DOCUMENTATION OF A DIGITAL SPATIAL DATA BASE FOR HYDROLOGIC INVESTIGATIONS, BROWARD COUNTY, FLORIDA

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations Report 92-4061

Prepared in cooperation with the

SOUTH FLORIDA WATER MANAGEMENT DISTRICT and the

BROWARD COUNTY OFFICE OF NATURAL RESOURCE PROTECTION

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By Roy S. Sonenshein

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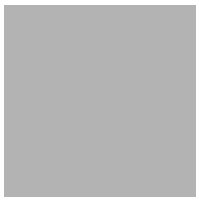
Tallahassee, Florida
1992

U.S. DEPARTMENT OF THE INTERIOR
MANUEL LUJAN, JR., Secretary



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CONVERSION FACTORS AND VERTICAL DATUM

Multiply	By	To obtain
foot (ft)	0.3048	meter
foot per day (ft/d)	0.3048	meter per day
gallon (gal)	3.785	liter
mile (mi)	1.609	kilometer
foot squared per day (ft^2/d)	0.09290	meter squared per day
cubic foot per day (ft^3/d)	0.02832	cubic meter per day

Sea level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929--a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

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ABSTRACT

Geographic information systems have become an important tool in planning for the protection and development of natural resources, including ground water and surface water. A digital spatial data base consisting of 18 data layers that can be accessed by a geographic information system was developed for Broward County, Florida. Five computer programs, including one that can be used to create documentation files for each data layer and four that can be used to create data layers from data files not already in geographic information system format, were also developed.

Four types of data layers have been developed. Data layers for manmade features include major roads, municipal boundaries, the public land-survey section grid, land use, and underground storage tank facilities. The data layer for topographic features consists of surveyed point land-surface elevations. Data layers for hydrologic features include surface-water and rainfall data-collection stations, surface-water bodies, water-control district boundaries, and water-management basins. Data layers for hydrogeologic features include soil associations, transmissivity polygons, hydrogeologic unit depths, and a finite-difference model grid for south-central Broward County. Each data layer is documented as to the extent of the features, number of features, scale, data sources, and a description of the attribute tables where applicable.

1.0 INTRODUCTION

1.1 Purpose and Scope

DOCUMENTATION OF A DIGITAL SPATIAL DATA BASE FOR USE IN A GEOGRAPHIC INFORMATION SYSTEM (GIS)

A digital spatial data base that can be used in a GIS for hydrologic investigations has been documented. The data base includes 18 data layers.

Geographic information systems (GIS) have become an important tool in assessing and planning for the protection of natural resources. Most Federal and State natural resource agencies and many County environmental agencies in Florida are currently using GIS to assist in mathematical modeling, resource mapping, and risk assessments.

The U.S. Geological Survey (USGS), in cooperation with the South Florida Water Management District (SFWMD) and the Broward County Office of Natural Resource Protection (BCONRP), developed a digital spatial data base for Broward County consisting of layers of data that can be used in water-resources investigations. These data layers include manmade features such as municipal boundaries and roads, topographic features, hydrologic features such as canals and lakes, and hydrogeologic features such as aquifer thickness. Computer programs were written for use in developing additional layers of data from existing data bases such as the Florida Department of Environmental Regulation (FDER) underground storage tank data base.

This report describes the digital spatial data base that was developed and the five computer programs[1] that can be used to create additional data layers from existing data files or to document existing layers. Most of the data layers cover Broward County east of the conservation areas (fig. 1.1-1.). Some data layers cover all of Broward and may include parts of Dade County.

As more digital spatial data bases are developed for use with GIS, there is a need of information to document these data bases, including the source, scale, and limitations of each data layer. This documentation is necessary to eliminate the possibility of data-base users misinterpreting the spatial data.

[1]The computer programs presented in this report run on machines used by the U.S. Geological Survey.

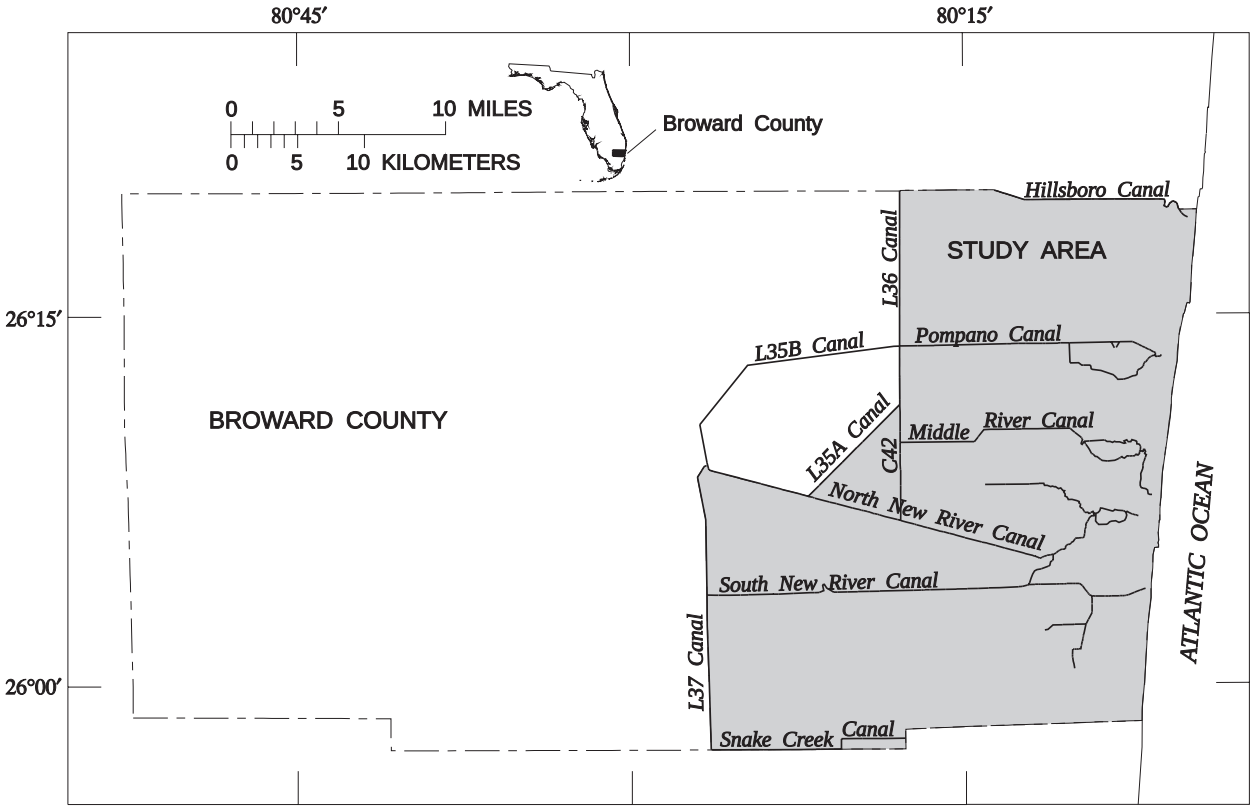

Figure 1.1-1. Broward County showing location of the study area.

DATA LAYERS DEVELOPED FROM MULTIPLE DATA SOURCES

Many different sources and means were used to develop the data layers, including digitizing, modification of existing data layers, and use of computer programs to access data bases not in GIS format.

Data layers for the digital spatial data base were developed by many different means and from many different sources. Some layers such as canals and lakes were digitized directly from topographic quadrangles and aerial photographs; whereas other layers were created using coordinates from point data such as section corners and underground storage tank locations. Existing layers were sometimes modified and combined to create new layers. This maintains consistency between layers. For example, several layers were developed using the roads, canals, and section lines as a base. These include municipal boundaries, drainage districts, and drainage basins. Several layers of data were developed using computer programs that accessed existing nonspatial data-base formats. This allows these layers to be recreated and updated as the nonspatial data bases are updated. These layers include the underground storage tanks and output from the MODFLOW model particle tracking programs. The reference section, presented here, lists the sources of data that are cited in this report.

Documentation files for each data layer were prepared using computer programs developed by Nebert and others (see section 2.1). These files store information about the layer (map projection and source of data) and about the data attributes (attribute descriptions, data domain, and data accuracy).

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----- 1952c, Survey of township 51 south, range 42 east: Fort Lauderdale, 1 sheet.

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1.0 INTRODUCTION--Continued
1.3 Glossary of Terms

GLOSSARY OF ACRONYMS AND COMMON TERMS

The glossary defines those terms and acronyms that may be unfamiliar to the reader.

AAT	Arc attribute table. Data-base table containing line attribute data.
ALBERS	A standardized coordinate system commonly used for large-scale maps with a predominant east-west expanse such as the conterminous United States.
AML	ARC Macro Language. Interactive, intepreted, programming language used within the ARC/INFO software.
ARC/INFO[2]	A geographic information system developed by Environmental Systems Research Institute, Redlands, Calif.
ATT	Data layer attribute description file created by the DOCUMENT computer program.
ATTRIBUTE	Descriptive information associated with map features.
AUTOCAD	A computer-aided drafting program developed by Autodesk, Inc.
BCONRP	Broward County Office of Natural Resource Protection. Before January 1989, the agency was known as the Broward County Environmental Quality Control Board.
BND	Data layer extent. The minimum and maximum coordinates that define the limits of the features in a data layer.
CPL	Command Procedure Language. Interactive, interpreted, programming language used within the PRIMOS operating system, developed by Prime Computer, Inc., Framingham, Mass.
DANGLE LENGTH	The minimum length allowed for arcs that are not connected to themselves or another arc at one of the end points.
DATA LAYER	A set of geographic features containing identity, geometric and topological location, and attribute data.
DBHYDRO	A data base system developed by the South Florida Water Management District for storage of hydrologic data.
DD	Decimal-degrees of latitude or longitude.
DLG	Digital Line Graph. Line map information in digital form produced by the U.S. Geological Survey (1989).
DMS	Degrees-minutes-seconds of latitude or longitude.
DOC	Data layer documentation file created by the DOCUMENT computer program.
ENDPOINT	Endpoint and starting point data file created by the MODPATH computer program.
FAC	Facility data file in the stationary tank inventory.
FDER	Florida Department of Environmental Regulation.
FDOR	Florida Department of Revenue.
FUZZY TOLERANCE	The minimum distance between all arc coordinates in a data layer.
GIS	Geographic Information Systems.
LOC	Location file in the stationary tank inventory.

[2]Use of firm and trade names in this report is for identification purposes only and does not constitute endorsement by the U.S. Geological Survey.

MODPATH	A computer program that calculates particle pathlines using data from a ground-water flow model.
NAR	Data layer documentation narrative file created by the DOCUMENT computer program.
NW	Northwest quadrant of the world.
NWIS	National Water Information System. A data-base system developed by the U.S. Geological Survey for storage of hydrologic data.
PAT	Polygon or Point Attribute Table. Data-base table containing polygon or point attribute data.
PATHLINE	Particle path data file created by the MODPATH computer program.
PLSS	Public Land-Survey System. The system is comprised of township, range, and section lines.
SFWMD	South Florida Water Management District.
STI	Florida Department of Environmental Regulation stationary tank inventory.
TICS	Registration or geographic control points that allow data layer features to be registered to a common coordinate system.
TIN	Triangulated Irregular Network. A set of adjacent nonoverlapping triangles used to represent the facets of a surface.
TNK	Storage tank data file in the stationary tank inventory.
UNIX	A system independent computer operating system.
USDA	U.S. Department of Agriculture.
USGS	U.S. Geological Survey.
USTARC	A computer program that creates point data layers from the stationary tank inventory files.
UTM	Universal Transverse Mercator. A standardized coordinate system based on the transverse Mercator projection and commonly used for large-scale mapping.
WORKSPACE	A logical computer file structure for organizing data layers and related tabular data into related groups.
WRMD	Broward County Water Resources Management Division.

2.0 COMPUTER PROGRAM DOCUMENTATION
2.1 DOCUMENT

DOCUMENT PROGRAM CREATES AND UPDATES DOCUMENTATION FILES FOR DATA LAYERS IN A GIS

A program to create and access a data layer documentation file is documented.

This section presents the documentation for the DOCUMENT program that creates and provides access to a data layer documentation file. Table 2.1-1 contains attributes and their descriptions within the documentation file (DOC) and the attribute description file (ATT) that are created by this program. The documentation for the DOCUMENT program and a sample outline for the narrative file (NAR) are listed below.

PROGRAM:	DOCUMENT
AUTHOR:	Douglas Nebert, U.S. Geological Survey, Reston, Virginia Original coding, February 1990 Peter VanMetre, U.S. Geological Survey, Tucson, Arizona Tim Liebermann, U.S. Geological Survey, Carson City, Nevada
SYSTEM:	ARC/INFO 5.0.1 UNIX
LANGUAGE:	ARC Macro Language (AML)
RELEASE:	REVO.9.1
DATE:	4/30/91
PURPOSE:	To create and access a data layer documentation file, proposed as a standard for use in the USGS, Water Resources Division; the documentation file is created as a combination of INFO and free-format text files that are managed as INFO files to ensure Export-Import translation.
CALLS:	ATT (ARC/INFO menu)--Attribute documentation ATTTABLE (ARC/INFO menu)--Attribute table documentation DOC (ARC/INFO menu)--First part of data layer documentation DOCCITE (ARC/INFO MENU)--Second part of data layer documentation (VARIOUS ARC 5.0 SYSTEM COMMANDS) (INFO SUBSYSTEM)--The documentation file templates must exist as INFO files in the ARC/INFO workspace ARCEXE50>ATOOL>ARC>DOC
USAGE:	DOCUMENT <data layer> {DISPLAY | CREATE | UPDATE | DELETE} {COPY | CITE} {source data layer} {FILE} {output file}

ARGUMENTS:

<data layer> - Mandatory; the data layer for which documentation is being accessed

{option} - Optional; documentation process to be performed; the choices are:

DISPLAY:	Default option if none is given; displays the contents of an existing documentation file
CREATE:	Creates documentation files using an interactive session; four INFO files are created, all having the root name <data layer>; the four files are the document file (.DOC), the reference file (.REF), the attribute description file (.ATT), and the narrative file (.NAR)
UPDATE:	Updates existing documentation files using an interactive session
DELETE:	Removes documentation files from <data layer>
COPY:	Copies existing documentation files from another {source data layer}
CITE:	Copies citation lines from the {source data layer}.DOC file to the <data layer>.REF file
FILE:	Writes contents of documentation files plus the data layer log and projection file (if present) to the sequential access file {output file}

{source data layer} - Optional; data layer with existing documentation for the COPY and CITE options

{output file} - Optional; sequential access output file to create for the FILE option

SAMPLE OUTLINE FOR NARRATIVE FILE (NAR)

1. Abstract
   1.1 Keywords
   1.2 Descriptors
2. Applications that use these data
   2.1 Intended use of data
   2.2 Limitations of data
3. Attribute discussion
4. Procedures used to create or automate data
5. Revisions made to data (revision number, date, description)
6. Reviews applied to data (review type, date, person, description)
7. Related spatial and tabular data sets
8. References cited
9. Notes

Table 2.1-1. Attributes from data layer documentation file (DOC) and attribute table documentation file (ATT**)**

[P, provided by program; US, user specified]

Attribute	Definition	Source
	Data Layer Documentation File (DOC)	
DOC-REV	Document program revision number	P
CREATE-DATE	DOC file create date	P
UPDATE-PERSON	Computer identification of update individual	P
UPDATE-DATE	Latest DOC file update	P
COVER	Computer name of data layer	P
WORKSPACE	Pathname of data layer location	P
EXTENT	Minimum and maximum coordinates	P
PRECISION	Data precision	P
TOLERANCES	Fuzzy and dangle tolerance limits	P
NUM-ARCS	Number of arcs	P
NUM-SEGS	Number of segments	P
NUM-POLYS	Number of polygons	P
NUM-POINTS	Number of points	P
NUM-TICS	Number of tics	P
NUM-ANNOS	Number of annotation features	P
THEME	Theme of data layer	US
DESCRIPTION	Description of data layer	US
CONTACT-PERSON	Contact person for data layer	US
CONTACT-INSTRUC	Contact phone number	US
ORGANIZATION	Source organization of contact	US
COVER-REV	Data layer revision number	US
LOCATION	Location of data layer	US
RESOLUTION	Resolution of data layer	US
SCALE	Scale at which data layer is accurate	US
ARCHIVE	Archive status	US
PUB-STATUS	Publication status	US
CITATION-1	Line 1 of citation used for REF file	US
CITATION-2	Line 2 of citation used for REF file	US
CITATION-3	Line 3 of citation used for REF file	US
CITATION-4	Line 4 of citation used for REF file	US
CITATION-5	Line 5 of citation used for REF file	US
	Attribute Table Documentation File (ATT)	
PATHNAME	Pathname of data layer location	P
TYPE	Type of entity to be described (table or column)	P
FILENAME	Attribute file name	P
ITEMNAME	Attribute name	P
ITEMWIDTH	Attribute width	P
OUTPUTWIDTH	Attribute output width for report making	P
ITEMTYPE	Attribute item type (character, number)	P
NUMDECIMAL	Number of decimal places (for real and floating point values)	P
USERNAME	Computer identification of entry update individual	P
SHORTDEF	Definition of attribute	US
DATADOMAIN	Allowed values for attribute	US
DATASOURCE	Source of values for attribute	US
ATTACCURACY	Accuracy of values for attribute	US

2.0 COMPUTER PROGRAM DOCUMENTATION--Continued
2.2 CREATEPOINT

CREATEPOINT PROGRAM CREATES POINT DATA LAYER FROM SEQUENTIAL ACCESS FILES

A program to create point data layers with associated attributes from a sequential access file is documented.

Below is the documentation for the CREATEPOINT program, which is used to create a point data layer from a sequential access file. Figure 2.2-1 is a sample plot of a data layer created from the National Water Information System (NWIS) data base.

PROGRAM: CREATEPOINT
AUTHOR: Todd W. Augenstein, U.S. Geological Survey, Richmond, Virginia
Original coding as PRIMOS CPL program
Roy S. Sonenshein, U.S. Geological Survey, Miami, Florida
Convert to ARC/INFO AML

SYSTEM: ARC/INFO 5.0.1 UNIX
LANGUAGE: ARC Macro Language (AML)
RELEASE: REV91.1
DATE: 9/01/91

PURPOSE: To create an ARC/INFO point data layer from any sequential access file; attribute data in the file can be associated with the data layer; the user is queried for the file format for the attribute items that are to be transferred to the ARC/INFO data layer; the user is also queried for the output projection; this can be easily customized by the user for any projection parameters

CALLS: CORLAB (F77)--Strips latitude and longitude from user file
APPEND (F77)--Builds input file for ARC/INFO GENERATE command
NEWFOR (F77)--Reformats user file for input into INFO
(VARIOUS ARC 5.0 SYSTEM COMMANDS)
(INFO SUBSYSTEM)

USAGE: CREATEPOINT <input file> <output data layer>

ARGUMENTS:

<input file> - Mandatory; a sequential access file containing point information; the file must consist of one line of formatted data for each data point; each line must contain geographic coordinates (latitude and longitude) that identify the point location; these coordinates can be either in degrees-minutes-seconds (DMS) or decimal-degrees (DD) format; the coordinates are assumed to be in the northwest quadrant (NW) of the world; longitudes and latitudes must, therefore, be supplied as positive values; the file may also contain information (data attributes) that describe the point

<ouput data layer> - Mandatory; the point layer to be created; the resulting data layer has associated attribute (PAT), boundary (BND), and tic location (TIC) files; the PAT file contains attribute data from the input file

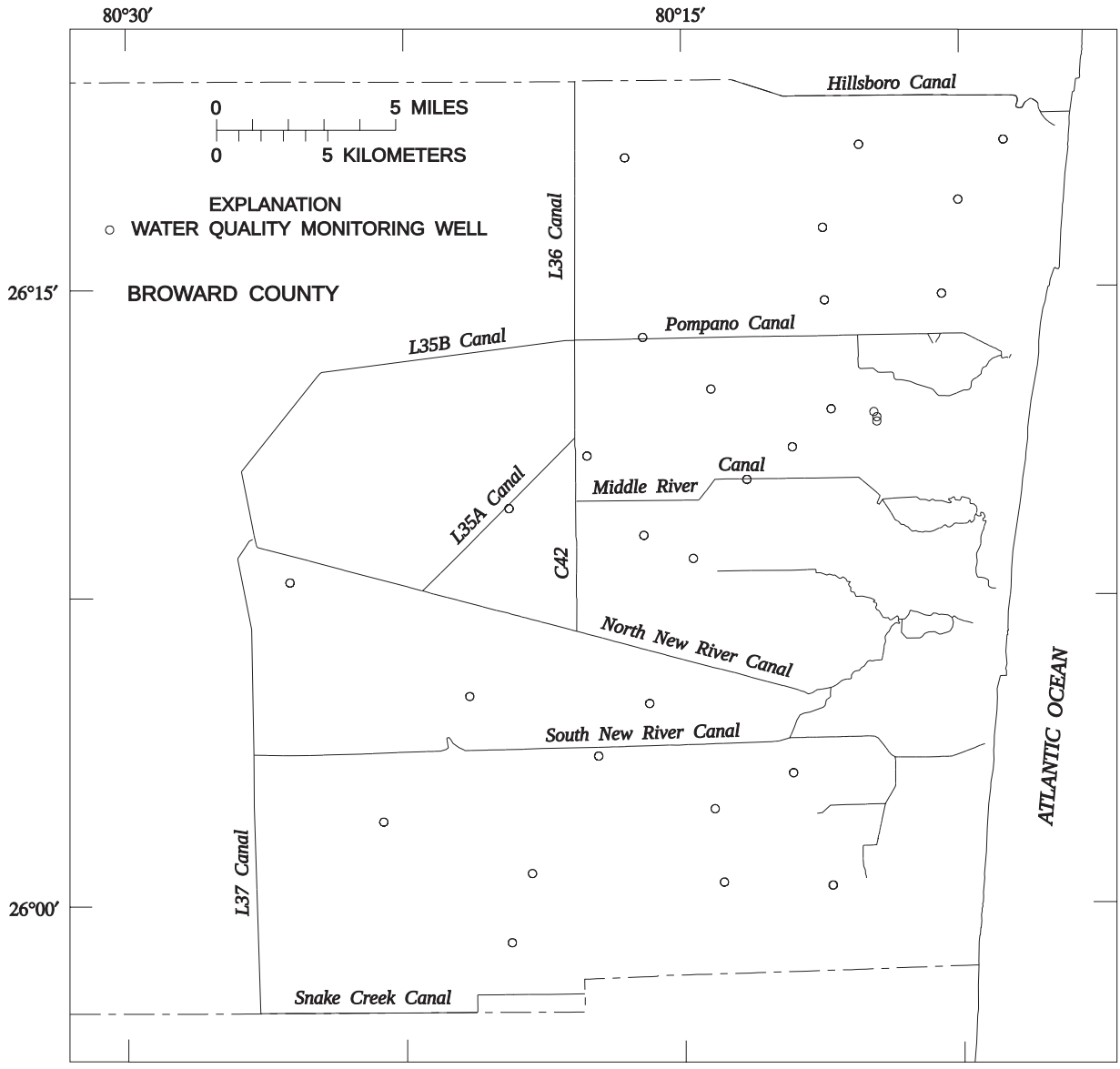

Figure 2.2-1. Location of water-quality monitoring stations in eastern Broward County.

2.0 COMPUTER PROGRAM DOCUMENTATION--Continued
2.3 MODELGRID

MODELGRID PROGRAM CREATES DATA LAYERS FOR USE WITH FINITE-DIFFERENCE MODELS

A program to create polygon, line, and point data layers that can be used to represent a finite-difference model grid is documented.

Below is the documentation of the MODELGRID program, which creates three data layers that can be used to represent a finite-difference model grid. Figure 2.3-1 shows a model grid created for southern Broward County.

PROGRAM: MODELGRID

AUTHOR: Dan Winkless, U.S. Geological Survey, Albuquerque, New Mexico
Original coding, April 1988
Mike Kernodle, U.S. Geological Survey, Albuquerque, New Mexico
Revisions to program

SYSTEM: ARC/INFO 5.0.1 UNIX

LANGUAGE: ARC Macro Language (AML)

RELEASE: REV2.0

DATE: 8/28/91

PURPOSE: To create three ARC/INFO data layers that can be used to represent a model grid; the first data layer contains polygons with each polygon representing a grid cell with related cell attributes row and column number, area, and perimeter; other attributes required to run the model can also be associated with each grid cell; this data layer is used to perform overlay operations on other data layers such as rivers, lakes, land use, and soil types; the second data layer contains points, with each point located at the centroid of a grid cell; these points can have associated attributes like the polygon data layer, except that the area and perimeter of the cell are not calculated; this data layer is useful for storing data upon which contouring operations can be performed; the third data layer contains lines with each line running the entire length of the grid; this data layer is used for plotting the model grid because long straight lines will plot much faster than polygon blocks.

CALLS: GRIDDER (F77)--Builds input file of grid line endpoints to be used by the ARC/INFO GENERATE command to create the LINE and POLYGON data layers
CNTCHK (F77)--Reads the ARC/INFO data layer centroid file and uses the coordinates to build a file to be used by the ARC/INFO GENERATE command to create the POINT data layer
(VARIOUS ARC 5.0 SYSTEM COMMANDS)
(INFO SUBSYSTEM)

USAGE: MODELGRID <input file> <output root name of data layers>

ARGUMENTS:

<input file> - Mandatory; a sequential access file containing the following free-formatted data:

Line 1: Number of rows, number of columns
Line 2: Counterclockwise rotation of the grid, in degrees
Line 3: The coordinates of the origin (upper left corner) of the grid in the user's chosen map projection, such as Universal Transverse Mercator (UTM) or ALBERS

The rest of the file consists of the row spacings followed by the column spacing specified in a free format; there must be one value for each row and one for each column; because the input is free formatted, multiple repetitions of a spacing can be represented using the * format (5*4000 indicates 5 rows or columns with a spacing of 4000);

on two separate lines, one after the row spacings and the other after the column spacings, is the word END beginning in the first column; the following is a sample input file (note the flexibility of the free format):

```
15 20
46.
-195000. 130000.
10000,7500.,5000,5*4000
2*5000
5*7500
END
20*3000.
END
```

<output root name of data layers> - Mandatory; the root name of the three data layers to be created; the polygon data layer has the appendix .POL; the point data layer created has the appendix .PTS; the line data layer created has the appendix .ARC; the resulting data layers have associated attribute (PAT for the point and polygon data layers, arc attribute table [AAT] for the line data layer), boundary (BND), and tic location (TIC) files; the PAT files contain row and column numbers

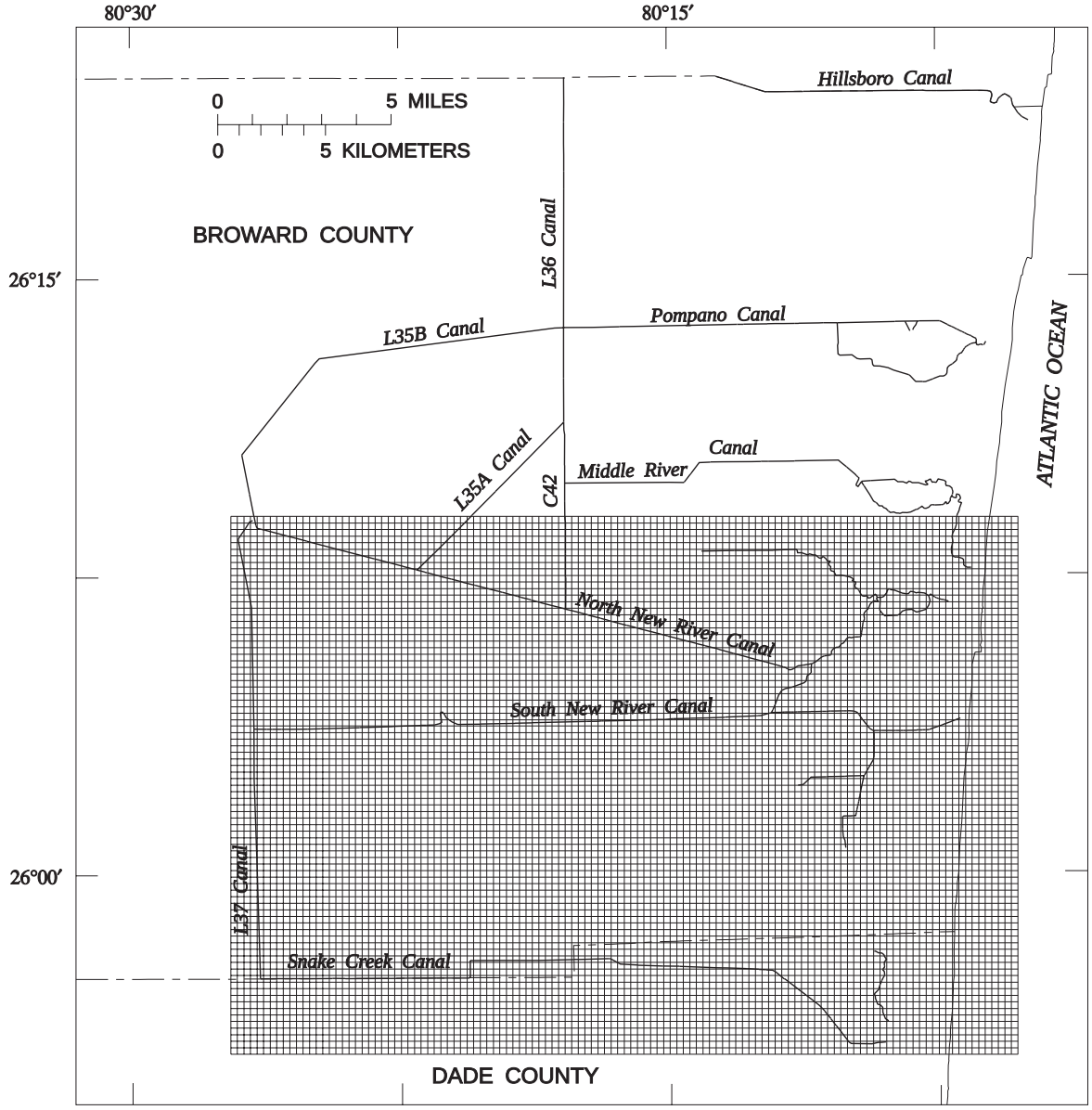

Figure 2.3-1. Eastern Broward County showing a grid generated for use with a finite-difference ground-water flow model.

MODPATHARC PROGRAM CREATES PARTICLE PATH DATA LAYER

A program to create data layers from the output files of the MODPATH particle tracking program is documented.

Below is the documentation for the MODPATHARC program that can create either a line data layer from the PATHLINE file or a point data layer from the ENDPOINT file generated by the MODPATH particle tracking program (Pollock, 1989). Figure 2.4-1 shows a plot of a sample line data layer created by this program.

PROGRAM: MODPATHARC
AUTHOR: Roy S. Sonenshein, U.S. Geological Survey, Miami, Florida

SYSTEM: ARC/INFO 5.0.1 UNIX
LANGUAGE: ARC Macro Language (AML)
RELEASE: REV91.1
DATE: 10/10/91

PURPOSE: To create an ARC/INFO data layer from the PATHLINE or ENDPOINT output file created by the MODPATH particle tracking program; the output data layer is either a LINE (from PATHLINE file) or a POINT (from ENDPOINT file) data layer that contains all attribute data (row, column, depth, time of travel) from each line of the input file

CALLS: RFMT (F77)--Reformats input file, creating a file that can used by the ARC/INFO GENERATE command (location file) and a file that contains attribute data that can be loaded into the data layer attribute table
(VARIOUS ARC 5.0 SYSTEM COMMANDS)
(INFO SUBSYSTEM)

USAGE: MODPATHARC <input file> <output data layer> <line|point>
<x-coordinate> <y-coordinate> <rows> <width>

ARGUMENTS:

<input file> - Mandatory; the sequential access file output by the MODPATH program; this can be either the PATHLINE file or the ENDPOINT file

<output data layer> - Mandatory; the data layer to be created; this will be a LINE data layer if the PATHLINE file is used or a POINT data layer if the ENDPOINT file is used; the resulting data layer has associated attribute (AAT for line and PAT for point), boundary (BND), and tic location (TIC) files; the attribute file contains data from the input file

<line|point> - Mandatory; must be either LINE (for PATHLINE file) or POINT (for ENDPOINT file)

The next four arguments are required to convert the input file coordinates into coordinates in the user's chosen map projection such as UTM or ALBERS; because the MODPATH program uses the southwestern corner of the grid as the origin and the grid is created using the northwestern corner of the grid (see section 2.3 for MODELGRID.AML), the spacing and number of rows is required to perform the conversion

<x-coordinate> - Mandatory; the x-coordinate of the upper left corner of the model grid used in the finite-difference flow model (McDonald and Harbaugh, 1988) that generated the files processed by the MODPATH program; this coordinate must be in projection units such as UTM or ALBERS meters

<y-coordinate> - Mandatory; the y-coordinate of the upper left corner of the model grid used in the finite-difference flow model (McDonald and Harbaugh, 1988) that generated the files processed by the MODPATH program; this coordinate must be in projection units such as UTM or ALBERS meters

<rows> - Mandatory; the number of rows in the model grid used in the finite- difference flow model (McDonald and Harbaugh, 1988) that generated the files processed by the MODPATH program

<width> - Mandatory; the grid spacing, in feet, along the Y-axis of the model grid

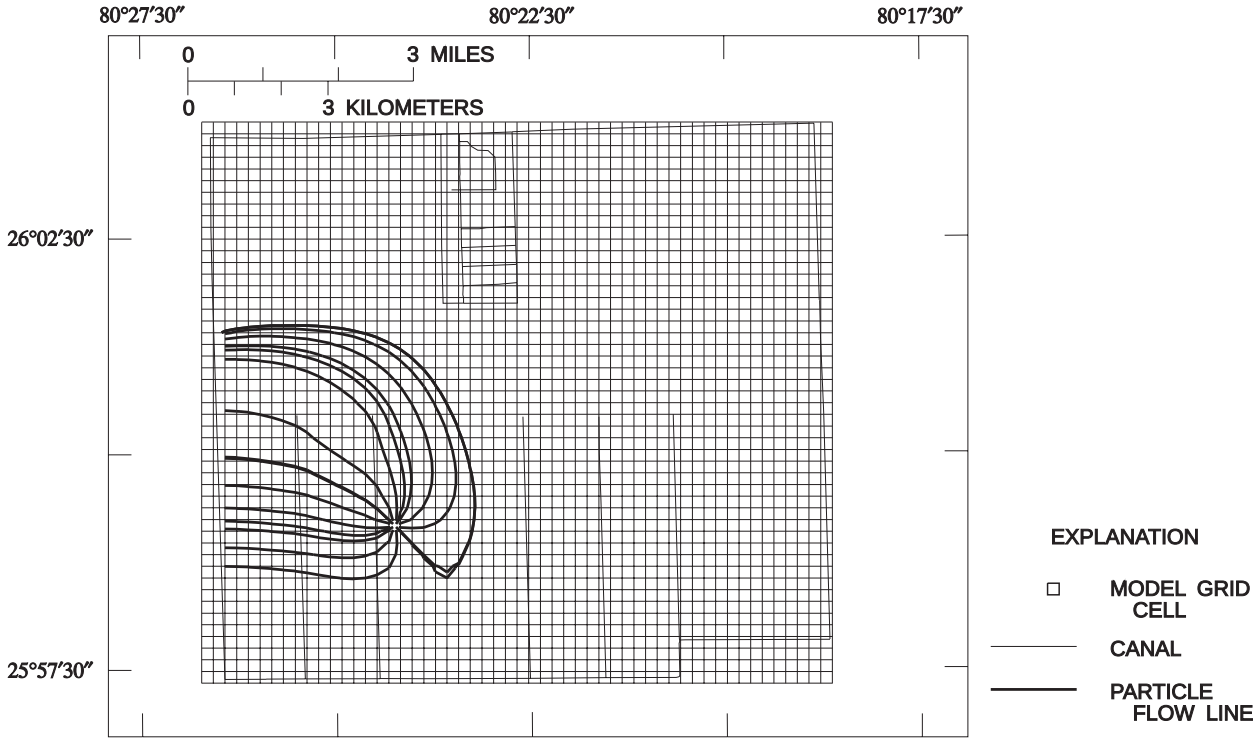

Figure 2.4-1. Sample particle paths determined by the MODPATH program for part of Broward County.

2.0 COMPUTER PROGRAM DOCUMENTATION--Continued
2.5 Underground Storage Tank Files

USTARC PROGRAM USES FLORIDA DEPARTMENT OF ENVIRONMENTAL REGULATION STATIONARY TANK INVENTORY (STI) FILES TO CREATE STORAGE TANK DATA BASE

A program to create data layers from files output from the STI system is documented.

Below is the documentation for the USTARC program that creates point data layers from files output from the STI system. Two data layers can be created--a facility file (information about facilities that contain storage tanks) and an optional tank file (information about each storage tank located at a facility). Figure 2.5-1 shows the location of storage tank facilities and the number of underground storage tanks at each facility using a data layer created from a test data set.

PROGRAM: USTARC
AUTHOR: Roy S. Sonenshein, U.S. Geological Survey, Miami, Florida

SYSTEM: ARC/INFO
LANGUAGE: ARC Macro Language (AML)
RELEASE: REV91.1
DATE: 3/01/91

PURPOSE: To create an ARC/INFO point data layer of storage tank data and storage tank facilities data; data are loaded from fixed-format sequential access files obtained from the STI system; three file types can be used; the location (LOC) and facility (FAC) files are mandatory; the storage tank (TNK) file is optional; only selected attributes are loaded from the FAC and TNK files

CALLS: FACILITY (CPL) AND TANKS (CPL)--These programs run CREATEPOINT (AML), which creates data layers from the LOC, FAC, and TNK files and loads attribute data into the appropriate attribute file
(VARIOUS ARC 5.0 SYSTEM COMMANDS)
(INFO SUBSYSTEM)

USAGE: USTARC <location file> <facility file> <facility data layer>
{tank file} {tank data layer}

ARGUMENTS:

<location file> - Mandatory; a fixed-format sequential access file (LOC) containing facility identification number, latitude, and longitude

<facility file> - Mandatory; a fixed-format sequential access file (FAC) containing facility attributes such as owner, address, and number of tanks

<facility data layer> - Mandatory; facility data layer to be created; the resulting data have associated attribute (PAT), boundary (BND), and tic location (TIC) files; the PAT file contains data from the FAC file

{tank file} - Optional; a fixed-format sequential access file (TNK) containing tank attributes such as tank identification number, size and contents of tank, and types of monitoring systems

{tank data layer} - Optional; tank data layer to be created; the resulting data layer has associated attribute (PAT), boundary (BND), and tic location (TIC) files; the PAT file contains data from the TNK file

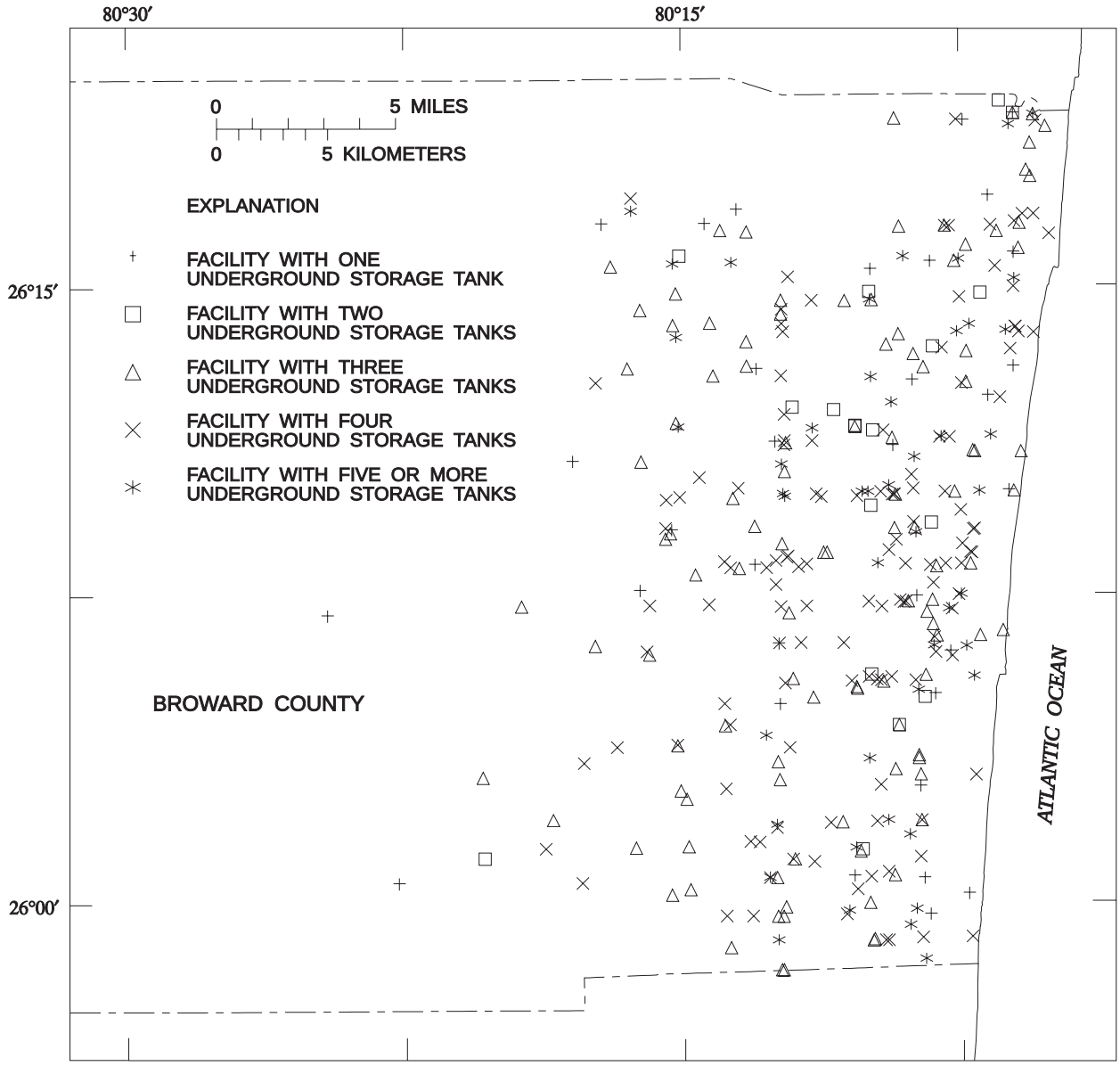

Figure 2.5-1. Location of underground storage tank facilities in eastern Broward County.

3.0 DATA LAYERS

3.1 Manmade Features

3.1.1 Major Roads in Southern Florida

MAJOR ROADS DATA LAYER CREATED FROM DIGITAL LINE GRAPH (DLG) DATA

A data layer of major roads in southern Florida, modified from the DLG data layer, was updated using more recent aerial photography and USGS topographic quadrangles

A data layer of major roads in southern Florida was created using the 1:100,000 DLG data (U.S. Geological Survey, 1989) as a source. The DLG data were created using maps from 1981 and earlier. Because of the rapid growth in southern Florida, many major roads were not included. These additional roads were digitized from aerial photography and more recent 1:24,000 USGS topographic quadrangles. This data layer is intended to be used as a background data layer for map products and for reference to location when editing other data layers. The part of the data layer falling within Broward County is shown in figure 3.1.1-1. Table 3.1.1-1 summarizes the data layer, and table 3.1.1-2 describes the variables stored in the related arc attribute table.

Table 3.1.1-1. Summary of major roads line data layer for southern Florida

[Coordinates in Universal Transverse Mercator meters, zone 17. USGS, U.S. Geological Survey]

Documentation attribute	Value
Minimum coordinate	x = 426704, y = 2764869
Maximum coordinate	x = 594341, y = 2931240
Number of arcs	1,058
Number of segments	12,876
Scale	1:100,000
Data sources	U.S. Geological Survey (1989) 1:24,000 USGS topographic quadrangles Dolph Map Company (1988)
Attribute table name	roads.aat
Attribute table output width (columns)	94

Table 3.1.1-2. Description of variables in major roads arc attribute table

Attribute	Type	Length	Definition
NAME1	Character	20	Street or road name
NAME2	Character	15	Alternate street or road name
NUMBER1	Character	15	City, County, State, or Federal road number
NUMBER2	Character	15	City, County, State, or Federal road number
FLAG	Character	1	User-defined variable

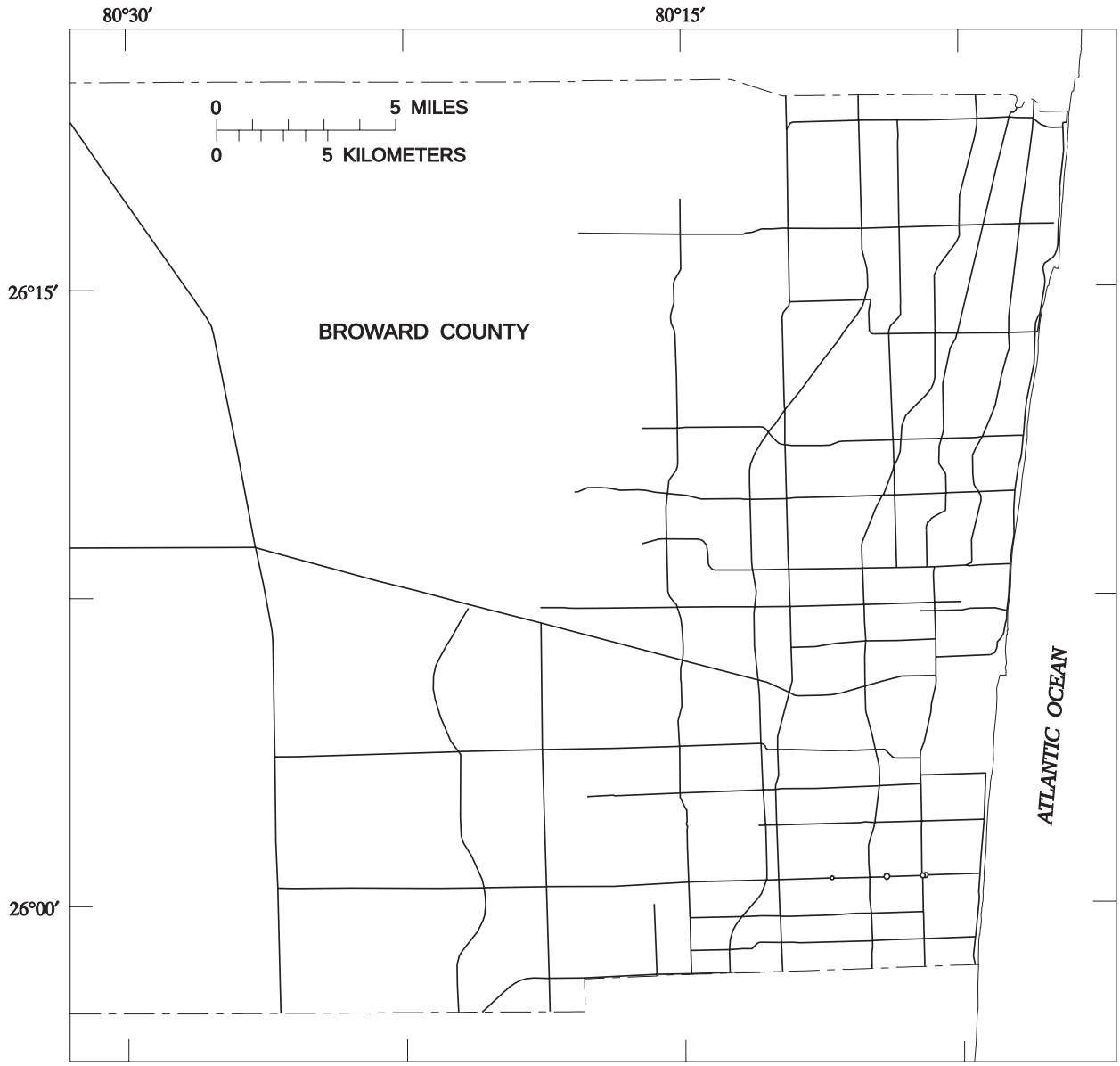

Figure 3.1.1-1. Roads in the major roads data layer for eastern Broward County.

3.0 DATA LAYERS--Continued
3.1 Manmade Features--Continued
3.1.2 Municipal Boundaries

BROWARD COUNTY MUNICIPALITY DATA LAYER DIGITIZED

The boundaries for 29 municipalities were digitized at a scale of 1:24,000

The municipal boundaries in Broward County were digitized from 1:24,000 USGS topographic quadrangles using the major roads (see section 3.1.1) and the canals (see section 3.3.4) as reference data layers. The boundaries for 29 municipalities were obtained from the Broward County Metropolitan Area Map (Broward County, 1989). This data layer is intended to be used as a background data layer for map products and to perform overlay operations on other data layers. Figure 3.1.2-1 shows the municipal boundaries and the unincorporated areas within Broward County. Table 3.1.2-1 summarizes the data layer.

Table 3.1.2-1. Summary of municipal boundaries polygon data layer for Broward County

[Coordinates in Universal Transverse Mercator meters, zone 17]

Documentation attribute	Value
Minimum coordinate	x = 555035, y = 2870823
Maximum coordinate	x = 592312, y = 2912778
Number of arcs	207
Number of segments	3,393
Number of polygons	84
Scale	1:24,000
Data source	Broward County (1989)
Attribute table name	city.pat
Attribute table output width columns	49

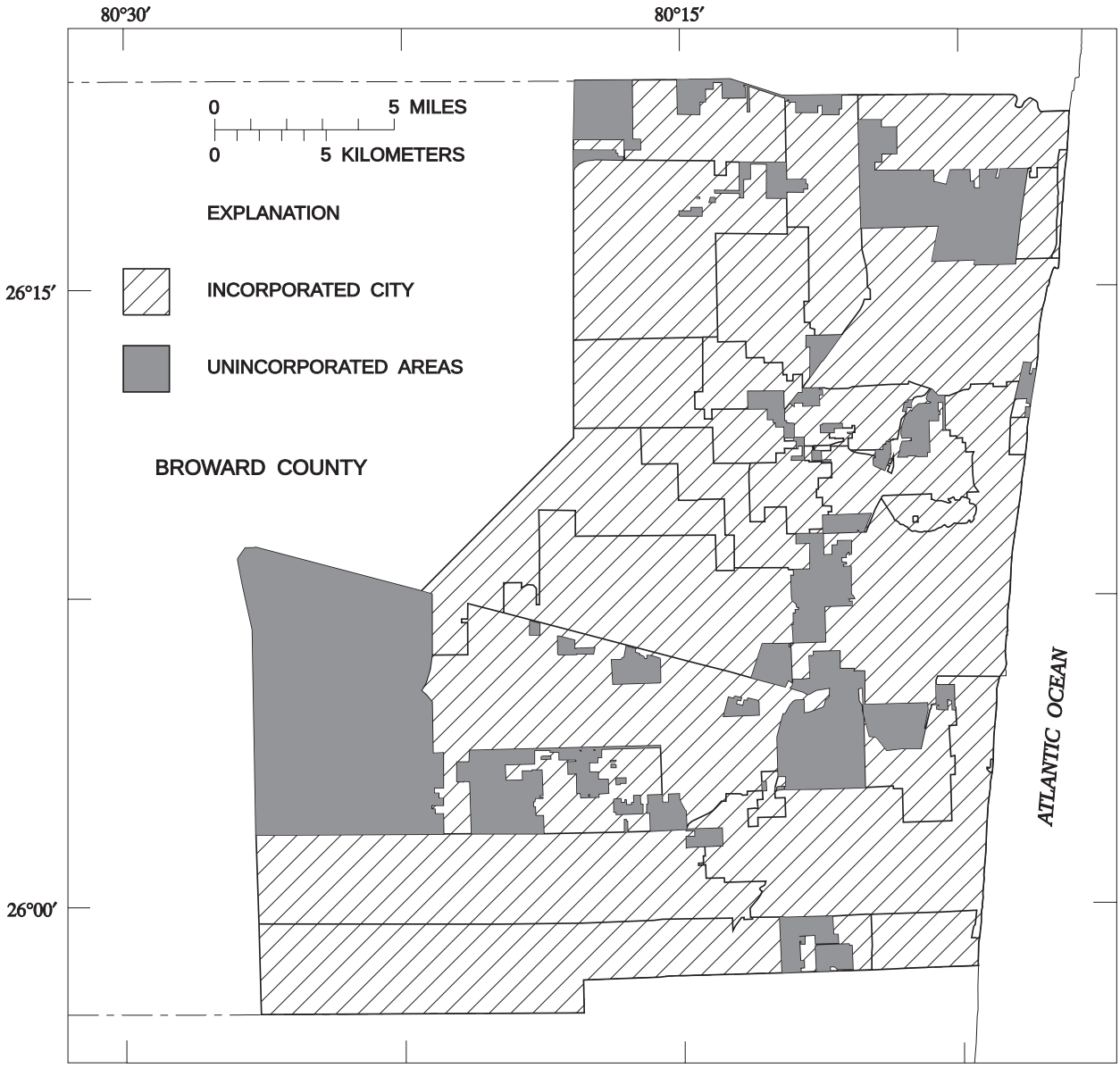

Figure 3.1.2-1. Boundaries in the municipal boundaries data layer for eastern Broward County.

3.0 DATA LAYERS--Continued
3.1 Manmade Features--Continued
3.1.3 Public Land-Survey Section Grid

FLORIDA DEPARTMENT OF REVENUE (FDOR) TAX DATA RELATED TO PUBLIC LAND-SURVEY SECTION GRID

A data layer consisting of the public land-survey section grid and the county line for Broward County was created from survey point coordinates and 1:24,000 USGS topographic quadrangles. Land-use data for each section was stored in a related data file.

The public land-survey section grid used by State, County, and municipal agencies to provide a legal description of a site location was entered into a data layer using surveyed point coordinates and digitized data. The coordinates for the section corners in eastern Broward County were obtained from the Broward County Engineering Department (1951, 1952a, 1952b, 1952c, 1975, 1977a, 1977b, 1985, 1987a, and 1987b), which were then used to create the section lines. The survey lines in the western part of the county were digitized from 1:24,000 USGS topographic quadrangles. Usually, no section lines were shown on the maps, so only the township and range lines were digitized. The coastline and county line used as boundaries for the data layer were also digitized from 1:24,000 USGS topographic quadrangles. Figure 3.1.3-1 shows the entire grid for Broward County. Table 3.1.3-1 summarizes the data layer. A related TIC file data layer containing only the section corners was created for use in digitizing from aerial photographs and other maps where the section corners are to be used as TIC points. There are 945 TICS In this data layer.

The Florida land-use data base created by the FDOR from 1985 tax roll data was used to create a related data file to the Public Land-Survey System (PLSS) data layer. This data file contains land-use information by PLSS section, including the number of acres and number of parcels of each type of land use within each section (table 3.1.3-2). The land-use codes used are the 99 codes developed by FDOR. In addition, the land uses have been subdivided by the SFWMD into six groups based on the potential for contamination. This index is also included in the data file.

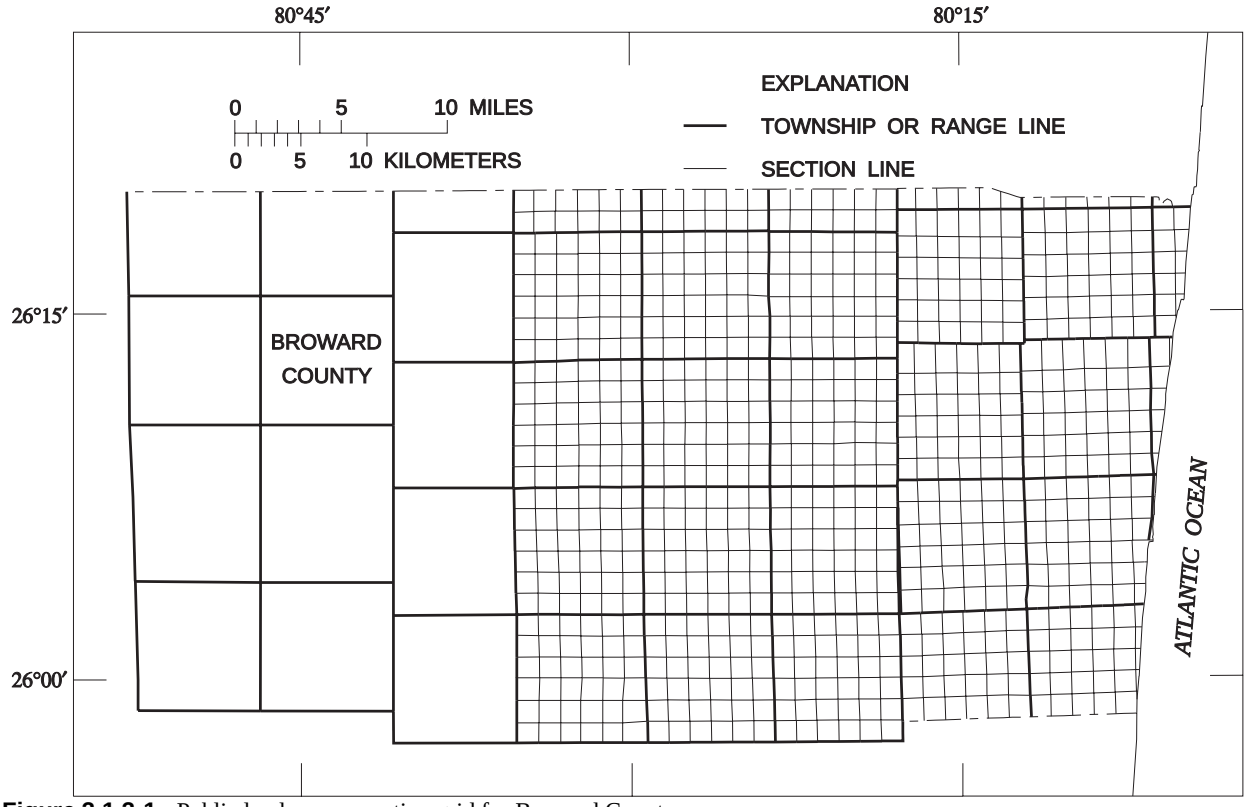

Figure 3.1.3-1. Public land-survey section grid for Broward County.

Table 3.1.3-1. Summary of public land-survey section grid polygon data layer for Broward County

[Coordinates in Universal Transverse Mercator meters, zone 17. FDOR, Florida Department of Revenue; USGS, U.S. Geological Survey]

Documentation attribute	Value
Minimum coordinate	x = 511817, y = 2870740
Maximum coordinate	x = 592311, y = 2912778
Number of arcs	1,743
Number of segments	3,196
Number of polygons	794
Scale	1:24,000
Data sources	Broward County Engineering Department (1951, 1952a, 1952b, 1952c, 1975, 1977a, 1977b, 1985, 1987a, 1987b)
	1:24,000 USGS topographic quadrangles
	FDOR land-use data base
	Fairbank (1985)
Attribute table name	brwd_grd.pat
Attribute table output width (columns)	22
Attribute table name	brwd_grd.aat
Attribute table output width (columns)	29
Related table name	brwd_grd.lu
Related table definition	FDOR land-use data base
Related table output width (columns)	23

Table 3.1.3-2. Description of variables in public land-survey section land-use related table

[FDOR, Florida Department of Revenue; SFWMD, South Florida Water Management District]

Attribute	Type	Length	Definition
TRS	Integer	6	Township, range, and section
DOR-CODE	Integer	2	FDOR land-use code
CONT	Integer	2	SFWMD contamination potential category
OCCURS	Integer	5	Number of parcels of DOR-CODE within TRS
ACRES	Real	8.1	Number of acres of DOR-CODE within TRS

3.0 DATA LAYERS--Continued
3.1 Manmade Features--Continued
3.1.4 Land-Use Polygons

3.1.4.1 Eastern Broward County

SFWMD LAND-USE DATA BASE UPDATED

Aerial photography from 1986 and field work were used to update SFWMD land-use polygon data files.

Land-use polygons were digitized for eastern Broward County from 1986 aerial photography. A classification system developed for the Florida Department of Transportation (Kuyper and others, 1981) was used to define the land-use categories. This data layer was an update of one created in 1983 by SFWMD. Digitizing and field checking of the data were done by the South Florida Regional Planning Council. The data were then transferred to SFWMD and edited and stored in their AUTOCAD data base by the USGS 1:24,000 quadrangle sheet. Those quadrangles covering eastern Broward County were transferred to USGS ARC/INFO and combined into a single land-use data layer. Figure 3.1.4.1-1 shows the level one land uses for the southwestern part of eastern Broward County. Table 3.1.4.1-1 summarizes the data layer.

Table 3.1.4.1-1. Summary of land-use polygon data layer for eastern Broward County

[Coordinates in Universal Transverse Mercator meters, zone 17]

Documentation attribute	Value
Minimum coordinate	x = 549987, y = 2861774
Maximum coordinate	x = 591351, y = 2917345
Number of arcs	12,141
Number of segments	45,602
Number of polygons	4,695
Scale	1:3,600
Data sources	South Florida Water Management District South Florida Regional Planning Council
Attribute table name	landuse.pat
Attribute table output width (columns)	20
Related table name	landuse.tab
Related table definition	land-use code lookup table
Related table output width (columns)	84

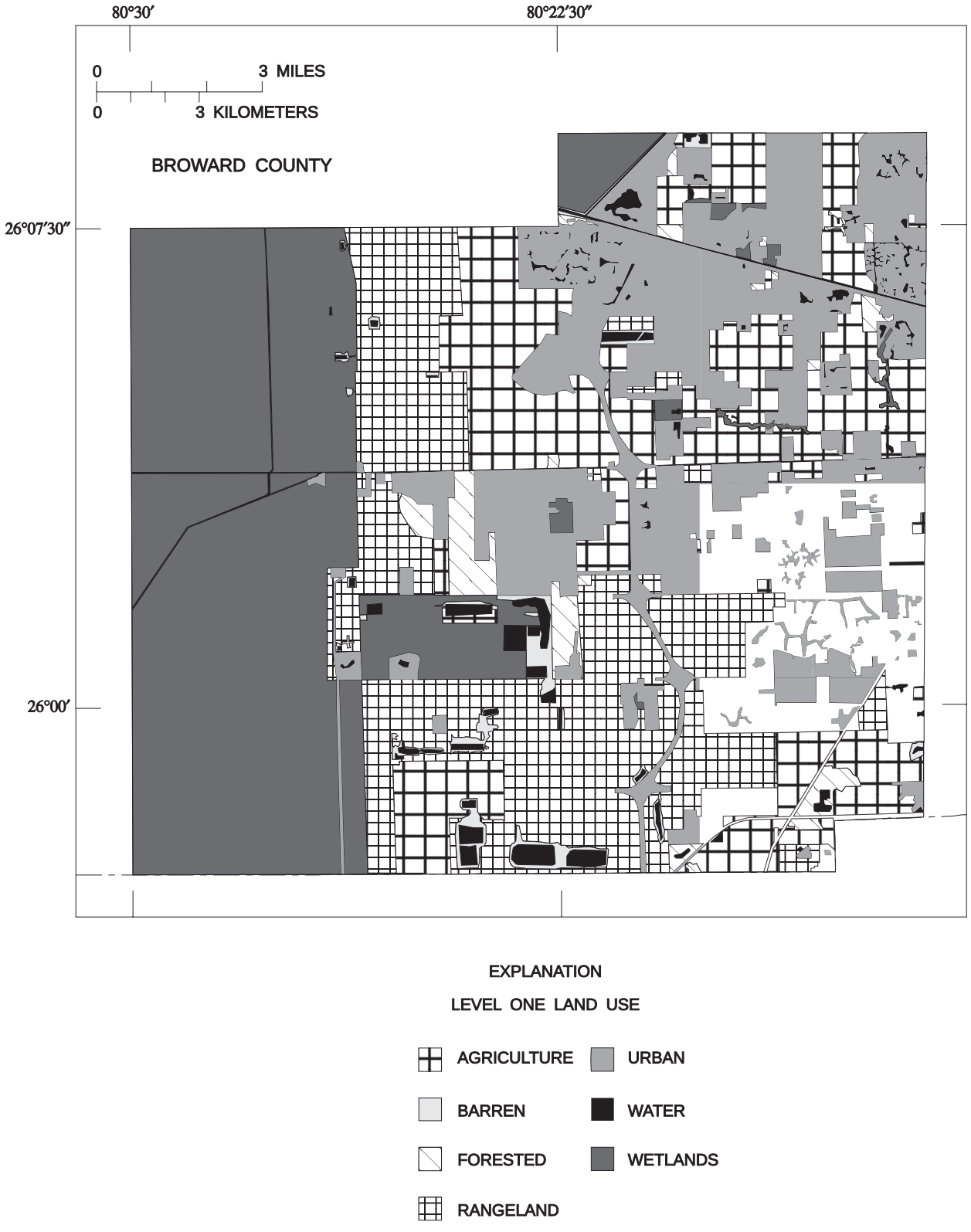

Figure 3.1.4.1-1. Level one land uses in the southwestern part of eastern Broward County from the South Florida Water Management District land-use data base.

3.0 DATA LAYERS--Continued
3.1 Manmade Features--Continued
3.1.4 Land-Use Polygons--Continued

3.1.4.2 Southwestern Part of Eastern Broward County

1987 AERIAL PHOTOGRAPHY OF SOUTHWESTERN BROWARD USED TO CREATE LAND-USE DATA LAYER

Aerial photography at a scale of 1:3,600 was used to digitize 785 land-use polygons for the southwestern part of eastern Broward County.

Land-use polygons were digitized for the southwestern part of eastern Broward County (fig. 3.1.4.2-1) as part of the southwestern Broward and northwestern Dade subregional study, phase II (South Florida Regional Planning Council, 1990). A classification system developed for the Florida Department of Transportation (Kuyper and others, 1981) was used to define the land-use categories. Several additional codes were added by the BCONRP. Aerial photography at a scale of 1:3,600 supplied by the Broward County Engineering Division, Public Works Department (1987), was used by the BCONRP to define the land-use polygons. Land-survey section corners were used as reference (TIC) marks for digitizing from the photography. These reference marks on the aerial photography were difficult to locate, so there was some error registering the aerial photography to known spatial coordinates. Because the photography was at a scale of 1:3,600 and only a 1:24,000 scale was required for the study, this error was considered acceptable. In addition, the roads (section 3.1.1) and PLSS grid (section 3.1.3) were used as references for the land-use polygons because the polygons often coincided with these features. Table 3.1.4.2-1 summarizes this data layer.

Table 3.1.4.2-1. Summary of land-use polygon data layer for the southwestern part of eastern Broward County

[Coordinates in Universal Transverse Mercator meters, zone 17]

Documentation attribute	Value
Minimum coordinate	x = 554890, y = 2870790
Maximum coordinate	x = 572188, y = 2891743
Number of arcs	1,854
Number of segments	17,486
Number of polygons	785
Scale	1:3,600
Data sources	Broward County Office of Natural Resource Protection Broward County Engineering Division, Public Works Department (1987)
Attribute table name	bcluc.pat
Attribute table output width (columns)	34
Related table name	bcluc.tab
Related table definition	land-use code, lookup table
Related table output width (columns)	84

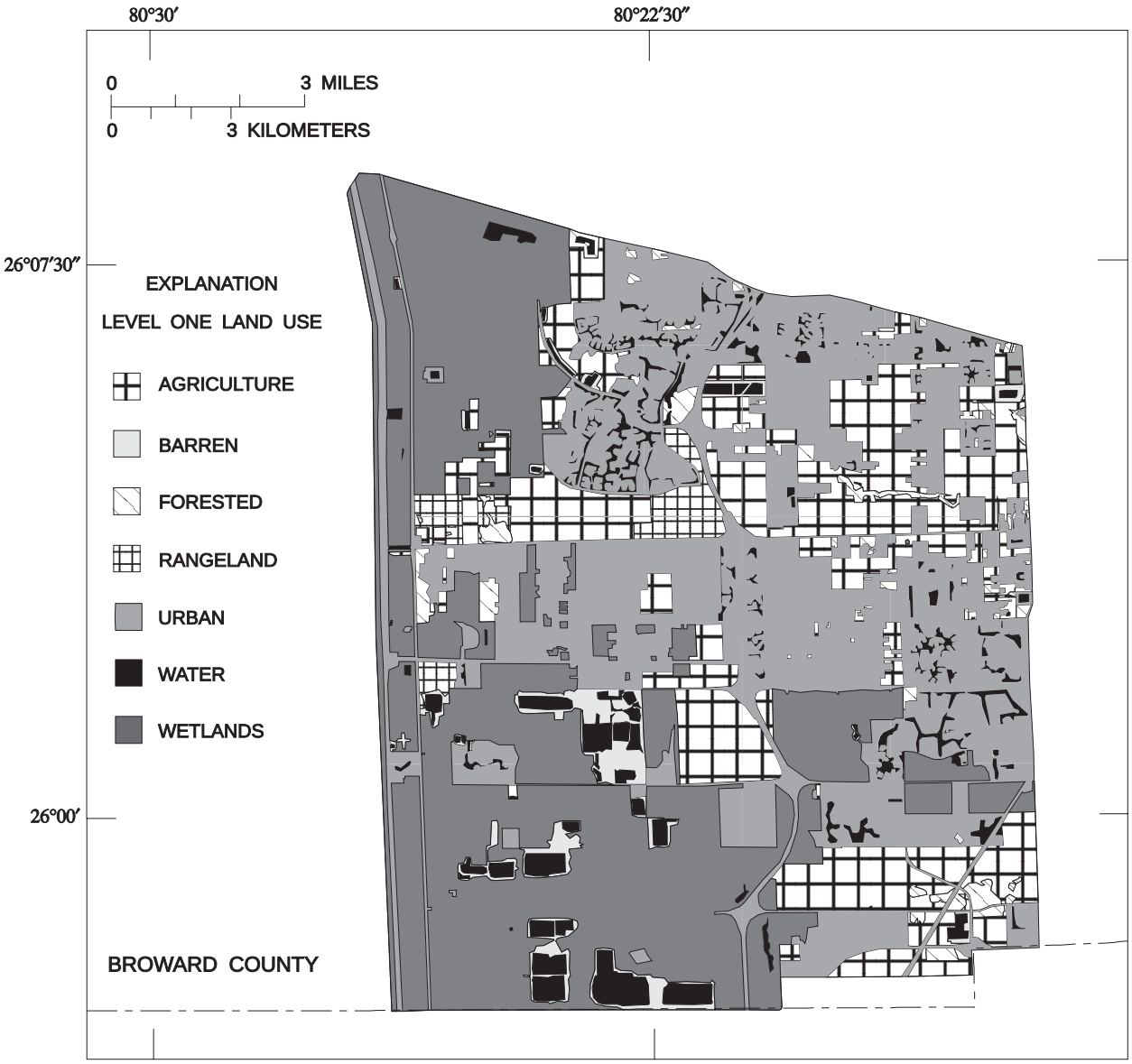

Figure 3.1.4.2-1. Level one land uses in the southwestern part of eastern Broward County from the Broward County Office of Natural Resource Protection land-use data base.

3.0 DATA LAYERS--Continued
3.1 Manmade Features--Continued
3.1.5 Underground Storage Tank Facilities

USTARC PROGRAM USED TO CREATE STORAGE TANK DATA LAYERS

STI files for 1,309 tanks at 509 facilities were loaded into two separate data layers using the USTARC program.

Storage tank data obtained from STI files were loaded into two separate data layers. The two data layers were created using the program USTARC.AML described in section 2.5. Geographic coordinates provided in the STI files were not verified. Data layer 1 includes information about facilities containing storage tanks such as gasoline stations for Broward County (fig. 3.1.5-1 and table 3.1.5-1). Only selected attributes from the STI files were stored in the attribute table, including the FDER facility identification number, facility name, and location and descriptive information (table 3.1.5-2). Data layer 2 contains information about the individual storage tanks at each facility (table 3.1.5-1). The selected attributes stored for this data layer include the FDER facility identification number, tank identification number, descriptive information about the tank, and information on types of monitoring systems (table 3.1.5-2). Some of the data stored in these two layers are presented in figure 3.1.5-1, which shows the location of facilities containing underground gasoline storage tanks.

Table 3.1.5-1. Summary of storage tank facility point data layer 1 and storage tank point data layer 2 for Broward County

[Coordinates in Universal Transverse Mercator meters, zone 17; STI, Florida Department of Environmental Regulation stationary tank inventory]

Documentation attribute	Value (data layer 1)	Value (data layer 2)
Minimum coordinate	x = 517266, y = 2872747	x = 517266, y = 2872747
Maximum coordinate	x = 591391, y = 2911993	x = 591391, y = 2911993
Number of points	509	1,309
Scale	Unknown	Unknown
Data source	STI	STI
Attribute table name	facility.pat	usts.pat
Attribute table output width (columns)	131	88

Table 3.1.5-2. Description of variables in storage tank facility point attribute table (data layer 1) and in storage tank point attribute table (data layer 2)

[FDER, Florida Department of Environmental Regulation; ID, identification; PLSS, Public Land-Survey System; WRTG, with respect to ground. Type: C, character; I, integer]

Data layer 1				Data layer 2			
Attribute	Type	Length	Definition	Attribute	Type	Length	Definition
DERID	I	9	FDER facility ID number	DERID	I	9	FDER facility ID number
NAME	C	38	Facility name	TANK-NO	C	6	FDER storage tank ID number
STREET	C	32	Street address	SIZE	I	8	Size of tank, in gallons
CITY	C	20	City (facility location)	CONTENTS	C	1	Tank contents code
SECTION	I	3	PLSS section	YEAR	I	2	Year tank installed
TOWNSHIP	I	2	PLSS township	CODE	C	1	Location of tank (WRTG)
RANGE	I	2	PLSS range	CONST	C	12	Tank construction code
SPILL	C	1	Leak or spill indicator code	PIPING	C	9	Piping system code
BURIED	I	4	Number of underground tanks	MONITOR	C	10	Monitoring system code
ABOVE	I	4	Number of above-ground tanks	STATUS	C	1	Tank status code
				LAT	C	6	Latitude of facility
				LONG	C	7	Longitude of facility

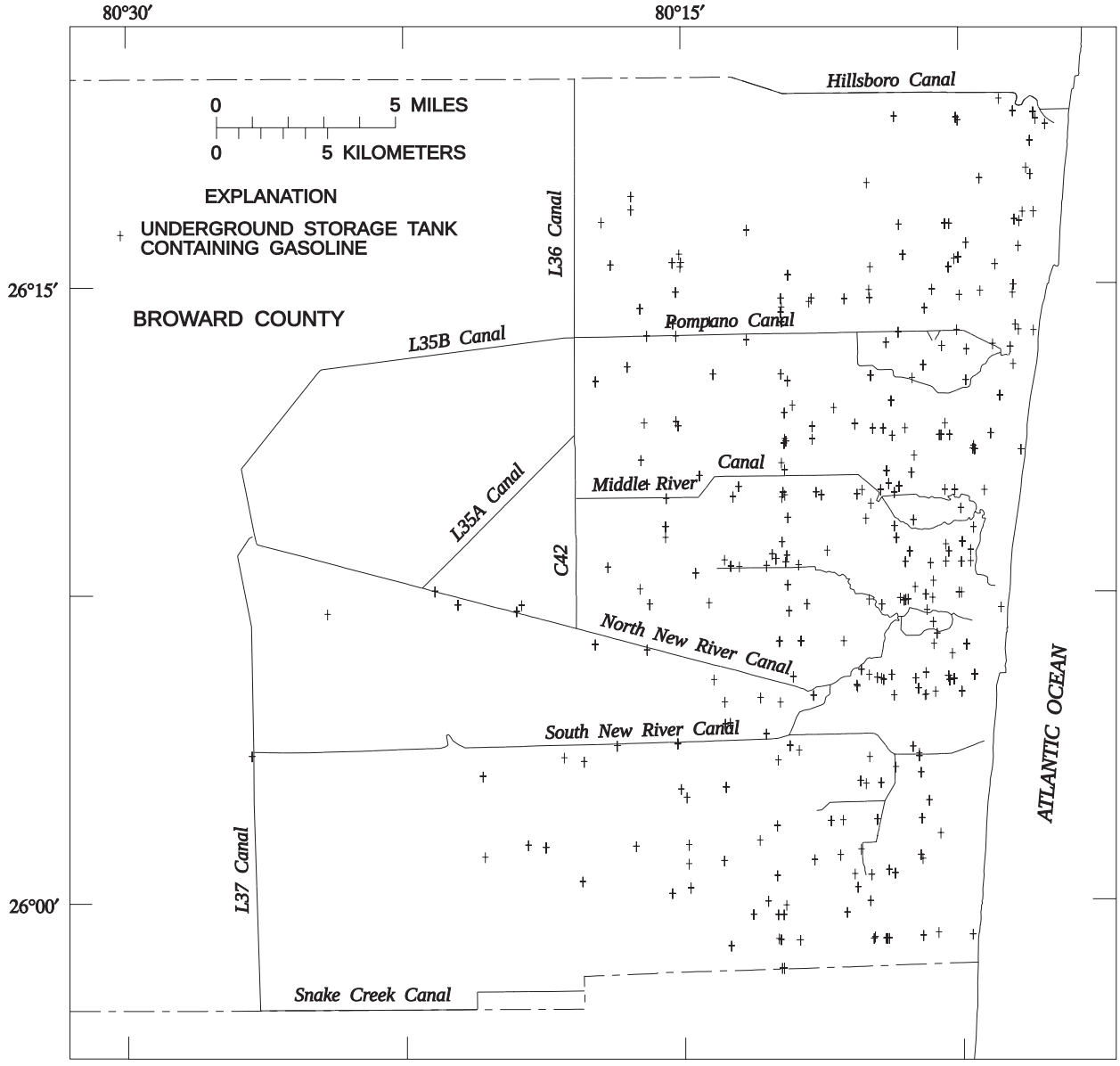

Figure 3.1.5-1. Location of underground storage tanks containing gasoline in eastern Broward County.

3.0 DATA LAYERS--Continued
3.2 Topographic Features--Surveyed Point Land-Surface Elevations

LAND-SURFACE ELEVATIONS DATA LAYER FOR SOUTHWESTERN PART OF EASTERN BROWARD COUNTY CONTAINS 1,163 POINTS

Land-surface elevations at 1,163 points in the southwestern part of eastern Broward County were entered into a point data layer.

Several sources of land-surface elevations at surveyed points were digitized to produce this data layer that covers the southwestern part of eastern Broward County. In the western parts of the Snake Creek Canal (canal 9) and the South New River Canal (canal 11) drainage areas and in part of the North New River Canal drainage area, maps at a scale of 1:24,000 were prepared by the South Florida Water Management District (1975; 1979). These maps contained land-surface elevations at points located at about 1,000-ft intervals, generally along the section lines. Survey points were digitized from aerial photographs (scale of 1:3,600) of 10 sections of land east of US-27 and south of North New River Canal (Craig A. Smith & Associates, 1987). For that section of the data layer not covered by other sources of data, survey points were digitized from the 1:24,000 Cooper City USGS topographic quadrangle. A total of 1,163 data points were input from the three sources (fig. 3.2-1). Table 3.2-1 summarizes the data layer.

The land-surface elevation data layer was created to determine unsaturated thicknesses of the Biscayne aquifer for the southwestern Broward and northwest Dade subregional study, phase II (South Florida Regional Planning Council, 1990). Because of the flat relief of the area, point land-surface elevations are very difficult to interpret. The location on the ground where the survey rod is held can affect the results of the survey. No information is available on the techniques used in these surveys. For this reason, any contour maps produced by computer programs from this data layer must be carefully analyzed before the data can be used.

Table 3.2-1. Summary of surveyed point land-surface elevation point data layer

[Coordinates in Universal Transverse Mercator meters, zone 17; USGS, U.S. Geological Survey]

Documentation attribute	Value
Minimum coordinate	x = 555856, y = 2867628
Maximum coordinate	x = 572082, y = 2890388
Number of points	1,163
Scale	1:24,000
Data sources	1:24,000 USGS topographic quadrangles South Florida Water Management District (1975; 1979) Craig A. Smith & Associates (1987)
Attribute table name	elev.pat
Attribute table output width (columns)	32

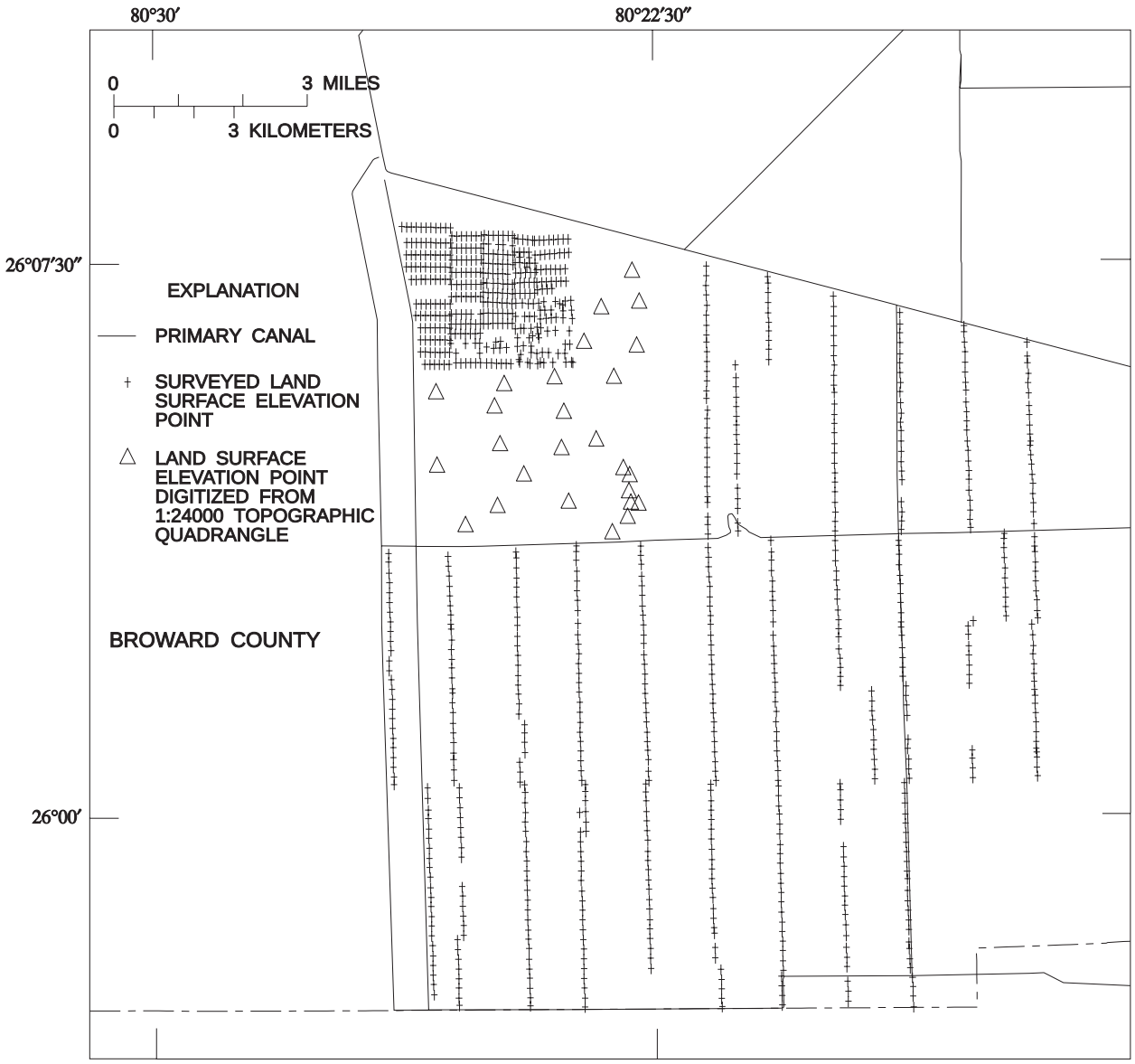

Figure 3.2-1. Location of land-elevation survey points in the southwestern part of eastern Broward County.

3.0 DATA LAYERS--Continued
3.3 Hydrologic Features
3.3.1 Surface-Water Stage Data-Collection Stations

129 SURFACE-WATER DATA-COLLECTION STATIONS IN EASTERN BROWARD COUNTY

Surface-water data-collection stations at 129 locations in eastern Broward County were entered into a data layer.

The Broward County Water Resources Management Division (WRMD) maintains surface-water stage data-collection stations on canals and lakes throughout eastern Broward County (fig. 3.3.1-1). Generally, stages are measured weekly, either from staff gages or from points of known elevation. The stage data are stored by WRMD. Latitude and longitude for these sites, reported by Sonenshein and others (1982, table 3), were transformed into UTM coordinates (zone 17, meters) that were used to create the data layer. The site locations were not field checked. Table 3.3.1-1 summarizes the data layer.

Table 3.3.1-1. Summary of surface-water stage data-collection stations point data layer

[Coordinates in Universal Transverse Mercator meters, zone 17]

Documentation attribute	Value
Minimum coordinate	x = 556479, y = 2870941
Maximum coordinate	x = 590298, y = 2912095
Number of points	129
Scale	1:24,000
Data source	Sonenshein and others (1982)
Attribute table name	bcwmd.pat
Attribute table output width (columns)	24

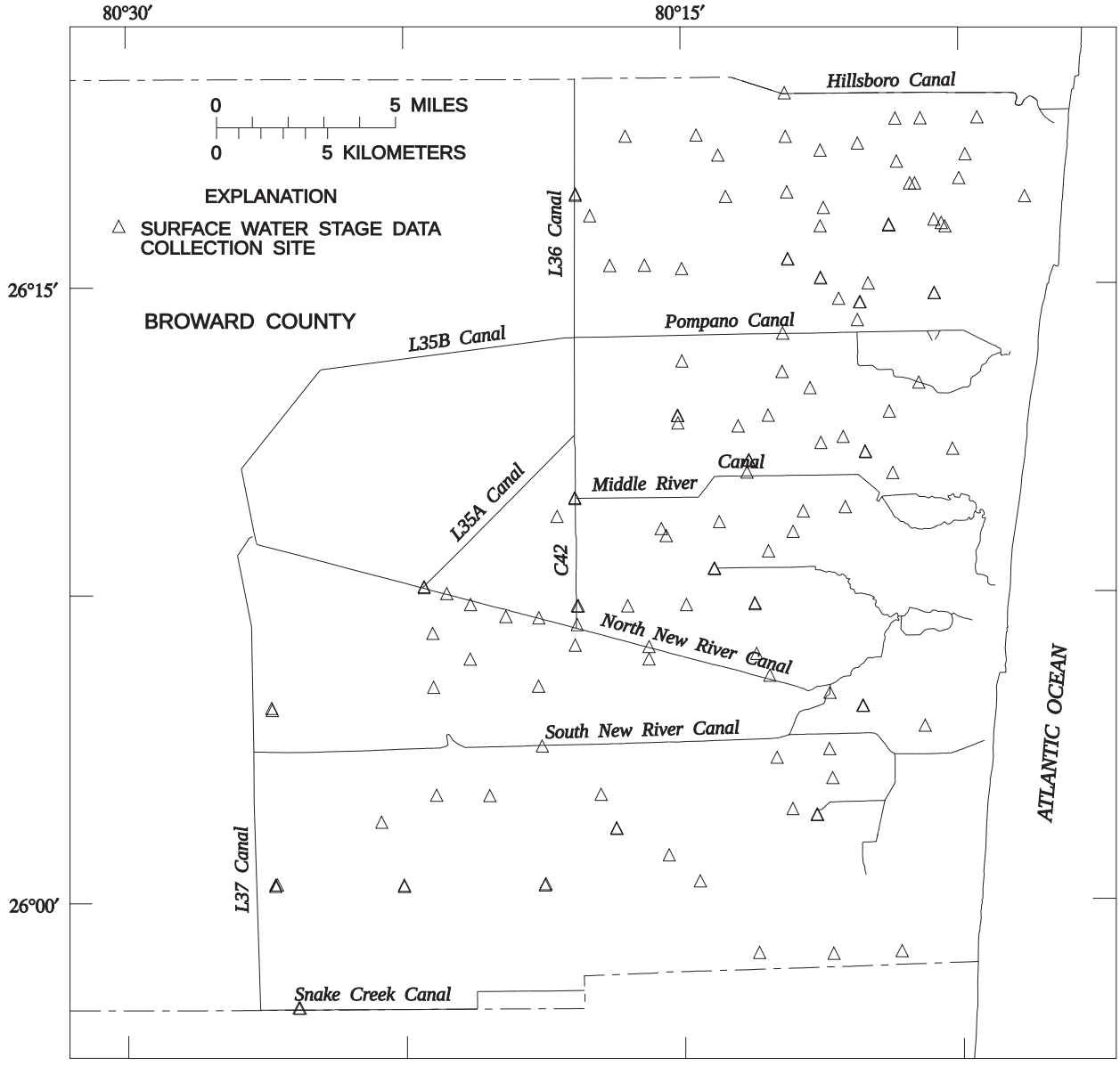

Figure 3.3.1-1. Surface-water stage data-collection sites in eastern Broward County maintained by the Broward County Water Resources Management Division.

3.0 DATA LAYERS--Continued
3.3 Hydrologic Features--Continued
3.3.2 Rainfall Data-Collection Stations

BROWARD COUNTY HAS 52 RAINFALL DATA-COLLECTION STATIONS

Rainfall data-collection stations at 52 locations in Broward County were entered into a data layer.

Rainfall data-collection station locations (fig. 3.3.2-1) and attribute data were entered into a data layer using the CREATEPOINT program (section 2.2). The locations and attribute data were retrieved from the hydrologic data base, DBHYDRO, maintained by the South Florida Water Management District (1988). All station locations and attributes in Broward County were retrieved from DBHYDRO and entered into the data layer. Rainfall data for these stations are collected and stored by various agencies. Table 3.3.2-1 summarizes the data layer. The station locations and attribute data were not verified. Only selected attributes were retrieved from DBHYDRO (table 3.3.2-2).

Table 3.3.2-1. Summary of rainfall data-collection stations point data layer

[Coordinates in Universal Transverse Mercator meters, zone 17]

Documentation attribute	Value
Minimum coordinate	x = 516375, y = 2867299
Maximum coordinate	x = 589894, y = 2908932
Number of points	52
Scale	Unknown
Data source	South Florida Water Management District (1988)
Attribute table name	rainfall.pat
Attribute table output width (columns)	113
Attribute lookup tables available	AGENCY, FREQ, METH, REC

Table 3.3.2-2. Description of variables in rainfall data-collection stations point attribute table

Attribute	Type	Length	Definition
NAME	Character	52	Station name
DBKE	YInteger	5	Data base key identifier
METH	Character	3	Computational method used to report data
FREQ	Character	2	Frequency of data stored
REC	Character	4	Recorder type used to collect data
BEGIN	Integer	4	Begin year of data collection
END	Integer	4	End year of data collection
ALTID	Character	15	Source agency identifying number
AGENCY	Character	4	Agency that processed the data
FLAG	Character	4	User-defined code

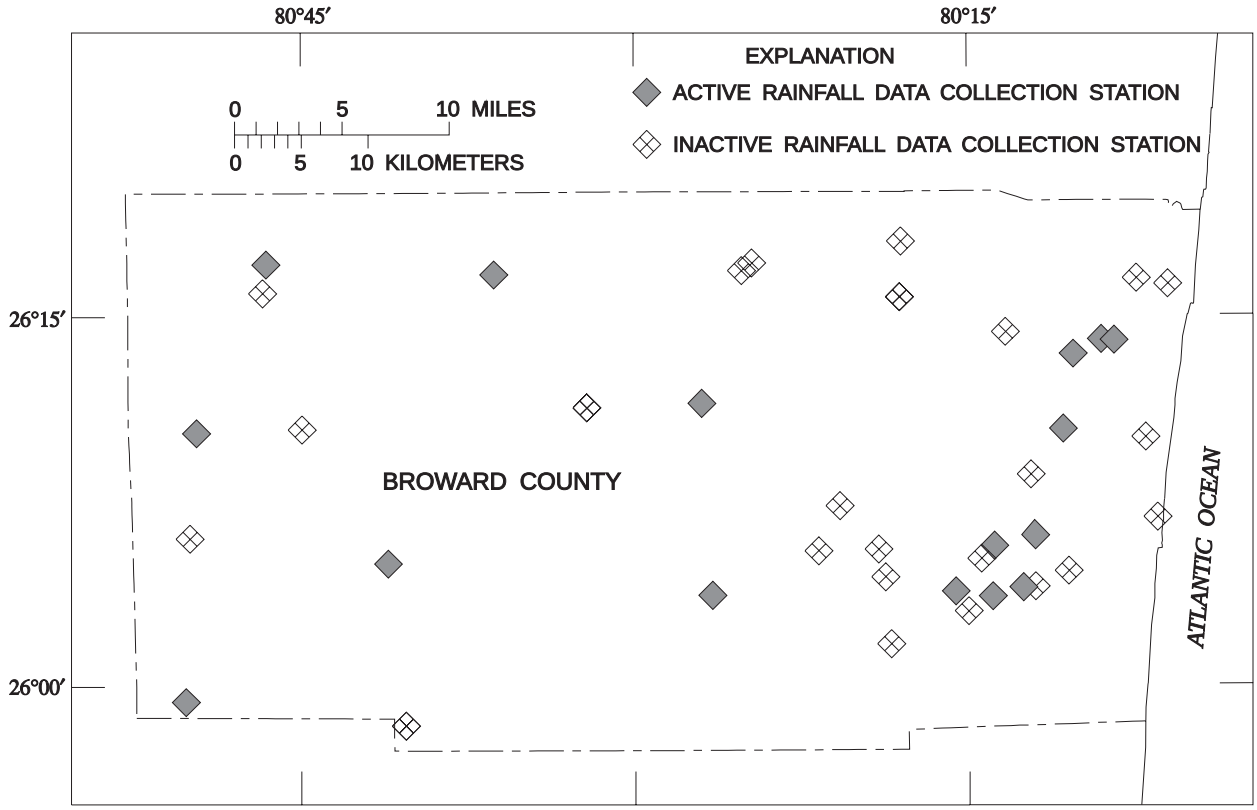

Figure 3.3.2-1. Rainfall data-collection stations in Broward County.

3.0 DATA LAYERS--Continued
3.3 Hydrologic Features--Continued
3.3.3 Surface-Water Control Structures

27 MAJOR SURFACE-WATER CONTROL STRUCTURES IN EASTERN BROWARD COUNTY

Surface-water control structures at 27 locations in eastern Broward County were entered into a data layer.

Many types of surface-water control structures are used in southern Florida. These structures include lift gates, spillways, pumping stations, gated culverts, and weirs. The locations for the major structures in eastern Broward County were plotted on 1:24,000 USGS topographic quadrangles, from which they were digitized into a data layer (fig. 3.3.3-1). Table 3.3.3-1 summarizes this data layer. Attribute data are summarized in table 3.3.3-2.

Table 3.3.3-1. Summary of surface-water control structures point data layer

[Coordinates in Universal Transverse Mercator meters, zone 17; USGS, U.S. Geological Survey]

Documentation attribute	Value
Minimum coordinate	x = 553931, y = 2870833
Maximum coordinate	x = 586775, y = 2912158
Number of points	27
Scale	1:24,000
Data sources	1:24,000 USGS topographic quadrangles Operating agency
Attribute table name	structures.pat
Attribute table output width (columns	73
Attribute lookup tables available	STYPE

Table 3.3.3-2. Description of variables in surface-water control structures point attribute table

Attribute	Type	Length	Definition
SNAME	Character	15	Structure name
STYPE	Integer	4	Structure type code
OPERATOR	Character	30	Structure operating agency

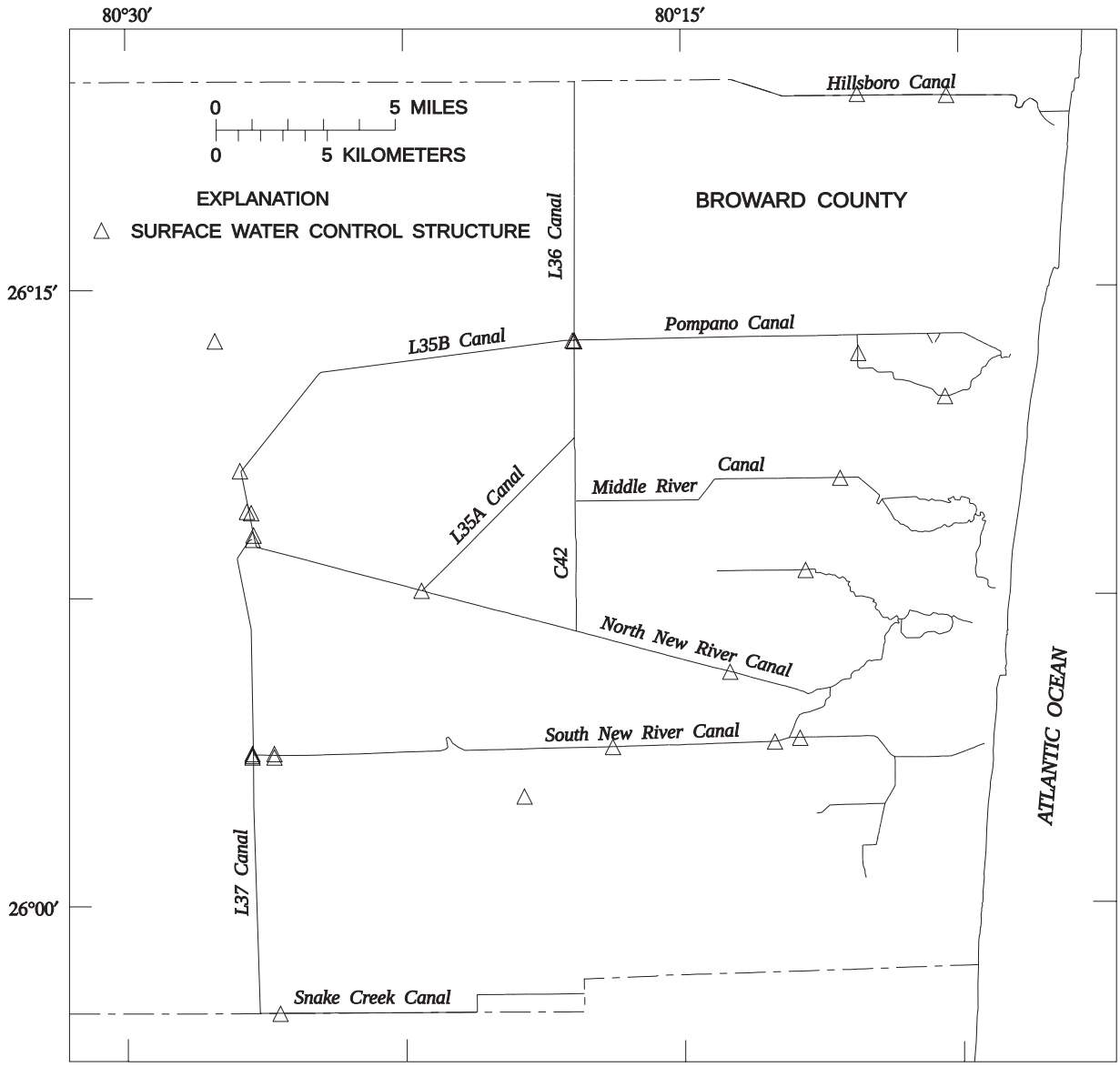

Figure 3.3.3-1. Primary surface-water control structures in eastern Broward County.

3.0 DATA LAYERS--Continued
3.3 Hydrologic Features--Continued
3.3.4 Surface-Water Features--Canals and Streams

AERIAL PHOTOGRAPHY USED TO UPDATE CANAL DATA LAYER

A data layer of canals and streams that can be used to prepare input data sets for ground-water flow models was prepared from 1:24,000 USGS topographic quadrangles and 1:3,600 aerial photography.

A data layer of canals and streams for eastern Broward County was created from 1:24,000 USGS topographic quadrangles and aerial photography. The data layer was initially created by digitizing all canals and streams from the 1:24,000 USGS topographic quadrangles. These were then plotted at a scale of 1:3,600 and compared with 1987 aerial photography for the area. Canals and streams that no longer existed were removed from the data layer, and new canals were digitized from the photographs. The section corners (see section 3.1.3) were used as TIC marks. These reference marks on the aerial photography were difficult to locate, so there was some error in the digitizing process. Because the photography was at a scale of 1:3,600 and only a 1:24,000 scale was required for the study, this error was considered acceptable. Table 3.3.4-1 summarizes the data layer.

Table 3.3.4-1. Summary of canals and streams arc data layer for eastern Broward County

[Coordinates in Universal Transverse Mercator meters, zone 17; USGS, U.S. Geological Survey]

Documentation attribute	Value
Minimum coordinate	x = 549975, y = 2861776
Maximum coordinate	x = 592572, y = 2917383
Number of arcs	6,538
Number of segments	36,914
Scale	1:24,000
Data sources	1:24,000 USGS topographic quadrangles Broward County Engineering Division, Public Works Department (1987) Agency maintaining canal
Attribute table name	canals.aat
Attribute table output width (columns)	187

Attribute data include the data needed to prepare input data sets for the MODFLOW ground-water flow model (McDonald and Harbaugh, 1988) and other descriptive information about the canal or stream (table 3.3.4-2). These data were obtained from the agency that installed or managed the canal. When top widths were unavailable, they were measured from the aerial photographs. Some attributes such as sediment thickness and hydraulic conductivity were estimated from values for similar representative canals in the area. The length of the channel (CLENGTH), length of bank (BLENGTH), and length of wetted perimeter (WP) were calculated from other attributes using the following expressions:

```
CLENGTH = 2*((CSLOPE**2*(CELEV-BOTTOM) ** 2)+(CELEV-BOTTOM)**2)**0.5
BLENGTH = 2*((BSLOPE**2*(STAGE-CELEV)**2)+(STAGE-CELEV)**2)**0.5
     WP = BLENGTH+CLENGTH+BWIDTH
```

where the attributes are as defined in table 3.3.4-2.

Table 3.3.4-2. Description of variables in canals and streams arc attribute table

Attribute	Type	Length	Definition
SOURCE	Integer	2	Source of canal or stream
NAME	Character	15	Canal name
DISTRICT	Character	20	Agency maintaining canal
SUBDIST	Character	20	Basin name within
DISTRICTBASIN	Character	20	Water-management basin (Cooper and Lane, 1987)
DATE	Integer	4	Date of construction
TYPE	Integer	1	Use of canal
STAGE	Real	4.1	Control water-level elevation (feet, sea level)
BOTTOM	Real	8.1	Bottom elevation (feet, sea level)
TWIDTH	Integer	3	Top width (feet)
BWIDTH	Integer	3	Bottom width (feet)
COND	Real	5.1	Hydraulic conductivity of bottom sediments (feet per day)
THICKNESS	Real	4.1	Thickness of bottom sediments (feet)
CELEV	Real	4.1	Elevation of top of channel (feet, sea level)
CSLOPE	Real	8.3	Channel slope (vertical to horizontal)
BSLOPE	Real	8.3	Bank slope (vertical to horizontal)
CLENGTH	Real	8.3	Total length of channel slopes (feet)
BLENGTH	Real	8.3	Total length of bank slopes (feet)
WP	Real	8.3	Total wetted perimeter (feet)
FLAG	Character	4	User-defined variable
LAYER	Integer	2	Lowest model layer penetrated by canal

3.0 DATA LAYERS--Continued
3.3 Hydrologic Features--Continued
3.3.4 Surface-Water Features--Canals and Streams--Continued

Canals and streams in southern Florida are managed for three major purposes. Because surface-water features have a major effect on the ground-water resources of the region, they are managed to provide a means of recharging or draining the surficial aquifer system. They also are used for flood-control purposes, helping to quickly remove excess runoff to storage areas and the ocean. Finally, they are managed to help maintain the quality of the natural environment. This surface-water system is constantly being modified as more areas become developed. Changes include the addition of new canals and control structures and the widening and deepening of existing canals. Figure 3.3.4-1 shows the primary and secondary drainage and recharge canals in eastern Broward County.

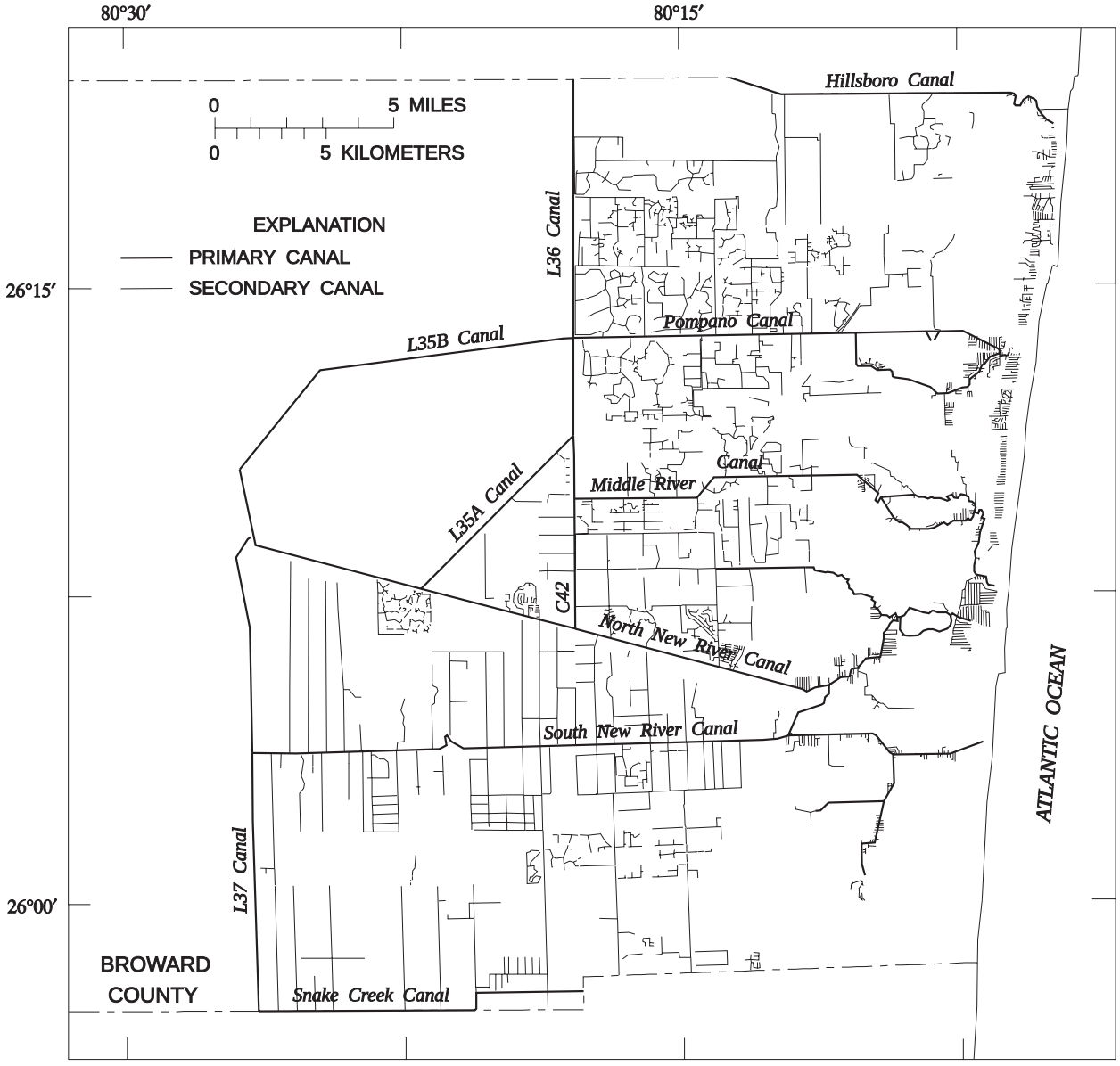

Figure 3.3.4-1. Primary and secondary canals in eastern Broward County.

3.0 DATA LAYERS--Continued
3.3 Hydrologic Features--Continued
3.3.5 Surface-Water Features--Lakes

2,143 LAKES LOCATED IN EASTERN BROWARD COUNTY

A data layer of lakes that can be used to prepare input data sets for ground-water flow models was prepared from 1:24,000 USGS topographic quadrangles and 1:3,600 aerial photography.

A data layer of lakes in eastern Broward County was prepared from 1:24,000 USGS topographic quadrangles and 1:3,600 aerial photography. All of the lakes are manmade; many are active rock quarries. The data layer was created using the same method as that used for the canals and streams data layer (section 3.3.4). Table 3.3.5-1 summarizes the lakes data layer. The only available attribute data (area and perimeter) are automatically calculated by the GIS software.

There is often little distinction between a canal and a lake in southern Florida. Therefore, users of this data layer might want to use it in conjunction with the canals data layer when any analysis of lakes is made. Figure 3.3.5-1 shows the lakes and primary canals in eastern Broward County.

Table 3.3.5-1. Summary of lakes polygon data layer for eastern Broward County

[Coordinates in Universal Transverse Mercator meters, zone 17; USGS, U.S. Geological Survey]

Documentation attribute	Value
Minimum coordinate	x = 553863, y = 2861877
Maximum coordinate	x = 592144, y = 2917343
Number of arcs	2,194
Number of segments	112,083
Number of polygons	2,143
Scale	1:24,000
Data sources	1:24,000 USGS topographic quadrangles Broward County Engineering Division, Public Works Department (1987)
Attribute table name	lakes.pat
Attribute table output width (columns)	18

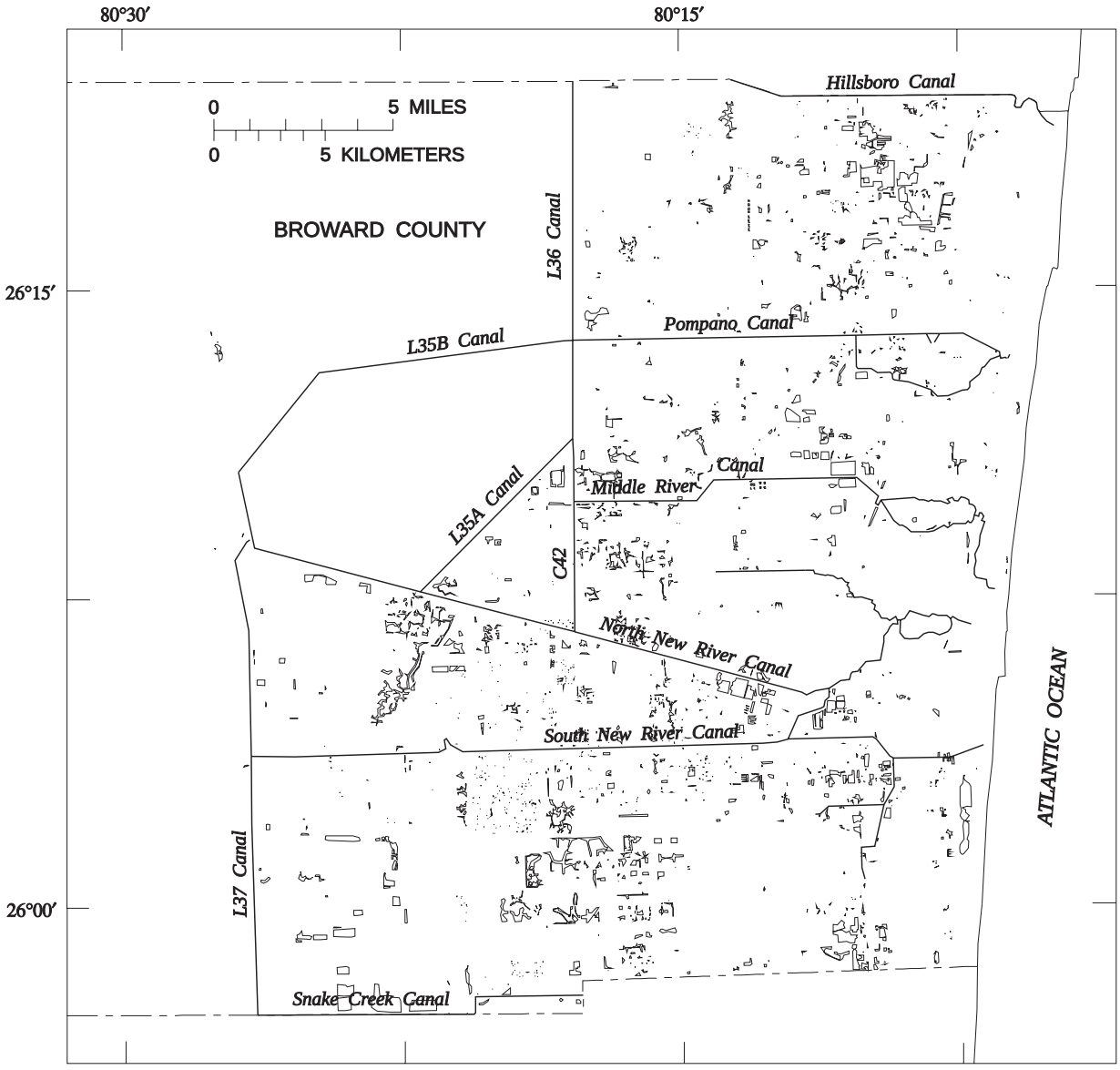

Figure 3.3.5-1. Lakes and primary canals in eastern Broward County.

3.0 DATA LAYERS--Continued
3.3 Hydrologic Features--Continued
3.3.6 Water-Control District Boundaries

BROWARD COUNTY HAS 20 WATER-CONTROL DISTRICTS

A data layer of the 20 water-control districts and their basins was created for eastern Broward County.

Most of eastern Broward County is divided into water-control districts (fig. 3.3.6-1). The district responsibilities include flood control and water management. The boundaries for these 20 districts and for the basins within the district (Broward County Water Resources Management Division, 1989) were plotted on and digitized from 1:24,000 USGS topographic quadrangles. Table 3.3.6-1 summarizes this data layer. Surface-water features (canals and lakes) were used as reference layers during digitizing. This layer can be used to assign values to surface-water features within the district.

Table 3.3.6-1. Summary of water-control districts polygon data layer for eastern Broward County

[Coordinates in Universal Transverse Mercator meters, zone 17]

Documentation attribute	Value
Minimum coordinate	x = 555680, y = 2870827
Maximum coordinate	x = 588603, y = 2912741
Number of arcs	136
Number of segments	964
Number of polygons	52
Scale	1:24,000
Data source	Broward County Water Resources Management Division (1989)
Attribute table name	districts.pat
Attribute table output width (columns)	56

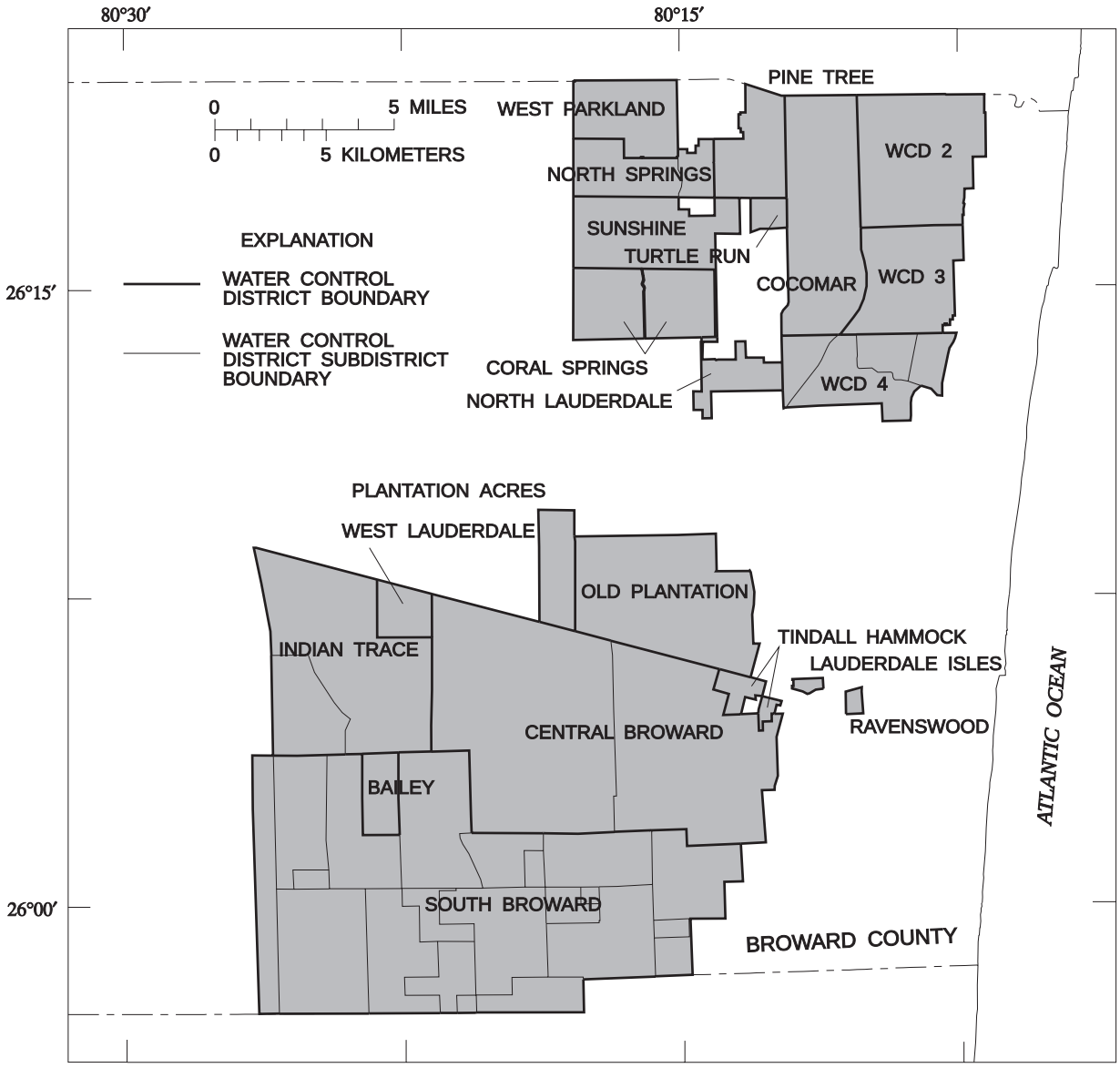

Figure 3.3.6-1. Water-control districts in eastern Broward County.

3.0 DATA LAYERS--Continued
3.3 Hydrologic Features--Continued
3.3.7 Water-Management Basins

BROWARD COUNTY CONTAINS 16 WATER-MANAGEMENT BASINS

A data layer of water-management basins was created for eastern Broward County.

Because southern Florida has a very flat terrain, drainage divides are extremely difficult to determine. Instead, the region has been divided into water-management basins as shown in figure 3.3.7-1 (Cooper and Lane, 1987). The basin boundaries for eastern Broward County were plotted on and digitized from 1:24,000 USGS topographic quadrangles. Table 3.3.7-1 summarizes this data layer. Surface-water features (canals and lakes) were used as reference layers during digitizing.

Table 3.3.7-1. Summary of water-management basins polygon data layer for eastern Broward County

[Coordinates in Universal Transverse Mercator meters, zone 17]

Documentation attribute	Value
Minimum coordinate	x = 554951, y = 2870827
Maximum coordinate	x = 592311, y = 2915050
Number of arcs	47
Number of segments	1,788
Number of polygons	17
Scale	1:24,000
Data source	Cooper and Lane (1987)
Attribute table name	basins.pat
Attribute table output width (columns)	36

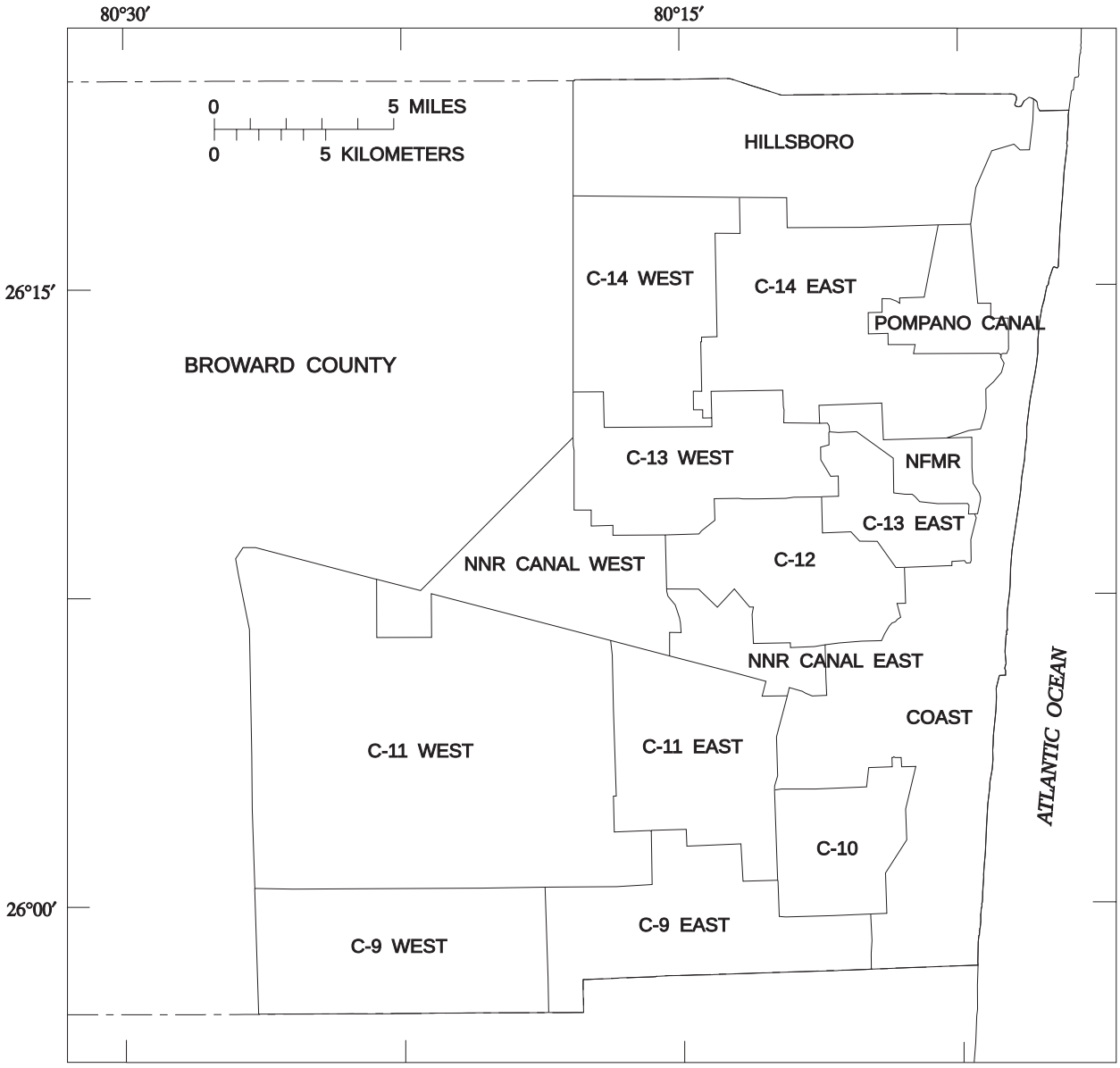

Figure 3.3.7-1. Water-management basins in eastern Broward County.

3.0 DATA LAYERS--Continued
3.4 Hydrogeologic Features
3.4.1 Major Soil Associations

U.S. DEPARTMENT OF AGRICULTURE (USDA) MAPS USED TO CREATE SOILS DATA LAYER

A data layer of the major soil associations was created for southeastern Broward County and northeastern Dade County.

Soil data are needed to determine recharge characteristics when using ground-water models. The major soil associations for southeastern Broward County (fig. 3.4.1-1) were digitized from the 1982 general soils map prepared by Pendleton and others (1984). The major soil associations for northeastern Dade County (fig. 3.4.1-1) were digitized from the 1958 detailed soil survey (Gallatin and others, 1958). Although these maps are at scales of 1:65,000 and 1:63,360, they are sufficient for most hydrologic applications at a scale of 1:24,000 because the divisions between major soil associations are not clearly defined spatially. Table 3.4.1-1 summarizes this data layer.

Table 3.4.1-1. Summary of major soil associations polygon data layer for southeastern Broward County

[Coordinates in Universal Transverse Mercator meters, zone 17]

Documentation attribute	Value
Minimum coordinate	x = 554013, y = 2866954
Maximum coordinate	x = 589768, y = 2892447
Number of arcs	88
Number of segments	1,417
Number of polygons	33
Scale	1:65,000
Data sources	Gallatin and others (1958) Pendleton and others (1984)
Attribute table name	soils.pat
Attribute table output width (columns)	18
Related table name	soils.lu
Related table definition	major soil association lookup table
Related table output width	42

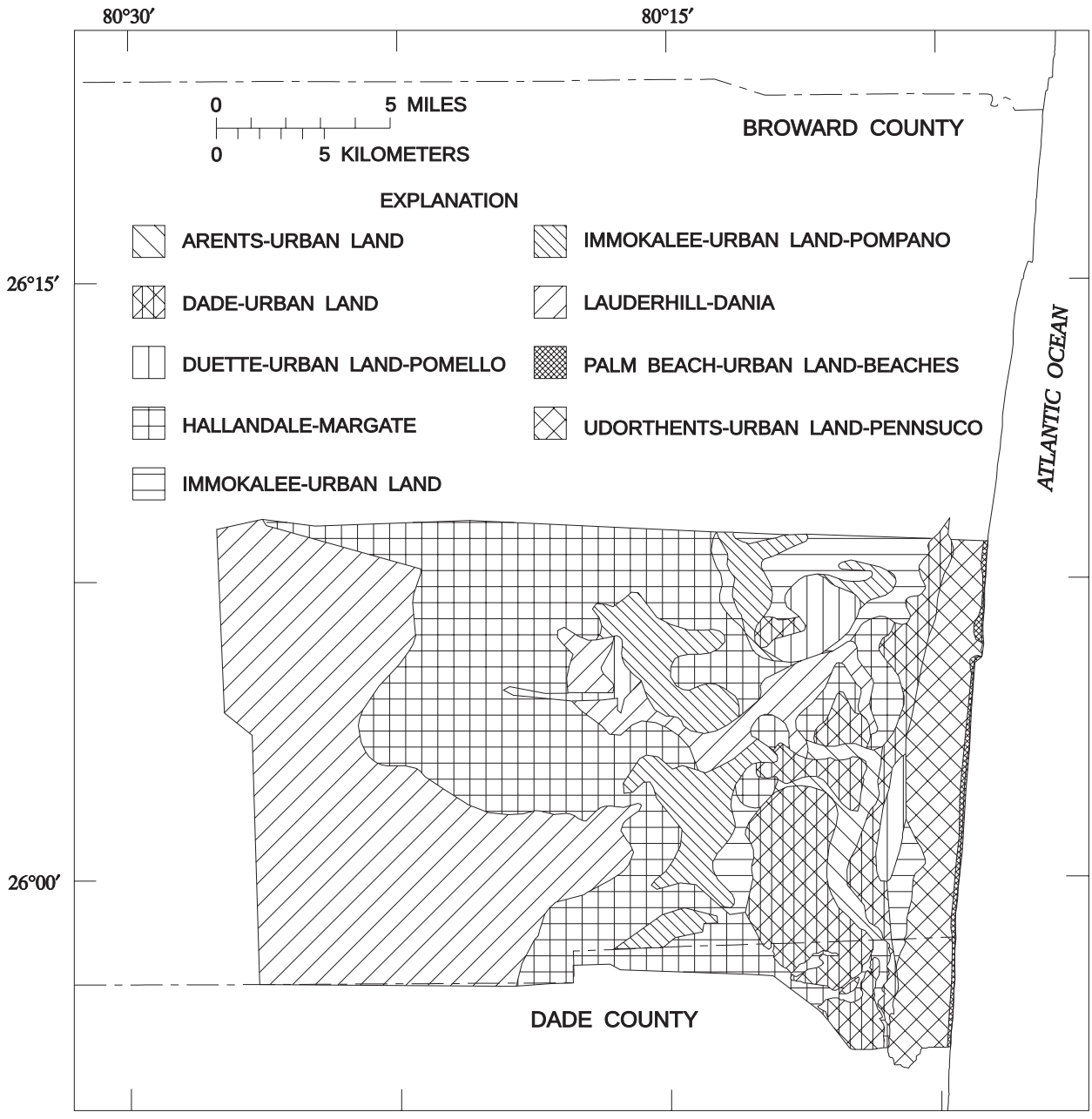

Figure 3.4.1-1. Major soil associations in southeastern Broward County and northeastern Dade County.

TRANSMISSIVITY DATA LAYER DIGITIZED FROM 1988 REPORT

A data layer of the generalized distribution of transmissivity of the surficial aquifer system in Broward County was created.

The generalized distribution of transmissivity of the surficial aquifer system in Broward County (fig. 3.4.2-1) was digitized from a 1:96,000 scale base map prepared by Fish (1988, fig. 38). The attribute data consist of boundary lines between transmissivity ranges, with values in feet squared per day, and of polygons with transmissivity ranges for each polygon, in feet squared per day. Table 3.4.2-1 summarizes this data layer.

Table 3.4.2-1. Summary of transmissivity polygon data layer for Broward County

[Coordinates in Universal Transverse Mercator meters, zone 17]

Documentation attribute	Value
Minimum coordinate	x = 511817, y = 2870740
Maximum coordinate	x = 592311, y = 2912778
Number of arcs	14
Number of segments	241
Number of polygons	8
Scale	1:96,000
Data source	Fish (1988)
Attribute table name	trans.aat
Attribute table output width (columns)	38
Attribute table name	trans.pat
Attribute table output width (columns)	36

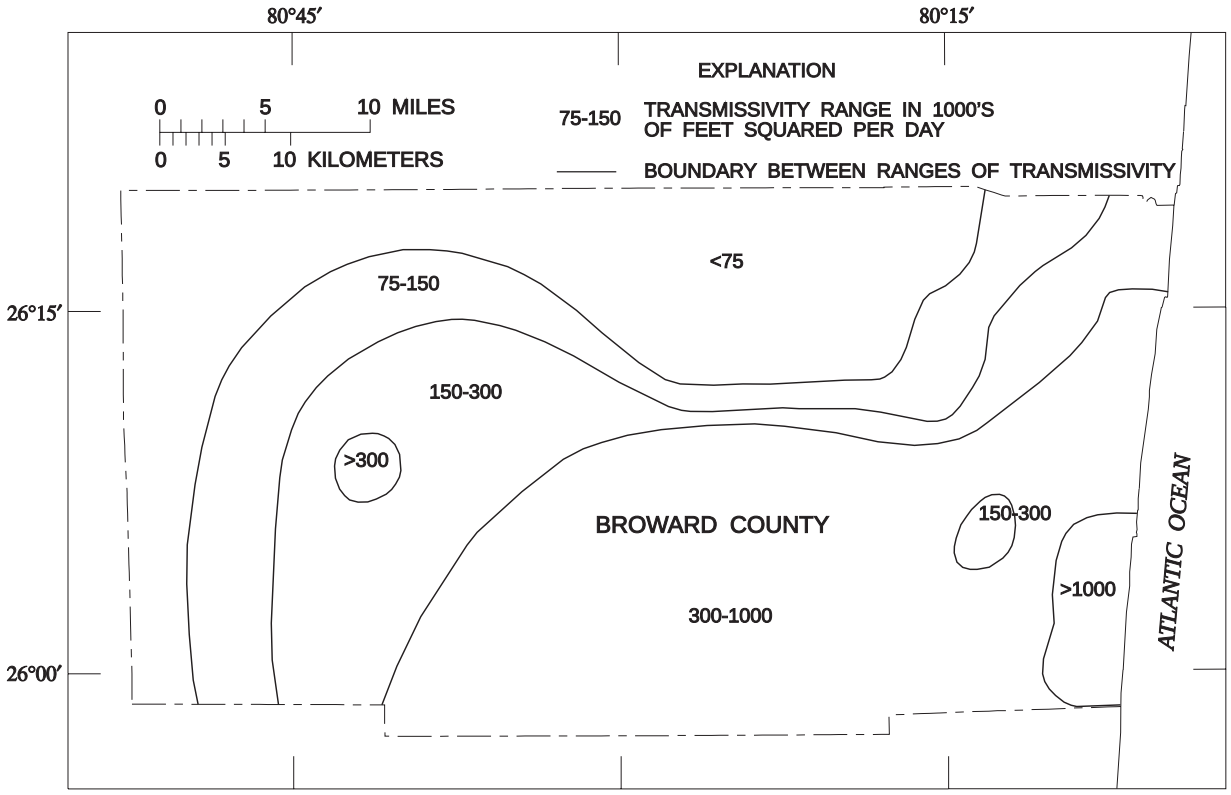

Figure 3.4.2-1. Generated distribution of transmissivity in Broward County.

3.0 DATA LAYERS--Continued
3.4 Hydrogeologic Features--Continued
3.4.3 Hydrogeologic Unit Depths at Selected Points

HYDROGEOLOGIC UNIT DEPTHS AND GENERALIZED LAND ELEVATIONS AT 321 POINTS ENTERED INTO DATA LAYER

Hydrogeologic unit depths at 321 selected points, determined from published cross sections and contour maps, were entered into a point data layer. Generalized land-surface elevations were also entered for each point.

Hydrogeologic unit depths were entered into a data layer containing point locations along published cross sections (Fish, 1988, figs. 15-22) and points interpolated from published contour maps (Fish, 1988, figs. 35 and 37; Waller and others, 1987, fig. 10). A data layer was created containing the test-well sites used for the cross sections (table 3.4.3-1). Additional data points were then entered at an interval of 1 mi along each cross section and at 1,000-ft intervals along the coast and offshore (fig. 3.4.3-1). The bases of the surface sand, the Biscayne aquifer, and the surficial aquifer system were then determined from the cross sections and contour maps and entered into the point attribute table associated with the data layer (table 3.4.3-2). Approximate land-surface elevations for each data point were entered so that the thickness of the surface sand could be calculated.

Table 3.4.3-1. Summary of hydrogeologic units point data layer at selected points in south-central Broward County

[Coordinates in Universal Transverse Mercator meters, zone 17]

Documentation attribute	Value
Minimum coordinate	x = 512732, y = 2857935
Maximum coordinate	x = 592786, y = 2902469
Number of points	321
Scale	1:24,000
Data sources	Waller and others (1987); Fish (1988)
Attribute table name	units_pts.pat.
Attribute table output width (columns)	42

Table 3.4.3-2. Description of variables in hydrogeologic units point attribute table

[Depth in feet above or below land surface. USGS, U.S. Geological Survey]

Attribute	Type	Length	Definition
SNAME	Character	10	USGS local name or report cross-section reference number
DEPTH-SS	Real	4.3	Depth of the base of the surface sands
DEPTH-BS	Real	4.3	Depth of the base of the Biscayne aquifer
DEPTH-SA	Real	4.3	Depth of the base of the surficial aquifer system
LAND-ELEV	Integer	4	Approximate elevation of land surface in feet above or below sea level

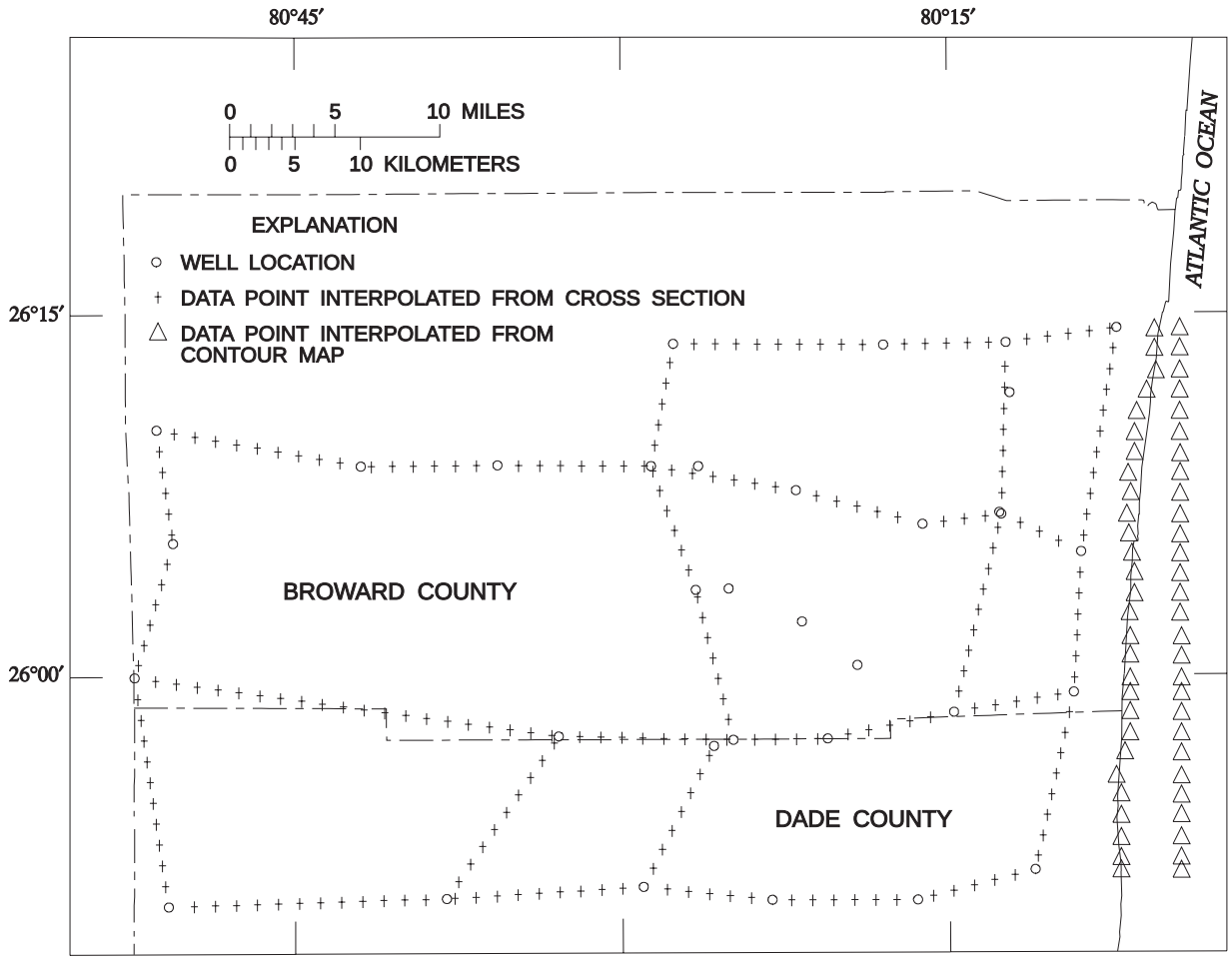

Figure 3.4.3-1. Hydrogeologic unit depth information sites in Broward County and northern Dade County.

3.0 DATA LAYERS--Continued
3.4 Hydrogeologic Features--Continued
3.4.4 Finite-Difference Model Grid for South-Central Broward County

FINITE-DIFFERENCE MODEL GRID COMBINED WITH HYDROGEOLOGIC POINT DATA LAYER TO DETERMINE AQUIFER THICKNESSES

A finite-difference model grid polygon data layer with an associated point data layer containing hydrogeologic unit depths was created for south-central Broward County.

A finite-difference model grid polygon data layer was created using the MODELGRID program described in section 2.3. The grid contains 82 rows and 120 columns (fig. 2.3-1), with a constant spacing of 1,000 ft (304.8 meters). The x- and y-coordinates of the origin of the grid (northwest corner) in UTM units (zone 17) are 554609.3 and 2892317.6 meters, respectively. Table 3.4.4-1 summarizes the model grid data layer.

A point data layer containing a point located at the centroid of each model grid cell was also created using the MODELGRID program (table 3.4.4-1). This data layer contains the attribute data associated with each cell of the model grid (table 3.4.4-2). A triangulated irregular network (TIN) was produced from the hydrogeologic unit depths at selected points data layer (section 3.4.3) in relation to the base of the surface sands, Biscayne aquifer, and surficial aquifer system (table 3.4.3-2). Each TIN was overlain on the model point data layer to determine the values of each of these three attributes for each grid cell. These TIN's can also be used to produce arc data layers representing the bases of the surface sands, Biscayne aquifer, and surficial aquifer system (fig. 3.4.4-1). A generalized land-surface elevation was also entered for each data point so that the thickness of the surface sand could be calculated. Thicknesses for the surface sands, the Biscayne aquifer, and the surficial aquifer system were then determined for each data point (table 3.4.4-2).

Table 3.4.4-1. Summary of finite-difference model grid polygon data layer and finite-difference model point data layer for south-central Broward County

[Coordinates in Universal Transverse Mercator meters, zone 17. See section 2.3 for MODELGRID program]

Documentation attribute	Value (polygon data layer)	Value (point data layer)
Minimum coordinate	x = 554609, y = 2867324	x = 554761, y = 2867476
Maximum coordinate	x = 591185, y = 2892317	x = 591032, y = 2892165
Number of arcs	19,882	Not applicable
Number of points	Not applicable	9,840
Number of segments	19,882	Not applicable
Number of polygons	9,841	Not applicable
Scale	Not applicable	Not applicable
Source	MODELGRID program	MODELGRID program
Attribute table name	model.pat	model_pts.pat
Attribute table output width (columns)	24	64

Table 3.4.4-2. Description of variables in finite-difference model point attribute table

[Depth in feet above or below land surface; thickness in feet]

Attribute	Type	Length	Definition
ROW	Integer	4	Row number for finite-difference model grid
COLUMN	Integer	4	Column number for finite-difference model grid
LAND-ELEV	Real	4.3	Approximate elevation of land surface in feet above or below sea level
DEPTH-SS	Real	4.3	Depth of the base of the surface sands
DEPTH-BS	Real	4.3	Depth of the base of the Biscayne aquifer
DEPTH-SA	Real	4.3	Depth of the base of the surficial aquifer system
THICK-SS	Real	8.3	Thickness of the surface sands (LAND-ELEV - DEPTH-SS)
THICK-BA	Real	8.3	Thickness of the Biscayne aquifer (DEPTH-SS - DEPTH-BS)
THICK-SA	Real	8.3	Thickness of the surficial aquifer system (DEPTH-BS - DEPTH-SA)

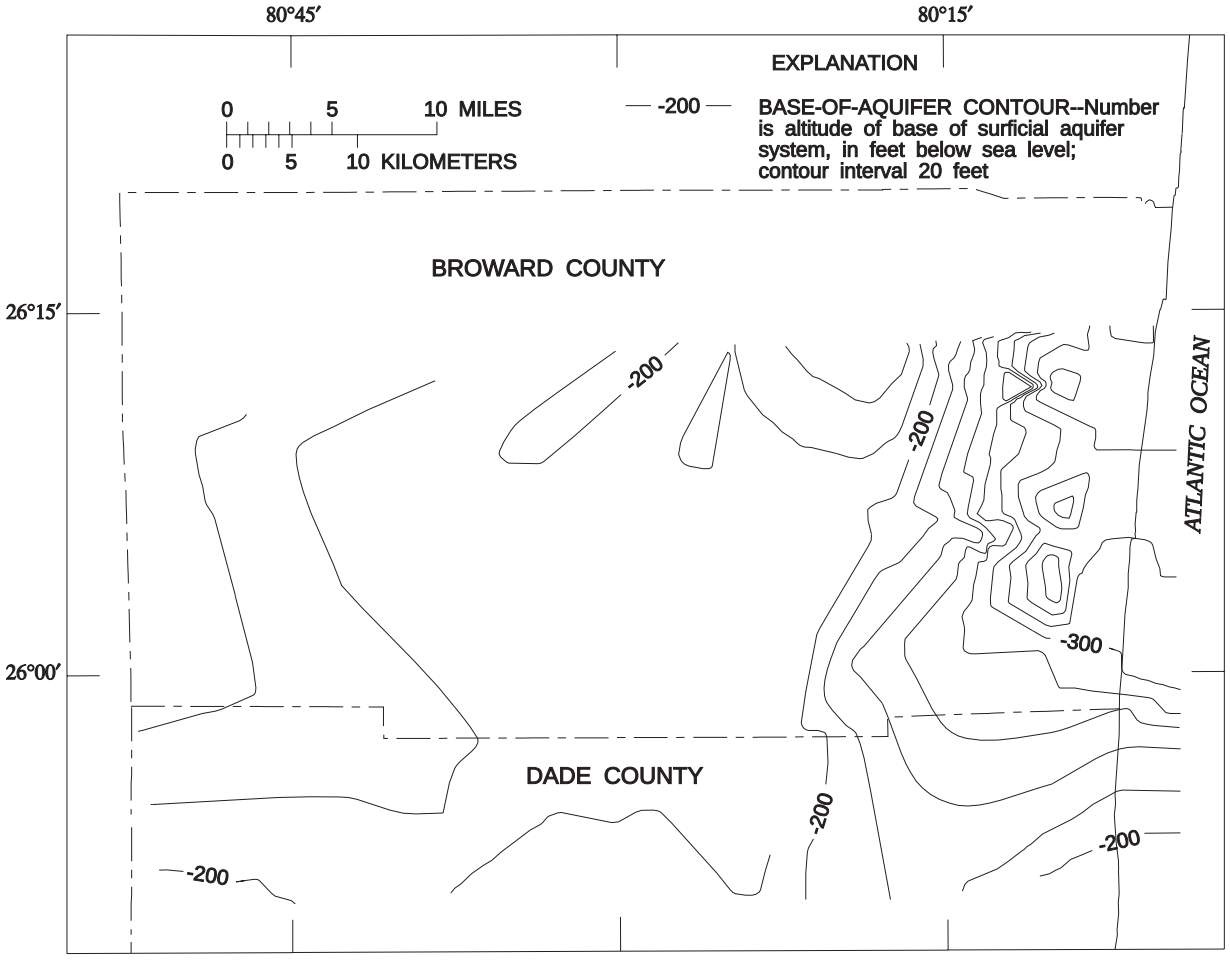

Figure 3.4.4-1. Sample contours created from the Triangulated Irregular Network of the base of the surficial aquifer system in Broward County and northern Date County.