolymers. Small amounts of vinylidene chloride may be released to water in industrial effluents and from the disposal of solid wastes. It can be a degradation product of trichloroethylene and perchloroethylene via bacterial action. Chemically stable in water and mobile in soil, vinylidene chloride can migrate with groundwater.

Under the operating conditions utilized in the VOC's analysis, methylene chloride and vinylidene chloride elute together and individual values can not be assigned to them. Therefore a positive detection can mean one or both compounds are present in the samples.

Positive detections occurred in groundwater samples from sites 11-7 (average of field duplicate 1.01 ug/l) and 15-2 (0.23 ug/l). Site 15-2 is near the Tamiami Airport. Probable sources include aircraft, vehicular or maintenance activities using degreasers and paint removers containing methylene chloride. Site 11-7 is located in an industrial area incorporating a variety of different businesses ranging from photographic studios and scrap metal processing to blenders and distributors of petroleum products and mineral oils. Levels detected were low; there is currently no standard for these VOC's.

1,2-Dichloroethene

A combination of the cis and trans isomers of 1,2-dichloroethene is used as a captive intermediate in the manufacture of other chlorinated solvents. They are chemically stable in water and mobile in soils. At high concentrations the dichloroethenes possess anesthetic properties. Studies indicate that the trans-isomer is about twice as potent as the cis-isomer in depressing the central nervous system. The trans isomer is more thermodynamically stable.

Although neither the cis nor the trans isomer is known to be utilized in Dade County, cis-1,2-dichloroethene has been identified as a microbial degradation product of trichloroethylene and tetrachloroethylene in groundwater. The cis isomer was detected at site 11-7 (average of field duplicate, 1.20 ug/l) as well as trichloroethylene and tetrachloroethylene. There is no existing groundwater standard for 1,2-dichloroethene.

1,2-Dichloroethane, 1,1,1-Trichloroethane and Carbon Tetrachloride

1,2-Dichloroethane is produced in larger amounts than any other organic chlorine compound. Major uses include the production of vinyl chloride and dispersive uses such as manufacture of paints, coatings and adhesives, cleaning textiles and as a solvent for processing pharmaceutical products and animal fats. It exhibits a high degree of toxicity in animals and is a mutagen as well as an animal carcinogen.

1,1,1-Trichloroethane is used in the cleaning and vapor degreasing of fabricated metal parts, as a spot remover and film cleaner, in the synthesis of other organic chemicals, and as an additive in metal cutting oils. When released to soil it migrates readily to ground water.

Carbon tetrachloride is used in the production of chlorofluorcarbons (used as refrigerants, solvents, etc.), in fumigants, as a solvent in metal cleaning and in the manufacture of paints and plastics. It is toxic to animals and produces adverse affects on the liver and kidneys of man. The three compounds elute together and no detections were observed in the groundwater samples analyzed.

1,1-Dichloroethane

The principal use of 1,1-dichloroethane is for organic reactions performed in synthesis laboratories. It was not detected in the groundwater samples.

Chloroform

Chloroform is used as a refrigerant, aerosol propellent and as a fumigant. It is also used in the synthesis of fluorinated resins, and in the past was used in pharmaceuticals and toiletries. The use of chloroform as an ingredient in human drugs or cosmetic products was banned by the Food and Drug Administration (FDA) in 1976.

Chloroform is one of several compounds produced as a by-product of chlorinating water. When drinking water is disinfected, formation of these by-products is limited by a standard of 100 ug/l. Chloroform resists biodegradation in water. When ingested, chloroform is rapidly absorbed, distributed throughout body fat deposits and tissues and rapidly excreted. Acute toxicity of chloroform is characterized by hepatic and renal lesions and damage, including necrosis and cirrhosis.

Chloroform was detected in the groundwater at site 23-1 (average of field duplicates was 0.49 ug/l). Site 23-1 is in the middle of a small warehouse district and a residential area. The presence of chloroform may be due to the discharge of chlorinated water.

Trichloroethylene

Trichloroethylene is used as a degreaser for metal components, as an industrial solvent and in refrigerant and fumigant formulations. Trichloroethylene, when released to the ground does not degrade rapidly and will migrate readily to groundwater. Under certain conditions trichloroethylene in groundwater is microbially degraded to dichloroethylene and vinyl chloride. It may also be found in groundwater as a product of degradation of tetrachloroethylene. It does not bioaccumulate. Exposure to trichloroethylene results in central nervous system depression, loss of coordination and unconsciousness. It is readily excreted in expired air.

Trichloroethylene was detected in groundwater samples at sites 11-7 (0.41 ug/l), 15-2 (0.15 ug/l), 14-3 (0.10 ug/l), and 22-4 (0.07 ug/l). Site 11-7 has been cited as a pollution source resulting from the land use in the area. In the case of 15-2 the source of trichloroethylene is probably the Tamiami Airport (refer to the discussion of methylene chloride and vinylidene chloride). Site 14-3 is surrounded by residential areas and encompasses a few gasoline service stations. Site 22-4 is an agricultural area where trichloroethylene may be used as an inert substance in pesticide formulations. It should be noted, however, that the levels of trichloroethylene detected were extremely low and an order of magnitude were below the standard of 3.0 ug/l.

1,2-Dichloropropane and Bromodichloromethane

1,2-Dichloropropane has been used in dry cleaning operations, as a degreaser, and as a component of soil fumigants. 1,2-Dichloropropane migrates in soil and has been shown to biodegrade in water over a number of weeks. It may be carcinogenic to humans.

Bromodichloromethane has been used as a solvent for fats, waxes, resins, in fire extinguishers and for laboratory use during mineral and salt separations. These compounds coelute under the conditions of analysis and can not therefore be separately identified.

An average value for the field duplicates of 0.06 ug/l was found at site 23-1, a residential/business area. 1,2-dichloropropane is a manufacturing by-product of Telone II which has 1,3-dichloropropene as the active ingredient of the soil fumigant (utilized in Dade County). Transformation and degradation of 1,2-dichloropropane occurs by microbial action. It diffuses through the soil more rapidly than 1,3-dichloropropene and is more often found in groundwater than 1,3-dichloropropene. There is currently no standard for 1,2-dichloropropane.

1,3-Dichloropropene

1,3-Dichloropropene is a constituent of Telone II, used as a soil fumigant for nematode, disease and weed control. Prolonged contact with skin results is severe burns; its vapors are acutely toxic. Because of lower mobility than 1,2-dichloropropene, it is not surprising that 1,3-dichloropropene was not detected in the groundwater study, whereas 1,2-dichloropropane was detected at low levels.

Tetrachloroethylene and 1,1,2-Trichloroethane

Tetrachloroethylene is used in dry cleaning processes, as a metal degreaser, in the textile industry and as a solvent. Tetrachloroethylene is mobile in soil and once introduced into ground water, where volatization does not occur, it may remain for extended periods. It may degrade in groundwater to trichloroethylene and later to dichloroethylene and/or vinyl chloride.

1,1,2-Trichloroethane is used as an industrial solvent and as a degreaser for metal components. Oral exposure of humans has resulted in vomiting and abdominal pain followed by a temporary loss of consciousness.

Since both compounds elute together, either one, or both, of them were detected at site 11-7 (0.24 ug/l) which is an industrial area that has been sited as a source of pollution. Detections were an order of magnitude below the groundwater standard of 3.0 ug/l for tetrachloroethylene.

Dibromochloromethane

Dibromochloromethane is a by-product of water disinfection with chlorine. It was not detected during this groundwater study.

Chlorobenzene

Chlorobenzene is used as a solvent in adhesives, paints, waxes and polishes; in metal cleaning operations, and in the production of chloronitrobenzene and diphenyl ether. It is a central nervous system depressant at high concentrations but rarely occurs as an environmental contaminant.

Though chlorobenzene is relatively resistant to biodegradation processes, transport to groundwater is slow because of its affinity to soil particles. Chlorobenzene was not detected in this groundwater study.

Bromoform (Tribromomethane)

Bromoform is used in pharmaceutical manufacturing, as a solvent for waxes, greases and oils and as a ingredient in fire-resistant chemicals. It resists biodegradation in water. Bromoform was not detected at any site in the groundwater network.

1,1,2,2-Tetrachloroethane

1,1,2,2-Tetrachloroethane is a potential human carcinogen. It is used as a solvent; in the manufacture of paints, varnish and rust removers; in soil sterilization, and in weed killer and insecticide formulations as well as an intermediate in the manufacture of trichloroethylene. It is a powerful narcotic and a liver poison. 1,1,2,2-Tetrachloroethane was detected at site 22-2 (0.20 mg/l) which is surrounded by agricultural activities typically utilizing insecticide formulations. There is currently no groundwater standard for 1,1,2,2-Tetrachloroethene.

Chlorotoluene

Of the three isomers of chlorotoluene, (ortho, meta and para), o-chlorotoluene is most widely used as a solvent, in dye stuff, and as an inert substance in pesticide formulations. These compounds were not detected in this study.

Dichlorobenzenes

Isomers of dichlorobenzenes are classified according to the ring positions on which the chlorine atoms are attached. The ortho isomer (o-dichlorobenzene) has chlorine atoms at carbon ring positions 1 and 2; the meta isomer (m-dichlorobenzene) has chlorine atoms at positions 1 and 3, and the para isomer (p-dichlorobenzene) has chlorine atoms at positions 1 and 4. o-Dichlorobenzene is used as a solvent, deodorizer, as a chemical intermediate as well as a herbicide, insecticide and soil fumigant. m-Dichlorobenzene has no documented usage and p-Dichlorobenzene is used as a deodorizer and as an insecticide. The majority of the para isomer released to the environment is a result of its use as a deodorant and sanitizer (in toilets and refuse containers) and as a moth repellent. Dichlorobenzenes resists biodegration processes in the environment and gradually migrate to the groundwater as they slowly leach from soil. There is evidence that dichlorobenzenes are toxic to man, causing injury both to the liver and the kidneys.

o-Dichlorobenzene was detected at site 22-2 (0.61 ug/l), an agricultural area where it may be utilized either as an inert ingredient in pesticides or in its capacity as a soil fumigant or insecticide. There is currently no groundwater standard for the dichlorobenzenes.

Vinyl chloride

Vinyl chloride is a highly volatile gas used primarily to produce polyvinyl chloride (PVC), a raw material in plastics, rubber, paper, glass and automotive industries. As PVC, it is used extensively in the building and construction industries, manufacturing of electrical wire insulation and cables, industrial and household equipment, food packaging materials and medical supplies. PVC is extremely stable, and is not a significant source of vinyl chloride contamination in the groundwater.

Groundwater contamination with vinyl chloride has been shown to be a result of biodegradation of trichloroethylene and tetrachloroethylene, solvents which are used extensively in southeast Florida for various commercial and industrial applications. Vinyl chloride has acute and chronic toxic effects in man and is a potent human carcinogen. Vinyl chloride was not detected in groundwater samples from the ambient monitoring network.

Summary

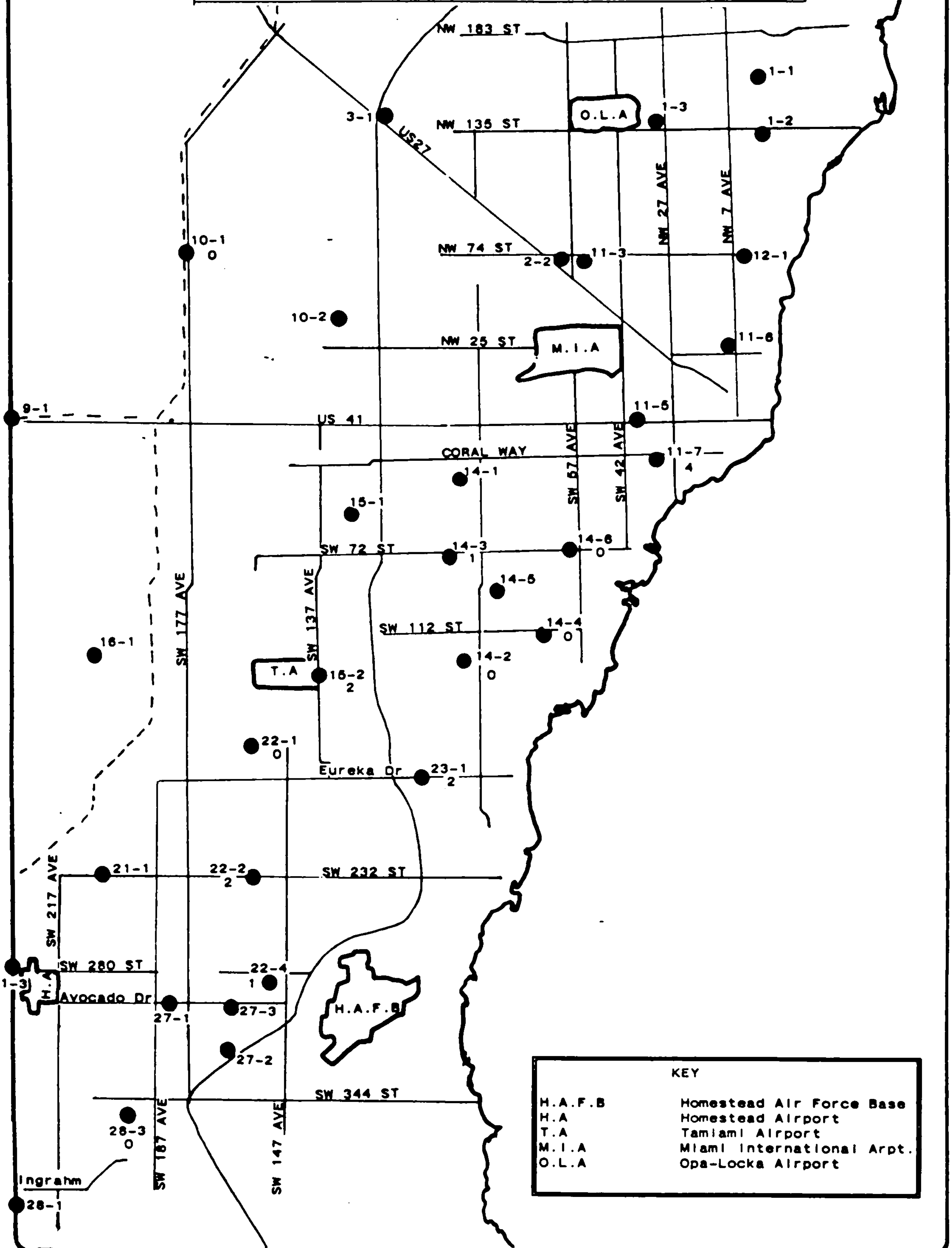
The ambient Groundwater Network designed by Dade County's Department of Environmental Resources Management, is a program which monitors the quality of Dade's only natural source of drinking water. The program has some capability to detect pollution problems as they arise, allowing for early remediation of potentially greater problems. The effects of salt water intrusion, land use, septic tanks, mineralization from canal waters and a flowing artesian well have been noted by the data base.

Site 11-3 had exceedances of organic residues, lead and five other metals at higher-than-baseline levels. The surrounding residential and commercial land use is the likely source of the degraded water quality.

The presence of VOC's in 46% of the sites sampled is of concern and indicates a need for more intensive inspections of potential sources of hazardous materials and waste proximal to the affected sites. The number of VOC's detected per site is displayed in Figure 6 and reflects the general impact of commercial, industrial, residential and agricultural land use on the quality of the groundwater.

Site 11-7 (residential/business/industrial area) was the most affected site with quantifiable levels of four volatile organic compounds. The detected levels were very low but may signal a trend towards further degradation of groundwater quality in the area. Another contributor to groundwater quality degradation may be agricultural activities. Fifty percent of the monitoring sites located in agricultural areas had detectable levels of VOC's.

FIGURE 6: OCCURRENCES OF VOLATILE ORGANIC COMPOUNDS DETECTED IN THE 1984 GROUNDWATER MONITORING PROGRAM



APPENDIX I

1984 GROUNDWATER MONITORING PROGRAM

	1-1A	1-1B	1-1C	1-1D	1-2	1-3	2-2	3-1	9-1A	9-1B
ALKALINITY (mg/l)	103	174	183	198	204	170	128	231	278	252
CHLORIDES (mg/l)	8	6	8	29	38	22	7	132	80	114
COLOR (PCU)	50	50	50	50	50	35	40	50	50	50
SULFATES (mg/l)	5.1	7.04	12.51	32.25	42.89	23.28	7.94	2.3	8.27	15.28
FLUORIDES (mg/l)	0.08	0.21	0.15	0.13	0.14	0.23	0.13	0.24	0.18	0.18
NH3-N (mg/l)	0.19	0.13	0.14	0.11	0.28	0.38	0.08	0.27	1.4	1.2
NOx-N (mg/l)	0.29	0.18	0.08	0.03	<0.01	0.34	0.59	0.05	0.21	0.04
PHENOLS(ug/l)	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
O-PO4-P (mg/l)	0.02	0.01	0.024	0.011	0.035	0.07	0.052	0.003	0.03	0.01
T-PO4-P (mg/l)	0.03	0.019	0.04	0.02	0.04	0.85	0.07	0.01	0.04	0.02
TFR (mg/l)	177	237	247	328	320	251	183	459	457	500
Ag (ug/l)	0.3	0.2	0.1	0.1	<0.1	0.2	0.1	<0.1	0.1	0.1
As (ug/l)	1.1	<1	1.4	1.8	<1	<1	4	1.1	<1	<1
Cd (ug/l)	0.5	0.2	1.1	0.2	0.2	0.4	0.2	<0.1	0.3	0.3
Cr (ug/l)	1.5	1.3	1.2	1.4	0.4	0.9	1.7	0.2	1	1.2
Cu (ug/l)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	1.2	<0.1
Fe (mg/l)	7.78	3.89	2.37	1.38	1.46	0.75	0.09	0.4	3.54	3.99
Hg (ug/l)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.2	<0.2	<0.2
Mn (ug/l)	83	17.8	13.4	8.4	9.3	13.4	<0.1	10.8	33	33
Ni (mg/l)	0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.03	<0.01
Pb (ug/l)	4	2.5	7.8	<1	<1	<1	4.7	<1	1.4	<1
Se (ug/l)	<1	<1	<1	<1	3.9	<1	2.4	1.8	<1	<1
Zn (mg/l)	0.05	0.01	0.02	0.01	0.01	0.01	<0.01	0.01	0.01	0.01
TURBIDITY (NTU)	41.4	2.9	4.5	3	5.9	1	8	1.2	7	12.5

1984 GROUNDWATER MONITORING PROGRAM

	10-1	10-2	11-3	11-5	11-6	11-7	12-1	14-1	14-2	14-3
ALKALINITY (mg/l)	224	237	199	429	199	242	234	227	232	206
CHLORIDES (mg/l)	113	68	54	25	312	388	64	26	49	53
COLOR (PCU)	50	50	50	50	15	10	50	40	25	40
SULFATES (mg/l)	7.48	2.15	13.79	12.76	53.11	63.91	15.87	17.51	24.05	10.8
FLUORIDES (mg/l)	0.28	0.19	0.21	0.49	0.19	0.14	0.13	0.15	0.12	0.16
NH3-N (mg/l)	0.31	0.9	2.9	0.04	0.77	1.3	0.52	0.88	0.14	0.06
NOx-N (mg/l)	0.09	0.11	2.4	3.6	<0.01	0.12	<0.01	<0.01	0.38	0.18
PHENOLS(ug/l)	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
O-PO4-P (mg/l)	0.005	0.01	0.028	0.07	0.009	0.01	0.009	0.002	0.004	0.005
T-PO4-P (mg/l)	0.01	0.03	0.055	0.082	0.013	0.012	0.012	0.005	0.005	0.01
TFR (mg/l)	435	368	6193	682	631	831	323	283	294	428
Ag (ug/l)	<0.1	0.1	0.2	<0.1	<0.1	0.2	<0.1	<0.1	0.3	0.3
As (ug/l)	<1	<1	6.8	2.3	<1	1	<1	<1	<1	2.9
Cd (ug/l)	0.1	0.4	1.4	0.3	0.1	<0.1	0.1	0.3	<0.1	0.2
Cr (ug/l)	1.2	0.9	3.9	2.2	0.2	0.1	<0.1	<0.1	0.7	1.7
Cu (ug/l)	<0.1	<0.1	10	3	<0.1	<0.1	<0.1	<0.1	<0.1	1
Fe (mg/l)	1.35	1.35	30.48	0.2	1.27	0.93	2.17	1.87	0.09	4.87
Hg (ug/l)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Mn (ug/l)	35	18.6	138	4.5	4.4	9.1	7.2	12.3	13.4	28.8
Ni (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Pb (ug/l)	1	<1	160.3	1.7	4.2	<1	<1	<1	<1	49
Se (ug/l)	1	<1	<1	1.1	1	1.4	<1	<1	<1	<1
Zn (mg/l)	0.01	0.03	0.04	0.01	<0.01	0.01	0.01	0.02	0.01	0.02
TURBIDITY (NTU)	1.3	3	175	42.5	5.6	3	30	9.9	0.5	20

1984 GROUNDWATER MONITORING PROGRAM

	14-4	14-5	14-6	15-1	15-2	16-1B	21-1	21-3	22-1	22-2
ALKALINITY (mg/l)	222	222	171	206	195	184	215	185	206	223
CHLORIDES (mg/l)	55	38	38	60	53	29	111	24	91	29
COLOR (PCU)	5	15	5	30	25	25	5	20	10	5
SULFATES (mg/l)	22.8	12	15.07	3.72	12.22	0.33	75.8	4.96	66.42	52.55
FLUORIDES (mg/l)	0.16	0.15	0.22	0.18	0.08	0.17	0.09	0.11	0.12	0.11
NH3-N (mg/l)	0.09	0.37	0.1	0.12	0.09	0.37	0.04	0.19	0.02	0.02
NOx-N (mg/l)	0.43	<0.01	0.1	0.02	0.04	<0.01	0.01	<0.01	3.9	5
PHENOLS(ug/l)	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
O-PO4-P (mg/l)	0.08	<0.001	0.125	0.008	0.007	0.006	<0.001	0.002	0.005	0.01
T-PO4-P (mg/l)	0.065	0.002	0.127	0.01	0.01	0.011	0.002	0.01	0.008	0.011
TFR (mg/l)	297	235	250	322	410	230	467	264	415	319
Ag (ug/l)	0.2	<0.1	0.3	<0.1	<0.1	<0.1	<0.1	<0.1	0.1	<0.1
As (ug/l)	<1	1	1	1	<1	<1	<1	<1	<1	<1
Cd (ug/l)	<0.1	0.2	0.2	0.2	<0.1	0.2	0.2	0.2	<0.1	<0.1
Cr (ug/l)	<0.1	<0.1	1	<0.1	0.3	0.7	0.2	0.7	0.5	0.4
Cu (ug/l)	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Fe (mg/l)	0.02	0.98	0.1	0.61	1.62	1.94	0.48	0.8	0.12	0.1
Hg (ug/l)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Mn (ug/l)	<0.1	3.3	3.5	8.7	8.3	28.7	5.5	8.6	3.2	<0.1
Ni (mg/l)	<0.01	0.03	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Pb (ug/l)	<1	<1	<1	<1	1.5	<1	<1	1	<1	<1
Se (ug/l)	1.6	<1	<1	1.1	<1	1.2	1.2	1	1.7	<1
Zn (mg/l)	0.01	0.01	0.01	0.08	0.01	0.01	0.01	0.01	0.01	0.01
TURBIDITY (NTU)	0.5	2.6	0.5	1.1	12.5	2.6	0	2.5	0.5	0.6

1984 GROUNDWATER MONITORING PROGRAM

	22-4	23-1	27-1A	27-1B	27-1C	27-1D	27-2	27-3	28-1	28-3
ALKALINITY (mg/l)	183	192	204	210	199	199	245	209	195	189
CHLORIDES (mg/l)	21	37	44	48	48	47	41	36	61	35
COLOR (PCU)	5	5	5	5	5	5	30	10	10	5
SULFATES (mg/l)	32.63	19.67	21.14	5.43	22.8	23.91	166.08	33.45	22.06	56.99
FLUORIDES (mg/l)	0.13	0.14	0.12	0.1	0.1	0.1	0.1	0.1	0.14	0.09
NH3-N (mg/l)	0.02	0.03	0.04	0.04	<0.04	0.02	0.04	0.05	0.05	0.02
NOx-N (mg/l)	2.9	1.5	1.5	1.8	1.8	1.9	4.8	3.8	<0.01	0.04
PHENOLS(ug/l)	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5	<2.5
O-PO4-P (mg/l)	0.008	0.005	0.01	0.002	0.002	<0.001	0.005	0.004	0.002	0.005
T-PO4-P (mg/l)	0.01	0.006	0.012	0.01	0.009	0.002	0.02	0.01	0.009	0.006
TFR (mg/l)	227	236	203	240	204	172	574	230	306	308
Ag (ug/l)	0.1	<0.1	0.2	0.1	0.1	0.2	0.2	0.1	0.2	0.2
As (ug/l)	<1	2	1.2	1.8	2.4	<1	<1	1	<1	<1
Cd (ug/l)	<0.1	<0.1	0.2	0.2	0.2	<0.1	0.1	<0.1	0.2	<0.1
Cr (ug/l)	0.1	0.6	0.3	0.2	<0.1	2.8	0.5	0.5	0.3	0.5
Cu (ug/l)	<0.1	1.2	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Fe (mg/l)	0.04	0.03	0.19	0.15	0.58	0.14	0.08	0.05	0.39	0.17
Hg (ug/l)	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Mn (ug/l)	<0.1	<0.1	2.3	0.6	1	0.4	5.2	<0.1	6	2.6
Ni (mg/l)	<0.01	0.02	0.02	0.02	<0.01	0.01	0.02	<0.01	<0.01	<0.01
Pb (ug/l)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
Se (ug/l)	1.8	1.1	1	1.4	<1	1.8	<1	2.4	1.6	1.2
Zn (mg/l)	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01	0.01
TURBIDITY (NTU)	0.4	0.2	0.5	0.4	0.6	0.6	0.4	0	1.6	0.9

1984 GROUNDWATER PROGRAM

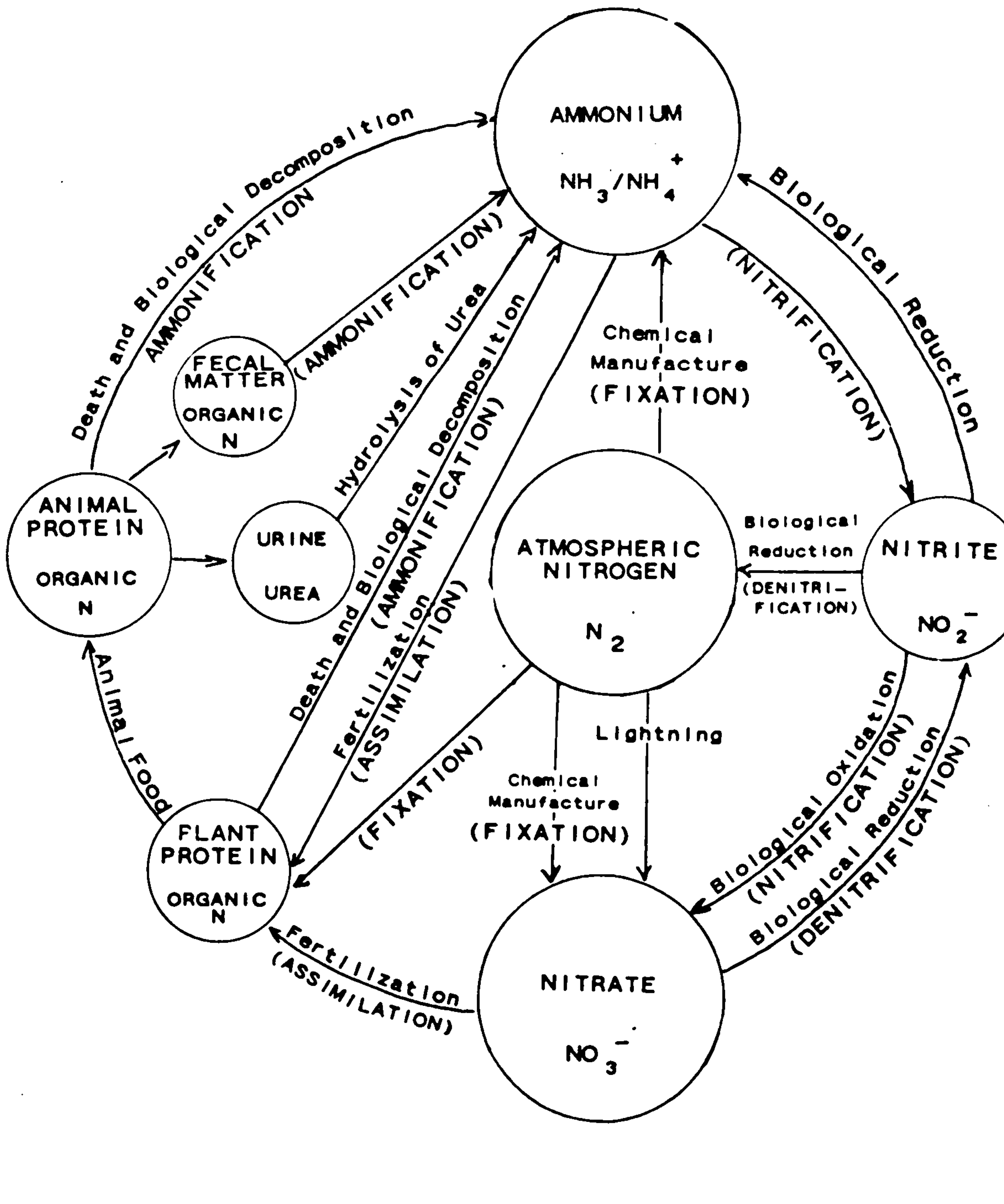
PARAMETER	AVERAGE VALUE	MAXIMUM VALUE	MINIMUM VALUE	VARIANCE
ALKALINITY (mg/l)	210	429	103	2187
CHLORIDES (mg/l)	64	388	6	5268
COLOR (PCU)	27	50	5	357
SULFATES (mg/l)	26.20	166.08	0.33	864.21
FLUORIDES (mg/l)	0.16	0.49	0.08	0.01
NH3-N (mg/l)	0.34	2.90	0.00	0.30
NOx-N (mg/l)	0.95	5.00	0.00	2.07
PHENOLS(ug/l)	0.0	0.0	0.0	0.0
O-PO4-P (mg/l)	0.017	0.125	0.000	0.001
T-PO4-P (mg/l)	0.043	0.850	0.002	0.017
TFR (mg/l)	488	6193	172	855253
Ag (ug/l)	0.1	0.3	0.0	0.0
As (ug/l)	0.8	6.8	0.0	1.9
Cd (ug/l)	0.2	1.4	0.0	0.1
Cr (ug/l)	0.8	3.9	0.0	0.7
Cu (ug/l)	0.4	10.0	0.0	2.7
Fe (mg/l)	1.97	30.48	0.02	23.37
Hg (ug/l)	0.0	0.2	0.0	0.0
Mn (ug/l)	14.5	138.0	0.0	617.5
Ni (mg/l)	0.00	0.03	0.00	0.00
Pb (ug/l)	6.0	160.3	0.0	670.0
Se (ug/l)	0.8	3.9	0.0	0.8
Zn (mg/l)	0.01	0.08	0.00	0.00
TURBIDITY (NTU)	10.2	175.0	0.0	799.4

1984 GROUNDWATER MONITORING PROGRAM DATA: VOLATILE ORGANIC COMPOUNDS

	COMPOUNDS	SITES AS DEFINED IN TEXT														
		3-1	10-1	11-7	11-7 FD	14-2	14-3	14-4	14-6	15-2	22-1	22-2	22-4	23-1	23-1 FD	20-3
1 2	Methylene Chloride Vinylidene Chloride	* ND	ND	*** 1.12	0.9	ND	ND	ND	** BDL	0.23	ND	BDL	ND	BDL	BDL	ND
3	trans 1,2-Dichloroethene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4	1,1-Dichloroethane	ND	ND	ND	ND	BDL	ND	ND	BDL	ND	ND	ND	ND	ND	ND	ND
5	cis 1,2-Dichloroethene	ND	ND	1.38	1.02	ND	ND	ND	BDL	ND	ND	ND	ND	ND	ND	ND
6	Chloroform	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.5	0.48	ND
7 8 9	1,2-Dichloroethane 1,1,1-Trichloroethane Carbon Tetrachloride	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
10	Trichloroethylene	ND	ND	0.33	0.48	BDL	0.1	BDL	BDL	0.15	ND	ND	0.07	ND	ND	ND
11 12	1,2-Dichloropropane Bromodichloromethane	BDL	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.07	0.05	ND
13 14	trans 1,3-Dichloropropene cis 1,3-Dichloropropene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
15 16	Tetrachloroethylene 1,1,2-Trichloroethane	ND	ND	0.24	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
17	Dibromochloromethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
18	Chlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
19	Bromoform	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
20	1,1,2,2-Tetrachloroethane	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.2	ND	ND	ND	ND
21 22 23	o-Chlorotoluene m-Chlorotoluene p-Chlorotoluene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
24 25	m-Dichlorobenzene p-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	BDL	ND	ND	ND	ND
26	o-Dichlorobenzene	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	0.61	ND	ND	ND	ND
27	Vinyl Chloride	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

* ND = Not Detected
** BDL = Below Detection Level
*** All units in ug/l

THE NITROGEN CYCLE



Part II

1984 CANAL MONITORING PROGRAM

The Canal Monitoring Program was implemented by Dade County Department of Environmental Resources Management as a means of assessing water quality of the County's major canal systems. Under this program, fifteen canals were sampled and analyzed for dissolved oxygen, specific conductance and nitrate/nitrites on a monthly basis during 1984.

Sampling sites were selected to reflect background conditions (unaffected by man-made pollution), effects of land use (mid-canal locations) and discharge points (charactering water quality entering Biscayne Bay and also demonstrating the extent of salt water intrusion and the effectiveness of the salinity dams).

The canals included in the network were:

Canal	Site Designated	# Monitoring Stations
Oleta River	A series	2
Snake Creek Canal	B "	3
Biscayne Canal	C "	3
Little River Canal	D "	3
Red Road Canal	E "	1
Miami Canal	F "	7
Tamiami Canal	G "	3
Coral Gables Waterway	H "	3
Snapper Creek Canal	I "	4
C-100 Canal	J "	3
Black Creek Canal	K "	4
C-103 Canal	L "	4
Goulds Canal	M "	4
Card Sound	N "	2
C-102 Canal	P "	2

Figure 7 maps the monitoring stations and Table 4 lists their locations. Additionally, the Coral Gables Waterway was selected this year for more intensive monitoring. This data is discussed in a separate report entitled the "Intensive Canal Study" (DERM 1984). The following is a discussion of the data obtained for the 1984 Canal Study.

RESULTS

Specific Conductance

As ions principally occur in a disassociated form in water, the charged ions are able to move under the influence of an electrical potential. Therefore by imparting an electrical current to a solution, the conductance of the solution can be determined. The ability of the solution to conduct the current is a function of the concentration and charge of the ions and the rate at which the ions can move under the influence of the potential.

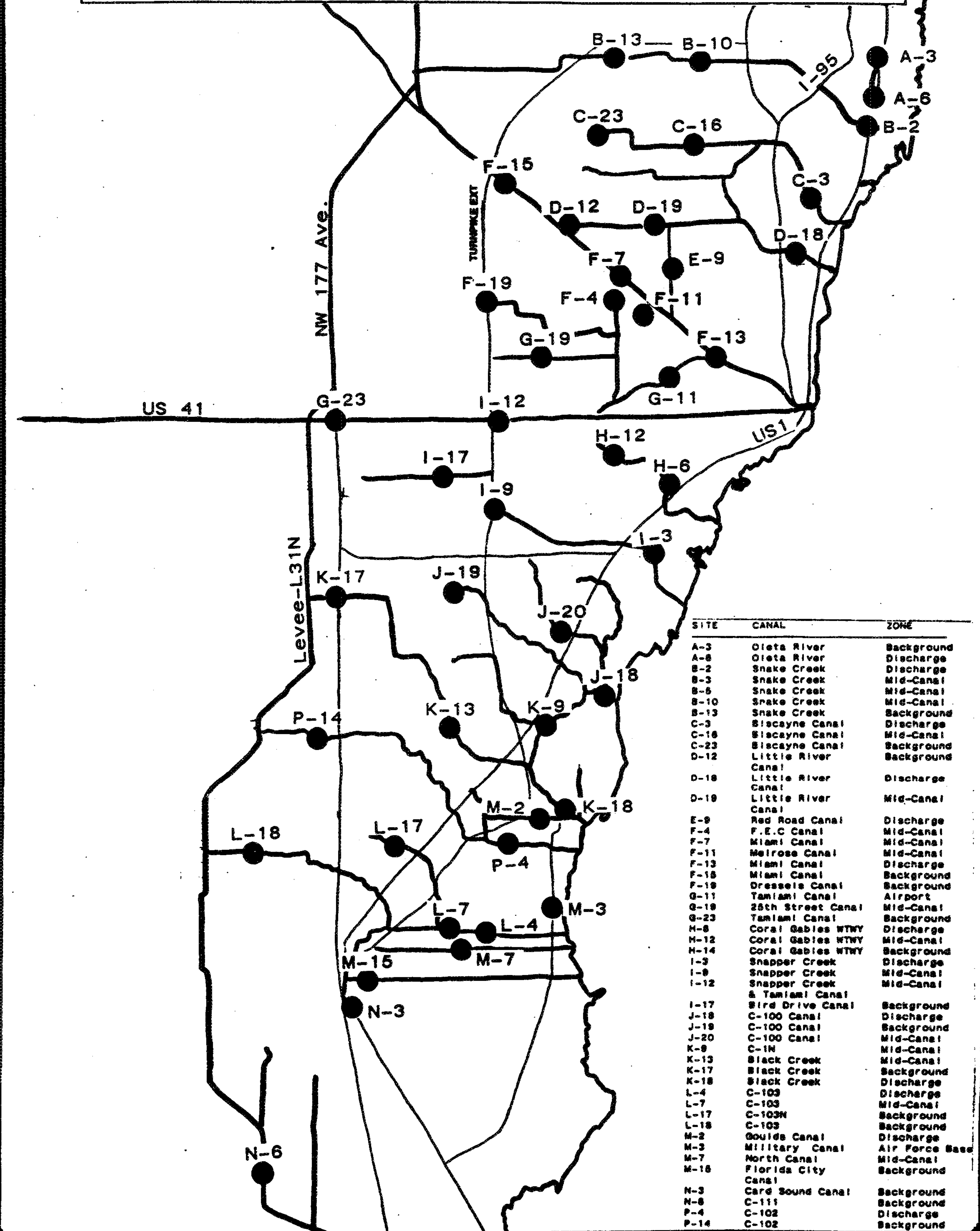
Since natural waters contain a variety of both ionic and uncharged species in various amounts and proportions, conductivity determinations cannot be used to obtain accurate estimates of ion concentration or total dissolved solids. There is however, good correlation between chloride and conductivity although correlation is poor with other ions such as sulfates and bicarbonates. Normally an approximate correlation between conductance and total dissolved solids (TDS) can be used:

$$TDS = kcC$$

where kc varies between 0.54 and 0.96 for natural water.

The average conductivity for the year was 1076.9 umhos/cm. Although 83% of the sites had levels that exceeded the standard, most of these levels may be considered as background for Dade County canals. Sites with conductivity levels which exceeded the average

FIGURE 7: LOCATION OF SITES IN THE 1984 GENERAL CANAL MONITORING PROGRAM



SITE	CANAL	ZONE
A-3	Oleta River	Background
A-6	Oleta River	Discharge
B-2	Snake Creek	Discharge
B-3	Snake Creek	Mid-Canal
B-5	Snake Creek	Mid-Canal
B-10	Snake Creek	Mid-Canal
B-13	Snake Creek	Background
C-3	Biscayne Canal	Discharge
C-16	Biscayne Canal	Mid-Canal
C-23	Biscayne Canal	Background
D-12	Little River Canal	Background
D-18	Little River Canal	Discharge
D-19	Little River Canal	Mid-Canal
E-9	Red Road Canal	Discharge
F-4	F.E.C Canal	Mid-Canal
F-7	Miami Canal	Mid-Canal
F-11	Melrose Canal	Mid-Canal
F-13	Miami Canal	Discharge
F-15	Miami Canal	Background
F-19	Dressels Canal	Background
G-11	Tamiami Canal	Airport
G-19	25th Street Canal	Mid-Canal
G-23	Tamiami Canal	Background
H-6	Coral Gables WTWY	Discharge
H-12	Coral Gables WTWY	Mid-Canal
H-14	Coral Gables WTWY	Background
I-3	Snapper Creek	Discharge
I-9	Snapper Creek	Mid-Canal
I-12	Snapper Creek & Tamiami Canal	Mid-Canal
I-17	Bird Drive Canal	Background
J-18	C-100 Canal	Discharge
J-19	C-100 Canal	Background
J-20	C-100 Canal	Mid-Canal
K-9	C-1N	Mid-Canal
K-13	Black Creek	Mid-Canal
K-17	Black Creek	Background
K-18	Black Creek	Discharge
L-4	C-103	Discharge
L-7	C-103	Mid-Canal
L-17	C-103N	Background
L-18	C-103	Background
M-2	Goulds Canal	Discharge
M-3	Military Canal	Air Force Base
M-7	North Canal	Mid-Canal
M-15	Florida City Canal	Background
N-3	Card Sound Canal	Background
N-6	C-111	Background
P-4	C-102	Discharge
P-14	C-102	Background

TABLE 4: LOCATION OF SITES IN THE 1984 CANAL MONITORING PROGRAM

Station	Canal River Name Major	Sub-System	Station Address
A-3	Oleta River		NE 26 Ave. & NE 203 St.
A-6	Oleta River		W.Dixie Hwy. & NE 176 St.
B-2	Snake Creek		US1 & NE 166 St.(Dam West)
B-10	Snake Creek		NW 37 Ave. & NW 204 St.
B-12	Snake Creek		NW 47 Ave. & 207 St.
B-13	Snake Creek		NW 67 Ave & 207 St.
C-3	Biscayne		NE 6 Ave. & NE 113 St.
C-16	Biscayne		NW 32 Ave. & NW 155 St.
C-23	Biscayne		NW 77 Ave. & NW 160 St.
D-12	Little River		NW 87 Ave. & NW 106 St.
D-18	Little River		NE 2nd Ave. & NE 85 St.
D-19	Little River		NW 107 St. & NW 52 Ave.
E-9	Little River	Red Road	NW 57 Ave & NW 70 St.
F-4	Miami River	FEC	NW 69 Ave & NW 69 St
F-7	Miami River		NW 65 Ave & US 27
F-11	Miami River	Melrose Canal	S.Esplanade & Morningside
F-13	Miami River		NW 39 Ave & NW 36 St. (Salinity dam west)
F-15	Miami River		NW 138 St & US-27
F-19	Miami River	Dressels	NW 117 Ave. & 58 St.
G-11	Tamiami Canal		NW 42 Ave. & NW 20 St.
G-19	Tamiami Canal	25 St.	NW 97 Ave & NW 25 St
G-23	Tamiami Canal		SW 177 Ave.& 8 St
H-6	Coral Gables Waterway	West Waterway	University of Miami at Student Union Bridge
H-12	" " "		SW 67 Ave & SW 36 St.
I-3	Snapper Creek		SW 57 Ave & SW 88 St.
I-9	Snapper Creek	117 Ave.	SW 117 Ave & SW 55 St.
I-12	Snapper Creek	" "	SW 117 Ave & SW 8 St.
I-17	Snapper Creek	Bird Drive	SW 142 Ave & SW 42 St.

TABLE 4 (Cont): LOCATION OF SITES IN THE 1984 CANAL MONITORING PROGRAM

Station	Canal River Name Major	Sub-System	Station Address
J-18	C-100	Lindgren Road	SW 174 St & Old Cutler
J-19	C-100	"	SW 134 Ave & SW 110 St.
J-20	C-100	"	SW 92 Ave & SW 136 St.
K-9	Black Creek	C-1 North	SW 102 Ave & SW 192 St.
K-13	Black Creek		SW 130 Ave & SW 200 St.
K-17	Black Creek		SW 177 Ave & SW 112 St.
K-18	Black Creek		SW 97 Ave & 237 St.
L-4	C-103		SW 117 Ave & SW 320 St.
L-7	C-103		SW 137 Ave & SW 320 St.
L-17	C-103N		SW 157 Ave & 264 St.
L-18	C-103		SW 217 Ave & 266 St.
M-2	Goulds		SW 97 Ave & SW 248 St.
M-3	Military		SW 107 Ave & SW 300 St.
M-7	North		SW 137 Ave & SW 328 St.
M-15	Florida City		SW 167 Ave & 344 St.
N-3	Card Sound		Card Sound Rd. & US 1
N-6	C-111		SW 227 Ave & 396 St.
P-4	C-102		SW 112 Ave.
P-14	C-102		SW 187 Ave.

were found at Oleta River (discharge and background), Coral Gables Waterway (discharge) and Goulds Canal (discharge). These high levels are indicative of salt water intrusion. When the data from these sites is omitted, the average conductivity value is 546 umhos/cm.

Excluding the canals that were subjected to salt water intrusion, there was no significant difference between the wet and dry season conductivity levels: 541 umhos/cm for the wet season and 553 umhos/cm for the dry season.

A comparison of the conductivity data for the discharge and background sites for all the canals, except those known to be subjected to saltwater intrusion (Oleta River, Coral Gables Waterway and Goulds Canal) showed that the discharge sites had higher conductivities throughout the year except during the months of March, April, July and December (Figure 8). Discharge sites at canals subjected to salt water intrusion sustained higher conductivity values than the background sites throughout the year (Figure 9).

Dissolved Oxygen

Dissolved oxygen (D.O.) levels are typically lower in the surface waters of south Florida than in surface water systems in other areas of the state and country. This is due to the close hydraulic connection between the surface and groundwater systems (which are typically low in dissolved oxygen). Average D.O. levels for all sites was 3.7 mg/l, which is just below the Dade County standard of 4 ug/l. In general, levels showed large variations from site to site. D.O. levels were higher in the southern canals than those in the north (Figure 10) for most of the year. The average for the southern canals from the Tamiami Canal down to and including C-102 canal was 4 mg/l, while the northern canals (Oleta River to Miami Canal) averaged 3 mg/l.

FIGURE 8: 1984 GENERAL CANAL MONITORING PROGRAM
CONDUCTIVITY DATA FOR CANALS NOT SUBJECTED TO SALT WATER INTRUSION

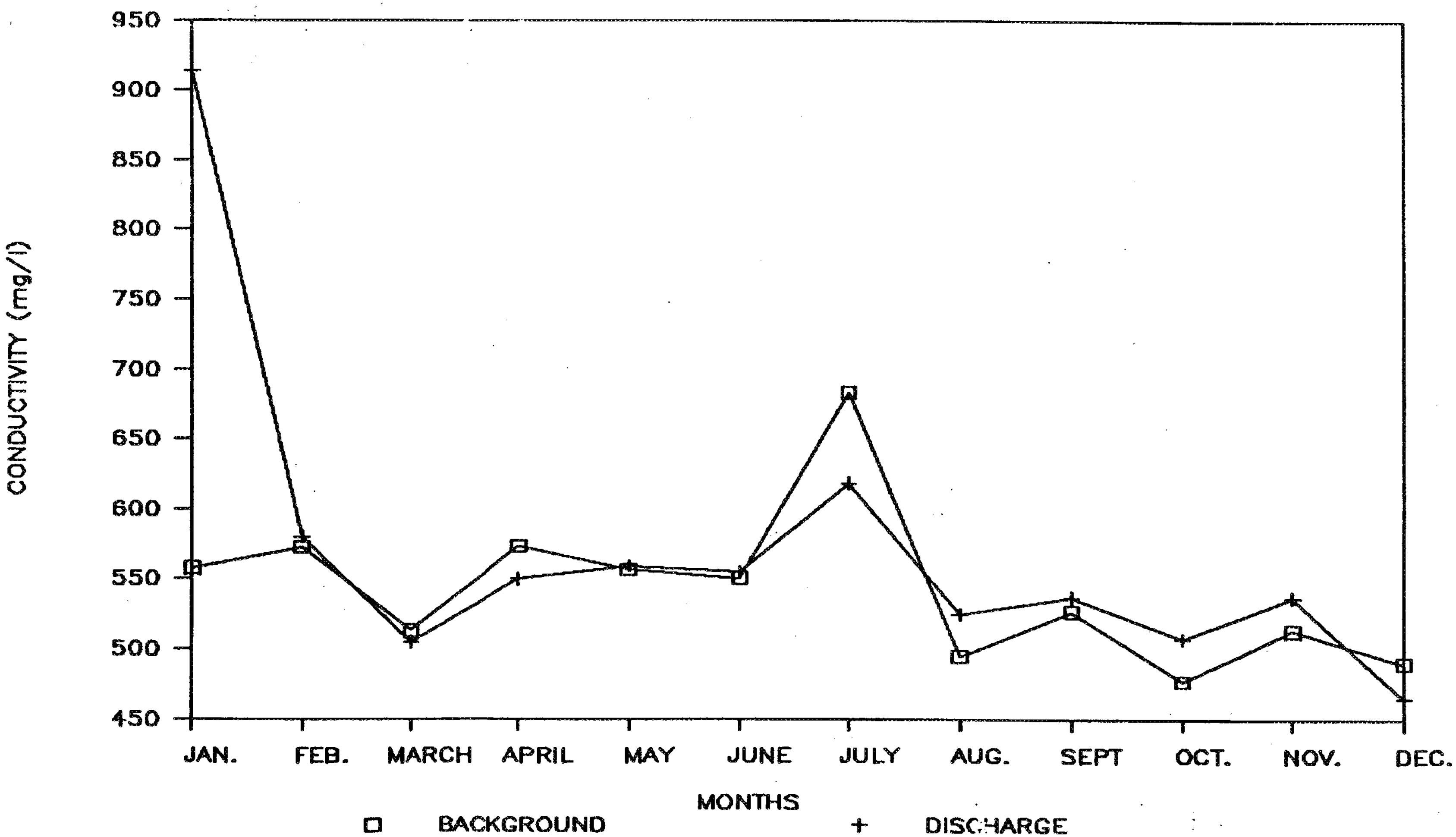


FIGURE 9: 1984 GENERAL CANAL MONITORING PROGRAM
CONDUCTIVITY DATA FOR CANALS THAT ARE SUBJECTED TO SALT WATER INTRUSION

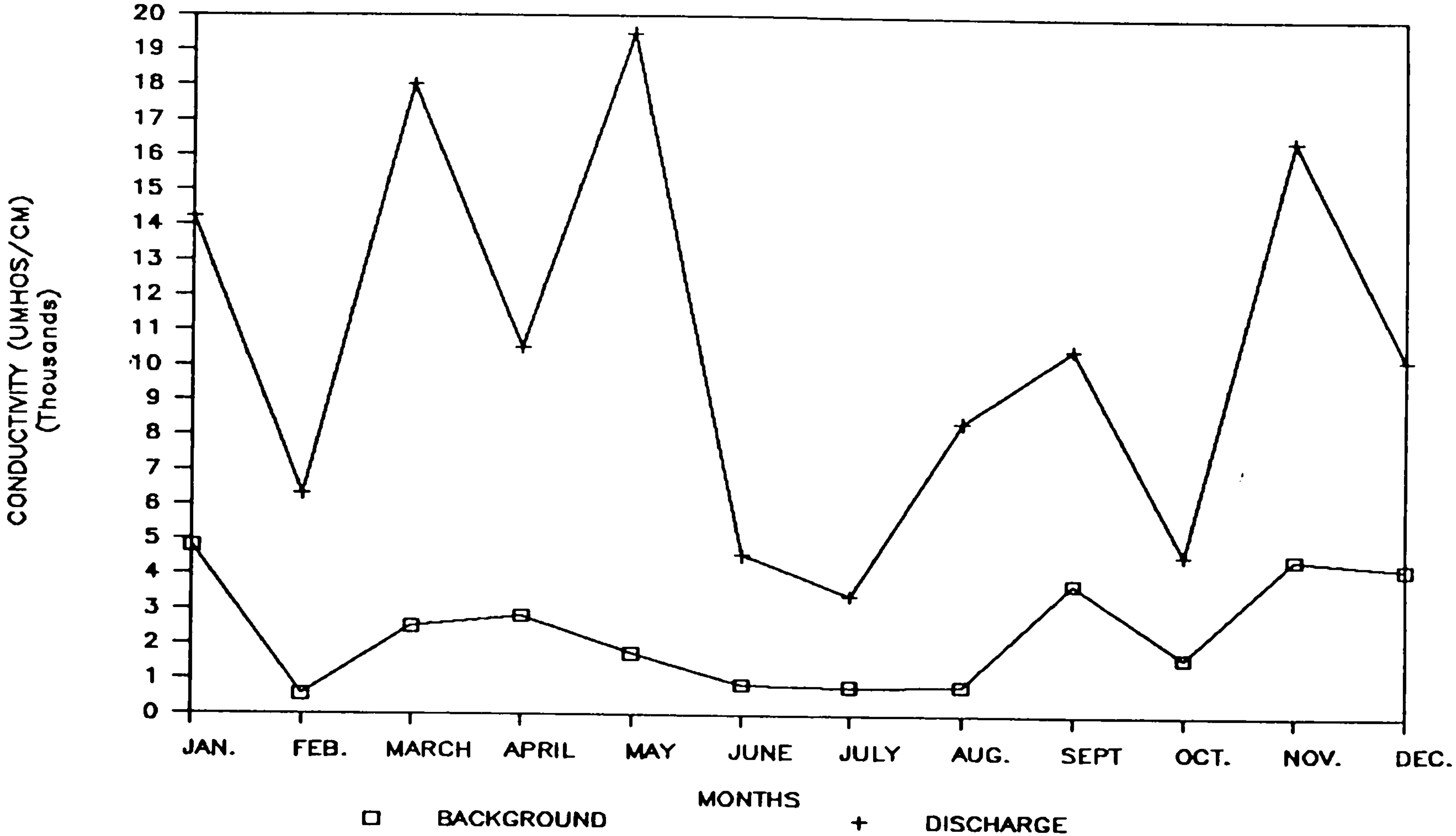
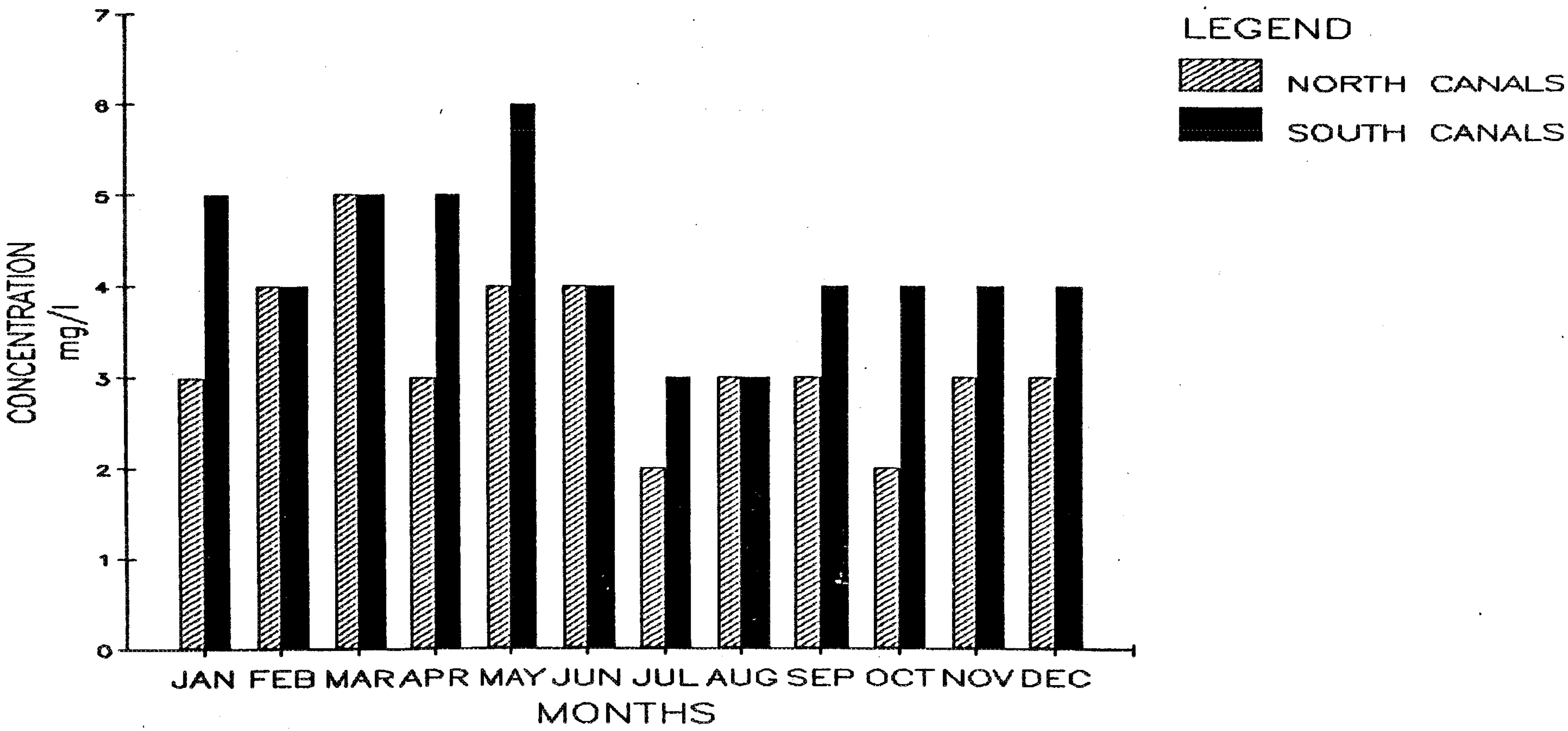


FIGURE 10
DISSOLVED OXYGEN DATA FOR THE NORTHERN AND SOUTHERN CANALS IN THE 1984 GENERAL CANAL PROGRAM



Snapper Creek canal had low levels of D.O. at three of its four sites (I-9, I-12, I-17) for most of the year. Black Creek Canal had low levels of D.O. during the wet season months. As demonstrated in Figure 11, discharge sites typically had higher dissolved oxygen levels than the background sites, which may be a result of less influence of the groundwater.

Total NOx-N

Average NOx-N concentrations in samples from the canal stations was 0.43 mg/l which was well below the standard of 10 ug/l. The C-103, Goulds and C-102 Canals have elevated levels of NOx-N, perhaps due to the use of nitrogenous fertilizers by farms in this area. If these sites are omitted from the calculation of the averages, southern canals averaged 0.14 mg/l, close to the average of 0.16 mg/l obtained for the northern canals.

Canal discharge sites often had higher monthly NOx-N levels than background sites (Figure 12), indicating the impact of urban and/or agricultural activities around the canals.

Summary

The Canal Pollutant Survey monitors the water quality in Dade County's major canal systems. It is reflective of background conditions, urbanization and pollution sources. Slight degradation of surface water quality by urban and agricultural activities is evident. However, the data obtained in the 1984 study does not indicate major pollution problems at any of the canals.

FIGURE 11: DISSOLVED OXYGEN DATA FOR THE 1984 GENERAL CANAL MONITORING PROGRAM

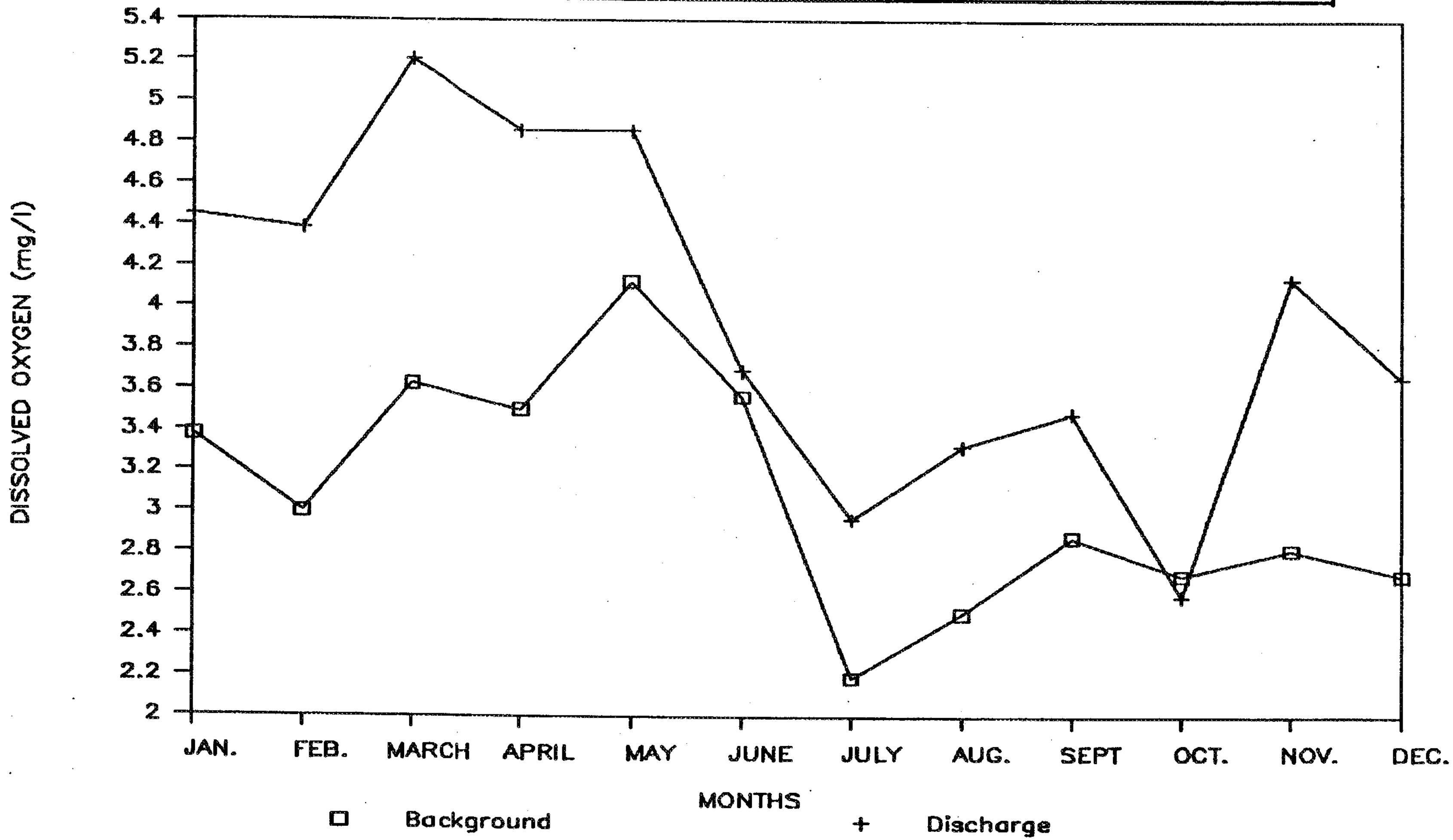
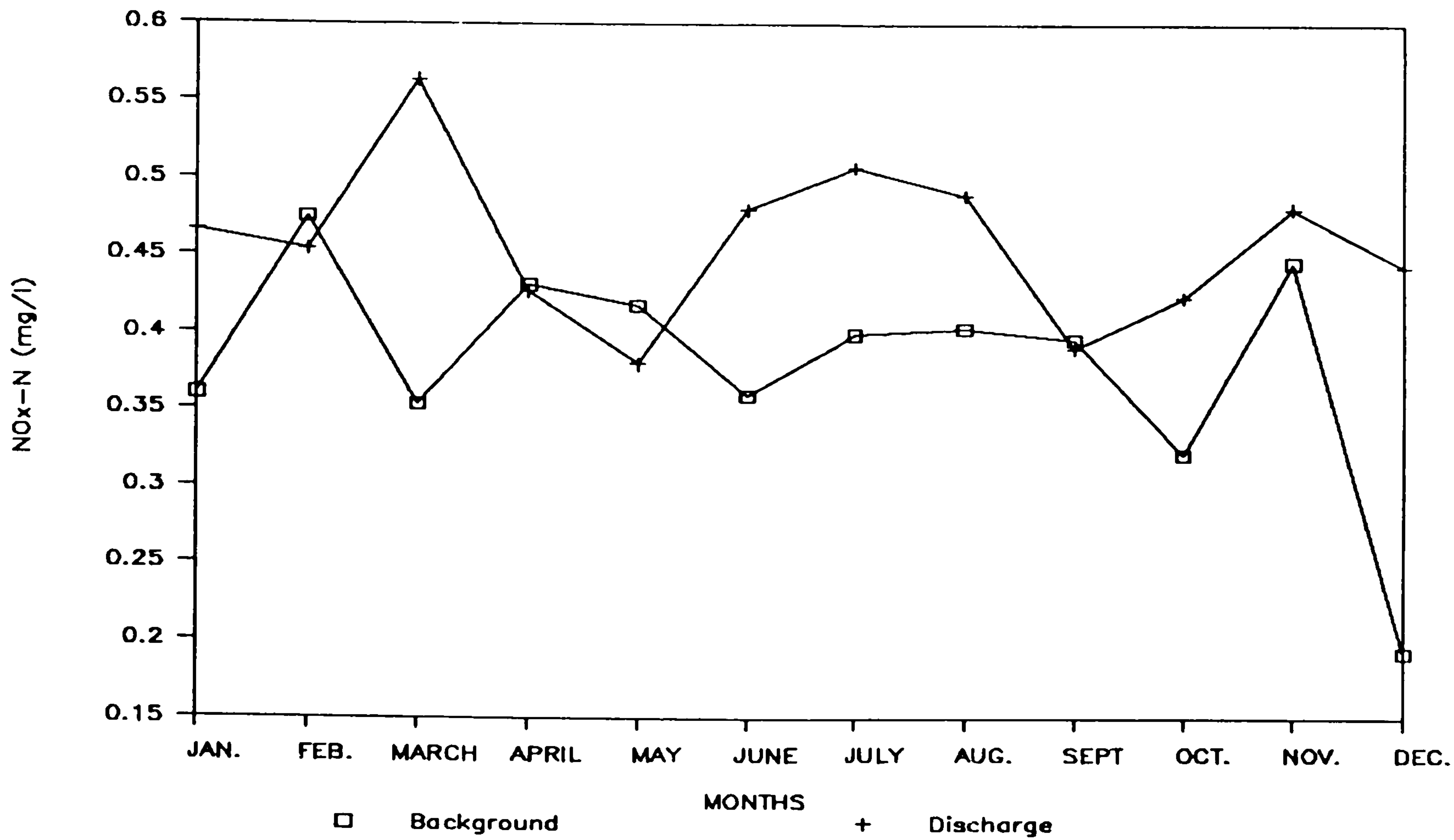


FIGURE 12: NOx-N DATA FOR THE 1984 GENERAL CANAL MONITORING PROGRAM



APPENDIX II

1984 CANAL POLLUTANT SURVEY

CONDUCTIVITY
(UHMOS/CM)

SITES	JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT	OCT.	NOV.	DEC.	SITE AVERAGE
A-3	9000	600	4500	5000	2850	1200	1100	1010	7000	2800	8500	8000	4297
A-6	21000	4600	30000	15000	33000	4150	4000	13300	15000	6000	24500	13000	15296
B-2	850	650	450	600	600	550	600	760	550	550	600	500	605
B-10	800	700	550	600	650	600	600	550	550	700	750	500	629
B-12	800	750											775
B-13			450	650	650	600	650	610	550	550	600	500	581
C-3	600	800	400	500	500	500	500	410	550	500	500	400	513
C-16	600	500	450	500	500	500	500	550	500	500	500	450	504
C-23	700	600	520	600	650	600	600	600	600	550	550	500	589
D-12	750	650	520	700	650	650	600	590	600	500	600	500	609
D-18	700	650	500	600	650	600	600	560	550	500	550	450	576
D-19	800	650	500	600	650	600	600	650	600	500	550	500	600
E-9	650	650	700	600	700	500	500	500	600	450	600	500	579
F-4	520	700	550	700	700	550	600	600	600	500	450	400	573
F-7	600	650	490	650	700	650	600	700	600	600	600	500	612
F-11	650	650	600	450	650	550	500	400	500	450	450	500	529
F-13	600	650	600	700	650	600	700	500	600	550	600	500	604
F-15	700	700	590	700	700	670	650	500	650	550	600	500	626
F-19	520	500	600	500	600	550	550	400	400	500	500	400	502
G-11	500	520	500	450	550	500	500	400	450	450	500	400	477
G-19	500	500	500	550	700	500	500	400	550	500	500	400	508
G-23	600	520	600	700	500	600	650	540	500	500	500	450	555
H-6	7500	8000	6000	6000	6000	5000	2800	3500	6000	3200	8500	7500	5833
H-12	600	500	500	600	600	500	500	600	500	500	500	450	529
I-3	500	520	500	500	500	500	550	410	500	500	450	400	486
I-9	520	550	500	550	500	650	550	600	500	600	500	400	535
I-12	520	500	500	500	500	550	550	450	500	500	500	400	498
I-17	520	550	500	550	500	520	550	600	500	500	500	400	516
J-18	500	500	450	500	500	500	400	480	500	500	850	450	511
J-19	520	500	500	500	500	500	400	290	500	450	450	750	488
J-20	420	400	320	300	300	390	400	300	300	400	300	300	344
K-9	500	500	420	450	490	500	400	500	500	450	400	400	459
K-13	500	600	550	500	500	550	400	450	550	500	500	500	508
K-17	500	700	550	550	500	550	400	400	550	500	500	500	517
K-18	500	500	450	450	400	550	400	600	550	500	500	450	496
L-4	500	500	520	700	600	750	950	650	600	550	800	600	643
L-7	500	500	500	500	450	500	900	500	550	450	500	500	529
L-17	550	500	500	700	550	500	1000	600	600	500	500	500	583
L-18	450	600	520	550	600	500	900	400	500	400	500	500	535
M-2	9500	600	550	550	350	650	1500	600	500	500	500	650	1371
M-3	500	450	400	500	500	520	650	450	500	400	450	450	481
M-7	550	500	500	500	500	500	700	500	550	500	500	500	525
M-15	500	500	400	450	500	550	800	500	500	400	500	500	508
N-3	600	500	500	500	400	570	800	490	550	450	500	500	530
N-6	500	700	500	500	600	500	850	500	500	450	450	400	538
P-4	600	520	520	650	550	600	1100	500	600	450	500	500	591
P-14	500	600	520	550	600	500	950	450	500	400	500	500	548
MONTHLY AVG	1550	828	1353	1086	1430	742	772	866	1107	723	1395	1062	
YEARLY AVG	1076												
MAXIMUM VALUE	33000												
MINIMUM VALUE	290												
NORTH CANALS	2269	869	2387	1647	2558	812	803	1288	1722	958	2333	1589	
SOUTH CANALS	1088	801	688	725	705	696	752	595	711	571	791	723	

1984 CANAL POLLUTANT SURVEY

DISSOLVED OXYGEN
(MG/L)

SITES	JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT	OCT.	NOV.	DEC.	SITE AVERAGE
A-3	3	5	5	5	4	9	1	3	4	2	4	4	4
A-6	5	8	6	6	4	6	2	3	5	1	2	3	4
B-2	6	6	6	5	5	5	1	5	3	2	5	4	4
B-10	4	4	4	4	5	3	2	4	2	2	3	2	3
B-12	–	6											3
B-13	3		3	4	4	3	2	3	1	2	2	2	3
C-3	5	5	7	6	1	3	2	2	2	2	4	4	4
C-16	6	5	6	7	4	7	2	4	5	3	5	4	5
C-23	5	4	6	5	5	4	3	4	4	2	4	2	4
D-12	2	2	2	1	4	6	4	4	1	1	1	2	3
D-18	3	3	6	2	2	2	2	3	3	1	1	2	3
D-19	1	2	2	2	3	1	2	2	3	1	2	1	2
E-9	2	5	4	2	4	1	4	3	2	1	3	2	3
F-4	4	3	3	2	3	3	2	2	2	1	5	3	3
F-7	2	4	3	2	1	2	2	2	2	1	2	1	2
F-11	3	3	4	2	5	4	3	2	1	1	3	3	3
F-13	2	5	5	2	3	3	2	2	2	1	2	2	3
F-15	1	4	3	2	1	1	1	1	4	1	1	2	2
F-19	2	5	6	2	4	4	3	3	1	3	5	3	3
G-11	4	1	7	4	4	4	3	4	4	3	5	3	4
G-19	5	5	5	3	6	3	2	2	3	1	3	2	3
G-23	2	5	3	2	2	4	5	1	2	1	2	2	3
H-6	7	9	8	8	3	6	4	6	3	5	11	4	6
H-12	4	2	2	3	2	3	2	3	3	2	2	2	3
I-3	2	4	5	2	4	3	4	4	3	2	4	6	4
I-9	1	1	1	2	2	1	2	3	1	1	2	1	2
I-12	5	1	1	2	1	3	2	1	1	1	2	1	2
I-17	2	1	1	6	1	1	2	1	1	1	2	1	2
J-18	6	5	7	7	6	5	6	4	5	3	5	6	5
J-19	3	2	4	4	9	3	4	6	3	7	4	5	5
J-20	9	6	6	9	5	6	4	6	7	4	4	6	6
K-9	6	3	6	10	9	3	5	4	6	3	5	5	5
K-13	5	6	6	6	8	1	6	1	1	1	5	6	4
K-17	1	2	2	2	8	1	1	1	1	1	4	1	2
K-18	6	6	6	8	6	2	5	2	1	1	4	6	4
L-4	6	5	5	8	8	7	3	4	8	7	6	8	6
L-7	5	7	6	9	10	8	2		7	6	6	7	7
L-17	8	2	5	5	1	6	3	3	5	5	3	3	4
L-18	5	2	2	1	7	1	1	2	2	2	2	2	2
M-2	6	6	6	8	12	7	3	8	7	10	10	6	7
M-3	7	6	9	8	6	8	4	8	5	7	5	5	7
M-7	6	4	10	6	7	4	3	3	4	4	4	3	5
M-15	2	3	6	4	7	4	2	3	7	6	3	4	4
N-3	2	3	5	5	6	1	1	2	2	2	2	2	3
N-6	7	2	3	4	1	5	1	1	4	4	3	4	3
P-4	4	4	8	6	7	4	3	4	6	5	6	5	5
P-14	5	2	2	2	3	1	2	2	3	2	2	2	2
MONTHLY AVG	4	4	5	4	5	4	3	3	3	3	4	3	
YEARLY AVG	4												
MAXIMUM VALUE	12												
MINIMUM VALUE	0												
NORTH CANALS	3	4	5	3	3	4	2	3	3	2	3	3	
SOUTH CANALS	5	4	5	5	5	4	3	3	4	3	4	4	

1984 CANAL POLLUTANT SURVEY

TOTAL NOx-N
(MG/L)

SITES	JAN.	FEB.	MARCH	APRIL	MAY	JUNE	JULY	AUG.	SEPT	OCT.	NOV.	DEC.	SITE AVERAGE
A-3	0.96	0.22	0.25	0.16	0.20	0.15	0.21	0.20	0.09	0.12	1.20	0.29	0.34
A-6	0.12	0.01	0.04	0.10	0.04	0.17	0.24	0.17	0.15	0.25	0.21	0.28	0.15
B-2	0.18	0.26	0.21	0.12	0.30	0.33	0.38	0.48	0.17	0.53	0.38	0.21	0.30
B-10	0.08	0.10	0.09	0.11	0.09	0.27	0.29	0.09	0.11	0.26	0.18	0.16	0.15
B-12	0.06	0.06											0.06
B-13			0.08	0.11	0.07	0.26	0.26	0.09	0.11	0.23	0.13	0.11	0.15
C-3	0.28	0.23	0.14	0.14	0.07	0.21	0.20	0.16	0.15	0.27	0.35	0.38	0.22
C-16	0.27	0.28	0.33	0.22	0.12	0.21	0.16	0.24	0.13	0.26	0.38	0.30	0.24
C-23	0.27	0.26	0.22	0.30	0.20	0.27	0.20	0.26	0.20	0.15	0.33	0.22	0.24
D-12	0.05	0.09	0.02	0.02	0.20	0.06	0.14	0.14	0.04	0.08	0.23	0.02	0.09
D-18	0.79	0.33	0.37	0.24	0.28	0.31	0.22	0.22	0.16	0.23	0.15	0.15	0.29
D-19	0.04	0.07	0.05	0.06	0.28	0.29	0.06	0.06	0.12	0.28	0.10	0.08	0.12
E-9	0.29	0.12	0.09	0.09	0.08	0.11	0.05	0.09	0.09	0.03	0.11	0.08	0.10
F-4	0.32	0.05	0.23	0.04	0.08	0.22	0.06	0.17	0.20	0.11	0.21	0.28	0.16
F-7	0.12	0.08	0.10	0.06	0.01	0.07	0.07	0.07	0.07	0.12	0.09	0.05	0.08
F-11	0.16	0.12	0.11	0.11	0.04	0.12	0.06	0.06	0.04	0.16	0.08	0.14	0.10
F-13	0.12	0.08	0.12	0.06	0.05	0.10	0.04	0.10	0.05	0.09	0.07	0.05	0.08
F-15	0.02	0.08	0.08	0.06	0.01	<0.01	0.03	0.02	0.02	0.09	0.05	0.04	0.04
F-19	0.08	0.20	0.23	0.10	0.08	0.12	0.08	0.05	0.10	0.10	0.14	0.10	0.12
G-11	0.42	0.28	0.35	0.29	0.08	0.25	0.27	0.30	0.26	0.54	0.36	0.38	0.32
G-19	0.14	0.20	0.26	0.10	0.08	0.07	0.06	0.11	0.12	0.19	0.15	0.12	0.13
G-23	0.11	0.09	0.07	0.03	0.02	0.02	0.02	<0.01	0.04	0.03	0.08	0.17	0.06
H-6	0.18	0.70	0.36	0.36	0.46	0.75	1.10	0.30	0.16	0.52	0.15	0.66	0.48
H-12	0.68	0.22	0.20	0.20	0.24	0.24	0.18	0.18	0.13	0.22	0.20	0.32	0.25
I-3	0.29	0.30	0.24	0.20	0.15	0.16	0.13	0.18	0.24	0.19	0.16	0.17	0.20
I-9	0.04	0.02	0.05	0.03	0.06	0.02	<0.01	0.02	0.04	0.04	0.07	0.03	0.04
I-12	1.00	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.04	0.02	0.05	0.04	0.11
I-17	0.10	0.03	0.02	0.02		0.09	<0.01	0.02	0.01	0.04	0.08	0.02	0.04
J-18	0.05	0.06	0.09	0.18	0.02	0.09	<0.01	0.04	0.06	0.09	0.12	0.12	0.08
J-19	0.02	0.05	0.04	0.03	0.04	0.04	0.05	0.01	0.10	0.02	0.11	0.08	0.05
J-20	0.01	0.02	0.02	0.01	0.03	0.02	0.02	0.01	0.08	0.02	0.09	0.05	0.03
K-9	0.30	0.33	0.28	0.04	0.10	0.26	0.34	0.25	0.12	0.28	0.29	0.32	0.25
K-13	0.07	0.11	0.16	0.18	0.05	0.35	0.36	0.24	0.11	0.27	0.23	0.36	0.21
K-17	0.01	0.04	0.01	0.01	0.03	0.32	<0.01	0.01	0.16	0.28	0.23	0.03	0.09
K-18	0.16	0.19	0.04	0.04	0.05	0.28	0.48	0.21	0.14	0.26	0.19	0.20	0.19
L-4	1.60	1.20	2.50	1.30	1.30	0.62	2.40	1.10	1.00	0.75	1.50	1.20	1.37
L-7	1.00	1.60	2.00	1.80	1.80	2.10	1.80	1.70	1.60	1.30	1.80	1.20	1.64
L-17	2.10	3.70	4.00	4.70	4.80	3.60	4.00	4.60	4.20	3.70	2.10	0.04	3.46
L-18	0.69	0.58	0.05	0.08	0.16	0.07	0.04	0.04	0.12	<0.01	0.16	0.04	0.17
M-2	1.20	1.10	3.40	0.78	0.55	1.90	2.90	3.10	1.20	2.10	2.60	1.40	1.85
M-3	0.58	0.72	0.35	0.03	0.04	0.02	0.19	0.06	0.16	0.48	2.30	0.82	0.48
M-7	1.30	2.25	1.60	2.80	1.50	1.40	0.96	1.60	2.00	1.50	0.92	1.80	1.64
M-15	0.82	1.35	0.40	1.20	0.38	0.70	1.10	0.92	1.10	0.15	1.90	1.70	0.98
N-3	0.05	0.26	0.01	0.04	0.04	0.03	<0.01	0.02	0.02	0.01	0.16	0.04	0.06
N-6	0.06	0.11	0.03	0.03	0.03	0.01	0.05	0.03	0.04	0.01	0.06	0.06	0.04
P-4	2.30	2.80	3.00	2.60	3.00	2.90	1.80	2.90	2.50	1.50	2.80	2.40	2.54
P-14	0.06	0.04	0.03	0.08	0.08	0.06	0.23	0.05	0.05	<0.01	0.12	0.03	0.07
MONTHLY AVG	0.43	0.46	0.49	0.42	0.38	0.43	0.46	0.45	0.39	0.39	0.51	0.36	
YEARLY AVG	0.43												
MAXIMUM VALUE	4.80												
MINIMUM VALUE	0.00												
NORTH CANALS	0.23	0.15	0.15	0.12	0.12	0.18	0.15	0.15	0.11	0.19	0.24	0.16	
SOUTH CANALS	0.55	0.66	0.70	0.61	0.56	0.59	0.66	0.64	0.56	0.52	0.68	0.49	

Part III

1984 ANNUAL POLLUTANT STUDY

The Annual Pollutant Study was undertaken to evaluate the effects of urbanization on surface water quality by comparing upstream (background) water quality to that of discharge stations in Dade County's major canal systems. Samples were taken during the dry season (March) and the wet season (August). The following parameters were analyzed.

Physical Parameters
- Conductivity
- Turbidity
- Total Filtrable Residue

Nutrients
- Ammonia
- Total Kjeldahl Nitrogen
- Total Organic Nitrogen
- Total Nitrates/Nitrites
- Ortho Phosphorus
- Total Phosphorus

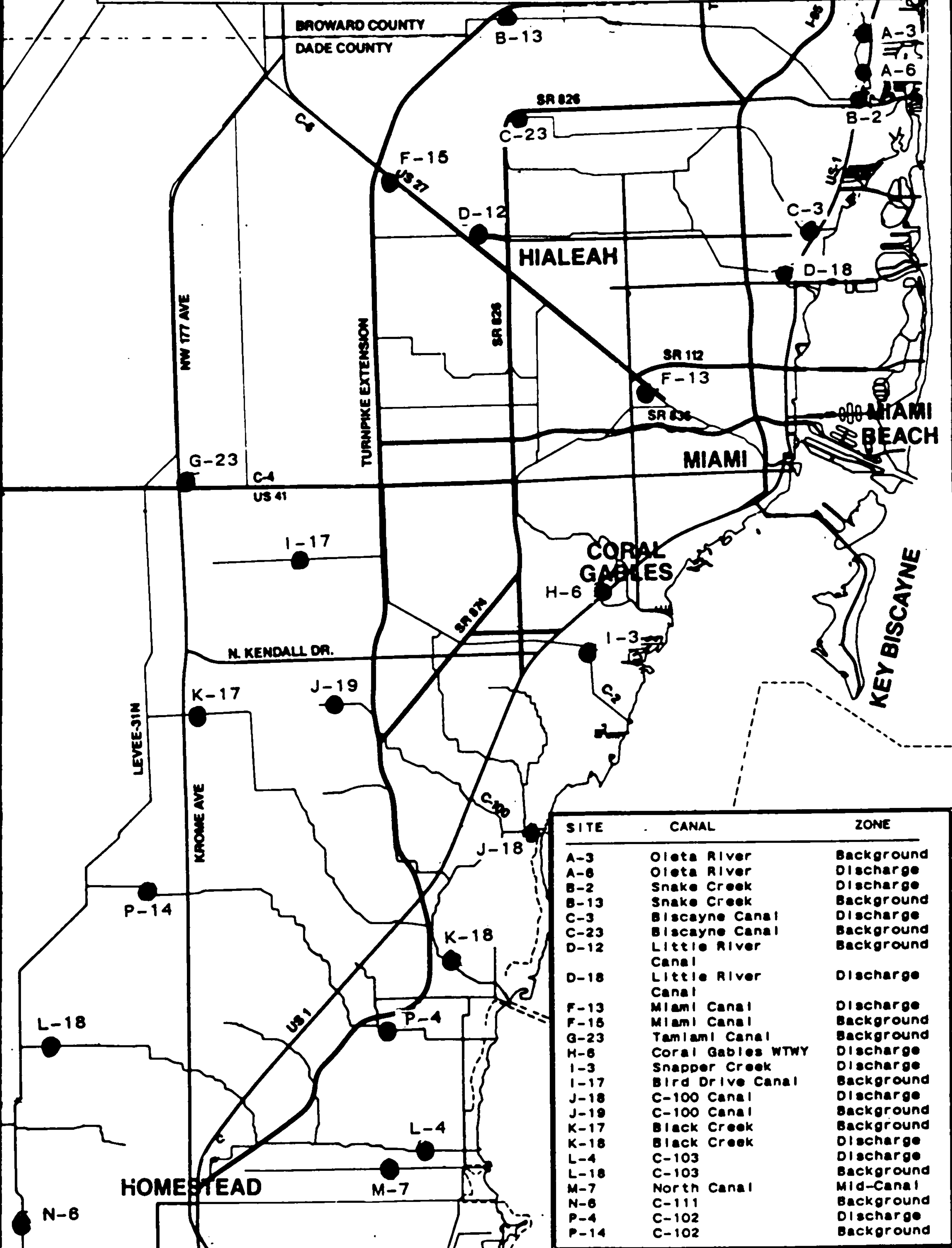
Major Inorganics
- Alkalinity
- Fluorides

Trace Elements:
- Arsenic
- Cadmium
- Chromium
- Copper
- Mercury
- Nickel
- Lead
- Selenuim
- Silver
- Zinc

Organics
- Methylene Blue Active Substance
- Biochemical Oxygen Demand
- Chemical Oxygen Demand
- Phenols
- Herbicides

A total of 24 sampling sites were included in the study (Figure 13). During the dry season Biscayne, Snapper Creek, Black Creek, Goulds, C-111, C-102, and Miami canals were sampled. In the wet season, Oleta River, Snake Creek, Little River, Tamiami, Coral Gables Waterway, C-100 and C-103 canals were sampled.

FIGURE 13: LOCATION OF SITES IN THE 1984 ANNUAL POLLUTANT STUDY



SITE	CANAL	ZONE
A-3	Oleta River	Background
A-6	Oleta River	Discharge
B-2	Snake Creek	Discharge
B-13	Snake Creek	Background
C-3	Biscayne Canal	Discharge
C-23	Biscayne Canal	Background
D-12	Little River Canal	Background
D-18	Little River Canal	Discharge
F-13	Miami Canal	Discharge
F-15	Miami Canal	Background
G-23	Tamiami Canal	Background
H-6	Coral Gables WTWY	Discharge
I-3	Snapper Creek	Discharge
I-17	Bird Drive Canal	Background
J-18	C-100 Canal	Discharge
J-19	C-100 Canal	Background
K-17	Black Creek	Background
K-18	Black Creek	Discharge
L-4	C-103	Discharge
L-18	C-103	Background
M-7	North Canal	Mid-Canal
N-6	C-111	Background
P-4	C-102	Discharge
P-14	C-102	Background

RESULTS

Physical Parameters

Turbidity

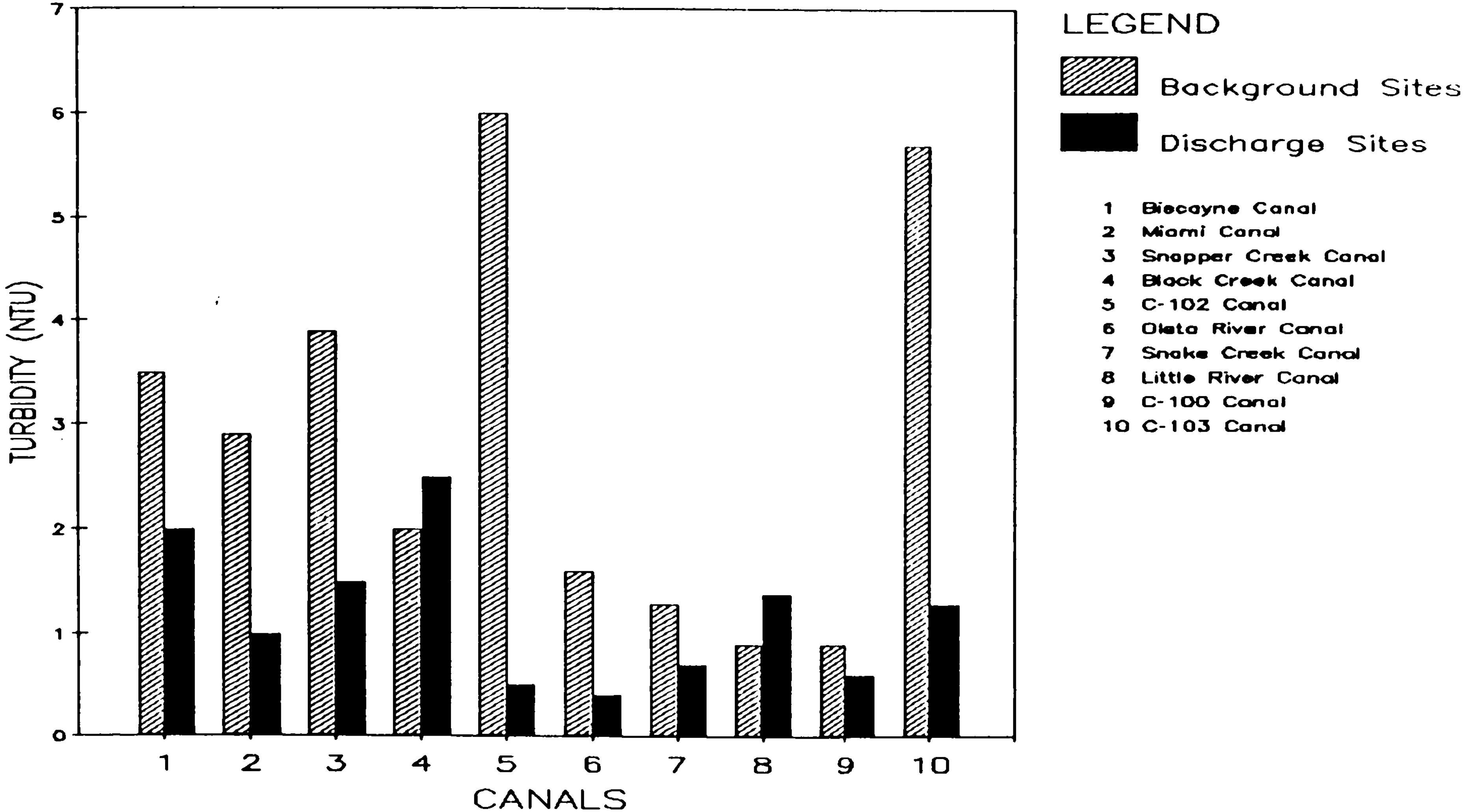
The average turbidity value was 2.1 Nephelometric turbidity units (NTU) with a maximum value of 6.0 NTU at the background station of C-102 canal. Turbidity might be expected to increase as canal water traverses from undeveloped areas (background) through urbanized or agricultural areas to discharge stations at salinity control structures. Only the Little River and Black Creek canals exhibited this tendency; otherwise the turbidity levels were generally higher at the background sites (Figure 14). Previous years' data also indicated a similar distinction.

This pattern may be due to differences in water velocities in different reaches of a canal. Generally, as velocity increases, the resulting turbulence resuspends settled solids. At the discharge sites the salinity dams considerably retard flow unless they are opened to discharge stormwater. Water velocities at the background stations may be greater because the canals can be receiving discharges from the western water conservation areas and simultaneously recharging groundwater depleted by withdrawals for potable and irrigation use.

Specific Conductivity

The average conductivity level in the canal samples was 1215 uhmos/cm. This uncharacteristically high level reflects substantial salt water intrusion at the Oleta River and Coral Gables Waterway. Conductivity values in the other canals ranged from 290-760 uhmos/cm. Excluding the salt intruded canals, 50% of the sites had levels that exceeded the 500 umhos/cm standard. In general, there was no substantive differences in conductivity levels between the background and discharge sites for most of the canals.

FIGURE 14: TURBIDITY DATA FOR THE 1984 ANNUAL POLLUTANT STUDY



Total Filtrable Residue (TFR)

As with conductivity, the county wide TFR average of 782 mg/l is skewed by inclusion of samples from discharge sites subject to salt water intrusion at the Oleta River and Coral Gables Waterway. The other canals had TFR levels ranging between 208 - 454 mg/l, which are consistent with the previous years' data and represent background values.

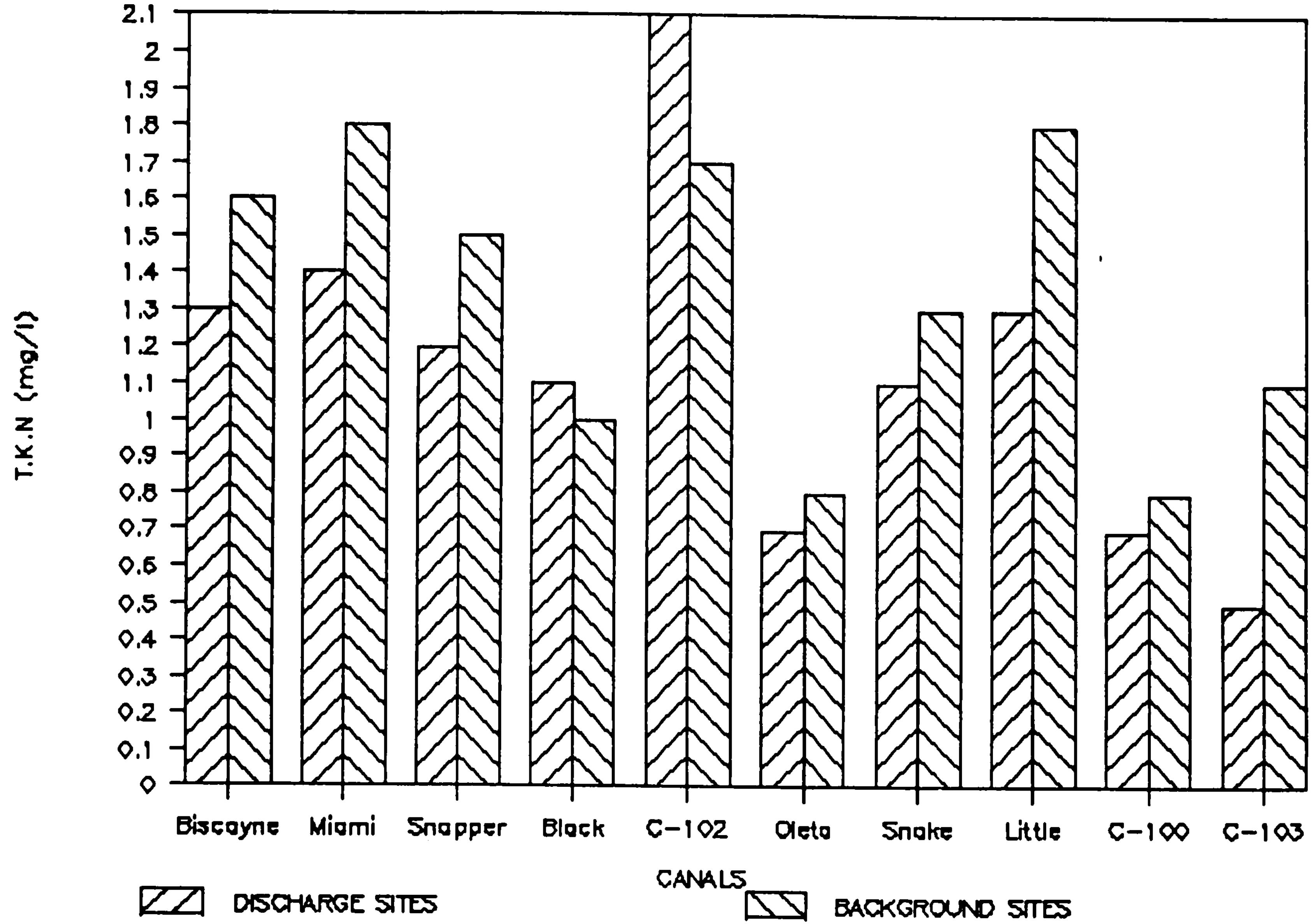
Nutrients

Nitrogen

Ammonia is naturally occurring in surface water primarily because of natural deamination of organic-containing compounds and the hydrolysis of urea. Nitrates generally occur in trace amounts in surface waters. Runoff from land may contain agricultural fertilizers which may be high in nitrates or ammonia. Organic nitrogen is defined as organically bound nitrogen in the trivalent state. Organic nitrogen and ammonia may be analyzed together and is referred to a Total Kjeldahl Nitrogen (TKN).

Ammonia levels in canal samples averaged 0.3 mg/l ranging from 0.08 to 1.4 mg/l. The ammonia standard for fresh surface water is 0.5 mg/l. This value was exceeded at the background stations on C-102 (0.7 mg/l), Bird Drive canal (0.6 mg/l) and Little River Canal (1.4 mg/l). TKN values were higher at the background sites than at the discharge stations (Figure 15), probably because of the presence of the decaying organic manner in the mucky soils of the north (Water Conservation Area 3B) and agricultural practices in the south. Nitrate levels ranged from 0.01 to 3.0 mg/l and averaged 0.4 mg/l, well below the standard of 10 mg/l. Several of the southern sites, had nitrate levels elevated an order of magnitude above average, (C-103 C-102, and North Canal) possibly indicating impacts of agriculture. Overall elevated nitrate levels are probably attributable to agricultural and residential fertilizer application. The average TKN value was 1.2 mg/l, and the total organic nitrogen averaged 0.9 mg/l. Thus, the majority of the nitrogen found in the canal pollutant study is

FIGURE 15: T.K.N. DATA FOR THE 1984 ANNUAL POLLUTANT STUDY



organically bound i.e., as proteins, peptides, nucleic acids, urea and synthetic organic materials.

Phosphorus

Phosphates represent the main forms of phosphorus in surface water. Ortho phosphate applied to agricultural land or residential lawns as fertilizers enters surface water via storm water runoff. The average ortho phosphate levels in the canal samples was 0.004 mg/l, and total phosphates averaged 0.019 mg/l. Levels remained fairly consistent with previous years and are considered background levels.

Major Inorganics

Alkalinity

The standard recommends that alkalinity levels should not fall below 20 mg/l if aquatic life is to be supported. The average alkalinity level in canal samples was 239 mg/l. Alkalinity tended to increase slightly from background to discharge sites, although for C-100 the reverse was true (Figure 16).

Fluoride

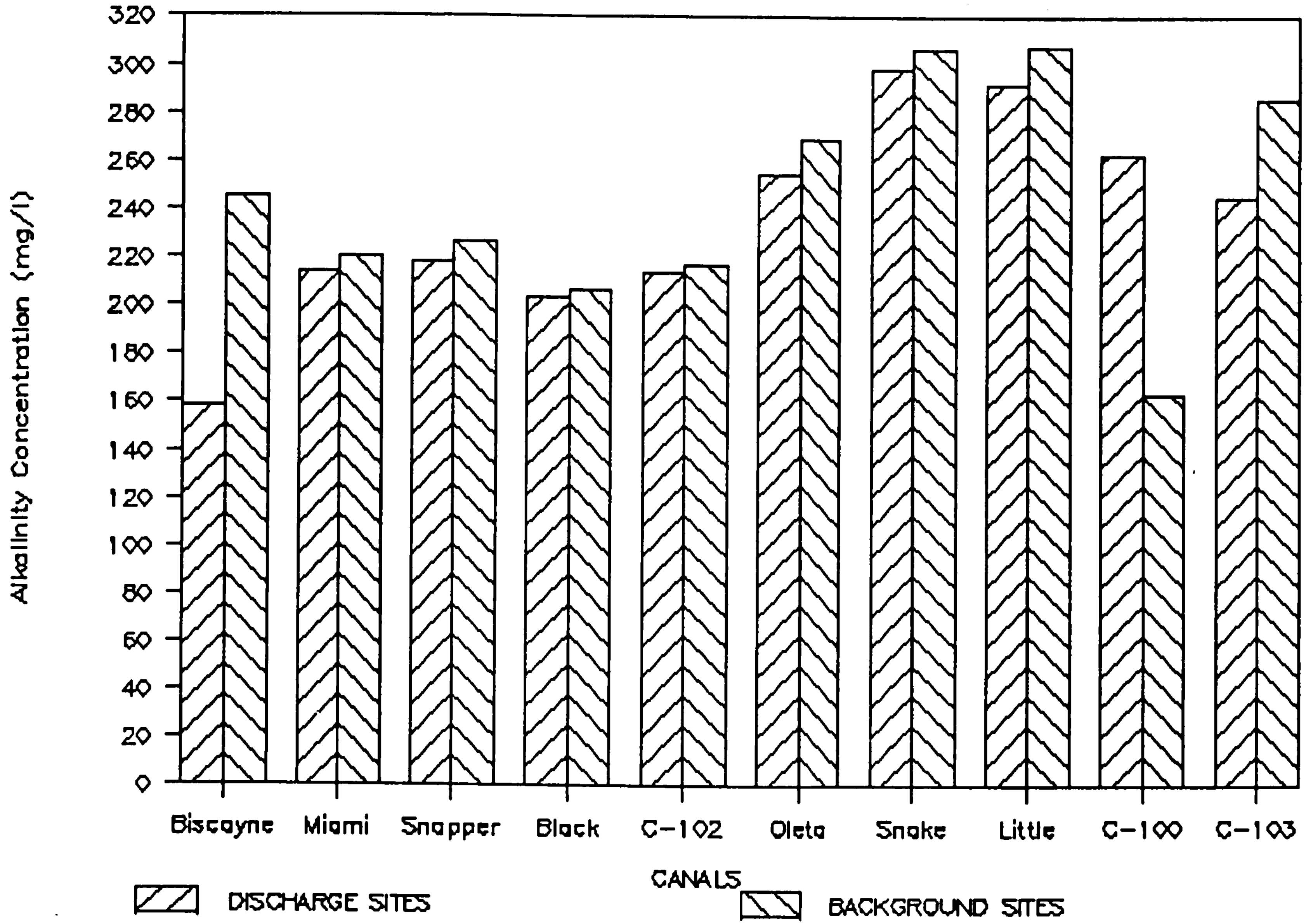
Fluoride concentrations in canal samples were consistently low throughout the study, averaging 0.2 mg/l, well below the 1.4 mg/l standard.

Trace Elements

Trace element levels were consistently low throughout the study.

Arsenic levels averaged 1.6 ug/l in canal samples, ranging from below the detection limit of 0.5 ug/l to 4.7 ug/l. The highest levels were detected in the Oleta Canal sites, however they were still an order of magnitude below the 50 ug/l standard. Levels were consistent with previous years and may be considered background values.

FIGURE 16: COMPARISON OF THE ALKALINITY DATA FOR THE BACKGROUND AND DISCHARGE SITES IN THE 1984 ANNUAL POLLUTANT STUDY



Cadmium concentrations averaged 0.9 ug/l in the canal sample just below the fresh surface water standard of 1.2 ug/l. Levels ranged from below dectection limit of 0.1 ug/l, to 8.5 ug/l at the discharge site of Black Creek Canal. The levels in general were elevated over previous years' data. Several sites slightly exceeded standards: Black Creek, Biscayne Canal (average 1.7 mg/l), North Canal (2.1 ug/l) and C-102 (1.7 ug/l at the discharge site). Cadmium concentrations were consistently higher for samples collected during the dry season than the wet season.

Chromium averaged 0.6 ug/l in the canal samples, two orders of magnitude below the 50 ug/l standard. The maximum concentration detected was 1.2 ug/l at Biscayne Canal. These levels are consistent with previous data and may be considered background values.

Copper averaged 2.5 ug/l in the canal samples. Biscayne Canal had much higher copper concentrations of 14.9 ug/l (discharge) and 10.4 ug/l (mid canal), however, it remained below the 400 ug/l standard. These values are significantly elevated over previous years' data.

Lead concentrations in the canal samples were consistently low with an average of 2.9 ug/l, two orders of magnitude below the 950 ug/l standard. The highest level of lead (11.4 ug/l) was detected at North Canal, a result which is not consistent with previous data obtained from this site. Canal concentrations were much lower in the wet season than the dry season.

Mercury levels averaged 0.2 ug/l, the detection limit for the analytical method. Concentrations range from below detection limits to 0.5 ug/l. Fifty percent of the sites had levels of mercury that exceeded the standard of "none-detectable".

Nickel levels were usually below detection limits (0.01 mg/l), an order of magnitude below the standard of 0.1 mg/l.

Selenuim levels averaged 0.8 ug/l, consistently lower then the 25.0 ug/l standard.

Silver concentrations were consistent with previous data, averaging 0.4 ug/l and ranging from below the detection limit of 0.1 ug/l to 1.0 ug/l. These concentrations exceeded the standard of 0.07 ug/l and suggest industrial pollution.

Zinc is a common environmental contaminant and levels are typically higher then the other trace elements. Zinc levels averaged 0.1 mg/l in the canal samples, an order of magnitude below the standard of 1 mg/l.

Organic Parameters

Methylene Blue Active Substance (MBAS)

Methylene Blue Active Substances are those which form a blue salt or ion pair when reacted with methylene blue, a cationic dye. They are generally described as surfactants (i.e., detergents). MBAS includes linear alkylbenzene sulfonate (the most widely used anionic surfactant), other anionic surfactants as well as other strongly amphiphilic anions, natural or man-made. It is because of this lack of specificity that the materials are lumped together and simply designated MBAS.

The average MBAS level obtained in this study was 0.03 mg/l. The highest value was 0.2 mg/l, at the discharge site of Black Creek Canal which is below surface water criteria (0.5 mg/l). This was the second time this site was sampled for MBAS and although this year's level was significantly higher, further data is needed before background levels can be established or a trend can be determined.

Biochemical Oxygen Demand (BOD)

BOD measures the oxygen required for biochemical degradation of organic material (carbonaceous demand) and the oxygen necessary to oxidize inorganic material such as sulfides and ferrous iron. It may also measure the oxygen used to oxidize reduced forms of nitrogen unless their oxidation is prevented by an inhibitor. Elevated BOD is a good indicator of sewage pollution.

If BOD remains below 4 mg/l, organic loading does not seem to be a problem. It is normally desirable that BOD not exceed a value which would cause dissolved oxygen to be depressed below 4-5 mg/l.

Levels quantified were consistent with earlier data from the canal sites, averaging 2.5 mg/l. The highest value was detected at the Biscayne canal discharge site, 5 mg/l BOD, and within the background concentration for the site. There were no distinct difference in BOD levels between the background and discharge sites studied.

Chemical Oxygen Demand (COD)

COD is a measure of the oxygen equivalent of the organic matter content of a sample that is susceptible to oxidation by a strong chemical oxidant. It is a good indicator of pollution or oxidizable material loads.

Due to technical difficulties at the time of the study, COD was only analyzed during the wet season. As indicated in Figure 17, canal samples from the background sites consistently had higher levels than the discharge sites. The average COD value was 31.6 mg/l with the highest level at Miami Canal (48 mg/l) which typically has higher than average values.

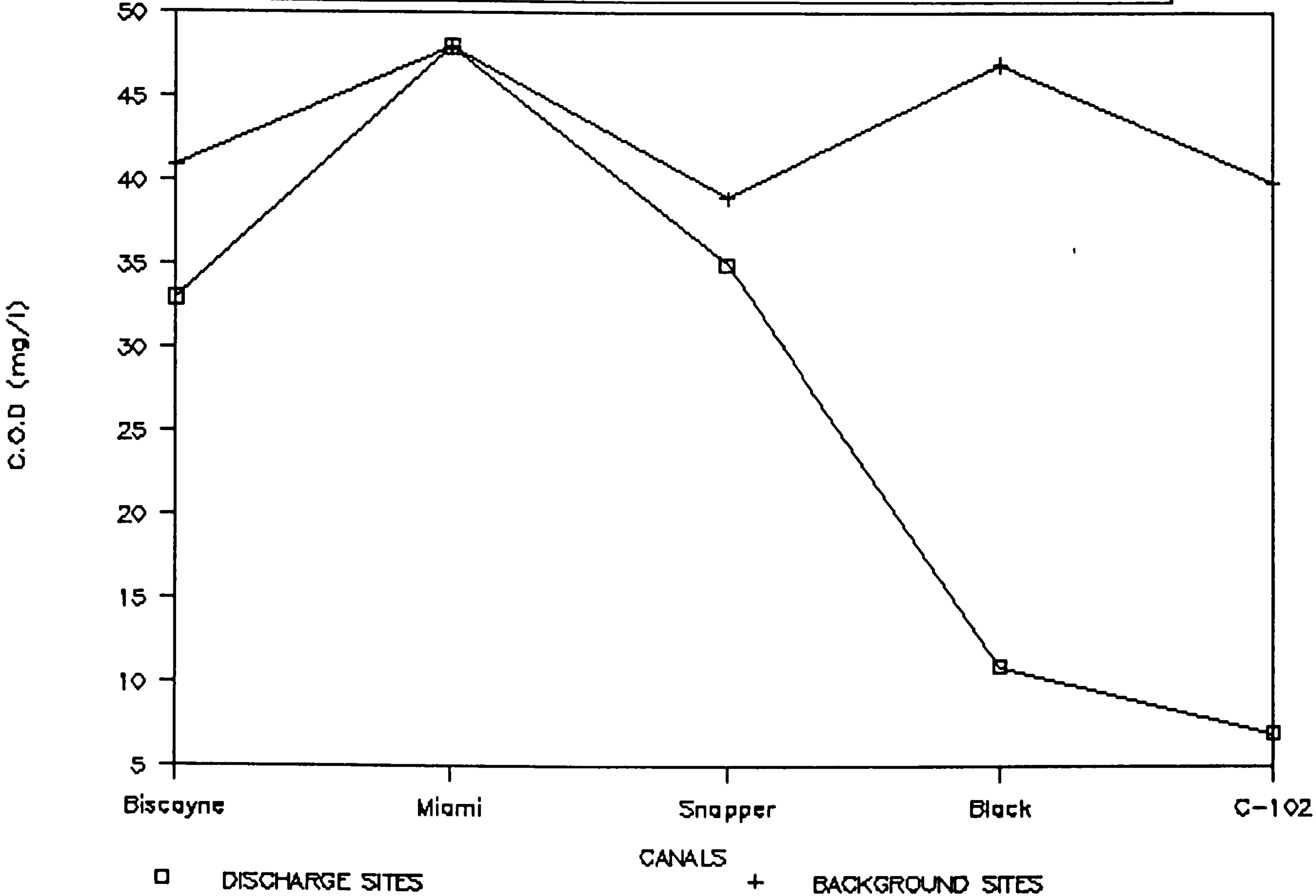


FIGURE 17: C.O.D. DATA FOR THE 1984 ANNUAL POLLUTANT STUDY

Phenols

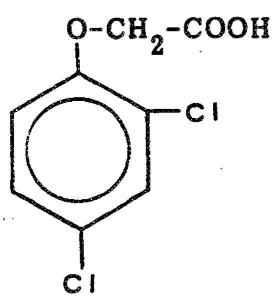
High levels of phenolic compounds have been detected in Dade County surface waters. Naturally occurring sources of phenols are decaying vegetation. Phenols can also result from urban pollution.

The average phenol value in the canal samples was 9 ug/l which exceeds the Dade County surface water criteria of 1 ug/l. The highest levels were found at Oleta Canal (average of 49 ug/l). The phenol data do not demonstrate any impact of urbanization upon water quality of the canals as there was no consistent trend between background and discharge sites. It is more likely that the high phenolic levels result from exotic vegetation in the area.

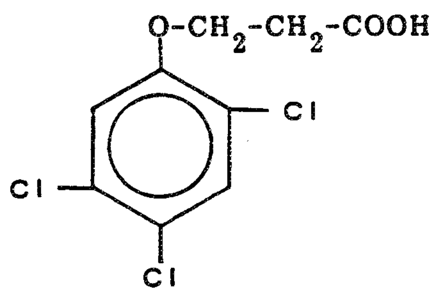
Herbicides

Herbicides attack and destroy unwanted plants either by direct poisoning or by accelerating their growth rates to the detriment of the plant. In general they are not persistent, being broken down rather quickly in the soil by bacterial metabolism.

The two major herbicides analyzed in this study were 2,4-D (2, 4-dichlorophenoxyacetic acid) (structure I) and 2,4,5-T (2,4, 5-trichlorophenoxy propionic acid) - (structure II).



I



II

The only herbicide detected in the 1984 canal pollutant study was 2,4-dichlorophenoxylacetic acid (2,4-D). 2,4-D is used as a herbicide on wheat, corn, pasture, barley and lawns. It is widely used to control broadleaf weeds and aquatic and canal bank vegetation. It is degraded in the environment and is not considered persistent. Surface water contamination is usually attributed to agriculture, landscaping or canal bank maintenance. The highest level of 2,4-D was found at the Snake Creek Canal background site (0.64 ug/l).

Biscayne canal samples had levels of 2,4-D of 0.17 ug/l (discharge) and 0.07 ug/l (mid canal). Sixty percent of the detections were found to occur during the wet season. This may be a result of increased storm water runoff from landscaped areas where 2,4-D is utilized.

With the exception of Snake Creek Canal, the discharge sites had higher levels of 2,4-D than the background sites, demonstrating adverse environmental impact from its use.

Summary

This annual pollutant study was designed to determine the effect of urbanization upon surface water quality. Levels remained fairly consistent with data from previous years, but new occurrences of 2,4-D pollution were noted, mostly at discharge sites. Further studies are needed. Exceedences of standards included those of mercury, cadmium, phenols, ammonia and conductivity.

APPENDIX III

1984 ANNUAL POLLUTANT SURVEY

WET SEASON

	B	D	D	B	B	D	B	D	D	B	D	B
	A-3	A-6	B-2	B-13	D-12	D-18	G-23	H-6	J-18	J-19	L-4	L-18
ALKALINITY(mg/l	269	255	298	307	308	292	300	216	263	164	245	286
B.O.D(mg/l)	2	2	2	2	4	3	3	4	1	2	2	1
MBAS(mg/l)	0.05	0.04	0.03	0.02	0.02	0.03	0.02	0.01	0.02	0.02	0.03	0.03
T.F.R (mg/l)	844	8938	386	416	404	394	382	1146	328	208	435	344
FLUORIDES(mg/l)	0.15	0.42	0.24	0.26	0.24	0.23	0.19	0.20	0.14	0.10	0.11	0.15
AMMONIA (mg/l)	0.15	0.14	0.32	0.20	1.40	0.30	0.43	0.05	0.03	0.02	0.04	0.50
T.K.N (mg/l)	0.80	0.70	1.10	1.30	1.80	1.30	1.40	0.90	0.70	0.80	0.50	1.10
T-ORG-N (mg/l)	0.60	0.60	0.80	1.10	0.40	1.00	1.00	0.80	0.70	0.80	0.50	0.60
CONDUCT.(UHMOS)	1010	13300	760	610	590	560	540	3500	480	290	680	490
NOX-N(mg/l)	0.20	0.17	0.48	0.09	0.14	0.22	<0.01	0.30	0.04	0.01	1.10	0.04
PHENOLS(ug/l)	48.0	50.0	<2.5	3.8	<2.5	<2.5	2.5	5.0	3.0	3.8	<2.5	<2.5
O-PO4(mg/l)	0.002	0.003	0.001	0.001	0.002	0.004	0.001	0.010	0.005	0.001	0.008	0.005
T-PO4(mg/l)	0.040	0.025	0.010	0.010	0.020	0.030	0.015	0.050	0.012	0.020	0.012	0.010
C.O.D(mg/l)								19				
TURBIDITY(NTU)	1.6	0.4	0.7	1.3	0.9	1.4	0.8	3.3	0.6	0.9	1.3	5.7
OIL&GREASE(ug/l						2.0						
SILVER(ug/l)	<1	<1	1.0	1.0	<1	<1	<1	<1	<1	<1	<1	<1
ARSENIC(ug/l)	4.7	3.6	1.0	1.2	1.4	1.8	1.0	1.1	1.1	1.4	1.7	1.4
CADMIUM(ug/l)	<0.01	<0.01	<0.01	0.2	<0.01	0.1	0.1	0.2	<0.01	0.1	0.1	0.2
CHROMIUM(ug/l)	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1	<1
COPPER(ug/l)	<1	<1	2.7	2.5	<1	3.1	<1	1.7	<1	<1	1.1	1.0
MERCURY(ug/l)	0.4	0.2	0.3	<0.2	<0.2	<0.2	<0.2	0.2	<0.2	<0.2	<0.2	<0.2
NICKEL(mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
LEAD(ug/l)	<1	<1	<1	<1	<1	<1	<1	<1	<1	1.0	<1	<1
SELENIUM(ug/l)	1.0	1.8	1.0	1.6	1.0	<1	1.1	<1	<1	<1	<1	1.5
ZINC(mg/l)	0.03	0.03	0.03	0.08	0.04	0.04	0.03	0.06	0.06	0.02	0.02	0.04

1984 ANNUAL POLLUTANT SURVEY

	DRY SEASON											
	D C-3	M C-23	D F-13	B F-15	D I-3	B I-17	B K-17	D K-18	M M-7	B N-6	D P-4	B P-14
ALKALINITY(mg/l	158	245	214	220	218	226	206	203	186	217	214	217
B.O.D(mg/l)	5	4	2	4	3	3	2	3	1	2	2	2
MBAS(mg/l)	0.04	0.02	0.04	0.04	0.03	0.02	0.02	0.19	0.02	0.02	0.01	0.02
T.F.R (mg/l)	373	403	392	454	351	363	401	319	345	371	395	377
FLUORIDES(mg/l)	0.19	0.21	0.23	0.28	0.17	0.18	0.19	0.12	0.11	0.18	0.11	0.15
AMMONIA (mg/l)	0.19	0.35	0.18	0.35	0.28	0.67	0.29	0.30	0.02	0.38	0.23	0.70
T.K.N (mg/l)	1.30	1.60	1.40	1.80	1.20	1.50	1.00	1.10	0.80	1.60	2.10	1.70
T-ORG-N (mg/l)	1.10	1.20	1.20	1.40	0.90	0.80	0.70	0.80	0.80	1.20	1.90	1.00
CONDUCT.(UHMOS)	500	550	600	650	400	500	600	450	500	550	550	500
NOX-N(mg/l)	0.18	0.19	0.06	0.06	0.14	0.16	0.13	0.20	3.00	0.06	2.70	0.04
PHENOLS(ug/l)		2.0	6.0				2.0	12.0	7.0			
O-PO4(mg/l)	0.010	0.011	0.005	0.005	0.002	0.002	0.006	0.005	0.004	0.002	0.002	0.004
T-PO4(mg/l)	0.040	0.033	0.020	0.022	0.010	0.010	0.009	0.015	0.012	0.009	0.003	0.010
C.O.D(mg/l)	33	41	48	48	35	39	47	11	4	39	7	40
TURBIDITY(NTU)	2.0	3.5	1.0	2.9	1.5	3.9	2.0	2.5	3.0	2.8	0.5	6.0
OIL&GREASE(ug/l	2.0		3.0		4.0			5.0	5.0	4.0		
SILVER(ug/l)	0.3	0.1	0.3	0.2	0.3	0.3	0.3	0.5	0.3	0.3	0.2	0.1
ARSENIC(ug/l)	2.0	2.7	1.0	<1	<1	<1	1.0	2.1	1.2	1.4	1.7	1.7
CADMIUM(ug/l)	1.8	1.7	0.3	0.9	0.3	1.1	0.3	8.5	2.1	0.5	1.7	0.5
CHROMIUM(ug/l)	1.2	0.7	1.0	0.8	0.7	0.8	0.5	0.6	0.9	0.6	0.5	0.5
COPPER(ug/l)	14.9	10.4	1.2	2.5	1.5	4.8	0.8	0.1	1.5	2.9	2.3	0.8
MERCURY(ug/l)	0.3	0.4	0.3	0.2	0.4	0.2	0.4	0.3	0.3	0.4	0.3	0.5
NICKEL(mg/l)	<0.01	0.02	0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
LEAD(ug/l)	7.1	5.4	6.1	3.0	4.9	4.9	3.1	4.6	11.4	2.3	3.1	7.0
SELENIUM(ug/l)	<1	<1	<1	<1	<1	<1	<1	1.1	<1	<1	<1	<1
ZINC(mg/l)	0.20	0.27	0.15	0.07	0.05	0.19	0.11	0.10	0.62	0.06	0.06	0.32

1984 ANNUAL POLLUTANT SURVEY

	AVERAGE	MAXIMUM	MINIMUM	VARIANCE
ALKALINITY(mg/l	239	308	158	1854
B.O.D(mg/l)	3	5	1	1
MBAS(mg/l)	0.03	0.19	0.01	0.00
T.F.R (mg/l)	782	8938	208	2925578
FLUORIDES(mg/l)	0.19	0.42	0.10	0.00
AMMONIA (mg/l)	0.31	1.40	0.02	0.08
T.K.N (mg/l)	1.23	2.10	0.50	0.16
T-ORG-N (mg/l)	0.91	1.90	0.40	0.10
CONDUCT.(UHMOS)	1215	13300	290	6710967
NOX-N(mg/l)	0.40	3.00	0.00	0.59
PHENOLS(ug/l)	8.5	50.0	0.0	227.7
O-PO4(mg/l)	0.004	0.011	0.001	0.000
T-PO4(mg/l)	0.019	0.050	0.003	0.000
C.O.D(mg/l)	32	48	4	231
TURBIDITY(NTU)	2.1	6.0	0.4	2.3
OIL&GREASE(ug/l	3.6	5.0	2.0	1.4
SILVER(ug/l)	0.2	1.0	0.0	0.1
ARSENIC(ug/l)	1.5	4.7	0.0	1.0
CADMIUM(ug/l)	0.9	8.5	0.0	2.9
CHROMIUM(ug/l)	0.4	1.2	0.0	0.2
COPPER(ug/l)	2.3	14.9	0.0	11.6
MERCURY(ug/l)	0.2	0.5	0.0	0.0
NICKEL(mg/l)	0.00	0.02	0.00	0.00
LEAD(ug/l)	2.7	11.4	0.0	9.5
SELENIUM(ug/l)	0.4	1.8	0.0	0.4
ZINC(mg/l)	0.11	0.62	0.02	0.02

WET SEASON

	A-3	A-6	B2	B13	D-12	D-18	G-23	H-6	J-18	J-19	L-4	L-18
HERBICIDES												
2,4-D(ug/l)	ND	ND	ND	0.64	ND	0.03	ND	ND	0.09	ND	ND	ND
2,4,5-TP(ug/l)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CHLORINATED INSECTICIDES												
ALDRIN(ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
CHLORDANE(ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
(o,p)-DDD(ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
(p,p)-DDD(ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
(o,p)-DDE(ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
(p,p)-DDE(ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
(o,p)-DDT(ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
DIELDRIN(ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
ENDRIN(ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
HEPTACHLOR(ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
HEP. EPOX(ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
LINDANE(ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
METHOX.(ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
MIREX(ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
TOXAPHENE(ug/l)	-	-	-	-	-	-	-	-	-	-	-	-

1984 ANNUAL POLLUTANT SURVEY

DRY SEASON

	C-3	C-23	F-13	F-15	I-3	I-17	K-17	K-18	M-7	N-6	P-4	P-14
HERBICIDES												
2,4-D(ug/l)	0.17	0.07	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
2,4,5-TP(ug/l)	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
CHLORINATED INSECTICIDES												
ALDRIN(ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
CHLORDANE(ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
(o,p)-DDD(ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
(p,p)-DDD(ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
(o,p)-DDE(ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
(p,p)-DDE(ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
(o,p)-DDT(ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
DIELDRIN(ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
ENDRIN(ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
HEPTACHLOR(ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
HEP. EPOX(ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
LINDANE(ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
METHOX.(ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
MIREX(ug/l)	-	-	-	-	-	-	-	-	-	-	-	-
TOXAPHENE(ug/l)	-	-	-	-	-	-	-	-	-	-	-	-

Part IV

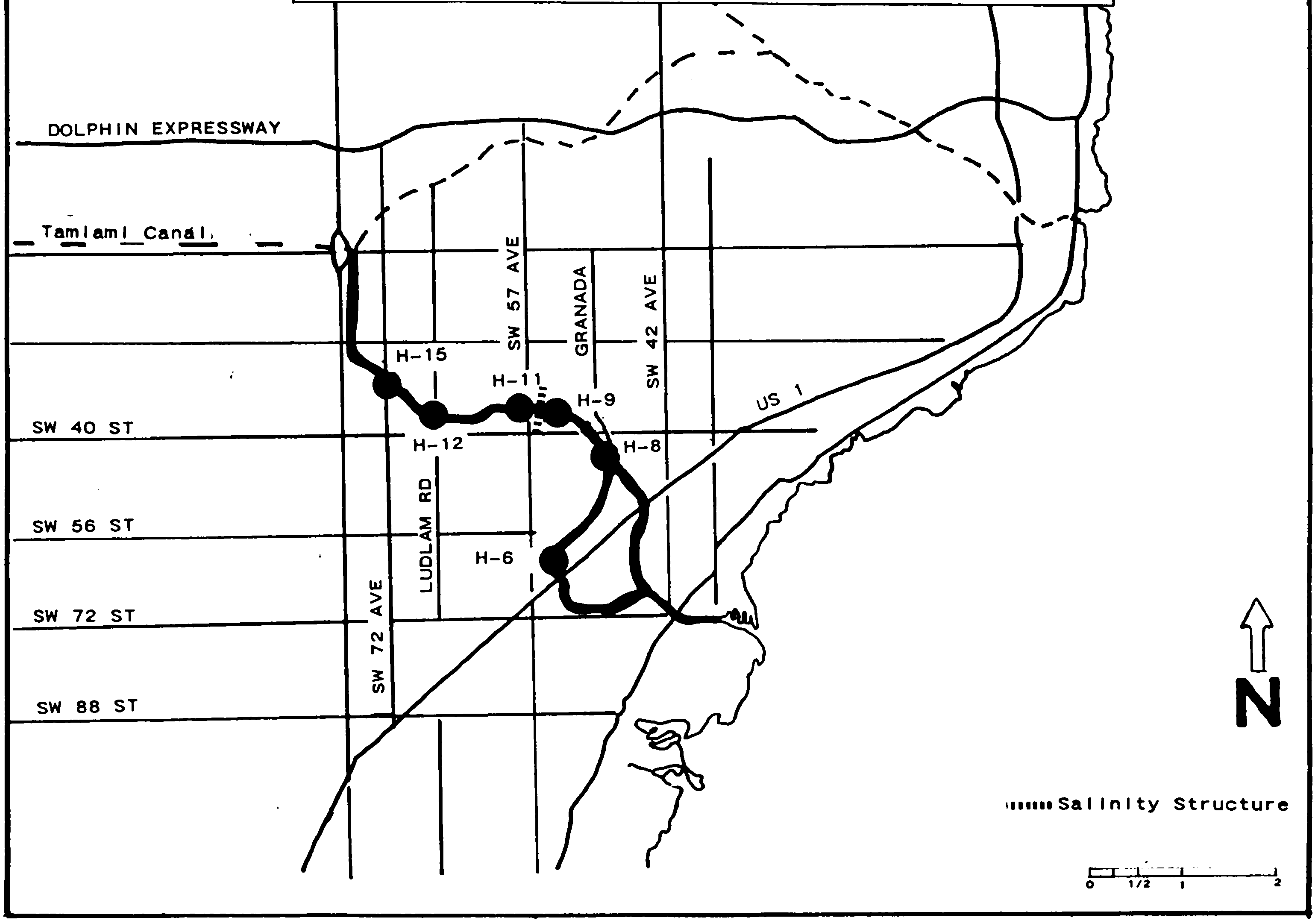
1984 INTENSIVE CANAL STUDY

The Dade County Department of Environmental Resources Management (DERM) annually selects and samples one major canal for a much more extensive set of physical and chemical parameters then those included in Part III. This program can more clearly detect water quality problems of a specific nature (extending beyond the general canal program) because additional sampling stations are included and the sampling frequency is significantly increased. Canals studied in previous years include Snapper Creek (1980), Miami Canal (1981), Tamiami and Dressels Canals (1982) and Black Creek (1983).

The Coral Gables Waterway was selected for extensive monitoring during 1984. The canal traverses residential, business areas and a large university (see Figure 18). In addition to the discharge and mid canal sites of the general canal, four additional sites were chosen along the Coral Gables Waterway. The following describes the analytical protocol and sampling frequencies:

PARAMETER	SAMPLING SCHEDULE
Physical Properties:	
Conductivity	Monthly
Turbidity	Monthly
Total Filtrable Residue	Monthly
Nutrients:	
Ammonia	Monthly
Nitrite/Nitrate	Monthly
Total Kjeldahl Nitrogen	Jan., April, July, Oct.
Ortho and Total Phosphorus	Monthly

FIGURE #18: 1984 INTENSIVE CANAL STUDY
LOCATION OF SITES ALONG THE CORAL GABLES WATERWAY



Major Inorganics:	
Alkalinity	Monthly
Fluorides	Jan., April, July, Oct.
Chlorides	May
MBAS	Jan., April, May, July. Aug., Oct., Dec.
Trace Elements:	
Arsenic	Jan., April, July, Oct.
Cadmium	Jan., April, July, Oct.
Chromium	Jan., April, July, Oct.
Copper	Jan., April, July, Oct.
Lead	Jan., April, July, Oct.
Mercury	Jan., April, July, Oct.
Nickel	April, July, Oct.
Selenuim	Jan., April, July, Oct.
Zinc	Jan., April, July, Oct.
Minerals:	
Calcium	May
Magnesuim	May
Potassium	May
Sodium	May
Organic Constituents	
Biochemical Oxygen Demand	Monthly
Chemical Oxygen Demand	Monthly
Phenols	Monthly
Herbicides	Feb., Aug.
Oil and Grease	Jan., July, Aug., Oct.

RESULTS

Physical Properties

Specific Conductance

Site H-6 had consistently high conductivity values throughout the year with an average of 5833 umhos/cm, reflecting salt water intrusion. July, October and August were months with the lowest conductivity values (2800, 3200 and 3500 umhos/cm respectively), probably the result of heavy rainfall diluting the ion/solid concentrations.

The average value for conductivity for all the sites (with the exception of H-6 discussed above) was 526 umhos/cm. These values are consistent with previous canals studies done in Dade County (DERM 1981, 1982, 1983) and are considered background levels for the area.

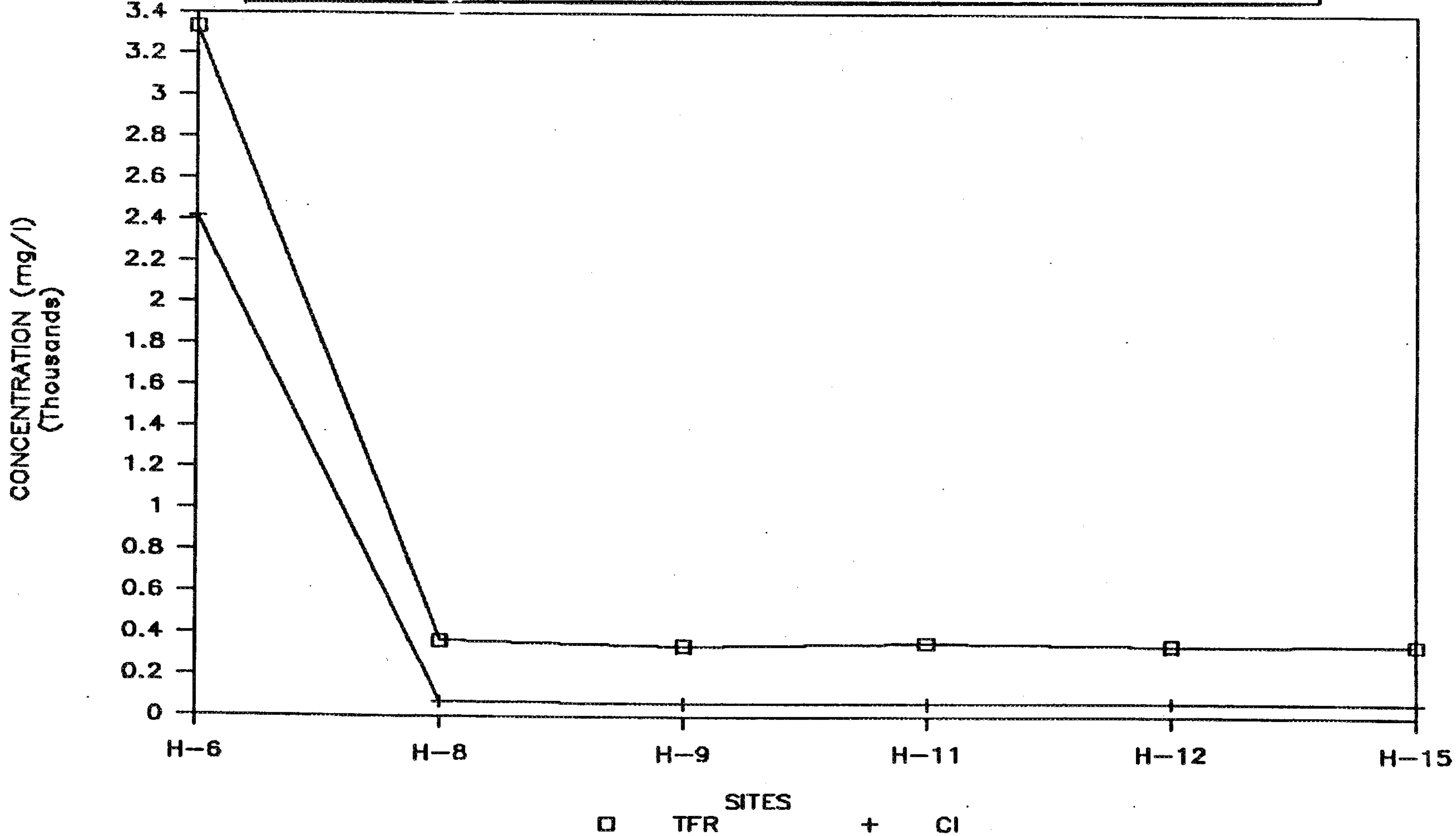
Turbidity

Turbidity interferes with recreational use and aesthetic enjoyment of water. Turbidity levels averaged 2.8 NTU, ranging from 1.0 to 6.5 NTU's. These levels were low and comparable to data from other canals.

Total Filtrable Residue (TFR)

The TFR values ranged from 296-4409 mg/l and closely parallel chloride concentrations at all sites (Figure 19). Site H-6 had the highest TFR values which averaged 3436 mg/l. Salt water intrusion is confirmed at this site both by the high chloride level (2415 mg/l) and its high conductivity (5833 umhos/cm, average).
Average TFR values for the remaining sampling sites was 351 mg/l which is consistent with other county canals. With the exception of H-6, there were no exceedances of the 500 mg/l standard. In general, TFR did not show any significant variation between wet and dry seasons.

FIGURE 19: COMPARISON OF T.F.R. AND CHLORIDE DATA IN THE 1984 INTENSIVE CANAL STUDY



Nutrients

Ammonia

Ammonia levels in this study ranged from 0.05 mg/l to 0.91 mg/l with an average of 0.25 mg/l. Except at site H-6, (which remained low throughout the study), the highest values were found during October. One possibility is that heavy rainfall during the month aided migration of NH_3 from the Tamiami Canal (traditionally high NH_3 levels) to the Coral Gables Waterway, up to site H-8. If reducing conditions existed, nitrates would have been converted to ammonia. This appeared unlikely because nitrate levels did not decrease significantly during October. Another possibility is that during October the canal environment supported the conversion of organic nitrogen to NH_3 (see Nitrogen Cycle Appendix I). This possibility exists because: a) NOx-N values remained constant, b) TKN values ($TKN=TON+NH_3$) were constant, and NH_3 values increased. TON must have decreased if the equation is to hold true.

NOx-N levels ranged from 0.11 ug/l to 1.1 mg/l and averaged 0.29 mg/l with little variation between dry and wet seasons. The highest levels were found at site H-6 located in the vicinity of a large private university and a golf course with well-maintained landscaping. The average nitrate/nitrite levels of the Coral Gables Waterway was twice as high as previous DERM studies of other Dade County canals (ICS 1981, ICS 1982). The Coral Gables Waterway transverses an affluent residential area (through most of its extent), a golf course and a university, thus the NOx-N values possibly reflect heavy use of lawn fertilizers. Quantified levels did not exceed the 10 mg/l standard.

Total Kjeldahl Nitrogen (TKN)

TKN was analyzed quarterly and the values were fairly consistent throughout the sampling with an average value of 0.99 mg/l. This indicated possible ammonification of the organic nitrogen to ammonia (see discussion under ammonia).

Ortho and Total Phosphorus

Ortho phosphorus levels ranged between 0.002 mg/l to 0.055 mg/l with an average of 0.016 mg/l. With the exception of site H-6, the values were generally low throughout the year except during October when the levels averaged 0.052 mg/l. Site H-6 had consistently low ortho phosphate levels throughout the year.

The total phosphate levels during the year averaged 0.046 mg/l and ranged from 0.015 to 0.100 mg/l. Sites H-6 and H-11 had high total phosphate levels for most of the year. Both ortho and total phosphate levels were high in the Coral Gables Waterway in comparison to other canals (DERM 1980, 1981, 1982 and 1983). This may be due to the application of lawn fertilizers in the surrounding residential area.

Major Inorganics

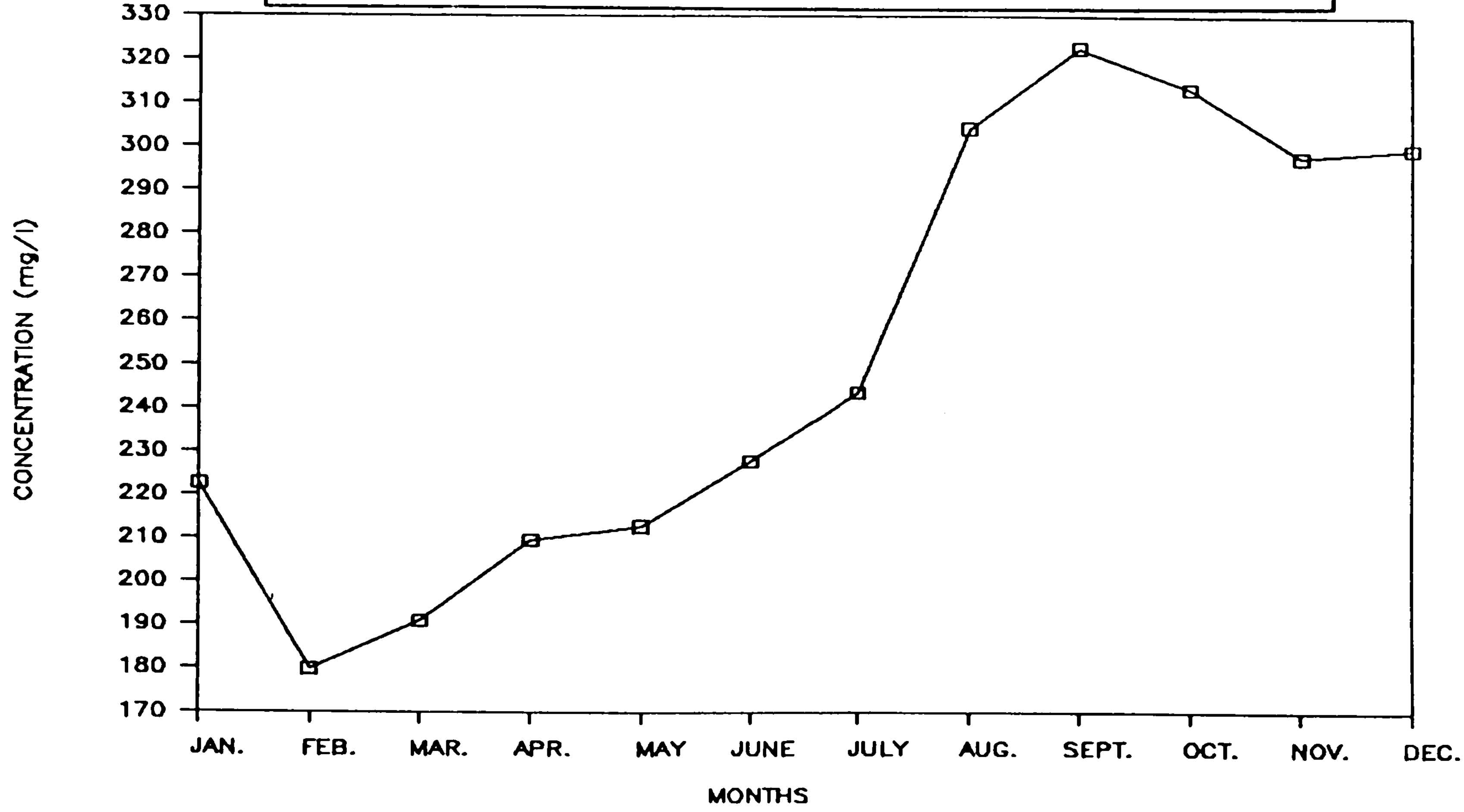
Alkalinity

Alkalinity ranged from 158 mg/l to 335 mg/l with an average of 252 mg/l. This data is consistent with the other canals studied and may be considered background values. Alkalinity levels seem to peak in the summer (August and September) after being at their lowest levels in February and March (Figure 20). Alkalinity levels are expected to be higher after a rainy period as the stormwater runoff would bring more carbonate and bicarbonate ions into solution.

Fluorides

Fluorides were studied on a quarterly basis and ranged from 0.13 mg/l to 0.28 mg/l. The average level was 0.16 mg/l. The highest level was found at site H-6, but this is still within the range of background concentrations for Dade's surface waters.

FIGURE 20: VARIATION OF ALKALINITY DATA IN THE 1984 INTENSIVE CANAL STUDY



Chlorides

Chlorides were analyzed only once during the year, and levels averaged 64 mg/l, excluding data from site H-6 (2415 mg/l) where salt water intrusion was encountered. Both H-6 and H-8 are downstream from the salinity dam; however, only H-6 (the farthest downstream) shows effects of salt water intrusion. This is due to the higher head elevation being maintained in recent years in groundwater and surface water inducing a very slow fresh water flow seeping around the salinity structure. The freshwater flow downstream of the structure may be sufficient to sustain fresh water at site H-8 whereas site H-6 is subjected to tidal incursions of saltwater.

Methylene Blue Active Substances (MBAS)

MBAS was analyzed seven times during the year. The average value was 0.12 mg/l, and ranged from 0.01 to 3.08 mg/l. The highest level was from site H-15 during December. This value exceeded the 0.15 ug/l standard. This exceedence was a single occurrence and was not confirmed by resampling or regarded as indicative of a trend.

Trace Elements

Arsenic levels in the canal sample were consistently low, averaging 1.2 ug/l, an order of magnitude below the standard.

Cadmium levels in the canal samples were at background levels, averaging 0.2 ug/l.

Chromium levels in the canal samples averaged 1.0 ug/l. The chromium concentrations were below detection limits at most sites; however H-6, the salt water intruded site, had consistently higher levels.

Copper levels in the canal samples averaged 1.6 ug/l, two orders of magnitude below the standard. Concentrations ranged from below the detection limit to 6.7 ug/l at site H-15 which had consistently higher levels along with H-6.

Lead values averaged 1.4 ug/l in the canal samples. The highest level detected was 10 ug/l which is well below the Dade County standard of 950 ug/l.

Mercury values were at or below the detection limit of 0.2 ug/l in all of the canal samples.

Nickel levels averaged 0.01 mg/l, an order of magnitude below the standard. The highest value was detected at H-6 (0.04 mg/l in July).

Selenium levels in the canal samples were very low and averaged 1.2 ug/l, an order of magnitude below the standard.

Zinc concentrations averaged 0.09 mg/l. None of the samples exceeded the 1.0 mg/l groundwater standard.

Minerals

Canal samples were analyzed for calcium, magnesium, potassium and sodium once during 1984. Values from site H-6 were deleted before calculating averages for the waterway because this site was subjected to saltwater intrusion.

Calcium (Ca)

The most common forms of calcium in sedimentary rocks are the carbonates. Two crystalline forms, calcite and aragonite, have the same general formula $CaCO_3$. Limestone consist mostly of calcite mixed with magnesium and other impurities.

Equilibria involving carbonates are the major factor in limiting the solubility of Ca in most natural waters. On surface streams, however, there may be some departure from equilibrium because the factors influencing the system are continuously varying. Calcium concentrations in the canal samples averaged 82.3 mg/l. Previous data for Black Creek Canal (DERM 1983) are consistent with this average and indicate a normally high Ca level. Site H-6 had a calcium level of 130.5 mg/l due to salt water intrusion (see discussion under sodium).

Sodium (Na)

Sodium is the most abundant of the alkali metal group. When sodium is in solution, it tends to remain dissolved because there is no important precipitation reaction that can maintain low sodium concentrations in water.

Sodium levels in the freshwater canal samples varied little, averaging 29.2 mg/l, and were consistent with ambient background concentrations. At site H-6, the sodium value was 870 mg/l, consistent with salt water intrusion.

Potassium (K)

In natural water, potassium occurs in lower concentrations than sodium because potassium is less easily liberated from silicate minerals. Moreover, potassium exhibits a strong tendency to be re-incorporated into solid, weathering products.

The average potassium concentration obtained in the samples was 2.0 mg/l. The effect of salt water intrusion resulted in slightly elevated potassium levels for H-6 (8.5 mg/l).

Magnesium (Mg)

Magnesium ion, Mg^{2+}, is the predominant species of Mg in solution in natural waters. Most limestone contains a moderate amount of magnesium. Ca and Mg both contribute to the overall hardness of water. In this study the average Mg value was 5.9 mg/l, which is assumed to be the background level for canals in Dade County. Elevated levels of magnesium at site H-6 (120 mg/l) are consistent with salt water intrusion.

Organic Constituents

Biochemical Oxygen Demand (BOD)

The average BOD value obtained was 3 mg/l; the highest value was 12 mg/l (H-6 in 11/84). Background BOD values for Dade canals usually average 2-3 mg/l. Coral Gables Waterway in the freshwater areas was within this BOD range. Site H-6 BOD values ranged from 3-12 mg/l. Dissolved oxygen levels at site H-6 averaged 6.2 mg/l (1984 Canal Monitoring Program), indicating that elevated BOD levels do not pose a water quality problem at this site.

Chemical Oyxgen Demand (COD)

The average value for COD obtained in the freshwater canal samples was 23 mg/l, ranging from 1 to 42 mg/l. No obvious correlation could be made between the wet and dry seasons because of the high variability in the data.

Phenols

The average phenol level was 7 ug/l, exhibiting substantial variation from site to site and month to month. No consistent variation between wet and dry seasons could be observed. Site H-6 had the lowest levels fluctuations from 2 ug/l to 10 ug/l. Although 93% of the samples exceeded the 1 ug/l standard, high phenol levels may be a consequence of exotic vegetation (e.g. melaleuca trees) in the area exuding phenolic substances to the environment. The background site, H-15, averaged 7 ug/l.

Herbicides

2,4-D was detected at site H-11, in the February sampling, with a low concentration of 0.05 ug/l. Its presence may be the result of use in canal bank maintenance.

Oil and Grease

Oil and grease refers to any material recovered as a substance soluble in trichlorotrifluoroethane ("Freon"). It includes other materials extracted by the solvent from an acidified sample (e.g., sulfur compounds, certain organic dyes, chlorophyll, biological lipids and mineral hydrocarbons) and not volatilized during the determination.

The Dade County surface water standard is 15 mg/l for oil and grease. Oil and grease levels were consistently low with an average of 1.7 mg/l. None of the canal samples exceeded the standard.

Summary

The Coral Gables Waterway was intensively sampled in 1984 to (1) expand the data base available on this canal from the more general canal monitoring program, (2) evaluate the impact of general land use in the area, and (3) provide the basis for assessing long term water quality trends in this canal.

Water quality in Coral Gables Waterway is generally good along the course of the canal and consistant with past data. Elevated nutrient levels indicate some degradation from urban activities, particularly application of fertilizers. Presence of phenols in the canal samples may be due to both natural and urban sources. Low levels of arsenic and copper also indicate that pollutants from the Miami Wood Treating facility at Coral Way and 70th Street, have not yet adversely impacted the Coral Gables Waterway.

APPENDIX IV

1984 INTENSIVE CANAL SURVEY DATA

PARAMETER	JAN.	FEB	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
							H-6					
ALKALINITY(mg/l)	203	122	171	218	224	225	237	216	307	271	252	283
BOD(mg/l)	5	6	3	8	6	4	3	4	4	3	12	3
MBAS(mg/l)	0.087			0.06	0.09		0.06	0.06		0.03		0.032
TFR(mg/l)	4074	2986	3807	3912	3954	3395	1965	2230	3910	1974		4409
FLUORIDES(mg/l)	0.23			0.28			0.19			0.19		
NH3-N(mg/l)	0.1	0.13	0.15	0.06	0.08	0.13	0.15	0.05	0.14	0.11	0.06	0.13
T-Org-N(mg/l)	1.1			0.7			0.5			0.2		
TKN(mg/l)	1.2			0.8			0.7			0.3		
COND.(UHMOS)	7500	8000	6000	6000	6000	5000	2800	3500	6000	3200	8500	7500
NOx-N(mg/l)	0.18	0.7	0.36	0.16	0.46	0.75	1.1	0.36	0.16	0.52	0.15	0.66
PHENOLS(ug/l)	4	5	2	1	2	2	2	2			10	
O-PO4-P(mg/l)	0.003	0.006	0.004	0.013	0.015	0.015	0.003	0.010	0.015	0.010	0.020	0.010
T-PO4-P(mg/l)	0.032	0.03	0.043	0.050	0.072	0.060	0.015	0.050	0.045	0.060	0.075	0.060
COD(mg/l)	28	25	31	24	31	25	11	19	26	42	30	22
TURBIDITY(NTU)	2.0	3.5	4.7	2.3	5.5	4.2	1.0	3.3	4.0	2.0	4.5	2.6
As(ug/l)	<1			1.6			1.0			<1		
Ca(mg/l)					130.5							
Cd(ug/l)	0.7			<0.1			0.1			0.6		
Cr(ug/l)	1.5			1.2			1.0			3.6		
Cu(ug/l)	1.6			<1			2.3			3.5		
Hg(ug/l)	<0.2			0.2			<0.2			<0.2		
K(mg/l)					8.5							
Mg(mg/l)					120.0							
Na(mg/l)					870.0							
Ni(mg/l)				0.04			<0.01			0.01		
Pb(ug/l)	10.0			<1			<1			<1		
Se(ug/l)	3.2			<1			1.5			<1		
Zn(mg/l)	0.07			0.07			0.05			0.06		
O&G(mg/l)												
CHLORIDES(mg/l)					2415							

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1 9 8 4   I N T E N S I V E   C A N A L   S U R V E Y   D A T A

PARAMETER	H-8											
	JAN.	FEB	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
ALKALINITY(mg/l)	224	158	189	198	211	232	244	304	327	320	301	298
BOD(mg/l)	4	3	1	2	3	3	2	2	2	2	2	1
MBAS(mg/l)	0.043			0.06	0.04		0.08	0.08		0.04		0.021
TFR(mg/l)	342	371	335	357	380	374	387	383	347	376		369
FLUORIDES(mg/l)	0.16			0.18			0.15			0.13		
NH3-N(mg/l)	0.11	0.13	0.26	0.12	0.1	0.58	0.14	0.11	0.29	0.61	0.09	0.08
T-Org-N(mg/l)	0.8			1			0.8			0.2		
TKN(mg/l)	0.9			1.1			0.9			0.8		
COND.(UHMOS)	600	500	600	500	650	550	500	650	500	550	500	500
NOx-N(mg/l)	0.19	0.16	0.24	0.28	0.2	0.26	0.38	0.37	0.38	0.32	0.18	0.22
PHENOLS(ug/l)	2	4	20	8	2	8	12	12			8	4
O-PO4-P(mg/l)	0.012	0.008	0.007	0.002	0.004	0.014	0.012	0.013	0.010	0.050	0.017	0.015
T-PO4-P(mg/l)	0.030	0.02	0.034	0.015	0.030	0.045	0.035	0.062	0.033	0.052	0.045	0.040
COD(mg/l)	19	21	35	31	32	16	6	10	7	20	10	15
TURBIDITY(NTU)	1.6	3	1.9	2.3	2.5	2.7	3.5	2.3	2.5	2.5	2.3	2.1
As(ug/l)	<1			1.4			1.7			0.5		
Ca(mg/l)					86.0							
Cd(ug/l)	<0.1			0.4			0.1			0.1		
Cr(ug/l)	<1			<1			<1			1.2		
Cu(ug/l)	1.8			<1			<1			4.5		
Hg(ug/l)	<0.2			0.2			<0.2			<0.2		
K(mg/l)					2.2							
Mg(mg/l)					6.0							
Na(mg/l)					31.0							
Ni(mg/l)				<0.01			<0.01			<0.01		
Pb(ug/l)	1.1			<1			2.1			<1		
Se(ug/l)	<1			<1			<1			1.7		
Zn(mg/l)	0.07			0.31			0.08			0.06		
O&G(mg/l)							1					
CHLORIDES(mg/l)					68							

1984 INTENSIVE CANAL SURVEY DATA

PARAMETER						H-9						
	JAN.	FEB	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
ALKALINITY(mg/l)	214	189	182	207	210	236	246	316	330	299	305	293
BOD(mg/l)	2	2	2	3	3	2	3	3	2	2	2	2
MBAS(mg/l)	0.021			0.1	0.01		0.05	0.05		0.04		0.032
TFR(mg/l)	321	368	323	319	341	379	359	347	363	296		346
FLUORIDES(mg/l)	0.15			0.18			0.15			0.13		
NH3-N(mg/l)	0.11	0.15	0.24	0.4	0.12	0.65	0.27	0.28	0.32	0.84	0.14	0.14
T-Org-N(mg/l)	1			0.7			1.1			0.1		
TKN(mg/l)	1.1			1.1			1.4			0.9		
COND.(UHMOS)	580	500	500	500	600	500	500	600	500	500	500	450
NOx-N(mg/l)	0.32	0.18	0.26	0.31	0.2	0.22	0.36	0.36	0.13	0.26	0.2	0.28
PHENOLS(ug/l)	5	8	24	1	8	8	6	6		4	8	6
O-PO4-P(mg/l)	0.004	0.01	0.010	0.003	0.005	0.032	0.030	0.020	0.010	0.054	0.015	0.015
T-PO4-P(mg/l)	0.015	0.025	0.030	0.020	0.030	0.059	0.049	0.025	0.045	0.080	0.050	0.040
COD(mg/l)	18	25	38	33	37	19	13	11	1	32	29	31
TURBIDITY(NTU)	2.2	3.5	1.7	2.0	1.9	2.0	3.0	1.8	2.9	4.0	2.9	2.5
As(ug/l)	<1			2.0			1.5			<1		
Ca(mg/l)					80.5							
Cd(ug/l)	0.1			0.2			0.1			0.3		
Cr(ug/l)	<1			<1			0.5			1.0		
Cu(ug/l)	1.0			<1			0.5			1.0		
Hg(ug/l)	<0.2			<0.2			<0.2			<0.2		
K(mg/l)					1.9							
Mg(mg/l)					5.5							
Na(mg/l)					28.5							
Ni(mg/l)				0.01			<0.01			<0.01		
Pb(ug/l)	3.0			<1			1.2			<1		
Se(ug/l)	1.3			<1			1.6			2.7		
Zn(mg/l)	0.09			0.30			0.04			0.06		
O&G(mg/l)												
CHLORIDES(mg/l)					61							

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PARAMETER	JAN.	FEB	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
ALKALINITY(mg/l)	224	194	203	210	209	231	245	322	334	330	307	327
BOD(mg/l)	2	2	2	2	3	2	3	4	2	1	2	3
MBAS(mg/l)	0.032			0.06	0.02		0.04	0.04		0.08		0.043
TFR(mg/l)	319	344	318	348	412	373	368	379	346	320		391
FLUORIDES(mg/l)	0.14			0.16			0.16			0.14		
NH3-N(mg/l)	0.25	0.16	0.26	0.16	0.08	0.72	0.24	0.28	0.26	0.91	0.13	0.2
T-Org-N(mg/l)	0.7			1.1			0.8			0.2		
TKN(mg/l)	0.9			1.3			1			1.1		
COND.(UHMOS)	550	500	500	500	600	500	490	600	500	500	500	450
NOx-N(mg/l)	0.19	0.18	0.24	0.26	0.21	0.22	0.37	0.51	0.14	0.22	0.23	0.57
PHENOLS(ug/l)	5	4	12	1		8	20	6	4		3	8
O-PO4-P(mg/l)	0.019	0.01	0.010	0.004	0.006	0.045	0.020	0.022	0.011	0.055	0.020	0.020
T-PO4-P(mg/l)	0.043	0.02	0.040	0.015	0.030	0.100	0.040	0.069	0.047	0.075	0.050	0.055
COD(mg/l)	14	28	41	31	37	19	16	11	15	21	14	20
TURBIDITY(NTU)	1.6	3	2.5	3.0	3.9	4.0	3.0	3.4	2.6	3.3	2.3	6.5
As(ug/l)	<1			1.6			2.6			1.0		
Ca(mg/l)					78.0							
Cd(ug/l)	<0.1			<0.1			0.2			0.2		
Cr(ug/l)	<1			<1			<1			1.0		
Cu(ug/l)	1.5			<1			<1			1.0		
Hg(ug/l)	<0.2			<0.2			<0.2			0.2		
K(mg/l)					2.0							
Mg(mg/l)					6.0							
Na(mg/l)					29.0							
Ni(mg/l)				<0.01			<0.01			0.01		
Pb(ug/l)	1.2			<1			1.6			<1		
Se(ug/l)	<1			1.0			<1			1.6		
Zn(mg/l)	0.04			0.04			0.05			0.06		
O&G(mg/l)										2		
CHLORIDES(mg/l)					62							

1 9 8 4 INTENSIVE CANAL SURVEY DATA

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PARAMETER	JAN.	FEB	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
ALKALINITY(mg/l)	230	207	195	210	213	222	246	335	327	329	309	295
BOD(mg/l)	2	1	3	2	3	3	3	3	2	2	3	2
MBAS(mg/l)	0.01			0.04	0.07		0.04	0.04		0.05		0.021
TFR(mg/l)	314	333	346	352	361	334	352	375	326	320		339
FLUORIDES(mg/l)	0.16			0.15			0.16			0.14		
NH3-N(mg/l)	0.18	0.35	0.28	0.19	0.18	0.49	0.3	0.28	0.21	0.77	0.13	0.19
T-Org-N(mg/l)	0.4			1.1			0.9			0.1		
TKN(mg/l)	0.6			1.3			1.2			0.9		
COND.(UHMOS)	600	500	500	600	600	500	500	600	500	500	500	450
NOx-N(mg/l)	0.68	0.22	0.2	0.23	0.24	0.24	0.18	0.18	0.13	0.22	0.2	0.32
PHENOLS(ug/l)	5	4		14		4	10	20	8	1	4	4
O-PO4-P(mg/l)	0.014	0.035	0.010	0.007	0.010	0.020	0.010	0.022	0.015	0.049	0.020	0.015
T-PO4-P(mg/l)	0.035	0.054	0.031	0.031	0.040	0.050	0.050	0.057	0.042	0.080	0.063	0.050
COD(mg/l)	13	26	37	31	41	15	11	7	10	10	21	20
TURBIDITY(NTU)	2.3	2.8	2.7	3.5	1.9	2.0	2.8	5.2	1.6	2.5	3.4	1.6
As(ug/l)	<1			1.1			2.6			1.6		
Ca(mg/l)					86.5							
Cd(ug/l)	<0.1			<0.1			<0.1			0.2		
Cr(ug/l)	<1			<1			<1			<1		
Cu(ug/l)	1.0			<1			<1			1.1		
Hg(ug/l)	<0.2			0.2			0.2			<0.2		
K(mg/l)					2.0							
Mg(mg/l)					6.0							
Na(mg/l)					29.0							
Ni(mg/l)				<0.01			<0.01			0.01		
Pb(ug/l)	2.0			<1			<1			<1		
Se(ug/l)	<1			1.0			<1			2.1		
Zn(mg/l)	0.12			0.17			0.05			0.06		
O&G(mg/l)	3						1			1		
CHLORIDES(mg/l)					63							

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PARAMETER						H-15						
	JAN.	FEB	MAR.	APR.	MAY	JUNE	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.
ALKALINITY(mg/l)	240	209	205	214	209	220	243	332	311	331	312	301
BOD(mg/l)	3	1	3	4	2	4	3	3	5	3	2	4
MBAS(mg/l)	0.01			0.06	0.02		0.02	0.02		0.05		3.08
TFR(mg/l)	317	328	322	350	388	360	373	369	337	323		346
FLUORIDES(mg/l)	0.14			0.16			0.15			0.14		
NH3-N(mg/l)	0.41	0.27	0.38	0.26	0.14	0.34	0.37	0.07	0.24	0.73	0.19	0.14
T-Org-N(mg/l)	0.4			1.1			0.7			0.3		
TKN(mg/l)	0.8			1.4			1.1			1		
COND.(UHMOS)	600	500	500	450	600	500	500	600	500	500	520	400
NOx-N(mg/l)	0.36	0.23	0.14	0.2	0.26	0.19	0.2	0.13	0.11	0.22	0.2	0.28
PHENOLS(ug/l)	3	4	2	10				10	12		7	4
O-PO4-P(mg/l)	0.021	0.027	0.010	0.005	0.010	0.020	0.010	0.013	0.011	0.050	0.020	0.015
T-PO4-P(mg/l)	0.035	0.049	0.030	0.020	0.040	0.055	0.032	0.095	0.060	0.080	0.060	0.060
COD(mg/l)	13	32	38	34	34	31	9	10	10	38	25	26
TURBIDITY(NTU)	2.0	2.5	2.0	2.3	2.0	2.6	2.9	4.8	2.0	2.4	3.4	2.0
As(ug/l)	<1			1.7			2.5			1.1		
Ca(mg/l)					80.5							
Cd(ug/l)	0.2			0.1			<0.1			0.3		
Cr(ug/l)	<1			<1			<1			<1		
Cu(ug/l)	6.7			1.0			3.3			2.5		
Hg(ug/l)	<0.2			<0.2			<0.2			<0.2		
K(mg/l)					1.8							
Mg(mg/l)					6.0							
Na(mg/l)					28.5							
Ni(mg/l)				<0.01			0.02			0.01		
Pb(ug/l)	3.7			<1			1.0			<1		
Se(ug/l)	1.2			<1			1.9			2.7		
Zn(mg/l)	0.08			0.01			0.06			0.08		
O&G(mg/l)								2				
CHLORIDES(mg/l)					64							

1984 INTENSIVE CANAL SURVEY DATA

PARAMETER	AVERAGES	MAXIMUM CONC.	STANDARD DEV.	VARIANCE
ALKALINITY(mg/l)	252	335	53	2820.069
BOD(mg/l)	3	12	2	2.604166
MBAS(mg/l)	0.12	3.08	0.46	0.214860
TFR(mg/l)	847	4409	1164	1354475.
FLUORIDES(mg/l)	0.16	0.28	0.03	0.001080
NH3-N(mg/l)	0.25	0.91	0.19	0.037718
T-Org-N(mg/l)	0.7	1.1	0.3	0.119722
TKN(mg/l)	1	1	0	0.064097
COND.(UHMOS)	1410	8500	2114	4467080.
NOx-N(mg/l)	0.3	1.1	0.2	0.028442
PHENOLS(ug/l)	7	24	5	25.70897
O-PO4-P(mg/l)	0.016	0.055	0.012	0.000152
T-PO4-P(mg/l)	0.046	0.100	0.019	0.000348
COD(mg/l)	23	42	10	105
TURBIDITY(NTU)	2.8	6.5	1.0	1.0
As(ug/l)	1.1	2.6	0.9	0.8
Ca(mg/l)	90.3	130.5	18.2	332.1
Cd(ug/l)	0.2	0.7	0.2	0.0
Cr(ug/l)	1.0	3.6	1.0	0.7
Cu(ug/l)	1.4	6.7	1.6	2.7
Hg(ug/l)	0.0	0.2	0.1	0.0
K(mg/l)	3.1	8.5	2.4	5.9
Mg(mg/l)	24.9	120.0	42.5	1808.2
Na(mg/l)	169.3	870.0	313.3	98187.5
Ni(mg/l)	0.01	0.04	0.0	0.0
Pb(ug/l)	1.1	10.0	2.1	4.5
Se(ug/l)	1.0	3.2	1.0	1.1
Zn(mg/l)	0.09	0.31	0.07	0.01
O&G(mg/l)	2	3	1	1
CHLORIDES(mg/l)	456	2415	876	767933

APPENDIX V

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