Metropolitan Dade County, Florida

DEPARTMENT OF ENVIRONMENTAL RESOURCES MANAGEMENT

1982 GROUND AND SURFACE WATER MONITORING PROGRAMS:

Ambient Groundwater
General Canal
Background Discharge
Tamiami Canal

DERM

Technical Report 83-3

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DEPARTMENT OF ENVIRONMENTAL RESOURCES MANAGEMENT

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Metro-Dade DERM Technical Report 83-3

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Preface

This report presents information and discusses results of programs the Dade County Department of Environmental Resources Management, Planning and Evaluation Division, is currently conducting to ascertain the quality of the county's ground and surface waters. These programs include the Groundwater Quality Monitoring Network, monthly Canal Monitoring Program, Intensive Canal Program, and Annual Pollutant Study.

The Groundwater Quality Monitoring Network features biannual (rainy and dry season) sampling for a wide array of parameters to characterize existing groundwater quality in the county and provide a data base to establish long-term trends.

The Canal Monitoring Program provides an overview of water quality on all of the county's major canal systems through monthly sampling and analysis of general physical and chemical parameters. A companion program is the Intensive Canal Study, where samples are taken monthly on one major canal per year for a comprehensive set of parameters. This program is designed to determine if any specific problems exist for that canal, as well as establishing baseline water quality for future studies. A third surface water program, the Annual Pollutant Study (sampled biannually), was initiated to provide a measure of the effects of increasing urbanization on the major canals of the county by comparing physical and chemical parameters at background and discharge stations along the canals.

Groundwater Quality Monitoring Network

A complete description of Dade County's groundwater quality monitoring program has been presented in an earlier report (DERM, 1981a). Briefly, the network is designed to monitor the quality of groundwater in the county via biannual (rainy and dry season) sampling and analysis of routine parameters (field analyses, nutrients, major ions, indicator bacteria where appropriate, etc.) and analysis of more specific parameters (metals, volatile organics, pesticides and herbicides) on a less frequent basis. The objectives are to characterize existing groundwater quality in various land uses in Dade County and build a data base from which long-term trends might be discerned.

Results

The initial sampling of this network was done September, 1981, near the end of the rainy season. Subsequent samplings occurred in April and September of 1982. Figure 1 shows the locations of these sites and Table 1 provides information about each of the wells.

The following parameters were analyzed:

Field analyses

- Specific conductance
- pH
- Alkalinity
- Temperature

Indicator bacteria (September, 1981, all shallow wells, less than 30 feet)

- Total coliform

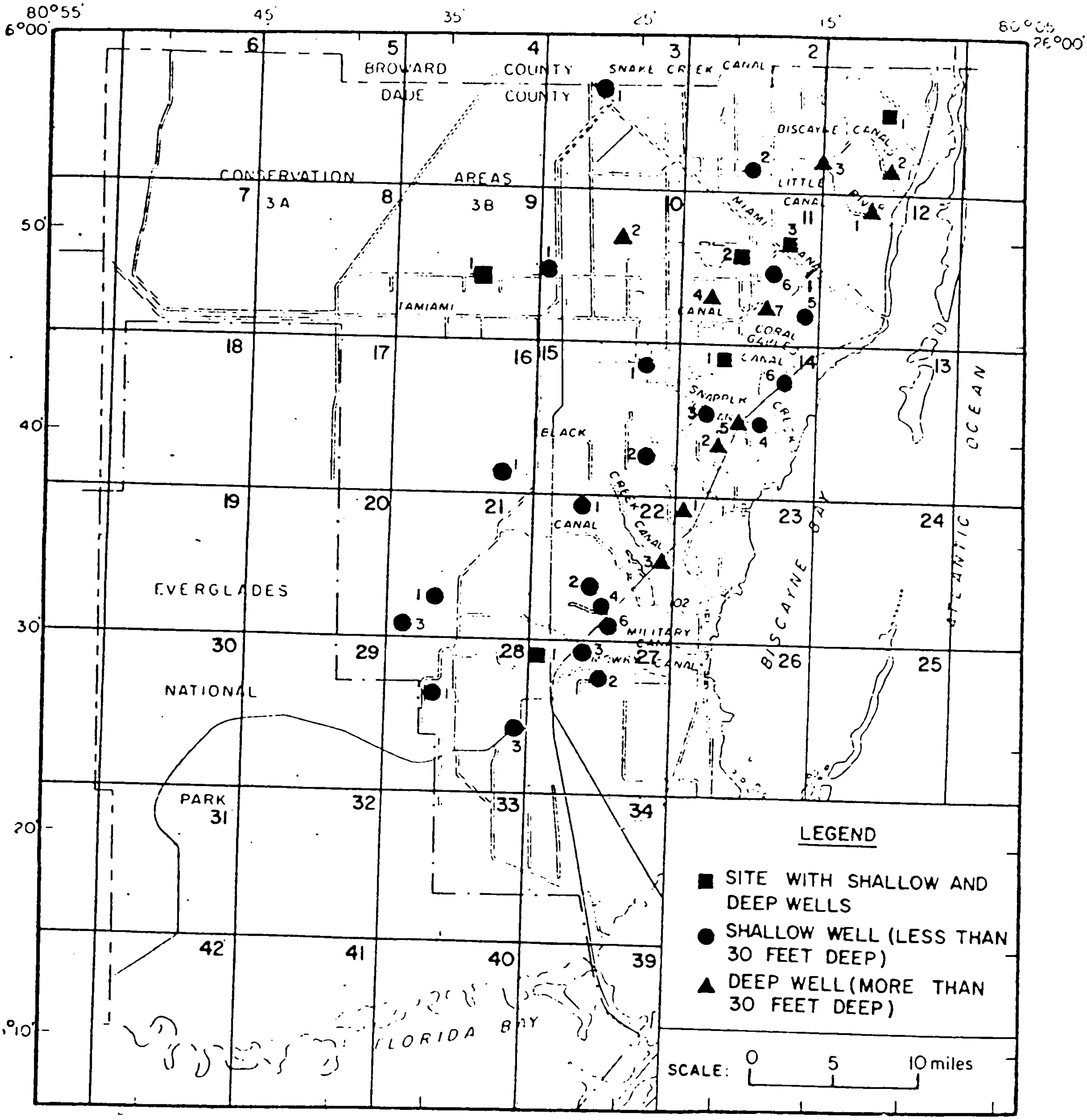


Figure 1

Locations of groundwater quality network sites and superimposed 7.5 minute identification grid

Fecal coliform
Fecal streptococci

Major inorganic ions

Calcium
Sodium
Potassium
Magnesium
Sulfate
Chloride
Fluoride

Nutrients

Ammonia
Total organic nitrogen
Nitrate
Nitrite
Total kjeldahl nitrogen
Ortho-phosphate
Total phosphorus

Pesticides (September, 1981)

Aldrin
γ-Chlordane
α-Chlordane
DDE op'
DDE pp'
DDD op'
DDD pp'
DDT op'
Dieldrin
Endrin
Heptachlor epoxide

NETWORK #:	USGS #	DEPTH (Feet)	LAND USE	SEWERED	LOCATION
1-1B	G-1631	20	Residential	No	NE 2nd Ave.& 163 St.
C	G-1632	31			
D	G-1633	45			
1-2	G-430	97	Residential	No	Meml Hwy & NE 136-7 St.
1-3	(Opa-Locka WTP)	100	Residential	No	Burlington & Codadad (Opa-Locka)
2-2	GW-4	8	Bus., Residential	No	W 8th Ave.& 74 St(Hialeah)
3-1	G-1637	26	Recharge/Storage,Ind.	No	US 27,Opa-Locka W Airpt.
9-1A	G-3202	10	Residential		US 41 at Coopertown
B	G-3203	35	Recharge/Storage		
10-1	G-1488	20	Recharge/Storage	No	NW 177 Ave.& 72 St.
10-2	G-3103	21	Recharge/Storage	No	NW 120 Ave. & 42 St.
11-3	G-1610	10	Residential,Bus.	Yes	W 1st Ave.& 19 St(Hialeah)
11-4		60	Mia.Int'l Airport	Yes	NW 66 Ave.& 18 St.
11-5	GW-6	10	Residential	Yes	SW 37 Ave.& Ponce de Leon Blvd.
11-6		60	Industrial	Yes	NW 11 Ave. & 22 St.
11-7	F-179	77	Residential,Bus.		SW 32 Ave. & 24 Terr.
12-1	F-46	90	Residential	Yes	NW 5 Ave. & 69 St.
14-1	G-1609	60	Residential	Yes	SW 90 Ave. & 38 St.
14-2	G-553	91	Residential,Ind.	No	SW 89 Ave. & 128 St.
14-3	G-3073	20	Residential,Bus.		SW 97 Ave. & 72 St.
14-4	G-580A	22	Residential	No	SW 67 Ave. & 112 St.
14-5	G-1604	62	Residential,Bus.	No	SW 75 Ave. & 105 Terr.
14-6	F-319	20	Residential,Bus.	No	US 1 & SW 72 St.
15-1	G-958A	27	Residential,Undev.	No	SW 127 Ave. & 51 St.
15-2	G-858	20	Resid.,Undev.,Ind.	No	SW 137 Ave. & 128 St.
16-1A	G-3188	11	Recharge/Storage		SW 207 Ave. & 120 St.
B	G-3189	21			
21-1	G-3108	15	Residential,Agric.		SW 202 Ave. & 232 St.
21-3	G-3177	22	Recharge/Storage, Agric.		SW 237 Ave. & 280 St.
22-1	G-1362	33	Residential,Agric.	No	SW 157 Ave. & 168 St.
22-2	G-614	18	Residential,Agric.	No	SW 157 Ave. & 232 St.
22-4	G-1486	20	Residential,Agric.	Yes	SW 152 Ave. & 284 St.
23-1	S-182	51	Residential,Agric.	Yes	SW 104 Ave. & 185 Terr.
27-1A	G-1615	12	Residential,Agric.	No	SW 182 Ave. & 296 St.
C	G-1617	36			
D	G-1618	45			
E	G-1619	61			
27-2		27	Residential	Yes	SW 162 Ave. & 320 St.
27-3A		20	Undev., Bus.		US 1 & SW 296 St.
B		20			
28-1B	G-3180	21	Recharge/Storage	No	SW 232 Ave. & 392 St.
28-3	G-864	20	Residential/Agric.	No	SW 192 Ave. & 352 St.

Table 1
Groundwater Sampling Sites

Lindane
Methoxychlor
Mirex
Toxaphene
Heptachlor

Herbicides (September, 1981)

2,4, -D
2,4,5, - TP (Silvex)

Other parameters

Total filterable residue
Phenols
MBAS (detergents)
Color
Turbidity

As mentioned above, analysis for trace metals, volatile organics, pesticides and herbicides are more specialized and time-consuming. These parameters will be done initially for all wells in the network (to establish baseline groundwater quality) and later on a more site-specific basis. Trace metals and volatile organics are scheduled for chemical analysis during the 1983 sampling.

Specific Conductance is the ability of a substance to conduct an electric current, and is reported in micromhos per centimeter at 25° Centigrade. The measurement provides an indication of ion concentration. Natural waters are not simple solutions, and contain a variety of both ionic and undissociated species. However, conductivity readings are very useful in a practical way as general indications of dissolved solids concentrations. Most recently, this parameter has been utilized for water quality planning in Everglades National Park (Flora and Rosendahl, 1981).

Conductivity readings were generally in the 350-700 micromho range, which is consistent with past groundwater information in Dade County (for example, see recent U.S. Geological Survey reports). The only specific values which fell out of this range were obtained at sites near the inland extent of seawater intrusion (11-6 and 11-7) and another site showing contamination from a flowing artesian well (21-1). The sparsely populated wetland areas in northwest Dade (10-1 and 10-2) showed values in the 500-700 mmho range (some stations in this area were influenced by nearby canals which contained more mineralized water -- see section on "Major Inorganic Ions", p. 11).

pH, or hydrogen-ion activity, is expressed in logarithmic units, the abbreviation "pH" representing the negative base -10 log of the hydrogen-ion activity in moles per liter.

Most groundwaters have a pH range from around 6.0 to 8.5, but there is much variation. In the network, values ranged from 6.70 to 7.14.

Alkalinity is defined as the capacity of a solution to neutralize acid at a specified pH value. In Dade groundwaters, alkalinity is practically all produced by dissolved bicarbonate ions (see discussion under Major Inorganic Ions), and is expressed as equivalent concentrations of calcium carbonate.

In the groundwater network, alkalinity generally ranged from 150 mg/l to 300 mg/l. Levels thus far have appeared consistent for a given station. Some variation can be expected, as processes releasing carbon dioxide (such as sulphate reduction) can contribute to higher values of alkalinity.

Temperature ranged from 24.5 to 30.0° Centigrade for the wells sampled. It might be expected that the shallow wells would show the highest temperatures and the deeper ones lower temperatures; this holds true in some cases, but from the available data no trend is evident. At this time the above temperature range will be considered normal for the rainy season.

Indicator Bacteria (see also discussion under the Monthly Canal Program, p. 20-21). Total and fecal coliform and fecal streptococci were sampled (9/81) for twenty-two (22) shallow wells (less than 30 feet), since past experience has shown that bacteria in groundwater are generally short-lived and found close to the source of contamination. Results showed that no bacteria problems are evident in the network.

Major Inorganic Ions. The occurrence and proportions of the major inorganic ions impart some of the water's physical properties (hardness, dissolved solids, etc.). More complete background information with regard to major inorganic ions (and nutrients) in Dade's groundwater is presented in the report describing the groundwater network (DERM, 1981a, pp. 4-5) and the references contained therein.

The major dissolved cations (positively charged ions) include calcium, magnesium, sodium, and potassium; the major anions (negatively charged ions) are sulfate, chloride, fluoride and those ions (generally assumed to be carbonate and bicarbonate) contributing to alkalinity. Groundwater in Dade County is dominated by calcium and bicarbonate, with chloride, sulfate, potassium, sodium and magnesium being, for the most part, less significant. These ions are largely the dissolution products of the geologic materials comprising the aquifer (principally limestone). Carbonic acid, formed by carbon dioxide dissolving in the groundwater, leaches the limestone, forming large quantities of calcium bicarbonate.

In some portions of South Florida, particularly in undeveloped marshes such as the Water Conservation Areas, concentrations of the inorganic ions in groundwater reach a maximum at the end of the dry season and then decrease due to dilution (surface water often shows the opposite tendency, due perhaps to precipitation during the dry season). In the county network, however, no such trend was seen consistently, which may or may not be due to the lack of data collected thus far.

Calcium is the principal cation in most natural fresh waters. Concentrations in the network far exceed those of the other cations (magnesium, sodium, and potassium) combined. The element is widely distributed in the common minerals of rocks and soil.

Average ion concentrations for calcium were higher during the dry season. As stated above, the significance and validity of this observation cannot be evaluated until more data is accumulated.

Magnesium can substitute for calcium (as in the mineral dolomite) and along with calcium is the principal source of hardness in water. Geochemical behavior, however, is substantially different -- magnesium ions are smaller and, therefore, have a stronger charge density and a greater attraction for water molecules.

Magnesium concentrations in the network were low (for the most part, less than 10 mg/l) despite the fact that limestones generally contain a moderate amount of magnesium. Stations showing the highest concentrations were located near salt-intruded areas, i.e., 11-6 (average of 9.5 mg/l) and 11-7 (single occurrence of 22 mg/l, which was also the highest recorded in the network thus far), or sites in the northwestern and western background areas: site 3-1 (11.5 mg/l, probably influenced by canal water), 10-1 (8.2 mg/l), and to a lesser extent sites 10-2 and 9-1.

No significant differences were noted between the wet and dry seasons.

Sodium is the most abundant member of the alkali-metal group. When brought into solution, it tends to remain in that status. There are no important precipitation reactions that can maintain low sodium concentrations in the way that carbonate precipitation controls calcium concentration. Sodium is retained by adsorption onto mineral surfaces, especially those with high cation exchange capacities such as clays (which are rarely found in the Biscayne aquifer in Dade County).

Sodium concentrations are highest in the salt-intruded stations (11-6 and 11-7), the northwestern and western wetland areas (3-1, 10-1, 10-2, and 9-1), and some stations located in areas where septic tanks are commonly utilized (11-3 and 14-1).

Concentrations for the dry season sampling were approximately 15% higher than those of the wet season.

Potassium is another alkali metal, but behaves differently than sodium. Sodium tends to remain in solution rather persistently once it has been liberated from silicate mineral structures. Potassium is liberated with greater difficulty from these minerals and exhibits a strong tendency to be reincorporated into solid weathering products, especially certain clay minerals.

Concentrations of potassium tend to be much lower than those of sodium in most natural waters, and this was true in Dade's network. The (relatively) high occurrences showed the same tendencies as sodium, that is, in seawater-intruded areas, northwestern and western background sites, and stations influenced by septic tank effluent (11-3 and 14-1). Additionally, some sites in south Dade showed elevated concentrations, resulting from fertilizer application (22-2, 22-4, 27-2, 28-1, and 28-3). Station 27-1 possibly shows slight effects from fertilizer application as well as septic tanks.

In a departure from the tendencies of sodium, potassium concentrations were approximately 30% higher during the wet season than the dry (this may be related to flushing of the fertilizers applied during the dry season).

Sulfate concentrations were found to vary greatly over the county. This is largely due to the fact that the chemistry of sulfur in groundwater is controlled by many factors, particularly the presence of anaerobic bacteria and availability of oxygen, but also by pH, other dissolved ions in solution, and plant utilization. Although much sulfur might be available in the environment, the reduction of sulfate to sulfide by anaerobic bacteria can lower the sulfate concentration.

The highest concentrations appeared at stations 11-6 and 11-7 (averages of 56 and 93 mg/l respectively), which are located near the extent of seawater intrusion, and site 21-1 (92 mg/l), which is influenced by a flowing artesian well in Chekika Hammock State Park.

In general, sulfate concentrations in south Dade are considerably higher than those in north Dade. This is due to the greater permeability of the aquifer in south Dade, allowing oxidation of sulfide to sulfate, as well as to agricultural enrichment.

The three samplings thus far show no wet-dry season trend, and though there is much variation in sulfate concentration from site to site, concentrations tend to be fairly consistent at individual sites from one sampling event to the next.

Chloride shows a more subdued chemical behavior in groundwater when compared to the other major ions. Chloride ions do not significantly enter into oxidation or reduction reactions, form no important solute complexes with other ions, do not form salts of low solubility, are not significantly adsorbed on mineral surfaces, and play few vital biochemical roles. The circulation of chloride ions in the hydrologic cycle is largely through physical processes. As such, this ion can be utilized as a measure of certain sources of pollution, such as septic tanks, dumps, and industrial contamination.

The highest chloride concentrations were observed at the following: 11-6 and 11-7 (seawater intrusion), 21-1 (artesian well influence), 9-1 (influenced by mineralized water flowing from the north through the

L-67A Canal, then westward along the Tamiami Canal via the S-12 structures), and 3-1 (affected by the Miami Canal as it enters Dade County after flowing south through agricultural areas and Water Conservation Area 3A). Chloride concentrations in the background areas of northwest Dade (sites 10-1 and 10-2) averaged approximately 75 mg/l. No seasonal trend has surfaced for chloride.

Fluoride concentration was also examined. This constituent is naturally occuring and sometimes larger amounts may be derived from deeply-buried residues left from former invasions of the sea. Though detected at all localities, no site in the network showed a fluoride concentration approaching 1 mg/l. No seasonal trend appeared, and though some stations consistently showed higher concentrations than others, data at this time is insufficient to account for this.

Nutrients are essential for the growth, maintenance, and regeneration of life. Certain nutrients (such as oxygen, hydrogen, and carbon) are abundant and generally available in sufficient amounts. Nitrogen and phosphorus compounds, however, are sometimes limited in their concentration and distribution. The nitrogen and phosphorus species analyzed in the groundwater sampling are listed on page 3. Although nitrogen and phosphorus are naturally occurring, they also may be added to the groundwater system via contamination from septic tanks, dumps, stormwater runoff, sewage effluent, and fertilizer application.

The dominant nitrogen species depends largely upon the geology and soils of the area. In the northern part of the county there is a greater proportion of sand to limestone, which lowers permeability and facilitates reducing conditions, leading to the formation of ammonia. Additionally, decaying organic matter in the muck soil of the (undeveloped) northwestern portion of the county produces ammonia and organic nitrogen. In south Dade, the highly permeable limestone substrata promotes oxidation, which favors the occurrence of nitrate. Agricultural practices in this part of the county also contribute nitrate.

The southernmost stations (grids 21, 22, 23, 27, and 28 on figure 1) show low ammonia concentrations with higher nitrates (at least partially due to fertilizer application). Conversely, stations north of grids 21-22-23 show higher levels of ammonia with lower nitrates. Total organic nitrogen concentration appears similar for both areas.

Site 2-2 in Hialeah is an exception to the above tendency, showing nitrate concentrations around 1.5-2.0 mg/l with low (less than 0.23 mg/l) ammonia. Site 11-5 (central Dade) exhibits similar tendencies. Interestingly, site 2-2 is one of two sites in the network (two sampling events, 9/81 and 4/82) with nitrite concentrations above detectable limits.

Stations located proximal to septic tanks have exhibited higher nitrogen concentrations in samplings to date. Sites 11-3 and 14-1 (both included in a past USGS septic tank study - Pitt and others, 1975) register consistently elevated ammonia levels. Site 27-1 (also included in the above referenced USGS study) is the only site in south Dade with an ammonia concentration greater than 1 mg/l (4/82 sampling). This site is the only one in the overall network with elevated concentrations of both ammonia and nitrate (most likely a combination of contributions from fertilizer application and septic tank effluent).

Ortho-phosphate and total phosphorus concentrations are low throughout the network. Ortho-phosphate, which is readily assimilated by plants, averaged 0.018 mg/l in the wet season and 0.020 for the dry season sampling. Most of this nutrient is complexed with calcium ions, which chemically binds the phosphorus to limestone.

Total phosphorus, which includes phosphorus tied up in living cells and in detrital material, averaged 0.024 for the wet season and 0.030 for the dry.

Obviously, these numbers are very low and delineation of any trend is difficult at best. In the undeveloped (background) parts of northwest Dade (sites 3-1, 10-1, and 10-2), ortho-phosphate and total phosphorus concentrations are even lower than the averages given above (of the nutrients, phosphorus is generally the limiting factor in these wetland areas). Using this as an indication, the septic tank monitoring stations (1-1, 2-2, 11-3, 14-1, and 27-1) generally exhibit elevated concentrations.

Chlorinated Insecticides and Herbicides. Chlorinated insecticides were analyzed at all sites (9/81) and those detected are listed as follows:

Site	Compound(s) present
1-1	0.001 ug/l p.p.'DDE
1-2	0.001 ug/l Dieldrin
1-3	0.0026 ug/l Dieldrin
11-3	0.002 ug/l Dieldrin
12-1	0.001 ug/l Dieldrin

No other detections were recorded at any other site (detection limits are given in Table 2 for the substances examined).

The herbicides 2,4-D and 2,4,5-TP (Silvex) were analyzed for all sites with no detections.

Other Significant Parameters. In addition to the parameters already mentioned, turbidity, color, total filterable residue, methyl-blue activated substances (MBAS), and phenols were also examined.

Turbidity in groundwater is generally used to determine well damage or construction residue. Turbidity was examined for the 1982 samplings and levels generally stayed below the 10.0 FTU mark. There were some higher occurrences, however (mostly in north Dade), and more data is needed.

Color is a physical property which has no chemical significance. Color (reported in platinum-cobalt units) tended to be highest (40-80

Table 2

Detection Limits for

Chlorinated Insecticides and Herbicides (ug/l)

Chlorinated Insecticides:

Lindane	0.0005
Aldrin	0.0005
Heptachlor Epoxide	0.0010
o,p-DDE	0.0010
p,p-DDE	0.0010
γ-chlordane	0.0010
α-chlordane	0.0010
O,p-DDD	0.0010
p,p-DDD	0.0025
o,p-DDT	0.0025
Dieldrin	0.0010
Endrin	0.0025
Methoxychlor	0.0075
Mirex	0.0035
Toxaphene	0.010
Heptachlor	0.005

Herbicides:

2,4-D	0.001
2,4,5 TP(Silvex)	0.001

pcu) in the northern and northwestern areas, and lowest (5-30 pcu) in the central and southern parts of the county.

The higher colors tend to be the result of leaching of organic debris. However, the color number is purely empirical and has no direct connection with the actual amount of organic material present.

Total Filterable Residue is the anhydrous residue of the dissolved substances in water. Water with several thousand mg/l of dissolved solids is generally not potable, and the U.S. Public Health Service recommends that the maximum concentration of dissolved solids not exceed 500 mg/l in drinking water (this is also Dade County's standard). Generally, most industrial users will not tolerate concentrations higher than 1000 mg/l. Water with less than 1000 mg/l of dissolved solids is considered non-saline, with concentrations of 1000 to 3000 mg/l being considered slightly saline.

Total filterable residue ranged from 48 to 2272 mg/l in the network, with most readings falling in the 200-400 mg/l range. The higher levels generally occurred at stations near the inland extent of seawater intrusion (11-6 and 11-7) and stations in areas serviced by septic tanks (1-1, 1-2, 2-2, 11-3, 14-1, 22-1). Some stations showed wide ranges (after two samplings), so this variability must be examined for its significance in future events.

Although most of the wells sampled were shallow (less than 30 feet), deeper wells were also sampled and at this time no trend of concentration versus depth can be discerned.

MBAS can persist in waters which have been contaminated by sewage effluents. One mg/l is sufficient to cause a noticeable froth in water, and higher concentrations can be a serious problem. No excessive levels were observed in the network, as MBAS concentrations ranged from less than 0.010 mg/l to 0.109 mg/l in the 9/81 sampling, and did not exceed 0.070 in the 9/82 sampling.

Phenols indicate a broad spectrum of organic substances. The source of phenolic compounds may be naturally occurring or from industrial waste, domestic sewage, or pesticides. An excess of phenols may cause odor in water supplies, although health limits are orders of magnitude higher (3 mg/l - the numbers discussed in this section of the report are all much smaller, in ug/l).

Previous groundwater investigations in Dade and Broward Counties have indicated that phenol concentrations, even in background areas, are consistently high. This is verified by the results of the groundwater sampling thus far. Concentrations were generally low in the 9/81 and 4/82 samples, but showed higher in the 9/82 sampling. This discrepancy may be due in part to a change in analytical methods -- the 9/82 samples were processed on an auto-analyzer, a more sensitive method (to be used in all future samplings). The 9/82 data will be utilized for the bulk of this discussion.

That phenols are high even in background areas is evidenced by the results from Sites 3-1, 10-1, and 10-2. These stations are located in the Area B floodplain (between Krome Avenue and the Palmetto Expressway), which is an area receiving the major overflow from the Everglades. Before development, this overflow went through the Miami River. The vegetation of the area consists largely of melaleuca trees, an exotic species which invades wetlands and serves as a source of phenolic compounds. Results from 9/82 indicate an average of 10 ug/l for these stations, slightly above the county-wide average of 7.6 ug/l.

Results approaching 10 ug/l (and sometimes greater) are also seen at some stations in the sparsely populated areas of south Dade, including agricultural lands. Some stations near residential areas around the Snapper Creek Canal had lower levels than had been reported from previous studies (Snapper Creek Intensive Canal Study in DERM, 1981b, p. 19).

The highest concentration obtained in 9/82 was 38.8 ug/l (station 11-7, as compared to 2 ug/l in 4/82). It appears that phenol levels had a tendency to be elevated in both rainy season samplings, but it should again be stated that analytical techniques changed prior to the 9/82 event.

In summary, phenol levels can be characterized as high throughout Dade County, although not nearly approaching health limits. It has been speculated these high levels, even in background areas, may be due in part to exotic vegetation.

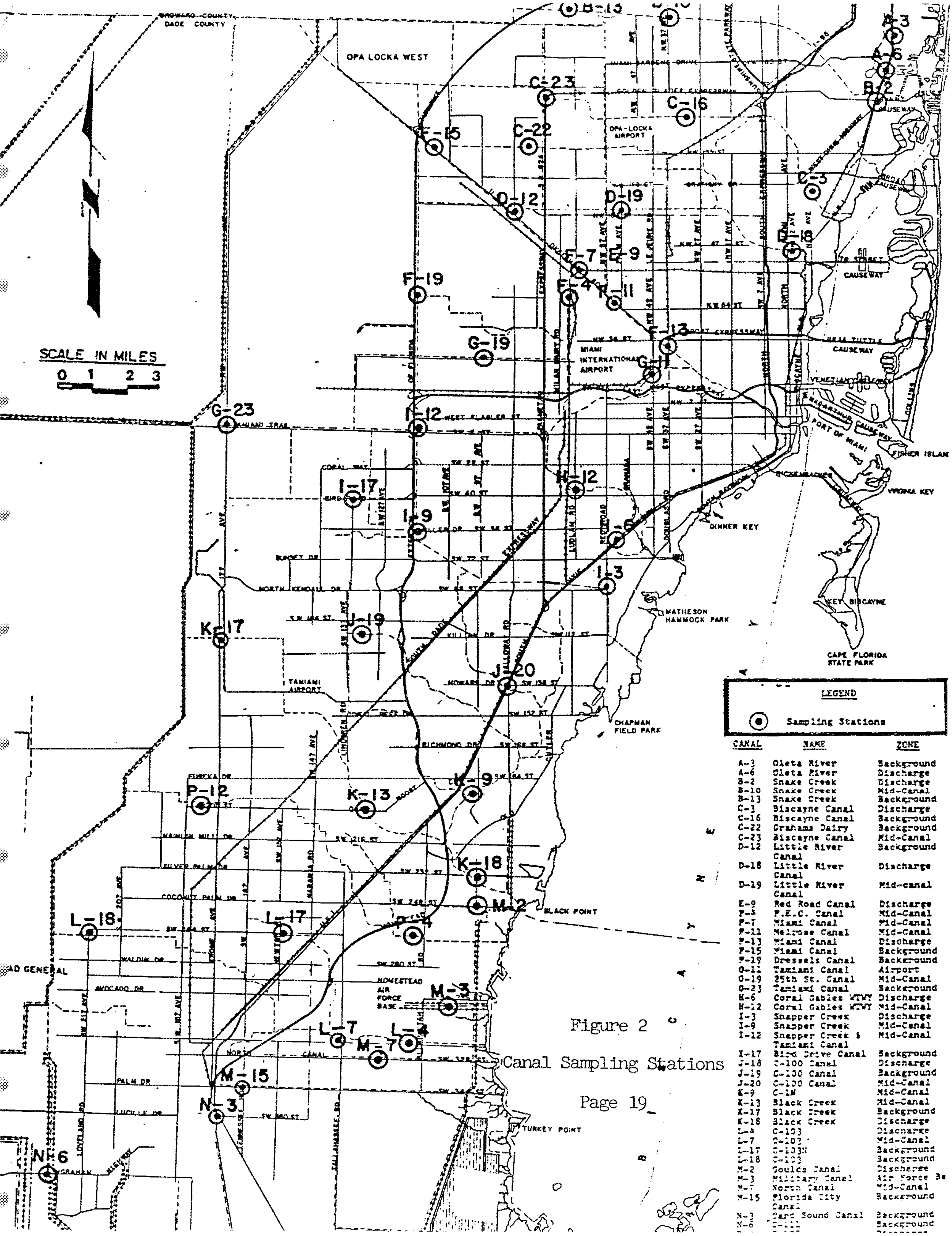
Canal Monitoring Program

Dade County's Canal Monitoring Program (DERM, 1979) is designed to present an overview of water quality for the County's major surface water systems by monthly sampling and analysis of physical and chemical parameters. Stations are located on each canal so as to obtain samples which are representative of background conditions (little affected by man), mid-canal conditions (which are representative of the predominant land use(s) along the canal and may or may not show the effects of contamination), and discharge points, which are representative of the quality of inland waters entering Biscayne Bay. The latter also serve to measure the inland extent of seawater intrusion and give indications whether or not salinity gates are functioning effectively.

The canals sampled in the network include the following (Figure 2):

1.	Oleta River	A series
2.	Snake Creek Canal	B series
3.	Biscayne Canal	C series
4.	Little River Canal	D series
5.	Miami Canal	F series
6.	Tamiami Canal	G series
7.	Coral Gables Waterway	H series
8.	Snapper Creek Canal	I series
9.	C-100 Canal	J series
10.	Black Creek Canal	K series
11.	C-103 Canal	L series
12.	Goulds Canal System	M series
13.	C-102 Canal	P series

Two additional stations on the Tamiami Canal (G-22 and H-14) are provided for this year's Intensive Canal Study (See Figure 4, p. 31 for locations).



CANAL	NAME	ZONE
A-3	Oleta River	Background
A-6	Oleta River	Discharge
B-2	Snake Creek	Discharge
B-10	Snake Creek	Mid-Canal
B-13	Snake Creek	Background
C-3	Biscayne Canal	Discharge
C-16	Biscayne Canal	Background
C-22	Grahams Dairy	Background
C-23	Biscayne Canal	Mid-Canal
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 St. Canal	Mid-Canal
G-23	Tamiami Canal	Background
H-6	Coral Gables WTWY	Discharge
H-12	Coral Gables WTWY	Mid-Canal
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 Ba
M-7	North Canal	Mid-Canal
M-15	Florida City Canal	Background
N-3	Card Sound Canal	Background
N-6	C-111	Background

Figure 2

Canal Sampling Stations

Parameters

The following parameters are analyzed monthly as an indication of general water quality:

- Indicator Bacteria
  - Total coliform
  - Fecal coliform
  - Fecal streptococci
- Specific conductance
- Dissolved oxygen
- NO_x (nitrate + nitrite)
- Transparency (secchi disk)

Additionally, water depth and temperature, and general field observations (wind speed and direction, canal flow, cloud cover, air temperature and any other pertinent water conditions) are recorded for each station.

Results and Discussion

Indicator bacteria Most natural aquatic systems contain bacteria, some of which are due to natural causes (such as wildlife and soil), and some of which are pathogenic. Pathogenic bacteria may enter water bodies through discharge of domestic sewage into the waterway and from stormwater or agricultural runoff. Certain non-pathogenic bacteria (coliforms and fecal streptococci) are used as indicators of pathogens. The number of these bacteria indicate the degree of contamination, and their ratios may indicate the source.

Coliform bacteria are the most commonly used indicators of domestic sewage and runoff entering a water body. This group of bacteria includes Escherichia coli, a variety of intermediary species from warm-blooded animals. Coliform bacteria also include a variety of species occurring naturally in soils.

Fecal streptococci are found in greater numbers within the intestines of warm-blooded animals than in human intestines. The ratios of fecal coliform to fecal streptococci give an indication of the source of contamination (Geldreich and Kenner, 1969).

As reported in previous years (DERM, 1981b, 1982), high total and fecal coliform concentrations are the major surface water problem in the County at the present time (Table 3 shows these concentrations and Table 4 provides the 1981 data for comparison). Stations traditionally showing high total and/or fecal coliform levels were also sampled for fecal streptococci. The fecal coliform/fecal strep ratios for these stations are shown in Figure 3. This procedure has been utilized in other surface water quality investigations in South Florida (Waller and Miller, 1982). The ratios show that nearly all of these stations indicate contamination from human sources, which may include surrounding land uses, sewage disposal, stormwater runoff and drainage systems, and septic tanks.

Indicator bacteria levels fluctuate greatly during the course of the year; it would be expected that high concentrations due to stormwater would fall off greatly in these canals during the dry season. This is true for some canals but not others known to receive large quantities of runoff (most notably, the Coral Gables Waterway, which shows high bacteria concentrations throughout the year). Obviously, many factors interact. For example, some of the high concentrations in north Dade may be at least partly due to contributions from soil coliforms, since north Dade has a thicker and better developed (organic) soil mantle than does south Dade.

Dissolved Oxygen on some major canals did not meet the applicable standard (at least 4 mg/l) at all times, but this does not necessarily indicate a problem. Low D.O. levels can result in eutrophic conditions, but as water is continually released through control struc-

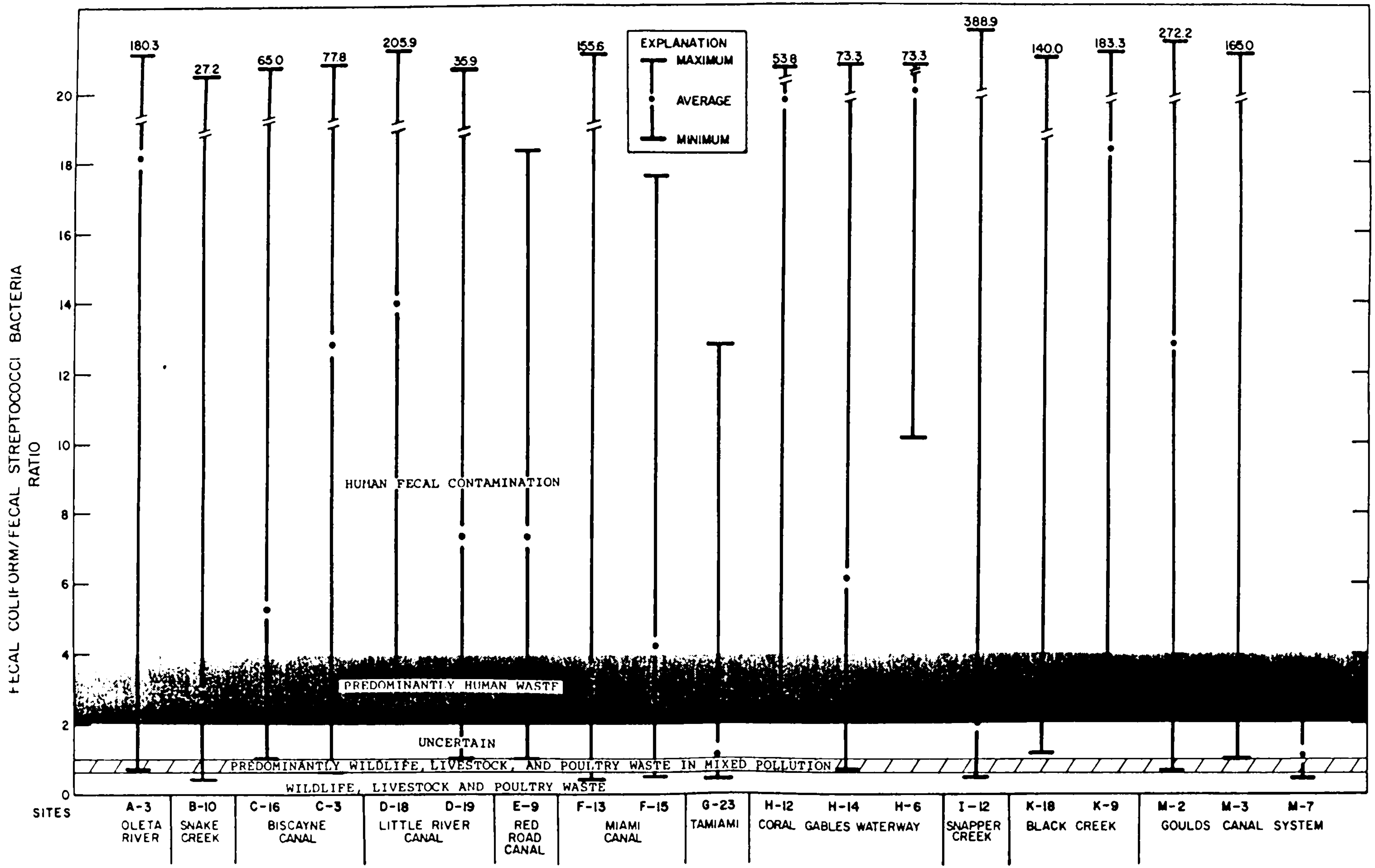


Figure 3

Fecal Coliform/Fecal Streptococci Rates
for Canals Showing High Levels of Indicator Bacteria

tures, this problem seldom occurs in Dade County. D.O. levels are lower in the South Florida surface water system than in other surface water systems due to the close hydraulic interaction between the canals and the groundwater, which contains little dissolved oxygen. The variation of D.O. levels through the county, with the lowest levels seen in north Dade and the highest levels observed in south Dade canals, is consistent with geologic conditions in the county. The predominantly sandy substrata in the north allows much less oxygen to mix with the groundwater than the highly porous limestone in the south.

As has been the case for the past two years, the overall average D.O. level for all stations in the network is 4.0 mg/l.

Specific conductance values for Dade canals generally range from 400 to 800 mmhos/cm (at 25° C.), with a system-wide mean of about 650. These levels reflect the calcium bicarbonate equilibrium system (discussed in the groundwater section, p. 7). Saturation with respect to calcium bicarbonate can contribute as much as 300 mmhos to the overall value. Conductivity values greater than 1000 mmhos/cm occur at stations located near the inland extent of seawater intrusion, including stations A-3 and A-6 (Oleta River), H-6 (Coral Gables Waterway) and M-3 (Military Canal).

Conductance levels were lower than in 1981, probably due to dilution by increased rainfall.

Nitrate and Nitrite (NO_x) occur as different oxidation states of nitrogen. In general, the oxidation of organic nitrogen in air can be expected to produce nitrite (N^{+3} oxidation state) and finally nitrate (N^{+5} form). Nitrite tends to be very unstable, short-lived, and oxidizes immediately to nitrate.

Nitrogen in the form of dissolved nitrate is a major nutrient for vegetation, and the element is essential to all life. Certain species of bacteria in soil and blue-green algae and other micro-biota occuring

Table 3

1982 Levels of Indicator Bacteria in Major Canals

Canal System	No. of Stations	Total Coliform	Fecal Coliform	Fecal Strep
		(MPN/100 ml)		
Oleta River	2	2,863	616	56
Snake Creek Canal	3	633	178	25
Biscayne Canal	4	1,495	219	33
Little River Canal	3	2,686	767	69
Red Road Canal	1	1,111	385	57
Miami Canal	6	587	193	63
Tamiami Canal	4	612	150	23
Coral Gables Waterway	3	2,149	775	67
Snapper Creek Canal	4	745	174	50
C-100 Canal	3	283	50	
Black Creek Canal	4	894	122	20
C-103 Canal	4	248	48	
Goulds Canal System	4	993	155	29
Card Sound	1	901	149	
C-111 Canal	1	315	59	
C-102 Canal	2	473	98	18
Overall Canal System Average	49	1,014	244	42

Table 4

1981 Levels of Indicator
Bacteria in Major Canals

Canal System	No. of Stations	Total Coliform	Fecal Coliform	Fecal Strep
		-	(MPN/100ml)	-
Oleta River	2	968	30	43
Snake Creek	3	551	133	32
Biscayne Canal	4	1,132	152	40
Little River Canal	3	984	295	77
Red Road Canal	1	2,034	636	87
Miami Canal	8	613	184	59
Tamiami Canal	4	579	126	61
Coral Gables Waterway	2	1,232	707	78
Snapper Creek Canal	3	635	289	66
C-100 Canal	3	248	53	26
Black Creek Canal	4	682	117	25
C-103 Canal	4	128	41	25
Goulds Canal	4	1,145	80	35
Card Sound	1	606	56	61
C-111 Canal	1	145	54	27
C-102 Canal	2	288	44	31
Overall Canal System Average	49	706	177	47

in water can extract nitrogen from air and convert it to nitrate. Some nitrate occurs in rainfall. Also, as explained in the Groundwater Section of this report (See p. 11), the oxidizing or reducing capability of the strata will determine whether nitrate or ammonia is the dominant nitrogen species in groundwater. This refers only to background water quality, and not contributions by man.

As shown in Table 5, nitrate levels in south Dade canals exceed those in north Dade, due mainly to the agricultural activity in this area. However, in only one instance did a value exceed 8 mg/l (L-17, the background station for C-103N). These concentrations compare with those in the Everglades Agricultural Area south of Lake Okeechobee.

South Dade canals showing the highest nitrate concentrations were the C-103, Goulds, and C-102 systems (Table 5).

Transparency. Secchi disk readings have shown that south Dade canals have a greater degree of transparency than those in north Dade. This is a result of higher color contributed from the better-developed soil cover in the north. Lowest secchi disk readings are seen in canals flowing through the Water Conservation Areas, including the Miami, Tamiami, and Snake Creek canals. The peat and muck soil of the Conservation Areas contribute organic matter which adds color to canal waters, reducing transparency.

Transparency is also low at discharge stations (including those in south Dade), probably as a result of increased turbidity and contributions from seawater.

Table 5

NO_x Levels on Major

Dade County Canals for 1982

	(mg/l)
Oleta River	0.30
Snake Creek Canal	0.16
Biscayne Canal	0.20
Little River Canal	0.19
Red Road Canal	0.14
Miami Canal	0.14
Tamiami Canal	0.12
Coral Gables Waterway	0.17
Snapper Creek Canal	0.12
C-100 Canal	0.10
Black Creek Canal	0.41
C-103 Canal	1.98
Goulds Canal System	1.34
C-111 Canal	0.05
Card Sound Canal	0.05
C-102 Canal	1.41
Overall Canal System Average	0.47

Intensive Canal Study

The Dade County Department of Environmental Resources Management (DERM) annually samples one major canal and analyzes an extensive set of physical and chemical parameters. This program can detect water quality problems of a specific nature extending beyond the general canal monitoring program, and establishes baseline water quality for the county's surface water systems.

In 1980 Snapper Creek was selected as the first canal to be monitored in this program, largely due to its location near a major wellfield. The Miami Canal was sampled in 1981 for much the same reason (wellfields located adjacent to canals derive much dry season recharge from the canal due to the close hydraulic connection with the aquifer in this area).

Another major canal, the Tamiami, was the subject of the 1982 study. Selection was influenced by the possibility of the South Florida Water Management District (SFWMD) initiating water-supply backpumping of stormwater along portions of the canal. Though this program may not begin for several years, it was felt that this study could complement SFWMD's own studies as well as characterizing the canal as it now exists. Additionally, in 1982 the U.S. Geological Survey was analyzing many of the same parameters as DERM at stations around the S-12 structures (between Levee 67A and 40-Mile Bend) as part of a cooperative study with Everglades National Park (ENP)), so the availability of this data facilitated comparison of a greater number of data points. Thanks are due to William J. Haire, Chief of Hydrologic Records, and Donald J. McKenzie, Hydrologist, of the Miami Subdistrict for supplying this data promptly.

Unrelated to the Tamiami study, an additional station on the Dressels Canal (F-19, p 15) was included in the sampling to provide background surface water information proximal to the new Northwest Wellfield prior to its operation.

Site Location (Figure 4)

Stations selected along the Tamiami Canal included G-23 (Krome Avenue) and G-11 (Miami International Airport) from the monthly network. Also monitored were stations G-22 (Palmetto Expressway) and H-14 (Coral Gables Waterway).

Parameters

The following parameters were analyzed for the Tamiami and Dressels Canals:

Depth	Specific conductance
Dissolved oxygen	Indicator bacteria
Alkalinity	Total filterable residue
Biochemical oxygen demand	Phenols
Chemical oxygen demand	Silver
Ammonia	Arsenic
Total organic nitrogen	Cadmium
Total kjeldahl nitrogen	Chromium
Nitrate	Copper
Nitrite	Mercury
Ortho-phosphate	Lead
Total phosphorus	Zinc
Flouride	Chlorinated insecticides
MBAS	Herbicides
Turbidity	Polyaromatic hydrocarbons

All parameters were analyzed monthly (except where noted).

Results and Discussion

Depth Depth of the Tamiami Canal stations averaged about 3 to 4 meters, with lowest averages occurring at the junction with the Coral Gables Waterway (H-14, about 2.2 meters). Ranges between the rainy and dry season were approximately 0.5 meters, but it should be remembered that sometimes lows occurred prior to heavy rains when flood gates were fully opened.

The Dressels Canal consistently stayed around 1.0 meters deep, with a maximum of 2.0 occurring at the end of the rainy season.

Specific Conductance levels for the Tamiami Canal ranged from about 400-600 mmhos/cm (at 25° C), with highest levels seen at the background station (G-23). This correlates well with the groundwater stations 9-1 and 10-1 in this vicinity (see p. 6).

More variation was seen at the USGS S-12 stations, with S-12A and S-12C falling in the 200-500 mmho/cm range, and S-12E much higher (300-850 mmhos, average of 600). Waters at S-12E (actually sampled at L-67A Canal 0.5 miles north of U.S. 41, but referred to as S-12E) are transported by Levee 67A Canal from the northern parts of the conservation areas and more closely resemble water found just south of Lake Okeechobee (Waller and Earle, 1975), and are characterized by higher conductivities and higher sodium:calcium ratios (Flora and Rosenthal, 1981). Waters flowing through S-12A more closely resemble marsh water, the conservation area 3A, with lower conductivities and lower nutrient concentrations. Water quality at the S-12C station will vary, depending upon season, delivery schedules through the S-12 structures, and other factors, but will resemble S-12A more than S-12E (see also the discussion on the following pages under "Ammonia").

The range for the Dressels Canal was similar to the county stations on the Tamiami, and as with the Tamiami, maximums occurred during the dry season.

Dissolved Oxygen. As with most other Dade canals, D.O. levels for the Tamiami showed a fairly wide range (about 5 mg/l), but generally were 2-4 mg/l. Lowest levels were seen at the background station, G-23.

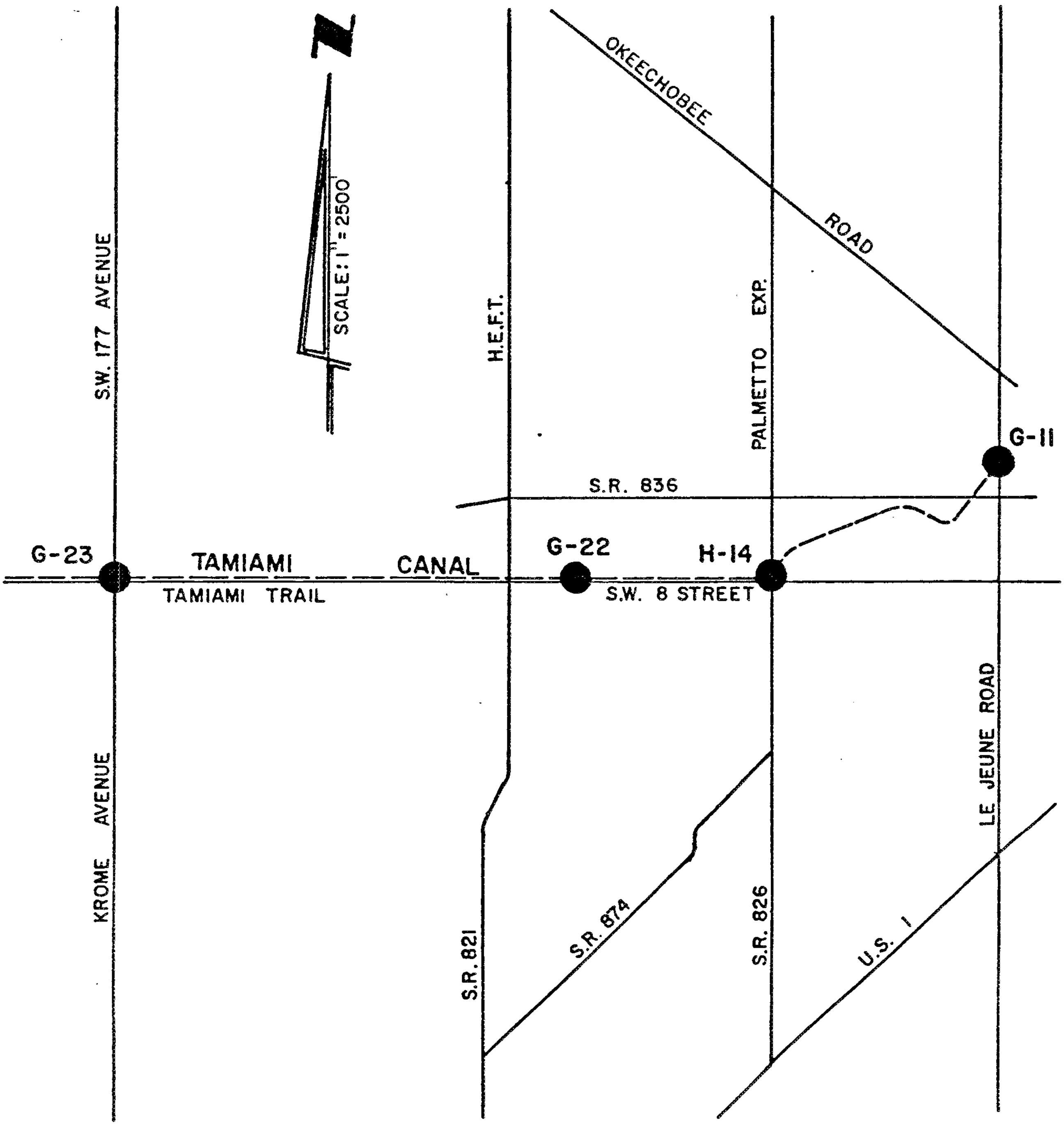


Figure 4

1982 Sampling Stations
on the Tamiami Canal

The S-12 stations also showed a wide range, but averaged 5 mg/l with station-to-station averages between 4.0 and 5.5 mg/l.

The Dressels Canal had a fairly low D.O., ranging from 1 to 3 mg/l and averaging 2. This is consistent with its location, as explained on p 23.

Indicator Bacteria concentrations, summarized in Table 3 (p 24), were highest at station G-11 (Miami International Airport) and H-14 (Coral Gables Waterway), and lower upgradient (G-23 and G-22). This trend reflects contributions from stormwater runoff at the two downgradient, more urban stations.

Concentrations in the Dressels Canal were very low, with mean total coliform = 68 MPN/100 ml and mean fecal coliform = 31 MPN/100 ml.

Alkalinity ranged from 110 to 250 mg/l and averaged 200 for the four county stations on the Tamiami. The USGS S-12 stations showed a range of 99 to 265 mg/l and averaged 154. These values are consistent with the geologic conditions in the county, discussed earlier, as alkalinity is a reflection of bicarbonate ions in solution (the USGS stations showed an average bicarbonate concentration of 193 mg/l).

The Dressels station ranged from 125 to 240 mg/l, and averaged 211 mg/l.

Biochemical Oxygen Demand BOD is a measure of the amount of oxygen consumed in a given volume of water during a specific time period (in this case, five days). These oxygen-consuming materials are highly reactive, reduced compounds, including bacteria, plankton, and detrital material. Relatively high BOD levels indicate oxygen-demanding materials in canals. These sites may be undergoing deoxygenation, and in turn may be characterized by noxious odors, lack of diversity in aquatic organisms, and limited uses of the canal. If BOD does not exceed 4 mg/l, however, organic loading is usually not deemed a problem. BOD in the Tamiami Canal averaged 2.5 mg/l, with a maximum of 7 mg/l seen at Station G-23 (background) in May. On a station-to-station comparison, G-22 (Palmetto Expressway) showed the lowest yearly level (average of 1.9 mg/l) and station G-23 showed the highest, 3.1 mg/l.

BOD in the Dressels Canal ranged from 1 to 5 mg/l, with an average of 2.1.

Chemical Oxygen Demand COD is utilized as a general measure of pollutants and indicates everything in a sample which can be oxidized (including inert materials when made soluble). Values for the Tamiami ranged from 10 to 56 mg/l, and averaged 38 mg/l for all stations. These levels are lower than those seen on the Miami Canal in 1981 (30 to 96 mg/l, average of 53). BOD was also higher for the Miami Canal, averaging 2 mg/l.

No significant variations were noted station-to-station, with the highest average again appearing at station G-23 (43.5 mg/l).

The Dressels Canal showed similar COD levels as the Tamiami, ranging from 14.5 to 53.5 mg/l, and averaging 41.5.

Ammonia In 1981, ammonia concentrations for the Miami Canal showed a seasonal trend, more than doubling during the rainy season. This was attributed to an increased contribution of groundwater to the canal when floodgates were opened. A similar seasonal pattern was not observed during the 1982 Tamiami Canal study, nor for Snapper Creek in 1980. However, groundwater did influence the county stations on the Tamiami, showing higher overall concentrations than the Miami Canal (all-station average of 0.5 mg/l).

Station-to-station comparisons showed some variation; G-23 and H-14 were comparable (near the overall average). Station G-11 had the lowest overall ammonia concentration, and station G-23 had the highest, 0.70 mg/l.

Ammonia concentrations for the USGS stations at the S-12 structures were an order of magnitude lower, with an overall tri-station average of 0.07 mg/l. This reflects strictly surface water, as the canal in this area does not receive contributions from groundwater (in contrast, the groundwater station 9-1 shows higher ammonia concentrations characteristic of portions of the county overlain by peat and marsh soils). Again, it should be remembered that stations in the county canal network reflect an interaction with groundwater.

The Dressels Canal had a higher mean ammonia concentration, 0.89 mg/l; a maximum of 3.64 mg/l occurred during one dry season month (February), and no seasonal trend was seen.

Total Organic Nitrogen TON concentrations for Dade's canals are rarely below 0.7 mg/l, and data for the Tamiami Canal are consistent with this observation. The all-station average was 1.1 mg/l (as compared to 1.3 for the Miami Canal in 1981), and there was little station-to-station fluctuation. Concentrations for the USGS stations were higher, 1.6 mg/l, again with little variation. These higher levels may be due to differences in deliveries from the north, increased biological activity in the less-developed western portion of the county, or (most likely) derived from the peat soils.

The Dressels Canal showed a similar trend as the USGS Tamiami stations, averaging 1.6 mg/l.

No significant seasonal TON variations were observed at any of the above sites.

Nitrate and Nitrite Nitrite concentrations were low for all stations, as has been the case in the past (see p. 23). This is due to no loading and plant uptake for the large submerged aquatic weed population. Nitrate and nitrite were analyzed individually for the county stations for the first three months of 1982, then analyzed as NO_x, as is the case for the Monthly Canal Program. The final NO_x average concentration was 0.11 mg/l, which equaled the nitrate concentration (see p. 27 for a comparison of NO_x levels for other Dade canal systems).

The only county station showing a relatively high nitrate (or NO_x) concentration was G-11 (M.I.A.)

The USGS stations averaged 0.04 mg/l, which approximately equaled the county stations with G-11 deleted. As with the county stations, no seasonal trend was apparent.

NO_x concentrations for the Dressels Canal averaged 0.6 mg/l, again with no seasonal trend.

Ortho-Phosphate and Total Phosphorus (see also the discussion in the groundwater section of this report, p. 12). Ortho-phosphate and total phosphorus levels were nowhere along the Tamiami Canal excessive, and compared well with the S-12 stations. The DERM stations averaged 0.008 and 0.020 mg/l respectively, and the S-12 stations 0.011 and 0.025. No seasonal or station-to-station trend was evident save for H-14, which showed higher mean concentrations (0.012 and 0.034), as well as higher rainy season levels. This is indicative of contributions of nutrient-rich stormwater runoff.

The Dressels Canal showed slightly lower ortho-phosphate and total phosphorus concentrations, 0.003 and 0.011 mg/l, but was similar to the nearby Miami Canal (0.003 and 0.017 mg/l in 1981).

Flourides occur naturally in water and in some cases are added in treatment processes. Concentrations for the Tamiami and Dressels Canals were consistently low, averaging 0.19 and 0.21 mg/l, respectively.

MBAS (methyl blue activated substances, or "detergents") were very low in concentration for both canals, averaging 0.03 mg/l and showing no significant station-to-station variation.

Turbidity. The turbidity standard for Dade County is 50 Jackson Turbidity Units. However, analysis by the DERM laboratory is now reported in Formazin Turbidity Units. A conversion (provided by the Florida Department of Environmental Regulation) shows the standard to equal 29 FTU. Turbidity for the Tamiami Canal averaged 13.2 FTU and showed no high values.

The Dressels Canal station averaged 4.2 FTU, similar to the 4.0 1982 value for the Miami Canal and, as with the Tamiami, did not show an individual reading as high as 10.

The USGS reports turbidity in Nepholometric Turbidity Units (NTU). To avoid confusion, a detailed comparison will not be attempted; however, the highest levels were seen at S-12E, which would be expected as this station discharges more water than the other two, as well as receiving water which bypasses the natural marsh system.

Total Filterable Residue (dissolved solids in USGS terminology). TFR levels for both the Tamiami and Dressels Canals were in accord with Dade's standard for surface waters (500 mg/l), averaging 350 and 355 mg/l, respectively. This contrasts with the 1981 average of 490 for the Miami Canal. Individual stations were uniform, and no obvious seasonal trend was evident.

As would be expected, the S-12 stations showed lower levels. Station-to-station variations were pronounced, with S-12A(175) and S-12C(206) contrasting with S-12E(337), which more closely resembled the County station at Krome Avenue (G-23, 338 mg/l). The higher levels at the latter station can be attributed to contributions from more mineralized water from the north.

Phenols (see the discussion on p. 16). Though the overall phenol concentration for the Tamiami Canal was 5.2 ug/l, each station showed a fairly high occurrence at some time. Maximums were as follows (all in ug/l): G-23 (Krome Avenue) - 16 (July); G-22 (Palmetto Expressway) - 24 (October); H-14 (Coral Gables Waterway) - 36 (July); and G-11 (Miami International Airport - 52 (June). The latter is even higher than some levels seen in the Miami Canal discharge station (F-13, figure 2) in 1981, surmised to be a result of connection with the 36th Street drainage ditch. It is interesting to note that most of the higher concentrations appeared during the rainy season (in addition to the concentrations cited above). Unfortunately, samples were not obtained during August or September to more fully document this trend.

A trend also emerged indicating increasing phenol levels toward the eastern, more urbanized land use portions of the canal, with an average station low at G-23 (3.2 ug/l), and an average station high at G-11 (7.5 ug/l). This trend could also reflect the influence of drainage from Area B to the north.

In contrast to the Tamiami, the Dressels Canal showed very low phenol levels. The average for the year was 1 ug/l, with a maximum of 3 ug/l in October. No seasonal trend can be determined.

Trace Metals were analyzed at frequencies ranging from two to four times during this study (Note: unless otherwise indicated, both the Tamiami and Dressels Canals are discussed together).

Silver (April, July, October) showed no significant detection (0.2 ug/l in April, 0.3 ug/l in July and October).

Arsenic (April, July, October) was in all instances below detectable limits.

Cadmium (April, June, July, October) showed some detections (mostly in June and July) at all stations, with a maximum at station G-11 (M.I.A.), 1.91 ug/l in April. All occurrences were below the aquatic standard of 12 ug/l. Station G-11, however, showed an average concentration of more than double the all-station average.

Chromium (April, June, July, October) was detected only at the Dressels Canal and the Tamiami G-11 station (twice), but these occurrences were very low.

Copper (April, June, July, October) was detected at all stations, with G-11 showing the highest station average (2.6 ug/l).

Mercury (April, July, October) showed no significant detections.

Nickel (April and July) concentrations were everywhere low; some detections were noted in July, with the canal maximum (0.05 ug/l) at background station G-23.

Lead (April, June, July, October) was detected at all stations, with the highest station average again seen at G-11 (although the Dressels Canal station was second, with the maximum of 7.3 ug/l recorded in June). All occurrences were well below any applicable standard.

Selenium (April and July) was not detected.

Zinc (April, June, July, October; reported in mg/l) was present in varying concentrations at all stations. Station-to-station annual averages were similar, save for G-23 (background), which tripled the average for all others, mainly due to a maximum of 1.10 mg/l in April.

Chlorinated Insecticides and Herbicides (see table on p. 14) were sampled in January and July. No detections were noted, except for an occurrence of 0.001 ug/l of dieldrin at the Dressels Canal in January.

Polyaromatic Hydrocarbons (napthelene, acenaphthene, fluorine, acenaphthylene, anthracene, pyrene, and fluoranthene) were analyzed for all sites in April with no detections.

Summary

Results for the 1982 Intensive Canal Study suggest the following conclusions:

(1) Water quality along the Tamiami Canal is generally good, especially at the upgradient, less urbanized stations, which to some extent resemble the U.S.G.S. stations near the S-12 structures. At the County's downgradient, more intensive land use stations (Coral Gables Waterway and Miami International Airport), some potential problems were noted. These include increased levels of indicator bacteria, greater concentrations of nutrients, and detections of several metals at the M.I.A. station. Phenol levels, though high throughout the County, increase

along the Tamiami Canal to maximums at the downgradient stations.

(2) Water quality at the Dressels Canal station is good.

Annual Pollutant Study

In 1981 DERM initiated a study to compare chemical and physical parameters measured at upstream (background) and discharge stations on the county's major canal systems. The program differs from the Monthly Canal Network in that only these two stations are sampled for each major canal system, and (see below) a more comprehensive set of parameters are analyzed. The results yield an indication of the influence of urbanization upon surface water quality.

Sampling for this year was conducted on five canal systems during the dry season (January) and six canal systems during the rainy season (June). The order was reversed the previous year, so that no canal is sampled in the same season for two consecutive years.

Canals sampled during the wet season were the Oleta River, Snake Creek, Little River, Tamiami, C-100, and C-103 Canals. Those sampled during the dry season included the Biscayne, Snapper Creek, Black Creek, C-111, and C-102 Canals (See Figure 2, on p.19).

The following parameters were analyzed:

- Alkalinity
- Biochemical oxygen demand
- Chemical oxygen demand
- Total filterable residue
- MBAS
- Turbidity
- Phenols
- Flourides
- Ammonia
- Total organic nitrogen
- Total kjeldahl nitrogen
- Nitrate
- Nitrite
- Ortho-phosphate

Total phosphorus
Trace metals
Chlorinated insecticides
Herbicides

Results

The program by design is one which requires several years' data for accurate conclusions; however, at this time some general trends can be commented upon.

Alkalinity remained at acceptably high levels at both background and discharge stations.

Biochemical Oxygen Demand at no time attained a high or significant level at any station. Generally, BOD increased from background to discharge stations (as opposed to last year's results).

Chemical Oxygen Demand. With one exception (Oleta River), COD decreased from background to discharge stations. However, all values were fairly low and gave no evidence of organic loading.

Total Filterable Residue increased greatly at the discharge stations for the Oleta River and the Tamiami Canal (Coral Gables Waterway, Station H-6) and increased slightly at some south Dade discharge stations. These readings are doubtlessly due to the effects of sea-water intrusion.

MBAS showed comparable, low levels at all stations for both samplings.

Turbidity would be expected to increase from background to discharge stations, but this was not conclusively shown. All values were very low.

Phenols - Phenols, when detected, were higher at background stations (e.g., Biscayne Canal, Tamiami Canal). As discussed elsewhere in this report, this is consistent with the hypothesis that naturally-occurring phenolic compounds are contributed to the hydrologic system in wetland areas. This has already been referred to (see the discussion in the Groundwater and Intensive Canal Sections of this report, pages 16 and 36, respectively).

Flouride - As was the case for the 1981 samplings, flouride concentrations show no significant increase over the length of the canals studied and nowhere approached the Dade County standard of 1.4 mg/l.

Organic Nitrogen and Ammonia show highest concentrations at background stations. Especially in north Dade, ammonia is high due to the proximity of decaying organic matter in the muck soils of Water Conservation Area 3B. Concentrations are lower at discharge stations due to some inorganic uptake, sedimentation, and dilution.

Nitrate and Nitrite -- In north and central Dade, nitrate and nitrite levels tend to increase slightly from background to discharge stations, largely due to fertilizer application on residential lawns. In south Dade, the background stations are located in the predominantly agricultural areas, and receive contributions of these nutrients from this source. The discharge stations are in coastal areas, and show lower nitrate and nitrite levels due to dilution and plant uptake.

Ortho- and Total Phosphorus would be expected to show tendencies similar to those of nitrate and nitrite, especially in south Dade. However, concentrations are generally so low that at this time it is difficult to say if a trend is real. In this area, phosphorus is a limiting nutrient and high concentrations are expected only when point or nonpoint loading occurs at a particular site.

Trace Metals -- (silver, arsenic, cadmium, chromium, copper, mercury, lead, and zinc were examined) generally were below detectable limits, but where detected, appeared highest at discharge stations. As was the case in 1981, the discharge station on the Coral Gables

Waterway (H-6) showed considerably higher concentations of metals than any other station.

Chlorinated Insecticides and Herbicides (See Table 2). Only a few sporadic (and very low) occurrences were noted. Actually, more of these determinations appeared at background stations.

Summary

The current ground and surface water monitoring programs conducted by the County have the dual purpose of detecting problems which currently exist and establishing baseline water quality for these systems.

The biannual Groundwater Monitoring Program is designed to characterize existing groundwater quality throughout the county and serve as a basis for delineating long-term trends. The program provides background information for special studies and gives indications of the effect of various land uses on groundwater quality.

Results thus far have shown that the network is sensitive enough to discern influences from such factors as seawater intrusion, agricultural activity, septic tanks, mineralization from canal waters and a flowing artesian well, and some indications of rainy/dry season fluctuations in concentrations of major inorganic ions. Additionally, preliminary results show that phenol concentrations are high throughout the county, largely due to natural occurrences rather than any specific pollution problems. Continued acquisition of data will cement some of the relationships outlined above and yield insight into the water quality of the county's groundwaters.

Dade's Canal Monitoring Program includes monthly sampling and analysis of general physical and chemical parameters for the county's major surface water systems. Results from past years show that the most serious water quality problems presently encountered are high levels of indicator bacteria, which in turn is related to many interracting factors, including the amount of stormwater discharged into the canals. As the canals are primarily designed as a vehicle for drainage, there are limits to the corrective measures that can be taken.

Another potential problem is indicated by elevated nitrate concentrations in south Dade, although these levels are comparable with

others seen in agricultural areas in south Florida. Future studies will be in order to more fully monitor these occurrences.

To supplement the Monthly Canal Program, DERM annually samples one major canal and analyzes a wide array of parameters. The subject of 1982's Intensive Canal Study was the Tamiami Canal, selected due to the possibility of the South Florida Water Management District initiating water-supply backpumping along portions of the canal in future years. Results show that water quality west of the Palmetto Expressway is generally good, but with potential problems seen at the stations located at the intersection of the Canal with the Coral Gables Waterway (probably due to stormwater runoff) and near the Miami International Airport.

In 1981 DERM initiated an Annual Pollutant Study, designed to measure the impact of urbanization upon surface water quality. Results thus far have indicated that in most cases this impact has not been serious; however, it is necessary to accumulate several years of data before any trends can be documented.

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