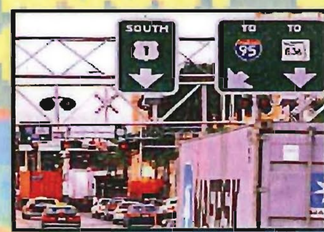
TRANSPORTATION SYSTEM HURRICANE EMERGENCY PREPAREDNESS STUDY

METRO-DADE

Dade County Metropolitan Planning Organization
Dade County Office of Emergency Management



Post, Buckley, Schuh & Jernigan, Inc.
The Gothard Group, Inc.
Herbert Saffir Consulting Engineers
Marlin Engineering, Inc.

05098/95

Technical Report No. 1

TRANSPORTATION SYSTEM INVENTORY

TECHNICAL REPORT 1:
TRANSPORTATION SYSTEM INVENTORY

Prepared for:

DADE COUNTY METROPOLITAN PLANNING ORGANIZATION
and
DADE COUNTY OFFICE OF EMERGENCY MANAGEMENT

Prepared by:

POST, BUCKLEY, SCHUH & JERNIGAN, INC.

In Association With:

MARLIN ENGINEERING, INC.
HERBERT S. SAFFIR, CONSULTING ENGINEERS
THE GOTHARD GROUP, INC.

JULY 1995

TABLE OF CONTENTS

TABLE OF CONTENTS (Continued)

LIST OF FIGURES

LIST OF TABLES

EXECUTIVE SUMMARY

The Dade County Metropolitan Planning Organization (MPO) undertook a study to review, and where appropriate, enhance hurricane emergency preparedness planning addressing key elements of the Dade County area transportation system. The firm of Post, Buckley, Schuh & Jernigan, Inc. was retained by the MPO to lead the consultant team conducting the study. Project work was closely coordinated with the Dade County Office of Emergency Management (OEM), and project efforts integrated input from transportation planning, operating, and supporting agencies at local, state, and federal levels as well as incorporating recently updated information from the South Florida Water Management District and the National Hurricane Center. The study was funded by a US DOT Planning Emergency Relief (PLER) grant obtained after Hurricane Andrew.

The objectives of the study were to systematically identify principal physical, functional and personnel resources within the transportation system, to evaluate the system's exposure and vulnerability to deal with hurricane events, and to review and assess typical plans and procedures associated with the system's hurricane preparedness and response capabilities. Principal tasks of the study were:

1. Inventory key transportation system components pertinent to the transportation system, and key human resources of the system relevant to hurricane preparedness and response;

2. Assess susceptibility of transportation system to hurricane occurrence by evaluating exposure, vulnerability, and survivability issues; and

3. Review transportation system preparedness procedures, identifying both effective and less effective points in them, and to develop and offer proposals for refinement.

The purpose of Technical Report #1 is to review data collection activities undertaken in Task 1, to summarize the data collected, and to identify the databases in which the data were compiled. Databases were developed within ARC/INFO, the proprietary Geographic Information System (GIS) used by Dade County. A GIS structure expedites database development and facilitates its maintenance, greatly advances conducting sophisticated locational analyses, and produces strongly effective and informative presentations. GIS provides a vital capability to automate and enhance the kinds of spatial analysis fundamental for purposes of transportation system hurricane preparedness planning and assessment.

This report, Technical Report #1, summarizes the inventories developed in Task 1 required before performing subsequent study analysis, review, and assessment tasks. GIS-based maps depicting transportation system physical facilities, functional elements, and personnel important to the functioning of the system before, during, and immediately following a hurricane emergency were produced based on inventory databases developed in this phase of the study. This report is the first in a series of technical reports documenting study tasks.

Technical Report #1 is intended to be used as a working document: it represents existing conditions to date. As such, the database and its working files will require periodic updating to support ongoing Dade County hurricane preparedness planning work and its refinement.

Supplementing Technical Report #1 is a series of maps bound together in Appendix 1A. This appendix offers a broad and extensive look at many of the products of inventory activities associated with the study. Because GIS is such a powerful tool for comparing objects in a geographic space with spatial criteria and with each other, a virtually unlimited number of maps may indeed be produced based upon the need for analysis and the budget allocated for such activities. However, the maps developed during the course of the study reflect the concerns the study team felt were most germane to producing visual representations of the information collected during the course of the inventory work for analysis to follow.

It is, in fact, the analysis phase of any GIS-based study, and particularly this Transportation System Hurricane Preparedness Study, which produces the greatest number and variety of maps, wherein spatial comparisons, contrasts, and locationally-based calculations are used in turn to produce other maps, visualize results, and, in the end, drive the analytic process to render more comprehensible results and inferences, construct conclusions, and develop recommendations.

Among the strictly inventory-related maps are those which show the locations of public hurricane shelters, major police and fire stations, hospitals, etc., in Dade County. Included as well are maps representing the County's major roadway network, the functional classification of its facilities, and the locations and types of installations for the traffic signals. And finally, there are maps which indicate where, and how densely developed residences and employment are when Dade is areally subdivided by several transportation-significant schemes into different areas or zones for analysis of travel and travel impacts. These focus on County population distribution and location, as these are the primary inputs to developing estimates of potential evacuees and the impacts of evacuation upon roadway traffic.

Included in Appendix 1A are not only inventory maps directly generated as a result of Task 1 activities, but also a number of analytic maps, which portray the consequences of some of the anticipated impacts of hurricane occurrence on the transportation system. Among these are estimates of population by Evacuation Modeling Zones (EZs), and numbers of those in each EZ who are projected to evacuate depending on storm strength, surge inundation, and evacuation recommendations. Perhaps the most significant of these are those representations of how the street system and highway network can be expected to become crowded with vehicles attempting to evacuate and what the relative amounts of congestion indeed are in different areas of the County and on different segments of these roadways.

Also accompanying Technical Report #1 are a series of technical appendices documenting the actual inventory information captured and the detailed structure of the databases in which they reside. By employing both Technical Report #1 and the technical appendices, analyses may be further developed, the databases can be updated, and other maps similar to those exhibited in Appendix 1A may be produced. In combination with the GIS software, this package offers the GIS and emergency management analyst the tools to consider a wide range of alternative hurricane scenarios to test, analyze, and report should the need arise.

Technical Report #1 and the accompanying technical appendices provide a broad and fairly extensive summary of transportation system features and population (and employment) patterns, and a detailed explanation of the inventories as recorded and stored in the databases developed in Task 1. This data and the database structural descriptions provide information pertinent to conducting hurricane analyses both for current and presently forecast future situations, and for updating databases for the continuous revision of contemporary and future year forecasts of probable storm impacts on Dade County.

1.0 PURPOSE, SCOPE AND METHODOLOGY

1.1 OBJECTIVES

On August 24th, 1992, Hurricane Andrew struck South Florida and became the most destructive storm in United States history. Despite the fact that it ravaged the least heavily urbanized areas of Dade County, monetary damages were greater than any previous U.S. natural disaster, exceeding twenty billion dollars worth of devastation. With sustaining winds of 145 mph and gusts over 175 mph, Andrew destroyed thousands of homes (whole neighborhoods were decimated) and businesses across its 30-mile-wide path of wreckage, with even many more thousands damaged.

As a result of Hurricane Andrew's massive impacts on the social fabric, economy, and physical urban infrastructure systems of Dade County, the awareness of the need for improved hurricane preparedness was further heightened and sharpened.

The magnitude of the damage caused by Andrew to the transportation system graphically underscored the need to review, refine and where possible, enhance preparedness for the vital urban transportation sector. In response to this recognition, the Dade County Metropolitan Planning Organization (MPO), supported by U.S. DOT Planning Emergency Relief (PLER) funds, undertook a study to review, and where appropriate, enhance hurricane emergency preparedness planning addressing key elements of the Dade County area transportation system. The firm of Post, Buckley, Schuh & Jernigan was retained by the MPO to lead the consultant team conducting the Transportation System Emergency Preparedness Study. Project work was closely coordinated with the Dade County Office of Emergency Management (OEM), and integrated input from transportation planning, operating, and supporting agencies at local, state and federal levels, as well as incorporating recently updated information from the South Florida Water Management District and the National Hurricane Center.

The objectives of the study were to systematically identify principal physical, functional, and personnel resources within the transportation system, to evaluate the system's exposure and vulnerability to hurricane events, and to review and assess typical plans and procedures associated with the system's hurricane preparedness and response capabilities. The three primary tasks of the study were:

1. Inventory key transportation system components, pertinent features of the transportation system, and key human resources of the system relevant to hurricane preparedness, endurance, and response;

2. Assess susceptibility of the transportation system to hurricane occurrence by evaluating exposure, vulnerability, and survivability issues; and

3. Review transportation system preparedness procedures, identifying both effective and less effective points in them, and to develop and offer proposals for refinement.

The purpose of this report is to review the data collection activities undertaken in Task 1, to summarize the data collected, address basic database structures, and to identify the databases in which the data were compiled. Databases were developed within ARC/INFO, a proprietary Geographical Information System (GIS). A GIS accelerates multiple source spatially-oriented database development and facilitates its maintenance, expedites dynamic spatial analyses, and produces strongly effective, informative presentations. GIS provides a vital capability to automate and enhance the kinds of spatial analysis so fundamental for purposes of transportation system hurricane preparedness planning and assessment.

Technical Report #1 is intended to be used as a working document: it represents existing conditions to date. As such, the database and its working files will require periodic updating to support ongoing Dade County hurricane preparedness planning refinements. The database and its components have, and will continue to have with suitable updating, wide applicability transcending strictly transportation planning applications.

1.2 PROJECT SCOPE

There were three facets of dimensions addressed in defining the scope of this Study Task. Geographic, temporal, and institutional considerations provided the major thrusts of investigation for the study; organization of the study, data collection, and analyses basically proceeded along these main axes of consideration.

1.2.1 Geographic Scope

The transportation system components, and transportation system-relevant elements were typically inventoried on an inclusive countywide geographic basis. These included the fundamental functional components of the system - the highway and transit networks. The highway inventory included identifying the features of roads and roadway rights-of-way (ROWs) having particular significance to hurricane damage which might result in their becoming impassable after a storm, or those with particular significance for hurricane evacuation before a storm, and for access and re-entry to storm-damaged areas following the storm's passage, such as medians and shoulders, roadside trees and signs, and roadway-spanning sign bridges.

Also included in this inclusive geographic scope were the major elements of the power distribution and mass communications systems - Florida Power and Light power generation and power distribution substations, and the sites of almost all of the television and radio studios in Dade County. These are important because not only transportation systems, but other infrastructure systems and the general public as well, depend on them for the basic supporting services of the electric power so essential for numerous vital functions and for information dissemination prior to, during, and following the advent of the storm.

Transportation system infrastructure elements were inventoried both within an inclusive countywide scope, as well as specific elements significant to transportation being selectively chosen. Elements inventoried inclusively included the County traffic signals, along with the type of installation which characterized each; the latter allows for estimating damages expected due to storms of varying intensity on the signal system, to anticipate the quantity and location of downed signals for varying storm scenarios. Selectively included were the major depots associated with the provision of transportation services; among these were major Florida DOT sites for operations, and Transit Agency bus garages, and rail yards and shops. Also selectively included were major intermodal and government administration centers in the County. When augmented with data collected via an agency survey (discussed later in Technical Report #1), it allows for estimating damages potentially incurred by these facilities under a number of hurricane scenarios before any actual storm occurrence. This approach supports hurricane preparedness improvement strategies and initiatives, an approach which eventually will benefit not only the transportation system, but general governmental service provisions as well, and support minimizing losses of time, records and other vital resources, and money spent in restoration.

Additionally, socioeconomic data pertaining to later evacuation modeling work were also collected. The Metro-Dade Planning Department provided 1990 and 1993 estimates, and year 2000 projections, of population and employment by standard County traffic analysis zones, which the study team then incorporated into the growing database. Not only are the data required to pursue evacuation modeling tasks, but the location and magnitude of where people live and work now and in the future provides one of the foundations upon which risk assessments and vulnerability analyses are based.

1.2.2 Temporal Scope

In a departure from previous general practice (in the experience of the veteran Study Team), the Dade County Transportation System Hurricane Preparedness Study addressed evacuation system forecasts not only for a 1993 base year, but in an innovative approach unique to this study, a future year 2000 forecast has been developed as well. This allows emergency planners to foresee potential problems not only for current situations, but to estimate those associated with a growing, developing, and expanding County that may present an environment differing from present conditions. It thus fosters awareness of the potential impacts of hurricanes on projected growth and development, and complementarily, of growth and development on hurricane readiness, especially resultant changes in evacuation patterns and volumes.

Because Hurricane Andrew induced significant albeit relatively temporary perturbations to the County's patterns of growth and development, the estimation of future year growth was based not on differences between 1993, the base year for evacuation studies, and the future year 2000, but on changes in population and employment between 1990 and 2000. This latter approach better captures the salient characteristics of County growth, in that restorations following Andrew, significantly advanced at the time the study initiated data collection work, had not progressed nearly as far in 1993, only a year after the storm ravaged the County. The vacating of significant numbers of businesses and residents from many areas in the heavily hurricane-afflicted parts of Dade, when used to provide the baseline for projected growth, would have resulted in inflated estimates of change in these areas, thus concomitantly inflating storm threat as a function of increased exposure due to the disproportionately increased rates of growth.

It was then forecast, and is now realized, that although an estimated 30,000 Dade Countians permanently relocated out-County, the areas they vacated would not remain empty. Indeed, significant rehabilitation has occurred to restore or rebuild many of damaged buildings in most of the storm-wrought areas, and many if not most are now reoccupied or lived in by new occupants. While the immediate effects were drastic, the longer term effects demonstrate less permanence, and will continue to be minimized with the passage of time. Therefore, in order to gain a better insight into changes occurring in Dade, the base year chosen for purposes of comparison was 1990, the most recent census year, the year for which the greatest amount of the most reliable data is available.

However, at the (present) time of the study, it was desired to have a more representative picture of the current situation for evacuation modeling purposes, to develop forecasts as close to what can be expected under current conditions. 1993 was selected as the base year because data on traffic and the transportation system were collected as part of another study, and a scientific survey was conducted, again, as part of a separate investigation, to gather information from people concerning what actions they took before Andrew and what they anticipated doing if threatened by a (another) hurricane. The 1993 survey produced the most recent behavioral data available associated with the local population's revealed and intended hurricane response patterns, and was developed to enable reliable (confidence level of 95% and confidence interval of 5%) estimation of behaviors not only county wide, but for residents of six geographic subsections of the County as well.

1.2.3 Institutional Scope

While the study addresses many countywide aspects of the transportation system, constraints were required to be observed to limit what could have become almost infinite data collection activities leading to myriad countless permutations and combinations of GIS- and other-based analyses. Therefore, not only were limits placed upon the tangible physical and functional aspects of the system to be inventoried, but also limits on the institutional representation in the study.

The three primary providers in the domain of transportation services delivery and operations in Dade County are FDOT District Six, the Dade County Public Works Department, and the Metro-Dade Transit Agency. Virtually all expressways, public highways, and major arterials fall under the jurisdiction of either FDOT or Public Works, and all publicly: provided mass transit services are administered by MDTA; these three agencies have control over the overwhelming majority of transportation facilities and services in the county, and were of course most heavily relied upon for information input to the developing databases.

Directly transportation-specific components and functions form the backbone of the transportation system, but ancillary, allied elements contribute to its functioning as well. Among these are a variety of police, fire-rescue, planning, emergency management, and general political administration functions found at both county and local municipal levels in Dade. As a result, information pertaining to major county and large city fire and police locations, all identified local offices of emergency management, and major local administrative centers were identified, as these will be nodes in chains-of-command during hurricane emergencies, be responsible for many areas of traffic transportation system control, etc. In addition, a number of particularly vulnerable non-transportation institutions were identified for database inclusion because they either will or might need to be evacuated before a hurricane, thus adding to evacuation burdens, or might be significant response resources required in the wake of a storm. Among those were mobile home parks, hospitals, and nursing and/or adult congregate living facilities, all of whom have populations who, because of facility location or disabilities or infirmities, may be particularly vulnerable to storm impacts such as surge tides, loss of power, or loss of sheltering capability. Finally, of particular and specific interest are the locations and capacities of County public hurricane shelters. Shelter data are important for both actual evacuations and development of the study's evacuation modeling forecasts, and also, potential response activities as well.

In addition, while not being inventoried in and of themselves, a number of institutions are locally significant for input into the hurricane emergency management process and were relied upon for input into developing a number of the study parameters and constraints. Among these are the South Florida Water Management District, the National Hurricane Center, the Federal Emergency Management Administration (FEMA), and the US Army Corps of Engineers.

1.3 PROJECT COORDINATION

Coordination between the Dade County Metropolitan Planning Organization (MPO), the Dade County Office of Emergency Management (OEM), the various transportation agencies, the local municipalities, and the Study Team was a key element in performing the Study. As noted previously, a great wealth of data was collected from many different agencies at different levels of government; these included:

- Federal - FEMA - Federal Emergency Management Administration
- State - Florida DOT, Florida Highway Patrol
- Regional - South Florida Water Management District (SFWMD)
- County - MPO, OEM, MDTA, and Department of Public Works, Information Technology, Police, Fire, and the Seaport and Airport Departments
- Cities - Coral Gables, Hialeah, Homestead, Miami, Miami Beach, and North Miami

In addition, meetings held with the project Steering Committee, composed of transportation and ancillary agency representatives at both local and County levels, were helpful in refining study approaches, identifying data collection needs, and eliminating some tentatively contemplated but nonessential proposals. Most of the Committee were valuable sources of information, either directly, or as resources to obtain appropriate connections to pursue data collection.

Data collection and compilation would not have been successful without the valuable and cooperative efforts of both the agencies noted above and the Steering Committee. The MPO, OEM, and the Study Team thank them for their work and contributions.

1.4 METHODOLOGY

Task 1 Transportation System Inventory compilation was comprised of three subtasks: data discovery, data collection, and database development.

1.4.1 Data Discovery

In the data discovery phase, contacts were developed and interviews conducted with officials of transportation and other agencies. The purpose of this subtask was to locate data sources and determine the availability of data required. For data determined to be available, ascertaining the contents and structure of the data sources was required, and then arranging for their acquisition by the study team in formats as compatible as possible with those proposed for information storage and subsequent processing, analysis, and evaluation activities needed to be performed.

1.4.2 Data Collection

1.4.2.1 Overview

Data collection consisted of actually obtaining data from a variety of public and private sources. Included were networks obtained from FDOT and FP&L, site- and location-specific facility data obtained from the transportation and transportation-supportive agencies, and population and employment data from the County Planning Department. A number of pre-existing GIS coverages pertinent to the study were obtained from the County's Information Technology Department (ITD); these were developed and maintained in the County's computer center ARC/INFO GIS system.

For data determined to be unavailable from existing sources, methods of acquiring raw data required development, formats for data capture needed to be created, timetables for data collection needed to be programmed, and the data collection work scheduled and performed.

Two types of data were recognized as commonly "unavailable." The first type was detailed information on roadway characteristics not currently inventoried by FDOT or County Public Works agencies; these included features such as the relative abundance or scarcity of major roadside vegetation, road ROW power and light poles, shoulder and median data not sufficiently detailed for study use, location of significant, large signs proximal to roadway surfaces and overhead sign bridges, etc. The study team conducted field observations of a number of county and state roads, recording the information collected on forms designed to provide the data in formats compatible with the database, and delivered the information to the study team data development specialists.

The second type of commonly "unavailable" data collected pertained to agencies' buildings and facilities, and included specifications relevant to hurricane vulnerability such as building age, elevation, height, roof age and construction type, and window types and areas, etc., other information concerning hurricane preparedness such as presence of emergency generators and fuel reserves, etc., and significant building contents, such as records, or communications and computer equipment. A survey was designed and executed to gather these data items.

1.4.2.2 Data Collection in the Field

An inventory of the roadway characteristics such as the number of lanes and lane widths, the shoulder and median characteristics was conducted for the county roads. This data was collected in the field because currently the Dade Public Works Department does not currently possess this information.

The roadway characteristics for interchanges were not available from the FDOT Roadway Characteristic Inventory (RCI) system. The number of lanes and lane widths, the shoulder and median characteristics for principal interchanges were collected from the field. The study team selectively developed a list of principal interchanges to survey; they are identified in Section 3 of this report.

The Public Works Department Traffic Signal Division was contacted to obtain a listing of all the existing and future signalized intersections in the county. The installation type information was not available from the Public Works Department.

The type of installation of each signal location was surveyed in the field. There are more than 2,000 operating signals within the study area. Four types of installations were identified. This information will be used to determine the wind vulnerability to each type.

The major roadside information such as vegetation was collected in the field. The road segment was divided into links and the relative abundance of roadside foliage was identified and included in the database.

1.4.2.3 Agency Facility Survey

The study team, with the cooperation of the Dade County Office of Emergency Management (OEM), developed an agency facility survey to obtain information on the characteristics of key buildings, operations/maintenance centers which are relevant to hurricane damage potential. In addition, information concerning presence of emergency power sources, generators and fuel, and equipment and devices anticipated to be supported by emergency power was collected. The agency's emergency preparedness plan for hurricanes was gathered. Figure 1-1 illustrates the survey form.

The survey was mailed to the following municipalities and agencies:

COUNTY AGENCIES - TRANSPORTATION

- Dade County Public Works Department
- Metro-Dade Transit Agency
- Miami International Airport
- Port of Miami

COUNTY AGENCIES-NON-TRANSPORTATION

- Dade County Office of Emergency Management
- Metro-Dade Fire Rescue
- Metro-Dade Police Department

Figure 1-1

AGENCY FACILITY QUESTIONNAIRE

DADE COUNTY
TRANSPORTATION HURRICANE EMERGENCY PREPAREDNESS STUDY

1. Please list each of the facilities in Dade County that your agency uses for its normal operations (administrative office buildings, maintenance yards and buildings, locations where vehicles are stored, shops, transit stations, etc.)

2. Please identify sites and facilities which may be predesigned for use in emergencies.

3. For each facility, please give an address/location and list the first floor elevation/ground elevation (in feet above mean sea level) if available. Also, please indicate the source of the elevation data if known.

4. Please list/describe the characteristics of each facility relevant to hurricane damage potential. The following features should be discussed:

   - Approximate age of facility
   - Number, location, and types of windows (casement, large plate glass, jalousies, etc.)
   - Number, location, and types of external doors (steel, wood, with/without windows, etc.)
   - Available protection features (e.g., shutters, bars, etc.)
   - Roof type (e.g., flat, gable, hip, etc.)
   - Roof construction (e.g., steel or wood, truss or beam, etc.)
   - Roofing materials (e.g., gravel, shingle, tile, etc.)
   - Age of roof
   - Number, location, and type of AC unit(s) (e.g., small individual window or wall units, large (2-5+ Ton) commercial wall or wall/window units, central units with ground-mounted compressors, central units with roof-mounted compressors, etc.)
   - Number, location, and type(s) of emergency power source(s) (e.g., batteries [number, power, expected duration], generators [fuel type, size/power output], etc.)
   - Type(s) and amount(s) of emergency fuel for generators
   - Location(s) of emergency fuel for generators
   - Equipment and devices anticipated to be supported by emergency power (e.g., lights, exit signs, computers, communications equipment, etc.
   - Equipment subject to damage if flooding occurs (electrical components, computers, communications equipment, vehicles, etc.)
   - Amount and location(s) of emergency water and food supplies.

5. Please list/describe the damage(s) resulting from Hurricane Andrew to facility(ies), equipment, vehicles, and other significant items.

6. Lastly, please provide, as available, a copy of your agency's emergency preparedness plans for hurricanes. This should include both your plan to support countywide hurricane responsibilities, and your plan to guide internal preparedness procedures for staff, physical plant, and equipment, if they are separate documents.

Agency ______________________
Your Name ______________________
Position ______________________
Phone # ______________________

Please return the questionnaire to Ms. Yajaira Moleiro of PBS&J at 2001 N.W. 107th Avenue, Miami, Florida 33172-2507.

MUNICIPALITIES

- City of Coral Gables
- City of Hialeah
- City of Homestead
- City of North Miami
- City of Miami
- City of Miami Beach

STATE AGENCIES

- Florida Department of Transportation District 6
- Florida Highway Patrol

Data collection would not have been successful without the cooperation of all the agencies contacted.

Even though the Miami International Airport Aviation Department did not provide information on their buildings, they were kind enough to sent their emergency preparedness plan.

1.4.3 Database Development

Finally, data integration and database compilation, structuring, and development were performed to conclude the Task 1 Transportation System Inventory work effort. Collected data were intensely reviewed and scrutinized; many nonessential portions were extracted from various dataset inputs, and significant data cleaning was performed to render the information collected optimally useful for study purposes. The reconciled data were incorporated into and organized within the ARC/INFO GIS database system. Data organization and database structural considerations are addressed in the following section.

2.0 INVENTORY DATA ORGANIZATION AND DATABASE STRUCTURE: BACKGROUND

Information from multiple public and private sources in transportation and non-transportation agencies was acquired and integrated within ARC/INFO GIS, the proprietary geographic information system (GIS) utilized by Dade County's countywide computer system. A GIS approach was chosen because it facilitates initial database development as well as subsequent database maintenance and updating, expedites the performance of sophisticated spatial and locational analyses, and produces visually strong, effective, and informative map presentations. GIS provides a robust capability to automate and enhance the kinds of spatial and locational analyses fundamental for purposes of assessing and evaluating transportation systems, and most especially for system hurricane preparedness planning and assessment applications. ARC/VIEW was selected because it permits easier database manipulation and analysis operations in a desktop computer environment, and although it does not posses a number of the more powerful information synthesizing and manipulating capabilities of the full ARC/INFO system, it can still perform vigorous and potent analyses in its own right, and is easily affordable by public institutions.

While the organization of the inventory and the structure of the database in which the inventory resides are intimately linked, they are also sufficiently differentiable to be separately addressed. Both the database organization and the GIS database structure will be explained and illustrated in ensuing sections.

Section 3 addresses the various items selected for inclusion in the inventory, articulates the rationale for each item's selection, and introduces them in a way in which the interdependence between the various items and the taxonomy of the entire inventory are presented. This section provides an overview of the general approach to organizing the inventory and discusses information desired and collected for various facets of the transportation system and a number of related non-transportation facilities and functions important to consider in the context of

3.0 INVENTORIES

A variety of specific item inventories, only briefly and partially described previously, were developed, including highway, transit, and other pertinent components of the transportation system, and augmented with other significant transportation-supporting agency information as well as data only indirectly associated with transportation per se, but which assume great significance when considerations of hurricane emergencies and the transportation system functioning intersect.

Public agency data sources included the MPO, MDTA, DCPW, ITD, FDOT, SFWMD, and FEMA; private sector agencies from which information was obtained included FP&L; and new information was collected from Metro-Dade Departments, Dade County municipalities and a number of their city departments. New data was also collected as a result of direct field work and telephone interviews with both public and private sector parties and the Agency Facility Survey. A survey instrument was developed and the mail-out/mail-back survey conducted to obtain detailed information about significant buildings of important agencies concerned with transportation and/or emergency response.

3.1 TRANSPORTATION SYSTEM DATA

Different features of the transportation system, mainly in the highway sector, were identified as part of this study, such as roadways and their functional classification, traffic signals and sign structures which are part of the physical elements. Also, the location of the main administrative centers, major depots, intermodal centers and the agency facilities information were collected as part of the physical elements.

The functional components are the networks characteristics which tie modal components together and allow them to perform as a unified transportation system. The functional components are tied into the physical elements. Typical sections, the shoulder and median characteristics for the state roads and major county roads were collected as part of the functional components. In addition, the right-of-way hazards such as the trees and poles for the state roads were identified as well. All this information is compiled in the database.

Transportation system data maps are contained in Appendix 1A.

3.1.1 Highway Network Data

The street network serving Dade County is basically a grid system bisected by several major diagonal roads. The expressway system in Dade County comprises north-south routes such as Interstate 95, Palmetto Expressway and Florida Turnpike Homestead Extension; east-west routes such as Palmetto Expressway, Airport Expressway, Dolphin Expressway, and Snapper Creek Expressway. Other major arterials in Dade County include South Dixie Highway, Biscayne Boulevard, and Krome Avenue in the north-south direction; Miami Gardens Drive, Flagler Street, Tamiami Trail, Bird Road, Kendall Drive and others in the east-west direction.

A large portion of the inventory database for this study is associated with the Dade County roadway network. Information related to the road system sources was acquired from several sources and integrated within several Geographic Information System (GIS) road networks. This study obtained and developed four specific GIS roadway networks:

- Detailed Roadway Network
- Simplified Highway Network
- Route-Milepost Highway Network
- Highway Network for Hurricane Evacuation Clearance Time Model

Detailed Roadway Network (DNET)

The "Detailed Roadway Network" obtained from the Dade County Information Technology Department (ITD), contains almost all the roads within Dade County along with many road features such as name, type (e.g., expressway, divided highway, other highway, collect road, feeder road), street address and zip code. This network is one of the most complicated GIS road networks in the United States with more than 90,000 road segments in the database. In general, a road segment is defined as extending from one intersection to another intersection.

The most important contribution of this network to this study is its address feature. Each road segment contains a street name, an address range for both sides of the segment and a zip code. For example, the road segment of SW 87th Avenue (between SW 56th Street and SW 58th Street) has its address range as 5601 to 5799 for the east side of the segment (from north to south) and 5600 to 5708 for the west side of the segment (from north to south). GIS has one powerful function called "address matching" which can automatically locate a facility on a map based on an address. For example, the address for the Dade County Office of Emergency of Management (OEM) is 5680 SW 87th Avenue, Miami FL 33173. GIS is capable of finding the geographic location of this address based on the address range and the name of the road segment within the highway network.

This study requires the identification of many agency facility sites and personnel residential locations. All the locational information for the required agency and personnel data were collected in an address format. This study utilized the geocoding function to convert an address into the GIS coordinate system based on the accurate location definition of the detailed highway network.

Simplified Highway Network (SNET)

The detailed highway network is very useful for address matching and other general information management operations, but is not as suitable for storing the pertinent inventory information of this study because of the time consuming process required to update information and to perform even very simple analysis tasks. Moreover, streets and highways are often key features on map that provide orientation for the location of point information such as a hospital site. The detailed highway network itself is not suitable for representation on a map because of the density of the street network. This study therefore developed a Simplified Highway Network (SNET) with 3,700 roadway segments which includes all the expressways and their ramps, major arterials and significant local roads.

It was important to develop the SNET not only to facilitate the data input and update efforts, but also to reduce analysis processing time. The SNET serves as the base structure for storing the inventory data related to the highway network. The SNET also serves as the street network background for all the GIS maps produced by this study.

Route-Milepost Highway Network (RNET)

Most roadway system attribute data, such as number of through lanes, roadway shoulder type and width, and roadway median, were collected and maintained by Florida Department of Transportation (FDOT) in its Roadway Characteristics Inventory (RCI). The RCI data was collected and stored by using a route-milepost system in which the data is related locationally by reference route and mileposts along that route. In order to efficiently represent this data within GIS, a highway network with the route-milepost feature was obtained from FDOT. The route-milepost or RCI derived data is depicted in a geographic format via RNET which is visually compatible with the SNET structure. A detailed explanation for the use of this network and development procedures for its application is discussed in detail in the database structure section of this report.

Highway Network for Hurricane Evacuation Clearance Time Model (ENET)

The Hurricane Evacuation Clearance Time Model does not have any graphic presentation capabilities for showing input and output data. A highway network was developed for the purpose of integrating GIS and highway-related data of this model. Each link and node of the ENET is identical with highway coding structure of the model. Therefore, the model's input and output data can be integrated into the GIS database. Illustrating model data in a graphic format can greatly enhance portrayal of the objectives of this model which are to estimate evacuation clearance trips and clearance time for a number of different scenarios for existing and future years, to define the evacuation road network, and to review general traffic control issues affecting traffic flow along critical roadway systems. GIS served as the database management and graphic module for the model to query and to produce a variety maps or other graphic displays. The model includes two types of information: Zonal based information (such as public shelter demand and demographic information by evacuation zone) and highway-based information (such as forecasted evacuation traffic volume on the roadway network by hurricane category). All highway-related data was integrated into the ENET which was derived from the Simplified Highway Network by deleting all unnecessary links and nodes.

3.1.1.1 Federal Functional Classification

The functional classification of highways defines a hierarchy of road function, capacity, and typical section as well as tends to dictate the funding sources and the amount of money to be allocated for certain types of roadway improvement. This information can be useful in transportation system emergency planning. Florida Department of Transportation(FDOT) periodically updates the functional classification of highways based on their characteristics and function within a network.

The latest information about functional classification of the Dade County highways which was available for this study is the 1992 Federal Functional Classification of major arterial highways in Dade County. The data was collected from the FDOT District Six Planning Office and is illustrated on a map in Appendix 1A.

The functional classification is broken down into three categories: Principal Arterial, Minor Arterial, and Collector. In order to illustrate the difference of geometric feature and traffic operation for principal arterial, all principal arterials were portrayed on the map by two sub-categories: Principal Arterial Expressway and Principal Arterial At-Grade.

3.1.1.2 FDOT Disaster Response Priorities

For emergency situations, the Florida Department of Transportation has a prioritized list of work activities which the Department would perform or have performed on the state highway system. The main purpose is to clear the principal access to the county, remove the debris, prepare sites for temporary storage or burn of debris for the recovery phase. Priority Number 1 is to clear all the critical roadways (highways/groups) such as I-95 from U.S. 1 to the Broward County line to a point where at least one lane in each direction of travel is open for emergency vehicles. Priority Number 2 consists of clearing roadways in Group 2 such as N.W. 36th Street from SR 112 to SR 826 to a point where at least one lane in each direction is open for emergency vehicles. The third priority includes the Group 3 roads such as Flagler Street from SR 913/87th Avenue to I-95 to clear the roads to a point where at least one lane in each direction is open for emergency vehicles. The priority list continues from 1 to 10.

Refer to Appendix 1A for a map of this element.

3.1.1.3 Typical Sections

The number of lanes on each side of the roadway median and the width of the through lanes on each side of the roadway median were collected for all the state roads. This information was available through the Roadway Characteristic Inventory (RCI) system maintained by FDOT.

FDOT RCI system is updated every year. A state road is planned, designed, constructed and maintained by the Florida Department of Transportation. The information for the state roads is very precise but did not include interchanges. Therefore, information for 15 critical major expressway interchanges were surveyed in the field and include the following:

1 - HEFT & Turnpike
2 - HEFT & I-75
3 - Golden Glades
4 - I-75 & SR 826
5 - I-95 & SR 112/I-95
6 - SR 112 & LeJeune Road
7 - SR 836/I-395
8 - HEFT & SR 836
9 - SR 836 & SR 826
10 - I-95 Downtown Connector
11 - U.S. 1/I-95 & Rickenbacker Causeway
12 - SR 836 & LeJeune Road
13 - SR 826 & SR 874
14 - SR 874 & SR 878
15 - HEFT & SR 874

A county road is planned, designed, constructed and maintained by the Public Works Department. Currently, the Dade County Public Works Department does not have the roadway characteristics information. This information is useful in assessing capacity of the roads and in identifying evacuation routes. The study team selected the county roads to be field surveyed and the information is included in the database. The information is included in Appendix 1B and the map is found in Appendix 1A. In addition, this information will help on the restoration activity.

3.1.1.4 Median Characteristics

A median is also defined as the portion of a divided highway separating the traveled ways for traffic in opposite directions. A median is defined as a separator located longitudinally between roadways to separate traffic traveling in opposite directions.

The type of median and median widths were collected for all state roads from the Florida Department of Transportation. In some areas the median type, such as painted (continuous left turn) may be usable as a travel lane for emergency situations. The median type information for county roads was surveyed in the field. The information is contained in Appendix 1B and the graphical representation is included in Appendix 1A.

3.1.1.5 Shoulder Characteristics

The inside and outside shoulder types and widths for all the state roads, including the interchanges, were collected. Inside shoulders are that portion of a roadway between the outer edge of the pavement and the median.

Outside shoulders are that portion of the roadway between the outer edge of the through traffic pavement to the end of the shoulder or to the intersection of the slope lines of the outer edge of the roadway with the ditch. The maximum shoulder widths entered should not exceed 12 feet.

The shoulder type and width for the county roads information were field surveyed. In some areas the shoulder may be usable as a travel lane for emergency or police purposes, or possible for increased evacuation capacity. The conversion of a shoulder to a travel lane would increase the directional capacity of the facility allowing for larger volumes of traffic to be served and travel times of these vehicles to be reduced. Careful planning should take place before this strategy is implemented to make sure that all geometric concerns are addressed in order to limit agency liability. In some areas, the feasibility of this activity is limited due to capacity obstructions such as bridges, lane drops and so forth. In addition, there may be operational requirements such as placement of signing and cones as well as manual supervision. The information is contained in Appendix 1B.

3.1.1.6 Traffic Signals

A listing of traffic signals was obtained from Dade County Public Works Department. There are a total of 2,693 signals in Dade County. Of these, there are 23 illuminated signs, 55 flashing signs, 205 school speed zone sign flashers, 15 flashing signals, 23 slaves, 24 pre-empt actuated signals, 70 locations under construction and 2,278 operating signals. As part of this study, the type of installation for more than 2,000 operating signals was surveyed. The controller is a device, whether manually, electrically or mechanically operated, by which traffic is alternately directed to stop and permitted to proceed. This important device is subject to flooding by storm surge as well as by intense rainfall. If flooding occurred and power is lost, the intersection will be unoperational and traffic problems will be encountered. Failure of areawide traffic signals due to hurricane wind and/or flooding impacts will contribute to post-hurricane traffic chaos. Supporting structures of traffic signals could be damaged by heavy wind or wind blown debris and the hurricane surge inundation could damage traffic signal control devices which are usually installed at ground level. The following controller types were field surveyed:

1. SA - Semi-Actuated
2. FA - Fully Actuated
3. NA - Not Actuated
4. SL - Slave
5. PT - Pre-timed
6. PE - Pre-emption Actuated Only

The wind susceptibility of traffic signals depends on the type of traffic signal installation that is in the manner in which traffic signal heads are supported. There are four types of traffic signal installation types existing in Dade County and they are listed as follows:

1. Wire Strand (or span wire)

2. Mast Arm Rigid (signal heads fixed to arm)
3. Mast Arm Dangling (signal heads on pivot mount)
4. Pedestal

Because information on traffic signal installation type had not been periodically gathered, a countywide field survey was conducted by the consultant to collect this information.

Each traffic signal has its own controller for controlling phase changes. Most of these control devices are mounted at the ground level; therefore, traffic signals located in hurricane surge prone areas might be subject to flooding damage. The geographic locations of traffic signals were tabulated in a spreadsheet format and converted into the GIS format.

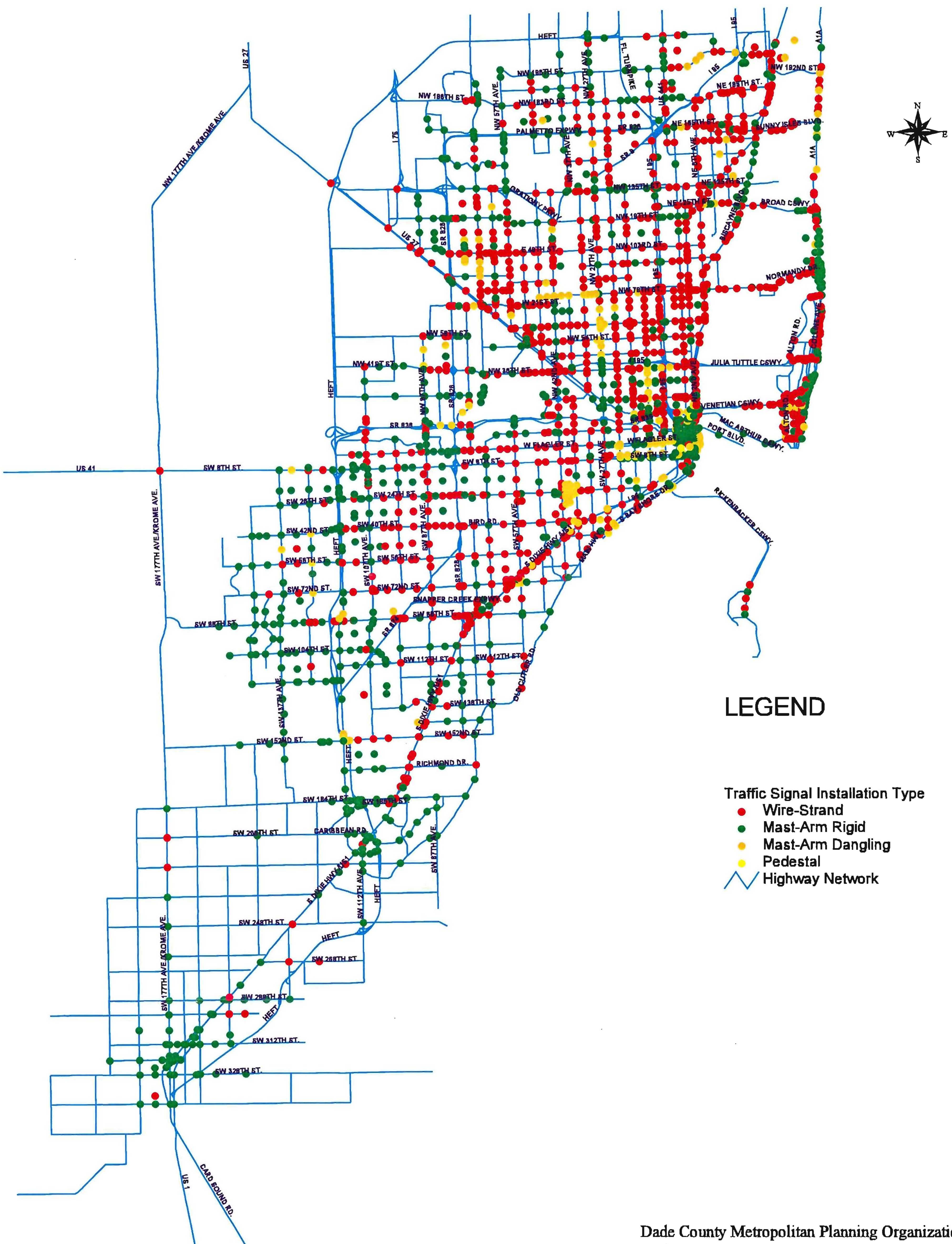
The signal information covers the location (address) of the signals, the control type such as pre-timed signal, semi-actuated, the installation type and the status of the signal as existing, under construction, or future construction.

The signal inventory information is contained in Appendix 1B. A map showing the traffic signal installation types is shown in Figure 3-1.

3.1.1.7 Right-of-Way Hazards

Information concerning right-of-way hazards such as power poles and trees was collected from aerial maps and surveyed on the field for all state roads. The relative densities (low vs. high) of power poles and trees were identified. The information can be used to evaluate the potential impact that storm wind may have on power poles and trees along the roadway network. Foliage and tree damage is a decided factor in recovery efforts after a hurricane. The damage causes that the streets will be virtually impassable to vehicular traffic making the recovery period extremely difficult.

Traffic Signal Installation Types



Dade County Metropolitan Planning Organization
Dade County Office of Emergency Management
Figure 3-1

Dade County Transportation System
Hurricane Emergency Preparedness Study

POST, BUCKLEY, SCHUH & JERNIGAN, INC.

METRO-DADE

3.1.1.8 Sign Structures

Large guide signs for the major state roads were surveyed to determine the type of sign mounting, including as overhead truss, overhead cantilever and butterfly mount in median. An overhead truss is also referred to as a "sign bridge", and spans over the travel lanes. An overhead cantilever mounting extends over the outside lane from one side of the roadway. Finally, a butterfly sign support refers to a sign mounted discretely on a post, and one nearly always located in the median. Aerial maps were used to inventory these sign installations. Guide signs are essential to guide drivers along roads, inform them of intersecting routes, direct them to towns, villages and other destinations. More importantly, these sign structures could present a hazard during a hurricane, since they are subject to wind vulnerability. The inventory of this element is contained in Appendix 1B.

3.1.2 Transit Network Data

Transit services in Dade County include regular local bus, heavy rail, downtown people-mover and commuter rail. MDTA was contacted to obtain information on the characteristics of buildings for Metrobus, Metrorail and Metromover such as stations' age, elevation height, construction type, window types, etc. In addition, information on the emergency generators and fuel reserves was collected. The rail and mover guideway data was also obtained for vulnerability analyses. This information is relevant to hurricane vulnerability and preparedness.

3.1.2.1 Bus Transit

Metrobus operates 73 routes including one midday-only and nine peak-hour-only routes. The bus routes file, in a GIS format, was obtained from ITD.

Three Metro-Dade bus garages are shown on the map that illustrates the major depots. The information obtained from MDTA on the age of the buildings, construction type, construction material, etc. will be evaluated to determine the susceptibility of wind damage and is included in Appendix 1B. Location of the garages is important prior to an emergency event to determine if buses will be able to be used as a means of transporting people to public shelters and to serve people with special needs. MDTA has assigned pickup points.

Special Transportation Services (STS) provides curb-to-curb van and minibus for Dade residents unable to use the transit system; due to its variable demand responsive nature, system operations were not inventoried.

3.1.2.2 Rail Transit

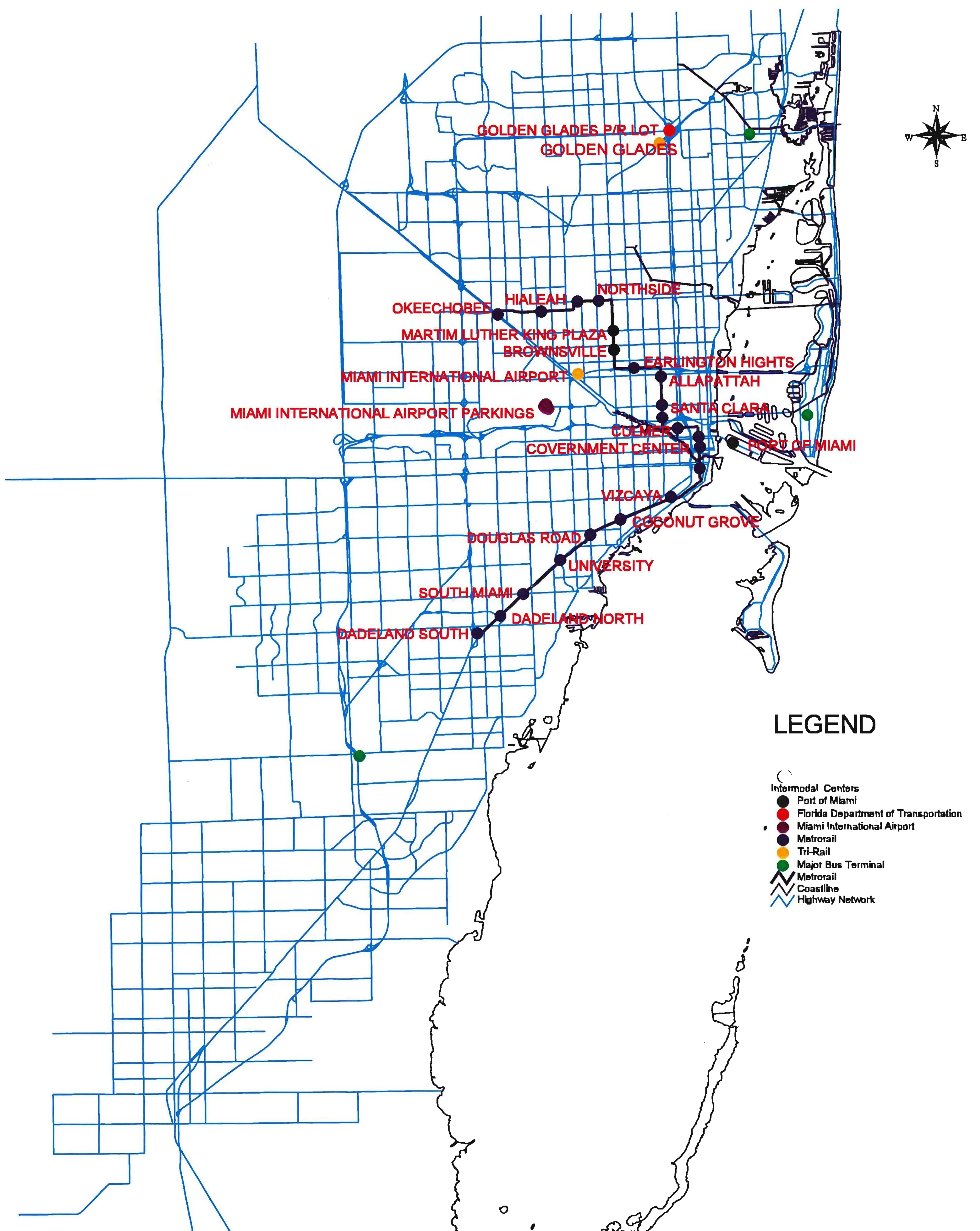
Metrorail is the fixed rail portion of Dade County's transit system. Metrorail provides services along 21.1 miles of rail line serving 24 stations between the Okeechobee Station in Hialeah to the northwest and the Dadeland South station to the southwest. The data was geocoded and a map was produced showing the Metrorail station. The Metrorail station locations are shown on the intermodal center map (see Figure 3-2).

The Metromover system is a fully automated people mover system that serves downtown Miami and connects with the Metrorail, which consists of a 1.9-mile double loop and two spurs serving the Brickell and Omni areas. The Metromover system is composed of 21 stations. The location of each station was collected and geocoded using ARC-VIEW.

The information for the Metrorail and Metromover stations' characteristics are contained in Appendix 1B.

Tri-County Commuter Rail (Tri-Rail) is the commuter rail transit system that connects Palm Beach, Broward and Dade Counties. Tri-Rail shares the CSX tracks. These tracks are owned

Dade County Intermodal Centers



Dade County Metropolitan Planning Organization
Dade County Office of Emergency Management
Figure 3-2

PBSJ POST, BUCKLEY, SCHUH & JERNIGAN, INC.

Dade County Transportation System
Hurricane Emergency Preparedness Study

METRO-DADE

by the FDOT (land and track). Tri-Rail operates a commuter train on those tracks and maintains the stations. The Tri-Rail system consists of 67 route miles along 15 stations. Out of the 15 stations, 3 stations are in Dade County and are the following: Miami Airport Station, Metrorail Station and Golden Glades Station.

3.1.3 Rail Freight Network Data

To complete the rail facility inventory, coverage of railroad corridors providing freight movement was developed. While the initial database associated with this element is limited, it may be of future use in regard to the potential shipment of relief materials into South Florida. The file covers freight rail corridors and yard areas.

Refer to Appendix 1A for a map of this element.

3.1.4 Transportation System Building Data

3.1.4.1 Intermodal Centers

The major access and transfer points for the transit modes were identified. The parking facilities for the Port of Miami, Miami International Airport and the transit mode were identified and the parking capacity information was collected. A graphical representation is shown in Figure 3-2. The inventory is shown in Appendix 1B and a map is included in Appendix 1A.

The Port of Miami facilities will not be available because of the dangerous zone that they are located in. This area is one of the first that will be evacuated because of storm surge damage. Debris is expected to occur.

3.1.4.2 Major Depots

A listing of the locations of the maintenance yards and the storage facilities for the transportation agencies were identified. The information is contained in Appendix 1B.

3.1.5 Human Resources

Planning for personnel is essential to successful emergency operations before and after the storm. The major operating agencies were contacted and are the following: Florida Department of Transportation (FDOT District 6), Metro-Dade Transit Agency (MDTA) and Dade County Public Works Department.

A listing of the administrative and technical staff was obtained for each agency. In addition, bus drivers using different garages such as the Central garage, Coral Way and Northeast garage were categorized for MDTA.

The information was received on a code basis for the name to preserve confidentiality. The division, staff position and normal residential information were collected as part of the inventory. The personal residential location can be identified to be in a storm surge vulnerability area. This information will be used to estimate how many people are affected by the storm if they will be able to fulfill their emergency positions and how soon they will be able to return to work. By locating the bus drivers' residences, potential information on bus services can be identified.

3.2 TRANSPORTATION - SUPPORTING FACILITIES DATA

A survey was mailed to selected municipalities, state agencies and county agencies to collect information on their buildings/facilities. The survey form is shown in Figure 1-1 and the agencies contacted are discussed in the previous section.

The location of the facilities, the first floor elevation, the number of doors and windows, the age of roof, the roof type and construction, the power sources, emergency generators and the significant building contents such as computers, communication equipment that may be subject to flooding are included in the inventory. The information is relevant to determine the vulnerability and readiness to a hurricane.

The findings of the inventory are contained in Appendix 1C.

3.2.1 Main Administrative Centers

The information was gathered at local (county and cities) and state levels. At the county level the administrative center for the transportation sectors were identified and the characteristics of the buildings were collected. MPO, MDTA and the Public Works Department offices were identified and located. The mayors' or city managers' office locations and public works department offices for major municipalities were also identified. At the state level, two significant locations for FDOT activities were identified. This information was incorporated in the database. The findings are shown in Appendix 1B and the graphical display is included in Appendix 1A. This information is useful before a storm event. Figure 3-3 shows the main administrative centers.

3.2.2 Major Fire and Police Stations

During an emergency, the location and telephone number of the police and fire stations is vital. The Metro-Dade Fire Rescue Department and Metro-Dade Police Department were contacted to collect the data. Selected municipalities within the study area, including the five more populated, were contacted to obtain information on the police and fire stations.

Police play a major role prior to, during and following a storm because they are involved in traffic control and maintenance of security in the devastated area. Their bases of operations are therefore significant.

The fire departments are a primary source of immediate health care for emergency situations and are likewise a key response facility.

The information is incorporated in the database and is contained in Appendix 1C. Graphical representations of the major police and fire stations are included in Appendix 1A.

3.3 NON-TRANSPORTATION FACILITIES DATA

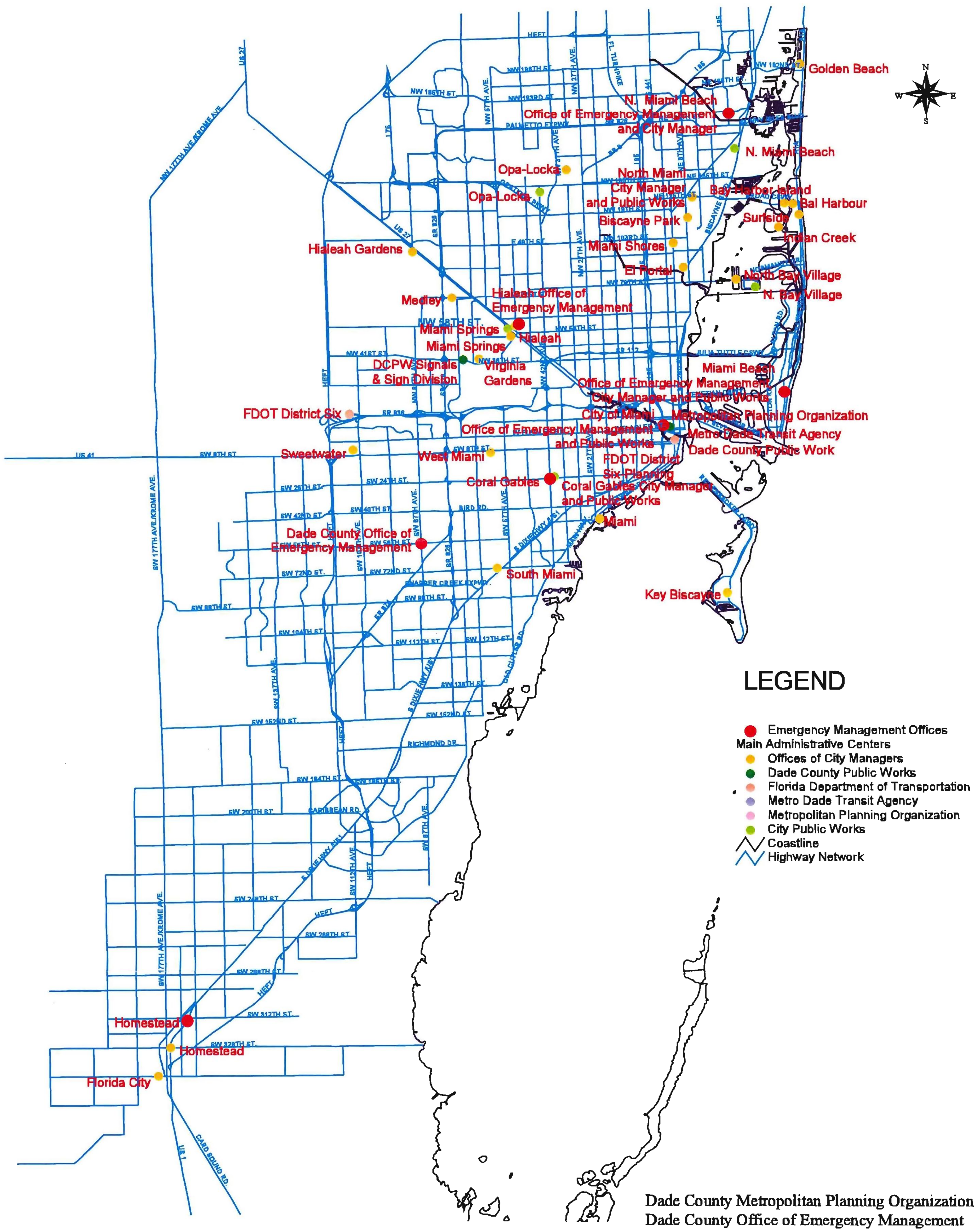
3.3.1 Offices of Emergency Management

The primary office is the Metro-Dade Office of Emergency Management (OEM) which coordinates the County's response to unusual emergencies such as natural disasters (i.e. hurricanes, tornadoes, flooding), hazardous material events, radiological emergencies, civil disturbances and man-made disasters. The OEM works in conjunction with municipalities, state and federal government and a large number of public and private agencies. The OEM also provides hurricane preparedness information and maintains a registry of People With Special Needs to assist those who cannot evacuate independently. Offices of emergency management for the selected cities were contacted and the location was geocoded. The OEMs within the study area are shown on the main administrative centers map (see Figure 3-3) and the information is contained in Appendix 1B.

3.3.2 Public Shelters

The Metro-Dade OEM was contacted and the latest listing of the hurricane public shelters was obtained. The public shelter list included 78 shelters with approximately 50,000 spaces. This

Main Administrative Centers



Dade County Metropolitan Planning Organization
Dade County Office of Emergency Management
Figure 3-3

PBSJ POST, BUCKLEY, SCHUH & JERNIGAN, INC.

Dade County Transportation System
Hurricane Emergency Preparedness Study

METRO-DADE

information is important for transportation modeling purposes to evaluate shelter resources within the county. The listing of address was geocoded and a map was developed showing the hurricane shelters. The map is shown in Figure 3-4. The database is contained in Appendix 1B.

3.3.3 Mobile Home Parks

The mobile home park information was collected from FEMA. This information is vital in an emergency situation. All mobile homes should be evacuated as soon as a hurricane warning is issued. They are vulnerable to wind and storm surge and having a geographical inventory , their location is useful for damage assessment. The address associated to these homes as well as if they are a FEMA park or not can be retrieved from the database as shown in Appendix 1B. A map showing the mobile home parks is shown in Figure 3-5.

3.3.4 Health Facilities

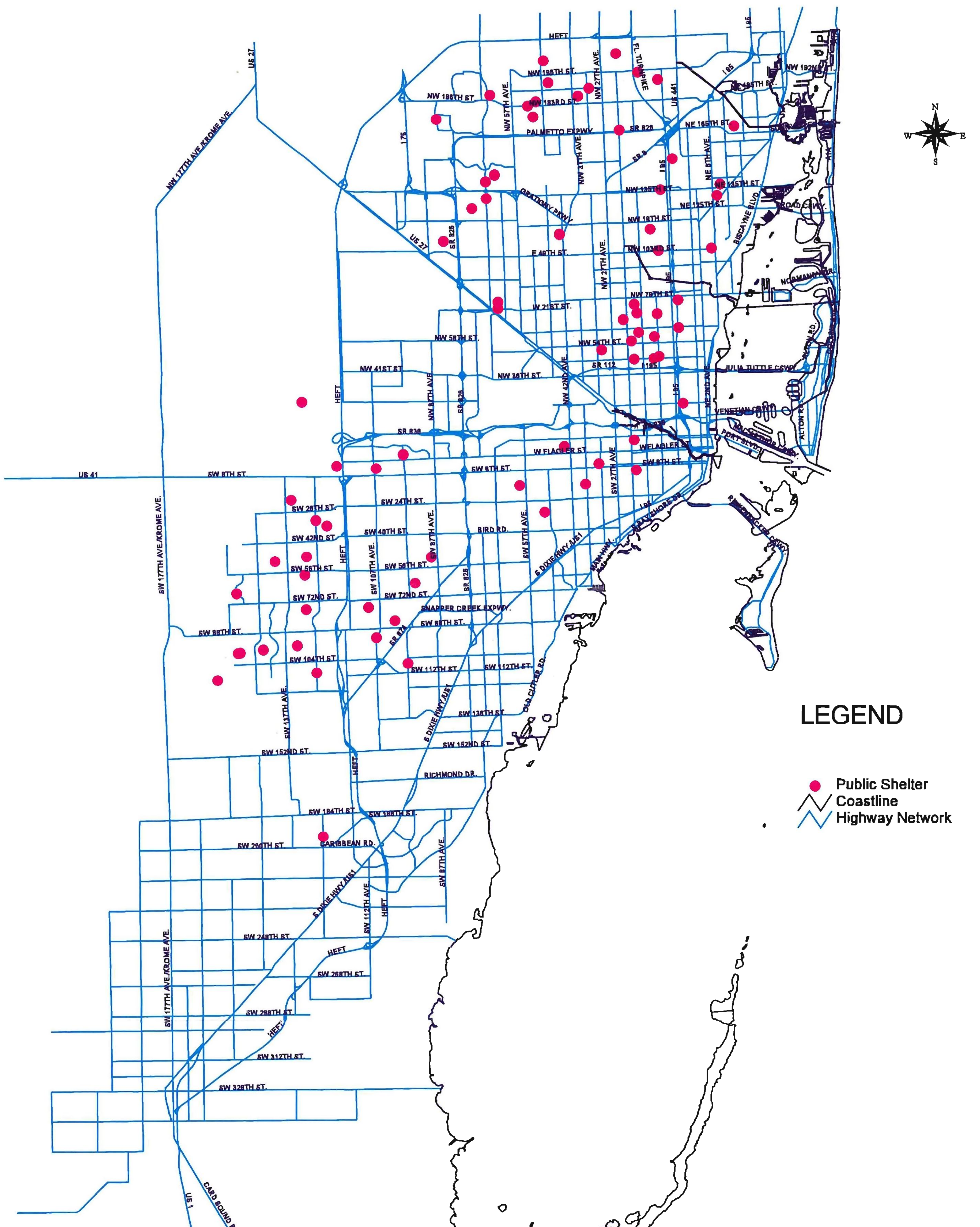
3.3.4.1 Hospitals

All the hospitals in Dade County were surveyed by telephone. An important information that was collected was the capacity (number of beds) of each facility. This information is very helpful for evacuation purposes. The number of people that need to be evacuated for each category type can be determined by cross referencing hospital sites and the storm surge limits. The inventory information is contained in Appendix 1B. A graphical representation of the hospitals is shown in Figure 3-6.

3.3.4.2 Nursing Homes and Adult Living Congregate Living Facilities

All the nursing homes and adult living congregate living facilities (ALCF) in Dade County were surveyed by telephone. The number of beds of each facility is included in the database and is

Dade County Public Hurricane Shelters



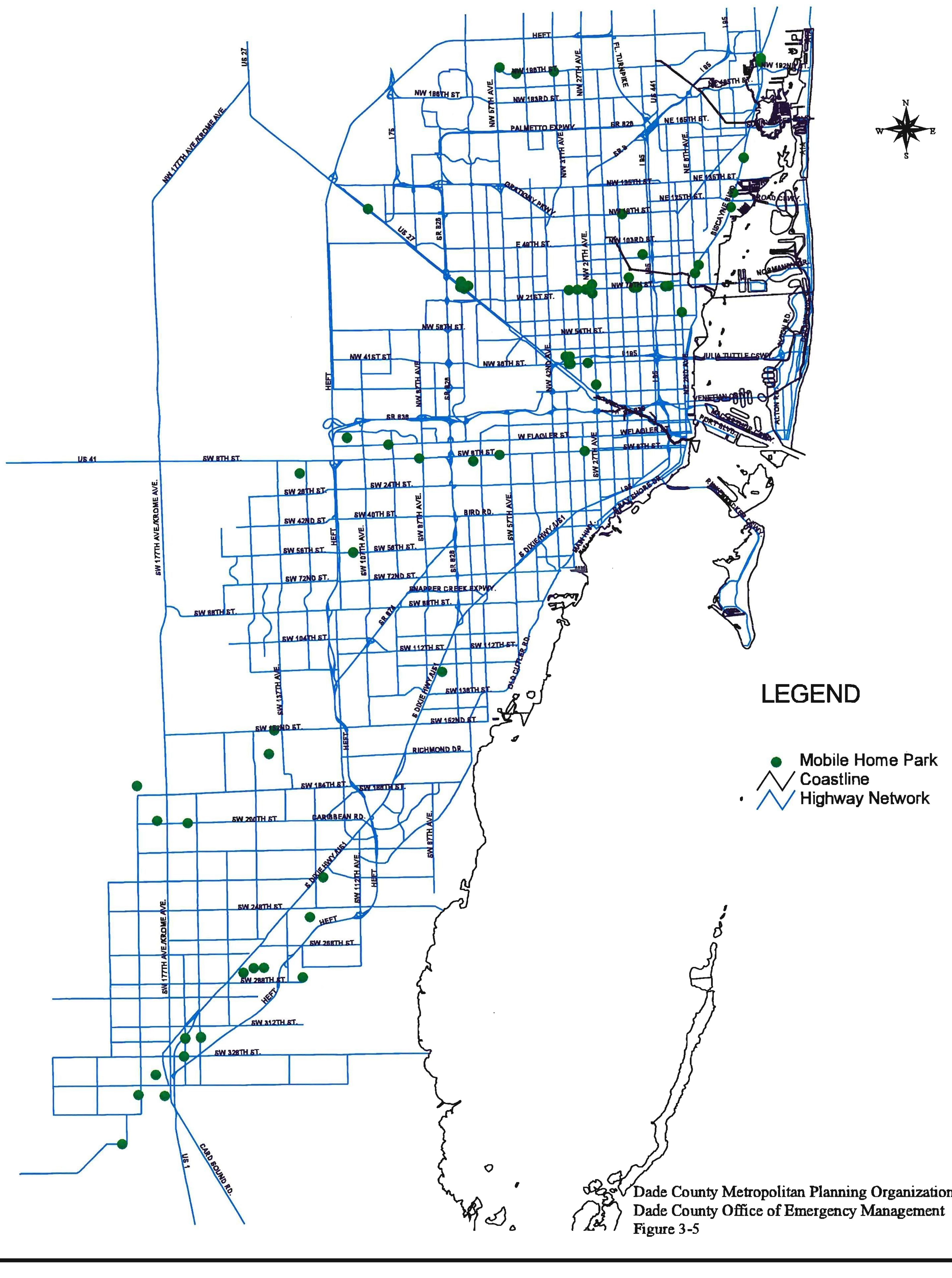
Dade County Metropolitan Planning Organization
Dade County Office of Emergency Management
Figure 3-4

POST, BUCKLEY, SCHUH & JERNIGAN, INC.

Dade County Transportation System
Hurricane Emergency Preparedness Study

METRO-DADE

Dade County Mobile Home Parks



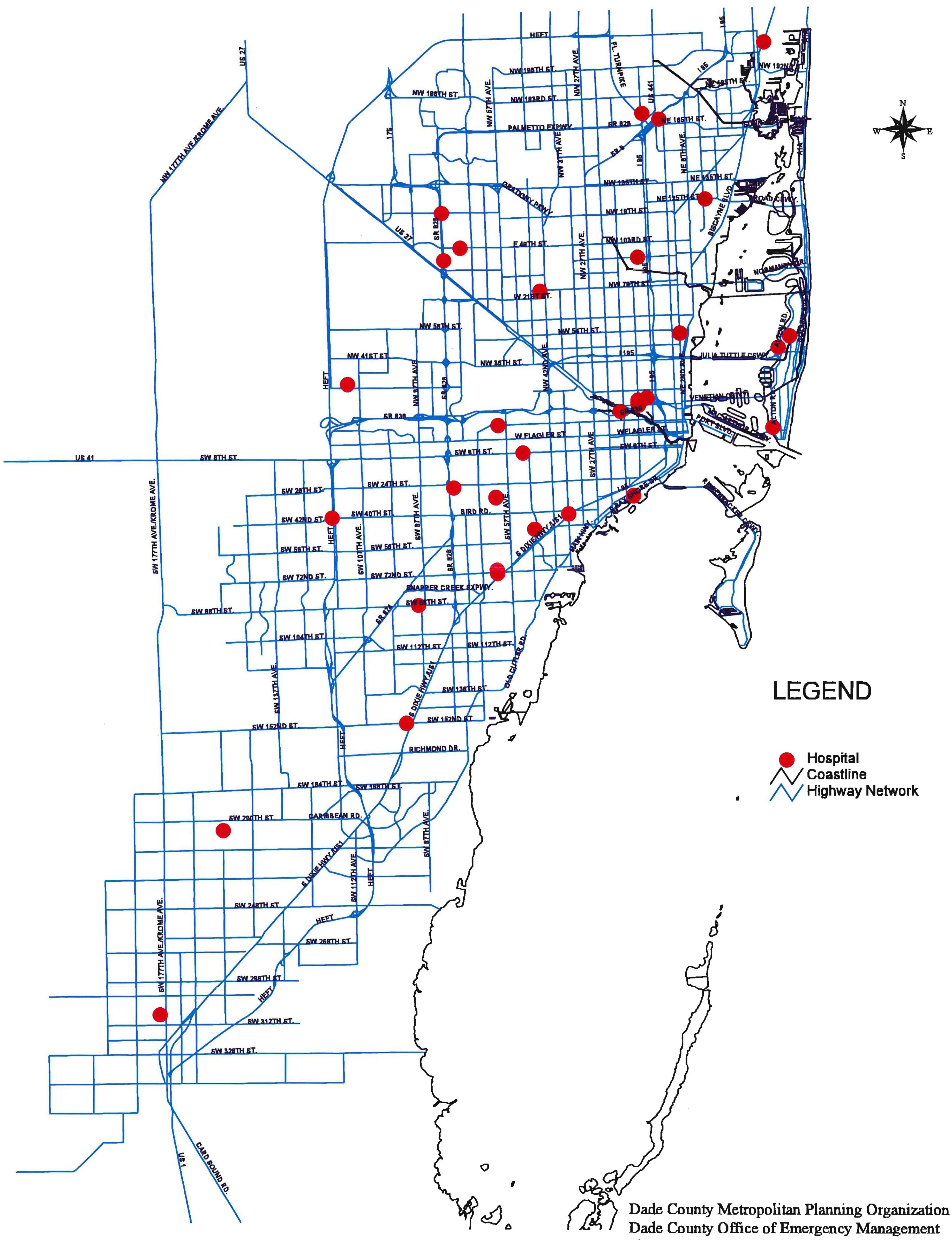
Dade County Metropolitan Planning Organization
Dade County Office of Emergency Management
Figure 3-5

Dade County Transportation System
Hurricane Emergency Preparedness Study

PBSJ POST, BUCKLEY, SCHUH & JERNIGAN, INC.

METRO-DADE

Dade County Hospitals



Dade County Metropolitan Planning Organization
Dade County Office of Emergency Management
Figure 3-6

PBSJ POST, BUCKLEY, SCHUH & JERNIGAN, INC.

Dade County Transportation System
Hurricane Emergency Preparedness Study

METRO-DADE

contained in Appendix 1B. The capacity of these facilities is important for evacuation purposes. A graphical representation is shown in Figure 3-7.

3.3.5 Power Substations

The Florida Power & Light Company was contacted to obtain information on the power substations. The information is useful because not only transportation systems, such as traffic signals, signs, lighting poles, but other infrastructure systems and the general public as well, depend on electric power for numerous vital functions. This information is shown in Appendix 1B and the map is included in Appendix 1A.

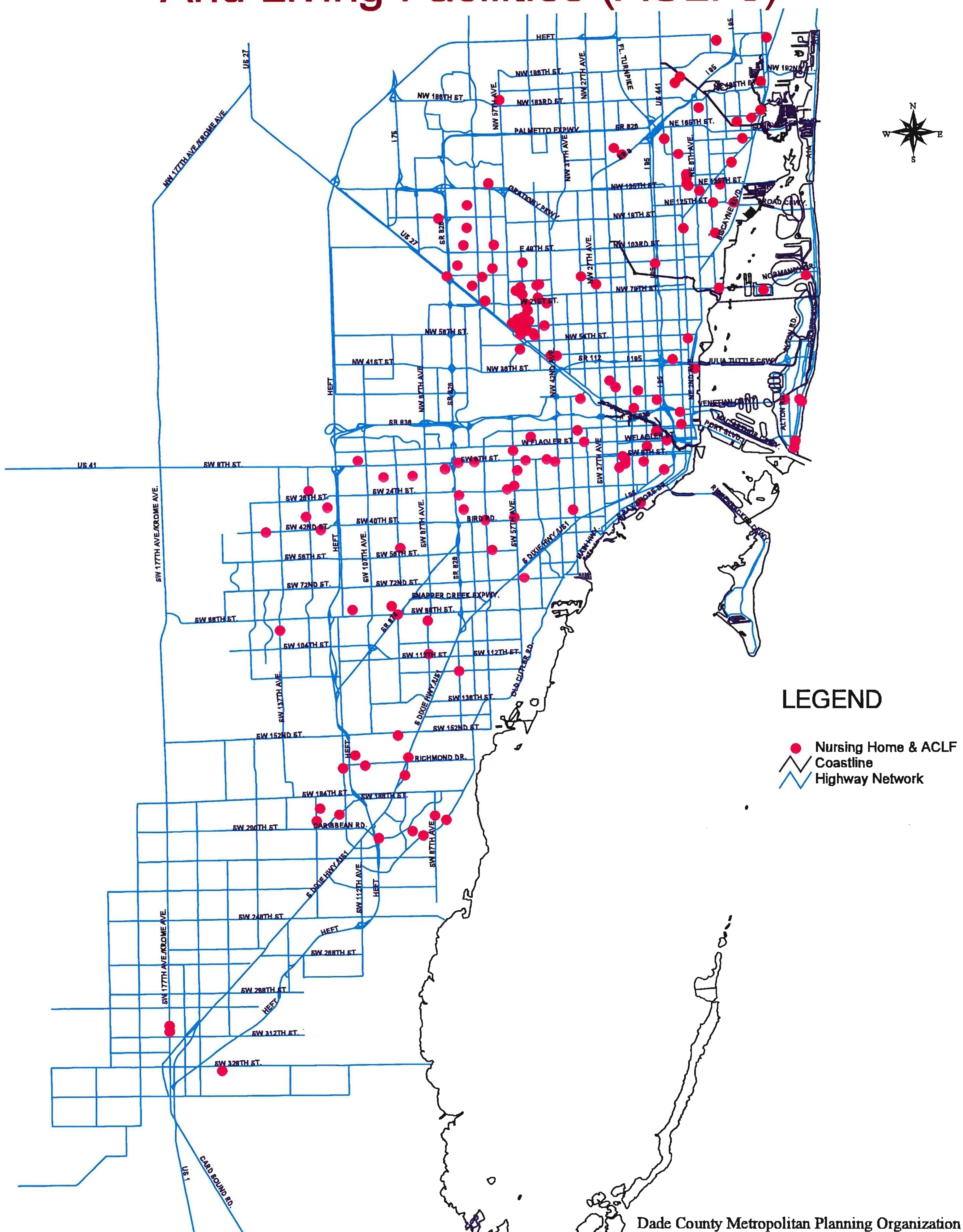
3.3.6 Television and Radio Studios

All the television and radio studios broadcasting sites were surveyed by telephone. A telephone survey was conducted to obtain the address information as shown in Appendix 1B. After the storm, radio and television stations may loose power at the transmitting and broadcasting sites. The information is incorporated in the database and is part of Appendix 1B. The maps illustrating the studios are contained in Appendix 1A.

3.3.7 Armories

The locations of armories were identified because they are generally secure buildings and can be used as distribution sites during post-hurricane. These sites can be used as bases of operation for security or relief teams such as the National Guard. The database information is contained in Appendix 1B and a map is included in Appendix 1A.

Nursing Homes And Adult Congregate And Living Facilities (ACLFs)



Dade County Metropolitan Planning Organization
Dade County Office of Emergency Management
Figure 3-7

PBSJ POST, BUCKLEY, SCHUH & JERNIGAN, INC.

Dade County Transportation System
Hurricane Emergency Preparedness Study

METRO-DADE

3.4 DEMOGRAPHIC DATA

3.4.1 Population and Employment

3.4.1.1 Traffic Analysis Zones

Dade County has been divided into 1,164 Traffic Analysis Zones (TAZ). The TAZ represents small areas with associated population and employment information for the years: 1990 (the census year), 1993 (the evacuation analysis base year) and 2000 (a future year projection). This information was available from the Dade County Planning Department.

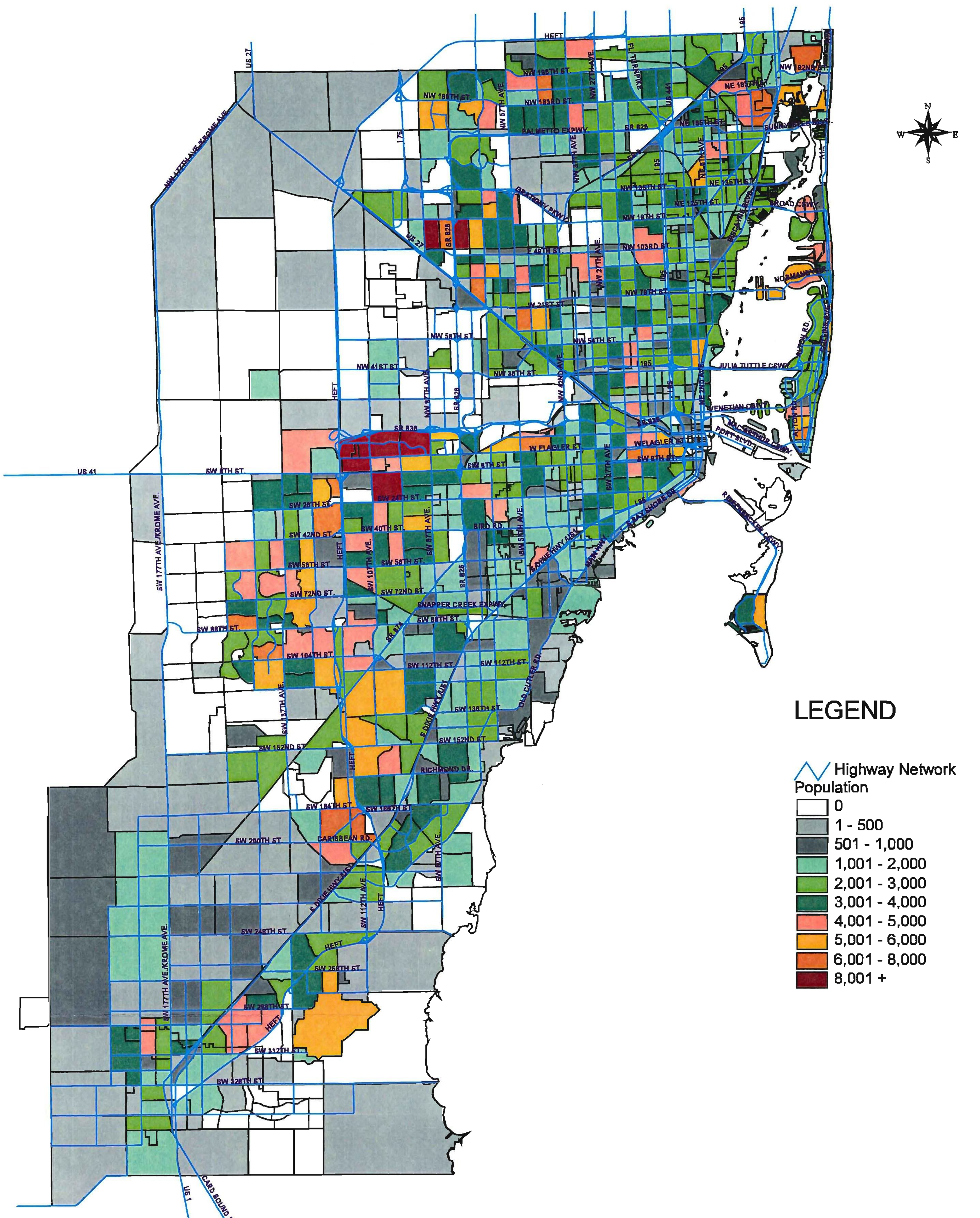
A geographical representation of employment and population data for the years 1990 and 2000 by TAZ are shown in Figures 3-8, 3-9, 3-10, and 3-11.

Through the use of a color density map, the distribution in population and employment for the years 1990, 1993 and 2000 by TAZ is illustrated. This information is useful in determining the concentration of population and employment in the surge vulnerable areas.

3.4.1.2 Traffic Analysis Districts

In order to evaluate the socioeconomic conditions and travel pattern at the subarea more aggregate level, the county has been divided into 89 Traffic Analysis Districts (TADs). These TADs were cooperatively developed by the MPO, Dade County Planning Department and Dade County Public Works Department by aggregating a number of TAZs together to form mid-size geographical areas. The appendix provides a conversion table which indicates the relationship of these TADs to specific traffic analysis zones (TAZs).

1990 Population By Traffic Analysis Zone



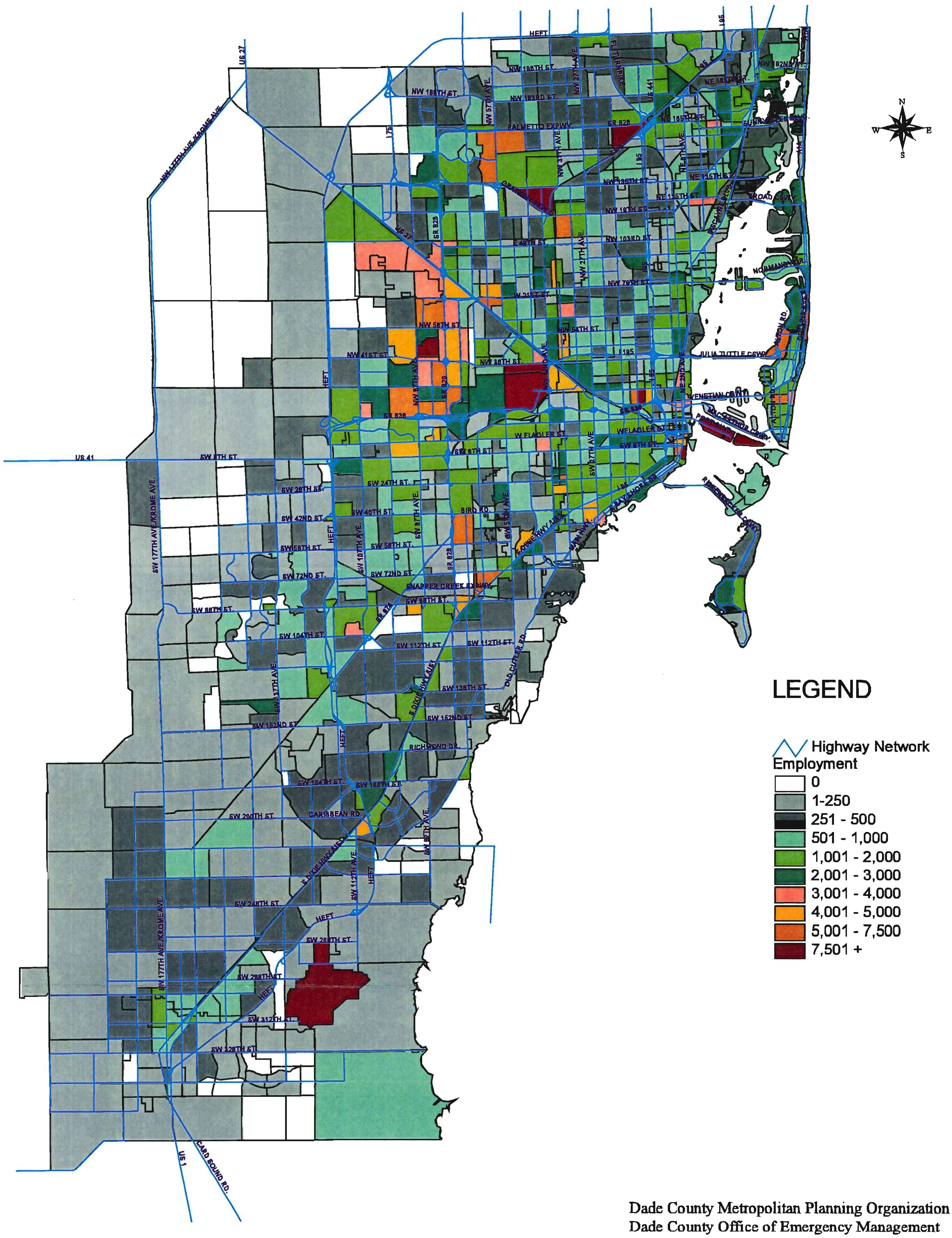
Dade County Metropolitan Planning Organization
Dade County Office of Emergency Management
Figure 3-8

PBSJ POST, BUCKLEY, SCHUH & JERNIGAN, INC.

Dade County Transportation System
Hurricane Emergency Preparedness Study

METRO-DADE

1990 Employment By Traffic Analysis Zone



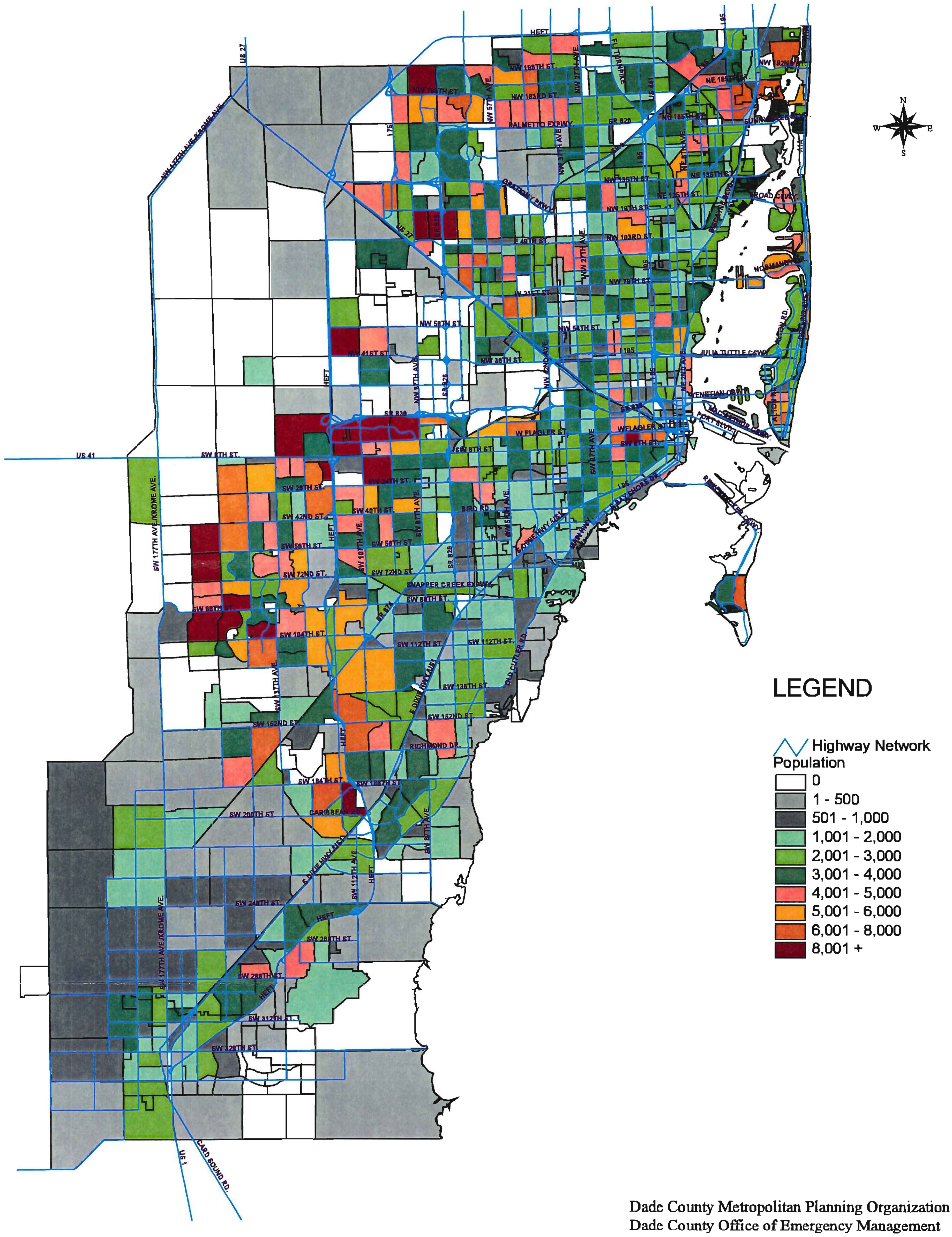
Dade County Metropolitan Planning Organization
Dade County Office of Emergency Management
Figure 3-9

PBSJ POST, BUCKLEY, SCHUH & JERNIGAN, INC.

Dade County Transportation System
Hurricane Emergency Preparedness Study

METRO-DADE

2000 Population By Traffic Analysis Zone



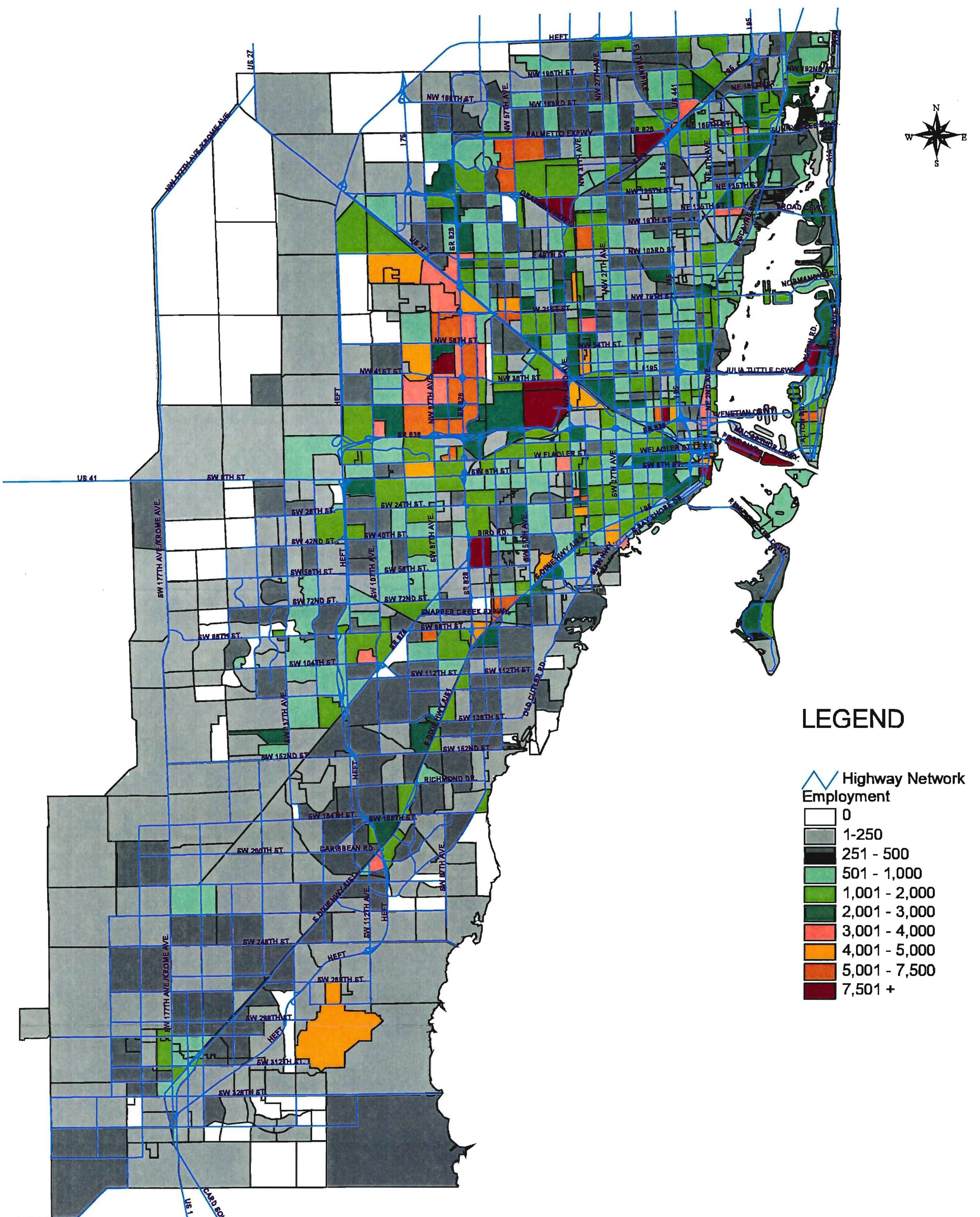
Dade County Metropolitan Planning Organization
Dade County Office of Emergency Management
Figure 3-10

PBSJ POST, BUCKLEY, SCHUH & JERNIGAN, INC.

Dade County Transportation System
Hurricane Emergency Preparedness Study

METRO-DADE

2000 Employment By Traffic Analysis Zone



Dade County Metropolitan Planning Organization
Dade County Office of Emergency Management
Figure 3-11

PBSJ POST, BUCKLEY, SCHUH & JERNIGAN, INC.

Dade County Transportation System
Hurricane Emergency Preparedness Study

METRO-DADE

3.4.1.3 Traffic Analysis Superdistricts

To evaluate the socioeconomic conditions and travel pattern at the subarea more aggregate than TAD, Dade County is subdivided into 37 Traffic Analysis Superdistricts (TASs). A TAS is developed by aggregating a number of TADs together.

A listing of the geographical subdivisions available and the information contained within the GIS is provided as general information in Appendix 1B.

3.5 GEOPOLITICAL DATA

3.5.1 Commission Districts

Dade County is divided into 13 commission districts and the data is incorporated in the database. The database information was obtained from ITD. The location of the commission districts in relation with the surge vulnerable area will help determine to what extent of potential storm surges may pose a threat to the urbanized area, and which of the County Commission Districts are most liable to saltwater inundation. In addition, this data will help to determine the restoration and recovery action to be taken by the officials. The database information is contained in Appendix 1B.

3.5.2 Municipal Boundaries

At the time this report was written, Dade County included 28 distinct municipalities. Each municipality has its own government, and may provide selected city services, such as police protection or zoning designation and enforcement. The City of Miami is the County's most populace municipality, followed by Hialeah, Miami Beach, North Miami and Coral Gables. Municipal boundaries was collected from ITD. The database information is contained in Appendix 1B and the graphical representation is included in Appendix 1A.

4.0 DATABASE STRUCTURE

GIS is a powerful tool which allows data from wide and disparate sources to be integrated based on an associated location, then spatially analyzed, manipulated, and summarized, and finally presented in a map format or other graphical display. For this transportation system study, the GIS maps represent a compilation of principal physical elements, major functional components, and key personnel data for the county transportation system, and incorporate important County demographic and geographic features as well as hurricane impact characteristics against which the system inventory data are compared and analyzed. Database and maps variously address specific components such as roads and their features; traffic signals and their installation type, and typical structures; functional system elements, such as the local roadway network and the transit system; sites of key agency facilities such as major local police and fire departments which support emergency transportation functions; and location of key personnel and staff for the major transportation operating agencies.

GIS is being used for this study to integrate diverse information for the simple reason that most information relates in some way to a location on the earth, and in the case of this study, to a geographic location within Dade County. A homogeneous class of data is usually organized in a GIS coverage which represents a single theme or layer. For example, the traffic signal coverage which was developed in this study includes information about the location of traffic signals, installation type, and traffic control type. The fire station coverage has information for all major fire stations within Dade County including their location, name, building structure features, and so on. In general, a GIS coverage contains both topologic data (which defines locational information) and attribute data (which describes these locational information).

The topologic data is defined by coordinates and the adjacent geographic relations of data elements to each other. For example, a line can be defined by a series of connected (x,y) coordinate points and a list of the other lines to which it connects at each of its endpoints. A series of lines such as streets may enclose a traffic analysis zone. The GIS coverages developed by this study can be categorized as following four types based on the topologic features of each GIS coverage: point feature, line feature, area feature and linear feature. A point feature is represented by a discrete location defining a map object whose boundary or shape is too small to be shown as a line or area feature, such as a police station, fire station, traffic signal or hospital on a county level map. A line feature is a set of ordered coordinates that, when connected, represents the linear shape of a map object too narrow to be displayed as an area. An example of this would be a segment of roadway. An area feature is a closed figure whose boundary encloses a homogeneous area, such as a county boundary, traffic analysis zone or hurricane evacuation area. Within GIS, spatial information is often represented by a two-dimensional (x,y) coordinate system such as point and line features. As opposed to taking two exact (x,y) measurements, a linear feature records data in the field by using a single relative position. In this type of representation scheme, location is given in terms of a known feature and a position or measure along it. For example, "SR 836 and Milepost 10.3" uniquely identifies a position in geographic space without having to express it as an (x,y) coordinate or in terms of latitude and longitude.

The attribute data contains information which describes a geographic feature. For example, for a traffic signal coverage, the topologic data describes each traffic signal location (a point feature) and its attribute data comprises tabular data about installation types (such as wire-strand, mast-arm rigid and mast-arm dangling) and operating control types (such as semi-actuated, fully actuated, pre-timed and so on). Attribute data for a roadway coverage (a line feature), includes roadway length, street name, FDOT functional classification, roadside tree density and so on for each roadway segment. For a Traffic Analysis Zone (TAZ) coverage (an area feature), its attribute database consists of the size of a TAZ in terms of square feet, TAZ number, population and employment data for each TAZ. For the roadway characteristics inventory coverage (a linear feature), the attribute tables contain the information about number of through lane and lane width, roadway shoulder type and width, and roadway median type and width.

To simplify data input efforts, to reduce data query and analysis processing time, and to reduce database storage space, some attribute data is presented in a coded format within the GIS database. Using the traffic signal installation type as an example, attribute number "1" represents the wire-strand traffic installation type and "2" describes the mast-arm rigid. The appendices "GIS Database Structure" and "GIS Database Structure and Reference Tables" provide the detailed descriptive information for all the codes used for each coverage. A summary directory of GIS coverages organized by topologic feature is listed in Table 4-1. The GIS attribute elements and their rational for inclusion into the GIS database are detailed described in the preceding chapter.

The type of topologic data for each GIS coverage is determined based on geographic feature, data collection method and/or GIS development method. For police station coverage, hospital coverage and other coverages with point features listed in Table 4-1, their geographic boundaries or shape are too small to be shown as a line or area in a county level map. It is proper to construct them in the GIS database with point feature. Moreover, from a data collection and GIS database development standpoint, there are advantages to develop these coverages as point features. This is because an (x,y) coordinate represents a geographic location of a facility in the GIS topologic data structure, while the information of a facility geographic locations is usually available in a mailing address format. For example, "6125 SW 31st Street" defines geographic location of the Miami Children's Hospital. It is possible to collect (x,y) coordinate information for a coverage as a point feature through field survey, which is a time consuming process. However, GIS provides a geocoding or address matching technique which can automatically convert a street address to an (x,y) coordinate system to represent geographic location as a point feature. Therefore, this is a very efficient way to collect facility geographic data and to convert it into a GIS format for coverages represented as point features.

In general, topologic features for coverages with line and area features are relatively more precise in terms of describing their geographic location and their relation to other lines or area boundaries than are coverages with point features. For the highway network, hurricane surge

Table 4-1

BASIC GIS TRANSPORTATION SYSTEM FEATURES

GIS INVENTORY		FEATURE*
Intersection	Signal emplacement type	point
Transportation Facilities	Main administrative centers	point
	Major depots	point
	Intermodal centers	point
Health Care	Hospitals	point
	Major nursing facilities	point
Emergency Response	Shelters	point
	Fire Stations	point
	Police Stations	point
	Office of Emergency Management	point
	Armories	point
Other	Mobile home parks	point
	Power substations	point
	Television and Radio Studios	point
Road Class	FDOT Functional Classification	line
Road Characteristics	Typical sections	linear
	Median characteristics	linear
	Shoulder characteristics	linear
Wind Hazard Presence	Right-of-way hazards	line
	Sign structures by direction	line
Evacuation Route	FDOT Priority Route Designation	line
Commission Districts	Commission Districts	area
Municipal Boundaries	Municipal Boundaries	area
Transportation Zones	Traffic Analysis Zones	area
	Traffic Analysis Districts	area
	Traffic Analysis Superdistricts	area
Storm Surge Zones	Storm Surge Zones	area
Evacuation Zones	Evacuation Zones	area

*See Appendix 1B

limits, evacuation areas, traffic analysis zone coverage and other coverages with line and area features, the topologic data for each were digitized into GIS format.

It is an efficient way to represent FDOT Roadway Characteristics Inventory (RCI) data as a linear feature because most of these data are readily available and maintained by FDOT using a route mile-post referencing system. In the RCI database, a roadway section number and the beginning and end milepost, uniquely represent RCI features for a particular roadway segment. For example, the statistics "Section Number 87200000, Begin Milepost 1.3 and End Milepost 3.3" uniquely represent the Dolphin Expressway between NW 107th Avenue and NW 87th Avenue. The attribute data of the RCI such as the number of through lanes, lane width, roadway shoulder type and width, and roadway median type and width is associated with a roadway section number and a beginning milepost and an end milepost in the FDOT database. A roadway network with line feature structure does not have a mile-post referencing system. In order to represent the linear RCI data on this highway network, for each roadway segment a section number and beginning milepost and end milepost is assigned to either end of a roadway segment to convert the network from a line feature structure to a linear feature structure. Another advantage of using the linear feature structure is that it can associate information to any portion or segment of a road or roadway network. For a roadway network with line feature structure, each segment represents a set of data associated with the segment. In general, a segment is defined as extending from one intersection to another intersection. As an example, SR 836 between NW 107th Avenue (Milepost 1.3) and NW 87th Avenue (Milepost 3.3) is defined as one segment on the highway network. For the RCI data, the information may vary at any point along a roadway segment. For example, the roadway median type and width for SR 836 changes mid-segment at Milepost 1.08 and Milepost 3.87 which are west of NW 107th Avenue and east of NW 87th Avenue intersections, respectively. A roadway network with linear features can accurately represent the information, but a network with line feature could not unless two new break points were added at Milepost 1.08 and 3.87. It is obvious that it is not efficient to break roadway segments at every break point of one attribute because the break points for the roadway median attribute may be not as same as that for the roadway shoulders attribute. However, a roadway network in a linear feature structure is capable of associating multiple sets of data with a single mile-post reference system on a single road network.

The attribute data for GIS coverages is stored in a relational database format. Depending on the data collection methods, this data was either manually input or converted using many computer programs developed by the study team. For example, information on traffic signal installation type was collected from the field and then this information was manually entered into the traffic signal coverage. In contrast, most of the RCI data were retrieved from the FDOT statewide database, and this data file was converted into GIS through the application of DBASE programs.

The power of the GIS technique lies in the link between the topologic data and their attribute data. GIS provides a powerful and efficient framework for the integration and analysis of numerous data files. The GIS database developed during the inventory phase of this study will be used to assist in the evaluation of the susceptibility of the inventoried transportation system resources to both storm surge and wind exposures during the analysis phase.

5.0 SUMMARY

This technical report summarizes the inventory of existing physical conditions of the transportation system. In addition, the personnel assigned to emergency operations for the transportation section were collected as part of this study. GIS based maps, such as large scale maps and 11" x 17" maps, agency facilities survey results, and GIS database structure and tables are included in the appendices. The data collected during this task will serve as the basis for assessment of susceptibility of storm occurrence for the study area. This is the first in the series of technical reports documenting the various tasks of the study.

Information from multiple sources was acquired and integrated within the county's ARC/INFO GIS, a Geographic Information System, to perform database development and facilitate its maintenance, conduct analysis, and produce strongly effective, informative presentations.

The GIS database provides the ability to determine where the roads have excess capacity and to evaluate if shoulders can be used as travel lanes during an evacuation effort. The GIS will provide agencies with the ability to access information on evacuation routes in a real time manner.

This report is intended to be used as a working document; it represents existing conditions to date. To maintain the accuracy of future analyses, the computerized database created by the study team should be updated periodically. The objectives of this emergency transportation management effort should be to maintain mobility, support response and recovery efforts and provide the tools necessary for planning and responding to emergencies.

The emergency personnel is an important resource when an emergency situation arises. The update of this database is very important in order to provide a realistic assessment of resources in real time.

The study team has created a very large and rich database that should be maintained and agency personnel should be trained to use the system.

m:R-91-II