ANNUAL REPORT 1983

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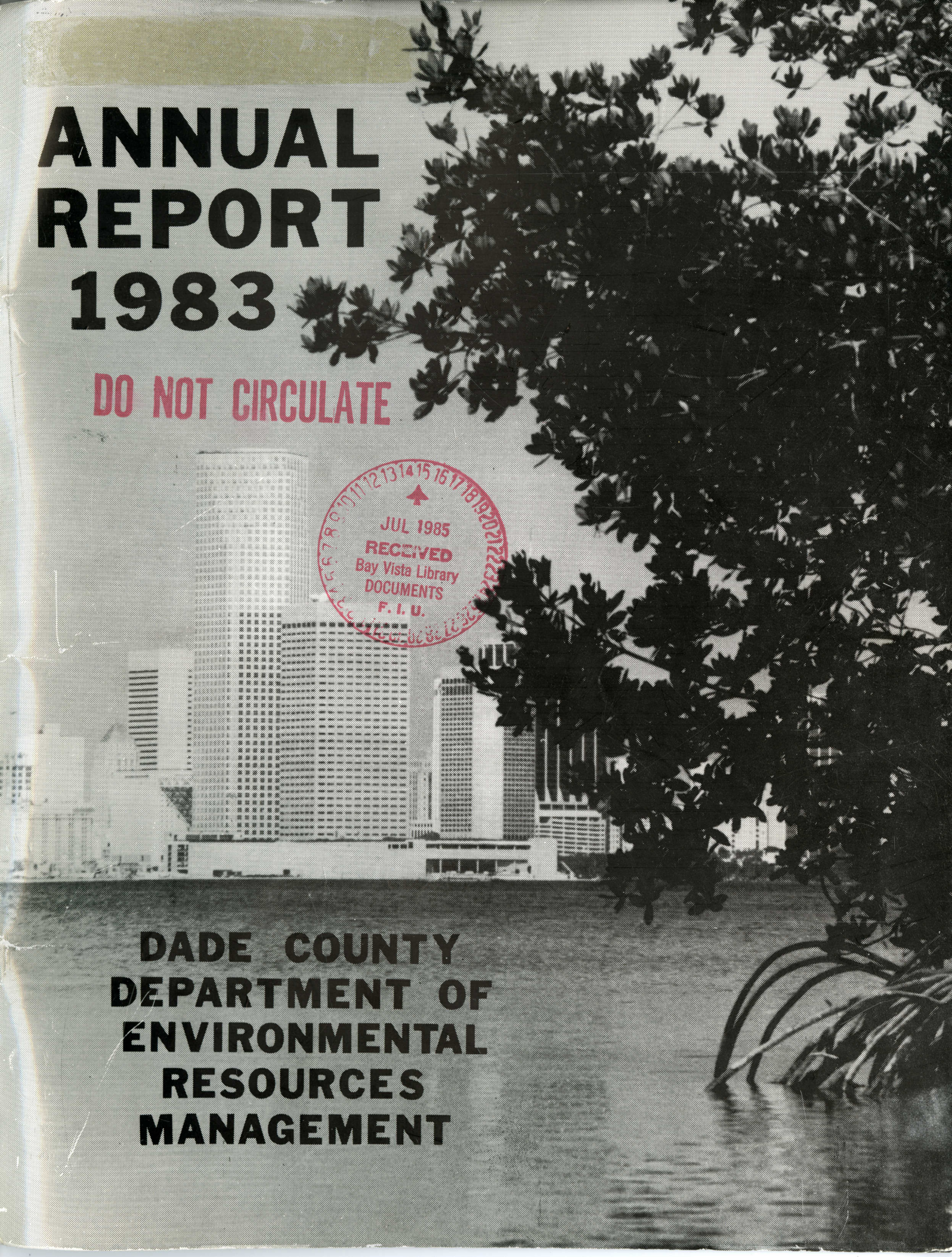

DADE COUNTY DEPARTMENT OF ENVIRONMENTAL RESOURCES MANAGEMENT

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Annual Report

1983

Metropolitan Dade County Department of

Environmental Resources Management

909 Brickell Plaza, Suite 402

Miami, Florida 33131

February, 1985

Letter from the Director

Each year the staff of the Environmental Resources Management Department prepares an assessment of environmental conditions in Dade County based upon environmental data collected throughout the year and pertinent actions taken to resolve environmental problems. The report is designed to familiarize residents and officials with environmental conditions, problems, and programs. It also serves as a tool to evaluate the effectiveness of programs and to identify the need for change.

Reconciliation of the objectives of economic growth and environmental protection is particularly difficult in an area with such a fragile eco-system and a history of rapid growth. We now know through the expensive abandonment of contaminated wellfield that there are limitations to the concept of "clean industry", and we must be ever more cautious to protect our only practical drinking water supply. We know, also, that despite favorable natural conditions such as flat terrain and prevailing winds, future growth must be well planned to prevent degradation of our relatively clean air. And the location of Dade County between two great national resources, Everglades National Park and Biscayne National Park, gives residents unique opportunities and responsibilities to enjoy and protect those types of very special marine and wetland resources.

During 1983 several important actions occurred with respect to environmental protection in Dade County. A partial list includes the following:

- Implementation of ordinances to regulate underground storage tanks and liquid waste haulers to prevent ground water contamination.
- Creation of a "mini-superfund" to provide a means of emergency cleanup of spills or contamination. ground water contamination.

- Establishment of special rules to protect the new Northwest Wellfield.

- Creation of a program, including a blue ribbon citizen task force, to plan for long term wellfield protection.

- Initial operation of the new wellfield enabling abandonment of the contaminated Medley Wellfield.

- Initiation of a survey of abandoned dumps.

- Approval by the Legislature of a special surcharge on auto tag fees to finance the expansion of local air quality programs.

- Enactment of a comprehensive freshwater wetlands ordinance.

- Permit approvals for re-nourishment of Key Biscayne beaches and construction of a marina at Black Point.

- Completion of a map of the Biscayne Bay bottom.

- Construction of a fishing pier and reef at Pelican Harbor.

- Continued additions of material to artificial reef sites.

These very positive achievements reflect the Department's priorities of protecting drinking water, water resources, and air quality, and enhancing the viability and public enjoyment of Dade County's coastal resources. While environmental conditions have remained relatively stable during the past year, there has been increasing community and

staff concern about the potential harmfulness of various synthetic chemicals detected in some portions of the ground water. This remains the Department's top priority.

In the pages that follow, these various programs and conditions are described in detail. Additional information is available from the Department.

Executive Summary

The Metropolitan Dade County Department of Environmental Resources Management (DERM) is the agency responsible for the protection, management and monitoring of the sensitive environment and natural resources of Dade County. This annual report summarizes the programs, activities and permitting responsibilities conducted by DERM during the past year. The report includes sections on Air Quality, Drinking Water Protection and Natural Resource Protection and Enhancement. Although the report emphasizes events and activities occurring during 1983, some historical background is provided in order to place recent events in proper perspective.

Protection of Air Quality

The focus of the air quality program is on the attainment and maintenance of the National Ambient Air Quality Standards established for the criteria (health-related) air pollutants. Ambient air quality in Dade County although rated with the best in the nation will at times exceed acceptable levels. Carbon monoxide, for example, in the downtown area, will occasionally be above the prescribed standard. A significant decrease in CO violations was realized in 1983 as compared with 1982; there were 13 days in the unhealthful range in 1983 as compared with 33 in 1982. To address this problem prior to a formal designation by E.P.A. as a carbon monoxide non-attainment area, a multi-agency task force was organized by the Metropolitan Planning Organization (MPO) to investigate a remedial transportation control strategy for the downtown area (CBD).

Ozone, another automotive-related air pollutant and the criteria air pollutant for which the Environmental Protection Agency has designated Dade County as a nonattainment area, was in the spotlight. DERM and the State Department of Environmental Regulation have questioned the validity of certain 1982 ozone data the E.P.A. has used to make its nonattainment determination. To resolve this issue, a special purpose ozone monitoring project will be conducted during

1984 to supplement the existing two monitoring sites and provide more representative data. This additional information will help decide the attainment/nonattainment question for Dade County.

Supporting air quality management decision-making is the data generated by a countywide air monitoring network. In addition to detecting trends, and possible air pollution episodes, the network provides the public with air pollution advisory information contained in the daily pollution standard index (PSI).

DERM's air permitting activities continue to focus on those commercial and industrial activities discharging uncontrolled volatile organic compounds (hydrocarbons) which can contribute to the build-up of elevated levels of ozone. A pilot automobile tampering and fuel switching program, also aimed at reducing ozone levels, was authorized by the U.S. Environmental Protection Agency for implementation by DERM. Public opinion surveys indicate the public to be strongly supportive of measures taken to provide and protect clean air.

Drinking Water Protection

The Biscayne aquifer is a highly productive water table aquifer which has been designated by the United States Environmental Protection Agency as a "sole source aquifer" for Dade County's drinking water supply. The vulnerability of this aquifer to contamination has necessitated protection and monitoring efforts which include: a wellfield protection program; regulating, permitting and monitoring of water supplies, wastewater disposal methods and storers, handlers and generators of hazardous materials and wastes; and a countywide groundwater and surface water monitoring network.

Water quality management plans for Dade County were required by the Federal Water Pollution Control Act of 1972. Dade's Areawide Water Quality Management (208) Plan, which described various water quality issues, was completed in 1979. The majority of the Plan's recommendations have been implemented, most notably the Potable Water Supply Well Protection Ordinance. Since its original adoption in

March of 1981, the wellfield protection program has undergone continued refinement. The most significant developments in 1983 were the establishment of an expanded protection zone for the new Northwest Regional Wellfield and refined wellfield protection maps based on more sophisticated computer modelling techniques. The increased protection zone approximates the full extent of the cone of influence which was justified by the fact that the Northwest Wellfield water quality is free from contaminants associated with urbanization. The current land use regulatory approach established in the wellfield protection program for the Northwest Wellfield is under review by two committees appointed by the County Manager. Comprehensive recommendations from the committees concerning the protection program are expected by the end of 1984.

The pumping of the Northwest Wellfield has resulted in improved finished water quality from both the Hialeah and Preston water treatment facilities. The partial activation of the Northwest Wellfield resulted in the permanent phase out of the Medley Wellfield, which was in an industrialized area. Full operation of the Northwest Wellfield is expected during 1984, which will permit the phase-out of certain older wells in the Hialeah/Miami Springs Wellfield complex. This is in keeping with a policy of utilizing the best overall source of raw water.

DERM has a program in place to monitor the operation of all the water and sewer plants in Dade County. During 1983, a water service agreement moratorium was imposed by the Director of DERM on the entire water service area of the Alexander Orr water treatment facility. The moratorium was imposed because the projected water demands exceeded the plant design capacity. The moratorium was quickly resolved upon the completion of several improvements which made a limited amount of capacity available, and the completion of two softener units in 1984 will result in additional capacity to meet long term future water demands. This will also allow the future phase-out of 6 small, interim water treatment facilities.

The start-up of the South District Regional Wastewater Treatment Plant has allowed for the diversion of flows from the Central District facility, which was operating near design capacity. This has resulted in increased available capacity for the Central District plant, thereby permitting future sewer connections.

Educational and regulatory programs have been established by DERM to address the proper management and disposal of hazardous wastes. Two ordinances were adopted in 1983 which establish effective controls for underground storage facilities and for liquid waste haulers. These ordinances will enable DERM to establish essential programs for permitting, monitoring, enforcing and directing corrective actions for these operations.

A Hazardous Wastes Assessment Program was developed by DERM with monies provided by the Water Quality Assurance Act. This program will continue through 1984 notifying hazardous waste generators of their responsibilities for properly disposing hazardous wastes and providing information concerning the types, quantities and management practices of hazardous wastes generated. The information will lead to the establishment of an effective hazardous waste management program in Dade County.

DERM has continued and stepped up its involvement in hazardous waste clean-up activities. DERM has coordinated clean-up efforts with the Florida Department of Environmental Regulation and the U.S. Environmental Protection Agency for several hazardous waste sites including Miami Wood Treating, Pepper's Steel and Alloys, Crown Paint, Gold Coast Oil and several smaller sites. Several of these operations will continue through 1984.

Monitoring programs are conducted for surface and groundwaters of the county, including county landfill monitoring (conducted in cooperation with the Dade County Public Works Department). The latter program is designed to assess the extend of water quality contamination resulting from county-operated landfills, as well as detective monitoring to ensure that containment systems are operating properly.

In addition, the Florida Department of Environmental Regulation contracted with Dade County to study the residual effects of former solid waste sites and assess their impacts in order to initiate remedial actions. The project is expected to be completed by the end of 1985.

Other monitoring programs have been emplaced to establish baseline water quality for the county's ground and surface waters and to evaluate the effect of various land uses on water quality. Evaluation of the 1983 data reveals continued moderate to high levels of indicator bacteria in Dade County canals. There were no surprises in the groundwater network, indicating compliance with applicable standards. The county landfill monitoring program is indicating that there is an effect on groundwater quality immediately downgradient of the landfills but the elevated concentrations of pollutants do not exceed applicable standards.

Natural Resource Protection and Enhancement

Dade County has a variety of aquatic and terrestrial natural resources including Biscayne Bay, Atlantic Ocean beaches and reefs, wetlands and forested uplands. DERM has established programs and activities to protect and enhance the ecological, recreational, economic, and aesthetic values of these resources. Bay programs include the Biscayne Bay Restoration and Enhancement Program, Metro-Dade Artificial Reef Program, water quality monitoring, beach restoration and renourishment projects and coastal permitting. Wetland and terrestrial resources are protected through permitting activities and rules and regulations established in the Dade County Code.

Coastal, wetland and terrestrial resources permitting is administered by DERM to ensure the management and protection of Dade County's natural resources. The adoption of several new ordinances during 1983 have improved the permitting programs to ensure better protection and management of Dade County's upland, wetland, coastal and marine resources. Projects permitted during 1983 included the expansion of Homestead Bayfront Park Marina, the Christo "Surround-

ed Islands" project, the construction of new bridges for the Rickenbacker Causeway and many other smaller projects.

The monitoring of Biscayne Bay is an ongoing activity and major objective of the Biscayne Bay Restoration and Enhancement Program. The data collected provide valuable information about existing conditions and will be utilized in establishing future management recommendations as long term trends emerge.

Other notable projects and activities that occurred during 1983 as part of the Biscayne Bay Restoration and Enhancement Program included the completion of the Biscayne Bay bottom community map, the annual two week celebration of Biscayne Bay known as "Baynanza", the completion of a habitat and access enhancement project at North Bayshore Park, and continued activities to increase public awareness of Biscayne Bay resources.

Improved public awareness is also a major goal of the Metro-Dade Artificial Reef Program. The program was created to improve Dade County's fishery resources by constructing artificial marine habitats from manmade materials. DERM coordinates the construction of artificial reefs, both offshore and inshore. Public brochures are available which describe the program and identify existing artificial reef sites.

DERM continues to be active in seeking and managing beach restoration and renourishment projects. All of Dade County's eastern border lies along the Atlantic Ocean which provides direct economic benefits, extensive recreational opportunities, and elements of essential storm protection. However, the ongoing erosion process has severely depleted Dade County's beaches in recent years. Beach restoration for a 10.5 mile stretch from Haulover Beach Park south to Government Cut has been completed. Current proposals include a renourishment project in North Dade for the Sunny Isles area and the restoration of the southern 2.4 miles on Key Biscayne.

In addition to beach restoration, DERM has developed several seagrass restoration programs. Seagrass provided a highly productive marine habitat as well as stabilizing sediment and reducing turbidity. Three seagrass mitigation projects were developed in 1983 and all are scheduled to commence planting in 1984.

Acknowledgements

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Part 1

Protection of Air Quality

Progress made in 1983 in regulating the emissions of air pollutants from mobile and stationary sources was significant. Although ranked with the best in the nation as a community with clean air, Dade County managed to reinforce this position in 1983 when monitored data indicated a year without a single day when the ozone standard was exceeded. In other major urban areas throughout the country by comparison, it is not unusual to have as many as 100 or more days when adverse health effects could be experienced (ozone standard exceeded). This is the automotive-related air pollutant which has caused the Environmental Protection Agency to designate Dade County as a nonattainment area. As 1983 ended, considerable concern was being expressed by Dade County DERM and the State of Florida Department of Environmental Regulation (F-DER) that E.P.A.'s decision to retain Dade County in a nonattainment status was based on questionable 1982 data. This matter, having major economic implications for Dade County, is discussed further in the section on ozone. Another automotive-related air pollutant, carbon monoxide, is being monitored closely, primarily near congested traffic on downtown Flagler Street where levels in the "unhealthful" range have been documented. In 1983 there were 13 violations of the CO standard monitored on Flagler Street, compared to 33 in 1982. A multi-agency task force has been organized to determine how to improve air quality on downtown Flagler Street by minimizing traffic congestion.

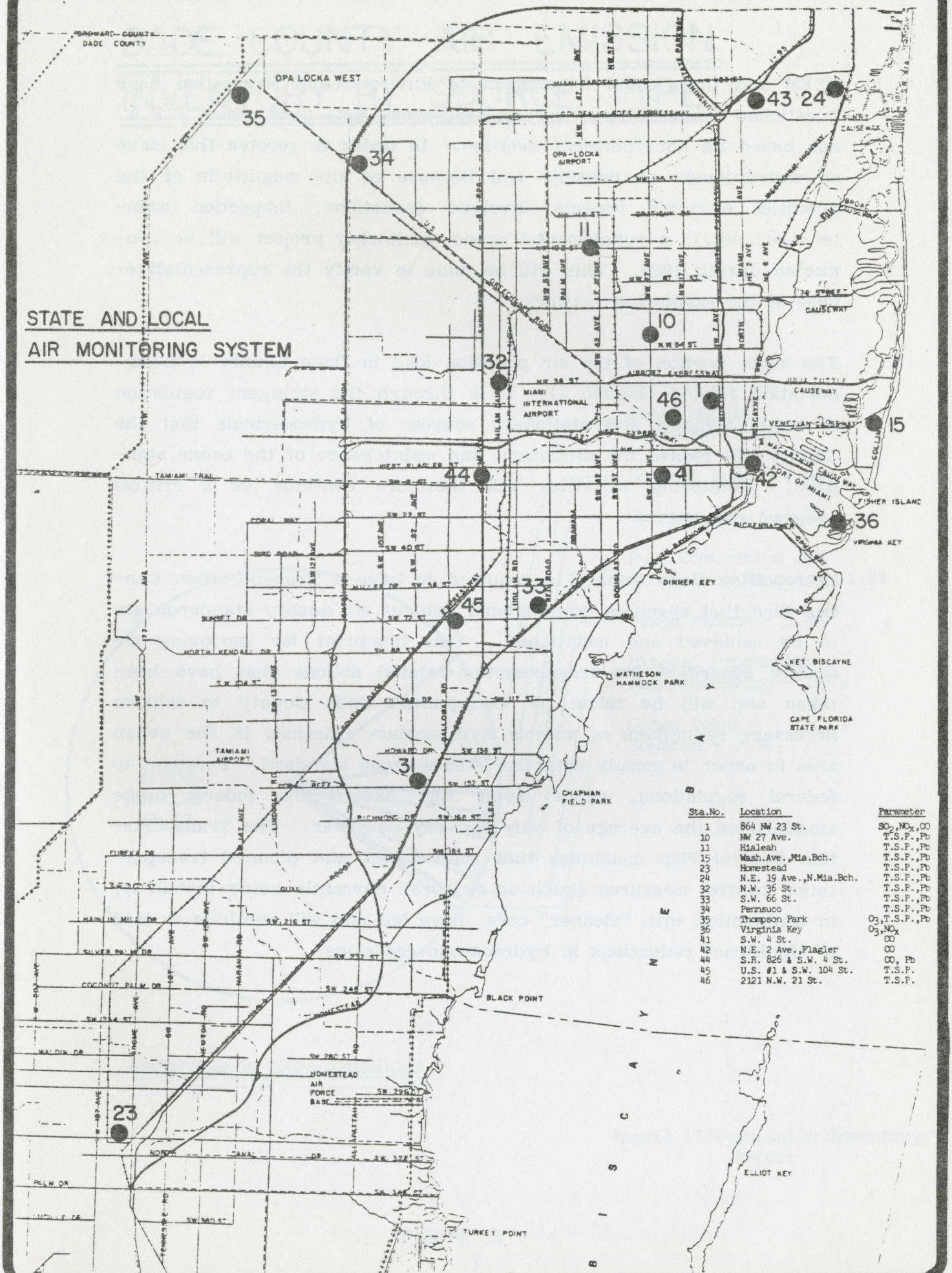
With the automobile the prime target, control strategies for improving and maintaining air quality will be directed toward the implementation of transportation control measures that will decrease emissions from motor vehicles. This can be accomplished by reducing the use of motor vehicles and by accelerating traffic flows. Plans are being reviewed by the Dade County Metropolitan Planning Organization (MPO) who have approved such transportation control measures as computerized traffic controls, exclusive bus lanes, carpool programs, park and ride lots and bus fleet improvements. Yet to be realized air quality benefits will accrue when Metrorail is introduced in May 1984 and the Downtown Component of Metrorail (people mover) the following year. The one single control measure, most effective in restoring clean air, is the Federal Motor Vehicle Control Program

Automobiles have been identified as the major source of air pollution in Dade County. (Photo courtesy of U.S. E.P.A.)

The six health-related air pollutants being monitored in the network and for which National Ambient Air Quality Standards (NAAQS) have been set are discussed in the following sections:

Ozone

The air sampling network shown in Figure 1 monitors concentrations of six health-related air pollutants. Perhaps the pollutant of most concern at the present time is Ozone (0_3). The Environmental Protection Agency has declared Dade County an area which has not demonstrated the attainment of the National Ambient Air Quality Standard (NAAQS) for ozone. This pollutant is formed when unburned or partially burned hydrocarbons and nitrogen oxides react with sunlight. Ozone levels in concentrations consistently exceeding the standard can adversely affect the general public but especially those people with respiratory problems. Prior to 1983, the problem in Dade County was limited to a few hours per year when moderately high concentrations of ozone were recorded. In 1983 however, there were no ozone concentrations monitored that exceeded the standard. Notwithstanding this demonstration of ozone reduction, E.P.A. has proposed that Dade County continue as an ozone nonattainment area based on ambiguous 1982 data.



Sta.No.	Location	Parameter
1	864 NW 23 St.	SO_2,NO_x,CO
10	NW 27 Ave.	T.S.P.,Pb
11	Hialeah	T.S.P.,Pb
15	Wash.Ave.,Mia.Bch.	T.S.P.,Pb
23	Homestead	T.S.P.,Pb
24	N.E. 19 Ave.,N.Mia.Bch.	T.S.P.,Pb
32	N.W. 36 St.	T.S.P.,Pb
33	S.W. 66 St.	T.S.P.,Pb
34	Pennsuco	T.S.P.,Pb
35	Thompson Park	O_3,T.S.P.,Pb
36	Virginia Key	O_3,NO_x
41	S.W. 4 St.	CO
42	N.E. 2 Ave.,Flagler	CO
44	S.R. 826 & S.W. 4 St.	CO, Pb
45	U.S. #1 & S.W. 104 St.	T.S.P.
46	2121 N.W. 21 St.	T.S.P.

FIGURE 2

Carbon Monoxide (CO)

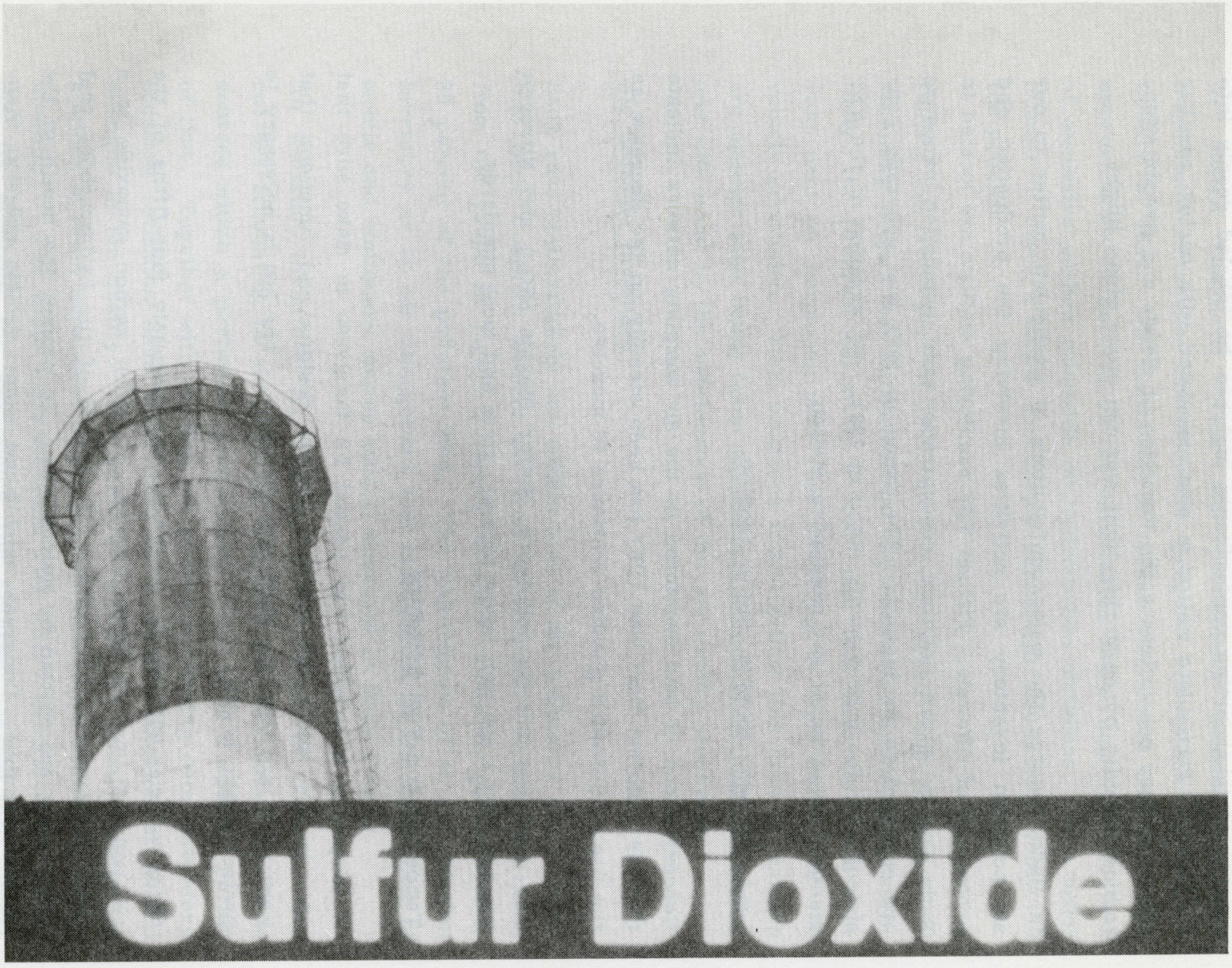
Carbon Monoxide (CO) is another criteria pollutant being monitored closely in Dade County since it is a good indicator of the effectiveness of the Federal Motor Vehicle Control Program. The new vehicle emission control program calls for cleaner emissions as the areawide fleet is modernized through attrition. As might be expected, the Central Business District (CBD) produces higher levels of carbon monoxide than other areas where monitors have been sited. Concentrations of CO measured at the downtown monitor are occasionally in violation of the eight hour (secondary) standard, but not in violation of the one hour (primary) standard. Special purpose monitoring in the downtown area has shown that the area experiencing the higher levels of CO may be limited to just a few blocks.

In 1983 there were 13 violations of the eight-hour CO standard on downtown Flagler Street compared to 33 CO violations monitored in 1982. More favorable meteorological conditions combined with stepped up enforcement and cleaner cars are contributing beneficial factors. A multi-agency CO task force has been organized and is expected to submit recommendations in 1984 for achieving and maintaining the CO ambient air quality standard on downtown Flagler Street. Explored, for example, will be such air quality improvement techniques as re-routing traffic, a transit mall, and restricting truck delivery hours. Metrorail and the Downtown Component of Metrorail (Metromover) are scheduled to open during the next two years. The anticipated reductions in automobile traffic in the downtown area should significantly reduce the levels of automotive-related air pollutants in the CBD.

There were no violations recorded at any of the other three CO monitoring sites.

Total Suspended Particulate (TSP)

TSP is the term used to describe airborne particles. These particles may be composed of products of combustion, dust from manufacturing processes, wind blown dust, aerosols or pollen.



Combustion sources which burn fuel oil or coal such as power plants and cement plants produce Sulfur Dioxide, a criteria pollutant; however, levels in Dade County are well below federal, state and local standards. (Photo courtesy of U.S. E.P.A.)

Adverse health effects are caused by particulate matter in the size range of 3.5 microns and less. This is because such particles are capable of transporting contaminants and can be inhaled deeply into the lungs. Particulate matter is also associated with certain weather effects. They can influence the formation of clouds and precipitation, reduce visibility by scattering light and can cause plume blight.

In Dade County, the major contributors of particulate matter to our air pollution inventory are activities involving the production and processing of minerals. Fifteen TSP monitoring stations are located in Dade County where pollutant concentration and population exposure are expected to be highest. The trend in 1983 was generally consistent with the improvements noted in 1982. No violation of the TSP standard occurred at any monitoring station.

Lead, Nitrogen Dioxide, Sulfur Dioxide

Concentrations of lead monitored in the air sampling network indicate that air pollution from lead (Pb) has been steadily on the decrease as the use of unleaded gasoline continues to increase.

The remaining criteria pollutants, Sulfur Dioxide (SO_2) and Nitrogen Dioxide (NO_2) are well below federal, state and local standards.

Tampering and Fuel Switching

A tampering prohibition was passed bu Congress to make sure that cars in use retain the emission control designs and functions that were built into them by their manufacturers. The law is necessary to protect public health.

Motor vehicles (Figure 3) contribute approximately four-fifths of the air pollution load in Dade County, of which carbon monoxide is a major component. In addition, 75 percent of the hydrocarbons that cause smog are emitted by automobiles. To protect the health of the American public, Congress established motor vehicle emission standards that have to be met by every new car sold in the country.

Tampering and neglected maintenance, however, cause a car to exceed its design standard. This was particularly evident when an inspection/maintenance demonstration program was conducted in Dade County in 1980. An inspection of 10,000 automobiles indicated that approximately 39 percent of the cars tested failed inspection because of excessive carbon monoxide or hydrocarbon emissions. In a major number of cases a simple carburetor adjustment would have corrected the problem.

During the latter part of 1983, an EPA-sponsored tampering and fuel switching project was authorized for implementation by DERM. Essentially, the program will study a 2,000 unit taxi fleet which will provide data on tampering and fuel switching in that element of the vehicle population. Pilot programs investigating this area of concern are another step being taken to provide protection for our air quality and will assist in the maintenance of our air quality standards.

Air Emission Inventory

Each year approximately one million tons of air pollutants are charged into Dade County's ambient air from all sources. As may be noted from the graph in Figure 3, motor vehicles contribute approximately 80 percent of the pollutant load. The maintenance of an air emission inventory as an air management tool is essential in the evaluation of mobile and stationary source control measures in Dade County.

An emission inventory is, ideally, a comprehensive accurate and current accounting of air pollutant emissions and associated data from sources within a particular geographical area, over a specific period of time. Together with ambient air quality monitoring data, inventory emission estimates have been used as a direct indicator of annual changes in air quality. The siting of ambient air quality monitoring stations is often dependent upon emission information maintained in an inventory. The State Implementation Plan (SIP) describes the strategy for attaining and maintaining the National Ambient Air Quality Standards. The nonattainment plan provision in the SIP requires that Dade County conduct an annual hydrocarbon emission inventory. In

addition, nitrogen oxides are expected to be included in the 1983 inventory. This is being done in the event further studies and ozone modeling are required to reduce ambient levels of volatile organic compounds (hydrocarbons). A significant reduction (22%) in the hydrocarbon load has occurred since the initial hydrocarbon inventory in 1977. This is attributed primarily to the effect of the Federal Motor Vehicle Control Program and more stringent control of stationary sources of hydrocarbons.

Part 2

Drinking Water Protection

Drinking Water Protection

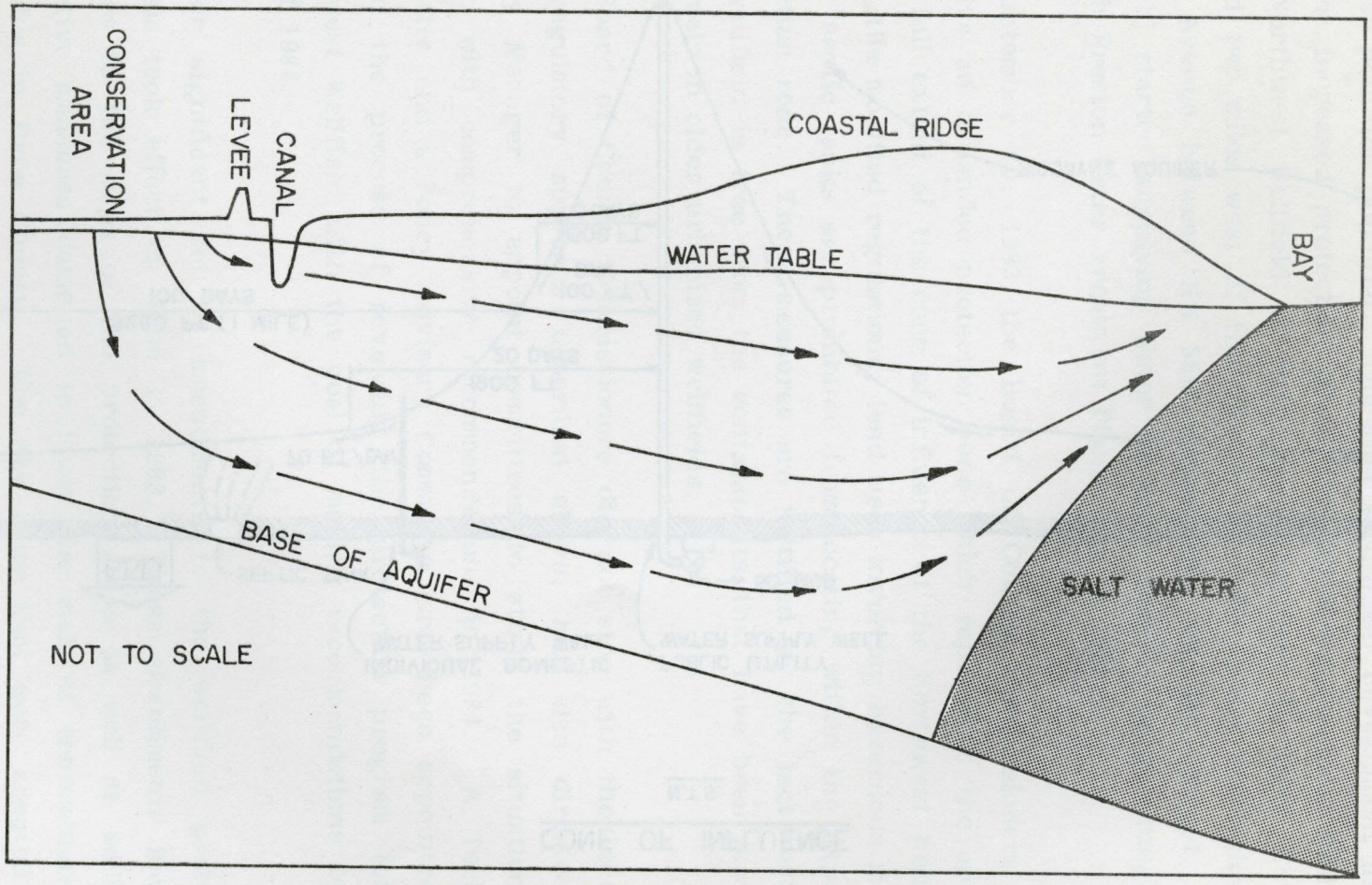
The Biscayne Aquifer

Considerable effort is expended by the Department of Environmental Resources Management (DERM) in the area of drinking water protection. The overriding reason for this attention is that Dade County is totally dependent upon groundwater for potable water supply. The source of this supply is the Biscayne aquifer, designated by the United States Environmental Protection Agency (EPA) as a "sole source aquifer". Briefly, the Biscayne aquifer is a water table aquifer (meaning that it rises and falls freely in response to rainfall) and is highly productive in its ability to transmit water. The major component of the aquifer is cavernous limestone. Recharge is directly from rainfall, and in dry periods by canals and upstream wetlands such as the water conservation areas. There is constant flow in the aquifer from the inland water conservation areas towards the bay (west to east or southeast) and only by maintaining adequate water levels inland do we prevent this flow from reversing and thus causing salt water intrusion of our only water supply.

Not all of the Biscayne aquifer contains potable water. Large portions on the coast are seawater-intruded (see figure 4); in other areas, the aquifer is known to contain low levels of contaminants from such sources as dumps and industrial activities. Even less intensive factors such as sewage disposal and stormwater runoff can have potential adverse effects. This vulnerability has necessitated DERM's efforts, and the remainder of this Chapter will outline some of the groundwater protection activities and programs designed to monitor and minimize contamination of the Biscayne aquifer.

Wellfield Protection

The Dade County wellfield protection program has continued to develop since adoption in March of 1981. The program defines cones of



--Generalized ground water flow paths--

FIGURE 4 - CROSS SECTION OF BISCAYNE AQUIFER

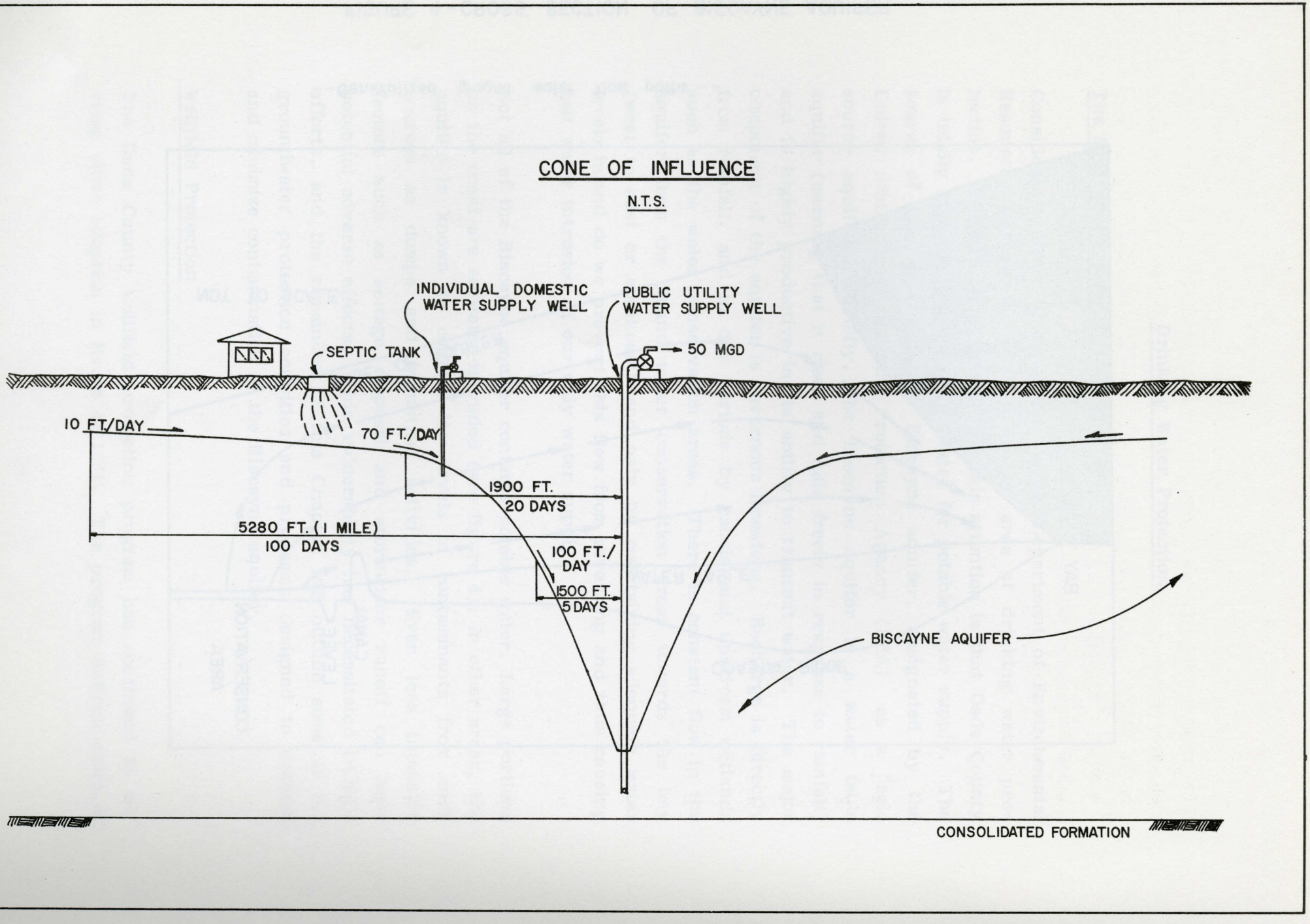


FIGURE 5 - CONE OF INFLUENCE

influence (Figure 5) around wellfields (the area of the aquifer which is influenced by pumping wells, and defined by hydraulic travel times), as well as providing for land use controls within this area to minimize pollution potential. The most significant development in 1983 was the increased protection given the Northwest Regional Wellfield. The Northwest Wellfield is the newest wellfield in Dade County, located two miles west of the Florida Turnpike along theoretical NW 137th Avenue between NW 58th Street and NW 90th Street. The wellfield started supplying water to North Dade County through the Hialeah Preston Water Treatment Plant early in 1983.

On September 30, 1983 the Board of County Commissioners made effective an expanded protection zone which represents the approximate full extent of the cone of influence of the Northwest Wellfield. Under the modified regulations, land uses involving hazardous materials or septic tanks are prohibited from locating within the expanded protection zone. These measures are justified by the fact that this new wellfield is free from the contaminants that have been found at low levels in older urbanized wellfields.

The Board of County Commissioners did not stop with the land use and regulatory approach described above, but also directed the County Manager to appoint committees to study the situation and return with comprehensive recommendations in 1984. A Technical Committee and a Policy Advisory Committee have been appointed and are in the process of reviewing the protection program for the Northwest Wellfield with the goal of making recommendations by the end of 1984.

Another significant set of amendments to the wellfield protection program took effect on June 1, 1983. These amendments included changes to the maps of the protection areas as well as additional protective measures designed to lower the risk of contamination of wellfields in Dade County. The new maps that were adopted were produced by a consultant hired by Dade, Broward and Palm Beach Counties under a federal grant using more sophisticated computer

modelling techniques than had been used previously. Almost all of the public utility water supply wellfields in the county were modelled and although the new maps are not significantly different from the previous set, they are based on a more accurate representation of the actual hydrogeologic conditions. An enhanced version of this same computer model was used to produce the map of the full extent of the cone of influence of the Northwest Wellfield.

A number of amendments are intended to provide better protection for the wellfields from the numerous and varied sources of contamination which might otherwise be present in a cone of influence. A new standard is established for sanitary sewer construction limiting the amount of sewage that can leak out of new sewer lines constructed within a wellfield protection area. Another new provision deals with larger properties which might be located partially inside and partially outside of the protection area. New language specifically describes how to deal with these situations requiring that all sources of pollution be located as far away as possible from the wellfield. The other significant amendment applies to existing land uses already involving hazardous materials. Under the new provision, these establishments are allowed to modernize or otherwise upgrade aging facilities such that the risk of pollution from the site will be less after the improvement than before. This provision allows continued handling of hazardous materials only if a number of water pollution control safeguards are provided, including monitoring, secondary containment, inventory control, stormwater management and security. Approval is available only one time and for no more than 50% more material handling than existing at the time the wellfield protection ordinance was passed.

The development of the wellfield protection program continues into 1984 with a series of amendments to be proposed in the summer and with recommendations from the wellfield committees, due at the end of 1984.

The Miami-Dade Water and Sewer Authority Department's Alexander Orr Water Treatment Facility provides drinking water to most of Dade County south of West Flagler Street. (Photo: John Farina)

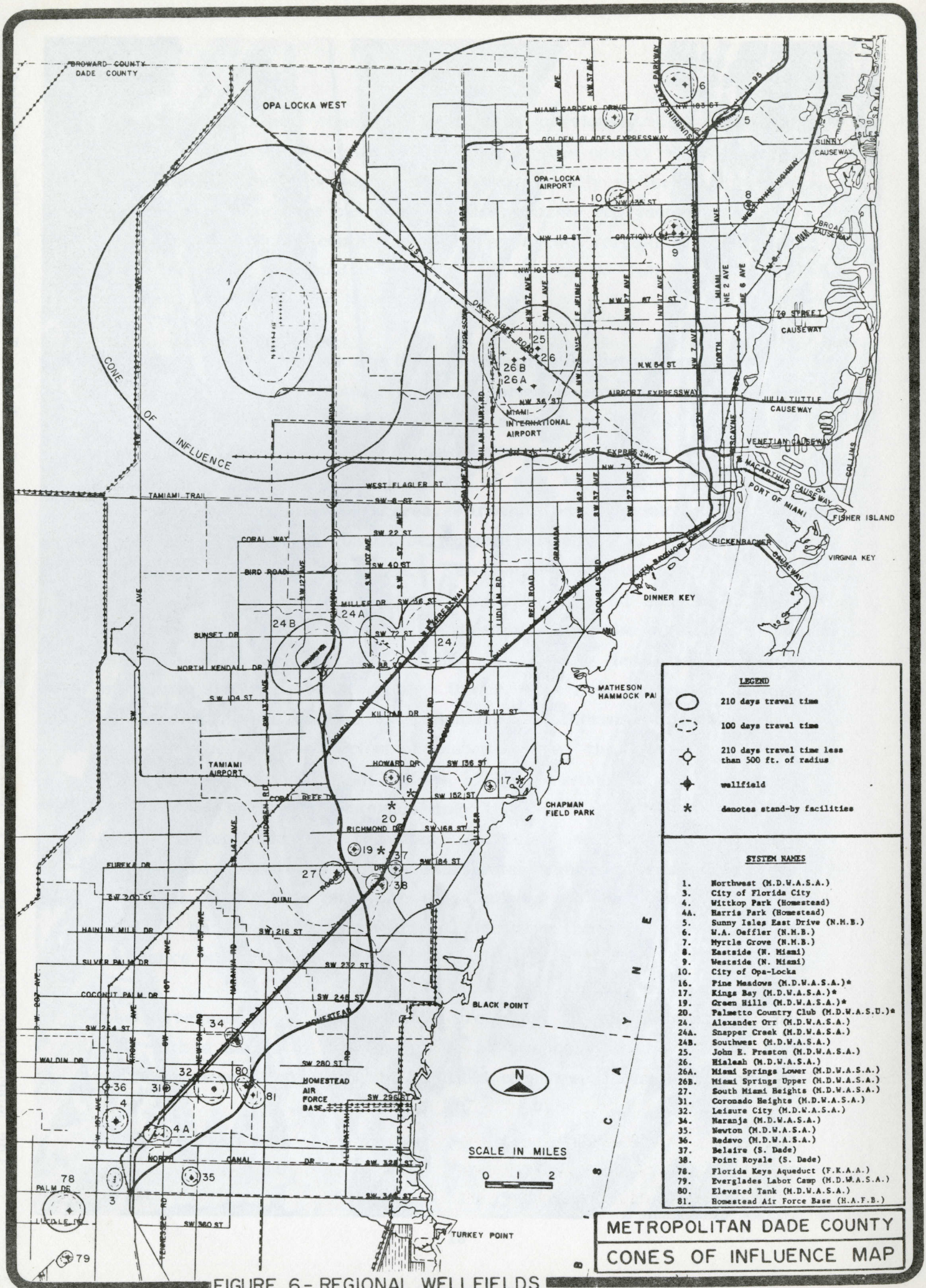


FIGURE 6 - REGIONAL WELLFIELDS

Regional Water Plant Status (Figure 6)

Expansion of major water treatment plants continued during 1983 in order to assure adequate capacity and water quality. The 1983 status of the six major water plant expansion projects is as follows:

1. 8 of 15 new wells of the Northwest Wellfield were placed in service by the end of 1983 and supplied the major portion of raw water for both the Hialeah and Preston water plants.

2. Two chlorine contact/stabilization basins were completed at the Alexander Orr plant during July.

3. A successful performance demonstration at the Alexander Orr plant was completed after construction of the previously noted chlorine contact basin.

4. Construction of two large water softening units at the Alexander Orr plant was started.

5. Installation of three large pumps for maintaining system pressure was completed at the Alexander Orr plant.

6. Installation of pumps and related pumping for four new wells at the Southwest Wellfield was started. In the future these wells will augment the raw water supply of the Alexander Orr plant.

Five of the previously noted six projects were related to the Alexander Orr plant. Nevertheless, a water service agreement moratorium affected the service area of this water plant during the period between May 18, 1983 and July 15, 1983. This moratorium effectively halted the issuance of new building permits for development projects which would result in increased water demands. The area affected by the moratorium extended from Flagler Street to S.W. 248 Street. The Director of Environmental Resources Management imposed this moratorium because construction of the two additional water softening units were seriously delayed and projected water demands exceeded

the plant design capacity. Consequently, this action was needed in order to preserve the quality of service being provided to the estimated 600,000 persons who were already served by that plant.

The concern which brought about the moratorium was quickly resolved by the completion of the chlorine contact basins, the successful performance demonstration (which resulted in a 23 percent increase in capacity), and the start of construction of the two softeners. These improvements immediately made a limited amount of capacity available for development projects. The remaining Orr plant improvements are intended to provide capacity to meet long term future water demands and allow the future phase out of six small interim water treatment facilities which do not provide softening treatment. The future phase out of these facilities is in keeping with Dade County's policy of supplying the public with fully treated water from regional facilities.

The completion of the first 8 wells of the Northwest Wellfield is also particularly significant. The use of these wells has resulted in a substantial reduction in the concentrations of manmade organic compounds in the finished water of both the Hialeah and Preston water treatment plants. This improvement in overall water quality has occurred because the new wells are in an isolated location which is less subject to manmade contamination. The partial activation of the Northwest Wellfield allowed the permanent phase out of the Medley Wellfield, which was in an industrialized area. Although the water supplied from the Hialeah and Preston plants met all existing standards, the activation of the Northwest Wellfield and the phase out of certain older wells is in keeping with the policy of utilizing the best overall source of raw water.

During 1983 all regional water treatment plants produced finished water which consistently met primary drinking water standards. However, the use of the Northwest Wellfield resulted in an increase in the color of the finished water from the Hialeah and Preston water plants. As a result, water plant operators made operational adjustments in order to achieve lower levels of color. The increased color

resulted from naturally occurring organic compounds which are typically found in groundwater in western Dade County. The color of the finished water relates to the aesthetics (i.e. appearance) of the water and is not of health significance. Despite the increase in color, the utilization of the Northwest Wellfield resulted in an overall improvement in water quality as noted previously.

Wastewater Systems

The Department assumed increased responsibility for permitting wastewater treatment facilities and collection/transmission system construction with the signing of an operation agreement with the State of Florida Department of Environmental Regulation. Under the terms of this agreement DERM is designated as the lead agency for monitoring and issuing construction/modification and operating permits for all wastewater treatment plants in the County having design capacities of less than 500,000 gallons per day. Facilities operated by MDWASAD remain the prime responsibility of the State.

DERM has also been delegated full responsibility for all wastewater collection/transmission pipeline construction permitting. This new permitting activity has given the County the authority to assure that wastewater systems comply with State of Florida codes as well as local ordinances.

During 1983, the Department issued two permits for modifications to existing interim wastewater treatment plants, 219 permits for construction of wastewater collection/transmission line extensions and two (2) permits for construction of regional pumping stations. Twenty-two public utility owned treatment plant/collection systems and 54 interim treatment plant annual operating permits were issued. At the beginning of the year, 14 publicly owned and 68 private interim plants were in operation. By the end of the year, five of the utility plants and eleven of the private facilities were deactivated and their flows routed to the regional collection system for treatment and ultimate disposal either by ocean outfall or deep well injection.

The remaining treatment facilities discharge to the groundwater with the exception of one plant which discharges to the FEC canal. Effluent from this facility has remained at acceptable levels, thus minimizing the negative environmental effect this discharge has on the canal system. DERM is exploring long-term options to phase out this facility.

Regional Wastewater Facility Status (Figure 7)

The North District wastewater treatment facility received average monthly flows of 63 mgd or 78.8 percent of its design capacity. Average monthly flows increased during the latter part of the year as a result of several interim plants being deactivated and their inflows directed to the North District system.

A suitable sampling point was installed in the effluent outfall for chlorine residual monitoring. Application was made to the State for a new operating permit to upgrade the design capacity from 60 to 80 mgd following completion of the facilities' second phase construction program.

A decrease in average monthly flows received from the service area of the Central District facility has lowered the possibility of a moratorium being placed on sewer connections in this service area. The Water and Sewer Authority started diverting flow from this plant to the new South District regional plant at a year-end rate of approximately 4 mgd.

The initial 50 mgd design capacity rating of the South District regional plant was upgraded to 75 mgd. This plant has met effluent standards after receiving peak flows as high as 68 mgd with two of the four oxygenation tanks and two of the four final settling tanks in operation. After having operated well within design criteria since its start up in January, 1983, an application for a regular operating permit was submitted to the State at the end of the year.

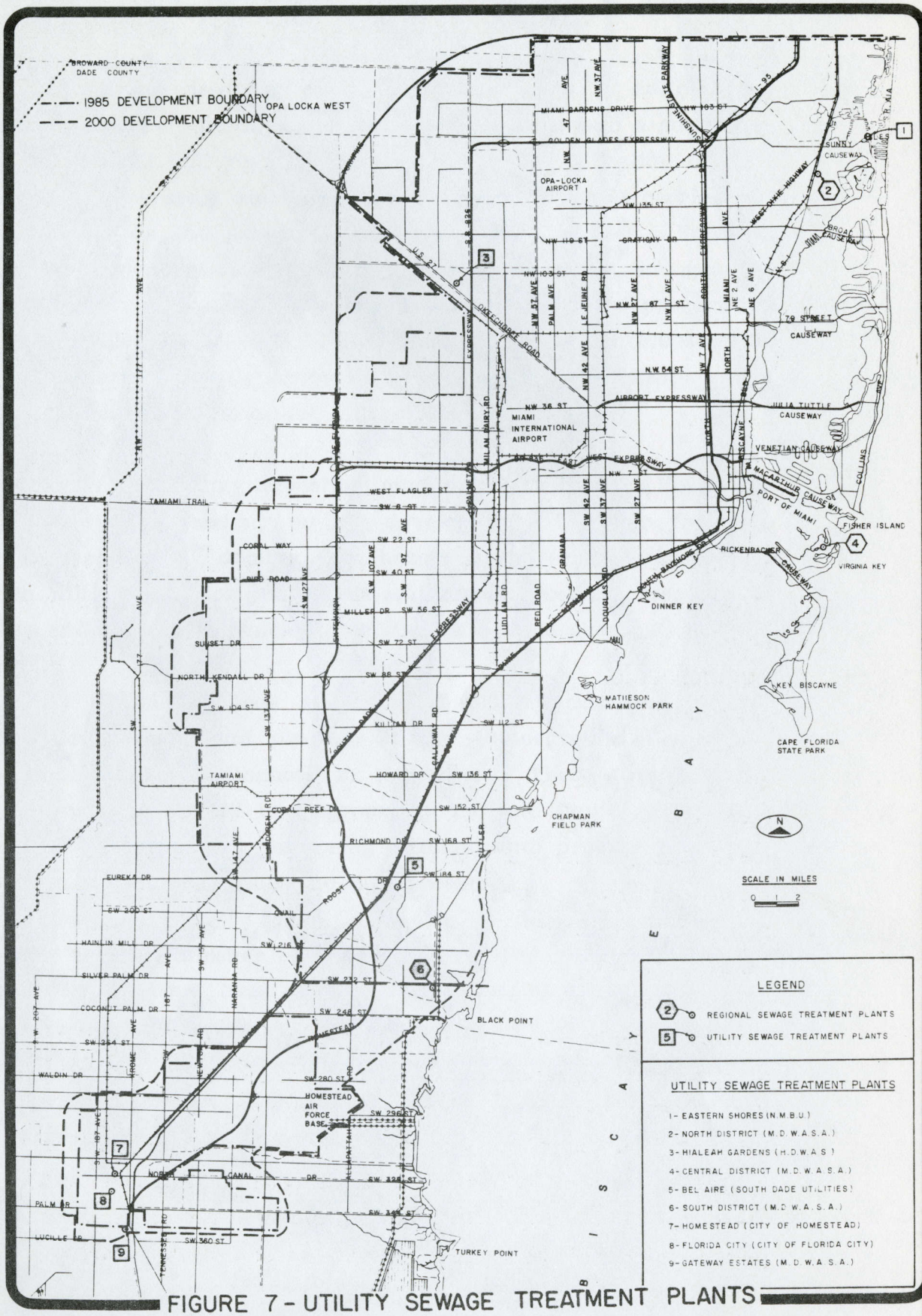
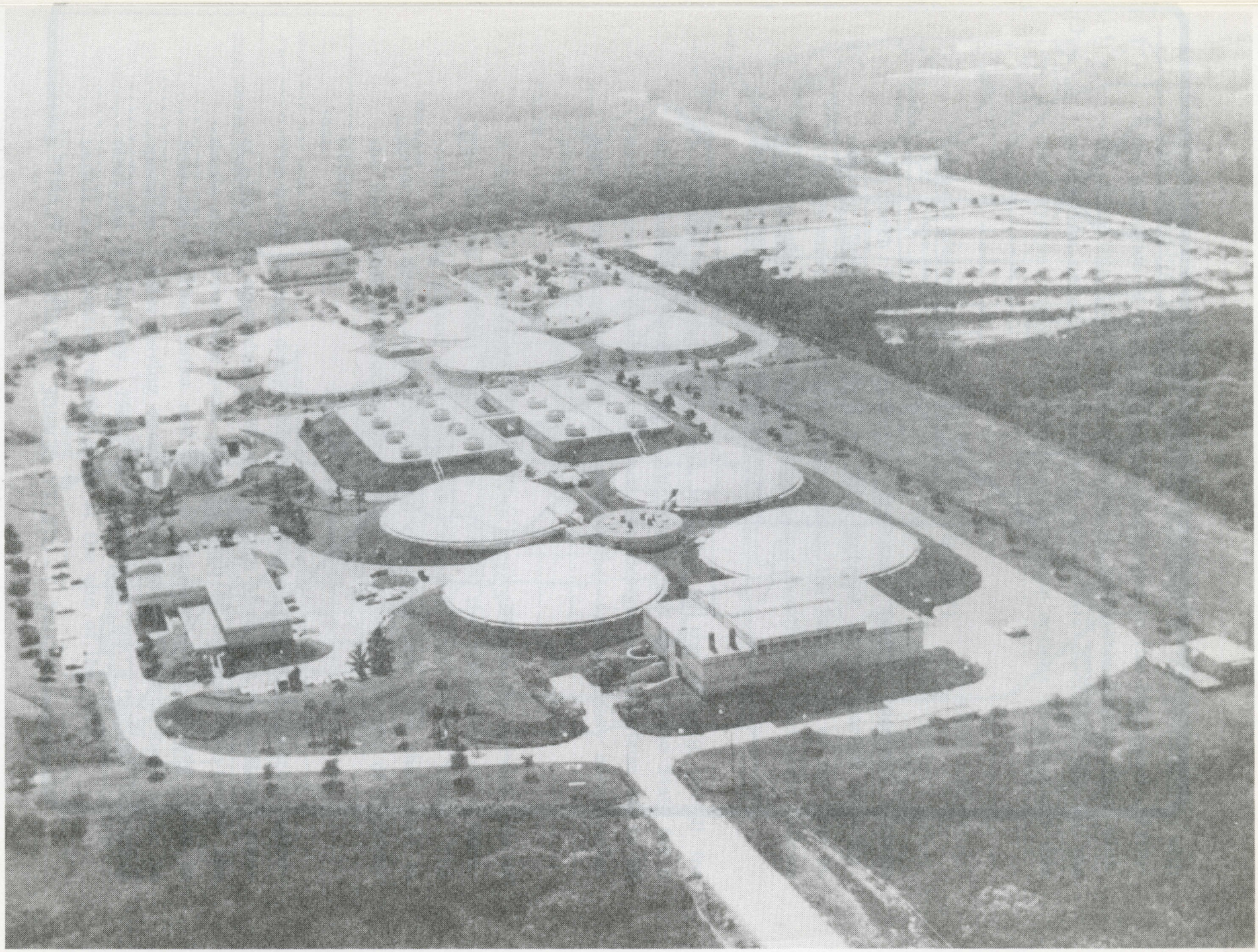


FIGURE 7 - UTILITY SEWAGE TREATMENT PLANTS



The North District Regional Wastewater Treatment and Disposal Facility located at Interama is an 80 MGD facility which serves most of northern Dade County. (Photo: John Farina)

Hazardous Materials

The Hazardous Materials Section of DERM continues to address the problems of improper disposal of hazardous waste through a combination of educational and regulatory programs. The education of hazardous waste generators and industrial representatives is carried out through workshops and presentations to interested parties. Enforcement of existing pollution control regulations governing the management of hazardous materials including civil and/or criminal prosecution of those who illegally dispose of hazardous materials continues to be an essential part of the department's efforts toward the elimination of the chemical contamination of the environment.

In addition to continuing education and enforcement, the Hazardous Materials Section is working on the development of a plan for more rapidly and effectively dealing with hazardous materials emergencies. The plan will provide for the safest and fastest possible response to accidents and other emergencies involving hazardous chemicals.

The County Commission took additional regulatory measures in 1983 with the development and passage of the Underground Tanks and Liquid Waste Hauler Ordinances in November. These programs will require registration of all underground tanks and liquid waste haulers, which will enhance monitoring efforts and provide inventory control of hazardous materials and liquid wastes.

Due to the alarming number of incidents involving gasoline and diesel fuel spills which result from defective underground storage tanks and their associated piping systems, an Underground Tank Ordinance was prepared by DERM and passed by the County Commission in November 1983. Pursuant to the Underground Tank Ordinance, DERM reviews construction plans, monitors the installation of, permits the usage of, identifies problems and directs corrective actions for underground hazardous materials storage facilities throughout Dade County. These efforts should greatly reduce the possibilities of spills or leaks and insure rapid detection and reporting of these incidents so prompt action may be taken to reduce the detrimental effects of these occur-

Throughout Dade County, there exist thousands of facilities which store hazardous materials in underground tanks partially submerged in the Biscayne Aquifer. Rules were developed and adopted in 1983 which regulate such underground storage facilities. (Photo: Rick Poley)

rences on the groundwater quality. In 1983, over 25,000 gallons of fuel were reported as lost due to spills and leaks in Dade County. More than 80% of this material was recovered.

Additional efforts to prevent hazardous material contamination of the environment resulted in the development of the Liquid Waste Transporters Ordinance. This ordinance, which was approved in November, 1983 by the County Commission, was enacted in order to more effectively regulate the transport and final disposal of all liquid wastes, including hazardous wastes, throughout Dade County. The enactment of this ordinance has enabled DERM to establish an essential program which will accurately monitor and catalogue the amounts and types of liquids and hazardous wastes generated in Dade County. Since the very recent development of the Liquid Waste Haulers Program, DERM has already documented several instances of illegal dumping of chemicals and sludges and initiated appropriate enforcement and corrective measures to stop the illegal dumping and remedy the environmental damage it has caused. Since November 25, 1983, DERM has reviewed applications and permitted 94 out of 109 liquid and hazardous waste haulers operating in Dade County. The monthly reporting required of the permittees should enable DERM to document the disposal methods used for hazardous wastes generated in Dade County.

In 1983, monies were provided by the Water Quality Assurance Act to fund studies of hazardous waste generation in Florida. The newly established Hazardous Waste Assessment Program of DERM will use the above-mentioned State grant to notify hazardous waste generators of their responsibilities in the disposal of their wastes, as well as survey the types, quantities and management practices of hazardous waste generators in Dade County. Using the results obtained from this program, the requirements for a permanent hazardous waste collection facility in Dade County will be determined, and possible sites for this facility will be recommended. This program will continue its study throughout 1984 and should yield valuable data on the hazardous waste generated in Dade County as well as a recommenda-

tion on the type and location of necessary hazardous waste collection facilities for the effective management of the wastes generated.

These combined efforts in education and enforcement have succeeded in increasing the general awareness of the problems caused by improper disposal of industrial wastes, and have resulted in greater participation by other governmental agencies and the public in reporting cases of illegal dumping of hazardous wastes. Several cases brought to staff attention by members of the public have resulted in full scale investigations and cleanups of hazardous waste sites.

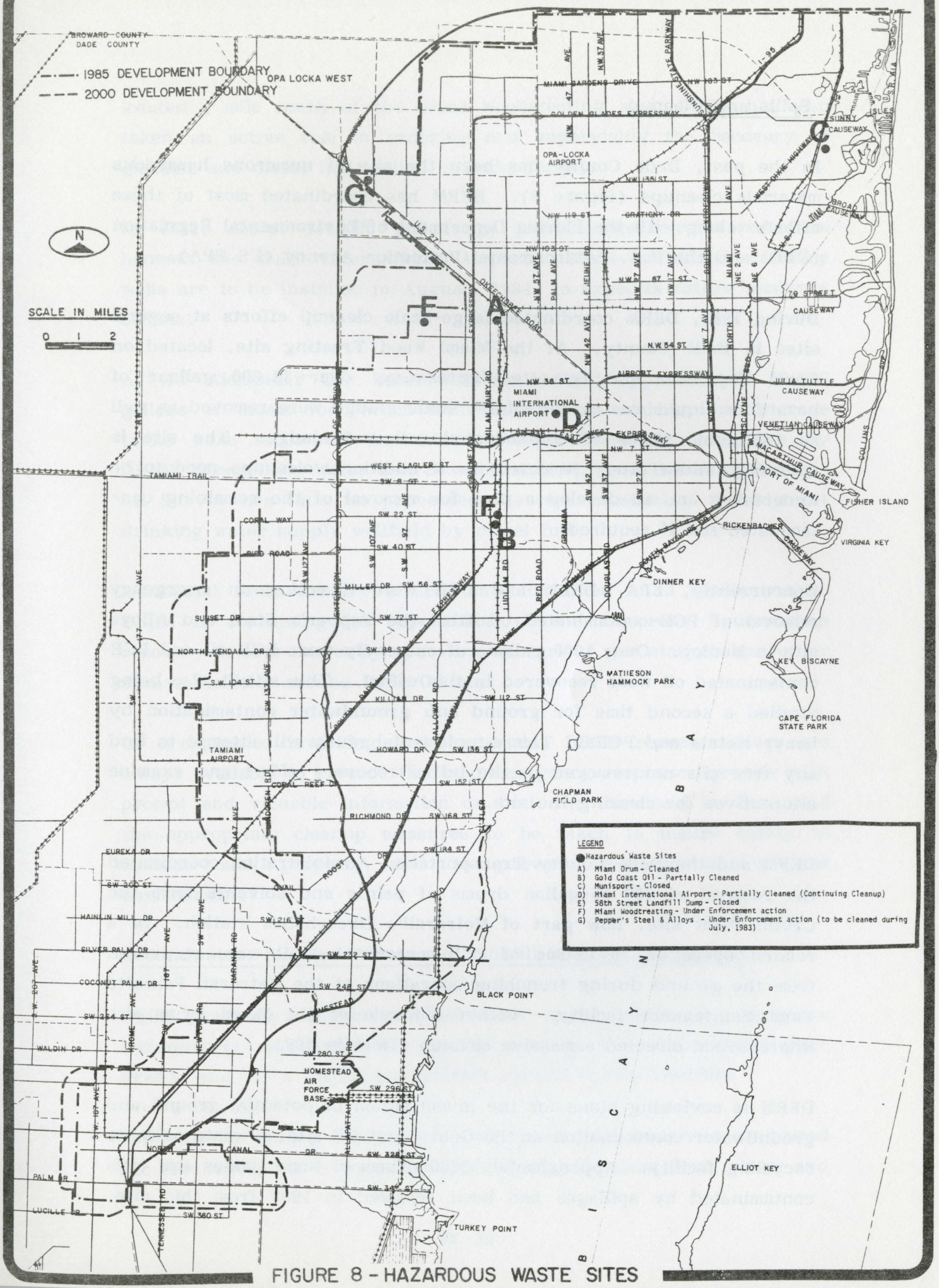


FIGURE 8 - HAZARDOUS WASTE SITES

Spills and Cleanup

In the past, Dade County has been the site of numerous hazardous materials cleanups (Figure 8). DERM has coordinated most of these efforts along with the Florida Department of Environmental Regulation (DER) and the U.S. Environmental Protection Agency (US EPA).

During 1983, DERM coordinated large-scale cleanup efforts at several sites in Dade County. At the Miami Wood Treating site, located on Coral Way near the Palmetto Expressway, over 33,000 gallons of hazardous liquid wastes and highly toxic sludge were removed as well as 140 cubic yards of contaminated soil and sludge. The site is currently under study to determine if additional cleanups need to be undertaken and to develop a plan for removal of the remaining contaminated soil if required.

Concurrently, EPA, DERM and DER were directing an emergency removal of PCB-contaminated oil from the Pepper's Steel and Alloys site in Medley. Over 1200 gallons of extremely toxic PCB oil and PCB contaminated oil were recovered in this effort. This site is also being studied a second time for ground and groundwater contamination by heavy metals and PCBs. This supplemental study will attempt to find any free oils not removed in the initial recovery effort and examine alternatives for clearing the site.

DERM and the Dade County Transportation Administration coordinated the removal of 600 55-gallon drums of paints and solvents from the Crown Paint site, now part of Metrorail's Okeechobee station. In a related operation, 6 drums of PCB-contaminated oil were recovered from the ground during trenching operations at the Metrorail Palmetto Yard Maintenance facility - within 1/4 mile of the Miami Drum site where DERM directed a massive cleanup effort in 1982.

DERM is reviewing plans for the investigation of potential ground and groundwater contamination at the Gold Coast Oil site, a waste solvents recycling facility. Approximately 2500 drums of toxic wastes and soils contaminated by spillages had been removed in 1982 from this site,

located ¼ mile south of the Miami Woodtreating site. DERM has also taken an active role in ordering and supervising the recovery of gasoline and diesel fuel spilled in Dade County.

In 1983, almost 140,000 gallons of jet fuel were recovered from beneath the Miami International Airport. Three additional recovery wells are to be installed in August, 1984, to expedite future recovery efforts.

At the Alexander Orr Water Treatment Plant approximately 25,000 gallons of diesel fuel which had leaked from underground storage tanks were recovered from the ground. The quick response by DERM, Miami-Dade Water and Sewer Authority, and the U.S. Geological Survey has thus far prevented the contamination of the adjacent drinking water supply wellfield by diesel fuel.

Additional fuel recovery efforts have occurred on a smaller scale. DERM is continuing its supervision of the numerous hydrocarbon recovery efforts currently operating at various gas stations and other similar facilities around Dade County.

In emergencies involving toxic materials, DERM representatives are always available to provide the local emergency response agencies with prompt and valuable information on both the chemicals involved and the appropriate cleanup measures to be taken to insure safety to citizens and property and to prevent contamination of the environment.

Groundwater, Surface Water, and Landfill Monitoring Programs

DERM presently conducts several water quality monitoring programs including (1) a groundwater quality network, (2) several canal programs, and (3) a monitoring network around county landfills.

Groundwater quality and surface water monitoring programs conducted by the county have been emplaced during the past four years and

have the dual purpose of detecting problems which currently exist and establishing baseline water quality for these systems.

The biannual (rainy and dry season) Groundwater Quality Monitoring Program (Figure 9) consisting of approximately 50 monitoring wells 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 septic tanks and 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 of major inorganic ion concentrations. 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 (Figure 10) includes monthly sampling and analysis of general physical and chemical parameters from a network of approximately 50 stations covering the county's major surface water systems. Results from past years show that the most serious water quality problems are high levels of indicator bacteria, which in turn is related to the amount of stormwater discharged into the canals. As the canals are primarily designed as a vehicle for drainage, there are limits to corrective measures that can be taken.

To supplement the Monthly Canal Program, DERM annually samples one major canal and analyzes a wide array of parameters. The subject of the 1982 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

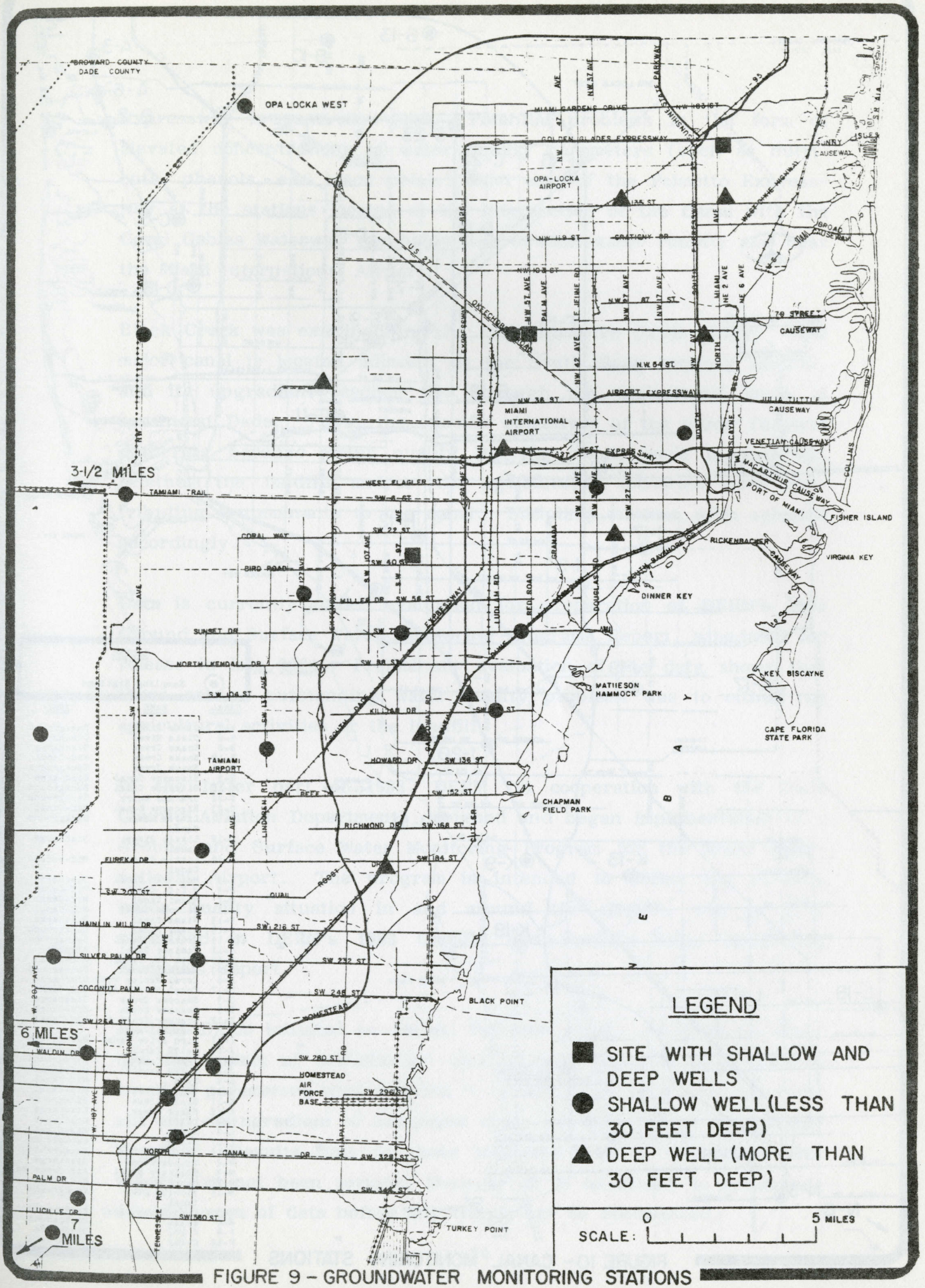
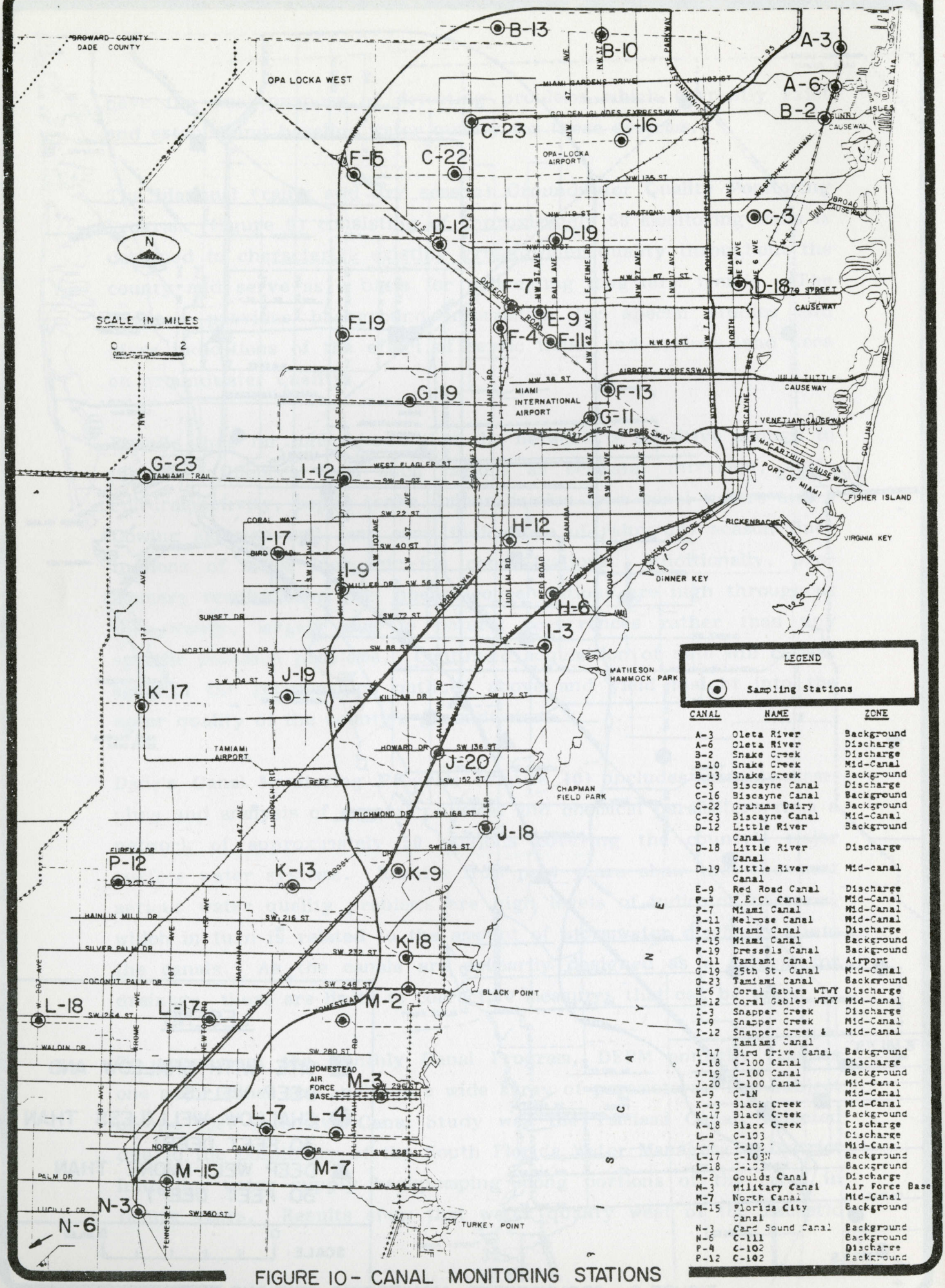


FIGURE 9 – GROUNDWATER MONITORING STATIONS



LEGEND

◉ Sampling Stations

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 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-12	C-102	Background

FIGURE 10- CANAL MONITORING STATIONS

Expressway is generally good. Potential problems in the form of elevated concentrations of water quality parameters (such as nutrients, phenols, and trace metals) exist east of the Palmetto Expressway 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.

Black Creek was examined for the 1983 Intensive Canal Study. This major canal is located adjacent to the South Dade sanitary landfill, and its upgradient reaches flow through the agricultural lands of southwest Dade, Thus, the specific objectives of the study (beyond gathering baseline water quality for the canal) were to ascertain whether the landfill and/or the agricultural activities were contributing contaminants to the canal. Sampling stations were selected accordingly.

Data is currently under evaluation for preparation of DERM's 1983 Ground and Surface Water Monitoring Programs Report, scheduled for release in late 1984. Preliminary evaluation of the data shows that there are no outstanding water quality problems due to either the agricultural activities or the landfill.

In the latter part of 1983, DERM (in cooperation with the Dade County Aviation Department) designed and began implementation of a Ground and Surface Water Monitoring Program for the Miami International Airport. The program is intended to define the existing water quality situation in and around the airport, and is fully described in DERM's 1983 Ground and Surface Water Monitoring Programs Report.

In 1981 DERM initiated an Annual Pollutant Study, designed to measure the impact of urbanization upon surface water quality. Various chemical parameters were selected to be monitored at stations upgradient and downgradient of urbanized areas and included in the Monthly Program. 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.

Groundwater monitoring is conducted by DERM at the county's sanitary landfill (South Dade) as well as two former disposal facilities (North Dade and 58th Street) under Agreement with the Dade County Public Works Department (See Figure 11 for location of the disposal sites). Private and municipal landfills are also required to submit monitoring data. Monitoring parameters include general contaminant indicators (ammonia nitrogen, specific conductance, pH, phenols) and those which are potential health hazards if present in significant concentrations (cadmium, chromium, lead). Additional parameters such as pesticides and synthetic organic compounds are monitored on a site-specific basis.

Landfill monitoring is source-oriented, with a twofold purpose:

a.) interpretive monitoring at former waste disposal sites to assess the extent of contamination and evaluate the effectiveness of remedial measures. Wells are located upgradient (background) and downgradient to the apparent extent (leading edge) of contamination. The wells typically are placed in multi-depth clusters to provide a vertical cross-section of the aquifer.

b.) detective monitoring at the sanitary landfills to insure that the pollutant contaminant systems are performing properly. Wells are located at shallow depths around the perimeter of the sites as an "early warning" system for the detection of any failures or improper operation.

The following conclusions can be made concerning the disposal sites which are monitored by DERM:

Former Disposal Sites -- Both of the former disposal facilities reported indicator (i.e., ammonia nitrogen, specific conductance) parameters in excess of background water quality in 1983. However, these values were generally lower than or approximated 1982 concentrations. Trace

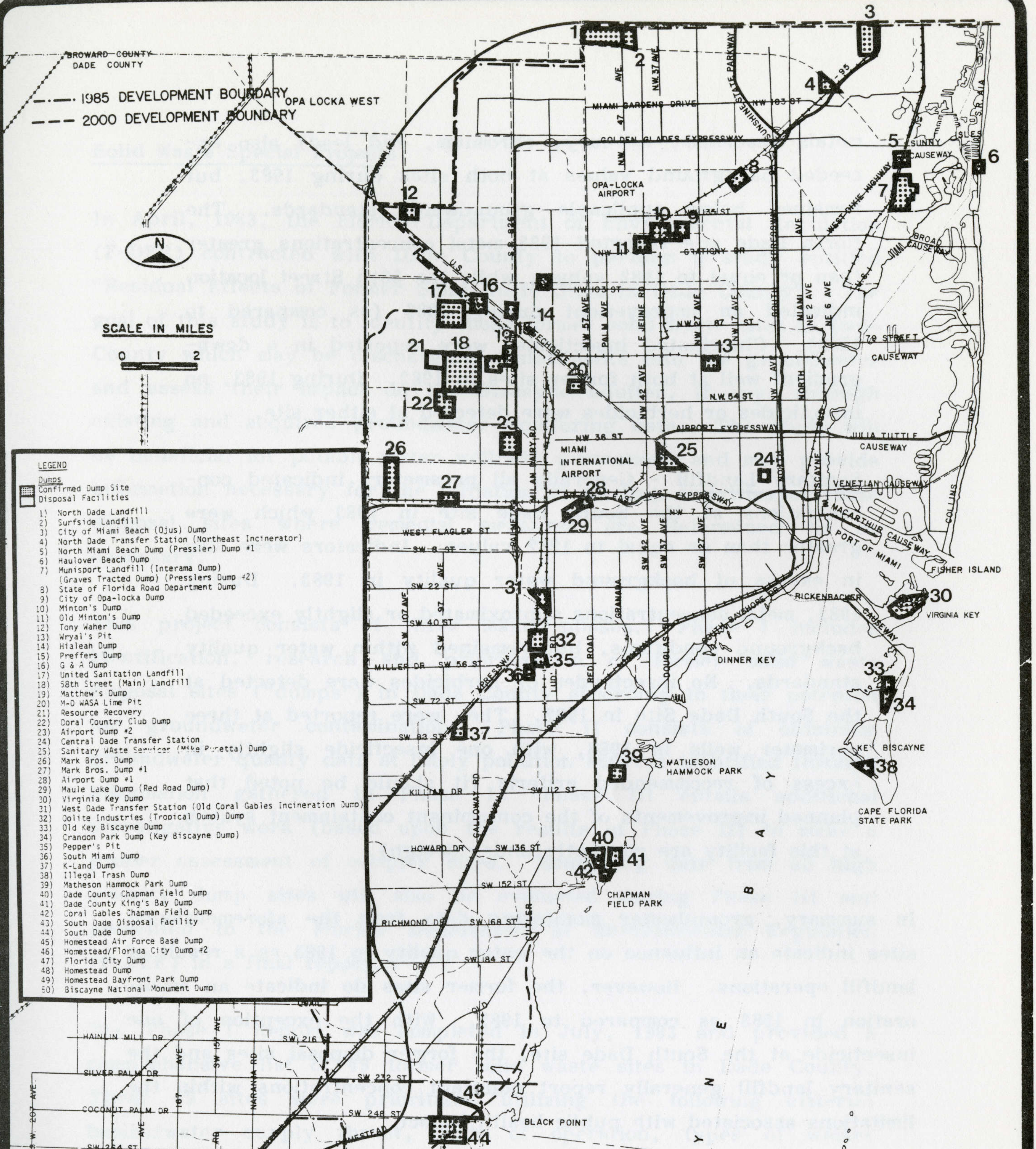


FIGURE 11 - COUNTY DUMPS, LANDFILLS & DISPOSAL FACILITIES

metals (cadmium, mercury, chromium, and lead) also exceeded background values at both sites during 1983, but remained below applicable groundwater standards. The North Dade site reported 1983 metal concentrations greater than or equal to 1982 values, while the 58th Street location indicated an improvement during 1983 (as compared to 1982). Chlorinated insecticides were reported in a downgradient well at both former sites in 1982. During 1983, no insecticides or herbicides were detected at either site.

Sanitary Landfill - Generally all parameters indicated concentrations at the South Dade site in 1983 which were greater than or equal to 1982 values. Indicators were also in excess of background water quality in 1983. During 1983, metal concentrations approximated or slightly exceeded background conditions, but remained within water quality standards. No insecticides or herbicides were detected at the South Dade Site in 1982. They were reported at three perimeter wells in 1983, with one insecticide slightly in excess of recommended criteria (it should be noted that planned improvements of the contaminant containment system at this facility are currently under design).

In summary, groundwater monitoring data from the aforementioned sites indicate an influence on the water quality in 1983 as a result of landfill operations. However, the former sites do indicate an amelioration in 1983 as compared to 1982. With the exception of one insecticide at the South Dade site, the former disposal sites and the sanitary landfill generally report pollutant concentrations within the limitations associated with public health impact.

Solid Waste Special Projects

In April, 1983, the Florida Department of Environmental Regulation (F-DER) contracted with Dade County to perform a study entitled "Residual Effects of Former Solid Waste Sites in Dade County". The goal of this study is to identify those former solid waste sites in Dade County which may be discharging contaminants into the groundwater and assess their impact on the Biscayne aquifer, if any, through existing and acquired groundwater monitoring data. The study will be beneficial for potable water wellfield protection, and may provide information necessary for the initiation of cleanup activities at those disposal sites where remedial measures are determined to be necessary.

This project consists of three major phases. Phase I includes identification, research and prioritization of former solid waste disposal sites ("dumps") in Dade County according to their potential for groundwater contamination. Phase II consists of obtaining groundwater quality data at likely pollution sources identified through information gathered in Phase I. Phase III entails additional investigative work (based upon the results of Phase II) to make a proper assessment of complex sites. Monitoring data from all high priority dump sites will also be evaluated during Phase III and presented to the Florida Department of Environmental Regulation (F-DER) in a final report.

The Phase I Report was completed in July, 1983 and provided a comprehensive list of 49 former solid waste sites in Dade County. These 49 sites were prioritized utilizing the following criteria: health/water supply threat, mode of operation, types of wastes received, duration and size of operation and suitability for further study in Phase II. Existing groundwater monitoring data indicates that sites which contain waste materials in contact with the groundwater pose the greatest pollution threat.

As part of this investigation, 8 of the 49 prioritized sites were selected as high priority sites under Phase II of this project

which commenced in mid-August 1983 (with scheduled completion in June, 1984). These 8 sites will be further studied utilizing surface geophysical remote sensing methodology to determine the extent of the groundwater contamination, and to aid in the placement of groundwater monitoring wells. Monitoring wells will be installed at the 4 most severely contaminated sites.

The Phase II and III sampling program, commencing in 1984, will consist of 4 separate sampling events three (3) months apart in order to provide for groundwater monitoring twice during wet season and twice during the dry season. Routine analysis will include ammonia, nitrogen, mercury and other metals, phenols, chlorides, specific conductance, and, as part of Phase III expanded monitoring, priority pollutants. The Phase II project report is scheduled for completion in October, 1984 while the final project report will be submitted to F-DER in December, 1985.

Flood Criteria Requirements

The Director of the Department of Environmental Resources Management has been authorized by the Dade County Code to administer the Countywide programs of water control and flood protection. The Department's function in the area of flood protection is twofold:

1. To regulate the development and improvement of new lands so that proper land filling and adequate drainage works are provided (Authority based on Chapters 24, 28 and 33 of the Code).

2. To regulate the required elevations of new building construction in order to meet the objectives of the National Flood Insurance Act of 1968. (Authority based on Chapter 11-C).

The first goal is accomplished through the enforcement of the Dade County Flood Criteria Maps and drainage regulations for new subdivisions. The Flood Criteria Maps show the minimum required elevations for street construction and site development and are intended to provide flood protection for a 10-year storm. DERM is responsible for maintaining and amending as required the County Flood Criteria Maps, for providing information to the public and to other Departments and Agencies on required County Flood Criteria and to coordinate with the Public Works Department on matters related to the platting of new developments.

The second goal is accomplished through the enforcement of Flood Insurance Rate Maps (F.I.R.M.) and the provisions of the Federal Flood Insurance Program. The successful administration of this program entitles Dade County to continued eligibility for subsidized rates for Flood Insurance. The Flood Insurance Maps are issued by the Federal Emergency Management Agency (F.E.M.A.) and show the

different flood zones and minimum required elevation for building construction. These minimum elevations are intended to provide protection from floods generated by 100-year storms and from ocean surge associated with a hurricane event.

It is the Department's function to provide public information on the requirements of the Flood Insurance Program, to act as coordinators and consultants for the Federal Government and to act and issue variances from the program when the strict application of the standards would cause an exceptional hardship. The role of D.E.R.M. in the performance of this function acquired special importance during 1983, when the F.E.M.A. amended the flood insurance maps to incorporate the effects of wind and wave action during a hurricane. The Department provided proper public coordination in order to inform the public of the upcoming changes and the effects of the new change.

Additional services are provided by circulating public notices on specific Flood Zones, among Realtors, Land Surveyors, Insurance Agents and the public in general. Also, the Department initiated during 1983 the processing of Elevation Certificates required by the F.E.M.A. These certificates have enabled numerous property owners to reduce their premium rates for flood insurance and are a requirement by the financing institutions for the purchase of a house.

Underground Injection Permitting

The use of drainage wells is the alternative solution for the disposal of stormwater runoff when other systems are not feasible because of limited available area for the installation of other drainage facilities or the presence of soils with poor exfiltration capabilities. Drainage wells are acceptable at locations where the chloride concentration in the aquifer is sufficiently high to make it unsuitable for water supply or irrigation purposes. The use of drainage wells at these locations

provides the additional advantage of injecting a freshwater head which would reduce the inland migration of salt water intrusion. Drainage wells are used for full on-site retention of stormwater runoff or for the retention of the first inch of runoff, in combination with systems having an emergency overflow.

During the 1983 fiscal year, Dade County has seen a dramatic increase in the use of drainage wells, particularly associated with the boom in construction of high rise buildings in the Brickell area and other areas abutting Biscayne Bay. The use of drainage wells has also assumed great importance for major transportation projects. Wells were used extensively by state, county and city agencies for drainage of major arterials and secondary road construction in areas where the above described factors for the use of drainage wells were present.

Drainage wells were also used to provide relief from flooding of existing arterial roads. It is anticipated that official agencies will continue to use this alternative solution for stormwater disposal in the future.

DERM reviews drainage wells applications for the number and size of wells, size of sedimentation tanks associated with well installation and compliance with water quality criteria. The Department has worked in coordination with the state DER and has been successful in implementing the new rules of F-DER for Class V wells construction.

Part 3

Natural Resources Protection & Enhancement

Located in Dade County are a variety of valuable natural resources. Among these are Biscayne Bay, Atlantic Ocean beaches and reefs, mangrove and freshwater wetlands, and forested uplands. These aquatic and terrestrial environments provide a habitat for a productive and diverse community of subtropical plants and animals. Dade's waters and shores also offer both economic and recreational opportunities to visitors and its 1.7 million residents.

In the past, uncontrolled urbanization has caused adverse environmental impacts, diminished public access and the loss of some natural lands and waters of Dade County. DERM, therefore, has initiated programs and activities to protect and enhance the ecological, recreational, economic and aesthetic values of these resources. These programs include coastal, wetland, and terrestrial resources permitting activities, the Biscayne Bay Restoration and Enhancement Program, the Biscayne Bay Water Quality Monitoring Program, the Artificial Reef Program, and restoration and renourishment of Dade County beaches.

Permitting

Coastal Permitting. DERM is responsible for managing and protecting Dade County's coastal and marine resources. These include coastal wetland vegetation, such as mangroves, and benthic (bottom) communities, such as seagrass beds and reef areas. The Department manages these resources through the coastal permitting program under the authority granted by Section 24-58 of the Dade County Code.

A Class I Coastal Permit is required for any work in coastal wetlands or work in, on, or upon tidal waters of Dade County. Thus, Class I Permits are required for such activities as the construction of marinas, piers, docks, seawalls, and riprap revetments, dredging or filling. On July 19, 1983, the Board of County Commissioners passed Ordinance 83-61, which requires that a Class I permit must also be obtained prior to the trimming or cutting of mangroves. This ordinance was necessary since the mangrove communities of Biscayne

Christo's controversial "Surrounded Islands" project takes shape around a spoil island in Biscayne Bay. (Photo: Bob Karafel)

Bay's intertidal zone and proximal shorelines provide continuing service to the ecosystems of Biscayne Bay by stabilizing the shoreline, attenuating wave action and storm driven tides, enhancing water quality and clarity, providing feeding, breeding and maturation areas for a variety of organisms, and by serving as the basis of a complex estuarine food chain which supports much of Florida's fish and wildlife. This ordinance became effective July 29, 1983.

Each application for a Class I Permit is evaluated on the basis of a number of criteria specified in the Dade County Code. The most important evaluation factor is the expected environmental impact of a particular project. To receive approval, projects must have minimal or no impact on marine and coastal wetland resources. In many instances, mitigation may be required to offset unavoidable impacts for otherwise permittable projects. Mitigation may include activities such as mangrove or seagrass replanting, placement of natural limerock boulder riprap, or the creation of artificial reefs.

In addition to mitigation, DERM places strict conditions or restrictions on each project to ensure that impacts are minimized and environmental standards are maintained. Dredging projects in shallow water, for example, must be enclosed with a turbidity curtain (silt screen) in order to contain the turbid water. New or rebuilt marinas are required to provide sewage pumpout stations to remove wastes from vessels using the facility, and new or rebuilt seawalls require the placement of natural riprap waterward of the wall.

In 1983, a total of 131 Class I Coastal Construction Permits were issued. The largest of these included the expansion of Homestead Bayfront Park Marina and construction of a new access channel, the Christo "Surrounded Islands" project, the reconstruction of the Government Cut North Jetty, the construction of new bridges for the Rickenbacker Causeway, a new offshore artificial reef site northeast of Fowey Rocks and the widening of Sunny Isles Boulevard.

The Department regulates the development of wetlands throughout Dade County in cooperation with the U.S. Army Corps of Engineers and the State of Florida Department of Environmental Regulation. (Photo: George Molnar)

In addition, permits were issued for smaller projects including single family docks, new or replacement seawalls and mooring piles. Permits were also issued for the expansion or repair of several small marinas and the construction of seven commercial piers or docks. The remainder of the permitted activities included installation of several subaqueous cables or pipelines, five minor dredging projects, repair of a bridge and a bridge fender system, a small jetty repair, several revetments and one mangrove trimming project.

Freshwater Wetland Permitting DERM is responsible for protecting the biological and hydrological values of the County's freshwater wetland resources. Freshwater wetlands in Dade County serve vital functions which are essential to the health and welfare of the people of Dade County. Our wetland areas provide direct recharge of water to the Biscayne aquifer, the County's sole source of drinking water. Moreover, our wetlands serve to filter and purify surface and groundwaters as well as provide habitat for wildlife, including many rare and endangered species. DERM's policy is to permit only those uses of the freshwater wetlands that have an insignificant individual and cumulative impact on the intrinsic public resource values provided by freshwater wetland areas.

The first comprehensive Freshwater Wetlands Ordinance for Dade County was approved on September 6, 1983 by the Board of County Commissioners. The ordinance, which became effective ten days later, requires a Class IV Permit for all work within freshwater wetlands areas. As a part of this new ordinance, the outdated sheet flow ordinance (Section 9-72), which was formerly used to control freshwater wetland activities, was deleted from the Metro Code and the new ordinance became part of Section 24-58 of the Metro Code.

The East Everglades Zoning Overlay Ordinance, Section 33B of the Dade County Code, specifies certain environmental performance standards and development restrictions for the East Everglades area, which is located in the western part of Dade County between Levee

31N and Everglades National Park. These are enforced by DERM through permitting requirements. The ordinance also assigns DERM the responsibility for reviewing, and jointly approving with the Building and Zoning Department, "Conditional Use" permit applications for the East Everglades area. Conditional Use Permits allow certain limited land uses in the East Everglades that are less stringent than allowed under the Zoning Overlay Ordinance.

The freshwater wetland regulatory activities of DERM include both permitting and enforcement. Permit applications in the past have included proposals for small scale residential uses, agricultural uses, rockmining operations and utility roads. During 1983, DERM received a total of 17 Class IV Permit applications. Nine of these have currently been approved. These approvals include four rockmining projects, two agricultural projects, one residential fillpad, one radio tower complex and one temporary road. DERM's review of these applications has been based on the potential impacts of the proposed work on the values associated with wetland resources, particularly those values relating to the recharge and protection of the County's water supply as well as wetland habitat values. Many of the criteria for protection of these wetland values are outlined as permit evaluation criteria in Section 24-58.3 of the County Code. The baseline criteria used for evaluating permit applications in the East Everglades are outlined in the East Everglades Management Plan.

During 1983, eight (8) enforcement actions relating to unauthorized wetland development were initiated by DERM. These unpermitted activities include roads, fill pads, agriculture and sanitary nuisance violations. Some of these enforcement actions have been resolved or are being resolved through removal of the violation and restoration of the property and/or by obtaining proper permits. Several of these actions, as well as actions initiated in 1982, are now in court under civil and criminal charges filed by DERM.

The Dade County Manager has also assigned DERM the task of overseeing the proposed oil drilling activities on the County's jetport

property in Dade and Collier Counties. During 1983, DERM reviewed the plans for the first oil exploration activities schedules for the Hughs & Hughs 10-2 site in Collier County. Work at this site is expected to begin in 1984.

DERM is involved in Governor Graham's East Everglades Resource Planning and Management Committee, which is seeking to develop long-term solutions for implementing the Governor's Everglades restoration plan in relation to the East Everglades. The Committee is expected to address this issue in detail over the next year.

During 1983 DERM proposed the partial consolidation of the regulatory process so that, where feasible, freshwater wetland protection for certain categories of projects can be accomplished completely on the local level. In order to implement this procedure, delegation of certain permitting authority from both Federal and State agencies to DERM through general permit mechanisms will be required. It is expected that additional discussion of this proposal will occur during 1984, with the possible delegation of some environmentally acceptable wetland work.

Terrestrial Resources. The protection of Dade County's upland natural resources is administered by DERM by utilizing sections of the Metro-Dade County Code that apply to forested areas and urban tree stands. Section 26B of the Dade County Code, the Tree Preservation Ordinance, establishes that a Tree Removal Permit is required for removal or relocation of any trees in Dade County (with the exception of certain municipalities which enforce their own tree ordinances). DERM's policy under the Tree Preservation Ordinance is to issue Tree Removal Permits only when a permit applicant has designed his project to adequately protect and/or mitigate for a site's tree resources. In the case of high value natural pinelands and hammocks this entails preservation, to the maximum extent possible, of the forested portions of a site. Where preservation is not feasible, replacement trees of sufficient number and size to replace the existing canopy are required. DERM issued 311 Tree Removal Permits in 1983. In addition,

The protection of Dade County's upland tree resources is administered by DERM. Developments which are sensitive to tree resources results in aesthetically pleasing projects which can also significantly reduce energy usage. (Photo: Rick Poley)

37 enforcement cases involving unauthorized tree removal were initiated. To date 20 of these have been satisfactorily resolved. During 1983 DERM prepared an ordinance which will modify Section 26B of the County Code, and it is expected that the ordinance will be presented to the Board of County Commissioners for consideration in early 1984. The proposed ordinance more clearly defines where a tree removal permit is required, provides increased protection for natural forested areas, and officially designates DERM as the County Tree Protection Agency.

Section 25B of the Dade County Code, the Endangered Lands Ordinance, provides for significant property tax savings to owners of high value forested lands who agree through a Restrictive Covenant mechanism to preserve and protect their property in its natural state. DERM's responsibilities under this ordinance are to evaluate applications for endangered land tax exemptions, make recommendations to the County Commission on each application, prepare management plans for each qualifying tract, and ensure adherence by property owners to all preservation and management provisions of their Restrictive Covenants. DERM receives the assistance of the County Urban Forester (Florida Division of Forestry) in administering this program. To date, 34 applications for endangered lands tax exceptions totalling 176.4 acres of forestland have been approved. In addition, a total of 32 applications have been rejected because they did not qualify based on DERM's environmental criteria for site evaluation. Also, during 1983, a pamphlet outlining the Endangered Lands Program was prepared and printed for public distribution.

Section 24-27.1 of the Dade County Code, the Exotic Species Ordinance, was enacted in 1982 with the expressed purpose of prohibiting further importation, transportation, sale, planting and propagation of certain species of exotic trees known to cause serious adverse environmental impact. These species are Australian pine, melaleuca, and Brazilian pepper. DERM has implemented an enforcement program to ensure complete elimination of these species from nursery stocks and to ensure they are not used as landscape plants in Dade County.

Moreover, DERM, in cooperation with the Florida Division of Forestry, is providing information on the appropriate alternative species that may be used to achieve the same landscaping purpose.

Biscayne Bay Restoration and Enhancement

The goal of the Restoration and Enhancement program is to maintain, restore or improve the ecological value and recreational and aesthetic potential of Biscayne Bay. It is funded through the State of Florida Department of Environmental Regulation and locally administered by DERM. The program was initiated in 1978 with a habitat and access improvement project at Pelican Harbor demonstrating the feasibility of bay restoration and enhancement through the placement of riprap and construction of an artificial reef and fishing pier. In 1982, the program received the National Association of Counties Achievement Award. At the outset, it was estimated that ten years and funds in excess of $15 million would be required to complete the program. Since 1979, approximately $2.0 million of State funds have been made available for various restoration and enhancement activities having one or more of the following objectives.

* Provide continued monitoring of the Bay in order to assemble an adequate data base for Bay Management;

* Maintain or improve water quality to permit safe recreation and growth of marine life;

* Identify and maintain, or enhance if necessary, those biological communities that are essential to the long term viability of Biscayne Bay;

* Optimize the quality and quantity of marine life;

* Provide protection for endangered, threatened or rare species of plants and animals that exist in Biscayne Bay or the adjacent coastal wetlands;

* Provide a wide variety of water oriented recreational opportunities at the water's edge;

* Enhance physical and visual access, thereby increasing the potential for environmentally sound utilization and attractiveness of Biscayne Bay for the public at large;

* Improve public awareness of Biscayne Bay resources.

Early efforts to develop strategies for Biscayne Bay resource management were hampered by the lack of comprehensive, scientific data. Therefore, monitoring and study of the Bay became one of the key elements of the Restoration and Enhancement program and constitute a foundation upon which other program elements are built. Four major studies, which began in 1982, continued through 1983. These studies, performed by a team of scientific consultants, include an assessment of Bay fisheries resources, a model of water circulation in North Biscayne Bay, identification of sources of turbidity, and a benthic organism sampling program. An additional study of bay sediment chemistry was initiated in 1983. These projects will be completed in the Spring of 1984 and will be used to develop management recommendations.

A milestone for the Restoration and Enhancement program, the Biscayne Bay bottom community map, was completed in 1983. The map, which is available to the public, delineates the distribution of seagrasses, algal communities, rocky bottoms characterized by sponges and soft corals, and dredged and barren areas. The map shows that seagrasses are the dominant bottom type, covering more than 140 square miles or about 65% of the Bay (see Figure 12). North Biscayne Bay communities have been most seriously impacted by development with over 41% of the bottom altered by dredging. A related mapping project, the shoreline survey, indicates that approximately 41% of the Biscayne Bay shoreline is bulkheaded, and about 35% is covered by mangroves (see Figure 15). Sand or gravel

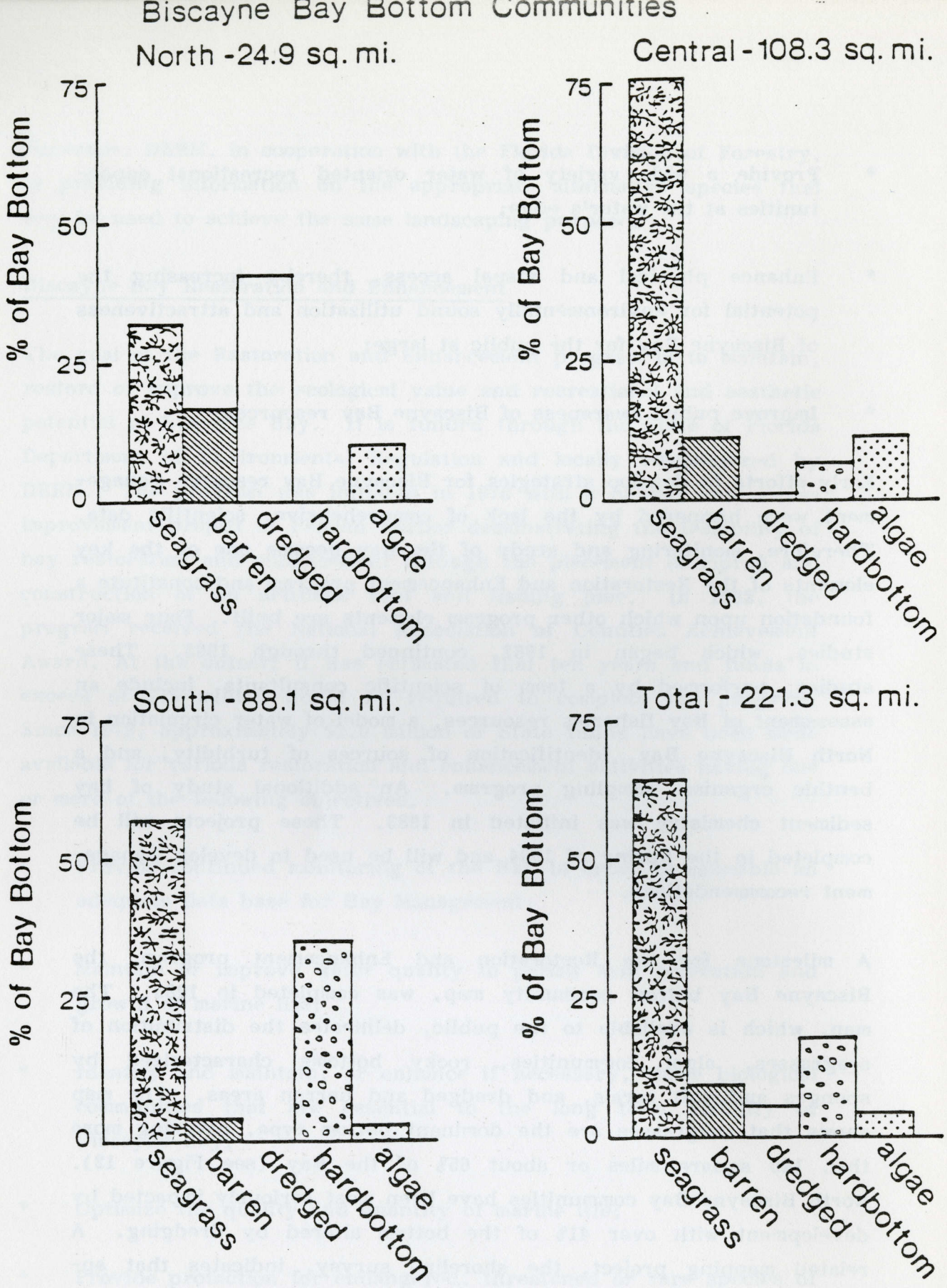


FIGURE 12 Data collected during preparation of the Bottom Community Map was used to determine the relative abundance of seagrasses, dredged areas, and other bottom types. North Biscayne Bay includes the area between the Dade-Broward County line and Rickenbacker Causeway. Central bay extends from the Rickenbacker Causeway to the Featherbed Banks. South bay includes the remainder of Biscayne Bay to the Dade-Monroe County line.

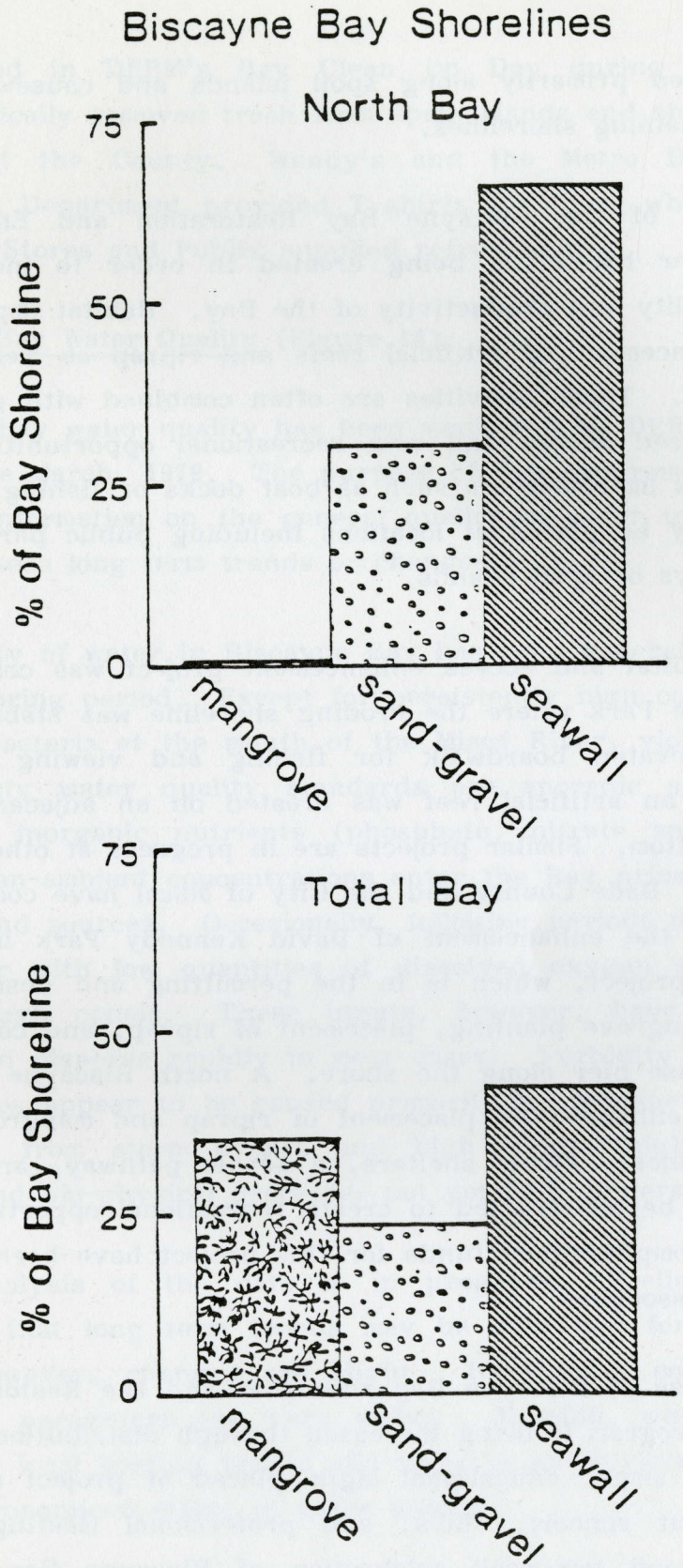


FIGURE 13 The Shoreline Survey confirms that over half of Biscayne Bay is bordered by seawalls. Mangrove shorelines have been nearly eliminated in North Biscayne Bay. Sand or gravel beaches occur primarily along causeways and spoil islands. North Biscayne Bay includes the area between the Broward-Dade County line and Rickenbacker Causeway.

beaches, located primarily along spoil islands and causeways, constitute the remaining shorelines.

Another focus of the Biscayne Bay Restoration and Enhancement effort, in-water habitat is being created in order to increase the biological viability and productivity of the Bay. Habitat improvements include the placement of artificial reefs and riprap as well as mangrove planting. These activities are often combined with projects to provide increased access and new recreational opportunities to the public. Access improvements such as boat docks or fishing piers and boardwalks may be placed at locations including public parks, street ends, causeways or spoil islands.

In 1983, a habitat and access enhancement project was completed at North Bayshore Park where the eroding shoreline was stabilized with riprap, an elevated boardwalk for fishing and viewing was constructed, and an artificial reef was created on an adjacent area of barren bay bottom. Similar projects are in progress at other sites in Biscayne Bay. Dade County and the City of Miami have completed an agreement for the enhancement of David Kennedy Park in Coconut Grove. This project, which is in the permitting and design stage, will include mangrove planting, placement of riprap, and construction of a multiple use pier along the shore. A north Biscayne Bay spoil island will be enhanced by placement of riprap and mangroves along eroding shorelines. Picnic shelters, a scenic pathway, and a small boat dock will be constructed to create recreational opportunities for the public. Complimentary funds for this project have been provided by Quayside Associates.

Public awareness of Biscayne Bay resources and the Restoration and Enhancement program is being increased through distribution of new brochures and maps, educational signs placed at project sites, and presentations at schools, clubs, and professional meetings. Baynanza, an annual two-week celebration of Biscayne Bay, held in October also enlightened Dade Citizens as to the attributes of Biscayne Bay as an economic, recreational and educational resource. Over one thousand Girl Scouts, Boy Scouts and members of the public

participated in DERM's Bay Clean Up Day during Baynanza and enthusiastically removed trash from spoil islands and shorelines throughout the County. Wendy's and the Metro Dade Park and Recreation Department provided T-shirts for those who participated, and Farm Stores and Publix supplied refreshments.

Biscayne Bay Water Quality (Figure 14)

Biscayne Bay water quality has been monitored by DERM on a regular basis since March, 1979. The purpose of this program is to establish baseline information on the general quality of water in Biscayne Bay and to assess long term trends or changes.

The quality of water in Biscayne Bay has been generally good during the monitoring period. Except for persistently high concentrations of coliform bacteria at the mouth of the Miami River, violations of State and County water quality standards are sporadic and infrequent. Dissolved inorganic nutrients (phosphate, nitrate and ammonia) in higher-than-ambient concentrations enter the Bay primarily via canals from upland sources. Occasionally, following periods of high rainfall, freshwater with low quantities of dissolved oxygen also enters the Bay through canals. These inputs, however, have a short lived impact and disperse rapidly in most cases. Turbidity and suspended particulates appear to be caused primarily by resuspension of bottom sediments from storm events and high winds, high thrust motor vessels and bio-physical processes not yet fully understood.

Trend analysis of the data is in progress. Preliminary analysis indicates that long term trends may be identified for a few parameters; however, changes are slight. Day-to-day concentrations of monitored parameters can vary widely. Rainfall, wind velocity and direction, local boating traffic and variable water circulation patterns have a pronounced effect on water quality.

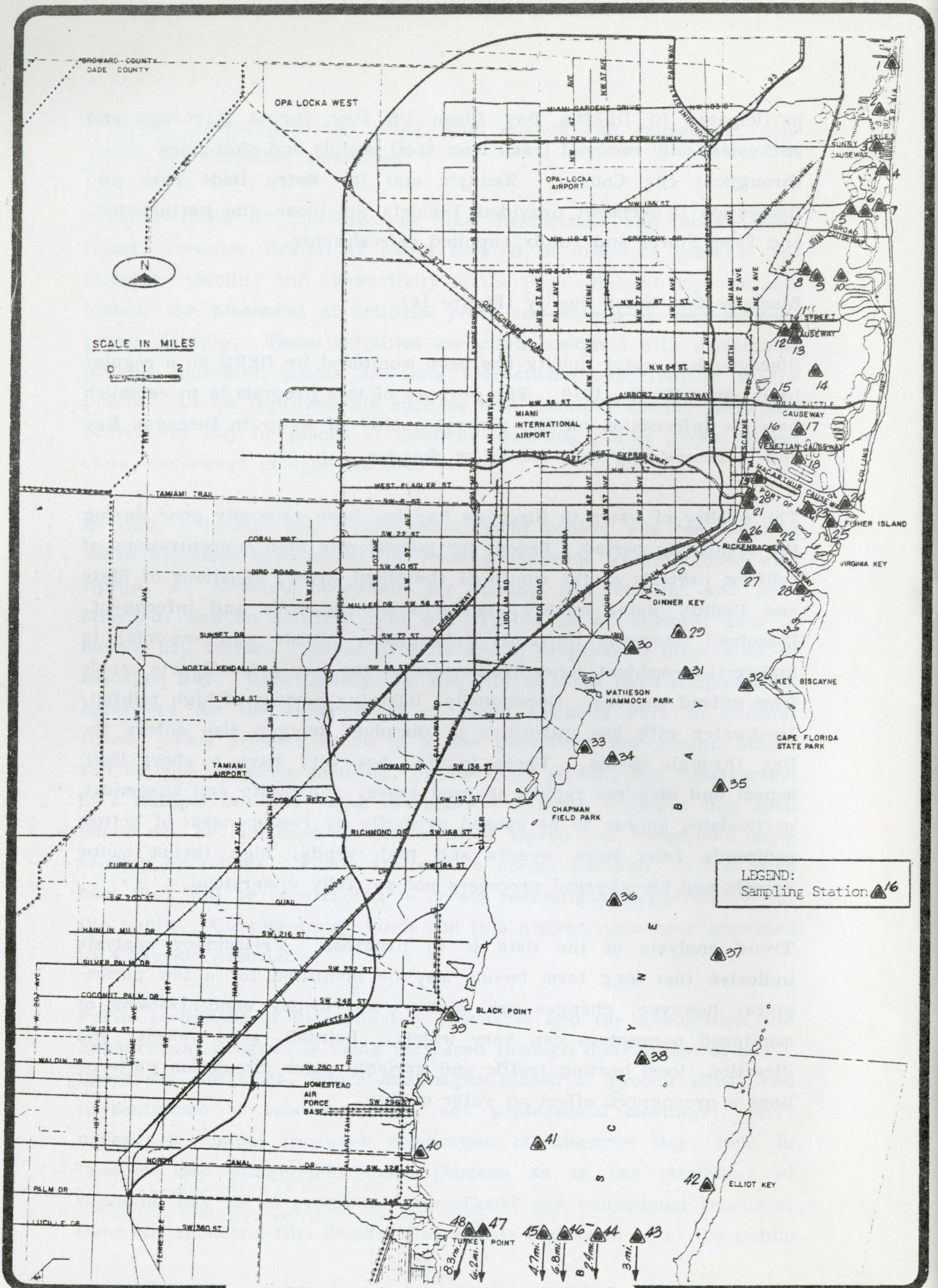
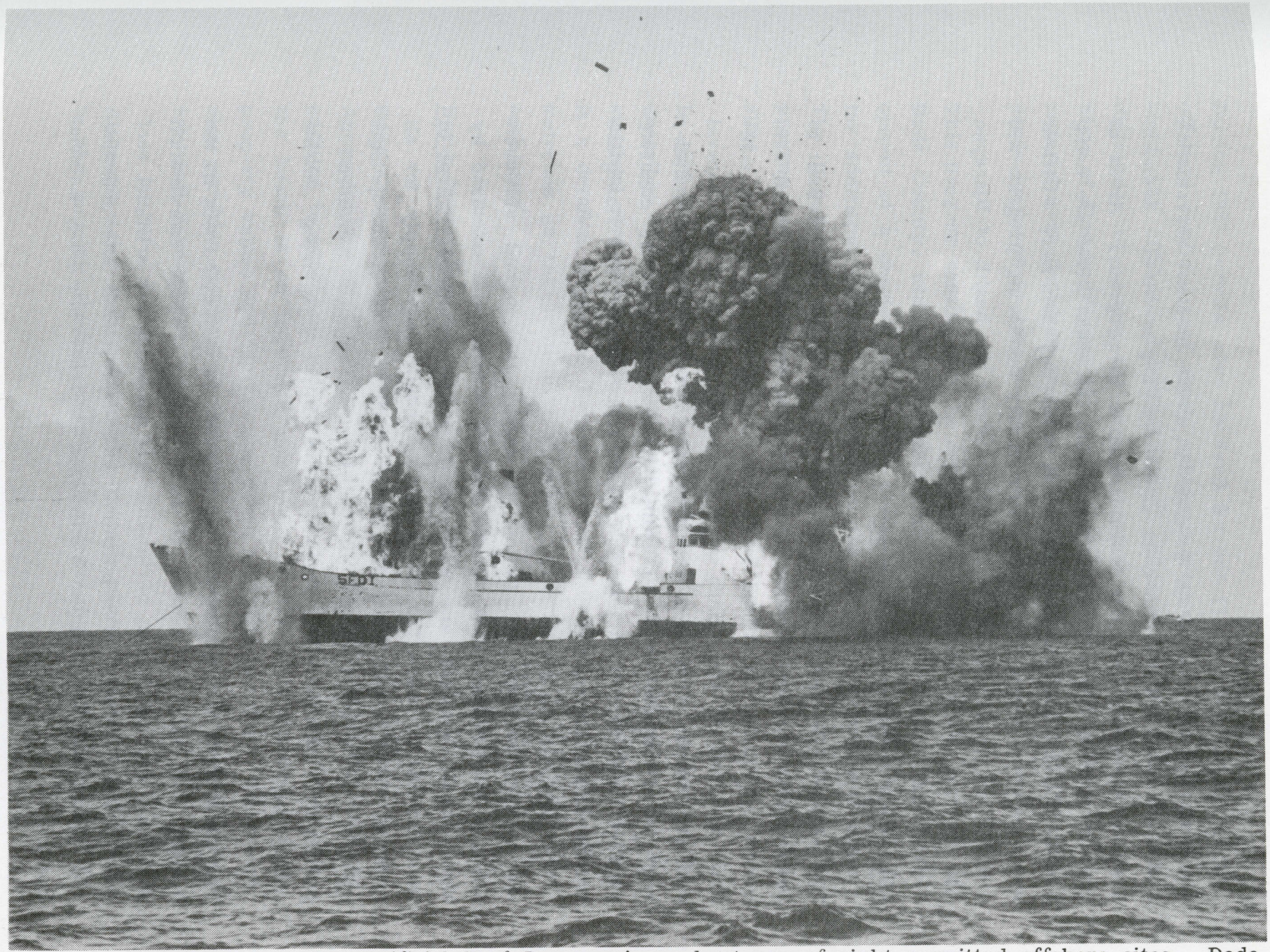


FIGURE 14 - BAY MONITORING STATIONS



An old ship donated to the Artificial Reef Program is sunk at one of eight permitted offshore sites. Dade County has the largest number of artificial reef sites in Florida. (Courtesy of Metro Dade County Department of Tourism).

The water quality monitoring program is under constant reevaluation and more sophisticated analysis has been implemented. Sediment analysis for pesticides and trace metals is in progress. Areas of concern such as the Munisport Landfill and the Miami River are being monitored intensely, and a search is underway for more efficient water pollution indicators. The water quality monitoring program will continue to provide valuable information about the health of Biscayne Bay.

Metro-Dade Artificial Reef Program

The primary goal of the Artificial Reef Program is the enhancement of Dade County's fishery resources by increasing the habitat available to marine organisms. Artificial reefs are constructed by placing man-made materials in areas that were previously barren of any natural reef structures. The most effective and durable materials include: large steel objects such as ships, barges, and tanks; concrete products such as culvert pipe and construction rubble; and fiberglass reinforced structures.

Once these materials are placed at depths that permit sufficient sunlight penetration, they become rapidly covered and colonized by algae, corals, sponges, and other sessile marine organisms. These in turn provide a protective cover and abundant food supply for all types of juvenile and adult reef fish, which in turn attract pelagic species. In a short period of time the reef material transforms a previously unproductive ocean bottom into a thriving marine community.

The Department coordinates the construction of artificial reefs in the inshore and offshore waters of Dade County. This coordination includes: the solicitation of funding and materials for artificial reef construction, material transportation and deployment, site selection and permitting, and public notification of reef site and material locations.

During 1983 permits were received for one (1) inshore and three (3) offshore artificial reef sites, making a total of four (4) inshore and eight (8) offshore permitted sites. This gives Dade County the distinction of having the largest number of permitted sites in the State of Florida (Figure 15). Also during 1983, 13,000 cubic yards of material were deployed on these sites, for a total of over 40,000 cubic yards deployed to date.

This program continues to be a productive addition to the services of Dade County, utilizing community input and resulting in the development of a charter boat scuba diving industry. Future plans call for additional material placement on the newly permitted reef sites. The Department welcomes the donation of material for use in the program and encourages involvement by corporations and the public alike.

In 1983 the Department made available to the public a brochure which describes the program and which includes a location chart for the artificial reef sites. Also available, at a cost of two dollars ($2.00), is a detailed listing of the locations of individual wrecks and other materials on the artificial reef sites. This listing is updated twice each year.

Beach Restoration

Dade County's entire eastern border lies along the Atlantic Ocean. Approximately 21 miles of this shoreline is made up of beach areas. In addition to providing the county with an extensive recreational area, the beach is an important component in the local economy. High property values and tourism are direct economic benefits. The beach also provides elements of essential storm protection for upland property and development.

Although major storms can cause dramatic changes in the shoreline, it is the ongoing erosion process that must be managed in order to

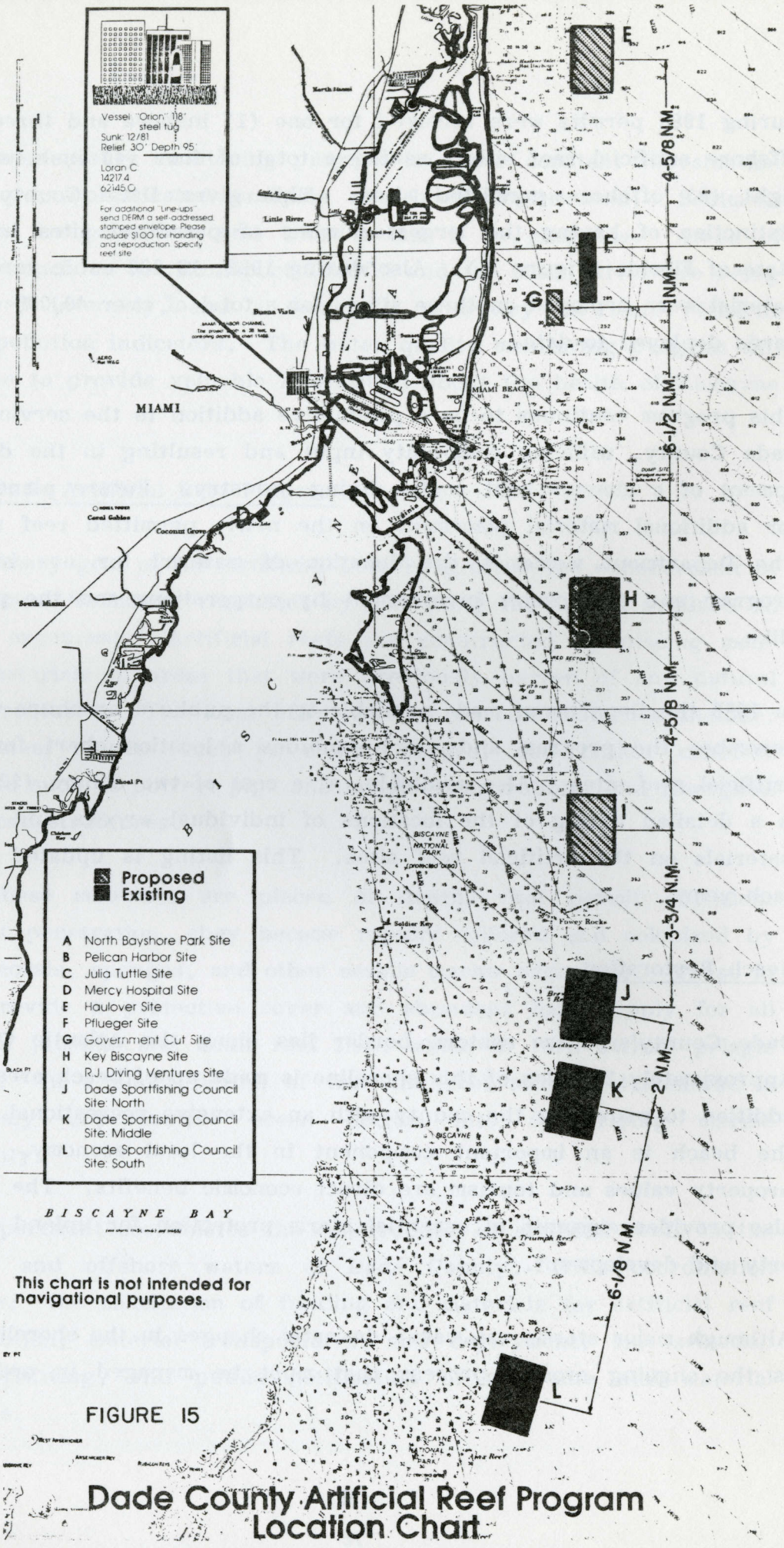


FIGURE 15

Dade County Artificial Reef Program Location Chart

The Beach renourishment project from Haulover Beach Park south to Government Cut has been completed, and similar renourishment projects are planned for the Sunny Isles area and Key Biscayne. (Photo: Rick Poley)

maintain the valuable beach. Most of Dade's beaches have been significantly depleted by erosion in recent years.

DERM has the responsibility of seeking and managing projects which address the beach erosion problem in Dade County. Beach restoration and revegetation projects have been consistently selected as the most effective management tools. Other forms of beach protection, such as the use of groins, have proven less effective and, ultimately, more expensive. To date, DERM has helped the county implement beach restoration projects in critically eroded areas of the county and is continuing to pursue additional projects still needed to adequately maintain the shoreline.

In North Dade, a beach restoration project estimated at $9,500,000 has been proposed for the Sunny Isles area. At present, there is no beach in some areas, leaving upland development exposed to direct wave attack and erosive undermining of seawalls. Additionally, potential recreational benefits are not being utilized. A design study has been completed by the U.S. Army Corps of Engineers' Board of Engineers and Chief of Engineers, and additionally has received strong support from Congressman William Lehman. When completed, the new beach would provide public beach seaward of the approximate present mean high water level. Congressional authorization is needed for this project and is included in current House and Senate Bills expected for floor action in the summer of 1984.

From Haulover Beach Park south to Government Cut, the Dade County Beach Erosion Control and Hurricane Protection Project (the largest hurricane protection restoration project in the world) was authorized by Congress in the 1968 Flood Control Act. The project was established to address the serious erosion problem that had virtually eliminated the recreational and protective viability of the ocean beach along this 10.5 mile stretch of shoreline.

Today, the new beach provides hurricane protection for the highly developed shoreline. Beachgoers appear in ever-increasing numbers. Although the initial construction of the beach has been completed, additional projects remain. Renourishment of the new beach is performed where needed approximately every 5 to 7 years to maintain the beach and preserve the initial investment. It is expected that during the fall of 1984 a jetty will be constructed at the north side of Haulover Inlet at a total cost of $3,500,000 to help contain the beach north of the inlet. A $4,000,000 vegetation project will be implemented once County funds are made available to vegetate the dune portion of the 10.5 mile beach. This, in addition to providing an important aesthetic boost, will help protect the beach during a major storm.

Dade County's beach shoreline south of Government Cut consists of Fisher Island, Virginia Key, and Key Biscayne (areas further south of here have mangrove ocean shorelines). At this time, Fisher Island is privately owned and Virginia Key, which was restored in 1968 and 1972, is owned by the City of Miami, and they are thus not included in Dade County's Beach Management Program. However, a restoration project for Key Biscayne has been in the development stages for some years, and present plans are to restore the southern 2.4 miles of the Key. This will add approximately 100 feet of beach width and will restore the Bill Baggs State Park shoreline as well as 1.2 miles of seriously eroded beach along privately owned upland property. The public will gain ownership of the beach in the private sector east of the erosion control line, which is established approximately at the present mean high water line. In addition, public access between the State Park and Crandon Park will be created. Administrative and design tasks are nearing completion, so that construction is expected to begin in 1985.

Special Bay Projects - Seagrass Restoration

Seagrass is well documented as a highly productive habitat which stabilizes sediment, reduces turbidity, and provides food and shelter