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SOUTH FLORIDA DRINKING WATER INVESTIGATION BROWARD, DADE AND PALM BEACH COUNTIES

June 1984

National Enforcement Investigations Center, Denver

U.S. Environmental Protection Agency

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF ENFORCEMENT AND COMPLIANCE MONITORING

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NATIONAL ENFORCEMENT INVESTIGATIONS CENTER
Denver, Colorado

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This comprehensive study of public drinking water supplies in south Florida would not have been possible without the cooperation and assistance of various Federal, State and local agencies, water utilities, private firms and individuals. The contributions of all of these entities are gratefully acknowledged.

A major portion of the study was conducted by National Enforcement Investigations Center personnel. This included most of the compilation and evaluation of existing data, preparation of reports, sampling of about half of the public water supplies and groundwater monitoring wells, sampling of selected industrial facilities and analytical support for these sampling activities. EPA Region IV in Atlanta, Georgia, (Water Management Division) provided overall project coordination and contributed existing information. Other EPA divisions in Atlanta also contributed information. Region IV's Environmental Services Division in Athens, Georgia, conducted the other half of the water supply and well sampling and provided associated analytical support. EPA's Office of Drinking Water in Cincinnati, Ohio, provided data and conducted field testing of water treatment equipment, including analytical support. Other Federal agency support was provided by U.S. Geological Survey offices in Tallahassee and Miami that furnished information and well sampling equipment.

Major data inputs were provided by the Florida Department of Environmental Regulation through their central office in Tallahassee and the Southeast Florida District office in West Palm Beach. The District office provided local coordination in the study area.

Three local agencies provided file information, assisted in selection of water supplies to be sampled and provided direct assistance in the EPA sampling of water supplies. These were the Dade County Department of Public Health, the Broward County Public Health Unit and the Palm Beach County Health Department, all associated with the Florida Department of Health and

Rehabilative Services. The Broward County Environmental Quality Control Board provided file information and assisted in the sampling of monitoring wells and industrial facilities. The Metropolitan Dade County Department of Environmental Resources Management provided extensive file information and references.

Various water utilities, municipalities and water supply owners cooperated in the water supply sampling and provided well data.

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I. INTRODUCTION

Drinking water supplies for about 3.5 million persons in the Miami-Fort Lauderdale-West Palm Beach area of southeast Florida are obtained from groundwater underlying the metropolitan areas. Various studies by Federal, State and local agencies during the past decade have detected synthetic organic chemicals in this groundwater and, in some cases, in public drinking water supplies. Data on chemical contamination were available for less than a fourth of the major public water supplies. The observed levels and frequency of occurrence of chemical contamination in these supplies, however, were such that there was public and regulatory agency concern about the significance and areawide scope of the contamination. Data on sources of the contamination were limited, increasing uncertainty and concern. There was, therefore, the need for a comprehensive investigation of the scope of chemical contamination of public water supplies, of the sources of such contamination and of associated regulatory programs.

This report presents the results of a year-long study of south Florida water supplies conducted by the Environmental Protection Agency (EPA) in cooperation with the Florida Department of Environmental Regulation (DER) and various local agencies. Data are presented on organic chemical contamination of public water supplies compiled from previous studies and EPA sampling of 218 public supplies in early 1984. An overview is given of potential sources of chemical contamination based on previous studies, and data are presented from EPA sampling of selected industrial wastewater discharges to groundwater in 1984. An overview of present environmental control programs is presented, and recommendations are made for enhancement of these programs.

The Miami, Fort Lauderdale and West Palm Beach metropolitan areas are the heart of a major population and economic center that extends for about 100 miles along the Atlantic coast from Homestead to Jupiter [Figure 1]. This "Gold Coast" has experienced rapid growth since World War II, and

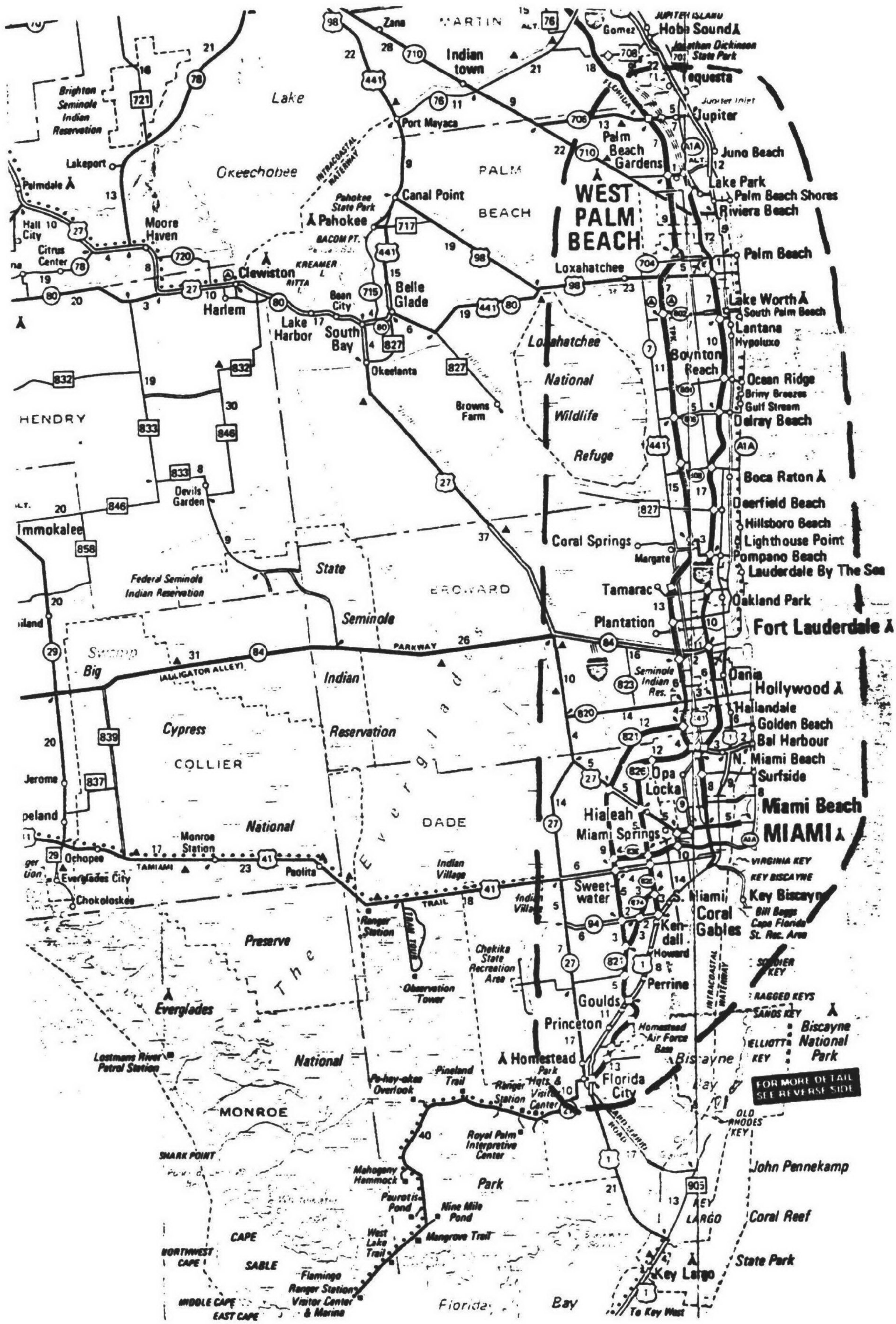

Figure 1: Study Area

development continues at a fast pace. In addition to its well known tourism economy and popularity as a retirement center, the area is a major light manufacturing center.

All public drinking water supplies (except the city of West Palm Beach) and the numerous private water supplies are obtained from the highly productive Biscayne Aquifer, a sand and limestone aquifer underlying the southern two-thirds of the developed area or from the Coastal Aquifer, a sand aquifer underlying the northern third of the developed area. These aquifers have a thickness up to 200 ft and lie immediately below the ground surface. They are recharged by rainfall infiltration, outflow from the Everglades, infiltration of surface water from numerous drainage canals, and by wastewater and surface runoff discharged directly into the ground at numerous locations. Because the aquifers are highly permeable and near the ground surface, they are very vulnerable to contamination by pollutants introduced in the recharge water. Any release of pollutants into the area environment such as spills or leaks of chemicals, inadequate hazardous waste disposal, discharge of inadequately treated wastewaters, etc. may result in contamination of groundwater and, in some cases, of drinking water.

Rapid population and economic growth have had detrimental effects on environmental conditions including groundwater quality. During the 1960s, rapid growth resulted in a proliferation of small wastewater treatment plants that often discharged inadequately treated domestic sewage and commercial and industrial wastewaters to drainage canals. Contaminated surface runoff from urban and residential areas was also discharged to the canals. As a result, the canals became eutrophic with seriously degraded water quality. This surface water quality degradation was the subject of a federal/state enforcement conference in 1970. During the 1970s, much progress was made in removing discharges of pollutants from surface waters, and surface water quality has substantially improved. Unfortunately, however, some of the pollutants were diverted into the groundwater.

In the past, construction of community sewer systems and water supplies did not keep pace with the rapid development. As a result, large residential and commercial areas were often built without community systems and were serviced with individual septic tank systems that discharged pollutants directly into the aquifer. Although most new developments have community systems and older areas are gradually being sewered, some sizeable developed areas are still not served by community sewer systems. These are often the same areas that are served by private water supplies. This increases the potential for contamination of these water supplies.

Large volumes of garbage, trash, septic tank sludges, industrial waste and hazardous waste were generated that required disposal. Early disposal practices involved open dumps, seepage pits, and other practices that allowed pollutants to leach directly into the groundwater. Recent investigations have identified several localized areas of significant groundwater contamination attributable to these inadequate disposal practices.

Regulation of public water supplies traditionally has been directed toward assuring that the sanitary (bacterial contamination) and chemical (primarily inorganic) quality of water supplies are within regulatory limits designed to protect public health. Water supplies are routinely monitored for these parameters. Water treatment is provided to ensure delivery of acceptable quality water to the consumer. In general, area water supplies are of adequate quality.

Beginning in the 1970s, several developments of national scope occurred that were to impact area water supplies. Sophisticated analytical techniques were developed that allowed the detection of various synthetic organic chemicals at very small concentrations (low parts per billion or ppb). At the same time, health research suggested ingestion of some organic chemicals at the low ppb levels found in drinking water could have adverse health affects. A national screening survey by EPA in 1974 detected significant levels of previously undetected organic chemicals in various public water supplies, including the single supply tested in Miami. This led to additional study of water supplies at the national and local levels, especially in the late 1970s and continuing to the present. At the local level, sampling of water supplies in Dade County for organic chemicals began in 1977 and was expanded to include Broward and Palm Beach Counties in 1981 and 1982. By 1983, available data were adequate to indicate that both the level of contamination and frequency of occurrence of several volatile organic chemicals were such to be of concern to environmental agencies. Of about 250 public water supply wells sampled, nearly 20% were found to be contaminated with one or more volatile organic chemicals at a concentration of 1 ppb or greater. Most of the wells sampled were in Dade County, but observed levels and frequency of contamination were similar in Broward and Palm Beach Counties.

Although 250 wells were a substantial number, they represented only a small fraction of the area's several thousand public and private wells. The scope of the presence of volatile organic chemicals in area water supplies was thus only partially defined. Sources of contamination of some wells had been defined, but in most cases, only general conclusions could be drawn. State and local agencies began developing regulatory approaches to deal with known sources of pollution.

In mid-1983, the Water Management Division, EPA Region IV in Atlanta, Georgia (the EPA unit with overview responsibilities for public water supplies in Florida) conducted a preliminary review of readily available information on organic chemical contamination of south Florida public water supplies. The review indicated the need for a systematic study of south Florida to fully define the scope of the problem, potential sources of contamination, and regulatory approaches for assuring adequate drinking water quality. In June 1983, Region IV requested technical assistance from the National Enforcement Investigations Center (NEIC) in conducting the study.

Objectives

A four-phase study was designed by NEIC to meet the following objectives:

1. Define the scope of contamination of drinking water supplies with synthetic organic chemicals.

2. Define major sources of groundwater contamination impacting drinking water supplies.

3. Identify past, present and proposed remedial measures, abatement actions and control programs for protection of drinking water quality.

4. Identify what additional and/or revised remedial measures and/or abatement programs/actions appear to be needed to minimize contamination of groundwater and to maximize protection of drinking water supplies.

Study Phases

The four phases of the study were as follows:

1. An evaluation of existing information to determine the current status of knowledge of area environmental conditions with emphasis on groundwater and drinking water quality. This phase defined the data needed to meet the study objectives.

2. An areawide evaluation of groundwater and drinking water quality to define the scope of groundwater and drinking water contamination. Sampling and analysis of public water supplies and groundwater were conducted as necessary to supplement existing data.

3. A limited investigation of potential sources of groundwater contamination to supplement previous studies.

4. An evaluation of water treatment procedures useful in removing synthetic organic chemicals from drinking water. Additional water treatment may be necessary for supplies where pollution sources cannot be identified and/or controlled and alternate water supplies are not available.

Scope

Geographically, the study focused on the eastern developed portions of Broward, Dade and Palm Beach Counties [Figure 1]. This area extends along the Atlantic coast for about 100 miles from Homestead to Jupiter and encompasses a population of about 3.5 million persons in the Miami, Fort Lauderdale and West Palm Beach metropolitan areas and adjacent communities.

The scope of the initial phase of the study consisted of an evaluation of available data and information compiled from the published literature, from Federal, State and local agency files, and from interviews with key personnel in these regulatory and water resource agencies.

During the second phase, most (135) of the public community water supplies in the study area were sampled. Finished water supplies were sampled at all facilities, and raw water samples were obtained when aeration was present in the treatment system. About 15% (83) of the public non-community supplies were sampled. No private water supplies were sampled. Sixty groundwater monitoring wells in Broward County were sampled.

The third phase was directed to the confirmation of the contamination potential of industrial wastewater discharges to groundwater from facilities using or handling significant amounts of volatile organic chemicals. Wastewater discharges and groundwater were sampled at six selected electronic component manufacturing and metal finishing plants.

The fourth phase of the study involved an evaluation of the use of packed tower aeration units to remove volatile organic chemicals from contaminated water supplies by air stripping. This phase of the study is being conducted by EPA's Office of Drinking Water in Cincinnati, Ohio. Field tests of aeration units have been completed on contaminated well water in Fort Lauderdale, Miami and Riviera Beach. Technical reports presenting the results of this research are in preparation and will be released later this year.

Existing data on synthetic organic chemicals in groundwater and public water supplies in south Florida, available at the start of this study, indicated that a group of chemicals referred to as volatile organic chemcials (VOCs) were most frequently detected and were usually present at the highest concentration. In addition, other synthetic organic chemicals were usually not present in significant concentrations without VOCs also being present. Selected VOCs were also the chemicals of most concern from a public health aspect, and drinking water standards were under development to define the significance of observed levels of contamination. By limiting water sampling and analyses to VOCs only, available study resources could screen the maximum number of water supplies. For these reasons, this study was primarily focused on volatile organic chemicals.

For purposes of this study, volatile organic chemicals are defined as those synthetic organic chemicals that can be analyzed for by purge and trap methods. These include three general groups of chemicals: trihalomethanes, aromatics and other VOCs. Trihamomethanes are formed in drinking water by the chlorination of naturally-occurring organic chemicals found in south Florida groundwaters. They are of public health concern when found at high levels in drinking water but are rarely present in significant levels in groundwater. Aromatics of concern are benzene and toluene which are always an indication of groundwater contamination, frequently by petroleum products. The VOCs of most concern are trichloroethylene (also known as trichloroethene or TCE), a common degreasing solvent; tetrachloroethylene (also known as perchloroethylene or PCE), a dry cleaning chemical and degreasing solvent; and 1,1,1-trichloroethane, also a degreasing solvent. These three VOCs are believed to be the source of much of the VOC contamination of groundwater and public water supplies. Other commonly detected VOCs include the following that are believed to primarily occur as the result of biodegradation of the three main solvents: vinylidene chloride (1,1-dichloroethene), ethylene dichloride (1,2-dichloroethane), vinyl chloride and cis- or trans-1,2-dichloroethene.

Report Organization

Section II summarizes the findings of the study including the known extent of groundwater and drinking water contamination, other environmental conditions and problems affecting drinking water quality, known and suspected sources of contamination and environmental pollution and existing environmental control programs.

Background data are presented in Section III including a description of the study area, summaries of selected previous studies and study methods. Environmental conditions are discussed in Section IV. General groundwater and drinking water quality are discussed and specific information presented on synthetic organic chemical contamination as defined by previous studies and the EPA sampling of 218 public water supplies and 60 groundwater monitoring wells. Other environmental conditions impacting drinking water supplies are discussed.

There are numerous known and potential sources of groundwater contamination. Section V discusses the various types of sources and presents estimates of the potential number and magnitude of each type of source. Detailed source inventories are not presented, however, as these are beyond the scope of study. Data are presented on the industrial wastewater discharges to groundwater sampled by EPA.

Environmental control programs at the Federal, State and local levels are discussed in Section VI.

II. SUMMARY OF FINDINGS AND RECOMMENDATIONS

ENVIRONMENTAL CONDITIONS

Drinking Water

Sampling of essentially all public community water supplies with their own wellfields in the study area showed that finished drinking water at four supplies (North Miami Beach-Sunny Isles Plant, Pompano Beach, Riviera Beach and Seacoast Utilities-Richard Road plant) contained volatile organic chemicals (VOCs) that slightly exceed Florida maximum contaminant levels that take effect June 1985. These four supplies serve about 290,000 persons (8% of study area population) and represent less than 3% of community supplies. An additional 18 supplies had detectable levels of VOCs in finished water. Five of these supplies, serving about 130,000 persons [Table 1] contained VOCs in excess of screening criteria used by this study to identify significant levels of contamination. Five supplies had detectable levels of VOCs in this raw water but they were removed by treatment. Levels of VOCs in the 27 supplies with detectable amounts were in the range of 1 to 58 μg/ℓ (parts per billion) with most supplies containing amounts less than 5 μg/ℓ.

The observed levels of VOCs in finished drinking water represent a major reduction during the last 2 years in the number of persons receiving drinking water with VOCs in excess of the new Florida maximum contaminant levels. About 1.3 million persons were served by systems with excess VOC levels in 1982. Completion of the Northwest Wellfield supplying Miami-Dade Water and Sewer Authority's Hialeah and Preston treatment plants, which serve about 500,000 persons in Miami and northeast Dade County, has reduced VOC levels in this system to below maximum contaminant levels. The Hialeah-Preston system must still make selective use of wells in older wellfields with elevated VOC levels in order to meet seasonal water demands. The Five Ash water system, which serve about 180,000 persons in Fort Lauderdale, has reduced VOC levels to below detection by shutting down and/or making selective use of contaminated wells in the Executive wellfield and by special water treatment. Contaminated wells have been taken out of service at Riviera Beach and Hallandale.

Table 1

COMMUNITY WATER SUPPLIES WITH VOC LEVELS EXCEEDING CRITERIA

System Name	City	Population Served	Raw Water	Finished Water
	BROWARD COUNTY			
Broadview Park Water Co.	Plantation	6,000	NS[a]	THM[b]
Broadview Utilities Co.	Pompano Beach	6,000	NS	THM
Broward Correctional Institute	Pembroke Pines	500	NS	THM
Cooper City Utilities East	Cooper City	10,000	NS	THM
Cooper City Utilities West	Cooper City	3,000	NS	THM
Coral Springs, City of	Coral Springs	26,000	NS	THM
Crystal Lakes MHP	Ft. Lauderdale	125	NS	THM
Dania, City of	Dania	12,500	ND[c]	THM
Ferncrest Utilities	Ft. Lauderdale	5,500	NS	THM
Ft. Lauderdale, City of (Five Ash WTP)	Ft. Lauderdale	180,000	XM*	ND
Gulf Stream Utility Co.	Plantation	21,000	NS	D,THM
Miramar, City of	Miramar	33,500	D[d]	THM
Parkland Utilities	Parkland	830	NS	THM
Pembroke Pines, City of (#1)	Hollywood	50,500	NS	THM
Pembroke Pines, City of (#2)	Pembroke Pines		NS	THM
Pembroke Pines, City of (Holly Lake)	Hollywood	310	NS	D,THM
Pompano Beach, City of	Pompano Beach	70,500	NS	XM[e]
Seminole Industries	Hollywood	100	NS	THM
Taylor Trailer Park	Ft. Lauderdale	100	NS	THM
	DADE COUNTY			
Miami-Dade Water & Sewer Auth. (Hialeah-Preston System)	Miami	500,000	XM**	XS**
N. Miami, City of (Winson)	N. Miami	65,900	XS[f]	XS
N. Miami Beach, City of	N. Miami Beach	125,000		
(Norwood)			NS	THM
(Sunny Isles)			NS	XM

Table 1 (contd)

System Name	City	Population Served	Raw Water	Finished Water
	PALM BEACH COUNTY			
Acme Improvement Dist.	Wellington	8,700	ND	THM
Akers Away Trailer Park	W. Palm Beach	210	NS	THM
Arrowhead Village MHP	Lantana	825	NS	THM
Atlantis Utilities	Atlantis	2,750	ND	THM
Boca Raton, City of	Boca Raton	65,000	NS	XS
Century Village (Century Util.)	W. Palm Beach	16,000	NS	THM
Colonial Estates MHP	Delray Beach	540	NS	THM
Consolidated Utilities	W. Palm Beach	2,500	ND	THM
Florida Water Service (Seminole Manor)	W. Palm Beach	3,700	NS	THM
Highland Beach Water Plant	Boca Raton	4,200	NS	THM
Jamaica Bay MHP	Boynton Beach	750	NS	THM
Juno Beach Mobile Court	Juno Beach	120	NS	XS
Kokomo MHP	Lake Worth	245	NS	THM
Lake Worth Village MHP	Lake Worth	1,200	NS	THM
Loxahatchee Road Prison	W. Palm Beach	86	XS	XS
Manalapan Water Dept.	Manalapan	2,100	ND	THM
Meadowbrook	W. Palm Beach	7,000	ND	THM
Palm Beach Co. - ECR #2	W. Palm Beach	27,300	XS	THM
Palm Beach Co. - ECR #3	W. Palm Beach	30,100	ND	THM
Palm Beach Co. - SCR #1	W. Palm Beach	2,300	NS	THM
Palm Beach Co. - SCR #2	W. Palm Beach	23,800	NS	THM
Riviera Beach, City of	Riviera Beach	38,000	XM	XM,THM
Royal Manor MHP	Boynton Beach	800	NS	THM
Royal Palm Beach Utilities	Royal Palm Beach	7,800	ND	THM
Seacoast Utilities	Palm Beach Gardens	59,400		
(Richard Road)			XM	XM
(Hood Road)			NS	XS
(Lilac Street)			XS	ND
Village of Golf	Boynton Beach	3,500	NS	THM

a *NS - Raw water was not sampled at this system.*
b *THM - Observed total concentration of trihalomethanes exceeds the maximum contaminant level of 100 µg/ℓ applicable to systems serving 10,000 persons or more.*
c *ND - VOCs not detected at the level of detection for the analytical methods used.*
d *D - VOCs detected but below screening criteria.*
e *XM - Observed VOC levels exceed one or more maximum contaminant limits.*
f *XS - Observed VOC levels exceed one or more screening criteria.*
* *Composite raw water from Prospect and Executive wellfields did not contain detectable VOCs. Some wells in Executive wellfield used on a seasonal basis exceed maximum contaminant levels.*
** *Raw water from Hialeah, Preston and Miami Springs wellfields exceeds VOC MCLs. VOCs not detected in Northwest wellfield raw water. Composite raw water with main supply from Northwest does not exceed criteria. Finished water meets screening criteria if supply from Northwest exceeds 90% of raw water.*

Sampling of the community water supplies also detected levels of trihalomethanes in 39 supplies in Broward and Palm Beach Counties in excess of the maximum contaminant level of 100 μg/ℓ [Table 1]. One supply in Dade County had excess levels of trihalomethanes. Trihalomethanes are synthetic organic chemicals formed during water treatment by the chlorination of naturally occurring groundwater pollutants. Most large water supplies have recently reduced trihalomethane levels to meet maximum contaminant levels. Eleven of the 40 supplies are required to meet these regulations. Trihalomethane levels can be reduced by modifications of the treatment procedures.

About 15% of the more than 500 non-community water supplies in the study area were screened for VOC contamination. Non-community supplies serve office buildings, shopping centers, restaurants, schools, etc. Five of the 83 non-community supplies sampled had VOC levels in finished water in excess of the maximum contaminant levels applicable to the community systems [Table 2]. An additional 16 supplies had detectable levels of VOCs ranging from 1 to 74 μg/ℓ. Nine non-community supplies had elevated THM levels [Table 2].

The three non-community supplies sampled in the Medley area with known groundwater contamination all had significant VOC levels. Because most non-community supplies have relatively small and shallow wells, observed frequencies and levels of VOC contamination may be somewhat representative of private wells which were not sampled during this study. The data suggest the need for a systematic screening of private and non-community supply wells in areas with known groundwater contamination to detect any water supplies with unacceptable VOC levels.

Cis-1,2-dichloroethene was the VOC most frequently detected in water supplies. Other compounds detected in a number of supplies included 1,2-dichloroethane (ethylene dichloride), trichloroethylene (TCE), vinyl chloride and tetrachloroethylene. TCE and tetrachloroethylene are chlorinated solvents commonly used as degreasers, dry cleaners and for other manufacturing and repair processes. The other compounds are believed to be present in south Florida groundwater as biodegradation products of the chlorinated

Table 2

NON-COMMUNITY WATER SUPPLIES WITH VOC LEVELS EXCEEDING CRITERIA

System Name	City	Population Served	Raw Water	Finished Water
	BROWARD COUNTY			
Everglades Holiday Park	Ft. Lauderdale	180	NS[a]	THM[b]
Pompano Turnpike Plaza	Ft. Lauderdale	5,000	NS	THM*
	DADE COUNTY			
Century 21	Medley	25	NS	*
Levine, S.L., Red Sunset Bldg.	Coral Gables	726	NS	XM[c]
Motor Service	Medley	41	NS	THM*
Westland Country Club	Hialeah	70	NS	THM
Wollard Aircraft	Medley	120	NS	*
	PALM BEACH COUNTY			
Everglades Youth Camp	W. Palm Beach	150	ND[d]	THM
Frat House Restaurant	W. Palm Beach	400	NS	XM
Hagen Road Elementary School	W. Palm Beach	200	NS	THM
Lake Worth Raquet Club	Lake Worth	137	NS	XM
Lion Country Safari	W. Palm Beach	500	NS	THM
Pratt-Whitney Aircraft	W. Palm Beach	6,000	XM	THM
Short Stop Convenience	W. Palm Beach	25	NS	THM
Sunshine Preschool	Palm Beach Gardens	25	NS	XM

a *NS - Raw water not sampled at this system.*
b *THM - Total trihalomethanes exceeds maximum contaminant level of 100 µg/ℓ applicable to community supplies.*
c *XM - Observed VOC levels exceed one or more maximum contaminant levels applicable to community supplies.*
d *ND - VOCs not detected at limit of detection for analytical methods used.*
* *Sample contaminated with low levels of benzene, toluene and xylene compounds.*

solvents. Benzene, toluene and xylene compounds were detected in some supplies. These compounds may originate from petroleum products entering groundwater.

Sampling of finished water and individual supply wells by previous studies has demonstrated that monitoring of finished water (or composite raw water when aeration is present in the water treatment) is adequate to detect any significant VOC contamination of individual wells. At least annual monitoring of water supplies for VOCs appears to be needed for wellfields near industrial facilities to ensure that any new contamination exceeding maximum contaminant levels is detected in a timely manner.

Limited data developed by this study indicate that aerators used by a number of water treatment plants in the study area achieve greater than 80% reductions in the levels of most VOCs present in raw water. Additional detailed technical studies of aerators being conducted by EPA will provide data on several supplies in the study area within a few months.

Groundwater

An extensive area of the Biscayne Aquifer in the Miami Springs, Hialeah, Miami International Airport, Medley vicinity is contaminated with volatile organic chemicals ranging up to as much as a hundred times in excess of the new Florida maximum contaminant levels for drinking water. Special treatment of this groundwater, such as aeration or activated carbon filtration, would be necessary for it to achieve drinking water standards. Until late 1983, this groundwater was the main source of the Hialeah-Preston water supply serving much of Miami and northeast Dade County. Portions of the Biscayne Aquifer in North Miami and North Miami Beach in northeast Dade County also have elevated VOC levels. Small scattered areas of groundwater contaminated with VOCs have been detected at other Dade County locations. This contamination has adversely impacted major water supplies and has forced the expenditure of millions of dollars for new wellfields, system modifications and increased water treatment. Data are inadequate to define if the contaminated areas are stable in size or are continuing to expand.

In Broward County, the most significant contamination is in the Biscayne Aquifer in an area around the east end of the Fort Lauderdale Executive Airport. This contamination has spread into a portion of Fort Lauderdale's Executive wellfield. Contamination as high as 2,000 times maximum contaminant levels has been detected in water supply wells. The contaminated area appears to still be expanding. Other areas of groundwater contamination appear to be small and scattered, primarily at industrial facilities. Groundwater contamination in Palm Beach County has been detected only in scattered small areas, primarily in industrial areas in the north part of the county. However, the frequency of occurrence of contamination appears to be increasing and contamination may be spreading in wellfields where already present.

The VOCs of most concern that have been detected in groundwater are the chlorinated solvents trichloroethylene, tetrachloroethylene and 1,1,1-trichloroethane. They are very mobile in groundwater, have been detected at concentrations as high as 1,000 $\mu g/\ell$ in groundwater and can pose significant health risks at low levels. Of equal concern are the biodegradation products of these solvents including vinylidene chloride, ethylene dichloride and vinyl chloride. These VOCs are also present at elevated levels in contaminated groundwaters and can present significant health risks at low levels. Various benzene, toluene and xylene compounds have been detected in contaminated groundwater at some locations. These compounds frequently originate from petroleum product contamination of groundwater. Vinyl chloride and benzene are human carcinogens. Some other VOCs are suspected animal and/or human carcinogens.

SOURCES OF GROUNDWATER CONTAMINATION

Industrial manufacturing plants are considered the most important sources of VOC contamination of groundwater. Contamination can occur from spills or leaks of raw materials or products, from discharges of industrial wastewaters to ground disposal and from the inadequate handling or disposal of hazardous wastes. Of about 2,200 manufacturing plants in the study area, about one-third have the potential to be significant sources of VOCs because of their use or handling of chlorinated solvents. Most of these plants are in the electronic and electrical component, chemicals, fabricated metals and machinery industrial categories. These facilities tend to be grouped in industrial areas that increase the probability of groundwater contamination in that vicinity. The worst groundwater contamination has been observed in the vicinity of older industrial areas that were initially not served by public sewer systems. There are several hundred commercial facilities, primarily dry cleaners and auto repair shops, that also use chlorinated solvents and may be significant sources of VOC contamination.

Investigations by EPA, DER and local agencies have documented VOC contamination of groundwater at sites where industrial wastewaters are being or have been discharged to groundwater from electronic component manufacturing and metal finishing plants and other facilities that use or handle chlorinated solvents. These results indicate that there may be other sites where past discharges of industrial wastewaters may have contributed to localized areas of groundwater contamination that may still be present. Some of these sites may have been properly closed but groundwater at most has never been sampled for VOCs. Adequate monitoring wells are probably not available at many of these sites.

Monitoring results from several groundwater contamination sites where deeper monitoring wells were available suggest that the 10 to 20-foot deep monitoring wells commonly used at most wastewater disposal sites may not be adequate to detect migration offsite of VOC contamination. VOC contamination extending downward through much of the 100+ feet aquifer thickness has been detected at several sites.

Many of the industrial and commercial facilities in the study area that use or handle VOCs generate hazardous wastes. Many of these facilities are exempt from full RCRA regulation because they are small quantity generators, store hazardous wastes for less than 90 days or recycle their wastes. EPA, State and local agency visits to some of these exempt facilities have found poor practices that could result in VOC contamination of groundwater. Dade County has initiated an inspection program to deal specifically with this problem.

Hazardous wastes have been disposed of at at least 50 sites in the study area. These include industrial plant sites and municipal landfills. Groundwater contamination is known or believed to be present at most of these sites and several have been linked to actual or potential contamination of water supply wellfields. Detailed site assessments have been completed at some sites and others are underway.

There are eight hazardous waste sites in the study area that are on the National Priority List for remedial action under "Superfund". Four of these are in the area surrounding the Hialeah-Preston wellfields. Surface and near-surface cleanup has been completed at the Miami Drum site. Some removal of contamination was accomplished and hydrocarbon recovery is progressing at the large Varsol cleaning solvent spill site at Miami International Airport. All hazardous disposal activities have ceased at the large 58th Street Municipal Landfill and a closure plan is under review by regulatory authorities. An immediate removal action was taken at Pepper's Steel and Alloy after site contamination was discovered. Further site cleanup is anticipated.

Two other Superfund sites are in other areas of Dade County. Surface cleanup has been completed by the site owner at Gold Coast Oil, a closed solvent recycling facility in west Miami. No remedial actions have been taken at Munisport, a privately operated but municipally owned landfill in North Miami. Remedial investigations are continuing.

Two Superfund sites are in Broward County. Groundwater contamination has been detected at Davie Landfill, a large county-owned municipal landfill west of Hollywood. No remedial actions have been completed but the sludge lagoon contributing contamination of concern is no longer operable. At the Hollingsworth Solderless Terminal Company site in Ft. Lauderdale, high levels of VOC contamination have been detected. A remedial investigation and feasibility study has been completed and is under review by regulatory agencies. This is the highest priority Superfund site in the study area for remedial actions because of its apparent contribution to contamination of the Ft. Lauderdale Executive wellfield.

ENVIRONMENTAL CONTROL PROGRAMS

Maximum contaminant levels (MCLs) for eight VOCs in drinking water, which take effect in June 1985, have been promulgated by the Florida Department of Environmental Regulation (DER). These regulations will be a key element in protection of both drinking water and groundwater from VOC contamination. They also provide a measure of the significance of observed VOC contamination.

All discharges of industrial wastewaters to surface or groundwaters must obtain a permit from DER. Most of the permits for existing discharges contain effluent limitations and conditions developed prior to the availability of information on the potential for VOC contamination of such discharges. The permits do not limit discharges of VOCs or require effluent and groundwater monitoring for VOCs.

All facilities that treat, store or dispose of hazardous wastes are required to meet various regulatory requirements prescribed by the Resource Conservation and Recovery Act (RCRA). Active facilities that do not have final RCRA permits have "interim status" that require them to meet certain minimum administrative and technical provisions. Final permits place more stringent requirements on hazardous waste facilities and minimize the potential for releases into the environment. Some facilities that handle significant amounts of VOCs are exempt from full RCRA regulation.

Local environmental and public health agencies, along with DER, have been active in the inspection of potential sources of VOC contamination, compliance monitoring and enforcement of environmental regulations. There has been substantial activity in the last few years to develop State and local regulations specific to the protection of groundwater and public water supplies.

Both Broward and Dade Counties have developed regulations and ordnances that control the use and handling of hazardous materials in the vicinity of public water supply wellfields. Such regulations reduce the potential for new contamination of water supplies. An active inspection and enforcement program is key to the success of this regulatory approach.

RECOMMENDATIONS

1. Individual wells should be sampled at all multiple-well public water supplies for which VOC contamination has been detected by this study to determine if major contamination is present in any well. Single well supplies for which significant contamination (exceeds screening criteria or maximum contaminant levels) was detected should be resampled to verify the observed levels of VOCs.

2. Water supplies for which VOCs exceed maximum contaminant levels in finished drinking water should initiate steps to lower VOC levels below maximum contaminant levels as soon as practical but no later than June 1, 1985, for systems serving more than 1,000 persons or January 1, 1987 for smaller systems. Ideally, VOC levels should be reduced to less than analytical detection limits.

3. Appropriate actions should be initiated by the 40 community water supplies in Table 1 with elevated THM levels to reduce THMs to below the maximum contaminant level. This is required by regulation for the 11 large systems and is desirable from a public health viewpoint for all systems. The nine non-community supplies in Table 2 with elevated THM levels should also give consideration to reducing their THM levels.

4. Consideration should be given to the screening of all non-community and private water supply wells in areas with known groundwater contamination to determine if significant VOC contamination is present in any supply.

5. Whenever significant contamination of a well or water supply is detected, followup investigations should be conducted to detect the possible sources of contamination. The investigation should attempt to determine if there is an active source of contamination that can be abated or if remedial action for a past contamination incident is needed.

6. Permits for discharges of industrial wastewaters to surface or groundwaters from facilities handling VOCs should contain effluent limitations on VOCs. The effluents and receiving groundwaters should be routinely monitored for VOCs.

7. Groundwater monitoring wells and monitoring programs for existing industrial discharges should be reviewed for adequacy in detecting migration of VOC contamination from the wastewater disposal site. This should include consideration of requirements for at least one deeper monitoring well at each site in addition to the 10 to 20-foot depth wells commonly used in south Florida.

8. All discharges of industrial wastewaters to groundwater from facilities handling VOCs should be phased out as soon as practicable. Priority should be given to discharges in the zone of influence or upgradient of major public water supply wellfields.

9. Groundwater sampling for VOC analyses should be conducted at all disposal areas for former industrial wastewater discharges to groundwater from electronic component manufacturing plants, metal finishing plants or any other facilities using or handling VOCs.

10. In the processing of final RCRA permits for facilities that treat, store and/or generate hazardous wastes, priority should be given to facilities near public water supply wellfields.

11. All facilities that use, handle, store or manufacture volatile organic chemicals, especially trichloroethylene, tetrachloroethylene and 1,1,1-trichloroethane, and that are within the zone of influence of public water supply wellfields should be inspected regularly. This should include small quantity hazardous waste generators as well as larger facilities. Continuation and expansion of existing local programs in this regard are encouraged.

12. The administration and enforcement of local ordinances and regulations governing the handling and storage of hazardous materials within the zone of influence of public water supply wellfields should give priority to activities involving the chlorinated solvents trichloroethylene, tetrachloroethylene and 1,1,1-trichloroethane.

13. A detailed investigation of the industrial areas to the north and east of the Ft. Lauderdale Executive Airport should be conducted by appropriate regulatory agencies to identify and abate sources of VOC contamination. This should include consideration of subsurface investigations at sites most likely contaminated and appropriate remedial actions including aquifer restoration where warranted.

14. Remedial actions should be expedited at the Hollingsworth Solderless Terminal Company site including recovery and treatment or disposal of contaminated groundwater at the site to prevent further spread of this contamination toward public water supply wellfields.

15. Preliminary assessments (and remedial investigations where warranted) should be completed at all known hazardous waste disposal sites in the study area. Priority should be given to those sites in the vicinity of public water supply wellfields.

III. BACKGROUND

DESCRIPTION OF STUDY AREA

Cultural Features and Population

Miami, Fort Lauderdale and West Palm Beach are the population centers of the "Gold Coast", the urbanized, Atlantic coast portion of Dade, Broward and Palm Beach Counties in southeastern Florida [Figure 1]. Situated between the Atlantic Ocean on the east and the Everglades wetlands on the west, the area is a rapidly growing tourist resort, popular retirement area, and light manufacturing center. The 1980 population of the three counties was about 3.2 million residents.[1] During peak tourist periods, several hundred thousand more persons are present in the area. Essentially all of the development and population is confined to the coastal area except in Palm Beach County where extensive farmland and a small population are located inland.

Dade County has the most extensive development and largest population. About half of the area population is in Dade County which had a 1980 population of 1.6 million.[1] Miami and Miami Beach are central to the developed area [Figure 2]. Miami Beach is densely populated with numerous resort facilities, restaurants, hotels and high-rise condominiums. Miami has a variety of types of development including a central business district and sprawling areas of typical single-family neighborhoods, luxury homes, low-rise apartments, commercial areas and industrial areas. These industrial areas typically contain closely spaced, warehouse type buildings with numerous small light manufacturing facilities. Many are electronics and other high technology type industries.

Most of the older development in Miami is east of the Palmetto Expressway (State Route 826) and the North-South Expressway (Interstate 95) in northern Dade County. The area between the Palmetto Expressway and Florida's Turnpike (State Route 821) has been developed more recently with development continuing. Extensive development has been planned for areas

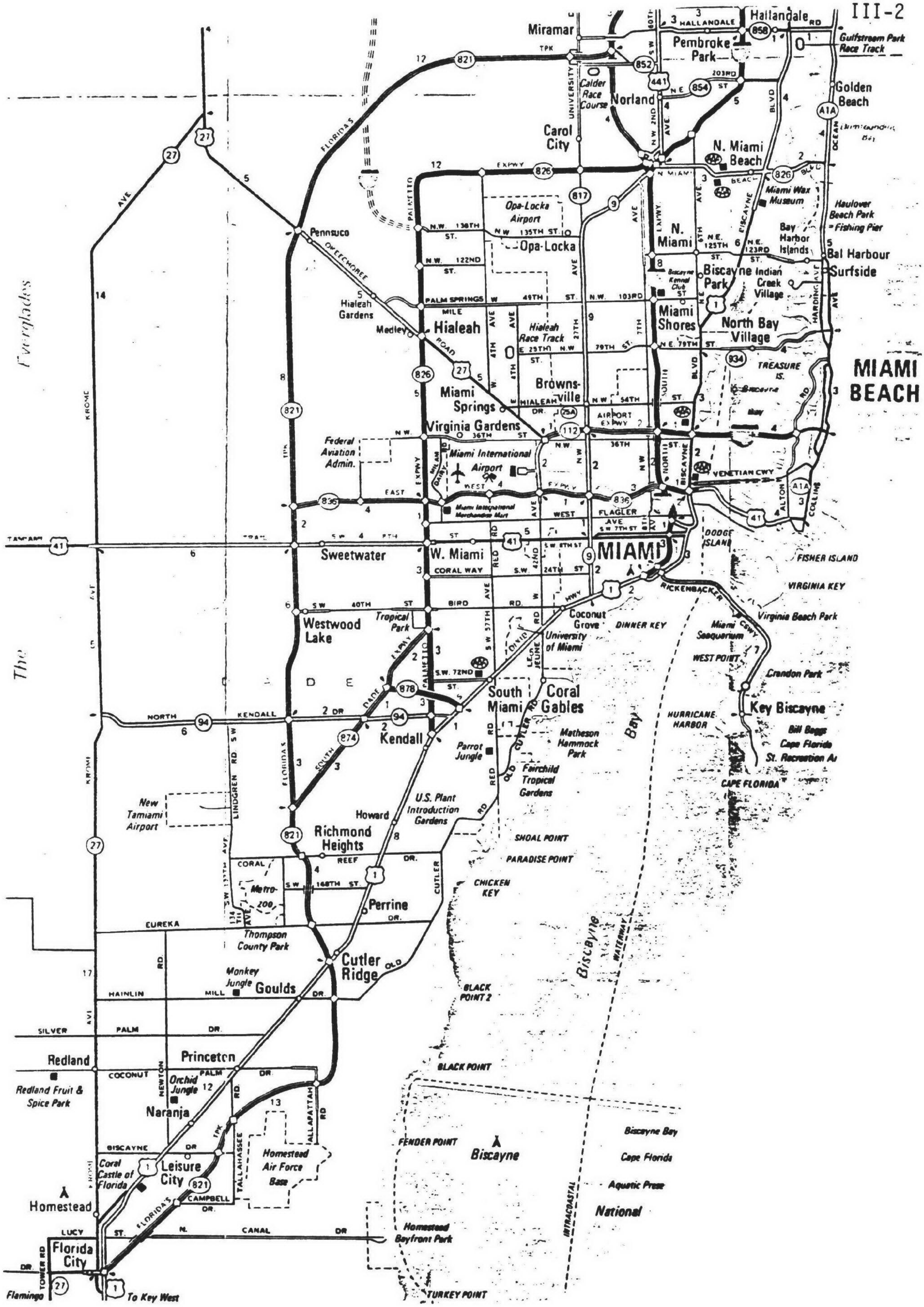

Figure 2: Dade County Study Area

inland from the Turnpike where development has recently begun. Major industrial areas are around Miami International Airport and in the Medley and North Miami vicinities, although clusters of industrial activity can be found in much of the north and west portions of Miami.

To the southwest of Miami, development is much lighter between Coral Gables and Homestead. Communities are relatively small and predominantly residential with limited industry. This area has extensive agricultural land where vegetables, fruits and other intensive crops are grown.

Dade County has a total area of about 2,000 square miles of which only about one-third can be developed. The bulk of the county is in Everglades National Park and other Everglades wetlands. The developed area is now about 400 square miles.

Broward County is less developed than Dade County but has many of the same characteristics and is experiencing rapid growth. Fort Lauderdale and Hollywood are the major population centers for this county with a 1980 population of about 1 million [Figure 3].[1] Development is most extensive in the south with lighter population densities in the north.

Resort communities are along the coastline with residential, commercial and industrial areas extending inland. Major industrial areas are around the Port Everglades harbor area, the Executive and International Airports and along Interstate 95 between the airports.

Only about a third of Broward County's 1,200 square miles can be developed, as the rest of the area is occupied by the Everglades and water conservation areas. Present development is less than 300 square miles in a narrow strip less than 15 miles wide. Agricultural land occupies the northwest portion of the area available for development.

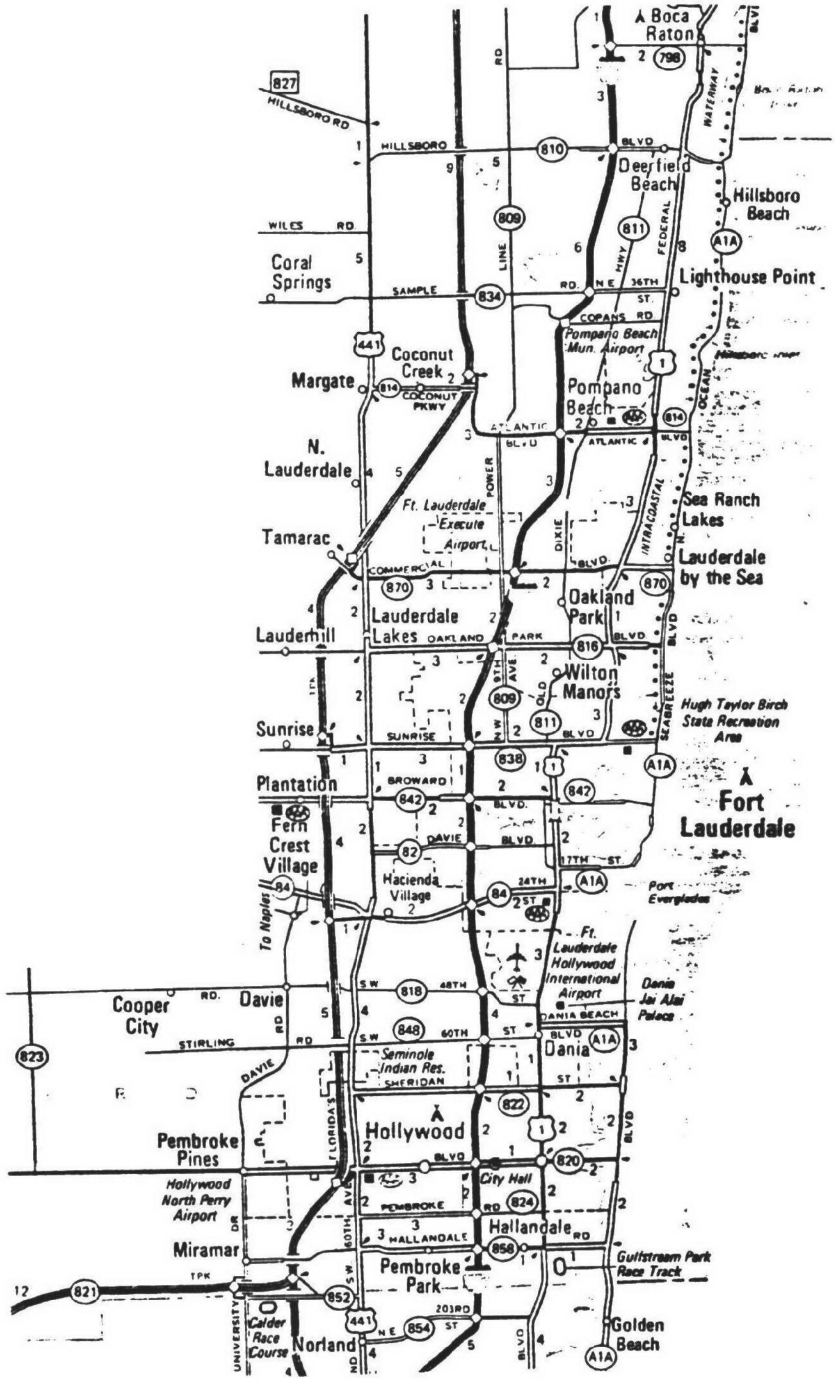

Figure 3: Broward County Study Area

Palm Beach County is about the same total size as Dade County but has a much smaller population and level of development. County population in 1980 was about 0.6 million.[1] This population was primarily in West Palm Beach, the largest city, and the coastal resort communities, but a small population was scattered about the extensive agricultural area of western Broward County and in the small communities around Lake Okeechobee [Figure 1]. In the southern portion of the county between Boca Raton and West Palm Beach, development is primarily confined to a narrow strip between Interstate 95 and the coast [Figure 4]. Development extends farther inland in the West Palm Beach area. Industrial areas are primarily in Riviera Beach, West Palm Beach and along the Interstate 95 corridor. Agriculture (vegetables and fruits) occupies much of the land available for development in eastern Palm Beach County.

Topography

An east-west cross section of the study area taken anywhere between Miami and West Palm Beach would exhibit similar topography [Figure 5].[2] On the east, the coastline begins with barrier islands only a few feet above sea level. These long, narrow islands are separated from the mainland by shallow estuarine waters such as Biscayne Bay and Lake Worth. Miami Beach and Palm Beach are built on such islands.

The Atlantic Coastal Ridge, a sandy ridge about 5 to 50 feet above sea level, extends about 2 to 3 miles inland from the estuaries and northward from Miami out of the study area. When development began in South Florida, the coastal ridge was developed first because of its elevation and relatively dry conditions.

West of the Coastal Ridge, the land surface slopes down to about 5 to 10 feet above sea level. This area was historically all wetlands, but much of it has been drained and developed for agricultural urban purposes. Large areas of the Everglades wetlands west of the developed area have been preserved in the Everglades National Park or in water conservation areas in Dade and Broward Counties. In Palm Beach County, a large area of wetlands

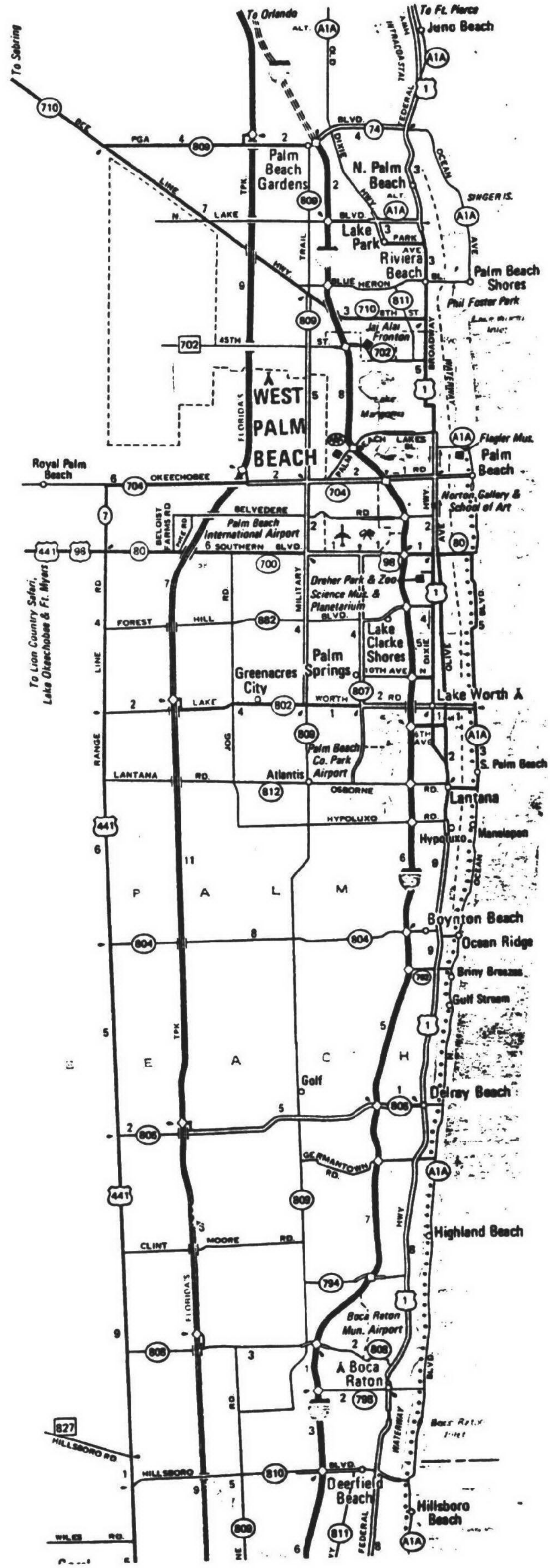

Figure 4: Palm Beach County Study Area

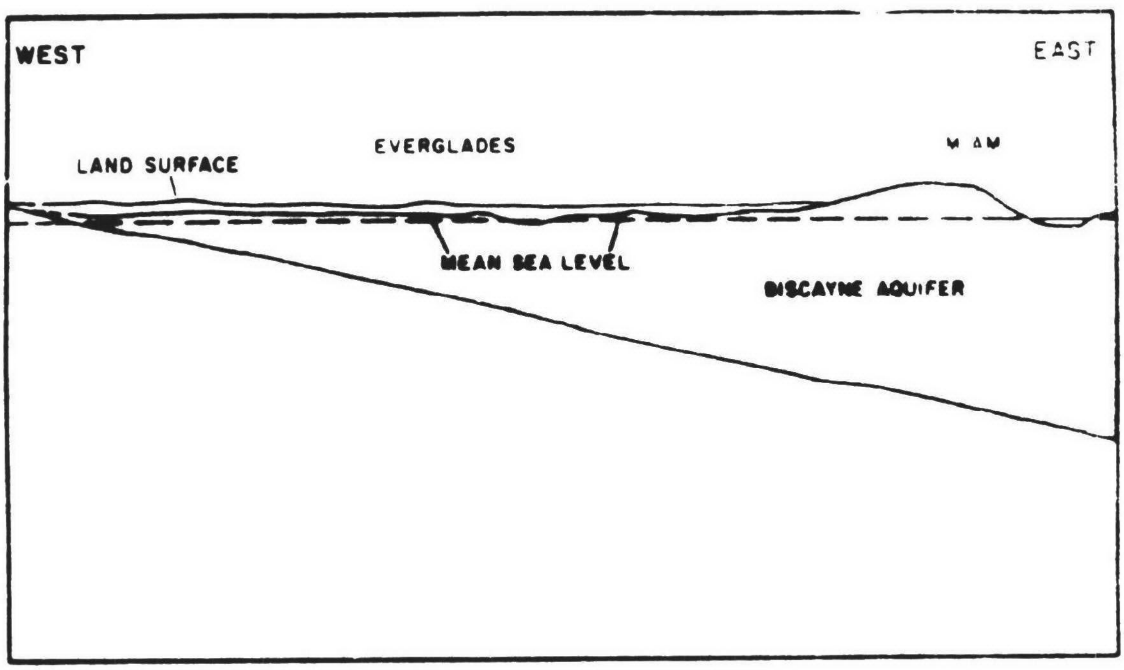

Figure 5. Typical Cross-Section of the Biscayne Aquifer

has been preserved in the Loxahatchee National Wildlife Refuge. Large areas in the remainder of the county have been drained for agricultural use, primarily sugar cane.

Lake Okeechobee, a large (750 square mile), shallow freshwater lake is in the northwest corner of Palm Beach County. A number of large drainage and water supply canals, interconnected by various smaller canals, convey water south and eastward to the coastal areas.

Climate

The study area has a sub-tropical climate with warm, humid summers and mild, drier winters. Average annual rainfall is in the range of 50 to 60 inches, depending on location. A major portion of the rainfall occurs in intense thunderstorms during the summer and fall, producing distinct wet and dry seasons. The area is also subject to hurricanes and tropical storms that can produce more than 12 inches of precipitation a day. These storms usually occur in the fall.

The peculiarities of the south Florida climate strongly influence both the quality and quantity of drinking water supplies. Floods and drought problems occur. This has necessitated the construction of extensive water management facilities. Surface and groundwater quality and quantity are closely related. These interrelationships are discussed in the following section.

Hydrology

Due to the particular geology of south Florida, there are complex interrelationships between the quantity and quality of surface and groundwaters in the study areas. Seasonally, the transfer of water between surface waterways and groundwater reverses with groundwater discharging to drainage canals in the wet season and surface water from the canals recharging the aquifer during the dry season. This interaction is enhanced by the operation of the canal system and by withdrawal of groundwater by public water supply wells. Proximity to the ocean results in sea water intrusion into the fresh water canals and aquifers under some conditions. All of these interactions impact water quality.

The Biscayne Aquifer, a highly productive, unconfined aquifer, underlies all of the developed area of Dade and Broward Counties and the southeast portion of Palm Beach County [Figure 6].[2] The aquifer is wedge-shaped in cross section [Figure 5] with its base about 150 to 200 feet below sea level near the coast and sloping upward to the ground surface in the Everglades. The top of the aquifer is within 5 feet of the ground surface in most areas. Average thickness in much of the developed area ranges from 80 to 160 feet.

The Biscayne Aquifer is composed of limestone, sandstone and sand. Southwest of Miami, the aquifer is primarily limestone and sandstone, but north of Miami the aquifer is primarily sand. The surface of the aquifer is primarily oolitic limestone to the southwest of Miami and sand to the north. There are both horizontal and vertical variations in the permeability of the aquifer. The limestone is riddled with solution cavities in many areas and is more permeable than the sand. Limestone cavities near the surface are often filled with sand. There are distinct vertical zones within the aquifer in many areas. Three zones are common in Dade County. Although these zones are present, all parts of the aquifer are hydraulically connected so movement of pollutants occurs from zone to zone. Maximum well yields are as high as 7,000 gpm [Figure 6].[2]

The Coastal Aquifer is present in the developed area of Palm Beach County north of the Biscayne Aquifer [Figure 6]. It is an unconfined sand aquifer similar to the Biscayne. There is some question as to whether most of the Coastal Aquifer in Palm Beach County may actually be a northern extension of the Biscayne. The Coastal Aquifer has lower permeability than the Biscayne but is still highly productive, especially in a 5-mile wide zone paralleling the coast and a few miles inland.[3] This zone is composed of cavity-riddled sandy limestone in the lower layers. The aquifer ranges in depth from 75 to 250 feet in the developed area. Maximum well yields are about 1,000 gpm [Figure 6].[2]

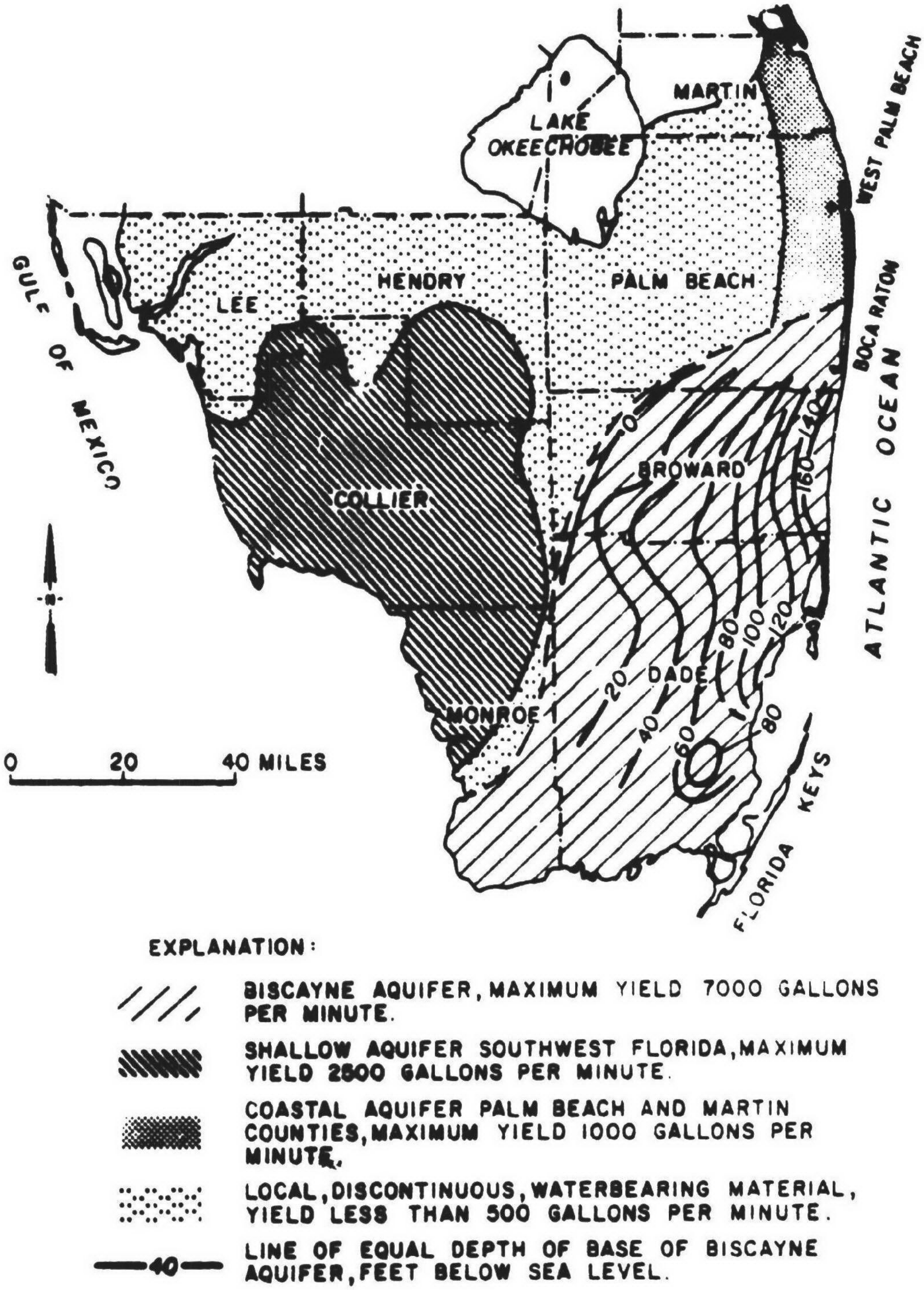

Figure 6. Areal Extent of Bīscayne and Coastal Aquifers

The entire study area (and most of Florida) is underlain by the Floridan Aquifer, a deep confined aquifer that dips below the Biscayne and Coastal Aquifers. It is found in the study area at depths of 1,000 to 3,000 feet and is separated from the surface aquifers by several hundred feet of impervious formations. Water in the Floridan is unusable in the study area because of high chlorides. Several deep injection wells dispose of municipal wastewaters into the Floridan.

Surface soils include sand, muck, peat, marl and rockland [Figure 7].[2] Soil types affect both the rate of infiltration and groundwater quality. The sandy soils near the coast and in northern Broward and Palm Beach Counties allow rapid infiltration and also filter out some pollutants. In contrast, the muck and peat soils add organic acids to the infiltrating surface waters that cause solution cavities in the underlying limestone. Other organics are also added that are precursors to the formation of trihalomethanes in the chlorination of drinking water. The muck is also the source of high color in the groundwater. Where cavity-riddled limestone is near the surface, the aquifer is most vulnerable to contamination because there is little attenuation of pollutants in the cavities.

Recharge of the surface aquifers occurs in several ways of which infiltration of rainfall directly on the aquifer is the most important. Surface water in the Everglades also infiltrates and moves southeastward in the aquifer into the study area. Infiltration of surface water from canals during the dry seasons is also important, especially near wellfields where the water table is depressed. Wastewater discharges from municipal and industrial sources to seepage pits and dry wells are a minor source of recharge but are important with respect to groundwater contamination. Surface runoff from parking lots, highways, etc., is often discharged to groundwater.

Of the approximate 60 inches of precipitation received annually in the study area, about one-third is directly evaporated and another one-third is withdrawn from groundwater by evapotranspiration.[2] This leaves a net

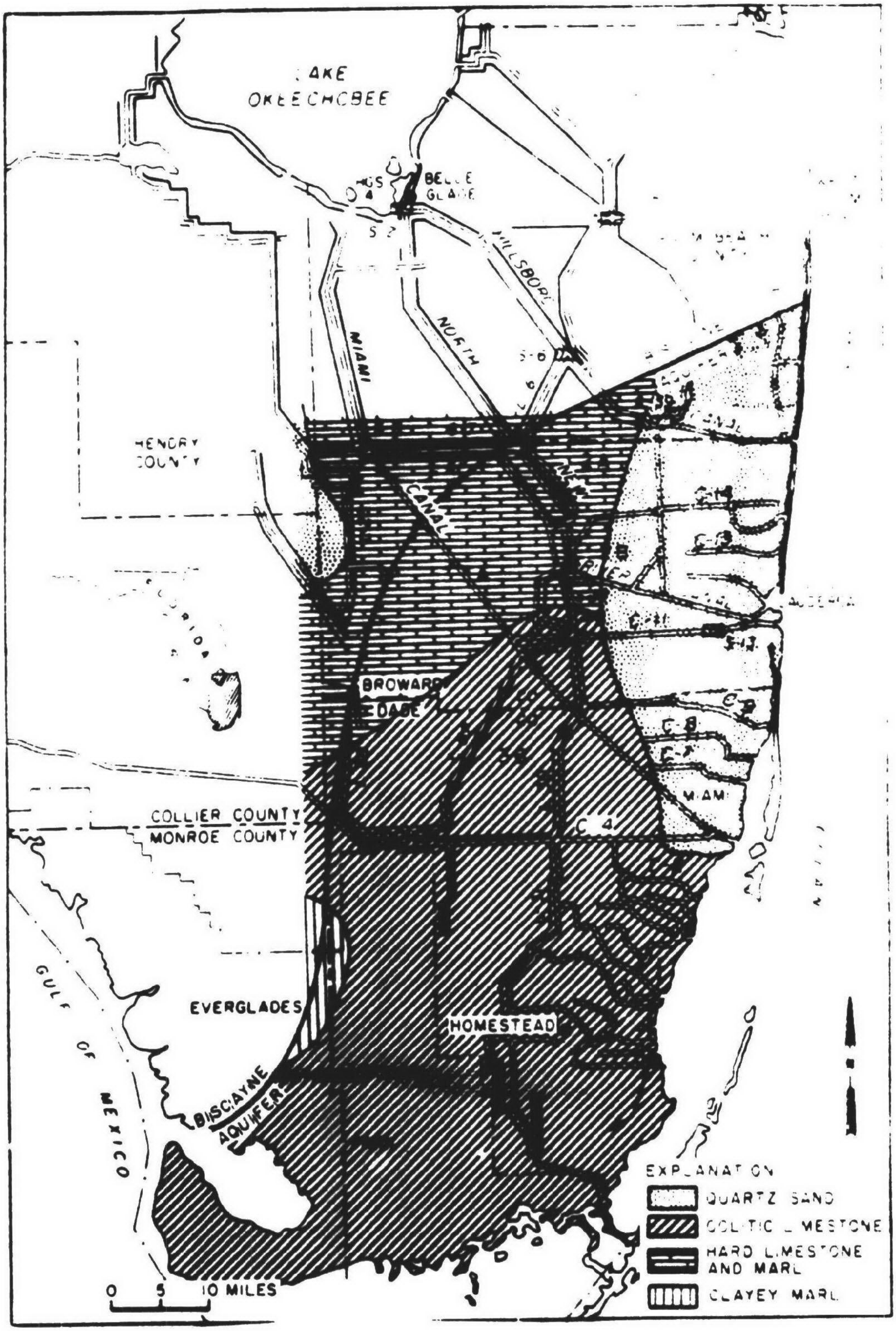

Figure 7. Surface Geology of the Study Area

recharge of about 15 to 20 inches. About 2 to 4 inches are withdrawn for public water supply, depending on the area. The remaining water is discharged to the ocean through the drainage canals or through the aquifer under the sea floor.

Because the aquifer is connected to the ocean, differences in water levels in the aquifer affect the location of the boundary between fresh and saline water. During the wet season, water levels rise and this boundary is pushed seaward. In the dry season, water levels decline and sea water moves inland. This salt intrusion was accelerated by the early land drainage projects that lowered water levels and, more recently, groundwater drawdown by water supply wells during drought periods. Some wells near the coast have become contaminated with salt water and have been abandoned. Seawater also moved inland in the early canals during drought periods and infiltrated the aquifer. Salinity barriers have been constructed across the canals to abate this intrusion.

Surface water movement in essentially all of southeast Florida is controlled by a complex system of canals, water conservation areas, a large storage reservoir (Lake Okeechobee), control structures and pumping stations operated by the South Florida Water Management District [Figure 8].[2]

Canals were originally constructed to drain the coastal ridge and provide protection against hurricane flooding. The canals were later extended inland to drain wetlands to make more land available for development. Eventually the canals were extended all the way to Lake Okeechobee, a large (750 square mile) natural lake now diked as a storage reservoir.

During the wet season, canal controls are opened, and large volumes of fresh water are discharged to the ocean. Water levels in the canals are maintained at low elevations. Water levels in the aquifer, elevated by rainfall infiltration, are drawn down by discharges of groundwater to the canals. Excess water inland is stored in the water conservation areas and Lake Okeechobee. Some water is backpumped from the canals into these storage areas.

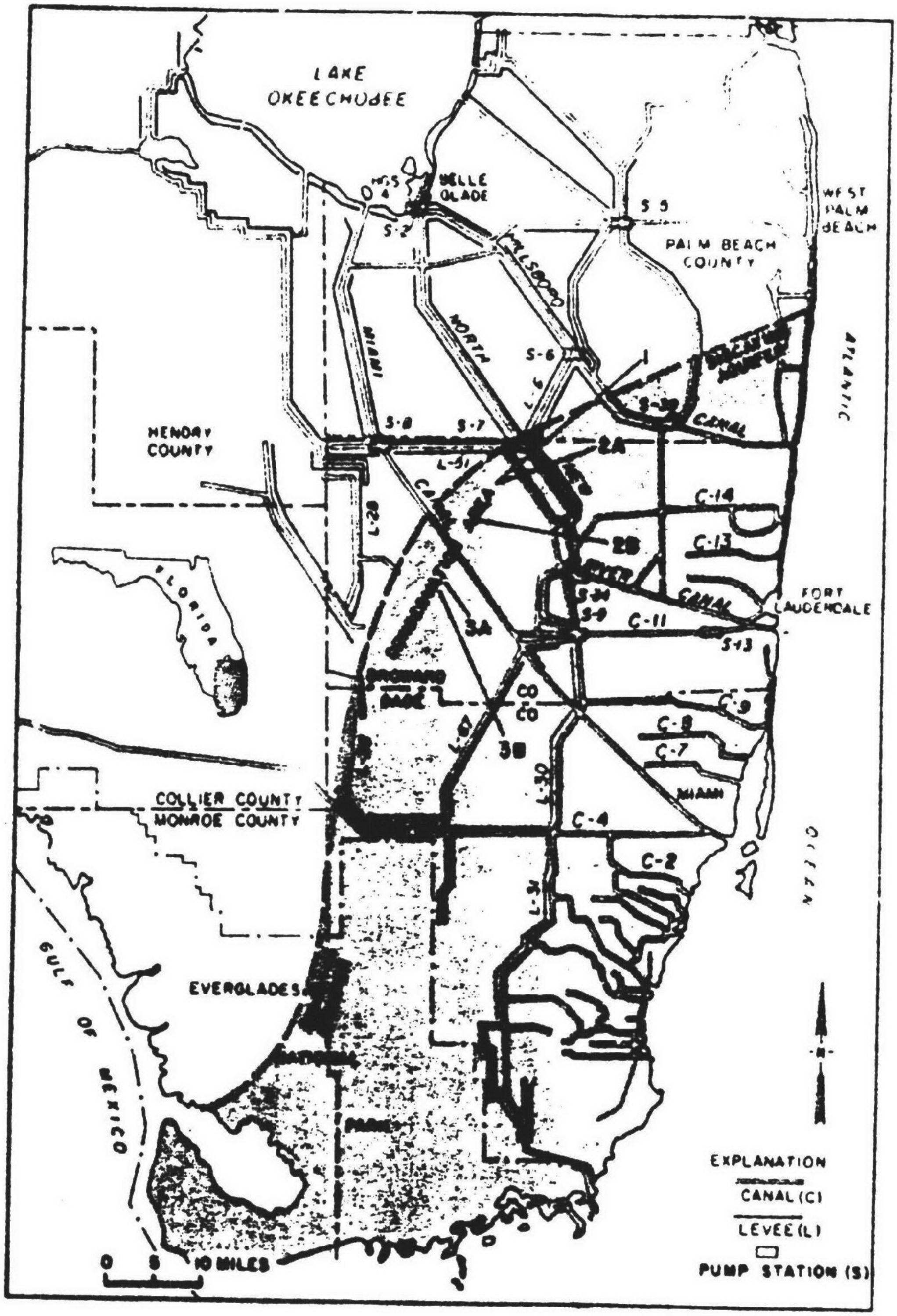

Figure 8. Hydrologic Features

Procedures are reversed during the dry season. Canal controls are closed to prevent salinity intrusion and to elevate water levels in the canals above adjacent water tables. This results in infiltration of surface water into the aquifer. During extreme dry periods, water is released from Lake Okeechobee and the water conservation areas to maintain flow in the canals.

Groundwater movement in the study area is generally toward the ocean (east or southeast). In the vicinity of canals and wellfields, however, more complex flow patterns occur. The large wellfields produce large cones of depression in the water table (as much as 10 feet at the center and several miles across). Water levels fluctuate several feet between wet and dry seasons. As discussed above, groundwater flow may be either toward or away from canals. These factors may result in seasonal changes (even reversals) in the direction of groundwater flow near large wellfields. This makes location of sources of contamination of a particular well difficult. Other complicating factors in this regard are the highly permeable solution cavities in the limestone and high average flow velocities (2-3 feet/day) in the aquifer.

Drinking Water Supplies

All water supplies in Broward and Dade Counties are obtained from Biscayne Aquifer groundwater. In Palm Beach County, all supplies in the study area, except West Palm Beach, are obtained from groundwater. West Palm Beach uses surface water from Clear Lake and Lake Mangonia. These lakes are supplied by canal from a water conservation area in the west part of the city and from Lake Okeechobee. Groundwater in Palm Beach County is obtained from the northern portion of the Biscayne Aquifer and from the Coastal Aquifer in the northern part of the county.

There are three categories of water supplies in the study area as defined by environmental regulations. Public water systems (two categories) provide piped water to the public for human consumption and have at least 15 service connections or regularly serve at least 25 persons at least 60 days of the year.[4] If the persons served are year-round residents, the public system is a community system. If the persons served are not residents, the public system is a non-community system. All other systems are private water supplies. Public community water supplies range in size from the large municipal systems to small systems serving small groups of residences such as trailer parks. Public non-community supplies service facilities such as shopping centers, restaurants, office buildings and service stations. Private supplies are most commonly individual residence wells. Systems within the three different categories of water supplies differ significantly in the average number of persons served, well construction, water treatment, applicable regulatory controls, and ultimately, in the typical quality of water delivered to the consumer.

Community water supplies are typically obtained from multiple wells which are properly constructed and have large yields. The wells are usually finished in the mid to lower levels of the aquifer. Raw water typically receives lime softening, filtration and chlorine disinfection in a central, well-operated treatment plant. Aeration may be provided for iron and sulfide removal, especially in Palm Beach County. The most stringent regulations apply to community water supplies. Water quality is regularly monitored for regulated parameters. Contamination problems are most likely to be detected if they involve regulated parameters but may escape detection if they involve non-regulated parameters. When problems occur, they affect large numbers of people.

In contrast, non-community water supplies are typically obtained from one well, frequently a shallow well which may be relatively small in yield. Well construction may not be as good as community wells and, in some cases, may be inadequate to prevent contamination by nearby sources of pollution. Although some non-community supplies receive a high degree of treatment, many of them may not receive much more than disinfection. Quality regulations are limited, and monitoring is infrequent except for selected supplies, such as schools, which receive regular monitoring. Contamination incidents are less likely to be detected until health problems occur. On the other hand, the number of persons affected may be small.

Private water supplies are usually obtained from single, small, shallow wells. Well construction is highly variable and may be inadequate to protect the supply from bacterial contamination from surface runoff or nearby septic tanks. While some supplies may receive treatment for iron and hardness removal and may be disinfected, most receive no treatment at all. The supply need only meet bacteriological requirements. Monitoring is infrequent.

Table 3 summarizes the number of community and non-community public water supplies in each of the three counties by size of population served. These are approximate numbers taken from an EPA Region IV 1982 inventory.[5] The inventory includes some water supplies that do not have wellfields and/or treatment plants but purchase finished water from another system. Only about half of the approximate 250 community systems listed are considered major supplies and are closely monitored by State and local regulatory agencies. Table 3 also shows a January 1984 estimate of the number of active community and non-community supplies in each county as listed in a DER computer inventory.[6] The number of supplies (especially non-community supplies) has been sharply reduced in recent years as a result of community system expansions.

Although Dade County has the largest population, it has the fewest number of community systems. This reflects the fact that regionalization of water supplies has been underway for a number of years. Several smaller treatment plants have been phased out. Three large treatment plants (Alexander Orr, Hialeah and John Preston) operated by the Miami-Dade Water and Sewer Authority (WASA) provide water for more than half of the Dade County population. In 1980, there were about 220 major public water supply wells in 65 wellfields serving the community water supplies.

There are currently about 116 non-community water supplies in Dade County [Table 3]. Many of these serve fewer than 50 people. Estimates of the population served by private wells in Dade County run as high as 100,000. Based on an average of 2.5 persons per residence, there could be as many as 40,000 private wells in the county.

Table 3

SUMMARY OF PUBLIC WATER SUPPLIES

Population Served	Broward Co.		Dade Co.		Palm Beach Co.		Total		All Public
	Com.*	Non-Com.**	Com.	Non-Com.	Com.	Non-Com.	Com.	Non-Com.	
<101	2	74	13	185	17	394	32	653	685
101-500	14	21	13	47	28	69	55	137	192
501-1000	6	2	3	17	10	8	19	27	46
1001-2500	8	1	11	6	13	4	32	11	43
2501-3300	2	0	2	1	1	1	5	2	7
3301-5000	3	1	5	0	5	0	13	1	14
5001-10,000	14	0	11	0	6	1	31	1	32
10,001-50,000	29	0	9	0	13	0	51	0	51
50,001-75,000	3	0	1	0	3	0	7	0	7
75,001-100,000	0	0	1	0	1	0	2	0	2
>100,000	2	0	4	0	0	0	6	0	6
EPA TOTALS (1982)	83	99	73	256	97	477	253	832	1,085
DER TOTALS (1/84) (All Populations)	55	74	35	116	75	307	165	497	662

* *Community*
** *Non-Community*

Broward County has 55 community water systems in the DER inventory [Table 3]. Broward County agencies identified 53 community systems they regulate.[7] Most of these are medium-sized systems. Only about 74 non-community systems have been identified, most serving fewer than 50 persons. An estimated 20,000 persons are served by about 8,000 private wells in this county.

There are 75 community water systems in Palm Beach County reflecting less regionalization among the smaller communities than in other counties. There is a large number (more than 300) of small non-community systems. Estimates of the population served by private wells were not available.

There are probably about 3.5 million persons (including tourists) served by community water systems in the study area. An additional 100,000 are served by non-community systems. However, because these are often day users only, these persons probably receive part of their supply from the community systems. Estimates of population served by private systems are in the range of 100,000 persons. Community water systems thus serve the large majority of area residents.

Groundwater withdrawals for public water supplies in 1982 were about 300 mgd in Dade County, 210 mgd in Broward County and 100 mgd in Palm Beach County.

PREVIOUS STUDIES

There have been numerous studies of the south Florida environment involving air and water quality, air and water pollution sources, hazardous waste management and disposal, pesticide use, groundwater hydrology, water resources, and other aspects of potential interest to this study. Literature and file materials compiled from a variety of sources were reviewed and data of particular interest abstracted. The studies discussed below were specifically useful in this regard.

In 1970, the Governor of Florida requested technical assistance from the Federal Water Quality Administration (the predecessor of EPA) in determining water pollution abatement requirements for Dade County. This assistance was coordinated by the Lower Florida Estuary Study based in Fort Lauderdale.[8] An evaluation of water quality of Biscayne Bay and the various inland drainage canals found that water quality was severely degraded in the canals, primarily by inadequately treated municipal sewage and septic tank effluents. The need for an inventory and evaluation of industrial sources of pollution was identified. The potential for contamination of groundwater supplies by polluted surface waters was also recognized.

In late 1970 and early 1971, NEIC assisted the Estuary Study in compiling an inventory of all industrial sources of pollution in Dade County.[9] About 1,800 industries were identified as being located in the metropolitan area of Dade County. Based on the type of industry, this list was reduced to about 600 potential sources of pollution. Phone contacts were made with these 600, and 233 plants were selected for field inspections. Of these 233, 89 were found to have significant industrial wastewater discharges. Thirty-eight discharged to public sewers, 36 discharged to dry wells, seepage pits or other methods of discharging into the ground, and 15 discharged to surface waters. Many of the surface and ground discharges contained toxic pollutants such as heavy metals and chemical solvents. Most of these toxic pollutant sources were located in the Miami International Airport vicinity, in the cone of influence of the Miami Springs-Hialeah well fields. The hazard to the well fields was identified and the recommendation made to connect industrial discharges to public sewers. Sampling of the industrial discharges, groundwater and public water supply wells was also recommended to evaluate the fate of toxic pollutants in the aquifer. This was the earliest indication in the materials reviewed for the current study of potential toxic contamination of drinking water in the Miami area.

Based on the discovery of synthetic organic chemicals in the New Orleans water supply, EPA conducted a reconnaissance survey of 80 water supplies across the nation in 1974.[10] Treated water from the Preston plant in

Miami was analyzed for six volatile organic chemicals (chloroform, bromoform, bromodichloromethane, dibromochloromethane, carbon tetrachloride,and 1,2-dichloroethane). The first four compounds are known as trihalomethanes and are usually formed by the chlorine disinfection of drinking water. The other two compounds had been found in other water supplies. The analysis detected 311 μg/ℓ of chloroform, the highest of all 80 cities sampled. Other trihalomethanes were also high. Carbon tetrachloride was not detected. A trace (<0.2 μg/ℓ) of 1,2-dichloroethane was detected.

Based on the results of the national reconnaissance, several water supplies, including Miami, were selected for additional monitoring in early 1975.[11] Analysis was not limited to only the six compounds. Both raw (untreated) and finished (treated) water were analyzed at the Preston treatment plant. The analyses qualitatively detected 35 different volatile organic compounds including benzene, chlorobenzene, p-dichlorobenzene, 1,1-dichlorethylene (vinylidene chloride), cis- and trans-1,2-dichloroethylene, toluene, trichloroethylene, and vinyl chloride. Vinyl chloride was quantified as 5.6 μg/ℓ in finished water. These data indicated that chemicals of industrial origin were present in groundwater in the Preston wellfield.

EPA Region IV conducted additional sampling and analysis of groundwater, raw water supplies, and finished water supplies in the vicinity of the Hialeah and Preston treatment plants and the 58th Street dump, a major Dade County landfill, in 1975 to verify the extent of contamination and possible sources.[12] This sampling confirmed the continued presence of organic chemicals in the Preston water supply. No volatile organic chemicals were found in the groundwater samples taken from U.S. Geological Survey (USGS) observation wells upgradient of the 58th Street dump, but contamination was present in downgradient observation wells.

A 2-year study was begun in mid-1976 by Florida International University, Miami-Dade Water and Sewer Authority (WASA), the Dade County Health Department and EPA to develop a method for removing trihalomethanes and other organic chemicals (including trihalomethane precursors) from the Preston water supply.[13] The study evaluated the use of two absorbent resins and granular activated carbon in filter columns receiving raw, partially treated and finished water. The study confirmed the continuing presence of several organic chemicals in the raw and finished water of which trichloromethanes, cis-1,2-dichloroethene and vinyl chloride were the most significant. Concentrations of cis-1,2-dichloroethene were observed to range between 5 and 40 μg/ℓ with averages for several test periods ranging from 10 to 20 μg/ℓ. Vinyl chloride ranged from 0 to 35 μg/ℓ with test averages of 0 to 8 μg/ℓ. Concentrations were highly variable from day to day.

The USGS, in cooperation with the Broward County Environmental Quality Control Board (BCEQCB), conducted a groundwater study at the Davie Landfill southwest of Fort Lauderdale in 1974 and 1975.[14] The Davie Landfill is one of two major landfills in Broward County. A lagoon at the site was receiving large volumes of septic tank sludges, oil and grease from commercial grease traps and some industrial sludges. A municipal incinerator discharged air pollution scrubber water to another lagoon. The monitoring detected a plume of pollutants from the two lagoons moving into the Biscayne Aquifer. Lead, zinc and mercury in excess of applicable groundwater quality criteria were detected. No analyses for volatile organic chemicals were done.

A similar USGS study was conducted from 1973 to 1975 at the 58th Street Landfill in cooperation with the Dade County Public Works Department.[15] A leachate plume was detected extending about half a mile east from the landfill toward the Hialeah-Preston wellfields and toward the then proposed Medley wellfield. Heavy metals (cadmium, lead and zinc) in excess of applicable standards were detected in the plume. Several pesticides were also detected in the aquifer. No volatile organic chemical analyses were done.

The Dade County Department of Environmental Resources Management (DERM) undertook a large-scale study of major public water supply wells in Dade County in 1977 and 1978.[16] All major public water supply wells were inventoried, theoretical cones of influence calculated, and land use within the cones defined. Raw water samples were collected twice from the wells and analyzed for 15 volatile organic chemicals. A total of 218 wells in 67 well fields were sampled during the 1977 wet season (May to October). During the 1977-78 dry season (November to April), 210 wells in 66 well fields were sampled. Total concentrations of the 15 volatile organic chemicals analyzed averaged for all wells sampled in a wellfield were found to exceed 5 μg/ℓ for 18% of the wellfields in the wet season and 11% in the dry season. Average concentrations ranged from below detection limits (<1 μg/ℓ) to 51 μg/ℓ in the Sunny Isles (East Drive) wellfield. The Hialeah-Preston wellfields averaged 32 μg/ℓ. Individual wells at a number of locations exhibited much higher total volatile organic chemical concentrations. A maximum of 272 μg/ℓ was observed. Cis-1,2-dichloroethene was observed in more than half of the wellfields. Vinyl chloride was also frequently observed. Contamination levels were significantly higher in wellfields north of Tamiami Canal than in south Dade County except for the Homestead area. General land use patterns within cones of influence of wellfields were compared to average contamination levels. In general, higher levels of contamination were associated with industrial land uses.

An intensive study of the Hialeah-Preston wellfield complex was conducted by DERM in 1978-79.[17] Four adjacent wellfields and the Hialeah and Preston water treatment plants comprise this complex that supplied about 100 mgd of treated water to about half of the Miami urban area. The wellfields are surrounded by large areas of industrial land use including Miami International Airport. Fifteen USGS monitoring wells scattered about the cone of influence of the wellfields were monitored regularly for 1 year for 15 volatile organic chemicals. Land use in the vicinity of each monitoring well was mapped. Industrial facilities were inventoried, and the type of activity documented. Observed annual average volatile organic contamination ranged from 0 in the undeveloped areas to 57 μg/ℓ in an industrial area. Levels of contamination generally increased with increased proportions of industrial land use. Cis-1,2-dichloroethene was the chemical most often detected.

In late 1980 and 1981, EPA's Office of Drinking Water conducted a national sampling survey of finished water from 945 public water supplies obtained from groundwater sources.[18] About half of the supplies were randomly selected, and the other half selected by State agencies based on probability of volatile organic chemical (VOC) contamination. Samples were analyzed for 35 volatile organic chemicals. The occurrence of VOCs above quantitation limits ranged from 17 to 37% with lower frequencies of occurrence for the randomly selected small (<10,000 person) systems and the highest percentage for large State selected systems. The frequency of occurrence of VOC levels greater than 5 µg/ℓ ranged from 3 to 18%.

As part of this groundwater supply survey, 16 water supplies were sampled in the study area in August 1981. In contrast to observed results in other parts of the country, observed VOC levels were above 5 µg/ℓ in all supplies and were above 100 µg/ℓ in all but three supplies as a result of the high trihalomethane levels then common in south Florida chlorinated water supplies.[19] Excluding trihalomethanes, five of the supplies had observed VOC levels above 5 µg/ℓ.

In 1982, the Office of Drinking Water did a followup survey. Water supplies for which significant VOC contamination had been detected were encouraged to submit additional samples for VOC analysis. Samples of finished water and of raw water from selected supply wells were analyzed for VOCs. Samples from 67 wells and 13 supplies in the study area were taken in July, August and September 1982 (one sample per location). For the finished water samples, results were similar to the 1981 survey. Excluding trihalomethanes, four (31%) of the 13 supplies had observed VOC levels exceeding 5 µg/ℓ.[19] Twenty (30%) of the 67 water supply wells had VOC levels exceeding 5 µg/ℓ.

The 1981 and 1982 groundwater supply survey data represent the only VOC data available for nine of the 13 water supplies sampled in Broward and Palm Beach Counties. Subsequent sampling has been done on the other supplies as a result of the detection of significant VOC contamination.

As part of the widespread "Superfund" investigations of major hazardous waste disposal sites, EPA contractors conducted an intensive study of the area potentially impacting the Hialeah-Preston wellfield complex and WASA's new Northwest wellfield.[20] The study area included three Superfund sites on the national priority list: 58th Street Landfill, Miami Drum and the

Miami International Airport "Varsol" spill. An unsewered industrial area in Medley and Hialeah Gardens, a fourth potential source of contamination, was also included in the study. Samples (three in the wet season of November to December 1982 and three in the dry season of March 1983) were collected from 120 wells for comprehensive chemical analysis. These wells included public water supply wells, monitoring wells at the 58th Street Landfill, USGS monitoring wells and special new groundwater observation wells. Results of the sampling were similar to and confirmed the earlier DERM study of much of the same area.[17] Volatile organic chemical contamination was widespread in the developed portions of the study area and ranged from mean total VOC concentrations of 1 μg/ℓ in the unsewered industrial area to 57 μg/ℓ in the Hialeah wellfield. Public water supply wells in the Hialeah-Preston complex were found to be more contaminated than groundwater observation wells. Vinyl chloride and trans-1,2-dichloroethene were the compounds most frequently detected.

Another Superfund site, the Hollingsworth Solderless Terminal Company in Fort Lauderdale, has been the subject of investigations by DER, BCEQCB and EPA contractors as the result of major contamination of a nearby Fort Lauderdale wellfield. Hollingsworth used trichloroethylene (TCE) in the production of electrical connectors and allegedly disposed of spent TCE down a 100-foot deep well into the Biscayne Aquifer. Very high levels (2,000 μg/ℓ vinyl chloride, 3,850 μg/ℓ trans-1,2-dichloroethene, 207 μg/ℓ TCE) of VOCs have been detected in Fort Lauderdale wells.[21] [22]

As part of their continuing Biscayne Aquifer study, DERM in September 1982 published an inventory of known and potential sources of pollution within 210 days travel time of all public water supply wellfields in Dade County.[23].

An inventory of 49 former solid waste dumps in Dade County was completed by DERM in July 1983.[24] These sites primarily received garbage and trash but may also have received industrial wastes. Twenty of the sites were identified for further study including groundwater monitoring.

An investigation of the Hialeah Garden and Medley areas was completed by the Water Management Division, EPA Region IV, in March 1983.[25] Public health concerns in this unsewered industrial and residential area as related to groundwater contamination were evaluated. Field observations at various industrial facilities documented numerous practices that could be contaminating groundwater with solvents, other chemicals and other pollutants.

For 1982, as part of an environmental assessment of wastewater treatment facilities in the Boca Raton vicinity of Palm Beach County, EPA investigated the impacts of an existing treated wastewater discharge on groundwater quality.[26] About 2 mgd of treated municipal wastewater at Sandalwood Cove was discharged to a percolation pond in a golf course. Analysis of groundwater from four monitoring wells, two private residence water supply wells and two large public water supply wells indicated that all priority pollutants, including volatile organic chemicals, were below detection limits.

An industrial pretreatment study was completed for the city of West Palm Beach by an engineering consultant in 1981.[27] The study inventoried and evaluated industrial facilities in the service area of the east central subregional wastewater treatment plant, an area east of Florida's Turnpike from Lantana to Riviera Beach. An inventory of 355 industries in the study area was prepared, and each facility was surveyed by mail or phone to determine chemical use and disposal practices. Most industries were found to be "clean" operations, but a significant number had actual or potential discharges of chemical wastes. Twenty-three facilities were on septic systems that discharged to groundwater. Twenty plants were visited. Various practices were observed that could have resulted in chemical contamination of groundwater. Industries with the most significant pollution potential were located in the Riviera Beach and Mangonia Park area.

A cooperative study of the impact of stormwater retention basins on groundwater quality in Broward County was completed by USGS and the Broward County Water Resources Management Division in March 1983.[28] Seven retention basins scattered about the eastern section of the county were sampled for heavy metals, pesticides and other parameters but not volatile organic chemicals. Elevated levels of heavy metals and pesticides were found in bottom sediments, but it was concluded that the basins were not adversely impacting groundwater quality.

An assessment of the extent of pesticide residues in surface and groundwater and public water supplies in Broward County was completed by the Broward County Water Resources Management Division in March 1983.[29] The study, based on existing data, concluded that public water supplies were not contaminated with pesticides, but that significant contamination potential existed from a variety of sources. Data on pesticide use in Broward County were presented.

Because water supplies in the study area typically have high levels of trihalomethanes produced by the chlorination of natural organic compounds, several studies of treatment methods for THM removal have been conducted in the study area. Treatment methods evaluated include packed tower aeration, granular activated carbon filters, and powdered activated carbon feed. Plants studied were in Fort Lauderdale,[30] Pembroke Pines,[31] N. Lauderdale and Broward County.[32]

DERM conducted additional sampling of major public water supplies for volatile organic chemicals from February to April 1983.[33] Data on about 70 sampling locations, including selected water supply wells, water treatment plant effluents and selected distribution system points, were released in a data report in November 1983. An interpretive report is in preparation.

DERM also released THM monitoring data for 10 major Dade County water supplies in spring 1983.[34] Average THM concentrations ranged from 4 to 149 $\mu g/\ell$.

A draft report on an investigation of vinyl chloride contamination of the Preston-Hialeah water supply system was obtained from DERM in mid-1983.[35] The report summarizes available data on vinyl chloride contamination in the Hialeah and Preston treated water in supply wells. Potential sources of contamination are identified and abatement strategies discussed.

STUDY METHODS

The initital phase of the study consisted of a compilation and evaluation of existing information on VOC contamination of groundwater and drinking water, potential sources of contamination and environmental control programs. Three basic approaches were used to compile this available information: a computerized file search, manual searches of regulatory agency files and interviews with regulatory and water resource agency personnel. An extensive computerized literature search was conducted by NEIC's Information Services Branch. A wide variety of environmental data bases were searched using both subject and geographical terms to get the broadest coverage possible and to identify all published literature of possible use in this study. Several hundred citations were identified. Abstracts of these documents were reviewed and appropriate items procurred. As received, these references were reviewed for secondary references of interest, and appropriate items were also procurred. Some documents contained specific data used in this report. These documents are referenced in the text and listed in the Reference section. Other documents containing information of general interest were not referenced in the report but are listed in the Bibliography.

A major source of information was the various files maintained by regulatory and water resource agencies. Detailed manual file searches were conducted for several program offices in EPA Region IV, Atlanta, Georgia[36] and the Florida DER subdistrict office in West Palm Beach.[22] Selected files were also reviewed for the following agencies: EPA Region IV Environmental Services Division, Athens, Georgia;[11] EPA Office of Drinking Water, Cincinnati,[37] Ohio; Florida DER (several divisions), Tallahassee;[38] Broward County Health Department[39] and Broward County Environmental Quality Control Board,[40] Fort Lauderdale; Dade County Health Department[41] and Metropolitan Dade Department of Environmental Resources Management,[34] Miami; Palm Beach County Health Department,[42] West Palm Beach and the U.S. Geological Survey, Tallahassee[43] and Miami.[44] These manual file searches were supplemented by computer searches of various EPA and DER data bases.

The third approach was personal interviews with key personnel in each of the agencies listed above for which file searches were performed. Information was obtained on past, present and projected future activity relative to drinking water quality, groundwater pollution, regulation of sources of pollution, regulation changes, etc.

In the second study phase, 60 groundwater monitoring wells in Broward County were sampled and VOC analyses performed. Standard sampling and analytical procedures were used. A team composed of EPA (NEIC and/or Region IV Environmental Services Division) and Broward County Environmental Quality Control Board (EQCB) personnel conducted the sampling. A gasoline engine-powered centrifugal pump was used to purge at least five casing volumes from each well. The pump suction line was rinsed with organic-free water prior to insertion into the well. The pump suction line was removed from the well while still pumping. A stainless steel bailer was then used to collect a sample from the well. The sample was transferred without aeration to a clean 40-mℓ glass vial with Teflon®-lined septum cap. Concentrated HCl acid had previously been added to each vial as a preservative. All samples were placed on ice and maintained at 4° C until analyzed. Samples were analyzed within 14 days of collection. Quality control replicates and trip blanks were also collected and analyzed.

Half of the samples were analyzed by the Region IV laboratory in Athens, Georgia and half by the NEIC laboratory in Denver. All analyses at the Athens laboratory were for purgeables by EPA Method 624 using a gas chromatograph/mass spectrometer (GC/MS). This method determines all VOCs of interest in this study, including aromatics, trihalomethanes and other halogenated compounds. All samples handled in Denver were analyzed for purgeable halocarbons by EPA Method 601 using a gas chromatograph equipped with a Hall detector. This method detects the same compounds as Method 624, with the exception of aromatics. Selected samples were analyzed by Method 624 for confirmation of compounds detected by Method 601 and for screening for aromatics. Detection limits for most compounds were about 0.5 μg/ℓ for Method 601 and 1-5 μg/ℓ for Method 624. Standard quality control procedures were followed by both laboratories.

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The major sampling effort of the second study phase was directed toward public water supplies. Region IV personnel from Athens with the assistance of the Broward County Public Health Unit sampled 45 community and 17 non-community water supplies in Broward County. Athens personnel with assistance from the Dade County Department of Public Health sampled 18 community and 21 non-community supplies in Dade County. Community water supplies in Broward County selected for sampling represented all supplies with their own wellfields. Community supplies that obtained their water from another supply were not sampled. The same approach to selection of community supplies was used in Dade County, with the exception that the large Hialeah, Preston and Orr supplies operated by Miami-Dade Water and Sewer Authority were not sampled because adequate data were available. For non-community supplies, an inventory of active supplies was sorted geographically. All large supplies serving 500 or more persons were selected for sampling. The remaining supplies to be sampled were selected from the inventory by a random process with a few minor adjustments to assure that all geographical areas were represented.

Grab samples of finished water were collected from all systems, generally at the water treatment plant. Samples were collected in the 40-mℓ vials with acid preservative as described for the monitoring wells above. In addition, since the finished water was chlorinated, thiosulfate was added to each sample to eliminate any chlorine residual. For water supplies which had aeration units in their treatment systems, a grab sample of raw water was also collected. Field replicates and trip blanks were collected per standard methods.

All water supply samples collected by Athens personnel were analyzed at the Athens laboratory. Method 624 was used as described above for the monitoring wells.

In Palm Beach County, 72 community and 45 non-community supplies were sampled by NEIC with assistance from the Palm Beach County Health Department. Selection of supplies to be sampled and sampling techniques were the same as for Broward County. All samples were analyzed at the NEIC laboratory in Denver using Method 601. Selected samples were also analyzed by Method 624.

The third study phase involved the sampling to wastewater effluent and groundwater monitoring wells at six industrial facilities. NEIC conducted the sampling with assistance provided by the Broward County Environmental Quality Control Board for the four facilities in Broward County. Sampling procedures for the wastewater effluents were the same as for water supplies. Groundwater monitoring wells were sampled in the same manner as the Broward County monitoring wells discussed above, with the exception that electric diaphragm pumps were used at some wells in lieu of the gasoline-powered centrifugal pump. All samples were analyzed at NEIC using Method 624.

Standard EPA chain-of-custody and documentation procedures were used for all sample handling.

IV. ENVIRONMENTAL CONDITIONS

Groundwater quality is the environmental condition of most concern in south Florida because groundwater is the source of drinking water for most of the region's population. Natural pollutants, sea water intrusion and, most recently, pollutants from man's activities have adversely impacted groundwater quality. Contamination of groundwater with volatile organic chemicals (VOCs) during the last decade has occurred at various locations, including several public water supply wellfields. This has resulted in major expenditures for public water supplies, including increased treatment and relocation of wellfields. The current status of VOC contamination of groundwater as defined by existing data and new data generated by EPA sampling of monitoring wells in Broward County is summarized below. Several localized groundwater contamination problems at industrial facilities or hazardous waste disposal sites are discussed in Section V.

The quality of drinking water supplies has major public health significance. This quality is a function of groundwater quality and the type of water treatment provided. Because most water supplies do not provide treatment to remove VOCs, contamination of groundwater has resulted in the occurrence of significant levels of VOCs in some public drinking water supplies. In the following section, current levels of VOCs in public community water supplies are defined based on existing data and new data generated by an intensive EPA sampling study. New data on a representative sampling of non-community water supplies are also presented. Observed levels of VOC contamination are compared to Florida and EPA drinking water regulations that define the relative significance of the contamination. Water supply improvements that have recently substantially reduced the population served by supplies contaminated with significant levels of VOCs are also discussed.

Because area groundwaters contain natural organic chemicals from the Everglades and muck soils, chlorine disinfection of drinking water has typically produced high levels of synthetic chemicals called trihalomethanes (THMs). High levels have public health significance. Most major water supplies have reduced THM levels to meet Florida and EPA regulations, but the recent EPA study indicates THM levels are still excessive in some major supplies and a significant number of smaller supplies.

GROUNDWATER

Groundwater in the Biscayne and Coastal Aquifers is a major natural resource in the study area. The Biscayne Aquifer has been designated as a sole source aquifer by EPA under the provisions of the Safe Drinking Water Act. This legal designation reflects the major importance placed on protection of the quality of this source of drinking water for most of the area.

Currently, there are no Federal regulations that specify water quality limits for groundwater, with the exception of hazardous waste management regulations established under the Resource Conservation and Recovery Act that apply to land disposal facilities.[45] Florida DER has established water quality criteria applicable to all groundwater in the study area. The Biscayne and Coastal aquifers in the study area are classified for potable water use. Applicable water quality criteria are specified in the Florida Administrative Code (FAC) Chapter 17-3. Major components of these criteria are the primary and secondary drinking water quality standards established by DER for public water supplies [Appendix A]. Groundwater is thus required to meet drinking water standards unless lower quality is present due to natural conditions (FAC 17-3.404). The groundwater must also meet other general criteria (FAC 17-3.402, Appendix B). Until recently, no quality standards had been established for volatile organic chemicals, although the regulations made provision for adding maximum contaminant levels for other pollutants. DER has promulgated maximum contaminant levels for eight volatile organic chemicals that are applicable to public water supplies and, by reference, to groundwater. The criteria take effect in June 1985.

DERM has established water quality criteria for groundwater in Dade County [Appendix B]. These criteria include fewer pollutants than the DER criteria. The Broward County Environmental Quality Control Board has established water quality criteria for Broward County groundwater [Appendix B].

Pollutants covered are similar to the drinking water standards. The criteria do include a limit of 0.01 mg/ℓ for chlorinated hydrocarbons other than specifically named pesticides.

Groundwater quality throughout the study area has been extensively studied and monitored by USGS and other agencies. In addition, water utilities and regulatory agencies regularly monitor raw water at water treatment plants and supply wells. These studies were primarily directed at evaluating the suitability of various portions of the aquifer for water supply, monitoring salinity intrusion and detecting water supply contamination. Parameters observed were usually typical physical and inorganic chemical measurements. Organic chemical measurements were few and generally limited to selected pesticides. The reader is referred to the Bibliography for selected sources of this extensive conventional groundwater quality data. General groundwater conditions are summarized below. Available data on toxic pollutants are also discussed.

Biscayne Aquifer water is generally of good quality, but several natural conditions reduce quality in some areas, requiring varying degrees of water treatment to produce acceptable drinking water. In south Dade County, groundwater generally meets drinking water standards, and only disinfection is required to produce adequate water quality. From central Dade County northward, water characteristics such as hardness, iron, color, sulfides and chlorides vary due to natural conditions and exceed desirable levels in some areas requiring water treatment.

Biscayne Aquifer water is a hard calcium bicarbonate type with total hardness in the range of 150 to 300 mg/ℓ.[7] There are no regulatory limits on hardness, but total hardness less than 100 mg/ℓ is desirable for domestic water uses. Most water treatment plants north of central Miami provide lime softening for hardness removal and to aid in iron and color reduction.

Dissolved iron is quite variable in the aquifer, ranging from about 0.1 to 3 mg/ℓ. A concentration of less than 0.3 mg/ℓ is considered desirable. Chlorides and dissolved solids are at acceptable levels throughout most of the developed area, except along the coastline where sea water intrusion has occurred. In Broward and Palm Beach Counties, chloride levels increase with distance from the coastline due to easterly flow of connate water from the Everglades.

A major natural quality problem is the high organic content of the groundwater derived from the muck and peat soils of the Everglades. Color is very high in much of the aquifer, ranging from less than 10 units near the coastline and in south Dade County to more than 100 units near the Everglades. Most public supplies, except in south Dade County, must treat for color removal.

The high organic content produces a second drinking water problem. Many of the organic materials are precursors for the formation of trihalomethanes during the chlorination of drinking water for color removal and disinfection. Special disinfection procedures have been initiated by several area water supplies to overcome this problem.

Sulfides are present at undesirable levels in some areas of the aquifer, especially in Palm Beach and northern Broward Counties. Sulfides impart undesirable odor to the water. Some water supplies aerate drinking water for sulfide removal.

Under natural conditions, the best groundwater quality was found under the Atlantic Coastal Ridge. As this area developed first, most of the early water supply wells were located near the coastline. Drainage canals lowered the water table, and some salinity intrusion into the freshwater aquifer occurred. Groundwater withdrawals increased as population increased, which lowered local water tables and allowed more salinity intrusion. Major public water supply wells in Miami and Ft. Lauderdale have been abandoned because of salinity intrusion. Florida has experienced a relatively wet period in recent years. Groundwater withdrawals have increased substantially since the last major drought in 1970-71. There is a potential for salinity contamination of additional wells along the coastline, should another major drought occur.

Nitrates throughout the aquifer are generally low, less than 1 mg/ℓ. Exceptions to this are the vicinities of local sources of pollution such as sludge lagoons and septic tanks and an agricultural area of south Dade County. A DERM study in south Dade detected elevated levels of nitrates (1-10 mg/ℓ) in some water supply wells.[46] This was attributed to agricultrual sources.

There has been limited sampling for pesticides in groundwater. A 1978 DERM study sampled raw water from 31 wellfields in Dade County.[16] Samples were analyzed for 12 organochlorine pesticides used in the area. Pesticides were detected at trace levels (1 to 15 nanograms per liter) in only three supplies. In 1979, DERM sampled 34 wellfields for two herbicides: 2,4,5-TP (Silvex) and 2,4-D.[47] Silvex was detected in two wellfields at a concentration of 0.02-0.5 μg/ℓ. In 1983, the Florida Department of Health and Rehabilitative Services (HRS) coordinated sampling of selected wells in the study area for the pesticide ethylene dibromide (EDB).[41] This followed detection of this pesticide in groundwater in other areas of the State. To date, EDB has not been detected in the study area. An extensive study (6 samples at each of 120 wells) of the Hialeah-Preston wellfields vicinity in 1982-83 as part of a Superfund investigation only detected pesticides in two wells, both in the 58th Street Landfill area.[20]

With the exception of pesticides included in the drinking water standards and the Broward County chlorinated hydrocarbon limit (10 μg/ℓ), there were no water quality criteria established for synthetic organic chemicals in area groundwaters until early 1984. In March 1984, DER promulgated maximum contaminant levels for eight volatile organic chemicals (VOCs) as part of their primary drinking water regulations [Appendix A]. These criteria specify the maximum allowable levels of the eight VOCs in public community water supplies and are enforceable limits. The MCLs are incorporated in DER groundwater quality criteria by reference [Appendix B]. The MCLs are applicable to community water systems serving 1,000 or more persons beginning June 1, 1985 and to smaller community systems beginning January 1, 1987.

The eight MCLs are given below and are compared with proposed EPA RMCLs discussed below.

Volatile Organic Compound	Florida DER MCLs (μg/ℓ)	Proposed EPA RMCLs (μg/ℓ)
trichloroethylene	3	2.8
tetrachloroethylene	3	0.7
carbon tetrachloride	3	0.4
1,1,1-trichloroethane	200	22
1,2-dichloroethane EDC	3	0.6
vinyl chloride	1	1.0
benzene	1	0.7
1,1-dichloroethene vinylidene chloride	-	0.2
ethylene dibromide	0.02	-

EPA is developing maximum contaminant levels for drinking water for selected organic chemicals most frequently detected in groundwater and drinking water supplies. In March 1982, EPA published an advance notice of proposed rulemaking, indicating the intent to establish recommended maximum contaminant levels (RMCLs) for six volatile organic chemicals (VOCs): trichloroethylene (TCE), tetrachloroethylene (perchloroethylene or PCE), carbon tetrachloride, 1,1,1-trichloroethane, 1,2-dichloroethane and vinyl chloride.[48] Possible values for RMCLs were in the range of 1 to 1,000 μg/ℓ.

Based on comments received on the advance notice and on additional scientific data, EPA has developed a set of proposed RMCLs that were in the final stage of Agency review in late 1983.[12] Eight RMCLs were proposed for the six VOCs in the advance notice plus benzene and 1,1-dichloroethene (vinylidene chloride). Tentatively proposed values are given above.

Recommended MCLs are health goals and are not enforceable under the Safe Drinking Water Act. They are designed to specify water quality at which no adverse health effects would be expected, including a margin of safety. The RMCL values listed above represent very low health risks. They are based on an estimated risk level of one excess case of cancer per one million persons drinking the water for a 70-year lifetime. As shown, the Florida MCLs are slightly higher for most VOCs. These values reflect adjustment for analytical detection limits for test procedures generally in use at present.

The proposed RMCLs were used as screening criteria to evaluate available data on VOCs in groundwater. Levels of VOCs exceeding these criteria are of concern because most private and some public water supplies provide no treatment that would remove VOCs. Unless aeration is provided, treatment systems on most public water supplies also do not significantly reduce raw water VOCs. Thus, the finished drinking water would reflect groundwater quality. Data were also compared to the new Florida MCLs.

There have been five studies between 1977 and 1983 that provide a limited overview of the level of VOC contamination of groundwater in the study area. A number of other studies have been conducted at specific sites as the result of various pollution problems.

Table 4 presents a summary of available data on VOC contamination of public water supply wells that reflect groundwater quality at the wellfield locations. In most cases, Table 4 gives a range of observed VOC concentrations for the wellfield rather than data on individual wells. In some cases, raw water data are presented which represent the quality of water delivered to the treatment plant by the particular combination of wells in operation at the time of sampling. Table 4 also presents data on finished water quality that are discussed in the following section.

Dade County

The 1977-78 study by DERM encompassed 218 major public water supply wells in Dade County.[16] Two samples per well were taken several months apart during the historical wet and dry seasons and analyzed for 15 VOCs. Cis-1,2-dichloroethene was the VOC most frequently detected. This compound, along with trans-1,2-dichoroethene, is frequently associated, in the Biscayne aquifer, with the occurrence of vinyl chloride. For this reason, screening criteria were established for the EPA study for both cis- and trans-1,2-dichloroethene to indicate when these compounds were present at significant levels. A criterion of 5 μg/ℓ was selected for each compound because this level often corresponded with vinyl chloride in the range of the 1 μg/ℓ MCL.

Table 4

OBSERVED VOC CONCENTRATION IN SELECTED WATER SUPPLIES AND WELLFIELDS

System	Flow (mgd)	Date	Vinyl chloride	Vinylidene chloride	Cis-1,2-dichloroethene	Trichloroethene
			EPA Screening Criteria/DER MCLs (μg/ℓ)			
			1/1	0.2/None	5/None	2.8/3
			BROWARD COUNTY			
Broward Co. Utilities (Palmdale-1B)	(Standby)					
Finished Water		8/81	<1	<0.2	0.5	<0.2
Finished Water		7/82	<1	<0.2	0.6	<0.2
Wells (3/5)		7/82	<1	<0.2	<0.2-0.7	<0.2
Broward Co. Utilities (N. District-2A)	11.3					
Finished Water		8/81	<1	<0.2	4.9	0.6
Finished Water		7/82	<1	0.24**	3.8	0.2
Wells (5/7)		7/82	<1	<0.2-1.3**	<0.2-14**	<0.2-0.4
Raw Water		2/84	ND[a]	ND	1-2	ND
Finished Water		2/84	ND	ND	ND	ND
City of Hallandale	5.8					
Finished Water		8/81	<1	<0.2	5.3**	<0.2
Finished Water		7/82	<1	<0.2	67**	5.7*
Wells (4/8)		7/82	<1	<0.2-0.25**	0.8-190**	<0.2-24*
Raw Water		3/84	ND	ND	1	ND
Finished Water		3/84	ND	ND	0.9	ND
City of Hollywood	19.1					
Finished Water		8/81	<1	0.22**	1.7	1.8
Finished Water		7/82	<1	<0.2	1.6	1.0
Wells (11/28)		7/82	<1	<0.2-6.1**	0.8-4.5	0.2-3.0*
Finished Water		3/84	ND	ND	2	ND
City of Ft. Lauderdale (Five Ash)	36					
Finished Water		8/82	5-8*	<1	<1	<1
Composite Raw Water		8/82	95-100*	<1-10**	7-8**	<1
Wells (10/23)		7&8/82	31-2010*	3-19**	25-2240**	<2-207*
Wells (6/23)		10/82	<1-554*	<5-48**	<1-2920**	<5
Raw Water		2/84	<1	<1	<1	<1
Finished Water		2/84	<1	<1	<1	<1

Table 4

OBSERVED VOC CONCENTRATION IN SELECTED WATER SUPPLIES AND WELLFIELDS

System	Flow (mgd)	Date	Vinyl chloride	Vinylidene chloride	Cis-1,2-dichloroethene	Trichloroethene
			EPA Screening Criteria/DER MCLs (μg/ℓ)			
			1/1	0.2/None	5/None	2.8/3
City of Pembroke Pines (System #2)	4.1					
Finished Water		8/81	<1	<0.2	0.3	<0.2
Finished Water		7/82	<1	<0.2	0.2	<0.2
Wells (2/5)		7/82	<1	<0.2	<0.2	<0.2
Finished Water		3/84	ND	ND	ND	ND
City of Pompano Beach	21.7					
Finished Water		8/81	<1	<0.2	1.2	19*
Finished Water		7/82	<1	<0.2	<0.2	0.6
Wells (5/16)		7/82	<1	<0.2	<0.2-0.5	<0.2-3.6*
Finished Water		2/84	ND	ND	8.9**	22*
City of Sunrise (System #1)	5.4					
Finished Water		8/81	<1	<0.2	<0.2	<0.2
Finished Water		7/82	<1	<0.2	<0.2	<0.2
Wells (5/16)		7/82	<1	<0.2	<0.2	<0.2
Finished Water		2/84	ND	ND	ND	ND
DADE COUNTY (See Figure 9 for System Locations)						
Carol City Utilities (Shut down)						
Wells (8)		W77[b]	<0.1-0.16	<0.02-0.02	<0.02-0.7	<0.02-0.3
Wells (8)		D78[c]	<0.1	<0.02	<0.02-0.6	<0.02-0.3
Dade Utilities (now WASA) (Mansionette) (Shut down)						
Finished Water		3/83	<0.1	0.1	<0.02	0.63
Distribution System		3/83	<0.1	<0.02	<0.02	<0.02-0.07
Composite Raw Water		4/83	<0.1	0.32**	<0.02	<0.02
Wells (5)		W77	0.15-13.6*	<0.02	0.2-0.9	<0.02
Wells (5)		D78	<0.1	0.02	<0.02-0.75	<0.02-0.28

Table 4

OBSERVED VOC CONCENTRATION IN SELECTED WATER SUPPLIES AND WELLFIELDS

System	Flow (mgd)	Date	Vinyl chloride	Vinylidene chloride	Cis-1,2-dichloroethene	Trichloro-ethene
			EPA Screening Criteria/DER MCLs (μg/ℓ)			
			1/1	0.2/None	5/None	2.8/3
City of Florida City	1.2					
Wells (3)		W77	<0.1-6.8*	<0.02	<0.02	<0.02-0.06
Wells (3)		D78	<0.1	<0.02	<0.02	<0.02
Finished Water		2/83	ND	ND	ND	ND
Finished Water		3/84	ND	ND	ND	ND
Florida Keys Aqueduct	9					
Wells (6)		W77	<0.1-3.9*	<0.02-0.03	<0.02-0.37	<0.02-0.76
Wells (6)		D78	<0.1	<0.02	<0.02	<0.02-0.5
Finished Water		3/84	ND	ND	ND	ND
Florida Water Utility System (now WASA)						
Coral Reef (Shut down)						
Wells (3)		W77	<0.1-0.76	<0.02-0.18	<0.02-0.03	<0.02-0.06
Wells (3)		D78	<0.1	<0.02	<0.02-0.06	<0.02
Cutler Ridge (Shut down)						
Wells (5)		W77	<0.1	<0.02	<0.02	<0.02
Wells (5)		D78	<0.1	<0.02	<0.02-0.05	<0.02-0.02
Fairway Park (Shut down)						
Wells (1)		W77	0.8	0.04	<0.02	<0.02
Wells (1)		D78	<0.1	<0.02	<0.02	<0.02
Green Hills (Standby)						
Wells (2)		W77	<0.1	<0.02-0.03	<0.02	<0.02
Wells (2)		D78	<0.1	<0.02	<0.02	<0.02
Kings Bay (Standby)						
Wells (3)		W77	<0.1-0.98*	<0.02	<0.02	<0.02-0.12
Wells (3)		D78	<0.1	<0.02	<0.02-0.03	<0.02

Table 4

OBSERVED VOC CONCENTRATION IN SELECTED WATER SUPPLIES AND WELLFIELDS

System	Flow (mgd)	Date	Vinyl chloride	Vinylidene chloride	Cis-1,2-dichloroethene	Trichloroethene
			EPA Screening Criteria/DER MCLs (µg/ℓ)			
			1/1	0.2/None	5/None	2.8/3
City of Homestead	7.2					
Wells (3)		W77	1.7-18*	<0.02	<0.02-0.3	<0.02-1.2
Wells (4)		D78	<0.1	<0.02	<0.02	<0.02
Finished Water		3/83	ND	0.10-0.18	ND	ND
Finished Water		3/84	ND	ND	ND	ND
Miami-Dade WASA						
Alexander Orr	137					
Finished Water		2/83	<0.1	<0.02	<0.02	<0.02-0.4
Wells (Orr-4)		2/83	<0.1	<0.02	<0.02-2.6	<0.02-3.8*
Wells (Orr-4)		4/83	<0.1	<0.02-0.36**	<0.02-0.9	<0.02-0.06
Wells (Orr-10)		W77	<0.1	<0.02	<0.02-5.6**	<0.02-0.28
Wells (Orr-10)		D78	<0.1	<0.02	<0.02-14**	<0.02-1.4
Wells (SW-5)		4/83	<0.1	<0.02	<0.02-0.4	<0.02
Wells (SW-10		W77	<0.1	<0.02-0.02	<0.02	<0.02-0.07
Wells (SW-10)		D78	<0.1	<0.02-0.03	<0.02	<0.02-0.08
Wells (Snapper Ck-1)		4/83	<0.1	0.36**	<0.02	0.17
Wells (Snapper Ck-4)		W77	<0.1	<0.02	<0.02	<0.02
Wells (Snapper Ck-4)		D78	<0.1	<0.02	<0.02	<0.02
Composite Raw Water		2/84	<1	<1	Tr.	<1
Finished Water		2/84	<1	<1	Tr.	<1
Hialeah	150***					
Wells (Plant-3)		W77	<0.1-3.3*	<0.02-0.18	0.1-15**	<0.02-0.17
Wells (Plant-3)		D78	<0.1-0.84	<0.02-0.1	0.4-8.6**	<0.02-0.03
Wells (Lower MS-8)		W77	<0.1-11.1*	<0.02-0.18	<0.02-66**	<0.02-0.4
Wells (Lower MS-8)		D78	<0.1-7.6*	<0.02-0.33**	0.4-51**	<0.02-0.5
Wells (Upper MS-12)		W77	<0.1-23.9	<0.02-0.23**	0.2-26**	<0.02-0.4
Wells (Upper MS-12)		D78	<0.1-0.15	<0.02-0.35**	0.8-19**	<0.02-0.22
Wells (Lower MS-4)		11 & 12/82	<1-52*	NA	NA	NA
Wells (Upper MS-7)		11 & 12/82	<1-72*	NA	NA	NA
Finished Water		12/82	3.3-8.5*	NA	NA	NA
Composite Raw Water		12/82	6-10*	NA	NA	NA
Distribution System		3/83	<0.1-4.3*	NA	NA	NA
Distribution System		4/83	0.6-3.9*	NA	NA	NA
Composite Raw Water		2/84	<1	<1	Tr.	<1
Finished Water		2/84	Tr.	<1	Tr.	<1

Table 4

OBSERVED VOC CONCENTRATION IN SELECTED WATER SUPPLIES AND WELLFIELDS

System	Flow (mgd)	Date	Vinyl chloride	Vinylidene chloride	Cis-1,2-dichloroethene	Trichloroethene
			EPA Screening Criteria/DER MCLs (μg/ℓ)			
			1/1	0.2/None	5/None	2.8/3
Preston	150***					
Wells (7)		W77	NA	<0.02-0.16	9-169**	0.12-1.2
Wells (7)		D78	<0.02-0.18	<0.02-0/13	4-34**	0.05-0.44
Wells (5)		1/82	1.1-13*	NA	NA	NA
Wells (6)		11/82	<1-26*	NA	NA	NA
Wells (6)		12/82	<1-27*	NA	NA	NA
Wells (Medley-4)		10/82	33-389*	6-21**	<01-7.5**	NA
Wells (Medley-2)		12/82	7-45*	NA	<1-2	NA
Finished Water		11/82	5-37*	NA	NA	NA
Composite Raw Water		11/82	7.3-8.8*	NA	NA	NA
Finished Water		12/82	4.0*	NA	NA	NA
Composite Raw Water		12/82	5.1*	NA	NA	NA
Finished Water		1/83	3.9*	NA	NA	NA
Composite Raw Water		1/83	4.4*	NA	NA	NA
Wells (Northwest-4)		3/83	<5	<5	<5	<5
Composite Raw Water		2/84	<1	<1	<1	<1
Finished Water		2/84	<1	<1	<1	<1
South Miami Heights	2.8					
Wells (5)		W77	<0.1	<0.02	<0.02	<0.02
Wells (5)		D78	<0.1	<0.02	<0.02	<0.02
Finished Water		2/83	<0.1	<0.02	<0.02	<0.02
City of North Miami						
Eastside (Shut Down)						
Wells (6)		W77	<0.1	<0.02	<0.02-1.1	<0.02
Wells (6)		D78	<0.1	<0.02	<0.02-1.1	<0.02
Distribution System (WASA)		3/83	<0.1-1.7*	<0.02-0.32**	2.2-5.2**	1.2-2.5
Winson (Westside)	6.7					
Wells (8)		W77	<0.1	<0.02-0.07	<0.02-18.3**	0.03-0.74
Wells (8)		D78	<0.1	<0.02-0.03	<0.02-15**	<0.02-2.2
Finished Water		8/81	<1	<0.2	1.9	0.26
Finished Water		7/82	<1	<0.2	2.2	1.6
Wells (5)		7/82	<1.-1.0*	<0.2	<0.2-7.5**	<0.2-12*

Table 4

OBSERVED VOC CONCENTRATION IN SELECTED WATER SUPPLIES AND WELLFIELDS

System	Flow (mgd)	Date	Vinyl chloride	Vinylidene chloride	Cis-1,2-dichloroethene	Trichloroethene
			EPA Screening Criteria/DER MCLs (μg/ℓ)			
			1/1	0.2/None	5/None	2.8/3
Finished Water		3/83	<0.1	<0.02	2.0-2.2	2.0-2.2
Distribution System		3/83	<0.1	<0.02-0.28**	0.3-2.7	0.9-2.3
Wells (6)		3/83	<0.1	<0.02-0.36**	0.7-9.5**	0.3-15.7*
Finished Water		3/84	ND	ND	5.3-7.2**	2
City of North Miami Beach						
Myrtle Grove (Shut Down)						
Composite Raw Water		W77	<0.1	<0.02	3.7	1.12
Composite Raw Water		D78	<0.1	<0.02	5.7**	0.12
Distribution System (WASA)		3/83	0.6-2.6*	0.-0.77**	5.9-7.3**	0.09-0.25
W.A. Oeffler (Norwood)	15					
Wells (10)		W77	<0.1	<0.02	<0.02-12**	<0.02-1.8
Wells (10)		D78	<0.1	<0.02	0.07-12**	0.13-1.5
Finished Water		3/83	ND	0.06-0.34**	ND	0.06-0.18
Wells (2)		3/83	ND	0.02-0.03	0.25-0.53	ND
Finished Water		3/84	ND	ND	2	ND
Sunny Isles	8					
East Drive Wells (8)		W77	<0.1-38*	<0.02-7.8**	0.13-89**	0.02-31*
East Drive Wells (8)		D78	<0.1-3.7*	<0.02-4.3**	0.14-30**	<0.02-23*
East Drive Wells (4)		7/82	4.9-12*	<0.2-0.69**	6-34**	<0.2-0.53
East Drive Wells (4)		9/82	1.4-27*	<0.2-0.82**	1.6-50**	<0.2-0.37
Old Wells (12)		W77	<0.1	<0.02-0.23**	0.3-88**	<0.02-0.44
Old Wells (8)		D78	<0.1	<0.02-0.11	0.7-16.6**	<0.02-2.8**
Finished Water		8/81	6.5*	0.35**	15**	<0.2
Finished Water		7/82	4.3*	<0.2	10**	<0.2
Finished Water		9/82	6.4*	<0.2	12**	<0.2
Finished Water		3/83	0-2.0*	0-0.34**	0.9.7**	0-0.23
Finished Water		3/84	2*	ND	1	ND
North Miami Shores (Shut Down)						
High Ridge						
Well (1)		W77	<0.1	0.02	12.8**	<0.02
Well (1)		D78	0.1	<0.02	29.4**	0.04

Table 4

OBSERVED VOC CONCENTRATION IN SELECTED WATER SUPPLIES AND WELLFIELDS

System	Flow (mgd)	Date	Vinyl chloride	Vinylidene chloride	Cis-1,2-dichloroethene	Trichloroethene
			EPA Screening Criteria/DER MCLs (µg/ℓ)			
			1/1	0.2/None	5/None	2.8/3
City of Opa-Locka						
Wells (8)		W77	<0.1-5.5*	<0.02-0.06	0.3-29**	<0.02-1.3
Wells (8)		D78	<0.1-2.6*	<0.02	0.3-8.8**	0.03-0.4
Finished Water		3/83	ND	ND	ND	0.5
Wells (4)		4/83	0-0.68	ND	1.7-2.5	0.11-0.25
Finished Water		2/84	<1	<1	<1	<1
Wells (6)		2/84	<1	<1	<1	<1
Finished Water		3/84	ND	ND	2	ND
Rex Utilities (now WASA)						
Leisure City	6.1					
Wells (5)		W77	<0.1-46*	<0.02-0.04	0.08-3.9	<0.02-0.3
Wells (5)		D78	<0.1	<0.02	<0.02	<0.02-0.07
Finished Water		8/81	<1	<0.2	<0.2	<0.2
Finished Water		2/83	<0.1	0.22**	<0.02	0.11
Distribution System		2/83	<0.1	<0.02	<0.02	0.09
Finished Water		3/84	ND	ND	ND	ND
Marcia Jane (Shut Down)						
Wells (2)		W77	<0.1	<0.02	0.02-0.22	<0.02-0.09
Wells (2)		D78	<0.1	<0.02-0.16	<0.02	<0.02
Naranja	1.0					
Wells (1)		W77	3.3*	<0.02	0.03	<0.02
Wells (2)		D78	<0.1	<0.02	<0.02	<0.02-0.03
Newton	1.3					
Well (1)		W77	8.2*	<0.02	0.12	0.17
Well (1)		D78	<0.1	<0.02	<0.02	0.08
Finished Water		2/83	<0.1	<0.02	<0.02	<0.02
Distribution System		2/83	<0.1	<0.02-0.23**	<0.02	<0.02-0.09

Table 4

OBSERVED VOC CONCENTRATION IN SELECTED WATER SUPPLIES AND WELLFIELDS

System	Flow (mgd)	Date	Vinyl chloride	Vinylidene chloride	Cis-1,2-dichloroethene	Trichloroethene
			EPA Screening Criteria/DER MCLs (µg/ℓ)			
			1/1	0.2/None	5/None	2.8/3
Redavo	0.02					
Wells (2)		W77	12.8-60*	<0.02-0.02	<0.02-2.6	<0.02-0.04
Wells (2)		D78	<0.1	<0.02	<0.02	<0.02
Finished Water		3/83	<0.1	<0.02	<0.02	<0.02
Finished Water		3/84	ND	ND	ND	ND
South Dade Utilities						
Bel Aire	0.6					
Wells (2)		W77	<0.1-0.18	<0.02	0.03	<0.02
Wells (2)		D78	<0.1	<0.02	<0.02-0.04	<0.02
Finished Water		2/83	<0.1	<0.02	<0.02	Tr.
Distribution System		2/83	<0.1	<0.02-0.1	<0.02	0.04-0.14
Pt. Royale	1.3					
Well (1)		W77	1.06*	<0.02	<0.02	<0.02
Well (1)		D78	<0.1	<0.02	<0.02	<0.02
Finished Water		2/83	<0.1	0.11	<0.02	0.04
Distribution System		2/83	<0.1	<0.02	<0.02	<0.02-0.09
Southern Gulf Utilities (now WASA)						
Riverdale (Shut down)						
Wells (2)		4/83	<0.1	<0.02	<0.02	<0.02
Wells (5)		W77	<0.1	<0.02-0.07	<0.02	<0.02-0.02
Wells (5)		D78	<0.1	<0.02-0.03	<0.02	<0.02-0.05
Finished Water		8/81	<1	<0.2	<0.2	<0.2
Finished Water		3/83	<0.1	0.21**	<0.02	0.02
Distribution System		3/83	<0.1	<0.02-1.8**	<0.02	<0.02
Tamiami Airport						
Well (1)		W77	<0.1	0.12	<0.02	2.72
Well (1)		D78	<0.1	0.09	<0.02	<0.02

Table 4

OBSERVED VOC CONCENTRATION IN SELECTED WATER SUPPLIES AND WELLFIELDS

System	Flow (mgd)	Date	Vinyl chloride	Vinylidene chloride	Cis-1,2-dichloroethene	Trichloroethene
			EPA Screening Criteria/DER MCLs (µg/ℓ)			
			1/1	0.2/None	5/None	2.8/3
			PALM BEACH COUNTY			
City of Boca Raton	9.9					
Finished Water		8/81	<1	<0.2	<0.2	<0.2
Finished Water		3/84	<0.5	<0.5	<0.5	<0.5
Century Village	1.1					
Century Utilities						
Finished Water		8/81	<1	<0.2	<0.2	<0.2
Finished Water		7/82	<1	<0.2	<0.2	<0.2
Wells (3/3)		7/82	<1	<0.2	<0.2	<0.2
Finished Water		4/84	<0.5	<0.5	<0.5	<0.5
Town of Lantana	1.8					
Finished Water		8/81	<1	<0.2	<0.2	<0.2
Finished Water		7/82	<1	<0.2	<0.2	<0.2
Wells (4/4)		7/82	<1	<0.2	<0.2-0.8	<0.2
Finished Water		5/84	<0.5	<0.5	<0.5	<0.5
City of Riviera Beach	6.5					
Finished Water		8/81	<1	<0.2	0.2	0.3
Finished Water		7/82	4*	<0.2	1.6	0.9
Wells (8/19)		7/82	<1-270*	<0.2	<0.2-33**	<0.2-28*
Wells (#11)		1/83	217-260*	<5	62**	<5
Finished Water		1/83	<1	<5	<5	<5
Finished Water		3/84	<0.5	<0.5	<0.5	3*
Composite Raw Water		3/84	<0.5	<0.5	<0.5	10*

Table 4

OBSERVED VOC CONCENTRATION IN SELECTED WATER SUPPLIES AND WELLFIELDS

System	Flow (mgd)	Date	Vinyl chloride	Vinylidene chloride	Cis-1,2-dichloroethene	Trichloroethene
			EPA Screening Criteria/DER MCLs (μg/ℓ)			
			1/1	0.2/None	5/None	2.8/3
Seacoast Utilities	3.9					
Richard Road						
Finished Water		8/81	<1	<0.2.	<0.2	<0.2
Finished Water		7/82	<1	<0.2	<0.2	2.2
Wells (8/17)		7/82	<1	<0.2	<0.2-0.7	<0.2-58*
Well (#11)		1/83	NA	NA	NA	105-119*
Finished Water		8/83	NA	NA	NA	<1-4.5*
Finished Water		4/84	2*	<0.5	3	<0.5
Composite Raw Water		4/84	17*	<0.5	15**	<0.5

* *Exceeds Florida MCLs*
** *Exceeds screening criteria*
*** *150 mgd total for Hialeah and Preston water treatment plants*
a *Not detectable by analytical method used*
b *Sampled during April-October wet season 1977*
c *Sampled during 1977-78 dry season*
d *Not analyzed*
e *Trace*

During the wet season, VOC concentrations in excess of screening criteria were detected in 58 (27%) of the 218 wells. Cis-1,2-dichloroethene was found in excess of the screening criterion of 5 μg/ℓ in 32 wells (15%). Vinyl chloride exceeded the Florida MCL of 1 μg/ℓ in 28 wells (13%). Other compounds were at excess levels in less than 5% of the wells. During the dry season, the frequency of occurrence of VOC contamination exceeding screening criteria was significantly lower. Of the 210 wells sampled, 33 (16%) had VOC levels above screening criteria. Cis-1,2-dichloroethene was the most common VOC, with 30 wells exceeding screening criteria. Vinyl chloride exceeded the Florida MCL in 6 wells. Data on each wellfield are summarized in the Dade County section of Table 4.

The results of the 1977-78 study are shown graphically in Figure 9 which shows the location of all major wellfields in Dade County in 1982. Essentially all of these, except the new Northwest (Three Square Mile) and Medley wellfields, were sampled in the study. Wellfields for which one or more wells exceeded screening criteria are shown by black squares. The maximum sum of all 15 VOCs analyzed observed at any well in the field is also shown for wet and dry seasons. The highest VOC concentrations for both seasons were observed at the Sunny Isles (East Drive) wellfield in North Miami Beach. The Hialeah and Preston wellfields in northwest Miami also had high concentrations. Wellfields in North Miami and Opa-Locka also had significant contamination.

To the southwest, contamination levels were lower, especially during the dry season. In the Alexander Orr, Snapper Creek and Southwest wellfields feeding WASA's Orr treatment plant, VOC levels were very low in the large grouping of wellfields. Near Homestead, all of the wellfields had one or more wells exceeding criteria during the wet season but none during the dry season. Vinyl chloride was usually the excessive VOC.

Because the Hialeah-Prestion wellfields/treatment plants complex supplied a large population in Miami and had the second highest levels of VOC contamination observed in the 1977-78 study, DERM conducted a followup intensive investigation in 1978-79.[17] Fifteen USGS observation wells within

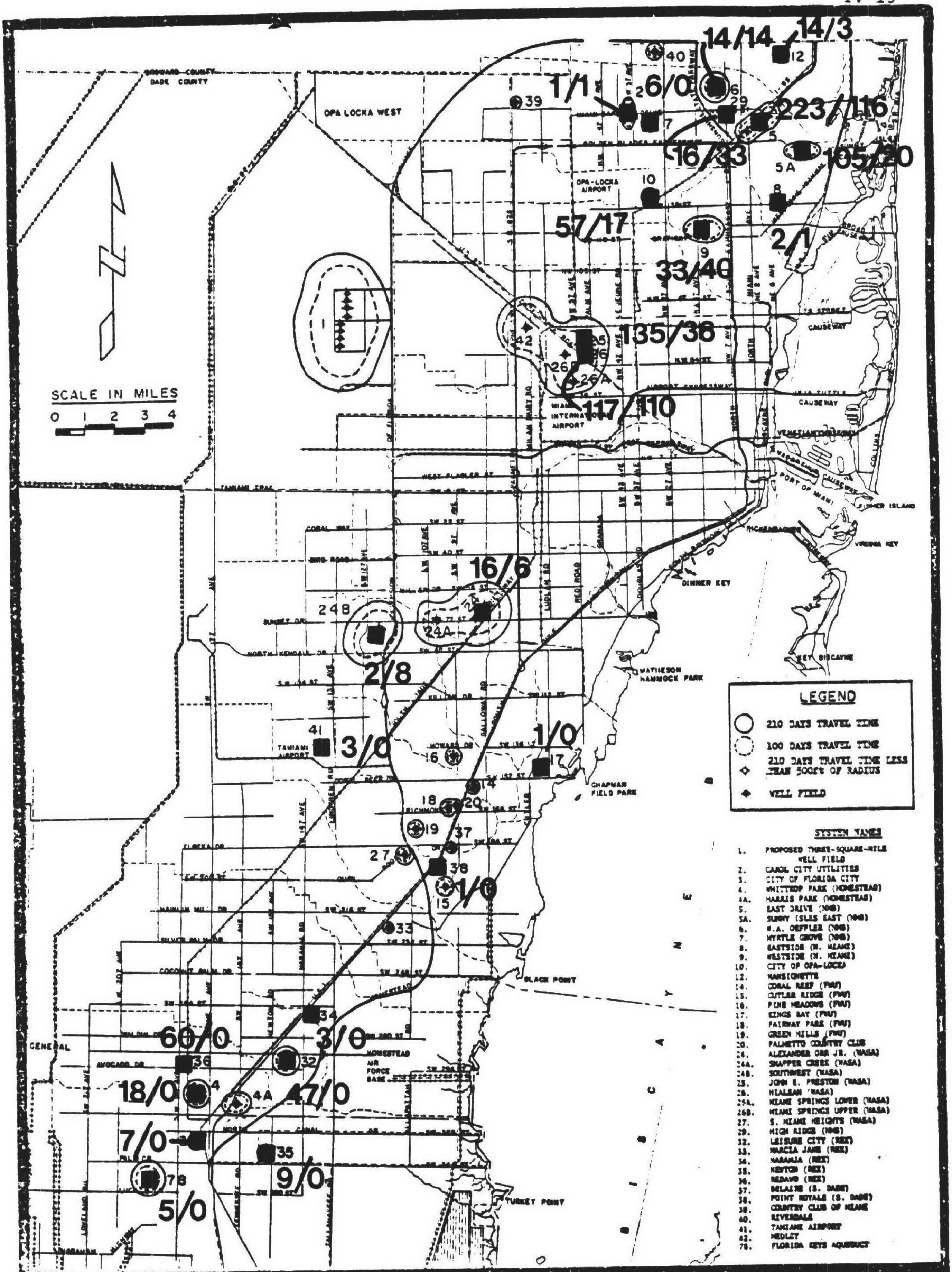

Figure 9: Observed VOC Contamination of Dade County Wellfields

the cone of influence of the wellfields were monitored regularly for VOC contamination. Supply wells were also sampled. The study confirmed the earlier detection of significant levels of VOC contamination in the water supply study[16], with higher levels present in several wells during the later study. Lower levels of VOC contamination were observed in the USGS monitoring wells. Four of the 15 monitoring wells had vinyl chloride exceeding the Florida MCL of 1 μg/ℓ. A maximum of 7 μg/ℓ was observed in one USGS well. Cis-1,2-dichloroethene exceeded the 5 μg/ℓ screening criterion in three wells, with 123 μg/ℓ the maximum concentration observed.

During the same study, VOC samples were taken from a number of irrigation and water supply wells at parks, industrial plants, etc. in an attempt to better define sources of contamination. Widely varying levels of VOC contamination were observed similar to the other wells sampled. Two producing wells and several USGS observation wells in the Alexander Orr wellfield vicinity were also sampled. Low levels of a few VOCs well below screening criteria were all that were detected confirming the 1977-78 results for the Orr wellfield.

This study seemed to indicate a correlation between industrial land uses and well contamination. Higher levels of VOC contamination were observed in water supply wells than in groundwater observation wells. No significant differences between wet and dry seasons were discernible for most wells, although a good correlation between monthly rainfall and concentrations of cis-1,2-dichloroethene was demonstrated for one USGS well near the center of the wellfield.

The large-scale Superfund study in 1982-83 also concentrated on the Hialeah-Preston area and an unsewered industrial area to the northwest [Figure 10].[20] The study collected six samples each from about 120 wells, including water supply wells, USGS groundwater observation wells and special observation wells. Analytical techniques used by the study had a detection limit of 5 μg/ℓ for VOCs, about an order of magnitude higher than the DERM studies. Screening criteria used by the Superfund study to evaluate the significance of observed VOC contamination were also about an order of magnitude

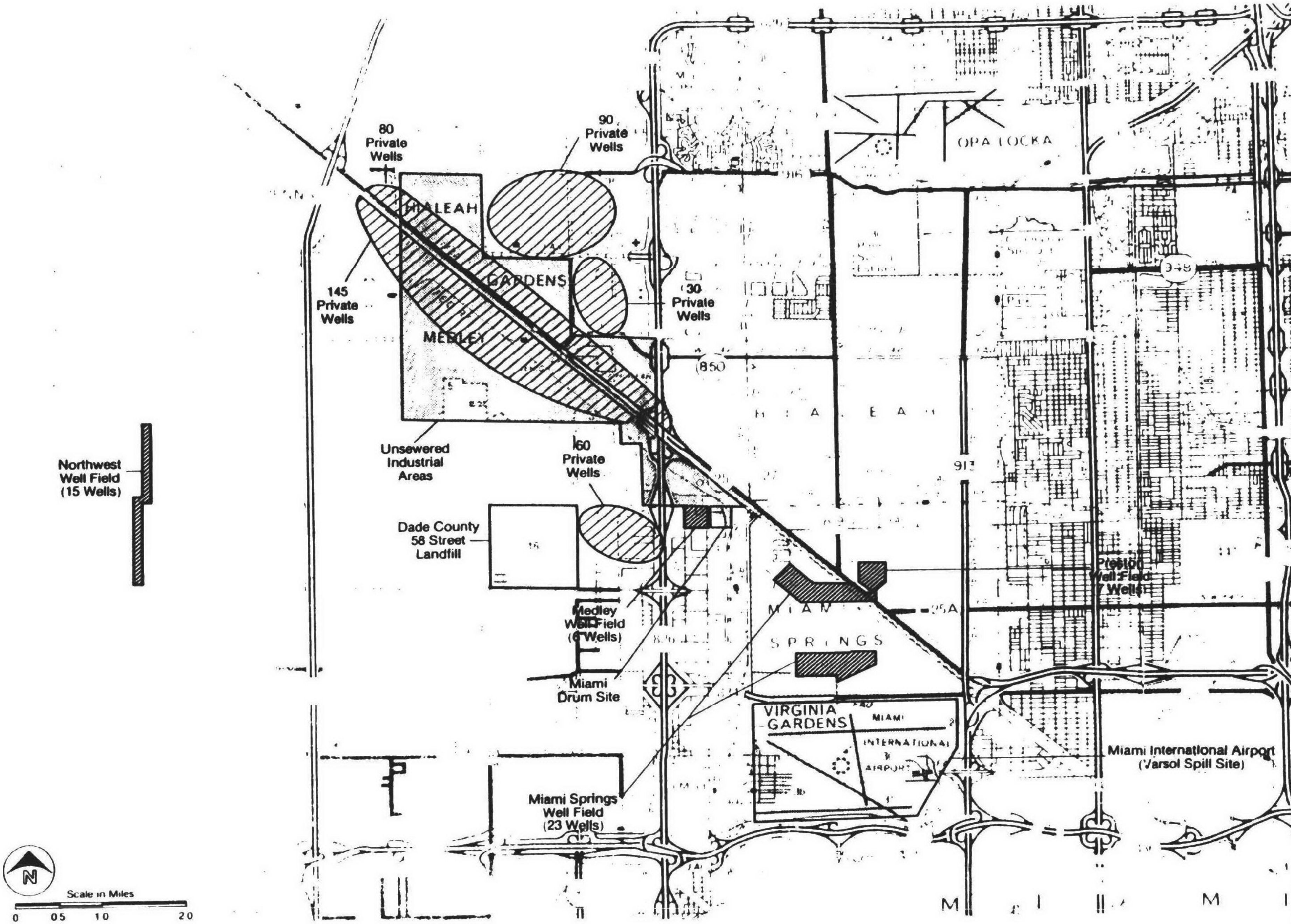

Figure 10. Biscayne Aquifer (Superfund) Study Area

higher than the EPA criteria used for this study. The analytical technique used did not distinguish between cis- and trans-1,2-dichloroethene. Results were reported as trans-1,2-dichoroethene. Based on other sampling results for the area, observed contamination was probably cis-1,2-dichloroethene.

The Superfund study confirmed and expanded upon the results of the DERM studies. Vinyl chloride and trans (cis)-1,2-dichloroethene contamination was detected the most frequently. A number of other purgeable organics and other organic pollutants were detected, generally at low levels and at scattered locations. The distribution of vinyl chloride, trans(cis)-1, 2-dichloroethene and total VOC contamination by geographical area is shown below:

Mean VOC Levels By Area (μg/ℓ)

Area	Total VOC	Vinyl Chloride	Trans-1,2-dichloroethene
Hialeah	57	23	28
Upper Miami Springs	33	17	7.3
Lower Miami Springs	20	8.7	3.6
Airport (36th Street)	10	3.5	1.1
58th Street Landfill	6.2	0.31	0.53
Unsewered Industrial Area	1.0	0.25	0.25

Note that the mean vinyl chloride levels exceeded the screening criterion and the Florida MCL in the Hialeah and Upper and Lower Miami Springs wellfields and the airport area. Observed VOC concentrations were higher in the water supply wells than in groundwater observation wells. No seasonal trends could be discerned.

Wells sampled tapped three different vertical zones in the Biscayne aquifer. Evaluation of VOC contamination levels by zone indicated that contamination was significantly lower in the upper zone than the two lower zones which were similar to each other.

The 1981 EPA Groundwater Supply Survey sampled only finished water.[18] The 1982 resurvey also evaluated selected supply wells.[19] Wells in North Miami and North Miami Beach were sampled. The results confirmed the 1977-78 DERM study [Table 4]. In North Miami, sampling of five wells at the Winson (Westside) wellfield found that vinyl chloride and cis-1,2-dichloroethene exceeded screening criteria in one well, and trichloroethylene and tetrachloroethylene exceeded screening criteria and Florida MCLs in another well. Total VOCs were 30 μg/ℓ in one well.

In North Miami Beach, all eight of the wells sampled in the Sunny Isles East Drive wellfield had vinyl chloride levels in excess of the screening criterion and Florida MCL. Vinylidene chloride exceeded the screening criterion in four wells, and excessive cis-1,2-dichloroethene was present in seven wells. Vinyl chloride ranged from 1-27 μg/ℓ. Total VOCs up to 60 μg/ℓ were present in the wells.

WASA's Medley wellfield west of the Hialeah-Preston wellfields was placed in service in 1980. Complaints of taste and odor problems when the wellfield was in use led to extensive testing of wellwater.[34] Major VOC contamination was detected in the wells. The wellfield was permanently taken out of service in 1982. Contamination (maximum levels in μg/ℓ) included vinyl chloride (389), 1,1-dichloroethane (249), 1,1-dichloroethylene (22), tetrachloroethylene (7), chlorobenzene (3) and dichlorobenzene.

DERM conducted another countywide study in 1982-83 to evaluate VOC levels in water supplies.[33] Most of the samples were taken from the distribution systems or finished water at treatment plants. Supply wells were sampled at North Miami (Winson), North Miami Beach (Norwood), Southern Gulf Utilities (Riverdale), Dade Utilities (Mansionette) and Alexander Orr. All of these wellfields, except the Orr wellfield, are in northeast Dade County. Wells Nos. 4 and 7 at the Winson wellfield were found to exceed screening criteria for vinylidene chloride, cis-1,2-dichloroethene and tetrachloroethylene, and Florida MCLs for trichloroethylene. These VOC levels were similar to levels observed in 1978 [Table 4]. The two wells sampled at Norwood had low VOC levels below screening criteria, an improvement from

1978. The two wells sampled at Riverdale had no detectable VOC contamination, but vinylidene chloride exceeded screening criteria in finished water, suggesting that contamination may have been present in other wells [Table 4]. Composite raw water at Mansionette had a low level of vinylidene chloride, exceeding the screening criterion which was an improvement from higher vinyl chloride levels observed in 1977. At Alexander Orr, three wells in the Orr and Snapper Creek wellfields had low levels of vinylidene chloride, exceeding the screening criterion; one well in the Orr wellfield exceeded the Florida MCL for trichloroethylene.

Broward County

In Broward County, the only existing groundwater VOC data compiled for this study were from the 1982 EPA resample[19] and extensive investigations of the Fort Lauderdale Executive wellfield[39] and adjacent Hollingsworth Solderless Terminal Superfund site.[21] In the 1982 study, a total of 35 samples were taken from seven wellfields.[19] In the southeast part of the county, four wells were sampled at Hallandale. One well contained cis-1,2-dichloroethene (190 μg/ℓ) and vinylidene chloride in excess of screening ctiteria and trichlorethylene (24 μg/ℓ) in excess of the Florida MCL. At Hollywood, five samples were taken from a total of 11 wells. Vinylidene chloride (max. 6 μg/ℓ) was detected in excess of the screening criterion in three samples. Trichloroethylene (max. 3 μg/ℓ) exceeded the Florida MCL in the other two samples. Two wells may have been responsible for this contamination.

In the Pembroke Pines System #2, Sunrise System #1, and Broward County Utilities-Palmdale-1B wellfields, a total of eight wells were sampled with no contamination exceeding screening criteria detected. At Pompano Beach, five wells were sampled. One well had trichloroethylene present at 3.6 μg/ℓ which exceeds the Florida MCL. Five wells were sampled at the Broward County Utilities North District 2A wellfield in Pompano Beach. Two wells had vinylidene chloride and cis-1,2-dichloroethene (max: 14 μg/ℓ) in excess of screening criteria.

Fort Lauderdale operates the Executive and Prospect wellfields in the Executive Airport vicinity which supply the Five Ash treatment plant. Several wells in the older Executive wellfield are highly contaminated with VOCs, allegedly partially the result of illegal discharges of trichloroethylene at Hollingsworth Solderless Terminal Company, a Superfund site. One well in the Executive field has been abandoned due to saltwater intrusion. Six contaminated wells are used for emergencies only. An additional six wells with significant contamination are used seasonally. The contamination has not yet spread to the adjacent Prospect wellfield. However, the contamination appears to be spreading in the Executive wellfield.

Analysis of samples from the Executive wellfield in 1982 by the Florida Department of Health and Rehabilitative Services (HRS) found very high levels of vinyl chloride (2,010 μg/ℓ) and trans-1,2-dichloroethene (2,920 μg/ℓ) in one well and several hundred μg/ℓ in other wells.[39] This is the highest level of contamination reported in the study area. Other VOCs detected at high levels included trichloroethylene (207 μg/ℓ) and 1,1,1-trichloroethane (732 μg/ℓ).

Broward County Environmental Quality Control Board has established a county-wide network of groundwater quality monitoring wells [Figure 11]. This network consists of 30 sets of two monitoring wells (three at Executive Airport), one about 20 to 50 feet deep corresponding to shallow private and non-community water supply wells in the area and the second well about 80 to 200 feet deep, depending on the producing zone depth of nearby large community water supply wellfields. To provide an overview of general groundwater quality in Broward County, EPA sampled this monitoring network in February 1984 and conducted VOC analyses. Such data were not previously available for Broward County.

Analytical results indicated that low levels of VOCs were present in 16 of the 58 wells sampled. At Deerfield Beach, trans-1,2-dichloroethene was present in the 55-ft deep shallower well at a level of 8 μg/ℓ that exceeded screening criteria (#2 in Figure 11). This was the only well with VOC contamination exceeding criteria. Benzene, xylene and toluene compounds

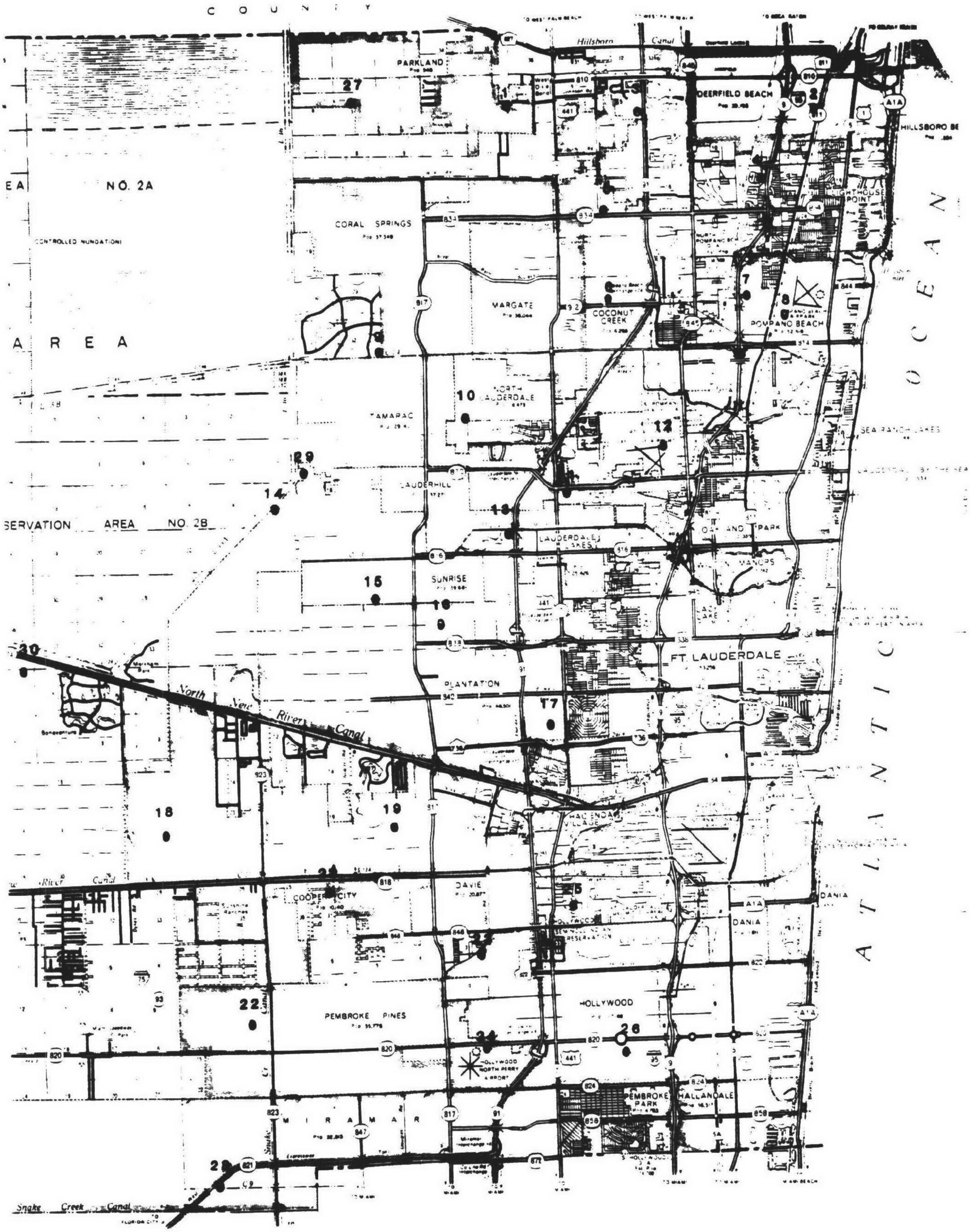

Figure 11: Broward County Groundwater Monitoring Wells

were also present in this well at levels of 1-3 µg/ℓ. Five other wells had one or more benzene, toluene or xylene compounds present at levels of 1-8 µg/ℓ (#s 5, 6, 22, 27 and 29 in Figure 11). This contamination could possibly have been the result of contamination by the exhaust from the gasoline engine driven pump during the well sampling. Four wells that had been recently constructed had significant levels of tetrahydrofuran (8-4,000 µg/ℓ) and methyl ethyl ketone (MEK) (20-3,000 µg/ℓ). These compounds are solvents in PVC adhesives, so this contamination was most likely the result of well construction. The shallow well west of Deerfield Beach (#3 in Figure 11) had 2 µg/ℓ of trichloroethylene and 0.5 µg/ℓ of trans-1,2-dichloroethene present. The deep well (157 feet) at Executive Airport (#12 in Figure 11) had 3 µg/ℓ of trans-1,2-dichloroethene present. This well is in the contaminated portion of the Executive wellfield. Other observed contamination was 0.5 µg/ℓ of 1,1,1-trichloroethane in Flamingo (#28 in Figure 11), 0.5 µg/ℓ of 1,2-dichloroethane in Oak Ridge (#25 in Figure 11), and 1 µg/ℓ of cis-1,2-dichloroethane and 1 µg/ℓ of chlorobenzene in the Dixie wellfield (#17 in Figure 11).

Palm Beach County

Palm Beach County data on VOC contamination of groundwater were limited to the 1982 EPA resampling data, additional followup sampling at Riviera Beach and Seacoast Utilities Richard Road system (Palm Beach Gardens), and data on contamination of the Pratt-Whitney industrial plant supply.[22] In the EPA study, seven wells in Lantana and Century Utilities (West Palm Beach) wellfields were sampled.[19] No VOC contamination was detected. At Seacoast Utilities, eight wells were sampled at Richard Road. Trichloroethylene (max. 58 µg/ℓ) and tetrachloroethylene exceeded Florida MCLs in two wells. Resampling by the utility found TCE at levels as high as 289 µg/ℓ. At Riviera Beach, eight wells were sampled and three were found to have high VOC levels, including cis-1,2-dichloroethene that exceeded screening criteria and 1,2-dichloroethane, trichloroethylene and very high vinyl chloride (270 µg/ℓ) in excess of Florida MCLs. Other VOCs present included chlorobenzene, ethylbenzene and xylene. This contamination was confirmed by DER resampling in January 1983.[22]

At Pratt-Whitney, a major aircraft component manufacturing and research facility in North Palm Beach County, several potable water wells onsite have been contaminated with halogenated solvents by waste disposal activities.[22] Raw water sampled by EPA in March 1984 contained 140 μg/ℓ of chloroethane, 70 μg/ℓ of 1,1-dichloroethane, 20 μg/ℓ of cis-1,2-dichloroethene, 10 μg/ℓ of 1,1,1-trichloroethane, and 8 μg/ℓ of vinyl chloride. Special water treatement is used to remove this contamination.

DRINKING WATER QUALITY

The quality of drinking water in the study area is a function of groundwater quality and the type of water treatment provided. In south Dade County, groundwater quality is relatively good, and no water treatment other than disinfection is provided for most public water supplies. Drinking water quality in this area is thus groundwater quality with the addition of low levels of trihalomethanes. In other areas of the study area, lime softening is commonly provided. Such treatment would be expected to have little effect on volatile organic chemicals.

In the northern and middle parts of the study area, many of the public water treatment plants provide aeration (usually simple cascade aeration) for sulfide removal and improved iron removal. Such aeration may significantly reduce some VOCs. The Fort Lauderdale Five Ash water treatment plant has mechanical surface aeration that has demonstrated high vinyl chloride removals.[22] The Sunny Isles treatment plant in North Miami Beach uses powdered activated carbon and aeration to reduce various organic chemicals in the finished water.[34] At Pratt-Whitney, multi-stage aeration is used to essentially remove all VOC contamination present in the groundwater supply. For these water supplies, drinking water may be of substantially better quality than groundwater.

North of south Dade County, most water supplies treat for color removal. In the past, this was usually done exclusively by chlorination. Unfortunately, this resulted in very high levels (100 to 600 μg/ℓ) of trihalomethanes in the finished water. Because free chlorine residual disinfection was practiced, more THMs were formed in the distribution system. Since mid-1981, all public water supplies serving more than 75,000 persons have been required by drinking water standards [Appendix A] to maintain THM levels in drinking water at less than 100 μg/ℓ. Beginning on November 29, 1983, all public water supplies serving more than 10,000 persons were required to achieve the same standard. There are no THM limits applicable to smaller supplies.

As discussed in the Previous Studies section, various methods of treatment for THM reduction were investigated for area water supplies. These included changing chlorination points in the treatment process, aeration, activated carbon or resin filters and the chloramine process. In the latter process, ammonia is added to the chlorinated water to quench the chlorination process and form chloramines (bacterial disinfectants). Chloramines are used as a residual disinfectant in the distribution systems. By using the chloramine process, WASA was able to reduce their previously high THM levels to an average of about 21 μg/ℓ in 1982.[49] Monitoring by DERM in 1982-83 indicated that all Dade County water supplies required to reduce THMs to less than 100 μg/ℓ by the December 1983 deadline were already well below this limit except for the City of Opa-Locka (149 μg/ℓ) and Southern Gulf Utilities (Riverdale) (144 μg/ℓ).[49] The Riverdale plant has since shut down, and Opa-Locka has reduced THM levels to below the 100 μg/ℓ limits. The EPA sampling in early 1984 found high THM levels at several major water supplies and a significant number of smaller supplies in the three counties.

Chloramine disinfection apparently has some difficulties. An April 1983 bacterial contamination outbreak in Miami Beach was traced to an apparent correlation with low chloramine levels in the distribution system.[41] Recent investigations by the Dade County Health Department have detected unusually high levels (up to 1 mg/ℓ) of nitrites in the outer areas of the WASA distribution system.[41] These seem to be related to the survival and growth of nitrifying bacteria in the distribution system. Special operating procedures are now being used to reduce nitrifying bacteria populations.

Drinking water quality is regulated by standards promulgated by DER [Appendix A]. These are essentially EPA's primary and secondary drinking water standards promulgated under authority of the Safe Drinking Water Act. Enforcement of the standards in Florida has been delegated to DER. DER has in turn delegated enforcement to the three county health departments in the study area but retains overall responsibility for enforcement.

The primary standards apply to all community public water supplies. Maximum contaminant levels (MCL) are specified for inorganics (primarily heavy metals, nitrates and fluoride), organics (six pesticides), turbidity, bacteria, radionuclides and trihalomethanes. Only the nitrate and microbiological limits apply to non-community water supplies obtained from groundwater.

The secondary drinking water standards apply only to community water supplies. They specify MCLs for several physical and inorganic chemical characteristics of the water supply.

The county health departments regulate the quality of private drinking water supplies. Only microbiological limits apply.

Public community water supplies regularly monitor for regulated water characteristics. Any problems are quickly noted by the health departments and appropriate actions taken to ensure safe drinking water of acceptable quality. Major public community water supplies in the study area are thus believed to be generally in compliance with drinking water standards.

State regulations require that non-community water supplies must meet only the nitrate and microbiological standards. Monitoring is infrequent. The status of compliance is not well defined. Many of the smaller non-community supplies provide a minimum of water treatment and may only disinfect. Since chlorine disinfection is used, THM levels may be high. Water quality in these systems would be expected primarily to reflect local groundwater quality. In Dade County, certain non-community water supplies such as schools and trailer parks must meet other quality parameters and are regularly inspected.

There are thousands of private wells in the study area. Most are shallow wells (<25 ft deep) and many have no treatment. On others, treatment may range from disinfection to softening, iron removal and, in some cases, activated carbon filters (either the small faucet mounted units or larger home filters). Water quality in the private systems could be expected to be highly variable and be primarily dependant upon local groundwater quality.

Currently, there are no drinking water standards for volatile organic chemicals, although Florida has promulgated standards that become effective in 1985. As previously discussed in the groundwater quality section, EPA has developed proposed recommended maximum contaminant levels (RMCLs) for eight VOCs frequently found in drinking water. When promulgated, these RMCLs will be health goals only and will not be enforceable limits. They will not apply to private water supplies. They are still in the proposal development stage and may change before proposal or promulgation. However, the RMCLs do provide an indication of what EPA believes to be a lower limit on significant levels of VOC contamination. For this reason, the RMCLs were used as screening criteria to detect significant levels of VOC contamination in the available VOC data on finished drinking water.

As previously discussed in the groundwater quality section, cis-and trans-1,2-dichloroethene were frequently associated with vinyl chloride contamination of groundwater. A level of 5 μg/ℓ was used as screening criteria for significant levels of cis- and trans-1,2-dichloroethene.

Florida has promulgated MCLs for eight VOCs that become effective in June 1985 for community systems serving more than 1000 persons and in January 1987 for smaller community systems. These MCLs will be enforceable limits. As shown in the table in the groundwater section, the MCLs are slightly higher than the RMCLs being developed by EPA. This reflects adjustments for analytical detection limits. Drinking water quality was also screened against the MCLs to define supplies that may need to take steps to reduce VOC levels before June 1985.

In the screening of available data on VOC concentrations in both groundwater and finished drinking water, the compounds observed to most frequently exceed screening criteria were vinyl chloride, vinylidene chloride, cis-1, 2-dichloroethene and trichloroethylene. Table 4 in the groundwater quality section is a summary of VOC data on these four compounds in both wellfields and finished water for major public water supply systems for which data existed prior to this EPA study. Because only limited data were available on most systems, only the observed range was presented. No averages were computed. Well data often represent only part of the available wells for that supply. Screening criteria and the MCLs are presented, and systems with VOC contamination exceeding criteria are flagged.

Several conclusions can be drawn from the data presented in Table 4 and the basic data from which the table was constructed. There appear to be definite geographical differences in the levels of observed contamination. In general, this can be related to proximity to industrial types of land use. Other factors specific to some systems are discussed below.

Observed levels of contamination varied substantially among wells within the same wellfield. This, coupled with the area differences, seemed to indicate that contamination was probably primarily due to point sources rather than broad-scale, non-point sources. As discussed in Section V, several significant point sources have been identified.

Data in Table 4 were primarily derived from the DERM and 1982 EPA studies discussed in the groundwater quality section. Additional data on finished water were obtained from the 1983 DERM county-wide study[33], the 1981 and 1982 EPA groundwater supply study[19], and from the 1984 EPA sampling.

Table 4 lists all public water supplies for which data on VOC contamination were available prior to start of this study. Data were available on most community systems in Dade County but only about 10% of the community systems in Broward and Palm Beach Counties. No data were available on non-community supplies or private domestic wells. The frequency of occurrence and observed levels of VOC contamination of the supplies for which data were available suggested the need to screen the other public water supplies, for which no data were available, to determine if similar patterns of contamination existed in these supplies.

In cooperation with DER and local agencies, EPA conducted an extensive sampling of public water supplies during February-May 1984. Essentially all community water supplies in Broward (45) and Palm Beach (72) Counties were sampled. In Dade County, 18 community supplies were sampled. The main Miami-Dade Water and Sewer Authority (WASA) system, including the Alexander Orr, John Preston, Hialeah and South Miami Heights treatment plants, was not sampled because of extensive existing data. In addition, a representative sample (about 15%) of non-community supplies was sampled in each county. This included 17 systems in Broward County, 21 in Dade County and 45 in Palm Beach County. Altogether, 135 community and 83 non-community supplies were sampled.

At each water supply, a sample of finished water was obtained and analyzed for purgeable volatile organic chemicals. If water treatment included aeration, a sample of raw water was also obtained for VOC analysis. In this manner, data on VOC removal at existing treatment plants were also obtained.

The results of the EPA study of community systems are presented alphabetically by county in Table 5. Results for non-community systems are presented in Table 6. Data for community systems listed previously in Table 4 also are incorporated in that table. The locations of water supplies sampled by EPA are shown in Figures 12-19.

The VOCs most often observed by the EPA study were trihalomethanes (predominantly chloroform), cis or trans-1,2-dichloroethene, 1,2-dichloroethane (ethylene dichloride), trichloroethylene (TCE) and vinyl chloride. Tables 5 and 6 list the observed concentration for these substances. Observed concentrations exceeding study screening criteria or Florida MCLs are flagged.

The results of the EPA sampling indicate that for most public water supplies, VOC contamination of groundwater is not a problem. For several major community systems, groundwater contamination has been a problem but is currently being adequately managed. In a few cases, VOC contamination

Table 5

OBSERVED LEVELS OF VOCs IN COMMUNITY WATER SUPPLIES (µg/ℓ)

Map Key[a]	System Name	Total THM[b]	Total non-THM[c]	Cis/trans[d]	EDC[e]	TCE[f]	Vinyl Chloride
	Broward County (See Figure 13)						
1	Acme Mobile Home Park	2	ND[g]				
2	Broadview Park Water Co.	269*	ND				
3	Broadview Utilities Co.	272*	ND				
4	Broward Co.-1A (Lauderdale Lakes)	38	ND				
5	Broward Co.-2A (North District)						
	Finished Water	7	ND				
	Raw Water #5	ND	1	1			
	Raw Water #6	ND	2	2			
6	Broward Co.-3A (Playland Isles)	16	ND				
7	Broward Co.-3B (High Ridge-Lake Forest)	48	ND				
8	Broward Correctional Inst.	331*	ND				
9	Cooper City Utilities East	281*	ND				
10	Cooper City Utilities West	238*	ND				
11	Coral Springs Improvement	8	ND				
12	Coral Springs, City of	106*	ND				
13	Crystal Lakes MHP	141*	ND				
14	Dania, City of						
	Finished Water	168*	ND				
	Raw Water	3	ND				
15	Davie Utilities	59	ND				
16	Deerfield Beach, City of	36	ND				
17	Deerfield Lake MHP	1	ND				
18	El Rancho MHP	5	ND				
19	Ferncrest Utilities	124*	ND				
	Ft. Lauderdale, City of						
20	Five Ash Finished Water	60	ND				
21	Peele-Dixie Finished Water	55	ND				
	Peele-Dixie Raw Water	6	0.7	0.7			
22	Gulf Stream Utility Co.	334*	7				
23	Hallandale, City of						
	Finished Water	10	0.9	0.9			
	Raw Water	ND	1.6	1			
24	Hillsboro Beach, Town of	31	ND				
25	Hillsboro MHP	NS	NS[h]				
26	Hollywood, City of	33	2	2			
27	Lauderhill, City of	52	ND				
28	Margate, City of	61	ND				

Table 5

OBSERVED LEVELS OF VOCs IN COMMUNITY WATER SUPPLIES (μg/ℓ)

Map Key[a]	System Name	Total THM[b]	Total non-THM[c]	Cis/ trans[d]	EDC[e]	TCE[f]	Vinyl Chloride
	Broward County						
29	Miramar, City of						
	Finished Water	150*	ND				
	Raw Water	ND	1	1			
30	New Mark Glenn MHP	39	ND				
31	N. Lauderdale, City of	18	ND				
32	Ocean Waterway MHP	70	ND				
33	Parkland Utilities	208*	ND				
34	Pembroke Pines, City of (#1)	249*	ND				
35	Pembroke Pines, City of (#2)	229*	ND				
36	Pembroke Pines, City of (Holly Lake)	353*	58**				
37	Plantation, City of						
	Finished Water	18	2	2			
	Raw Water East	12	1	1			
	Raw Water West	4	2	2			
38	Pompano Beach, City of	67	31	9***		22*	
39	Seminole Industries	132*	0.9	0.9			
40	Sunrise, City of (#1)	6	ND				
41	Sunrise, City of (#2)	80	ND				
42	Tamarac, City of	33	ND				
43	Taylor Trailer Park	112*	ND				
44	University Utilities	90	ND				
45	Coral Lake MHP	NS	NS				
	Dade County (See Figure 12)						
1	Americana Village	80	ND				
2	Boystown of Florida	1	ND				
3	Florida City	21	ND				
4	Florida Keys Aqueduct Comm.	12	ND				
5	Homestead AFB	4	ND				
6	Homestead, City of	8	0.7				
7	Jones Fish Camp	5	ND				
8	Laguna Palms MHP	30	ND				
9	N. Miami, City of (Winson)						
	Finished Water	12	7	5***		2	
	Raw Water	ND	9	7***		2	
	N. Miami Beach, City of						
10	Norwood Finished Water	108*	2	2			
11	Sunny Isles Finished Water	15	15	10***			2*
12	Opa-Locka, City of						
	Finished Water	68	4	2			
	Raw Water	ND	5	2			

Table 5

OBSERVED LEVELS OF VOCs IN COMMUNITY WATER SUPPLIES
(μg/ℓ)

Map Key[a]	System Name	Total THM[b]	Total non-THM[c]	Cis/trans[d]	EDC[e]	TCE[f]	Vinyl Chloride
13	Pak Kan MHP	2	ND				
14	Quail Roost MHP	20	ND				
15	Redlands MHP	1	ND				
16	Rex Utilities-Leisure City	NS	NS				
17	Rex Utilities-Redavo	9	ND				
18	Silver Palm MHP	4	ND				
	Palm Beach County (SeeFigures 14 and 15)						
1	Acme Improvement District						
	Finished Water	310*	ND				
	Raw Water	ND	ND				
2	Akers Away Trailer Park	364*	ND				
3	Anchorage MHP	ND	ND				
4	Arrowhead Village MHP	274*	0.5				
5	Atlantis Utilities						
	Finished Water	116*	ND				
	Raw Water	ND	ND				
6	Blue Sky MHP	8	ND				
7	Boca Raton, City of	20	2				
8	Boulevard Trailer Park	ND	ND				
9	Boynton Beach, City of	23	ND				
10	Brierwood Apartments	61	ND				
11	Casa Loma Trailer Park	25	ND				
12	Century Vil.-Century Util.	108*	ND				
13	Colonial Estates MHP	214*	ND				
14	Consolidated Utilities Co.						
	Finished Water	294*	ND				
	Raw Water	ND	ND				
15	Delray Beach Water Dept.						
	Finished Water	60	ND				
	Raw Water	ND	1				
16	Floranda Trailer Park	21	0.8	0.8			
17	Florida Water Service-Lake Clark	NS	NS				
18	Florida Water Service-Seminole Manor	202*	ND				
19	Fred's Motel						
	Finished Water	4	ND				
	Raw Water	ND	ND				
20	Garden Lane Apartments	50	ND				
21	Gulfstream Water Dept.	NS	NS				
22	Harney's Trailer Park	5	ND				
23	Highland Beach Water Plant	189*	ND				
24	Highland Trailer Park	50	ND				
25	Holley, A. G., State Hospital	49	ND				

Table 5

OBSERVED LEVELS OF VOCs IN COMMUNITY WATER SUPPLIES (μg/ℓ)

Map Key[a]	System Name	Total THM[b]	Total non-THM[c]	Cis/ trans[d]	EDC[e]	TCE[f]	Vinyl Chloride
26	Hypoluxo MHP	ND	ND				
27	In the Pines	20	ND				
28	Jamaica Bay MHP	197*	ND				
29	Juno Beach Mobile Court	29	2		2***		
30	Juno Beach Water Dept.	NS	NS				
31	Jupiter, Town of	20	ND				
32	Kokomo MHP	176*	ND				
33	Lake Worth Utilities Auth.	5	ND				
34	Lake Worth Village MHP	234*	ND				
35	Lantana, Town of						
	Finished Water	84	ND				
	Raw Water	ND	ND				
36	Linda'a Trailer Park	20	ND				
37	Loxahatchee Road Prison						
	Finished Water	7	2		2***		
	Raw Water	ND	4	2	2***		
38	Manalapan Water Dept.						
	Finished Water	116*	ND				
	Raw Water	7	ND				
39	Mangonia Park Utility Co.	6	ND				
40	Mayacoo Lakes Country Club	2	ND				
41	Meadowbrook						
	Finished Water	176*	ND				
	Raw Water	ND	ND				
42	Melaleuca Trailer Park	4	ND				
43	Monet Acres	66	ND				
44	Northern Pines MHP	12	ND				
45	Palm Beach Co.-SCR #1	247*	ND				
46	Palm Beach Co.-ECR #2						
	Finished Water	220*	0.5	0.5			
	Raw Water	2	6	6***			
47	Palm Beach Co.-SCR #2	279*	ND				
48	Palm Beach Co.-ECR #3						
	Finished Water	225*	ND				
	Raw Water	1	ND				
49	Palm Beach Co. Utility (Pike Utility)	NS	NS				
50	Palm Beach Faith Farm						
51	Palm Springs, Village of	98	ND				
52	Parry Trailer Village	ND	ND				
53	Palm Beach Co. (Pheasant Trail)	NS	NS				
54	Pine Grove Village	33	ND				
55	Riviera Beach, City of						
	Finished Water	138*	3			3*	
	Raw Water	ND	10			10*	
56	Royal Manor MHP	222*	ND				

Table 5

OBSERVED LEVELS OF VOCs IN COMMUNITY WATER SUPPLIES ($\mu g/\ell$)

Map Key[a]	System Name	Total THM[b]	Total non-THM[c]	Cis/trans[d]	EDC[e]	TCE[f]	Vinyl Chloride
57	Royal Palm Beach Utilities						
	Finished Water	154*	ND				
	Raw Water	ND	ND				
58	Royal Palm MHP	5	ND				
59	S. Palm Beach Utilities	53	ND				
	Seacoast Utilities						
60	Hood Road						
	Finished Water	10	2		2***		
	Raw Water	ND	ND				
61	Lilac Street						
	Finished Water	15	ND				
	Raw Water	ND	1.4			0.7	
62	Richard Road						
	Finished Water	11	5	3			2*
	Raw Water	ND	33	15***			17*
63	Sherwood Villas Apartments	2	ND				
64	Sunshine Meadows	66	ND				
65	Sunshine Trailer Park	36	ND				
66	Tequesta Water Dept.						
	Finished Water	49	ND				
	Raw Water	ND	ND				
67	Topper House Apartments	5	ND				
68	Tropical Terrace	ND	ND				
69	Twin Lakes MHP	52	ND				
70	Village of Golf	760*	0.5				
71	West Palm Beach, City of	5	ND				
72	Woodhaven Villas	61	ND				

a *See Figures 12, 13, 14 and 15 for locations of systems.*
b *Total trihalomethanes are the sum of observed concentrations of chloroform, bromoform, bromodichloromethane and dibromochloromethane.*
c *Sum of all other observed purgeable volatile organic chemicals*
d *Cis and/or trans-1,2-dichloroethene*
e *1,2-dichloroethane or ethylene dichloride*
f *Trichloroethylene or trichloroethene*
g *Not detected at limit of detection for analytical method used*
h *Not sampled*
* *Exceeds Florida DER maximum contaminant levels*
** *Sample contaminated with toluene, benzene and xylene compounds and methyl isobutyl ketone.*
*** *Exceeds study screening criteria*

Table 6

OBSERVED LEVELS OF VOCs IN NON-COMMUNITY WATER SUPPLIES (μg/ℓ)

Map Key[a]	System Name	Total THM[b]	Total non-THM[c]	Cis/trans[d]	EDC[e]	TCE[f]	Vinyl Chloride
	Broward County (See Figure 17)						
1	Ambassador Christian Academy	81	ND[g]				
2	Dairy Queen	77	2	2			
3	Everglades Holiday Park	344*	ND				
4	Gate City, Inc.	10	ND				
5	Golf Manor Bldg. A	2	ND				
6	Greenburg Warehouse #1	ND	2	2			
7	Hollywood Free Will Bapt. Ch.	20	ND				
8	Marino's Restaurant	1	ND				
9	Math Igler Groves	3	ND				
10	New England Seafood	24	ND				
11	Oak Ridge Country Club	6	ND				
12	Orange Tree	2	ND				
13	Pompano Turnpike Plaza	277*	6**				
14	Seminole Health Club	27	ND				
15	Seminole Truck Stop	20	ND				
16	Tradewinds Park	55	ND				
17	Tree Tops Park	10	ND				
	Dade County (See Figure 16)						
1	Andersons Corner Grocery	ND	ND				
2	Birdlis V. Rental Bldg.	ND	0.9				
3	Capriccio Restaurant	7	1				
4	Century 21	ND	20.5**				
5	Exxon Oil-Kents Station	0.9	ND				
6	FL-DOT Maintenance Yard	90	1				
7	Gateway Inn	ND	ND				
8	Gulfstream Steel, Inc.	ND	ND				
9	Kentucky Fried Chicken	1	0.8	0.8			
10	KOA Campground	5.7	5				
11	Levine, S. L., Red Sunset Bldg.	ND	6	1			5*
12	Magram Dairy Queen	8.8	ND				
13	Marrero Shell Station	3	1				
14	Metatherapy Institute	3.7	ND				
15	Motor Service	462*	16**				
16	Pit Bar BQ	17.9	0.7	0.7			
17	Rinker-Portland Cement Corp.	47.5	ND				
18	Road Runner Inn	ND	0.8				
19	Southwest Alliance Church	65	ND				
20	Westland Country Club	228*	ND				
21	Wollard Aircraft Equip. Corp.	ND	74**				

Table 6

OBSERVED LEVELS OF VOCs IN NON-COMMUNITY WATER SUPPLIES
(μg/ℓ)

Map Key[a]	System Name	Total THM[b]	Total non-THM[c]	Cis/trans[d]	EDC[e]	TCE[f]	Vinyl Chloride
	Palm Beach County (See Figures 18 and 19)						
1	Anchor Inn	ND	ND				
2	Banyan Golf Club	5	ND				
3	Barnett Bank	ND	ND				
4	Bedner Labor Camp	ND	ND				
5	Boynton Beach Lions Club	17	ND				
6	Brass Bull	ND	ND				
7	Byrd's Grocery	ND	ND				
8	Calvary Baptist Church	ND	ND				
9	Calvin's House	4	ND				
10	Coca Cabana	ND	ND				
11	Congress Restaurant	10	ND				
12	Copper Kettle Restaurant	ND	ND				
13	Cumberland Farm Store	ND	ND				
14	Daisey Fresh Budget Store	5	ND				
15	Delray Skateway	ND	ND				
16	Everglades Youth Camp						
	Finished Water	135*	ND				
	Raw Water	ND	ND				
17	First Baptist Church-Greenacres	ND	ND				
18	Frat House Restaurant	ND	20	10***	10*		
19	Good Samaritan Hospital	24	1		1		
20	Gulfstream Trailer Park	50	ND				
21	Hagen Road Elementary School	322*	ND				
22	Holiday Country Club Golf	2	ND				
23	Indian Hills Groves	ND	1				
24	L. W. McNamara & Sons	5	ND				
25	Lake Worth Raquet Club	ND	1				1*
26	Lil General Store	3	ND				
27	Lion Country Safari	210*	ND				
28	Military Trail Golf Club	ND	ND				
29	Mill & Bill Bar	ND	ND				
30	Ocean Way MHP	ND	ND				
31	Paco's Tortillas	ND	ND				
32	Palm Beach Trap & Skeet Club	2	ND				
33	Plush Pony South	ND	ND				
34	Pratt-Whitney Aircraft						
	Finished Water	382*	ND				
	Raw Water	1	250	20***			8*
35	Royal Palm Polo	ND	ND				
36	Scotchel Office Bldg.	ND	ND				

Table 6

OBSERVED LEVELS OF VOCs IN NON-COMMUNITY WATER SUPPLIES
(μg/ℓ)

Map Key[a]	System Name	Total THM[b]	Total non-THM[c]	Cis/trans[d]	EDC[e]	TCE[f]	Vinyl Chloride
37	Short Stop Convenience	280*	ND				
38	Sportman's Inn West	60	ND				
39	Step Saver #45	ND	ND				
40	Sunshine Preschool	10	4		4*		
41	T's	3	ND				
42	Trinity Assembly of God Ch.	ND	ND				
43	Vince's Deli	ND	ND				
44	Williamson's Country Store	ND	ND				
45	Winkle Oil Truck Stop	ND	ND				

a *See Figures 16, 17, 18 and 19 for locations of systems.*
b *Total trihalomethanes are the sum of observed concentrations of chloroform, bromoform, bromodichloromethane and dibromochloromethane.*
c *Sum of all other observed purgeable volatile organic chemicals*
d *Cis and/or trans-1,2-dichloroethene*
e *1,2-dichloroethane or ethylene dichloride*
f *Trichloroethylene or trichloroethene*
g *Not detected at limit of detection for analytical method used*
h *Not sampled*
* *Exceeds Florida DER maximum contaminant levels*
** *Sample contaminated with toluene, benzene and xylene compounds*
*** *Exceeds study screening criteria*

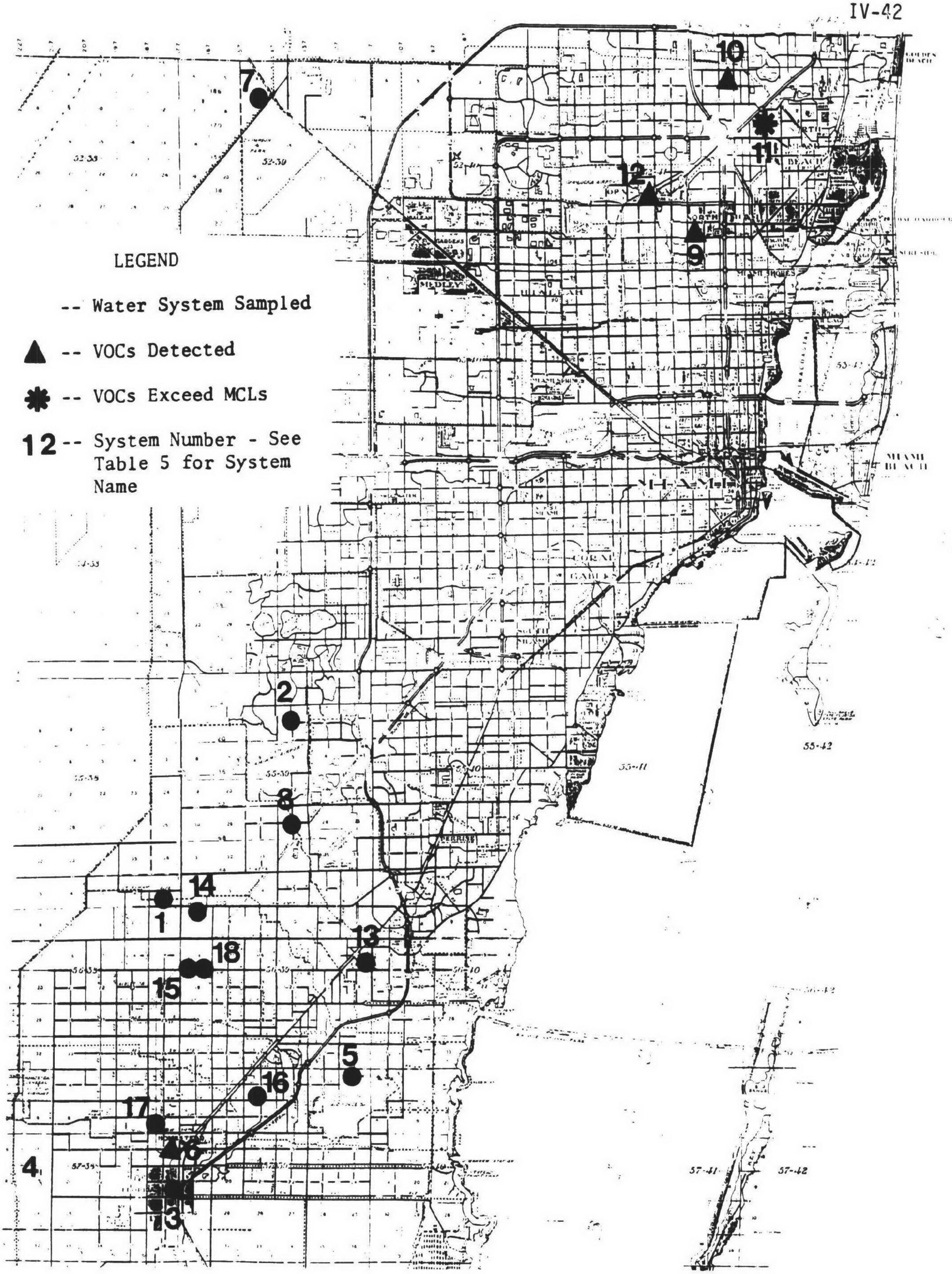

Figure 12: Community Water Supplies Sampled in Dade County

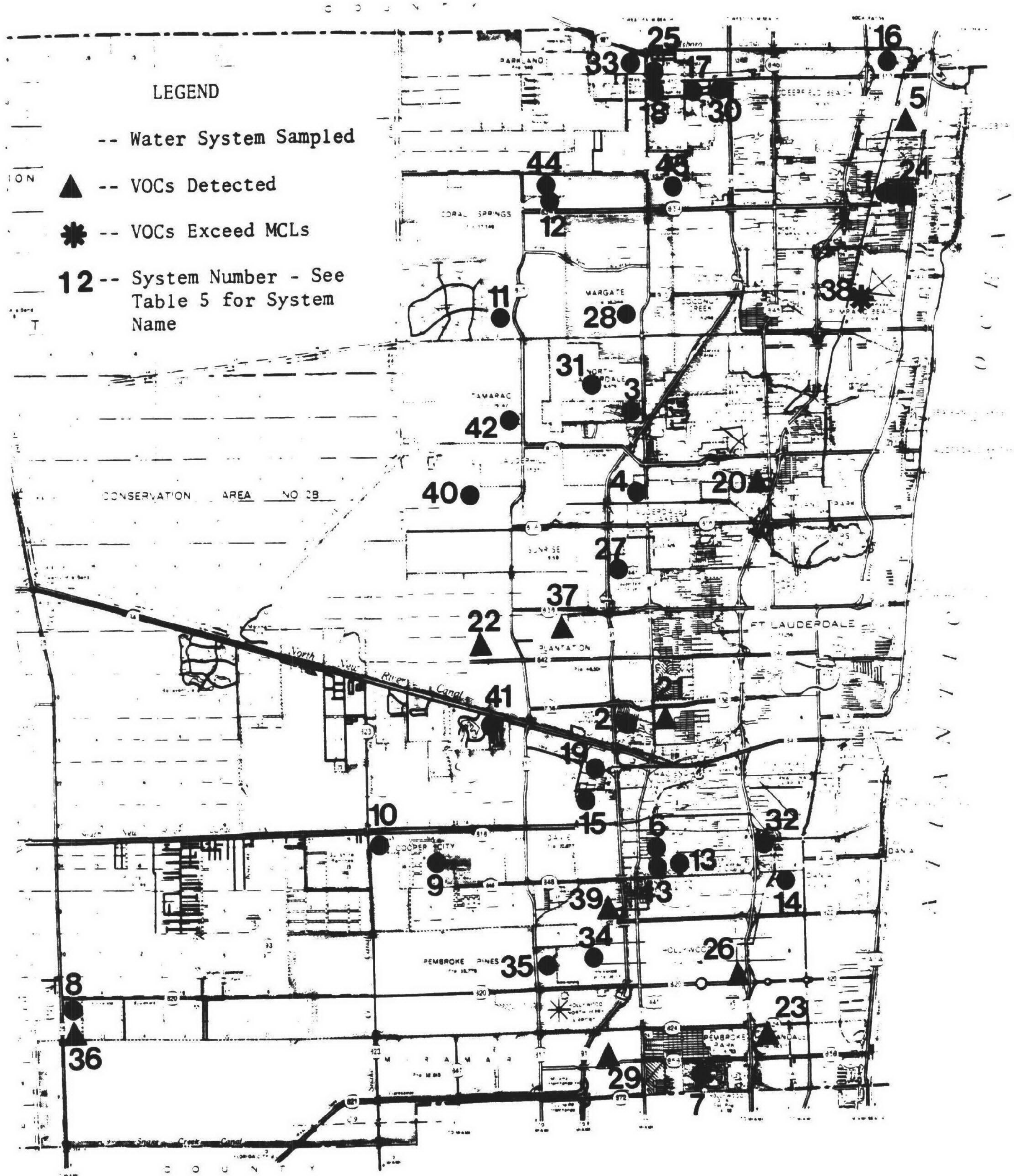

Figure 13: Community Water Supplies Sampled in Broward County

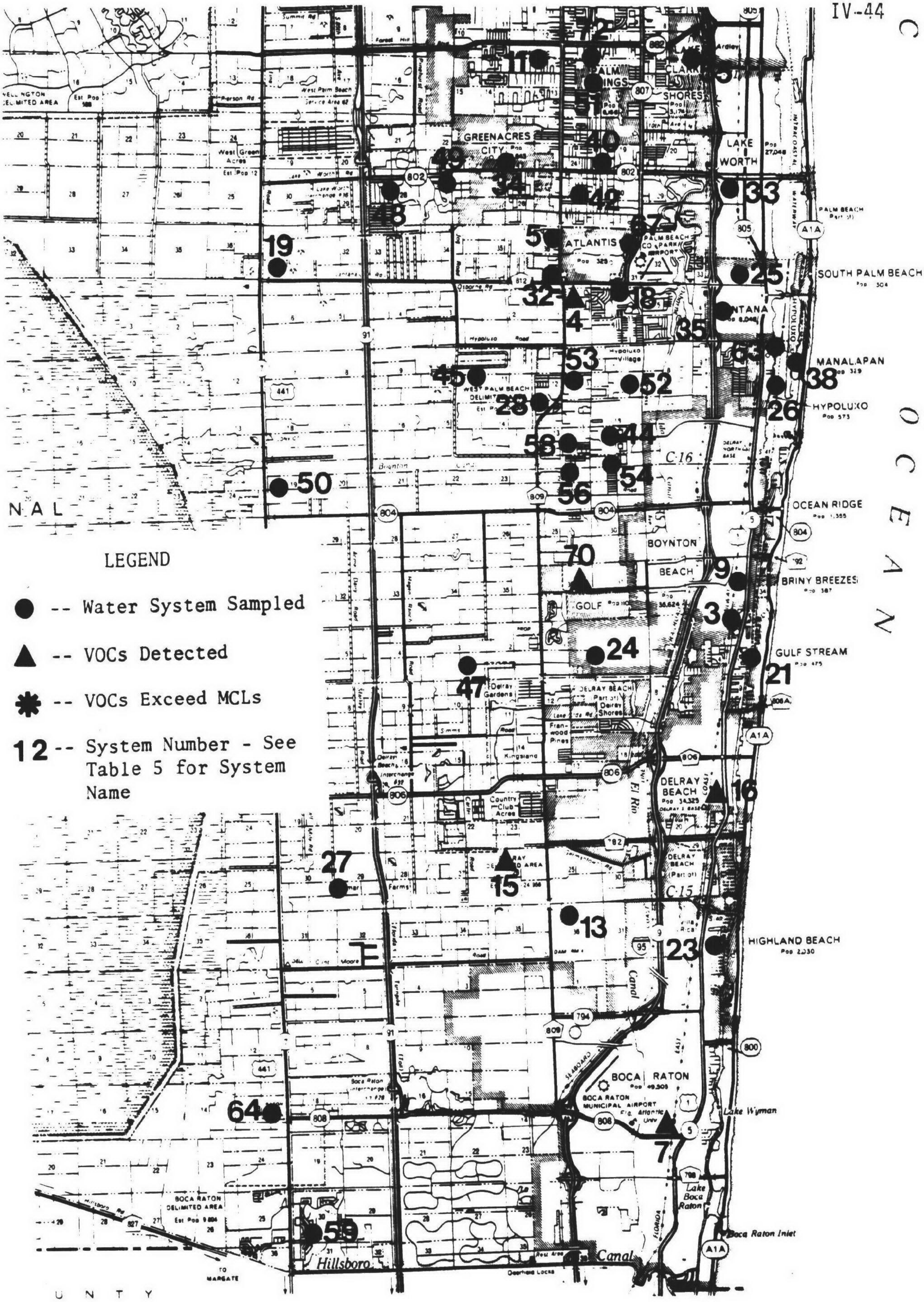

Figure 14: Community Water Supplies Sampled in South Palm Beach County

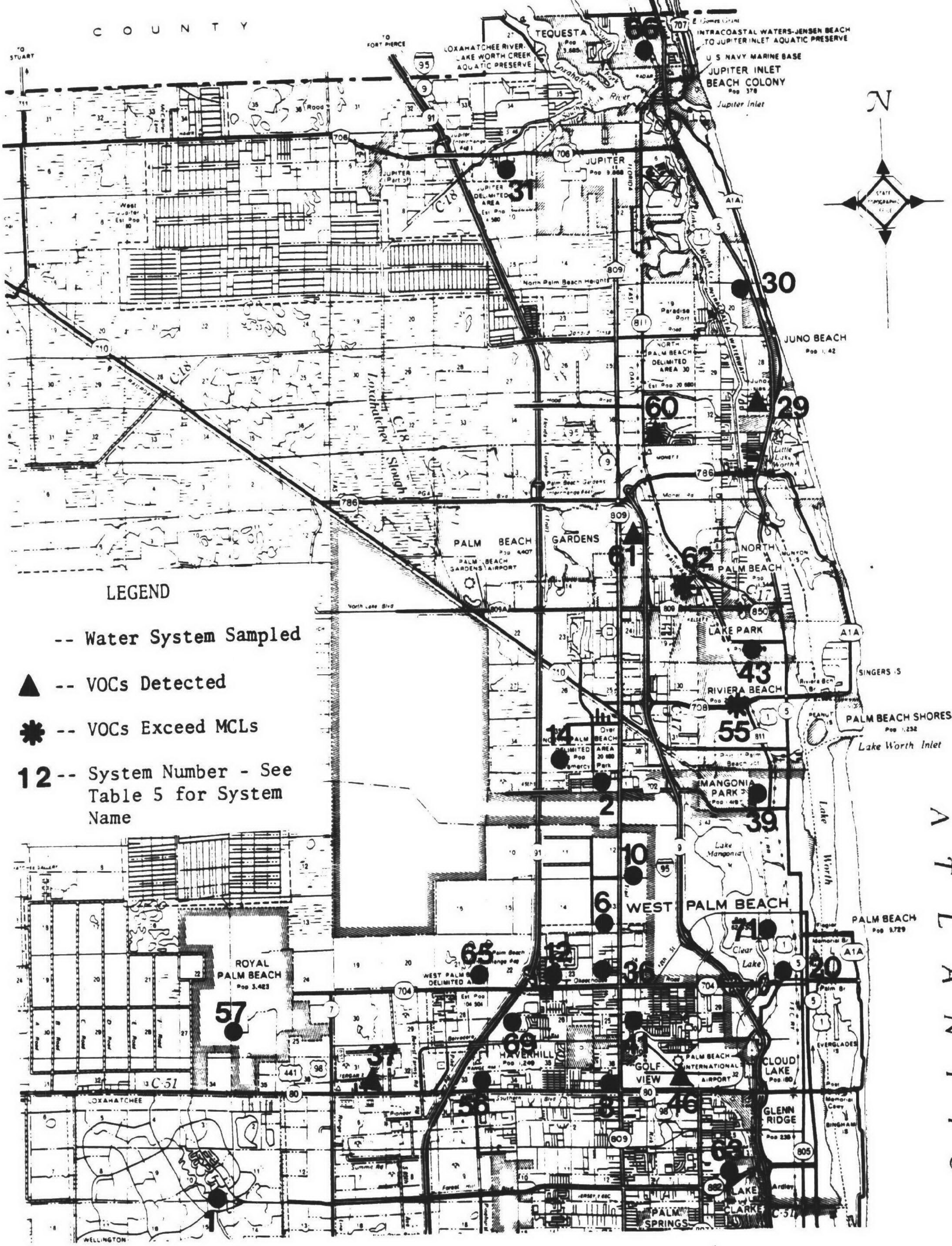

Figure 15: Community Water Supplies Sampled in North Palm Beach County

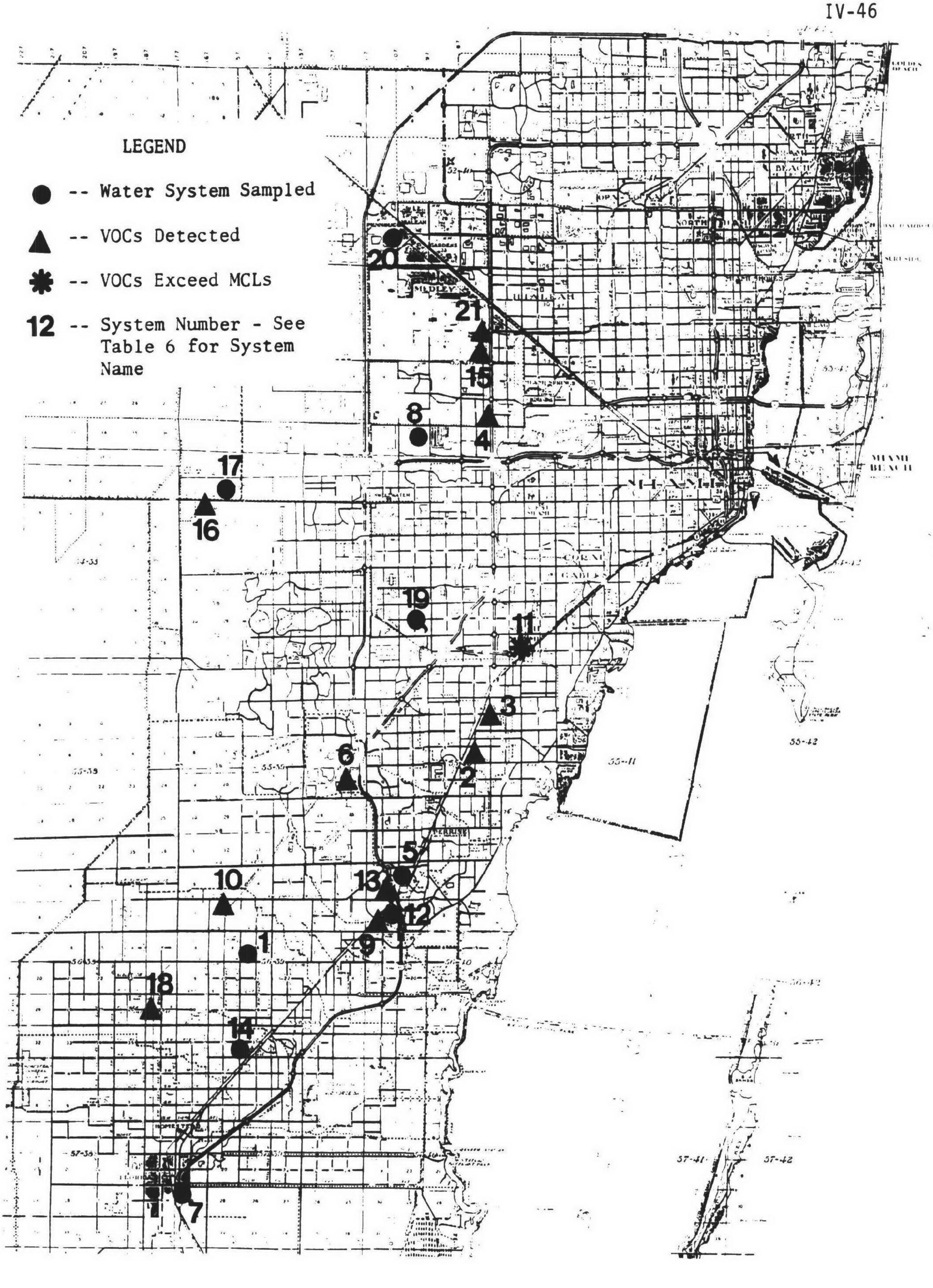

Figure 16: Non-Community Water Supplies Sampled in Dade County

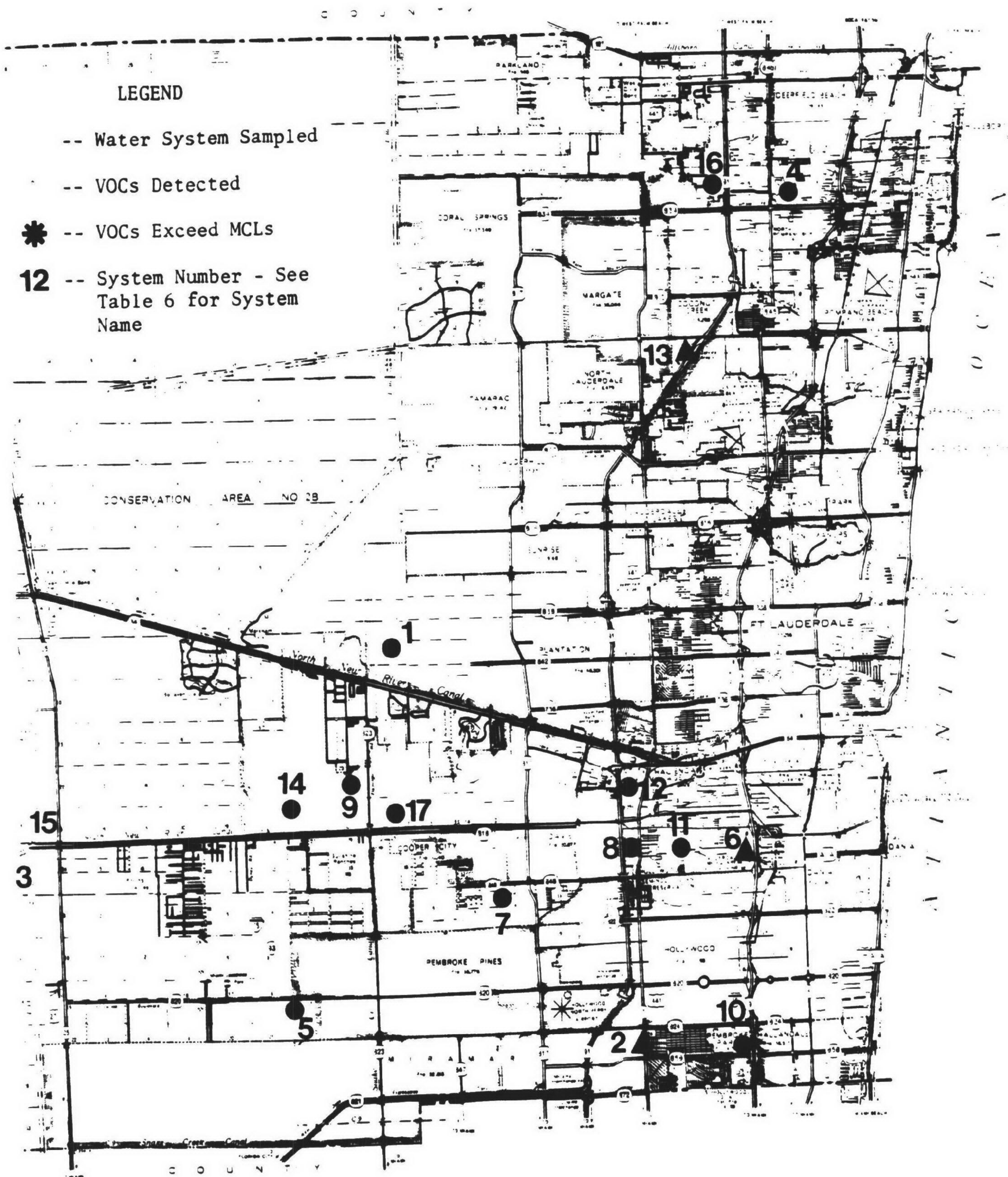

Figure 17: Non-Community Water Supplies Sampled in Broward County

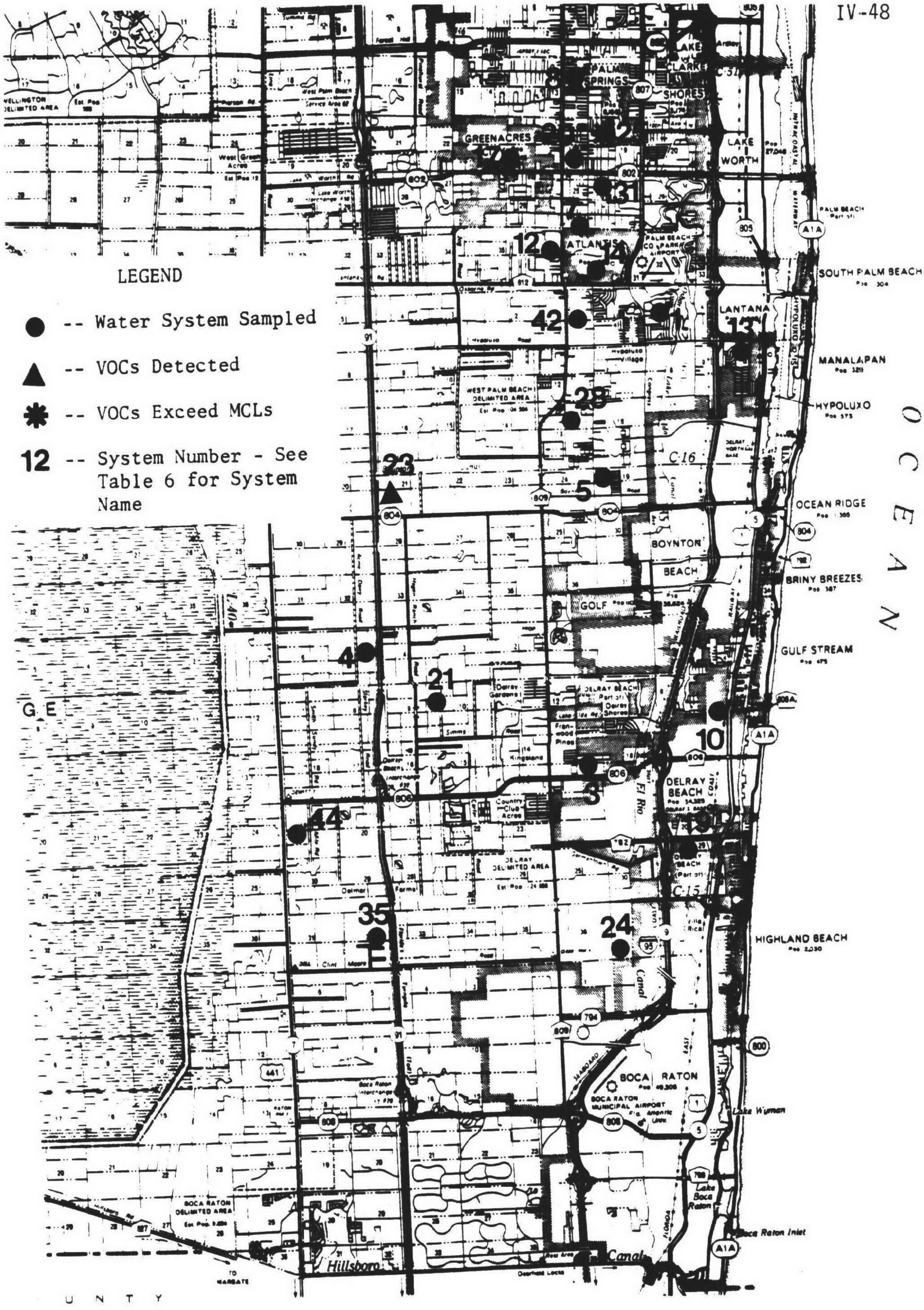

Figure 18: Non-Community Water Supplies Sampled in South Palm Beach County

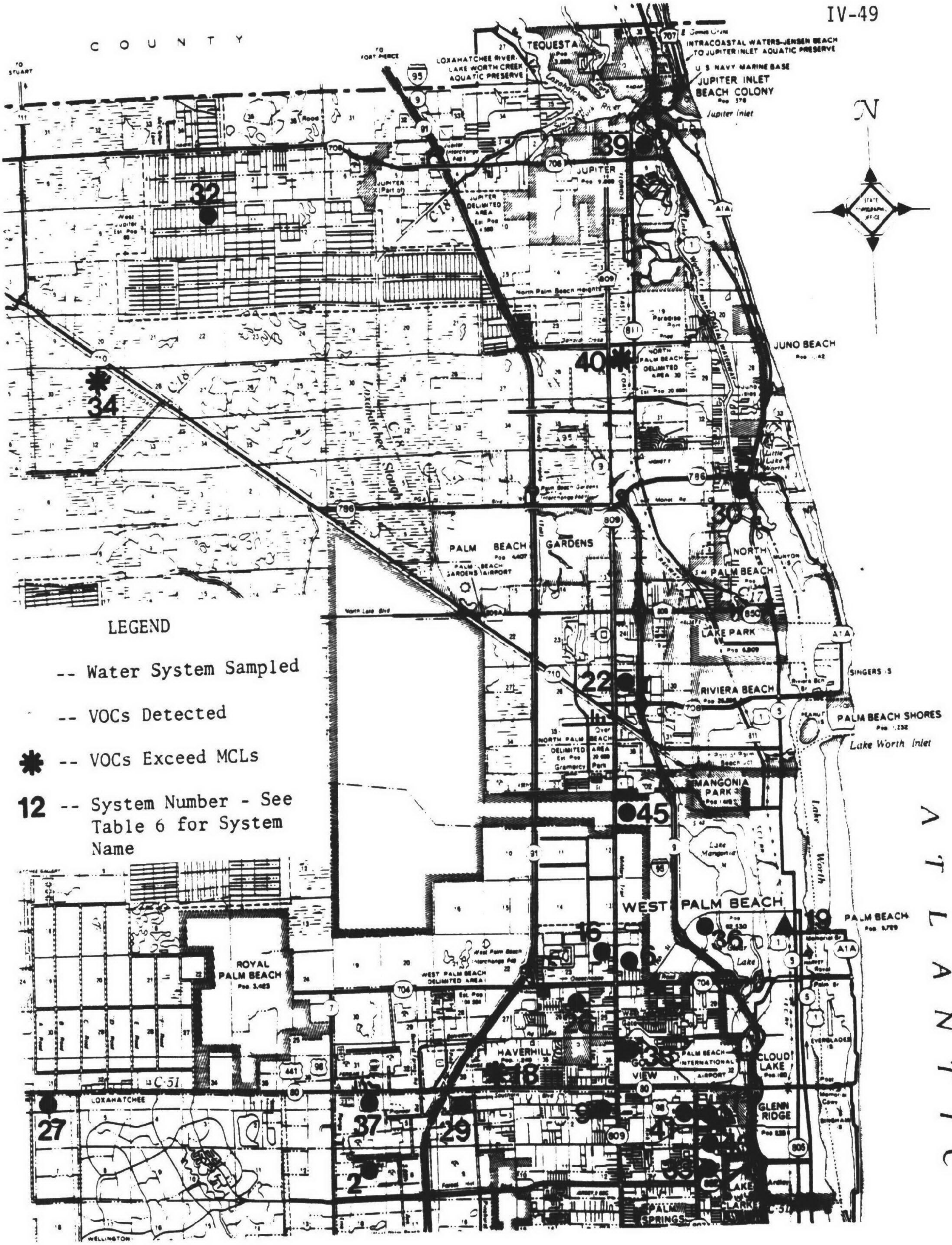

Figure 19: Non-Community Water Supplies Sampled in North Palm Beach County

exceeds Florida MCLs in finished water, and reduction of this contamination is needed.

The EPA sampling also indicates that trihalomethanes still exceed MCLs in a number of community supplies, although most major supplies have achieved major reductions in THMs in recent years.

The current status of public water supplies with respect to VOC contamination is discussed below by county, beginning with south Dade county and moving northward through Broward and Palm Beach Counties.

Dade County

There are definite areal differences in the level and frequency of VOC contamination of water supplies in Dade County. South of the Tamiami Trail (US Highway 41) [Figure 2], both the level and frequency of contamination are low. In contrast, in northwest Miami and in northeast Dade County, several major water supply systems have significant levels of VOC contamination.

In the Homestead area of southeast Dade County between Florida City and Princeton, there are four main water supply systems serving about 135,000 persons[49] [Figure 12]. The Florida Keys Aqueduct, which supplies water to the Florida Keys offshore, has its wellfield southwest of Florida City. Both Florida City and Homestead have their own water supplies. The remainder of the area is supplied by the former Rex Utilities system now operated by WASA. Six water treatment plants (Coronado Heights, Elevated Tank, Everglades Labor Camp, Leisure City, Naranja Park and Newton) feed an interconnected distribution system. The separate Redavo treatment plant serves an isolated area. Most of these well fields were sampled during the wet season in 1977.[16] Vinyl chloride in excess of the Florida MCL was reportedly detected in a number of wells. The dry season sampling in late 1977-early 1978 did not detect this contamination. The 1983 study that sampled only Leisure City, Newton and Redavo found vinylidene chloride slightly in excess of screening criteria but no significant vinyl chloride.[33] Sampling by EPA in 1984 at

Leisure City and Redavo did not detect any significant VOC contamination [Table 5].

The area southwest of Miami between Coral Gables and the Homestead area, including Goulds, Cutler Ridge and Richmond Heights, is primarily served by WASA-operated systems [Figure 12].[49] WASA's South Miami Heights plant serves much of the area with water from the Alexander Orr plant also entering the area from the north. Three former Florida Water and Utilities plants (Green Hills, Kings Bay and Pine Meadows) and the Palmetto Country Club plant are on a standby basis. The Cutler Ridge, Coral Reef, Fairway Park and Marcia Jane plants have been shut down. A small area (10,000 persons) is served by the South Dade Utilities (Bel Aire and Pt. Royale) plants. In 1977, vinyl chloride approximating the Florida MCL was detected at Kings Bay and Pt. Royale.[16] In 1983, low levels of trichloroethylene, tetrachloroethylene and vinylidene chloride well below screening criteria were detected in the South Dade Utilities system.[33] The WASA system was clean. The entire area appears to have a low contamination potential. Existing data are adequate for screening purposes. Periodic resampling would be desirable to detect any increase in contamination.

There were 14 non-community water supplies sampled by EPA in the south part of the county. Many of these are along South Dixie Highway (US-1) [Figure 16]. Eight of these systems had detectable VOC contamination other than THMs [Table 6]. Toluene was present at about 1 μg/ℓ at the Birdlis Rental Building, Capriccio Restaurant, FL-DOT Maintenance Yard, Marrero Shell Station and Road Runner Inn and at 5 μg/ℓ at the KOA Campground. Trans-1, 2-dichloroethene was present at 1 μg/ℓ at Kentucky Fried Chicken. At the S. L. Levine Red Sunset Building, vinyl chloride was detected at the significant level of 5 μg/ℓ, exceeding the Florida MCL applicable to community supplies but not to this system.

To the west of Miami, two non-community supplies were sampled [Figure 16]. The supply at the Pit Bar BQ Restaurant had a low level of trans-1, 2-dichloroethene [Table 6].

WASA's Alexander Orr treatment plant in southwest Miami is the largest plant in the study area, serving about a half million people in the south half of Miami and area to the southwest.[49] Most of the 24 wells supplying this plant are clean or have only traces of VOC contamination [Table 4]. Three wells in the plant wellfield and one in the Snapper Creek wellfield had vinylidene chloride contamination slightly exceeding the screening criterion.[33] One well at the plant had trichloroethylene contamination exceeding the Florida MCL. The Southwest wellfield was clean of VOC contamination. The low levels of contamination present in the few wells are diluted to very low levels by the clean wells. Data on these wellfields are adequate for screening purposes. Periodic resampling of these wells, especially those with known contamination, to detect any changes would be desirable.

WASA's other large system is supplied by the interconnected Hialeah and Preston water treatment plants and serves about a half million persons in the north half of Miami, Miami Beach, Hialeah and other adjacent communities.[49] The nearly adjacent Hialeah and Preston treatment plants are currently served by five wellfields including two plant wellfields, the Upper and Lower Miami Springs wellfields and the new Northwest (formerly Three Square Mile) wellfield. The two plant wellfields and the Miami Springs wellfields have moderate to high levels of VOC contamination as shown in Table 4. Vinyl chloride is the contaminant of most concern. Vinyl chloride levels in the distribution system of 3 to 6 μg/ℓ and up to 37 μg/ℓ in the Preston finished water had been detected prior to the phasing in of the Northwest wellfield in 1983. An additional new wellfied (the Medley wellfield) was placed in service in 1980 but was found to have high levels of organic chemical contamination shortly thereafter. Its use was phased out in 1982. The large Northwest wellfield with 15 wells was phased in during 1983. It has no detected VOC contamination and is in an undeveloped area.

Beginning in May 1983, the Northwest wellfield was phased in as wells became available. The use of old wells in the Hialeah, Preston and Miami Springs wellfields was gradually reduced. More than 90% of the Hialeah-Preston water supply is now obtained from the Northwest wellfield. The dilution effect of the Northwest supply has substantially reduced VOC levels in the distribution system. Finished water from both the Hialeah and Preston treatment plants now meets Florida MCLs for VOCs.

The Hialeah-Preston system has been extensively sampled and evaluated, and wellfield contamination problems are well documented. No further screening data are needed. However, due to the known contamination of four of the five wellfields, regular VOC monitoring of finished water is needed to ensure that VOC levels remain low.

EPA sampled five non-community water supplies in the northwest Miami area in 1984 [Figure 16]. The three supplies along the west side of the Palmetto Expressway south of Medley had significant VOC contamination similar to that observed by the Superfund study of this portion of the Biscayne Aquifer. The Century 21 Building had 10 μg/ℓ of chlorobenzene and 0.5 μg/ℓ of toluene present in its supply. The Wollard Aircraft Equipment Corporation had 70 μg/ℓ of chlorotoluene and 4 μg/ℓ of chlorobenzene present in its supply. The Motor Service supply contained 14 μg/ℓ of methylene chloride and 2 μg/ℓ of carbon tetrachloride. THMs were very high at 462 μg/ℓ. At Westland Country Club, no VOCs were detected, but THMs were high at 228 μg/ℓ. No MCLs have been established for chlorobenzene, chlorotoluene, methylene chloride or toluene.

There are five major public water supply systems serving the northeast Dade County area that includes North Miami, North Miami Beach, Opa-Locka, Carol City and Norland [Figure 12].[49] The largest system is in the city of North Miami Beach which serves about 160,000 persons in the city and another 25,000 persons through three utilities that purchase bulk water from North Miami Beach. Treated water was formerly supplied by three treatment plants: Myrtle Grove, Norwood (Oeffler) and Sunny Isles. The Myrtle Grove plant was shut down in 1982, and bulk water is being purchased from WASA (Hialeah-Preston system). This accounts for the elevated VOC levels observed in 1983 in the distribution system [Table 4]. Current VOC levels should approximate Hialeah-Preston finished water previously discussed. At the Norwood system, cis-1,2-dichloroethene in excess of screening criteria was observed in some wells in 1977-78 [Table 4] and was present at 2 μg/ℓ in finished water during the 1984 EPA sampling. Vinylidene chloride in excess of the screening criterion was detected in 1983. Finished water appears to currently meet Florida MCLs. Due to the known presence of VOCs in some wells, regular monitoring of VOC levels in finished water should be performed to ensure VOC levels remain low.

The Sunny Isles water treatment plant obtains its water supply from the remote East Drive wellfield. The old wellfield at the plant has been abandoned. The 1977-78 DERM study detected high levels of VOC contamination in the East Drive wellfield [Table 4].[16] Total VOC levels were the highest observed in any Dade County wells at that time. As indicated in Table 4, all four VOCs exceeded screening criteria. The plant wells also had significant VOC contamination.

The 1977 detection of VOC contamination led to changes in the Sunny Isles operation. After testing several approaches, powdered activated carbon (PAC) fed into the existing treatment system was selected as a method for reducing VOC levels in finished water. Aeration is also practiced. Preferential use is made of the least contaminated wells to reduce VOC levels in raw water. As shown in Table 4, vinyl chloride levels in finished water were still significantly above the screening criterion in 1981 and 1982 after PAC feed had been initiated.[19] The 1984 EPA sampling indicated that VOC levels have been reduced since 1982, but vinyl chloride (2 µg/ℓ) still exceeds the Florida MCL. The Sunny Isles plant is scheduled to be phased out in 1984, and bulk water purchased from WASA (Hialeah-Preston system). This change in water supply would eliminate the current contamination in this system. If this change should be delayed, regular monitoring of VOC levels should be conducted to ensure that VOC levels are maintained as low as practical.

North Miami serves about 67,000 persons with water from its Winson (Westside) treatment plant and bulk purchased water from WASA (Hialeah-Preston system).[49] The bulk purchases replace the supply from the Eastside plant that has been shut down. Data reported for the Eastside distribution system in 1983 [Table 4] reflect Hialeah-Preston finished water quality.

Sampling data [Table 4] over the last 7 years indicate significant VOC contamination in the Winson system for the entire period.[16 19] In 1983, vinylidene chloride slightly exceeded the screening criterion in the distribution system and wells.[35] Cis-1,2-dichloroethene and trichloroethylene exceeded criteria in the wells and were elevated in the distribution system in 1983. The 1984 EPA data indicate that trichloroethylene is present in finished water slightly below the Florida MCL, and that cis-1,2-dichloroethene exceeds the screening criterion.

The City of Opa-Locka operates one treatment plant serving about 15,000 persons.[49] In 1977, VOC contamination of wells exceeded the Florida MCL for vinyl chloride and the screening criterion for cis-1,2-dichloroethene [Table 4].[16] Data on finished water in 1983 indicate that low levels of vinyl chloride, cis-1,2-dichloroethylene and trichloroethylene were present. These compounds were below detection limits in 1984. – in city data

Southern Gulf Utilities serves about 26,000 persons in north Dade County.[49] About 18,000 persons in the Riverdale area until recently were supplied by the Riverdale treatment plant. This plant has been closed, and finished water is now supplied by WASA (Hialeah-Preston system). Bulk water purchased from the City of North Miami Beach (Norwood system) is supplied to 8,000 persons in the Skylake area. Contamination levels in the Riverdale system are generally low, with the exception of vinylidene chloride which was detected above the screening criterion in 1983 [Table 4].[33]

About 8,000 persons were served until recently by Dade Utilities' Mansionette treatment plant. Observed VOC levels in 1983 were low, but vinylidene chloride exceeded the screening criterion in the raw water, and trichloroethylene was present in the finished water [Table 4]. This area is now served by WASA. No non-community water supplies were sampled in northeast Dade County, and none are listed in the water supply inventory.

THM levels in all community water supplies in Dade County sampled by EPA in 1984 were below the 100 μg/ℓ MCL, except for a level of 108 μg/ℓ detected in the Norwood system. Two non-community supplies exceeded the THM limit [Table 6].

Broward County

Prior to the 1984 EPA study, data on VOC contamination of public water supplies in Broward County were only available for seven community systems monitored by the 1981 and 1982 EPA Ground Water Supply Survey and the Ft. Lauderdale Five Ash system [Table 4].[19 22] Five of these systems had detectable VOC contamination in wells and/or finished water. No data were available on non-community systems. These data were inadequate to define the scope of VOC contamination of water supplies in Broward County.

In early 1984, EPA sampled 45 community and 18 non-community water supply systems for VOC analysis. This represents essentially all community water supplies in the county that have their own wellfields. About 15% of non-community systems were sampled. Data on total trihalomethanes and other VOCs most often detected in the community and non-community water supplies are presented in the Broward County sections of Tables 5 and 6, respectively. System locations are shown in Figures 13 and 17.

The 1984 study detected VOC contamination (other than THMs) in raw water and/or finished water at 10 community and three non-community supplies. This was the initial detection of contamination at six community and the three non-community supplies. All of the contamination detected in finished water was below Florida MCLs, with the exception of the city of Pompano Beach. Systems with detectable VOC contamination are discussed below.

With respect to trihalomethanes, 17 of the 45 community systems sampled had total trihalomethanes in excess of the 100 μg/ℓ MCL applicable to community supplies serving more than 10,000 persons. Six of the systems with high THMs (Cooper City East, Coral Springs, Dania, Gulf Stream Utility Co., Miramar and Pembroke Pines) serve more than 10,000 persons. All 17 systems are flagged in Table 5. Two non-community systems (Everglades Holiday Park and Pompano Turnpike Plaza) also had high THMs [Table 6].

The city of Pompano Beach provided a water supply to about 70,000 persons from a wellfield at the Pompano Beach Airport. In 1981, trichloroethylene (TCE) was detected at 19 μg/ℓ in finished water [Table 4].[19]

Lower levels were detected in finished water and wells in 1982.[19] However, only five of 16 wells were sampled. The 1984 sampling detected 22 μg/ℓ of TCE in finished water, about 7 times the Florida MCL. Cis-1,2-dichloroethene was also detected in excess of the screening criterion. This significant level of contamination, higher than in 1981 and 1982, suggests the need for monitoring of all wells to detect the sources of contamination. Steps should also be taken to reduce the TCE level to below the MCL. Industrial areas are near the airport.

Ft. Lauderdale has two water systems. The Peele-Dixie water treatment plant and wellfield service about one-fourth the 240,000 population served. The 1984 EPA study detected 0.7 μg/ℓ of trans-1,2-dichloroethene in the composite raw water but none in the finished water. The treatment includes aeration.

The major Five Ash water treatment plant serves the bulk of the Ft. Lauderdale system. Water supply is obtained from two wellfields: Executive surrounding the Executive Airport runways and Prospect around Prospect Lake west of the airport. Prospect is the newer wellfield and provides most of the supply. One well in the Executive wellfield has been shut down due to salt water intrusion. Nine wells are on emergency standby only, and six wells are used only seasonally.

Sampling of the eastern wells in the Executive Wellfield in 1982 detected very high levels of VOC contamination in some wells [Table 4].[22] Vinyl chloride and cis-1,2-dichloroethene exceeded 2,000 μg/ℓ, and trichloroethylene exceeded 200 μg/ℓ in some samples. This was the highest level of VOC contamination of public water supply wells in the study area that has been documented. Sampling at the Five Ash treatment plant in 1982 indicated that VOC contamination of the composite raw water from all wells operating was also high [Table 4]. Aeration in the treatment plant was removing more than 90% of the VOC contamination, but vinyl chloride (5 μg/ℓ) still exceeded the Florida MCL in finished water.

The 1984 EPA sampling of finished water at the Five Ash plant indicated that VOC levels were below detection limits. Aeration at the treatment plant, in combination with shutdown of contaminated wells, appears to be maintaining acceptable quality finished water. The city of Ft. Lauderdale conducts periodic monitoring of raw and finished water and individual wells.

Although finished water now meets drinking water standards, the Executive wellfield contamination is of concern. Should an extended dry period like that which occurred in 1971 occur again, use of the contaminated standby wells might be necessary, and VOC contamination of finished water could be the result.

Well monitoring data over the last 3 years suggest that the contaminated goundwater might be migrating westward which could result in contamination of additional wells.

None of the other VOC contamination detected in community supplies exceeded Florida MCLs or EPA screening criteria. The small city of Pembroke Pines Holly Lake system had significant VOC contamination in the finished water for which no screening criteria have been established. There were 30 μg/ℓ of methyl isobutyl ketone, 22 μg/ℓ of xylene, 5 μg/ℓ of ethyl benzene and 0.5 μg/ℓ of toluene present. At Gulf Stream Utility Co., 7 μg/ℓ of toluene were detected in finished water.

Low levels (1-2 μg/ℓ) of cis-1,2-dichloroethene were detected in raw and/or finished water in seven systems [Table 5]. At the Broward County Utilities District 2A (North District) system, cis was present in raw water but not finished water after aeration. The low level observed was an improvement over both raw and finished waters in 1981 and 1982 [Table 4].[19] At the city of Hallandale, the low levels of cis-1,2-dichloroethene in both raw and finished water in 1984 were a major improvement over 1981 and 1982 when high levels of cis-1,2-dichloroethene and trichloroethylene were detected [Table 4].[19] One contaminated well has been shut down. At the city of Hollywood, the low cis-1,2-dichloroethene level in finished water was an improvement over 1981 and 1982 levels [Table 4].[19] No earlier data were available for comparison for the city of Miramar (raw water), city of Plantation (raw and finished waters) and Seminole Industries (finished water) [Table 5]. Finished water after aeration contained no detectable cis-1,2-dichloroethene at Miramar.

Only three non-community supplies contained detectable levels of VOCs other than THMs. Cis-1,2-dichloroethene was present at 2 μg/ℓ in both the Dairy Queen and Greenburg Warehouse #1 supplies [Table 6 and Figure 17]. At Pompano Turnpike Plaza, a total of 6 μg/ℓ of toluene, ethyl benzene and xylene compounds were present, possibly from spills of gasoline or petroleum products.

Palm Beach County

In Palm Beach County prior to the 1984 EPA study, data on VOC contamination of public water supplies were available for only five systems that were sampled by the Ground Water Supply Survey in 1981 and 1982 [Table 4][19]. Significant contamination was present at two systems. For non-community supplies, data were available for only the contaminated Pratt-Whitney system. As in the case of Broward County, these data were inadequate to define the scope of VOC contamination in the more than 400 public supplies.

In March-May 1984, EPA sampled 72 community and 45 non-community supplies for VOC analyses. This represented essentially all community supplies in Palm Beach County with their own wellfields and about 15% of non-community supplies. The results of this study are presented in the Palm Beach County sections of Tables 5 and 6. The locations of supplies sampled are shown in Figures 14, 15, 18 and 19.

The 1984 study detected VOC contamination (other than THMs) at 12 community and six non-community supplies. At Riviera Beach and the seacoast Utilities Richard Road system, finished water exceeded Florida MCLs. Study screening criteria were exceeded at Juno Beach Mobile Court, Loxahatchee Road Prison, Palm Beach County ECR #2, and the Seacoast Utilities Hood Road system. For non-community supplies, Florida MCLs (applicable only to community supplies) were exceeded at the Lake Worth Raquet Club, Frat House

Restaurant and Sunshine Preschool and in raw water at Pratt-Whitney. These supplies are discussed in more detail below.

Twenty-two community supplies [Table 5] and five non-community supplies [Table 6] had total THM levels exceeding the 100 μg/ℓ limit applicable to supplies serving more than 10,000 persons. Four of the supplies (Century Village, Palm Beach County ECR #2 and ECR #3, and Riviera Beach) serve more than 10,000 persons.

The city of Riviera Beach north of West Palm Beach supplies water to about 38,000 persons. Finished water in 1981 had low VOC levels, but additional sampling in 1982 detected 4 μg/ℓ of vinyl chloride in the finished water along with elevated levels of cis-1,2-dichloroethene and trichloroethylene [Table 4].[19] The contamination was traced to well #11 that had very high (270 μg/ℓ) vinyl chloride and 28 μg/ℓ of trichloroethylene. This contamination was confirmed by resampling of well #11 in early 1983, and the well was removed from service. The 1984 EPA sampling indicated that both vinyl chloride and cis-1,2-dichloroethene were below detection limits in both raw and finished water, but trichloroethylene was present at 10 μg/ℓ in raw water and 3 μg/ℓ (after aeration) in finished water. These TCE levels exceed Florida MCLs. If well #11 is still shut down, these data indicate the presence of additional contamination in the Riviera Beach wellfield. Additional sampling of individual wells is needed to identify the source of contamination. Industrial facilities are in the vicinity of the wellfield. Steps should be taken to reduce TCE levels in finished water.

Seacoast Utilities operates three water supplies in Palm Beach Gardens north of Riviera Beach serving about 60,000 persons. Although no VOC contamination was dected in Richard Road finished water in 1981, sampling in 1982 and 1983 detected increasing levels of TCE in finished water which was traced to high (119 μg/ℓ) levels in well #11 [Table 4].[19 22] Aeration at the plant was removing about half of the TCE, but finished water exceeded the Florida MCL. The 1984 EPA sampling found significantly different VOC contamination than the 1982-83 data. No TCE was detected, but vinyl chloride was present at 2 μg/ℓ in finished water and 17 μg/ℓ in raw water.

Similar levels of cis-1,2-dichloroethene were present. The vinyl chloride exdeeds the Florida MCL, and the cis-1,2-dichloroethene exceeds the screening criterion in raw water. Aeration in the treatment plant was removing 80-90% of the VOCs. The observed shift in contamination suggests that TCE may have degraded to vinyl chloride and cis-1,2-dichloroethene. Sampling of wells is needed to identify the source of contamination to facilitate reducing vinyl chloride levels in finished water. One of two wellfields supplying the Richard Road treatment plant is located in an industrial park.

VOC contamination was also detected in the other two Seacoast Utilities water supplies. Ethylene dichloride was present in excess of the screening criterion of 0.6 μg/ℓ in finished water (2 μg/ℓ) at the Hood Road treatment plant [Table 5]. At the Lilac Street system, raw water contained 0.7 μg/ℓ each of trichloroethylene and tetrachloroethylene. Aeration removed VOCs in finished water to below detection limits.

Ethylene dichloride (2 μg/ℓ) was detected in excess of the screening criterion in finished water at Juno Beach Mobile Court and in both raw and finished water at Loxahatchee Road Prison [Table 5]. Cis-1,2-dichloroethene was also present at 2 μg/ℓ in raw water at the prison. At Palm Beach County ECR #2, cis-1,2-dichloroethene was present at 6 μg/ℓ in raw water and 0.5 μg/ℓ in finished water after aeration. Although ethylene dichloride exceeded screening criteria in these cases, finished water met Florida MCLs.

Five non-community supplies had detectable levels of VOCs other than THMs [Table 6]. Finished water at three supplies exceeded Florida MCLs applicable to community supplies only. At the Frat House Restaurant, both cis-1,2-dichloroethene and ethylene dichloride were detected at 10 μg/ℓ each. The EDC exceeds the Florida MCL and the cis exceeds the screening criterion. Good Samaritan Hospital finished water contained 1 μg/ℓ of EDC. At Lake Worth Raquet Club, vinyl chloride was detected at 1 μg/ℓ, the Florida MCL. Raw water at Pratt-Whitney was the most contaminated of any public water supply in Palm Beach County sampled during the 1984 study. Contamination included 140 μg/ℓ of chloroethane, 70 μg/ℓ of 1,1-dichloroethane, 20 μg/ℓ of cis-1,2-dichloroethene, 10 μg/ℓ of 1,1,1-trichloroethane, 8 μg/ℓ of vinyl chloride and 2 μg/ℓ of chlorobenzene. Due to multi-stage aeration water treatment, finished water contained no detectable amounts of these contaminants. At Sunshine Preschool, 4 μg/ℓ of EDC was detected in finished water, exceeding the Florida MCL.

V. SOURCES OF ENVIRONMENTAL CONTAMINATION

Environmental contamination in the study area is contributed by a variety of man-made sources. Of particular interest to this study are sources of volatile organic chemicals (VOCs) that have been detected at significant levels in the groundwater. Industrial manufacturing plants are believed to be the most important sources of VOCs. Wastewater discharges, spills and leaks of raw materials and products and hazardous waste management and disposal are important processes by which VOCs are released to the environment by industrial facilities. Hazardous waste disposal sites, solid waste landfills and dumps, municipal wastewater treatment plants and certain types of commercial facilities are also potential sources of VOCs.

These types of sources of contamination are point sources. Non-point sources of interest in the study area include unsewered areas served by septic tanks, surface runoff (urban and industrial) and agricultural actitivies.

Vinyl chloride has been frequently detected in groundwater at signficant levels. There are no known users or producers of vinyl chloride monomer in the study area. There are thus no known direct sources of vinyl chloride contamination. Research at Florida International University suggests that the vinyl chloride may be a biodegradation product of trichloroethylene (TCE) and/or tetrachloroethylene (perchloroethylene or PCE) or other chlorinated solvents.[51] This hypothesis has proven to be somewhat controversial because other research has indicated that biodegradation of TCE and PCE did not produce vinyl chloride.[52] Vinyl chloride has been detected at at least four other locations outside Florida where TCE contamination of groundwater occurred, but vinyl chloride was not initially present. These were in Long Island, New York,[53] eastern Pennsylvania[54] and California.[54] In all four cases, a contributing factor appeared to be bacterial contamination from septic tank sludges or other biological sludges. In south Florida, the muck soils may provide suitable bacteria for vinyl chloride production.

For lack of a better answer to the sources of vinyl chloride in south Florida groundwater, the TCE biodegradation hypotheses was used in this study to identify potential sources of VOCs. Thus, sources of TCE, PCE and other chlorinated solvents were identified in an attempt to define sources of vinyl chloride.

POINT SOURCES

Industrial

Industrial facilities in the study area are predominantly small to medium size light manufacturing plants. This is in contrast to many industrialized areas of the country where a few large, heavy manufacturing plants dominate the area and are responsible for most of the environmental contamination.

The 1982 Directory of Florida Industries indicates that there are more than 2200 manufacturing plants in the study area.[55] Dade County, with 1242 plants employing about 137,000 persons, is the top-ranked county in Florida both in number of plants and employees. Broward County has 630 plants and about 39,000 employees. This ranks third in number of plants and fourth in number of employees. Palm Beach County, with 365 plants and 34,000 employees, ranks seventh and fifth, respectively. Collectively, the three counties comprise the largest industrial center in Florida.

Important industrial categories include apparel, chemicals, electrical and electronic components, fabricated metal, food, furniture, machinery, miscellaneous plastics and printing and publishing. With respect to potential sources of VOCs, the chemicals, electrical and electronic components, fabricated metal and machinery categories are of the most interest.

Industrial facilities release pollutants to the environment through several pathways. Process wastewaters contain a variety of contaminants that may include VOCs. In the study area, some wastewaters are discharged directly into the ground through unlined surface impoundments, dry wells, seepage pits and leach fields. These discharges are of the most concern because of their potential for introducing pollutants directly into the groundwater. Direct discharges to groundwater were more common in the past but are now being phased out as municipal sewers become available. Past discharges may be an important source of groundwater contamination.

Wastewater may also be discharged to surface waters. These discharges were a problem in the past, especially in the Miami International Airport area[9], but now have practically been eliminated. Pollution of surface waters from such discharges was an indirect source of groundwater contamination due to the seasonal recharge of groundwater aquifers by canal infiltration.

Most industrial process wastewaters are discharged to municipal sewers for treatment and disposal. Most of this treated effluent is discharged to the ocean or is injected into the Floridan aquifer and is thus isolated from groundwater sources of drinking water. Some of the smaller municipal wastewater treatment plants still discharge to inland surface waters or to groundwater through seepage pits or lagoons. Although municipal wastewater treatment plants achieve significant removals of most VOCs, there is some potential for groundwater contamination by such municipal wastewater discharges.

Exfiltration of wastewater from municipal sewers carrying industrial wastewaters is another potential source of groundwater contamination. Studies to date have considered this potential source but have apparently been unable to define the significance of exfiltration.

Various types of industries use VOCs and other chemicals as raw materials, solvents, lubricants, etc. in their processes. The storage and handling of these materials and their ultimate disposal when contaminated or spent are all potential sources of groundwater contamination. Spills and leaks of the virgin or used materials may contaminate groundwater directly by seeping into the ground or indirectly by contaminating surface runoff that is discharged to either the ground or surface waters. Leaks of solvents from underground storage tanks have been implicated as major sources of groundwater contamination in other parts of the country, especially in areas where concentration of electronics plants are found. This has not yet been identified as a major problem in the study area.

Most of the VOCs used by area industries are considered hazardous wastes when spent. Storage and handling of these wastes have caused contamination of surface and groundwaters in the past, both at the industrial facilities and at offsite hazardous waste management facilities.

Volatile organic chemicals are also emitted to the air by a variety of industrial types. Sources include degreasing operations, application of surface coatings, etc. There is some potential for rainout of these emissions to contribute to surface and groundwater contamination, but no data were available to evaluate this pathway. Contributions, if any, from this pathway must be minor because VOC contamination of groundwater tends to be either not present at low detection limits or present at significant levels. This suggests the sources of contamination are primarily multiple point sources and not low-level areawide sources that would occur with rainout of emissions.

Many of the 2200+ industrial facilities in the study area are not considered to be potential sources of VOCs because they do not use or handle these chemicals. Other industrial facilities may use very small amounts of VOCs but are not considered significant potential sources of contamination because they do not produce process wastewaters or hazardous wastes. The approximate universe of potential industrial sources was estimated in two ways. The number of facilities in industrial categories most likely to use or handle VOCs was estimated from the industrial directory.[55] Inventories of facilities with wastewater discharge permits or that have notified EPA of hazardous waste management activities were reviewed to also estimate the number of potential sources of contamination.

The approximate number of plants in each of the four types of industrial activity most likely to be sources of VOC contamination are listed by county below:

Industrial Category	Total	County Broward	Dade	Palm Beach
Chemicals	110	24	70	16
Electrical/Electronic	133	50	59	24
Fabricated Metal	338	104	172	62
Machinery	208	102	97	9
TOTALS	789	280	398	111

There are no large chemical manufacturing plants in the study area. The 110 plants listed in the industrial directory were generally relatively small (fewer than 100 employees) and often produced cleaning chemicals, paints, inks, adhesives, cosmetics, pharmaceutical preparations, insecticides, and similar products. Some handled or produced degreasers and other solvents and would be of the most concern with respect to potential sources of VOC contamination.

The 133 electrical and electronic components plants varied widely in size from fewer than 10 employees to more than 1000. About 50 of the plants produced some form of electronic components including crystals, microcircuits, printed circuit boards and electronic assemblies. These electronics plants make extensive use of chlorinated solvents as degreasers and for other process purposes such as developers and cleaners. The electrical products plants produce such items as lamps, switches, transformers and a variety of assemblies. Use of chlorinated solvents as degreasers is common in this industrial category. Electroplating type operations are also frequently associated with electrical and electronic products manufacturing.

Fabricated metal facilities were numerous (338) and ranged in size from fewer than 5 employees to several hundred. Most shops were small.

Fabricated sheet metal such as air conditioning ducts and a variety of extruded aluminum products such as windows and doors were common products in this industry. Some of these plants would be expected to use degreasers. This industrial category also includes the electroplating job shops that do a wide variety of electroplating and other metal finishing operations. These shops are sources of heavy metals and often of spent solvents.

The 208 machinery manufacturers include machine shops that do a lot of tool and die work and other shops that produce a variety of machinery ranging from small tools to large manufacturing equipment. Some of these facilities use degreasers, especially shops that recondition used equipment.

It was beyond the scope of this study to relate potential sources of contamination to known cases of wellfield contamination. The reader is referred to various previous studies for more detailed information in this regard. Industrial facilities in the cone of influence of the Hialeah-Preston wellfields have been identified by several EPA and DERM studies.[9 17 23 25 35] Industrial facilities and other sources of pollution within the cones of influence of other wellfields in Dade County were identified by a 1982 DERM report.[23] Broward County industries that discharged pollutants of concern to municipal sewers, had direct discharges to groundwater, or that generated hazardous wastes or industrial sludges were identified in an October 1981 BECQCB report.[56] Industrial facilities in a portion of Palm Beach County were identified by an industrial waste pretreatment study.[27] Facilities handling hazardous materials in the vicinity of Seacoast Utilities wellfields in the Lake Park area of Palm Beach County were identified in another study.[22] Several of these studies involved actual site visits to a number of industrial facilities. A variety of inadequate handling, storage, use and disposal practices were observed with a frequency of occurrence and severity of contamination potential that suggests that the numerous small industrial facilities handling VOCs may collectively represent a major source of groundwater contamination.

There are very few industrial wastewater discharges to surface waters in the study area. EPA's Permit Compliance System (PCS), a computerized data base that maintains a list of National Pollutant Discharge Elimination System (NPDES) permits, listed only 32 industrial permits in the study area.[57] This is unusually low for an area of this size and level of industrial development and reflects the extent to which surface discharges have been diverted to municipal sewer systems or to ground disposal. Of the 32, eight are for stormwater runoff from bulk petroleum storage facilities, and six are for cooling water discharges at thermal electric generating plants. The other 18 represent a variety of miscellaneous industries and generally represent relatively small noncontact cooling water discharges or other wastewaters containing low levels of pollutants. Known industrial discharges to surface waters appear to represent a low potential for groundwater contamination.

State permits are issued by DER to industrial wastewater discharges to both surface and groundwaters. Facilities that have NPDES permits also receive a state industrial waste permit. A DER inventory of industrial waste permits indicates there were 35 active permits in Broward County, 51 in Dade County and 48 in Palm Beach County, making a total of 134.[58] This suggests that there were about 102 discharges to the ground in the study area. Review of permit file data indicated that discharge volumes ranged from <500 gpd to about 400,000 gpd.[22] Disposal methods included unlined evaporation/percolation ponds, seepage pits, leach fields and dry wells.

Some of the industrial discharges to groundwater have a low potential of chemical contamination due to wastewater type or characteristics and the nature of the industrial facility. Examples of these are noncontact cooling water from an industrial facility with no process wastewaters or wastewaters from food manufacturers or concrete mixing plants.

Review of DER permit files indicated that about 25 of the discharges to groundwater have the potential to be significant sources of VOC contamination. Many of the discharges also contain heavy metals. There have been several instances of groundwater contamination with heavy metals in the study area related to such industrial discharges.

The industrial discharges of interest were primarily from electronic component manufacturers, metal finishing plants (including electroplaters) and chemical plants. The electronic component industrial discharges were of particular concern. In general, these facilities have some type of process that is similar in nature to an electroplating operation and produces similar wastewater characteristics. Heavy metals and possibly cyanides are usually present in the discharges. The discharge permits contain limits on these pollutants based on DER and DERM or BCEQCB effluent limits. There are no effluent or discharge limits on VOCs.

Permit file data indicate that most electronic component manufacturers in the study area use one or more degreasers or other chlorinated solvents in their process.[22] Trichloroethylene, tetrachloroethylene and/or 1,1,1-trichloroethane are often used. Spent solvents are usually accumulated and stored in tanks or drums and then shipped offsite for recycling or for disposal as a hazardous waste. However, plant visits have shown that storage and handling of both virgin and spent solvents is often inadequate, resulting in spills, leaks and high potential for groundwater contamination.

Sampling of treated and untreated process wastewaters from the electronic components industry at various locations around the country by EPA's Effluent Guidelines Division has shown that the chlorinated solvents are frequently present in these wastewaters at significant levels.[59] Treatment provided is usually for cyanide destruction and heavy metals removal which would have little effect on solvent concentrations. Flow weighted mean and maximum concentrations for the most significant toxic organic chemical constituents of the semiconductor wastes sampled are shown below:

Chemical	Maximum Concentration (mg/ℓ)	Flow Weighted Mean Concentration (mg/ℓ)
1,2,4-trichlorobenzene	27	0.41
1,1,1-trichloroethane	8	1.48
1,2-dichlorobenzene	186	0.80
methylene chloride	2	0.44
phenol	4	0.32
tetrachloroethylene	0.8	0.58
trichloroethylene	4	0.28
total toxic organics	245	3.36

These data indicated that electronic component plants could be previously unidentified, significant sources of groundwater contamination with VOCs. The Effluent Guidelines Division study found that, with good solvent management practices, total toxic organic concentrations of less than 1 mg/ℓ could be consistently achieved. If solvent management was poor, much higher levels of toxic organics were discharged.

Most of the electronic component discharges in the study area are relatively small. A 10,000 gpd discharge could still produce significant groundwater contamination if inadequate solvent handling occurred or if spent solvents were periodically deliberately discharged. A 10,000 gpd discharge contaminated to the 10 mg/ℓ level would discharge a solvent load adequate to contaminate a 10 mgd water supply to a concentration of 10 μg/ℓ, well above the drinking water MCLs. Put another way, the same small contaminated discharge would release about 304 lb/year of solvents to the aquifer. This could increase VOC levels in a square mile area of the aquifer by about 2 μg/ℓ, assuming uniform mixing, an aquifer saturated thickness of 100 feet and a storage coefficient of 0.2.

Because no data were available on VOC concentrations in industrial discharges or receiving groundwaters at electronic component or metal finishing plants in the study area, EPA conducted a limited sampling study in April 1984. Wastewater effluents and receiving groundwaters were sampled at three electronic component manufacturers and a metal finishing plant. Groundwater was sampled at two electronic component plants that previously had discharged wastewaters to groundwater.

VOCs were present in wastewaters and/or monitoring wells at all six facilities [Table 7]. The highest levels of VOC contamination in both wastewater and monitoring wells were detected at the Davco Printed Circuits plant in Fort Lauderdale near the International Airport. Treated wastewater from this plant was found to have high levels of methylene chloride and tetrachloroethene, both used as process chemicals [Table 7]. About 150,000 gpd of wastewaters are discharged to a leach field. High levels of tetrachloroethene and trichloroethene were detected in monitoring wells. Observed VOC

Table 7

RESULTS OF VOC SAMPLING AT SELECTED INDUSTRIAL FACILITIES

Facility Name	Compound	Wastewater (μg/ℓ)	Monitoring Wells (μg/ℓ)
Davco Printed Circuits	Methylene chloride	1600	ND[a]
	Tetrachloroethene	600	ND-830
	Trans-1,2-dichloroethene	ND	ND-61
	Trichloroethene	ND	2-1400
	1,1-dichloroethane	ND	8-76
	Chloroform	26	ND-3
	1,1,1-trichloroethane	9	ND-88
	Acetone	ND	ND-60
Motorola	1,1,2-trichlorotrifluoro-ethane	NS[b]	160-620
	1,2-dichloro-1,1,2-tri-fluoroethane	NS	ND-<100
	1,1-dichloroethene	NS	ND-11
	Tetrahydrofuran	NS	ND-510
	Chloroform	NS	ND-4
Graphic Products	Acetone	NS	30-70
	Trichloroethene	NS	ND-5
	Trans-1,2-dichloroethene	NS	2-13
	Chloroform	NS	ND-1
	2-pentanone	NS	ND-25
	1-butanol	NS	ND-PNQ[c]
E. B. Stimpson Co.	Acetone	390	ND
	Chloroform	120	ND
	Dichlorobromomethane	8	ND
	Chlorodibromomethane	2	ND
	Trichloroethene	2	ND
	1,1-dichloroethane	ND	ND-1
	Trans-1,2-dichloroethene	ND	ND-1
Trans Circuits	Acetone	60	ND
	1,1,1-trichloroethane	12	ND
	Chloroform	7	ND-2
	Benzene	4	ND
	Tetrachloroethene	1	ND-1
	1-butanol	PNQ	ND
	2-nor-butoxy ethanol	<100	ND
RCA	1,1,1-trichloroethane	8	ND
	Chloroform	1	ND
	Fluorotrimethyl silane	<100[d]	ND

a - Not detected
b - Not sampled
c - Present but not quantified
d - Tentative identification

levels were in excess of Broward County effluent limitations and groundwater criteria and the new Florida MCLs that take effect in June 1985.

The large Motorola electonics components and communications equipment plant in Plantation discharged industrial wastewater to a percolation pond until 1980, when the discharge was connected to the municipal sewer system. Due to heavy metal contamination at the pond site, the pond contents and underlying soils were excavated and disposed of out of state in 1981. Subsequent groundwater sampling detected some heavy metal and cyanide contamination in groundwater under the site. EPA sampled four monitoring wells ranging in depth from 15 to 35 feet. Freon 113, a chlorinated fluorocarbon degreasing solvent (1,1,2-trichlorotrifluroethane), was detected at levels ranging from 160 to 620 µg/ℓ [Table 7]. A second fluorocarbon was detected in two wells. These fluorocarbons are process chemicals. Tetrahydrofuran was detected in two wells, possibly from PVC cement used in well construction. Vinylidene chloride (1,1-dichloroethene) and chloroform were also detected. The observed levels of VOC contamination exceed Broward County groundwater criteria.

Graphic Products is a small printed circuit board manufacturer adjacent to Executive Airport in Fort Lauderdale. Until late 1983, about 120,000 gpd of industrial wastewater was discharged to a drain field. This discharge is now connected to municipal sewers. Two monitoring wells about 20 feet deep were sampled. Acetone was the VOC present in the highest concentration [Table 7]. Trichloroethene exceeded the new Florida MCLs. VOC concentrations exceeded the Broward County groundwater criteria.

The E. B. Stimpson Company in southwest Pompano Beach northeast of Executive Airport manufactures various metal fasteners. About 150,000 gpd of industrial wastewaters was discharged to two seepage ponds. There were no detectable VOCs in two of the three monitoring wells, and the third had only low levels of 1,1-dichloroethane and trans-1,2-dichloroethane. Wastewater effluent contained elevated levels of acetone and trihalomethanes and 2 µg/ℓ of trichloroethene. The trihalomethanes (primarily chloroform) may have originated in the public water supply.

Trans Circuits is a printed circuit board manufacturer in Lake Park in Palm Beach County. About 144,000 gpd of treated wastewater is discharged to a percolation pond. The ponded wastewater contained acetone, 1,1,1-trichloroethane and low levels of other VOCs [Table 7]. Low levels of VOCs were detected in two of three wells sampled. These data are not considered representative of actual groundwater quality, however, due to difficulties in proper purging and sampling of the wells.

RCA manufactures semiconductors at a plant in Palm Beach Garden. About 400,000 gpd of wastewater is discharged to a 1.5-acre lagoon. No VOCs were detected in the three wells sampled--a deep main plant supply well, a shallow ornamental pond supply well and a 25-ft deep monitoring well at the lagoon. Wastewater effluent contained 8 μg/ℓ of 1,1,1-trichloroethane (a process chemical), 1 μg/ℓ of chloroform and less than 100 μg/ℓ of a compound tentatively identified as fluorotrimethyl silane, probably a process chemical.

The detection of high levels of VOCs in groundwater at two of six industrial wastewater disposal sites sampled indicates that such sites (both past and present) may be significant sources of VOC contamination of groundwater when VOCs are used or handled at the facility. Sampling of groundwater at all such sites is needed to verify this. It is also clear that all active discharges to groundwater from facilities using or handling VOCs should have effluent limitations on appropriate VOCs in their discharge permits and should be required to regularly monitor effluents and groundwater for these VOCs.

Industrial and commercial facilities generating or handling hazardous wastes are potential sources of VOC contamination of groundwater. In 1980, all facilities that generated, transported or treated, stored or disposed of solid wastes listed as hazardous wastes by EPA (40 CFR Part 261) were required to notify EPA of their activity. There were 42 generators, 21 transporters and 53 treatment, storage or disposal (TSD) facilities in the study area distributed among the three counties as shown below:

County	Generators	Transporters	TSD Facilities
Broward	11	5	15
Dade	22	11	26
Palm Beach	9	5	12
TOTAL	42	21	53

While some of these notifiers generate or handle hazardous wastes that are corrosive, a substantial number generate or handle spent solvents, indicating they are potential sources of VOC contamination. Site inspections have been made at most generators and TSD facilities by DER staff. Many of the facilities were found to be small-quantity generators, had stopped the activity requiring notification, or were storing hazardous wastes for less than 90 days. These facilities were often exempt from RCRA permit requirements but, nevertheless, remained potential sources of VOC contamination.

There are no permitted hazardous waste disposal facilities in the study area. Most hazardous wastes are either recycled or shipped out of state for disposal, often to Emelle, Alabama. In the past, some hazardous wastes were disposed of onsite at industrial facilities or at municipal dumps or landfills, resulting in pollution problems. Some of the local recycling activities also caused pollution problems. These problems are discussed in the following section.

Hazardous Waste Disposal Sites

Hazardous wastes, primarily heavy metals and chlorinated solvents, have been inadequately disposed of at at least 50 sites in the study area.[36] These sites are of three types: municipal dumps or landfills, contaminated manufacturing plant sites and contaminated sites where industrial wastewaters were discharged to the ground.

Groundwater contamination is believed to be present at most of the sites and has been documented at about half of the sites. This contamination was limited to the plant site in most cases. In at least two cases, contamination of major public water supply wellfields has occurred. Eight of the sites are considered major environmental problems and have been placed on the National Priorities List for remedial action under "Superfund".[60]

The status of remedial actions at the 50 sites ranges from complete removal of site contamination to no action at all. A substantial amount of investigative work is under way as discussed below.

There have been 27 sites identified in Dade County.[36] About half of these sites are in the Medley-Hialeah-International Airport region of northwest Miami that surrounds the major public water supply wellfields serving the Hialeah and Preston water treatment plants [Figure 10]. This area includes extensive industrial parks, part of which are not on municipal sewers. There are also sizeable residential areas on private wells. Groundwater in this area was sampled by the large-scale Biscayne Aquifer Superfund study. The study found widespread groundwater contamination but did not define specific sources of the contamination.

The other half of the sites in Dade County are at scattered locations and have not been specifically connected with public wellfield contamination. Of the 27 sites in the county, 19 are at industrial facilities, five are municipal landfills and three are federal facilities.

There are six Superfund sites in Dade County; four are in the Hialeah-Preston wellfield vicinity [Figure 10]. The largest site is the 58th Street Landfill, a municipal landfill covering an area of about 600 acres west of Miami Springs. The landfill was operated by Dade County for about 30 years, beginning in 1952. A wide variety of municipal and industrial solid wastes, garbage, trash, grease trap pumpouts, etc. were landfilled. Disposal rates ranged between 100,000 and 1,000,000 tons per year. Studies by USGS and EPA about 1975 detected contaminated groundwater in a plume extending about a half mile east of the site toward Medley wellfied.[12 15] Various methods of abating this contamination have been discussed, including intercepting leachate from the landfill and injecting it into the Floridan Aquifer through deep wells.

The Biscayne Aquifer Superfund study included an evaluation of groundwater contamination in the landfill vicinity but did not define a specific plume of contamination.[20] The site is inactive, except for disposal of construction debris and water treatment plant lime sludge. A closure plan has been prepared and is undergoing regulatory agency review.

The Miami Drum Superfund site is near the east edge of the Medley wellfield [Figure 10]. The facility was a steel drum recycling operation that was shut down because of pollution problems in June 1981, after 15 years of operation. Drums recycled had previously held a wide variety of materials including industrial solvents, acids and heavy metals.[61] The drums were washed out with a caustic cleaning solution, and the spent solution along with chemical residues from the drums were discharged to seepage pits on-site. This resulted in contamination of soil and near-surface groundwater with phenols, heavy metals and volatile organic chemicals. In late 1981 and early 1982, a contractor hired by Dade County removed contaminated soil, up to depths of 8 ft in some places, from the site and transported it out of state for disposal as hazardous waste. Contaminated groundwater in the excavation was treated and returned to the ground. Superfund has since reimbursed Dade County for most of the $1.6 million cleanup cost.

The Medley wellfield was permanently shut down in 1982 because of contamination after less than 2 years of operation. The possible contribution of the nearby Miami Drum site was apparently never defined. Recent monitoring at the Miami Drum site indicates that contamination of the underlying groundwater is relatively low for the area.

Pepper's Steel and Alloys in Medley is a recently discovered site. Among other activities, the facility recycled scrap steel from old power transformers. Unfortunately, waste oil from the transformers containing PCBs was simply dumped on the ground surface and percolated into the ground. Surface contamination and PCB items were removed in 1983 soon after the site was discovered by a combination of voluntary responsible party actions and regulatory agency response. Further site cleanup is anticipated.

The fourth Superfund site in the Hialeah-Preston wellfields vicinity is the Varsol spill at the Miami International Airport. A spill of about 1.5 millions gallons of petroleum-based cleaning solvent was discovered in 1970. Other spills of fuels and hydrocarbons have occurred periodically at the airport. These materials tend to float on the water table. Spilled materials have been partially recovered and recovery operations are continuing.

The other two Superfund sites in Dade County are Gold Coast Oil and Munisport. Gold Coast Oil recycled waste chemicals and solvents and also sold a variety of chemicals. Contamination problems at the site west of Coral Gables were discovered in 1980. The facility subsequently closed. Seaboard Coast Line Railroad, the site owner, conducted a voluntary cleanup of stored wastes and surface soil contamination at a cost of about $200,000. Regulatory agencies are assisting Seaboard and other responsible parties in a remedial investigation to define final cleanup needs. About 60 responsible parties, primarily waste generators, have been identified. The Gold Coast site is remote from any major public water supply wellfields.

The Munisport site covers nearly 300 acres of the old Graves Tract on Biscayne Bay on the east side of North Miami.[24] Owned by the City of North Miami, the site was operated as a permitted sanitary landfill until 1980 by Munisport, Inc. The site is believed to have operated as a dump in the 1950s. In addition to municipal trash and garbage, the site is known to have received some industrial chemicals. Groundwater contamination is present under and downgradient of the site. The landfill is east of the 1000 ppm isochlor line and about 2 miles from the nearest public water supply wellfield.

There have been 16 hazardous waste disposal sites identified in Broward County, including two Superfund sites on the National Priorities List. Half of the sites are at industrial facilities, and the others are landfills or dumps. Nine of the sites are in Fort Lauderdale and four in Pompano Beach.

One Superfund site is at Hollingsworth Solderless Terminal Company, an electrical connector manufacturer in Fort Lauderdale on the east edge of Executive Airport. The facility improperly disposed of various industrial wastes, including heavy metals and spent degreasing solvents (trichloroethylene), to the ground surface, septic tank leach fields and a 100-ft deep injection well previously used as a cooling water disposal well.[22] Discovery of this source of contamination in 1981 led to sampling of public water supply wells in the city of Fort Lauderdale's Executive wellfield. High levels of volatile organic chemical contamination were found in the wells as discussed in Section IV. Hollingsworth appears to have been a major contributor to this contamination, although it is likely that there are other sources of contamination in the surrounding industrial area. Hollingsworth recovered some contaminated groundwater from the well in 1981 and capped the well.[22] All disposal at this site was discontinued in 1981. A remedial investigation in 1982 found additional contamination near the leach fields.[21] Trichloroethylene as high as 4,200 μg/ℓ and vinyl chloride as high as 700 μg/ℓ were detected at the site by additional remedial investigations in 1983. Although VOC contamination has decreased at the site in most monitoring wells, high levels are still present through much of the aquifer depth at the south edge of the site, and vinyl chloride levels have increased. A feasibility study has been completed and is under review by regulatory agencies. Simple groundwater modelling indicates that the Hollingsworth disposal activities could have contributed substantially to contamination observed in the Executive wellfield. There appears to be a need to expedite remedial actions at the Hollingsworth site to arrest the continued migration of this contamination into the Executive wellfield. Consideration should be given to recovery and treatment or disposal of the most contaminated groundwater. No monitoring wells are available to evaluate the extent of the southern edge of the most contaminated groundwater, and additional monitoring may be needed in this regard.

The second Superfund site is the Davie Landfill, also known as the Broward County Solid Waste Disposal Facility. Four types of disposal activities were conducted at this 150-acre site owned and operated by Broward County.[14, 62] Municipal solid waste was landfilled in lined trenches. Trash was landfilled in a separate area. This landfill activity is one of only two currently active sites in Broward County. (The other site is at Pompano Beach.) A third activity which was discontinued in 1981 was the lagoon disposal of waste sludges from wastewater treatment plants, septic tanks, grease trap pumpouts and some industrial treatment plants. Incineration of solid wastes at the site has also been discontinued.

Studies by USGS and BCEQCB in 1975, 1980 and 1981 indicated groundwater contamination problems with the sludge lagoon.[14 62] This is the basis for the Superfund designation. The landfill is several miles upgradient from several public water supply wellfields.

Several of the sites in Broward County represent illegal discharges or spills of hazardous materials or contamination at permitted wastewater disposal sites. In several case, the contamination has been removed.

Only eight disposal sites have been identified in Palm Beach County, and none are on the Superfund National Priorities List. Five of these are municipal landfills, and the others are industrial facilities. At the large Pratt-Whitney aircraft engine plant in north Palm Beach County, disposal of industrial wastes in an onsite landfill and discharge of wastewaters to unlined surface impoundments resulted in groundwater contamination. Private wells supplying the facility were contaminated. The plant is remote from major public water supply wellfields.

<u>Solid Waste Disposal Sites</u>

Municipal (domestic and commercial) solid waste, including garbage, trash and vegetative debris, has been disposed of at numerous sites in the study area. Three basic types of disposal have been used. Some wastes were disposed on top the existing land surface and then covered with fill materials in successive lifts. In other cases, trenches were excavated 10 to 15 feet into the ground, filled with solid waste and covered with the excavated material. In low-lying areas, the trenches were excavated into the water table, allowing direct contact between wastes and groundwater. In the third type of disposal, fill material was excavated and sold, leaving a manmade lake filled with surface or groundwater. Solid wastes were then used to backfill the lake. This also placed wastes in direct contact with groundwater. New landfills must have impervious liners to prevent leachate migration to the groundwater. Some landfills without liners are still operating.

Municipal solid wastes do contain some hazardous/toxic substances contributed in small amounts by numerous households and commercial facilities. Examples are discarded pesticide containers and filters from dry cleaners. It has been estimated that filters, typically disposed of in commercial solid waste, from dry cleaners throughout the study area may contain as much as 200 lb/day of tetrachloroethene.[38] It is probable that some industrial hazardous wastes have been illegally or ignorantly disposed of in solid waste landfills.

A DERM study completed in 1983 identified 49 former solid waste disposal sites in Dade County.[24] Twenty of the sites were prioritized for site/groundwater investigations because of pollution potential and proximity to water supply wells. Most of the priority sites were near the Hialeah-Preston wellfields' cone of influence or in northeast Dade County, both areas with known water supply well contamination. A 1980 Broward County study identified seven former and four active solid waste disposal sites in that county.[63] Thirteen sludge disposal sites were also identified.

Commercial Facilities

In addition to industrial facilities, various types of commercial facilities use chemicals that pose a groundwater pollution potential. Automotive service stations and various other types of maintenance and repair facilities use degreasers and other solvents. Although the amounts used at each facility are usually small, collectively the large number of such units poses a significant pollution potential if the solvents are improperly handled or disposed of.

Dry cleaners use large amounts of perchloroethylene (tetrachloroethylene). Many of these have stills for recycling spent solvents. Although still bottoms are required to be disposed of as hazardous waste, improper disposal could cause pollution problems. This would be especially true if the waste was placed in septic tanks.

There have been numerous cases of leaking underground gasoline storage tanks at service stations. Although these hydrocarbons usually float on the water table, they can be drawn into water supply wells, causing a fire hazard as well as a contaminated water supply. Benzene, toluene and xylene may also leach into the groundwater from such spills.

Municipal Wastewater Treatment Plants

During the 1960s and early 1970s, proliferation of municipal wastewater treatment plants in pace with rapid population growth resulted in the discharge of large volumes of frequently inadequately treated wastewaters to inland surface waters and to estuarine waters with adverse water quality impacts. During the last decade, major regionalization of municipal wastewater systems, coupled with improved levels of wastewater treatment, have resulted in a substantial reduction in the number of treatment plants and removal of large pollutant loads from surface waters.

Five basic methods of disposing of municipal effluents are used in the study area. Most of the large regional treatment plants discharge effluents to the Atlantic Ocean through long ocean outfalls. One regional plant in south Dade County injects effluent into a deep well terminating in the salty Floridan Aquifer, as does a Broward County plant. At least a third of the plants still discharge to inland surface waters. These plants must meet stringent effluent limitations and are gradually being phased out. Other primarily small treatment plants discharge effluent to percolation ponds or seepage pits for disposal to groundwater. These discharges are also being phased out. A few plants use spray irrigation for effluent disposal.

There are about 35 NPDES pemits for publicly-owned treatment works (POTWs) (usually the major mumicipal plants) and 25 permits for domestic waste treatment plants for facilities such as apartments and mobile home parks in the study area.[57] In Dade County, there are 11 POTWs (most with ocean outfalls) and only two domestic treatment plants. Regionalization is the most complete in Dade County.

In Broward County, there are 16 POTWs and 13 domestic treatment plants with NPDES permits.[57] A 1982 BCEQCB annual report indicated there were 68 POTWs in the county in 1982.[62] Twenty-five discharged to surface waters (inland and estuarine), and two were major regional plants with ocean outfalls. There were 41 plants disposing of effluents to the ground including three spray irrigation facilities and one deep well. Of the total wastewater flow of 127 mgd, about 68 mgd was discharged to the ocean, 39 mgd to surface waters, and 20 mgd to groundwater. Regionalization of treatment facilities was expected to phase out 12 surface discharges and 21 ground discharges. Of the remaining 20 groundwater discharges, about 10 mgd would be discharged to the Biscayne aquifer and 5.4 mgd to the Floridan Aquifer.

There were eight POTWs and 10 domestic treatment plants in Palm Beach County. [57] Regionalization is not as far along yet in this county because of a lower population density.

Treated municipal wastewaters typically contain low levels of volatile organic chemicals unless there are significant industrial contributions. Municipal systems serving primarily residential areas would appear not to be significant sources of VOC contamination of groundwaters, especially where the discharge is to surface waters where additional VOC removal and dilution would occur prior to infiltration into the groundwater. On the other hand, a municipal system receiving signficant industrial inputs and discharging to the ground could be a significant source of contamination. No effluent data were available to identify any problem sources.

NON-POINT SOURCES

Septic Tanks

There are substantial portions of the study area that are not currently served by public sewer systems. The common form of wastewater disposal in such areas is a septic tank and leach field. This allows wastewaters which have received only minimal treatment to percolate directly into the groundwater.

In residential areas, groundwater can become contaminated with high levels of nitrates and pathogenic bacteria if the areal density of disposal systems is too great. This can result in localized contamination of private water supply systems where individual walls are used. Residential septic tanks have occasionally contributed to contamination of public water supply wells.

In some parts of the country, septic tank cleaners containing degreasers to break up grease layers have been used, resulting in contamination of groundwater with trichloroethylene or other solvents. This has not been identified as a problem in the study area.

In unsewered industrial areas, the use of septic tanks poses a much higher potential for groundwater contamination. Typically, a septic tank at an industrial facility is approved by the regulatory agency for use for domestic wastewaters only or for relatively uncontaminated wastewaters. Changes in the types of operations at the facility, sloppy housekeeping or even deliberate illegal practices may result in the discharge of unauthorized pollutants such as hazardous waste to the groundwater. These problems are difficult to detect and regulate. Regulatory agency files contained numerous examples of this type of contamination.

Storm Runoff

Because the study area has high annual rainfall (about 60 in.), large volumes of stormwater must be disposed of. In urban areas, this stormwater contains a variety of pollutants that can impact the quality of both surface and groundwater. In the past, direct discharges of contaminated urban runoff to surface waters contributed to the pollution of drainage canals and other surface waters. Nutrients (from lawn fertilizers), pesticides and heavy metals were of concern.

Much of the stormwater has now been diverted from direct discharges to surface waters. Runoff from building roofs, streets, parking areas and roadways is often discharged to storm ponds, dry wells and seepage pits. This results in the infiltration of this stormwater into the groundwater. Research has demonstrated that most of the pollutants present in the stormwater are attenuated within a few feet of travel in the aquifer, especially where the surface layers are fine sands that act as filters. This is especially true of lead particulates from automobile exhausts and pesticides from lawns and parks that are attached to soil particles. No data on volatile organic chemicals in stormwater in the study area were found to evaluate if the urban runoff could be a significant source of groundwater contamination.

Stormwater runoff at industrial plants can be contaminated with significant levels of VOCs if spills or leaks of raw materials or products occur of if hazardous wastes are handled improperly. Thus, stormwater runoff can add to groundwater contamination problems at an industrial site with inadequate disposal of industrial wastewaters.

Agricultural

Production of crops, especially the intense truck farming practiced in some of the study area, makes use of large volumes of fertilizer and pesticides. Infiltration of rainfall on cropland can be a source of groundwater contamination. In south Dade County, high nitrate levels in part of the Biscayne Aquifer were attributed to application of fertilizers on cropland.

Pesticides (both herbicides and insecticides) have been detected at low levels in groundwater at a few locations in the study area. They have also frequently been detected in the bottom sediments of surface waters including drainage canals and storm ponds.

Most pesticides appear to usually be bound up on the sediments and do not readily move into the groundwater. Some types of pesticides such as ethylene dibromide (EDB) apparently do move through the aquifer and pose a threat to groundwater quality where they are used. EDB has been detected in groundwater in other areas of Florida but has not been detected in the study area to date.

VI. ENVIRONMENTAL CONTROL PROGRAMS

Environmental control programs at the Federal, State and local levels are directly or indirectly involved in the protection of public drinking water supplies. Regulatory programs at all three levels are designed to ensure that public water supplies deliver to the consumer drinking water that is safe and of acceptable quality. Because most drinking water is obtained from groundwater, programs that regulate the quality of groundwater are of interest. These include direct regulation of groundwater quality and indirect regulation through controls on discharges of pollutants into the ground. Regulation of surface water quality is also of interest because groundwater systems are partially recharged by seepage of surface water. Surface water quality is also regulated by controls on discharges of pollutants to surface waters. Regulation of hazardous waste management and disposal is of special interest because hazardous wastes are frequently the source of serious groundwater contamination incidents. At the local level, land use ordinances are being applied for protection of major public water supply wellfields. These environmental control programs are discussed below.

DRINKING WATER

The Federal drinking water program stems from the authority of the Safe Drinking Water Act (42 USC 300 et seq). EPA is required by the SDWA to promulgate national drinking water regulations that specify water quality limits that must be met in all public water supplies for the protection of public health. The SWDA establishes the states as the primary enforcers of the national regulations. Florida has assumed primacy for enforcement of the SDWA with this responsiblity delegated to the Department of Environmental Regulation. The DER central office in Tallahassee administers the program, with the enforcement activities in the study area conducted by the Southeast Florida district office in West Palm Beach. EPA overview of the Florida program is maintained by the Water Management Division in Region IV, Atlanta, Georgia.

As required by the SDWA, EPA has promulgated interim primary and secondary drinking water regulations that specify maximum contaminant levels (MCLs) for various contaminants in drinking water. EPA is in the process of making major additions and revisions to these regulations. In an advance notice of proposed rulemaking in March 1982, EPA announced its intent to propose MCLs for several volatile organic chemicals.[48] As previously discussed in more detail in Section IV, EPA is expected to propose recommended MCLs for eight VOCs within the next few months. These RMCLs are not enforceable but specify health goals for drinking water supplies. These would be the first national regulations on VOCs. EPA is expected to later propose and promulgate enforceable MCLs for some VOCs.

In October 1983, EPA published another advance notice of proposed rulemaking, indicating its intent to propose additional revisions of the drinking water regulations.[64] These would cover additional organic chemicals as well as inorganic chemicals, microbiological contaminants, radionuclides, and disinfection byproducts including trihalomethanes. Phased implementation of these revisions would occur over several years.

Florida passed their own SWDA as the legal authority for assuming primacy of the drinking water program. DER promulgated regulations (FAC Chapters 17-22) implementing the program. Chapter 17-22.104 establishes quality standards [Appendix A] for public water supplies that basically incorporate the Federal drinking water regulations. The Florida regulations also contain a provision authorizing DER to establish additional MCLs. Under this provision, in early 1984 DER promulgated MCLs which take effect in June 1985 for volatile organic chemicals in drinking water.

Without formal regulations to define the significance of observed levels of VOC contamination in water supplies, the water utilities were understandably reluctant to expend resources on monitoring or treatment improvements to lower VOC concentrations. The new Florida MCLs now provide a basis for defining which water supplies need to address the VOC problem and help define the level of treatment or other remedial measures needed.

DER regulations also provide for a permit program regulating the design, construction, operation and maintenance of public water supply systems. In addition to obtaining permits, system operators are required to conduct periodic monitoring of the quality of their water supply, to keep certain records, and to report data to DER.

Both DER and the Florida Department of Health and Rehabilitative Services are authorized to conduct surveillance of public water supplies including water quality monitoring. In the three counties of the study area, this authority has been delegated to the county health departments. In Dade County, DERM also enforces drinking water regulations.

Enforcement of drinking water regulations is usually against the water system. If monitoring detects problems with the quality of a supply, the county health department and/or DER notifies the system operators to take appropriate steps to improve water quality. Where an imminent health hazard exists, a boil water order may be issued to the public, or the supply may be temporarily shut down and an alternate water supply provided. When a well is found to be contaminated, several actions may be taken. If the contamination is severe and irreversible, the well may be taken permanently out of service. In less severe cases, the well may be taken out of service temporarily, or restrictions placed on its use. Revisions or additions to treatment processes may be required when alternate supplies are not available.

The key aspect of drinking water regulations with respect to contamination incidents is that enforcement of the regulations is usually against the water suppliers. In most cases, VOC contamination orginates from some other source, not the supplier. Other regulations are usually used to enforce against the source of contamination as discussed below. The SDWA does contain emergency powers provisions that allow action directly against the source of contamination, but this approach is rarely used.

GROUNDWATER

There is currently no Federal program directed specifically at protection of groundwater quality in the broad sense. The SDWA establishes an underground injection control (UIC) program for the control of the introduction of pollutants into groundwater through injection wells. The UIC program deals with the point sources of pollution but does not establish groundwater quality criteria. Under the Resource Conservation and Recovery Act (RCRA), the release of hazardous wastes to groundwater from land disposal facilities is regulated. Again, this program deals with point sources of groundwater contamination and not the aquifer in general. Neither program deals with industrial wastewater discharges (that are not hazardous wastes) to ground disposal such as percolation ponds or seepage pits.

EPA is drafting a national groundwater policy that deals with protection of groundwater aquifers using a combination of existing programs/authorities and new statutory authorities. Recent policy drafts suggest that the basic approach will be a groundwater classification system with water quality criteria based on water uses to be protected.

Florida already has in place a groundwater classification regulation and groundwater quality criteria (FAC Chapter 17-3) [Appendix B]. The Biscayne and Coastal Aquifers are classified for potable water use. In addition to minimum quality criteria, the primary and secondary drinking water standards [Appendix A] apply to groundwater. The minimum quality criteria address toxic substances but do not set any numerical limits. There are thus no currently effective limits on VOCs in groundwater, but the new Florida MCLs will be applicable to groundwater when effective in June 1985.

Broward and Dade Counties also have groundwater quality criteria [Appendix B]. Both sets of criteria are similar to the current State criteria. The Broward County regulations, however, contain a key criterion of a 0.01-mg/ℓ limit on chlorinated hydrocarbons other than specified pesticides. This is the only numerical limit in the study area that can currently be applied to VOCs in groundwater.

The groundwater criteria are directly enforceable against a source of pollution whether or not it has a discharge permit. Violations of groundwater criteria have been used as the basis for remedial actions to remove contamination of the aquifer.

In Broward County, the Environmental Quality Control Board (BCEQCB) enforces the groundwater standards. In Dade County, the Metropolitan Dade Environmental Resources Management Division (DERM) enforces the criteria. BCEQCB and DERM are responsible for protection of the groundwater components of public water supplies in their counties, whereas drinking water quality in the public water systems is the responsibility of the county health departments. DERM also enforces water supply regulations. Both BCEQCB and DERM have groundwater monitoring programs to detect trends in groundwater quality and any contamination problems. The U.S. Geological Survey also does extensive groundwater monitoring in the area. With the exception of special studies by DERM, most of the monitoring has not included VOCs. Both DER and BCEQCB have begun VOC monitoring of groundwater at some industrial facilities. BCEQCB has begun VOC monitoring using the county-wide well network.

SURFACE WATER

Under the Clean Water Act, a Federal-State program for protection of surface water quality has been established. The program parallels the Florida groundwater program. All surface waters are classified according to use, and water quality criteria are established to protect that use. The states establish the classifications and criteria and administer the program with EPA guidance and overview.

DER has classified all surface waters in the study area for propagation of aquatic life except for the canals and lakes feeding the West Palm Beach water supply, Lake Okeechobee and a small, abandoned rock pit in northwest Dade County. These waters are classified for public water supply. Broward and Dade Counties have also established surface water quality criteria. Neither the DER nor county criteria limit VOCs.

The surface water quality criteria are generally not enforced directly but rather through source controls. Monitoring of water quality is conducted by various agencies. Effluent limits are established on point source discharges to surface waters as discussed below. The counties have programs to encourage the diversion of non-point sources such as storm runoff out of surface waters.

WASTEWATER DISCHARGES

Wastewater discharges from municipal and industrial point sources to surface waters are regulated by the Federal National Pollutant Discharge Elimination System (NPDES) permit program. EPA is required by the Clean Water Act to develop guidance and procedures for the permit program, including effluent limitation guidelines for various industrial categories. EPA has developed guidance and is in the process of promulgating effluent guidelines for all industrial categories.

The NPDES program was designed to be operated by EPA with eventual delegation to the states. EPA issued NPDES permits to all discharges in the study area. Florida has not taken over the NPDES program, so compliance monitoring and enforcement of permit conditions are the responsibility of EPA.

DER does have a wastewater discharge permit program that covers discharges to both surface and groundwaters. DER has adopted NPDES effluent guidelines by reference as a basis for effluent-limited permits, whether to surface or groundwaters. Permit limits may be based on surface or groundwater quality criteria where necessary. Both Broward and Dade Counties have adopted effluent limitations applicable to all wastewater discharges to surface and groundwaters in these counties.

Compliance monitoring and enforcement of DER permits are conducted by BCEQCB and by DERM in Broward and Dade Counties, respectively. In Palm Beach County, the health department has these responsibilities.

Enforcement of industrial waste permits to discharge to groundwaters has been used to abate several serious groundwater contamination problems. Lack of such a permit has also been used to abate problems.

HAZARDOUS WASTE MANAGEMENT AND DISPOSAL

The active generation, transportation and treatment, storage or disposal of hazardous wastes (as defined by 40 CFR Part 261) are regulated at the Federal level by Subtitle C of the Resource Conservation and Recovery Act (RCRA). EPA has nearly completed the initial promulgation of regulations to fully implement the RCRA program and is revising the regulations to improve the management of hazardous wastes. A major element of the RCRA program is a permit program applicable to all facilities that store, treat, or dispose of hazardous wastes. All generators and transporters of hazardous wastes are not required to obtain permits but must comply with various RCRA regulations. The intent of the RCRA program is to regulate hazardous wastes from generation to ultimate disposal.

The permit program operates in two major phases. Because a lengthy period of time was required to develop permit standards and begin issuing RCRA permits, all treatment, storage and disposal (TDS) facilities that notified EPA of their activity by mid-1980 were automatically granted "interim status", a quasi-permit in which the operations were required to meet certain requirements similar to but generally less stringent than permit standards. At a later date the facility is issued a RCRA permit containing additional technical and administrative requirments specific to the facility.

It is the intent of RCRA that the entire hazardous waste program be operated by the states with EPA overview. This was to be achieved in two phases. The state would initially be authorized to enforce the interim status standards. In the second phase, the state would be authorized to operate the full program, including permit issuance and enforcement.

Florida pursed and has obtained authorization for the full RCRA program. Interim status authorization was granted by EPA to DER in 1982. DER has conducted numerous interim status inspection of hazardous waste management facilities. Enforcement actions have been taken to secure compliance with interim status standards.

DER has promulgated regulations establishing a hazardous waste program for Florida (FAC Chapter 17-30). Application for full program authorization was made to EPA in July 1983, and authorization to issue permits to storage facilities and incinerators was granted in December 1983. Authorization to issue land disposal permits was granted in February 1984.

RCRA permits for TSD facilities and regulations for generators and transporters will reduce the instances of improper hazardous waste management that contributed to groundwater contamination in the past. However, interim status inspections have shown that much of the industrial activity in the study area involving volatile organic chemicals is exempt from most RCRA regulation because the facility is a small generator or wastes are stored for less than 90 days or recycled. Thus other means of detecting and preventing bad practices may be needed. DERM has initiated an inspection program in Dade County to address this problem.

The Comprehensive Environmental Response, Compensation and Liability Act (CERCLA or Superfund) was established to deal with two types of hazardous waste problems: spills or leaks of hazardous materials that pose an imminent threat to public health or the environment and inactive hazardous waste disposal sites that pose major environmental problems. Superfund can be used for immediate removal of spills or of contamination at an inactive disposal site when it is discovered that an imminent hazard is present. Long-term remedial actions can be taken at inactive sites if the environmental problems are severe enough to place the site on the National Priorities List. There are eight sites in the study area among the nearly 500 on the list. Superfund is funded by a tax on the production of certain types of chemical and petroleum products. Site cleanup costs are initially provided by the fund. Reimbursement is then sought from responsible parties. Voluntary remedial actions may also be undertaken by responsible parties.

In most cases, the state is required to provide 10% of the cleanup costs. Florida has established a hazardous waste trust fund similar to Superfund to provide matching money and to clean up additional sites.

More than $2 million from Superfund have been spent in the study area to clean up the Miami Drum site, to conduct site investigations and feasibility studies at numerous sites, and to develop remedial action master plans for several sites. EPA and DER are cooperating in directing this effort with contractor technical support.

There are a number of inactive disposal sites in the study area that may eventually require remedial action but probably do not warrant placement on the National Priorities List. An alternate means of funding remedial actions will be needed in these cases.

Florida has recently begun a program to enhance the safe disposal of small quantities of hazardous wastes frequently disposed of inadequately or illegally. On designated "Amnesty Days", citizens may bring small quantities of hazardous wastes to a collection point for disposal by a contractor.

LAND USE

Both Broward and Dade Counties have recognized the vulnerability of the various public water supply wellfields to contamination by the improper handling and disposal of volatile organic chemicals and other pollutants near the wellfields. Dade County has passed an ordinance that identifies the location of all public water supply wellfields in the county and establishes the limits of a zone around each wellfield that represents the theoretical extent of a 210-day travel time for groundwater in the aquifer. Land uses within this 210-day limit are restricted. No new activity handling certain hazardous materials can be located in these wellfield zones. Existing activities are also restricted.

Broward County is in the process of implementing such an ordinance.

Because of problems with groundwater contamination from leaking underground storage tanks, primarily gasoline tanks at service stations, ordinances regulating such tanks are being developed.

It is clear that there are many agencies and regulatory programs directly or indirectly related to the protection of drinking water quality. A partial listing of those agencies involved in the study area includes the following:

Federal

U.S. Environmental Protection Agency
U.S. Geological Survey

State

Department of Environmental Regulation
Department of Health and Rehabilitative Services
South Florida Water Management District

Broward County

Public Health Unit
Environmental Quality Control Board
Water Resources Planning Division

Dade County

Department of Health
Metropolitan Dade County Department of Environmental Resources Management

Palm Beach County

Public Health Unit

Numerous Water and Sewer Utilities

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APPENDICES

A PRIMARY AND SECONDARY DRINKING WATER STANDARDS

B GROUNDWATER QUALITY CRITERIA

APPENDIX A

PRIMARY AND SECONDARY DRINKING WATER STANDARDS

samples must be collected from locations representative of the distribution system, unless otherwise specified.

17-22.104 Quality Standards: Maximum Contaminant Levels or Treatment Techniques.

(1) PRIMARY DRINKING WATER REGULATIONS-maximum contaminant levels.

(a) INORGANICS

1. *The following are maximum* contaminant levels applicable to community water systems.

Contaminant	Level, milligrams per liter
Arsenic	0.05
Barium	1.
Cadmium	0.010
Chromium	0.05
Lead	0.05
Mercury	0.002
Nitrate (as N)	10.
Selenium	0.01
Silver	0.05
Sodium	160

2. The maximum contaminant level for nitrate (as N) applicable to non-community water systems is 10 milligrams per liter unless all of the following conditions are met, in which case the Department or designated county health unit can allow a maximum contaminant level for nitrate (as N) of up to 20 milligrams per liter.

a. The water distributed by the water system is not available to children under 6 months of age.

b. There is continuous posting of the fact that nitrate levels exceed 10 milligrams per liter and the potential health effects of exposure.

c. Local and state public

PART II QUALITY STANDARDS, ANALYTICAL METHODS, SAMPLING

General--The ultimate concern of a public drinking water program is the quality of the water when the water reaches the citizens. The following regulations establish the maximum contaminant levels or the treatment technique as well as sampling and analysis requirements for the water within public water systems. All health authorities are notified annually of nitrate levels that exceed 10 milligrams per liter.

d. No adverse health effects shall result from the increased nitrate level.

e. Monitoring is increased to once per quarter for the first year 10 milligrams per liter is exceeded, semiannually for the second year, and once per year thereafter.

3. When the annual average of the maximum daily air temperatures for the location in which the community water system is situated is the following, the maximum contaminant levels for fluoride are:

Temperature Degrees Fahrenheit	Degrees Celsius	level, milligrams per liter
53.7 and below	12.0 and below	2.4
53.8 to 58.3	12.1 to 14.6	2.2
58.4 to 63.8	14.7 to 17.6	2.0
63.9 to 70.6	17.7 to 21.4	1.8
70.7 to 79.2	21.5 to 26.2	1.6
79.3 to 90.5	26.3 to 32.5	1.4

(b) ORGANICS-The following are maximum contaminant levels applicable to community water systems.

Contaminant	Level, milligrams per liter
1. Chlorinated hydrocarbons:	
Endrin (1,2,3,4,10,10-hexachloro-6,7-epoxy--1,4,4a,5,6,7,8,8a-octa-hydro-endo, endo--1,4:5,8--dimethano naphthalene).	0.0002
Lindane (1,2,3,4,5,6,-hexachloro-cyclohexane, gamma isomer).	0.004
Methoxychlor (1,1,1,-Trichloro-2,2-bis (p-methoxyphenyl) ethane.	0.1
Toxaphene ($C_{10}H_{10}C_8$-Technical chlorinated camphene, 67-69 percent chlorine).	0.005
2. Chlorophenoxys:	
2,4,--D,(2,4,--Dichlorophenoxyacetic acid).	0.1
2,4,5,-TP, Silvex (2,4,5-Trichlorophenoxypropionic acid).	0.01

(c) TURBIDITY-The maximum contaminant levels for turbidity are applicable to both community water systems and non-community water systems using surface water sources in whole or in part. The maximum contaminant level for turbidity also applies to community water supply systems utilizing groundwater source(s). The maximum contaminant levels for turbidity in drinking water, measured at a representative entry point(s) to this distribution system or at other points on each system as may be significant to such as post-precipitation conditions or iron precipitate build up and release, are:

1. One turbidity unit, as determined by a monthly average for surface water systems or a single triennial analysis for groundwater systems, except that five or fewer turbidity units may be allowed if the supplier of water can demonstrate to the Department that the higher turbidity does not do any of the following:

a. Interfere with disinfection;

b. Prevent maintenance of an effective disinfectant agent throughout the distribution system; or

c. Interfere with microbiological determinations.

2. Five turbidity units based on average for two consecutive days.

(d) MICROBIOLOGICAL-The maximum contaminant levels for coliform bacteria, applicable to community water systems and non-community water systems, are as follows;

1. When the membrane filter technique is used, the number of coliform bacteria shall not exceed any of the following:

a. One per 100 milliliters as the arithmetic means of all samples examined per month;

b. Four per 100 milliliters in more than one sample when less than 20 are examined per month; or

c. Four per 100 milliliters in more than five percent of the samples when 20 or more are examined per month.

2. When the fermentation tube method and 10 milliliter standard portions are used, coliform bacteria shall not be present in any of the following:

a. more than 10 percent of the portions in any month;

b. three or more portions in more than one sample when less than 20 samples are examined per month; or

c. three or more portions in more than five percent of the samples when 20 or more samples are examined per month;

3. When the fermentation tube method and 100 milliliter standard portions are used, coliform bacteria shall not be present in any of the following:

a. more than 60 percent of the portions in any month;

b. five portions in more than one sample when less than five samples are examined per month; or

c. five portions in more than 20 percent of the samples when five or more samples are examined per month.

4. At the Department's discretion, community systems required to take 10 or fewer samples per month may be authorized to exclude one positive membrane filter routine sample (+1 or greater) per month or one positive routine sample per month consisting of one or more positive tubes from the monthly or quarterly average calculation if all of the following conditions are met.

a. As approved on a case-by-case basis, the Department determines and indicates in writing to the public water system that no unreasonable risk to health existed under the conditions of this modification. This determination should be based upon a number of factors including but not limited to the following:

(i) the system provided and had maintained an active disinfectant residual in the distribution system,

(ii) a minimal potential for contamination as indicated by a sanitary survey, and,

(iii) the history of the water quality at the public water system.

b. The supplier shall initiate a check sample on each of two consecutive days from the same sampling point within 24 hours after notification that the routine sample is positive, and each of these check samples must be negative.

c. The original positive routine sample is reported and recorded by the supplier pursuant to 17-22.111(1)(a) and 17-22.111(2)(a). The supplier shall report to the Department its compliance with the conditions specified in this paragraph and a summary of the corrective action taken to resolve the prior positive sample result. If a positive routine sample is not used for the monthly calculation, another routine sample must be analyzed for compliance purposes. This provision may be used only once during two consecutive compliance periods.

5. For community or non-community systems that are required to sample at a rate of less than 4 per month, compliance with Sections (1)(d)1., 2., or 3. shall be based upon sampling during a 3-month period. The Department may upon request authorize compliance to be based upon sampling during a one-month period.

6. If an average MCL violation is caused by a single sample MCL violation as described in 17-22.104 (1)(d)1.b., then the case shall be treated as one violation with respect to the public notification requirements of 17-22.112.

(e) RADIONUCLIDES-The following are maximum contaminant levels applicable to community water system:

1. Radium-226, radium-228, and gross alpha particle radioactivity.

a. Combined radium-226 and radium-228 - 5 pCi/l.

b. Gross alpha particle activity (including radium-226, but excluding radon and uranium) - 15 pCi/l.

2. Beta particle and photon radioactivity from man-made radionuclides.

a. The average annual concentration of beta particle and photon radioactivity from man-made radionuclides in drinking water shall not produce an annual dose equivalent to the total body or any internal organ greater than 4 millirem/year.

b. Except for the radionuclide listed in Table A, the concentration of man-made radionuclides causing 4 mrem total body or organ dose equivalents shall be calculated on the basis of a 2 liter per day drinking water intake using the 168-hour data listed in "Maximum Permissible Body Burdens and Maximum Permissible Concentration of Radionuclides in Air or Water for Occupational Exposure," NBS Handbook 69 as amended August 1963, U.S. Department of Commerce. If two or more radionuclides are present, the sum of their annual dose equivalent to the total body or to any organ shall not exceed 4 millirem/year.

Table A-Average Annual Concentration Assumed to Produce a Total Body or Organ Dose of 4 mrem/year.

Radionuclide	Critical organ	pCi per liter
Tritium	Total body	20,000
Strontium-90	Bone marrow	8

(f) TRIHALOMETHANE-The following maximum contaminant levels are for trihalomethanes (THM's) and are applicable to all community water supply systems serving a population of 10,000 or more individuals and which add a disinfectant (oxidant) to the water in any part of the drinking water treatment process:

1. Total Trihalomethanes (TTHM) shall include the sum of the concentrations bromodichloromethane, dibromochloromethane, tribomomethane (bromoform) and trichloromethane (chloroform)-0.10 mg/l (MCL).

(2) SECONDARY DRINKING WATER REGULATIONS-maximum contaminant levels. These levels shall not be exceeded in community water systems. If an MCL is exceeded, appropriate action, acceptable to the Department, including water treatment plant additions and modifications, shall be taken to provide water in which the MCL is not exceeded. Results of secondary contaminant analyses performed by a certified laboratory prior to the effective date of these revised regulations shall be considered for acceptance by the Department. The following are maximum contaminant levels applicable to community water systems:

Contaminant	Levels, Milligrams Per Liter*
Chloride	250
Color	15 color units
Copper	1
Corrosivity	**neither corrosive nor scale forming.
Foaming agents	0.5
Iron	0.3
Manganese	0.05
Odor	3 (threshold odor number)
pH (at collection point)	6.5 (min. allowable - no max.)
Sulfate	250
TDS	500 (may be greater if no other MCL is exceeded)
Zinc	5

*except color, odor, corrosivity and pH.
**Assessment of degree of corrosion or scale forming tendencies must be based on historical water characteristics of the system. A Langelier Index range of -0.2 to +0.2 should be used as a guideline toward obtaining water stability if calcium carbonate is present. If stabilizers are used, the -0.2 to +0.2 range may not be applicable.

(3) OTHER CONTAMINANTS WITHOUT A STANDARD-It is prohibited to introduce into a public water system any contaminant which creates or has the potential to create an imminent and substantial danger to the public.

(4) RELATIONSHIP BETWEEN 17-22.104 & 17-22.105, FLORIDA ADMINISTRATIVE CODE-All contaminants having an MCL established by Section 17-22.104, Florida Administrative Code, are required to be sampled and analyzed as established by Section 17-22.105, Florida Administrative Code.

Specific Authority: 403.861(8), F.S. Law Implemented: 403.852(12)(13), 403.853(1), F.S. History: New 11-9-77, Amended 1-13-81, 3-30-82.

17-22.105 Sampling and Analytical Methods.

(1) SAMPLING AND ANALYTICAL REQUIREMENTS FOR PRIMARY CONTAMINANTS

(a) INORGANIC chemical sampling and analytical requirements.

1. Analyses for the purpose of determining compliance with 17-22.104(1)(a) are required as follows:

a. Analyses for all community water systems utilizing surface water sources shall be completed by June 24, 1978. These analyses shall be repeated at yearly intervals.

b. Analyses for all community water systems utilizing only ground water sources, shall be completed by June 24, 1979. These analyses shall be repeated at three-year intervals.

c. For non-community water systems, whether supplied by surface or ground water sources, analyses for nitrate shall be completed by June 24, 1979. These analyses shall be repeated at five-year intervals.

2. If the result of an analysis made pursuant to paragraph 17-22.105 (1)(a)1. indicates that the level of any contaminant listed in 17-22.104(1)(a) exceeds the maximum contaminant level, the supplier of water shall report said fact to the Department within 7 days and initiate and complete three additional analyses for the suspect contaminant at the same sampling point within one month.

3. When the average of four analyses made pursuant to paragraph 17-22.105(1)(a)1. and 2. of this Section, rounded to the same number of significant figures as the maximum contaminant level for the substance in question, exceeds the maximum contaminant level, the supplier of water shall notify the Department pursuant to 17-22.111(2). Monitoring after public notification shall be at a frequency designated by the Department and shall continue until the maximum contaminant level has not been exceeded in two successive samples or until a monitoring schedule as a condition to a variance, exemption or enforcement action shall become effective.

4. The provisions of paragraphs (1)(a)2. and 3. of this section notwithstanding, compliance with the maximum contaminant level for nitrate shall be determined on the basis of the mean of two analyses. When a level exceeding the maximum contaminant level for nitrate is found, a second analysis shall be initiated within 24 hours, and if the mean of the two analyses exceeds the maximum contaminant level, the supplier of water shall report his findings to the Department pursuant to 17-22.111(2) and shall notify the public pursuant to 17-22.112.

17-22.104(1)(g) VOLATILE ORGANICS

The following maximum contaminant levels (MCL's) for volatile organics are applicable to all community water systems. These concentrations are based on present "state of the art" analytical detection limits as applied to routine sampling, risk analysis, carcinogenicity and chronic toxicity, and may be lowered in the future, commensurate with increasing laboratory capability or further data indicating adverse effects on human health.

Contaminant	Level, Micrograms Per Liter
Trichloroethylene	3
Tetrachloroethylene	3
Carbon Tetrachloride	3
Vinyl Chloride	1
1,1,1-Trichloroethane	200
1,2-Dichloroethane	3
Benzene	1
Ethylene Dibromide	0.02

17-22.105(1)(g) VOLATILE ORGANICS - Sampling and Analytical Requirements:

1. Regulations for volatile organic MCLs as set forth in 17-22.104(1)(g) shall take effect June 1, 1985 for systems serving more than 1,000 persons, and January 1, 1987 for systems serving less than 1,000 persons. Analyses for contaminants shall be performed at three year intervals. Sampling shall be performed on finished water leaving the water treatment plant except for ethylene dibromide which shall be sampled before chlorination. When a system is provided water from multiple treatment plants a sample(s) representative of the distribution system's water will be

sufficient. If a sample analysis exceeding the MCL occurs, two additional samples shall be collected and confirmed by GC/MS within one month. If the average value of the three sample results exceeds the MCL, quarterly sampling will be required until two consecutive sample results do not exceed the MCL value.

2. Analyses conducted to determine compliance with 17-22.104(1)(g) shall be made in accordance with the following methods further identified at the end of 17-22.105(1)(h)4.

Trichloroethylene, Tetrachloroethylene, Carbon Tetrachloride, Vinyl Chloride, 1,1,1-Trichloroethane, and 1,2-Dichloroethane - Methods 501.1, 501.2, 501.3, 502.1, 503.1, 601, 602, and 624.

Benzene - Methods 501.1, 501.2, 501.3, 502.1, 503.1, 601, 602, and 624.

Ethylene Dibromide - "Analysis of 1,2-Dibromoethane in Drinking Water", Florida Department of Health and Rehabilitative Services, Jacksonville Central Laboratory, 1217 Pearl Street, Post Office Box 210, Jacksonville, Florida 32231-0042.

17-22.105(1)(h) - SYNTHETIC ORGANIC CONTAMINANTS MONITORING

Analyses for synthetic organic contaminants (SOCs) shall be submitted to the department by January 1, 1985 for all community systems serving 1,000 or more persons, and by October 1, 1985 for all community systems serving less than 1,000 persons. Analyses for the following list of SOCs shall be performed every three years on finished water except when results or conditions warrant more frequent monitoring as determined by the department. After the first round of sampling, this list may be modified to include the addition or deletion of certain SOCs based on their actual or potential occurrence in Florida waters.

1. PURGEABLES - Methods 501.1, 501.2 501.3, 502.1, 503.1, 601, 602, 603, and 624. Identification of methods is listed at the end of 17-22.105(1)(h)4.

Acrolein
Acrylonitrile
Benzene
Bromodichloromethane
Bromoform
Bromomethane
Chlorobenzene
Chloroethane
2-Chloroethylvinyl ether
Chloroform
Chloromethane
Dibromochloromethane
Dichlorodifluoromethane
1,1-Dichloroethane
1,1-Dichloroethene
trans-1,3-Dichloropropene
1,2-Dichloroethene
1,2-Dichloropropane
cis-1,3-Dichloropropene
Ethylbenzene
Methylene chloride
1,1,2-Trichloroethane
Trichlorofluoromethane
Toluene
*Xylene
*Styrene
Dichlorobenzene
1,2-Dibromo-3-Chloropropane
1,1,2,2-Tetrachloroethane

*Can be analyzed using Methods 602 and 624, though not specifically indicated in these methods.

2. PESTICIDES - Methods 509-A, 606, 608, 612, 614, 617, 625, and HPLC. Identification of methods is listed at the end of 17-22.105(1)(h)4.

Aldrin	Endrin Aldehyde
a-BHC	Heptachlor
b-BHC	Heptachlor Epoxide
g-BHC	Toxaphene
d-BHC	PCB-1016
Chlordane	PCB-1221
4,4'-DDD	PCB-1232
4,4'-DDE	PCB-1242
4,4'-DDT	PCB-1248
Dieldrin	PCB-1254
Endosulfan I	PCB-1260
Endosulfan II	Aldicarb (non-extractable)
Endosulfan Sulfate	Diazinon
Ethion	Malathion
Trithion	Parathion
o,p-DDT,DDE and DDD	Guthion
Tedion	Kelthane (Dicofal)

3. BASE NEUTRAL EXTRACTABLES - Methods 605, 606, 607, 609, 610, 612, 613, and 625. Identification of methods are listed at the end of 17-22.105(1)(h)4.

Acenaphthene

Acenaphthylene

Anthracene

Benzo(a)anthracene

Benzo(b)fluoranthene

Benzo(k)fluoranthene

Benzo(a)pyrene

Benzo(g,h,i)perylene

Benzidine

Bis(2-chloroethyl)ether

Bis(2-chloroethoxy)methane

Bis(2-ethylhexyl)phthalate

Bis(2-chloroisopropyl)ether

4-Bromophenyl phenyl ether

Butyl benzyl phthalate

2-Chloronaphthalene

4-Chlorophenyl phenyl ether

Chrysene

Dibenzo(a,h)anthracene

Di-n-butylphthalate

1,3-Dichlorobenzene

1,4-Dichlorobenzene

1,2-Dichlorobenzene

3,3-Dichlorobenzidine

Diethylphthalate

Dimethylphthalate

2,4-Dinitrotoluene

2,6-Dinitrotoluene

Dioctylphthalate

1,2-Diphenylhydrazine

Fluoranthene

Fluorene

Hexachlorobenzene

Hexachlorobutadiene

Hexachloroethane

Hexachlorocyclopentadiene

Indeno(1,2,3-cd)pyrene

Isophorone

Naphthalene

Nitrobenzene

N-Nitrosodimethylamine

N-Nitrosodi-n-propylamine

N-Nitrosodiphenylamine

Phenanthrene

Pyrene

2,3,7,8-Tetrachlorodibenzo-p-dioxin (Dioxin)

1,2,4-Trichlorobenzene

4. ACID EXTRACTABLES - Methods 604 and 625. Identification of methods is listed at the end of 17-22.105(1)(h)4.

2-Chlorophenol

4-Nitrophenol

2,4-Dichlorophenol

2,4-Dimethylphenol

2,4-Dinitrophenol

2-Methyl-4,6-Dinitrophenol

Pentachlorophenol

Phenol

2,4,6-Trichlorophenol

Methods 501.1 and 501.2 - "Analysis of Trihalomethanes in Drinking Water", Federal Register, Vol. 44, number 231, Thursday, November 29, 1979/Rules and Regulations, and Correction to Federal Register Thursday, November 29, 1979, Part III, Appendix C; "Analysis of Trihalomethanes in Drinking Water", Federal Register, Vol. 45, Number 49, Tuesday, March 11, 1980.

Method 501.3 - "Measurement of Trihalomethanes in Drinking Water with Gas Chromatography and Selected Ion Monitoring", U.S. Environmental Protection Agency, Environmental Monitoring and Support Laboratory, Cincinnati, Ohio 45268.

Method 502.1 - "The Determination of Halogenated Chemical Indicators of Industrial Contamination in Water by the Purge and Trap Method", Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268.

Method 503.1 - "The Analysis of Aromatic Chemicals in Water by the Purge and Trap Method", Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268.

Method 509-A - "Standard Methods for the Examination of Water and Wastewater", 15th Edition, 1980.

Methods 601, 602, 603, 604, 605, 606, 607, 608, 609, 610, 611, 612, 613, 624, and 625 - "Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater", Environmental Monitoring and Support Laboratory, U.S. Environmental Protection Agency, Cincinnati, Ohio 45268.

Method 614 - "The Determination of Organophosphorus Pesticides in Industrial and Municipal Wastewater", National Technical Information Services, 5285 Port Royal Road, Springfield, Virginia 22165.

Method 617 - "The Determination of Organic Pesticides and PCB's in Industrial and Municipal Wastewater", National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22165.

HPLC Method - Journal of Chromatography, Vol. 185, 1979, pp 615-624. Resolution, Sensitivity, and Selectivity of a High-Performance Liquid Chromatographic Post-Column Fluorometric Labeling Technique for Determination of Carbamate Insecticides, by Richard T. Krause.

NAME OF PERSON ORIGINATING PROPOSED RULE: Al Bishop

NAME OF SUPERVISOR WHO APPROVED THE PROPOSED RULE: Victoria J. Tschinkel

DATE APPROVED: February 14, 1984

APPENDIX B

GROUNDWATER QUALITY CRITERIA

PART IV
WATER QUALITY CRITERIA – GROUND WATER

17-3.401 Ground Water: General.

(1) This part contains criteria which are applicable to ground water.

(2) In order to determine if the ground water criteria in this part are being met, ground water quality shall be monitored in accordance with this Section and Section 17-4.245, F.A.C.

(3) A violation of any ground water criterion contained in this part constitutes pollution.

(4) In addition to any technology-based effluent limitations required by Department rule, the Department may also specify water quality-based effluent limitations to assure that the water quality criteria will be met.

(5) Notwithstanding the classification and criteria for ground water set forth in this part, discharge to ground water shall not impair the designated use of contiguous surface water.

(6) Compliance with ground water standards shall be determined by analyses of unfiltered ground water samples, unless a filtered sample is as or more representative of the particular ground water quality.

(7) For owners of installations having filed a complete application for a Chapter 403 permit covering water discharges as of January 1, 1983, or discharging pollutants to ground water as of July 1, 1982, compliance with the minimum criteria set forth in Section 17-3.402, F.A.C., shall be determined by analysis of the constituents of the waste stream of the installation causing the discharge; provided, however, that the installation owner may, at his option, place a monitoring well immediately outside the site boundary to measure compliance with the minimum criteria, as long as the discharge poses no danger to the public health, safety or welfare.

Specific Authority: 403.061, 403.062, 403.087, 403.504, 403.704, 403.804, F.S. Law Implemented: 403.021, 403.061, 403.087, 403.088, 403.141, 403.161, 403.182, 403.502, 403.702, 403.708, F.S. History: Formerly 17-3.071, Amended and Renumbered 1-1-83.

17-3.402 Minimum Criteria for Ground Water.

(1) All ground water shall at all places and at all times be free from domestic, industrial, agricultural, or other man-induced non-thermal components of discharges in concentrations which, alone or in

combination with other substances, or components of discharges (whether thermal or non-thermal):

(a) Are harmful to plants, animals, or organisms that are native to the soil and responsible for treatment or stabilization of the discharge relied upon by Department permits; or

(b) Are carcinogenic, mutagenic, teratogenic, or toxic to human beings, unless specific criteria are established for such components in 17-3.404; or

(c) Are acutely toxic to indigenous species of significance to the aquatic community within surface waters affected by the ground water at the point of contact with surface waters; or

(d) Pose a serious danger to the public health, safety, or welfare; or

(e) Create or constitute a nuisance; or

(f) Impair the reasonable and beneficial use of adjacent waters.

(2) The minimum criteria shall not apply to Class G-IV ground water, unless the Department determines there is a danger to the public health, safety or welfare.

(3) The following procedures shall apply in the implementation of subsection (1)(b):

(a) The Secretary is authorized to make determinations, in individual permitting or enforcement proceedings, that a particular level for a substance is a prohibited concentration in violation of a minimum criterion pursuant to subsection (1)(b). This determination may not be delegated to the districts.

(b) Any notice of proposed agency action published pursuant to Section 17-1.62, F.A.C., which contains such a determination shall include notification of the particular substance and prohibited concentration level being proposed. The notice shall be submitted to the Florida Administrative Weekly at the time it is sent to the permit applicant for publication.

(c) The Department shall notify the Commission semiannually of every application of a determination to a discharger made by the Secretary during the preceding six months pursuant to subsection (a) for any constituent and concentration level not adopted by the Commission as a rule. The notification shall identify the discharger(s) to whom the application of a determination has been made, the type of industry, the constituent and concentration level set and a summary of the basis for the determination. At the written request of the Commission or any substantially affected member of the public, the Department shall, within 120 days of the written request, submit to the Florida Administrative Weekly a notice of rulemaking pursuant to Section 120.54(1), F.S., on the determination for the particular constituent and concentration level that is the subject of a notification in the preceding sentence.

(d) The application of the determination under paragraph (a) to the permittee or to other affected dischargers shall be subject to:

1. Modification where necessary to conform to any final rulemaking action of the Commission under subsection (c); or

2. Withdrawal if the Commission elects not to adopt a corresponding rule after initiation of rulemaking for the constituent under subsection (c).

(e) The notice procedures contained in subsection (3) shall not act as a stay of Department enforcement proceedings.

(f) Once a particular standard for a criterion is established by the Commission, it shall be listed in subsection (g) below.

(g) Reserved.

Specific Authority: 403.061, 403.062, 403.087, 403.504, 403.704, 403.804, F.S. Law Implemented: 403.021, 403.061, 403.087, 403.088, 403.141, 403.161, 403.182, 403.502, 403.702, 403.708, F.S. History: Formerly 17-3.051, Amended and Renumbered 1-1-83.

17-3.403 Classification of Ground Water, Usage, Reclassification.

(1) All ground water of the State is classified according to designated uses as follows:

CLASS G-I	Potable water use, ground water in single source aquifers which has a total dissolved solids content of less than 3,000 mg/l.
CLASS G-II	Potable water use, ground water in aquifers which has a total dissolved solids content of less than 10,000 mg/l, unless otherwise classified by the Commission.
CLASS G-III	Non-potable water use, ground water in unconfined aquifers which has a total dissolved solids content of 10,000 mg/l or greater, or which has total dissolved solids of 3,000-10,000 mg/l and either has been reclassified by the Commission as having no reasonable potential as a future source of drinking water, or has been designated by the Department as an exempted aquifer pursuant to Section 17-28.13(3), F.A.C.
CLASS G-IV	Non-potable water use, ground water in confined aquifers which has a total dissolved solids content of 10,000 mg/l or greater.

(2) It shall be the Department policy to afford the highest protection to single source aquifers. Upon petition by an affected party as provided in subsection (6), the Commission may reclassify aquifers or portions of aquifers as Class G-I ground water.

(3) The specific water quality criteria corresponding to each ground water classification are listed in Sections 17-3.404 - 17-3.406, F.A.C.

(4) Ground water quality classifications are arranged in order of the degree of protection required, with Class G-I ground water having generally the most stringent water quality criteria and Class G-IV the least.

(5) Reclassification of ground water as provided in subsection (1) above shall be accomplished in the following manner:

(a) Any substantially affected person or a water management district may seek reclassification of any ground water of the State by filing a petition with the Secretary in the form required by Section

17-1.24, F.A.C. In addition, the Department, on its own initiative or at the direction of the Commission, may seek reclassification by initiating rulemaking pursuant to Section 17-1.06, F.A.C.

(b) A petition for reclassification shall contain the information necessary to support the affirmative findings required in this section.

(c) All reclassifications of ground water of the State shall be adopted after public notice, written notification to local governments whose jurisdiction includes any portion of the ground water proposed to be reclassified, and public hearing only upon an affirmative finding by the Commission that:

1. The proposed reclassification will establish the present and future most beneficial use of the ground water; and

2. Such a reclassification is clearly in the public interest.

(d) Reclassification of ground water of the State which establishes more stringent, or less stringent, criteria than presently established by this Chapter shall be adopted upon additional affirmative finding by the Commission that the proposed designated use is attainable, upon consideration of environmental, water quality, technological, social, economic, and institutional factors.

(6) In addition to the procedures in subsection (5) above, the following procedure shall be used to designate single source aquifers:

(a) Rulemaking procedures pursuant to Chapter 17-1, F.A.C., shall be followed;

(b) At least one fact-finding workshop shall be held in the affected area;

(c) All local county or municipal governments, water management districts, and state legislators whose districts or jurisdictions include all or part of a proposed single source aquifer shall be notified in writing by the Secretary at least 60 days prior to the workshop;

(d) A prominent public notice shall be placed in a newspaper, or newspapers if a large area is to be designated, of general circulation in the area of the proposed single source aquifer at least 60 days prior to the workshop;

(e) The Commission may reclassify an aquifer or portion of an aquifer as a single source aquifer within specified boundaries upon the affirmative finding that:

1. The aquifer or portion of the aquifer is the only reasonably available source of potable water to a significant segment of the population; and

2. The designated use is attainable, upon consideration of environmental, technological, water quality, institutional, and social and economic factors.

(f) When making the finding required by subparagraph (e), the Commission must specifically consider, upon presentation of any competent evidence at the hearing, the following:

1. Other sources of potable water which could be used and the costs of developing these sources; and

2. The long term adequacy of the ground water aquifer to supply expected future demands if other sources are not developed; and

3. Potential adverse effects from continued consumption of water from the aquifer if G-I classification does not occur; and

4. Potential adverse impacts on existing and potential discharges to the affected ground water if G-I

classification occurs.
Specific Authority: 403.061, 403.062, 403.087, 403.504, 403.704, 403.804, F.S. Law Implemented: 403.021, 403.061, 403.087, 403.088, 403.141, 403.161, 403.182, 403.502, 403.504, 403.702, 403.708, F.S. History: Formerly 28-5.06, 17-3.06, 17-3.081, Amended and Renumbered 1-1-83.

17-3.404 Standards for Class G-I and Class G-II Ground Water.

(1) In addition to the minimum criteria provided in Section 17-3.402, F.A.C., waters classified as Class G-I and Class G-II ground water shall meet the following standards:

(a) The primary and secondary drinking water quality standards for public water systems established pursuant to the Florida Safe Drinking Water Act, which are listed in Section 17-22.104, F.A.C., except as provided in Section 17-4.245(8), F.A.C.

(b) The following maximum contaminant levels: (Reserved).

(2) If the concentration for any constituent listed in (1) in the natural unaffected background quality of the ground water is greater than the stated maximum, or in the case of pH is also less than the minimum, the representative background value shall be the prevailing standard for Class G-I and Class G-II ground water.

(3) These standards shall not apply within a permitted zone of discharge as provided in Section 17-4.245, F.A.C. The minimum criteria specified in 17-3.402 shall apply within the zone of discharge.
Specific Authority: 403.061, 403.062, 403.087, 403.504, 403.704, 403.804, F.S. Law Implemented: 403.021, 403.061, 403.087, 403.088, 403.141, 403.161, 403.182, 403.502, 403.702, 403.708, F.S. History: Formerly 17-3.101, Amended and Renumbered 1-1-83.

17-3.405 Standards for Class G-III Ground Water. The criteria established in Section 17-3.402, F.A.C., shall apply to all Class G-III ground water.
Specific Authority: 403.061, 403.062, 403.087, 403.504, 403.704, 403.804, F.S. Law Implemented: 403.021, 403.061, 403.087, 403.088, 403.141, 403.161, 403.182, 403.502, 403.702, 403.708, F.S. History: Formerly 17-3.151, Amended and Renumbered 1-1-83.

17-3.406 Standards for Class G-IV Ground Water. The Department shall specify applicable standards on a case-by-case basis for discharges to Class G-IV ground water. The minimum criteria in Section 17-3.402 will not apply unless the Department determines there is danger to the public health, safety or welfare.
Specific Authority: 403.061, 403.062, 403.087, 403.504, 403.704, 403.804, F.S. Law Implemented: 403.021, 403.061, 403.087, 403.088, 403.141, 403.161, 403.182, 403.502, 403.702, 403.708, F.S. History: Formerly 17-3.151, Amended and Renumbered 1-1-83.

(4) WATER QUALITY STANDARDS FOR DADE COUNTY

Chemical, Physical or Biological Characteristic	*Fresh Water (water containing less than 500 ppm chlorides)*	*Tidal Salt Water (water containing more than 500 ppm chlorides)*	*Groundwater*
Dissolved oxygen (mg/l)	5 ppm during at least 10 hours per 24 hour period, never less than 4 ppm, unless acceptable data indicate that the natural background dissolved oxygen is lower than the values established herein.		—
Biochemical oxygen demand (mg/l)	Shall not exceed a value which would cause dissolved oxygen to be depressed below values listed under dissolved oxygen and in no case shall be great enough to produce nuisance conditions.		—
pH	6.0—8.5[1]	6.0—8.5[1]	6.0—8.5[1]
Floating solids, settleable solids, sludge deposits	None attributable to sewage, industrial wastes or other wastes	None attributable to sewage, industrial wastes, or other wastes	—
Oil and grease (mg/l)	15[2]	15[2]	15[2]
Odor-producing substances	None attributable to sewage, industrial wastes or other wastes. Threshold odor number not to exceed 24 at 60°C as a daily average		—
Temperature			
Sources permitted prior to July 1, 1972	Shall cause no environmental damage		
Sources permitted after July 1, 1972	3° above ambient	(June—September) 2° above ambient; (October—May) 4° above ambient.	—
Turbidity	50, except after heavy rains		
Ammonia (mg/l)	5 ppm as N	5 ppm as N	5 ppm as N
Chlorides (mg/l)	500[3]	[3]	500[3]
Chromium (mg/l) total	.05	05	05
Copper (mg/l)	0.4	0.4	0.4
Cyanides (mg/l)	None detectable	None detectable	None detectable
Detergents (mg/l)	0.5	Insufficient to cause foaming	0.5

Chemical, Physical or Biological Characteristic	*Fresh Water (water containing less than 500 ppm chlorides)*	*Tidal Salt Water (water containing more than 500 ppm chlorides)*	*Groundwater*
Fluoride (mg/l)	1.4 as F	10 as F	1.4 as F
Lead (mg/l)	0.05	0.35	0.05
Phenol (mg/l)	0.001	0.005	0.001
Zinc (mg/l)	1.0	1.0	1.0
Sulfides (mg/l)	0.2	1.0	0.2
Coliform organisms (MPN/100 ml)	1,000[4]	1,000[5]	50
Mercury	None detectable	None detectable	None detectable
Iron	0.3 mg/l	0.3 mg/l	0.3 mg/l
Arsenic	0.05 mg/l	0.05 mg/l	0.05 mg/l
Specific conductance	500 micromhos per cm (fresh water). Not more than 100% above background in waters other than fresh		
Dissolved solids	Not to exceed 500 mg/l for monthly average or 1000 mg/l at any time		
Radioactive substances	Gross beta activity (in known absence of strontium 90 and alpha emitters), not to exceed 1000 micro-microcuries at any time		
Other compounds	Other toxic or undesirable compounds than those listed above may occur in individual waste streams. Limits for these components may be specified by the pollution control officer based on the latest scientific knowledge concerning toxicity and adverse effects of the intended water use.		
Synergistic action	Whenever scientific evidence indicates that a combination of pollutants exert a greater effect than the individual pollutants, the pollution control officer may, on the basis of these findings, lower the herein established limits to the level necessary to prevent damage to the waters of the county.		

[1] Shall not cause the pH of the receiving waters to vary more than 1.0 unit. When the natural background pH lies outside the limits established, the introduction of a waste shall not displace the pH of the receiving waters more than 0.5 pH units from these standards.
[2] Shall not be visible, defined as irridescence, or cause taste or odors.
[3] Waste shall not increase natural background more than 10 percent.
[4] Maximum MPN/100 ml in a surface water used as a drinking water supply shall be 100.
[5] Maximum MPN/100 ml in a tidal water from which shellfish are harvested for human consumption shall be 70.

(28)	Solids, Floating (Suspended or Settleable	Not attributable to sewage, industrial or other wastes
(29)	Temperature	Not to be above 90 Degrees Fah.
(30)	Turbidity	Not to exceed 10 Jackson Units
(31)	Zinc	Not to exceed 0.03 mg/l
(32)	Pesticides and Herbicides	
1)	Aldrin/Dieldrin	Not to exceed 0.003 ug/l Total
2)	Chlordane	Not to exceed 0.01 ug/l
3)	DDT	Not to exceed 0.001 ug/l
4)	Demeton	Not to exceed 0.1 ug/l
5)	Endosulfan	Not to exceed 0.003 ug/l
6)	Endrin	Not to exceed 0.004 ug/l
7)	Guthion	Not to exceed 0.01 ug/l
8)	Heptachlor	Not to exceed 0.001 ug/l
9)	Lindane	Not to exceed 0.01 ug/l
10)	Malathion	Not to exceed 0.1 ug/l
11)	Methoxychlor	Not to exceed 0.03 ug/l
12)	Mirex	Not to exceed 0.001 ug/l
13)	Parathion	Not to exceed 0.04 ug/l
14)	Silvex (2-4-5 TP)	Not to exceed 1.0 ug/l
15)	2-4 D	Not to exceed 1.0 ug/l
16)	Toxaphene	Not to exceed 0.005 ug/l

Specific Auth., Spec. Act 65-1338 Laws of Fla. 1965, as amended. Charter Ref. Sec. 8.17, 1974. History, New Revision 6/12/80 (Reg. 80-1).

Section 27-5.073 STANDARDS FOR GROUND WATERS:

	Item	Water Quality Requirement
(1)	Arsenic	Not to exceed 0.050 mg/l
(2)	BOD5	Not to exceed 5.0 mg/l
(3)	Cadmium	Not to exceed 0.01 mg/l
(4)	Chlorinated Hydro-carbons (Not other-wise identified by name)	Not to exceed 0.01 mg/l
(5)	Chromium (Total)	Not to exceed 0.05 mg/l
(6)	COD	Not to exceed 10 mg/l
(7)	Color	No unnatural discoloration shall be apparant except for that resulting from scientific investigation or environmental monitoring.
(8.1)	Coliform (Fecal)	a) not to exceed 200 per 100 ml for monthly average. b) Not to exceed 400 per 100 ml for 100% of samples. c) Not to exceed 800 per 100 ml in any sample.
(8.2)	Coliform (Total)	Not to exceed 1000/100 ml
(9)	Copper	Not to exceed 1.0 mg/l
(10)	Cyanide	Not to exceed 0.2 mg/l
(11)	Detergent (as MBAS)	Not to exceed 0.5 mg/l
(12)	Lead	Not to exceed 0.05 mg/l
(13)	Mercury	Not to exceed 0.002 ug/l
(14)	Nickel	Not to exceed 0.1 mg/l

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(15)	Nitrogen (Nitrate Nitrogen As N)	Not to exceed 10.0 mg/l
(16)	Odors	None shall be cetectable due to sewage or industrial waste
(17)	Oil and Grease	Dissolved or emulsified oil or grease shall not exceed 10.0 ppm. No undissolved or visible oil as iridescense shall be present
(18)	Pathogens	Not to exceed 1/per gallon.
(19)	pH	Not less than 6.5 nor more than 8.5 units
(20)	Polychlorinated Biphenyls (PCB's)	Total not to exceed 0.001 ug/l
(21)	Phenolic Compounds	Total not to exceed 0.001 mg/l
(22)	Phosphates (Total as P)	Not to exceed 0.01 mg/l
(23)	Radioactivity	Gross Beta not to exceed 1000 pc/l; Radium 226 not to exceed 3 pc/l, Strontium 90 not to exceed 10 pc/l
(24)	Selenium	Not to exceed 0.01 mg/l
(25)	Silver	Not to exceed 0.05 mg/l
(26)	Solids (Floating (Suspended or Settleable	None attributable to sewage, industrial or other wastes
(27)	Temperature	Not to be above 90 degrees Fah.
(28)	Turbidity	Not to exceed 10 Jackson Units
(29)	Zinc	Not to exceed 5.0 mg/l
(30)	Pesticides and Herbicides	
1)	Aldrin/Dieldrin	Not to exceed 1.0 ug/l Total
2)	Chlordane	Not to exceed 0.3 ug/l
3)	DDT	Not to exceed 4.0 ug/l
4)	Demeton	Not to exceed 0.1 ug/l
5)	Endosulfan	Not to exceed 0.1 ug/l
6)	Endrin	Not to exceed 0.02 ug/l
7)	Guthion	Not to exceed 0.1 ug/l
8)	Heptachlor	Not to exceed 1.0 ug/l
9)	Lindane	Not to exceed 4.0 ug/l
10)	Malathion	Not to exceed 0.1 ug/l
11)	Methoxychlor	Not to exceed 3.0 ug/l
12)	Mirex	Not to exceed 0.01 ug/l
13)	Parathion	Not to exceed 1.0 ug/l
14)	Silvex (2-4-5 TP)	Not to exceed 1.0 ug/l
15)	2-4 D	Not to exceed 1.0 ug/l
16)	Toxaphene	Not to exceed 0.005 ug/l

Specific Auth., Spec. Act 65-1338 Laws of Fla. 1965, as amended. Charter Ref. Sec. 8.17, 1974. History, New Revision 6/12/80 (Reg. 80-1). Amended 11/2/81 (81-8).