NFRAP
3/23/90
35044

FT. LAUDERDALE GASIFICATION PLANT
AKA: PEOPLE'S GAS SYSTEM COX PLANT
FLD 984169268
PRELIMINARY ASSESSMENT

A. SITE DESCRIPTION. The Ft. Lauderdale Gasification Plant AKA: People's Gas System Cox Plant was located at the southeast corner of N.W. 4th Street and N.W. 7th Avenue, Ft. Lauderdale, Broward County, Florida. This plant produced water gas from at least 1930 until 1959. Only recently were all aboveground structures and appurtenances removed from the site [1,2,5-9,17] (Figs. 1-3).

B. SITE HISTORY - Manufacturing Information. In 1930, water gas was manufactured on-site at a rate of 8 million standard cubic feet/year (mm scf/yr.). No additional information concerning gas production rates or by-product production rates (e.g., coke, tar, ammonia & other) were reported [1,3,4] (Fig. 2).

C. DESCRIPTION OF HAZARDOUS CONDITIONS, INCIDENTS, PERMIT VIOLATIONS AND PROCESS DESCRIPTION. Prior to the availability of natural gas (mid-1950's) bituminous coal and coke were "carbonized" or destructively distilled for the production of illuminating or blue gas (carbon monoxide, hydrogen) [1,2,3,4,13]. Coal tar, aqueous ammoniacal liquor and hydrogen cyanide were common by-products of the gasification process. The uses of coal tar and its distillates (wood preserving, asphalt) are numerous, however, no concentrated effort was made in the United States to use coal tar before 1887, when tar distillation was established as a separate industry [2,3,4]. It can therefore be assumed that; before this time and for some time after; the coal tar from gasification plants was largely disposed of at or near the plant site as a matter of convenience. In addition, poor housekeeping practices are documented to have occurred at these gasification sites [1-4].

The carbureted water gas process used coke (or coal), steam and various oil products to produce a combustible gas product. Crushed coke (or coal) was placed into the top of a reaction vessel (clay/silica retort) where it was heated (1700°F) to drive off the volatile fraction. Steam was fed through the bed of the incandescent coke, producing a gas containing hydrogen and carbon monoxide. This gas (blue gas) then passed through two chambers containing hot fire brick where oil was sprayed into the gas and "cracked" into gaseous hydrocarbons and tar. A variety of oil-based feed-stocks were used in the production of carbureted water gas including: naphtha, gas oil, fuel oil (diesel fuel) and residuum oils [1-4,9,13] (Fig. 2).

On 8/16/85, the Broward County Environmental Quality Control Board (BCEQCB) issued a Notice of Violation (NOV) to People's Gas (Cox Plant) for an unlawful discharge of Polynuclear Aromatic Hydrocarbons (PAH's). BCEQCB subsequently collected two groundwater samples (8/23/85) and found lead (2.33 ppm) and PAH's - Total (539 ug/l). Lead was found at levels exceeding Primary Drinking Water Standards (PDWS) [4,5].

On 12/23/85, five back-hoe test pits (Phase 1 Investigation) were excavated on-site (0-6 feet). Soil samples collected from each pit were composited into one sample and analyzed for metals. Cyanide (3.5 mg/kg) was detected in the soil sample. No heavy metals were detected above detection limits [9] (Fig. 2).

In 3/86, four surficial aquifer, monitor wells were installed on-site as part of the Phase 2 Investigation. Groundwater samples collected (4/86) by Environmental Resources Management - South, Inc. (ERM) and analyzed by Thorton Laboratories, Inc. contained naphthalene (950 ug/l) and trace amounts of acenaphthene (COX-1). Water level measurements taken from the on-site, monitor wells indicated a south-southwesterly groundwater flow. Naphthalene (<10 ug/l) was not detected in upgradient (background) monitor well COX-3 [9] (Fig. 3).

BCEQCB lab split samples, collected concurrently with the ERM samples, contained acenaphthene (213 ug/l), anthracene (.23 ug/l), fluorene (4.7 ug/l) and phenanthrene (1.5 ug/l) in well COX-4 [5,9] (Fig. 3).

On 2/4/87, the four existing on-site, monitor wells were resampled and analyzed for lead (total and dissolved), volatile aromatic/unsaturated organics and PAH's. Acenaphthylene (100 ug/l), anthracene and phenanthrene (150 ug/l), benzo(a)anthracene and chrysene (75 ug/l), fluorene (60 ug/l), naphthalene (920 ug/l), benzene (1,360 ug/l), ethylbenzene (129 ug/l), toluene (36 ug/l), o+p-xylene (250 ug/l), m-xylene (186 ug/l) and lead (30 ug/l) were found in on-site, monitor well COX-1. Benzo(b)fluoranthene and benzo(k)fluoranthene (9.7 ug/l) and lead (60 ug/l) were found in on-site, monitor well COX-4. Benzene and lead levels exceeded PDWS. No contaminants were detected (above detection limits) in upgradient (background) monitor well COX-3 [9] (Fig. 3).

An FDER off-site reconnaissance of the site conducted on 4/5/89 found the site cleared with no aboveground structures visible. The site appeared clean with only a few pieces of coal visible on-site. The site was completely fenced, however, the gate was open [8].

D. RCRA STATUS. In 8/85, People's Gas System received generator status in order to dispose of lead contaminated material from the gas holder located at the Cox Plant. This facility was reclassified from generator to non-handler by FDER in 1986 [6,10].

E. NATURE OF HAZARDOUS MATERIALS. Many of the components of coal tar and coal tar distillates are Polynuclear Aromatic Hydrocarbons (PAH's), which are highly toxic and known or suspected carcinogens [1-5,7,9,11-13].

Anthracene, phenanthrene, benzo(b)fluoranthene, benzo(a)anthracene and benzene are highly toxic and known carcinogens. Chrysene is a suspected carcinogen. Lead is a carcinogen of the liver and kidneys. Naphthalene causes damage to the liver and red blood cells. Benzo(k)fluoranthene is highly toxic and emits acrid smoke and irritating fumes when heated. Ethylbenzene is moderately toxic and might exacerbate liver, lung and kidney conditions. Toluene and xylene are flammable and affect the central nervous system, liver and kidneys. Acenaphthene is irritating to the skin and mucous membranes. Cyanide is highly toxic and can cause cardiac irregularities [1,2,4,11-13].

F. ROUTES OF CONTAMINATION. Groundwater is a known route of contamination. Air and direct contact are potential routes of contamination. Surface water runoff is not deemed to be an important route because of the flat terrain and high permeability of on-site soils [9,15-18] (Fig. 1).

G. POSSIBLE AFFECTED POPULATION AND RESOURCES. The unconfined, surficial aquifer (Biscayne aquifer) is the sole-source of drinking water in Broward County. The aquifer consists of, in ascending order, the Tamiami Formation, Caloosahatchee Marl, Fort Thompson Formation, Key Largo Limestone, Anastasia Formation, Miami Oolite and the Pamlico Sand. The aquifer is composed of Pleistocene to Pliocene Age limestone, sandstone, sand, shell, limemud (micrite) silt, clay and an admixture of these materials. The top of the aquifer (water table) is found 3 to 5 feet below land surface. The aquifer is approximately 320 feet thick in the site area [9,14-16,18] (Fig. 1).

Most area residents and businesses are provided drinking water from the City of Ft. Lauderdale and Broward County Utilities public water systems. All the Broward County Utilities wellfields, including the 1A, 1B, 3A and Broadview wellfields, are located more than 4 miles from the site. The City of Ft. Lauderdale Prospect/Executive wellfield is also located more than 4 miles from the site. The City of Ft. Lauderdale North Dixie and South Dixie wellfields are situated between 3.36 miles (South Dixie Well #11) and 4.1 miles (South Dixie Well #23) west-southwest of the site [14,15,17,20,21].

The drinking water supply comes exclusively from the municipal/county wells. The Cities of Wilton Manors, Oakland Park and Port Everglades receive drinking water (100%) from the Ft. Lauderdale system. Many private wells are used in the area, however, they are used primarily for lawn irrigation. An inspection of South Florida Water Management District well completion reports indicates only 4 such irrigation wells present within 3 miles of the site [14,17,18,28].

This site is located in an area of Ft. Lauderdale which is outside of any modeled wellfield cones-of-influence; and is in an area designated as Zone IV (no potable drinking water wells) by the BCEQCB [9].

This site is situated in an area of highly permeable soil, flat terrain and no flooding potential. There are no paved areas visible on-site and most surface water runoff will percolate into the soil before migrating any appreciable distance. However, the potential exists for a small amount of surface water runoff to be directed, via any storm sewers in the area, to the New River, located 3,100 feet south of the site. The New River is used for recreational fishing (Tarpon) and boating. The New River is also a habitat for the endangered (federally designated) West Indian Manatee [8,17,18,22-24] (Fig. 1).

H. RECOMMENDATIONS AND JUSTIFICATIONS. All the aboveground structures have recently been removed from the site. However, during the decommissioning of other gas manufacturing plants, underground tanks (tar separators) were often left filled with tar or other liquid wastes. We recommend that a limited geophysical survey be undertaken by the Potential Resposible Party (PRP) in order to determine the possible existence of any remaining underground tanks [3,8,9].

Since no public or private drinking water wells serving any type of population are present near the site and the possibility of any surface water migrating off-site is remote, we recommend No Further Action under the federal CERCLA program. We defer any future enforcement and remediation efforts to the PRP, FDER and BCEQCB.

The ERM Group

FIGURE 1
SITE LOCATION MAP
FT. LAUDERDALE, FLORIDA

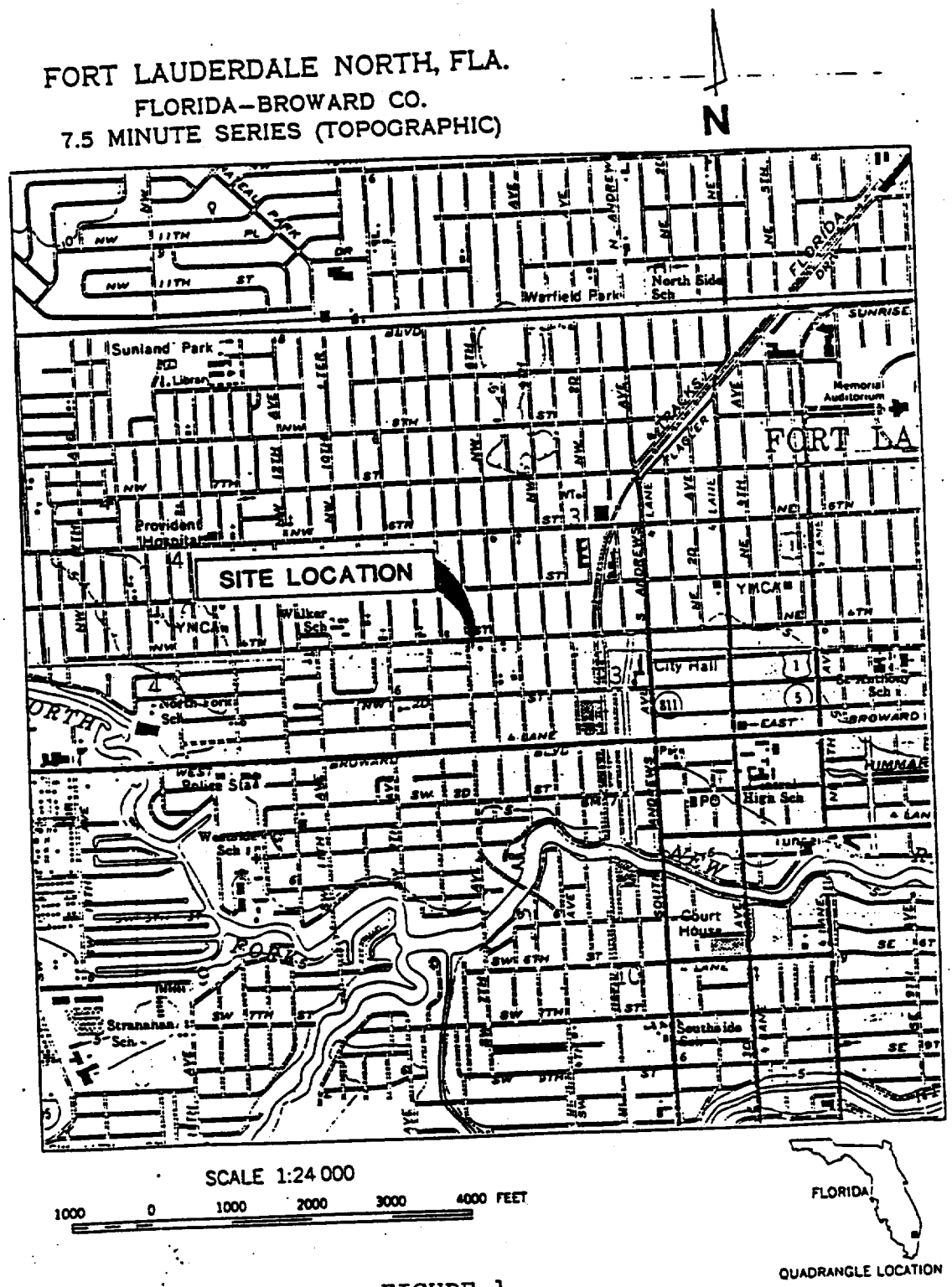


FIGURE 1

FIGURE 2
SITE LAYOUT MAP

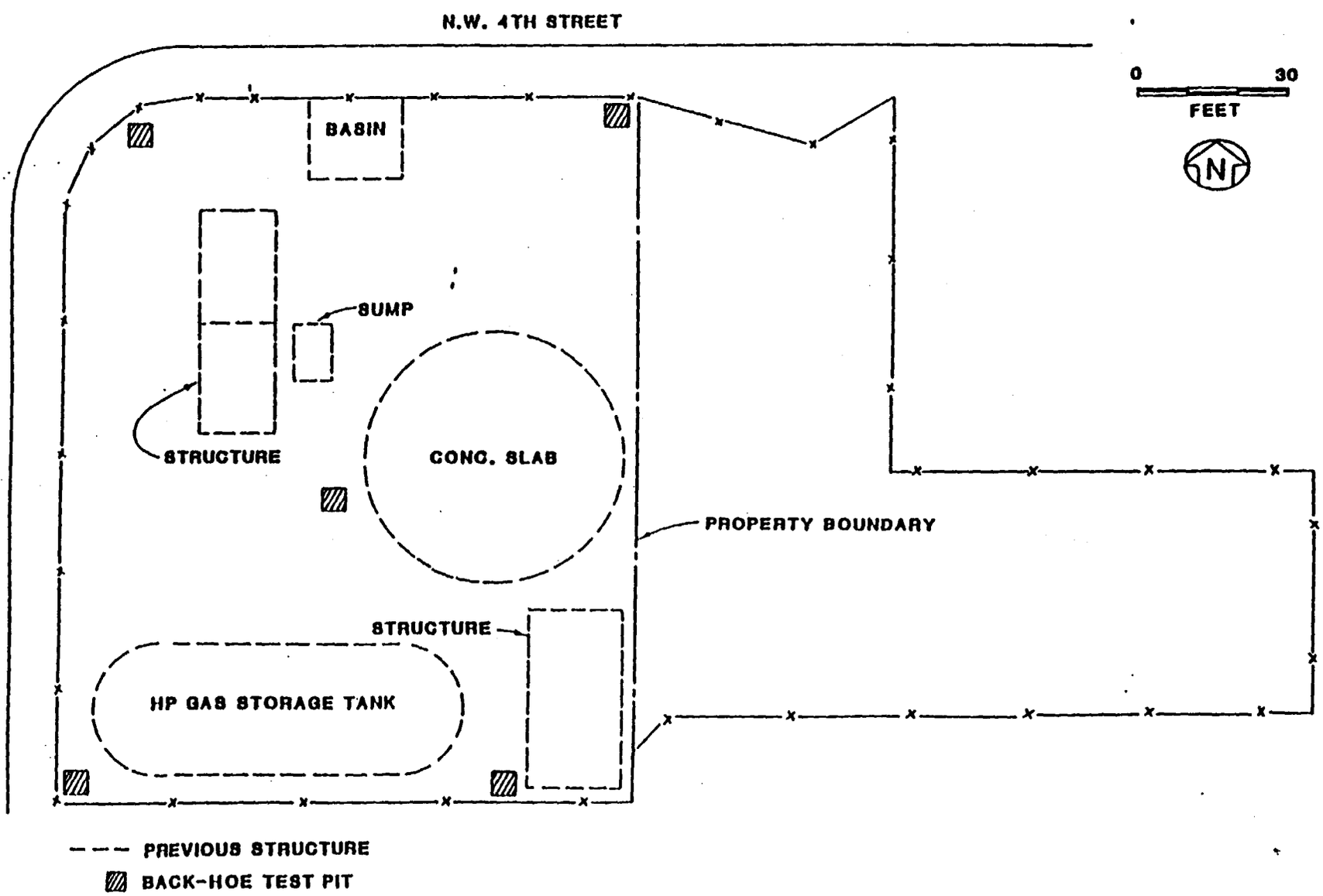
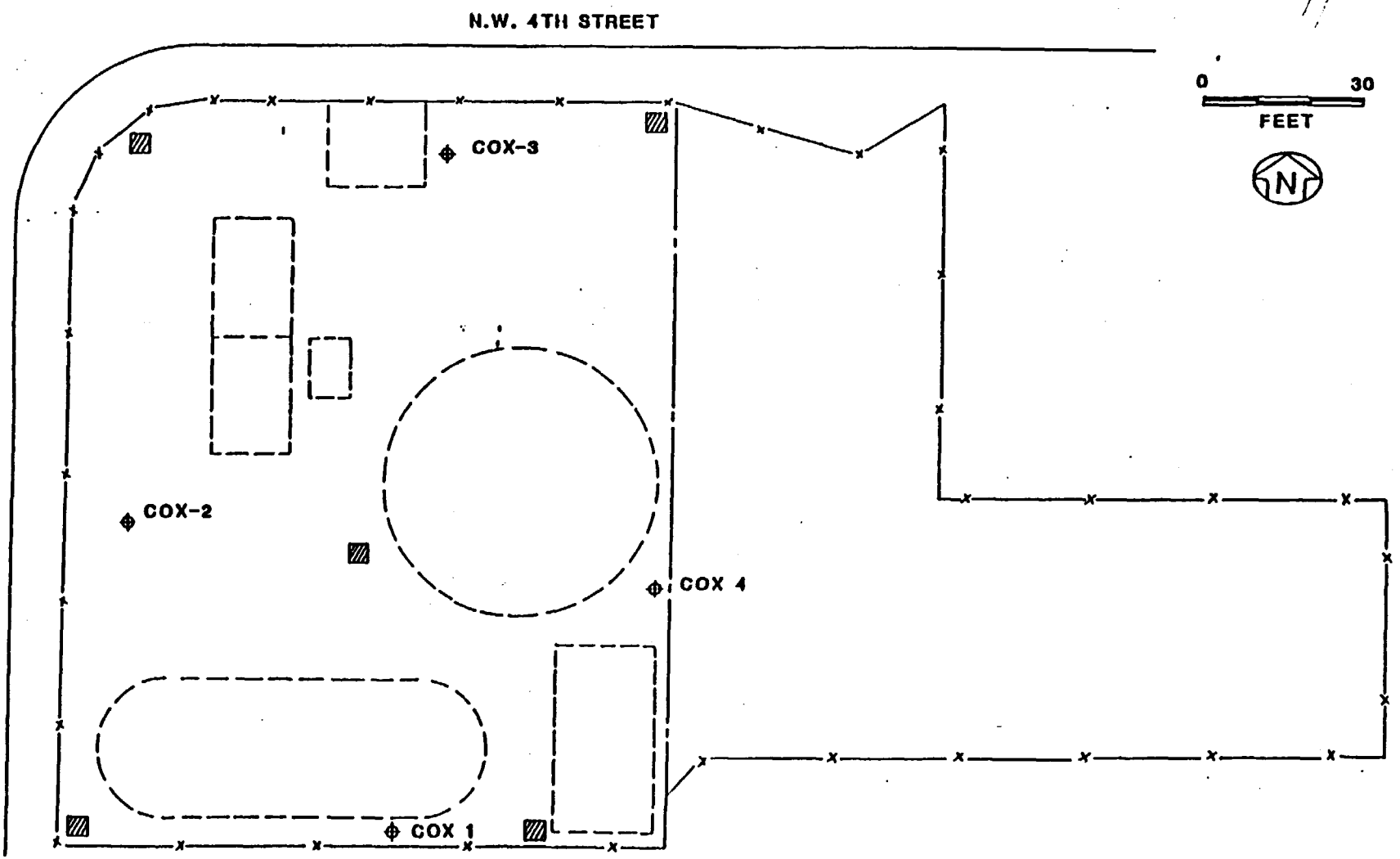


Figure 2

FIGURE 3
MONITORING WELL LOCATION MAP



GROUND-WATER MONITORING WELL

BACKHOE TEST PIT

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The ERM Group

POTENTIAL HAZARDOUS WASTE SITE
PRELIMINARY ASSESSMENT
Part 1 - Site Information and Assessment

I. IDENTIFICATION

01 STATE: FL
02 SITE NUMBER: D984169268

II. SITE NAME AND LOCATION

01 SITE NAME (Legal, common or descriptive name of site)
Ft. Lauderdale Gasification Plant
AKA: People's Gas System Cox Plant

02 Street, Route No., or Specific Location Identifier
Southeast Corner of N.W. 4th Street and N.W. 7th Avenue

03 CITY: Ft. Lauderdale
04 STATE: FL
05 ZIP CODE: 33311
06 COUNTY: Broward
07 COUNTY CODE: 011
08 CONG DIST: 17

09 COORDINATES LATITUDE: 26° 07' 33". N" LONGITUDE: 080° 09' 02". W" [1,5,6,8,9] (Figs. 1-3)

10 DIRECTIONS TO SITE (Starting from nearest public road) - Heading north on 6th Avenue (US 1) take a left (head west) on Broward Blvd. At the intersection of Broward Blvd. and N.W. 7th Avenue, take a right (head north) on N.W. 7th Avenue. The site is located 4 blocks north of Broward Blvd. on the southeast corner of N.W. 4th Street and N.W. 7th Avenue [1,5,6,8,9,17] (Figs. 1-3).

III RESPONSIBLE PARTIES

01 OWNER (if known)
Peoples Gas System, Inc. (PGS)

02 STREET (Business, mailing, residential) - City Hall
555 N.E. 124th Street

03 CITY: North Miami [1,5-9]
04 STATE: FL
05 ZIP CODE: 33161
06 TELEPHONE NUMBER: (305) 893-2522

07 OPERATOR (if known and different from owner)
PGS, Inc. Attention: Mr. Ed Champion

08 STREET (Business, mailing, residential)
Same

09 CITY: Same
10 STATE:
11 ZIP CODE:
12 TELEPHONE NUMBER: (305) 351-3400

13 TYPE OF OWNERSHIP (Check one)
X A. Private __ B. Federal _____ (Agency name) __ C. State __ D. County __ E. Municipal
__ F. Other _____ (Specify) __ G. Unknown [1,5,6,8,9]

14 OWNER/OPERATOR NOTIFICATION ON FILE (Check all that apply)
__ A. RCRA 3001 DATE RECEIVED ____ Month Day Year __ B. UNCONTROLLED WASTE SITE DATE RECEIVED ___/___/___ Month Day Year X C. NONE

IV. CHARACTERIZATION OF POTENTIAL HAZARD

01 ON SITE INSPECTION
X YES DATE ___/___/___ Month Day Year
__ NO
[5,7,9] (See Narrative)

BY (Check all that apply)
__ A. EPA __ B. EPA CONTRACTOR __ C. STATE X D. OTHER CONTRACTOR
X E. LOCAL HEALTH OFFICIAL __ F. OTHER _____ (Specify)
CONTRACTOR NAME(S): ERM - South Inc.

02 SITE STATUS (Check one)
__ A. ACTIVE X B. INACTIVE [8,9] __ C. UNKNOWN

03 YEARS OF OPERATIONS
Prior to 1930 / 1959
Beginning Year Ending Year
__ UNKNOWN [1,9]

04 DESCRIPTION OF SUBSTANCES POSSIBLY PRESENT, KNOWN OR ALLEGED - This site is the former location of the Ft. Lauderdale Gasification Plant which produced water gas for illuminating or blue gas. Coal tar by-product contaminants have been detected in on-site, surficial aquifer groundwater. All aboveground structures have recently been removed [1-4,8,9] (Figs. 1-3).

05 DESCRIPTION OF POTENTIAL HAZARD TO ENVIRONMENT AND/OR POPULATION - Polynuclear Aromatic Hydrocarbons (PAH's) and heavy metals (lead) are common components of coal tar. Many of the components are highly toxic and known carcinogens. Coal tar present in on-site soil may threaten anyone using this site. However, no public or private drinking water wells are known present within 3 miles of the site [1-4,9,11-13,14,17,19-21] (Fig. 1).

V. PRIORITY ASSESSMENT

01 PRIORITY FOR INSPECTION (Check one. If high or medium is checked, complete Part 2 - Waste Information and Part 3 - Description of Hazardous Conditions and Incidents)
__ A. HIGH (Inspection required promptly)
__ B. MEDIUM (Inspection required)
__ C. LOW (Inspect on time available basis)
X D. NONE (No further action needed, complete disposition form)

VI. INFORMATION AVAILABLE FROM

01 CONTACT: Eric S. Nuzie
02 OF (Agency/Organization): FDER/BWC
03 TELEPHONE NUMBER: (904) 488-0190

04 PERSON RESPONSIBLE FOR ASSESSMENT: A. James McCarthy
05 AGENCY: FDER
06 ORGANIZATION: BWC
07 TELEPHONE NUMBER: (904) 488-0190
08 DATE: 12 / 07 / 89 Month Day Year

EPA FORM 2070-12(7-81)

HAZARD RANKING SYSTEM SCORING SUMMARY

FOR

FT. LAUDERDALE GASIFICATION COX PLANT
EPA SITE NUMBER FLD984169268
FT. LAUDERDALE
BROWARD COUNTY, FL
EPA REGION: 4

SCORE STATUS: IN PREPARATION

SCORED BY JIM McCARTHY
OF FDER
ON 12/11/89

DATE OF THIS REPORT: 12/11/89
DATE OF LAST MODIFICATION: 12/11/89

GROUND WATER ROUTE SCORE	:	4.47
SURFACE WATER ROUTE SCORE	:	5.31
AIR ROUTE SCORE	:	0.00
MIGRATION SCORE	:	**4.01**

HRS GROUND WATER ROUTE SCORE -Biscayne Aquifer

CATEGORY/FACTOR	RAW DATA	ASN. VALUE	SCORE	
1. OBSERVED RELEASE	YES	45	45	(See Note 1)
2. ROUTE CHARACTERISTICS				
DEPTH TO WATER TABLE				
DEPTH TO BOTTOM OF WASTE				
DEPTH TO AQUIFER OF CONCERN				
PRECIPITATION				
EVAPORATION				
NET PRECIPITATION				
PERMEABILITY				
PHYSICAL STATE				
TOTAL ROUTE CHARACTERISTICS SCORE:			N/A	
3. CONTAINMENT			N/A	
4. WASTE CHARACTERISTICS				
TOXICITY/PERSISTENCE:LEAD (60ug/1)			18-Monitor well COX-4	Refs.2,9,27.
WASTE QUANTITY CUBIC YDS	0			
DRUMS	1	(Default value)		Refs.9,27.
GALLONS	0			
TONS	0			
TOTAL	0 CU. YDS	1	1	
TOTAL WASTE CHARACTERISTICS SCORE:			19	
5. TARGETS				
GROUND WATER USE		1	3	
(Irrigation & another Water source available)				Refs.9,14,17-22, 27.
DISTANCE TO NEAREST WELL	17741 FEET(South Dixie Well #11)			
AND	MATRIX VALUE	0	0	
TOTAL POPULATION SERVED	0 PERSONS			Refs.9,14,17,19-22,27.
NUMBER OF HOUSES	0			
NUMBER OF PERSONS	0			
NUMBER OF CONNECTIONS	0			
NUMBER OF IRRIGATED ACRES	0			
TOTAL TARGETS SCORE:			3	

GROUND WATER ROUTE SCORE (S_{gw}) = 4.47

NOTE 1: Acenaphthylene, anthracene/phenanthrene, naphthalene, benzene, ethylbenzene and xylene were found in on-site, monitor well COX-1 more than 10X the detection limit of clean background (upgradient) monitor well COX-3. Refs.9,27 (See Fig.3).

HRS SURFACE WATER ROUTE SCORE New River

CATEGORY/FACTOR	RAW DATA	ASN. VALUE	SCORE	
1. OBSERVED RELEASE	NO	0	0	
2. ROUTE CHARACTERISTICS				
SITE LOCATED IN SURFACE WATER	NO			
SITE WITHIN CLOSED BASIN	NO			
FACILITY SLOPE	0.2 %			Refs.9,17,27.
INTERVENING SLOPE	0.1 %	0	0	Refs.9,17,27,
24-HOUR RAINFALL	4.5 INCHES	3	3	Refs.26,27.
DISTANCE TO DOWN-SLOPE WATER (New River)	3100 FEET	2	4	Refs.8,17,27.
PHYSICAL STATE (Coal Tar - liquid)	3		3	Refs.1-3,9,11-13,27
TOTAL ROUTE CHARACTERISTICS SCORE:			10	
3. CONTAINMENT-Pile, No Containment	3		3	Refs.9,27.
4. WASTE CHARACTERISTICS				
TOXICITY/PERSISTENCE:LEAD			18	Refs.2,3,9,27.
WASTE QUANTITY CUBIC YDS	0			
DRUMS	1 (Default value)			Refs.9,27.
GALLONS	0			
TONS	0			
TOTAL	0 CU. YDS	1	1	
TOTAL WASTE CHARACTERISTICS SCORE:			19	
5. TARGETS				
SURFACE WATER USE (Recreational fishing & boating)		2	6	Refs.8,17,23,24.
DISTANCE TO SENSITIVE ENVIRONMENTS		0	0	
COASTAL WETLANDS	NONE			Ref.17.
FRESH-WATER WETLANDS	NONE			Ref.17.
CRITICAL HABITAT	NONE			Refs.17,22,27.
DISTANCE TO STATIC WATER	) 3 MILES			Refs.14,17.
DISTANCE TO WATER SUPPLY INTAKE	) 3 MILES			
AND	MATRIX VALUE	0	0	
TOTAL POPULATION SERVED	0			Refs.14,17.
NUMBER OF HOUSES	0			
NUMBER OF PERSONS	0			
NUMBER OF CONNECTIONS	0			
NUMBER OF IRRIGATED ACRES	0			
TOTAL TARGETS SCORE:			6	

SURFACE WATER ROUTE SCORE (Ssw) = 5.31

HRS AIR ROUTE SCORE NOT SCORED

CATEGORY/FACTOR	RAW DATA	ASN. VALUE	SCORE
1. OBSERVED RELEASE	NO	0	0

2. WASTE CHARACTERISTICS

REACTIVITY:

MATRIX VALUE

INCOMPATIBILITY

TOXICITY

WASTE QUANTITY CUBIC YARDS
DRUMS
GALLONS
TONS

TOTAL

TOTAL WASTE CHARACTERISTICS SCORE: N/A

3. TARGETS

POPULATION WITHIN 4-MILE RADIUS
0 to 0.25 mile
0 to 0.50 mile
0 to 1.0 mile
0 to 4.0 miles

DISTANCE TO SENSITIVE ENVIRONMENTS
COASTAL WETLANDS
FRESH-WATER WETLANDS
CRITICAL HABITAT

DISTANCE TO LAND USES
COMMERCIAL/INDUSTRIAL
PARK/FOREST/RESIDENTIAL
AGRICULTURAL LAND
PRIME FARMLAND
HISTORIC SITE WITHIN VIEW?

TOTAL TARGETS SCORE: N/A

AIR ROUTE SCORE (Sa) = 0.00

HAZARD RANKING SYSTEM SCORING CALCULATIONS
FOR
SITE: FT. LAUDERDALE GASIFICATION COX PLANT
AS OF 12/11/89

GROUND WATER ROUTE SCORE

OBSERVED RELEASE		45
WASTE CHARACTERISTICS	X	19
TARGETS	X	3

= 2565 /57,330 X 100 = 4.47 = S1gw

SURFACE WATER ROUTE SCORE

ROUTE CHARACTERISTICS		10
CONTAINMENT	X	3
WASTE CHARACTERISTICS	X	19
TARGETS	X	6

= 3420 /64,350 X 100 = 5.31 = S1sw

AIR ROUTE SCORE

OBSERVED RELEASE 0 /35,100 X 100 = 0.00 = S1air

SUMMARY OF MIGRATION SCORE CALCULATIONS

	S	S02
GROUND WATER ROUTE SCORE (S1gw)	4.47	19.98
SURFACE WATER ROUTE SCORE (S1sw)	5.31	28.20
AIR ROUTE SCORE (S1air)	0.00	0.00
S02gw + S02sw + S02air		48.18
√ (S02gw + S02sw + S02air)		6.94
S1M = √ (S02gw + S02sw + S02air)/1.73		4.01

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FT. LAUDERDALE GASIFICATION PLANT
AKA: PEOPLE'S GAS SYSTEM COX PLANT

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Refenence 1

DEPARTMENT OF ENVIRONMENTAL REGULATION

Interoffice Memorandum

FOR ROUTING TO OTHER THAN THE ADDRESSEE

To: Eric Loc'n:

To: Loc'n:

To: Loc'n:

From: Date:

TO: District Managers

FROM: Bill Buzick

DATE: September 6, 1985

SUBJECT: Former Gas Manufacturing Facilities

Attached is part of an EPA document entitled, "Survey of Tar Waste Disposal and Locations of Town Gas Producers." These former gas manufacturing sites should be investigated for potential contamination due to coal tar, a by-product of the manufacturing process. Coal tar contains polynuclear aromatic hydrocarbons and phenols, and possibly volatiles and metals. An assessment of the Peoples Gas facility in North Miami Beach has shown the presence of these organic compounds in soil, sediment and ground water. The SE District has developed a Consent Order to address the problem and I would like this to be the model order for any other site you find of similar nature.

Please have your staff work with Eric Nuzie and his people to conduct preliminary assessments of these sites. The investigation shall include a file search and a windshield survey and further assessment should be prioritized by the potential for direct skin contact or drinking water well impact.

We understand that most of the plants have been dismantled or are being dismantled. The sites may be paved over or occupied by buildings. Additional information regarding the Peoples Gas sites has been requested by the Bureau of Operations (Zoe Kulakowski) and will be sent to you when it becomes available.

WB/zkh

Attachment

cc: John Ruddell
Eric Nuzie
Zoe Kulakowski

August 1984

"This document has not been peer and administratively reviewed within EPA and is for internal use/distribution only"

SURVEY OF TAR WASTE DISPOSAL AND LOCATIONS OF TOWN GAS PRODUCERS

Radian Corporation
7655 Old Springhouse Road
McLean, Virginia 22102

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Appendix B

IDENTIFICATION OF TOWN GAS MANUFACTURING SITES -- ALL PLANTS (1890 - 1950)

This appendix contains the detailed data concerning gas production, by-product production, and manufacturing processes reported for each decennial year for each plant. The following explains the information included under each column heading of the table:

City - This column heading contains the city name in which the reported plant is located. The cities are arranged first by chronological order (based on the first decennial year found in Brown's) and then alphabetically by city name. As mentioned above, there is almost always a one-to-one correspondence between city entries and plant sites. There were, however, instances where several sites were listed under a single city entry. This was usually a result of consolidation of nearby plants, which were listed separately in previous years. Thus, these previously listed plant sites are separately included in the total site tally (see Table 1). Although local addresses were reported in later editions of Brown's, these were not included since the reported address did not necessarily refer to the plant site (the address may refer to non-manufacturing locations: e.g, main office).

Year - This column lists the decennial years for which data were compiled (from 1890 to 1950). These years are repeated for each city entry.

Status - The symbol in this column (refer to legend) indicates the status for a particular year. The possibilities are that the plant (in that year):

1. Manufactured gas (*),
2. Purchased gas (P),
3. Only supplied natural gas (N),
4. Did not report data, or no information was found (0),
5. Discontinued operation (X), or
6. Was not yet in existence (blank)

Once it was determined that a plant was a natural gas supplier, solely a purchaser of gas, or discontinued gas manufacturing operations, data for subsequent years were not compiled. This is indicated by a "-" under the status column.

Gas Type - The entry under GAS TYPE indicates the specific type of manufactured gas: coal, water (or carburetted water), oil, or other. The definition of each gas type is given in Appendix A. It is possible that more than one type of gas was produced; this is indicated by multiple entries under GAS TYPE separated by commas. For example, the entry, "C,W", means that both coal and water gas were produced that year.

The gas type was usually either specified in the reported annual production or determined from the listing of process of manufacture. For example, the use of the Lowe process almost invariably indicates the production of water gas. When the gas type could not be determined from the available information, a "?" was entered under GAS TYPE. Occasional inconsistencies were found between the annual production and the process of manufacture information reported in Brown's. These were attributed to the subjective nature of the surveys, on which the reported data were based. In these cases, the annual production information was considered more reliable than the reported process of manufacture.

Gas Production Rates - Annual gas productions are reported separately for coal, water, oil, and other types of manufactured gas in units of million standard cubic feet under this column (rounded to the nearest MM scf). The production for carburetted water gas, which is essentially enriched water gas (see Appendix A), was included in the water gas column. "Other" types of manufactured gas usually referred to coke oven based gas. The sum of these productions for a particular plant is also shown for each year. This sum, however, does not include values enclosed in parentheses or brackets, which are discussed next. Whenever production data were not reported in Brown's, the following information was reported instead (listed in order of decreasing reliability):

1. Annual sales - This is usually equivalent to the annual production unless the company consumes (within the plant) or purchases significant amounts of gas.

2. Half of the maximum yearly output - The annual production can be estimated as 180 days/year times the maximum daily sendout, or one-half of the maximum annual output. This is based on a rule of thumb reported in Brown's. This estimate is shown in square brackets and is not included in the totals or average productions.

3. Population served - The annual production can be roughly estimated as one million cubic feet/1,000 of population served based on a judgment of the correlation between population served and gas production. This estimate is shown in parentheses (in units of 1,000 of population or million cubic feet of gas) in Table B-1 and is not included in the total or average productions. This information is reported only when the above data were unavailable.

Where none of the above information was available, a "?" is shown under this column.

Occasionally, only one production was reported in Brown's although it was determined that more than one gas type was being produced (almost always coal and water gas), as indicated in the GAS TYPE column. In these cases, it was assumed that coal gas was produced and the production was entered in this column.

Gasifier/Process - The process of manufacture or gasifier type is shown in this column as reported in Brown's. Due to the variety in water gas processes (See Appendix A), the particular water gas process was usually specified whereas details regarding the manufacture of coal gas were reported infrequently. The indication of a particular process does not signify that only the associated gas type is produced; the gases which are produced are shown in the GAS TYPE column.

By-Product Production Rate - The amounts of coke, tar, ammonia, or other by-products of concern are reported separately under this column. The sum of these by-product productions for each year was not calculated because each type of by-product production is reported in different units (refer to legend for corresponding units). As can be seen from Table B-1, such data were not available in Brown's until 1920. For a significant portion of the plants, the amounts of by-product made and sold were reported (most frequently for coke). In these cases, the net amount (difference between by-product made and sold) is reported (in parentheses) since it is this unaccounted for amount which is important in this study. When the amount sold is greater than the amount made, a "(-)" is shown. Such negative values can be attributed to sale of by-products produced either in other years or from non-gas manufacturing operations. The net values are not included in the calculated average. Unsold by-products are the materials which may have become wastes and disposed of.

Miscellaneous Information - Information typically shown in this column includes details of "other" types of gases or by-products, consolidations of companies, multiple sites, and unconventional feedstocks.

Average Productions - The average production rates shown in the last line of data for each plant are the calculated average values of the plant data reported directly above. Estimated gas production (as indicated by parentheses or brackets) or net by-product productions were not included in these calculated average values.

It should be noted that these values are averaged for only the years in which production of each particular type of gas was produced. The calculations used to arrive at these values were discussed in the subsection explaining Table 2.

LEGEND FOR TABLE B-1

STATUS

* - Manufactured gas for that year
X - Discontinued/Out of business that year
O - Not found for that year
C - Consolidated with another company (see comments)
N - Natural gas supplier for that year
P - Gas purchased from another firm that year

COMPANY

" - "City name"
G - Gas
E - Electric
F - Fuel
L - Light
H - Heat
P - Power
Mfg - Manufacturing
Co - Company

GAS TYPE

C - Coal gas
W - Water gas
CW- Carburetted water gas
O - Oil gas
N - Natural

GAS PRODUCTION RATE

- Production rate of gas in million standard cubic feet (MM scf)
(#) - Population served in 1,000 (reported when production unavailable)
[#] - Production rate estimated from 1/2 of maximum output (MM scf)

GASIFIER/PROCESS

F --Flannery
G - Granger
H-L - Hanlon
J - Jermanowski
J(B) - Jermanowski (baby)
J-L - Janeway-Logan (Oil)
K - Kendall (Oil)

LEGEND FOR TABLE B-1 (continued)

GASIFIER/PROCESS (Continued)

M-C - McKay-Critchelow
P - Patton (Oil)
S - Springer
S-G - Smith-Goldthorpe
V-Si - Van Sickel (Oil)
V-St - Van Steenburgh
W - Wilkinson

BY-PRODUCT PRODUCTION RATE

Coke - a x 10^3 tons of coke produced that year;
(a)x 10^3 tons of coke unaccounted for that year (calculated as coke made minus coke sold).

Tar - b x 10^3 gallons of tar produced that year.

Ammonia - c x 10^3 lbs of ammonia produced that year.

Other - Amount of by-products, other than above, produced and reported that year (see MISCELLANEOUS INFORMATION for more details).

TABLE B-1: IDENTIFICATION OF TOWN GAS MANUFACTURING SITES - ALL PLANTS (1890-1950)

STATE: FLORIDA

NO.	CITY		YEAR	STATUS	GAS TYPE	GAS PRODUCTION RATE (MM cu.ft./YR) Coal	Water	Oil	Coke	Total	GASIFIER/ PROCESS	••••••••BY-PRODUCTS••••••••• Coke	Tar	Ammonia	Other	MISCELLANEOUS INFORMATION
1	Gainesville	(Gainesville • GEL Co Gas Co.) Peale Roofing Co	1890	•	C	5				5						PCAP in process -
			1900	•	C	3				3						
	SE 2nd Ave.		1910	•	W		4			4	Su					PA completed
			1920	•	W		10			10						
			1930	•	W		28			28						
			1940	•	CW		30			30						
			1950	•	CW		136			136						
			AVERAGES:			4	42			31						
2	Jacksonville	• GAE Co	1890	•	W		20			20						Bill Hern has investigated [illegible]
	Peoples Gas		1900	•	W		22			22						
	1445 W. Church St		1910	•	W		130			130						
			1920	•	C,W	352	97			449		(231)	350	235		Con ~~PCAP~~ [illegible]
	(division operation center, warehouse)		1930	•	C,W	236	367			603		12	218			
			1940	•	CW		476			476			904			Eff [illegible]
			1950	•	CW		925			925		1,076				
			AVERAGES:			234	291			375		544	491	235		
3	Key West	• GEL Co	1890	•	O			(10)								
			1900	O												
			1910	O												
			1920	•	W		71			71			(17)			
			1930	•	W		56			56						
			1940	•	CW		46			46						
			1950	N												
			AVERAGES:				58			58						
4	Orlando	So Florida G Co	1890	•	W		(61)									
	Peoples Gas		1900	•	W		4			4						
	600th block of West Robinson Street		1910	•	C,W	3	3			6						
			1920	•	W		17			17						
	(division office, shed)		1930	•	W		169			169						
			1940	•	CW		230			230						
			1950	•	CW		492			492			500			
			AVERAGES:			3	153			153			500			

[illegible] EPA should be doing PA-ST as part of pilot

TABLE B-1 IDENTIFICATION OF TOWN GAS MANUFACTURING SITES - ALL PLANTS (1890-1950)

STATE: FLORIDA

NO.	CITY	COMPANY	YEAR	STATUS	GAS TYPE	GAS PRODUCTION RATE (MM cu.ft./YR) Coal	Water	Oil	Coke	Total	GASIFIER/ PROCESS	BY-PRODUCTS Coke	Tar	Ammonia	Other	MISCELLANEOUS INFORMATION
5	Palatka	* GLFuel Co Municipal	1890	*	C	4				4						
			1900	*	C	3				3						
			1910	*	W		3			3	Lowe					
			1920	*	W		7			7	*					
			1930	*	W		11			11	*					
			1940	O												
			1950	O												
			AVERAGES:			4	7			6						
6	Pensacola	* G Co Municipal	1890	*	W		(15)									
			1900	*	W		17			17						
			1910	*	W		45			45						
			1920	*	W		86			86			19			
			1930	*	W		100			100			86			
			1940	N												
			1950	N												
			AVERAGES:				62			62			53			
7	Sanford	* LtFuel Co Fl Public Utilities	1890	*	W		3			3						
			1900	*	W		3			3						
			1910	*	W		9			9						
	830 W. 6th St.		1920	*	W		7			7						
		office + pkging lot	1930	*	W		(10)									
			1940	*	CW		58			58						
			1950	*	CW		93			93						
			AVERAGES:				29			29						
8	St Augustine	* GIEL Co Municipal	1890	*	W		12			12						
			1900	*	W		17			17						
			1910	*	W		30			30						
			1920	*	W		45			45			13			
			1930	*	W		77			77						
			1940	*	CW		58			59						
			1950	*	CW		93			93						
			AVERAGES:				47			47			13			

TABLE B-1: IDENTIFICATION OF TOWN GAS MANUFACTURING SITES - ALL PLANTS (1830-1950)

STATE: FLORIDA

NO.	CITY	COMPANY	YEAR	STATUS	GAS TYPE	GAS PRODUCTION RATE (MM cu.ft./YR) Coal	Water	Oil	Coke	Total	GASIFIER/ PROCESS	••••••••BY-PRODUCTS••••••••• Coke	Tar	Ammonia	Other	MISCELLANEOUS INFORMATION
9	Tallahasee	* GIEL Co	1830	•	C	(5)										
		Municipal (Tom Smith)	1900	•	C	6				6						
			1910	N												
		Gadsden & RR tracks	1920	•	W		6			6						✓
		(Called State Cascades Park)	1930	•	W		240			240						
			1940	•	W		52			52						
			1950	•	W		104			104						
			AVERAGES:			6	101			82						
10	Ocala	Citizen's Gill. Co	1830													
		Gulf Natural Gas Corp.	1900	•	W		2			2						West Fl. Natural Gas
		728 NE Osceola Ave.	1910	•	W		8			8						
		[up for sale]	1920	•	W		7			7						
			1930	•	W		15			15						CAR ~~submitted~~ submitted
			1940	•	CW		(7)									
			1950	•	W		31			31	Sewet Solvay					under review.
			AVERAGES:				13			13						
11	Tampa	* G Co	1830													
		Peoples Gas	1900	•	W		11			11	Lowe					
		1200 N. 13th Street	1910	•	W		43			43	•					
		(division operation	1920	•	W		246			246	•					
		center, warehouse)	1930	•	W		625			625	•		263			
			1940	•	CW		539			539	•		433			
			1950	•	CW		1,038			1,038	•		532			
			AVERAGES:				428			428						
12	De Land	Citizen's Mfg Co	1830													
		Fl Public Utilities	1900													
		Beres Ford Rd. Ave.	1910	•	CW		(3)				Lowe					
			1920	•	CW		(3)				•					
			1930	O												
			1940	O												
			1950	N	Prepare											
			AVERAGES:													

TABLE B-1: IDENTIFICATION OF TOWN GAS MANUFACTURING SITES - ALL PLANTS (1890-1950)

STATE: FLORIDA

NO.	CITY	COMPANY	YEAR	STATUS	GAS TYPE	GAS PRODUCTION RATE (MM cu.ft./YR) Coal	Water	Oil	Coke	Total	GASIFIER/ PROCESS	BY-PRODUCTS Coke	Tar	Ammonia	Other	MISCELLANEOUS INFORMATION
13	Miami	* G Co	1890													Tall.
	Peoples		1900													Gaines
	NW 17th St. & NW 1st Ave		1910	*	O			15		15	J-L					Palatka (2 Pls)
	(division operation center, metering stations, distribution yard)		1920	*	O			80		80	*					Jack-
			1930	*	W		386			386						Miami-
			1940	*	W		540			540						St. Augustine-
			1950	*	W		1,162			1,162						Tampa & St. Pete.
			AVERAGES:				696	48		437						
14	Daytona	* Public Serv Co	1890													
		Fl Power & Light.	1900													
	Seagrave & Bay St.		1910													
			1920	*	W		26			26	Lowe					
			1930	O												
			1940	O												
			1950	-												
			AVERAGES:				26			26						
15	Lakeland	* G Co	1890													
	Peoples		1900													
	South side of 734 West Peachtree St. (adjacent to Peoples Gas office) (field & parking lot)		1910													
			1920	*	W		13			13	Lowe					
			1930	*	W		64			64	*					
			1940	O												
			1950	O												
			AVERAGES:				39			39						
16	St Petersburg	* Municipal G Plant	1890													
	Peoples Gas		1900													
	1201 3rd Ave South	[proposed Gas ball field]	1910													
	now owned by City of St. Petersburg		1920	*	W		55			55	Lowe		30			
			1930	*	W		277			277	*		150			
			1940	*	CW		376			376	*					
			1950	*	CW		706			706	*					
			AVERAGES:				374			374			93			

CAR submitted 7-88

CAR completed

FS/RAP in process

RA

TABLE B-1: IDENTIFICATION OF TOWN GAS MANUFACTURING SITES - ALL PLANTS (1890-1950)

STATE: FLORIDA

ID.	CITY		YEAR	STATUS	GAS TYPE	GAS PRODUCTION RATE (MM cu.ft./YR) Coal	Water	Oil	Coke	Total	GASIFIER/ PROCESS	BY-PRODUCTS Coke	Tar	Ammonia	Other	MISCELLANEOUS INFORMATION
✓ 17	Bradenton	Southern GAS ~~Corp~~ Co	1890													
	6th Ave & 3rd St.		1900													
			1910													
			1920													
			1930	•	W		42			42						
		plant yard	1940	•	CW		65			65						
			1950	•	W		77			77						
		main office in Sarasota	AVERAGES:				61			61						
18	Clearwater	* Municipal G Dept Cecil Henderson	1890													
	400 N. Myrtle Ave		1900													
			1910													
			1920													
			1930	•	W		(11)				Tenney					
	(parking lot)		1940	•	CW		90			90	•					
	District has File		1950	•	W		180			180	•					
			AVERAGES:				135			135						
✓ 19	Fort Lauderdale	* G Co	1890													
	Peoples		1900													
	NW 7th Ave + NW 4th Street		1910													
	(plant is being dismantled		1920													
			1930	•	W		8			8						
			1940	0												
			1950	0												
			AVERAGES:				8			8						
20	Fort Myers	Commission of City of *	1890													
		municipal	1900													
		(also propane distributor)	1910													
		(private)	1920													
			1930	•	W		(10)									
			1940	•	W		40			40						
			1950	•	W		90			90						
			AVERAGES:				65			65						

walkover - PCAP requested.
- County -

TABLE B-1: IDENTIFICATION OF TOWN GAS MANUFACTURING SITES - ALL PLANTS (1890-1950)

STATE: FLORIDA

NO.	CITY		YEAR	STATUS	GAS TYPE	GAS PRODUCTION RATE (MM cu.ft./YR) Coal	Water	Oil	Coke	Total	GASIFIER/ PROCESS	********BY-PRODUCTS******** Coke	Tar	Ammonia	Other	MISCELLANEOUS INFORMATION
21	Miami Beach	G Co of *	1890													
	Peoples Gas		1900													
			1910													
	W. Dixie Highway		1920													
			1930	*	W		(15)									
			1940	*	CW		389			389						
	PCAP completed.		1950	*	CW		1,372			1,372						
			AVERAGES:				881			881						
22	West Palm Beach	Florida Public Util Co	1890													
			1900													
	209 2nd St,		1910													
			1920													
	office & parking lot		1930	*	W		177			177			50			
			1940	*	W		264			264						
			1950	*	W		535			535						
			AVERAGES:				325			325			50			
23	Winter Haven	* GL Co Central FL Elec	1890													
	1705 7th St SW		1900													
			1910													
	On a lake		1920													
			1930	P												
			1940	*	CW		49			49						
			1950	*	CW		120			120						
			AVERAGES:				85			85						

CAP in process pending approval. Removed some of the soil during

Reference 2

Proceedings of the Third National Symposium on Aquifer Restoration and Ground-Water Monitoring

Recovery of Coal Gasification Wastes: An Innovative Approach

by James F. Villaume, Philip C. Lowe and Dennis F. Unites

Introduction

Following Great Britain's lead, city coal gasification plants for the production of illuminating or blue gas were installed in Baltimore in 1816, Boston in 1822 and New York in 1825 (Rhodes 1979a). In these early plants, bituminous coal was "carbonized," or destructively distilled, in small cast-iron retorts at temperatures of 600 to 800 C (1,112 to 1,427 F). By 1920, there were 917 gas plants in the United States (Rhodes 1979b). With the availability of natural gas, most of these plants ceased operation by 1947.

Coal tar and an aqueous ammoniacal liquor were byproducts of the gasification process, as was hydrogen cyanide. The uses for coal tar and its distillates are numerous; however, no concerted effort was made in the United States to use coal tar before 1887, when tar distillation was established as a separate industry in Philadelphia (Rhodes 1979a). It can therefore be assumed that, before this and for some time after, the coal tar from city gasification plants was largely disposed of at or near the plant site as a matter of convenience.

Because of such disposal practices and because of the toxicity of some coal-tar components, such as anthracene and benzo(a)pyrene, many of these sites are now being identified as environmental trouble spots (Smith 1979; Hult and Schoenberg 1981; Yazicigil and Sendlein 1981; Ehrlich et al. 1982; Marean 1982). One such site in Burlington, Vermont, appeared on EPA's original list of 115 priority Superfund sites, and the site which is the subject of this paper appears on the expanded list of 418 priority Superfund sites and was the first site in the nation to receive emergency Superfund money (Lafornara et al. 1982; McManus 1982; Unites and Houseman 1982; Villaume 1982). Also, with the current interest in this country in in situ coal gasification, much attention has recently focused on the production and fate of coal-tar contaminants in ground water (Campbell et al. 1978; Dalton and Campbell 1978; Humenick and Novak 1978; Humenick and Mattox 1978; Mattox and Humenick 1979; Mattox and Humenick 1980) and Coates et al. (1982) recently highlighted the problems associated with coal-tar waste from steel industry coking operations.

The Stroudsburg Site

History

The Stroudsburg coal gasification plant is located in the borough of Stroudsburg along the west bank of the Brodhead Creek (Figure 1). The plant was built sometime in the mid-1800s and was operated until 1939. None of the original structures remain.

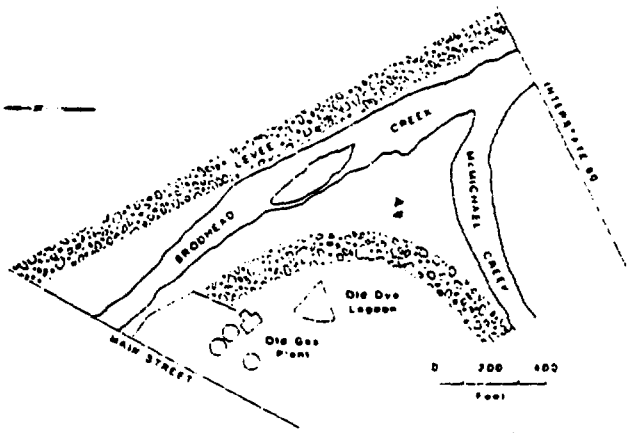

Figure 1. General location map of the coal-tar contamination site at Stroudsburg, Pennsylvania

The coal gas was manufactured by placing pulverized coal in a reaction vessel, where it was heated to drive off the volatile fraction. Superheated steam was then passed over the hot coal to produce a gas-steam mixture. Finally, this mixture was blown down into one of several large holding tanks ("gas holders"), where the steam condensed, leaving a gas at the top and a liquid containing coal tar at the bottom. Coal tar was also produced in the reaction vessel, which was cleaned out after each batch of coal was burned. Based on coal consumption records and known rates of coal-tar production, it is estimated that the plant could have produced as much as 16 million gallons of coal tar during its nearly 100-year operating life (Lafornara et al. 1982).

Early in the operation of the plant, the coal tar was considered strictly a waste product. Interviews with former employees and area eyewitnesses revealed that,

reaction vessel and placed into an open trench which ran along the western edge of the site and eventually discharged into Brodhead Creek. The water and tar which collected in the holding tanks was simply blown down onto the ground next to the tanks (Lafornara et al. 1982).

Later, as technology developed for reprocessing the coal tar during the early 1900s, the material was "purified" on-site to remove the commercially valuable constituents. The remaining residue was disposed of in an underground injection well located near the boiler house (Lafornara et al. 1981). The exact location of this well was determined from old insurance maps on file in the Library of Congress; however, its depth could not be ascertained. This practice continued until the plant was finally abandoned in 1939. (Hult et al. [1981] note the similar use of a 1917-vintage well at the coal-tar site they investigated and the authors are familiar with another city coal gasification plant near Stroudsburg where both the plant and the underground injection well are still intact.)

In 1955, the Brodhead Creek experienced its greatest flood of record as a result of Hurricane Diane. The extensive property damage caused by the flood water prompted the Army Corps of Engineers to modify the stream channel between 1958 and 1960. This modification consisted of straightening several reaches of the stream and placing the channel within a floodway lined by riprapped levees.

After construction of the levees, the stream bed experienced downcutting of some 6 feet in 20 years. To protect the levees from possible undercutting, the riprap was deepened an additional 10 feet in 1980. During this activity, coal tar was identified in the open trenches along the western shore of the Brodhead Creek.

In March 1981, the site was reported to the National Response Center. As a result, EPA became involved and ordered all the affected property owners to conduct a study to determine the extent of the coal-tar contamination and to identify suitable methods for dealing with it. Only Pennsylvania Power & Light Co., the largest property owner, complied. The study on the other properties was conducted by the Pennsylvania Department of Environmental Resources.

These studies estimated that an approximately eight-acre area was contaminated with up to 1.8 million gallons of free (discrete) coal tar. They further showed that the coal tar was confined primarily to the coarse, clean (few fines) gravels at the site and had collected in depressions in the underlying fine silty sand (Figure 2) as a separate liquid phase. To contain the coal tar and thereby prevent its continued seepage into the Brodhead Creek, EPA had a 700-foot bentonite-cement slurry cutoff wall constructed on the stream side of the western levee with money it received under the emergency provisions of Superfund. The wall is keyed into the silty sand and extends to just above the seasonally high ground-water table.

Coal-Tar Properties

A partial chemical analysis of the coal tar from the [illegible] organic constituents are the polynuclear aromatic hydrocarbons, chiefly naphthalene, anthracene and the methylated naphthalenes. Because more than 60 percent of the coal tar distills off at temperatures above 250 C (482 F), identification of high molecular weight aromatics and aliphatics with greater than 300 atomic mass units is extremely difficult using standard gas chromatograph-mass spectrographic (GC-MS) techniques. Of particular interest is the absence of a significant acid fraction, most notably phenol, which is generally considered a typical coal-tar constituent. Overall, the composition of the coal tar differs little from that of some common petroleum distillates (Figure 3).

The physical properties of the Stroudsburg coal tar are summarized in Table 2. Most significant is its specific gravity, which causes it to sink in water at room temperature and below. The viscosity of the coal tar is similar to that of a medium-weight oil and changes little with temperature, as indicated by its viscosity index. It is only moderately flammable and has a heat value in excess of 17,500 btu/pound, typical of a high-quality fuel oil. It is also practically nonconductive, which makes the interface it forms with the ground water easily distinguishable by standard electrical conductivity sensing methods, such as by electrical well sounding tape.

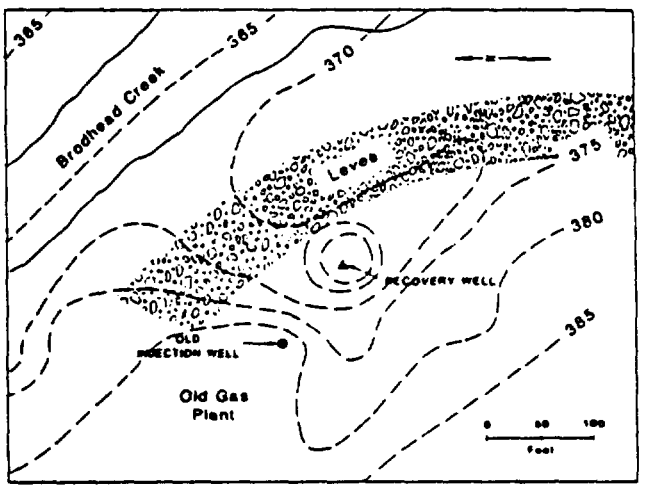

Figure 2. Top-of-sand contours (in feet) for the Stroudsburg coal-tar contamination site

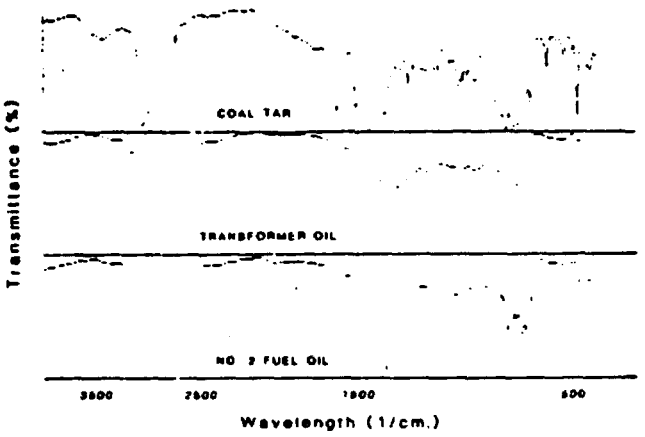

Figure 3. Infrared (IR) scans of the Stroudsburg coal tar, a naphthenic-based transformer insulating oil and a No. 2 fuel oil

Table 1
Partial Analysis of the Stroudsburg Coal Tar

Parameter	Value	Units
Naphthalene	**3.60**	%
Fluoranthene	3.20	%
Phenanthrene	**2.30**	%
Anthracene	**2.30**	%
Dimethyl naphthalenes	2.15	%
Trimethyl naphthalenes	1.78	%
Methyl phenanthrenes	1.50	%
Trimethyl benzene	1.30	%
Fluorene	**0.98**	%
Acenaphthylene	**0.74**	%
Acenaphthene	0.72	%
Pyrene	0.56	%
Benzo(a)anthracene	**0.31**	%
Chrysene	0.31	%
Benzo(a)pyrene	0.10	%
Other	7.84	%
Total	29.69	%
Acidity	0.62	mg KOH
pH	4.6	standard
Free carbon (Carbon I)	< 0.01	%
Ash	0.00	%
Total carbon	90.77	%
Total hydrogen	8.12	%
Total nitrogen	0.17	%
Sulfur	0.65	%
Chloride	50.	ppm
Ammonia	0.26	ppm
Cyanide	**0.18**	**ppm**
Iron	50.3	ppm
Copper	2.48	ppm
Manganese	2.11	ppm
Zinc	0.13	ppm
Nickel	0.19	ppm
Cadmium	0.01	ppm
Lead	**0.5**	**ppm**
Arsenic	12.7	ppm
Aluminum	22.4	ppm
Vanadium	1.6	ppm
Barium	0.5	ppm

Table 2
(Partial Analysis of the Stroudsburg Coal Tar)

Parameter	Value	Units
Specific gravity @ 45°F	1.028	—
@ 60°F	1.017	—
@ 100°F	0.991	—
@ 140°F	0.985	—
Distillation - 10%	420.	°F
50%	518.	°F
90%	662.	°F
Pour point	<-30.	°F
Flash point, Cleveland Open Cup	170.	°F
Heat value	17,763	btu/lb.
Surface tension	28.8	dynes/cm.
Interfacial tension w/water, Pt-Ir Ring tensiometer, @ 72°F	22.	dynes/cm.
Wetting angle in water against quartz, advancing, @ 78°F	125.	degrees
Absolute viscosity @ 45°F	18.98	centipoise
@ 122°F	5.04	centipoise
@ 140°F	3.89	centipoise
Viscosity index, ASTM D2270	194.	—
Conductivity	<0.1	μmhos

Porous Materials

The porous materials at the site consist primarily of both stratified and unstratified coarse glacial gravels and an underlying fine silty sand, which together form a valley fill type deposit of variable thickness over limestone. The single, steep-sided gravel-filled depression on the inside of the western levee can be explained as a kettle feature, where a large block of ice became imbedded in the silty sand and later melted. Particle size distribution histograms for these materials are presented in Figure 4.

By far, the majority of the site gravels are extremely "clean," meaning they have very few fines present. It is in these gravels exclusively that the free coal tar occurs, for reasons which will be explained. The cobbles range up to 7.50 inches in size, their average sphericity is 0.6[illegible] (compared to a value of 1.00 for a perfect sphere) and they are well-rounded (referring to the angularity of the edges and corners), all of which indicate the presence of relatively large voids. The hydraulic conductivity of this material was measured by falling head test at 5.28 x 10^{-3} cm/second.

The silty sand is fairly uniform throughout the site and has virtually no clay fraction present. While the porosity of this material may actually be higher than that of the clean gravels (41 percent compared to a typical range of 20 to 40 percent for most gravels), the pore sizes can be expected to be considerably smaller, based on the particle size distributions involved. The hydraulic conductivity of the silty sand was measured by falling head test at 5.28 x 10^{-4} cm/second.

Ground Water

The median depth to ground water across the site prior to slurry-wall construction was 10 feet and the hydraulic gradient was 0.015 foot per foot. Ground water generally flows to the southwest (Figure 5) at the rate of about 2 feet per day (based on a permeability of 1.5 x 10^{-3} feet/second). From short-term pump test data, the transmissivity of the gravel aquifer is on the order of 30,000 to 40,000 gallons/day/foot, assuming no boundary effects from the slurry wall. By comparison, the trans-

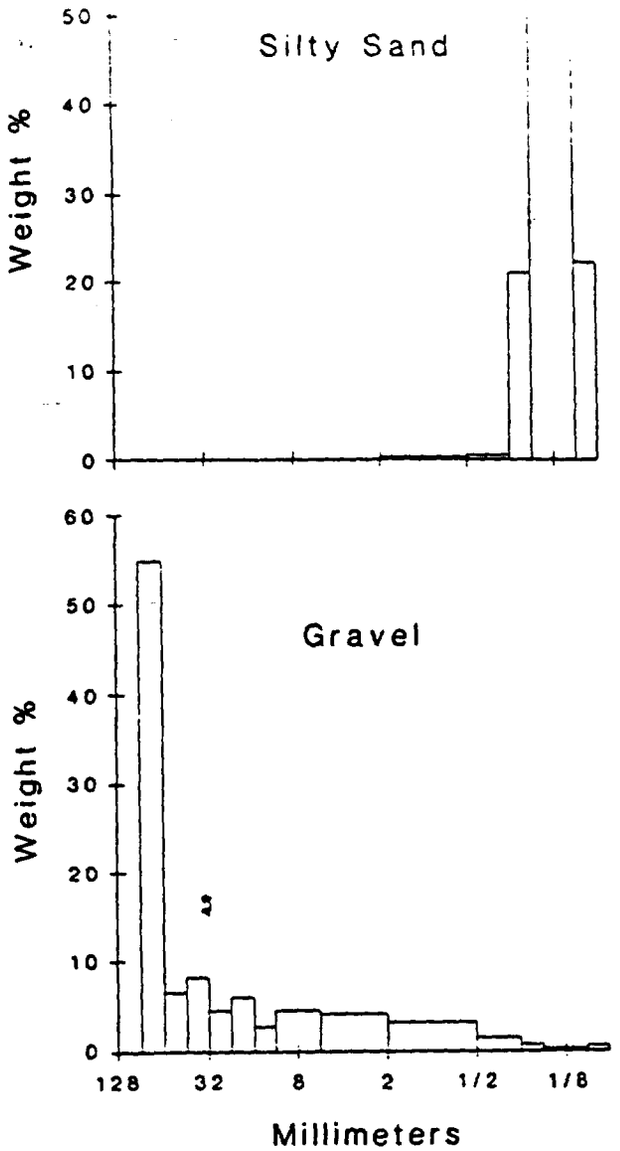

Figure 4. Histograms of the particle size distributions for samples of coal-tar contaminated gravel and silty sand from the Stroudsburg site

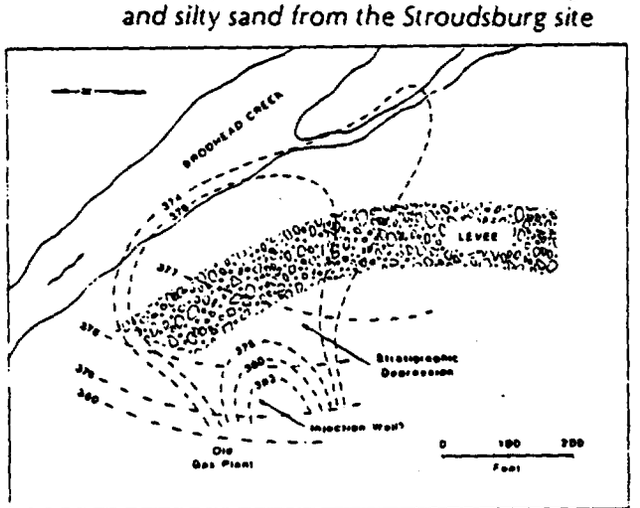

Figure 5. Stroudsburg site map with top-of-contamination (dash) and ground-water (dot-dash) contours (in feet) shown. The ground-water data is for June 12, 1981, prior to slurry wall construction. Almost no free coal tar occurs beyond the 374-foot contour

[illegible] coal tar in the same porous material is only about 50 gallons/day/foot, a 600 to 800 times difference. Thus, there is a drastic difference in the flow characteristics of the two fluids.

The borough of East Stroudsburg has two backup wells for the production of drinking water, one 720 and the other 705 feet deep, located about 1,500 feet from the site. Both are constructed in the deeper limestone aquifer system. Based on pump tests conducted by the borough, it was concluded that "the wells could present serious drawdown problems to properly constructed wells within a radius of 1,200 feet," which almost extends to the site. Thus, there is concern that the more soluble, and therefore mobile, coal-tar constituents could be picked up during long-term pumping of the wells. To test this hypothesis, EPA recently had several deep wells installed in the area of the site.

Distribution of Contaminants

Based on the detailed site investigation conducted during 1981, it was estimated that up to 1.8 million gallons of free coal tar were distributed over an approximately eight-acre area (Figure 5). Vertically, this contamination extends only to the top of the silty sand deposit, which it cannot penetrate under existing conditions due to the extreme capillary pressure forces involved. An accumulation of up to 35,000 gallons of nearly pure coal tar also occurs in the single stratigraphic depression located just below the old gasification plant (Figure 2). No other such accumulation was found anywhere on-site. It is this depression from which coal tar is presently being recovered.

Shallow ground-water samples from throughout the site also indicate the presence of dissolved contaminants. The polynuclear aromatics were generally detected at the part-per-billion (ppb) level, or within the range of known aqueous solubilities of the individual chemical species involved. As can be seen from Table 3, the principal control on the concentrations of these contaminants in the ground water is their aqueous solubility and not their concentration in the coal tar. Not enough data exist to determine whether there is a relationship between solubility and distance of transport; however, there does appear to be a rapid fall off in concentration just beyond the free coal-tar plume in the downgradient direction. The only contaminant detected at this point is naphthalene at less than 10 ppb.

Of the volatile organic fraction, only benzene, ethylbenzene and toluene were found in the shallow ground water; however, there is no clear correlation between aqueous solubility and concentration in this case (Table 3). Also, some of the base-neutral organics with significantly lower solubilities were found in the most distant downgradient well, while the volatile organics were entirely absent. This suggests the presence of a second, more recent contamination source, possibly gasoline or some other light petroleum distillate. An analysis of the coal tar for volatile organics has never been performed because it was assumed that none would be present, given the high aqueous solubilities involved and the length of time they would have been

exposed to ground-water leaching action; however, with EPA's recent interest in the possibility of deeper aquifer contamination at the site, this is an assumption which deserves further investigation.

No acid fraction organics, most notably phenol, were found in the shallow ground water. This is not unexpected given the nearly 4,000 times greater aqueous solubility of phenol compared to naphthalene (Hult and Shoenberg 1981), the most soluble polynuclear aromatic hydrocarbon detected. These materials were also detected in extremely low levels in the coal tar itself (phenols 0.95 and cresols 0.33 parts per million), which may be attributable either to their original absence or to prolonged leaching by ground water. This latter interpretation is supported by the findings of Campbell et al. (1979), who report nearly a thousandfold decrease in the concentration of phenolics in the ground water around an in situ coal-gasification experiment after 720 days, although the initial concentration in this case was only about 1 part per million.

Also characteristic of the shallow ground water at the site are the excessive levels of certain metals and cyanide. Aluminum, iron, manganese and cyanide were detected at levels as high as 218, 460, 25.5 and 0.30 parts per million, respectively, in some of the wells sampled. By comparison, these contaminants were measured in the raw coal tar at levels of 22.4, 50.3, 2.11 and 0.184 parts per million, respectively. Sodium was also found in the ground water at 26.2 parts per million, but was never analyzed in the coal tar. Cyanide, probably as either HCN or NH_4CN, is a primary combustion product of the coal gasification process and was typically removed from an iron salt (Schmidt 1943). The source of the aluminum, on the other hand, is more problematical and at such high concentrations is probably present as a precipitated solid (Hem 1970). The high sodium levels may be the result of sodium hydroxide usage at the plant. Even higher levels were found in the aquifers around the coal-tar distillation plant studied by Hult and Schoenberg (1981), who attributed them to such a source.

Stroudsburg as an Example of Two-Phase Flow

Basic Concepts

The free coal tar at Stroudsburg, being practically insoluble in water, represents a simplified example of immiscible liquid-liquid or two-phase flow. This is analogous to the secondary hydrocarbon migration problem in the petroleum exploration industry (movement from source rock to reservoir rock), except that the primary driving force in the case of coal tar is gravity, not buoyancy.

At Stroudsburg, coal tar was initially injected into the water-saturated gravels through what was probably a

Table 3
Organic Contaminants in Shallow Ground Water

Contaminant	Formula	Molecular weight	Aqueous solubility (mg/L)	Conc. in coal tar (mg/L)	Max. conc. in ground water (mg/L)
Base-Neutral Fraction					
Naphthalene	$C_{10}H_8$	128.16	31.7[1]	36,000.	3.525
Acenaphthylene	$C_{12}H_8$	152.21	—	7,400.	0.428
Acenaphthene	$C_{12}H_{10}$	154.21	3.93[1]	7,200.	0.275
Fluorene	$C_{13}H_{10}$	166.21	1.98[1]	9,800.	0.218
*Anthracene	$C_{14}H_{10}$	178.22	0.073[1]	23,000.	0.085
*Phenanthrene	$C_{14}H_{10}$	178.22	1.29[1]	23,000.	0.330
Fluoranthene	$C_{16}H_{10}$	202.26	0.26[1]	32,000.	0.038
Pyrene	$C_{16}H_{10}$	202.24	0.135[1]	5,600.	0.063
*1, 2-Benzoanthracene	$C_{18}H_{12}$	228.28	0.014[1]	3,100.	0.023
*Chrysene	$C_{18}H_{12}$	228.28	0.002[1]	3,100.	0.031
3, 4-Benzopyrene	$C_{20}H_{12}$	252.30	0.0038[1]	1,000.	0.013
3, 4-Benzofluoranthene	$C_{20}H_{10}$	252.32	0.0015[2]	370.	0.015
Benzo(ghi)perylene	$C_{22}H_{12}$	276.34	0.00026[1]	< 250.	< 0.010
Indeno(1, 2, 3-cd)pyrene	$C_{22}H_{12}$	276.34	0.0002[2]	< 250.	< 0.010
Volatile Fraction					
Benzene	C_6H_6	78.11	1,780.[3]	—	0.241
Toluene	C_7H_8	92.13	538.[3]	—	0.960
Ethylbenzene	C_8H_{10}	106.16	159.[3]	—	1.193

Notes: * Indicates isomers which are indistinguishable by GC-MS
[1] Data from Mackay and Shiu, *J. Chem. Engr. Data* 22 (4):399-402 (1977)
[2] Data from NBS Certificate of Analysis for Stand. Ref. Material 1647, 1981
[3] Data from McAuliffe, *Nature* 200:1092-1093 (1963)

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Biographical Sketches

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Questions and Answers

Q. Have you estimated the volume of coal tar that is present in the aquifer?

A. We now estimate that there were initially less than 10,000 gallons of pure, pumpable coal tar in the stratigraphic depression, down from a preliminary estimate of 26,000 to 103,000 gallons. The discrepancy could have been avoided by placing fully slotted, gravel-packed wells into the contaminated zone to identify the free coal tar surface.

Because of the highly non-uniform distribution of the coal tar throughout the site, the total quantity of contamination present in the gravel aquifer is virtually impossible to estimate; however, it is certainly far less than the 1.8 million gallons originally thought to be present, as this figure was based on complete saturation of an eight-acre area.

Q. What are the O & M costs of your recovery system?

A. The system is designed for unattended operation and functions well in that mode. Thus, the only operating cost is for electrical service to run the pumps and rental fees for various pieces of equipment which we have chosen not to purchase, such as pumps and storage tanks.

Maintenance requirements have also been minimal and involve periodic replacement of product pump

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Project Summary

U.S. Production of Manufactured Gases: Assessment of Past Disposal Practices

Scott M. Harkins, Robert S. Truesdale, Ronald Hill, Paula Hoffman, and Steven Winters

Sites formerly used for manufacture of gas, present problems for remediation and reuse of the sites. In some cases, polluted groundwater and surface waters are located near the sites. This study examines the history of the manufactured-gas industry of the United States, its production processes, disposal trends, waste toxicity, methods of site investigation, and the current status of manufacturing sites. The report is intended as a guide to those who are evaluating manufactured-gas sites, for environmental risks, or for possible remediation.

Six manufactured-gas sites and one spent oxide disposal area were visited during the project, and case studies were prepared for six former gas-manufacturing sites, two byproduct tar utilization facilities, a creosoting plant and a coal tar processor.

The current status of manufactured-gas sites in the United States was determined by contacting State and regional environmental officials to discover how they viewed manufactured-gas sites.

This Project Summary was developed by EPA's Hazardous Waste Engineering Research Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

Former sites of gas manufacture present problems for remediation and reuse of the sites. In some cases, polluted groundwater and surface waters are located near the sites. This study examines the history of the manufactured-gas industry of the United States, its production processes, disposal trends, waste toxicity, methods of site investigation, and the current status of manufactured-gas sites. The report is intended as a guide to those who are examining and evaluating manufactured-gas sites for either environmental risks or possible remediation.

History of Town Gas Production, Wastes and Disposal Practices

The gas used for lighting and heating in the United States from 1816 into the 1960's was manufactured. Three major processes were used to produce town gas: (1) coal carbonization, (2) carbureted water gas (CWG), and (3) oil gas. Coal carbonization consisted of heating bituminous coal in a sealed chamber, with destructive distillation of gas from the coal and the formation of coke. The gases were collected, cleaned, and distributed; the coke removed was sold and/or reused. The carbureted water-gas process used coke (or coal), steam,

and various oil products to produce a combustible product gas. Steam was fed through a bed of incandescent coke, producing a gas containing hydrogen and carbon monoxide. This gas (blue gas) then passed through two chambers containing hot firebrick where oil was sprayed into the gas and cracked into gaseous hydrocarbons and tar. Oil gas cracked oil alone into gaseous hydrocarbons, tar, and carbon (lampblack). A variety of oil-based feedstocks were used in the production of carburetted water gas and oil gas, including naphtha, gas oil, fuel oil, and residuum oils.

In general, all three processes were employed in all areas of the United States, but each process became predominant in specific geographical areas in the United States. Gas plants along the West Coast started as coal-gas plants, switched to CWG, then converted to oil-gas production. Plants along the East Coast were generally CWG, with some coal-gas production. Coal-gas production was predominant in the Middle States. The gas purification processes, byproducts, and wastes from the gas production varied with each production method. The final report discusses many aspects of the specific production methods and associated byproduct recovery operations of individual gas sites. Among the aspects discussed are: feedstocks, fuel gas chemical constituents and waste products.

The final report also presents a much longer, more detailed historical and scientific treatment of former sites. Included are alternative manufacturing processes, characteristics of early wastes, which often varied from site-to-site, and early waste disposal methods. A comparison of early gas production processes in the United States and the United Kingdom reveals that marketing of byproducts was more economically feasible in the UK, and that waste products were easier to haul away there, than in the U.S. As a consequence, U.S. sites contain more wastes discarded onsite.

In the U.S., after the first natural gas pipelines were installed in an area formerly served by manufactured gas, the natural gas was generally used to meet baseline demand, and the manufactured-gas plant was modified to produce gas for mixing with the natural gas to meet peak demands. As larger pipelines were installed for natural gas delivery and better storage methods for natural gas became available, the need for a standby gas production facility evaporated. The manufacturing plants were generally idle for several years before they were decommissioned. The most frequent reason for decommissioning the plants was to remove structures from the site and reduce the site valuation for tax purposes. The purpose of site decommissioning was to remove surface structures from the site. Gas storage tanks were cut off at ground level, and the tanks were filled with debris from the plant site. Underground tanks and structures were rarely removed, and some tanks and tar separators were left filled with tar or liquid wastes. Many gas companies still own the original sites used for the manufacture of gas, in that it is generally much cheaper to keep the site as unused land than it would be to clean the site for sale.

Investigation and Remediation of Town Gas Sites

The investigation and remediation of abandoned town gas sites is a large task, considering the large number of former sites that have been discovered and the even larger number that remain undiscovered. Contacts made with State and Federal agencies during the course of this project indicated that, of the sites that have been discovered, only a few have progressed beyond preliminary assessments, and fewer still have had remedial actions implemented to address contamination. Thus, site investigation activities and remedial action activities in town gas sites should increase markedly over the next few years.

As with any uncontrolled site contaminated with potentially hazardous chemicals, site investigation activities should focus on determining threats to human health and the environment posed by the site and on generating the information necessary to evaluate and select remedial alternatives. Selection of remedial alternatives should concentrate on cost-effective alternatives that effectively mitigate the threat, with an emphasis on treatment or destruction alternatives that eliminate the hazardous nature of the wastes.

The most commonly occurring and environmentally significant contaminants at abandoned town gas sites are byproduct tars and oils and spent oxide wastes. Byproduct tars and oils represent multiple-density contaminants at gas-works sites. For the purpose of this discussion, byproduct oils are defined as liquid hydrocarbon from gas manufacture with densities less than water; byproduct tars are defined as liquid hydrocarbons with densities greater than water. These substances are of concern environmentally because of their potential to contain high concentrations of carcinogenic compounds, such as PAH's and nitrogen heterocyclics. From the standpoint of groundwater contamination, the byproduct oils are of most concern because of their higher solubilities and tendency to float on the watertable, where soluble components may be leached out by infiltration. The byproduct tars are also of concern; however, because of their potential to flow in density currents through subsurface fractures and coarse-grained deposits.

Byproduct tars and oils from gas manufacture are immiscible fluids and as such do not readily mix with groundwater. The flow of immiscible fluids is more complex than is the flow of soluble contaminants. An immiscible fluid that is more dense (e.g., tar) than water will migrate according to the combined effects of relative density and the fluid-fluid and fluid-solid interfacial pressures. Because of the density contrast, the fluid will generally sink within the groundwater. Lighter hydrocarbons, such as byproduct oil, will generally "float" on the water table or on the tension-saturated zone. The existence of capillary pressure in a two-phase flow system means that the migration of an immiscible fluid is not entirely dependent on the flow of groundwater and, as a result, can migrate in an opposite direction of the dominant flow system. It is not uncommon in spills of low-density fluids, for example, for the fluid to migrate "upgradient" of the groundwater flow system within the capillary fringe. The most significant contaminants in spent oxide wastes are sulfuric acid, arsenic, and complexed iron cyanides. These complexed cyanides occur in the form of ferricferrocyanide, imparting a blue color to the spent oxide wastes. Procedures for conducting hydrogeological investigations of town gas facilities are not significantly different from those used for investigating uncontrolled chemical and industrial waste sites. The primary difference is that town gas sites generally tend to be older, and less background information is available about past site activities. In many cases, the present-day site has been cleared, and little or no evidence of past site activities is visible at the ground surface. As a result, research into historical records often is necessary to determine the physical layout and operating history of the plant. As with any

investigation of an industrial site, it is extremely important to utilize process information to help determine what contaminants may be present at the site and where these materials may be located.

Most investigations of manufactured-gas plant sites rely on conventional site investigation methods that are not significantly different from contamination investigations of other industrial sites. These methods include surface water sampling, shallow soil and groundwater sampling (from borings and test pits), and, when necessitated by the results of these sampling activities, more extensive groundwater monitoring. In most instances, these methods appear adequate for an initial understanding of the potential for adverse impacts on human health and the environment.

Other potentially useful (and often cost-effective) alternative techniques of investigation, such as geophysics and soil-gas sampling, have not been extensively employed at manufactured-gas sites to date. However, based on limited use at manufactured-gas sites and more extensive utilization at industrial waste sites, these techniques show potential utility for screening sites to optimize sampling and analysis plans.

A discrepancy commonly encountered in the gasworks site investigations reviewed by Research Triangle Institute (RTI) is insufficient information on the processes that operated at the specific sites. Most site assessments reported that gas was produced by coal pyrolysis or carbonization (i.e., retort or coke-oven gas); most of these sites actually were carbureted water gas (CWG) plants. The difference is significant, both in terms of waste characteristics and byproduct utilization practices. For instance, nitrogen and sulfur compounds are more prevalent in coal carbonization tars than in tars from CWG processes. Tar emulsions produced by CWG processes were hard to dewater. As a result, they were not reused and were disposed onsite, especially in smaller plants. Spent oxides from CWG cleanup processes often do not have the brilliant blue color often considered a characteristic of spent oxides because of the absence of significant levels of ferricterrocyanides. Historical background information on the gas industry is invaluable in planning and conducting gas plant site investigations because it can provide data on the characteristics and likely disposition of potential contaminants at site.

Site investigation techniques employed for hazardous waste site investigations are generally applicable to former manufactured-gas sites. However, some special considerations should be taken into account when conducting site investigations in order to focus the investigations on characteristic features of these sites. First, contaminants, especially gasifier tar and oil, often are contained in below-ground structures that were covered over and left when the plant was decommissioned. Gasworks site investigations initially should concentrate on identifying these structures because they often contain almost pure contaminants. Because such contaminants are contained, they are relatively easy to remove, and because they may be relatively pure, the materials may be reused as supplementary fuel or chemical feedstocks. In addition, it is especially important to take extreme care not to damage these structures during site investigation or remediation because this could result in the release and spread of contaminants, complicating and increasing the expense of cleanup operations.

Second, it is important to determine the real extent of contamination on and off a site as wastes, especially solid wastes from gas cleanup operations (e.g., woodchips, spent oxides). Such wastes were often disposed in areas adjacent to but not actually on the original gas plant site. In addition, gas plant sites were usually sited in low-lying areas (to facilitate gas distribution) and were adjacent to streams, lakes, or wetlands. In many cases, waste were accidentally or deliberately discharged into these areas; recent releases into streams, lakes, and rivers have resulted in site discoveries in many cases. It is important, therefore, to investigate wetlands and waterbodies adjacent to gas plant sites for potential contamination.

Third, it is important to recognize that organic contaminants with various densities commonly occur at gasworks sites. Multiple-density contaminants can result in complex contaminant migration patterns in the subsurface and can complicate the design and implementation of site investigation and groundwater monitoring. The relative density of potential contaminants should be known, at least qualitatively, during the planning stages of site investigation activities.

Fourth, it is important to understand the variety of methods used to produce the gas and the resulting variability of byproducts and waste products. By knowing the gas production processes used at a given manufactured-gas site, it is possible to determine the most appropriate chemical analyses for development of the site investigation plan, thereby resulting in lower investigation costs. For example, an assessment plan being developed for a site that used a coal-carbonization process should include analysis of phenolic compounds, nitrogen heterocyclics, ammonia, and cyanides. The analysis of these substances at carbureted water-gas and oil-gas production sites is less important because they usually were produced in low amounts in these processes. In addition, it is important to determine the potential toxicity and other hazards that may be associated with gas-plant wastes (e.g., the carcinogenicity of coal tar and the tendency of spent oxides to spontaneously combust) so that adequate provisions may be made for the health and safety of onsite workers and the general public during site investigation and remediation.

Gasworks sites have certain unique features that can influence the selection of remedial alternatives. First, the sites are old: many were abandoned more than 50 years ago, and almost all are more than 30 years old. This age can affect remediation in several ways. It can result in a low-priority ranking for the site in terms of cleanup. If the site owner can demonstrate that there is no history of contaminant migration and that wastes currently are remaining onsite, it is possible that site remediation efforts could be postponed without damage to human health or the environment. The fact that a site has existed for decades without problems may be taken as evidence that postponing remediation will cause no further problems. If cleanup is postponed, however, groundwater monitoring should be employed to detect contaminant release, and measures such as restricted site access should be taken to avoid exposure of the public to contaminants at the site.

On the other hand, the age of these sites can afford a long period of time for contaminants to move offsite, thereby resulting in a significant spreading of contaminants and an increase in the volume of material that must be cleaned up.

When gasworks were decommissioned, surface structures often were removed but structures below the surface usually were left in place. These

structures often contain contaminants, usually tars, oils, or tar/water emulsions. Because of this, it is important to determine the locations of these structures during a site investigation and to consider their locations when planning site remediation activities. In some cases, free tars and oils occur in these structures; such gasification byproducts may be reused as supplementary boiler fuel or chemical feedstocks. If reuse is not a viable alternative, careful recovery of the material from the structures results in a more concentrated waste stream for treatment or disposal. If surface structures are damaged during remediation efforts, contamination can spread into surrounding soils, increasing the expense and complexity of remediation efforts.

Another feature of gasworks sites that can affect remediation efforts is the presence of injection wells that were used for waste disposal (e.g., for tar residues and emulsions). At least one site reviewed in this study, Stroudsburg, Pennsylvania, may have had one of these wells. Research by the Stroudsburg site investigators suggested that other gasworks in the area may have used wells for waste disposal. Maps for the Lowell, Massachusetts, plant showed a "deep well" on the site. However, it is not clear whether this well was used for waste disposal. Additionally, it is important when reviewing old site maps not to confuse tar wells, which are underground structures containing tar, with injection wells used for disposing of wastes.

The location and depth of all wells on a site should be determined during remedial investigations. These wells may be reopened and sampled for contamination. Care should be taken during reopening to prevent them from adding to the spread of contaminants. If no contamination is detected, they should be properly closed and sealed to prevent them from becoming pathways for contaminant migration. If contaminated, they can complicate site remediation efforts. However, if wastes were pumped down a well, it may be possible to pump them back out. This was accomplished at Stroudsburg, where over 8,000 gallons of free coal tar was removed from the subsurface. However, considerable tar remains bound up in subsurface material at Stroudsburg; this necessitated containment (slurry wall) to prevent migration of contaminants offsite.

Remedial action alternatives for gasworks sites are similar to those for other uncontrolled hazardous waste sites. Containment, removal and disposal, and treatment all are applicable. Some containment generally will be required for all remedial actions to prevent the release and spread of contaminants. Slurry walls and caps have been used to contain gasworks wastes. Removal and disposal is a simple,but expensive option that also has been used to clean up gasworks sites. Treatment to stabilize, detoxify, or destroy gasworks wastes has not been employed to a great extent, but it is attractive, because it can destroy a waste's hazardous nature, enabling safe disposal of residues in nonhazardous waste landfills and eliminating future liability.

The final report discusses in much detail the technical and economic aspects of site investigations conducted at six former gas manufacturing sites and one iron oxide disposal site.

☆U. S. GOVERNMENT PRINTING OFFICE: 1988/548-158/67099

Reference 4

GROUNDWATER MONITORING PARAMETERS

AND

POLLUTION SOURCES

THIRD EDITION, MAY 1989

GEOFFREY B. WATTS

FLORIDA DEPARTMENT OF ENVIRONMENTAL REGULATION

BUREAU OF WASTE CLEANUP

7.5. Pollution Source - Coal Gasification Plants

Coal was used in early producer - gas plants for the manufacture of hydrogen/carbon monoxide gas mixtures. The basic process consists of reacting coking coal with steam and oxygen at approximately 1700°F to form the gas mixture (Shreve, et al., 1977). Major types of wastes and by-products are tar sludges, petroleum sludges and contaminated liquors (water and aqueous emulsions from the gas scrubber). A portion of the tar sludges was frequently mixed with light oil and sold as creosote for wood treating.

Table 7.5.1

Coal Tar(%) Composition (Fisher, 1938; Coal Tar Data Book, 1965).

Light Oil Fraction (5%) up to 200°C

benzene (0.1%)
Toluene (0.2%)
ethylbenzene (-)
xylenes (1.0%)
solvent naphtha (1.5%)
thiophene (-)

Middle Oil Fraction (17%) 200 - 250°C

naphthalene (10.9%)
unidentified (1.7%)

Tar acids (2.5%)
- phenol (0.7%)
- methylphenols (1.1%)
- dimethylphenols (0.2%)
- higher tar acids (0.5%)

Tar bases (2.0%)
- pyridine (0.1%)
- ammonia (-)
- heavy bases (1.9%)

Heavy Oil Fraction (7.0%) 250 - 300°C

methylnaphthalenes (2.5%)
dimethylnaphthalenes (3.4%)
acenaphthene (1.4%)
unidentified (1.0%)

Anthracene Oil (9.0%) 300 - 350°C

fluorene (1.6%)
phenanthrene (4.0%)
anthracene (1.1%)
dibenzopyrrole (1.1%)
unidentified (1.2%)

Pitch (62.0%)

gas (2.0%)
heavy oil (21.8%)
Red wax (7.0%)
carbon (32.0%)

Table 7.5.2

Monitoring Parameters - Coal Gasification Plants

Metals

iron*
manganese*

Volatile Organics

benzene*
toluene*
ethylbenzene*
xylenes*
thiophene

Base/Neutral Extractable Organics

acenaphthene*
acenaphthylene*
anthracene*
naphthalene*
fluorene*
phenanthrene*
methyl naphthalenes
dimethyl naphthalenes
dibenzopyrrole
pyridine

Acid Extractable Organics

phenol*
methyl phenols*
dimethyl phenols*

Miscellaneous Inorganics

ammonia
cyanide

*Key indicator parameter

Reference 5

BROWARD COUN ENVIRONMENTAL QUALITY CONTROL BOARD

EQCB closure

500 SW 14th Court
Fort Lauderdale, Florida 33315
(305) 765-5881

NO. 3793

NOTICE OF VIOLATION AND NOTICE OF HEARING TO ASSESS A CIVIL PENALTY

The undersigned certifies that he has just and reasonable grounds to believe and does believe that:

on the 16 day of August 1985, at 1100 A.M.

ISSUED TO: Edwin P. Champion, Manager

RESPONDENT: Peoples Gas System, Inc.

Resident Address: 555 N.E. 124th St.

City and State: North Miami Beach, Florida 33161

AT THE FOLLOWING LOCATION Peoples Gas System, N.W. 7thAvenue and 4th Street

IN: Fort Lauderdale (City) Broward (County) Florida (State)

Did: Unlawfully discharge Polynuclear Aromatic Hydrocarbons.

In Violation of:

[X] § 27-5.031 Code of Regulations of the Broward County Environmental Quality Control Board.

[ ] § _____ Florida Department of Environmental Regulation Rule

Victor N. Howard, P.E.
Pollution Control Officer

BY: Ronald J. Dresslein 865 (I.D. No.)

TITLE: Environmental Compliance Officer II/Enforcement

1) Date of mailing by Certified Mail, No. P046 324 013 9/16/85

2) Date of Personal Service _____ _____ (Time) A.M. P.M.

Hearing Information:

There will be a hearing held before the Broward County Environmental Quality Control Board or its duly appointed Hearing Examiner, at Nova University Law School, fifth floor, 3100 SW 9 Ave.Ft.Lauderdale,10:00 Am. on * . You may appear and present defenses to the Violation charged. The Hearing will take place whether or not you appear unless you make prior arrangements for a continuance pursuant to Section 27-2.20 of the Code of Regulations of the Broward County Environmental Quality Control Board. You may be represented by an attorney at the Hearing. After hearing the evidence, the Board may assess a Civil Penalty of up to $10,000.00 per offense and may assess the costs of the Hearing. If this violation has been corrected, you may request a settlement conference at least five (5) days prior to the scheduled Hearing to agree on the amount of penalty and costs to be assessed. The settlement conference may be arranged by contacting the Enforcement Office.

* Due to anticipated closure activities, the Hearing date will be set at a later time. You will be so advised.

POLLUTION INCIDENT CLOSURE REPORT

LEAD AGENCY: EQCB CLOSURE COORDINATOR:

SITE: PEOPLES GAS SYSTEMS INC START: / / EST. FINISH: / /
NW 7 Ave & NW 4 St
Ft Lauderdale

CONTACT PERSON: Edwin P. Champion TEL: ( ) 763 - 8900

CONSULTANT: TEL: ( )

BUSINESS TYPE: Abandoned Coal Gasification Plnt
REASON FOR CLOSURE:

INCIDENT DESCRIPTION
Lead sludge removed & hauled to Savannah
Ga. No H.W.# returned to Ft.Lauderdale.
PG applied for HW# South Carolina.

DATE	PROGRES
07/23/85	EQCB met w/PG reps & Cuyahoga Wrecking (CW) to discuss final closure requirements. GW sample analyzed.
07/28/85	Unsuccessful contact CW for site tour.
08/20/85	JMaudsley(PG) called TL,scheduled GW samples collected on8/23/85
08/23/85	EQCB collected GW samples from two excavations.
09/02/85	Sample results: NorthExc: Pb 2.33 ppm; 610 compounds 539 ppb. SouthExc: Pb 0.76 ppm; 610 compounds 21.3 ppb.
09/09/85	EQCB ltr to PG summarizing above data & requiring a CAP be submitted to restore GW by 9/27/85.
09/16/85	EQCB issued NOV 3792 for Reg 27-5.031 with open hearing date.
10/03/85	Staff met w/PGS&ERM-containing utility exempt from RCRA regs. Will submit soil sampling plan by 10/30/85.
10/28/85	EQCB rcvd ERM soil sampling proposal with QAQC plan.
11/01/85	EQCB ltr NTP with soil sampling program.

COMPLIANCE SCHEDULE
01/30/86 Submittal of soil results.

[5]

fm → EM

BROWARD COUNTY ENVIRONMENTAL QUALITY CONTROL BOARD

500 S.W. 14th Court
Fort Lauderdale, Florida 33315
(305) 765 5881

RECEIVED
FEB 18 1986
Dept. of Environmental Reg.
West Palm Beach

February 12, 1986

CERTIFIED

Mr. Edwin P. Champion
Manager Technical Services
Peoples Gas Systems, Inc.
555 NE 124 St.
P.O. Box 520855
N. Miami, FL 33152-0855

Subject: Status of Pollution Incident Closure Activity at the abandoned Peoples Gas System facility, NW 7 Ave. and 4 St., Ft. Lauderdale, Florida

Citation: No. 3793

Reference:
1. EQCB letter dated 9/9/85 to Mr. Champion — Summary of Closure Activities.
2. PSG letter dated 9/9/85 to EQCB — Disposal status of lead contaminated materials removed from tanks.
3. Meeting on 10/3/85 at EQCB — Discussion of Property Closure requirements.
4. On 10/28/85 EQCB received the ERM Contaminant Assessment Plan and QA/QC dated 10/23/85.
5. PSG letter dated 11/1/85 to EQCB — Copy of hazardous waste transport manifest enclosed.
6. EQCB letter 11/5/85 to Mr. Champion — Notice to Proceed with Amendments to CAP (data submittal required 1/31/86).
7. EQCB letter dated 12/13/85 to Mr. Champion.

Dear Mr. Champion:

On 1/31/86, EQCB received the ERM report titled Soils Sampling Test Results and Groundwater Sampling & Testing Plan, in accordance with the established compliance schedule. Staff has reviewed the submittal and agrees with the intent of the proposal to install four (4) permanent monitoring wells as depicted on figure 1.

This letter shall serve as Notice to Proceed with (Phase II) groundwater sampling at the subject facility according to the submitted plan. EQCB shall be notified seventy-two (72) hours prior to sampling to allow for scheduling of split samples. Please contact our staff hydrogeologist, Mr. T. A. Lawrence, if further details are necessary.

Sincerely,

Victor N. Howard

VICTOR N. HOWARD, P.E.
POLLUTION CONTROL OFFICER

cc: A. Padva (DER/WPB)
P. Gruber (ERM)
W. B. Taylor
Enforcement

VNH/TAL/sc
T2/ltrPeoples

PW ⇒ PW

↳ Do we have a case on the

NO.

PAJ 11/20

BROWARD COUNTY ENVIRONMENTAL QUALITY CONTROL BOARD

500 S.W. 14th Court
Fort Lauderdale, Florida 33315
(305) 765-5881

November 5. 1986

CERTIFIED — R.R.R.

Mr. C. H. Montague
Sr. V.P. — S. Florida Divisions
Peoples Gas System. Inc.
555 NE 124 Street
N. Miami, FL 33152-0855

Subject: Environmental closure status of the abandoned Peoples Gas Systems, Inc. gas manufacturing site. NW 7 Ave. and 4 St., Ft. Lauderdale. Florida
(Citation #3793)

Reference: Contaminant assessment reports — Phase I. dated 1/27/86; Phase II. dated 7/14/86. prepared by Environmental Resource Management South. Inc.

Dear Mr. Montague:

EQCB received the referenced (Phase II) report on 7/23/86. Copies of the report, were forwarded to FDER/WPB for comment. The results of groundwater quality sampling from your laboratory indicate the presence of Naphthelene in the down gradient monitoring well. Cox 1. at a concentration of 950 micrograms per liter and non-detectable of contaminants in the other 3 wells on-site. EQCB lab split samples from wells Cox 3 & 4 and found Acenaphthene, Anthracene, Fluorene and Phenanthrene from well Cox 4. The detection limits from your lab showed two order magnitude higher than EQCB lab's. This explains the discrepancy from two laboratories results. Our recommendations for further investigation of the site are described as follows:

1. Resample 4 wells and analyze for EPA methods 602 and 610 compounds and lead. Please notify EQCB 72 hours prior to sampling. EQCB reserves the right to split samples.

2. Identify the extent of Naphthelene contamination.

The location of the subject facility is outside of wellfield cone-of-influence. but groundwater is still classified as G-2 water. Please submit the results of the above mentioned assessment by 12/15/86.

If there are any questions, please contact Madeline Wu. P.E., at 765-5881.

Sincerely.

Bruce Kirstein for

VICTOR N. HOWARD, P.E.
POLLUTION CONTROL OFFICER

cc: J.S. Benyon (DER/WPB)
E. P. Champion (PGS)
P Gruber (ERM)

VNH/TAL/sc
W3/ltrPeoplel

BROWARD COUNTY ENVIRONMENTAL QUALITY CONTROL BOARD

500 S.W. 14th Court
Fort Lauderdale, Florida 33315
(305) 765-5881

December 2, 1986

Mr. Paul Gruber, P.G.
ERM—South, Inc.
5035 East Busch Blvd.
Suite 4
P.O. Box 290918
Tampa, FL 33617

Subject: Closure activities at the abandoned Peoples Gas System, Inc. Gas Manufacturing site, NW 7 & 4 St., Ft. Lauderdale, FL

Reference: EQCB letter dated 11/5/86 to Mr. Montague of Peoples Gas System, Inc.

Dear Mr. Gruber:

Per your request, we enclosed a copy of our test results of groundwater quality from monitoring wells, Cox 3 and Cox 4 at the subject site. You also requested an extension for submittal of report described in the reference letter. Due to delay in mailing and the coming holidays, EQCB grants the extension to 1/9/87. If there are any questions, please contact Madeline Wu, P.E. at 765-5881.

Sincerely,

Victor N. Howard

VICTOR N. HOWARD, P.E.
POLLUTION CONTROL OFFICER

cc: J.S. Benyon (DER/WPB)
C.H. Montague (PGS)
E.P. Champion (PGS)
VNH/MW/sc
W3/ltrPeople2

RECEIVED

Water Laboratory
05/12/86

Site : PEOPLES GAS WELL CO-4
Sample Date : 860410 Method No. : 610
Lab I.D. No. : 36650 Form No. : 001

Compound Name	Concentration (ug/l)	Detection Limit(ug/l)
1. ACENAPHTHENE	2.3	0.40
2. ACENAPHTHALENE	ND	0.10
3. ANTHRACENE	.23	0.10
4. BENZO(A)ANTHRACENE	ND	0.10
5. BENZO(A)PYRENE	ND	0.50
6. BENZO(B)FLUORANTHENE	ND	0.20
7. BENZO(K)FLUORANTHENE	ND	0.10
8. BENZO(g,h,i)PERYLENE	ND	0.20
9. CHRYSENE	ND	0.50
10. DIBENZO(A,H)ANTHRACENE	ND	0.20
11. FLUORANTHENE	ND	0.10
12. FLUORENE	4.7	0.20
13. INDENO(1,2,3,c,d)PYRENE	ND	0.50
14. NAPHTHALENE	ND	0.20
15. PHENANTHRENE	1.5	0.10
16. PYRENE	ND	0.20

ND = not detected Det. = detected but not quantified
- = not determinded

Hoboard County
I.L.G.C.B
Water Laboratory
05/12/86

Site : PEOPLES GAS WELL COX-3
Sample Date : 860410 Method No. : 610
Lab I.D. No.: 36649 Form No. : 001

	Compound Name	Concentration (ug/l)	Detection Limit(ug/l)
1.	ACENAPHTHENE	ND	0.40
2.	ACENAPHTHALENE	ND	0.10
3.	ANTHRACENE	ND	0.10
4.	BENZO(A)ANTHRACENE	ND	0.10
5.	BENZO(A)PYRENE	ND	0.30
6.	BENZO(B)FLUORANTHENE	ND	0.30
7.	BENZO(K)FLUORANTHENE	ND	0.10
8.	BENZO(g,h,i)PERYLENE	ND	0.20
9.	CHRYSENE	ND	0.30
10.	DIBENZO(A,H)ANTHRACENE	ND	0.20
11.	FLUORANTHENE	ND	0.10
12.	FLUORENE	ND	0.30
13.	INDENO(1,2,3,c,d)PYRENE	ND	0.30
14.	NAPHTHALENE	ND	0.20
15.	PHENANTHRENE	ND	0.10
16.	PYRENE	ND	0.20

ND = not detected Det. = detected but not quantified
- = not determinded

Reference 6

Peoples GAS SYST

DIVISION OFFICES
555 N.E. 124TH STREET • P.O. BOX 520855
NORTH MIAMI, FLORIDA 33152-0855

9/9/85

Mr. Terry Lawrence
Broward County Environmental
Control Board
500 S. W. 14th Court
Ft. Lauderdale, Fla. 33315

Re: Lead Contaminated Material

Dear Mr. Lawrence:

Per J. D. Maudsley's request, I am submitting an intermediate report on the disposition of the lead contaminated material originating in the gas holder at our Cox Plant in Ft. Lauderdale.

The material that was transported to a Savannah, Ga. landfill site and discussed with you in our meeting on July 23, 1985 has been removed from that site and returned to its original location in Ft. Lauderdale. The material and the drums used to move it to Savannah were returned in a closed container by Chemical Conservation Corp. on September 3, 1985.

The return of the material was carried out in order that Peoples Gas System, Inc. could maintain better control over its handling while awaiting approval from the State of South Carolina for GSX to receive the material at the Pinewood, S. C. disposal site.

Our plan is to place the remainder of the lead contaminated material in the enclosed container and to hold it, in total, at the plant site until it can be hauled to Pinewood.

To date, Peoples Gas System, Inc. has received Generator's U.S. EPA I. D. No. FL D 981026354 and has applied to GSX Hazardous Waste Disposal Site in Pinewood, S. C. to deliver the material there as soon as approval is received. It is expected that the approval process will not be completed for another 20 to 30 days.

For your information, I am attaching a copy of the Savannah, Ga. to Ft. Lauderdale manifest for returning subject material and a copy of the authorization request submitted to South Carolina Control Bureau.

RECEIVED

SEP 10 1985

Broward County
ENVIRONMENTAL QUALITY CONTROL BOARD

It is our intention to submit documentation to you as soon as final disposal has been accomplished. In the meantime, please let me know if you have need for any additional information.

Sincerely,

Edwin P. Champion
Manager Technical Services

EPC/et

Attachment

ATTACHMENT "B"

___ Amendment X New

South Carolina Department of Health and Environmental Control
Bureau of Solid and Hazardous Waste (803) 758-5681

X Landfill ___ Reclaim
___ Recycle ___ Incinerate
___ Landfarm ___ Energy Recove
___ Other ___

AUTHORIZATION REQUEST FORM

Facility Use Only:

Authorization Number: [ ] - [ ] - [ ] (1-11) ← To be entered by TSD Facility

Generator Information:

Generator ID # [F L D 9 8 1 0 2 6 3 5 4] (12-23) Name [PEOPLES GAS SYSTEM, INC.]

Address [P.O. BOX 520855] City [MIAMI] State [FL] Zip Code [33152]

Official Contact [C. H. Montague] Title [Sr. Vice President] Telephone [(305)893 -2522] [N/A] SC County (For In-State Generator Only)

Treatment, Storage, or Disposal Facility Information:

Facility EPA ID # [S C D 0 7 0 3 7 5 9 8 5] (24-35) Name [GSC CORPORATION]

Address [ROUTE 1, BOX 255] City [PINEWOOD] State [SC] Zip Code [29125]

Description of Hazardous Waste:
[P A I N T R E S I D U E A N D S E D I M E N T - M E G G A S S T O R A G E T A N K] (36-95)

EPA/DHEC Waste Codes: [D008] (1-4) [ ] (5-8) [ ] (9-12) [ ] (13-16) [ ] (17-20)

Handling Method: [D8] (21-23) Volume: (lbs/yr. only) [3 0 0 0 0] (24-32)

Enter Quarter for One-Time Disposal: [3] / [8 5] (33-35) Qtr/yr.

If Multiple Shipments Enter Frequency Here: [N/A] (36-39) times/yr.

Physical State of Waste @ 70°F (40):
1. [X] solid 2. [ ] liquid 3. [ ] N/A

Flash Point (cc) (41):
1. [ ] none 2. [ ] <60°F 3. [ ] 60-140°F 4. [X] >140°F

For DHEC Use Only:

Date Received [ ] [ ] [ ] (42-47)

Notes:

ATTACHMENT "B"

AUTHORIZATION REQUEST FORM (con't)

Proper DOT Shipping Name/Hazard Class/DOT ID # [Hazardous Waste Solid, D008, DRME, NA 9189]

Process Producing Waste [SEDIMENT IN WATER SEAL FROM PAINTING TANK] Line: [N/A]

Packaging for Shipment: [X] in Drums (size) [55] [X] in Bulk [X] Other May contain some dented drums.

Method of Transportation : [ ] Railroad tanker [X] truck [ ] Other [ ] Specific Gravity: [1.5]

Viscosity @ 70°F: [ ] Low [ ] Medium [X] High Layering: [X] None [ ] Bilayered [ ] Multilayered

Suspended Solids: % by weight or volume, Specify exact % [0] Dissolved Solids: by % weight, Specify exact % [0]

Thousands of Btu's/lb, Specify : [N/A] Organically Bound Sulfur (wt %): [N/A] Organically Bound Chloride: [N/A]

Organically Bound Nitrogen (Wt %) [N/A] Toxicity: [ ] High [ ] Medium [X] Low [ ] Unknown Ash %: [N/A]

Affinity for Water: [ ] Hydrophilic [X] Lipophilic pH (if hydrophilic): [ ]

Visual Description of waste: [Brown Colored Dirt]

Constituents: List specific constituents by name and corresponding percentage in waste stream.

Volatile Organics	%	Non Volatile Organics	%	Acid or Alkalis	%	Salts & Inorganics	%
See Attached		See Attached		See Attached		See Attached	
(4 pages)		(4 pages)		(4 pages)		(4 pages)	

Water: N/A %

ATTACHMENT "B"

AUTHORIZATION REQUEST FORM (con't)

Metallic: (total metals not EP Toxicity Test)

As ____ ppm	Cr^{+3} ____ ppm	Ag ____ ppm	Fe ____ ppm
Ba ____ ppm	Cr^{+6} ____ ppm	Ni ____ ppm	Sb ____ ppm
Cd ____ ppm	Hd ____ ppm	Cu ____ ppm	Mn ____ ppm
Pb ____ ppm	Se ____ ppm	Ti ____ ppm	Co ____ ppm
Zn ____ ppm	____ ____ ppm	____ ____ ppm	____ ____ ppm

Toxics:

Cyanide	____ ppm
Pesticides	____ ppm
Carcinogens	____ ppm
Other Toxics	____ ppm

Other Information : See attached lab test results (4 pages) zero

Certification :

I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is, to the best of my knowledge and belief, true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations.

Signature : C H Montague Date Submitted : 8/20/85

Print Name : Charles H. Montague Title : Senior Vice President-So. Fla. Divisions

TSD Facility Certification :

I certify that based on the information presented in this document, this facility is permitted to accept the waste stream described hereon, and do hereby inform the generator listed hereon of acceptance of the waste for treatment, storage, and/or disposal in the manner designated, and in compliance with the TSD Facility's standard terms and conditions.

Signature : ____ Date Submitted : ____

Print Name : ____ Title : ____

Please print or type. (Form designed for use on elite (12-pitch) typewriter.)

Form Approved. OMB No. 2000-0404. Expires 7-31-86

UNIFORM HAZARDOUS WASTE MANIFEST

1. Generator's US EPA ID No. 025 030 D(L) — Manifest Document No. 0001

2. Page 1 of

Information in the shaded areas is not required by Federal law.

3. Generator's Name and Mailing Address
CLIFTON EQUIPMENT RENTAL CO
P.O. BOX 7003 GARDEN CITY, GA 31408

4. Generator's Phone (912) 964-0345

A. State Manifest Document Number

B. State Generator's ID

5. Transporter 1 Company Name: CHEMICAL CONSERVATION CORP

6. US EPA ID Number: FLD980559728

C. State Transporter's ID

D. Transporter's Phone

7. Transporter 2 Company Name

8. US EPA ID Number

E. State Transporter's ID

F. Transporter's Phone 3058594441

9. Designated Facility Name and Site Address
PEOPLES GAS CO.
315 N.W. 7TH AVE
FT. LAUDERDALE, FL

10. US EPA ID Number: FLD 981026354

G. State Facility's ID

H. Facility's Phone

GENERATOR

11. US DOT Description (Including Proper Shipping Name, Hazard Class and ID Number)	HM		12. Containers No.	Type	13. Total Quantity	14. Unit Wt/Vol	I. Waste No.
a.	X	HAZARDOUS WASTE SOLID N.O.S. ORME NA 9189	1	CM	19,660	P	D008
b.							
c.							
d.							

J. Additional Descriptions for Materials Listed Above

K. Handling Codes for Wastes Listed Above

15. Special Handling Instructions and Additional Information

16. **GENERATOR'S CERTIFICATION:** I hereby declare that the contents of this consignment are fully and accurately described above by proper shipping name and are classified, packed, marked, and labeled, and are in all respects in proper condition for transport by highway according to applicable international and national governmental regulations.

Printed/Typed Name	Signature	Date Month Day Year
HAROLD CLIFTON	Harold Clifton	09 03 85

TRANSPORTER

17. Transporter 1 Acknowledgement of Receipt of Materials

Printed/Typed Name	Signature	Date Month Day Year
STEVE COCHRAN	Steve Cochran	09 03 85

18. Transporter 2 Acknowledgement of Receipt of Materials

Printed/Typed Name	Signature	Date Month Day Year

FACILITY

19. Discrepancy Indication Space

20. Facility Owner or Operator: Certification of receipt of hazardous materials covered by this manifest except as noted in Item 19.

Printed/Typed Name	Signature	Date Month Day Year
William D. Young	William D. Young	9 4 85

Style F15-6 Labelmaster, Chicago, IL 60646 (312) 478-0900

EPA Form 8700-22 (3-84)

Chemical Conservation Corporation

653 ROCKET BOULEVARD
ORLANDO, FLORIDA 32824

1-305-859-4441

6555

Date 9-4-85

Truck No. 14-R/0

pper CLIFTON EQUIP

dress GARDEN CITY GA

Ship To PEOPLES GAS

Address FT LAUDERDALE FL

UANTITY	COMMODITY	GALLONS – POUNDS – TONS	WEIGHT
1	ROLL OFF RN		

STOMER'S ORDER NO. 0001

STOMER'S SIGNATURE [signature]

IVER'S SIGNATURE [signature]

TIME IN

TIME OUT

TOTAL TIME

Peoples
GAS SYSTEM, Inc.

DIVISION OFFICES
555 N.E. 124TH STREET • P.O. BOX 520855
NORTH MIAMI, FLORIDA 33152-0855

7/23

ROUTE
FH 7/23/86
TAL 8/4/86
MW
FDER 8/4/86
File TAL

7/17/86

Mr. Victor N. Howard
Pollution Control Officer
Broward County Environmental Quality
Control Board
500 S. W. 14th Court
Fort Lauderdale, Florida 33315

Re: Pollution Incident Closure Activity at the abandoned Peoples Gas System, Inc. Gas Manufacturing Site, N. W. 7th & 4th St., Fort Lauderdale, Fla. Citation #3793

Dear Mr. Howard:

Pursuant to your letter of Feb. 12, 1986, in which Peoples Gas was notified to proceed with its plan to install four groundwater monitoring wells at referenced site and to subject samples taken from these wells to laboratory tests to determine groundwater quality at the site, on March 12, 1986; the wells were installed and water samples taken on April 10, 1986. Mr. Terry Lawrence of your staff split these samples with ERM-South geologist, Mark Culbreth.

As indicated in the enclosed copy of the report of testing and analysis and ERM-South's conclusions, the risks associated with this site from a soil or groundwater quality perspective are limited. Based upon these test results and an understanding of the limited amount gas manufacturing that actually took place on the site, Peoples Gas System, Inc. has determined that there have been no adverse environmental impacts associated with past operations at the facility or the dismantling of those facilities. Therefore, no further action is anticipated.

If for any reason, you may have further questions, Peoples Gas System, Inc. remains anxious to cooperate in any way possible.

Sincerely,

C. H. Montague

C. H. Montague
Sr. Vice President-South Fla. Divisions

RECEIVED
JUL 23 1986
Broward County
ENVIRONMENTAL QUALITY CONTROL BOARD

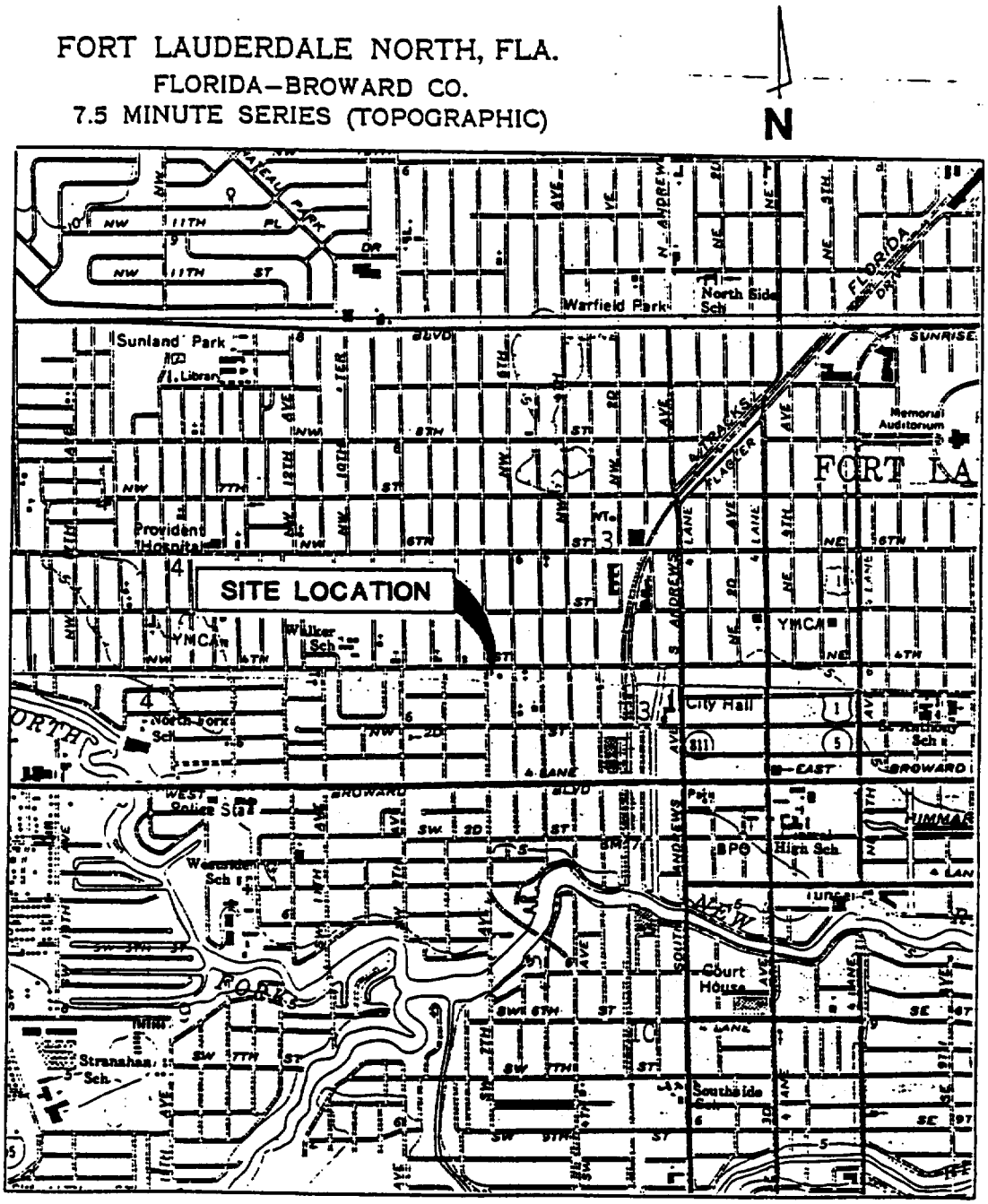
cc: N. H. Bollinger
William Taylor, IV
E. P. Champion

FIGURE 1

SITE LOCATION MAP

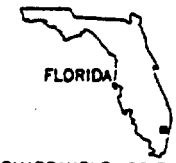
FT. LAUDERDALE, FLORIDA

FORT LAUDERDALE NORTH, FLA.
FLORIDA—BROWARD CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)



SCALE 1:24 000

1000 0 1000 2000 3000 4000 FEET



QUADRANGLE LOCATION

Peoples
GAS SYSTEM, Inc.

DIVISION OFFICES
555 N.E. 124TH STREET • P.O. BOX 520855
NORTH MIAMI, FLORIDA 33152-0855

6/17
ROUTE
FH 2A

6/16/87

Mr. Victor N. Howard, P.E.
Pollution Control Officer
Broward County Environmental Control Board
500 S. W. 14th Court
Fort Lauderdale, Florida 33315

Re: Closure activities of the abandoned Peoples Gas System, Inc. gas manufacturing site, N. W. 7th Ave. & 4th St., Ft. Lauderdale, Fla. (Citation #3793)

Reference: Contamination Assessment Report - Phase III

Dear Mr. Howard:

Enclosed are two copies of referenced report prepared by Environmental Resources Management-South, Inc. and submitted to Peoples Gas System, Inc.

Peoples Gas System, Inc. feels that the conclusions and recommendations expressed in the report are appropriate in that the results of the investigation clearly indicate that the water quality impacts observed are limited.

Sincerely,

C. H. Montague

C. H. Montague
Senior Vice President
South Fla. Divisions

Encl.

cc: N. H. Bollinger
William B. Taylor, IV
Paul Gruber
Mark Haney

RECEIVED
JUN 17 1987
Broward County
ENVIRONMENTAL QUALITY CONTROL BOARD

Reference 7

ERM-South, Inc.
Environmental Resources Management

5035 East Busch Boulevard • Suite 4 • P.O. Box 290918 • Tampa, Florida 33617 ☎ (813) 985-0335
1637 N.W. 79th Avenue • Miami, Florida 33126 ☎ (305) 591-3076

Reply To: Tampa office

January 20, 1987

Mr. Victor N. Howard, P.E.
Pollution Control Officer
Broward County Environmental
Quality Control Board
500 S.W. 14th Court
Ft. Lauderdale, FL 33315

RE: Peoples Gas System, Inc., Cox Plant, Ft. Lauderdale, Florida

Dear Mr. Howard:

Upon receipt of your letter containing the analytical results for the two split samples which were analyzed by Broward County EQCB for the Peoples Gas Ft. Lauderdale, Cox Plant and review of the analytical data, several questions were raised about the detection limits for methods used for analysis. I had several subsequent conversations with George Reilly of your office about the detection limits associated with these results, especially since they were two orders of magnitude lower than those achieved by our subcontract laboratory.

The particular concern we have regarding the collection of additional ground water quality samples from the existing on-site monitoring wells relates to the ability to achieve the detection limits which your laboratory was able to reach for the two analyses BCEQCB completed from the Peoples Gas site. The laboratory ERM selected to use for the ground water analyses at the PGS site in Ft. Lauderdale has an FDER-approved Quality Assurance/Quality Control Plan and has identified their method detection limits for the parameters your requested which range between 10 and 25 ug/l. Occasionally, if the range of concentration in the sample is low enough, a detection limit of 1 ug/l can be achieved. These detection limits are acceptable to the Water Quality Assurance section of the Florida DER, as evidenced by Thornton Laboratories' approval of their QA/QC Plan. Upon further analysis and review of 40 CFR Part 136, July 1982, the U.S. Enviornmental Protection Agency pub-

lished method detection limits which were also higher than those achieved by your laboratory utilizing the same techniques followed by Thornton Laboratories.

While I have no doubt, especially after talking to Mr. Reilly, that your laboratory achieved these detection limits, I have serious doubts that these detection limits would be repeatable and accurate on a routine basis if all of the wells on site had been split with your laboratory. On discussing the problem with Mr. Reilly, he had indicated to me that the analytical results reported by Thornton Laboratories at their stated detection limits which, again, are acceptable to the Florida DER, should be acceptable to the Broward County Environmental Quality Control Board. Thornton Laboratories will make every effort to achieve the lowest detection limit, but I am not sure if their analytical instrument procedures for the next set of samples will be able to achieve the detection limits which your laboratory was able to achieve. Due to the differences in laboratory detection limits and my client's concerns, I discussed the detection limit problem with Mr. Reilly shortly after Christmas. Mr. Reilly indicated to me that he felt that Thornton Laboratories' detection limits were acceptable and should be used as the basis for determining what level of activity, if any, should be undertaken when the data for the next round of ground water quality sampling is presented. I wanted to bring this issue to your attention so that there will be no misunderstanding about the acceptable laboratory detection limits.

ERM intends to collect additional ground water samples from the existing on-site monitoring wells and have these samples analyzed by EPA Methods 602 and 610 for the laboratory detection limits identified in Thornton Laboratories' QA/QC Plan. It is our intention to sample these monitoring wells during the week of January 26, 1987. We will contact Ms. Wu directly during the week of January 19 to arrange for a

mutually agreeable time and date for sampling. I appreciate your attention to this matter. Please contact me if you have any questions about the enclosed material.

Sincerely yours,

Paul Gruber, P.G.

PG:bai

cc: Madelaine Wu, Broward County EQCB
Charles Montague, Peoples Gas System
Ed Champion, Peoples Gas System
Fred Hartledge, Thornton Laboratories
J.S. Benyon, DER - West Palm Beach
Newt Bollinger - Peoples Gas System

ONT.

Broward County
E.Q.C.B
Water Laboratory
05/12/86

Site : PEOPLES GAS WELL CO-4

Sample Date : 860410 Method No. : 610

Lab I.D. No.: 36650 Form No. : 001

Compound Name	Concentration (ug/l)	Detection Limit(ug/l)
1. ACENAPHTHENE	2.3	0.40
2. ACENAPHTHALENE	ND	0.10
3. ANTHRACENE	.23	0.10
4. BENZO(A)ANTHRACENE	ND	0.10
5. BENZO(A)PYRENE	ND	0.30
6. BENZO(B)FLUORANTHENE	ND	0.30
7. BENZO(K)FLUORANTHENE	ND	0.10
8. BENZO(g,h,i)PERYLENE	ND	0.20
9. CHRYSENE	ND	0.30
10. DIBENZO(A,H)ANTHRACENE	ND	0.20
11. FLUORANTHENE	ND	0.10
12. FLUORENE	4.7	0.30
13. INDENO(1,2,3,c,d)PYRENE	ND	0.30
14. NAPHTHALENE	ND	0.20
15. PHENANTHRENE	1.5	0.10
16. PYRENE	ND	0.20

ND = not detected Det. = detected but not quantified

- = not determinded

Soil

Box 1

0-3 ppm naphth

BROWARD COUNTY ENVIRONMENTAL QUALITY CONTROL BOARD

SAMPLE NUMBER 36649

SOURCE SAMPLED: Peoples Gas Systems, NW 7th St

SAMPLED BY: T. Lawrence TIME: 0930 DATE: 4/10/86

SAMPLING POINT: COX - 3 North well Purged ~ 150 Gallons (STO. TNK)

SAMPLE RECEIVED IN LAB BY: Craig A. Wilk TIME: 1143 DATE: 4/10/86

LABORATORY ANALYSES (mg/1)*

PARAMETER	RESULTS	BY:	PARAMETER	RESULTS	BY:	PARAMETER	RESULTS	BY:
ARSENIC			D.O. (#)			PHENOL. CMPDS.		
BOD_5			FECAL STREP.			PHOSPHORUS		
CADMIUM			GREASE & OIL			SALINITY ‰		
CL_2 RES. FREE			HYDRO CARBONS CHLORINATED			SILVER		
CL_2 RES. TOTAL			LAS (MBAS)			SOLIDS, DISS.		
CHROMIUM			LEAD dissolved	<.001	WM	SOLIDS, SUSP.		
C.O.D.			MERCURY			SOLIDS, FLOAT.		
COLIF. FECAL			NICKEL			TEMPERATURE		
COLIF. TOTAL			NITROGEN			TURBIDITY		
COPPER			ODOR			ZINC		
CYANIDE			pH			FC/FS		

*EXCEPT: COLIF/100ml - TEMP. (F&C) - TURB. (JTU) - ODOR

PC 427

BOTTLE NUMBER	36649	
SAMPLE VOLUME	1 liter glass plus	500 ml Plastic
LAB TESTS	EPA 610	Lead (dissolved)
PRESERVATIVE	ICE	ICE

Broward County
E.R.C.B
Water Laboratory
05/12/86

Site : PEOPLES GAS WELL COX-3
Sample Date : 860410 Method No. : 610
Lab I.D. No.: 36649 Form No. : 001

Compound Name	Concentration (ug/l)	Detection Limit(ug/l)
1. ACENAPHTHENE	ND	0.60
2. ACENAPHTHALENE	ND	0.10
3. ANTHRACENE	ND	0.10
4. BENZ(A)ANTHRACENE	ND	0.10
5. BENZO(A)PYRENE	ND	0.30
6. BENZO(B)FLUORANTHENE	ND	0.30
7. BENZO(K)FLUORANTHENE	ND	0.10
8. BENZO(g,h,i)PERYLENE	ND	0.20
9. CHRYSENE	ND	0.30
10. DIBENZO(A,H)ANTHRACENE	ND	0.20
11. FLUORANTHENE	ND	0.10
12. FLUORENE	ND	0.30
13. INDENO(1,2,3,c,d)PYRENE	ND	0.30
14. NAPHTHALENE	ND	0.20
15. PHENANTHRENE	ND	0.10
16. PYRENE	ND	0.20

ND = not detected Det. = detected but not quantified
- = not determined

Reference 8

WINDSHIELD SURVEY FORM

Date: 4/5/99
Surveyed by: [illegible]

1. Site Name Ft. Lauderdale Gas Plant / Peoples Gas

Correct Address SE Corner NW 7th Ave & NW 4th St
Ft. Lauderdale FL

Phone # _____

EPA ID # FLD _____

Type of business/industry Gas

2. Directions to the Site Corner of NW 7th Ave & NW 4th St. Ft Laud.

3. Check if present on site and use the space provided to describe:

a. storage tanks (above/below ground; how many; condition) None

b. berms (material/condition) Site recently cleared

c. drums (covered/uncovered; on/off the ground; condition; number; labels) —

d. other storage containers —

e. impoundments/pits/ponds —

f. piles on ground (material; covered/uncovered) —

g. dumpster/bulk waste container —

h. air stacks —

i. air emissions/odor (wind direction) —

j. posted signs (which ones; location) None

k. sprayfield/ drainfield —

l. pesticide storage —

m. evidence of past fire/fire protection equipment —

n. soil discoloration None seen

Windshield Survey Form (Continued)

o. surface water (type) —

p. buildings (how many) —

q. sheds (how many) —

r. drainage ditches/pipes None seen

s. wells (monitoring/drinking) —

t. septic tank —

u. spills (describe) —

v. sewers/manholes 1st street

w. railroad tracks none seen

x. flora (describe) sparse grass trees

y. fauna (describe)

z. water supply City Water tower ½ mile NE of site

aa. other

bb. other

cc. other

dd. other

4. Check if present off site and use the space provided to describe:

a. soil discoloration

b. surface water

c. drainage ditches

d. sewer systems/manholes

e. spills (describe)

f. leachate

g. flora

h. fauna

i. municipal/domestic water supply

j. other

k. other

Windshield Survey Form (Continued)

4. Check if present off site...(Continued)

   l. other _____

   m. other _____

5. Access:

   a. Is the site fenced (describe)? yes

   b. Is access restricted? No, gate open

   c. Is the site guarded? No

   d. Comments Site appears clean, a few pieces of coal but no coal tar.

6. Is the site active/abandoned? _____

7. Surrounding community (describe land use and type of industries adjacent to the site; proportions):

   a. industrial _____

   b. commercial 25%

   c. residential 75% West, North

   d. rural/farms _____

   e. rural/woods _____

   f. the closest business/residence is: (give name, address and distance)

      Daniel's House of Beauty
      703 NW 4th St.
      Ft Laud

   g. comments _____

Windshield Survey Form (Continued)

8. Site sketch: (show North on map)

Windshield Survey Form (Continued)

9. Comments: _____

_____

_____

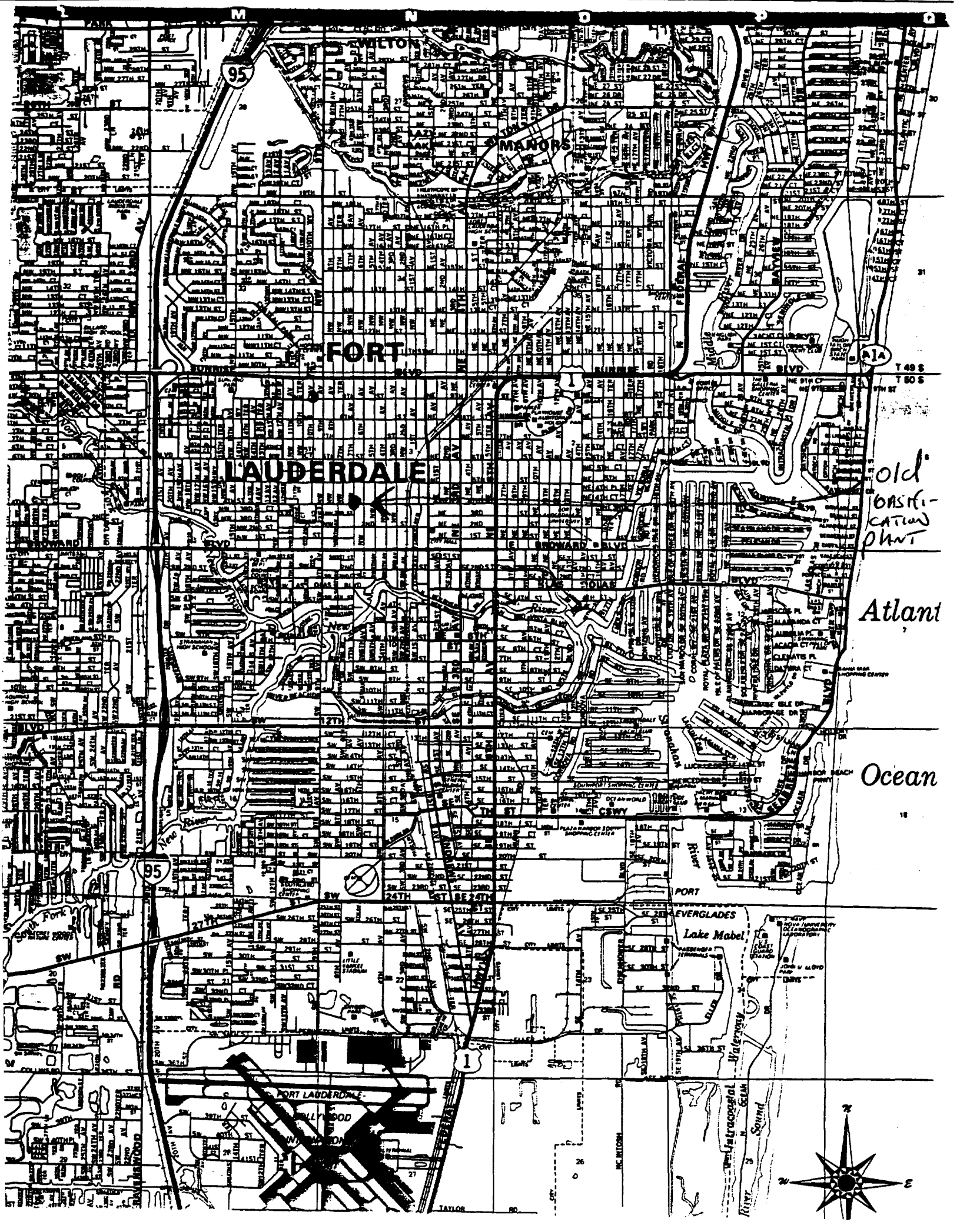
_____

_____

10. Recommendations: _____

_____

_____

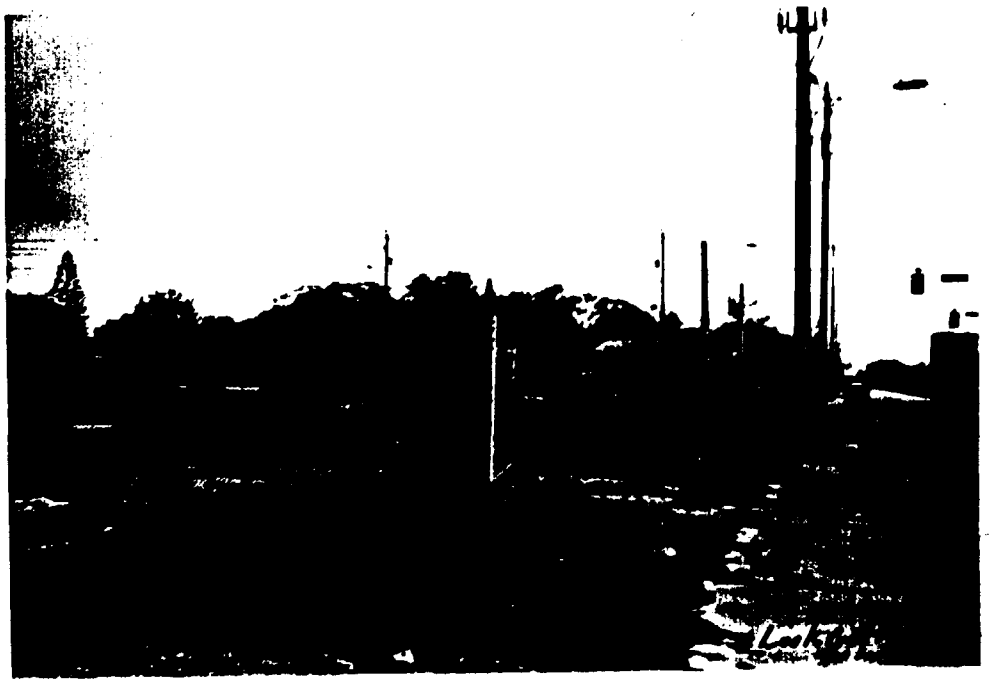


WILTON
MANORS
FORT
LAUDERDALE
Old
Oasifi-
cation
plant
Atlant
Ocean
T 49 S
T 50 S
PORT
EVERGLADES
Lake Mabel
PORT LAUDERDALE
HOLLYWOOD
Intracoastal Waterway
Sound

VUE-ALL Photo·Saver
Made in U.S.A.

DATE _____ NO. _____

TITLE _____



Reference 9

PHASE III ACTIVITIES REPORT
PEOPLES GAS SYSTEM, INC.
FT. LAUDERDALE, COX PLANT

JUNE 2, 1987

The ERM Group

PHASE3/1

PHASE III ACTIVITIES
REPORT
PEOPLES GAS SYSTEM
FT. LAUDERDALE, COX PLANT

June 2, 1987

Submitted to:

Peoples Gas System, Inc.
555 NE 124th Street
N. Miami, Florida 33161

RECEIVED
APR 14 1989
BUREAU OF WASTE CLEANUP
Twin Towers
From BC EPCB

Submitted by:

Environmental Resources Management-South, Inc.
5035 E. Busch Blvd., Suite 4
P.O. Box 290918
Tampa, Florida 33617
(813) 985-0335

RECEIVED
JUN 17 1987
Broward County
ENVIRONMENTAL QUALITY CONTROL BOARD

ERM-South, Inc.
Environmental Resources Management

5035 East Busch Boulevard • Suite 4 • P.O. Box 290918 • Tampa, Florida 33617 ☎ (813) 985-0335
1637 N.W. 79th Avenue • Miami, Florida 33126 ☎ (305) 591-3076

Reply To: Tampa office

June 2, 1987

Proj. No. 134-04

Mr. Ed Champion
Peoples Gas System, Inc.
555 NE 124th Street
N. Miami, FL 33161

RE: Phase III Activities - Ft. Lauderdale, Florida

Dear Mr. Champion:

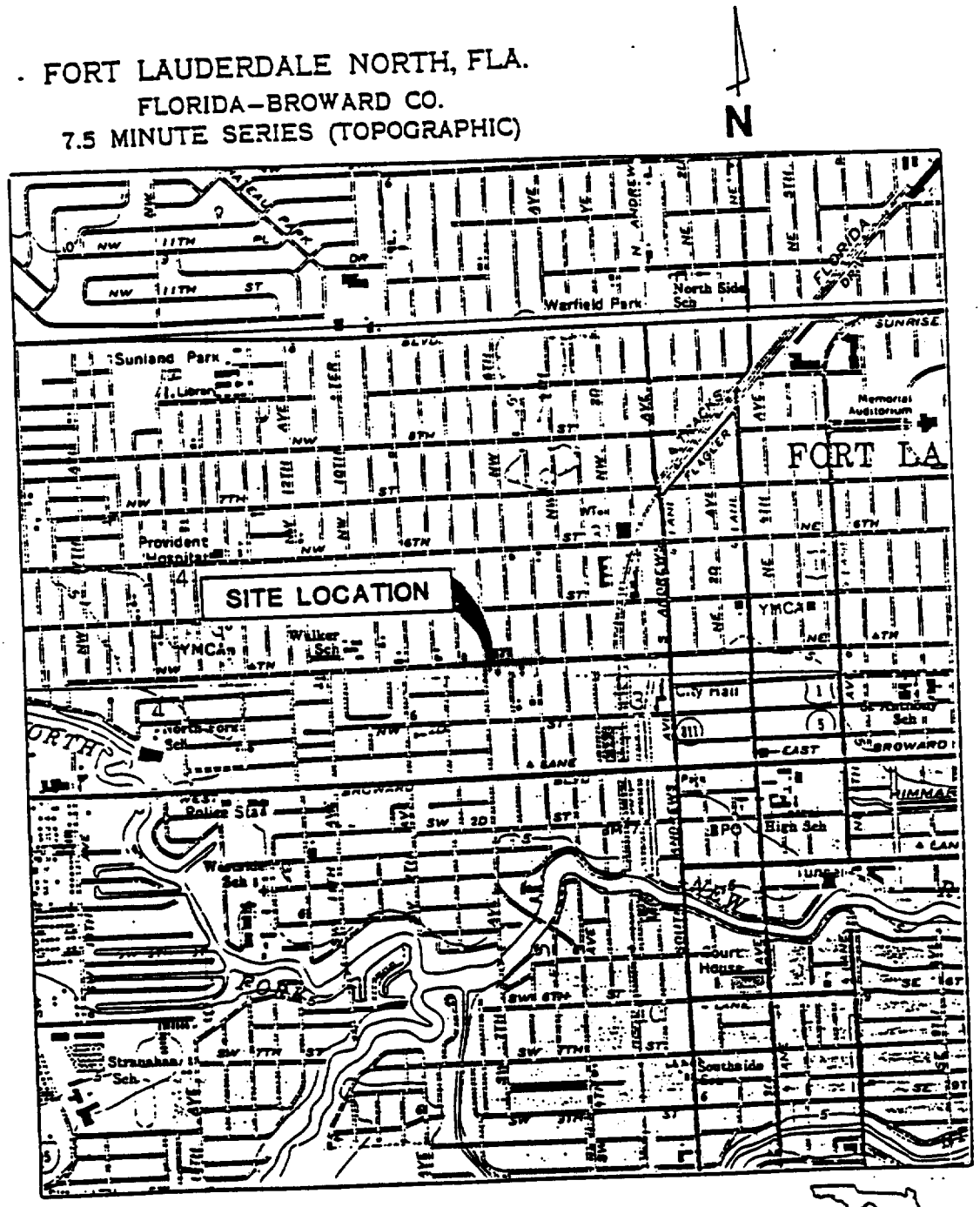
The following letter report was prepared to present the results of the Phase III ground-water sampling program completed at your Ft. Lauderdale (Cox Plant) facility. This third phase sampling program was initiated to confirm the results of Environmental Resources Management-South's (ERM) Phase II sampling and resolve analytical questions associated with Broward County Environmental Quality Control Board (BCEQCB) data.

INTRODUCTION

ERM was retained by Peoples Gas System, Inc. (PGS) to implement a site investigation preliminary to closure of county activities at the Ft. Lauderdale facility. This facility, located at the southeast corner of Northwest 4th Street and Northwest 7th Avenue in Ft. Lauderdale (Figure 1), through 1959, was a "coal gasification" plant, and only recently were all aboveground structures and appurtenances removed. The site is located in the downtown area of Fort Lauderdale; is outside of any modeled wellfield cones-of-influence; and is in an area designated as Zone IV (no potable drinking water supply wells) by the Broward County Environmental Quality Control Board. To comply with the County's closure requirements, a two-phase study was initially developed and implemented after County approval. Phase I studies included sampling the soils on site to determine if they were hazardous by virtue of EPA characteristics, as defined by RCRA. Phase II studies included sampling the ground water monitor to determine if any water-quality impacts due to past activities existed at the site. As a result of differences between laboratory data submitted by ERM and BCEQCB, a Phase III study was initiated and included ground-water sampling of the four existing, on-site wells to confirm the analytical results of the Phase II efforts. A copy of correspondence between ERM and BCEQCB discussing these differences is contained in Appendix A.

FIGURE 1
SITE LOCATION MAP
FT. LAUDERDALE, FLORIDA

FORT LAUDERDALE NORTH, FLA.
FLORIDA–BROWARD CO.
7.5 MINUTE SERIES (TOPOGRAPHIC)



FIELD INVESTIGATIONS SUMMARY

Phase I

On December 23, 1985, five back-hoe test pits were excavated at the locations shown in Figure 2. These pits were excavated to a total depth of approximately six feet, where the water table was encountered. The soils within the test pits were described by the on-site geologist. Soil samples were collected from each pit and were composited into one sample using the cone-and-quartering method, as described by ASTM. The composited soil sample was then analyzed by Thornton Laboratories of Tampa for RCRA characteristics and lead by EP toxicity.

The soils from within the test pits contained construction debris, such as concrete and galvanized pipe, within the upper one foot. At depths below this surface layer, the soils became darker and more fine-grained with depth, grading to dark brown to black, silty organic muck at the water table.

The laboratory analysis of the composite soil sample indicates that the on-site soils are not a hazardous waste, as defined under the Resource Conservation and Recovery Act (RCRA). None of the metals tested for exceeded the laboratory detection limits, as shown on the laboratory data sheet (Appendix B) and are also below the Maximum Concentration Limit for EP Toxicity.

Phase II

At the request of BCEQCB, four ground-water monitoring wells were installed at the facility between March 11 and 12, 1986 at the locations shown in Figure 3. Continuous split-spoon soil samples were collected in advance of the hollow-stem augering, according to ASTM D-1586 procedures. These soils were logged by the on-site geologist, with the associated drilling logs included as Appendix C. During the back-hoe test pit excavations executed during Phase I, what appeared to be muck, peat-type soil deposits were encountered within four to five feet of land surface. These peat-type deposits suggested that there might be a perched water table at this site at the time of the Phase I investigations. Therefore, ERM was prepared to install ground-water monitoring wells

FIGURE 2
SITE LAYOUT MAP

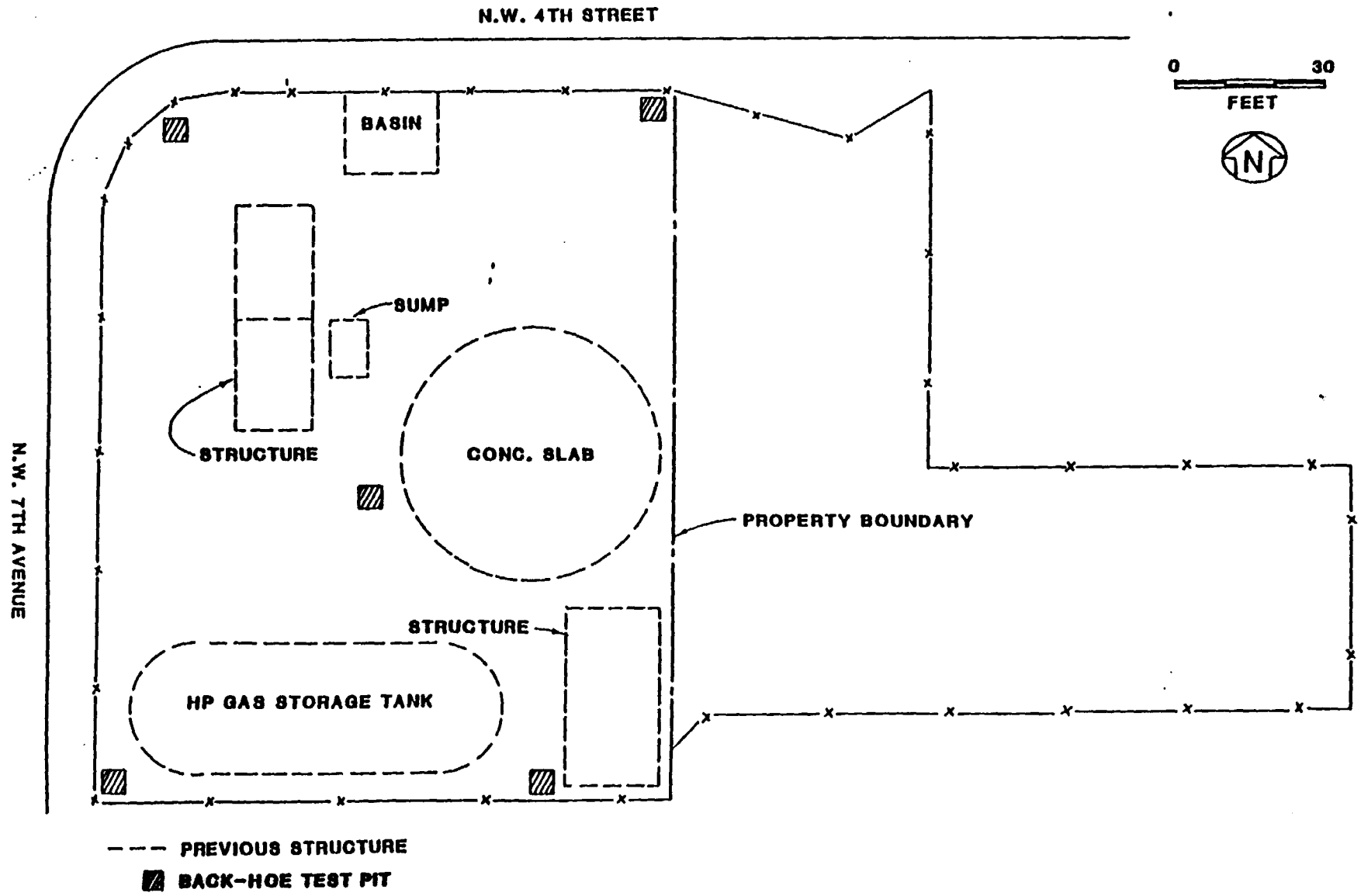
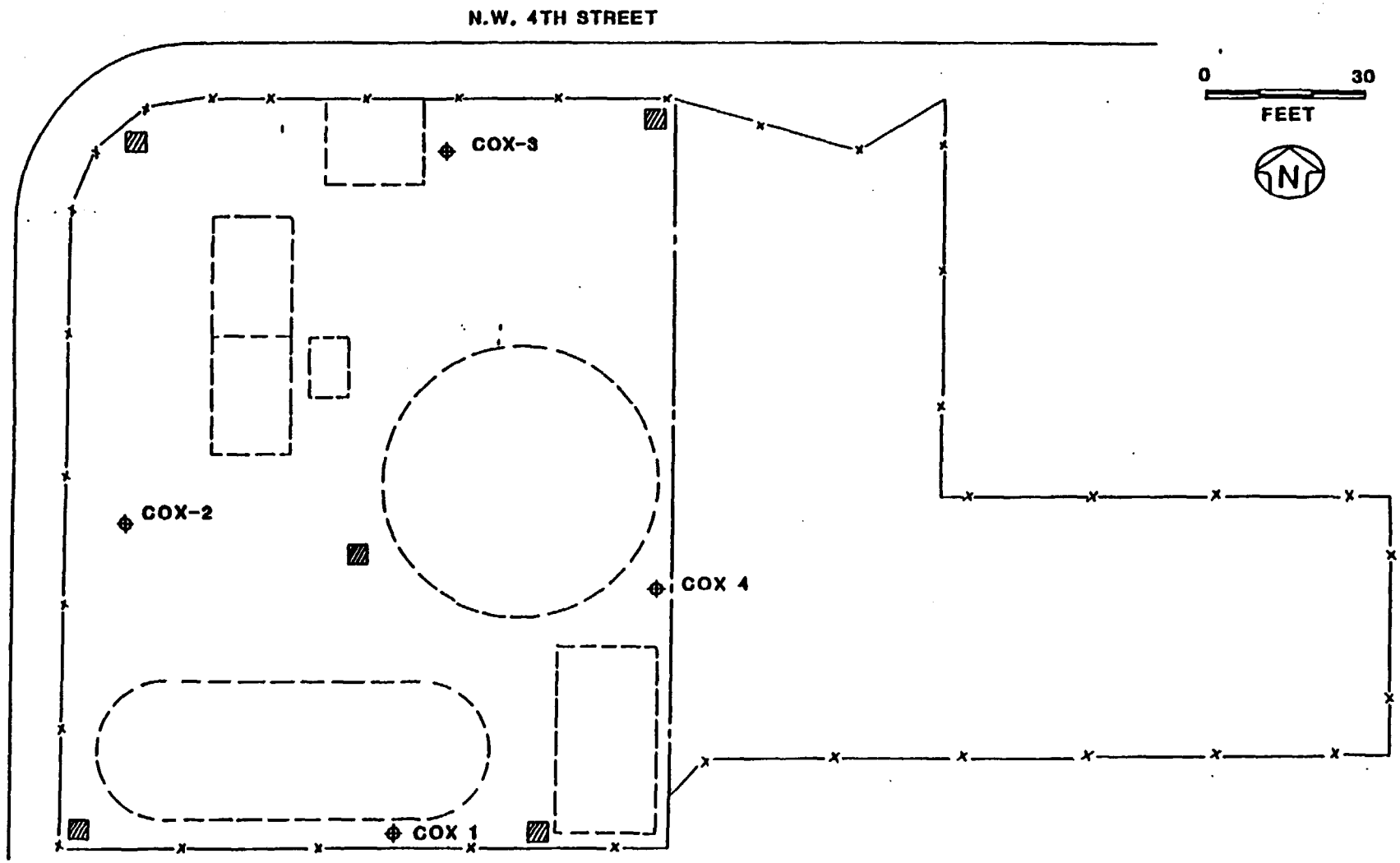


FIGURE 3
MONITORING WELL LOCATION MAP



GROUND-WATER MONITORING WELL

BACKHOE TEST PIT

Copyright ERM-South, Inc. 1987

with the screened interval within the first laterally continuous water-bearing zone beneath the peat-type material, if a perched water table existed.

The total depth sampled during the drilling operation varied between 12 and 16 feet below land surface in anticipation of locating these deposits. A moderate- to dusky-brown, silty, fine-sand was encountered at varying depths in all the borings. These soils resembled the apparent peat-type soil in color, as observed during the Phase I investigation, but no fibrous material was observed in any of the borings. Due to the absence of the peat deposits and observation of a continuous saturated zone during the soil boring program, the concept of a perched water table at the Ft. Lauderdale site was discounted. The boring at COX-1 was sampled to a depth of 16 feet below land surface, while sampling was terminated at 14 feet at COX-2, due to cave-in of soils from above. The water table was encountered at between three and four feet below land surface and contributed to the soil collapse in COX-2. The soils were composed entirely of medium to fine sand-sized materials. COX-3 and COX-4 borings encountered silt with small pieces (0.25 to 0.50 inch diameter) of limestone at 11.8 and 11 feet below land surface, respectively, while above this were found the same sand-sized materials as in COX-1 and COX-2, beginning at 4.4 and 7.7 feet below land surface, respectively.

These borings were converted to ground-water monitoring wells by enlarging the bore hole with a 7.25 inch O.D. hollow-stem auger and inserting a two-inch I.D., Schedule 40 PVC casing and screen inside the hollow stem to the desired depth. All wells were completed with five feet of 0.010-inch machine-slotted PVC screen attached by threaded flush joint or couplings with stainless steel screws to an appropriate length blank riser to the surface. A clean silica sand filter pack was emplaced to one foot above the top of the screened interval. One foot of bentonite pellets was placed atop this filter pack, and the remaining annular space grouted to ground surface with "neat" cement. These wells were finished at the surface with a locking cap installed inside a 2' x 2' x 4" concrete pad with a manhole and cover. All down-hole equipment was steam-cleaned before sampling and augering and between borings.

The total depth of the wells varied with the nature of the geologic deposits encountered at each boring location. COX-1 and COX-2 were terminated at 15 feet below land surface in the sand-size materials, while COX-3 and COX-4 were terminated at 12 feet below land surface when the silt and limestone fragments were encountered, thus placing the screened interval within a water-producing zone to ensure that the wells would produce enough water to permit sample collection. A Detailed Well Construction Summary Sheet for each well is included as Appendix D. Each well was subsequently developed by overpumping until the discharged water was clear and free of fine-grained materials. All wells were surveyed by a licensed Florida surveyor and base maps prepared with the location of the wells and the elevations of the measuring point (MP) of each well corrected to mean sea level (MSL).

On April 10, 1986, water levels were measured in all wells to the nearest 0.01 foot and a water-table contour map prepared in the field to determine the upgradient well and sequence of sampling. Sampling was performed starting with the upgradient wells and sampling the downgradient well last. The Water-Level Data Summary Sheets are included in Appendix E, and the Water-Table Map is shown as Figure 4. The average water-table gradient from north to south across the site is 0.0003 feet/feet. The lack of large topographic contrasts or surface discharge features in the area would result in very flat hydraulic gradients. The on-site deposits would have a low hydraulic conductivity, based upon their observed grain-size distribution and result in very low ground water flow velocities. This sluggish south-southwesterly flow would limit the extent of water-quality impacts downgradient from the property boundary.

After measuring the water level in each well, each well was purged by pumping until a minimum of three casing volumes of water were removed and stability of pH, temperature and conductivity were reached for three successive measurements. The stabilized readings are shown in the Field Sample Record as Appendix F. This purging technique is followed to ensure that a representative ground-water quality sample was collected in each well. The intake hose of the pump was cleaned with Alconox soap and rinsed with deionized water prior to the beginning of purging at each well. Each well

was sampled with a clean PVC bailer, dedicated to that particular well. All water samples were analyzed by Thornton Laboratories in Tampa for polynuclear aromatic hydrocarbons by EPA Method 610.

The results of these analyses contained in Appendix G indicate that none of the wells, except COX-1, contained any of the base/neutral extractable organics. Well COX-1 contained 950 ug/l (ppb) naphthalene only. All other parameters were below detection limits in all wells. As can be seen from Figure 4, ground water flows in a southerly direction, toward well COX-1. The area around COX-1 has a lower elevation than the remainder of the site and has historically been reported to be the site's surface-water collection area. It appears, then, that continued and past surface-water drainage from the site to this portion of the site may be responsible for the ground-water quality impacts observed in well COX-1, in addition to residuals from the dismantling of the plant which may have been discharged to the ground. As stated earlier, surface-water drainage on site was reported to be collected in the vicinity of COX-1, the topographically low area, would then percolate down to the water table and possibly leach constituents from the surface soils, resulting in these observed ground-water quality impacts.

Based upon the results of our Phase II investigation, the water-quality impacts at the Ft. Lauderdale Peoples Gas facility were limited to only the southern portion of the property, and the following conclusions can be stated:

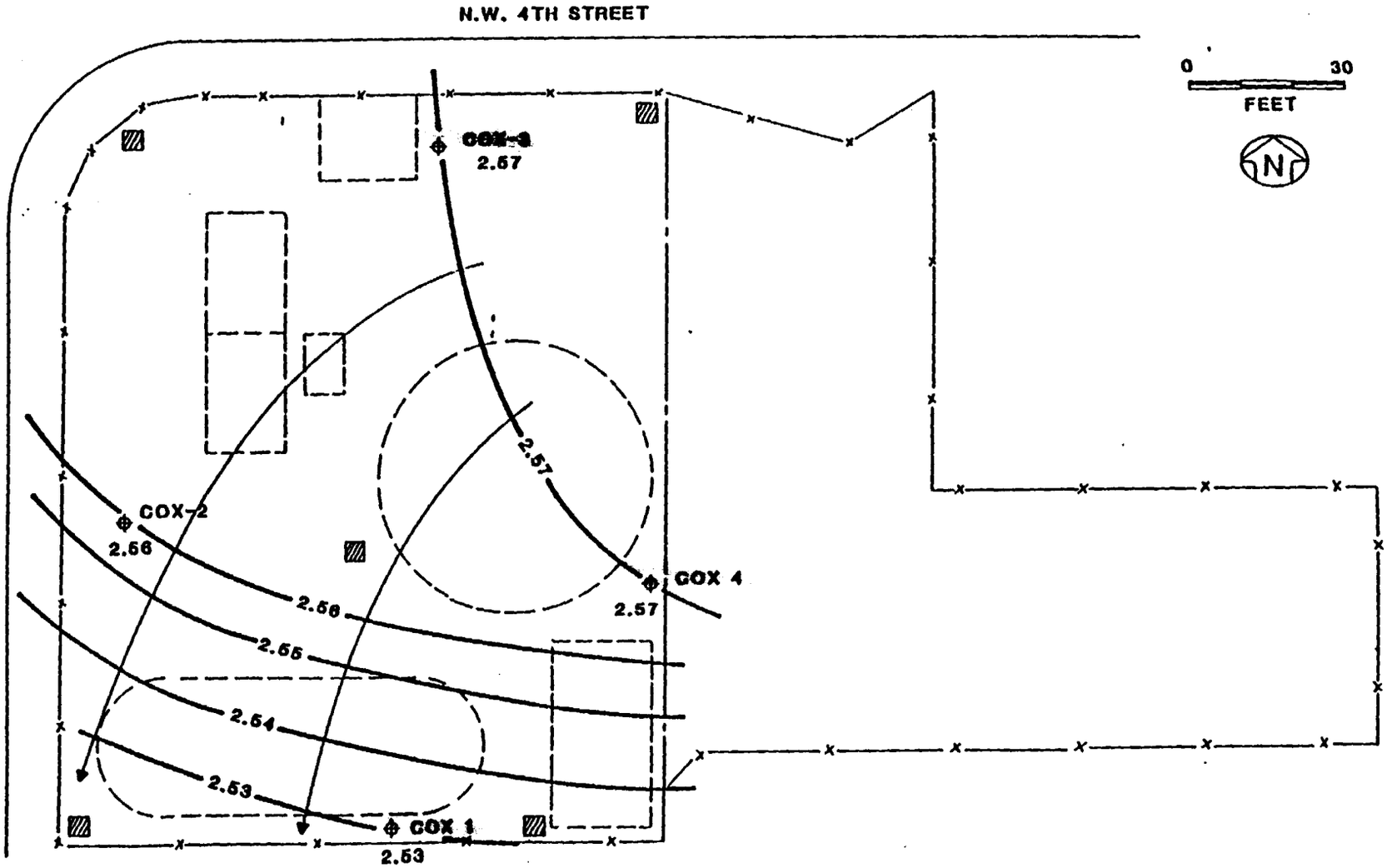
-- The site is located outside of any wellfield cones-of-influence;

-- The site is in an area which contains no drinking-water supply wells, as designated by BCEQCB;

-- There does not appear to be a perched water table on site, as originally suspected;

-- Ground water flows in a south-southwesterly direction under a low hydraulic gradient;

FIGURE 4
WATER TABLE MAP
4/10/86



GROUND-WATER MONITORING WELL
BACKHOE TEST PIT
2.57 WATER TABLE CONTOUR
GROUND-WATER FLOW DIRECTION

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-- Ground-water flow velocities and transport are expected to be low, based upon the fine-grained nature of the deposits and the low hydraulic gradients;

-- Ground-water quality impacts were detected in only one well, COX-1, and are likely related to seepage of surface-water drainage in that area to ground water;

-- Ground-water quality impacts detected at COX-1 were at low levels for only one base/neutral compound, naphthalene; and

-- Based upon the low ground-water flow velocities and limited extent of observed ground-water quality impacts, it is likely that the water-quality impacts are also limited in areal extent.

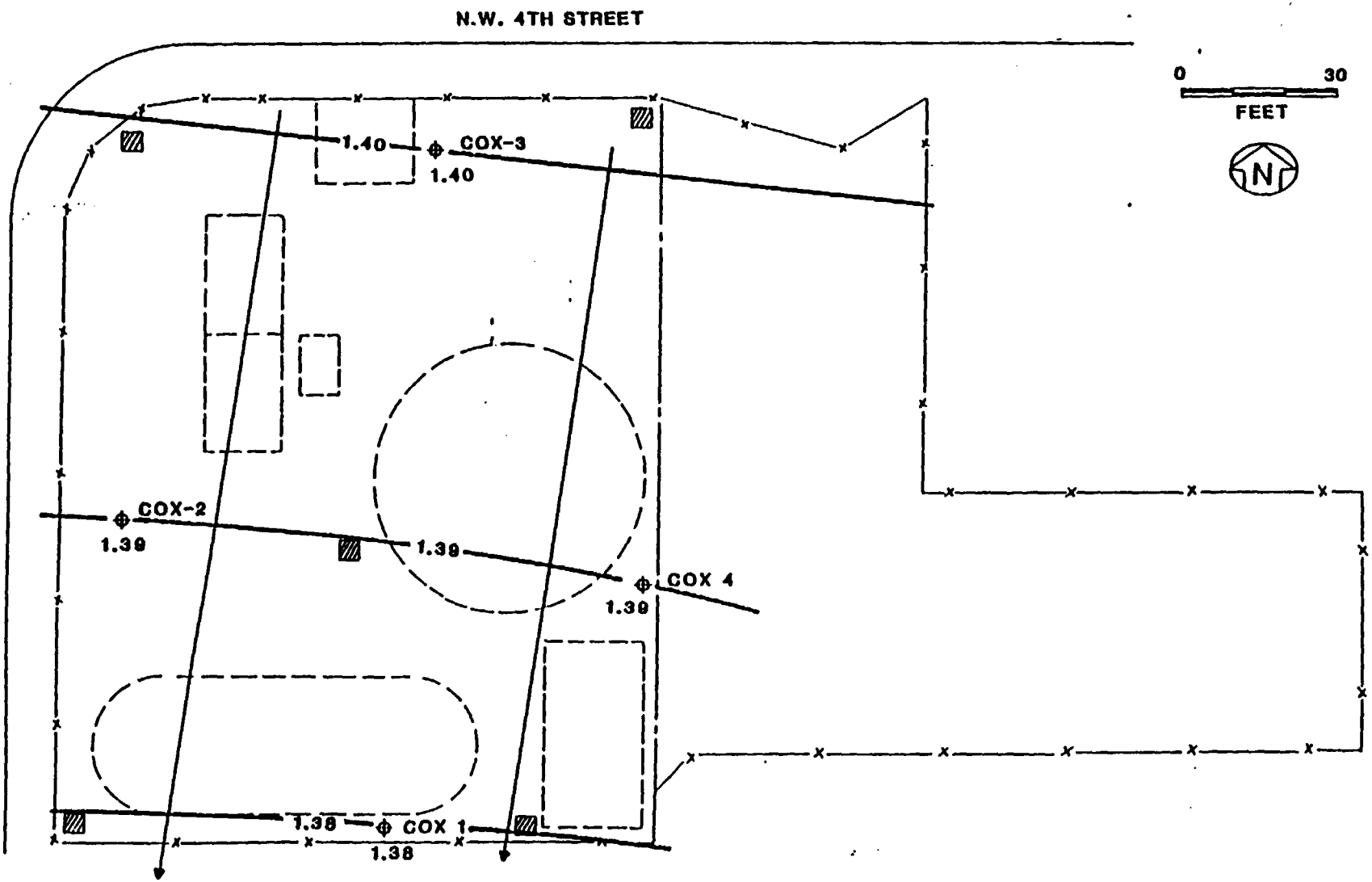
Phase III

On February 4, 1987, the four existing on-site wells were resampled and the water analyzed for total lead, dissolved lead and for EPA 602 and 610 parameters, as directed by BCEQCB to resolve the differences in analytical data obtained from ERM's and BCEQCB's laboratory. All samples collected throughout all phases of the investigation were maintained using strict chain-of-custody procedures. Chain-of-custody forms for all environmental samples are presented in Appendix H.

Prior to purging these wells for sampling, depth to water was measured to the nearest 0.01 foot. These measurements were corrected to mean sea level, contoured (Figure 5) and show that the water table is very flat, with a hydraulic gradient of 0.0002 ft/ft from north to south across the site, less than the gradient observed earlier. Ground-water flow is therefore very sluggish to the south.

The ground-water monitoring wells were sampled using the procedure described in Phase II and analyzed again by Thornton Laboratories using DER-approved QA/QC procedures. The results of the water-quality analysis are shown in Table 1, with the complete laboratory data sheets included as Appendix I.

FIGURE 5
WATER TABLE MAP



GROUND-WATER MONITORING WELL

BACKHOE TEST PIT

2.57 WATER TABLE CONTOUR

GROUND-WATER FLOW DIRECTION

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The ERM Group

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al:q47

TABLE 1
WATER-QUALITY ANALYSIS RESULTS
PEOPLES GAS SYSTEM
FT. LAUDERDALE, FLORIDA
FEBRUARY 4, 1987

PARAMETER	UNITS	DETECTION LIMIT	COX-1	COX-2	COX-3	COX-4	COX-10 (RINSE)	COX-11 (EQUIP)	COX-14 (COX-4) Dupe.
EPA 610's									
Acenaphthene	ug/l	5	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Acenaphthylene	ug/l	5	380	BDL	BDL	BDL	BDL	BDL	9.4
Anthracene & Phenanthrene	ug/l	5	150	BDL	BDL	BDL	BDL	BDL	BDL
Benzo (A) Anthracene & Chrysene	ug/l	5	75	BDL	BDL	BDL	BDL	BDL	BDL
Benzo (A) Pyrene	ug/l	5	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Benzo (B) Fluoranthene & Benzo (K) Fluoranthene	ug/l	5	BDL	BDL	BDL	6.5	BDL	BDL	9.7
Benzo (GHI) Perylene	ug/l	10	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Dibenzo (A,H) Anthracene	ug/l	10	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Fluoranthene	ug/l	5	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Fluorene	ug/l	5	60	BDL	BDL	BDL	BDL	BDL	BDL
Indeno (1,2,3-CD) Pyrene	ug/l	10	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Naphthalene	ug/l	5	920	6.1	BDL	BDL	BDL	BDL	BDL
Pyrene	ug/l	5	BDL	BDL	BDL	BDL	BDL	BDL	BDL
EPA 602's									
Benzene	ug/l	10	1360	BDL	BDL	BDL	BDL	BDL	BDL
Chlorobenzene	ug/l	10	BDL	BDL	BDL	BDL	BDL	BDL	BDL
Ethylbenzene	ug/l	10	129	BDL	BDL	BDL	BDL	BDL	BDL
Toluene	ug/l	10	36	BDL	BDL	BDL	BDL	BDL	BDL
o+p-Xylene	ug/l	10	250	BDL	BDL	BDL	BDL	BDL	BDL
m-Xylene	ug/l	10	186	BDL	BDL	BDL	BDL	BDL	BDL
Total BTX	ug/l		1961	0	0	0	0	0	0
Lead	mg/l	.01	.03	<0.01	<0.01	.05	<0.01	<0.01	.06
Dissolved Lead *	mg/l	.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

BDL : BELOW DETECTION LIMIT
* : FILTERED IN FIELD

The analyses indicate that the ground water from COX-1 contains naphthalene at a concentration (920 ug/l (ppb)) nearly equal to that measured in April 1986 (950 ug/l). COX-1 ground water was found to also contain other EPA 610 parameters which had not been detected by ERM during the earlier sampling program (Table 1). In addition to the EPA 610 parameters, the sample from well COX-1 also was found to contain other EPA 602 parameters, as shown in Table 1.

Low levels of several other EPA 610 compounds were detected in COX-2 and COX-4, but all were near the detection limit. No EPA 602 compounds (purgeable aromatics) were detected in any well other than well COX-1. Total and dissolved lead concentrations measured in the ground water are all below the National Interim Primary Drinking Water Standard for lead of 0.05 mg/l.

CONCLUSIONS AND RECOMMENDATIONS

Results of the Phase III sampling program confirmed the presence of ground-water quality impacts identified in the earlier ERM investigation. The expanded scope of the analytical testing program and lower laboratory detection limits achieved during the Phase III study resulted in additional EPA 610 and 602 parameters identified in on-site wells. However, well COX-1, the downgradient well, is the only well on site showing the presence of both classes of compounds.

Conclusions regarding the magnitude and extent of impacts identified during the previous phases of this investigation are not significantly altered. It appears that water-quality impacts are highly localized and, based upon site geologic and hydrogeologic conditions, the potential for downgradient migration is limited. Further ground-water quality investigations may not be particularly enlightening with respect to additional water-quality impacts. It is recommended that a quarterly monitoring program for the EPA 610 and 602 parameters be implemented to ensure that no changes occur in water-quality characteristics prior to closure of all site activities.

The ERM Group

ERM appreciates the opportunity to assist you with this project. If you have any questions, do not hesitate to contact either Bob Bretnall or me.

Sincerely yours,

Paul Gruber, P.G.
Principal

Robert E. Bretnall, Jr.
Hydrogeologist

PG:bai

APPENDIX A

CORRESPONDENCE BETWEEN ERM AND BCEQCB

ERM-South, Inc.
Environmental Resources Management

5035 East Busch Boulevard • Suite 4 • P.O. Box 290918 • Tampa, Florida 33617 ☎ (813) 985-0335
1637 N.W. 79th Avenue • Miami, Florida 33126 ☎ (305) 591-3076

Reply To: Tampa office

January 20, 1987

Mr. Victor N. Howard, P.E.
Pollution Control Officer
Broward County Environmental
Quality Control Board
500 S.W. 14th Court
Ft. Lauderdale, FL 33315

RE: Peoples Gas System, Inc., Cox Plant, Ft. Lauderdale, Florida

Dear Mr. Howard:

Upon receipt of your letter containing the analytical results for the two split samples which were analyzed by Broward County EQCB for the Peoples Gas Ft. Lauderdale, Cox Plant and review of the analytical data, several questions were raised about the detection limits for methods used for analysis. I had several subsequent conversations with George Reilly of your office about the detection limits associated with these results, especially since they were two orders of magnitude lower than those achieved by our subcontract laboratory.

The particular concern we have regarding the collection of additional ground water quality samples from the existing on-site monitoring wells relates to the ability to achieve the detection limits which your laboratory was able to reach for the two analyses BCEQCB completed from the Peoples Gas site. The laboratory ERM selected to use for the ground water analyses at the PGS site in Ft. Lauderdale has an FDER-approved Quality Assurance/Quality Control Plan and has identified their method detection limits for the parameters your requested which range between 10 and 25 ug/l. Occasionally, if the range of concentration in the sample is low enough, a detection limit of 1 ug/l can be achieved. These detection limits are acceptable to the Water Quality Assurance section of the Florida DER, as evidenced by Thornton Laboratories' approval of their QA/QC Plan. Upon further analysis and review of 40 CFR Part 136, July 1982, the U.S. Enviornmental Protection Agency pub-

lished method detection limits which were also higher than those achieved by your laboratory utilizing the same techniques followed by Thornton Laboratories.

While I have no doubt, especially after talking to Mr. Reilly, that your laboratory achieved these detection limits, I have serious doubts that these detection limits would be repeatable and accurate on a routine basis if all of the wells on site had been split with your laboratory. On discussing the problem with Mr. Reilly, he had indicated to me that the analytical results reported by Thornton Laboratories at their stated detection limits which, again, are acceptable to the Florida DER, should be acceptable to the Broward County Environmental Quality Control Board. Thornton Laboratories will make every effort to achieve the lowest detection limit, but I am not sure if their analytical instrument procedures for the next set of samples will be able to achieve the detection limits which your laboratory was able to achieve. Due to the differences in laboratory detection limits and my client's concerns, I discussed the detection limit problem with Mr. Reilly shortly after Christmas. Mr. Reilly indicated to me that he felt that Thornton Laboratories' detection limits were acceptable and should be used as the basis for determining what level of activity, if any, should be undertaken when the data for the next round of ground water quality sampling is presented. I wanted to bring this issue to your attention so that there will be no misunderstanding about the acceptable laboratory detection limits.

ERM intends to collect additional ground water samples from the existing on-site monitoring wells and have these samples analyzed by EPA Methods 602 and 610 for the laboratory detection limits identified in Thornton Laboratories' QA/QC Plan. It is our intention to sample these monitoring wells during the week of January 26, 1987. We will contact Ms. Wu directly during the week of January 19 to arrange for a

The ERM Group

mutually agreeable time and date for sampling. I appreciate your attention to this matter. Please contact me if you have any questions about the enclosed material.

Sincerely yours,

Paul Gruber, P.G.

PG:bai

cc: Madelaine Wu, Broward County EQCB
Charles Montague, Peoples Gas System
Ed Champion, Peoples Gas System
Fred Hartledge, Thornton Laboratories
J.S. Benyon, DER - West Palm Beach
Newt Bollinger - Peoples Gas System

The ERM Group

APPENDIX B

SOIL LABORATORY ANLAYSIS
12/23/85

THORNTON LABORATORIES, INC.
1145 EAST CASS STREET
TAMPA, FLORIDA 33601 - 2880
MARINE, ANALYTICAL AND ENVIRONMENTAL SERVICES

TWX 810 876-9134
THORNT LAB TPA

TELEPHONE (813) 223-9702
P.O. BOX 2880

January 13, 1986

REC'D JAN 14 1986

Laboratory Number 630482

Sample of Soil

Date Received December 26, 1985

For Environmental Resource Management South, Inc.
P.O. Box 290918
Tampa, FL 33617

Attn: Mark Culbreath

Marks: PGS Soil #1

CERTIFICATE OF ANALYSIS
EP TOXICITY
CONCENTRATION OF CONTAMINANTS IN EXTRACT*

EPA Hazardous Waste Number	Contaminant	Maximum Concentration (milligrams per liter)	Concentration Sample Extract (milligrams per liter)
D-004	Arsenic (As)	5.0	<0.5
D-005	Barium (Ba)	100.0	<10
D-006	Cadmium (Cd)	1.0	<0.1
D-007	Chromium (Cr)	5.0	<0.5
D-008	Lead (Pb)	5.0	<0.5
D-009	Mercury (Hg)	0.2	<0.02
D-010	Selenium (Se)	1.0	<0.1
D-011	Silver (Ag)	5.0	<0.5

* Prepared and analyzed in accordance with Identification and Listing of Hazardous Waste, EPA 8700-12 (FR) Federal Register Vol. 45, No. 98, May 19, 1980.

Ignitiability (Flash Point) Does not flash below 140 degrees F.

Reactivity - Reactive

Sulfide - <1.0 mg/kg

Cyanide - 3.5 mg/kg

THORNTON LABORATORIES, INC.

APPENDIX C

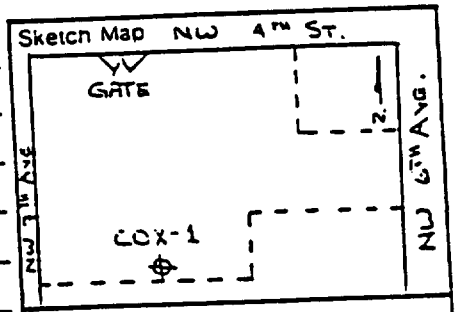
DRILLING LOGS

Drilling Log

Environmental Resources Management

Project: Peoples Gas — Owner: Peoples Gas
Location: Ft. Lauderdale, Fl. — W.O. Number: 134-04
Well Number: COX-1 — Total Depth: 16 feet — Diameter: 7¼" O.D.
Surface Elevation: 5.7' msl — Water Level: Initial: — 24-hrs: ~4.5' btoc
Screen: Dia. 2 inches — Length: 5 feet — Slot Size: 0.010 inch
Casing: Dia. 2 inches — Length: 10 feet — Type: Sch. 40 PVC
Drilling Company: J.M. Hensley — Drilling Method: Hollow Stem Auger
Driller: J.M. Hensley — Log By: R. Bretnall — Date Drilled: 3/11/86

Sketch Map



Notes

Depth (Feet)	Graphic Log	Well Construction	Sample Number	Description/Soil Classification (Color, Texture, Structures)
				N: 140 lb Hammer Blows Per 6 Inches Penetrated — N/S: Not Sampled
1			1 1 4 4	0-1'6": Sand, Pale Yellowish Brown (10YR 6/2), Medium to Fine, Well Sorted, Loose.
2			12 12	1'6"-2': Sand, Very Pale Orange (10YR 8/2) to Pale Yellowish Brown (10YR 6/2), Medium to Fine, Well Sorted, Some Roots, Loose.
3			9 10	2'-2'3": Sand, Dark Yellowish Brown (10YR 4/2), Medium to Fine, Silty, Loose.
4			7 8	2'3"-2'5": Concrete.
5			8 8	2'5"-4': Sand, Very Light Grey (N8) to Light Brownish Grey (5YR 6/1), Mottled, Medium to Fine, Well Sorted, Loose.
6			7 6	4'-4'3": Sand, Light Grey (N7), Fine, Well Sorted, Loose, Moist.
7			5 4	4'3"-4'5": Sand, Medium Dark Grey (N4), Fine, Well Sorted, Loose, Moist.
8			2 3	4'5"-6': Sand, Dark Grey (N3) to Greyish Black (N2), Fine, Well Sorted, Loose, Wet, Odor, Oily.
9			2 2	6'-6'6": Same As Above, Odor.
10			1 1	6'6"-8': Sand, Moderate Brown (5YR 3/4), Medium to Fine, Well Sorted, Loose, Saturated (Wet), Odor.
11			2 3	8'-10': Sand, Moderate Brown (5YR 3/4), Fine, Silty, Loose, Saturated (Wet), Odor.
12			6 12	10'-12': Sand, Greyish Brown (5YR 3/2) to Dusky Brown (5YR 2/2), Fine, Silty, Loose, Saturated, Odor with 1" lens Sand, Very Pale Orange (10YR 8/2), Cemented.
13			16 12	
14			9 12	
15			13 12	
16				

Drilling Log

Environmental Resources Management

Project _____ Owner _____

Location _____ W.O. Number _____

Well Number COX-1 Total Depth _____ Diameter _____

Surface Elevation _____ Water Level: Initial _____ 24-hrs. _____

Screen: Dia. _____ Length _____ Slot Size _____

Casing: Dia. _____ Length _____ Type _____

Drilling Company _____ Drilling Method _____

Driller _____ Log By _____ Date Drilled _____

Sketch Map

Notes

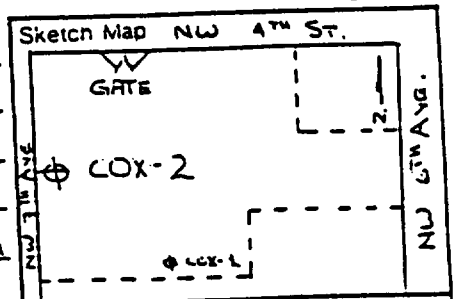
Depth (Feet)	Graphic Log	Well Construction	Sample Number	Description/Soil Classification (Color, Texture, Structures)
				12'-14': SAND, GREYISH ORANGE (10YR 7/4), FINE, LOOSE, SATURATED.
				14'-16': SAND, MODERATE YELLOWISH BROWN (10YR 5/4), FINE TO MEDIUM, LOOSE, SATURATED.

Drilling Log

Environmental Resources Management

Project: PEOPLES GAS Owner: PEOPLES GAS
Location: FT. LAUDERDALE, FL. W.O. Number: 134-04
Well Number: COX-2 Total Depth: 15 FEET Diameter: 7 1/4"
Surface Elevation: 5.9' AMSL Water Level: Initial: —— 24-hrs: ~4.5' BTOC
Screen: Dia. 2 INCHES Length: 5 FEET Slot Size: 0.010 INCH
Casing: Dia. 2 INCHES Length: 10 FEET Type: SCH. 40 PVC
Drilling Company: J.M. HENSLEY Drilling Method: HOLLOW STEM AUGER
Driller: J.M. HENSLEY Log By: R. BRETNALL Date Drilled: 3/11/86

Sketch Map



Notes

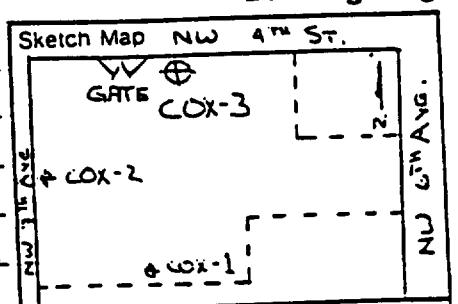
Depth (Feet)	Graphic Log	Well Construction	Sample Number	Description/Soil Classification (Color, Texture, Structures)
				N: 140 LB HAMMER BLOWS PER 6 INCHES PENETRATED — N/S: NOT SAMPLED
1			3	0-1': SAND, PALE BROWN (5YR 5/2) TO GREYISH BROWN (5YR 3/2), MEDIUM, LOOSE, DRY, WITH SOME CONCRETE PIECES.
2			4	1'-2': SAND, PALE YELLOWISH BROWN (10YR 6/2), MEDIUM TO FINE, WELL SORTED, LOOSE, WITH SOME CONCRETE PIECES.
3			7	2'-4': SAME AS ABOVE.
4			7	4'-5': SAME AS ABOVE.
5			8	5'-6': SAND, DUSKY BROWN (5YR 2/2), FINE, SILTY, LOOSE, WET, ODOR, PETROLEUM (GASOLINE?), WITH SOME ROOTS.
6			10	6'-6'10": SAND, PALE YELLOWISH BROWN (10YR 6/2), FINE, LOOSE, WET.
7			8	6'10"-7'8": SAND, GREYISH BROWN (5YR 3/2), FINE, LOOSE, WET.
8			10	7'8"-8': SAND, MODERATE BROWN (5YR 3/4), FINE, SILTY, LOOSE, WET, ODOR.
9			4	8'-9'6": SAND, BROWNISH GREY (5YR 4/1), FINE, LOOSE, WET, ODOR.
10			5	9'6"-10': SAND, VERY LIGHT GREY (N8), FINE, SILTY, LIMEY, VERY LOOSE, WITH PIECES OF HARD LIMESTONE.
11			5	10'-12': SAND, VERY LIGHT GREY (N8), FINE, SILTY, LIMEY, LOOSE, MANY HARD LIMESTONE PEBBLES.
12			6	12'-14': SAME AS ABOVE.
13			4	14-16': NOT SAMPLED.
14	N/S		3	
15			4	
16	N/S		5	

Drilling Log

Environmental Resources Management

Project: PEOPLES GAS Owner: PEOPLES GAS
Location: FT. LAUDERDALE, FL. W.O. Number: 134-04
Well Number: COX-3 Total Depth: 16 FEET Diameter: 7 1/4"
Surface Elevation: 6.4' AMSL Water Level: Initial: —— 24-hrs: ~4.5' BTOC
Screen: Dia. 2 INCHES Length: 5 FEET Slot Size: 0.010 INCH
Casing: Dia. 2 INCHES Length: 7 FEET Type: SCH. 40 PVC
Drilling Company: J.M. HENSLEY Drilling Method: HOLLOW STEM AUGER
Driller: J.M. HENSLEY Log By: R. BRETNALL Date Drilled: 3/12/86

Sketch Map



Notes

Depth (Feet)	Graphic Log	Well Construction	Sample Number	Description/Soil Classification (Color, Texture, Structures)
				N: 140 LB HAMMER BLOWS PER 6 INCHES PENETRATED — N/S: NOT SAMPLED
1			4 9 5	0-1': SAND, MODERATE BROWN (5YR 4/4), FINE, SILTY, LOOSE.
2			4 4 4	1'-2': SAND, VERY LIGHT GREY (N8) TO WHITE (N9), MEDIUM, WELL SORTED, CLEAN, LOOSE.
3			3 4 3	2'-3': SAME AS ABOVE.
4			3 3 3	3'-4': SAND, VERY LIGHT GREY (N8) TO BROWNISH GREY (5YR 4/1), MOTTLED, MEDIUM TO FINE, LOOSE.
5			3 2 2	4'-5'8": SAME AS ABOVE, MOIST.
6			2 1 1	5'8"-6': SAND, GREYISH BROWN (5YR 3/2), MEDIUM TO FINE, SATURATED, LOOSE.
7			1 1 1	6'-7': SAME SAND AS 3'-4' INTERVAL ABOVE.
8			1 3 6	7'-8': SAND, DUSKY BROWN (5YR 2/2), FINE, SILTY, SATURATED LOOSE.
9			5 6 5	8'-10': SAME AS ABOVE.
10			3 4 7	10'-11'10": SAME AS ABOVE.
11			9 12	11'10"-12': SILT, VERY LIGHT GREY (N8) TO LIGHT GREY (N7), LIMEY WITH SMALL (0.25" DIAMETER) PIECES OF LIMESTONE.
12				12'-14': SAME AS ABOVE WITH LARGER (0.50" DIAMETER) PIECES OF LIMESTONE.
13				14'-16': SAME AS ABOVE.
14				
15				
16				

Environmental Resources Management

Drilling Log

Project: PEOPLES GAS Owner: PEOPLES GAS

Location: FT. LAUDERDALE, FL. W.O. Number: 134-04

Well Number: COX-4 Total Depth: 12 FEET Diameter: 7 1/4"

Surface Elevation: 6.1' AMSL Water Level: Initial: —— 24-hrs: ~4.5' BTOC

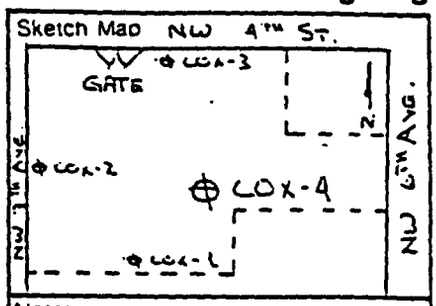
Screen: Dia. 2 INCHES Length: 5 FEET Slot Size: 0.010 INCH

Casing: Dia. 2 INCHES Length: 7 FEET Type: SCH. 40 PVC

Drilling Company: J.M. HENSLEY Drilling Method: HOLLOW STEM AUGER

Driller: J.M. HENSLEY Log By: R. BRETNALL Date Drilled: 3/12/86

Sketch Map



Notes

Depth (Feet)	Graphic Log	Well Construction	Sample Number	Description/Soil Classification (Color, Texture, Structures)
				N: 140 LB HAMMER BLOWS PER 6 INCHES PENETRATED N/S: NOT SAMPLED
1			3 5 5	0'-2': SAND, MODERATE YELLOWISH BROWN (10 YR 5/4), MEDIUM WELL SORTED, LOOSE.
2			5 5	2'-2'2": SAME AS ABOVE.
3			9 9	2'2"-4': SAND, GREYISH ORANGE (10 YR 7/4), MEDIUM TO FINE, LOOSE.
4			9 6	4'-5': SAME AS ABOVE.
5			4 3	5'-6': SAND, MODERATE BROWN (5 YR 3/4), MEDIUM TO FINE, MOIST LOOSE.
6			3 1	6'-8': SAME AS ABOVE, SATURATED.
7			1 1	8'-10': SAME AS ABOVE, SATURATED.
8			1 1	10'-11': SAME AS ABOVE.
9			1 1	11'-12': SILT, VERY LIGHT GREY (N8) TO LIGHT GREY (N7), LIMEY, WITH PIECES OF LIMESTONE.
10			3	
11			7 12	
12			12	

APPENDIX D

DETAILED WELL CONSTRUCTION SUMMARIES

ERM-South, Inc.

DETAILED WELL CONSTRUCTION SUMMARY

NOT TO SCALE

FEET, ABOVE(+) OR BELOW(-) LAND SURFACE

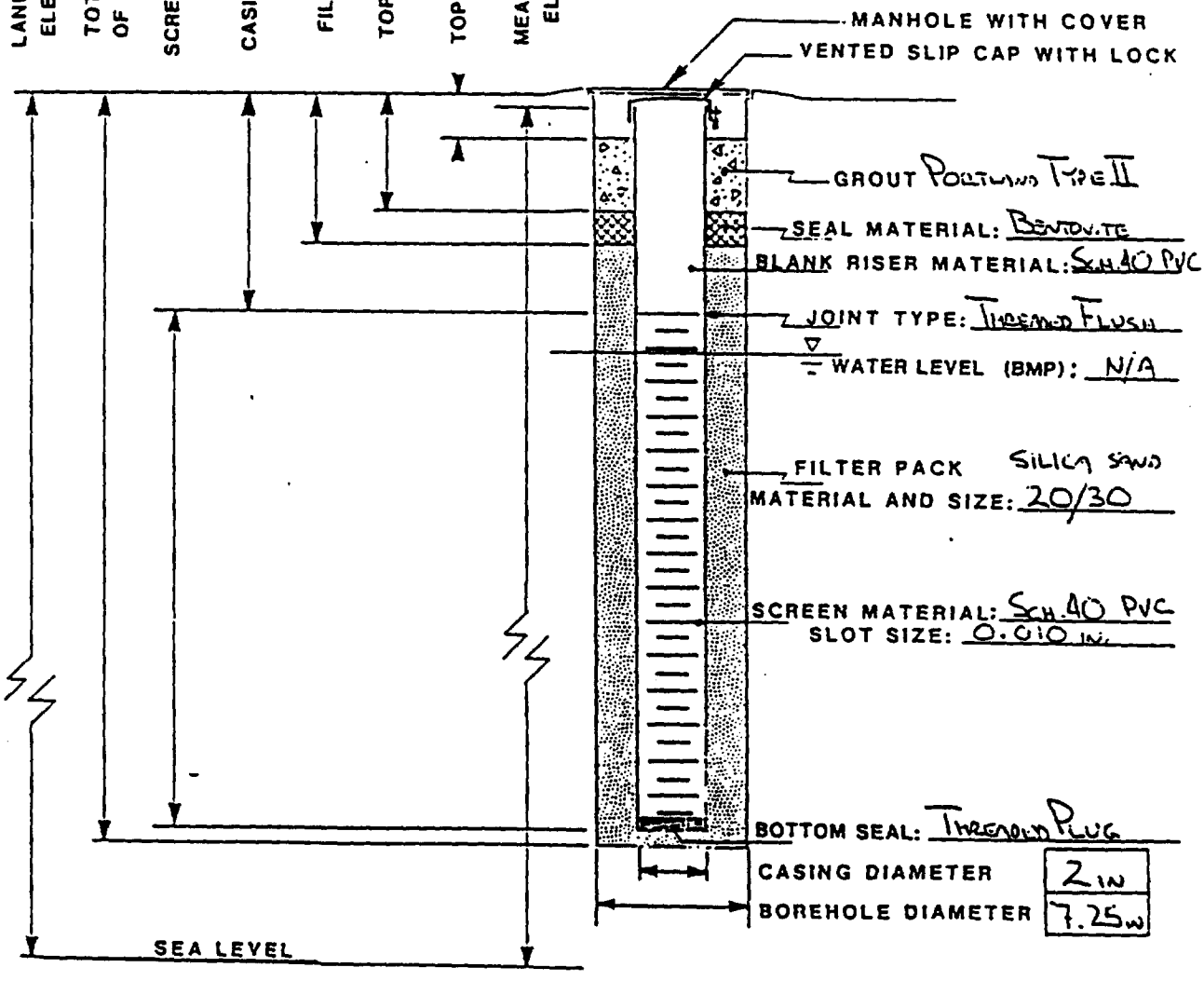
LAND SURFACE ELEVATION	TOTAL DEPTH OF BOREHOLE	SCREENED LENGTH	CASING LENGTH	TOP OF FILTER PACK	TOP OF SEAL	TOP OF GROUT	MEASURING POINT ELEVATION
5.7'	15'	5'	10'	-9'	-8'	-.5'	5.75'

PROJECT NUMBER: 134-04

LOCATION: Ft. Lauderdale, FL.

WELL NUMBER: COX-1

DATE INSTALLED: 3/11/86



ERM-South, Inc.

DETAILED WELL CONSTRUCTION SUMMARY

NOT TO SCALE

FEET, ABOVE(+) OR BELOW(-) LAND SURFACE

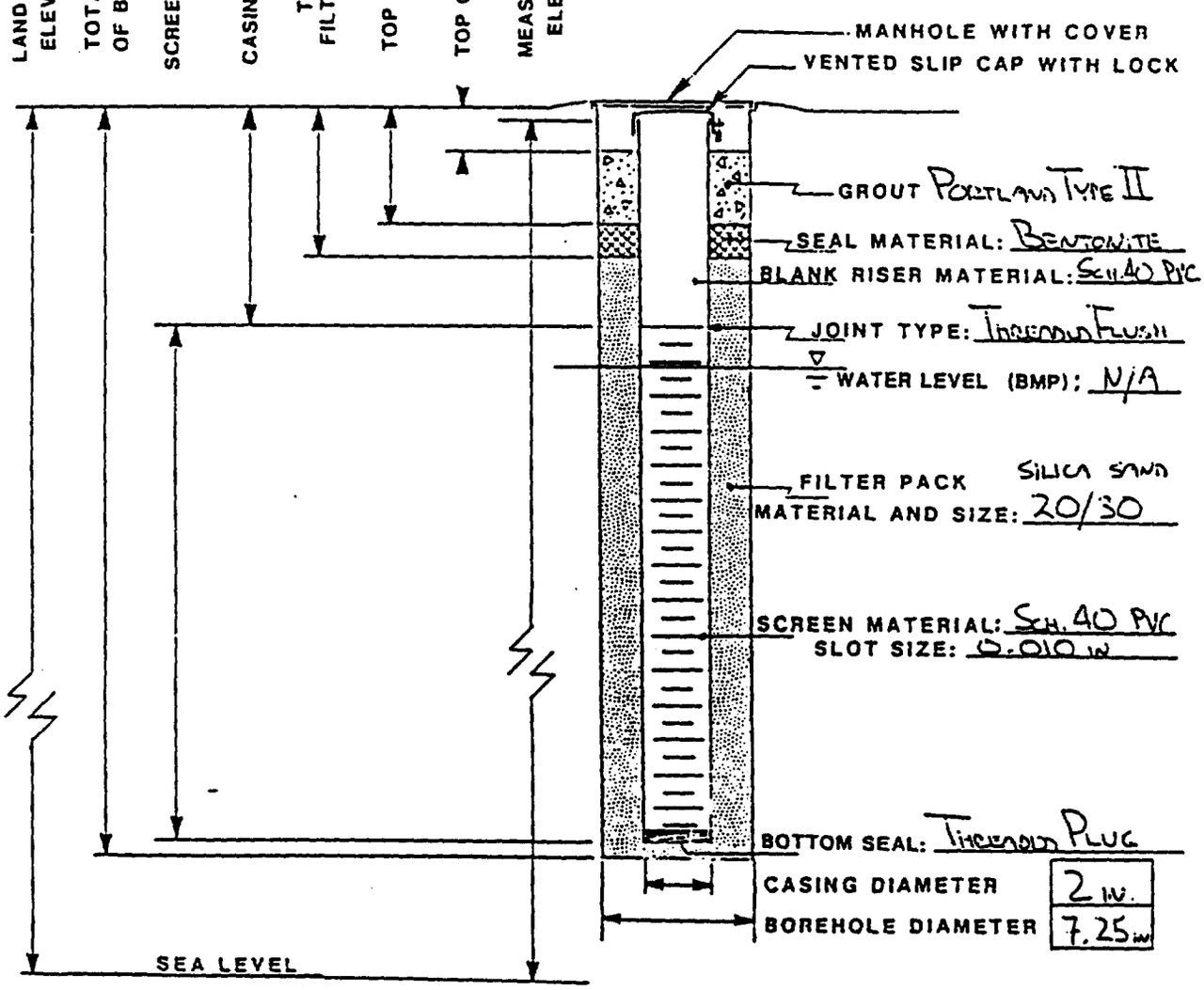
PROJECT NUMBER: 134-04

LOCATION: Ft. Lauderdale, Fl.

WELL NUMBER: COX-2

DATE INSTALLED: 3/11/86

LAND SURFACE ELEVATION	TOTAL DEPTH OF BOREHOLE	SCREENED LENGTH	CASING LENGTH	TOP OF FILTER PACK	TOP OF SEAL	TOP OF GROUT	MEASURING POINT ELEVATION
5.9'	15'	5'	10'	-9'	-8'	-.5'	5.89'



ERM-South, Inc.

DETAILED WELL CONSTRUCTION SUMMARY

NOT TO SCALE

FEET, ABOVE(+) OR BELOW(-) LAND SURFACE

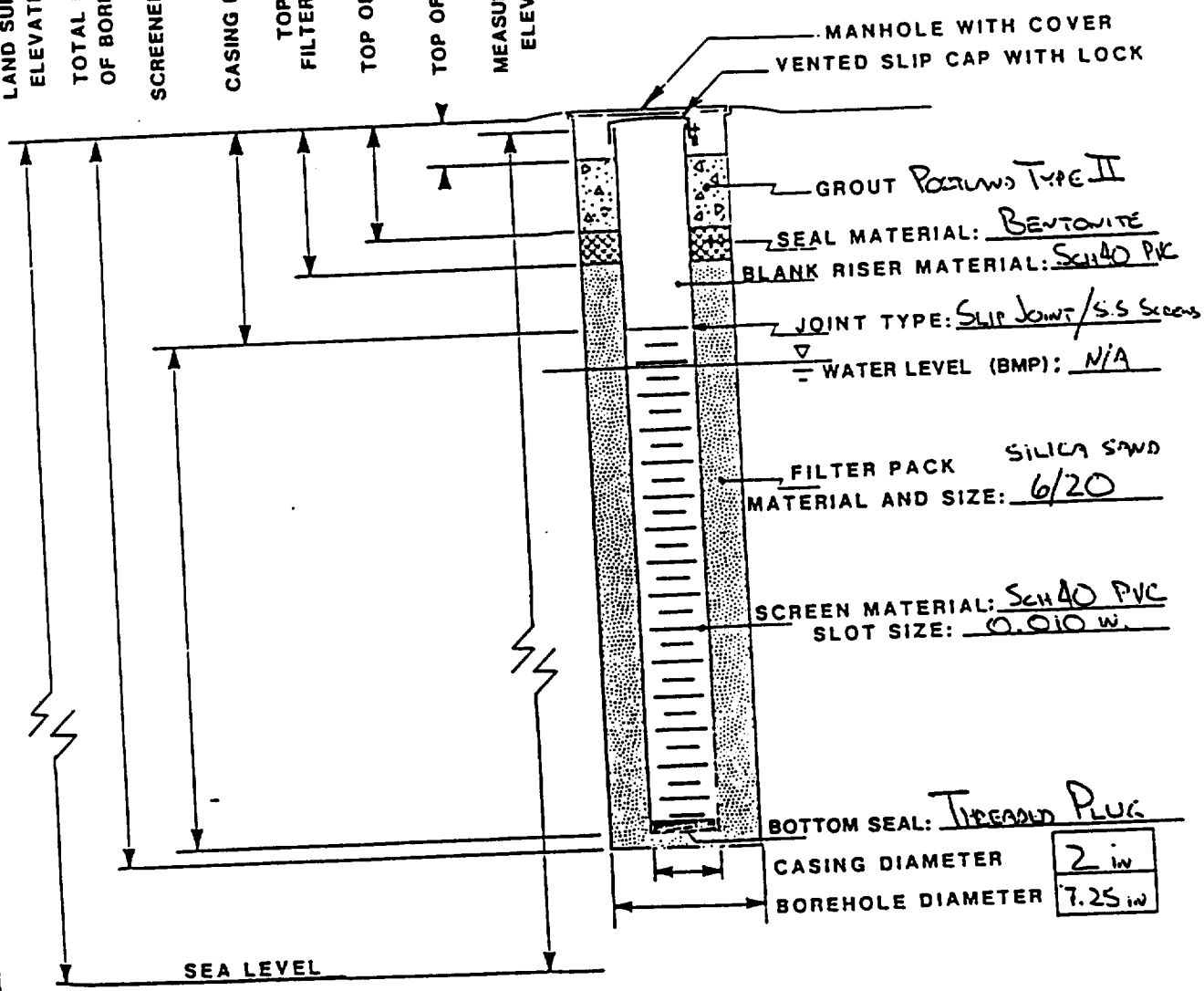
LAND SURFACE ELEVATION	TOTAL DEPTH OF BOREHOLE	SCREENED LENGTH	CASING LENGTH	TOP OF FILTER PACK	TOP OF SEAL	TOP OF GROUT	MEASURING POINT ELEVATION
6.4'	12'	5'	7'	-6'	-5'	-.5'	6.37

PROJECT NUMBER: 134-04

LOCATION: Ft. Lauderdale, Fl.

WELL NUMBER: COX-3

DATE INSTALLED: 3/12/86



ERM-South, Inc.

DETAILED WELL CONSTRUCTION SUMMARY

NOT TO SCALE

FEET, ABOVE(+) OR BELOW(-) LAND SURFACE

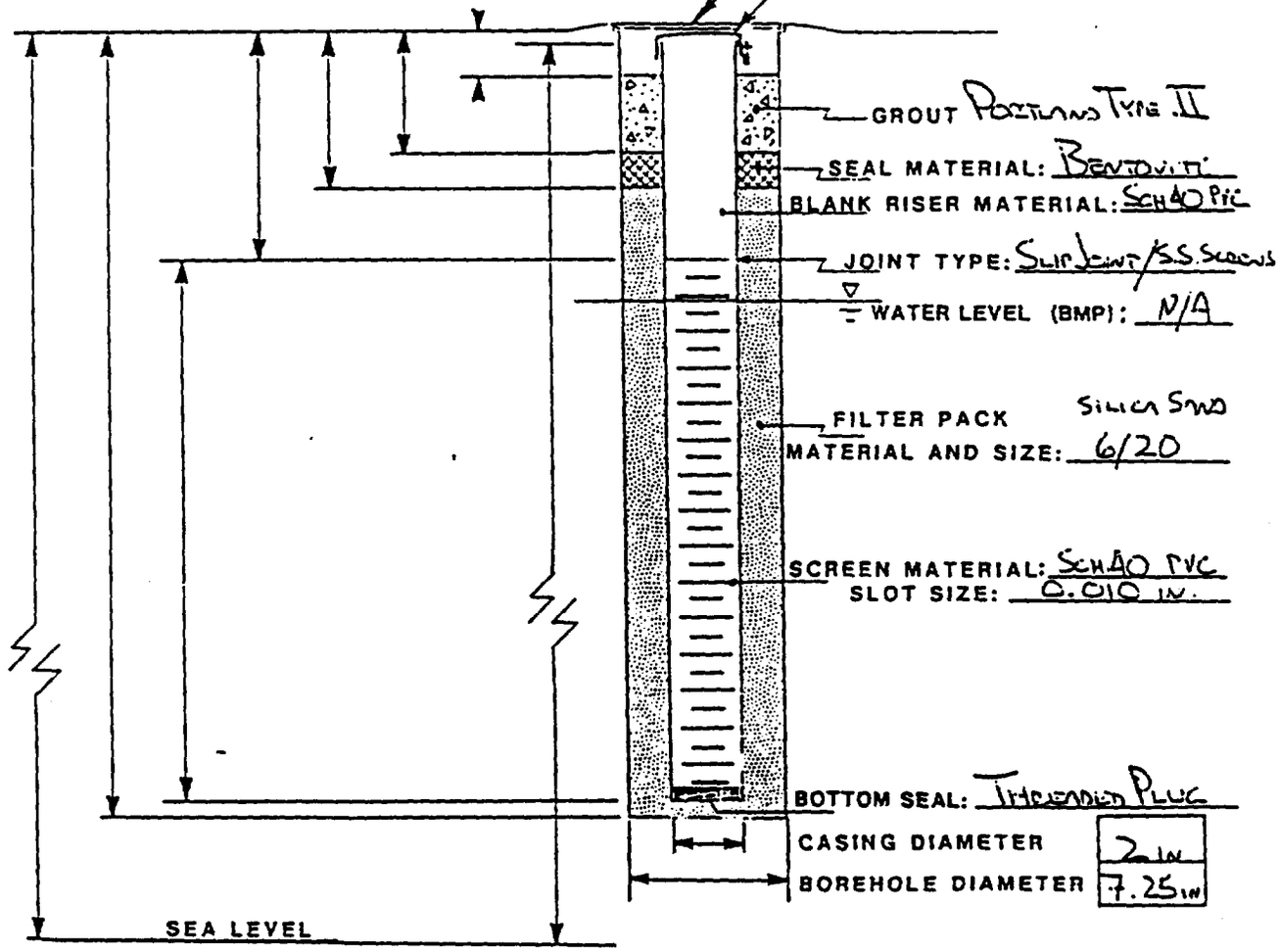
PROJECT NUMBER: 134-04

LOCATION: Ft. Lauderdale, FL

WELL NUMBER: COX-A

DATE INSTALLED: 3/12/86

LAND SURFACE ELEVATION	TOTAL DEPTH OF BOREHOLE	SCREENED LENGTH	CASING LENGTH	TOP OF FILTER PACK	TOP OF SEAL	TOP OF GROUT	MEASURING POINT ELEVATION
6.1'	12'	5'	7'	-6'	-5'	-.5'	5.94



APPENDIX E

WATER-LEVEL DATA SUMMARIES

Environmental Resources Management

Water Level Data Summary

Project PEOPLES GAS, FT. LAUDERDALE Station Location COX-1

Elevation of Measuring Point 5.75 ft. Land Surface Elevation 5.7 ft. Height of M.P. Above L.S. +0.05 ft.

Date	Time	Elevation of M.P. (+ MSL)	− Water Level Below M.P. (ft)	= Water Level Elevation (+ MSL)	Water Level Below M.P. (ft)	− Height of M.P. Above L.S. (ft)	= Depth To Water Below L.S. (ft)	Comments
1/10/87	0727	5.75	3.22	2.53	3.22	+0.05	3.17	
2/1/87	1322	5.75	4.37	1.38	4.37	0.05	4.42	

Environmental Resources Management

Water Level Data Summary

Project: Peoples Gas, Ft. Lauderdale Station Location: COX-2

Elevation of Measuring Point: 5.89 ft. Land Surface Elevation: 5.9 ft. Height of M.P. Above L.S.: -0.01 ft.

Date	Time	Elevation of M.P. (+ MSL)	− Water Level Below M.P. (ft)	= Water Level Elevation (+ MSL)	Water Level Below M.P. (ft)	− Height of M.P. Above L.S. (ft)	= Depth To Water Below L.S. (ft)	Comments
11/08/	0730	5.89	3.33	2.56	3.33	-0.01	3.34	
12/05/	1310	5.89	4.50	1.39	4.50	-0.01	4.51	

Environmental Resources Management **Water Level Data Summary**

Project PEOPLES GAS, FT. LAUDERDALE Station Location COX-3

Elevation of Measuring Point 6.37 ft. Land Surface Elevation 6.4 ft. Height of M.P. Above L.S. -0.03 ft

Date	Time	Elevation of M.P. (+ MSL)	− Water Level Below M.P. (ft)	= Water Level Elevation (+ MSL)	Water Level Below M.P. (ft)	− Height of M.P. Above L.S. (ft)	= Depth To Water Below L.S. (ft)	Comments
4/15/86	0745	6.37	3.80	2.57	3.80	-0.03	3.83	
2/4/87	1315	6.37	4.97	1.40	4.97	-0.03	5.00	

Environmental Resources Management

Water Level Data Summary

Project PEOPLES GAS FT. LAUDERDALE Station Location COX-4

Elevation of Measuring Point 5.94 ft. Land Surface Elevation 6.1 ft. Height of M.P. Above L.S. -0.07 ft

Date	Time	Elevation of M.P. (+ MSL)	− Water Level Below M.P. (ft)	= Water Level Elevation (+ MSL)	Water Level Below M.P. (ft)	− Height of M.P. Above L.S. (ft)	= Depth To Water Below L.S. (ft)	Comments
4/10/86	0720	5.94	3.37	2.57	3.37	-0.07	3.44	
2/4/87	1320	5.94	4.55	1.39	4.55	-0.07	4.62	

APPENDIX F

FIELD SAMPLE RECORDS

ERM-South, Inc.

FIELD SAMPLE RECORD

PROJECT: PEOPLES GAS- FT. LAUDERDALE PROJECT NO.: 134-04

SAMPLE NUMBER	STATION LOCATION	DATE	TIME	TYPE	COLLECTION METHOD	TEMPERATURE	pH	CONDUCTIVITY	SAMPLED BY	COMMENTS
1	COX-3	4/10/86	0925 EST	GW	B	24°C	7.4	580 umhos/cm	RL/PAF	THORNTON KIT # 1465
2	COX-4	4/10/86	1028 EST	GW	B	24°C	7.1	1200 umhos/cm	RL/PAF	THORNTON KIT # 1464
3	COX-2	4/10/86	1158 EST	GW	B	25°C	7.3	730 umhos/cm	RL/PAF	THORNTON KIT # 1467
4	COX-1	4/10/86	1223 EST	GW	B	24°C	7.1	720 umhos/cm	RL/PAF	THORNTON KIT # 1466

TYPES: GW = Ground Water; SW = Surface Water; SL = Soils; SD = Sediment; A = Air; HW = Hazardous Waste; WW = Waste Water; PC = Process Constituents; PW = Potable Water; Biological; X = Other

COLLECTION METHODS: A = Auger; T = Trovel or Shovel; BH = Back-Hoe; SS = Split Spoon; B = Bailer; P = Pump; DD = Direct Dipping; N = Nansen Bottle; DO = Dissolved Oxygen Dunker; K = Kemmerer Type Sampler; X = Other

The ERM Group

APPENDIX G

GROUND-WATER LABORATORY ANALYSES
4/10/86

Peoples Gas

THORNTON LABORATORIES, INC.

1145 EAST CASS STREET
TAMPA, FLORIDA 33601 - 2880
MARINE, ANALYTICAL AND ENVIRONMENTAL SERVICES

TWX 810 876-9134
THORNT LAB TPA

TELEPHONE (813) 223-9702
P.O. BOX 2880

CERTIFICATE OF ANALYSIS
LABORATORY ID #84147
May 08, 1986
EPA PRIORITY POLLUTANTS

Laboratory No 636264
Sample of Groundwater
Date Received 4-11-86

For Environmental Resource Management South, Inc.
P.O. Box 290918
Tampa, FL 33617
Attn: B. Bretnal

Marks Project: 134-04, Location: Peoples Gas, Ft. Lauderdale,
Sampled by: REB/PAF

Field Data:

Sample	1
Well	COX-3
Date	4-10-86
Time	0925
Water Depth	3.8' BTOC
pH	7.4
Temperature, Degrees C.	24
Conductivity umhos/cm	580
Vol. Removed before Sampling, gallons	>17

BASE/NEUTRAL EXTRACTABLE ORGANICS

NPDES #	COMPOUND	EPA METHOD	CONCENTRATION, ug/l	DETECTION LIMIT, ug/l
1B	Acenaphthene	610/625	BDL*	10
2B	Acenaphthylene	610/625	BDL	10
3B	Anthracene	610/625	BDL	10
5B	Benzo (A) Anthracene	610/625	BDL	10
6B	Benzo (A) Pyrene	610/625	BDL	10
7B	Benzo (B) Fluoranthene	610/625	BDL	10
8B	Benzo (G,H,I) Perylene	610/625	BDL	25
9B	Benzo (K) Fluoranthene	610/625	BDL	10
18B	Chrysene	610/625	BDL	10
19B	Dibenzo (A,H) Anthracene	610/625	BDL	25
31B	Fluoranthene	610/625	BDL	10
32B	Fluorene	610/625	BDL	10
37B	Indeno (1,2,3-CD) Pyrene	610/625	BDL	25
39B	Naphthalene	610/625	BDL	10
44B	Phenanthrene	610/625	BDL	10
45B	Pyrene	610/625	BDL	10

*Below Detection Limit.

THORNTON LABORATORIES, INC.

Fred R. Thornton

THORNTON LABORATORIES, INC.
1145 EAST CASS STREET
TAMPA, FLORIDA 33601 - 2880
MARINE, ANALYTICAL AND ENVIRONMENTAL SERVICES

TWX 810 876-9134
THORNT LAB TPA

TELEPHONE (813) 223-9702
P.O. BOX 2880

CERTIFICATE OF ANALYSIS
LABORATORY ID #84147
May 08, 1986
EPA PRIORITY POLLUTANTS

aboratory No 636265
ample of Groundwater
ate Received 4-11-86

or Environmental Resource Management South, Inc.
P.O. Box 290918
Tampa, FL 33617
Attn: B. Bretnal

arks Project: 134-04, Location: Peoples Gas, Ft. Lauderdale,
Sampled by: REB/PAF

ield Data:

Sample	2
Well	COX-4
Date	4-10-86
Time	1028
Water Depth	3.37' BTOC
pH	7.1
Temperature, Degrees C.	24
Conductivity umhos/cm	1200
Vol. Removed before Sampling, gallons	>40

BASE/NEUTRAL EXTRACTABLE ORGANICS

DES #	COMPOUND	EPA METHOD	CONCENTRATION, ug/l	DETECTION LIMIT, ug/l
3	Acenaphthene	610/625	BDL*	10
3	Acenaphthylene	610/625	BDL	10
3	Anthracene	610/625	BDL	10
3	Benzo (A) Anthracene	610/625	BDL	10
3	Benzo (A) Pyrene	610/625	BDL	10
3	Benzo (B) Fluoranthene	610/625	BDL	10
3	Benzo (G,H,I) Perylene	610/625	BDL	25
3	Benzo (K) Fluoranthene	610/625	BDL	10
3	Chrysene	610/625	BDL	10
3	Dibenzo (A,H) Anthracene	610/625	BDL	25
3	Fluoranthene	610/625	BDL	10
3	Fluorene	610/625	BDL	10
3	Indeno (1,2,3-CD) Pyrene	610/625	BDL	25
3	Naphthalene	610/625	BDL	10
3	Phenanthrene	610/625	BDL	10
3	Pyrene	610/625	BDL	10

elow Detection Limit

THORNTON LABORATORIES, INC.

THORNTON LABORATORIES, INC.
1145 EAST CASS STREET
TAMPA, FLORIDA 33601 - 2880
MARINE, ANALYTICAL AND ENVIRONMENTAL SERVICES

TELEPHONE (813) 223-9702
P.O. BOX 2880

CERTIFICATE OF ANALYSIS
LABORATORY ID #84147
May 08, 1986
EPA PRIORITY POLLUTANTS

ratory No 636266
ple of Groundwater
Received 4-11-86

Environmental Resource Management South, Inc.
P.O. Box 290918
Tampa, FL 33617
Attn: B. Bretnal

ts Project: 134-04, Location: Peoples Gas, Ft. Lauderdale,
Sampled by: REB/PAF

ld Data:

Sample	3
Well	COX-2
Date	4-10-86
Time	1158
Water Depth	—
pH	7.3
Temperature, Degrees C.	25
Conductivity umhos/cm	730
Vol. Removed before Sampling, gallons	—

BASE/NEUTRAL EXTRACTABLE ORGANICS

ES #	COMPOUND	EPA METHOD	CONCENTRATION, ug/l	DETECTION LIMIT, ug/l
	Acenaphthene	610/625	BDL*	10
	Acenaphthylene	610/625	BDL	10
	Anthracene	610/625	BDL	10
	Benzo (A) Anthracene	610/625	BDL	10
	Benzo (A) Pyrene	610/625	BDL	10
	Benzo (B) Fluoranthene	610/625	BDL	10
	Benzo (G,H,I) Perylene	610/625	BDL	25
	Benzo (K) Fluoranthene	610/625	BDL	10
	Chrysene	610/625	BDL	10
	Dibenzo (A,H) Anthracene	610/625	BDL	25
	Fluoranthene	610/625	BDL	10
	Fluorene	610/625	BDL	10
	Indeno (1,2,3-CD) Pyrene	610/625	BDL	25
	Naphthalene	610/625	BDL	10
	Phenanthrene	610/625	BDL	10
	Pyrene	610/625	BDL	10

elow Detection Limit.

THORNTON LABORATORIES, INC.

THORNTON LABORATORIES, INC.
1145 EAST CASS STREET
TAMPA, FLORIDA 33601 - 2880
MARINE, ANALYTICAL AND ENVIRONMENTAL SERVICES

TWX 810 876-9134
THORNT LAB TPA

TELEPHONE (813) 223-9702
P.O. BOX 2880

CERTIFICATE OF ANALYSIS
LABORATORY ID #84147
May 08, 1986
EPA PRIORITY POLLUTANTS

Laboratory No 636267
Sample of Groundwater
Date Received 4-11-86

For Environmental Resource Management South, Inc.
P.O. Box 290918
Tampa, FL 33617
Attn: B. Bretnal

Marks Project: 134-04, Location: Peoples Gas, Ft. Lauderdale,
Sampled by: REB/PAF

Field Data:

Sample	4
Well	COX-1
Date	4-10-86
Time	1240
Water Depth	—
pH	7.1
Temperature, Degrees C.	24
Conductivity umhos/cm	720
Vol. Removed before Sampling, gallons	—

BASE/NEUTRAL EXTRACTABLE ORGANICS

NPDES #	COMPOUND	EPA METHOD	CONCENTRATION, ug/l	DETECTION LIMIT, ug/l
1B	Acenaphthene	610/625	BDL*	10
2B	Acenaphthylene	610/625	BDL	10
3B	Anthracene	610/625	BDL	10
5B	Benzo (A) Anthracene	610/625	BDL	10
6B	Benzo (A) Pyrene	610/625	BDL	10
7B	Benzo (B) Fluoranthene	610/625	BDL	10
8B	Benzo (G,H,I) Perylene	610/625	BDL	25
9B	Benzo (K) Fluoranthene	610/625	BDL	10
18B	Chrysene	610/625	BDL	10
19B	Dibenzo (A,H) Anthracene	610/625	BDL	25
31B	Fluoranthene	610/625	BDL	10
32B	Fluorene	610/625	BDL	10
37B	Indeno (1,2,3-CD) Pyrene	610/625	BDL	25
39B	Naphthalene	610/625	950	10
44B	Phenanthrene	610/625	BDL	10
45B	Pyrene	610/625	BDL	10

*Below Detection Limit

THORNTON LABORATORIES, INC.

APPENDIX H

CHAIN-OF-CUSTODY RECORDS

ERM-South, Inc.

CHAIN OF CUSTODY RECORD

Project Name PEOPLE'S GAS SYSTEMS

Collector's Sample No. PGS SOIL #1

Project Number 134-04

Site: OLD PEOPLE'S GAS SYSTEMS FACILITY AT NW 7th AVE & 4th ST

Location of Sampling: FT LAUDERDALE FL

Type of Sample COMPOSITE SOIL SAMPLES

Company's Name ERM-SOUTH, INC

Telephone (813) 985-0335

Address 5035 E. BUSCH BLVD SUITE 4 TAMPA FLORIDA 33617
number street city state zip

Volume Collected 1 QUART

Number of Containers 1

Collector's Name MARK A. CULBRETH

Telephone (813) 985-0335

Signature [signature]

Date Sampled 12/23/85

Time Sampled COMPOSITED AT 1300 (am/pm)

Field Information THE COMPOSITE SOIL SAMPLE WAS COLLECTED FROM FIVE BACK-HOE TEST PITS EXCAVATED ON 12/23/85 FROM 0900 TO 1200.

Relinquished By: [signature] Date/Time: 12/24/85 / 9:30 AM

Received By: [signature] Date/Time: 12/24/85 / 9:31 AM

Relinquished By: _____ Date/Time: _____

Received By: _____ Date/Time: _____

Relinquished By: _____ Date/Time: _____

Received By: _____ Date/Time: _____

Authorization For Disposal _____ Date/Time: _____

Disposed By: _____ Date/Time: _____

ERM-South, Inc.
Environmental Resources Management

CHAIN OF CUSTODY RECORD

5035 East Busch Boulevard • Suite 4 • P.O. Box 290918 • Tampa, Florida 33617 ☎ (813) 985-0335
1637 N.W. 79th Avenue • Miami, Florida 33126 ☎ (305) 591-3076

Project No./I.D. 134-04 PEOPLES GAS-FT. LAUDERDALE Sheet 1 of 1
Sampled By R. BRETNALL Bottles Supplied By THORNTON LABS
NOTE: When analyses are complete return this form to:
Name: R. BRETNALL @ ERM-South, Inc., Tampa, Florida

Sample I.D.	Sample Description	Collection Date/Time	No. of bottles	Analysis Requested	Remarks THORNTON KIT #
#1 COX-3	GROUND WATER	4/10/86 0928	2	EPA 610	1465
#2 COX-4	GROUND WATER	4/10/86 1028	2	EPA 610	1464
#3 COX-2	GROUND WATER	4/10/86 1158	2	EPA 610	1467 RL
#4 COX-1	GROUND WATER	4/10/86 1240	2	EPA 610	1466

Shipping package opened by: R. BRETNALL Date: 4/9/86 Time: 0900
Employer: ERM-SOUTH, INC. Containers intact (Y/N) Y

Samples packaged & sealed by: R. BRETNALL Date: 4/10/86 Time: 1330
Employer: ERM-SOUTH, INC. Method of Shipment: AIR-BAGGAGE/ AUTOMOBILE

Received in laboratory by: Cliff Lemmons Date: 4-11-86 Time: 9:20 AM
Employer: Thornton Lab Seals intact (Y/N) yes
Containers intact (Y/N) yes If not, describe in Comments section

NOTE: Laboratory's Chain of Custody shall be in effect from receipt through analysis.

Relinquished By		Received By		Samples Intact	Date	Time	Initials	
Name	Employer	Name	Employer				Sender	Rec'r
R.B. Ell	ERM-SOUTH	C. Lemmons	Thornton Lab	yes	4/11/86	9:20 AM		

COMMENTS:

Copies: White - Project file; Yellow - Quality Control Officer; Pink - Sampler

ERM-South, I[illegible]
Environmental Resourc[illegible] [illegible]anagement

5035 East Busch Boulevard • Suite 4 • P.O. Box 290918 • Tampa, Florida 33617 ☎ (813) 985-0335
1637 N.W. 79th Avenue • Miami, Florida 33126 ☎ (305) 591-3076

CHAIN [illegible]F CUSTODY RECORD

Project No./I.D. 134-04 Peoples Gas - Ft. Lauderdale Sheet 1 of 2
Sampled By TORDI BECK Bottles Supplied By Thornton
NOTE: When analyses are complete return this form to:
Name: Mark Culbreth @ ERM-South, Inc., Tampa, Florida copy: Miami offi[illegible]

Sample I.D.	Sample Description	Collection Date/Time	No. of bottles	Analysis Requested	Remarks
Box 4 (Kit # 0133)	Groundwater	2/4/87 1630	7	602, 610, Total lead, Dissolved lead	
Box 14 (Kit # 0134)	"	2/4/87 1650	7	" "	
Box # 1 (Kit # 0135)	"	2/4/87 1700	7	" "	

Shipping package opened by: TORDI Date: 2/4/87 Time: 0800
Employer: ERM South Containers intact (Y/N) Y

Samples packaged & sealed by: TORDI Date: 2/5/87 Time: 0800
Employer: ERM South Method of Shipment: Bus

Received in laboratory by: [illegible] McKinley Date: 2-6-87 Time: 0800
Employer: Thornton Labs Seals intact (Y/N) Y
Containers intact (Y/N) _____ If not, describe in Comments section

NOTE: Laboratory's Chain of Custody shall be in effect from receipt through analysis.

Relinquished By		Received By		Samples Intact	Date	Time	Initials	
Name	Employer	Name	Employer				Sender	Rec'r
[illegible]	ERM	LMR	LMR	Y	2-6-87	0800	LMR	LMR

COMMENTS:

Copies: White - Project file; Yellow - Quality Control Officer; Pink - Sampler

ERM-South, I[illegible]
Environmental Resourc[illegible] [illegible]anagement

CHAIN [illegible] CUSTODY RECORD

5035 East Busch Boulevard • Suite 4 • P.O. Box 290918 • Tampa, Florida 33617 ☎ (813) 985-0335
1637 N.W. 79th Avenue • Miami, Florida 33126 ☎ (305) 591-3076

Project No./I.D. 134-04 Sheet 2 of 2
Sampled By TORDI, BECK Bottles Supplied By Thornton
NOTE: When analyses are complete return this form to:
Name: Mark Culbreth @ ERM-South, Inc., Tampa, Florida Copy: Miami offi

Sample I.D.	Sample Description	Collection Date/Time	No. of bottles	Analysis Requested	Remarks
COX 2 (KIT #0129)	Groundwater	2/4/87 1430	7	602, 610, Total Lead, Dissolved Lead	
COX 3 (KIT #0130)	"	2/4/87 1530	7	" "	
COX 10 (KIT #0131)	"	2/4/87 1550	7	" "	
COX 11 (KIT #0132)	"	2/4/87 1600	6	" "	

Shipping package opened by: TORDI Date: 2/4/87 Time: 0800
Employer: ERM South Containers intact (Y)N)

Samples packaged & sealed by: TORDI Date: 2/5/87 Time: 0800
Employer: ERM South Method of Shipment: BUS

Received in laboratory by: [illegible] Date: 2-6-87 Time: 0800
Employer: Thornton Labs Seals intact (Y/N) Y
Containers intact (Y/N) Y If not, describe in Comments section

NOTE: Laboratory's Chain of Custody shall be in effect from receipt through analysis.

Relinquished By		Received By		Samples Intact	Date	Time	Initials	
Name	Employer	Name	Employer				Sender	Rec'r
[illegible]	ERM	LRM	Thornton Labs	Y	2-6-87	0800	LRM	LRM

COMMENTS:

[illegible] White - Project file; Yellow - Quality Control Officer; Pink - Sampler

The ERM Group

APPENDIX I

GROUND-WATER LABORATORY ANALYSES
2/14/87

THORNTON LABORATORIES, INC.
1145 EAST CASS STREET
TAMPA, FLORIDA 33601 - 2880
MARINE, ANALYTICAL AND ENVIRONMENTAL SERVICES

810 876-9134
RNT LAB TPA

TELEPHONE (813) 223-9702
P.O. BOX 2880

March 16, 1987

atory Number 653228

e of Groundwater

Received 2/6/87

Environmental Resource Management South, Inc.
P.O. Box 290918
Tampa, FL 33617

Attn: J. Constant

: COX-1, Job #134-04

CERTIFICATE OF ANALYSIS

IC	Results, ug/L	Detection Limit, ug/L
hthene	BDL*	5
thylene	100	5
cene & Phenanthrene	150	5
(A) Anthracene & Chrysene	75	5
(A) Pyrene	BDL	5
(B) Fluoranthene	BDL	5
(GHI) Perylene	BDL	10
(K) Fluoranthene	BDL	5
o (A,H) Anthracene	BDL	10
nthene	BDL	5
ne	60	5
(1,2,3-CD) Pyrene	BDL	10
alene	920	5
	BDL	5

Detection Limit

THORNTON LABORATORIES, INC.

THORNTON LABORATORIES, INC.
1145 EAST CASS STREET
TAMPA, FLORIDA 33601 - 2880
MARINE, ANALYTICAL AND ENVIRONMENTAL SERVICES

810 876-9134
ANT LAB TPA

TELEPHONE (813) 223-9702
P.O. BOX 2880

March 16, 1987

atory Number 653228

e of Groundwater

Received 2/6/87

Environmental Resource Management South, Inc.
P.O. Box 290918
Tampa, FL 33617

Attn: J. Constant

s: Project #134-04, Peoples Gas, Ft. Lauderdale, Sampled by: Tordi, Beck;
Well #COX-1, Date/Time: 2/4/87, 17:15

CERTIFICATE OF ANALYSIS

602	Results, ug/L	Limit of Detection (micrograms per liter)
ene	1,360	10
robenzene	BDL*	10
lbenzene	129	10
ene	36	10
Xylene	250	10
lene	186	10

ow Detection Limit.

THORNTON LABORATORIES, INC.

THORNTON LABORATORIES, INC.
1145 EAST CASS STREET
TAMPA, FLORIDA 33601 - 2880
MARINE, ANALYTICAL AND ENVIRONMENTAL SERVICES

810 876-9134
ORNT LAB TPA

TELEPHONE (813) 223-9702
P.O. BOX 2880

March 16, 1987

ratory Number 653228

le of Groundwater

Received 2/6/87

Environmental Resource Management South, Inc.
P.O. Box 290918
Tampa, FL 33617

Attn: J. Constant

s: Project #134-04, Peoples Gas, Ft. Lauderdale, Sampled by: Tordi, Beck;
Well #COX-1, Date/Time: 2/4/87, 17:15

CERTIFICATE OF ANALYSIS

602	Results, ug/L	Limit of Detection (micrograms per liter)
ene	1,360	10
orobenzene	BDL*	10
ylbenzene	129	10
ene	36	10
-Xylene	250	10
ylene	186	10

low Detection Limit.

THORNTON LABORATORIES, INC.

THORNTON LABORATORIES, INC.
1145 EAST CASS STREET
TAMPA, FLORIDA 33601 - 2880
MARINE, ANALYTICAL AND ENVIRONMENTAL SERVICES

WX 810 876-9134
HORNT LAB TPA

TELEPHONE (813) 223-9702
P.O. BOX 2880

March 16, 1987

pratory Number 653228

ple of Groundwater

e Received 2/6/87

Environmental Resource Management South, Inc.
P.O. Box 290918
Tampa, FL 33617

Attn: J. Constant

ks: COM-1, Job #134-04

CERTIFICATE OF ANALYSIS

Lead (Pb)	0.03
Dissolved Lead (Pb)*	<0.01

*Filtered in Field

results expressed in mg/L unless otherwise noted.

ysis according to "Standard Methods for the Examination of Water&Wastewater"
, Latest Edition. LABORATORY ID #84147.

THORNTON LABORATORIES, INC.

810 876-9134
RNT LAB TPA

THORNTON LABORATORIES, INC.
1145 EAST CASS STREET
TAMPA, FLORIDA 33601 - 2880
MARINE, ANALYTICAL AND ENVIRONMENTAL SERVICES

TELEPHONE (813) 223-9702
P.O. BOX 2880

March 16, 1987

tory Number 653213

e of Groundwater

Received 2/6/87

Environmental Resource Management South, Inc.
P.O. Box 290918
Tampa, FL 33617

Attn: J. Constant

: COX-2, Job #134-04

CERTIFICATE OF ANALYSIS

10	Results, ug/L	Detection Limit, ug/L
phthene	BDL*	5
phthylene	BDL	5
acene	BDL	5
(A) Anthracene	BDL	5
(A) Pyrene	BDL	5
(B) Fluoranthene	BDL	5
(GHI) Perylene	BDL	10
(K) Fluoranthene	BDL	5
ene	BDL	5
zo (A,H) Anthracene	BDL	10
anthene	BDL	5
ene	BDL	5
o (1,2,3-CD) Pyrene	BDL	10
halene	6.1	5
nthrene	BDL	5
e	BDL	5

w Detection Limit

THORNTON LABORATORIES, INC.

THORNTON LABORATORIES, INC.
1145 EAST CASS STREET
TAMPA, FLORIDA 33601 - 2880
MARINE, ANALYTICAL AND ENVIRONMENTAL SERVICES

X 810 876-9134
ORNT LAB TPA

TELEPHONE (813) 223-9702
P.O. BOX 2880

March 16, 1987

ratory Number 653213

le of Groundwater

Received 2/6/87

Environmental Resource Management South, Inc.
P.O. Box 290918
Tampa, FL 33617

Attn: J. Constant

s: Project #134-04, Peoples Gas, Ft. Lauderdale, Sampled by: Tordi, Beck;
Well #COX-2, Date/Time: 2/4/87, 14:47

CERTIFICATE OF ANALYSIS

602	Results, ug/L	Limit of Detection (micrograms per liter)
ene	EDL*	1
robenzene	EDL	1
lbenzene	EDL	1
ene	EDL	1
Xylene	EDL	1
lene	EDL	1

ow Detection Limit.

THORNTON LABORATORIES, INC.

THORNTON LABORATORIES, INC.
1145 EAST CASS STREET
TAMPA, FLORIDA 33601 - 2880
MARINE, ANALYTICAL AND ENVIRONMENTAL SERVICES

(810 876-9134
ORNT LAB TPA

TELEPHONE (813) 223-9702
P.O. BOX 2880

March 16, 1987

atory Number 653213

e of Groundwater

Received 2/6/87

Environmental Resource Management South, Inc.
P.O. Box 290918
Tampa, FL 33617

Attn: J. Constant

: COX-2, Job #134-04

CERTIFICATE OF ANALYSIS

Lead (Pb)	<0.01
Dissolved Lead (Pb)*	<0.01

*Filtered in Field

esults expressed in mg/L unless otherwise noted.

sis according to "Standard Methods for the Examination of Water&Wastewater"
Latest Edition. LABORATORY ID #84147.

THORNTON LABORATORIES, INC.

THORNTON LABORATORIES, INC.
1145 EAST CASS STREET
TAMPA, FLORIDA 33601 - 2880
MARINE, ANALYTICAL AND ENVIRONMENTAL SERVICES

WX 810 876-9134
THORNT LAB TPA

TELEPHONE (813) 223-9702
P.O. BOX 2880

March 16, 1987

oratory Number 653214

ple of Groundwater

e Received 2/6/87

r Environmental Resource Management South, Inc.
P.O. Box 290918
Tampa, FL 33617

Attn: J. Constant

rks: COX-3, Job #134-04

CERTIFICATE OF ANALYSIS

8 610	Results, ug/L	Detection Limit, ug/L
enaphthene	BDL*	5
enaphthylene	BDL	5
thracene	BDL	5
nzo (A) Anthracene	BDL	5
nzo (A) Pyrene	BDL	5
nzo (B) Fluoranthene	BDL	5
nzo (GHI) Perylene	BDL	10
nzo (K) Fluoranthene	BDL	5
rysene	BDL	5
benzo (A,H) Anthracene	BDL	10
uoranthene	BDL	5
uorene	BDL	5
deno (1,2,3-CD) Pyrene	BDL	10
phthalene	BDL	5
enanthrene	BDL	5
rene	BDL	5

elow Detection Limit

THORNTON LABORATORIES, INC.

THORNTON LABORATORIES, INC.
1145 EAST CASS STREET
TAMPA, FLORIDA 33601 - 2880
MARINE, ANALYTICAL AND ENVIRONMENTAL SERVICES

TELEX 810 876-9134
THORNT LAB TPA

TELEPHONE (813) 223-9702
P.O. BOX 2880

March 16, 1987

ratory Number 653214

le of Groundwater

Received 2/6/87

Environmental Resource Management South, Inc.
P.O. Box 290918
Tampa, FL 33617

Attn: J. Constant

s: Project #134-04, Peoples Gas, Ft. Lauderdale, Sampled by: Tordi, Beck;
Well #CCW-3, Date/Time: 2/4/87, 15:25

CERTIFICATE OF ANALYSIS

602	Results, ug/L	Limit of Detection (micrograms per liter)
tene	BDL*	1
robenzene	BDL	1
lbenzene	BDL	1
uene	BDL	1
-Xylene	BDL	1
ylene	BDL	1

low Detection Limit.

THORNTON LABORATORIES, INC.

THORNTON LABORATORIES, INC.
1145 EAST CASS STREET
TAMPA, FLORIDA 33601 - 2880
MARINE, ANALYTICAL AND ENVIRONMENTAL SERVICES

X 810 876-9134
ORNT LAB TPA

TELEPHONE (813) 223-9702
P.O. BOX 2880

March 16, 1987

ratory Number 653214

le of Groundwater

Received 2/6/87

Environmental Resource Management South, Inc.
P.O. Box 290918
Tampa, FL 33617

Attn: J. Constant

s: COX-3, Job #134-04

CERTIFICATE OF ANALYSIS

Lead (Pb)	<0.01
Dissolved Lead (Pb)*	<0.01

*Filtered in Field

results expressed in mg/L unless otherwise noted.

ysis according to "Standard Methods for the Examination of Water&Wastewater"
Latest Edition. LABORATORY ID #84147.

THORNTON LABORATORIES, INC.

THORNTON LABORATORIES, INC.
1145 EAST CASS STREET
TAMPA, FLORIDA 33601 - 2880
MARINE, ANALYTICAL AND ENVIRONMENTAL SERVICES

(810 876-9134
RNT LAB TPA

TELEPHONE (813) 223-9702
P.O. BOX 2880

March 16, 1987

tory Number 653229

e of Groundwater

Received 2/6/87

Environmental Resource Management South, Inc.
P.O. Box 290918
Tampa, FL 33617

Attn: J. Constant

: Well #OCX-4, Project #134-04

CERTIFICATE OF ANALYSIS

10	Results, ug/L	Detection Limit, ug/L
phthene	EDL*	5
phthylene	EDL	5
acene	EDL	5
(A) Anthracene	EDL	5
(A) Pyrene	EDL	5
(B) Fluoranthene & to (K) Fluoranthene	6.5	5
(GHI) Perylene	EDL	10
ene	EDL	5
zo (A,H) Anthracene	EDL	10
anthene	EDL	5
ene	EDL	5
o (1,2,3-CD) Pyrene	EDL	10
thalene	EDL	5
anthrene	EDL	5
e	EDL	5

w Detection Limit

THORNTON LABORATORIES, INC.

THORNTON LABORATORIES, INC.
1145 EAST CASS STREET
TAMPA, FLORIDA 33601 - 2880
MARINE, ANALYTICAL AND ENVIRONMENTAL SERVICES

(810 876-9134
ORNT LAB TPA

TELEPHONE (813) 223-9702
P.O. BOX 2880

March 16, 1987

atory Number 653229

e of Groundwater

Received 2/6/87

Environmental Resource Management South, Inc.
P.O. Box 290918
Tampa, FL 33617

Attn: J. Constant

s: Project #134-04, Peoples Gas, Ft. Lauderdale, Sampled by: Tordi, Beck;
Well #COX-4, Date/Time: 2/4/87, 16:30

CERTIFICATE OF ANALYSIS

602	Results, ug/L	Limit of Detection (micrograms per liter)
ene	EDL*	1
robenzene	EDL	1
ibenzene	EDL	1
ene	EDL	1
Xylene	EDL	1
lene	EDL	1

low Detection Limit.

THORNTON LABORATORIES, INC.

THORNTON LABORATORIES, INC.
1145 EAST CASS STREET
TAMPA, FLORIDA 33601 - 2880
MARINE, ANALYTICAL AND ENVIRONMENTAL SERVICES

810 876-9134
ORNT LAB TPA

TELEPHONE (813) 223-9702
P.O. BOX 2880

March 16, 1987

ratory Number 653229

ie of Groundwater

Received 2/6/87

Environmental Resource Management South, Inc.
P.O. Box 290918
Tampa, FL 33617

Attn: J. Constant

s: COX-4, Job #134-04

CERTIFICATE OF ANALYSIS

Lead (Pb)	0.05
Dissolved Lead (Pb)*	<0.01

*Filtered in Field

results expressed in mg/L unless otherwise noted.

lysis according to "Standard Methods for the Examination of Water&Wastewater"
h, Latest Edition. LABORATORY ID #84147.

THORNTON LABORATORIES, INC.

THORNTON LABORATORIES, INC.
1145 EAST CASS STREET
TAMPA, FLORIDA 33601 - 2880
MARINE, ANALYTICAL AND ENVIRONMENTAL SERVICES

,810 876-9134
)RNT LAB TPA

TELEPHONE (813) 223-9702
P.O. BOX 2880

March 16, 1987

atory Number 653215

e of Groundwater

Received 2/6/87

Environmental Resource Management South, Inc.
P.O. Box 290918
Tampa, FL 33617

Attn: J. Constant

: COX-10, Job #134-04

CERTIFICATE OF ANALYSIS

10	Results, ug/L	Detection Limit, ug/L
phthene	BDL*	5
phthylene	BDL	5
acene	BDL	5
(A) Anthracene	BDL	5
(A) Pyrene	BDL	5
(B) Fluoranthene	BDL	5
(GHI) Perylene	BDL	10
(K) Fluoranthene	BDL	5
ene	BDL	5
zo (A,H) Anthracene	BDL	10
anthene	BDL	5
ene	BDL	5
o (1,2,3-CD) Pyrene	BDL	10
halene	BDL	5
nthrene	BDL	5
e	BDL	5

w Detection Limit

THORNTON LABORATORIES, INC.

THORNTON LABORATORIES, INC.
1145 EAST CASS STREET
TAMPA, FLORIDA 33601 - 2880
MARINE, ANALYTICAL AND ENVIRONMENTAL SERVICES

310 876-9134
INT LAB TPA

TELEPHONE (813) 223-9702
P.O. BOX 2880

March 16, 1987

itory Number 653215

: of Groundwater

Received 2/6/87

Environmental Resource Management South, Inc.
P.O. Box 290918
Tampa, FL 33617

Attn: J. Constant

: Project #134-04, Peoples Gas, Ft. Lauderdale, Sampled by: Tordi, Beck;
Well #COX-10, Date/Time: 2/4/87, 15:43

CERTIFICATE OF ANALYSIS

02	Results, ug/L	Limit of Detection (micrograms per liter)
ne	BDL*	1
cbenzene	BDL	1
lbenzene	BDL	1
ne	BDL	1
ylene	BDL	1
lene	BDL	1

ow Detection Limit.

THORNTON LABORATORIES, INC.

THORNTON LABORATORIES, INC.
1145 EAST CASS STREET
TAMPA, FLORIDA 33601 - 2880
MARINE, ANALYTICAL AND ENVIRONMENTAL SERVICES

TELEPHONE (813) 223-9702
P.O. BOX 2880

TX 810 876-9134
THORNT LAB TPA

March 16, 1987

ratory Number 653215

ple of Groundwater

Received 2/6/87

Environmental Resource Management South, Inc.
P.O. Box 290918
Tampa, FL 33617

Attn: J. Constant

s: COX-10, Job #134-04

CERTIFICATE OF ANALYSIS

Lead (Pb)	<0.01
Dissolved Lead (Pb)*	<0.01

*Filtered in Field

results expressed in mg/L unless otherwise noted.

lysis according to "Standard Methods for the Examination of Water&Wastewater"
, Latest Edition. LABORATORY ID #84147.

THORNTON LABORATORIES, INC.

,810 876-9134
)RNT LAB TPA

THORNTON LABORATORIES, INC.
1145 EAST CASS STREET
TAMPA, FLORIDA 33601 - 2880
MARINE, ANALYTICAL AND ENVIRONMENTAL SERVICES

TELEPHONE (813) 223-9702
P.O. BOX 2880

March 16, 1987

atory Number 653216

e of Groundwater

Received 2/6/87

Environmental Resource Management South, Inc.
P.O. Box 290918
Tampa, FL 33617

Attn: J. Constant

: COX-11, Job #134-04

CERTIFICATE OF ANALYSIS

:10	Results, ug/L	Detection Limit, ug/L
ıphthene	BDL*	5
ıphthylene	BDL	5
:acene	BDL	5
) (A) Anthracene	BDL	5
) (A) Pyrene	BDL	5
) (E) Fluoranthene	BDL	5
) (GHI) Perylene	BDL	10
) (K) Fluoranthene	BDL	5
sene	BDL	5
ızo (A,H) Anthracene	BDL	10
ranthene	BDL	5
rene	BDL	5
ıo (1,2,3-CD) Pyrene	BDL	10
thalene	BDL	5
anthrene	BDL	5
ne	BDL	5

ow Detection Limit

THORNTON LABORATORIES, INC.

THORNTON LABORATORIES, INC.
1145 EAST CASS STREET
TAMPA, FLORIDA 33601 - 2880
MARINE, ANALYTICAL AND ENVIRONMENTAL SERVICES

810 876-9134
ORNT LAB TPA

TELEPHONE (813) 223-9702
P.O. BOX 2880

March 16, 1987

atory Number 653216

le of Groundwater

Received 2/6/87

Environmental Resource Management South, Inc.
P.O. Box 290918
Tampa, FL 33617

Attn: J. Constant

: Project #134-04, Peoples Gas, Ft. Lauderdale, Sampled by: Tordi, Beck;
Well #COX-11, Date/Time: 2/4/87, 16:00

CERTIFICATE OF ANALYSIS

602	Results, ug/L	Limit of Detection (micrograms per liter)
ene	BDL*	1
robenzene	BDL	1
lbenzene	BDL	1
ene	BDL	1
ylene	BDL	1
lene	BDL	1

ow Detection Limit.

THORNTON LABORATORIES, INC.

THORNTON LABORATORIES, INC.
1145 EAST CASS STREET
TAMPA, FLORIDA 33601 - 2880
MARINE, ANALYTICAL AND ENVIRONMENTAL SERVICES

X 810 876-9134
ORNT LAB TPA

TELEPHONE (813) 223-9702
P.O. BOX 2880

March 16, 1987

ratory Number 653216

le of Groundwater

Received 2/6/87

Environmental Resource Management South, Inc.
P.O. Box 290918
Tampa, FL 33617

Attn: J. Constant

s: COX-11, Job #134-04

CERTIFICATE OF ANALYSIS

Lead (Pb)	<0.01
Dissolved Lead (Pb)*	<0.01

*Filtered in Field

results expressed in mg/L unless otherwise noted.

lysis according to "Standard Methods for the Examination of Water&Wastewater"
A, Latest Edition. LABORATORY ID #84147.

THORNTON LABORATORIES, INC.

THORNTON LABORATORIES, INC.
1145 EAST CASS STREET
TAMPA, FLORIDA 33601 - 2880
MARINE, ANALYTICAL AND ENVIRONMENTAL SERVICES

TELEPHONE (813) 223-9702
P.O. BOX 2880

x 810 876-9134
ORNT LAB TPA

March 16, 1987

ratory Number 653230

le of Groundwater

Received 2/6/87

Environmental Resource Management South, Inc.
P.O. Box 290918
Tampa, FL 33617

Attn: J. Constant

s: Well #COX-14, Job #134-04

CERTIFICATE OF ANALYSIS

610	Results, ug/L	Detection Limit, ug/L
aphthene	BDL*	5
aphthylene	9.4	5
racene	BDL	5
o (A) Anthracene	BDL	5
o (A) Pyrene	BDL	
o (B) Fluoranthene		5
enzo (K) Fluoranthene	9.7	10
o (GHI) Perylene	BDL	5
sene	BDL	10
nzo (A,H) Anthracene	BDL	5
ranthene	BDL	5
rene	BDL	10
no (1,2,3-CD) Pyrene	BDL	5
thalene	BDL	5
anthrene	BDL	5
ne	BDL	

low Detection Limit

THORNTON LABORATORIES, INC.

Reference 10

RA

August 20, 1985

Mr. Charles Montague
Vice President
Peoples Gas System Inc.
Post Office Box 520855
Miami, Florida 33152

Dear Mr. Montague:

The Hazardous Waste Management Program has reviewed your application for a hazardous waste EPA I.D. Number as a generator. Based on the information received you have been issued the following identification number for the facility located at 398 NW 7 Avenue, Ft. Lauderdale, Florida 33311:

FLD 981 026 354.

Florida Administrative Code Rule 17-30 requires all generators of hazardous waste and all hazardous waste treatment, storage, or disposal facilities to file an annual report of their hazardous waste activities with the DER. You are required to comply with this rule concerning the filing of an annual report by March 1 for the preceding calendar year. Additionally, all hazardous waste generators and facilities that are not subject to the annual report requirement but maintain an EPA/DER identification number are required to verify their status annually. This includes small quantity generators, generators that beneficially reuse or recycle all their waste, or generators and facilities either not handling waste during the reporting year or qualifying for another exemption. The annual report forms will be sent by the Department to the contact person at the address identified on the notification form.

If any of the information on the Hazardous Waste Activity form changes, please notify us in writing at the letterhead address. If I can be of further assistance, please call 904/488-0300.

Sincerely,

Melinda Bergeson
Solid & Hazardous Waste Section

MB/ls

cc: Nell Keever - EPA/Region IV
Jeff Tobergte - DER/West Palm Beach

RECEIVED
AUG 28 1985
Dept. of Environmental Reg.
West Palm Beach

FOR OFFICIAL USE ONLY

W

IX. DESCRIPTION OF HAZARDOUS WASTES *(continued from front)*

A. HAZARDOUS WASTES FROM NON—SPECIFIC SOURCES. Enter the four—digit number from 40 CFR Part 261.31 for each listed hazardous waste from non—specific sources your installation handles. Use additional sheets if necessary.

1	2	3	4	5	6
7	8	9	10	11	12

DETACH

B. HAZARDOUS WASTES FROM SPECIFIC SOURCES. Enter the four—digit number from 40 CFR Part 261.32 for each listed hazardous waste from specific industrial sources your installation handles. Use additional sheets if necessary.

13	14	15	16	17	18
19	20	21	22	23	24
25	26	27	28	29	30

C. COMMERCIAL CHEMICAL PRODUCT HAZARDOUS WASTES. Enter the four—digit number from 40 CFR Part 261.33 for each chemical substance your installation handles which may be a hazardous waste. Use additional sheets if necessary.

31	32	33	34	35	36
37	38	39	40	41	42
43	44	45	46	47	48

D. LISTED INFECTIOUS WASTES. Enter the four—digit number from 40 CFR Part 261.34 for each listed hazardous waste from hospitals, veterinary hospitals, medical and research laboratories your installation handles. Use additional sheets if necessary.

49	50	51	52	53	54

E. CHARACTERISTICS OF NON—LISTED HAZARDOUS WASTES. Mark "X" in the boxes corresponding to the characteristics of non—listed hazardous wastes your installation handles. *(See 40 CFR Parts 261.21 – 261.24.)*

- [ ] 1. IGNITABLE (D001)
- [ ] 2. CORROSIVE (D002)
- [ ] 3. REACTIVE (D003)
- [X] 4. TOXIC (D000)

X. CERTIFICATION

DETACH

I certify under penalty of law that I have personally examined and am familiar with the information submitted in this and all attached documents, and that based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment.

SIGNATURE	NAME & OFFICIAL TITLE *(type or print)*	DATE SIGNED
C.H. Montague	C. H. Montague, Vice Pres.S. Fla. Div.	7/30/85

STATE OF FLORIDA

DEPARTMENT OF ENVIRONMENTAL REGULATION

DALE TWACHTMANN
SECRETARY

BOB MARTINEZ
GOVERNOR

09-24-87

CHARLES MONTAGUE, VICE PRESIDENT
PEOPLES GAS SYSTEM INC.
P.O. BOX 520855
MIAMI FL 33152

RE: 1986 Annual Report - FLD981026354

In January of this year, the Department of Environmental Regulation sent you 1986 Hazardous Waste Annual Report forms to complete. As a hazardous waste generator and/or owner or operator of a hazardous waste treatment, storage, or disposal facility, you were required to submit an annual report to the Department by March 1, 1987. This requirement is specified in Chapter 17-30 of the Florida Administrative Code. As of this date, the Department has not received the appropriate annual report for 1986. You are hereby requested to submit the report as required within 30 days.

If you notified the Department as a generator of hazardous waste and have subsequently determined that you qualify for small quantity generator status (generate less than 1,000 kilograms or approximately 250 gallons of hazardous waste per month), you must certify your small quantity generator status on the annual report form. This can be accomplished by completing Items I-VIII.

The Department considers the annual report requirement to be a significant component of the hazardous waste regulations. Failure to provide the required annual report within 30 days may subject you to further enforcement action.

If you have any questions, please contact Linda Lakes, the Annual Report Coordinator, at (904) 488-0300. Thank you for your cooperation.

Sincerely,

Robert W. McVety, Chief
Bureau of Waste Management

Enclosure

cc: Charles Ouseph - DER/West Palm Beach

Peoples
GAS SYSTEM, Inc.

DIVISION OFFICES
555 N.E. 124TH STREET • P.O. BOX 520855
NORTH MIAMI, FLORIDA 33152-0855

10/1/87

State of Florida
Department of Environmental Regulation
2600 Blair Stone Road
Tallahassee, Florida 32301-8241

Attention: Linda Lakes

Re: 1986 Annual Report - FLD981026354

Dear Ms. Lakes:

Per our telephone conversation today concerning referenced report, I am enclosing same with only the first two pages filled in as you requested.

Since this division of Peoples Gas System, Inc was issued a change of classification from generator to non-handler in 1986 and subsequently received a notice, dated January 9, 1987, stating that unless we "did generate or handle any hazardous waste during 1986" we would not have to submit a report and our status would remain "non-handler", the 1986 report was not submitted.

Please note that the "non-handler" status is applicable to the above-referenced EPA/DER ID NUMBER which pertains to our Ft. Lauderdale site and to our North Miami Beach site, EPA/DER ID NUMBER 980843163.

If you have any further need for information concerning these reports, please contact Edwin P. Champion at (305) 893-2522. Thank you for your consideration in this matter.

Sincerely,

C. H. Montague

C. H. Montague
Sr. Vice President
South Fla. Divisions

CHM/et

GMST01 5006P81354 00 12/07/89 14.05.48

FACILITY OVERVIEW - PAGE 1

FACILITY NAME: PEOPLES GAS SYSTEM INC LAST UPDATED: 12/14/88
LOCATION: 398 NW 7 AVENUE CITY: FORT LAUDERDALE STATE: FL
SITE SUPERVISOR: PHONE: (
RESP.AUTH./LANDOWNER: PEOPLES GAS SYSTEM INC PHONE: (
ADDR: CTY/ST/ZIP: ,FL
COUNTRY (IF OTHER THAN THE U.S.):

FACILITY TYPE: 7 HAZ-NON-IND STATUS: A ACTIVE AS OF 8/85
CLASS: TYPE TREATMENT/PROCESS:
(CONT.):
DER OFFICE:SOUTHEAST COUNTY:BROWARD SITE LAT/LON:26.07.18.00/80.09.19.00
SECT-TOWN-RANGE: SEGMENT: QUAD: 25SC FORT LAUDERDALE S.
POP.SERVED: DESIGN CAP: DRINKING WELL ON SITE? UNKNOWN

DISPOSAL METHOD(S):
( ) SPILL,LEAK,DUMP,ETC. ( ) IMPOUNDMENT ( ) SURFACE WATER DISCHARGE
( ) BURIAL ( ) INJECTION WELL ( ) VOL.REDUCT./RECOVERY
( ) DRAINFIELD ( ) LAND APPLICATION (X) OTHER: H.W. NOTIFIER
( ) ENCAPSULATION ( ) LANDSPREADING

FOR HARD COPY, TAB TO HERE :

G
GMST02 5006P81354 00 12/07/89 14.05.44

FACILITY OVERVIEW - PAGE 2

FACILITY NAME: PEOPLES GAS SYSTEM INC LAST UPDATED: 12/14/88
LANDOWNER: ADDR:
CTY/ST/ZIP: , COUNTRY:

TYPE(S) OF WASTE HANDLED:

A. SOLID,NON-HAZARDOUS	B. SLUDGE(S)	C. HAZARDOUS SOLID/LIQUID
( ) AGRICULTURAL	( ) WATER TREATMENT/LIME SOFTENING	( ) CAUSTIC & ACID SOLUTIONS
( ) RESIDENTIAL		( ) EXPLOSIVES
( ) COMMERCIAL	( ) SEPTIC TANK	( ) HEAVY METAL SOLUTIONS
( ) HOSPITAL/CLINICAL	( ) AIR SCRUBBER	( ) INORGANIC CHEMICALS
( ) MINING	( ) INDUSTRIAL/COMMERCIAL	( ) ORGANIC CHEMICALS
( ) INDUSTRIAL	( ) DOMESTIC	( ) ORGANIC SOLVENTS & OILS
	( ) INCINERATOR RESIDUE	( ) PAINT & INK WASTES
D. WASTEWATER	( ) ION EXCHANGE	( ) PESTICIDES/FUNGICIDES
( ) DOMESTIC	( ) HAZARDOUS SLUDGE	( ) PATHOLOGICAL/INFECTIOUS
( ) INDUSTRIAL		( ) LOW-LEVEL RADIOACTIVE
( ) REJECT WATER	SLUDGE GENERATED OR DISPOSED? (G/D/B)	( ) MINING
( ) COOLING WATER		

E.( ) OTHER (SEE COMMENTS)

FOR HARD COPY, TAB TO HERE :

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GMST50 5006P81354 00 500 05006P81354 12/07/89 14.02.20

FACILITY COMMENTS

FACILITY NAME: PEOPLES GAS SYSTEM INC LAST UPDATED: 12/10/87

NARRATIVE SEQ.
[illegible] (500)

Reference 11

HANDBOOK OF TOXIC AND HAZARDOUS CHEMICALS AND CARCINOGENS

Second Edition

by

Marshall Sittig

Princeton University

dent and Managing
emical and Process
th E.I. Du Pont de
ring, Ethyl Corpo-
and Princeton Uni-
s.

np NOYES PUBLICATIONS
Park Ridge, New Jersey, U.S.A.

LIBRARY
STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL REGULATION

Reference 12

Dangerous Properties of Industrial Materials

Sixth Edition

N. IRVING SAX

Assisted by:

Benjamin Feiner/Joseph J. Fitzgerald/Thomas J. Haley/Elizabeth K. Weisburger

VAN NOSTRAND REINHOLD COMPANY
New York

Reference 13

The Condensed Chemical Dictionary

TENTH EDITION

Revised by

GESSNER G. HAWLEY

VNR VAN NOSTRAND REINHOLD COMPANY

LIBRARY
STATE OF FLORIDA
DEPARTMENT OF ENVIRONMENTAL REGULATION

ivation: (1) Oxidation of hydrogen; (2) end prod- of combustion; (3) end product of acid-base ction; (4) end product of condensation reaction ification: (1) Distillation; (2) ion exchange reac- (zeolite); (3) chlorination; (4) filtration

tainers: Glass carboys; tank cars; pipelines.

Suspending agent (papermaking, coal slurries); vent (extraction, scrubbing); diluent; beer and bonated beverages; hydration of lime, paper ings, textile processing, moderator in nuclear tors, debarking logs; industrial coolant, filtra- washing and scouring; sulfur mining hydrol- , Portland cement; hydraulic systems; power ice, steam generation; food industry, source of rogen by electrolysis and thermochemical de- position (see under hydrogen)

dso: ice; steam; heavy water; ocean water; rain- water; water, hard.

bound. See bound water.

gas (blue gas). A mixture of gases made from al, and steam. The steam is decomposed by ing it over a bed of incandescent coke, or by temperature reaction with natural gas or simi- hydrocarbons. Carbon monoxide about 40%, rogen about 50%; carbon dioxide about 3% and gen about 3%.

rd: Flammable, dangerous fire and explosion Explosive limits 7 to 72% in air. Toxic by lation.

Organic synthesis; fuel gas; ammonia synthesis lso synthesis gas.

glass. See sodium silicate.

hard. Water containing low percentages of ium and magnesium carbonates, bicarbonates, ates or chlorides, as a result of long contact with s substrates and soils. Degree of hardness is essed either as grains per gallon or parts per on (ppm) of calcium carbonate (1 grain of O per gallon is equivalent to 17.1 ppm). Up to ains is considered soft; over 30 grains is very Hardness may be temporary (carbonates and bonates) or permanent (sulfates, chlorides). ment with zeolites (q.v.) is necessary to soften anently hard water. Temporary hardness can ved by boiling. These impurities are respon- for boiler scale (q.v.) and corrosion of metals ine contact. Hard waters require use of syn- detergents for satisfactory "sudsing." See also er.

ark. See dandy roll.

of crystallization. Water chemically combined any crystallized substances; it can be removed heat 100°C, usually with loss of crystalline erties.

pollution. Contamination of fresh or salt with materials that are toxic, noxious, or wise harmful to fish and other animals, and to man, including thermal pollution (q.v.). Disposal of untreated chemical and municipal wastes in streams and rivers has been illegal since the early 1900's; in 1973 the EPA prohibited dumping of all types of wastes into the ocean. Unintentional pollution results from run-off containing toxic insecticidal residues. Oil spills at sea are a continual problem and probably will remain so. See also waste treatment; oil spill treatment; Environmental Protection Agency; environmental chemistry.

waterproofing agent. (1) Any film-forming substance which coats a substrate with a water-repellent layer, such as a paint, a rubber or plastic film, a wax, or an asphaltic compound. These are used on a wide variety of surfaces, including cement, masonry, metals, textiles, etc.

(2) Any metal salt or other chemical which impregnates textile fibers in such a way as to give an air-permeable, water-resistant product. There are three types of these: renewable, semidurable, and durable. Renewable repellents are water dispersions containing aluminum acetate or formate, emulsifying agents and protective colloids in the continuous phase, and a blend of waxes in the disperse phase. Semidurable repellents involve precipitation of insoluble metal salts on the fibers; water-soluble soaps and waxes are usually added to the mixture, which is especially effective on synthetic fibers. Durable repellents coat each fiber with a protective film without bonding them together or sealing the apertures.

water purification (water conditioning). Any process whereby water is treated in such a way as to remove or reduce undesirable impurities. The following methods are used: (1) sedimentation, in which coarse suspended matter is allowed to settle by gravity in special tanks or reservoirs; (2) coagulation of aggregates (called "floc") by means of aluminum sulfate, ferric sulfate, or sodium aluminate (the aggregates are formed from colloidally dispersed impurities activated by the coagulant); (3) filtration through a bed of fine sand, either by gravity flow or by pressure, to remove suspended particles; (4) chlorination, which is effective in sterilizing potable water, swimming pools, etc.; (5) adsorption on activated carbon for removal of organic contaminants causing unpleasant taste and odor; (6) hardness removal by ion-exchange or zeolite process.

USDA has reported that mercury can be removed from water by treatment with low percentages of black liquor from kraft papermaking.

water-soluble gum. See gum, natural.

water-soluble oil. Ammonia, potash, or sodium soaps of oleic, rosin, or naphthenic acids dissolved in mineral oils.

Uses: Boring; lathe-cutting; milling; polishing lubricants; dressing textile fibers; dust laying.

See also soluble oil.

...tion. **Production of gaseous or liquid hydro-...on fuels from coal (1) by direct addition of ...ogen to form methane (hydrogasification); (2)** ...eacting steam with hot coal (800°C) in the ...nce of air or oxygen to form carbon monoxide ...ydrogen (synthesis gas), followed by a meth-...on reaction; (3) by underground aeration. In ...ods (1) and (2) the coal enters the reaction ...ence in finely divided form; hydrocarbon gases, ...the, and fuel oils of various grades can be pro-...d by several modifications (see Fischer-...sch, Hygas, Lurgi, and Oil Gas processes). An ...rimental technique reported in 1979 utilizes ...olysis of a coal-water slurry, in which hydro-...nd carbon oxides are evolved at the platinum ...odes at 175°C. In method (3), air is pumped ...to previously ignited coal seams and the com-...on products evolved are collected. Experi-...al installations at a number of locations have ...under way for several years.

...ny variations of methods (1) and (2) have been ...rched in the U.S., but none is economically ...etitive with crude oil. Several have advanced ...e pilot stage, and projections of cost, invest-..., and installation for large-scale operation ...been made. Environmental and geographic ...derations have also been investigated. The ...olling factor for future development is the ...of crude.

...three methods mentioned above are techni-...feasible. During World War II hydrocarbon ...were produced from coal on large scale in ...any by both hydrogasification and Fischer-...sch methods. More recently, coal conversion ...een successfully achieved in Scotland and else-...e by the Lurgi process and in South Africa by ...ASOL method, both of which are based on the ...er-Tropsch reaction.

...rt. See noble gas; inert.

...s. See Boyle's law; Charles' law; Gay-Lussac's ...deal gas.

...uefied petroleum. See liquefied petroleum ...

...id. See light hydrocarbon.

...ural. See natural gas.

...ble. See noble.

... Coined term for a motor fuel blend of ...ded gasoline and 10–15% ethyl alcohol. It ...ated in Europe in the 1930's. It was introduced ...braska in 1974 during the oil embargo, the ...ol being derived by fermentation of spoiled ... It can also be obtained from such forms of ...ass as cellulosic residues, deadfall trees, and ...ultural wastes, over 1 billion tons of which ...enerated annually in the U.S. According to ..., the octane number of the 10% blend is 88 to ...hich is slightly higher than that of straight ...ded gasoline (87).

Gasohol is now widely produced in the U.S. and Brazil, where the blend contains 20% alcohol; and its use may be expected to increase. Further information on alcohol-based automotive fuel may be obtained from National Alcohol Fuels Information Center, 1617 Cole Blvd., Golden, Colorado 80401.

gas oil. A liquid petroleum distillate with viscosity and boiling range between kerosine and lubricating oil. Boiling range between 232 and 426°C. Flash point 150°F (65.5°C). Autoignition temp 640°F (337°C). Combustible.

Uses: Absorption oil; manufacture of ethylene.

gasoline (gasolene). A mixture of volatile hydrocarbons suitable for use in a spark-ignited internal combustion engine and having an octane number of at least 60. The major components are branched-chain paraffins, cycloparaffins, and aromatics. There are several methods of production, distillation or fractionation, which yields straight-run product of relatively low octane number, used primarily for blending; thermal and catalytic cracking; reforming; polymerization, isomerization; and dehydrocyclodimerization. All but the first are various means of converting hydrocarbon gases into motor fuels by modifications of chemical structure, usually involving catalysis. The present source of gasoline is petroleum, but it may also be produced from shale oil and Athabasca tar sands, as well as by hydrogenation or gasification of coal.

antiknock gasoline. A gasoline to which a low percentage of methyl tert.-butyl ether (MBTE) has been added to eliminate knocking and increase octane number. This compound has almost completely replaced the tetraethyllead formerly used, which was abandoned for environmental reasons. Gasolines of octane number 100 or more are used chiefly as aviation fuel; those having a research octane number of about 90 are in general automotive use. See also antiknock agent; octane number.

casinghead gasoline. See natural gasoline (below).

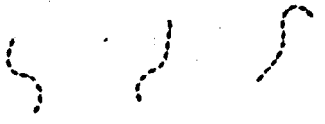
cracked gasoline. Gasolines produced by the catalytic decomposition of high-boiling components of petroleum. In general such gasolines have much higher octane ratings (from 80 to 100) than that produced by fractional distillation. The difference is due to the prevalence of unsaturated, aromatic and branched-chain hydrocarbons in the cracked gasoline. The actual properties vary widely with the nature of the starting material, and the temperature, time, pressure and catalyst used in cracking (q.v.).

high-octane gasoline. A gasoline with an octane number of from 90 to 100. See antiknock gasoline; octane number.

lead-free gasoline. An automotive fuel containing no more than 0.05 gram of lead per gallon, designed for use in engines equipped with catalytic converters.

natural gasoline. A gasoline obtained by recovering the butane, pentane, and hexane hydrocarbons

block polymer. A high polymer whose molecule is made up of alternating sections of one chemical composition separated by sections of a different chemical nature, or by a coupling group of low molecular weight. An example might be blocks of polyvinyl chloride interspersed with blocks of polyvinyl acetate. Such polymer combinations are made synthetically; they depend on the presence of an active site on the polymer chain which initiates the necessary reactions. See also graft polymer, stereoblock polymer.



blood. A complex, liquid tissue of sp. gr. 1.056 and pH of 7.35–7.45. It is comprised of erythrocytes (red cells), leucocytes (white cells), platelets, plasma proteins and serum. The plasma fraction (55–70%) is whole blood from which the red and white cells and the platelets have been removed by centrifuging. Hemoglobin (q.v.) is a protein found in the erythrocytes; it contains the essential iron atom, and functions as the transport agent for oxygen to the heart (artery) and of carbon dioxide from the heart (vein). Experimental work has been reported on the effectiveness of fluorocarbon compounds in carrying out the essential transport functions of blood, especially of the red cells.

Uses: Plasma is used to restore liquid volume and thus osmotic pressure in the body where blood loss has been extensive. Animal blood is used as a component of adhesive mixtures; in dried or powder form it is a component of fertilizers, poultry feeds, and deer repellents.

See also hemoglobin; plasma; platelet.

bloom. (1) A thin coating of an ingredient of a rubber or plastic mixture that migrates to the surface, usually within a few hours after curing or setting. Sulfur bloom in vulcanized rubber products is most common; it is harmless, but impairs the eye appeal of the product. Paraffin wax is often included purposely; when it migrates to the surface it provides an efficient barrier to sunchecking and oxidation.

(2) A piece of steel made from an ingot.

(3) An arbitrary scale for rating the strength of gelatin gels. When so used the word is capitalized.

(4) Efflorescence of phytoplankton in sea water, causing discoloration of the surface water. See red tide.

blowing agent. A substance incorporated in a mixture for the purpose of producing a foam. One type decomposes when heated to processing temperature to evolve a gas, usually carbon dioxide, which is suspended in small globules in the mixture. Typical blowing agents of this kind are baking powder (bread and cake), sodium bicarbonate or ammonium carbonate (cellular or sponge rubber), halocarbons and methylene chloride in urethane, pentane in expanded polystyrene; hydrazine and related compounds in various types of foamed plastics. Another type is air used at room temperature as blowing agent for rubber latex, it is introduced mechanically by whipping, after which the latex is coagulated with acid. Air is also used for this purpose in ice cream, whipped cream, and other food products, as well as in blown asphalt and blown vegetable oils. See also foam.

blow molding. A technique for production of hollow thermoplastic products. It involves placing an extruded tube (parison) of the thermoplastic in a mold and applying sufficient air pressure to the interior of the tube to cause it to take on the conformation of the mold. Polyethylene is usually used, but a number of other materials are adaptable to this process, e.g., cellulosics, nylons, polypropylene and polycarbonates. It is an economically efficient process and is especially suitable for production of toy bottles and other containers, as well as air conditioning ducts and various industrial items. The method is not limited to hollow products; for example, housings can be made by blowing a tube and sawing it along the parting line to make two housings.

blown asphalt. See asphalt, blown.

blown oil (oxidized oil; base oil; thickened oil; polymerized oil). Vegetable and animal oils which have been heated and agitated by a current of air or oxygen. They are partially oxidized, deodorized and polymerized by the treatment, and are increased in density, viscosity and drying power. Commonly blown oils are castor, linseed, rape, whale, and fish oils.

Uses: Paints, varnishes, lubricants, and plasticizers.

blue copperas. See copper sulfate.

blue gas. See water gas.

blue lead. See lead sulfate, blue basic.

blueprint. See Turnbull's Blue.

blue verdigris. See copper acetate, basic.

blue vitriol. See copper sulfate.

blush. Precipitation of water vapor in the form of colloidal droplets on the surface of a varnish or lacquer film, caused by lowering of the temperature immediately above the coated surface due to solvent evaporation. This results in unsightly graying of the dried film and can be avoided by use of a less volatile solvent.

board. See paperboard.

B.O.D. See biochemical oxygen demand.

body. (1) A non-specific term approximately syn

Reference 14

PUBLIC WATER SUPPLIES OF SELECTED MUNICIPALITIES IN FLORIDA, 1975

By Henry G. Healy

U.S. GEOLOGICAL SURVEY

WATER-RESOURCES INVESTIGATIONS 77-53

Prepared in cooperation with

FLORIDA DEPARTMENT OF ENVIRONMENTAL REGULATION
SOUTH FLORIDA WATER MANAGEMENT DISTRICT
SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT
ST JOHNS RIVER WATER MANAGEMENT DISTRICT
SUWANNEE RIVER WATER MANAGEMENT DISTRICT
NORTHWEST FLORIDA WATER MANAGEMENT DISTRICT
AND OTHER STATE, LOCAL, AND FEDERAL AGENCIES

July 1977

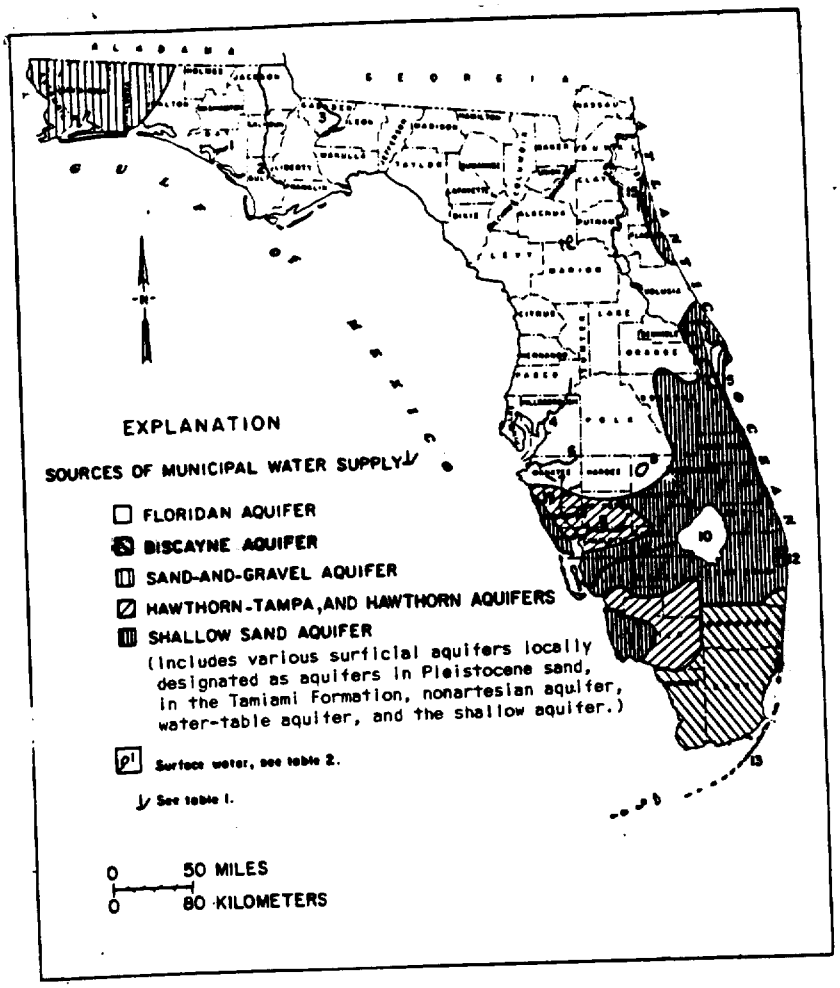


Figure 2.--Sources of water supply for municipal use.

Table 3.--Quantity of public-suppl municipalities, 1975.

Municipality	Source	Wat For th year (Mga
Miami	GW	68,87
Jacksonville	GW	21,33
Tampa	SW	19,23
Ft. Lauderdale	GW	16,79
Orlando	GW	14,86
St. Petersburg	GW	12,7
North Miami Beach	GW	9,1
Pensacola	GW	8,3
West Palm Beach	SW	7,7
Boca Raton	GW	6,2
Lakeland	GW	6,2
Pompano Beach	GW	5,4
Hollywood	GW	5,
Cocoa	GW	5,
Tallahassee	GW	5,
Gainesville	GW	5,
Winter Park	GW	4,
North Miami	GW	4.
Daytona Beach	GW	4,
Melbourne	SW	3.
Total		23

Table 2.--Quantity of water supplied by 22 municipalities, by source, 1975.

Source [1]	Municipality	Percentage supplied from source cited	Water supplied (Mgal)
1. Deer Point Reservoir	Callaway	100	105
	Panama City	100	1,737
	Panama City Beach	16	87
	Springfield	100	188
2. Chipola River	Port St. Joe	100	235
3. Quincy Creek	Quincy	100	432
4. Hillsborough River	Tampa	100	19,238
5. Lake Washington	Melbourne [2]	100	3,249
6. Manatee River	Palmetto	100	197
7. Braden River	Bradenton	100	1,397
8. Lake Sirena	Lake Placid	50	36
9. Shell Creek	Punta Gorda	100	666
10. Lake Okeechobee	Belle Glade	100	1,467
	Clewiston	100	424
	Okeechobee	100	380
	Pahokee	100	304
11. Caloosahatchee River	Ft. Myers	50	1,044
	Ft. Myers (suburban)	100	1,463
12. Lake Mangonia and Clear Lake	West Palm Beach [2]	100	7,760
13. Myakka-Hatchee River	N. Port Charlotte	100	359
14. Fordham Waterway	Port Charlotte	92	761
15. Infiltration gallery	St. Augustine	50	466
			41,995

[1]Numeral refers to figure 2.
[2]Includes other municipalities.

In 1975, five county water s
Mgal/d of public-supply water to
five systems provided, in the ag
two supplied 42 Mgal/d of surfac
quantities of water supplied by

County water System	Population served	Fo y (M
Bay County	65,000	11,
Broward County Utilities Dept.	136,000	7
Manatee County	55,000	3
Okaloosa County	20,870	
Pinellas County	319.110	12
TOTAL	595,980	3

a/ Includes 25.39 Mgal/d for i

Eighteen municipalities a
and four are supplied from bot
four supplied by both, the su
total supply (Panama City Bea
Charlotte) (table 2).

Table 3 lists the 20 lar
for 1975. On the average, th
or 72 percent of the total qu
56 percent of the entire publ
population of the 20 cities l
the 169 municipalities listed
population of Florida.

nicipalities, by source, 1975.

	Percentage supplied from source cited	Water supplied (Mgal)
	100	105
	100	1,737
ach	16	87
	100	188
	100	235
	100	432
	100	19,238
	100	3,249
	100	197
	100	1,397
	50	36
	100	666
	100	1,467
	100	424
	100	380
	100	304
	50	1,044
ban)	100	1,463
	100	7,760
	100	359
	92	761
	50	466
		41,995

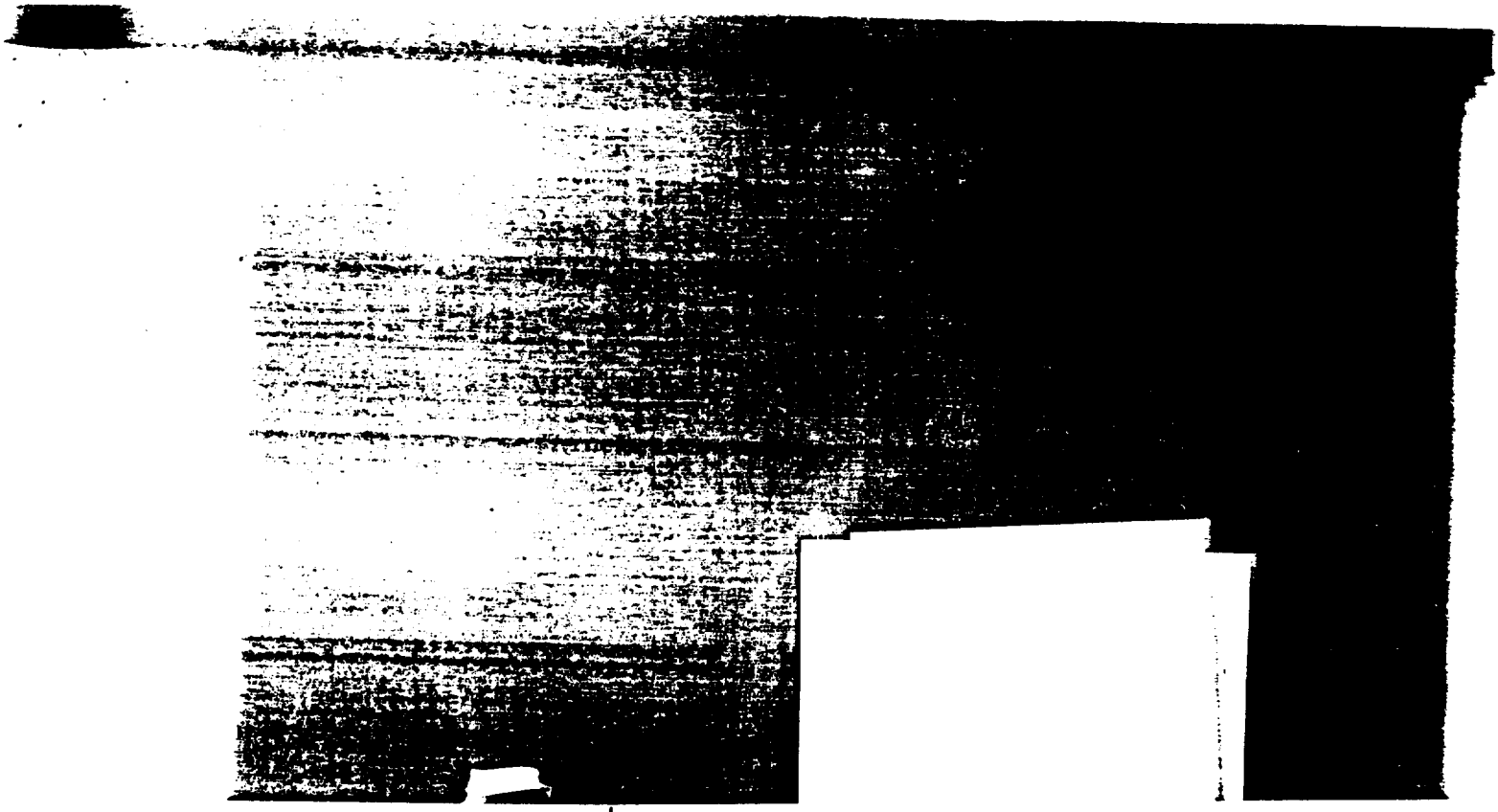
In 1975, five county water systems provided, on the average, 96 Mgal/d of public-supply water to a population of 595,980. Three of the five systems provided, in the aggregate, 54 Mgal/d of ground water, and two supplied 42 Mgal/d of surface water. The following table lists quantities of water supplied by all five.

County water System	Population served	Water Supplied: For the year (Mgal)	Water Supplied: Average daily (Mgal)	Source
Bay County	65,000	11,806.21	32.35[a/]	Deer Point Reservoir.
Broward County Utilities Dept.	136,000	7,081.0	19.40	Biscayne aquifer.
Manatee County	55,000	3,613.5	9.90	Manatee River
Okaloosa County	20,870	716.64	1.96	Floridan and sand-and-gravel aquifers.
Pinellas County	319.110	12,055.91	33.05	Floridan aquifer.
TOTAL	595,980	35,273.26	96.60	

a/ Includes 25.39 Mgal/d for industrial use.

Eighteen municipalities are supplied entirely from surface-water sources and four are supplied from both surface and ground-water sources. Of the four supplied by both, the surface-water supply ranged from 16 percent of total supply (Panama City Beach) to 92 percent of total supply (Port Charlotte) (table 2).

Table 3 lists the 20 largest municipal public supplies in the State for 1975. On the average, the municipalities listed pumped 638 Mgal/d or 72 percent of the total quantity of public-supply water reported and 56 percent of the entire public supply in the State. The aggregate population of the 20 cities listed is 57 percent of the population of the 169 municipalities listed in this report and 44 percent of the total population of Florida.



except as indicated)

LECTION DATE: 6-17-75

ıter plant.

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BROWARD COUNTY UTILITIES DEPARTMENT

County: Broward **Population served:** 136,000
River basin: Everglades and southeastern coastal area (09 02 02)

Ownership of supply or system: Broward County Utilities Department
Source of water: Ground water, Biscayne aquifer; 8 well fields, 37 wells, 57 to 178 feet deep; yield 150 to 2,600 gal/min

Rated plant capacity: 33.2 Mgal/d
Pumpage: Year— 7,081.0[a] Mgal **Average daily—** 19.4 Mgal
Highest month: Not reported **Lowest month:** Not reported

Per capita use: 143 gal/d
Finished-water storage: 12.17 Mgal
Treatment: Aeration, algae control, anti-precipitation and corrosion control, chlorination, clarification, coagulation, filtration, flocculation, fluoridation, sedimentation, softening [b]
Type/Frequency of analysis: Bacteriological/weekly; chemical, color, and turbidity/weekly; spectrographic/annually.
Sewage discharge: 10.9 Mgal/d
Sewage treatment: Activated sludge, aeration, chlorination, clarification, comminution, drying, secondary, settling, skimming

Waste discharged to: Atlantic Ocean

Remarks: Supplies water to Hollywood (partial), Melwyn Pk., Lighhouse Point (partial. 47,800 residents, 7.17 Mgal/d), Brentwood and Collier Estates, Lauderdale Lakes, Broward County areas. No chemical analysis available. Sherwood and others (1973.)

a/ Includes 1095.0 Mgal supplied to Lauderdale Lakes.

b/ Also includes stabilization, taste and odor control.

c/ Broward County Utilities Dept. regional plant. This plant, discharges after treatment, an additional 1.024 Mgal/d to a percolation pond and to Canal C-11.

oulation served: 10,000
ianatee Rivers (10 02 01)

District
nd aquifer, Pleistocene and
feet, yield 30 to 100 gal/min

Average daily— 1.01 Mgal
Lowest month: September, 21.44 Mgal

filtration

m 0.52 Mgal/d in 1970 to 1.01

cept as indicated)

:CTION DATE: 6-17-75
e

d solids	
lue at 180°C)	546
rdness	
CO_3)	330
nate hardness	
CO_3)	87
ity (as $CaCO_3$)	243
s)	7.8
conductance	
s/cm at 25°C)	902
Pt-Co units)	55
ure (°C)	--
y(JTU)	2
organic, total (C)	11
sphate	
(PO_4-P)	.27

FORT LAUDERDALE

County: Broward Population served: 226,430
River basin: Everglades and southeastern coastal area (09 02 02)

Ownership of supply or system: Municipal
Source of water: Ground water, Biscayne aquifer; 59 wells, 75 to 189 feet deep; yield 400 to 1,100 gal/min

Rated plant capacity: 60 Mgal/d
Pumpage: Year— 16,798.39 Mgal Average daily— 46.02[a/] Mgal
Highest month: April, 1,822.2 Mgal Lowest month: October, 1,172.3 Mgal

Per capita use: 203 gal/d
Finished-water storage: 20 Mgal
Treatment: Aeration, chlorination, coagulation, filtration, flocculation, pH control, softening, taste and odor control

Type/Frequency of analysis: Bacteriological, chemical, color, and turbidity/daily; spectrographic/30 times yearly
Sewage discharge: 16.97 Mgal/d (5 sewage treatment plants)
Sewage treatment: Chlorination, clarification, comminution (all); activated sludge, drying, grit chamber, skimming (2); aeration, digestion (3); contact stabilization, incineration (1)
Waste discharged to: North Fork New River Canal; Intracoastal Waterway (2); South Fork New River; North Fork Middle River
Remarks: Average daily pumpage increased from 17.10 Mgal/d in 1956 to 46.0 Mgal/d in 1973. City supplied at total of 6.576 mgd to Wilton Manors, Oakland Pk, Lazy Lake and Tamarac. City also supplies Lauderdale-by-the-sea, Sea Ranch Lake, Ft. Lauderdale, Hollywood airport and Fort Everglades. Supplementary supply for Dania, Plantation and Broward County Utilities Dept. (fig 24). Leach and others (1972), Sherrod and others (1973). a/ Combined pumpage, Dixie and Prospect Well Fields.

CHEMICAL ANALYSIS (milligrams per liter except as indicated)

ANALYSIS BY: U.S. Geological Survey COLLECTION DATE: 6-12-75
SAMPLING POINT: 261044080092001, Prospect water plant

Silica (SiO_2)	9.7	Dissolved solids (residue at 180°C)	388
Calcium (Ca)	100	Total hardness (as $CaCO_3$)	260
Magnesium (Mg)	2.8	Noncarbonate hardness (as $CaCO_3$)	15
Sodium (Na)	19	Alkalinity (as $CaCO_3$)	245
Potassium (K)	1.5	pH (units)	7.4
Strontium (Sr)	.78	Specific conductance (µmhos/cm at 25°C)	619
Bicarbonate (HCO_3)	299	Color (Pt-Co units)	45
Sulfate (SO_4)	26	Temperature (°C)	--
Chloride (Cl)	33	Turbidity(JTU)	--
Fluoride (F)	.3	Carbon, organic, total (C)	--
Nitrate (NO_3-N)	.01	Orthophosphate total (PO_4-P)	--
Nitrite (NO_2-N)	.00		
Nitrogen, organic (N)	--		
Nitrogen (ammonia, total (NH_4-N))	.63		
Iron (Fe)	1.8		
Phosphorus, total (P)	--		

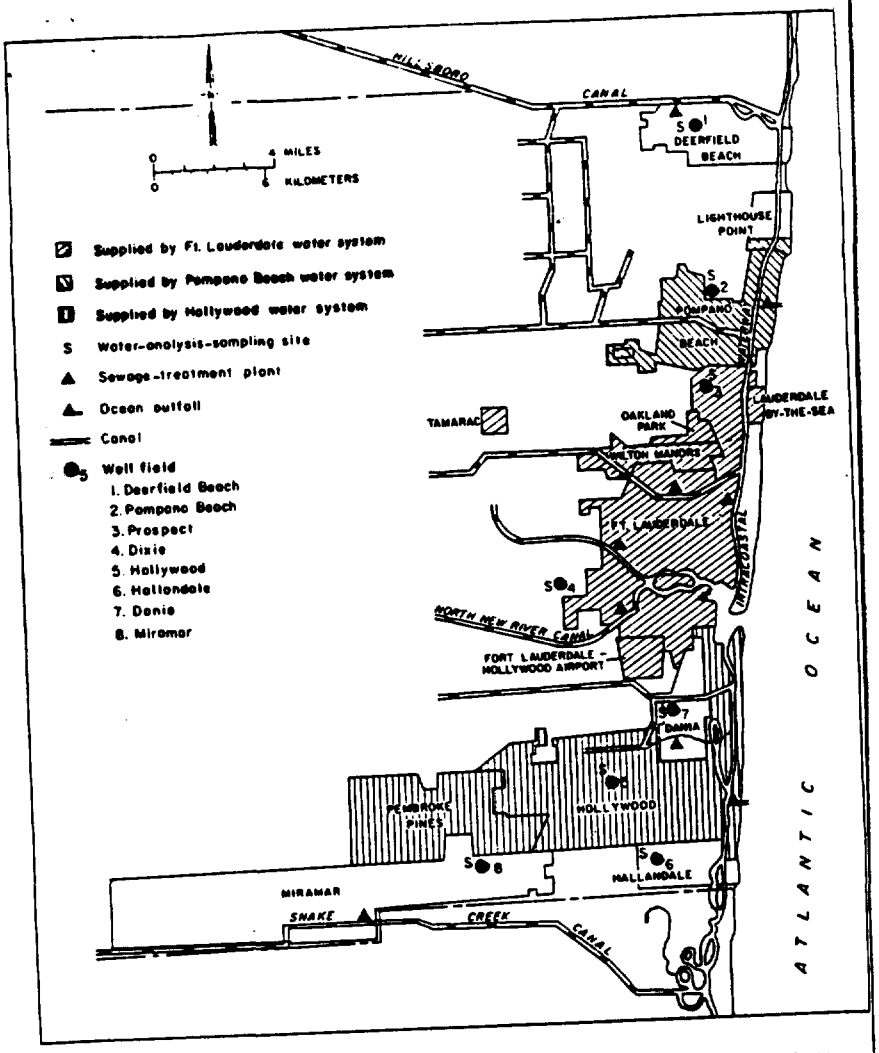

Figure 24.--Areas supplied water by individual and composite water systems, Broward County.

County: Lee
River basin: Caloosahatchee River

Ownership of supply or system: Mun
Source of water: Ground water, percent of supply; 11 wells 16 surface water, Caloosahatchee R
Rated plant capacity: 8.3 Mgal/d
Pumpage: Year— 2089 Mgal
Highest month: May, 208 Mgal

Per capita use: 150 gal/d
Finished-water storage: 2 Mgal
Treatment: Chlorination, filtrat recarbonation, softening

Type/Frequency of analysis: Bacter turbidity/monthly
Sewage discharge: 6.65 Mgal/d (2
Sewage treatment: High rate tric South Plant

Waste discharged to: Caloosahatche

Remarks: Average daily pumpage in 1975. Service connections: Sproul and others (1972),O'Donn a/ Includes 2.85 Mgal/d pumped aquifer at the well field.

CHEMICAL ANALYSIS (milligrams

ANALYSIS BY: U.S. Geological Su
SAMPLING POINT: 263824081513

Silica (SiO_2)	5.2
Calcium (Ca)	81
Magnesium (Mg)	14
Sodium (Na)	81
Potassium (K)	4.1
Strontium (Sr)	1
Bicarbonate (HCO_3)	217
Sulfate (SO_4)	49
Chloride (Cl)	136
Fluoride (F)	.3
Nitrate (NO_3-N)	.0
Nitrite (NO_2-N)	.0
Nitrogen, organic (N)	.7
Nitrogen (ammonia, total (NH_4-N))	.2
Iron (Fe)	1.6
Phosphorus, total (P)	.0

OAKLAND PARK

County: Broward
Population served: 29,000
River basin: Everglades and southeastern coastal area (09 02 02)

Ownership of supply or system: Municipal
Source of water: All water purchased from Ft. Lauderdale Five Ash water plant; ground water, Biscayne aquifer

Rated plant capacity: a/
Pumpage: Year—1,277.50 Mgal
Highest month: Not reported
Average daily— 3.50 b/ Mgal
Lowest month: Not reported

Per capita use: 121 gal/d
Finished-water storage: a/
Treatment: Chlorination

Type/Frequency of analysis: Bacteriological/monthly

Sewage discharge: 3.2 Mgal/d
Sewage treatment: Aeration, chlorination, activated sludge, clarification, filtration, drying, settling, primary, secondary

Waste discharged to: Canal C-14 (Middle River). Sludge is vacuum dried and land disposed
Remarks: Average daily pumpage increased from 0.16 Mgal/d in 1956 to 3.50 Mgal/d in 1975. City supplies water to North Andrews and Prospect Gardens. For chemical analysis of water supplied, see Ft. Lauderdale.

a/ See Ft. Lauderdale (p. 187).
b/ Includes 1.05 Mgal/d commercial use.

County: Okeechobee
River basin: Taylor Creek and in
(09 01 02)
Ownership of supply or system: Mu
Source of water: Surface water,

Rated plant capacity: 2.88 Mgal/d
Pumpage: Year—380.44 Mgal
Highest month: April, 37.6 M

Per capita use: 126 gal/d
Finished-water storage: 1.5 Mgal
Treatment: Aeration, chlorinat
flocculation, pH control, sed

Type/Frequency of analysis: Bacte
daily
Sewage discharge: 0.12 Mgal/d
Sewage treatment: Activated sl
contact stabilization, diffus
primary, secondary
Waste discharged to: Taylor Creel

Remarks: Average daily pumpag
1.04 Mgal/d in 1975. Water s

a/ Includes 0.104 Mgal/d com

CHEMICAL ANALYSIS (milligra

ANALYSIS BY: U.S. Geological
SAMPLING POINT: 02276400

Silica (SiO_2)	1.
Calcium (Ca)	32
Magnesium (Mg)	11
Sodium (Na)	37
Potassium (K)	3.
Strontium (Sr)	.
Bicarbonate (HCO_3)	102
Sulfate (SO_4)	39
Chloride (Cl)	58
Fluoride (F)	.
Nitrate (NO_3-N)	.
Nitrite (NO_2-N)	.
Nitrogen, organic (N)	1.
Nitrogen (ammonia, total (NH_4-N))	.
Iron (Fe)	.
Phosphorus, total (P)	.

D

er except as indicated)

OLLECTION DATE: 5-15-75
t, raw, composite

ead (Pb)	6
ithium (Li)	30
anganese (Mn)	10
ercury (Hg)	-
olybdenum (Mo)	3
ickel (Ni)	0
H(units)	7.5
elenium (Se)	-
anadium (V)	24
emperature (°C)	28.5
inc (Zn)	3

r except as indicated)

OLLECTION DATE: 5-17-75
Island Water plant

olved solids esidue at 180°C)	158
l hardness s $CaCO_3$)	20
arbonate hardness s $CaCO_3$)	19
linity (as $CaCO_3$)	1
units)	5.1
ific conductance mhos/cm at 25°C)	295
r (Pt-Co units)	0
erature (°C)	30.0
idity(JTU)	1
on, organic, total (C)	.00
ophosphate tal (PO_4-P)	.00

:2

PLANTATION

County: Broward
Population served: 35,000
River basin: Everglades and southeastern coastal area (09 02 02)

Ownership of supply or system: Municipal
Source of water: Ground water, Biscayne aquifer; 8 wells, 74 to 95 feet deep; yield 525 to 750 gal/min

Rated plant capacity: 7 Mgal/d
Pumpage: Year—1,892.89 Mgal
Highest month: March, 210.5 Mgal
Average daily— 5.19[a] Mgal
Lowest month: October, 129.9 Mgal

Per capita use: 148 gal/d
Finished-water storage: 1.85 Mgal
Treatment: Aeration, chlorination, filtration, softening, fluoridation

Type/Frequency of analysis: Bacteriological daily[b]; chemical, color, turbidity/annually; bacteriological/twice weekly[c]
Sewage discharge: 2.0 Mgal/d
Sewage treatment: Activated sludge, aeration, chlorination, contact stabilization, drying, polishing pond, secondary

Waste discharged to: Holloway Canal

Remarks: Average daily pumpage increased from 0.05 Mgal/d in 1956 to 5.19 Mgal/d in 1975.

a/ Includes 0.726 Mgal/d commercial use.
b/ Treated water.
c/ Raw water.

CHEMICAL ANALYSIS (milligrams per liter except as indicated)

ANALYSIS BY: U.S. Geological Survey COLLECTION DATE: 6-12-75
SAMPLING POINT: 260738080140701, Plantation Water Plant

Silica (SiO_2)	8.6	Dissolved solids (residue at 180°C)	416
Calcium (Ca)	110	Total hardness (as $CaCO_3$)	287
Magnesium (Mg)	2.8	Noncarbonate hardness (as $CaCO_3$)	38
Sodium (Na)	27	Alkalinity (as $CaCO_3$)	249
Potassium (K)	.8	pH (units)	7.5
Strontium (Sr)	.89	Specific conductance (µmhos/cm at 25°C)	668
Bicarbonate (HCO_3)	304	Color (Pt-Co units)	95
Sulfate (SO_4)	24	Temperature (°C)	--
Chloride (Cl)	48	Turbidity(JTU)	--
Fluoride (F)	.3	Carbon, organic, total (C)	--
Nitrate (NO_3-N)	.00	Orthophosphate total (PO_4-P)	--
Nitrite (NO_2-N)	.00		
Nitrogen, organic (N)	--		
Nitrogen (ammonia, total (NH_4-N))	.9		
Iron (Fe)	1.9		
Phosphorus, total (P)	--		

Reference 15

STATE OF FLORIDA
DEPARTMENT OF NATURAL RESOURCES
Randolph Hodges, *Executive Director*

DIVISION OF INTERIOR RESOURCES
Robert O. Vernon, *Director*

BUREAU OF GEOLOGY
C. W. Hendry, Jr., *Chief*

Report of Investigation No. 65

WATER RESOURCES OF BROWARD COUNTY, FLORIDA

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COUNCIL

By
C. B. Sherwood, H. J. McCoy, and C. F. Galliher

Prepared by the
UNITED STATES GEOLOGICAL SURVEY
in Cooperation with the
BUREAU OF GEOLOGY
FLORIDA DEPARTMENT OF NATURAL RESOURCES
and
BROWARD COUNTY

TALLAHASSEE
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WATER RESOURCES OF BROWARD COUNTY, FLORIDA

By
C. B. Sherwood, H. J. McCoy, and C. F. Galliher

ABSTRACT

Broward County has large potential supplies of fresh water because of its almost 60-inch annual rainfall and its massive man-made surface-water management system integrated with the highly permeable Biscayne aquifer. However, the rapid urbanization of the area has been accompanied by major natural and man-made water problems, most of which intensify with mushrooming population. Natural problems of flood and drought are caused by extreme variations in rainfall that range from as much as 20 inches per day during the rainy season to little or none for extended periods in the dry season. Man-made problems include contamination by sea-water intrusion or by man-made wastes and management of water resources so that maximum long-term supplies can be developed. Although the development of adequate supplies for all needs will become a more critical problem in the future, contamination is the chief threat to present supplies.

Surface water is derived from rainfall, ground-water inflow, and releases and seepage from interior water conservation areas. The quality of the surface waters is initially good but variable; mineral content generally does not exceed 500 mg/l (milligrams per liter).

Although the surface-water supply is large it is variable because of the seasonal nature of the rainfall. Also losses from the system are high: of the 60 inches of annual rainfall, an average of 42 inches is lost by evapotranspiration, and during 1963-68, 1,300 cfs (cubic feet per second), about 840 mgd (million gallons per day), was lost by seaward flow from the eight primary canals. However, since the late 1950's, water management has greatly reduced the seaward flow. The average annual flow from the Hillsboro and North New River Canals reduced by approximately 260 cfs and 375 cfs, respectively.

The unconfined Biscayne aquifer is the source of all fresh ground water in Broward County. The aquifer is composed chiefly of limestone, sandstone, and sand which range in age from late Miocene through the Pleistocene. The aquifer extends from the surface to a depth of about 200 feet along the coast, thins westward to a depth of about 70 feet in central Broward County and pinches out near the west county line. Wells that tap the thick limestone in the deep part (100 or more feet) of the aquifer near the coast yield more than 1,000 gpm (gallons per minute). The transmissivity of the aquifer ranges from 0.4 mgd per

foot in the northern part of the county to 2.5 mgd per foot near the southern part. The quality of the ground water is generally within the standards for potable water. It is a hard, calcium bicarbonate type, and in the southeastern part of the county it contains iron in objectionable concentrations.

Aquifer replenishment is by local rainfall and seepage from controlled canals and from the water conservation areas. Losses are by evapotranspiration, by ground-water flow to canals and the sea and by pumping from wells. Of the 60 inches of annual rainfall approximately 17 inches enters the aquifer, of which less than 2.5 inches is withdrawn by water users, and about 14.5 inches is discharged to the sea – 13.5 inches through the canals and about 1 inch by ground-water outflow along the coast. During extended dry periods when withdrawals are greatest recharge is only available from the canals.

The confined Floridan aquifer extends from a depth of about 900 feet to more than 3,000 feet and is overlain by a 500-to 600-foot section of clay, silt and marl of low permeability. Although water in wells tapping the Floridan aquifer will rise almost 40 feet above msl (mean sea level) and flow as much as 2,000 gpm, the water is not potable. Nevertheless, the water quality is adequate for such purposes as cooling or desalination and the aquifer has potential for storing fresh water or for effluent disposal.

The greatest inland penetration of sea water into the Biscayne aquifer is in the vicinity of the greatest concentration of tidal canals. This intrusion can be effectively controlled by the construction of salinity control structures in the canals and maintaining adequate fresh-water levels upstream.

Man-made contamination has occurred in both ground and surface waters. Surface-water contamination appears more serious because of the introduction of large quantities of effluent waste into the waterways. Although evidence of man-made contaminants was detected in all canals, levels of nutrients, BOD (biochemical oxygen demand), and pesticides were highest and levels of dissolved oxygen were lowest in the North Fork New River-Plantation Canal (C-12) system which receives large quantities of treated sewage effluent and has a relatively low flow. Coliform bacteria in most canals sampled during June 1968 were above the criterion of the Florida Pollution Control Department for recreational waters (2,400 coliform colonies per 100 milliliters). The dissolved oxygen content ranged from 0.2 to 8.2 mg/l. Generally, relatively low levels of dissolved oxygen are common throughout the Broward canal system. More than half the 45 area-wide samples contained less than 4 mg/l, and nine samples less than 2 mg/l. Levels of pesticides detected in water in the canal network are extremely low; however, pesticides are concentrated manyfold in the bottom sediments.

Water use in Broward C
and complete urbanization
maximum possible water sup
water utilities furnish about
average) for a permanent
population of 890,000, and
utility, Ft. Lauderdale's, fu
maximum population of 160
during the winter tourist se
domestic and recreational
Irrigation use is little noted
total irrigation use is high, al
use. Most of the industrial
day) is salty water for coolin
is estimated to be 35 mgd.
billion gallons per year, an
indicate that peak day needs
demand. If use by agricultur
it would amount to 330 mgd
550 mgd.

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drought are caused by extr
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during many months in th
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canal system. More than
g/l. and nine samples less
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manyfold in the bottom

Water use in Broward County is increasing at a faster rate than population, and complete urbanization will ultimately require the development of the maximum possible water supplies. More than 32 municipal and privately owned water utilities furnish about 32 billion gallons of water per year (88 mgd on the average) for a permanent population of 500,000, a peak tourist season population of 890,000, and most commercial use in the county. The largest utility, Ft. Lauderdale's, furnishes a peak supply of more than 60 mgd to a maximum population of 160,000. Urban water use is greatest, about 150 mgd, during the winter tourist season which coincides with the dry season when domestic and recreational use is maximum and lawn irrigation is heavy. Irrigation use is little noted because of the booming urban activity. However the total irrigation use is high, almost equal to the 32 billion gallons per year urban use. Most of the industrial water used, more than 1.5 bgd (billion gallons per day) is salty water for cooling at the two power plants; fresh-water industrial use is estimated to be 35 mgd. Public water needs by 1985 may be as much as 80 billion gallons per year, an average of about 220 mgd. Current data (1971) indicate that peak day needs are commonly as much as twice the average daily demand. If use by agriculture and industry increases in proportion to public use it would amount to 330 mgd in 1985 and total water use would average about 550 mgd.

INTRODUCTION

The explosive urbanization of Broward County has been accompanied by numerous natural and man-made water problems. Natural problems of flood and drought are caused by extreme variations in rainfall that may range from as much as 20 inches per day during hurricanes in the rainy season, to little or none during many months in the dry season. Man-made water problems include: sea-water intrusion that resulted from overdrainage of the area; obtaining adequate water supplies for the mushrooming population; and pollution caused by the disposal of increasing quantities of wastes.

The threat of sea-water intrusion into municipal well fields is a historic problem. As large amounts of fresh water were removed by drainage for ubanization, regional fresh-water levels declined and sea water advanced up the canals and moved inland through the aquifer during dry periods. This insidious invasion of salt water is an ever-present danger to the fresh-water supply of well fields near the coast.

The demand for water in Broward County is constantly increasing, owing to the rapid growth in population. State and County planners indicate this growth is destined to continue, and if projections are reasonably accurate, the demand for fresh water will more than double within the next 15 years.

HYDROLOGIC SETTING

CLIMATE

The climate of Broward County is semi-tropical marine, characterized by warm humid summers and mild dry winters. Mean annual temperature is 73° F, with infrequent extremes of temperature ranging from 29° F to 96° F (U. S. Department of Commerce, 1968). The climate is tempered by prevailing southeast winds, which bring warm moist air from the ocean, and by the Gulf Stream which passes within a few miles of the shoreline. January is usually the coldest month, averaging about 68° F and August is usually the hottest, averaging 83° F.

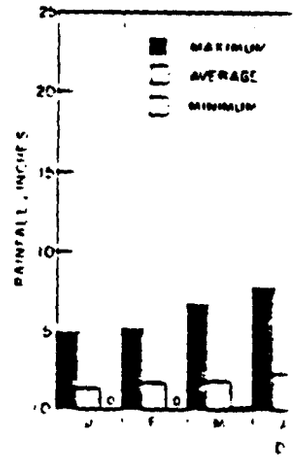
The average annual rainfall in the county ranges from about 52 inches in the western sector to as much as 60 inches along the coast. Wide differences in yearly totals have been recorded; in some years the rainfall is only 30 inches, in others, more than 100.

Rainfall is unevenly distributed throughout the year; about 75 percent of the rain falls in June - October. January is usually the driest month with an average rainfall of about 2 inches; September is usually the wettest month with an average rainfall of about 8.5 inches. For example, the average monthly rainfall at Fort Lauderdale and Boca Raton in January is 2.20 and 2.62 inches; in September, 8.98 and 8.16 inches (table 1). Rainfall is often unevenly distributed geographically. For example, on October 14-15, 1965, 25 inches of rain fell at a coastal yacht basin in Fort Lauderdale and less than 5 inches fell at an agriculture station 8 miles inland.

Annual rainfall at North New River Canal at Palm Beach - Broward County line (pumping station S-7) during a 26-year period averaged 52.10 inches; was 76.47 inches in 1947 and 30.40 inches in 1949 (fig. 3). Rainfall during that time was above average 57 percent of the time, and exceeded 70 inches 10 percent of the time (fig. 4).

TOPOGRAPHY AND DRAINAGE

The land surface slopes almost imperceptibly to the southeast. Land surface ranges from about 13 feet above msl (mean sea level) in the northwestern part of the county to less than 5 feet in the southern part. Most of the land is 5 to 10 feet high; some is higher along the coastal ridge which parallels the seacoast 2 to 3 miles inland. The coastal ridge is about 22 feet above msl in the Pompano Beach - Deerfield Beach area. West of the coastal ridge, the Everglades extends some 40 miles inland and covers the western two-thirds of the county.



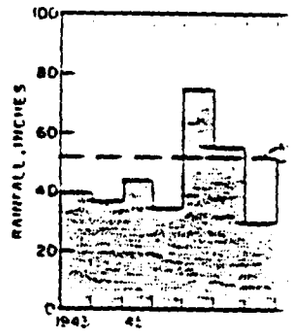


Figure 3. Distributi
1943-68.
Beach Co

The present day drainage is largely controlled by the system of canals of the FCD (fig. 5), the Broward Water Resources Department, and the various local drainage districts. In 1953, with the completion of the FCD levee barrier along the east border of the Everglades, the county was divided into two distinctly different land use areas; a 410-square-mile area east of the levee, suitable for urban use and agriculture, and an area of 810 square miles west of the levee, suitable only for water conservation, recreation, and as a wildlife refuge.

The primary canals of the FCD are, generally, controlled improvements to natural drainageways that have been extended to Lake Okeechobee. Secondary canals affect smaller areas between primary canals and the direction of drainage in these areas is dependent on local topography and water control.

GEOLOGY

The most common materials in Broward County to a depth of approximately 300-400 feet are sand and limestone, which range in age from Pleistocene to late Miocene. This 300-to 400-foot section is called the Biscayne aquifer and it contains all the fresh-water-bearing materials in Broward County. The Biscayne aquifer is discussed in detail in the section on ground water (p. 85). Underlying the Biscayne aquifer is a 500-600 foot section of marl and clay of Miocene age. Below this bed is the Floridan aquifer. This aquifer, composed chiefly of limestones, dolomites, and evaporites which range in age from early Miocene to early Eocene, extends to depths of more than 3,500 feet, and contains highly mineralized water. Similar materials which are not generally considered part of the Floridan aquifer extend to depths of more than 15,000 feet.

SURFACE-FLOW SYSTEM

In Broward County large quantities of surface water flow seaward in a system of controlled canals or are stored in the FCD conservation areas. Flow to the ocean from eight primary canals (fig.1), for 1963-1968, averaged more than 1,300 cfs (cubic feet per second), or more than 306 billion gallons per year.

The supply is variable because of the seasonal nature and annual variability of rainfall (fig. 3). In addition, losses from the system are very high. Evapotranspiration losses account for as much as two-thirds of the annual

rainfall. Although little surface
quantities replenish the aquifer

WAT

Maps of the 1850's sh
wilderness, virtually uninhabit
coastal ridge acted as a natur
Everglades. Drainage of the ea
the 1850's. However, drainag
(Everglades Drainage District)
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levees were constructed, and 1

When the EDD project
canals connecting Lake Oke
canals formed the framewor
County. The four major canals
South New River Canals, and
River, Plantation, and Snake (
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and wildlife conservation. T
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and prevent a recurrence of c

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uare-mile area east of the levee,
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the section on ground water (p.
600 foot section of marl and clay
aquifer. This aquifer, composed
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of more than 3,500 feet, and
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YSTEM

surface water flow seaward in a
FCD conservation areas. Flow to
1963-1968, averaged more than
306 billion gallons per year.

nal nature and annual variability
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ch as two-thirds of the annual

rainfall. Although little surface water is used directly, except for irrigation, large quantities replenish the aquifer in coastal areas during the long dry periods.

WATER MANAGEMENT

HISTORY

Maps of the 1850's show the Broward County area as a vast swampy wilderness, virtually uninhabited except for a narrow strip along the coast. This coastal ridge acted as a natural barrier to the seaward flow of water from the Everglades. Drainage of the eastern part of the Everglades was started as early as the 1850's. However, drainage was not effective until 1906, when the EDD (Everglades Drainage District) began a dredging program. Between 1906 and 1927, under the direction of EDD,440 miles of canals were dug, 47 miles of levees were constructed, and 16 dams and locks were installed.

When the EDD project was completed in 1928, four of the major drainage canals connecting Lake Okeechobee to the ocean and numerous secondary canals formed the framework of the present drainage system for Broward County. The four major canals included the Hillsboro, Miami, and the North and South New River Canals, and the secondary canals included Pompano, Middle River, Plantation, and Snake Creek Canals. This network of canals did much to open up new land in the eastern part of the county, but it was apparent that natural flow was inadequate to prevent flooding from rainstorms of high intensity.

Because of this inadequacy and more directly because of the public reaction to the flood of 1947, the Florida Legislature created the FCD in 1948 as a public corporation with jurisdictional control over the surface-water resources of the 17 counties comprising the district. In addition to the primary objectives of flood control and water conservation, the project was designed to prevent overdrainage, permit additional urban and agricultural development, prevent salt-water intrusion, provide ground-water recharge, and improve fish and wildlife conservation. The FCD has been in the process of attaining these objectives since it was formed and although still incomplete, their effects have been noted in all of the 17 counties.

A major project was the construction of a levee from Lake Okeechobee to South Dade County to divert interior flood waters away from the coastal areas and prevent a recurrence of conditions which existed during the 1947 flood.

The next major project was the creation of the Water Conservation Areas to store the diverted water and provide a reserve supply for the dry months because southeastern Florida was lacking in natural water-storage basins.

WATER-CONSERVATION AREAS AND PUMP STATIONS

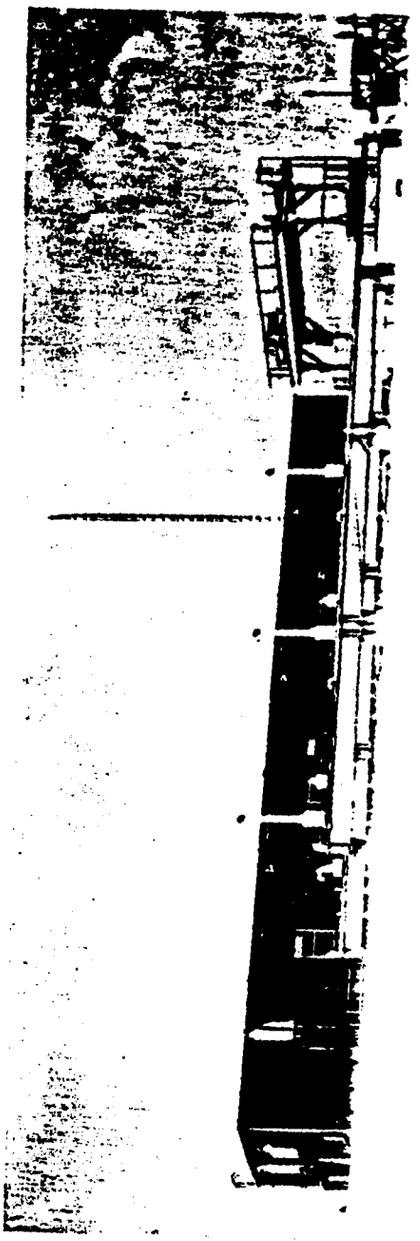
Water-conservation areas cover parts of Palm Beach, Broward, and Dade Counties, and have a total area of 1,340 square miles, 787 square miles of which are in Broward County (fig. 5). To provide better water control, the areas are divided into five interconnected pools, each enclosed by levees 10 to 15 feet high. The pools are designated by number from north to south as Water-Conservation Areas 1, 2A, 2B, 3A, and 3B (fig. 5). All except area 1 lie wholly or partly within Broward County. Under FCD staging, flow will gravitate from Water-Conservation Area 1 to 2A, from 2A to 2B and 3A, and from 3A to 3B. Flow interchange between all areas is regulated by gated controls or stoplog spillways. The regulation schedules in the conservation areas vary during the year as levels are lowered before the hurricane season. Levels scheduled for conservation areas 1, 2 and 3 are 15-17 feet, 13-14.5 and 9.5-10.5 feet above msl respectively, and corresponding storage capacities are 59,500-293,000 acre-feet, 201,000-366,000 acre-feet, and 560,000-1,015,000 acre-feet, respectively.

Major components of the FCD system are 17 pump stations planned or completed in the system. Four of these, S-7, S-8, S-9, and S-13 (fig. 5) are now operating in Broward County.

S-7 is on the North New River Canal at the Palm Beach - Broward County line, in the westernmost corner of Water-Conservation Area 2A. It is equipped with an electrically operated sluice gate and three 895 hp diesel powered pumps capable of pumping 2,490 cfs or 1,609 mgd (see photograph, fig. 6). S-7 is designed to remove three-fourths of an inch of runnoff per day from a 125-square-mile area north of the county line and discharge it into Water-Conservation Area 2A.

S-8 is on the Miami Canal, also at the Palm Beach - Broward County line, and in the northwest corner of Water-Conservation Area 3A. S-8, like S-7, has a sluice gate for water-level control, but it is equipped with four 895 hp diesel powered pumps. Their combined capacity is 4,160 cfs or 2,689 mgd. S-8 is designed to remove three-fourths inch of runoff per day from a 208-square-mile-area north of the county line and discharge it into Water-Conservation Area 3A.

S-9 is on the South New River Canal at its junction with Levee 33 and 37, half a mile west of U. S. Highway 27. S-9 has three 1,655 hp diesel powered



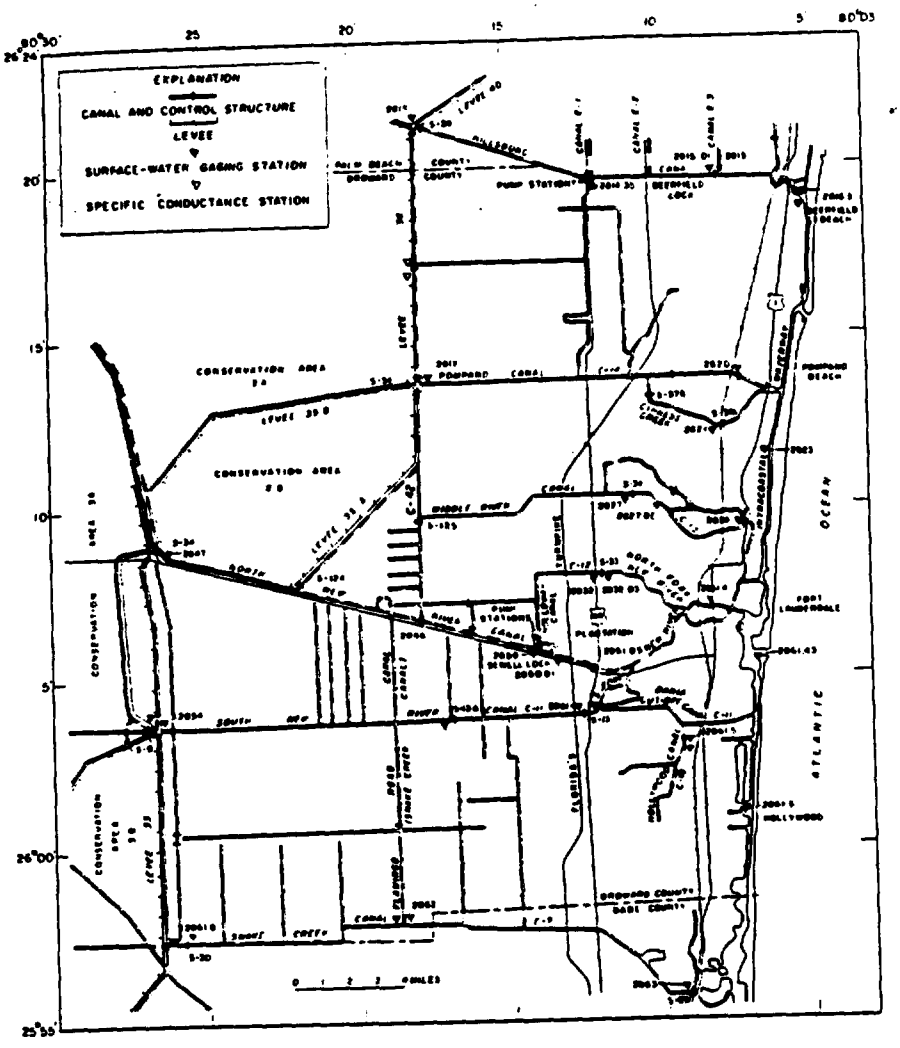


Figure 8. Location of surface-water daily data-collection stations in Broward County.

Broward County 10 miles west of Deerfield Beach (fig. 8) and travels east to the lock and dam near Deerfield Beach where it is again regulated.

Flow in the canal is affected by several lateral canals and unnumbered pumping stations in the urban and agricultural areas between S-39 and the coast (fig. 8). Canal E-1 of the Lake Worth Drainage District enters Hillsboro Canal from the north at U. S. Highway 441. Drainage into Hillsboro Canal is regulated

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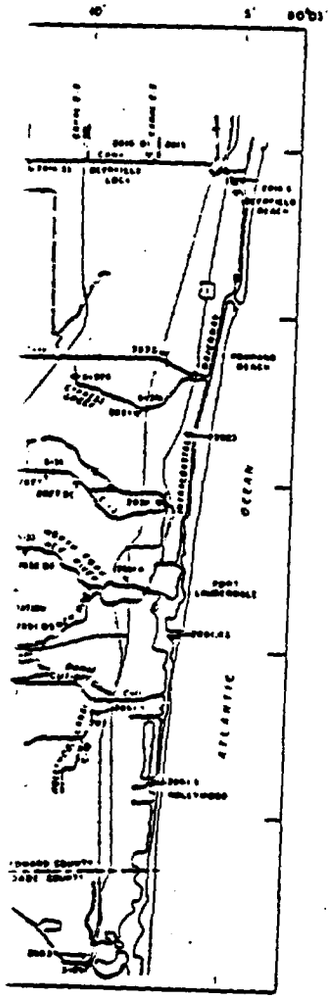
by a control structure and irrigation water is pumped into Canal E-1. A similar canal extending southward along U. S. Highway 441 also is equipped with a control structure and irrigation pumps. Canal E-2 of the drainage district has been integrated with the Florida Turnpike ditches. Gravity flow into Hillsboro Canal from these ditches is regulated by small control structures. A small controlled canal, 1.4 miles west of the Deerfield lock and dam, drains the urban area south of the canal and another controlled canal, 0.1 mile upstream from the lock and dam, regulates flow between the Hillsboro Canal and Canal E-3. Flow beyond the dam is unobstructed to the ocean.

Average 30-year discharge at the Deerfield lock and dam is 365 cfs or 264,200 acre-feet per year. Daily discharge was maximum, 3,490 cfs, on October 12, 1947 and water level above the dam was highest, 12.58 feet above msl, on December 24,1957. Land along the canal in Broward County is about 13.5 feet above msl and there has been no evidence of overbank flow above the dam.

Flow to the sea through the Deerfield lock and dam varies generally with rainfall and the resultant opening of the control, except that after wet periods excessive runoff lasts several months into the next year (fig. 9). Discharge in relation to rainfall decreased during the late 1950's after the effective closing of Conservation-Areas 1 and 2A by levees 40 and 36 and structure S-39. After 1961, most of the flow through the lower reach of the canal during rainy periods consisted of runoff from the coastal area, ground-water inflow, and levee seepage. When rainfall is heavy the opening of controls on the lateral canals east of U. S. Highway 441 can impose large sudden runoff loads on Hillsboro Canal.

POMPANO CANAL (C-14) AND CYPRESS CREEK CANAL

The Pompano Canal (fig. 8) was constructed by the EDD during 1906-27. From its mouth at the Intracoastal Waterway it extends 2 miles northwest to Pompano Beach, and then 11 miles west to S-38 at Levee 35A. There, the flow is normally eastward, but frequentlly reverses. Flow moving eastward is augmented by inflow from several laterals to the north and the canal is joined 3 miles west of Pompano Beach by the Cypress Creek Canal. At this point, depending on regulation, flow either continues eastward in the Pompano Canal or is diverted southeastward in the Cypress Creek Canal. Flow continuing in the Pompano Canal is subject to further regulation at controls 1 mile and 3 miles downstream; east of the latter control, flow is unobstructed and generally subject to tidal fluctuations. Before September 1967, flow in the canal was measured daily 150 feet east of S-38. Maximum daily positive seaward flow at S-38 (1962-67) was 707 cfs on August 8, 1966 and maximum daily reverse flow was 220 cfs November 4, 1966. Maximum daily flow recorded at Pompano Beach was 470 cfs on November 1, 1965, 1 day after a maximum stage of 5.91 feet above msl.



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Levee 35A Canal and Canal C-42 (fig. 8), 5 miles to the east, drain a recently established residential area on the north side of North New River Canal. Flow into North New River Canal from the Levee 35A Canal is regulated. The northern extension of Snake Creek Canal (Flamingo Road Canal) is connected to North New River Canal by a gated culvert under State Road 84, 8 miles east of S-34. Water control for two separate urban areas is provided by canals and pump stations north of the lower reach of North New River Canal. Water levels in the west urban area, 3 miles west of Sewell Lock, are controlled by a 245-mgd pump station established in 1969 by the developer. The east development is part of the Old Plantation Water Control District which includes the city of Plantation and was probably the earliest community in Broward County dependent on controlled water levels. Water in the district is controlled chiefly by the Holloway Canal and a 260-mgd pump station and control structure which is designed to pump or drain into North New River Canal downstream of Sewell Lock. At the Sewell Lock flow in the North New River Canal is subject to further regulation as it passes through the eight spillways controlled by stoplogs. The lock chamber is permanently closed by an earthen dam. Flow beyond of South New River Canal and acts as a divide between the drainage areas of S-9 and S-13.

Hydrographs for North New River Canal (fig. 12) indicate that flow during 1940-60 was related almost entirely to rainfall and the resultant runoff. During the 1960's a reduction of seaward flow resulted from the use of S-34 to hold water in storage in the conservation areas. During this period the flow through Sewell Lock was derived chiefly from runoff east of the levees, ground-water inflow and seepage along L-35 and L-35A.

The North Fork New River extends, as an improved natural waterway, about 3 miles northwest from the junction with New River, then joins the Plantation Canal (C-12) which extends westward to Holloway Canal. Flow in Plantation Canal is regulated by S-33, 0.5 mile east of U. S. Highway 441. Seaward flow in Plantation Canal at S-33 (fig. 13) is generally low because the area drained by the canal is small. During low flow effluent wastes concentrate in upstream reaches of the canal and stagnant conditions prevail. Construction is underway to connect the upstream reach of Plantation Canal with Middle River to provide adequate flow from the management system.

SOUTH NEW RIVER CANAL (C-11)

The South New River Canal begins at the Miami Canal in Conservation Area 3A in western Broward County (fig. 5) and flows due east for 23 miles to the junction with the Dania Cut-off Canal and the South Fork New River (fig. 8). The South Fork New River flows northeastward and joins the New River

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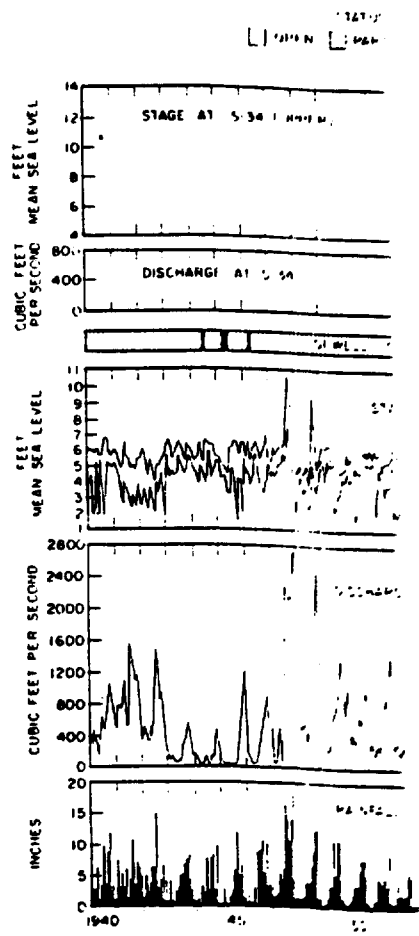

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system; the Dania Cut-off Canal continues eastward to the Intracoastal Waterway. Numerous drainage and irrigation canals and ditches enter the South New River Canal from both the south and north sides along the reach between the Florida Turnpike and Levee 33 (fig. 8). East of the Turnpike, along the Dania Cut-Off Canal, numerous navigable canals have been connected to develop waterfront property. The Hollywood Canal (C-10) flows northward about 3.5 miles and enters the Dania Cut-Off Canal less than a mile west of U. S. Highway 1.

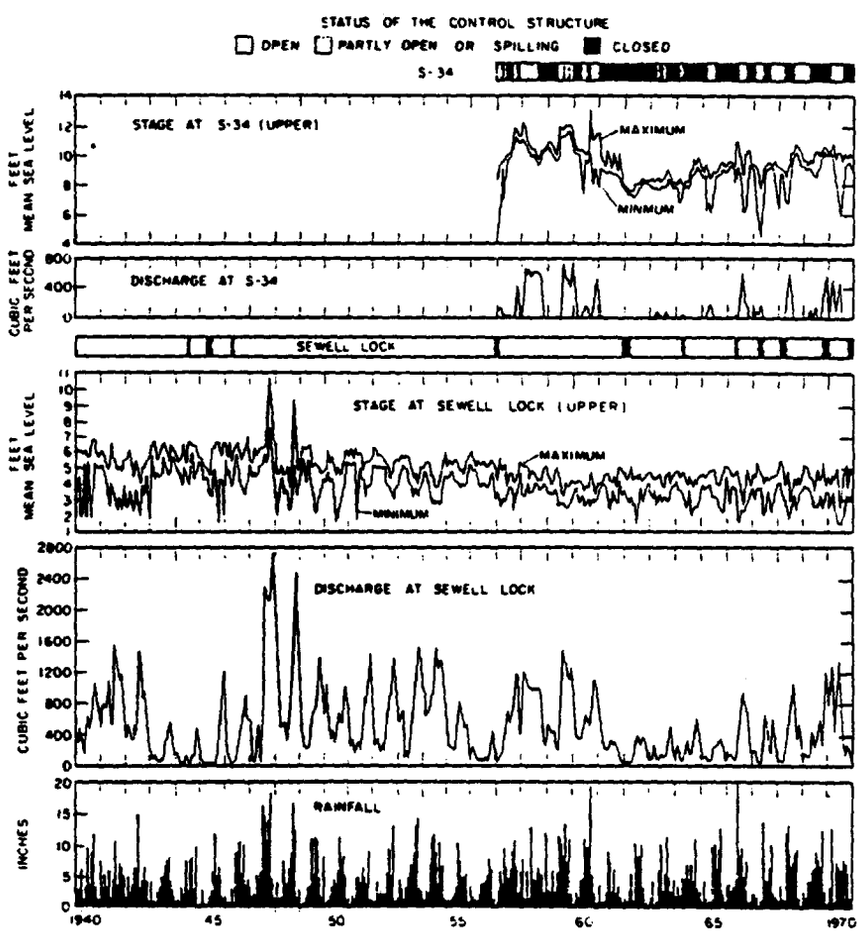

Figure 12. Monthly mean discharge and monthly extremes in stage in the North New River Canal at Sewell Lock (2850) and S-34 (2847), the average monthly rainfall at Fort Lauderdale, Belle Glade and Dania, and a record of gate operations for the periods of record.

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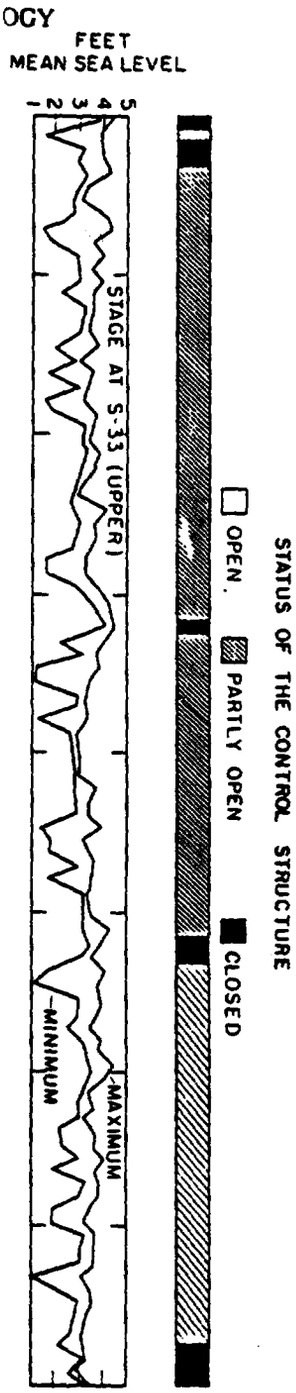

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The direction and amount of flow of South New River Canal are regulated by three control structures. S-9, about 0.5 mile west of U. S. Highway 27, is the only back-pumping station on the southeast boundary of the conservation areas. The pumping station is designed to remove flood waters from 71 square miles along the canal and discharge it into Conservation Area 3A for use during dry periods. Pumping station S-13, west of U. S. Highway 441, is designed to assist gravity flow by pumping seaward during flood periods and to regulate discharge during dry periods. Control structure S-13A regulates flow in the central reach of South New River Canal and acts as a divide between the drainage areas of S-9 and S-13.

A fourth control is located 0.25 mile east of U. S. Highway 441 at the Florida Power and Light Company's power plant. The power plant withdraws water from the Dania Cut-Off Canal for cooling condensers. The control retards salty tidal water from entering the intake area.

The dissimilarity between the hydrographs at S-9 and S-13 (fig. 14) is the result of the operations of the two pumping stations and the regulation at S-13A. When rainfall is excessive S-13A is closed and S-9 diverts water westward to Conservation Area 3A; at the same time pumping at S-13 assists gravity flow eastward to the ocean. During the growing season when irrigation water enters the western reach of the canal, S-13A is closed, S-9 diverts water westward to Conservation Area 3A and flow to the ocean east of S-13A is by gravity flow. When S-9 is not pumping and S-13A and S-13 are partly or completely open, flow is seaward throughout the entire reach.

SNAKE CREEK CANAL (C-9)

Snake Creek Canal, the primary drainage channel for the coastal area along the Dade - Broward County boundary (fig. 8), forms the south hydraulic boundary for Broward County. Flow in the canal is maintained chiefly by ground-water inflow, however, considerable surface runoff is introduced during rainy periods and water can be introduced from the conservation areas by manipulating S-30, 0.75 mile east of Levee 33. Submerged sluice gates at S-29 are manipulated to provide maximum discharge for flood protection during heavy rainfall and to prevent sea-water intrusion into the aquifer and into the upper reaches of the canal during dry periods. The hydrographs in figure 15 indicate that as much as half the flow at S-29 is derived from ground-water inflow or from lateral canals from Broward County upstream from the gaging station at 67th Avenue. Little water enters the canal from Conservation Area 3 except by levee seepage.

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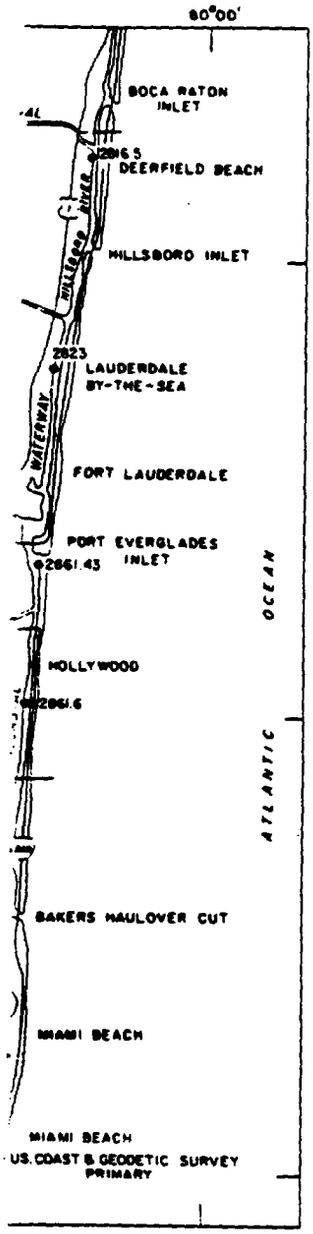


the Intracoastal Waterway.

INTRACOASTAL WATERWAY

The Intracoastal Waterway (fig. 21) borders the coast in Broward County and is separated from the ocean by a narrow offshore bar locally known as the beach. Tidal interchange between the waterway and the ocean is through the relatively narrow Port Everglades and Hillsboro Inlets in Broward County, Boca Raton Inlet in southern Palm Beach County and Bakers Haulover Cut in northern Dade County.

Tidal interchange between the ocean and the waterway through the Port Everglades Inlet and then northward along the waterway is good. Seaward flow from all the primary canals discharges into the waterway. Fresh water entering the waterway from the mainland canals affects the water levels and salinity in the waterway during high fresh-water discharge.

The Intracoastal Waterway is used extensively for boating and water sports and shipping in Port Everglades. In addition, some of the most intensely developed urban and tourist areas in the nation border its 30 miles of low lying shoreline.

Tidal data are available from four stations in Broward County and from the U. S. Coast and Geodetic Survey Primary Tide Gage at Miami Beach (fig. 21). Tidal data are also available from stations maintained by the U. S. Geological Survey or the Flood Control District at the salinity control structures on the primary canals (fig. 8).

The tidal ranges at Port Everglades and Lauderdale by-the-Sea are comparable with the range at Miami Beach (table 2). The range at Deerfield Beach is less because of the distance from the nearest inlets and the small size of the inlets. The range at Hollywood is less because of channel constrictions and the distance from an inlet. Typical tidal fluctuations at Port Everglades, Deerfield Beach and Hollywood are shown in figure 22.

The seasonal variation of monthly mean high water was less than 0.1 foot along the waterway (fig. 23). The tides were highest in September and October, the prime hurricane season. The elevation of mean half tide was higher along the waterway than at Port Everglades Inlet due primarily to an increase in the height of mean low water. The maximum difference between mean half tide (the average of mean high and mean low waters) and mean water level at the five stations was found to be 0.03 foot during the investigation.

BISCAYNE AQUIFER

The Biscayne aquifer is the source of all fresh ground water in Broward County and is composed chiefly of limestone, sandstone and sand (figs. 26-28) of marine origin which range in age from (oldest to youngest) late Miocene through Pleistocene. The aquifer is generally more than 200 feet thick along the coast in Broward County, and 350 feet at one point in Pompano Beach. The thickness of the consolidated limestone sections and the permeability of the aquifer as a unit generally decrease to the north. The aquifer also thins westward to about 70 feet at U. S. 27 in central Broward County and wedges out at the surface near the Collier - Broward County line.

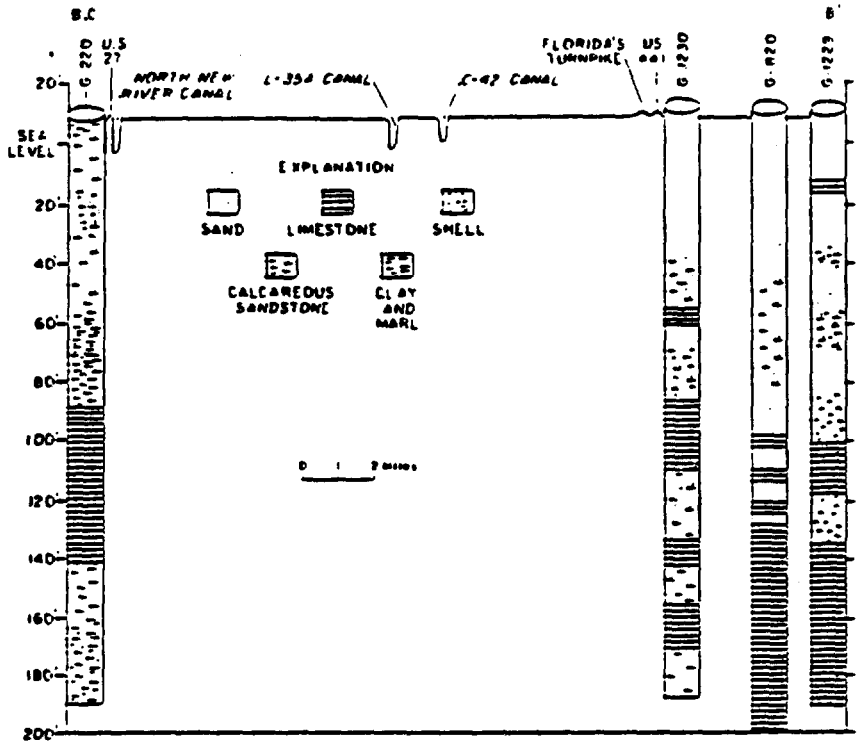


Figure 27. Lithologic logs along line B-B' in figure 29.

Most of the limestone beds in the Biscayne aquifer are capable of yielding large amounts of water to wells. Wells that tap the thick limestone in the deeper part (100-foot depths or more) near the coast, commonly yield more than 1,000 gpm (gallons per minute). Most of the municipalities obtain water from the deeper part of the aquifer.

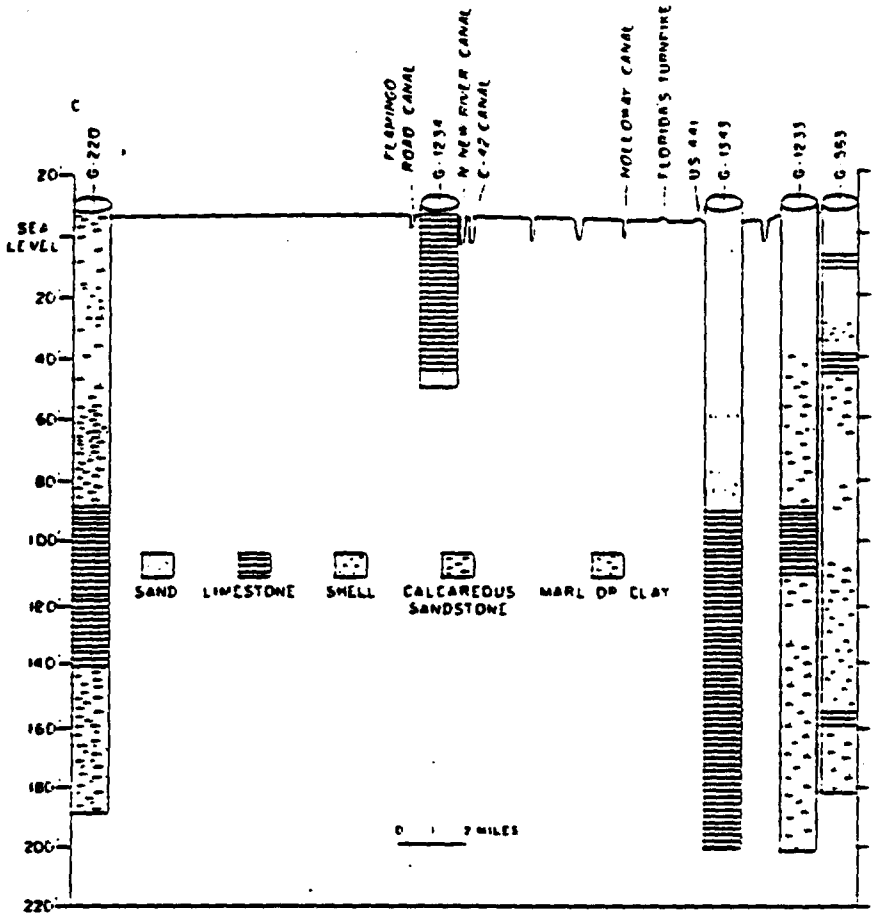


Figure 26. Lithologic logs along line C-C' in figure 29.

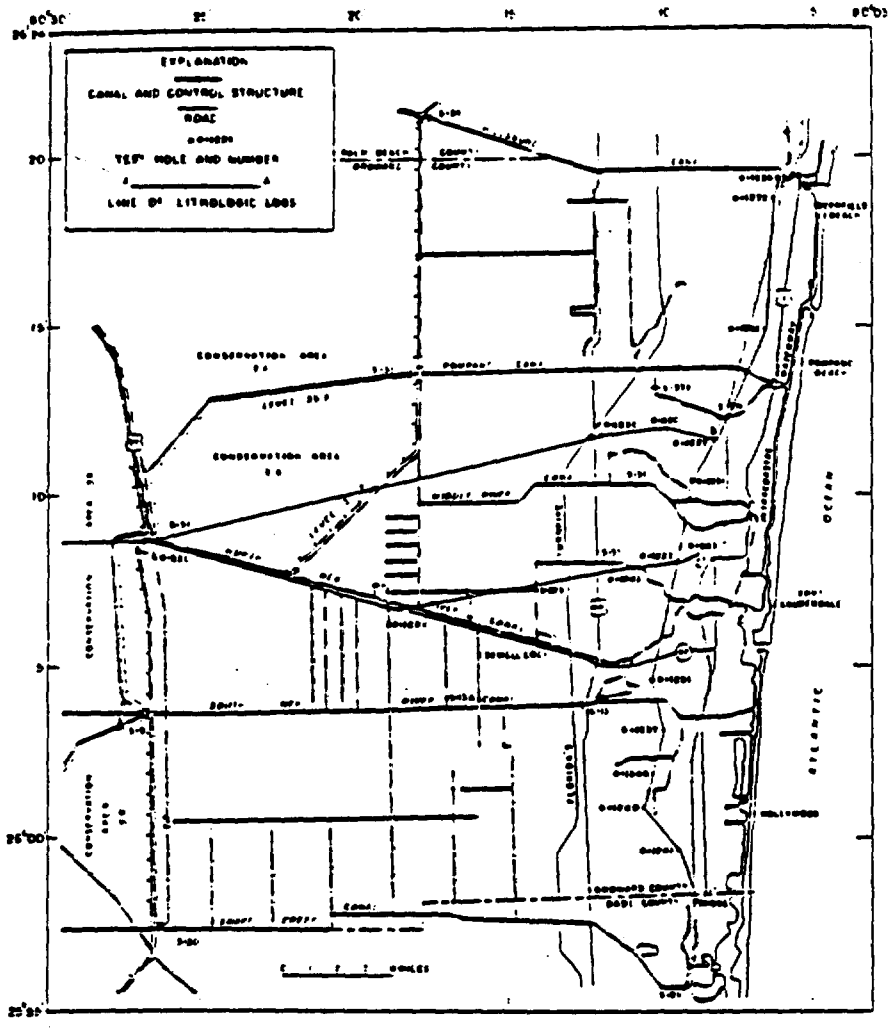


Figure 29. Location of test holes and lines of lithologic logs in eastern Broward County.

RECHARGE AND DISCHARGE

Infiltration of rainfall through surface materials and seepage from controlled canals and the conservation areas are the principal means of recharging the Biscayne Aquifer. Recharge by rainfall is greatest during the rainy season from June to November. Recharge from canals is greatest during the dry season, December to May, when canal levels are higher than adjacent water levels

in the aquifer. Discharge from the aquifer is by evapotranspiration, by ground-water flow to canals and to the sea, and by pumping from wells. Discharge by ground-water flow and by evapotranspiration are greatest after periods of rainfall when water levels are high; discharge by pumping from wells is greatest during the dry season as a result of the influx of tourists and heavy irrigation use when water levels are low. Well yield is only a small part of the total discharge from the aquifer, but during the dry season its importance is amplified because it occurs when total recharge and aquifer storage are smallest.

The average annual rainfall of about 60 inches if distributed evenly over the county would be equivalent to about 3,400 mgd. Evapotranspiration from surface waters would return about 22 inches (1,250 mgd) to the atmosphere. Evapotranspiration from the water table would return an additional 20 inches (1,130 mgd) to the atmosphere (fig. 30). A very small part, probably little more than 1 inch (60 mgd), would run off directly to the canals. Of the remaining 17 inches of water that enters the aquifer less than 2.5 inches is withdrawn for use and about 14.5 inches is discharged to the sea by coastal canals (13.5 inches) or ground-water outflow (1 inch). These figures are highly generalized and do not take into account variations in rainfall due to both location and time and minor changes in aquifer storage. Also, although not shown in the diagram, water imported into the county by canals of the FCD system and introduced to the aquifer plays an increasingly important part in the total flow system.

The foregoing summary indicates that much more water flows through the aquifer than is withdrawn for all types of use. However, it should be noted that water use is concentrated near the coast where supplies are most limited and that conditions depicted in the diagram do no persist throughout the year; during extended dry periods, when withdrawals are greatest, the only recharge available is from canals of the water-management system.

WATER-LEVEL FLUCTUATIONS

Water levels in the Biscayne aquifer fluctuate over a wide range in response to recharge or discharge and to a lesser extent to other factors such as tides, earthquakes, and changes in atmospheric pressure. The greatest fluctuations, as much as 5 to 10 feet per day, are caused by recharge from rainfall and by pumping; but gradual changes in water levels caused by evapotranspiration and normal ground-water outflow have an important effect on the amount of water in storage in the aquifer.

Ground water is continually moving at rates dependent on the hydraulic gradient and the permeability of materials through which it moves. Ground water flows by gravity from areas of high water levels to areas of low water levels. In a restricted sense, low water levels are associated with discharge areas.

flooding or a significant rise in water levels that normally would have resulted from the heavy rainfall. Minor flooding occurred in the Pompano Beach - Deerfield Beach area where the rainfall was most intense. The canal network in existence at that time prevented a flood of major proportions.

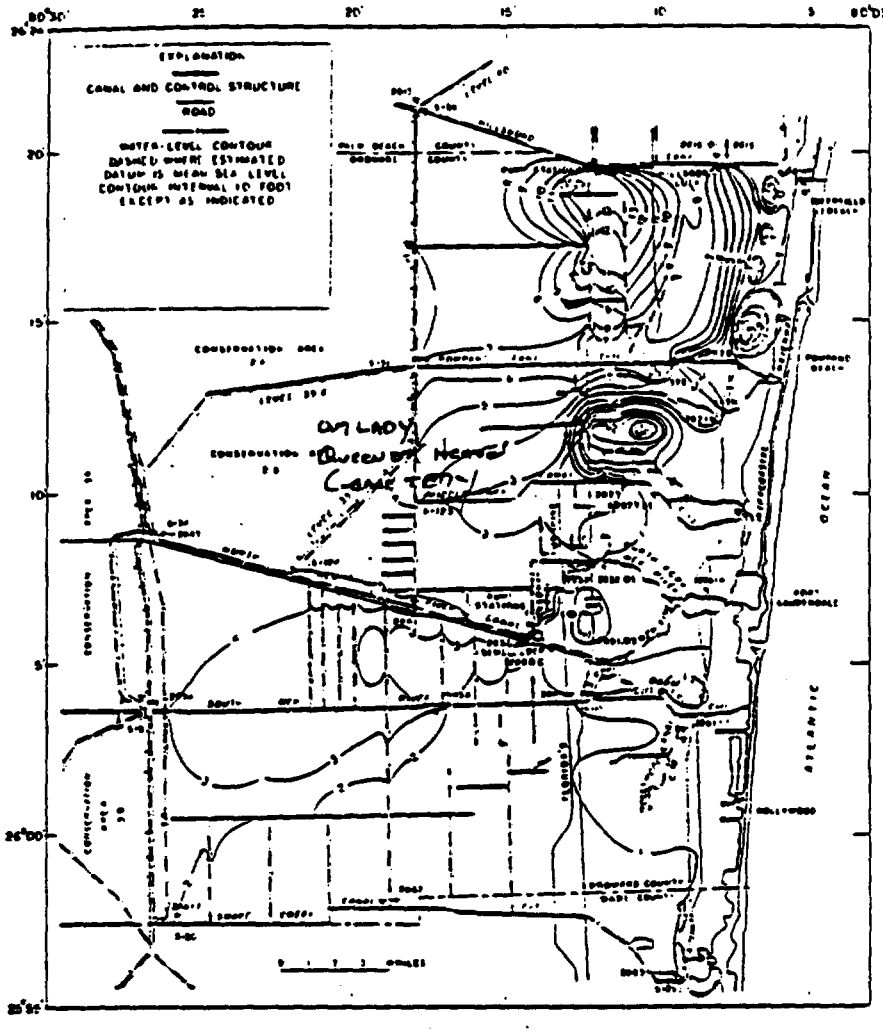


Figure 35. Water-level contour map of eastern Broward County under record low conditions, May 5, 1971.

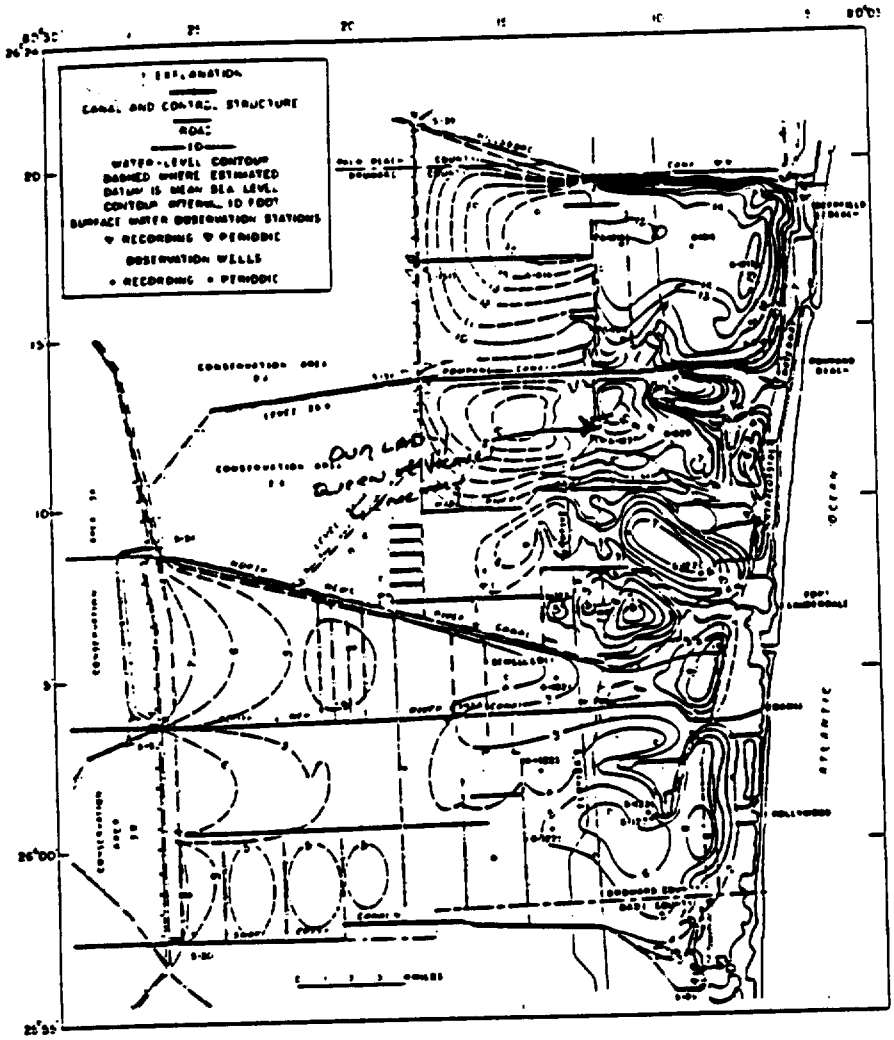


Figure 36. Water-level contour map of eastern Broward County under record high conditions, Nov. 1, 1965.

The configuration of the water table during a period of near-average water levels (fig. 37) is similar both to that when levels are low and when they are high. The water-table gradient is generally to the south, except near the coast, and near the conservation areas. In the intercanal areas surface runoff and ground water generally flow south or southeast into the canals and then seaward as canal discharge. The sandy surficial materials of low permeability along the coastal ridge north of Pompano Beach retard rapid movement of ground-water discharge thereby maintaining high water levels.

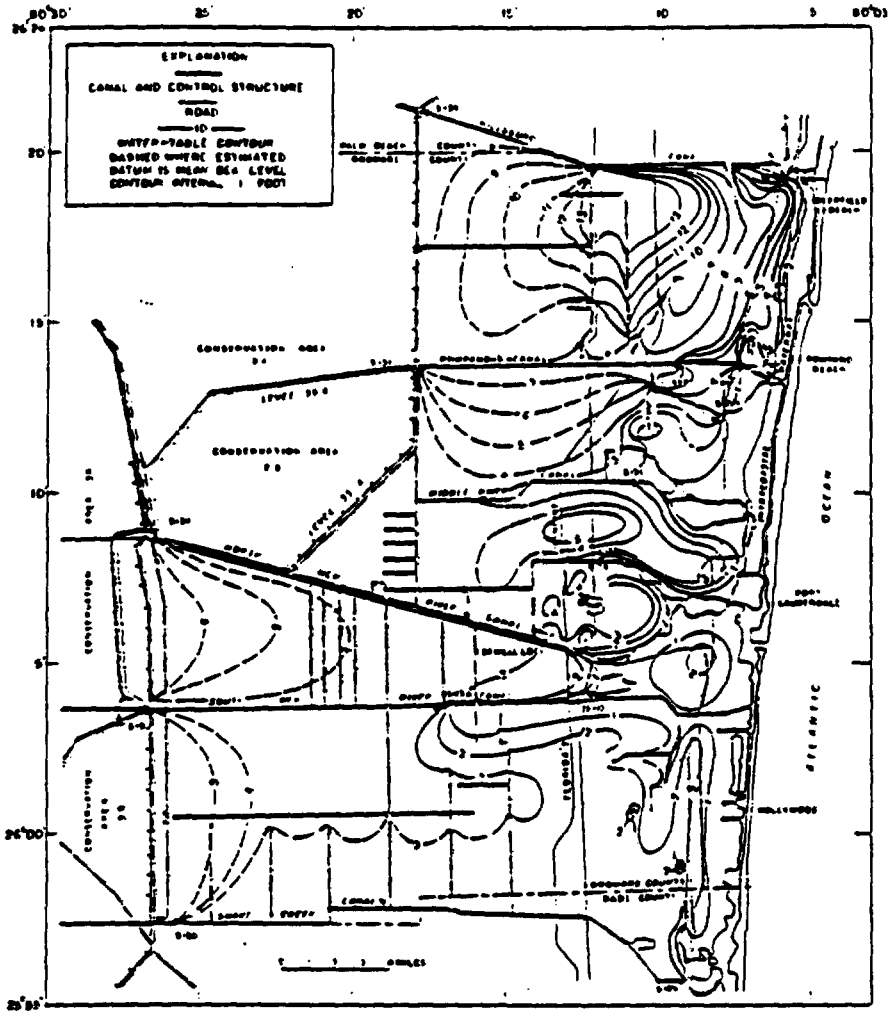


Figure 37. Water-level contour map of eastern Broward County under near-average conditions, May 25-26, 1964.

On May 5, 1971 (fig. 39), the large discharge from the Pompano beach well field had lowered the water level to 3 feet below mean sea level. Recharge to the well field was from the area of higher water levels to the west and from the Pompano Canal to the south. Water levels between the well field and the Intracoastal Waterway were near sea level.

In the Prospect well field, pumping during the dry season had lowered the water table by May 5, 1971 to more than 5 feet below mean sea level near the center of pumping and to mean sea level between the well field and the salty reach of Middle River Canal (fig. 40). Most of the recharge to the well field came from the controlled reach of the Cypress Creek Canal upstream of S-37A control and from areas of higher water levels to the west and northwest. During the

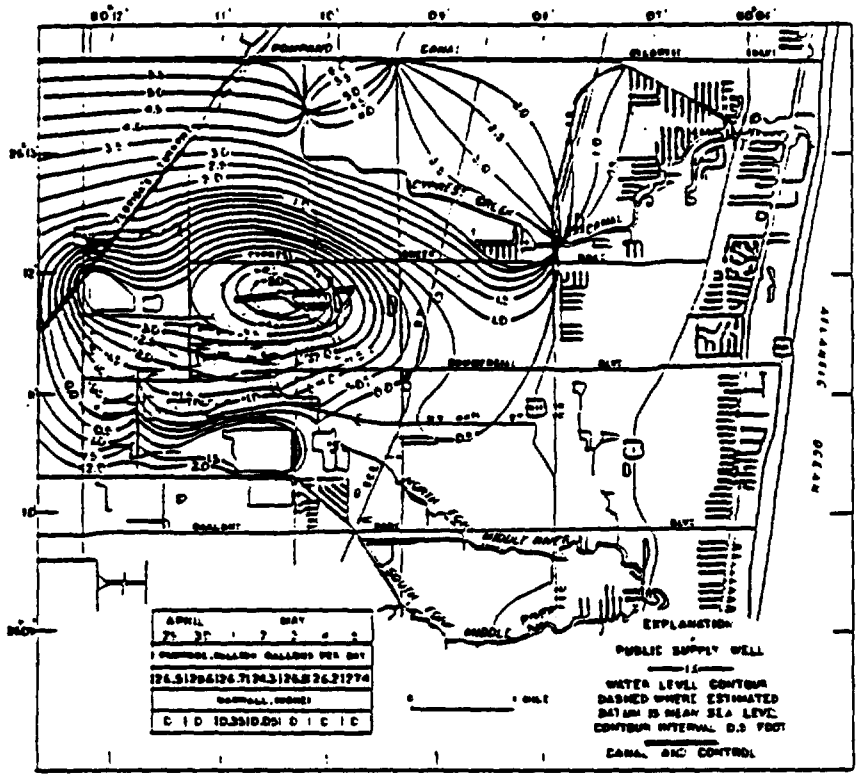


Figure 40. Water-level contour map of the Fort Lauderdale Prospect well field and surrounding area during a period of low-water levels and peak pumpage, May 5, 1971.

An early aquifer test using supply wells in the Fort Lauderdale Dixie well field indicated a transmissivity of 1.2 mgd per foot. In the Prospect well field test, selected municipal supply wells were pumped and other supply wells were used for observation of the water level responses; transmissivity ranged from 2 to 3 mgd per foot. The apparent storage coefficient was approximately 0.015, and the leakage coefficient was about 1 gpd per square foot per foot of head differential.

Muncipal supply wells were also used for tests in the Pompano Beach and Deerfield Beach aquifer tests. In the Pompano Beach test, transmissivity and storage coefficients were 1.4 mgd per foot and 0.34, respectively. The leakage coefficient was not computed. At the Deerfield Beach test, transmissivity and storage coefficients were 0.4 mgd per foot and 0.0004, respectively. Geologic data indicates that the low values for the hydraulic characteristics in the Deerfield Beach test were due to the development of the supply wells in a relatively thin limestone bed in the upper part (80 feet) of the aquifer which is overlain by calcareous sands of low permeability. Additional wells, nearby, bottomed in a deeper (110 feet) and thicker limestone yield greater quantities of water with considerably less drawdown indicating higher values for the hydraulic characteristics. Thus it appears that the Deerfield Beach test is only representative of a small area, where the upper limestone aquifer is confined, while the aquifer in general is unconfined.

The differences in tranmissivity for the four tests indicates that the potential for development of the Biscayne aquifer generally decreases in a northerly direction in Broward County. This is due primarily to a decrease in the permeability of the consolidated section of the aquifer as both the porosity and interconnection of the pores spaces decrease with increased sand content in the limestone beds. The aquifer is thickest in the northeastern part of the county, but conversely, the transmissivity is the smallest.

Water-level and aquifer-test data indicate that the Biscayne aquifer exhibits different characteristics under static conditions (nonpumping) than under pumping conditions. Under static conditions, the water level in a shallow well will be at the same elevation as the water level in an adjacent deep well, suggesting that the entire aquifer is under unconfined conditions. However, when the deep (100-150 feet), highly permeable zones of the aquifer are pumped, water levels in deep wells as much as 1,000 feet away show an immediate rapid decline and the levels in shallow wells much closer to the pumping wells show no immediate effect. Levels in these shallow wells do show a long-term drawdown of several feet. Thus, in aquifer tests of short duration (less than 24 hours) the zone in which the supply wells are developed reacts as a confined aquifer overlain and partly confined by a leaky roof of less permeable beds.

The high leakage and storage coefficients in the test at Snake Creek Canal indicates that the overlying semiconfining beds are more permeable than are similar beds in central and north Broward County and that the aquifer in south Broward responds to pumping much more as nonartesian aquifer than it does in other parts of the county.

FLORIDAN AQUIFER

The Floridan aquifer is a thick section of carbonate and evaporite rocks underlying all of Florida and parts of Georgia and Alabama. In southeastern Florida the aquifer underlies a thick section of impermeable marl and clay at depths below 900 feet and extends to depths of more than 3000 feet. It is composed primarily of a system of limestones of varying permeability which dip eastward and southward and are thought to intersect the ocean bottom several miles offshore along the Continental Slope.

The aquifer is confined except in the recharge area where the overlying confining materials are very thin or absent.

In Broward County, water in wells that tap the Floridan aquifer will rise almost 40 feet above msl. Flows range from 75 gpm to over 2,000 gpm and average about 750 gpm (Parker, 1955, p. 191). The water is highly mineralized, containing more than 1,500 mg/l (milligrams per liter) of chloride, 3,500 mg/l dissolved solids, and is sulfurous, hard, and corrosive. These characteristics greatly limit the use of the water from this aquifer for most purposes. Nevertheless, study is being directed toward determining the feasibility of using the aquifer for fresh-water storage and as a source of water for desalination in the upper less mineralized zones. One well near Lake Okeechobee is currently disposing of industrial wastes in the highly permeable "boulder zone" of the Floridan aquifer with apparent success. A similar well in Miami is used as a disposal well for treated sewage effluent. Current studies are designed to more accurately define the zonation and hydraulic characteristics of the Floridan aquifer in the hydrologic system of southeastern Florida.

WATER QUALITY

The chemical or physical quality of water generally is as important for most uses as its availability. Rainfall, the original source of water supplies, contains fewer impurities than water in most other parts of the hydrologic cycle. It contains only minute quantities of dust, dissolved gases, and wind-blown salt from the atmosphere. When rain strikes the ground, it comes into contact with many soluble materials and, aided by carbon dioxide absorbed from the air and soil, it begins to dissolve and pick up a wide variety of chemical and organic

constituents. The type and amount of dissolved matter in natural waters, depends on the materials contacted and the length of time involved in the movement of water through the rocks and soil and down the streams. Domestic and industrial wastes as well as sea water are also sources of mineral or biological contamination of streams and ground water.

NATURAL CONSTITUENTS

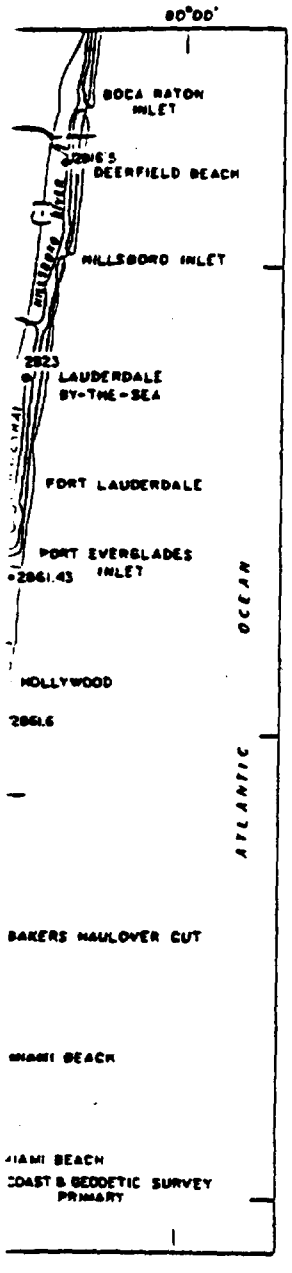
The chemical quality of the water in the interrelated surface and ground-water flow system in Broward County is generally good. The source of the water in the system is local rainfall or rainwater conveyed into the area by the regional canal network. The water often shows a mixture of ground-and surface-water characteristics because of the free interchange of water between the canals and the permeable limestone of the Biscayne aquifer.

GROUND WATER

The chemical characteristics of ground water in the county are influenced chiefly by soluble limestones and calcareous sand in the Biscayne aquifer. The water is generally hard, calcium bicarbonate in type with varying quantities of iron in most areas. Mineralization generally increases inland and with depth in the aquifer. Water of the best quality occurs in coastal areas where the aquifer has been flushed by the infiltration of rainfall. This is especially true along a low coastal ridge in the Pompano area where a thick section of permeable sand occurs in the upper part of the aquifer.

The chemical characteristics of water at different depths throughout the county were determined by the analysis of water samples from existing wells at known depths and from samples collected at different depths during the drilling of test wells. Table 3, adapted from Grantham and Sherwood (1968), summarizes the results of analyses of samples from the wells shown on figure 43.

Dissolved solids, hardness, and iron in ground water vary with depth in eastern Broward County as shown on the maps in figure 44 (adapted from Grantham and Sherwood, 1968). The relatively low dissolved solids and hardness in water in the Ft. Lauderdale area indicates the effects of flushing by the circulation of ground water caused by drainage to the canals and recharge by rainfall. The consistently high concentrations of dissolved solids at depths below 200 feet indicates that there is much less circulation at those depths and thus more time for the water to dissolve minerals from the aquifer materials. The similarity between dissolved solids and hardness illustrates that calcium and bicarbonate dissolved from the limestone are the major constituents of natural waters in the county. The ground water of Broward County ranges from hard to



Intracoastal Waterway.

Water in the Floridan aquifer is highly mineralized, has hydrogen sulfide gas in solution, and thus of slight value for normal use; however, the large quantities of water available and the excellent storage capacity of the aquifer seem to warrant much further investigation of potential uses. The aquifer yields artesian water whose chloride content ranges from about 1,500 mg/l in the upper producing zones to 18,000 mg/l sea-water concentrations near the bottom. The water is corrosive to metal. However, because wells in the Floridan aquifer flow freely and the water temperature is constant, the salty water has been used for industrial cooling and air-conditioning as well as for swimming pools, flushing wastes, and for irrigation of golf courses. Although it may not be feasible at present to use this water for more purposes than those just stated it has an excellent potential for use in future years when maximum growth is attained and all fresh-water resources are fully managed in the county.

In the Pompano Beach area a utility company uses two 18-inch wells more than 1,000 feet deep for effluent disposal. About 500,000 gallons of treated sewage are pumped into these wells each day against a head of about 30 feet. This same technique is being used or planned for use in other sections of the State to dispose of municipal and industrial wastes to prevent pollution of the streams and shallow ground water.

Because of the excellent storage capacity of the aquifer, especially the cavernous zones (boulder zone) below the 2,500 foot depth, the Floridan aquifer may have excellent potential for storing fresh water for retrieval. Depending upon the confining characteristics of intervening beds in the aquifer it is conceivable that fresh water could be safely stored in the upper low chloride zones and waste effluent injected into the lower cavernous zones. Safe use of the aquifer for this purpose would depend on detailed knowledge of its hydraulic properties.

SURFACE WATER

The chemical quality of the water in the canal system varies widely with extremes in discharge caused by rainfall and operation of water-control structures. During high discharge most of the water is surface runoff from inland areas and is highly colored but only slightly mineralized. During low discharge much of the water is derived from the more mineralized ground-water inflow and the amount of dissolved solids increases. Upstream from the salinity controls, the water in the canals is fresh and is therefore a major source of water; downstream, the water is generally salty except during periods of high discharge.

Water in the controlled canals is not used directly for municipal or domestic supplies, but infiltration from the canals supplies replenishment to

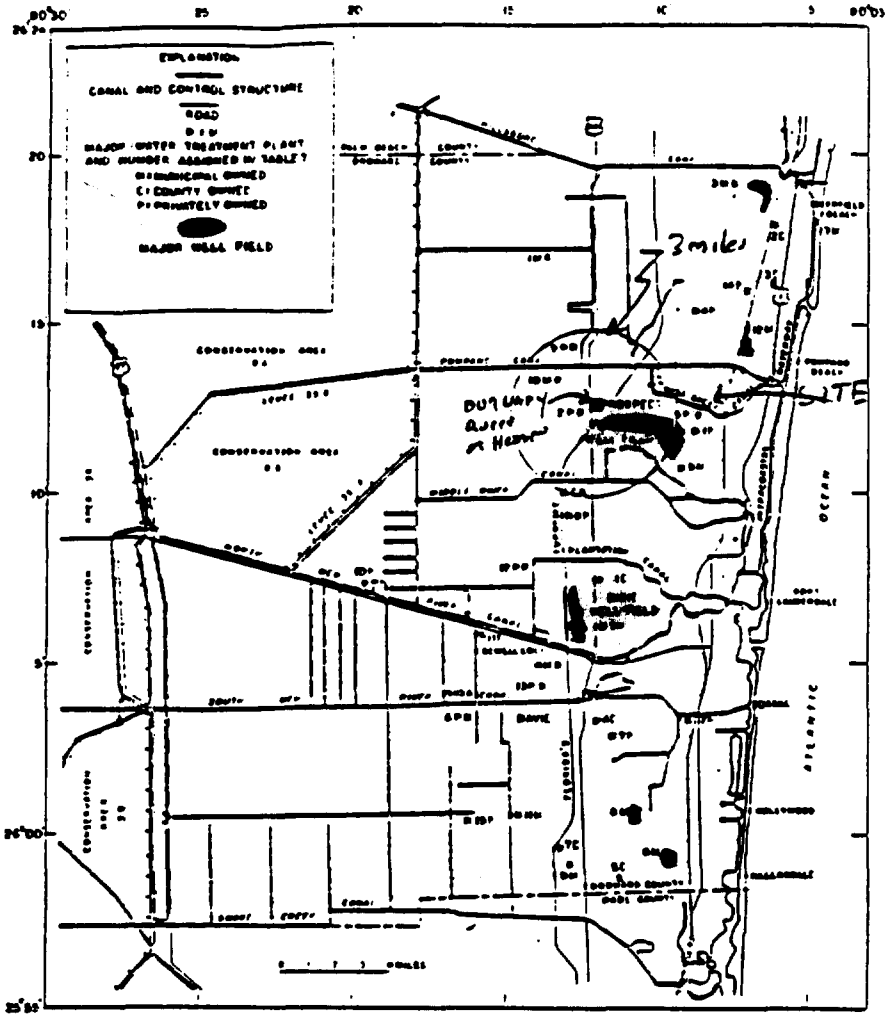


Figure 58. Location of major water treatment plants and well fields in Broward County.

WATER USE

Facts on the rapidly expanding use of water are especially important in Broward County where complete urbanization will ultimately require the maximum development of water supplies. Although the county has large fresh-water resources – ample with careful management to meet the needs of the foreseeable future – these resources are seriously threatened by problems associated with rapid urbanization such as overdrainage, sea-water intrusion, and especially contamination caused by poor waste disposal practices.

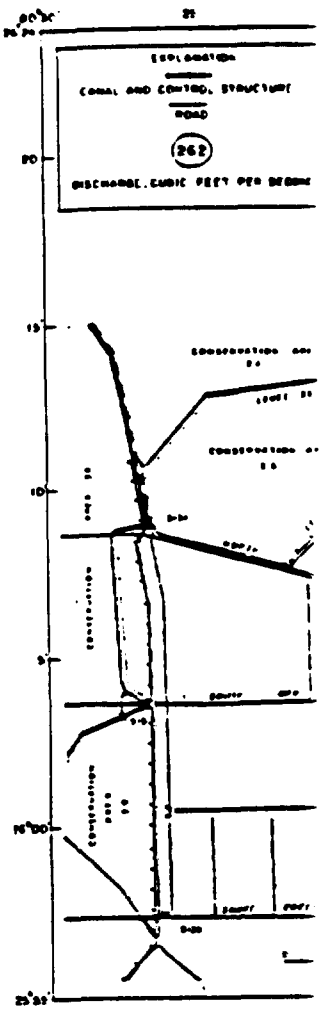


Figure 64. Annual
County,

Broward County ha
60-inch annual rainfall, it
surface-flow network of t
rapid urbanization of the
man-made water problem
expanding population.

Not all water use is consumptive. Much of the water used for public or industrial supplies is returned to the aquifer through septic tanks or to fresh-water streams from sewage treatment plants or industrial outfalls. The disposal of urban waste water or sewage has become a major hydrologic factor that affects both the quantity and quality of water available in Broward County. Depending on proper treatment of the sewage and location of disposal points, waste water may act as a source of replenishment to fresh water resources or be safely introduced into salt-water streams, the ocean, or highly mineralized isolated aquifers; with inadequate treatment it creates serious contamination problems in almost any receiving water body or land area. Thus, the manner of treatment and disposal of waste are major factors in determining whether public or industrial water use is consumptive or nonconsumptive as well as causing or alleviating contamination.

PUBLIC WATER SUPPLIES

More than 32 municipal and privately owned water utilities provide about 32 billion gallons of water per year for a permanent population of 500,000, a peak tourist season population of 890,000, and most commercial and industrial use in Broward County. The largest utility, Fort Lauderdale, can provide a peak supply of more than 60 mgd to a maximum population of 186,000 people. The smallest utilities provide a few thousand gallons per day to less than 100 people. Major water treatment plants and well fields are shown on the map in figure 58 and additional plant information is shown in table 7.

All public supplies in Broward County are pumped from wells. However, many well fields are replenished in part by the infiltration of water from nearby canals. Although most of the people in the urban area are served by municipal systems some single and multi-unit domestic systems are supplied by individual wells. It is estimated that between 30,000 and 35,000 private wells produce 3.65 billion gallons per year.

Urban water use is greatest, about 150 mgd, during the winter months when the tourist season and the dry season coincide to cause maximum domestic and recreational use along with heavy lawn irrigation. Although some swimming pools and lawn irrigation systems are supplied by individual wells most supplies in the urban area are provided by municipal water systems. The recent trend toward the building of condominiums and large apartment complexes which increase population density and water use has caused unanticipated demands on some systems. The cities of Fort Lauderdale, Pompano Beach, and Hollywood and the several plants of the Broward County Utilities Department are the largest suppliers of water with average daily pumpage rates ranging from 10 to 35 mg.

Table 7. Major water treatment plants in Broward County, 1969

No.	System (fig. 58)	Population Served	No. of Services	Plant Capacity MGD	Average Pumpage MGD	Highest Monthly Total MGM	Lowest Monthly Total MGM	No. of Wells	*Treatment	Water Source (Aquifer)	Total Storage MG
	"MUNICIPAL"										
1	Coral Springs		160	0.80	0.075			2		Biscayne	
2	Davie	8,500	2,696	3.0	1.21	Dec. 42.5	Sept. 30.9	4	SCAI	Biscayne	.63
3	Deerfield Beach	15,000	4,500	15.7	3.4	July 119.9	Sept. 82.9	16	SCAI	Biscayne	1.42
4	Lauderdale Village	1,000		0.50							
5	Ft. Lauderdale	186,000	44,753		35.1	Aug 1,229.0	June 923.0		SCAI	Biscayne	22.00
	Dixie Plant			20.0							
	Fresh Plant			40.0							
6	Hallandale	25,000	3,692	7.8	2.92	Apr. 103.0	June 71.6	6	SCAI	Biscayne	3.05
7	Hillsboro Beach		135	2.00	0.44			4		Biscayne	0.85
8	Hollywood	100,000	25,348	20.0	11.8	Dec. 370.0	June 298.0	15	SCA	Biscayne	7.50
9	Miramar	23,000	6,383	6.0	1.7	Apr. 58.4	June 48.5	9	SCAI	Biscayne	1.30
10	North Lauderdale			0.50				1		Biscayne	0.50
11	Pembroke Pines (Plant 1 & 2)	20,000	8,000	4.02	2.4	Sept 85.2	Feb. 58.0	6	SCAI	Biscayne	2.50
12	Pompano Beach	52,600	11,696	24.0	10.7	Dec. 384.0	June 275.0	14	CA	Biscayne	3.30
	"COUNTY"										
1	BCUD No. 1	11,583	3,861	2.6	1.26			4	SCAI	Biscayne	1.15
2	BCUD No. 2 (Pompano Beach Highlands)	9,071	6,357	5.0	3.83			6	CI	Biscayne	1.50
3	BCUD No. 2 (Collier Manor)	9,141	3,047	1.2	2.20			4	C	Biscayne	0.00
4	BCUD No. 3	4,284	1,428	0.65	0.35			2	SCAI	Biscayne	0.75
5	BCUD No. 4	8,685	2,895	3.1	0.76			3	SCAI	Biscayne	0.50
6	BCUD No. 5	5,817	3,149	3.6	0.81			3	SCAI	Biscayne	
7	BCUD No. 6	9,726	3,242	1.06	0.83			3	SCAI	Biscayne	0.50

Table 7. Major water treatment plants in Broward County, 1969

No.	System (fig. 58)	Population Served	No. of Services	Plant Capacity MGD	Average Pumpage MGD	Highest Monthly Total MGM	Lowest Monthly Total MGM	No. of Wells	*Treatment	Water Source (Aquifer)	Total Storage MG
	"PRIVATE"										
1	Brentwood Estates	5,000	1,353	1.5	0.33	May 12.2	Oct. 8.79	2	SCAF	Biscayne	0.30
2	Broadview Country Club	6,000	1,450	0.87	0.32	10.0	8.00	2	SCAF	Biscayne	0.36
3	Broad View Park	4,800	1,437	1.25	0.50			2	SCAF	Biscayne	0.36
4	Carver Homes		1,500	0.36	0.15			2		Biscayne	0.00
5	Collier Estates	6,000	1,375	1.5	0.47	Aug 17.5	March 9.90	3	SCAF	Biscayne	0.25
6	Cooper City		385	0.72	0.15			1			0.24
7	Lake Eden Gardens		138	0.72	N.A.			2		Biscayne	0.25
8	Lauderhill		1,300	0.68	0.60			2		Biscayne	0.20
9	Margate	12,900	3,700	1.5	1.20	Dec. 45.5	June 31.2	3	SCAF	Biscayne	0.50
10	Melaleuca Isles	600	200	0.075	0.075			2	SCAF	Biscayne	0.35
11	Park City Trailer Park		860	0.35	0.25			2		Biscayne	0.05
12	Plantation	22,000	6,535	6.5	3.46	Jan. 121.8	Dec 93.6	4		Biscayne	
13	Playland Village		670	0.33				2	SCAF	Biscayne	0.00
14	Pompano Estates		285	0.600	0.10			2		Biscayne	0.00
15	South Fla. Mental Hospital	2,665		0.5	0.39	Jan. 12.4	Sept 11.0	3	SCAF	Biscayne	0.33

*Treatment: S-Softening, C-Chlorination, A-Aeration, F-Filtration

FORT LAUDERDALE

The Fort Lauderdale water system, by far the largest in the county, treats and distributes almost as much water as all other systems combined (fig. 59). In addition to several unincorporated areas, Fort Lauderdale supplies water to the systems of Wilton Manors, Oakland Park, Tamaras, Port Everglades, and the Fort Lauderdale - Hollywood International Airport.

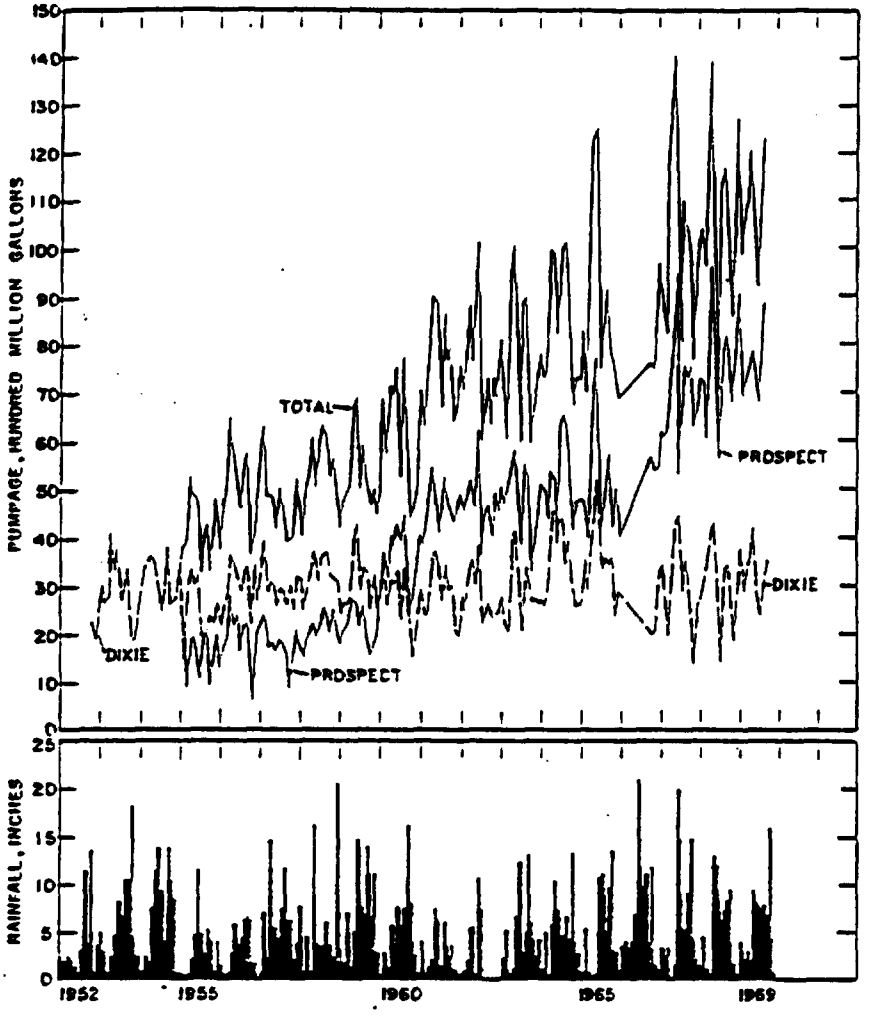


Figure 59. Monthly pumpage from the Fort Lauderdale Dixie and Prospect well fields and rainfall at Fort Lauderdale, 1952-69.

Water is supplied from two well fields and treatment plants - the Dixie well field and treatment plant established in 1926 between North New River Canal and Plantation Canal, near the city's west boundary and the Prospect well field and Fiveash treatment plant established in 1953 between Middle River Canal and Cypress Creek Canal near Prospect air field (fig. 58). The Dixie well field includes 26 wells ranging in depth from 114 to 148 feet and the Prospect well field includes 26 wells ranging in depth from 75 to 125 feet. The rated capacities of the Dixie and Fiveash treatment plants are 20 and 40 mg, respectively. Both plants provide aeration, coagulation and softening, iron and color removal, and disinfection. Monthly pumpage from both well fields is shown in figure 59. Per capita use is high, 193 gpd, because of heavy use during hot dry weather and the inclusion of use by the tourist trade and other commercial activities. The peak use is generally almost double the average use which adds to the economic and operation effort required to maintain an adequate supply distribution system. The distribution system includes ground storage of 19 million gallons, elevated storage of 3 million gallons, 634 miles of water mains (as much as 36 in. dia.) and 2,845 fire hydrants.

HOLLYWOOD

The Hollywood water system serves a population of 100,000 from two treatment facilities, with a total capacity of 20 mgd. The major plant was constructed in 1967 near the original plant site on Hollywood Boulevard, about 4 miles inland from the Intracoastal Waterway (fig. 58). The second plant, acquired in 1965 in conjunction with the annexation of an additional area west of the city, is maintained on a standby basis.

The source of water for the system is a group of 15 wells, 65 to 125 feet deep, extending north from the plant site. Average and peak day pumpage rates are 12 mgd and 16 mgd, respectively. A sharp increase in pumpage in 1965 followed the incorporation of an additional area into the system (fig. 60). The distribution system includes ground storage of 5.5 million gallons, elevated storage of 2 million gallons and water mains as much as 30 inches in diameter. It is interconnected with the system of Dania, Pembroke Pines, Hallandale and Davie to provide water during periods of peak demand.

POMPANO BEACH

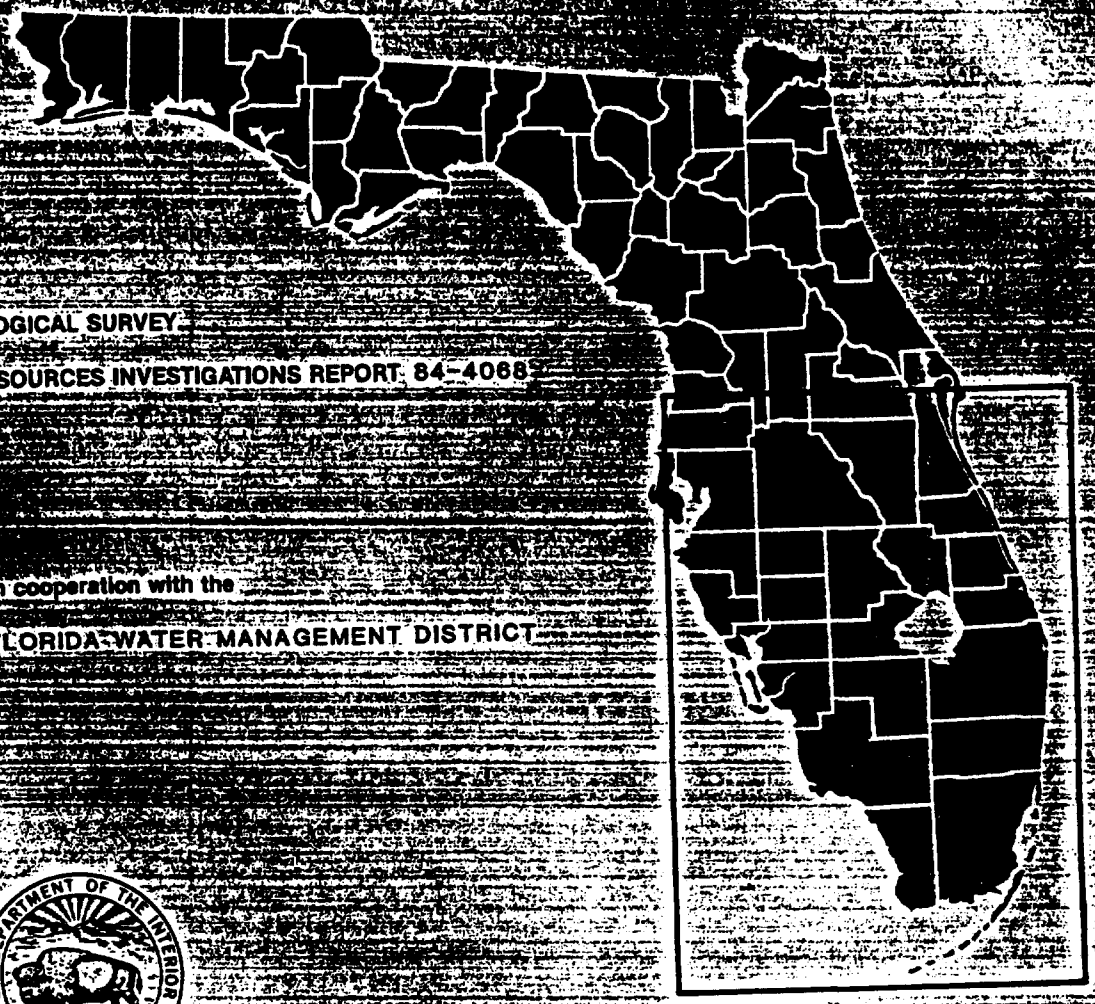
Water for Pompano Beach is provided by a treatment plant and well field located on the low sand ridge near the coast (fig. 58) in an area which yields ground water of very good quality. Because the water is of good quality a simplified treatment system is used, which includes removal of iron and hydrogen sulfide, and disinfection by prechlorination, post-chlorination, and

Reference 16

UNITED STATES
DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

GEOLOGY OF THE SURFICIAL AQUIFER SYSTEM, BROWARD COUNTY, FLORIDA

By Carmen R. Causaras



U.S. GEOLOGICAL SURVEY
WATER-RESOURCES INVESTIGATIONS REPORT 84-4068

Prepared in cooperation with the
SOUTH FLORIDA WATER MANAGEMENT DISTRICT

Tallahassee, Florida
1985

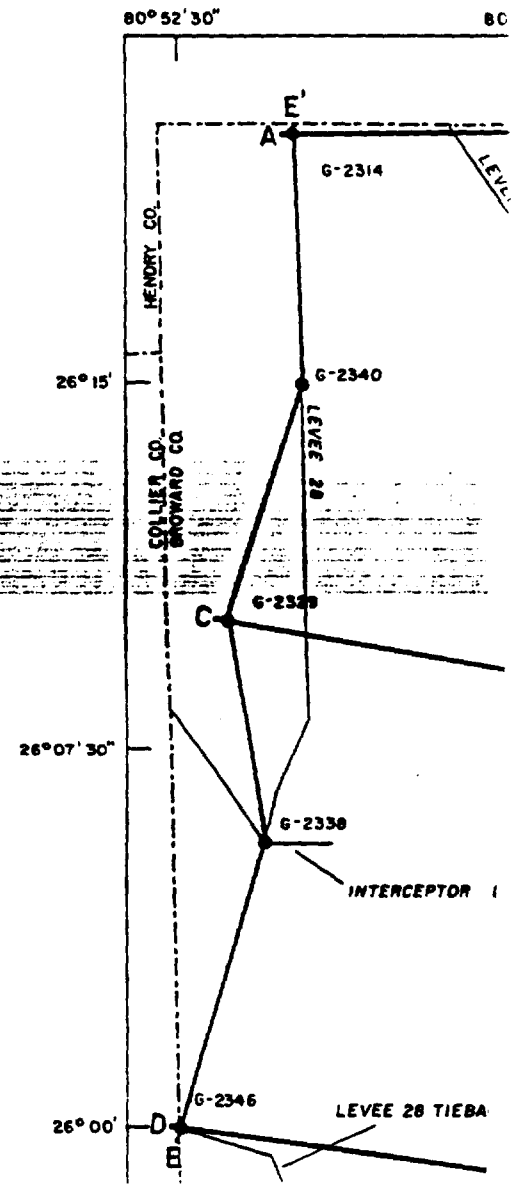
DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

INTRODUCTION

The principal source of freshwater in southeast Florida is the surficial aquifer system. The Biscayne aquifer, the major and only formally named aquifer of this system, is a highly permeable limestone and sandstone unit that occurs at or near land surface in most of Broward County (Parker and others, 1955). In Broward County, unnamed hydrogeologic units of low to relatively high permeability were penetrated below the Biscayne aquifer and laterally where it pinches out. These unnamed hydrogeologic units are hydrologically contiguous with the Biscayne aquifer and, together, they constitute the surficial aquifer system. The base of the surficial aquifer system is delineated at the top of a thick sequence of a relatively impermeable clay and silt unit in the lower part of the Tamiami Formation or in the Hawthorn Formation.

This report describes the geologic framework of the surficial aquifer system in Broward County, Fla. (fig. 1). It is part of a long-term intensive study begun by the U.S. Geological Survey in 1979, in cooperation with the South Florida Water Management District, to describe the geology, hydrologic characteristics, and the ground-water quality of the surficial aquifer system in southeast Florida.

Twenty-seven test wells were drilled completely through the surficial aquifer system and into the underlying, relatively impermeable, units of the Hawthorn Formation to obtain the data needed to describe the geology of the surficial aquifer system. The test wells were drilled by the reverse air, dual wall method. This method provided geologic samples superior to those obtained by most other methods in that the samples were uncontaminated by drilling fluid and were large enough for describing sedimentary and petrographic characteristics. Detailed lithologic logs were made from rock cuttings and cores obtained from these wells and are presented in this report. These logs were used to prepare geologic sections that show the lithologic variations, thickness of the lithologic units, and different geologic formations that comprise the aquifer system.



METHODS

The lithologic logs were made from microscopic examination of the well cuttings and cores collected during the drilling phase. Other methods, such as stains, dilute hydrochloric acid tests, and petrographic thin sections, were used when additional aid in identifying and describing the sample was needed. Folk's 1962 classification of carbonate rocks was used in classifying rocks with a calcium carbonate content of 50 percent and greater (Folk, 1968). The standard Wentworth terrigenous grain-size classification (Pettijohn, 1957, p. 27) was used in classifying sediments and rocks consisting of less than 50 percent calcium carbonate. A modifying term was added to the description of the terrigenous samples if a foreign size content greater than 10 percent was present. A silty sand contains over 10 percent silt, a clayey silt contains over 10 percent clay, and a sandy clay contains over 10 percent sand. The same principle was utilized for carbonate rocks, so that a sandy limestone contains more than 10 percent sand. The percentage of a given constituent was determined by using the "Comparison Chart for Visual Percentage of Estimation" from Terry and Chilingar (*in* Scholle, 1978, p. x). The constituent rock fragments (RF) found in some samples are noted in the lithologic descriptions in the abbreviated form RF. The colors indicated by the chart numbers in parenthesis are based on the "Rock-Color Chart" by Goddard and others (1948) and were assigned while the samples were damp.

GEOLOGY

The surficial aquifer system in Broward County is composed of limestone, sandstone, sand, shell, limemud, silt, clay, and an admixture of these materials. These sediments were deposited during the Pliocene through Pleistocene Epochs (Parker and others, 1955, p. 160) and were assigned to the following general stratigraphic sequence from bottom to top, however, some units are equivalent:

sandstone, sand, shell, limemud, silt, clay, and an admixture of these materials. These sediments were deposited during the Pliocene through Pleistocene Epochs (Parker and others, 1955, p. 160) and were assigned to the following general stratigraphic sequence from bottom to top, however, some units are equivalent: Tamiami Formation, Caloosahatchee Marl, Fort Thompson Formation, Key Largo Limestone, Anastasia Formation, Miami Oolite, and Pamlico Sand. The Caloosahatchee Marl occurs as erosional remnants in southeast Florida; in Broward County (Schroeder and others, 1958, p. 11), it has been reported only in the extreme northwestern part of the county. The Caloosahatchee Marl was not encountered in any well drilled during the present study.

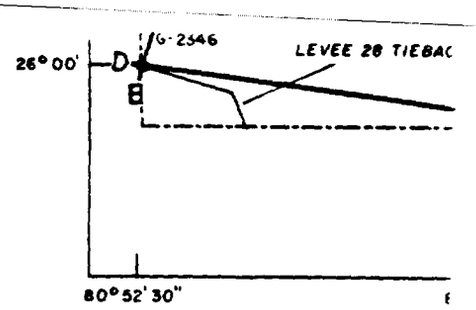
The geologic sections A-A′ to D-D′ on sheets 1 and 2 show some of the variations in the wedge of sediments that make up the framework of the surficial aquifer system. The aquifer system is thickest along the coast where in some areas it may exceed 400 feet in thickness and gradually thins inland toward the west and southwest where it is about 160 feet thick. The aquifer system is comprised of distinct lithologic units that show numerous facies changes that were brought about primarily by changes in sea level. A distinct contrast exists in lithologies between western and eastern Broward County defined, respectively, as the area west of and under the water conservation areas and the area east of U.S. Highway 441 (fig. 1). In the western part of the county, the aquifer system is primarily composed of limestone, sand, limemud, and clay, but the eastern part is primarily composed of sandstone, sand, sandy limestone, and silt (see sheets 1 and 2, sections A-A′ to D-D′). The transition between the predominantly carbonate and predominantly clastic areas lies between the water conservation areas and U.S. Highway 441.

The uppermost lithologic unit of the aquifer system in western Broward County usually consists of pale-orange to yellowish-brown, mottled, well-cemented limestone that contains abundant specimens of the freshwater gastropod *Helisoma* sp. and has undergone diagnesis as a result of prolonged contact with slowly moving water. The limestone exhibits features of dissolution, replacement, and reprecipitation of calcite as cavity-filling cement. Iron oxide stains and calcrete crust indicate that the limestone has been subaerially exposed. This limestone unit ranges in thickness from about 4 to 72 feet and is thickest along the south-central part of the county, feathering out toward the easternmost edge of the water conservation areas in the vicinity of wells G-2322 (section C-C′) and G-2341 (section B-B′). In places, lenses of shelly sandy micrite (limemud) and shelly micritic sand containing many specimens of *Chione cancellata* and *Turritella* sp. are interbedded with the limestone unit. The physical characteristics and faunal assemblage of this limestone are similar to the limestone units of the Fort Thompson Formation, as described by Schroeder and others (1958, p. 12–13).

A partially cemented, sandy, shelly, gray limestone lies unconformably below the upper unit. It contains a faunal assemblage that is abundant in pelecypods (*Pecten* sp. and *Ostrea* sp.), pink barnacles, and echinoids. The faunal assemblage, color, and other physical properties of this limestone are similar to the limestone prototype of the Tamiami Formation in Collier County, as described by Parker and others (1955, p. 85), and the limestone is probably equivalent in age. This gray limestone makes up most of the surficial aquifer system in western Broward County, and it decreases in thickness toward the east where it interfingers with sand, shelly sand, and sandstone or grades into a loosely cemented, shelly sandstone containing detrital carbonate. Local thin lenses of shelly clayey sand, shells, and micrite interfinger with the gray limestone in the western part of the county.

The gray limestone is underlain by fine to very fine grained quartz sand which contains phosphorite as an accessory mineral. The sand is shelly in many places; the shells are comparable in age to those in the overlying limestone and to those in the sand unit of the Tamiami Formation. With increasing depth, the silt and clay content of the fine-sand unit increases, and the unit grades into clay. Parker and Cooke (1944, p. 96–112) assigned this clay to the Hawthorn Formation. The clay is slightly calcareous and grades into clayey silt and silt toward the east where it was over 300 feet below land surface in test well G-2345 (sheet 1, section C-C′; sheet 2, section G-G′). In many of the wells drilled, it was difficult to differentiate between the Tamiami silt and the Hawthorn silt without a detailed foraminferal study. In these wells, the symbol "Tth" was used for Tamiami Formation and Hawthorn Formation undifferentiated. The silt and clay unit was not penetrated in test wells near the coast, two of which were drilled to a maximum depth of 476 feet below land surface (sheet 2, section H-H′). Apparently, the silt and clay unit grades laterally into impure Hawthorn limestone in this area.

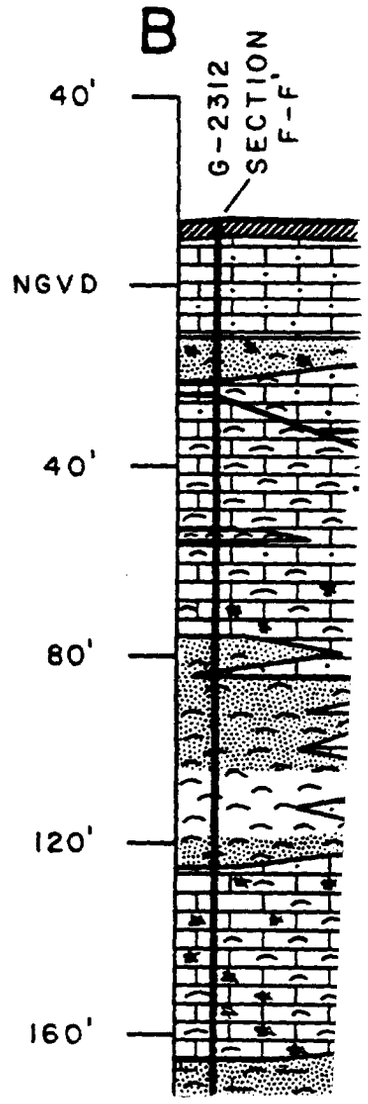
The part of the surficial aquifer system that extends from the coast to the eastern edge of the water conservation areas primarily consists of beach and inner shelf deposits such as sand, sandstone, and sandy shelly limestone. The uppermost part of the surficial aquifer system throughout that part of Broward County consists of a pale-orange to brown quartz sand that ranges from very coarse to very fine grained but is moderately to well sorted toward the medium sand-size fraction. This sand ranges in thickness from a minimum of 5 feet to a maximum of 52 feet in the vicinity of well G-2327 (sheet 2, sections D-D′ and G-G′). This sand was called the Pamlico Sand by Parker and Cooke (1944,



EXPLANATION

A ——— A′ LOCATION

G-2347 TEST WEL



clay is slightly calcareous and grades into clayey silt and silt toward the east where it was over 300 feet below land surface in test well G-2345 (sheet 1, section C-C'; sheet 2, section G-G'). In many of the wells drilled, it was difficult to differentiate between the Tamiami silt and the Hawthorn silt without a detailed foraminferal study. In these wells, the symbol "Tth" was used for Tamiami Formation and Hawthorn Formation undifferentiated. The silt and clay unit was not penetrated in test wells near the coast, two of which were drilled to a maximum depth of 476 feet below land surface (sheet 2, section H-H'). Apparently, the silt and clay unit grades laterally into impure Hawthorn limestone in this area.

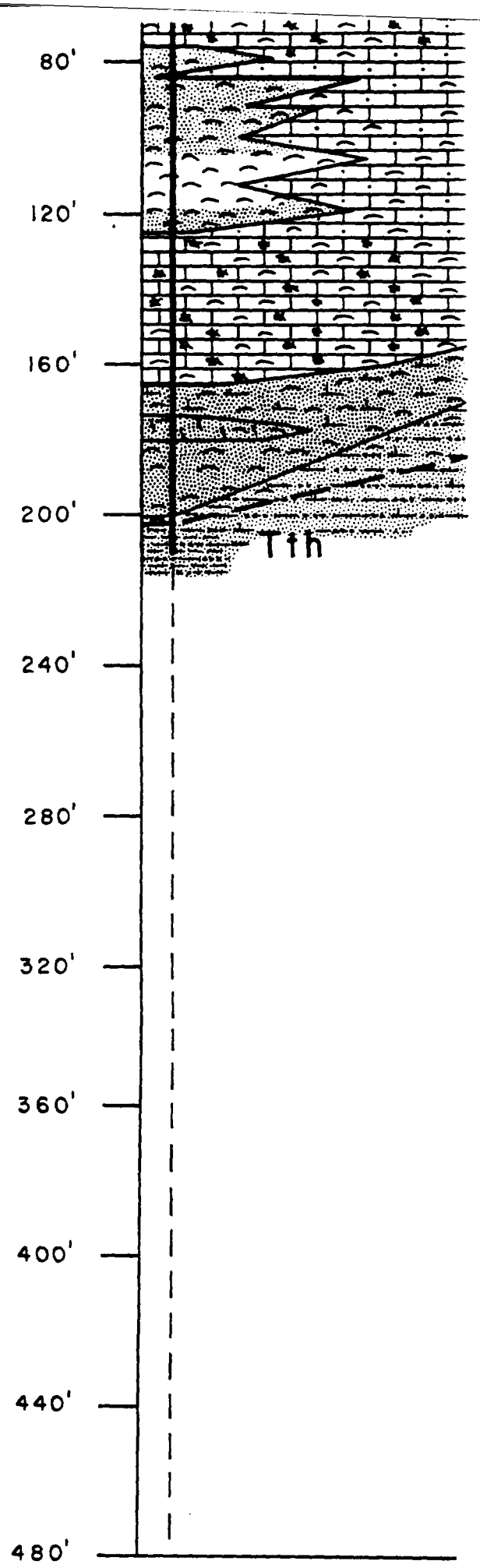
The part of the surficial aquifer system that extends from the coast to the eastern edge of the water conservation areas primarily consists of beach and inner shelf deposits such as sand, sandstone, and sandy shelly limestone. The uppermost part of the surficial aquifer system throughout that part of Broward County consists of a pale-orange to brown quartz sand that ranges from very coarse to very fine grained but is moderately to well sorted toward the medium sand-size fraction. This sand ranges in thickness from a minimum of 5 feet to a maximum of 52 feet in the vicinity of well G-2327 (sheet 2, sections D-D' and G-G'). This sand was called the Pamlico Sand by Parker and Cooke (1944, p. 75).

In test well G-2347 (sheet 1, section C-C'), a 13-foot thickness of the oolitic and bryozoan limestone facies of the Miami Oolite occurs at land surface. Well G-2347 was the only well drilled during this investigation that penetrated the Miami Oolite. Petrographic thin sections made from this limestone show that fine-grained angular quartz forms the nuclei of the ooids. A 20-foot layer of fine-grained quartz sand lies below the oolitic limestone. The sand grades into clay and limemud toward its base and contains approximately 3 to 10 percent ooids. This sand layer is considered in this report to be a part of the Miami Oolite.

The Key Largo limestone underlies this sand unit in well G-2347 and also was penetrated near the coast and southeast Broward County in wells G-2327, G-2328, and G-2344. The Key Largo is a highly crystalline, reefal limestone deposit that contains corals (including *Monastrea* sp.), Halimeda fragments, and mollusks.

Below the Pamlico Sand and interfingering with the Key Largo limestone and Miami Oolite in east Broward County are numerous layers and lenses of sand, shelly sand, shelly and nodular sandstone, and sandy limestone. These interbedded materials are part of the Anastasia Formation and are thickest in the northeastern part of the county where the Anastasia Formation is over 180 feet below land surface. The Anastasia Formation thins toward the central and southern parts of the county where it interfingers with the Fort Thompson Formation. Lying unconformably beneath these sediments are thin layers of limestone of the Tamiami Formation (similar to that found in west and central Broward County) interbedded with a sandstone and sand facies of the same formation. These materials are underlain by a relatively impermeable silt unit that is of Miocene age (F.W. Meyer, U.S. Geological Survey, oral commun., 1983) and whose top forms the base of the surficial aquifer system in east Broward County.

In the coastal areas (sheet 2, section H-H') instead of the silt unit, there occurs a loosely cemented, pale-green limestone which is probably of Hawthorn age; it was encountered at depths ranging from 300 to 480 feet below land surface. The limestone consists of fossiliferous micrites and intramicrites that are abundant in mollusks and planktonic foraminifers. This limestone unit is the base of the aquifer system in the coastal areas (J.E. Fish, U.S. Geological Survey, oral commun., 1983).



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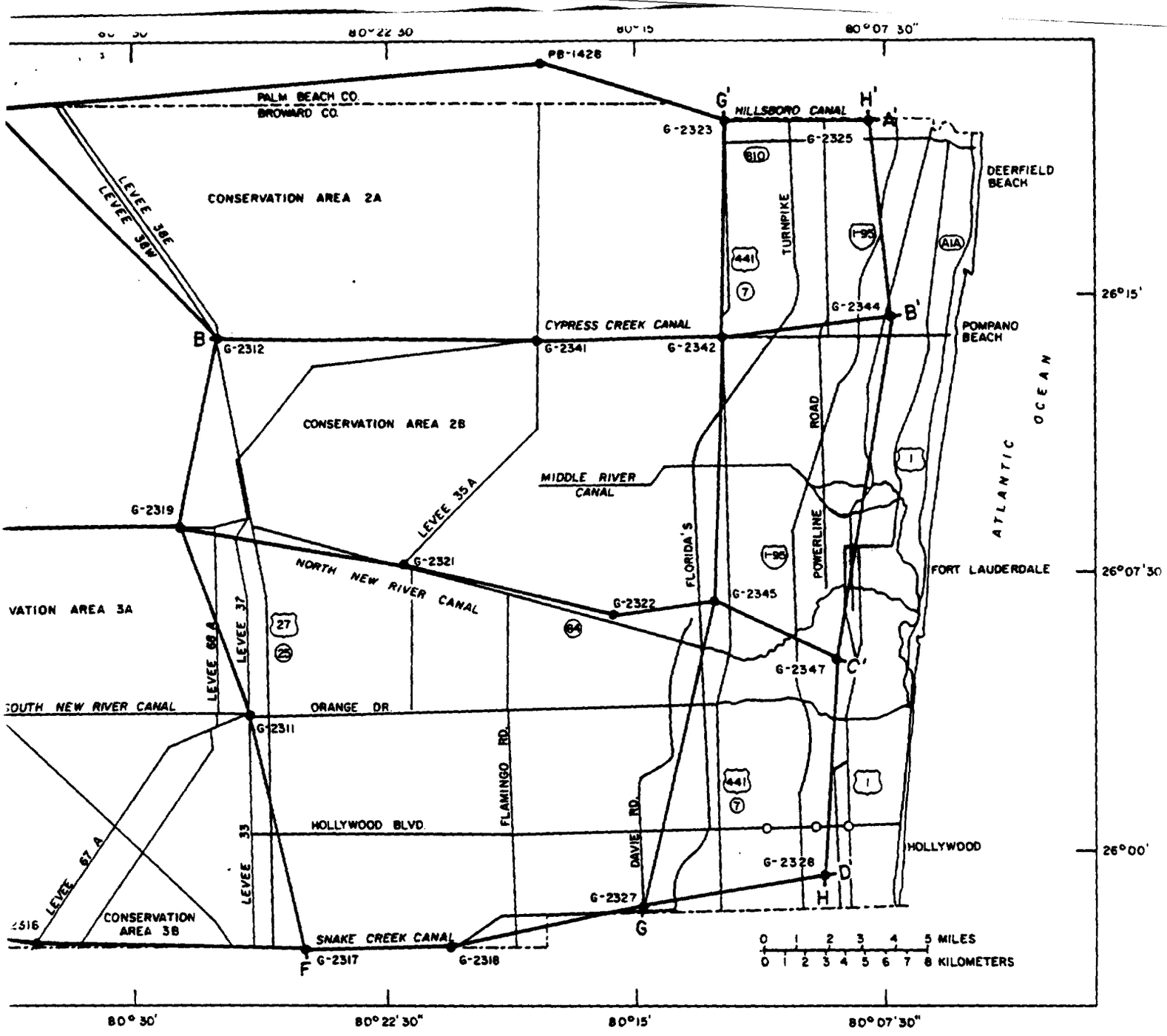
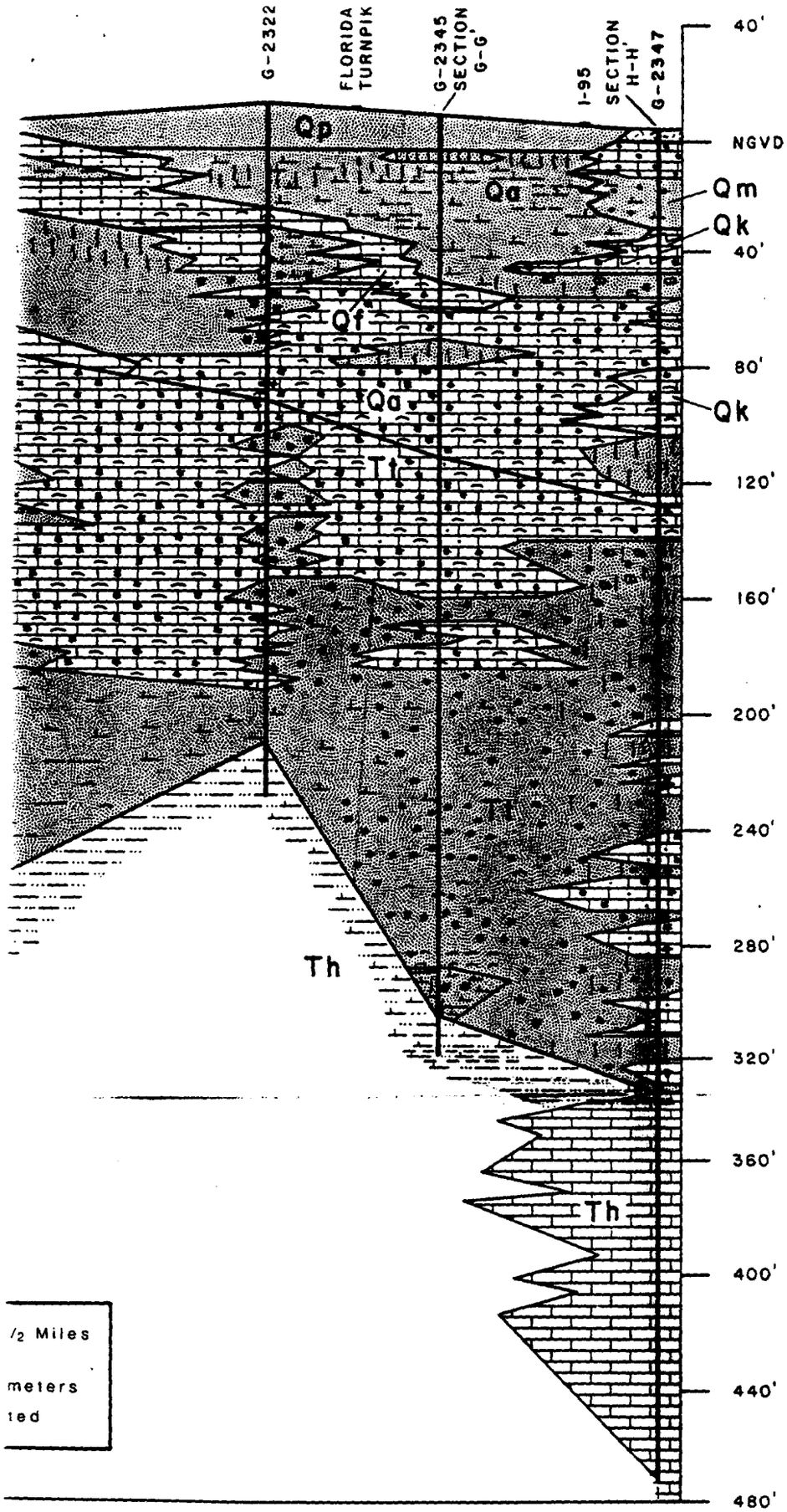


—Location of test wells and geologic sections in Broward County.



Black and white copies of this report can be purchased from:

EXPLANATION

Fill

Peat or muck

Sand

Sandstone

Detrital carbonate sand

Concretions

Shell

Silt

Clay

Claystone or siltstone

Micrite (Limemud)

Limestone

Oolitic limestone

Coralline limestone or Biolithite

GEOLOGIC FORMATIONS

Qp	Pamlico Sand
Qm	Miami Oolite
Qa	Anastasia Formation
Qk	Key Largo Limestone
Qf	Fort Thompson Formation
Tt	Tamiami Formation
Th	Hawthorn Formation
Tth	Tamiami Formation and Hawthorn Formation undifferentiated

Formation boundary

G-2314

Test well and number

NGVD National Geodetic Vertical Datum of 1929 (formerly called mean sea level)

[redacted]

0 2

0

Vertical

WEST-EAST SECTION C-C'

Bureau of Waste Cleanup

NOV 30 1989

Technical Review Section

GEOLOGY OF THE SURFICIAL AQUIFER SYSTEM

BROWARD COUNTY, FLORIDA

LITHOLOGIC LOGS

By Carmen R. Causarás

U.S. GEOLOGICAL SURVEY

WATER-RESOURCES INVESTIGATIONS REPORT 84-4068

Lithologic Log of Well G-2345

Lat 26°06'41", long 80°12'35"
Sec. 12, T. 50 S., R. 41 E.

Description	Thickness (feet)	Depth, feet below land surface
Sand, pale-yellowish-brown (10 YR 6/2), dark-yellowish-brown (10 YR 4/2), moderate-brown (5 YR 3/4), and grayish-brown (5 Y 3/2); quartzose, medium to fine grained, well sorted (fine), angular to subrounded; about 1 to 3 percent phosphorite, fine grained, subrounded to rounded.	13	0 - 13
Sand as above; interbedded with about 20 percent sandstone, quartzose, medium to very fine grained, well sorted (fine), angular to rounded; about 20 percent micrite matrix; about 5 to 10 percent shells, pelecypods; about 3 to 5 percent phosphorite, very fine grained, rounded.	3	13 - 16
Sand as in 0 to 3 feet; about 5 to 10 percent silty micrite, not cemented; about 3 to 5 percent detrital carbonate.	3	16 - 19
Limemud, pale-yellowish-brown (10 YR 6/2); silty micrite, not cemented; about 40 percent quartz, medium to very fine grained, moderately sorted (very fine), subangular to rounded; about 1 to 3 percent phosphorite, very fine grained, rounded.	4	19 - 23
Sand, pale-yellowish-brown (10 YR 6/2); quartzose, medium to very fine grained, well sorted (fine), angular to rounded; about 1 to 3 percent phosphorite, very fine grained, rounded.	3	23 - 26
Limemud, pale-yellowish-brown (10 YR 6/2); about 40 percent quartz, fine to very fine grained, well sorted (very fine), subangular to rounded; about 1 to 3 percent phosphorite, very fine grained, rounded.	3	26 - 29
Sand, pale-yellowish-brown (10 YR 6/2); quartzose, medium to very fine grained, moderately sorted, (fine), angular to rounded; about 30 percent silty micrite, not cemented.	4	29 - 33
Sand, very pale orange (10 YR 8/2) and yellowish-gray (5 Y 8/1); quartzose, fine to very fine grained, well sorted (fine), angular to subangular; about 5 to 10 percent silty micrite, not cemented.	6	33 - 39
Sand, yellowish-gray (5 Y 7/2); quartzose, medium to very fine grained, well sorted (fine), angular to rounded; about 3 to 10 percent silty micrite, not cemented; about 5 percent phosphorite and heavy minerals, fine to very fine grained, well sorted (very fine), angular to subrounded.	7	39 - 46
Sand, very pale orange (10 YR 8/2); quartzose, medium to fine grained, well sorted (fine), angular to rounded; about 5 percent phosphorite, medium to very fine grained, well sorted (very fine), angular to well rounded.	3	46 - 49

Lithologic Log of Well G-2345--Continued

Lat 26°06'41", long 80°12'35"
Sec. 12, T. 50 S., R. 41 E.

Description	Thickness (feet)	Depth, feet below land surface
Limestone, yellowish-gray (5 Y 7/2); sandy, packed intrasparite; about 15 to 20 percent quartz, coarse to very fine grained, poorly sorted, angular to rounded; about 5 to 10 percent phosphorite, coarse to very fine grained, moderately sorted (fine), subangular to well rounded; calcite cavity-filling cement is present at 76 to 79 feet; loosely to well cemented.	10	69 - 79
Limestone as above; about 5 to 10 percent quartz; interbedded with sandy, pelletiferous intramicrite; calcite cavity-filling cement is present; about 30 percent quartz, very fine grained, angular; about 5 to 10 percent phosphorite, very fine grained, well rounded; well cemented.	4	79 - 83
Sandstone, light-gray (N 7) to very light-gray (N 8); nodular; quartzose, very fine grained, angular to subangular; about 20 percent phosphorite and heavy minerals, very fine grained, subrounded to well rounded; about 10 percent sparite matrix; well cemented.	3	83 - 86
Limestone, yellowish-gray (5 Y 7/2); sandy intrasparite; about 20 to 30 percent quartz, very coarse to fine grained, moderately sorted (fine), subangular to rounded; about 10 to 15 percent phosphorite, very coarse to very fine grained, poorly sorted, subangular to well rounded; loosely to well cemented; grading into a very sandy sparite to a sandstone in places; about 40 to 55 percent quartz, fine to very fine grained, well sorted (fine), subangular to subrounded; well cemented.	3	86 - 89
Limestone, yellowish-gray (5 Y 7/2); sandy, pelletiferous intrasparite; about 20 to 25 percent quartz, fine to very fine grained, angular to subangular; about 20 percent phosphorite and heavy minerals, fine to very fine grained, well sorted (very fine), subrounded to well rounded; loosely to well cemented.	4	89 - 93
Limestone, yellowish-gray (5 Y 7/2); sandy intrasparite; about 30 percent quartz, medium to fine grained, moderately sorted (fine), subangular to rounded; about 10 to 15 percent phosphorite and heavy minerals, including iron-rich minerals, fine grained, subrounded to well rounded; loosely to well cemented.	3	93 - 96
Limestone, light-olive-gray (5 Y 6/1); sandy, intraclastic pelsparite; intraclastics exhibit parallel orientation resulting in faint banding; about 20 to 25 percent quartz, fine to very fine grained, well sorted (fine), angular to subrounded; about 10 percent phosphorite and heavy minerals, very fine grained, angular to well rounded; moderately to well cemented.	7	96 - 103

Lithologic Log of Well G-2345--Continued

Lat 26°06'41", long 80°12'35"
Sec. 12, T. 50 S., R. 41 E.

Description	Thickness (feet)	Depth, feet below land surface
Sand, yellowish-gray (5 Y 7/2); quartzose, coarse to fine grained, well sorted (fine), subrounded to rounded; about 5 to 10 percent phosphorite and heavy minerals, coarse to very fine grained, moderately sorted (fine), very angular to rounded; about 1 to 3 percent silty micrite; interbedded with about 10 to 15 percent sandy siltstone, yellowish-gray (5 Y 7/2) and grayish-black (N 2); about 35 to 40 percent quartz, medium to very fine grained, poorly sorted, angular to rounded; about 50 to 55 percent calcareous matrix consisting of a black and yellow mineral; about 5 percent phosphorite and heavy minerals, fine to very fine grained, well sorted (fine), subangular to well rounded; well cemented.	4	49 - 53
Sand, yellowish-gray (5 Y 7/2); quartzose, medium to very fine grained, moderately sorted (fine), angular to rounded; about 5 to 10 percent phosphorite and heavy minerals, fine to very fine grained, well sorted (fine), angular to well rounded; about 5 to 10 percent calcareous silt, quartzose.	3	53 - 56
Sand as above; about 20 percent phosphorite and heavy minerals, coarse to very fine grained, well sorted (fine), subangular to well rounded; about 3 to 5 percent calcareous silt.	2.5	56 - 58.5
Limestone, very pale orange (10 YR 8/2); sandy micrite; about 20 to 25 percent quartz, coarse to very fine grained, moderately sorted (fine), angular to rounded; about 15 to 20 percent phosphorite and heavy minerals, coarse to very fine grained, poorly sorted, subangular to well rounded; interbedded with fossiliferous micrite to sandy, fossiliferous micrite; about 5 to 10 percent quartz, very fine grained, subangular, coated with red silt; well cemented.	.5	58.5 - 59
Limestone, very pale orange (10 YR 8/2) and grayish-orange (10 YR 7/4); mixture: sandy, fossiliferous intramicrite, sandy dismicrite, and a sandy micrite grading into a sandstone in places; neomorphic calcite and subaerial features evident; serpulids and pellets; about 20 to 40 percent quartz, fine to very fine grained, well sorted (fine), angular to rounded; about 10 to 15 percent phosphorite, fine to very fine grained, well sorted (fine), subangular to well rounded; moderately to well cemented.	4	59 - 63
Limestone, yellowish-gray (5 Y 7/2); sandy, fossiliferous micrite, gastropods and pelecypods; about 20 to 30 percent quartz, fine to very fine grained, subangular to rounded; about 5 to 10 percent phosphorite, medium to very fine grained, moderately sorted (fine), subrounded to rounded; loosely to well cemented; interbedded with about 30 percent sand as in 56 to 58.5 feet.	6	63 - 69

Lithologic Log of Well G-2347

Lat 26°05'07", long 80°08'56"
Sec. 22, T. 50 S., R. 42 E.

Description	Thickness (feet)	Depth, feet below land surface
Fill.	4	0 - 4
Limemud, olive-gray (5 Y 4/1); sandy micrite; about 20 percent quartz, medium to fine grained, well sorted (fine), subrounded to rounded; interbedded with about 40 percent limestone mixture, yellowish-gray (5 Y 8/1); unsorted biosparite, mollusks and abundant bryozoans; neomorphic and cavity-filling calcite are present in matrix; well cemented; and sandy, fossiliferous oomicrite, mollusks; about 20 percent quartz, fine grained, subangular to subrounded; moderately cemented, friable.	3	4 - 7
Limestone, very pale orange (10 YR 8/2); sandy, sparse oomicrite, pelecypods; about 20 to 25 percent quartz, medium to fine grained, well sorted (fine), subrounded; moderately cemented, friable.	7	7 - 14
Limestone, very pale orange (10 YR 8/2); fossiliferous oomicrite grading into a sandy, fossiliferous oomicrite, pelecypods (smooth white tests); about 30 to 35 percent quartz as above; and an oosparite, cavity-filling calcite cement is present; moderately (friable) to well cemented.	3	14 - 17
Sand, very pale orange (10 YR 8/2) to pale-yellowish-brown (10 YR 6/2); quartzose, coarse to very fine grained, well sorted (fine), angular to subrounded; about 3 to 10 percent ooids, medium to fine grained, well sorted (medium), well rounded; about 3 to 10 percent clayey micrite, not cemented.	7	17 - 24
Sand as above, dark-yellowish-brown (10 YR 4/2); about 5 to 10 percent silty, calcareous clay; about 3 percent ooids.	3	24 - 27
Sand as above, dark-yellowish-brown (10 YR 4/2) to grayish-orange (10 YR 7/4) to very pale orange (10 YR 8/2); about 3 to 5 percent phosphorite and heavy minerals, fine grained, subangular to well rounded; about 3 to 5 percent silty, calcareous clay; about 1 to 5 percent silty clay.	10	27 - 37
Limestone, yellowish-gray (5 Y 8/1); biolithite, Monastrea sp.; neomorphic calcite present; about 5 to 10 percent quartz, fine grained, subangular to subrounded; grading into an intramicrite; about 5 percent clay; well cemented.	10	37 - 47
Limestone as above, grading into sandy intramicrite; about 25 to 30 percent quartz, medium to fine grained, moderately sorted (fine), subangular to subrounded; about 10 to 15 percent phosphorite and heavy minerals; coarse to very fine grained, poorly sorted, subangular to well rounded.	3	47 - 50

Lithologic Log of Well G-2347--Continued

Lat 26°05'07", long 80°08'56"
Sec. 22, T. 50 S., R. 42 E.

Description	Thickness (feet)	Depth, feet below land surface
Limestone, yellowish-gray (5 Y 8/1); sandy intrasparite; about 15 to 20 percent quartz, coarse to fine grained, moderately sorted (fine), subangular to rounded; about 5 percent phosphorite, very coarse to very fine grained; well cemented; interbedded with about 30 percent sandstone; quartzose, fine to very fine grained, well sorted (fine), subangular to rounded; about 20 percent phosphorite and heavy minerals, very fine grained, subangular to rounded; about 40 to 45 percent micritic matrix; rod-shaped with center composed of a neomorphic calcite matrix; moderately to well cemented.	4	50 - 54
Sand, yellowish-gray (5 Y 8/1); quartzose, fine to very fine grained, well sorted (fine), angular to subrounded; about 20 percent phosphorite and heavy minerals, very fine grained, subangular to rounded; interbedded with about 30 to 40 percent sandstone as above, nodular.	6	54 - 60
Sand, yellowish-gray (5 Y 8/1); quartzose, coarse to fine grained, well sorted (fine), angular to rounded; about 20 percent phosphorite and heavy minerals, medium to very fine grained, moderately sorted (fine), subrounded to well rounded; interbedded with about 30 to 35 percent limestone mixture: sandy, intraclastic, sparse biomicrite, mollusks including gastropods and pelecypods; about 20 to 25 percent quartz, fine to very fine grained, well sorted (fine), angular to subrounded; about 15 percent phosphorite and heavy minerals, fine to very fine grained, subrounded to rounded; and a sandy intrasparite; calcite cavity-filling cement is present; about 25 to 30 percent quartz, medium to fine grained, moderately sorted (fine), angular to rounded; about 10 percent phosphorite and heavy minerals, fine to very fine grained, well sorted; fossiliferous micrite, very pale orange (10 YR 8/2); gastropods and pelecypods; about 5 percent quartz, very fine grained, angular to subangular; well cemented.	4	60 - 64
Limestone, yellowish-gray (5 Y 7/2); sandy, sparse intramicrite, gastropods and pelecypods; about 20 to 25 percent quartz, medium to very fine grained, well sorted (fine), subangular to rounded; is a contact with a sandy intramicrite; about 25 to 30 percent quartz, medium to fine grained, well sorted (fine), subrounded to rounded; about 3 to 5 percent phosphorite and green mineral, medium to very fine grained, moderately sorted (very fine), angular to well rounded; moderately to well cemented.	3	64 - 67
Limestone, yellowish-gray (5 Y 7/2); sandy, fossiliferous intramicrite; about 20 to 25 percent quartz, medium to fine grained, moderately sorted (fine), subangular to subrounded; about 5 to 10 percent phosphorite, very coarse to very fine grained, poorly sorted, subangular to well rounded; well cemented; interbedded with about 20 percent sand; quartzose, very angular to angular; about 15 to 20 percent phosphorite, fine to very fine grained, rounded to well rounded.	13	67 - 80

Lithologic Log of Well G-2347--Continued

Lat 26°05'07", long 80°08'56"
Sec. 22, T. 50 S., R. 42 E.

Description	Thickness (feet)	Depth, feet below land surface
Limestone, yellowish-gray (5 Y 7/2); sandy, intrasparite; about 20 percent quartz, medium to very fine grained, poorly sorted, angular to rounded; about 5 percent phosphorite, medium to very fine grained, poorly sorted, subangular to well rounded; is a contact with a micrite, weathered, pitted texture; cavity-filling calcite cement is present.	4	80 - 84
Limestone, yellowish-gray (5 Y 8/1) to very pale orange (10 YR 8/2); pelletiferous, sparse intramicrite, framework organism, gastropods, pelecypods, coral including Monastrea sp., burrows, and pellets; neomorphic calcite present at 87 to 90 feet; about 10 percent quartz, very fine grained, angular to subangular; about 5 to 10 percent phosphorite and heavy minerals, very fine grained, subangular to well rounded; moderately to well cemented.	10	84 - 94
Limestone, yellowish-gray (5 Y 8/1 and 5 Y 7/2); intraclastic, sparse pelmicrite, pelecypods, halimeda, and abundant coral; neomorphic and cavity-filling calcite are present in matrix; moderately to well cemented.	10	94 - 104
Limestone, yellowish-gray (5 Y 7/2 and 5 Y 8/1); fossiliferous pelintramicrite, echinoid spines and fragments, and mollusks including pelecypods and Pecten sp.; well cemented.	3	104 - 107
Limestone, yellowish-gray (5 Y 8/1); sandy intramicrite, grading into a sandy intrasparite in places; about 20 to 30 percent quartz, medium to very fine grained, moderately sorted (fine), subangular to rounded; about 5 to 10 percent phosphorite and heavy minerals, coarse to very fine grained, poorly sorted, subangular to well rounded; well cemented.	3	107 - 110
Limestone, yellowish-gray (5 Y 7/2); sandy intrasparite; about 30 to 35 percent quartz, fine to very fine grained well sorted (fine), subangular to subrounded; about 5 to 10 percent phosphorite and heavy minerals, medium to very fine grained, well sorted (fine), subangular to well rounded; nodular; well cemented; interbedded with about 15 percent sand; quartzose, medium to very fine grained, well sorted (fine), subangular to rounded; about 10 percent detrital carbonate; about 5 to 10 percent phosphorite, medium to very fine grained, poorly sorted, subrounded to rounded.	4	110 - 114
Sandstone, yellowish-gray (5 Y 7/2); quartzose, medium to fine grained, well sorted (fine), subangular to subrounded; about 5 percent phosphorite, very coarse to very fine grained, poorly sorted, rounded to well rounded; about 25 percent detrital carbonate coarse to fine grained, moderately sorted (medium), angular to rounded; about 10 to 15 percent sparite matrix; grading into an intraclastic, unsorted biosparite; about 10 to 15 percent quartz and about 3 to 5 percent phosphorite as in sandstone; moderately to well cemented.	3	114 - 117

OVERSIZED

DOCUMENT

United States
Department
Agriculture

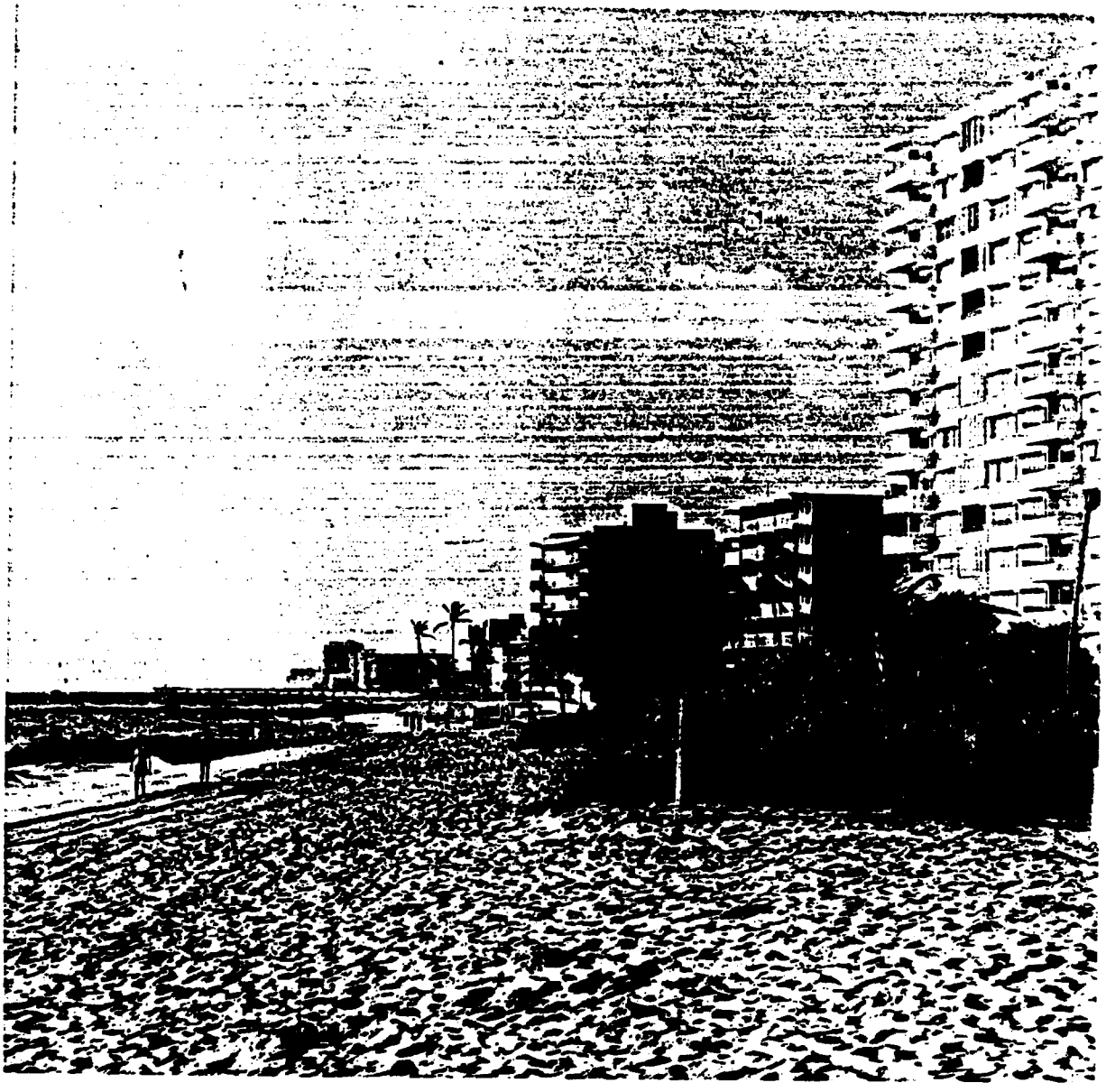
Soil
Conservation
Service

Reference 18

Agricultural Sciences,
Agricultural Experiment
Stations and Soil Science
Department, and the Florida
Department of Agriculture
and Consumer Services

Survey of Broward County Florida

Eastern Part



Soil Survey of
Broward County, Florida
Eastern Part

By Robert F. Pendleton, Hershel D. Dollar, Lloyd Law, Jr.,
Samuel H. McCollum, and David J. Betz, Soil Conservation Service

United States Department of Agriculture, Soil Conservation Service,
in cooperation with the
University of Florida, Institute of Food and Agricultural Sciences,
Agricultural Experiment Stations and Soil Science Department, and the
Florida Department of Agriculture and Consumer Services

Broward County, Eastern Part, is in the southeastern part of Florida. It has a total land area of 265,273 acres, or about 414.5 square miles. Fort Lauderdale is the county seat of Broward County. The survey area is bounded by Dade County on the south, a conservation area on the west, and Palm Beach County on the north.

Most of the survey area is low, nearly level land at an elevation of 2 to 10 feet above sea level. Two dominant sand ridges are in the area. One is the Atlantic Coastal Ridge, which extends from Palm Beach County and ends south of Pompano. The other is known as Pine Island and is west of Davie and north of Cooper City. This ridge consists of only about 400 acres but is at the highest elevation, 29 feet, in the survey area. The average temperature in the survey area is 75.4° F. Rainfall is abundant, but is unevenly distributed.

The county has a population of 1,005,315. Almost all of the people live east of the conservation area.

Generally, farm activity has diminished, but some citrus crops, winter truck crops, and cattle are produced.

Broward County, Eastern Part, is very popular with tourists and retired people because of the warm climate in winter and the various recreational facilities.

General Nature of the Survey Area

Soil is intimately associated with its environment. The interaction of all factors determines the overall behavior of a soil for a given use. This section discusses briefly the major factors of the environment other than those that affect the use and management of soils. The factors discussed are climate; transportation, markets, and farming; water supply; and physiography and drainage.

Climate

This section was prepared by James T. Bradley, climatologist for Florida, National Weather Service, U.S. Department of Commerce. For convenience in presentation this section includes climate data for all of Broward County.

The climate of Broward County, Eastern Part, is characterized by long, warm, humid summers and mild winters and is considered one of the most important natural resources of the county. The moderating influence of the waters of the Atlantic on maximum temperatures in summer and minimum temperatures in winter is quite strong along the immediate coast but diminishes noticeably a few miles inland. The moderation of the coastal winter temperatures gives this section of the survey area a tropical climate (temperatures of coldest month higher than 64.4° F), while the rest is designated as humid subtropical.

Rainfall also has a much greater variation in an east-west direction than it has in a north-south direction. Precipitation occurs during all seasons, but on the basis of mean monthly totals of precipitation, a rainy season of 5 months from June through October brings nearly 65 percent of the annual rainfall and a relatively dry season of 5 months from November through March produces only about 20 percent of the annual total. Average annual rainfall totals range from 60 inches along the coastal sections to nearly 64 inches a few miles inland, and then diminish to 50 inches along the western border of Broward County.

Most summer rainfall comes from showers and thunderstorms of short duration. They are sometimes heavy, with 2 or 3 inches of rain falling within a period of

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Figure 1.—The New River is an important docking area for pleasure craft in Ft. Lauderdale. The land area is part of the Immokalee, limestone substratum-Urban land complex.

The coastal areas have excellent facilities for fishing and boating (fig. 1).

Water Supply

The water supply for the cities in the survey area comes primarily from municipal wells. Many private wells are used, mostly for watering lawns. Because porous limestone is below most of the soils, water can move laterally for long distances. The water in the canals can be regulated to help recharge the ground water during dry periods.

Although most of the survey area receives about 60 inches of rainfall annually, this amount may not be sufficient to provide water needs in the future. The main alternate source could be Lake Okeechobee to the north of the survey area.

Physiography and Drainage

Broward County, Eastern Part, can be divided into three general regions based on differences in physiography and soils.

The western part is a nearly level, generally treeless sawgrass plain that appears to be flat. The soils are organic and overlie limestone. In many places the soils are shallow. Under natural conditions, water stood on these soils for months and only during extremely dry seasons was the surface exposed. Today, these soils have been drained, and water stands on the surface for only short periods. With drainage, the organic soils are subject to oxidation and subsidence. When exposed to air, organic matter is oxidized or slowly decomposed, and this gradual loss of organic matter results in subsidence or a lowering of surface elevation. Also, during dry seasons, wildfires have burned some of the organic surface soil and decreased the thickness of the organic material.

Very little acreage of the organic soils is farmed at present. A few acres are in improved pasture. In recent years, after some drainage, several types of trees have become established. These trees are melaleuca, Australian pine, and waxmyrtle. One method used for developing the organic soils for urban use removes the organic material and adds fill consisting of rock or sand.

The central part of the survey area consists of nearly level, grassy areas interspersed with small ponds. The soils here are wet and sandy and are underlain by limestone. Before drainage, water stood on these soils for several months each year. The original vegetation was water-tolerant grasses and a few cypress stands. In the higher areas, pine and palmetto were common. These areas are now farmed and produce excellent pasture and truck crops.

The central part is also an area of rapid urban development. The underlying limestone is mostly porous, and water moves through it laterally for long distances. Water-control ditches can be farther apart in these soils than in soils underlain by sand or loamy material. For urban development, fill is commonly added to raise the elevation to such a level that water does not cover the soil surface.

The eastern part of the survey area is made up of low, sandy ridges, a part of which is commonly referred to as flatwoods. The vegetation is mostly pine, palmetto, and native grasses. The flatwoods part is made up of deep, poorly drained, nearly level, sandy soils. These soils have been used mostly for truck crops and pasture, but are rapidly being developed for urban uses. They require drainage, and fill is added to low areas so that the entire acreage can be developed. The other part is made up of deep, excessively drained or well drained, sandy soils, many of which have been developed for urban uses.

The major drainage systems in the survey area flow from west to east and drain into the Atlantic Ocean. These systems are the Hillsboro Canal at the Palm Beach-Broward County line, the Pompano Canal at Margate, the Midriver Canal at Lauderhill, the North New River Canal at Davie, and C-9 at the Dade County line. These canals are under the control of the South Florida Water Management District.

How This Survey Was Made

This survey was made to provide information about the soils in the survey area. The information includes a description of the soils and their location and a discussion of the suitability, limitations, and management of the soils for specified uses. Soil scientists observed the steepness, length, and shape of slopes; the general pattern of drainage; the kinds of crops and native plants growing on the soils; and the kinds of bedrock. They dug many holes to study the soil profile, which is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biologic activity.

The soils in the survey area occur in an orderly pattern that is related to the geology, the landforms, relief, climate, and the natural vegetation of the area. Each kind of soil is associated with a particular kind of landscape or with a segment of the landscape. By observing the soils in the survey area and relating their position to specific segments of the landscape, a soil scientist develops a concept, or model, of how the soils were formed. Thus, during mapping, this model enables the soil scientist to predict with considerable accuracy the kind of soil at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, acidity, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. The system of taxonomic classification

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Most of the acreage of this soil is in natural vegetation or improved pasture. The natural vegetation consists of scattered slash pine and sawpalmetto, pineland threeawn, paspalum, bluejoint panicum, blue maidencane, and bluestem.

This soil is poorly suited to cultivated crops or citrus. Good pasture of improved grasses or grass and clover can be produced under intensive management. Some water control and fertilization with trace elements are needed.

This soil is in capability subclass IVw.

Hb—Hallandale-Urban land complex. This complex consists mainly of Hallandale fine sand and Urban land. The areas of these components are so intermixed or so small that separation at the scale of mapping is impractical. Depth to the water table depends on the established drainage in the area.

About 20 to 45 percent of the complex is open land, such as lawns and vacant lots, and about 40 to 70 percent is Urban land. The rest is modified areas of Margate, Pompano, and Basinger soils and filled ponds.

The open land consists of nearly level, poorly drained Hallandale soil that has been modified in most places by spreading fill material on the surface of the original soil to an average thickness of about 12 inches. The original soil below the fill material is Hallandale fine sand. About 80 percent of the fill material consists of a mixture of sand, limestone, and shell fragments that range from sand size to about 3 inches in diameter. The remaining 20 percent is sand.

The Urban land consists of areas covered by sidewalks, streets, patios, driveways, buildings, and other construction related to urban use.

The Margate soils have also been modified by spreading fill material on the surface of the original soil to an average thickness of about 12 inches, and the Pompano and Basinger soils have been modified by spreading fill material on the surface of the original soil.

The determined use of the soils for the foreseeable future is urban related.

This complex is not assigned to a capability subclass.

Hm—Hallandale and Margate soils. These are nearly level, poorly drained soils that have been modified by grading, shaping, and covering with 8 to 20 inches of fill material. These alterations were made to provide a base for construction of homes, streets, and industrial buildings. Depth to the water table in these soils is variable and depends on the established drainage in the area.

Hallandale soil covered by fill material makes up about 45 percent of the total acreage, and Margate soil covered with fill makes up about 35 percent. The remaining 20 percent is mostly filled ponds, areas of Pompano soils, and areas of Basinger soils that have been modified by spreading fill on the surface of the original soil.

Included with these soils in mapping are small areas of Urban land.

The fill material on these soils consists of sand, shell fragments, and limestone fragments. About 80 percent of the fill is mixed shell and limestone fragments ranging from sand size to 3 inches in diameter. The average thickness of the fill on these soils is about 12 inches, but some areas that originally were the lower areas in the landscape are covered by as much as 5 feet of fill material.

Planned use of these soils is for urban development only.

These soils are not assigned to a capability subclass.

Immokalee Series

The Immokalee series consists of nearly level, poorly drained soils on broad, low ridges in the eastern part of the survey area. These soils formed in unconsolidated marine sediment. Under natural conditions they have a water table at a depth of 10 inches or less for 1 to 4 months in most years, and at a depth of 10 to 40 inches for most of the rest of the year. In some years these soils are covered with shallow water for a few days.

Typically, the surface layer is dark gray fine sand about 6 inches thick. The subsurface layer is 34 inches of fine sand. The upper 14 inches is light gray, and the lower 20 inches is white. The subsoil extends to a depth of 80 inches. The upper 22 inches is black fine sand that is coated with organic matter. The next 3 inches is dark reddish brown fine sand that has black mottles and is coated with organic matter. The lower 15 inches is dark brown fine sand.

Permeability is moderate to moderately rapid in the subsoil and rapid in all other layers. Available water capacity is medium to high in the subsoil and very low in all other layers. Content of organic matter and natural fertility are low.

Where adequate water control and good management practices are in use, Immokalee soils are suited to winter truck crops and improved pasture grasses.

Typical pedon of Immokalee fine sand, 350 feet west of railroad and 1.25 miles south of Hillsborough Boulevard, SE1/4NW1/4 sec. 11, T. 48 S., R. 42 E.:

A1—0 to 6 inches; dark gray (10YR 4/1), rubbed, fine sand; light gray (10YR 7/1), unrubbed and dry, sand grains mixed with some organic matter; single grained; loose; common fine and medium roots; strongly acid; clear smooth boundary.

A21—6 to 20 inches; light gray (10YR 7/1) fine sand; single grained; loose; few fine and medium roots; strongly acid; clear smooth boundary.

A22—20 to 40 inches; white (10YR 8/1) fine sand; few fine distinct very dark gray (10YR 3/1) streaks along

Figure 6.—Typical vegetation of slash pine, sawpalmetto, and native grasses in an area of Immokalee fine sand.

streets commonly are excavated below the level of original land surface and serve as drainageways. The excavated material is spread over adjacent areas.

Included with this complex in mapping are small areas of Basinger, Immokalee, Margate, and Pompano soils. These soils have been altered by having had fill material up to 20 inches thick spread over the surface of the original soil. Also included are Arents and Udorthents.

Present land use precludes the use of this map unit for crops, pasture, or commercial trees. Most of the Immokalee, limestone substratum, part of this unit is used for grasses and ornamentals. Adequate surface drainage, proper watering, and regular applications of fertilizer are needed for satisfactory plant growth.

This complex is not assigned to a capability subclass.

Iu—Immokalee-Urban land complex. This complex consists of Immokalee fine sand and Urban land. The areas of these components are so intermixed or so small that separation at the scale of mapping is impractical. Depth to the water table depends on the established drainage in the area.

About 20 to 45 percent of the complex is open land, such as lawns and vacant lots; and about 40 to 70 percent is Urban land, or areas covered by sidewalks, streets, patios, driveways, and buildings, where the natural soil cannot be observed.

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Figure 7.—Eggplant in an area of Immokalee fine sand where water control measures and intensive management are in use.

The open land consists of nearly level, poorly drained Immokalee soils that have been modified in most places by spreading sandy material on the surface of the soil to an average thickness of about 12 inches, but ranging from about 6 to 20 inches. About 10 percent of the Immokalee soils have not been modified. The original soil below the fill material is Immokalee fine sand.

Included with this complex in mapping are small areas of Basinger, Pompano, Margate, and Hallandale soils. These soils have been modified by spreading fill material on the surface of the original soil.

About 80 percent of the fill material on the Immokalee soils is sand. The rest of the fill material on the Immokalee soils and most of the fill material on the other soils consist of a mixture of shell fragments and limestone fragments ranging from sand size to about 3 inches in diameter.

The determined use of these soils for the foreseeable future is urban related.

The complex is not assigned to a capability subclass.

Lauderhill Series

The Lauderhill series consists of nearly level, very poorly drained soils in broad flats in the Everglades. These soils formed in hydrophytic plant remains mixed with a small amount of mineral material. Under natural conditions these soils are covered with water most of the year. Even where drainage has been improved, water stands on the surface for 6 to 12 months each year.

Typically, the upper 9 inches is black sapric material, or muck. Below this, to a depth of about 27 inches, is dark reddish brown sapric material. Between depths of 27 and 31 inches is dark reddish brown sapric material that is about 77 percent mineral material, of which 15

Morphology, soil. The physical makeup of the soil, including the texture, structure, porosity, consistence, color, and other physical, mineral, and biological properties of the various horizons, and the thickness and arrangement of those horizons in the soil profile.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Muck. Dark colored, finely divided, well decomposed organic soil material. (See Sapric soil material.)

Munsell notation. A designation of color by degrees of the three simple variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Open space. A relatively undeveloped green or wooded area provided mainly within an urban area to minimize feelings of congested living.

Organic matter. Plant and animal residue in the soil in various stages of decomposition.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil. Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.2 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic.

Ponding. Standing water on soils in closed depressions. Unless the soils are artificially drained, the water can be removed only by percolation or evapotranspiration.

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Poor outlets (in tables). Refers to areas where surface or subsurface drainage outlets are difficult or expensive to install.

Productivity, soil. The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Rippable. Bedrock or hardpan can be excavated using a single-tooth ripping attachment mounted on a tractor with a 200-300 draw bar horsepower rating.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil

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TABLE 13.--ENGINEERING INDEX PROPERTIES--Continued

Map symbol and soil name	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
Df*:											
Duette	0-3	Sand	SP	A-3	0	100	100	60-100	1-4	---	NP
	3-66	Fine sand, sand	SP	A-3	0	100	100	60-100	1-4	---	NP
	66-80	Fine sand, sand	SP, SP-SM	A-3, A-2-4	0	100	100	60-100	4-12	---	NP
Urban land.											
Du*:											
Dade	0-27	Fine sand	SP, SP-SM	A-3	0	100	100	89-100	1-6	---	NP
	27-35	Fine sand, sand	SP, SP-SM	A-3	0	100	100	90-100	2-8	---	NP
	35	Weathered bedrock	---	---	---	---	---	---	---	---	---
Urban land.											
Ha	0-4	Fine sand	SP, SP-SM	A-3	0	100	100	90-100	2-6	---	NP
Hallandale	4-10	Fine sand, sand	SP, SP-SM	A-3	0	100	100	90-100	2-6	---	NP
	10-14	Fine sand, sand	SP, SP-SM	A-3	0	100	100	90-100	2-6	---	NP
	14-16	Fine sand, sand	SP, SP-SM	A-3	0	100	100	90-100	2-6	---	NP
	16	Weathered bedrock	---	---	---	---	---	---	---	---	---
Hb*:											
Hallandale	0-4	Fine sand	SP, SP-SM	A-3	0	100	100	90-100	2-6	---	NP
	4-10	Fine sand, sand	SP, SP-SM	A-3	0	100	100	90-100	2-6	---	NP
	10-14	Fine sand, sand	SP, SP-SM	A-3	0	100	100	90-100	2-6	---	NP
	14-16	Fine sand, sand	SP, SP-SM	A-3	0	100	100	90-100	2-6	---	NP
	16	Weathered bedrock	---	---	---	---	---	---	---	---	---
Urban land.											
Hm*:											
Hallandale	0-4	Fine sand	SP, SP-SM	A-3	0	100	100	90-100	2-6	---	NP
	4-10	Fine sand, sand	SP, SP-SM	A-3	0	100	100	90-100	2-6	---	NP
	10-14	Fine sand, sand	SP, SP-SM	A-3	0	100	100	90-100	2-6	---	NP
	14-16	Fine sand, sand	SP, SP-SM	A-3	0	100	100	90-100	2-6	---	NP
	16	Weathered bedrock	---	---	---	---	---	---	---	---	---
Margate	0-8	Fine sand	SP, SP-SM	A-3	0	100	100	93-100	2-8	---	NP
	8-16	Fine sand, sand	SP, SP-SM	A-3	0	100	100	93-100	2-8	---	NP
	16-28	Fine sand, sand	SP, SP-SM	A-3	0	100	100	93-100	2-8	---	NP
	28-32	Variable	---	---	---	---	---	---	---	---	---
	32	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
Ia	0-6	Fine sand	SP, SP-SM	A-3	0	100	100	70-100	2-10	---	NP
Immokalee	6-40	Fine sand, sand	SP, SP-SM	A-3	0	100	100	70-100	2-10	---	NP
	40-65	Fine sand, sand	SP-SM, SM	A-3, A-2-4	0	100	100	70-100	5-21	---	NP
	65-80	Fine sand, sand	SP, SP-SM	A-3	0	100	100	70-100	2-10	---	NP
Ir*:											
Immokalee	0-5	Fine sand	SP, SP-SM	A-3	0	100	100	85-99	2-10	---	NP
	5-48	Sand, fine sand	SP, SP-SM	A-3	0	100	100	85-99	2-10	---	NP
	48-58	Sand, fine sand	SP-SM, SM	A-3, A-2-4	0	100	100	80-99	5-15	---	NP
	58	Weathered bedrock	---	---	---	---	---	---	---	---	---
Urban land.											
Iu*:											
Immokalee	0-6	Fine sand	SP, SP-SM	A-3	0	100	100	70-100	2-10	---	NP
	6-35	Fine sand, sand	SP, SP-SM	A-3	0	100	100	70-100	2-10	---	NP
	35-54	Fine sand, sand	SP-SM, SM	A-3, A-2-4	0	100	100	70-100	5-21	---	NP
	54-72	Fine sand, sand	SP, SP-SM	A-3	0	100	100	70-100	2-10	---	NP
Urban land.											

See footnote at end of table.

TABLE 14.--PHYSICAL AND CHEMICAL PROPERTIES OF THE SOILS--Continued

Map symbol and soil name	Depth	Clay	Moist bulk density	Permeability	Available water capacity	Reaction	Salinity	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group	Organic matter
	In	Pct	G/cm³	In/hr	In/in	pH	Mmhos/cm					Pct
Hb*:												
Hallandale-------	0-4	<3	1.35-1.45	6.0-20	0.05-0.11	5.1-6.5	<2	Low--------	0.10	2	2	2-5
	4-10	<3	1.50-1.60	6.0-20	0.03-0.08	6.1-6.5	<2	Low--------	0.10			
	10-14	<3	1.50-1.60	0.6-6.0	0.03-0.08	5.6-8.4	<2	Low--------	0.10			
	14-16	<5	1.50-1.60	6.0-20	0.05-0.10	6.6-8.4	<2	Low--------	0.10			
	16	---	---	---	---	---	---	----------	----			
Urban land.												
Hm*:												
Hallandale-------	0-4	<3	1.35-1.45	6.0-20	0.05-0.11	5.1-6.5	<2	Low--------	0.10	2	2	2-5
	4-10	<3	1.50-1.60	6.0-20	0.03-0.08	6.1-6.5	<2	Low--------	0.10			
	10-14	<3	1.50-1.60	0.6-6.0	0.03-0.08	5.6-8.4	<2	Low--------	0.10			
	14-16	<5	1.50-1.60	6.0-20	0.05-0.10	6.6-8.4	<2	Low--------	0.10			
	16	---	---	---	---	---	---	----------	----			
Margate---------	0-8	1-4	1.25-1.45	6.0-20	0.05-0.10	4.5-6.0	<2	Low--------	0.10	3	2	1-4
	8-16	0-4	1.55-1.65	6.0-20	0.03-0.06	5.1-6.5	<2	Low--------	0.10			
	16-28	1-4	1.55-1.65	6.0-20	0.03-0.06	6.1-7.8	<2	Low--------	0.10			
	28-32	3-10	1.55-1.65	6.0-20	0.03-0.10	7.4-8.4	<2	Low--------	0.17			
	32	---	---	---	---	---	---	----------	----			
Ia---------- Immokalee	0-6	1-5	1.20-1.50	6.0-20	0.05-0.10	3.6-6.0	<2	Low--------	0.10	5	2	1-2
	6-40	1-5	1.45-1.70	6.0-20	0.02-0.05	3.6-6.0	<2	Low--------	0.10			
	40-65	2-7	1.30-1.60	0.6-2.0	0.10-0.25	3.6-6.0	<2	Low--------	0.15			
	65-80	1-5	1.40-1.60	6.0-20	0.02-0.05	3.6-6.0	<2	Low--------	0.10			
Ir*:												
Immokalee-------	0-5	1-5	1.20-1.50	>6.0	0.05-0.10	5.1-7.8	<2	Low--------	0.10	5	2	1-2
	5-48	1-5	1.40-1.70	>6.0	0.02-0.05	5.1-7.8	<2	Low--------	0.10			
	48-58	2-7	1.30-1.60	0.6-6.0	0.10-0.25	5.1-7.8	<2	Low--------	0.15			
	58	---	---	---	---	---	---	----------	----			
Urban land.												
Iu*:												
Immokalee-------	0-6	1-5	1.20-1.50	6.0-20	0.05-0.10	3.6-6.0	<2	Low--------	0.10	5	2	1-2
	6-35	1-5	1.45-1.70	6.0-20	0.02-0.05	3.6-6.0	<2	Low--------	0.10			
	35-54	2-7	1.30-1.60	0.6-2.0	0.10-0.25	3.6-6.0	<2	Low--------	0.15			
	54-72	1-5	1.40-1.60	6.0-20	0.02-0.05	3.6-6.0	<2	Low--------	0.10			
Urban land.												
La---------- Lauderhill	0-31	---	0.15-0.35	6.0-20	0.20-0.30	5.6-7.8	<2	Low--------	----	---	2	>55
	31	---	---	---	---	---	---	----------	----			
Ma---------- Margate	0-8	1-4	1.25-1.45	6.0-20	0.05-0.10	4.5-6.0	<2	Low--------	0.10	3	2	1-4
	8-16	0-4	1.55-1.65	6.0-20	0.03-0.06	5.1-6.5	<2	Low--------	0.10			
	16-28	1-4	1.55-1.65	6.0-20	0.03-0.06	6.1-7.8	<2	Low--------	0.10			
	28-32	3-10	1.55-1.65	6.0-20	0.03-0.10	7.4-8.4	<2	Low--------	0.17			
	32	---	---	---	---	---	---	----------	----			
Mu*:												
Margate---------	0-8	1-4	1.25-1.45	6.0-20	0.05-0.10	4.5-6.0	<2	Low--------	0.10	3	2	1-4
	8-16	0-4	1.55-1.65	6.0-20	0.03-0.06	5.1-6.5	<2	Low--------	0.10			
	16-28	1-4	1.55-1.65	6.0-20	0.03-0.06	6.1-7.8	<2	Low--------	0.10			
	28-32	3-10	1.55-1.65	6.0-20	0.03-0.10	7.4-8.4	<2	Low--------	0.17			
	32	---	---	---	---	---	---	----------	----			
Urban land.												
Ok---------- Okeelanta	0-40	---	0.22-0.38	6.0-20	0.20-0.30	4.5-6.5	<2	Low--------	----	---	2	>60
	40-60	1-5	1.30-1.55	6.0-20	0.05-0.10	5.1-7.8	<2	Low--------	0.15			
Pa---------- Paola	0-26	<2	1.45-1.60	>20	0.02-0.05	4.5-7.3	<2	Low--------	0.10	5	1	<.5
	26-83	<3	1.45-1.60	>20	0.02-0.05	4.5-7.3	<2	Low--------	0.10			

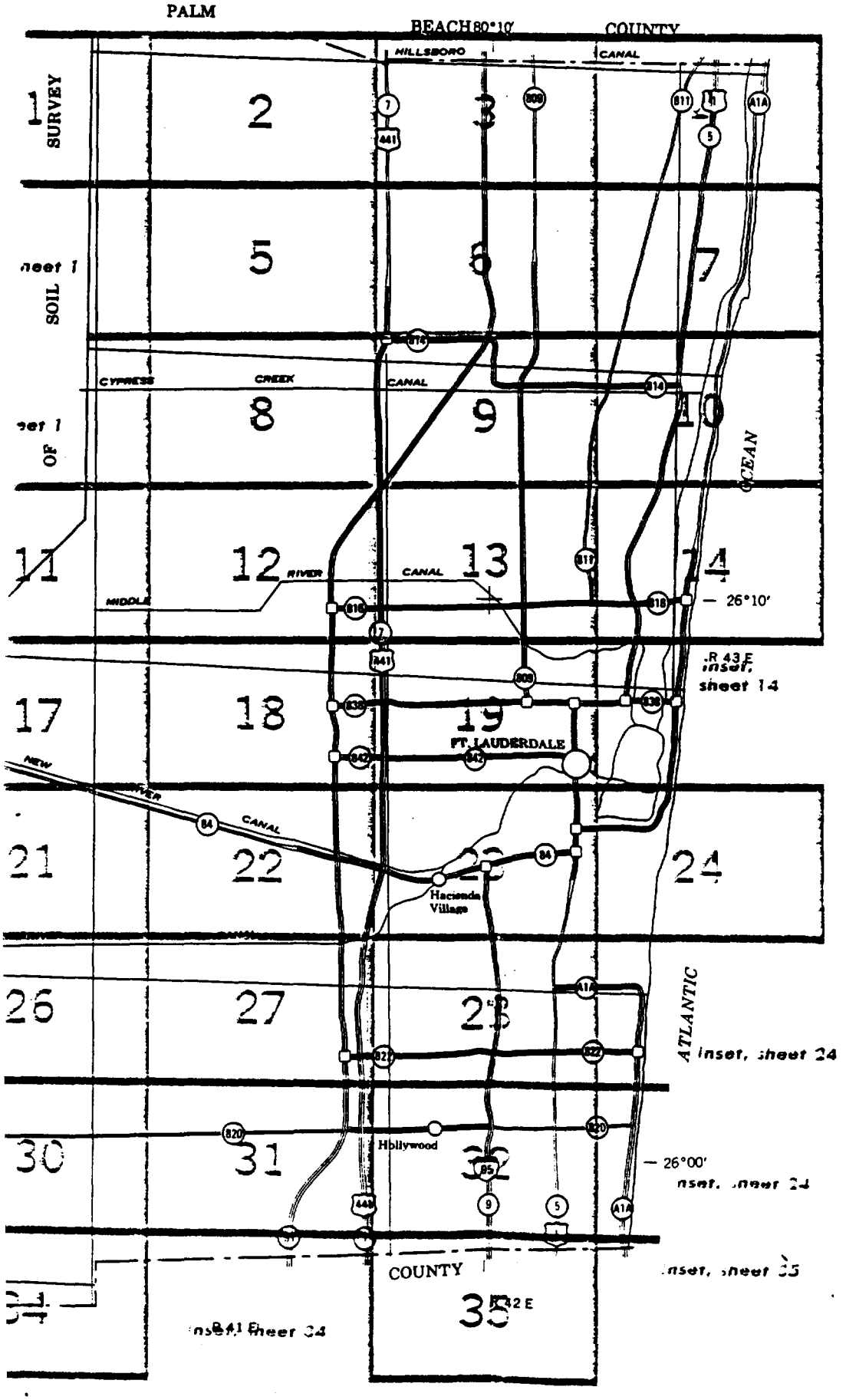
See footnote at end of table.

TABLE 15.--SOIL AND WATER FEATURES--Continued

Map symbol and soil name	Hydrologic group	Flooding			High water table			Bedrock depth	Initial subsidence	Risk of corrosion	
		Frequency	Duration	Months	Depth*	Kind	Months			Uncoated steel	Concrete
					Ft			In	In		
Hm**:											
Hallandale	B/D	None	---	---	0-1.0	Apparent	Jun-Nov	7-20	---	High	Low.
Margate	B/D	None	---	---	+1-1.0	Apparent	Jun-Feb	20-40	---	High	Moderate.
Ia Immokalee	B/D	None	---	---	0-1.0	Apparent	Jun-Nov	>60	---	High	High.
Ir**:											
Immokalee	B/D	None	---	---	0-1.0	Apparent	Jun-Nov	40-72	---	High	Moderate.
Urban land.											
Iw**:											
Immokalee	B/D	None	---	---	0-1.0	Apparent	Jun-Nov	>60	---	High	High.
Urban land.											
La Lauderhill	B/D	None	---	---	+1-1.0	Apparent	Jun-Feb	20-40	4-8	High	Moderate.
Ma Margate	B/D	None	---	---	+1-1.0	Apparent	Jun-Feb	20-40	---	High	Moderate.
Mu**:											
Margate	B/D	None	---	---	+1-1.0	Apparent	Jun-Feb	20-40	---	High	Moderate.
Urban land.											
Ok Okeelanta	B/D	None	---	---	+1-0	Apparent	Jun-Jan	>60	16-20	High	Moderate.
Pa Paola	A	None	---	---	>6.0	---	---	>60	---	Low	High.
Pb**:											
Paola	A	None	---	---	>6.0	---	---	>60	---	Low	High.
Urban land.											
Pc Palm Beach	A	None	---	---	>6.0	---	---	>60	---	Low	Low.
Pe Pennsuco	D	None	---	---	0-1.0	Apparent	Jun-Nov	40-72	---	High	Low.
Pf Pennsuco	D	Frequent	Long	Jan-Dec	0-1.0	Apparent	Jan-Dec	40-72	---	High	Low.
Pm Plantation	B/D	None	---	---	+1-1.0	Apparent	Jun-Nov	20-40	4-8	High	Moderate.

See footnotes at end of table.

TABLE 15.--SOIL AND WATER FEATURES--Continued


PALM
BEACH
COUNTY
80°10'
HILLSBORO
CANAL
SURVEY
SOIL
OF
CYPRESS
CREEK
CANAL
OCEAN
RIVER
CANAL
MIDDLE
26°10'
R 43 E
inset, sheet 14
FT. LAUDERDALE
NEW
RIVER
CANAL
Hacienda Village
ATLANTIC
inset, sheet 24
Hollywood
26°00'
COUNTY
inset, sheet 35
R 42 E
inset, sheet 34

INDEX
BR
E.

SOIL LEGEND

SYMBOL	NAME
Ae	Arents-Urban land complex
Ao	Arents, organic substratum-Urban land complex
Be	Basinger fine sand
Bc	Boca fine sand
Be	Beaches
Ce	Canaveral-Urban land complex
De	Dania muck
Dd	Dad fine sand
Df	Duette-Urban land complex
Du	Dade-Urban land complex
Ha	Hallandale fine sand
Hb	Hallandale-Urban land complex
Hm	Hallandale and Margate soils
Ia	Immokalee fine sand
Ir	Immokalee, limestone substratum-Urban land complex
Iu	Immokalee-Urban land complex
La	Lauderhill muck
Ma	Margate fine sand
Mu	Margate-Urban land complex
Ok	Okeelanta muck
Pa	Paola fine sand
Pb	Paola-Urban land complex
Pc	Palm Beach sand
Pe	Pennsuco silty clay loam
Pf	Pennsuco silty clay loam, tidal
Pm	Plantation muck
Po	Pomello fine sand
Pp	Pompano fine sand
Ps	Perrine silty clay loam
Pu	Palm Beach-Urban land complex
Pv	Perrine Variant silt loam
Se	Sanibel muck
St	St. Lucie fine sand
Tc	Terra Ceia muck, tidal
Ud	Udorthents
Um	Udorthents, marly substratum-Urban land complex
Un	Udorthents, shaped
Uo	Udorthents-Urban land complex
Ur	Urban land

CU

BOUNDA

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Minor c

Reserva state and

Land gr

Limit o

Field sh

AD HOC B

Small a cem

STATE CO

LAND DIV (section

ROADS

Divided if sca

Other r

Trail

ROAD EM

Interstat

Federal

State

County

RAILROA

POWER T (normal

PIPE LINE (normal

FENCE (normal

LEVEES

Without

With ro

With ra

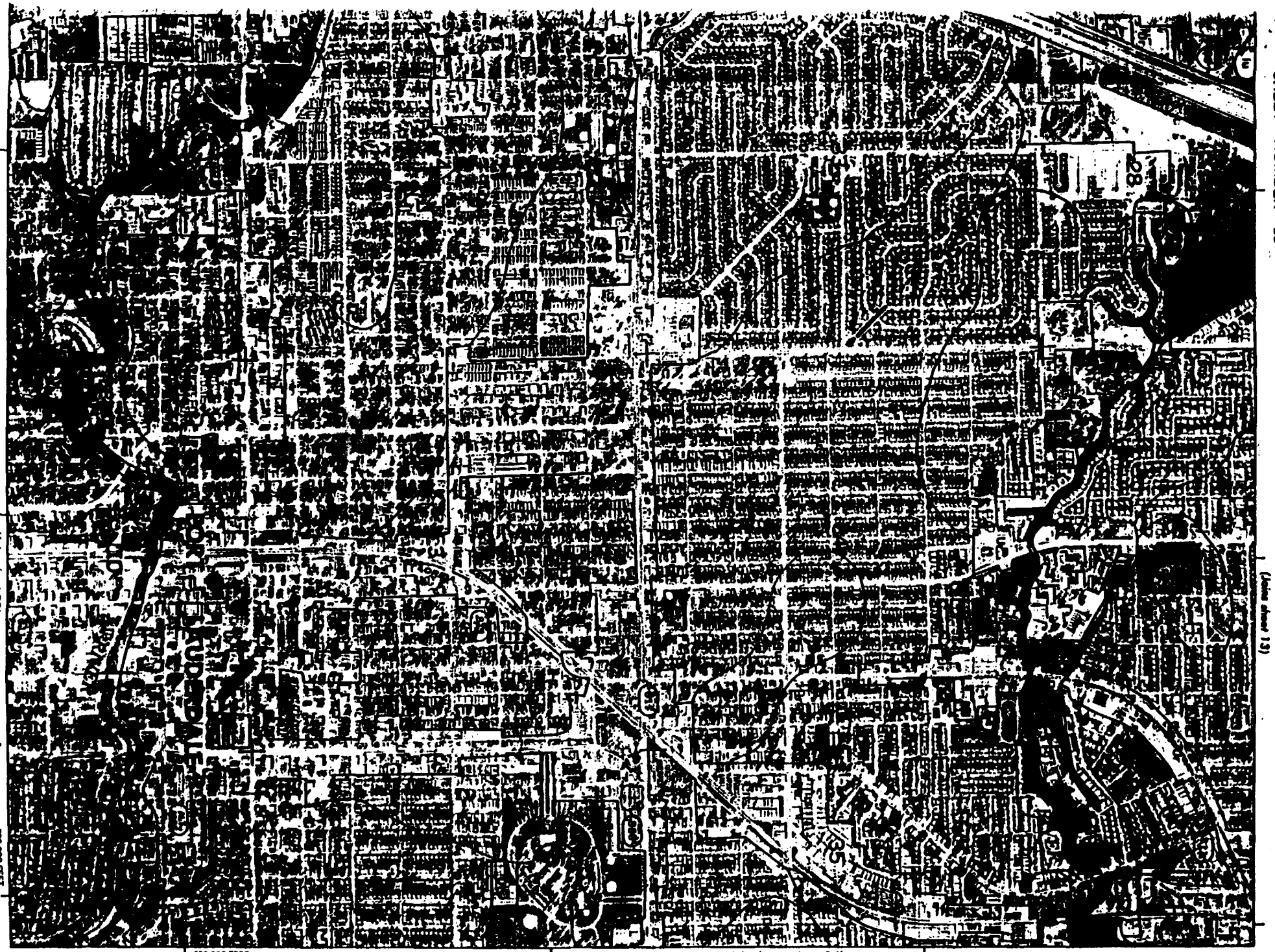
DAMS

Large (

Medium

PITS

Mine or


(Joins sheet 23)
(Joins sheet 19)
785 000 FEET
650 000 FEET
(Joins inset, sheet 14)
5000 4000 3000 2000 1000 0 5000 Feet
1 .5 0 1 Kilometer
Scale - 1:20000
N
19

Ft. Lauderdale Gasification Plant

Reference 19

A = ACTIVE
I = INACTIVE

```
PWS014 260733 300902 02 _      DRINKING WATER PROGRAM                    12/04/89
                          LATITUDE/LONGITUDE RANGE LOOK UP               15:21:18

 TYPE DISPLAYED: PLANT, SOURCE AND WELL
 LATITUDE LONGITUDE  PWS-ID PLT SRC WELL MAILING NAME                    ST/TP/RB

 26:06:00 80:07:10  4061603  01          PORT  EVERGLADES AUTHORITY      A  P  D
 26:07:00 80:02:00  4500351  02 001 0001 DELRAY BEACH WATER DEPARTMENT   A  C  D  ← NOT IN 4 mile radius
 26:07:00 80:03:00  4500351  01 001 0001 DELRAY BEACH WATER DEPARTMENT   A  C  D
 26:07:00 80:03:00  4500351  02          DELRAY BEACH WATER DEPARTMENT   A  C  D
 26:07:00 80:08:00  4500351  02 001      DELRAY BEACH WATER DEPARTMENT   A  C  D
 26:07:00 80:03:00  4500351  01          DELRAY BEACH WATER DEPARTMENT   A  C  D
```

```
 MORE DATA ON FILE? NO                 SCREEN ACTION _
PWS014 260733 300902 03 _      DRINKING WATER PROGRAM                    12/04/89
                          LATITUDE/LONGITUDE RANGE LOOK UP               15:21:58

 TYPE DISPLAYED: PLANT, SOURCE AND WELL
 LATITUDE LONGITUDE  PWS-ID PLT SRC WELL MAILING NAME                    ST/TP/RB

 26:05:35 80:12:02  4061444  01 001      TEXACO SERVICE STATION          I  N  D
 26:05:35 80:12:02  4061444  01          TEXACO SERVICE STATION          I  N  D
 26:06:00 80:07:10  4061603  01          PORT  EVERGLADES AUTHORITY      A  P  D
 26:06:15 80:12:00  4061925  01 001      FORT LAUDERDALE, CITY OF        A  C  D  — NOT WITHIN 4 miles
 26:07:00 80:03:00  4500351  02 001 0001 DELRAY BEACH WATER DEPARTMENT   A  C  D
 26:07:00 80:08:00  4500351  01 001 0001 DELRAY BEACH WATER DEPARTMENT   A  C  D
 26:07:00 80:08:00  4500351  02          DELRAY BEACH WATER DEPARTMENT   A  C  D
 26:07:00 80:03:00  4500351  02 001      DELRAY BEACH WATER DEPARTMENT   A  C  D
 26:07:00 80:08:00  4500351  01          DELRAY BEACH WATER DEPARTMENT   A  C  D
 26:10:00 80:10:00  4060163  01 001 0001 BROWARD CO - 1B                 A  C  D  —  "      "      "
 26:10:00 80:10:00  4060163  01 001      BROWARD CO - 1B                 A  C  D

 MORE DATA ON FILE? NO                 SCREEN ACTION _
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```
PWS002 4061603                DRINKING WATER PROGRAM                        12/04/89
                       SYSTEM INVENTORY INFORMATION PART 2                  15:23:43
                                                          LAST UPDATED: 12/21/88
MAILING NAME: PORT  EVERGLADES AUTHORITY            ACTIVE      NONTRANS NONC

 RET POP SERVED: ____3,937              BACT SAMPLES REQ'D: __4
     DESIGN CAP: ____6,444,000 (GPD)    RADS SAMPLES REQ'D: ___
    MAXIMUM DAY: ____1,369,000 (GPD)    RADS SAMPLES FREQY: ____  (MONTHS)
   % DESIGN CAP:  21.2                  TTHM SAMPLES REQ'D: ___
 AVG PRODUCTION:        916,000 (GPD)  TTHM SAMPLES FREQY: _____ (MONTHS)
   MAXIMUM/HOUR: _____________ (G)     SERVICE CONNECTIONS: ______125
TOT STORAGE CAP: _____________ (G)          NUMBER METERED: ______125
      METER CAP: ____________________        TYPE OF METER: ____________________
                                         CONSEC INDIC: 3 = BACTERIA MONITORING
SERVICE AREA CHARACTERISTICS:

  PRIMARY: RO = RETAIL/GENERAL MERCH          TOTAL # OF PLANTS:     1
SECONDARY: MA = MARINA                       TOTAL # OF SOURCES:     1

    PRIMARY PLANT:   1  LATITUDE: 26:06:00   LONGITUDE: 80:07:10
   PRIMARY SOURCE:   1  LATITUDE: 26:10:35   LONGITUDE: 80:09:36

                                  SCREEN ACTION _
PWS001 4061603                DRINKING WATER PROGRAM                        12/04/89
                       SYSTEM INVENTORY INFORMATION PART 1                  15:24:07
                                                          LAST UPDATED: 12/21/88

  STATUS: A = ACTIVE                RE-ACTIVATION DT: __/ __/ __
BEGIN DT: 02/ 76 INACT DT: __/ __/ __ INACT REASON: _ = ........................
PWS TYPE: P = NONTRANS NONC CATG./CLASS: 5D REG BY: D (D=DER OR H=HRS)
NC SEASON BEG: 01/ 01 END: 12/ 31    NUCLEAR FACIL: _ (REACTOR, WASTE OR OTHER)

MAILING NAME: PORT__EVERGLADES_AUTHORITY____   GENERAL MAIL: Y (Y OR N)
     ADDRESS: P.O._BOX_13136_________________  PHONE: ( 305 ) 523 - 3404
        CITY: PORT_EVERGLADES_____ STATE: FL   ZIP CODE: 33316 - ____

  OWNER NAME: PORT_EVERGLADES_AUTHORITY_____   GENERAL MAIL: Y (Y OR N)
     ADDRESS: P.O.BOX_13136_________________   PHONE: ( 305 ) 523 - 3404
        CITY: PORT_EVERGLADES_____ STATE: FL   ZIP CODE: 33316 - ____
  OWNER TYPE: M = MUNICIPALITY

DATE OF VISIT: __/ __/ __ CLASS: __ PRIOR VISIT: __/ __/ __ PRIOR CLASS: __
PERSON CONTACTED: ROBERT_P._CLAPP,_DIR._OF_ENG._  TITLE: ____________________
CONTACT PHONE: ( 305 ) 523 - 3404        SANITARY SURVEY: __/ __/ __
CREATE HISTORY OF MAILING/OWNER ? _
                                  SCREEN ACTION _
PWS004 4061603 01 001         DRINKING WATER PROGRAM                        12/04/89
                                SOURCE INFORMATION                          15:24:36
                                                          LAST UPDATED: 06/27/84

MAILING NAME: PORT  EVERGLADES AUTHORITY       ACTIVE      NONTRANS NONC
  PLANT NAME: PORT EVERGLADES AUTHORITY        ACTIVE      PLANT NUMBER:  1
          SOURCE NAME: FT._LAUDERDALE_FIVEASH_PLANT__
        SOURCE NUMBER: 001            SOURCE STATUS: A = ACTIVE
            LATITUDE: 26 : 10 : 35      LONGITUDE: 80 : 09 : 36
```

```
ANN %                SOURCE TYPE: P = PURCHASED
     GROUND,    NUMBER OF WELLS: ___

     SURFACE,   IDENTIFY SOURCE: ____________________________

 100 PURCHASED GROUND,   PWS ID: 4060486 _ NAME: FORT LAUDERDALE, CITY OF

 ___ PURCHASED SURFACE,  PWS ID: _______ _ NAME: ..............................

  LAST RECORD DISPLAYED                SCREEN ACTION: _
PWS002 4500351                DRINKING WATER PROGRAM                        12/04/89
                        SYSTEM INVENTORY INFORMATION PART 2                  15:25:04
                                                          LAST UPDATED: 12/04/89
MAILING NAME: DELRAY BEACH WATER DEPARTMENT          ACTIVE       COMMUNITY

 RET POP SERVED: ___44,271                BACT SAMPLES REQ'D: _50
     DESIGN CAP: ___20,400,000 (GPD)      RADS SAMPLES REQ'D: __1
    MAXIMUM DAY: ___16,298,000 (GPD)      RADS SAMPLES FREQY: __48  (MONTHS)
   % DESIGN CAP:  79.8                    TTHM SAMPLES REQ'D: __4
 AVG PRODUCTION:    12,000,000 (GPD)      TTHM SAMPLES FREQY: ___90 (MONTHS)
   MAXIMUM/HOUR: _____________ (G)       SERVICE CONNECTIONS: ___17,000
TOT STORAGE CAP: ____6,125,001 (G)            NUMBER METERED: ___17,000
      METER CAP: ____________________          TYPE OF METER: ____________________
                                            CONSEC INDIC: 0 = NOT CONSECUTIVE
SERVICE AREA CHARACTERISTICS:

  PRIMARY: MC = MUNICIPAL/CITY                  TOTAL # OF PLANTS:     2
SECONDARY: __ = ........................       TOTAL # OF SOURCES:     2

    PRIMARY PLANT:   1  LATITUDE:_26:07:00   LONGITUDE: 80:08:00
   PRIMARY SOURCE:   1  LATITUDE: 26:27:00   LONGITUDE: 80:05:30

                                    SCREEN ACTION  _
PWS001 4500351                DRINKING WATER PROGRAM                        12/04/89
                        SYSTEM INVENTORY INFORMATION PART 1                  15:25:28
                                                          LAST UPDATED: 12/04/89

  STATUS: A = ACTIVE                RE-ACTIVATION DT: __/ __/ __
BEGIN DT: 02/ 78 INACT DT: __/ __/ __ INACT REASON: _ = ........................
PWS TYPE: C = COMMUNITY     CATG./CLASS: 1A REG BY: D (D=DER OR H=HRS)
NC SEASON BEG: 01/ 01 END: 12/ 31    NUCLEAR FACIL: _ (REACTOR, WASTE OR OTHER)

MAILING NAME: DELRAY_BEACH_WATER_DEPARTMENT_   GENERAL MAIL: Y (Y OR N)
     ADDRESS: 100_N.W._1_AVENUE_____________   PHONE: ( 407 ) 276 - 7317
        CITY: DELRAY_BEACH________ STATE: FL   ZIP CODE: 33444 - ____

  OWNER NAME: ROBERT_PONTEK,_UTIL._DIRECTOR_   GENERAL MAIL: Y (Y OR N)
     ADDRESS: 200_S.W._6_STREET_____________   PHONE: ( 407 ) 276 - 4911
        CITY: DELRAY_BEACH________ STATE: FL   ZIP CODE: 33444 - ____
  OWNER TYPE: M = MUNICIPALITY

DATE OF VISIT: 09/ 27/ 89 CLASS: 01 PRIOR VISIT: 11/ 08/ 88 PRIOR CLASS: 01
PERSON CONTACTED: CAL_JONHSON____________________  TITLE: PLANT_MANAGER_______
CONTACT PHONE: ( 407 ) 278 - 2841        SANITARY SURVEY: 11/ 08/ 88
CREATE HISTORY OF MAILING/OWNER ? _
                                    SCREEN ACTION  _
PWS002 4061925                DRINKING WATER PROGRAM                        12/04/89
                        SYSTEM INVENTORY INFORMATION PART 2                  15:26:37
                                                          LAST UPDATED: 12/29/88
MAILING NAME: DAVIE (HACIENDA VILLAGE)               ACTIVE       COMMUNITY

 RET POP SERVED: ______120                BACT SAMPLES REQ'D: __2
     DESIGN CAP: _____________ (GPD)      RADS SAMPLES REQ'D: ___
```

```
   MAXIMUM/HOUR: ____________ (G)      SERVICE CONNECTIONS: ______110
 TOT STORAGE CAP: ____________ (G)          NUMBER METERED: _________
       METER CAP: ____________________        TYPE OF METER: ____________________
                                          CONSEC INDIC: 3 = BACTERIA MONITORING
SERVICE AREA CHARACTERISTICS:

  PRIMARY: SD = SUBDIVISION                    TOTAL # OF PLANTS:     1
SECONDARY: RO = RETAIL/GENERAL MERCH          TOTAL # OF SOURCES:     1

    PRIMARY PLANT:   1  LATITUDE: 26:10:35   LONGITUDE: 80:09:36
   PRIMARY SOURCE:   1  LATITUDE: 26:06:15   LONGITUDE: 80:12:00

                                  SCREEN ACTION  ___  TRANSMIT HERE ==> _
PWS001 4061925              DRINKING WATER PROGRAM                      12/04/89
                      SYSTEM INVENTORY INFORMATION PART 1                15:27:03
                                                        LAST UPDATED: 12/29/88

  STATUS: A = ACTIVE                RE-ACTIVATION DT: __/ __/ __
BEGIN DT: 02/ 78 INACT DT: __/ __/ __ INACT REASON: _ = ........................
PWS TYPE: C = COMMUNITY     CATG./CLASS: 4D REG BY: D (D=DER OR H=HRS)
NC SEASON BEGS __/ __ END: __/ __     NUCLEAR FACIL: _ (REACTOR, WASTE OR OTHER)

MAILING NAME: DAVIE_(HACIENDA_VILLAGE)______    GENERAL MAIL: Y (Y OR N)
     ADDRESS: 6591_SW_45TH_STREET___________    PHONE: ( 305 ) 584 - 0576
        CITY: DAVIE_______________ STATE: FL    ZIP CODE: 33314 - ____

  OWNER NAME: TOWN_OF_DAVIE_________________    GENERAL MAIL: Y (Y OR N)
     ADDRESS: 6591_SW_45TH_STREET___________    PHONE: ( 305 ) 584 - 0576
        CITY: DAVIE_______________ STATE: FL    ZIP CODE: 33314 - ____
  OWNER TYPE: M = MUNICIPALITY

DATE OF VISIT: __/ __/ __ CLASS: __ PRIOR VISIT: __/ __/ __ PRIOR CLASS: __
PERSON CONTACTED: ____________________________ TITLE: ____________________
CONTACT PHONE: ( 305 ) 584 - 0576       SANITARY SURVEY: __/ __/ __
CREATE HISTORY OF MAILING/OWNER ? _
                                  SCREEN ACTION  _
PWS004 4061925 01 001         DRINKING WATER PROGRAM                      12/04/89
                                SOURCE INFORMATION                        15:27:30
                                                        LAST UPDATED: 07/25/89

MAILING NAME: DAVIE (HACIENDA VILLAGE)          ACTIVE     COMMUNITY
  PLANT NAME: DAVIE (HACIENDA VILLAGE)          ACTIVE     PLANT NUMBER:  1
          SOURCE NAME: DAVIE(HACIENDA)/PEELE/DIXIE___
        SOURCE NUMBER: 001            SOURCE STATUS: A = ACTIVE
            LATITUDE: 26 : 06 : 15      LONGITUDE: 80 : 12 : 00

   SOURCE AVAILABILITY: P = PERMANENT
 SOURCE AVG PRODUCTION: ___12,000,000 (GPD)          % OF SYSTEM PRODUCTION: 100

ANN %                SOURCE TYPE: P = PURCHASED
     GROUND,    NUMBER OF WELLS: ___

     SURFACE,   IDENTIFY SOURCE: ____________________________

 100 PURCHASED GROUND,   PWS ID: 4060436 _ NAME: FORT LAUDERDALE, CITY OF

 ___ PURCHASED SURFACE,  PWS ID: _______ _ NAME: ..............................

  LAST RECORD DISPLAYED                SCREEN ACTION: _
PWS002 4060168              DRINKING WATER PROGRAM                      12/04/89
                      SYSTEM INVENTORY INFORMATION PART 2                15:27:53
                                                        LAST UPDATED: 09/08/89
MAILING NAME: BROWARD CO - 18                      ACTIVE      COMMUNITY
```

```
   MAXIMUM DAY: ____2,400,000 (GPD)     RADS SAMPLES FREQY: __48  (MONTHS)
  % DESIGN CAP: 120.0                   TTHM SAMPLES REQ'D: __1
 AVG PRODUCTION:       420,000 (GPD)   TTHM SAMPLES FREQY: ___90 (MONTHS)
   MAXIMUM/HOUR: ____________ (G)     SERVICE CONNECTIONS: ____4,127
TOT STORAGE CAP: ______600,000 (G)         NUMBER METERED: ____4,127
      METER CAP: ___________________         TYPE OF METER: ___________________
                                         CONSEC INDIC: U = NOT CONSECUTIVE
SERVICE AREA CHARACTERISTICS:

  PRIMARY: MC = MUNICIPAL/CITY                 TOTAL # OF PLANTS:     1
SECONDARY: __ = ......................       TOTAL # OF SOURCES:     1

    PRIMARY PLANT:   1  LATITUDE: __:__:__   LONGITUDE: __:__:__
   PRIMARY SOURCE:   1  LATITUDE: 26:10:00   LONGITUDE: 80:10:00

                                  SCREEN ACTION _
PWS001 4060168              DRINKING WATER PROGRAM                      12/04/89
                     SYSTEM INVENTORY INFORMATION PART 1                15:28:18
                                                     LAST UPDATED: 09/08/89

  STATUS: A = ACTIVE                RE-ACTIVATION DT: __/ __/ __
BEGIN DT: 02/ 78 INACT DT: __/ __/ __ INACT REASON: _ = ......................
PWS TYPE: C = COMMUNITY     CATG./CLASS: 1B REG BY: D (D=DER OR H=HRS)
NC SEASON BEG: __/ __ END: __/ __     NUCLEAR FACIL: _ (REACTOR, WASTE OR OTHER)

MAILING NAME: BROWARD_CO_-_1B_______________   GENERAL MAIL: Y (Y OR N)
     ADDRESS: PO_BOX_619002_________________   PHONE: ( 305 ) 772 - 8333
        CITY: POMPANO_BEACH_______ STATE: FL   ZIP CODE: 33061 - 9002

  OWNER NAME: BROWARD_CO_ENVIRONMENTAL_SVCS_   GENERAL MAIL: Y (Y OR N)
     ADDRESS: 300_N.W._66_STREET____________   PHONE: ( 305 ) 971 - 6220
        CITY: FT._LAUDERDALE______ STATE: FL   ZIP CODE: 33301 - ____
  OWNER TYPE: M = MUNICIPALITY

DATE OF VISIT: 08/ 23/ 89 CLASS: 01 PRIOR VISIT: 04/ 25/ 89 PRIOR CLASS: 01
PERSON CONTACTED: MR._S.L._SPRADLING,DIRECTOR___   TITLE: ___________________
CONTACT PHONE: ( 305 ) 971 - 6220       SANITARY SURVEY: 07/ 20/ 87
CREATE HISTORY OF MAILING/OWNER ? _
                                  SCREEN ACTION _
PWS004 4060168 01 001       DRINKING WATER PROGRAM                      12/04/89
                              SOURCE INFORMATION                        15:29:34
                                                     LAST UPDATED: 08/25/88

MAILING NAME: BROWARD CO - 1B                  ACTIVE     COMMUNITY
  PLANT NAME: BROWARD CO - 1B                  ACTIVE     PLANT NUMBER:  1
        SOURCE NAME: BROWARD_CO_-_1B_WELLFIELD_____
      SOURCE NUMBER: 001            SOURCE STATUS: A = ACTIVE
          LATITUDE: 26 : 10 : 00      LONGITUDE: 80 : 10 : 00

   SOURCE AVAILABILITY: P = PERMANENT
 SOURCE AVG PRODUCTION: ______420,000 (GPD)         % OF SYSTEM PRODUCTION: 100

ANN %                SOURCE TYPE: G = GROUND
 100 GROUND,     NUMBER OF WELLS: __7

     SURFACE,    IDENTIFY SOURCE: ____________________________

  ___ PURCHASED GROUND,   PWS ID: _______ _ NAME: ..........................

  ___ PURCHASED SURFACE,  PWS ID: _______ _ NAME: ..........................

   LAST RECORD DISPLAYED                SCREEN ACTION: _
```

Reference 20

CITY OF
FORT LAUDERDALE
FLORIDA

P. O. DRAWER 14250 · 33302

June 29, 1987

Mr. Jim McCarthy
State of Florida
Department of Environmental
Regulation
Bureau of Operations
2600 Blair Stone Road
Tallahassee, FL 32301

REF: PROJECT 8343 - Groundwater Studies and Water Use Permit

Dear Mr. McCarthy:

I am enclosing, at your request, one copy of drawing file #4-95-16 sheet 1, and #4-78-46 sheets 1 and 4, that show the location of the City's Raw Water Supply Wells at the Fiveash and Peele/Dixie Wellfields.

Sincerely,

CITY OF FORT LAUDERDALE

Henry Hattem

Henry Hattem, P.E.
Engineer III

HH/8225u

Enclosure

cc: A. J. Dilione, P.E., Acting City Engineer
F. Coulter, P.E., Deputy Utilities Director
C. Petrone, Fiveash Treatment Plant Supervisor

RECEIVED
JUL 1 1987
BUREAU OF
OPERATIONS

CONVERSATION RECORD

To:	File	File Name:	Broward County Wells
From:	Brian M. Moore	Contact Person:	Mr. Carl Sholenburger
Date:	6/31/88	Phone No.:	(305) 492-7845
Time:	11:30 A.M.	Subject:	Executive Prospect Wellfields

Status as of 12/87 of wells in the Executive Ft. Lauderdale wellfield.

Well #1 - Offline, isolated irrigation (sprinkling)
#2 & 3 - Emergency only
#4 & 5 - Closed
#6 - Emergency only
#7 - Sprinkling at the stadium
#8,9 & 10 - Emergency only
#11 - Emergency only
#12 - Irrigation
#13 - Closed
#14 - Emergency only
#15 & 23 - Closed

All other wells through new Well #49 should be pumping.

BM/mlr

PROSPECT WELL CONSTRUCTION DETAILS

Well No.	Depth (feet)	Cased (feet)	Open Hole (feet)	Inside Diameter (inches)	Drilled (year)	Well Capacity (gpm)
2	132	120	12	10	1953	600
3	125	113	12	10	1953	600
5	125	110	15	10	1953	600
6	116	104	12	10	1953	650
7	130	118	12	10	1953	600
8	128	116	12	10	1953	600
9	125	113	12	10	1953	600
10	125	113	12	10	1953	600
11	152	133	19	12	1958	600
12	115	100	15	12	1958	600
13	94	79	15	12	1958	600
14	100	85	15	12	1958	600
15	131	116	15	12	1958	600
16	90	75	15	12	1958	600
17	125	110	15	12	1958	600
18	79	64	15	12	1959	600
19	76	61	15	12	1959	1200
20	76	61	15	12	1959	1200
21	75	60	15	12	1959	1200
22	125	110	15	12	1959	1200
23	80	68	12	12	1959	600
24	80	68	12	12	1963	600
25	150	112	38	17	1963	1200
26	144	105	39	17	1969	2100
27	120	100	20	17	1969	2100
28	103	81	22	17	1971	2100
29	116	86	30	17	1971	2100
30	109	90	19	17	1972	2100
31	100	80	20	17	1972	2100
32	103	82	21	17	1973	2100
33	101	80	21	17	1973	2100
34	90	75	15	17	1973	2100
35	96	70	16	17	1973	2100
					1974	2100

total 33

EXHIBIT 5

Both SDWA and CERCLA provide for the protection of public health by limiting exposure to hazardous and toxic materials. The SDWA was not well designed for administrative or litigative actions against sources of contamination to drinking water. Program guidance exists that allows for this type of involvement, but it is unprecedented, possibly cumbersome and probably time-consuming.

Considering the time frame associated with contaminant movement, the potential health threat to a large population, the present involvement of EPA in a related Superfund investigation (Hollingsworth), and the general structure and intent of CERCLA, it seems the most practicable means of addressing the problems that appear imminent is to provide cleanup under CERCLA. Recovery of expended funds for the necessary clean-up should come from litigation against contributing sources.

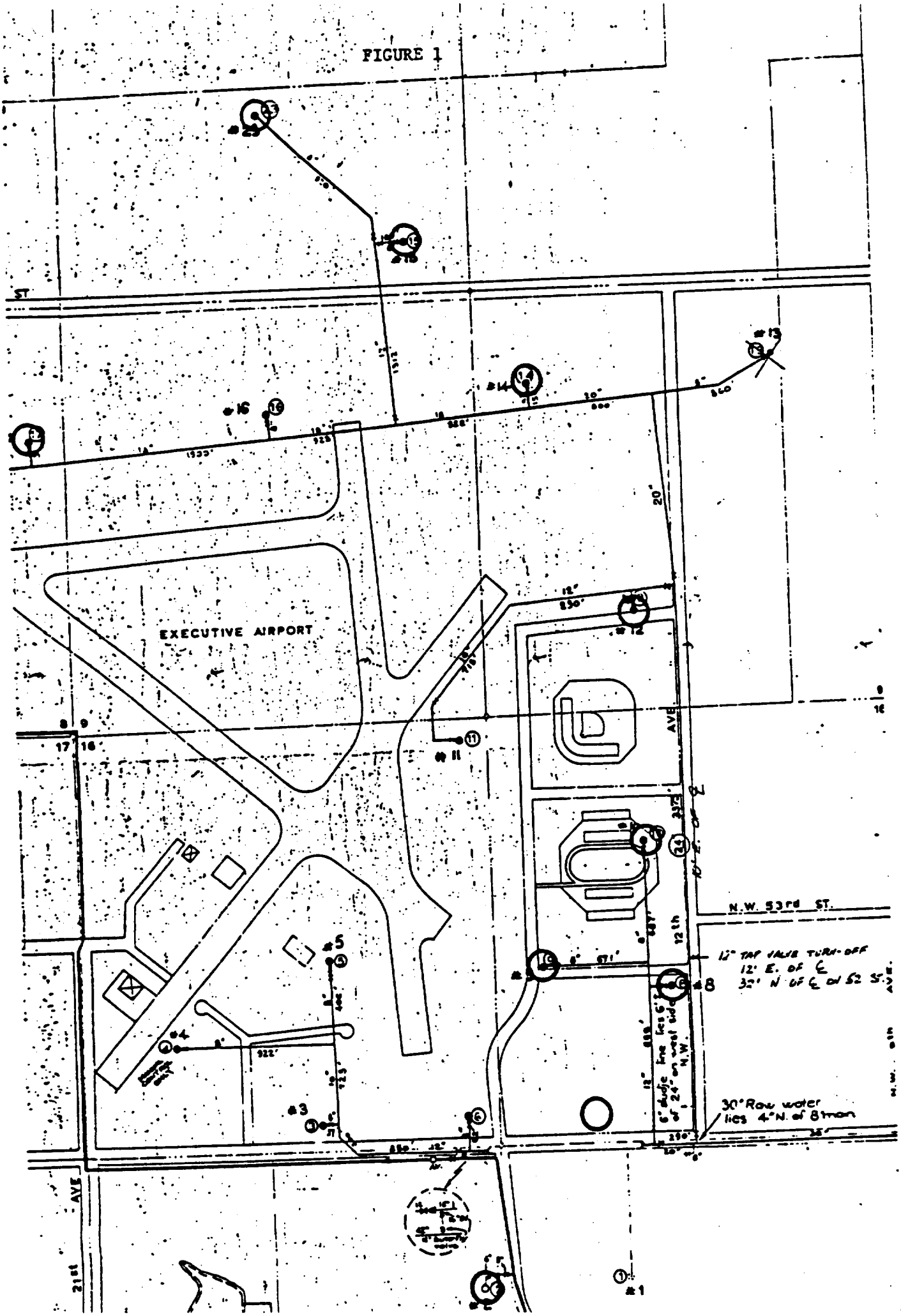
Rapid restoration of the portion of the aquifer that is contaminated would significantly reduce treatment needs for presently uncontaminated wells. Pumping and treatment at those wells that are now contaminated or those that would interupt contaminant movement would reduce treatment costs to a small percent of ultimate treatment needs.

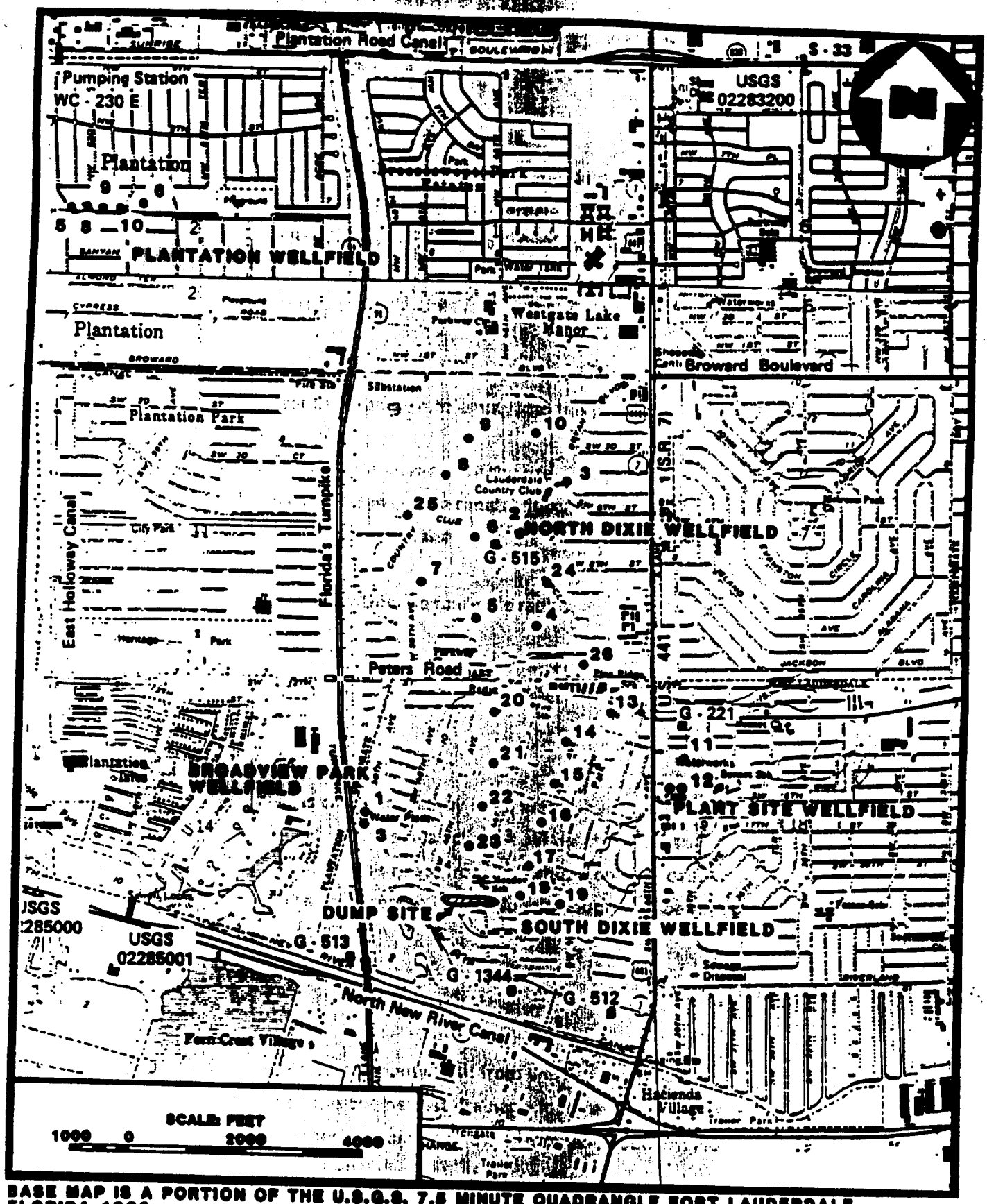
II. History of Executive - Prospect Wellfield Contamination

During the period of 1977 through 1981, the Hollingworth Solderless Terminal plant located directly east of Ft. Lauderdale's Executive wellfield is known to have disposed of trichloroethylene via a disposal well to the upper limestone portion of the Biscayne Aquifer. Discovery of this situation and the proximity of the Executive wellfield which serves as one of the two contiguous sources for the Ft. Lauderdale water supply system led to sampling and analyses of supply wells by the Florida Department of Environmental Regulation in August, 1982. The original 1982 sampling coupled with sampling since that time by consultants, EPA and the City of Ft. Lauderdale have shown results indicating elevated levels for trichloroethylene and other two-carbon chain chlorinated hydrocarbons (all within the definition of volatile synthetic organic chemicals (VOCs).

VOCs, as their name indicates, are synthetic compounds. They do not exist in nature. They are man-made for industrial purposes. Their presence in groundwater is a direct result of man-induced contamination, whether it be intentional or nonintentional. Some of the other two-carbon chain chlorinated VOCs found in the groundwater are believed to be biodegradative by-products of trichloroethylene.

FIGURE 1


EXECUTIVE AIRPORT
N.W. 53rd ST.
12th AVE
12" TAP VALVE TURN-OFF
12' E. OF ℄
32' N OF ℄ ON 52 ST.
30" Raw water
lies 4" N. of 8 man
6" sludge line lies 6' of 24" on west side
N.W.
AVE
21st
ST
#1
#3
#4
#5
#8
#11
#12
#13
#14
#16



BASE MAP IS A PORTION OF THE U.S.G.S. 7.5 MINUTE QUADRANGLE FORT LAUDERDALE, FLORIDA 1983.

WELL FIELDS LOCATION MAP
MEADOWBROOK ELEMENTARY SCHOOL DUMP
BROWARD COUNTY, FLORIDA

FIGURE 3

NUS CORPORATION

Broward Co. Utilities

Reference 21

Utilities Division
2401 N. Powerline Road
Pompano Beach, Fla. 33069
(305) 971-6220

RECEIVED
JUL 21 1987
BUREAU OF OPERATIONS

July 16, 1987

Mr. A. James McCarthy
Environmental Specialist
Bureau of Operations
Department of Environmental Regulation
2600 Blair Stone Road
Tallahassee, FL 32399-2400

Dear Mr. McCarthy:

Enclosed, please find the information you requested. I would like to clarify one point. The District 1C plant is out-of-service and will not be utilized in the future. The two wells will be abandoned in the approved manner in the very near future. The wells are on plant site and are maintained by maintenance crews on a monthly basis. The site is located on the topo maps for your information only.

The number of service connections for each facility are as follows:

District 1A	10,608
District 1B	3,366
District 2A	17,019
Broadview	2,199
District 3A	5,250
District 3B	6,037
District 3C	3,646

Should you require more information, please do not hesitate to contact me at 305-971-6220, ext. 282.

Sincerely yours,

Kathleen B. Reese

Kathleen B. Reese
Special Projects Coordinator III

KBR/tgt
cc: Michael J. Scottie
Ralph A. Piacente

BROWARD COUNTY BOARD OF COUNTY COMMISSIONERS
Scott I. Cowan Howard Craft Howard Forman Nicki Englander Grossman Ed Kennedy Sylvia Poitier Gerald Thompson
An Equal Opportunity Employer

Utility Director Edward Goscicki, P.E.
Telephone Number 305-971-6220
Number of Existing Wells 35

Permit No. _____ Number of Proposed Wells 6

Well No.	Location		Capacity Designed Pumpage (Test)	Average Pumpage	Total Depth (Feet)	Casing Depth (Feet)	Screened Interval (Feet)	Diameter (Inches)	Casing Material	Aquifer	Date Drilled (Year)	Drilling Company
	Latitude	Longitude										
1A-1	26°10'17"N	80°12'17"W	1200 (1500)	1030	100	72	Stby	12	C Steel	Biscayne	--	DRILLED IN THE 1950'S
1A-2	"	"	1150 (1500)	1080	100	70	Pump	12	"	"	--	
1A-3	"	"	1100 (1500)	1050	100	89	St By	12	"	"	--	
1A-4	"	"	1150 (1500)	1010	100	76	Pumping	12	"	"	--	
1A-5	"	"	2100 (3100)	2100	94	84	Pumping	20	"	"	1974	
1A-6	"	"	2100 (3100)	2100	200	69	Pumping	20	"	"	1982	
1A-7	"	"	2100 (3100)	2100	100	75	Pumping	20	"	"	1982	
1B-1	26°12'13"N	80°08'58"W	225	225	110	103	STANDBY PLANT	6	"	"	1957	St. By
1B-2	"	"	225	225	110	103		6	"	"	1957	St. By
1B-3	"	"	650	650	115	102		8	"	"	1964	Pumping
1B-4	"	"	650	650	115	102		8	"	"	1971	Pumping
1B-5	"	"	650	650	110	103		8	"	"	1971	Pumping
2A-1	26°17'34"N	80°06'57"W	600 (625)	600	178	--	St. By	8	"	"	--	

Utility Director Edward Goscicki, P.E.
Telephone Number 305-971-6220
Number of Existing Wells 35

Permit No. _____

Number of Proposed Wells _____

Well No.	Location		Capacity Designed Pumpage (Test)	Average Pumpage	Total Depth (Feet)	Casing Depth (Feet)	Screened Interval (Feet)	Diameter (Inches)	Casing Material	Aquifer	Date Drilled (Year)	Drilling Company
	Latitude	Longitude										
2A-2	26°17'34"N	80°06'57"W	2100 --	2100	154		Stby	12	C Steel	Biscayne	--	
2A-3	"	"	800 --	800	143	Pump	~~Stby~~	8	"	"	--	
2A-4	"	"	2100 (2100)	2100	120	107	Pump.	18	"	"	--	
2A-5	"	"	1800 (1800)	1800	142	125	St.	12	"	"	--	
2A-6	"	"	2100 (1950)	2100	133		St.	18	"	"	--	
2A-7	"	"	4200 (2100)	3000	176	156	Pumping	20	"	"	1971	
2A-8	"	"	3100 (3200)	3100	180	150	Pumping	24	"	"	1981	
2A-9	"	"	2400 (3200)	2400	155	85	Pumping	24	"	"	1981	
3A-1	26°03'40"N	80°11'54"W	545 (1175)	437	60	--		12	"	"	1956 --	St. By
3A-2	"	"	610 (700)	687	60	--		10	"	"	1956 --	Pumping
3A-3	"	"	815 (700)	1097	65	60		12	"	"	--	Pumping
3A-4	"	"	700 (1000)	847	180	40		14	"	"	1981	Pumping
3B-1	25°58'30"N	80°11'12"W	850 (850)	850	100	--		6	"	"	1953 --	St. By

Utility Director Edward Goscicki, P.E. Broward County
Telephone Number 305-971-6220
Number of Existing Wells 35

Permit No. _____ Number of Proposed Wells _____

Well No.	Location		Capacity	Average Pumpage	Total Depth (Feet)	Casing Depth (Feet)	Screened Interval (Feet)	Diameter (Inches)	Casing Material	Aquifer	Date Drilled (Year)	Drilling Company
	Latitude	Longitude	Designed Pumpage (Test)									
3B-2	25°58'30"N	80°11'12"W	930 (1000)	930	100			8	C Steel	Biscayne	1956	St. BY
3B-3	"	"	1250 (1800)	1250	130			10	"	"	1964 --	Pumping
3B-4	"	"	1800 (2100)	1800	140	102		18	"	"	1975 --	Pumping
3C-1			100 ---	100	80			4	"	"	1957 --	ABANDON
3C-2			~~350~~ ---	486 ~~280~~	57			6	"	"	1957 --	STANDBY
3C-3			~~500~~ ---	700 ~~500~~	80			10	"	"	--	Pumping
Broadview			400 ---	350	112	100		12	Black Steel	"	1957	St. BY
2			1000 ---	360	113.5	100		12	"	"	1960	Pumping
3			1050 ---	650	115	105		12	"	"	1972	Pumping
1A-8	26°10'15"N	80°12'17"W	2100		100	75		20				PROPOSED
1A-9	"	"	2100		100	75		20				"
3A-5	625038N	761471E	750		110	75		20				"
3A-6	625040N	761744E	750		110	75		20				"

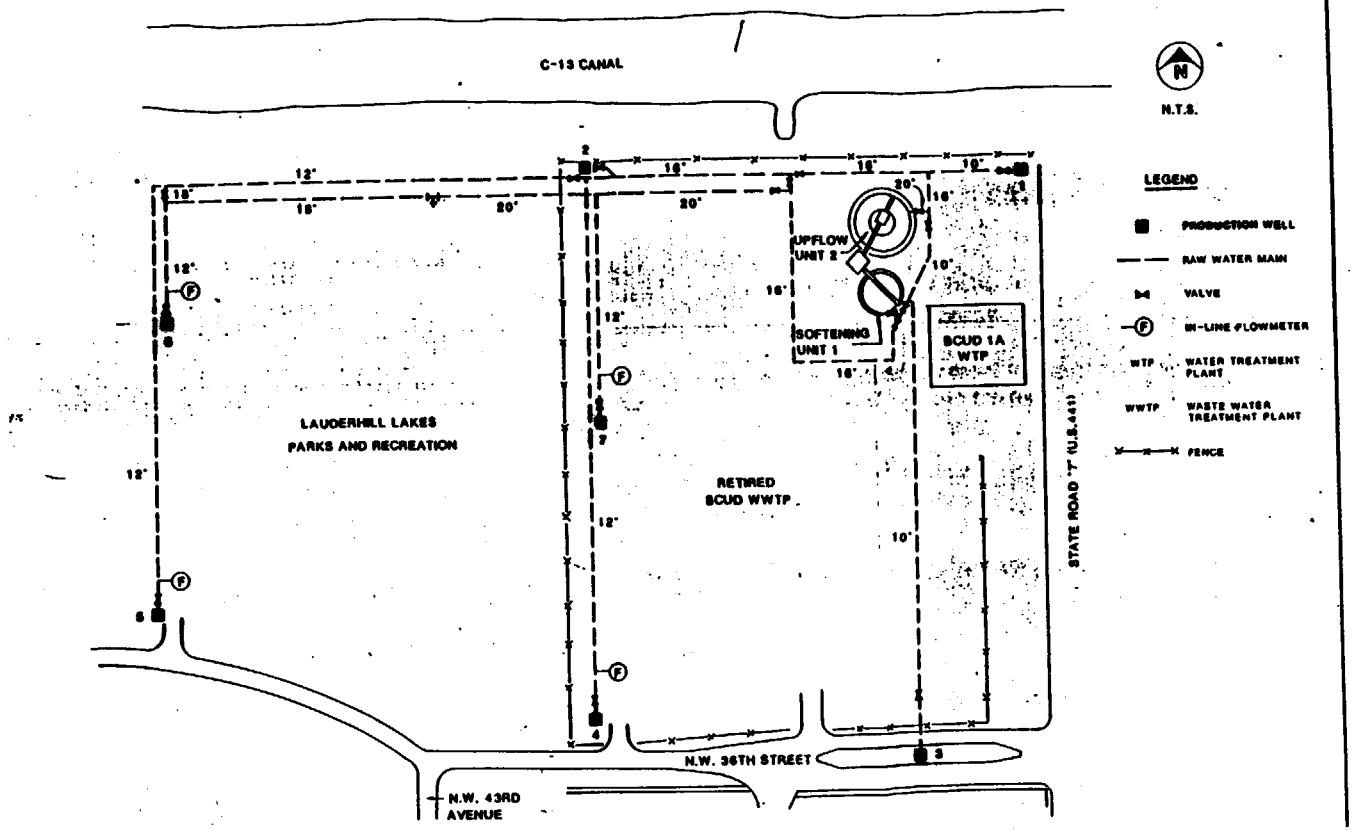
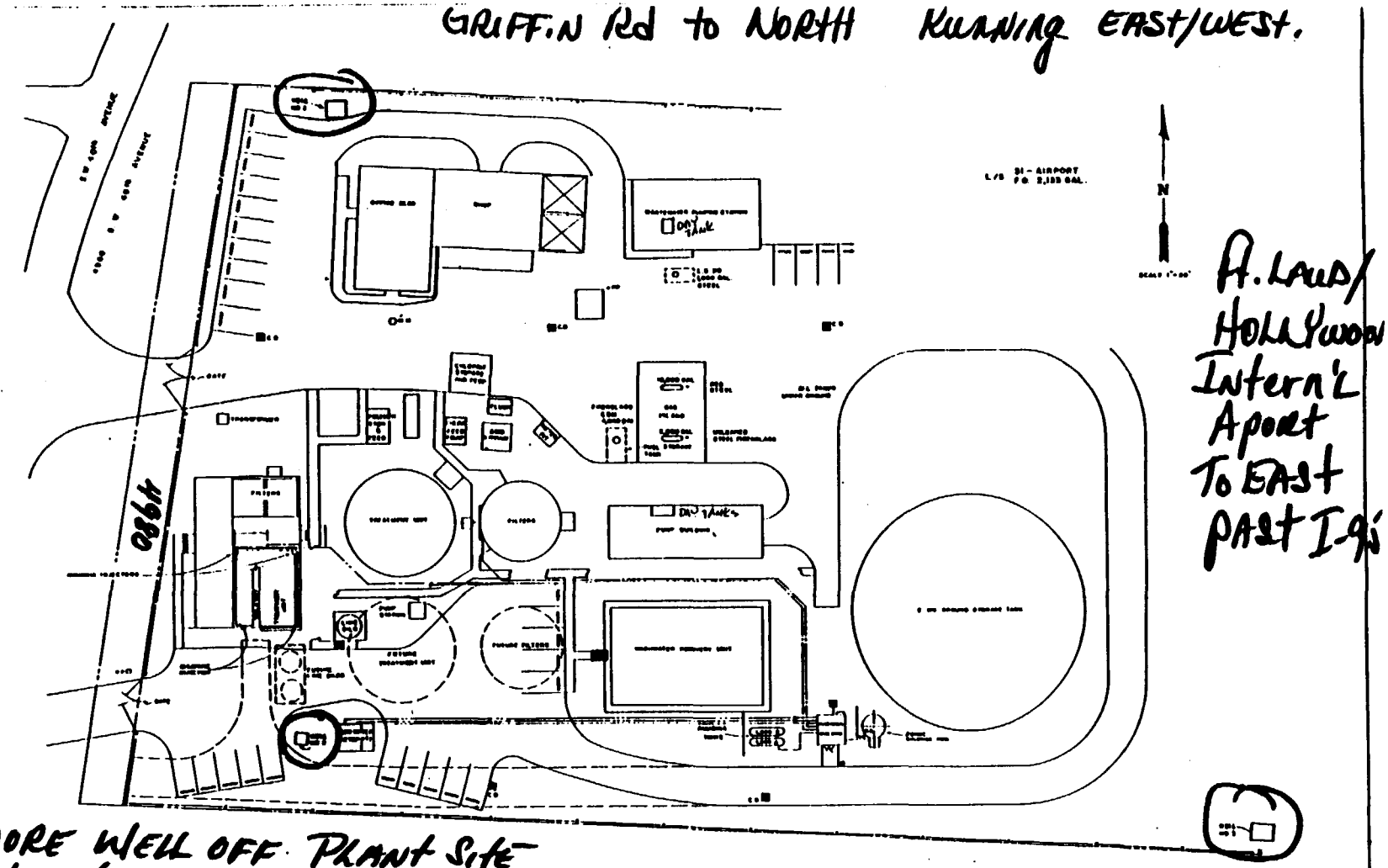


FIGURE 7-1

BCUD-1A WELLFIELD AND RAW WATER PIPING CONFIGURATION

CH2M HILL

GRIFFIN Rd to NORTH RUNNING EAST/WEST.

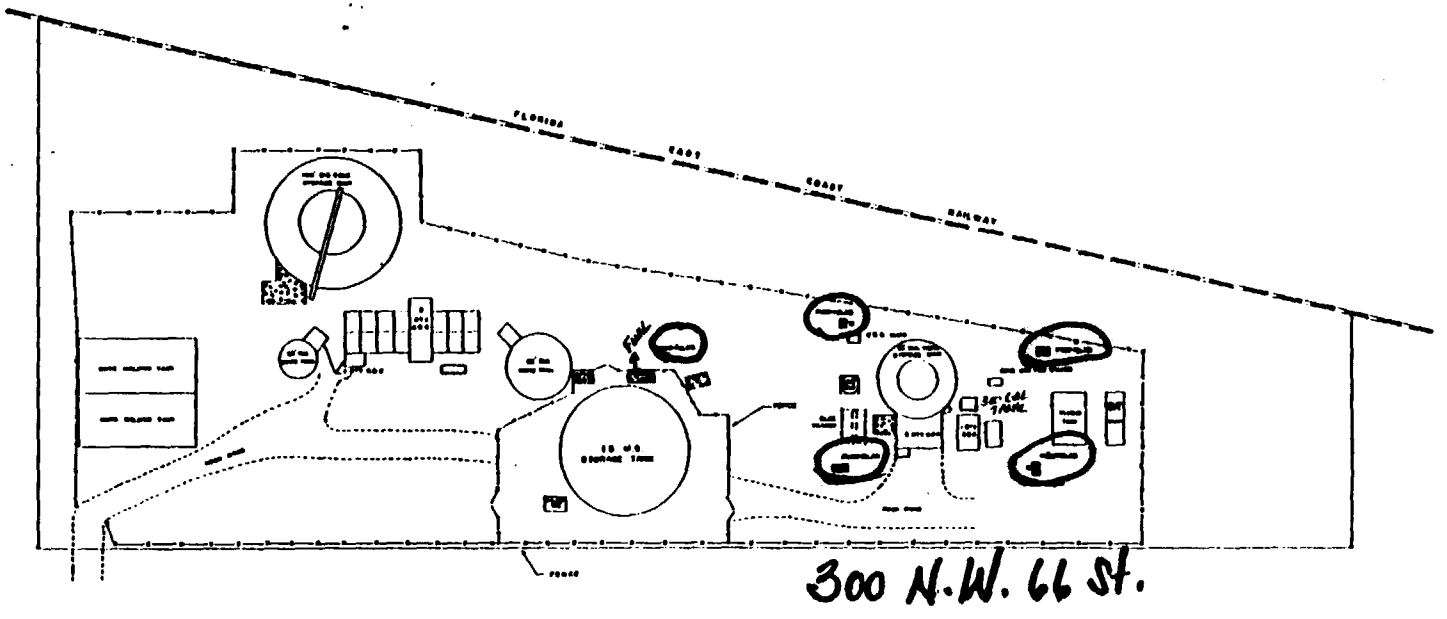


A. LAUD/
HOLLYWOOD
INTERN'L
APORT
TO EAST
PAST I-95

1 MORE WELL OFF PLANT SITE
LOCATED ON TOPO MAP
2 MORE WELLS ARE PROPOSED

BROWARD COUNTY WATER &
WASTEWATER DIVISION
DISTRICT 3 A WATER PLANT

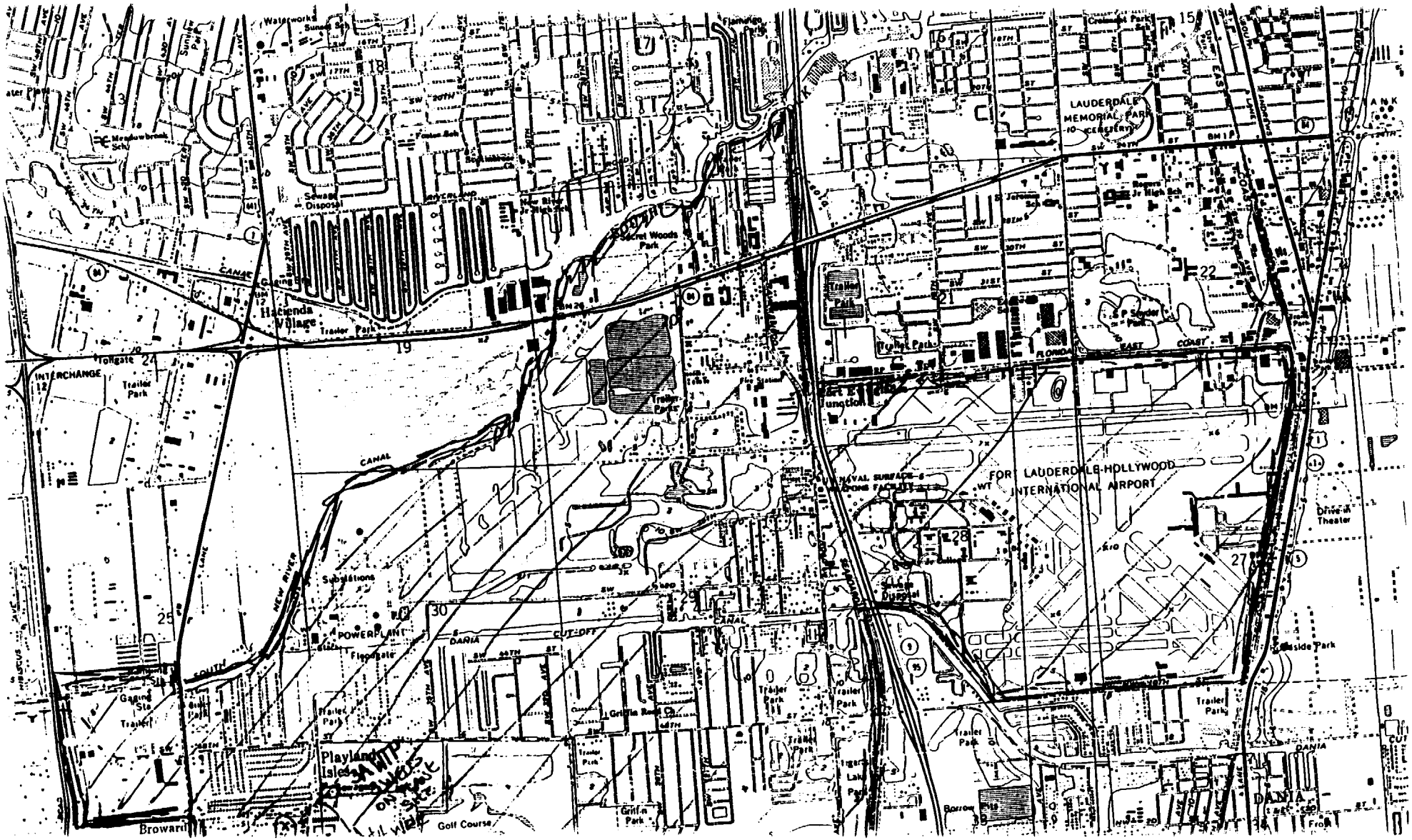
All wells on plant site



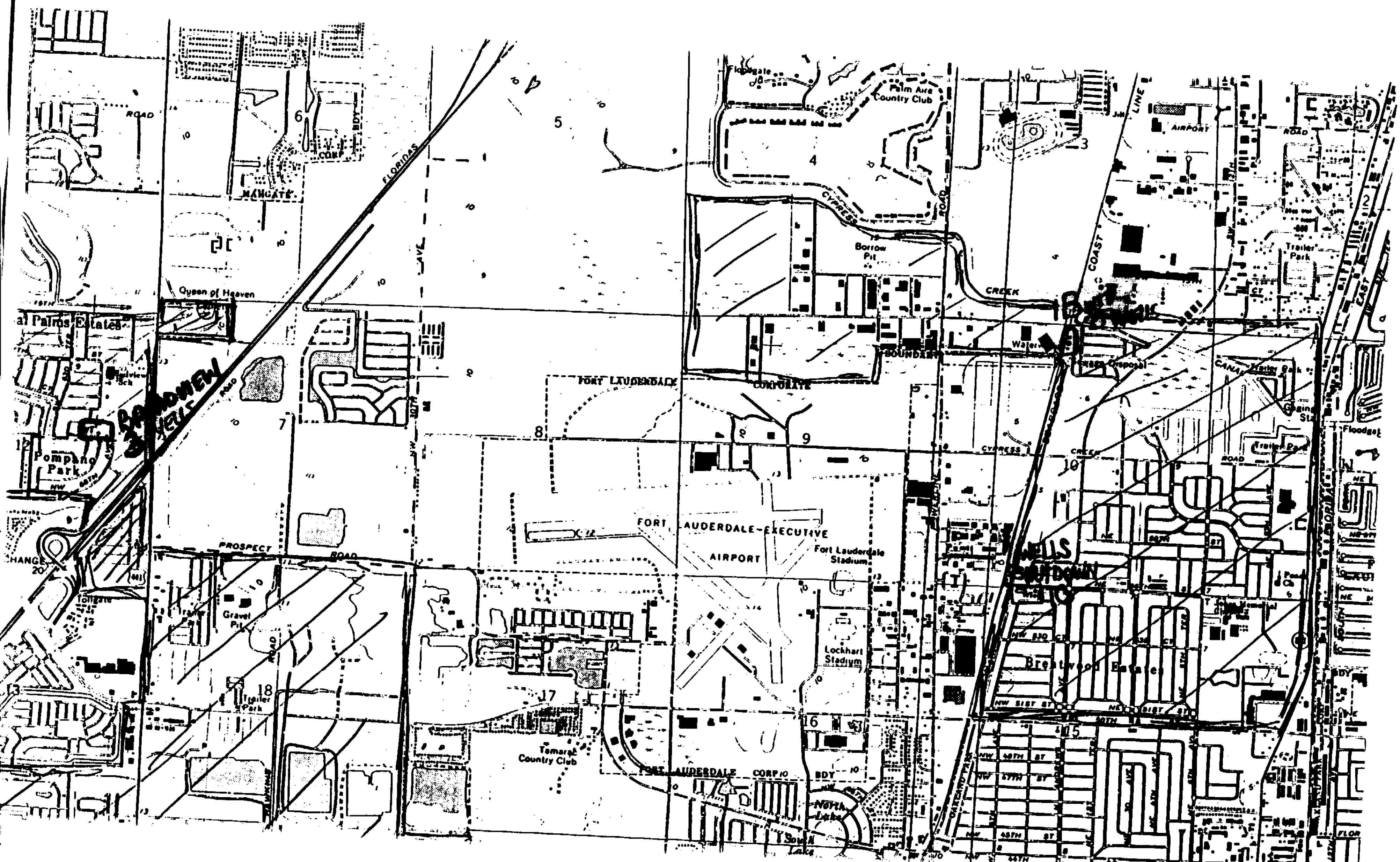
300 N.W. 66 St.

BROWARD COUNTY WATER & WASTEWATER DIVISION

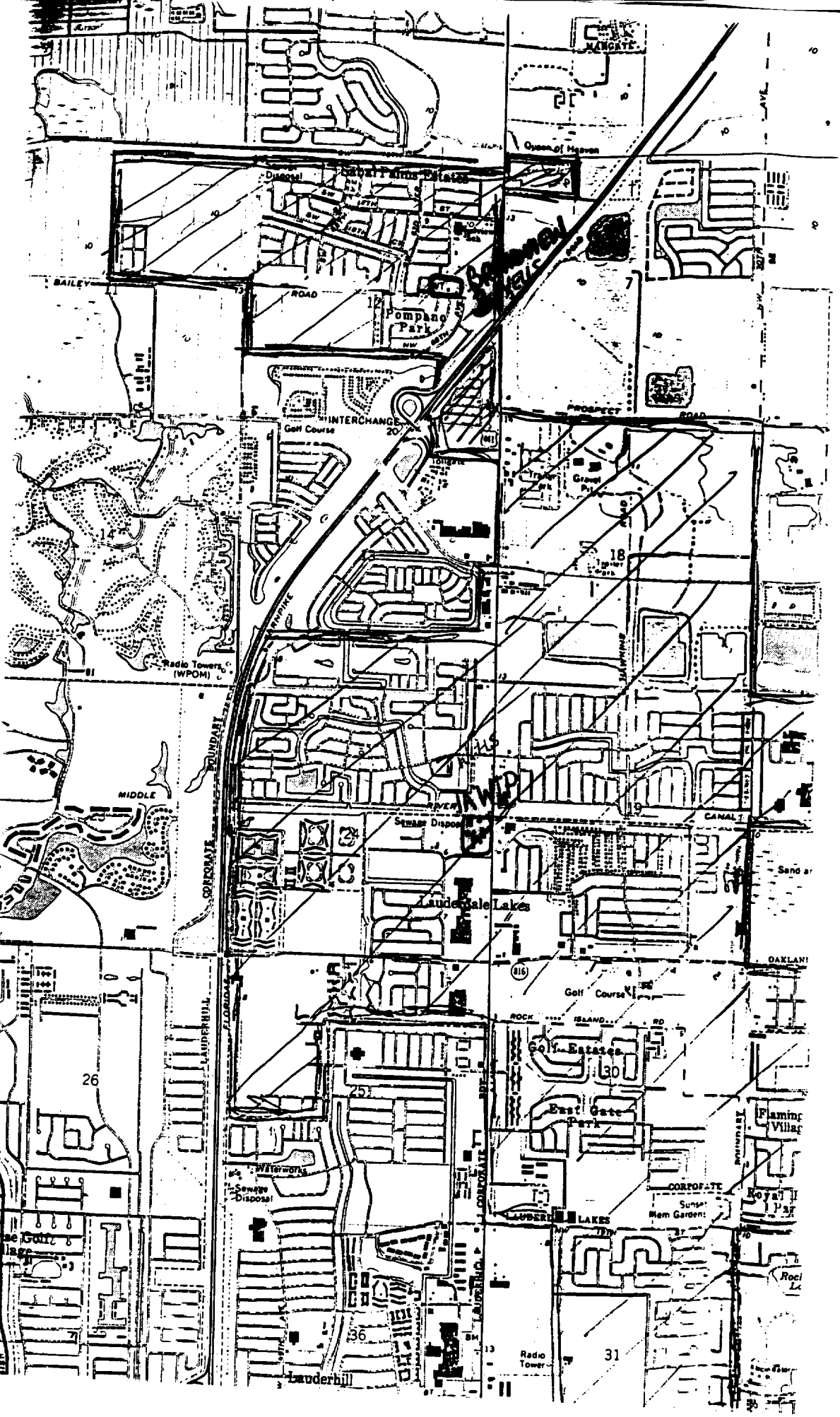
DISTRICT 1B PLANT



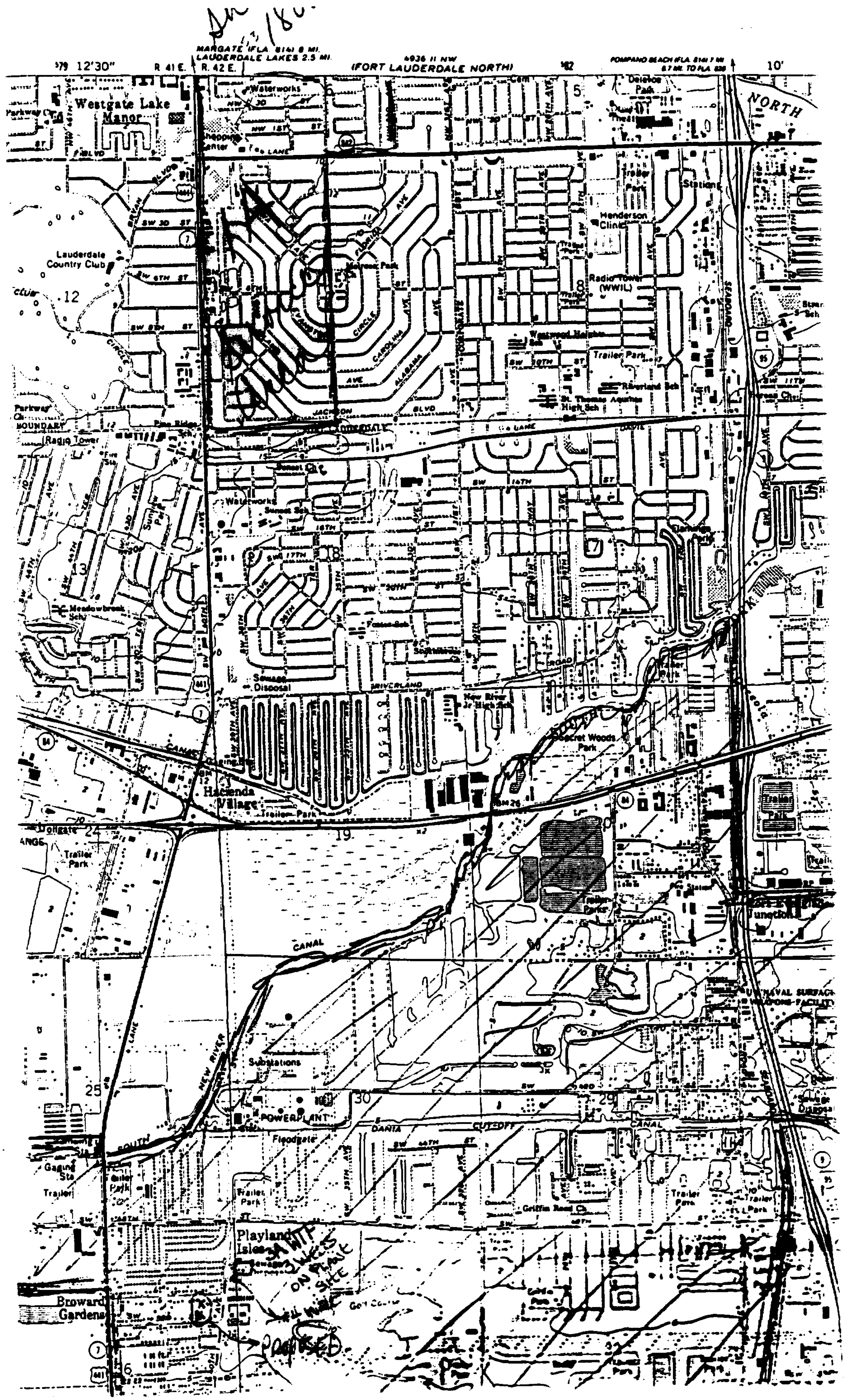
LAUDERDALE MEMORIAL PARK (CEMETERY)
Hacienda Village
Trailer Park
Secret Woods Park
Sewage Disposal
Waterworks
INTERCHANGE 12
Tollgate
CANAL
NEW RIVER
SOUTH
Substations
POWERPLANT
Floodgate
DANIA CUT-OFF
Playland Isles
Golf Course
Broward
Griffin Road Ch
Griffin Park
Trailer Park
Fort Lauderdale Junction
NAVAL SURFACE WEAPONS FACILITY
FORT LAUDERDALE-HOLLYWOOD INTERNATIONAL AIRPORT
FLORIDA EAST COAST
Drive-in Theater
Borrow Pits
DANIA



Queen of Heaven
Pompano Park
FLORIDAS
FORT LAUDERDALE
CORPORATE
BOUNDARY
CYPRESS
CREEK
ROAD
Borrow Pit
Palm Aire Country Club
Floodgate
AIRPORT
COAST LINE
Trailer Park
Sewage Disposal
PROSPECT
Gravel Pit
FORT LAUDERDALE-EXECUTIVE AIRPORT
Fort Lauderdale Stadium
Lockhart Stadium
Tamarac Country Club
North Lake
South Lake
Brentwood Estates
NW 51ST ST
CORP
BDY



Queen of Heaven
Sabal Palms Estates
Disposal
BAILEY
ROAD
Pompano Park
INTERCHANGE
Golf Course
PROSPECT
ROAD
Gravel Pit
Radio Towers (WPOM)
MIDDLE
CORPORATE
BOUNDARY
RIVER
Sewage Disposal
CANAL
Lauderdale Lakes
OAKLAND
Golf Course
ROCK ISLAND RD
Golf Estates
East Gate Park
Flaming Village
Waterworks
Sewage Disposal
CORPORATE
LAUDERHILL LAKES
Sunset Mem Gardens
Radio Tower
Lauderhill
LAUDERHILL
FLORIDA


MARGATE (FLA.) 8 MI.
LAUDERDALE LAKES 2.5 MI.
12'30"
R. 41 E.
R. 42 E.
(FORT LAUDERDALE NORTH)
10'
NORTH
Westgate Lake Manor
Waterworks
Lauderdale Country Club
Henderson Clinic
Radio Tower (WWIL)
Westwood Heights
Trailer Park
St. Thomas Aquinas High Sch
JACKSON BLVD
Radio Tower
Sunset Ch
Waterworks
Meadowbrook Sch
Sewage Disposal
New River Jr High Sch
Secret Woods Park
Hacienda Village
Trailer Park
CANAL
NEW RIVER
Substations
POWERPLANT
Floodgate
DANIA
CUT-OFF
CANAL
Griffin Road Ch
Playland Isles
Broward Gardens
Golf Course
NAVAL SURFACE WEAPONS FACILITY

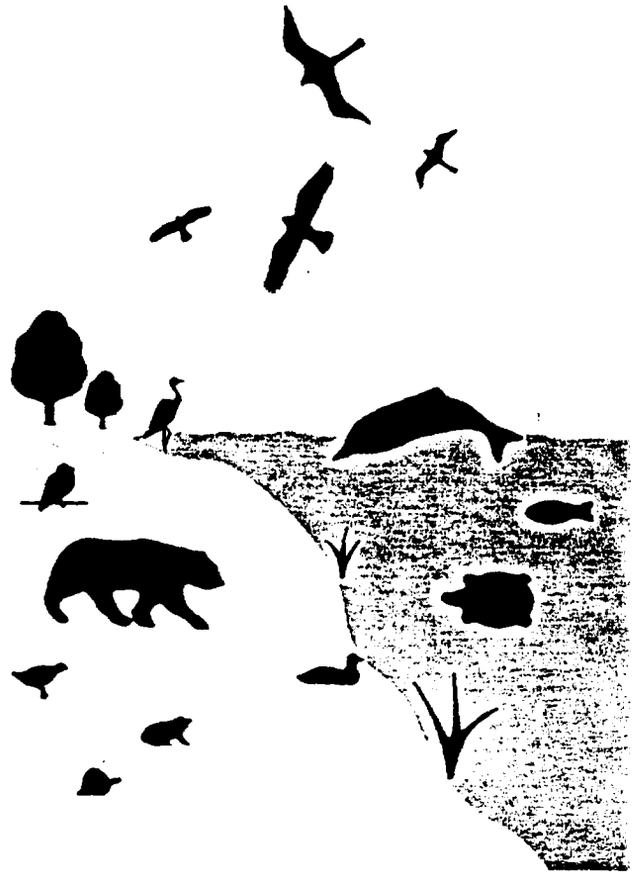
Reference 22

West Palm Beach

LORIDA

Library

1:250 000-scale map of Gulf Coast Ecological Inventory



Produced by
U. S. FISH AND WILDLIFE SERVICE
1982

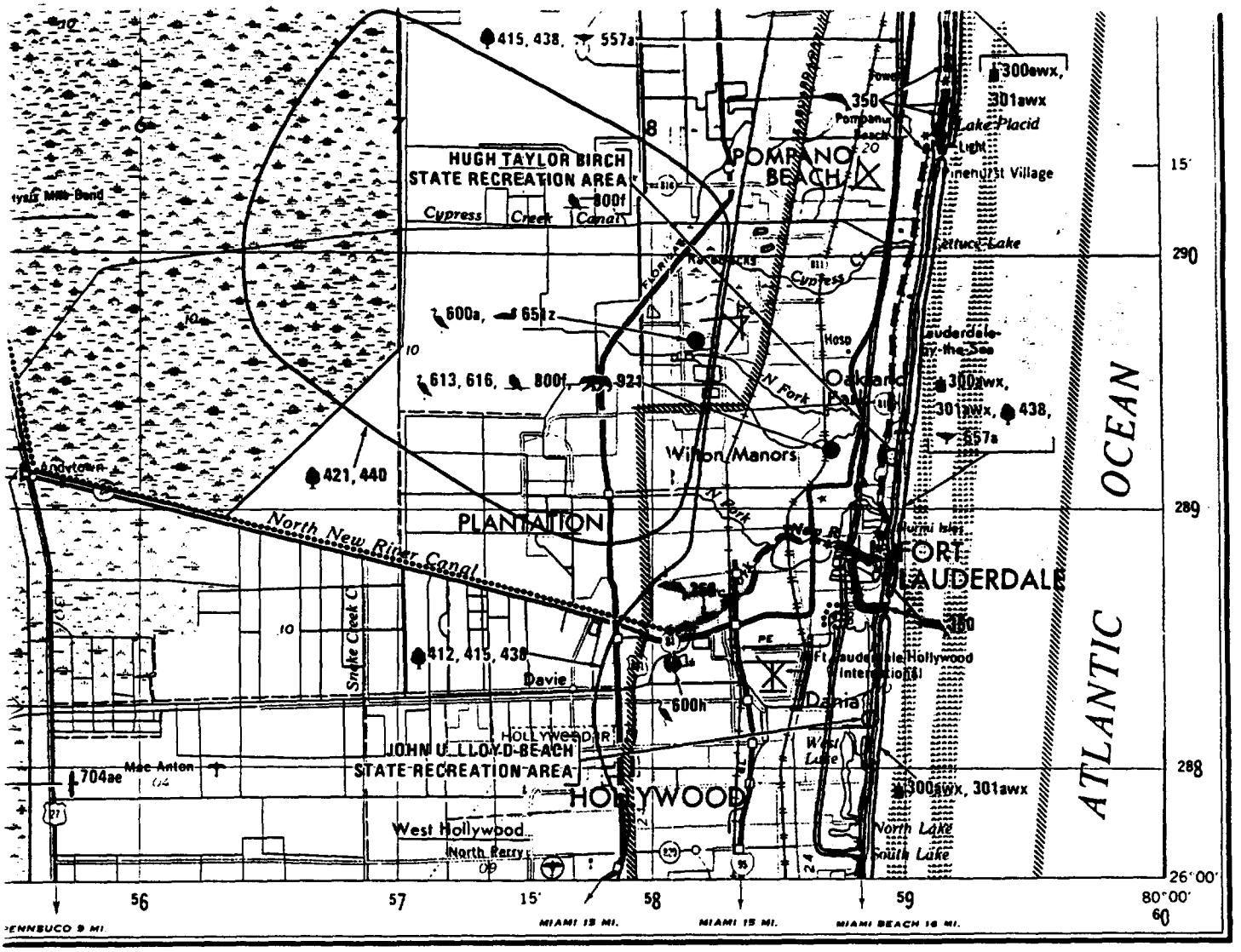
SYMBOL	SPECIES
	PLANTS (1-49)
1	Turtle grass
2	Widgeon grass
3	Shoal grass
	INVERTEBRATES (50-99)
50	Shrimp
51	White shrimp
52	Brown shrimp
53	Pink shrimp
54	Blue crab
55	Stone crab
56	Spiny lobster
57	Eastern oyster
58	Crayfish
59	Brackish-water clam
60	Sponges
61	Southern quahog
62	Northern quahog
63	Sunray venus clam
64	Bay scallop
65	Rock shrimp
66	Calico scallop
67	Unicolor mussel (S)
68	Fire coral
69	Horny coral
70	Stony coral
71	Gorgonian coral
72	Corals
73	Queen conch
74	Pygmy octopus
75	Atlantic geoduck
76	Loose coiled snail
77	Atherms villosa
	FISH (100-299)
100	Jack
101	Sharks, skates, rays
102	Grouper
103	Mullet
104	Catfish and bullheads
105	Snapper
106	Sunfish and bass
107	Drum
108	Spotted seatrout
109	Weakfish
110	Sand seatrout
111	Atlantic croaker
112	Red drum
113	Black drum
114	Star drum
115	Spot
116	Southern kingfish
117	Northern kingfish
118	Gulf kingfish
119	Sheepshead
120	Southern flounder
121	Blue catfish
122	White catfish
123	Channel catfish
124	Yellow bullhead
125	Brown bullhead
126	White crappie
127	Black crappie
128	Largemouth bass
129	Spotted bass
130	Green sunfish
131	Longear sunfish
132	Warmouth
133	Bluegill
134	Redear sunfish
135	Striped mullet
136	Red snapper
137	Florida pompano
138	Bluefish
139	Cobia
140	Atlantic spadefish
141	Little tunny
142	Spanish mackerel
143	King mackerel
144	Sea catfish
145	Gulf menhaden
146	Bay anchovy
147	Gars
148	Buffalos
149	Freshwater drum
150	Bowfin
151	Carp
152	Key silverside (S)
153	Tarpon
154	Ladyfish
155	Permit
156	Bonefish
157	Cero
158	Mutton snapper
159	Yellowtail snapper
160	Red grouper
161	Gray snapper
162	Grunts
163	Atlantic bonito
164	Sailfish
165	Vermilion snapper
166	Warsaw grouper
167	Tilefish
168	Great barracuda
169	Dolphin
170	Jewfish
171	Snook
172	Tripletail
173	Lane snapper
174	Nassau grouper
175	Black grouper
176	Gag
177	White grunt
178	Greater amberjack
179	Pinfish
180	Pigfish
181	Wrasses
182	Parrotfish
183	Damselfish
184	Butterflyfish

AQUATIC ORGANISMS (continued)

SYMBOL	SPECIES
	FISH (100-299)
203	Blue runner
204	Atlantic thread herring
205	Chain pickerel
206	Rivulus
207	Key blenny
208	Striped bass
209	Atlantic sturgeon (S)
210	Suwannee bass
211	Redbreast sunfish
212	Spotted sunfish
213	Flier
214	Redfin pickerel
215	Red porgy
216	Alabama shad
217	Skipjack herring
218	Spanish sardine
219	Bluestripe shiner (S)
220	Shoal bass
221	Blackmouth shiner (S)
222	Saltmarsh topminnow
223	Crystal darter (S)
224	Harlequin darter
225	Okaloosa darter (F)
226	Flathead catfish
227	White bass
228	Yellow bass

AQUATIC ORGANISMS (continued)

SYMBOL	SPECIES
	FISH (100-299)
247	Hinds
248	Yellowfin grouper
249	Scamp
250	Yellowedge grouper
251	Palometa
252	Yellow jack
253	Bar jack
254	Horse-eye jack
255	Hogfish
256	Dwarf seahorse
	REPTILES AND AMPHIBIANS (300-349)
300	Green sea turtle (F)
301	Loggerhead sea turtle (F)
302	Hawksbill sea turtle (F)
303	Kemp's Ridley sea turtle (F)
304	Leatherback sea turtle (F)
	MAMMALS (350-399)
350	West Indian manatee (F)
351	Atlantic bottlenose dolphin
352	Atlantic spotted dolphin
353	Finback whale (F)
354	Sperm whale (F)
355	Right whale (F)
356	Short-finned pilot whale



LAND USE–LAND COVER SYMBOLS

Study area (within territorial limits of United States)

Coastal zone boundary or Federal-state demarcation

Special land use areas, including refuges and wildlife management areas, parks and seashores; may be used in lieu of habitat boundary

Subdivision of a special land use area into more than one designation

Marsh or swamp

Beach/Dunes

Seagrass

Reef

POINT AND AREA FEATURE SYMBOLS

Shown in RED for species with special status, BLUE for aquatic organisms, and BROWN for terrestrial organisms.

Localized concentration of species — 650h

General habitat boundary for indicated species; may be superceded by special land use boundary — 50d

GULF COAST ECOLOGICAL INVENTORY

WEST PALM BEACH, FLORIDA

1982

Official Lists of Endangered and Potentially Endangered Fauna and Flora in Florida

1 July 1989

FLORIDA GAME AND FRESH WATER FISH COMMISSION

Compiled by Don A. Wood, Endangered Species Coordinator

Florida Game and Fresh Water Fish Commission

Scientific Name(s)	Common Name	Designated status[1] FGFWFC[2]	FDA[3]	USFWS[4]	CITES[5]
Oryzomys argentatus	Silver rice rat	E		UR4	
Oryzomys palustris planirostris	Pine Island rice rat			UR2	
Oryzomys palustris sanibeli	Sanibel Island rice rat	SSC		UR2	
Peromyscus floridanus	Florida mouse	SSC		UR2	
Peromyscus gossypinus allapaticola	Key Largo cotton mouse	E		E	
Peromyscus gossypinus anastasae	Anastasia Island cotton mouse			UR3	
Peromyscus gossypinus restrictus	Chadwick Beach cotton mouse	E		UR3	
Peromyscus polionotus allophrys	Choctawhatchee beach mouse	E		E	
Peromyscus polionotus decoloratus	Pallid beach mouse	E		UR3	
Peromyscus polionotus leucocephalus	Santa Rosa beach mouse			UR2	
Peromyscus polionotus niveiventris	Southeastern beach mouse	T		T	
Peromyscus polionotus peninsularis	St. Andrews beach mouse	E		UR2	
Peromyscus polionotus phasma	Anastasia Island beach mouse	E		E	
Peromyscus polionotus trissyllepsis	Perdido Key beach mouse	E		E	
Physter catodon	Sperm whale	E		E	
Plecotus rafinesquii	Southeastern big-eared bat			UR2	
Procyon lotor auspicatus	Key Vaca raccoon			UR2	
Procyon lotor incautus	Key West raccoon			UR2	
Scalopus aquaticus anastasae	Anastasia Island mole			UR5	
Scalopus aquaticus bassi	Englewood mole			UR2	
Sciurus niger avicennia	Big cypress fox squirrel	T		UR2	
Sciurus niger shermani	Sherman's fox squirrel	SSC		UR2	
Sigmodon hispidus exsputus	Lower Keys cotton rat			UR5	
Sigmodon hispidus insulicola	Insular cotton rat			UR2	
Sigmodon hispidus littoralis	Micco cotton rat			UR5	
Sorex longirostris eionis	Homosassa shrew	SSC		UR2	
Sylvilagus floridanus ammophilus	Micco cottontail rabbit			UR5	
Sylvilagus palustris hefneri	Lower Keys rabbit	E		UR1	
Tamias striatus	Eastern chipmunk	SSC			
Trichechus manatus latirostris	West Indian manatee	E		E	I
Ursus americanus floridanus	Florida black bear	T*		UR2	

*Not applicable in Baker and Columbia counties and Apalachicola National Forest

Scientific Name(s)	Common Name	Designated status[1] FGFWFC[2]	FDA[3]	USFWS[4]	CITES[5]
Triphora cubensis	Nodding caps (unnamed)		T		II
Triphora gentianoides	Nodding-caps (unnamed)		T		II
Triphora latifolia	Broad-leaved nodding-caps; broad-leaved pogonia		T	UR2	II
Triphora rickettii	Nodding-caps (unnamed)		T		II
Triphora trianthophora	Nodding pogonia; three-birds orchid		T		II
Tripsacum floridanum	Florida gramagrass			UR1	
Trismeria trifoliata	Braken fern (unnamed)		T		
Tropidia polystachya	Young-palm orchid		E		II
Vanilla barbellata	Worm-vine orchid; link vine		E		II
Vanilla dilloniana	Leafless vanilla		T		II
Vanilla inodora	Scentless vanilla		T		II
Vanilla mexicana	Vanilla (unnamed)		T		II
Vanilla phaeantha	Leafy vanilla; oblong-leaved vanilla		T		II
Vanilla planifolia	Commercial vanilla		T		II
Veratrum woodii	Woods' false hellebore		E		
Verbena maritima	Coastal vervain			UR2	
Verbena tampensis	Tampa vervain			UR1	
Verbesina chapmanii	Chapman's crownbeard		T	UR2	
Verbesina heterophylla	Variable-leaf crownbeard; North Florida crownbeard			UR1	
Vicia ocalensis	Ocala vetch		E	UR1	
Viola hastata	Halberd-leaved yellow violet		E		
Vittaria lineata	Shoestring fern		T		
Warea amplexifolia	Clasping warea; wide-leaf warea		E	E	
Warea carteri	Carter's mustard		E	E	
Warea sessilifolia	Sessile-leaved warea			UR5	
Woodsia obtusa	Blunt-lobed woodsia		T		
Woodwardia areolata	Netted chain fern		T		
Xyris drummondii	Drummond's yellow-eyed grass			UR2	
Xyris isoetifolia	Quillwort yellow-eyed grass; panhandle yellow-eyed grass			UR2	
Xyris longisepala	Karst pond yellow-eyed grass; Kral's yellow-eyed grass		E	UR5	
Xyris scabrifolia	Harper's yellow-eyed grass; harsh-leaf yellow-eyed grass		T	UR2	
Zamia floridana	Florida coontie		C		II
Zamia integrifolia	Florida arrowroot		C	UR5	II
Zamia umbrosa	East Coast coontie		C		II
Zanthoxylum flavum	Yellowheart		E		
Zephyranthes (all white species)	Rain lilies		T		
Zephyranthes simpsonii	Simpson zephyr lily		E	UR5	
Zephyranthes treatiae	Rain lily (unnamed)			UR5	
Zizia latifolia	Bristol golden alexander			UR2	
Ziziphus celata	Florida jujube; Florida ziziphus			UR2	

[1]E = Endangered
T = Threatened
T (S/A) = Threatened Due to Similarity of Appearance
SSC = Species of Special Concern
C = Commercially Exploited
I = Appendix I Species
II = Appendix II Species

UR1 = Under review for federal listing, with substantial evidence in existence indicating at least some degree of biological vulnerability and/or threat.

UR2 = Under review for listing, but substantial evidence of biological vulnerability and/or threat is lacking.

UR3 = Still formally under review for listing, but no longer being considered for listing due to existing pervasive evidence of extinction.

UR4 = Still formally under review for listing, but no longer being considered for listing because current taxonomic understanding indicates species is an invalid taxon and thus ineligible for listing.

UR5 = Still formally under review for listing, but no longer considered for listing because recent information indicates species is more widespread or abundant than previously believed.

[2]Florida Game and Fresh Water Fish Commission (list published in Section 39-27.03-05, Florida Administrative Code).

[3]Florida Department of Agriculture and Consumer Services (list published in Preservation of Native Flora of Florida Act, Section 581.185-187, Florida Statutes).

[4]United States Fish and Wildlife Service (list published in List of Endangered and Threatened Wildlife and Plants, 50 CFR 17.11-12).

[5]Convention on International Trade in Endangered Species of Wild Fauna and Flora.

SUMMARY

Status Designation	Fish	Amphibians/ Reptiles	Birds	Mammals	Invertebrates	Plants	Total
FGFWFC							
Endangered	3	6	9	21	3	--	42
Threatened	2	10	11	5	--	--	28
Special Concern	11	12	14	7	4	--	47
Subtotal	16	28	34	33	7	--	117
FDA							
Endangered	--	--	--	--	--	136	136
Threatened	--	--	--	--	--	283	283
Commercially Exp.	--	--	--	--	--	11	11
Subtotal						430	430
USFWS							
Endangered	2	5	10	15	1	23	58
Threatened	0	5	5	1	1	4	16
Threatened (S/A)	0	1	0	0	0	0	1
Under Review	4	19	15	32	82	238	379
Subtotal	6	30	29	48	84	267	454
CITES							
Appendix I	1	6	2	4	0	0	13
Appendix II	1	1	7	4	0	120	133
Subtotal	2	7	9	8	0	120	146

STATE OF FLORID
DEPARTMENT OF NATURAL

Reference 23

Marjory Stoneman Douglas Building • 3900 Commonwealth Boulevard • Tallahassee, Florida 32399
Tom Gardner, Executive Director

April 26, 1989

Mr. Charles Logan
Department of Environmental Regulation
Room 569-E
2600 Blairstone Road
Tallahassee, Florida 32399-2400

Dear Mr. Logan:

Enclosed is the information you requested concerning outdoor recreation facilities in Florida. Should you have any questions or need further information, feel free to contact me at 904/488-2300.

Sincerely,

Phil Flood
Planner IV
Office of Policy and Planning
Division of Recreation and Parks

PF/sh
Enclosures

RECEIVED
APR 27 1989
BUREAU OF WASTE CLEANUP
Twin Towers

FACILITY INDEX BY COUNTY / UNIT ID/ SITE ID

COUNTY	UNIT ID	SITE	UNIT NAME	SITE NAME	ADDRESS
BROW	M00946	00	HOLLAND PARK	HOLLAND PARK	JOHNSON STREET AND 6TH AVENUE ON INTRACOASTAL WATERWAY HOLLYWOOD
BROW	M00952	00	SAILORS POINT	SAILORS POINT	9TH AVENUE AND NORTH LAKE DRIVE ON NORTH LAKE HOLLYWOOD
BROW	M00982	00	15TH STREET BOAT RAMP	15TH STREET BOAT RAMP	1770 SE 15TH STREET ON STRANAHAN RIVER FT LAUDERDALE
BROW	M00993	00	HOUSTON PARK/DANIA YACHT CLUB	HOUSTON PARK/DANIA YACHT CLUB	850 NE 3RD STREET DANIA
BROW	M01006	00	BOAT RAMP	BOAT RAMP	NE 12TH TERRACE AND 29TH STREET OAKLAND PARK
BROW	M01019	00	GEORGE ENGLISH PARK	GEORGE ENGLISH PARK	1101 BAYVIEW DRIVE AND SUNRISE BLVD ON MIDDLE RIVER FT LAUDERDALE
BROW	M01023	00	7TH AVENUE BOAT RAMP	7TH AVENUE BOAT RAMP	400 SW 7TH AVENUE ON NEW RIVER AT SW 4TH STREET FT LAUDERDALE 33315
BROW	M01053	00	DONALDSON PARK	DONALDSON PARK	900 NW 43RD AVENUE AND COCONUT CREEK PARKWAY COCONUT CREEK
BROW	M01054	00	SPOILS AREA	SPOILS AREA	52ND STREET AND 31ST AVENUE ON INTRA-COASTAL WATERWAY LIGHTHOUSE POINT
BROW	M02333	00	ALSDORF BOAT LAUNCH PARK	ALSDORF BOAT LAUNCH PARK	NE 14TH STREET ON INTRACOASTAL WATERWAY POMPANO BEACH
BROW	M03229	00	HOLLYWOOD MARINA	HOLLYWOOD MARINA	700 POLK STREET ON NORTH LAKE HOLLYWOOD

FACILITY INDEX BY COUNTY / UNIT ID/ SITE ID

COUNTY	UNIT ID	SITE	UNIT NAME	SITE NAME	ADDRESS
BROW	S00107	00	LLOYD BEACH	JOHN U. LLOYD BEACH STATE RECREATION AREA	6503 NORTH OCEAN DRIVE ON ATLANTIC OCEAN AND INTRACOASTAL WATERWAY DANIA 33004
BROW	X00268	00	BROWARD MARINE	BROWARD MARINE	1601 SW 20TH STREET ON INTRACOASTAL WATERWAY FT LAUDERDALE 33335
BROW	X00309	00	CALMAC MARINA	CALMAC MARINA	491 RAVENSWOOD ROAD ON CANAL FT LAUDERDALE 33312
BROW	X00867	00	HEROLDS BOATS	HEROLDS BOATS	1112 EAST LAS OLAS BLVD ON NEW RIVER FT LAUDERDALE 33316
BROW	X00889	00	HILLSBORO INLET MARINA BOATING AREA	HILLSBORO INLET MARINA BOATING AREA	2635 NORTH RIVERSIDE DRIVE ON INTRACOASTAL WATERWAY POMPANO BEACH 33062
BROW	X01312	00	LOUS TACKLE AND MARINA	LOUS TACKLE AND MARINA	3463 GRIFFIN ROAD ON ATLANTIC OCEAN FT LAUDERDALE 33312
BROW	X01354	00	MARINA 84	MARINA 84	3000 SR 84 ON NEW RIVER FT LAUDERDALE 33312
BROW	X01491	00	CHINNOCK MARINE INC	CHINNOCK MARINE INC	510 LAS OLAS BLVD ON NEW RIVER FT LAUDERDALE 33312
BROW	X01747	00	RANGOM MARINA	RANGOM MARINA	4500 SR 7 ON NEW RIVER FT LAUDERDALE 33316
BROW	X01795	00	RIVERBEND MARINE	RIVERBEND MARINE	1905 SW 20TH STREET ON NEW RIVER FT LAUDERDALE 33315
BROW	X01902	00	SEA LAND MARINE BASIN	SEA LAND MARINE BASIN	2200 SW 22TH TERRACE ON SOUTH FORK OF NEW RIVER FT. LAUDERDALE 33312

FACILITY INDEX BY COUNTY / UNIT ID/ SITE ID

COUNTY	UNIT ID	SITE	UNIT NAME	SITE NAME	ADDRESS
BROW	X02324	00	YACHT HAVEN MOBILE HOME PARK	YACHT HAVEN	2323 STATE ROAD 84 ON NEW RIVER FT. LAUDERDALE
BROW	X02647	00	LAUDERDALE SELF SERVICE	LAUDERDALE SELF SERVICE	1001 SW 20TH STREET ON NEW RIVER FT LAUDERDALE 33315

					FT LAUDERDALE
BROW	X01747	00	RANGON MARINA	RANGON MARINA	4500 SR 7 ON NEW RIVER FT LAUDERDALE 33316
BROW	X01795	00	RIVERBEND MARINE	RIVERBEND MARINE	1515 SW 20TH STREET ON NEW RIVER FT LAUDERDALE 33315
BROW	X01902	00	SEA LAND MARINE BASIN	SEA LAND MARINE BASIN	2700 SE 25TH TERRACE ON SOUTH FORK OF NEW RIVER FT. LAUDERDALE 33312

FACILITY INDEX BY COUNTY / UNIT ID/ SITE ID

COUNTY	UNIT ID	SITE	UNIT NAME	SITE NAME	ADDRESS
BROW	X02324	00	YACHT HAVEN MOBILE HOME PARK	YACHT HAVEN	2303 STATE ROAD 84 ON NEW RIVER FT. LAUDERDALE
BROW	X02647	00	LAUDERDALE SELF SERVICE	LAUDERDALE SELF SERVICE	1801 SW 20TH STREET ON NEW RIVER FT LAUDERDALE 33315
BROW	Y00689	00	LAUDERDALE ISLES YACHT AND TENNIS CLUB	LAUDERDALE ISLES YACHT AND TENNIS CLUB	2637 WHALE HARBOR LANE ON NEW RIVER FT LAUDERDALE 33312
BROW	Y00692	00	FORT LAUDERDALE SMALL BOAT CLUB	FORT LAUDERDALE SMALL BOAT CLUB	1740 SW 42ND STREET FT LAUDERDALE 33314
BROW	Y00837	00	NEW RIVER YACHT CLUB	NEW RIVER YACHT CLUB	3001 SR 84 ON NEW RIVER FT LAUDERDALE 33312
BROW	Y01817	00	OLYMPIS CONDOMINIUM	OLYMPIS CONDOMINIUM	500 THREE ISLAND BLVD ON INTRACOASTAL WATERWAY HALLANDALE 33009

Facilities With Freshwater Boat Ramps

FACILITY INDEX BY COUNTY / UNIT ID/ SITE ID

COUNTY	UNIT ID	SITE	UNIT NAME	SITE NAME	ADDRESS
BROW	C00296	00	MARKHAM PARK	MARKHAM PARK	16001 STATE ROAD 84 ON NORTH NEW RIVER CANAL FT. LAUDERDALE
BROW	C00301	00	TIGERTAIL LAKE	TIGERTAIL LAKE	4841 SW RAVENSWOOD ROAD HOLLYWOOD
BROW	M01047	00	WINFIELD PARK	WINFIELD PARK	WINFIELD BOULEVARD AND NW 65TH AVENUE MARGATE
BROW	M02207	00	PARKS AND RECREATION OFFICE	PARKS AND RECREATION OFFICE	1400 W RIVER DRIVE MARGATE
BROW	M02335	00	COLOHATCHEE NATURE PARK	COLOHATCHEE NATURE PARK	1975 NE 15TH AVE AND 22ND STREET ON SOUTH MIDDLE RIVER WILTON MANORS
BROW	M03756	00	TAMARAC VETERANS PARK AT CYPRESS CREEK COMMONS	TAMARAC VETERANS PARK AT CYPRESS CREEK COMMONS	7825 SOUTHGATE BLVD ON CYPRESS CREEK CANAL TAMARAC 33321
BROW	M04001	00	MARGATE MARINA	MARGATE MARINA	NW 1ST STREET AND ROCK ISLAND ROAD ON CANAL 14 MARGATE
BROW	M04871	00	GATES OF HILLSBORO PARK	GATES OF HILLSBORO PARK	4000 BLOCK OF NW 5TH ST ON HILLSBORO CANAL DEERFIELD BEACH
BROW	S01065	00	TERRY TOWN ACCESS AREA BOAT RAMP	TERRY TOWN ACCESS AREA BOAT RAMP	US 27 ON NEW RIVER CANAL L-39W NORTH OF ANDY TOWN
BROW	S01066	00	WEASEL TRAIL ACCESS AREA BOAT RAMP	WEASEL TRAIL ACCESS AREA BOAT RAMP	US 27 AT 26 MILE BEND WATER CONSERVATION AREA 2-A ON NEW RIVER CANAL NORTH OF ANDYTOWN
BROW	S01067	00	STUB CANAL ACCESS AREA BOAT RAMP	STUB CANAL ACCESS AREA BOAT RAMP	US 27 ON NEW RIVER CANAL L-38 NORTH OF ANDYTOWN

FACILITY INDEX BY COUNTY / UNIT ID/ SITE ID

COUNTY	UNIT ID	SITE	UNIT NAME	SITE NAME	ADDRESS
BROW	S01068	00	SPILLWAY 11A ACCESS AREA	SPILLWAY 11A ACCESS AREA	OFF US 27 WATER CONSERVATION AREA 3 ON NEW RIVER CANAL L-38 ANDYTOWN
BROW	S01069	00	SAWGRASS RECREATION AREA BOAT RAMP	SAWGRASS RECREATION AREA BOAT RAMP	US 27 WATER CONSERVATION AREA 2 ON NEW RIVER CANAL ANDYTOWN

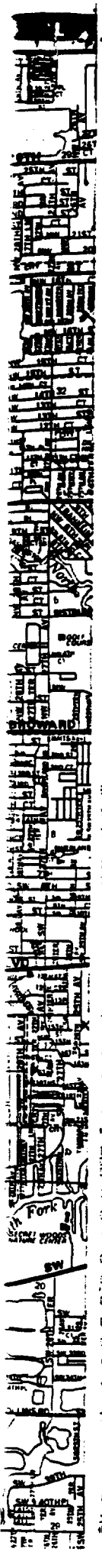
BROW	S01065	00	TERRY TOWN ACCESS AREA BOAT RAMP	TERRY TOWN ACCESS AREA BOAT RAMP	US 27 ON NEW RIVER CANAL L-35W NORTH OF ANDY TOWN
BROW	S01066	00	WEASEL TRAIL ACCESS AREA BOAT RAMP	WEASEL TRAIL ACCESS AREA BOAT RAMP	US 27 AT 26 MILE BEND WATER CONSERVATION AREA 2-A ON NEW RIVER CANAL NORTH OF ANDYTOWN
BROW	S01067	00	STUB CANAL ACCESS AREA BOAT RAMP	STUB CANAL ACCESS AREA BOAT RAMP	US 27 ON NEW RIVER CANAL L-38 NORTH OF ANDYTOWN

FACILITY INDEX BY COUNTY / UNIT ID/ SITE ID

COUNTY	UNIT ID	SITE	UNIT NAME	SITE NAME	ADDRESS
BROW	S01068	00	SPILLWAY 11A ACCESS AREA	SPILLWAY 11A ACCESS AREA	OFF US 27 WATER CONSERVATION AREA 3 ON NEW RIVER CANAL L-38 ANDYTOWN
BROW	S01069	00	SAWGRASS RECREATION AREA BOAT RAMP	SAWGRASS RECREATION AREA BOAT RAMP	US 27 WATER CONSERVATION AREA 2 ON NEW RIVER CANAL ANDYTOWN
BROW	S01070	00	ANDYTOWN ACCESS AREA BOAT RAMP	ANDYTOWN ACCESS AREA BOAT RAMP	US 27 NORTH OF SR 84 WATER CONSERVATION AREA 3 ON NEW RIFER CANAL 1 MILE NORTH OF ANDYTOWN
BROW	S01071	00	ALLIGATOR ALLEY BOAT RAMP	ALLIGATOR ALLEY BOAT RAMP	SR 84 WATER CONSERVATION AREA 3 ON MIAMI CANAL C-123 WEST OF ANDYTOWN
BROW	S01073	00	NEW RIVER CANAL NORTH BOAT RAMP	NEW RIVER CANAL NORTH BOAT RAMP	US 27 ON NEW RIVER CANAL 3 MILES NORTH OF ANDYTOWN
BROW	S01325	00	SEWELL LOCK BOAT RAMP	SEWELL LOCK BOAT RAMP	1 MILE W OF FLORIDA TURNPIKE AT SEWELL LOCK ON NEW RIVER CANAL PLANTATION
BROW	S01326	00	MACKS FISH CAMP	MACKS FISH CAMP	US 27 AT DADE/BROWARD COUNTY LINE ON MIAMI CANAL WEST OF MIRAMAR
BROW	S01405	00	NEW RIVER CANAL SOUTH BOAT RAMP	NEW RIVER CANAL SOUTH BOAT RAMP	US 27 ON NEW RIVER CANAL 2 MILES NORTH OF ANDYTOWN
BROW	S01427	00	S-36 BOAT RAMP	S-36 BOAT RAMP	PROSPECT ROAD ON CANAL 13 LAUDERDALE LAKES
BROW	S01428	00	S-8 BOAT RAMPS	S-8 BOAT RAMPS	NORTH SR 84 WATER CONSERVATION AREA 3 ON MIAMI CANAL WEST OF FORT LAUDERDALE
BROW	S01444	00	EVERGLADES HOLIDAY PARK	EVERGLADES HOLIDAY PARK	OFF US 27 ON SOUTH NEW RIVER CANAL SOUTH OF ANDYTOWN

FACILITY INDEX BY COUNTY / UNIT ID/ SITE ID

COUNTY	UNIT ID	SITE	UNIT NAME	SITE NAME	ADDRESS
BROW	X00923	00	TWIN LAKES TRAVEL PARK	TWIN LAKES TRAVEL PARK	3055 BURRIS ROAD SR 84 AND SR 71 ON TWIN LAKES FT. LAUDERDALE
BROW	X02941	00	AQUA GOLF RV PARK	AQUA GOLF RV PARK	1970 S PARK ROAD PEMBROKE PARK
BROW	X03099	00	EVERGLADES HOLIDAY PARK	EVERGLADES HOLIDAY PARK	21940 GRIFFIN ROAD OFF US 27 FT LAUDERDALE 33332



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OF

FORT LAUDERDALE

INCLUDING

- HOLLYWOOD
- HALLENDALE
- PEMBROKE PINES
- PLANTATION
- POMPANO BEACH
- DEERFIELD BEACH
- MARGATE
- CORAL SPRINGS

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- HALLENDALE
- PEMBROKE PINES
- PLANTATION
- POMPANO
- DEERFIELD
- MARGATE
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Ocean
14th Court
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PORT
EVERGLADES
Lake Mabel
Intracoastal Waterway
River Sound
FORT LAUDERDALE
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the Fort Myers power plant, or at the Felda Locks nearby. The saltwater side of Cape Coral's residential canals often hold small tarpon, too.

Along the eastern seaboard, certain areas of Biscayne Bay are sometimes loaded with tarpon, big and small. You're taking your chances at Government Cut when you fish for tarpon early in the morning during late winter and spring. Most of the tarpon you hook won't be small—but lots of little ones are sometimes mixed in with the larger fish. Farther south in the bay, the cooling canals of the Turkey Point power plant often hold baby silver kings, especially during the cooler months and along from early spring up until summer, lots of small tarpon can be found on the grassy flats near Broad Creek and other oceanside spots on down toward Key Largo.

Don't worry about building the complex leaders used for larger tarpon. They aren't needed.

In northern Biscayne Bay, look for tarpon around the bridges at night. They like to hang in the dark water just outside the circle of light from the bridges' streetlamps slurping shrimp and other goodies that flow by on the tide.

Fort Lauderdale's North New River is often loaded with small tarpon, especially well upstream. And on up the coast, you can still locate fish in the mosquito impoundments on Hutchinson Island between Jensen Beach and Fort Pierce.

Perhaps the best way of determining what tackle to use for these fish is to figure out where you'll be fishing.

If you intend to fish the backcountry of Southwest Florida for small tarpon, for instance, it's almost certain you'll be faced with casting around low-hanging mangroves. Since the fish you hope to hook are so active, you'll need to boost your tackle into the 12-pound class to have much of a chance of one. A stiff rod is a necessity in the backcountry and while I prefer baitcasting tackle, you may opt for spinning without handicapping yourself.

Where Rick's tarpon were located, out in the middle of a shallow grass flat in Florida Bay, almost any kind of tackle will work but if you really want to have a ball, try flycasting gear. Don't worry about manufacturing the complex leaders flycasters insist upon using when their target is a big silver king because it simply isn't necessary. Rick uses a five-foot length of 50-pound-test monofilament for leader during his small-tarpon outings. "I'm not after any records," he notes, "and the fun is in watching them jump and run. I want heavy enough line so that after a short battle, I can land and release the fish without tiring it to exhaustion. The 50-pound gives me plenty of protection against fraying, too."

If you prefer a more traditional leader system, a short piece of heavy monofilament shock leader in front of the tippet is necessary to keep the line intact. The raspy mouth of even a small silver king makes short work of light line. A floating, weight-forward line is adequate for most such shallow-water fishing. Long casts are seldom required in the murky water where many tarpon are found, but can be useful when the fish are in clear water.

Tarpon will attack a variety of flies, including popping bugs intended for bass, but my mainstays are streamers tied on a 2/0 hook in white, white-and-red or red-and-yellow.

Plug and spin anglers should give surface lures the first opportunity when fishing baby tarpon because the strike is so spectacular. If that doesn't work, crankbaits and floater-divers are both great tarpon attractors. Failing that, jigs or bait may work when everything else fails.

As in any tarpon fishing, there is great debate over when an angler should try to set the hook. The inside of the mouth of a tarpon is about as hard as concrete and you can start the hook-setting process by insuring that your barbs are needle-sharp. From there, I usually wait a second after the strike, until I feel the weight of the fish, before trying to set the hook. Plenty of tiny tarpon have been solidly hooked, however, by anglers who strike the fish immediately. You pays your dues and takes your chances.

As fun as they are to catch, juvenile tarpon can, at times, be frustrating. Rolling fish may be surfacing all around the boat, but not buying anything you throw at them. When you find yourself in this situation, about the only thing you can do is maintain your cool and keep casting. Sooner or later, they'll turn on and when they do, tiny tarpon can hook you as fast as they did David. FS

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KEY LARGO
Mariner's Cove Marina
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Mariner's Cove Marina
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(813) 598-9633

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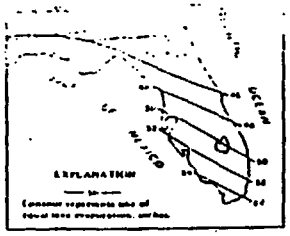
Discount Bait & Tackle
4484 Ridgewood Ave.
(904) 761-6571

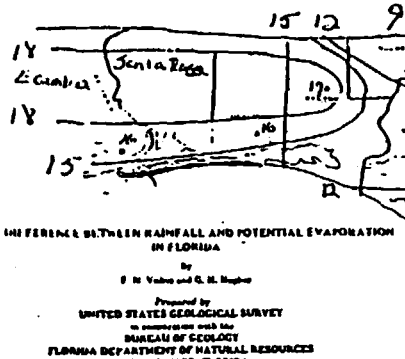
TARPON SPRINGS
Sigma Marine Supply
950 Roosevelt Blvd.
(813) 934-0794

GEOLOGICAL SURVEY

Reference 25



AVERAGE ANNUAL LAKE EVAPORATION



THE DIFFERENCE BETWEEN RAINFALL AND POTENTIAL EVAPORATION IN FLORIDA

by
F. W. Visher and G. H. Hughes

Prepared by
UNITED STATES GEOLOGICAL SURVEY
in cooperation with the
BUREAU OF GEOLOGY
FLORIDA DEPARTMENT OF NATURAL RESOURCES
TALLAHASSEE, FLORIDA
1968
SECOND EDITION 1976

Rainfall in Florida is generally abundant, but man presently has little opportunity to control or direct the use of a large part of the total rainfall. Evaporation from land, water and plant surfaces can have full use of the rainfall. Knowledge of the amount and areal variation of rainfall in excess of all evaporative losses is a necessary factor in appraising the outflow of water from an area. Outflow is the total surface and ground water flow from an area, and is equal to the difference between rainfall on an area and actual evaporation from an area.

Potential evaporation does not permit potential determination of evaporation from large areas of dissected soils and vegetation cover where the availability of water may differ and vary both in time and in space. Thus, outflow is not determined directly, but is evaluated by determining the instrumental outflow that results from the natural rainfall in the area. Such an approach usually is practicable in areas where net total outflow occurs in well-defined surface channels. In Florida, however, many areas are underlain by permeable limestone aquifers which transmit surface drainage divides and which transmit large quantities of water underground. Even though part of the water transmitted through aquifers may reappear as seeps or springs at some downstream point, the areas or points of perhaps all of the underground water cannot be determined, nor can all of the underground flow be accounted for with certainty. Thus, every analytical tool must be used to evaluate the outflow of an area. One concept which provides a common basis for appraising outflow from an area is the difference between rainfall and potential evaporation.

Outflow from an area can equal the difference between rainfall and potential evaporation only if water is continuously available and has access and flow off the area. In Florida, humid tropical areas are largely covered by lakes or swamps. Furthermore, the rainfall pattern in Florida tends to maximize the overall availability of water potential to equal with the evaporative demand. Rainfall occurs during predictable storm events throughout the year and is usually greatest during the warm months of the year, when evaporative demand is greatest, and least during the cold months, when evaporative demand is least. Consequently, in Florida the difference between rainfall and potential evaporation is largely owing to the determination of the difference between rainfall and potential evaporation large where the difference between rainfall and potential evaporation is large, and small where the difference is small.

Outflow cannot be less than the difference between rainfall and potential evaporation because, by definition, potential evaporation represents the maximum amount of water that can leave the area by that process. If rainfall exceeds potential evaporation, outflow must occur or an amount at least equal to the difference between the two. Although the difference between rainfall and potential evaporation may not define precisely the outflow from an area, it does indicate the lower limit of outflow from an area.

Potential evaporation cannot be considered equivalent to evaporation occurring naturally from an extensive water surface of large dimension; thus, the yearly potential evaporation for an area essentially equals evaporation from natural lakes within the area. The two may differ naturally because most lakes have some capacity to store energy temporarily rather than dissipate it immediately by evaporation, or other heat transfer processes, or vice versa. Although, however, an appreciable distortion, however, yearly lake evaporation provides a useful estimate of potential evaporation between rainfall, a yearly average, storage, and release are balanced.

The areal distribution of potential evaporation in Florida has been mapped in form a map of lake evaporation in the United States by Kohler, Nordenson, and Baker (1959, plate 3). The lake evaporation map provides a national estimate of average yearly lake evaporation during the period 1946-55. At two evaporation stations in Florida (Sanford and Belle Glade Experiment stations), average evaporation for the period 1946-55 was virtually the same as for a longer period 1946-65; thus, evaporation for the period 1946-55 probably provides a representative long-term average for Florida.

The general relationship of the evaporation map has not been widely proved in Florida because few measurements of lake evaporation have been made since the map became available. One such determination, based on mass transfer techniques applied to data compiled by Harbeck (1962b), was made during 1963 at Lake Hancock in central Florida (Hughes and others, 1966). Measured lake evaporation at Lake Hancock was 53 inches compared to an average of 49 inches shown by the evaporation map for the general area involved.

Among 1962, rainfall in central Florida was about 23 percent less than normal. Such a large deficiency in rainfall usually would be accompanied by a relative decrease in stream flow and humidity as well as a relative increase in air temperatures, all of which would tend to promote evaporation. Consequently, lake evaporation during 1963 was probably greater than the long-term average for the area. The difference between the two values is within the range of probable yearly variation at a particular lake.

The values shown by the evaporation map depend on meteorological factors such as solar radiation, wind movement, air temperature, and humidity, all of which are importantly related to lake evaporation. Thus, the values are applicable to individual lakes as long as the lakes are equally exposed to wind movement, a requirement met by most large lakes in Florida. The same requirement may not be met by some small lakes covering only a few acres that may lie at the bottom of deep and have depressions or that may be partially enclosed by tall and dense vegetation.

Yearly potential evaporation varies only slightly compared to yearly rainfall, which in many areas of Florida ranges from about 50 percent greater than normal to about 50 percent less than normal. Although some of the storm rainfall of wet years may be retained long as soil moisture to appear as lakes or in a shallow water table, much of the storm rainfall flows out of the area and does not remain available for evaporation in subsequent years. Similarly, but to a somewhat opposite extent, the energy expressed by potential evaporation that occurs in dry years of a lack of water during a dry year is not stored for later use but makes it dissipated. Because the yearly and seasonal evaporations between the supply and demand of water for evaporation are not controlled by storage, the average outflow of water tends to be greater than the difference between average rainfall and average potential evaporation—potential outflow that occurs during a year when rainfall may be much less than the yearly potential evaporation.

The topography and geology of an area also affect the outflow as distinct from the difference between rainfall and potential evaporation. Of prime importance are the slope of the land surface, the type of vegetation cover, and the permeability of the soil and underlying materials. Thus, surface flows from the rainfall in the humid areas of Florida are quite different and dissimilar from the area, such as deep land covers and partly permeable soils, for example, tend to make outflow greater than the difference between rainfall and potential evaporation. Permeable soils which permit water to quickly reach a deep water table that feeds streams or springs also tend to make outflow greater than the difference between rainfall and potential evaporation simply because the water flows out from the land surface to be evaporated. Factors which promote ponding and retention of water in place, such as flat land with bottom vegetation, tend to reduce outflow and make it more nearly equal to the difference between rainfall and potential evaporation.

The accompanying map shows the approximate areal distribution of the difference between yearly rainfall and yearly potential evaporation for Florida. Rainfall data used were the most recent U.S. Weather Bureau normal rainfall values for the period 1931-60. For stations where "normal" values were lacking, the average rainfall for the period of record at the station was used; however, all stations so selected have at least 25 years of record.

Average yearly rainfall varies appreciably in Florida—ranging from about 46 inches at Mount Dora in north Florida to about 64 inches at Bell Creek Reservoir in north Florida—but the variation does not follow a simple geographic trend. In contrast to rainfall, average yearly potential evaporation decreases only slightly and somewhat uniformly from 54 inches in north Florida to about 44 inches in north Florida, as shown on the small inset map. Consequently, on the accompanying large map, the contrasted isobaric patterns of the variations in the mean values for rainfall than to variations in potential evaporation. The map is the approximate for data for all but a few rainfall stations but the configuration of the isopleths is not necessarily or adequately defined in several areas of the state. An additional rainfall gage between problem, the configuration of the isopleths may be more truly defined. Thus, the map should be interpreted only in terms of broad areas where the average difference between rainfall and potential evaporation can be reasonably well established.

As mapped, rainfall exceeds the potential evaporation over most of Florida, but the difference varies greatly. The distribution of the differences is consistent in some ways with outflow, which also varies appreciably across the state. However, no simple or direct relation between the two is apparent. The effect of other hydrologic and geologic variables is great enough in some areas to obscure the effect of the difference between rainfall and potential evaporation on outflow.

The greatest difference between rainfall and potential evaporation occurs in the peninsular area of southwest Florida, where the greatest outflow in the state occurs and where the difference is from 15 to 18 inches. Inclusive rainfall average about 55 inches over most areas and by necessity or almost entirely within the peninsular area west of the Okeechobee Basin. This area is well drained by a network of streams whose basins are steep sloped relative to streams in other parts of Florida. Much of the area is underlain by widely connected or readily permeable limestone which quickly passes rainfall to the underground water table, which in turn maintains the high base flow of the streams. An equivalent contributing the outflow and runoff to this area contrast that most of the outflow of the state appears in streams.

In northwest Florida, the difference between rainfall and potential evaporation ranges from 4 to 9 inches or about half that for the peninsular area. In the part of the Suwannee River basin that lies entirely in almost entirely in northwest Florida, outflow rainfall averages about 14 inches. Large areas of northwest Florida are swampy and evaporation losses are almost equal to potential evaporation. On the other hand, larger areas are not swampy and have an defined network of medium streams. Much of the rainfall on these areas apparently moves downward to the water table and transmitted more throughgoing streams without large evaporation losses.

Over a large part of central Florida, the difference between rainfall and potential evaporation is about 2 to 4 inches. In the northeastern part of this area, including parts of Lake County and the northern half of Polk County, there are numerous lakes and swamps. Thus, for most of this area, evaporation and transpiration losses approach the difference between rainfall and potential evaporation. Surface runoff from the area, as measured by gaging stations on the upper Withlacoochee River, the Little Withlacoochee River, and the Ocklawaha River, averages about 1 inch. Outflow is somewhat greater than the surface runoff because there is a known underflow from the Floridan Aquifer. Pride and others (1966) showed that not the Lower Ocklawaha area, which transports an appreciable part of central Florida, averages to the Floridan Aquifer at about 2 inches annually. Thus, outflow from this part of central Florida may be about 3 inches.

The most potential area of central Florida is situated to the south by the Peace River. The Peace River basin is an area of recharge for the Floridan Aquifer, but over most of its length the river has recent drainage from the Floridan Aquifer. Surface runoff from the basin averages about 13 inches and most downstream gaging stations, which probably represent the outflow from the basin, indicate, in the approach 30 percent of an inch when most of the outflow occurs, natural outflow rainfall still averages about 10 inches. Thus, from the most potential area where the difference between rainfall and potential evaporation ranges from 3 to 6 inches, outflow ranges from 3 inches to 6 inches. Most of the difference between rainfall and potential evaporation is probably due to a lower actual evaporation from lakes and swamps in the northern areas.

In the southeastern part of the state, which includes the Caloosahatchee River basin, Lake Okeechobee, and the Everglades, the difference between rainfall and potential evaporation ranges from less than zero in the western part to 12 inches in the eastern part. The remainder is that the most prolific U.S. Weather Bureau rainfall stations are identifiable, drainage basins are for the most part indeterminable. Thus, the streamflow data probably for this region cannot be evaluated easily in terms of rainfall per unit area.

Outflow from other areas of the state was found to be always greater than the difference between rainfall and potential evaporation; consequently, that same good reasons should apply to the southern part of the state. The difference between outflow and the difference was greatest where rainfall averages are different and where lakes and swamps were generally absent, and least where drainage was good and where lakes and swamps were prominent. Outflow from the swamp and lake country in east Florida was estimated to be 3 inches less than the difference between rainfall and potential evaporation ranged from 1 to 6 inches. The disparity should be appreciably less for the southern part of the state where the availability of water is greater in such areas compared to the general area. Thus, for southern Florida, outflow probably does not exceed the difference between rainfall and potential evaporation by more than 3 inches.

Actual outflow cannot be determined directly from the map. In essence, the map portrays to evaporate outflow from an area. Actual outflow will almost never exceed the evaporation, because heat characteristics and transport to rainfall limit the availability of water for evaporation.

REFERENCES

Harbeck, G. E., Jr.
1962 *A practical manual for measuring reservoir evaporation using mass-transfer theory*: U.S. Geological Survey Prof. Paper 272E.

Healy, Henry G.
1963 *Instrumental output and areal of streamflow of the Floridan aquifer in Florida, July 6-12, 1963*: Florida Geol. Survey Map Series No.

Kohler, M. A., Nordenson, T. J., and Baker, D. R.
1959 *Evaporation Maps for the United States*: Technical Paper No. 37, U.S. Weather Bureau.

Pride, R. W., Meyer, F. W., and Cherry, R. N.
1966 *Hydrology of Green Swamp Area in Central Florida*: Report of Investigation No. 42, Bureau of Geology, Florida Board of Conservation.

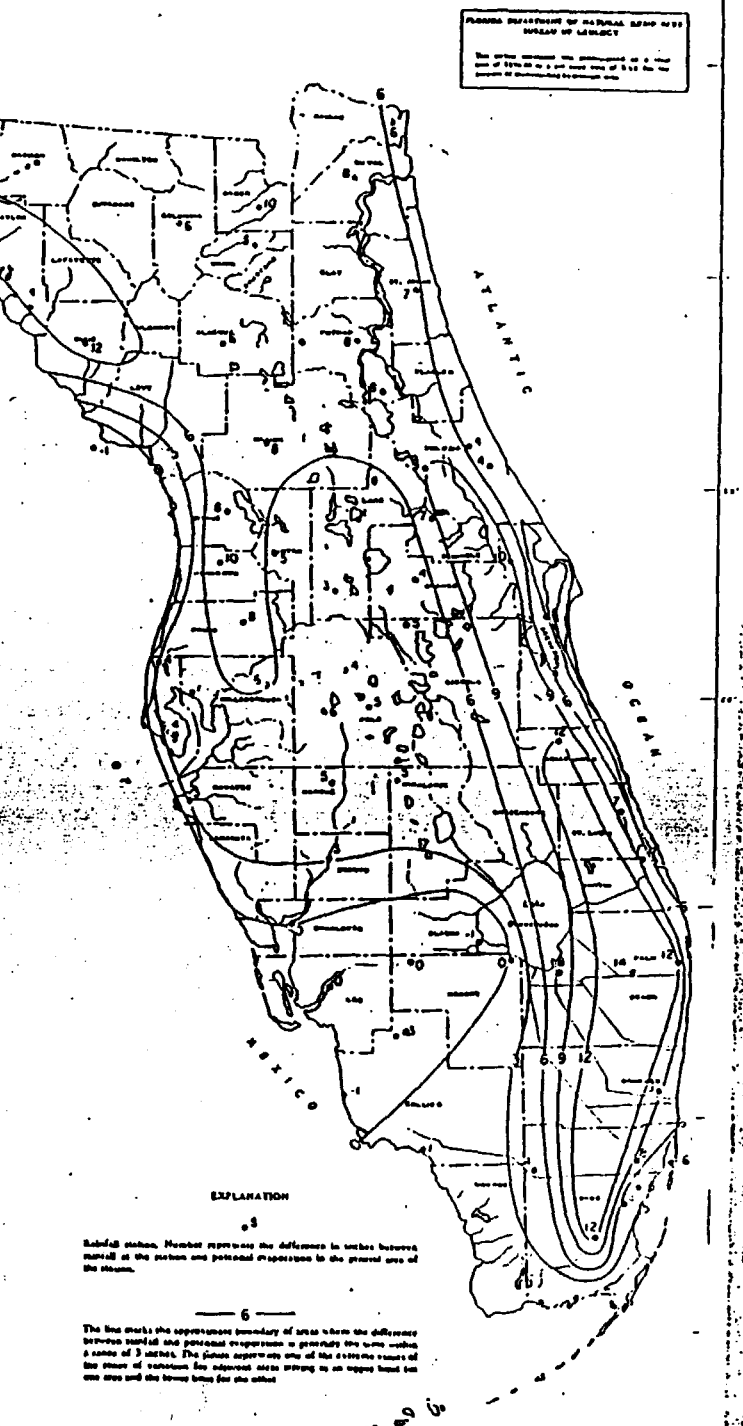
Stewart, H. G., Jr.
1966 *Ground-water resources of Polk County*: Florida Geol. Survey Rept. Inv. 43.

EXPLANATION

Rainfall station. Number represents the difference in inches between rainfall at the station and potential evaporation in the general area of the station.

6

The line marks the approximate boundary of areas where the difference between rainfall and potential evaporation is generally the same within a range of 3 inches. The labels approximate one of the extreme values of the range of variation for adjacent areas lying to an upper level for one area and the lower level for the other.



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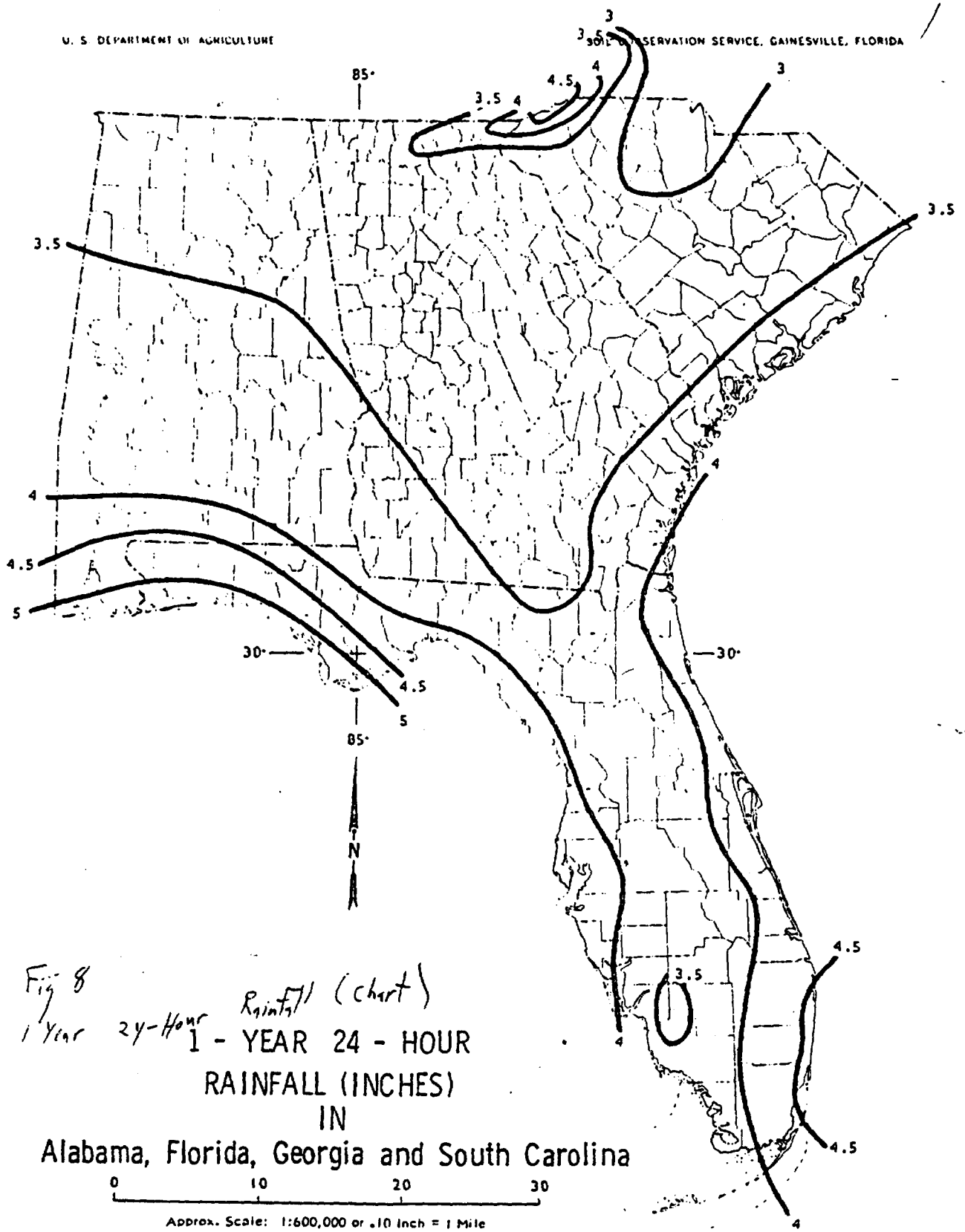

Reference Fig 8
1 Year 24-Hour Rainfall (chart)

1 - YEAR 24 - HOUR RAINFALL (INCHES) IN Alabama, Florida, Georgia and South Carolina

0 10 20 30

Approx. Scale: 1:600,000 or .10 Inch = 1 Mile

Ref: Technical Paper No. 40, Weather Bureau

USDA SCS-FORT WORTH, TEX. 1973

6-73 4-L-33137

Reference 27

HAZARD RANKING SYSTEM

DATA COLLECTION AND DOCUMENTATION TECHNIQUES FOR HRS SCORING OF HAZARDOUS WASTE SITES

MARCH, 1987

Prepared By

NUS Corporation
Superfund Division

In Cooperation With

U.S. Environmental Protection Agency
Investigations and Compliance Unit
Region IV

WELL COMPLETION REPORT — Reference 28

MARKETPLACE ASSO. 7131 [redacted]

Owner | Address | City | State | Zip

C. B. Maxson Jr. | 1063 | 1/23/85 | 105' | 120'

Contractor Signature | License No. | Completion Date | Casing Depth | Total Depth

C. B. Maxson Jr.

Drillers Name | Registration No.

TYPE OF WORK: Construct (✓) Repair ( ) Abandon ( )

WELL USE: Private ( ) Public ( ) Monitor ( ) Irrigation (✓)

Industrial ( ) Fire Well ( ) Other

METHOD: Rotary ( ) Cable Tool ( ) Jet ( ) Combination ( )

Other Driven

STATIC WATER LEVEL 8 Ft. below top of casing

PUMPING WATER LEVEL Ft. after Hrs. at GPM

PUMP SIZE H.P. CAPACITY GPM

PUMP TYPE INTAKE DEPTH

SOUTH WELL

LOCATION

Located Near Oakland & 441

County BROWARD

30 49S 42E

1/4 1/4 Section Township Range

26° 09' 56" 80° 12' 04"

Latitude Longitude

Cuttings sent to District ( ) Yes (✓) No

Note: PWS Wells attach a site map if well location is different from site location on permit application.

From top of ground

N

LOCATE IN SECTION

Grout Thickness & Depth	Casing Screen Diam & Depth	Depth (ft) From	To	DRILL CUTTINGS LOG Examine cuttings every 20 ft. or at formation changes. Give color, grain size, and type of material. Note cavities, depth to producing zones.
	4	0	6	WHITE SAND
	4	6	11	DARK BROWN SAND
	4	11	19	TAN-MEDIUM FINE SAND
	4	19	34	WHITE-MEDIUM SAND
	4	34	48	WHITE-FINE SAND
	4	48	57	WHITE-MEDIUM SAND
	4	57	66	WHITE-MEDIUM SAND + TRACES OF ROCK
	4	66	102	SOFT LIMEROCK-SOME COARSE SAND
	4 105	102	120	HARD + SOFT LIMEROCK

Casing: Black Steel ( ) Galv. (✓) PVC ( ) Fiberglass ( )

Screen: Type Slot size

Gravel pack from (ft.) to (ft.)

Type of grout with % additives

# of bags of cement

GROUND FORM NUMBER 0124 DECEMBER 1, 1984

WELL COMPLETION REPORT PERMIT NO.

Marketplace Asso. 7131 W. Broward Blvd. Plantation Fla

Owner | Address | City | State | Zip

C. B. Maxson Jr. | 1063 | 1/23/85 | 76' | 90'

Contractor Signature | License No. | Completion Date | Casing Depth | Total Depth

C. B. Maxson Jr.

Drillers Name | Registration No.

TYPE OF WORK: Construct (✓) Repair ( ) Abandon ( )

WELL USE: Private ( ) Public ( ) Monitor ( ) Irrigation (✓)

Industrial ( ) Fire Well ( ) Other

METHOD: Rotary ( ) Cable Tool ( ) Jet ( ) Combination ( )

Other Driven

STATIC WATER LEVEL 8 Ft. below top of casing

PUMPING WATER LEVEL Ft. after Hrs. at GPM

PUMP SIZE H.P. CAPACITY GPM

PUMP TYPE INTAKE DEPTH

NORTH WELL

LOCATION

Located Near Oakland & 441

County BROWARD

30 49S 42E

1/4 1/4 Section Township Range

26° 09' 56" 80° 12' 04"

Latitude Longitude

Cuttings sent to District ( ) Yes (✓) No

Note: PWS Wells attach a site map if well location is different from site location on permit application.

From top of ground

N

LOCATE IN SECTION

Grout Thickness & Depth	Casing Screen Diam & Depth	Depth (ft) From	To	DRILL CUTTINGS LOG Examine cuttings every 20 ft. or at formation changes. Give color, grain size, and type of material. Note cavities, depth to producing zones.
	4	0	9	WHITE-MEDIUM SAND
	4	9	14	FINE WHITE SAND + LOOSE ROCK
	4	14	25	FINE WHITE SAND
	4	25	56	MEDIUM-COARSE WHITE SAND
	4	56	67	MEDIUM-COARSE WHITE SAND + LOOSE ROCK
	4	67	74	LOOSE LIMEROCK
	4 76	74	90	HARD + SOFT LIMEROCK

Casing: Black Steel ( ) Galv. (✓) PVC ( ) Fiberglass ( )

Screen: Type Slot size

Gravel pack from (ft.) to (ft.)

Type of grout with % additives

# of bags of cement

WELL COMPLETION REPORT

PERMIT NO. _____

[illegible] Assoc 7131 W. Broward Blvd, Plantation FLA

Address | City | State | Zip

[illegible] Jr. 1063 | 1/23/85 | 70' | 90'

Licensed No. | Completion Date | Casing Depth | Total Depth

[illegible] Jr.

Registration No.

Construct ( ) Repair ( ) Abandon ( )

Public ( ) Monitor ( ) Irrigation (✓)

Industrial ( ) Fire Well ( ) Other

METHOD: Rotary ( ) Cable Tool ( ) Jet ( ) Combination ( )

Other Driven

STATIC WATER LEVEL 8 Ft. below top of casing

PUMPING WATER LEVEL _____ Ft. after _____ Hrs. at _____ GPM

PUMP SIZE _____ H.P. CAPACITY _____ GPM

PUMP TYPE _____ INTAKE DEPTH _____

EAST WELL

LOCATION

Located Near Oakland E

441

County Broward

30 49S 42E

1/4 1/4 Section Township Range

26°09'54" 80°12'08"

Latitude Longitude

Cuttings sent to District ( ) Yes

( ) No

Free top of ground

	X		

N

LOCATE IN SECTION

Note: PWS Wells attach a site map if well location is different from site location on permit application.

Grout Thickness & Depth	Casing Screen Size	Depth (ft) From	To	DRILL CUTTINGS LOG Examine cuttings every 20 ft. or at formation changes. Give color, grain size, and type of material. Note cavities, depth to producing zones.
	4	0	5	White-medium sand
	4	5	13	Dark Brown medium sand
	4	13	61	White-medium sand
	4	61	66	Coarse white sand & some Roc
	4 70'	66	79	Soft sand Rock & Lime
		79	90	Hard & soft layers of Lime Roc

Casing: Black Steel ( ) Galv. (✓) PVC ( ) Fiberglass ( )

Screen: Type _____ Slot size _____

Gravel pack from _____ (ft.) to _____ (ft.)

Type of grout with % additives _____

# of bags of cement _____

WELL COMPLETION REPORT

PERMIT NO. SE06135-B

Owner	Address	City	State	Zip
CITY OF LAUDERDALE LAKES	4300 NW 36 St.	LAUDERDALE LAKES	FLA	33319

Contractor Signature	License No.	Completion Date	Casing Depth	Total Depth
J.R. Kuzmik	1166	8-15-85	71'	83'

Driller's Name	Registration No.
RICHARD LINTHICUM	40277

TYPE OF WORK: Construct (X) Repair ( ) Abandon ( )
WELL USE: Private ( ) Public ( ) Monitor ( ) Irrigation (X)
Industrial ( ) Fire Well ( ) Other
METHOD: Rotary ( ) Cable Tool (X) Jet ( ) Combination ( )
Other
STATIC WATER LEVEL 5 Ft. below top of casing
PUMPING WATER LEVEL 6.5 Ft. after 4 Hrs. at 700 GPM
PUMP SIZE 10 H.P. CAPACITY 200 GPM
PUMP TYPE SUBMERSIBLE INTAKE DEPTH 30'

LOCATION
Located Near 3773 NW 21 St.
County BROWARD
[illegible] 42E
Section Township Range
[illegible] 13 1/4 W 80° 11' 49.9
Latitude Longitude

Cuttings sent to District? ( ) Yes
(X) No

From top of ground

LOCATE IN SECTION

Note: PWS Wells attach a site map if well location is different from site location on permit application.

Grout Thickness & Depth	Casing Screen Diam & Depth	Depth (ft) From	To	DRILL CUTTINGS LOG Examine cuttings every 20 ft. or at formation changes. Give color, grain size, and type of material. Note cavities, depth to producing zones.
	—	0	5	BROWN SAND
CEMENT CAP	10" 71'	5	12	LIGHT BROWN SAND
		12	33	GREY SAND
		33	50	" "
		50	63	" "
		63	68	WHITE SAND + SAND ROCK
		68	83	SAND ROCK

CONSTRUCT WELL PIT (4'x6'x4' DEEP) - CUT CASING APPROX 2' BELOW GRADE - CEMENT BOTTOM AROUND WELL - (PIT 3' BELOW GRADE)

Casing: Black Steel (X) Galv. ( ) PVC ( ) Fiberglass ( )
Screen: Type NONE Slot size
Gravel pack from (ft.) to (ft.)
Type of grout with % additives
# of bags of cement

SFWMD FORM NUMBER 0124 DECEMBER 1, 1984

WELL COMPLETION REPORT

FORM 0124 Rev. 4/85

WELL PERMIT NO.

Owner	Address	City	State	Zip
Jones Chemicals	1800 NW 22nd St.	Ft. Lauderdale	FL	33310

Contractor's Name	License No.	Completion Date	Casing Depth	Total Depth	Well #
J.M. Hensley Drilling	2489	11/20/85	10.2 ft	10.2 ft	5

Driller's Name	Registration No.
J.M. Hensley	40663

TYPE OF WORK: Construct (X) Repair ( ) Abandon ( )
WELL USE: Domestic Well ( ) Public ( ) Monitor (X) Test ( )
Irrigation ( ) Fire Well ( ) Other
METHOD: Rotary with MUD ( ) or Air ( ), Cable Tool ( ), Jet ( )
Casing Driven ( ), Other Auger
STATIC WATER LEVEL 5 Ft. below top of casing
PUMPING WATER LEVEL NA Ft. after Hrs. at GPM
PUMP SIZE NA H.P. CAPACITY GPM
PUMP TYPE NA INTAKE DEPTH
From top of ground

LOCATION
Located Near Jones address above near RR tracks
County Broward
1/4 SW 1/4 SW 1/4, 28 49S 42E
Section Township Range
26° 09' 15" N + 80° 10' 03" W
Latitude-Longitude

Cuttings sent to District? ( ) Yes
(X) No

LOCATE IN SECTION 28

Note: PWS Wells attach a site map if well location is different

Grout Thickness & Depth	Casing & Screen Diameter & Depth		Depth (ft) From	To	DRILL CUTTINGS LOG Examine cuttings every 20 ft. or at formation changes. Give color, grain size, and type of material. Note cavities, depth to producing zones.
2 ft			0	2'	cement grout
8 ft			2	10.2	6/20 silica sand
3'	2"	0.2'	0.2	3.2	PVC casing
5'	2"	3.2'	3.2	8.2	PVC screen
2'	2"	8.2'	8.2	10.2	PVC casing
2'			0	2'	SAND: fine to medium
					mixed w/ soil +
					limestone gvl.
Number of bags			2	10.2	SAND: fine to med.
8.2'					quartz sd. w/ occ.
					cse sd + gvl.

Casing: Black Steel ( ) Galv. ( ) PVC (X) Fiberglass ( )
Screen: Type PVC Slot size 0.01 in
Screened from 3.2 (ft.) to 8.2 (ft.)
Type of grout with % additives 6/20 sand
Water: Clear (X) Colored ( ) Sulphur ( ) Salty ( ) Iron ( )

FORM 0124
Rev. 12/84

WELL COMPLETION REPORT

CONSTRUCTION PERMIT NO. _____

CARD-DISTRICT
SHEET-DRILLER

Owner	Address	City	State	Zip
Palm Air [illegible]	[illegible]	[illegible]	Florida	[illegible]067

Contractors Name	License No.	Completion Date	Well No.	Total Depth
Morton [illegible] Supply	[illegible]	2-7-85		90'

Drillers Name	Registration No.
Patrick Seery	Applied for

TYPE OF WORK: Construct ( ) Repair ( ) Abandon ( )

WELL USE: Private Well ( ) Public ( ) Monitor ( ) Test ( )
Irrigation ( ) Fire Well ( ) Other _____

METHOD: Rotary with MUD ( ) or Air ( ), Cable Tool ( ), Jet ( )
Casing Driven ( ), Other _____

STATIC WATER LEVEL _____ Ft. below top of casing

PUMPING WATER LEVEL _____ Ft. after _____ Hrs. at _____ GPM

PUMP SIZE by others H.P. CAPACITY _____ GPM

PUMP TYPE _____ INTAKE DEPTH _____

From top of ground

Grout Thickness & Depth	Casing Screen Diam. & Depth	Depth From	(ft) To	DRILL CUTTING LOG Examine cuttings every 20 ft. or at formation changes. Give color, grain size, and type of material. Note cavities, depth to producing zones.
[illegible]	[illegible]	[illegible]	20	Sand
		20		Sand
		30	[illegible]	Sand
		[illegible]	[illegible]	Sand
		[illegible]	[illegible]	Sand
		35	[illegible]	Limestone

LOCATION

Located Near _____

County Broward

Sec. 5, Tr. A [illegible]

1/4 1/4 Section Township Range

Latitude - Longitude

Cuttings sent to District? ( ) Yes
(X) No

No cuttings sent "COLLECT" will be accepted

Note: PWS Wells attach a site map if well location is different from site location on permit application

LOCATE IN SECTION

Casing: Black Steel ( ) Galv. (X) PVC ( ) Fiberglass ( )

Screen: Type N/A Slot size _____

Gravel pack from _____ (ft.) to _____ (ft.)

Type of grout with % Additives Neat cement

# of bags of cement

FORM 0124
Rev. 12/84

WELL COMPLETION REPORT

CONSTRUCTION PERMIT NO. _____ CARD-DISTRICT SHEET-DRILLER

Owner	Address	City	State	Zip
M. SCHOENHOFT	770 N.E. 34 Ct.	OAKLAND PARK	FLA	33334

Contractors Name	License No.	Completion Date	Well No.	Total Depth
C.B. MAXSON JR. MAXSON WELL DRILLING INC	#1063	4/4/85	N/A	45'

Drillers Name	Registration No.
C.B. Maxson, Jr.	40294

TYPE OF WORK: Construct (✓) Repair ( ) Abandon ( )
WELL USE: Private Well (✓) Public ( ) Monitor ( ) Test ( )
Irrigation (✓) Fire Well ( ) Other _____
METHOD: Rotary with MUD (✓) or Air ( ), Cable Tool ( ), Jet ( )
Casing Driven (✓), Other _____
STATIC WATER LEVEL 7 Ft. below top of casing EST.
PUMPING WATER LEVEL _____ Ft. after _____ Hrs. at 125 GPM
PUMP SIZE _____ H.P. CAPACITY W/25" VACUUM GPM
PUMP TYPE GASOLINE/EST PUMP INTAKE DEPTH _____ From top of ground

LOCATION
Located Near OAKLAND PK BLVD & DIXIE HWY.
County BROWARD
49S 42E
1/4 1/4 Section Township Range
26° 10' 12" 80° 08' 20"
Latitude - Longitude

Cuttings sent to District? ( ) Yes
(✓) No
No cuttings sent "COLLECT" will be accepted
Note: PWS Wells attach a site map if well location is different from site location on permit application.

LOCATE IN SECTION

Grout Thickness & Depth	Casing Screen Diam. & Depth	Depth From	(ft) To	DRILL CUTTING LOG Examine cuttings every 20 ft. or at formation changes. Give color, grain size, and type of material. Note cavities, depth to producing zones.
2"	2	0	39	SAND
3'	42	39	42	LIMEROCK
		42	45	LIMEROCK

Casing: Black Steel ( ) Galv. (✓) PVC ( ) Fiberglass ( )
Screen: Type _____ Slot size _____
Gravel pack from _____ (ft.) to _____ (ft.)
Type of grout with % Additives PORTLAND W/5 GALS WATER PER BAG.
# of bags of cement 1

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WELL COMPLETION REPORT

CONSTRUCTION PERMIT NO. _____ CARD-DISTRICT SHEET-DRILLER

Owner	Address	City	State	Zip
Pat Hallett	2700 N.E. 29 St.	Ft Lauderdale	FLA	

Contractors Name	License No.	Completion Date	Well No.	Total Depth
C.B. Maxson Jr.	1063	3/1/85		24'

Drillers Name	Registration No.
C.B. Maxson Jr.	

TYPE OF WORK: Construct (✓) Repair ( ) Abandon ( )
WELL USE: Private Well (✓) Public ( ) Monitor ( ) Test ( )
Irrigation (✓) Fire Well ( ) Other _____
METHOD: Rotary with MUD (✓) or Air ( ), Cable Tool ( ), Jet ( )
Casing Driven (✓), Other _____
STATIC WATER LEVEL 8' Ft. below top of casing
PUMPING WATER LEVEL BY GASOLINE PUMP Ft. after _____ Hrs. at 90+ W/23" VACUUM GPM
PUMP SIZE _____ H.P. CAPACITY _____ GPM
PUMP TYPE _____ INTAKE DEPTH _____ From top of ground

LOCATION
Located Near OAKLAND PK BLVD & N. FEDERAL HWY.
County BROWARD
49S 42E
1/4 1/4 Section Township Range
26° 10' 48" 80° 06' 42"
Latitude - Longitude

Cuttings sent to District? ( ) Yes
(✓) No
No cuttings sent "COLLECT" will be accepted
Note: PWS Wells attach a site map if well location is different from site location on permit application.

LOCATE IN SECTION

Grout Thickness & Depth	Casing Screen Diam. & Depth	Depth From	(ft) To	DRILL CUTTING LOG Examine cuttings every 20 ft. or at formation changes. Give color, grain size, and type of material. Note cavities, depth to producing zones.
1"-0'	2	0	18	SAND
to 3'	21'	18	21	Coral Rock
		21	24	Coral Rock

Casing: Black Steel ( ) Galv. (✓) PVC ( ) Fiberglass ( )
Screen: Type _____ Slot size _____
Gravel pack from _____ (ft.) to _____ (ft.)
Type of grout with % Additives PORTLAND W/5 GALS WATER PER BAG
# of bags of cement 1

WELL COMPLETION REPORT — PERMIT NO. SE03146-A

Holland Mobile Homes, Inc. — 1300 S.W. 21st Lane — Fort Lauderdale, Florida — 33312
Owner — Address — City — State — Zip

Morton Pump & Supply — 1044 — May 8, 1986 — 85 — 105
Contractor Signature — License No. — Completion Date — Casing Depth — Total Depth

Mark C. Tiley — 400750 0
Drillers Name — Registration No.

TYPE OF WORK: Construct (X) Repair ( ) Abandon ( )
WELL USE: Private ( ) Public ( ) Monitor ( ) Irrigation (X)
Industrial ( ) Fire Well ( ) Other
METHOD: Rotary ( ) Cable Tool ( ) Jet ( ) Combination ( )
Other Driven
STATIC WATER LEVEL 5 Ft. below top of casing
PUMPING WATER LEVEL Ft. after Hrs. at GPM
PUMP SIZE 40 H.P. CAPACITY 650 GPM
PUMP TYPE Vert. Turbin INTAKE DEPTH
From top of ground

LOCATION
Located Near 1300 S.W. 21st Lane
Ft. Lauderdale, Fl.
County Broward
7 50S 42E
Section Township Range
80 10 03
Latitude Longitude

Cuttings sent to District? ( ) Yes
(X) No

LOCATE IN SECTION

Note: PWS Wells attach a site map if well location is different from site location on permit application.

Grout Thickness & Depth	Casing Screen Diam. & Depth		Depth (ft) From	To	DRILL CUTTINGS LOG Examine cuttings every 20 ft. or at formation changes. Give color, grain size, and type of material. Note cavities, depth to producing zones.
3"		3"	L.S.	45	Sand
5		5	45	55	Sandstone
3'		86	55	86	Limestone
			86	106	Same

Casing: Black Steel (X) Galv. ( ) PVC ( ) Fiberglass ( )
Screen: Type Slot size
Gravel pack from (ft.) to (ft.)
Type of grout with % additives Neat Portland
# of bags of cement 2½

SPEED FORM NUMBER 0134 DECEMBER 1, 1984

WELL COMPLETION REPORT — CONSTRUCTION PERMIT NO. — CARD-DISTRICT SHEET-DRILLER

Howell, Keith — 3830 S.W. 10th Court — Ft. Lauderdale — Fl.
Owner — Address — City — State — Zip

Morton Pump & Supply — 1044 — 4-15-85 — 70 ft.
Contractors Name — License No. — Completion Date — Well No. — Total Depth

Patrick Seery — Unknown
Drillers Name — Registration No.

TYPE OF WORK: Construct (X) Repair ( ) Abandon ( )
WELL USE: Private Well ( ) Public ( ) Monitor ( ) Test ( )
Irrigation (X) Fire Well ( ) Other
METHOD: Rotary with MUD ( ) or Air ( ) Cable Tool ( ) Jet ( )
Casing Driven (X) Other
STATIC WATER LEVEL Ft. below top of casing
PUMPING WATER LEVEL Ft. after Hrs. at GPM
PUMP SIZE H.P. CAPACITY GPM
PUMP TYPE INTAKE DEPTH
From top of ground

LOCATION
Located Near 3830 S.W. 10th Ct.
Ft. Lauderdale, Fl.
County Broward
7 50S 42E
1/4 1/4 Section Township Range
Latitude - Longitude

Cuttings sent to District? ( ) Yes
(X) No
No cuttings sent "COLLECT" will be accepted

LOCATE IN SECTION

Note: PWS Wells attach a site map if well location is different from site location on permit application

Grout Thickness & Depth	Casing Screen Diam. & Depth		Depth (ft) From	To	DRILL CUTTING LOG Examine cuttings every 20 ft. or at formation changes. Give color, grain size, and type of material. Note cavities, depth to producing zones.
2"	2"		L.S.	40	Sand and land fill
			40	63	Same
3"			63	70	Sandstone and lime-
	63'				stone, some shell

Casing: Black Steel ( ) Galv. (X) PVC ( ) Fiberglass ( )
Screen: Type Slot size
Gravel pack from (ft.) to (ft.)
Type of grout with % Additives Neat Portland
# of bags of cement

FORM 0124 Rev. 12/84

WELL COMPLETION REPORT

CONSTRUCTION PERMIT NO. [illegible]

CARD-DISTRICT SHEET-DRILLER

30

School Board of Broward County, 1320 SW 4 St. Fort Lauderdale, Fl. 33310

Owner / Address / City / State / Zip

Lesh Drilling Inc. 1939 3-29-85 Stranahan 92'

Contractors Name / License No. / Completion Date / Well No. / Total Depth

Lynn L. Lesh 40154

Drillers Name / Registration No.

TYPE OF WORK: Construct (x) Repair ( ) Abandon ( )

WELL USE: Private Well ( ) Public ( ) Monitor ( ) Test ( )

Irrigation (x) Fire Well ( ) Other

METHOD: Rotary with MUD (x) or Air ( ), Cable Tool ( ), Jet ( )

Casing Driven ( ), Other

STATIC WATER LEVEL 6 Ft. below top of casing

PUMPING WATER LEVEL 7 Ft. after 2 Hrs. at 600 GPM

PUMP SIZE 40 H.P. CAPACITY 550 GPM

PUMP TYPE Vertical Turbine INTAKE DEPTH 35' From top of ground

LOCATION

Located Near 1800 SW 5 Pl.

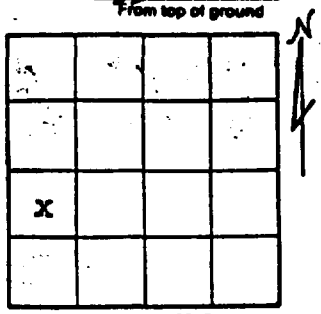
Ft. Lauderdale

County Broward

[illegible] SW 9 50S 42E

1/4 1/4 Section Township Range

Latitude - Longitude



Cuttings sent to District? ( ) Yes (x) No

No cuttings sent "COLLECT" will be accepted

Note: PWS Wells attach a site map if well location is different from site location on permit application.

x			

LOCATE IN SECTION

N

Grout Thickness & Depth	Casing Screen Diam. & Depth	Depth From	(ft) To	DRILL CUTTING LOG Examine cuttings every 20 ft. or at formation changes. Give color, grain size, and type of material. Note cavities, depth to producing zones.
2"	10"	0	30	Soft Buff Sand
		30	60	Green to Brown sandy
				clay with sandstone
				streaks (soft)
72'	72	60	72	Firm to hard sands-
				tone, some voids &
				water loss.
		72	92	Firm to hard
				sandstone (gray)
				Voids & water loss.
		72	92	Open Hole

Casing: Black Steel ( ) Galv. ( ) PVC (x) Fiberglass ( )

Screen: Type Slot size

Gravel pack from (ft.) to (ft.)

Type of grout with % Additives Neat Cement 5%

# of bags of cement 35 Bentonite

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WELL COMPLETION REPORT

CONSTRUCTION PERMIT NO.

CARD-DISTRICT SHEET-DRILLER

CARFAVE INC 848 N.E. 2 AVE FT. LAUDERDALE FLA

Owner / Address / City / State / Zip

C.B. MAXSON JR MAXSON WELL DRILLING INC 1063 8/29/85 1 36'

Contractors Name / License No. / Completion Date / Well No. / Total Depth

C.B. MAXSON JR 40294

Drillers Name / Registration No.

TYPE OF WORK: Construct (✓) Repair ( ) Abandon ( )

WELL USE: Private Well (✓) Public ( ) Monitor ( ) Test ( )

Irrigation (✓) Fire Well ( ) Other

METHOD: Rotary with MUD (✓) or Air ( ), Cable Tool ( ), Jet ( )

Casing Driven (✓), Other

STATIC WATER LEVEL 4 Ft. below top of casing

PUMPING WATER LEVEL Ft. after Hrs. at 100+ GPM 25" VACUUM

PUMP SIZE H.P. CAPACITY GPM

PUMP TYPE GAS TEST PUMP INTAKE DEPTH From top of ground

LOCATION

Located Near

County BROWARD

3 50S 42E

Section Township Range

26° 08' 02" 80° 08' 28"

Latitude - Longitude

Cuttings sent to District? ( ) Yes (✓) No

No cuttings sent "COLLECT" will be accepted

Note: PWS Wells attach a site map if well location is different from site location on permit application.

		x	

LOCATE IN SECTION

N

Grout Thickness & Depth	Casing Screen Diam. & Depth	Depth From	(ft) To	DRILL CUTTING LOG Examine cuttings every 20 ft. or at formation changes. Give color, grain size, and type of material. Note cavities, depth to producing zones.
2"	2	0	14	SAND
1' to		14	20	SAND + LOOSE ROCK
3'		20	32	SAND
	24	32	34	CORAL ROCK
		34	36	CORAL ROCK

Casing: Black Steel ( ) Galv. (✓) PVC ( ) Fiberglass ( )

Screen: Type Slot size

Gravel pack from (ft.) to (ft.)

Type of grout with % Additives NEAT PORTLAND W/5 GALS

# of bags of cement [illegible]

U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF EMERGENCY AND REMEDIAL RESPONSE
C E R C L A

M.2 - SITE MAINTENANCE FORM

TION: _

A ID: _____

TE NAME: Ft. Lauderdale Gasification Plant SOURCE: _ 51660

REET: Intersection of NW 7th Ave & NW 4th Street CONG DIST: 15

TY: Ft. Lauderdale ZIP: 33311-____

TY NAME: Broward Co. , CNTY CODE: 011

TITUDE: 26°, 7', 33" LONGITUDE: 80°, 9', 3"

SA: ____ HYDRO UNIT: _____

VENTORY IND: _ REMEDIAL IND: _ REMOVAL IND: _ FED FAC IND: _

L IND: _ NPL LISTING DATE: __/__ NPL DELISTING DATE: __/__

PROACH: ___ SITE CLASS: __

ITE/SPILL IDS: __ __ __ __ __

PM NAME: _____ RPM PHONE: ___-___-____

IOXIN TIER: ____ REG FLD1: _____ REG FLD2: _

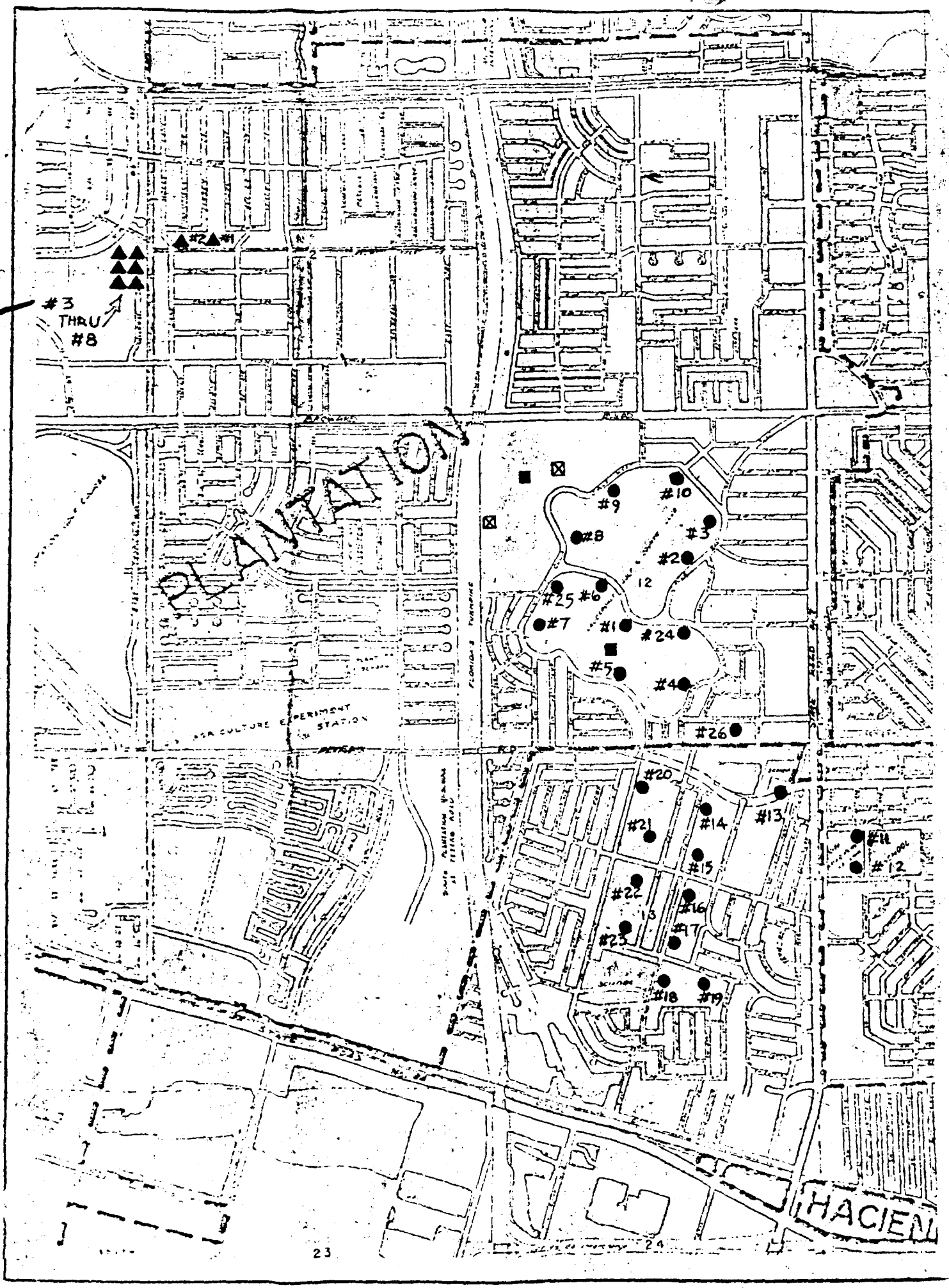
SP TERM: PENDING (_) NO FURTHER ACTION (_)

F DISP: NO VIABLE RESP PARTY (_) VOLUNTARY RESPONSE (_)

ENFORCED RESPONSE (_) COST RECOVERY (_)

ITE DESCRIPTION:

Coal TM components may be present on site
These components may have contaminated
the Biscayne Aquifer (shallow - sole source)
Aquifer.


#2 #1
#3 THRU #8
#9
#10
#8
#3
#2
12
#25 #6
#7
#1
#24
#5
#4
#26
AGRICULTURE EXPERIMENT STATION
#20
#21
#14
#13
#11
#12
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#22
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HACIEN