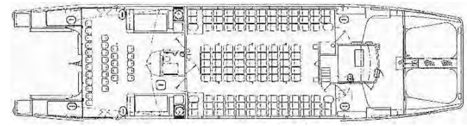


# Development of a Service Plan for

# Waterborne Transportation Service

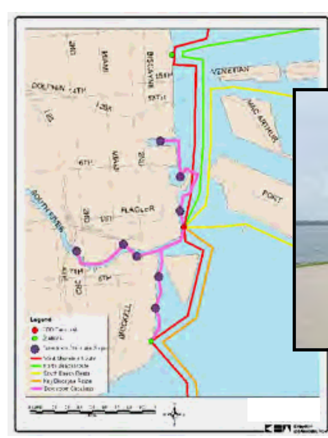
# in Miami-Dade County



## Prepared for:

**Miami-Dade County**
**Metropolitan Planning Organization**
**(Miami-Dade MPO)**

## Prepared by:



**Kimley-Horn and Associates, Inc.**

**Fort Lauderdale, Florida**

# Development of a Service Plan for Waterborne Transit Services in Miami-Dade County

**Final Report**

## Prepared for:

**Miami-Dade County Metropolitan Planning Organization (Miami-Dade MPO)**

## Prepared by:

**Kimley-Horn and Associates, Inc.**
Fort Lauderdale, Florida


Work Order # GPC II-08
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# EXECUTIVE SUMMARY

Miami-Dade County is privileged to be situated in an extraordinary geographic setting. Located in the subtropics at the southernmost end of the Florida peninsula, the area enjoys mild weather for all four seasons. Just as importantly, the mainland is sheltered by strings of offshore barrier islands that create Biscayne Bay. The County enjoys an extensive coastline and numerous inland waterways and the climate to take advantage of this magnificent marine environment throughout the year. The Bay, and these waterways, are vital resources that are extensively used for recreational purposes and commonly utilized for the commercial transportation of cargo. In recent years, as multimodalism has become more critical to improving travel and increasing the capacity and reach of urban area transportation systems, transportation planners have begun to research locally novel modes as potential supplements to the conventional car, truck, and transit landside surface modes to transport people and goods. Now, waterborne transportation services are being recognized as a potential alternative serving burgeoning travel demand by utilizing some of the extensive system of waterways available in Miami-Dade County.

## Purpose of this Study

The Miami-Dade Metropolitan Planning Organization (MPO) initiated the *Development of a Service Plan for Waterborne Transit Services in Miami-Dade County* to develop a water transit service plan that would describe a potential system intended to meet mobility goals such as offering alternatives to local commuters driving single occupant private automobiles, and providing viable as well as attractive mobility options for tourists and other visitors. Development of the service plan was desired to perform an impartial review of the projected ability of the system to meet these mobility objectives, to reasonably estimate realistic ridership, to determine the expected implementation and operating costs of such a system, and to recommend a good approach to implement such a system locally.

## Study Background

Several studies have been performed over the years by various local agencies, and some waterborne transportation services have been provided in the past, only to eventually be discontinued. Recently, the Miami-Dade MPO commissioned a study to examine the practicality of waterborne transportation for supplying additional capacity to the urban transportation network. The *Feasibility of Utilizing Miami-Dade County Waterways for Urban Commuter Travel* was completed in 2003. This study identified a potential waterway network on which commuter service could be provided by vessels similar in nature to those successfully providing service in other urbanized areas. Travel time comparisons found that waterborne transportation using conventional vessels could be competitive with the automobile along certain routes. Three potential routes for waterborne commuter transit service were identified including: (1) the Biscayne Bay Route, (2) the Miami River Route, and (3) the Coral Gables Waterway Route. More germane to this study's genesis, *The Feasibility of Utilizing Miami-Dade County Waterways for Urban Commuter Travel* recommended that additional service planning should be undertaken for the potential routes identified above.

Also in 2003, a proposal entitled *Rapid Mass Transit* was completed by Metro Aqua Cats, Inc. and submitted to the Miami-Dade MPO to introduce a waterborne transit service. Metro Aqua Cats outlined the need for additional transit services aimed at providing a potential solution to reduce commuter travel time in an efficient and cost-effective manner. The proposal promotes high speed ferry service in Biscayne Bay as the mode to fulfill that need. This proposal recommended implementing a water transit system based on a vessel specifically designed for traversing Biscayne Bay. The objective of Metro Aqua Cats' proposal was to provide a travel alternative to reduce commuter travel times experienced when using conventional land-based highway and transit modes. A review of the Metro Aqua Cats proposal is provided in the report for this study. The proposal specifies that the catamaran would operate on bio-diesel fuel, have forward facing sonar for manatee awareness, be compliant with the Americans with Disabilities Act (ADA), and have a Class I Coast Guard rating. Four potential routes for waterborne commuter transit service were identified by Metro Aqua Cats, Inc. for Biscayne Bay including: (1) West Shoreline Route North, (2) "B" Miami Beach Route, (3) West Shoreline Route South, and (4) Key Biscayne Route.

In response to the recommendation of further study made in the *Feasibility of Utilizing Miami-Dade County Waterways for Urban Commuter Travel*, as well as the desire to evaluate the Metro Aqua Cats *Rapid Mass Transit* proposal, the Miami-Dade MPO initiated the *Development of a Service Plan for Waterborne Transit Services in Miami-Dade County*.

The Waterborne Service Plan Study was conducted in several phases, each of which is summarized below.

## Data Collection

Data collection was performed for this study by further examining physical characteristics of waterways first identified in the *Feasibility of Utilizing Miami-Dade County Waterways for Urban Commuter Travel*. The objective of the data collection effort was to identify sections of waterways that exhibit restrictions to water travel mobility.

Miami-Dade County has many canals of varying characteristics. The primary deterrent to waterborne transit mobility within most canals is the presence of control structures such as salinity dams. These structures specifically and intentionally block connectivity with the saltwater of Biscayne Bay from the freshwater canals; this, of course, severely limits the potential for navigational mobility. Most canals also have numerous low bridges and pipeline crossings that render them impossible for use by waterborne transit vessels. The effect of the canal structure location on potential water transit mobility is to limit the length of trips that can be accommodated. Canals that exhibited short or intermittent segments of navigability were excluded from further study due to trip mobility constraints. As a result of the data collection portion of this study, the waterways that received further consideration for initial waterborne transit implementation include Biscayne Bay and canals downstream of the salinity dams.

Low Pipeline Crossing the Snake Creek (C-9) Canal

Existing Dock at Dinner Key Marina Adjacent to Coconut Grove Activity Center

Marinas and parks were inventoried to determine potential sites for terminals. Most marinas in Miami-Dade County are private facilities that are not likely candidates for a waterborne transit terminal, unless suitable arrangements with private entities can be reached. Public marinas may be used for waterborne transit stations, especially marinas near activity centers or parking facilities. Several parks contain existing marinas and/or docks that physically could be employed as water transit stops or stations.

However, utilizing park space for transportation terminals and potentially for providing additional parking facilities is antagonistic towards the recreational purposes of parks. Furthermore, certain rules, regulations, laws, and covenants governing park use may be violated by converting portions of parks to transportation uses. Transportation projects that require the conversion of public recreational space to transportation-related purposes are commonly required to replace the amount of park space that was lost due to the transportation project.

Data collected for Biscayne Bay include the location of manatee protection zones, sea grass habitats, reefs, and shipping channels, bathymetry, and bridge clearance information. Biscayne Bay is characterized by shallow waters, numerous sea grass habitats, and manatee protection zones. As a result, low draft vessels with minimal wake wash characteristics are appropriate for waterborne transportation purposes in Miami-Dade County. Manatee-detection equipment should be installed on the vessels as well. The Atlantic Intracoastal Waterway is a strategic navigation channel running through the western portion of Biscayne Bay, stretching the length of the county; this channel should be utilized where possible for the routing of waterborne transit vessels.

## Patronage Estimation

In addition to the data collection described in the previous section, other data were collected to aid in estimating patronage for the potential water transit system and align proposed water transit routes to serve major travel flows within the study area. Demographic data from several metropolitan areas that currently offer waterborne transportation service were collected along with ridership data for these systems. A linear regression analysis was then performed to develop an equation that forecasts system ridership based on the demographic characteristics of the metropolitan area. When applied to the routes developed in later portions of this study, the projected water transit patronage based on the analysis performed for this study is approximately 1.7 million annual passengers for the proposed system, which is anticipated to require a 5-year maturity period. It is expected that at least one-half of these passengers would transfer from existing Metrobus routes; therefore, connections between Metrobus and the waterborne transit system are vital. Only approximately 35 percent of the projected ridership is expected to switch from private automobiles to waterborne transportation.

## System Needs and Characteristics

Waterborne transit system needs and characteristics were analyzed for the *Development of a Service Plan for Waterborne Transit Services* by examining probable terminal requirements, service characteristics, vessel characteristics, staffing requirements, and real estate characteristics of what is considered the initial needs of the potential waterborne transit system in Miami-Dade County. The purpose of the system needs chapter of the report is to provide guidance for the type of facilities and service characteristics that would be appropriate for offering water transit service that represents a true mobility option for residents and visitors of Miami-Dade County. This chapter of the report presents system characteristics from waterborne transit systems in other metropolitan areas that have been in place for at least five years. Many of the system examples are from Australia because modern technologies have been used there for waterborne transportation systems that are successfully serving as viable regional transportation alternatives for commuters, which is an objective that has been identified for the potential system in Miami-Dade County. Many of the system needs for Miami-Dade County are similar to the characteristics of these successful Australian water transit systems.

## Water Transit Vessels

Vessel requirements for passenger-only transit ferry services on Biscayne Bay to serve Miami and its surrounding communities were researched using data from other locations around the world where these types of ferry services are operational. An appropriate vessel technology was synthesized to match the physical characteristics of the waterways presented in the Data Collection chapter and to meet the specific needs of navigating on generally shallow and environmentally sensitive Biscayne Bay.

Low-Wash Catamaran

The appropriate hull form for waterborne transit service in Miami-Dade County is a low wake wash catamaran with demi-hulls that exhibit a length-to-beam ratio of 20:1 or greater. A catamaran hull form, with its widely spaced demi-hulls, would provide appropriate stability in waves commonly experienced within Biscayne Bay. Passenger capacity should be in the range of 100 to 125 passengers per vessel to serve expected passenger demand and to utilize engines that require less power to operate at speeds of 22 to 24 knots than would be needed to power larger catamarans. The interior of the ferry's passenger cabin must be provided with air conditioning, with the system carefully chosen to minimize its weight. Due to the minimal depths of Biscayne Bay near its shorelines, the ferry vessel should have shallow draft properties in the range of 3 to 4 feet. It is recommended that vessels be designed to operate without the need to raise drawbridges, which would dictate a maximum air draft clearance of 12 feet to travel under the Venetian Causeway within the Intracoastal Waterway.

## Routes and Terminals

System operating characteristics were developed with the intention of providing service convenient enough to attract commuters by offering travel times competitive with that of private automobiles for the same trips. Figure ES-1 presents a prospective route structure along with the proposed terminal sites for a system of water transit services in Miami-Dade County. A series of four water transit routes were developed along with a complimentary downtown circulator system to serve the Miami Downtown waterfront areas using smaller water buses. Headways of no more than 20 minutes during peak travel periods are desired for ferries in Miami-Dade County. Headways during non-peak portions of the day may range from 30 minutes to 60 minutes for the primary routes, much as is done with surface transit routes. The daily service span for the water transit system should ideally approximate the service spans of the other transit services in Miami-Dade County, especially Metrobus and Metromover, to provide true mobility options. A route prioritization analysis was performed that determined the "South Beach Route" to be the most effective initial route. This route should be considered for demonstration purposes.

If water transit in Miami-Dade County proves to be successful, the "Phase I" system presented in Figure ES-1 may be expanded to include other routes or extensions of existing routes, such as a possible primary route along the Miami River following construction of the Miami Intermodal Center (MIC); the Miami River water bus (employing smaller vessels) would also serve the Civic Center area and provide waterborne access to the Orange Bowl for special events. In addition, extending the Coconut Grove route to the south into less densely populated areas may provide access for commuters in those areas to major CBD and Brickell waterfront or adjacent employment centers in Downtown Miami. Limited stop routes, such as Aventura to Miami, could be introduced if warranted by ridership volumes and patterns.

## Costs and Revenues

Capital costs, and operating and maintenance (O&M) costs, were estimated for the potential waterborne transit system in Miami-Dade County. Capital costs are primarily composed of vessel costs, terminal costs, and land/right-of-way costs. One advantage of most waterborne transportation systems is that the "guideway" already exists, so it does not have to be constructed, purchased, or leased. Therefore, waterborne transit systems generally incur much lower per mile capital construction costs than urban rail transit and light rail transit systems. The largest component of the capital costs is expected to be the land for terminals and ancillary facilities, such as park-n-ride lots. The capital cost estimate for the entire "Phase I" route network presented in Figure ES-1 is approximately $125 million to $150 million.

The major operating cost components for waterborne transit systems will include personnel, fuels and expendables, maintenance, and administrative costs. Labor represents the largest operating cost component for urban waterborne transit systems. Annual operating costs for the "Phase I" route network presented in Figure ES-1 is approximately $22 million at 5-year system maturity.

In general, transit fares cover only a fraction of transit operating costs, and basically no capital costs are recovered by the farebox revenues. The Year 5 operating deficit is projected to be in the range of $11 million to $18 million for the "Phase I" system. Recent Federal legislation continues the trend of phasing out federal support for operating assistance. The availability of federal capital assistance stands in stark contrast to the lack of federal assistance provided for transit operations. A transit project sponsor's operating plan should demonstrate an ability to rely on sustainable, largely local, funding sources to operate and maintain the entire transit system after the proposed transit project is in revenue service. It is expected that multiple local funding sources, such as sales tax revenues, bond revenues, joint development arrangements, and turnkey procurement arrangements will need to be utilized to provide adequate funding for both capital and O&M costs for the proposed waterborne transit system in Miami-Dade County.

## Business Model

A public/private business model presents the greatest opportunity for the facilitation of the implementation of the waterborne transportation system in Miami-Dade County described in this report. The role of local government would be to secure funding for initial capital investments for terminals and support facilities, and to provide oversight through a Management Agency. A private transportation provider would need to be attracted to provide waterborne transit vessels and to operate the service.

The major advantage of this model is that securing public funding would make it possible to offer lower fares for the waterborne transportation service, which would encourage residents and visitors to patronize the new service. Because the Management Agency would be responsible for securing funding for the initial capital investment, it may be easier to attract a ferry operator, as those costs would be borne by another source. By not having made significant capital investment, the ferry operator would have a lower exposure to the risk of a new service.

## Summary and Conclusions

Waterborne transit services implemented in Miami-Dade County in the past have failed to become a viable public transportation option. A recent feasibility study, *Feasibility of Utilizing Miami-Dade County Waterways for Urban Commuter Travel*, concluded that by appropriately addressing a number of issues heretofore underaddressed, waterborne transportation might indeed be able to be successfully implemented and developed in Miami-Dade County.

The study described in this report provides a service plan that addresses many pertinent issues related to waterborne transit implementation and develops a route structure and service characteristics that are intended to provide service adequate to attract local commuters and provide visitors and tourists with an attractive transit alternative by offering a reliable, useful, and novel addition to the existing public transportation system. The service is proposed to integrate with Metrobus routes and in Downtown Miami, to integrate with Metromover. Shuttle buses associated with individual terminals are also recommended to provide additional connectivity. Integrating the potential waterborne transportation system into the County's larger transportation system is key.

The capital construction costs associated with implementing the full "Phase I" network are relatively high for a system that has not been locally proven to be effective for providing true mobility options for commuters, although the per mile construction cost for the water transit system is significantly less than urban heavy rail systems. However, operating costs and operating efficiency measures are even less favorable for waterborne transit when compared to existing forms of transit.

However, despite the cost of providing waterborne transit service, there are several intrinsic advantages that water transit may have over other existing components of the multimodal network. Many visitors may be more willing to use the system than traditional forms of public transit for tourist trip purposes and may even view the system as an extension of the local tourist activities. If routes are planned and implemented to serve major travel patterns and meet their needs, some commuters may be more willing to travel by waterborne transit if the travel times on routes are, as they are anticipated to be, competitive with peak period landside travel options, and service is seen as providing a different, "better" atmosphere than other forms of local transit. In addition, initial routes can be implemented relatively quickly since the guideway (in this case Biscayne Bay) already exists and if existing marinas with good access are used as terminals.

Therefore, this study recommends developing waterborne transit services for Miami-Dade County on Biscayne Bay through a public/private partnership if a waterborne transit demonstration project, or pilot program, is deemed successful by local leaders at attracting commuters and tourists.

## Demonstration Project

It is suggested that proceeding with a demonstration waterborne transit project that replicates service on the South Beach Route shown in Figure ES-1 would be most appropriate for judging short-term acceptance and gauging possibilities for long-term success for a full-fledged system in the future. For the Miami CBD water transit stop, a scaled-down version of the CBD Terminal recommended in this study could be utilized along Chopin Plaza or within Bayfront Park. Terminal infrastructure for a demonstration project can be as minimal as two to four weather shelters and a docking pier. The existing Miami Beach Marina may be utilized as a terminal in Miami Beach in lieu of a terminal facility being constructed at South Pointe Park. Coordination with Miami-Dade Transit and the City of Miami Beach is recommended to ensure that local bus service connects to the water transit station in Miami Beach. Alternatively, a dedicated shuttle bus route could be established to provide connectivity to popular destinations along Collins Avenue and the Lincoln Road Mall. Additionally, strong consideration should be given to extending the demonstration route to the Dinner Key Marina to serve Coconut Grove since an extensive public marina already exists within a two-block walk of an activity center popular with both locals and visitors. It is important to note that the demonstration project should be operated for enough time to allow a fair assessment of its performance. Experience from other metropolitan areas indicates ridership may build gradually over at least the first two to three years of operation.

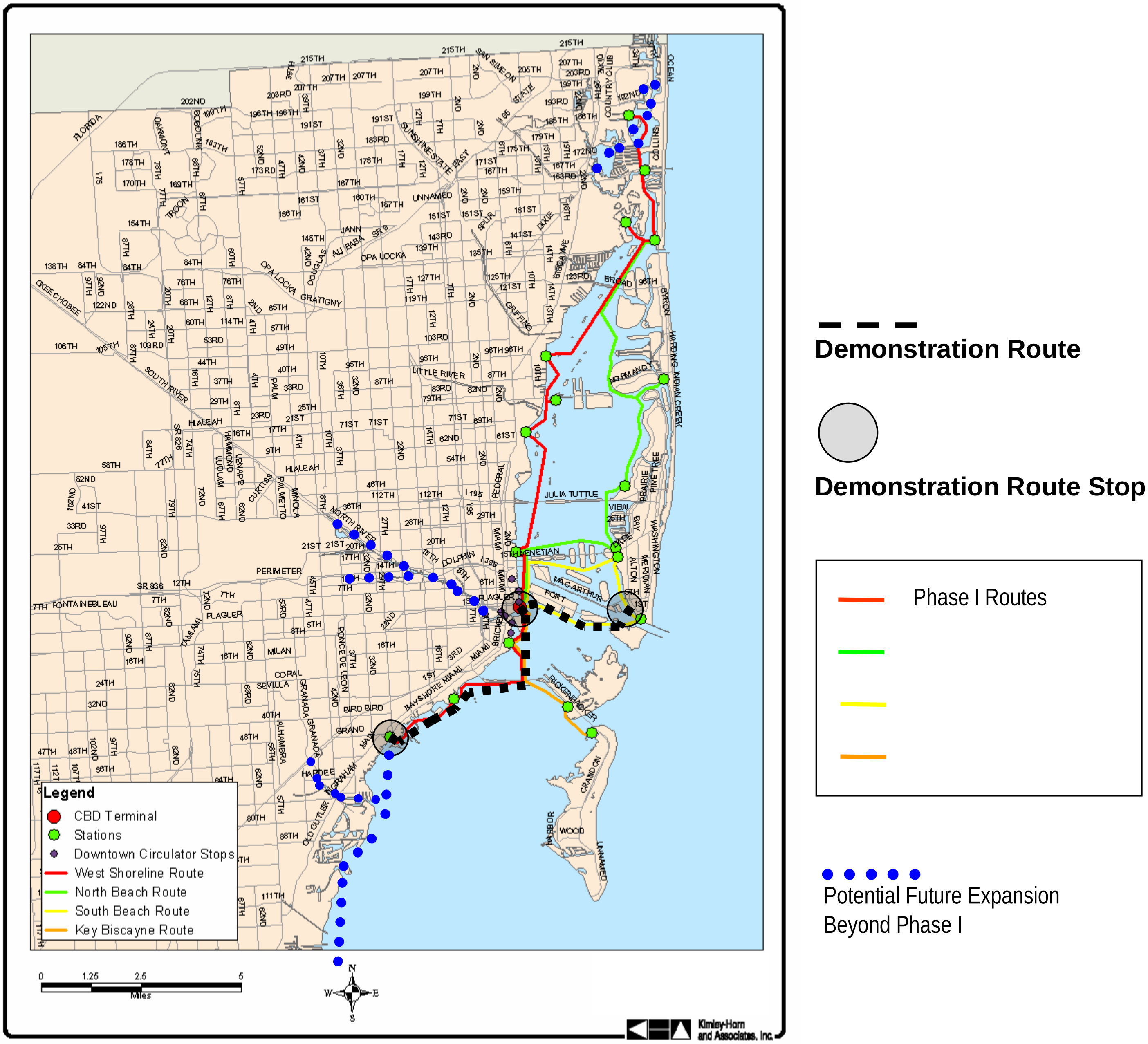


Figure ES-1. Potential Water Transit System in Miami-Dade

# INTRODUCTION

Miami-Dade County is blessed to have an extensive coastline and numerous inland water channels. These waterways are vital resources that are commonly used for the transportation of freight and for recreational purposes. In recent years, as multimodalism has become more critical to transportation planners, waterborne transportation services have been recognized as a potential alternative to reducing automobile travel demand by utilizing the system of waterways available in Miami-Dade County.

Several studies have been performed over the years and some waterborne transportation services have been provided in the past. Recently, the Miami-Dade MPO commissioned a study to examine the practicality of waterborne transportation for supplying additional capacity to the urban transportation network. The *Feasibility of Utilizing Miami-Dade County Waterways for Urban Commuter Travel* was completed in 2003. This study identified a potential waterway network on which commuter service could be provided by vessels similar in nature to those successfully providing service in other urbanized areas. Travel time comparisons found that waterborne transportation using conventional vessels could be competitive with the automobile along certain routes. Three potential routes for waterborne commuter transit service were identified including: (1) Biscayne Bay Route, (2) Miami River Route, and (3) Coral Gables Canal Route. These routes were identified by examining adjacent land use and intensity, connections to existing Urban Centers designated by Miami-Dade County, and the number of employers located adjacent to waterways.

The *Feasibility of Utilizing Miami-Dade County Waterways for Urban Commuter Travel* recommended additional service planning should be undertaken for the potential routes identified above. The recommended further study effort should include travel demand analysis, route refinement, schedule development, and the collection of additional data needed to assess physical constraints to commuter service on the "Currently Non-Navigable Waterways" network. Other recommendations included addressing policy issues such as the proposed organizational structure of the waterborne transit system, coordination with regulatory agencies regarding potential docking facilities, and an evaluation of landward constraints regarding access to proposed stops.

Also in 2003, a proposal entitled *Rapid Mass Transit* was completed by Metro Aqua Cats, Inc. and submitted to the Miami-Dade MPO to enhance the transit service for Miami-Dade County by introducing a waterborne transit service. The proposal identifies a need to add a potential waterborne transit network, on which commuter service could be provided by vessels similar in nature to the catamaran ferries successfully providing service in Brisbane, Australia called City Cat. The proposed vessel type is a catamaran with a hydrofoil lift that would be specifically designed for use in Biscayne Bay. The proposed catamaran would be designed with a minimum wake hull, a water draft of three feet, and an air draft of 14 feet. The proposal specifies that the catamaran would operate on bio-diesel fuel, have forward facing sonar for manatee awareness, be compliant with the Americans with Disabilities Act (ADA), and have a Class I Coast Guard rating.

*Rapid Mass Transit* indicates that the current Miami-Dade public transportation system is inadequate in providing efficient commuter travel times. According to Metro Aqua Cats, waterborne transportation using catamarans could reduce commuter travel time by 50 percent. Four potential routes for waterborne commuter transit service were identified for Biscayne Bay including: (1) West Shoreline Route North, (2) "B" Miami Beach Route, (3) West Shoreline Route South, and (4) Key Biscayne Route.

In response to the recommendation of further study made in the *Feasibility of Utilizing Miami-Dade County Waterways for Urban Commuter Travel*, as well as the desire to evaluate the Metro Aqua Cats *Rapid Mass Transit* proposal, the Miami-Dade MPO has initiated the *Development of a Service Plan for Waterborne*

*Transit Services in Miami-Dade County*. This report describes the work performed for this study, which builds upon the feasibility analysis of waterborne transit service already performed in the *Feasibility Study* to further assess the appropriateness of waterborne public transportation in Miami-Dade County and develop a service plan that the MPO can use to judge the level of commitment required to implement a system that could potentially meet mobility objectives such as attracting local commuters away from single occupant private automobiles and providing viable mobility options for visitors.

This report is divided into the following chapters, which approximates the steps performed in conducting the study.

- Introduction
- Background Research
- Data Collection and Patronage Estimation
- System Needs and Characteristics
- Waterborne Transit Service Costs
- Financial Feasibility Analysis
- Waterborne Transit Business Model
- Conclusion and Next Steps

Figure 1 presents the study area for the *Development of a Service Plan for Waterborne Transit Services in Miami-Dade County*. The study area includes the portion of Miami-Dade County within the 2015 Urban Development Boundary (UDB). Also included in Figure 1 are major roadways, the Miami-Dade Metrorail, Metromover, and Metrobus transit routes. Figure 2 presents the Currently Navigable Waterways of Biscayne Bay and adjacent canals. Canals shown as Currently Non-Navigable Waterways were not considered appropriate for public waterborne transportation services in this study due to physical constraints associated with the waterway.

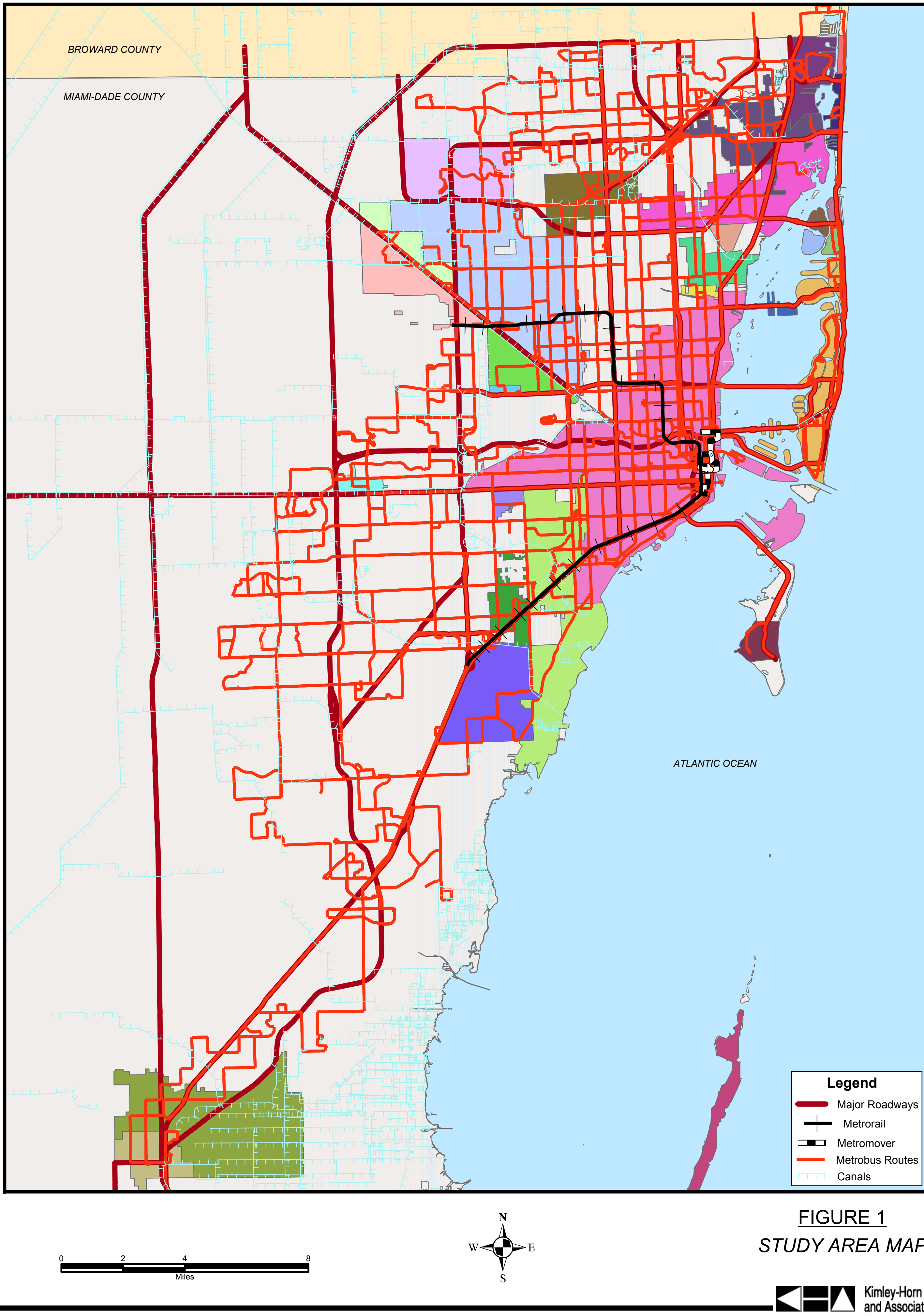


FIGURE 1

*STUDY AREA MAP*

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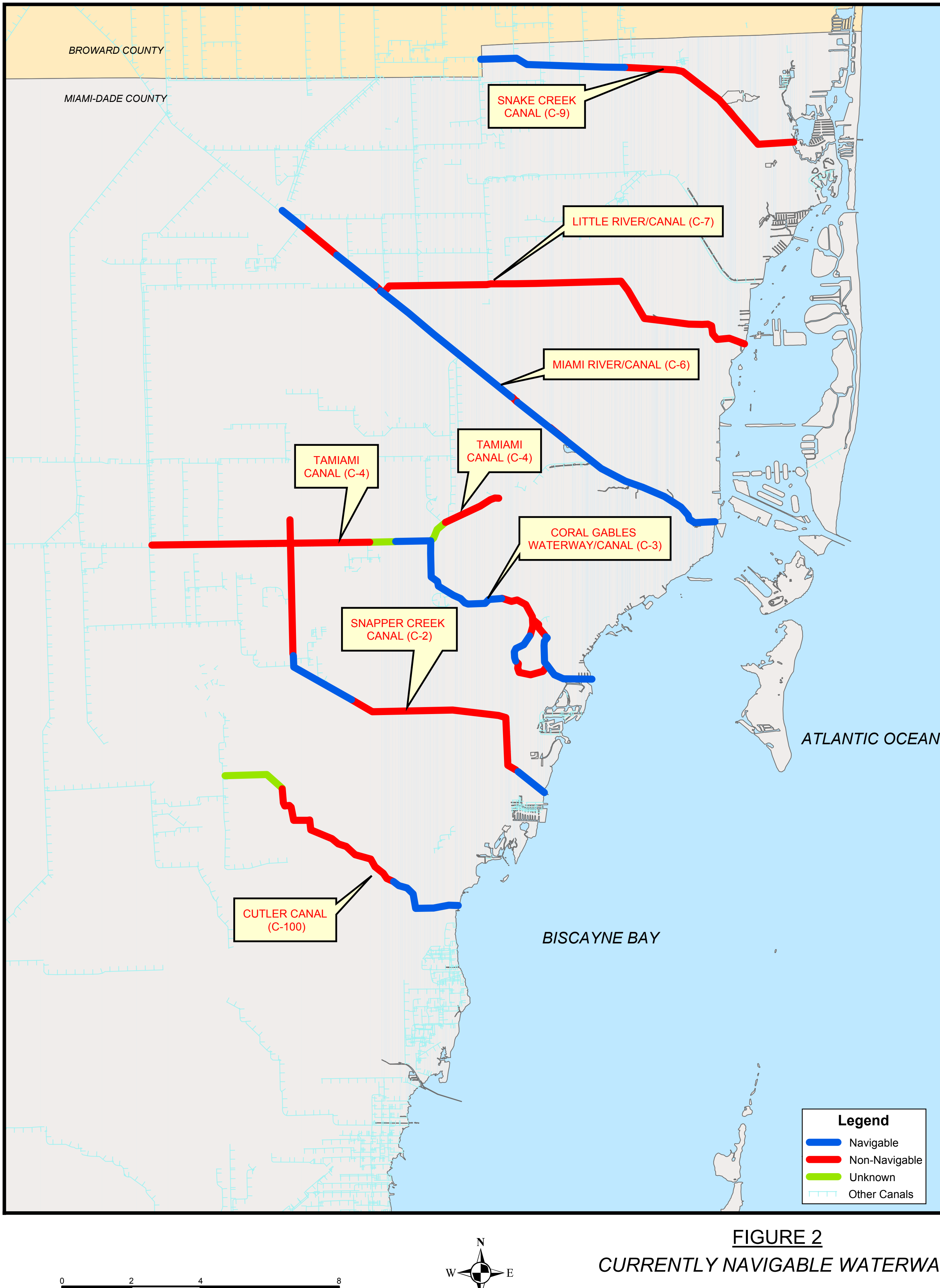


FIGURE 2

*CURRENTLY NAVIGABLE WATERWAYS*

Kimley-Horn and Associates, Inc.

# BACKGROUND RESEARCH

Background research was performed for the *Development of a Service Plan for Waterborne Transit Services in Miami-Dade County* by reviewing the previous waterborne transit feasibility study, the proposal prepared by Metro Aqua Cats, Inc., and a water bus service currently in operation in Broward County, Florida. Information from these prior studies and ongoing waterborne transit operations has been compiled in this chapter of the report.

## Feasibility of Utilizing Miami-Dade County Waterways for Urban Commuter Travel

The *Feasibility of Utilizing Miami-Dade County Waterways for Urban Commuter Travel* was completed in 2003. This feasibility study serves as a forerunner for the *Development of a Service Plan for Waterborne Transit Services in Miami-Dade County*. Therefore, a review of the feasibility study is provided in this chapter. The objective of the *Feasibility of Utilizing Miami-Dade County Waterways for Urban Commuter Travel* was to assess the potential of using the existing waterways within the Urban Growth Boundary (UGB) of Miami-Dade County for commuter travel.

### Review of Local and National Waterborne Transit Services

The *Feasibility Study* began by reviewing local and national waterborne transportation efforts, which are summarized below.

- In 1993, a private company named Water Taxi, Inc., initiated water taxi service in the Miami-Dade area along three routes - (1) West Biscayne Bay, (2) Collins Canal, and (3) between Downtown Miami and Miami Beach across Biscayne Bay. Service targeted visitors and tourists and was not coordinated with land-based transit service. The water taxi service ended in 1994.
- The Water Bus service in Fort Lauderdale, Florida was formed in November 2001 when Broward County Transit (BCT) entered a public/private partnership with Water Taxi, Inc. to provide fixed route water transit service consisting of 22 stops along the Intracoastal Waterway and the New River. Service is provided on 72-passenger vessels operating on 60-minute headways between 6:30 AM and 12:30 AM seven days per week. (Please note the actual published schedule as of May 2004 indicated a daily service span of 9:00 AM to 12:30 AM.) Although ridership is primarily tourism-based, efforts to attract commuters are ongoing. Connections between waterborne service and six BCT bus routes are coordinated and marked on signs. Water Bus stops are located at existing docks. Applicability of this service to Miami-Dade County was found to be high for service characteristics, vessel types, waterway characteristics, funding, and operational characteristics.
- The Hover Craft USA service in St. Petersburg, Florida, was initiated in 2002 between the St. Petersburg Pier, a resort hotel, and the Egmont Key natural preserve between 9:30 AM and 5:00 PM. The service within Tampa Bay is privately funded with no coordination with land-based transit service. The 17-passenger hovercraft is designed to operate in shallow waters without disturbing vegetation, dolphins, or manatees. Applicability of this service to Miami-Dade County was found to be high for vessel types and waterway characteristics.
- Three commuter ferry services in the San Francisco Bay area were reviewed including (1) Golden Gate Transit Larkspur Ferry, (2) Baylink Ferry, and (3) Alameda/Oakland Ferry. Ridership is primarily commuter on these routes with commute lengths ranging from 30 to 90 minutes across portions of San Francisco Bay. Service is provided by ferry boats and catamarans. Passenger capacities range from 300 to 750 persons per vessel. Applicability in Miami-Dade County was found to be high for service characteristics, vessel types, funding, and operational characteristics.

- Two ferry services are provided in San Diego Bay between Coronado Island and San Diego including (1) a privately owned and operated ferry service that operates from 9:00 AM to 11:00 PM and (2) a supplemental commuter service subsidized by the local government that operates between the same two stops beginning at 5:20 AM. Leases for both docks are held by the private operator. In addition to the ferry service, the same private operator provides water taxi service that utilizes public marina docks. Both ferry services utilize 300-passenger vessels approximately 90 feet in length and 20 feet wide. Applicability in Miami-Dade County was found to be high for service characteristics.
- Applicability in Miami-Dade County was found to be low for several services including the Logan Airport Water Shuttle in Boston, various passenger and automobile/passenger ferries in Washington and British Columbia, and the Harbor Hopper Water Taxi service in Oxnard, California.

### Characteristics of Successful Waterborne Transit Services

Successful waterborne transit systems tend to be reliable, convenient, and competitive. Most successful operations provide service between 2 to 3 stops, although the Water Bus service in Fort Lauderdale most closely resembles an urban public transit system with numerous stops along linear waterways. Typical commute lengths range from 20 to 90 minutes and headways are 30 minutes or longer. Waterborne transit systems were classified into three primary categories including (1) Water Taxi Service with passenger capacities of 100 or fewer, (2) Water Ferry Service (passenger only) on vessels with greater than 100-person capacities typically operating in bays and harbors, and (3) Water Ferry Service accommodating automobiles and passengers.

### Potential Service Characteristics Within Miami-Dade County

The *Feasibility Study* recommended potential waterborne transit service characteristics for Miami-Dade County. Cross-bay service opportunities are available within Biscayne Bay by the three categories of waterborne transit service identified above. Service within waterways downstream of salinity dams could also be provided by the three classes identified, although limitations exist for larger vessels relating to water depth and vertical clearance within a particular canal. Upstream of the salinity dams, service opportunities are limited to vessels that do not provide accommodation for automobiles. The *Feasibility Study* recommended that waterborne transportation in Miami-Dade County connect to the existing land-based transit system with transfers accepted between the two systems. Headways for service across Biscayne Bay may be as long as 60 minutes while headways for multiple stop routes along linear waterways may need to be more frequent to recognize peak hour demand and competition from other travel modes. Financial subsidy of the service will likely be required to maintain competitive fares.

Various funding sources were presented in *Feasibility of Utilizing Miami-Dade County Waterways for Urban Commuter Travel* including the following.

- The Ferry Boat Discretionary Program (FBDP), which is a special category for the construction of ferry boats and ferry terminal facilities.
- Congestion Mitigation and Air Quality (CMAQ) Improvement Program funds are used to implement projects that result in air quality improvements.
- Bus and bus-related Capital Investment Grants are available from the federal government with a 20 percent local match for three years.
- Urbanized Area Formula Grants are available to urbanized areas for transit-related projects including planning, engineering design, and capital investments.
- Job Access and Reverse Commute grants are intended to encourage transit service to assist welfare recipients and other low-income individuals with access to jobs, training, and other social services.

- The Clean Fuels Formula Grant Program is designed to accelerate the deployment of advanced bus technologies and incorporate low emission vehicles into the nation's transit fleets.

### Miami-Dade Waterway Characteristics

Within the study area, the following waterways were analyzed for potential waterborne transit service applications and are depicted in Figure 2 of this report.

- Biscayne Bay
- Snapper Creek Canal (C-2)
- Coral Gables Waterway/Canal (C-3)
- Tamiami Canal (C-4)
- Miami River/Canal (C-6)
- Little River Canal (C-7)
- Snake Creek Canal (C-9)
- Cutler Canal (C-100)

Operating constraints were researched for Currently Navigable Waterways and Currently Non-Navigable Waterways. Operating constraints within the Currently Navigable Waterways, including Biscayne Bay, consist of the following.

- Water depth
- Vertical clearance
- Channel locations
- No entry zones
- Speed zones
- Seagrass locations
- Existing dock locations

The water depth and vertical clearance within the Currently Navigable Waterways is documented on National Oceanic and Atmospheric Administration (NOAA) navigation charts. To limit impact to seagrass and marine habitats, waterborne transit service may be required to use dredged channels, primarily the Intracoastal Waterway (ICWW) within Biscayne Bay. Imposed speed zones and no entry zones act as operating constraints within the Currently Navigable Waterways that may limit mobility. Protected seagrass exists within several portions of Biscayne Bay, primarily within the Biscayne Bay Aquatic Preserve south of the Rickenbacker Causeway. The Dade County Manatee Protection Plan (DCMPP) and the designation of Biscayne Bay as an Aquatic Preserve restrict the ability to construct new docks in some parts of the study area. New or modified docking facilities are subject to the Marine Facility Siting Criteria adopted in the DCMPP.

Operating constraints within the Currently Non-Navigable Waterways consist of the following.

- Water depth
- Vertical clearance
- Control structure locations
- Speed zones

The canals evaluated as part of the *Feasibility Study* are primary canals maintained by the South Florida Water Management District (SFWMD) except the Coral Gables Canal, which is maintained by the City of Coral Gables. Water depth within the seven canals included in the study is a function of the elevation of the groundwater and flows into the canal, such as stormwater flows and controlled releases through gate structures maintained by the SFWMD. Vertical clearance is a function of the elevation of the water and the elevation of the lowest vertical obstructions along the canal. Vertical clearance data from the SFWMD were incomplete for the seven canals analyzed. Discharge and salinity control structures are located on each of the seven canals to control discharge into Biscayne Bay and limit salt water intrusion into the canals. Each control structure represents an obstruction between the Currently Navigable and Currently Non-Navigable sections of the canal. The only canals studied that do not have control structures within close proximity to Biscayne Bay are the Coral Gables Waterway and the Miami River. Only the Snapper Creek Canal and the Miami River do not have operating constraints imposed by the DCMPP relating to speed zones or no entry zones.

### Feasible Waterways

Waterborne commuter transportation was generally found to be feasible throughout Biscayne Bay with limits associated with speed zones, seagrass beds, and the need for construction of new docking facilities. Only the area northwest of Virginia Key and a section of the Little River Canal are subject to no entry restrictions. Although limited data existed along the Currently Non-Navigable Waterways, assumptions regarding water depth, vertical clearance, and low member data for vertical obstructions were made to determine suitability for waterborne transportation. The canals examined in the *Feasibility Study* had at least some portion of their length found to be non-navigable. As mentioned previously, only the Miami River and the Coral Gables Canal do not have control structures within close proximity to Biscayne Bay that would limit waterborne transportation opportunities.

Connectivity was examined during the *Feasibility Study* for the feasible waterways based on access to origins and destinations, as well as type and density of adjacent land use. The waterways examined were found to be highly connective except for the Snapper Creek Canal. In addition, the length of navigable sections was examined to determine appropriateness to meet commuter trip purposes. The Cutler Canal, the Snapper Creek Canal, and the Snake Creek Canal were found to exhibit navigable sections that were too short to meet commuter trip purposes.

### Preliminary Service Routes and Termini

The preliminary service routes and termini consider the physical and operating constraints within the waterways evaluated and the characteristics of the adjacent land use. Only general locations for termini were identified. Specific docking locations were not recommended because landward constraints associated with access, ownership, and land use were not determined.

Five preliminary routes were identified in the *Feasibility Study* for further analysis and are depicted in Figure 3.

- Biscayne Bay serving Coconut Grove, Miami, Miami Beach, North Miami, and Bal Harbour
- Biscayne Bay serving Aventura and North Miami Beach (within the Maule Lake area)
- Miami River and Miami River Canal from Biscayne Bay to Hialeah Gardens (Little River Canal) (Please note that provisions for travel connections across the salinity dam control structure located south of NW 36th Street were not discussed.)
- Coral Gables Canal from Biscayne Bay to U.S. 1 near the University of Miami
- Coral Gables Canal from Red Road (Coral Gables Wayside Park) to SW 82nd Avenue (Flagami on the Tamiami Canal)

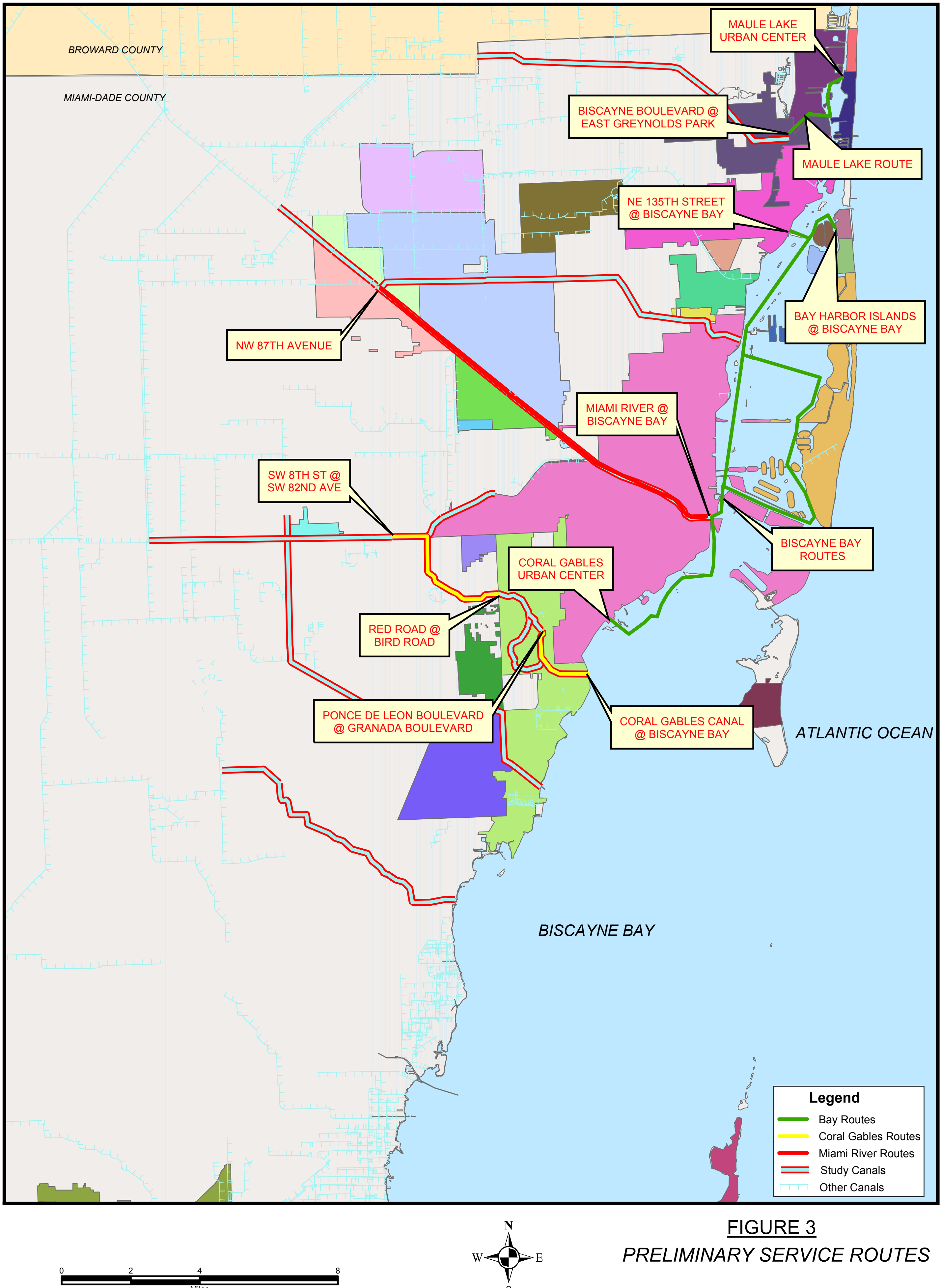


FIGURE 3

*PRELIMINARY SERVICE ROUTES*

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A travel time comparison was performed using automobile and transit travel times calculated for peak and off-peak periods using the 1999 base year network and the 2025 travel demand network developed for the *Miami-Dade County Long Range Transportation Plan* (LRTP). For conventional waterborne transit, travel between two pairs of preliminary termini on Biscayne Bay was predicted to be faster than by automobile during peak travel periods - (1) Alton Road @ 1st Street (Miami Beach) to Downtown Miami and (2) Little River Urban Center near the Kennedy Causeway to NE 135th Street in North Miami. Conventional waterborne transit is expected to be faster than automobile travel for two other pairs of preliminary termini - (1) Coral Gables Canal @ Red Road to SW 82nd Avenue along the Tamiami Canal and (2) the Miami River Canal from Le Jeune Road to Red Road. On average, travel by waterborne commuter service during peak travel periods exceeds automobile travel time between each pair of preliminary termini by 11 minutes. In the off-peak period, the average increases to 14 minutes.

In general, travel time comparisons between conventional waterborne service and the automobile and land-based transit modes indicate that waterborne transit vessels are competitive in limited portions of Biscayne Bay and the western portions of the Coral Gables Canal and the Miami Canal, but are not competitive in the eastern portion of the canals.

### Priority Waterways Commuter Service Opportunities

The *Feasibility of Utilizing Miami-Dade County Waterways for Urban Commuter Travel* evaluated the physical and operating constraints to the provision of urban commuter transportation in the waterways of Miami-Dade County. A feasible waterways network was identified on which commuter service could be provided by vessels similar in specification to those providing service in other locations in the United States.

Potential routes for commuter service were identified, recognizing the adjacent land use and intensity, connections to existing urban centers designated by Miami-Dade County, and the number of employers located adjacent to the feasible waterways network. Waterborne commuter service was recommended to be limited stop or express service, consistent with the service plans of other successful operations. Additional service planning is required for the potential routes recommended in the *Feasibility Study* including transit demand analysis, potential land-based constraints associated with the preliminary stop locations, and developing operating schedules. Hovercraft technologies were recommended to be evaluated for segments of routes that were determined to not exhibit competitive travel times with the automobile using conventional waterborne vessels.

In addition, the *Feasibility Study* recommended that Miami-Dade County evaluate and identify a proposed organizational structure for operation of a waterborne transit system. Coordination with regulatory agencies was also recommended to determine the opportunities for access to existing docking facilities and the conditions associated with the permitting of new docking facilities.

## Rapid Mass Transit (Proposal for Metro Aqua Cats, Inc.)

Metro Aqua Cats, Inc. prepared a proposal for high speed ferry service in Biscayne Bay in 2003, submitting a proposal to Miami-Dade County outlining the need for additional transit services aimed at providing a potential solution to reduce commuter travel time in an efficient and cost-effective manner. The proposal promotes high speed ferry service in Biscayne Bay as the mode to fulfill that need.

The Metro Aqua Cats' proposal to implement a water transit system was based on a vessel specifically designed for traversing Biscayne Bay. The objective of Metro Aqua Cats' proposal was to provide a travel alternative to reduce commuter travel times experienced when using conventional highway and transit land-based modes. A review of the Metro Aqua Cats proposal is provided below.

## Need for Waterborne Transit Services

The Metro Aqua Cats proposal begins with a description of the need to improve the public transportation system in Miami-Dade County. The existing public transportation system is characterized in the proposal as time consuming for its users with buses traveling on congested streets. As a result, many residents have no choice but to rely upon private automobiles for transportation.

The proposal advocates a type of waterborne transit found in Australia. The waterborne transit program in Brisbane, Australia, is comprised of a fleet of catamaran ferries called the City Cat, which serves areas along the Brisbane River. The City Cat provides service with a cruising speed of 30 miles per hour (mph) while producing a minimum amount of water displacement and wake. According to the proposal, the Brisbane River is comparable to the Intracoastal Waterway in Miami-Dade County between Aventura and Haulover Beach. A similar catamaran service operates in Sydney, Australia, where the ferries are known as the Harbourcats, Supercats, Jetcats, and Rivercats. The proposal advocates implementing a similar service within Biscayne Bay.

## Service Plan

Metro Aqua Cats, Inc. believes that a waterborne transit system could potentially be established in Biscayne Bay within two to three years adding a needed rapid mass transit alternative. The proposal notes that, in comparison, some of Miami-Dade County's proposed rail upgrades could take up to 25 years to implement. In addition, the proposal notes that the initial waterborne transit service would be provided by twelve vessels servicing fifty wharfs with an approximate set up cost of $50 million. The proposal states that this is the minimum amount of capital needed to get an adequate rapid transit service up and running; for the best possible service approximately $150 million in capital will be required.

The proposed Metro Aqua Cats service plan includes the following.

- Intermodal docking facilities that provide connections to existing land-based transit services in Miami-Dade County.
- Headways of 30-40 minutes coordinated for transfers with existing land-based transit services.
- Hours of operation will be 24 hours per day, 7 days per week with changes in headways during the off-peak hours.
- Carrying potential of 7-10 million passengers annually based on proposed routes and headways.

The proposed routes for the Metro Aqua Cats system include (1) West Shoreline Route North, (2) "B" Miami Beach Route, (3) West Shoreline Route South, and (4) Key Biscayne Route. In the proposal, several sites are identified along these routes as suitable for wharfs and many of these sites are owned by government entities. The feasibility of using these publicly owned sites for waterborne transit landings needs to be examined in more detail; those in private hands may also provide challenges to acquisition and conversion to marine and transit uses, and would need to be examined in detail as well.

The West Shoreline Route North includes stops at the following locations.

- Waterways Markets in Aventura
- Lehman Aventura Wharf
- Founders Park
- NE 163rd Street Wharf
- Haulover Wharf
- FIU North Miami Campus
- NW 109th Street
- NW 94th Street
- NW 79th Street Causeway West
- Legion Park
- East 55th Terrace
- NW 20th Street Park

- Herald/Omni Bus Terminal
- Bi-Centennial Park
- American Airlines Arena (during AAA events)
- Bayside Center Wharf
- Downtown Wharf (near Inter-Continental Hotel)
- Miami Convention Center
- City of Miami Administration Building
- Riverwalk Metro Mover Station
- Financial District Metro Mover

The "B" Miami Beach Route includes stops at the following locations.

- Fisher Island
- Washington Avenue
- 10th Street
- 14th Street
- Lincoln Road
- Island View Park
- Mount Sinai Hospital
- 65th Street Indian Creek
- MB Golf Course
- Byron Avenue
- FIU North Miami Campus

The West Shoreline Route South includes stops at the following locations.

- Mercy Hospital
- Coconut Grove
- St. Gaudens Road
- Matheson Hammock
- Gables by the Sea
- Chapman Field Park
- Deering Estate
- Black Point Marina

An additional tourist route is combined with the Key Biscayne Route during non-peak times with the following stops.

- Parrot Jungle Island
- Miami Seaquarium
- Crandon Park Tennis Center (used during events)
- Light House Point (Bill Baggs State Recreation Area)
- Vizcaya
- Deering Estate (Cutler/Palmetto Bay)

Several stops listed along the West Shoreline Route North and the "B" Miami Beach Route are specified as park-and-ride facilities; however, it is unclear which of these are proposed new parking facilities and which of these Metro Aqua Cats will attempt to utilize or rent existing parking spaces that may be externally owned and used for other purposes. Several of the stops on all proposed routes are sited in local parks where providing adequate station parking may be difficult without using parking capacity intended for park users or compromising open park space. Many proposed sites, whether P/R or drop off, occur in upscale residential neighborhoods where providing access to the waterfront by private vehicles, not to mention public transit vehicles, may be a formidable obstacle. Issues of both parking and private and public transit vehicular access associated with potential water transit terminals will be crucial to the feasibility of the potential service.

According to the proposal, the Miami River is not suitable for the proposed fast ferry service and will have to be serviced by water taxi to be incorporated into the waterborne transit network.

### Ridership Projections

Estimated ridership figures were presented in the Metro Aqua Cats report. However, details of the methodology used to calculate ridership are unclear. Information provided in the report appears to indicate that ridership was calculated by working backwards from the service capacity of the proposed water transit system, based on the number of trips, the size of the boats, and an assumption that one-fifth of the trips would be late night trips where ridership would be less than 25 percent of capacity. Although estimated service supply is a factor in calculating transit ridership, travel demand forecasting is conducted in greater detail and in depth and would likely provide a more realistic indicator of potential transit ridership, and usually starts with an assessment of the demand for travel between origins and destinations because of separation of housing from employment and other travel destinations, regardless of mode or schedules. Results of a travel demand methodology typically provide guidance regarding an appropriate amount of service to offer. Ridership forecasts for the proposed waterborne transit system should be examined closely before being accepted.

### Description of Vessels

Metro Aqua Cats contacted maritime designers to develop a catamaran that could handle local complexities including low bridges, environmental impacts associated with wake, shallow waters, access to wharfs, and the need to protect manatees and sea life from harm. The following requirements were requested.

- No higher than 14 feet off the waterline to travel under the Broad Causeway and the Venetian Causeway
- Draft of 3 feet for shallow water operation
- Minimum to no wake designed hulls
- Hulls shaped to minimize injury to sea life (manatees)
- Protected/caged propeller or jet propulsion system
- Quiet and comfortable ride
- Highest environmental standards

Note that research conducted for the *Development of a Service Plan for Waterborne Transit Services in Miami-Dade County* indicates that the vertical clearance below the Venetian Causeway in the Intracoastal Waterway is 12 feet according to nautical charts, which would restrict the ability of the proposed catamaran described in the Metro Aqua Cats report from traveling under the Venetian Causeway without raising the drawbridge.

The proposed vessel envisioned by the designers and described in the Metro Aqua Cats report to meet the requirements and specifications is a catamaran with hydro-foil lift that is approximately 70 feet long and 20 feet wide. These vessels are capable of carrying up to 149 total passengers and are Americans with Disabilities Act (ADA) compliant. These vessels could be manufactured for an estimated cost of approximately $1.8 million per vessel and would be capable of a cruising speed of 30 miles per hour (mph) and a full speed of 40 mph. The vessels are proposed to utilize bio-diesel fuel to reduce environmental impact and would be equipped with a forward facing sonar system with up to a 2-mile radius to reduce the likelihood of collisions with manatees.

The proposed 4-phase process to build the vessels includes (1) preliminary engineering, (2) design of key components of vessels and docks, (3) development and testing of the prototype, and (4) development of final bid documents. Phase 1 would include the final definition of the vessel criteria to meet the requirements of the Biscayne Bay area; Phase 2 would include development of preliminary hull lines, power and propulsion requirements, and docking requirements; Phase 3 would include development of technical specifications for the vessel, prototype and dock construction, wake testing, modifications to the design from test results, and design of a prototype; Phase 4 would include preparing bid documents, and providing bid evaluation and support.

Note that this 4-phase process does not appear to include a construction phase following the development of final bid documents. If final bid documents only initiate the actual construction process, construction and transport of the vessels from the construction site to Miami, if not performed locally, would certainly appear to add another phase to the process.

### Funding

The Federal Transit Administration (FTA) provides financial assistance for the planning, engineering and design, acquisition of vehicles and equipment, and construction of public mass transportation systems. Ferry projects that meet the definition of mass transportation are eligible for funding under the Capital Investment Program, Urbanized Area Formula Program, and Nonurbanized Area Formula Program. Ferry projects under the Capital Investment Program (Section 5309) must meet the New Starts criteria and a 20 percent local match is required. In urbanized areas with a population greater than 200,000, the Urbanized Area Formula (Section 5307) provides funding for capital projects and a 20 percent local match is also required. The Nonurbanized Area Formula Grants (Section 5311) would not be applicable in Miami-Dade County, as this program serves areas with a population under 50,000.

According to the proposal, the total cost of implementing the rapid mass transit ferry system would be approximately $150 million. The costs would include right-of-way acquisition, obtaining vessels and equipment, and incorporation of linkages with Miami-Dade's land-based mass transit system. The proposal expects that approximately a 50 percent share of funding is anticipated to be granted from FTA. As mentioned previously, the FTA programs only require a 20 percent local match. The proposal stipulates that the local match would essentially be comprised of dedicating publicly owned right-of-way for wharfs, docking facilities, and park-and-ride facilities. However, the feasibility of the dedication of publicly owned land qualifying as the local match needs to be examined in more detail, as would the approximate value of these dedications.

### Summary

Metro Aqua Cats, Inc. submitted a proposal to Miami-Dade County outlining the need for additional transit services aimed at providing a potential solution to reduce commuter travel time in an efficient and cost-effective manner, promoting high speed ferry service in Biscayne Bay as the mode to fulfill that need. The proposal contains several positive features including the identification of an operator, an environmentally sensitive vessel design, and a route network that is interconnected rather than several independent routes. However, some aspects of the proposal warrant further study such as the feasibility of using publicly owned sites for waterborne transit landings, route alignments, stops, frequencies, ridership projections, vertical clearance requirements for vessels, and the dedication of publicly owned land qualifying as the local match for FTA funding purposes.

## Fort Lauderdale Water Bus (Water Taxi, Inc.)

Water Taxi, Inc. operates the Water Bus service in Fort Lauderdale, Florida. The Water Bus service closely resembles an urban public transit system with numerous stops along linear waterways. The Water Bus service in Fort Lauderdale was formed in November 2001 when Broward County Transit (BCT) entered a public/private partnership with Water Taxi, Inc. to provide fixed route water transit service consisting of 22 stops along the Intracoastal Waterway and the New River. Prior to the public/private partnership, Water Taxi had been operating smaller boats to provide water-based transportation services.

Service is provided on 72-passenger vessels operating on 60-minute headways between 9:00 AM and 12:30 AM seven days per week. A north route (Route A) and a south route (Route B) is provided within the Intracoastal Waterway with both routes serving the New River. Connections between waterborne service and six BCT bus routes are coordinated and marked on signs. Transit passes can be used interchangeably on BCT buses and Water Bus vessels. One-way adult fares of $4 are relatively expensive compared to other forms of transit. However, monthly ($35) passes can be purchased at rates similar to BCT bus fares. During fiscal year 2003, the Fort Lauderdale Water Bus system carried 508,800 passengers.

Water Bus stops are located at existing docks, which significantly lowered the implementation cost of the system. No designated park-and-ride facilities are available, although metered public parking is available close to some docks. Most stops are located adjacent to hotels, restaurants, and shopping centers. Stops are also provided at the Broward County Convention Center and the Broward Center for the Performing Arts. Typical ridership appears to be tourism-based and patrons of local restaurants and shopping districts. Efforts to attract commuters are ongoing, although the existing Water Bus daily service span does not serve the traditional morning commuter travel peak period. Therefore, any reduction in roadway congestion caused by the Water Bus service is likely the result of fewer automobile trips between hotels, restaurants, and shopping centers. The Fort Lauderdale Water Bus system resembles a downtown circulator system whereas the waterborne transportation system being envisioned in Miami-Dade County is a regional transportation system.

# DATA COLLECTION AND PATRONAGE ESTIMATION

Data collection was performed for the *Development of a Service Plan for Waterborne Transit Services in Miami-Dade County* by examining physical characteristics of waterways identified in the *Feasibility of Utilizing Miami-Dade County Waterways for Urban Commuter Travel*. The objective of the data collection effort was to identify sections of waterways that exhibit restrictions to water travel mobility. In addition, data were collected to estimate patronage for the potential water transit system and align proposed water transit routes to serve major travel flows within the study area.

## Physical Characteristics of Waterways

Three primary steps were performed to identify the physical characteristics of waterways within the study area. First, data were collected from agencies with water-associated or water-oriented regulatory responsibilities. A base map was developed showing the locations of canals and physical structures within canals that may restrict mobility for water transit vessels. In addition, characteristics of Biscayne Bay that may affect water transit were collected and analyzed on the base map. Finally, a map of navigable and non-navigable sections of potential transit waterways was developed.

### Data Sources

Data obtained from agencies with water-associated or water-oriented regulatory responsibilities were used to organize information indicating the non-navigable sections of routes. Data were obtained from the following agencies.

- Miami-Dade County Department of Environmental Resources Management (DERM)
- Miami-Dade County Public Works (MDPWD)
- Miami-Dade Parks and Recreation Department
- South Florida Water Management District (SFWMD)
- Florida Department of Environmental Protection (FDEP)
- Florida Department of Transportation (FDOT)
- Florida Marine Research Institute (FMRI)
- National Oceanic and Atmospheric Administration (NOAA)
- United States Coast Guard
- United States DOT Bureau of Transportation Statistics (BTS)
- United States Army Corps of Engineers (USACE)
- United States Geological Survey (USGS)

The majority of the relevant data employed to estimate the physical characteristics of routes were obtained from the SFWMD, FDEP, and Miami-Dade County.

### Canals and Canal Structures

The most likely canals and Biscayne Bay alignments for routing waterborne transportation service were determined in the *Feasibility Study*. However, the *Feasibility Study* recommended further refining research to confirm findings regarding the navigability of waterways, especially canals. Canal and canal structure data were obtained from the SFWMD and Miami-Dade County.

Data obtained from the SFWMD included canals and canal structures, and was in the form of geographic information systems (GIS) point and line shapefiles. The canal shapefile shows the locations of canals maintained by the SFWMD; the canal structures shapefile identifies the locations of culverts, pumps, spillways, and weirs that may prohibit a vessel from traversing certain points in the canals. The most recent data available (2003) from SFWMD were utilized for this study.

The canal data obtained from Miami-Dade County included a line shapefile representing the locations of canals maintained by Miami-Dade County. These canals tend to be smaller than canals serviced by SFWMD and are less likely to be utilized by water transit vessels. County canals are often crossed by low bridges and pipelines that would inhibit the type of vessel necessary for public transportation service. No initial water transit route identified in the *Feasibility Study* utilized County canals.

Figure 4 identifies the location of canals maintained by SFWMD and Miami-Dade County; Figure 4 also presents locations of canal structures by type.

The primary deterrent to water transit vessels entering canals from Biscayne Bay are the spillways (salinity dams) located adjacent to the canals' outflow into Biscayne Bay. This severely limits the connectivity of most canals within Miami-Dade County to potential water transit routes within Biscayne Bay. Only the Coral Gables Canal and the Miami River have spillways located more than approximately one mile inland. Spillways are also located at various points along canals that further inhibit inland mobility to water transit vessels. SFWMD spillways are depicted as red circles on the map in Figure 4.

The effect of the canal structure location on potential water transit mobility is to limit the length of trips that can be accommodated. Thus, canals that are considered non-navigable are excluded from further consideration for waterborne transit routes. Canals that exhibit short or intermittent segments of navigability are also excluded due to trip mobility constraints. The waterways that should receive further consideration for initial waterborne transit implementation include Biscayne Bay and canals downstream of the salinity dams.

### Marinas

The location of marinas was researched by obtaining data from the Florida Marine Research Institute (FMRI). As explained in the Background Research chapter of this study, several water transit systems reduced implementation costs by utilizing and/or adapting existing docks and marinas for providing stops. Figure 5 presents the locations of marinas within Miami-Dade County. Figure 5 indicates that the majority of marinas within Miami-Dade County are located from the City of Miami north to the Broward County line.

Please note that the data provided by the FMRI includes both public and private marinas. Most marinas in Miami-Dade County are private facilities associated with ventures such as yachting clubs and boat sales and maintenance establishments; these marinas are not likely candidates for a waterborne transit terminal. However, a limited number of private marina owners may be interested in forming a partnership with a waterborne transit provider and allowing use of a private marina. Typically, these arrangements involve private entities that may stand to gain from the introduction of water transit service by the potential market represented by exposure to water transit patrons, providing convenient transportation for employees or visitors, or other similar circumstances. Private entities that may potentially be receptive to hosting a water transit terminal include hotels, restaurants, hospitals, business parks, shopping centers, entertainment districts, museums, universities, and to a lesser extent condominiums. Agreements with these private ventures would have to be negotiated and executed to utilize the majority of the marinas depicted in Figure 5. The location of suitable marinas is an important factor to consider when identifying water transit terminal locations during subsequent portions of this study.

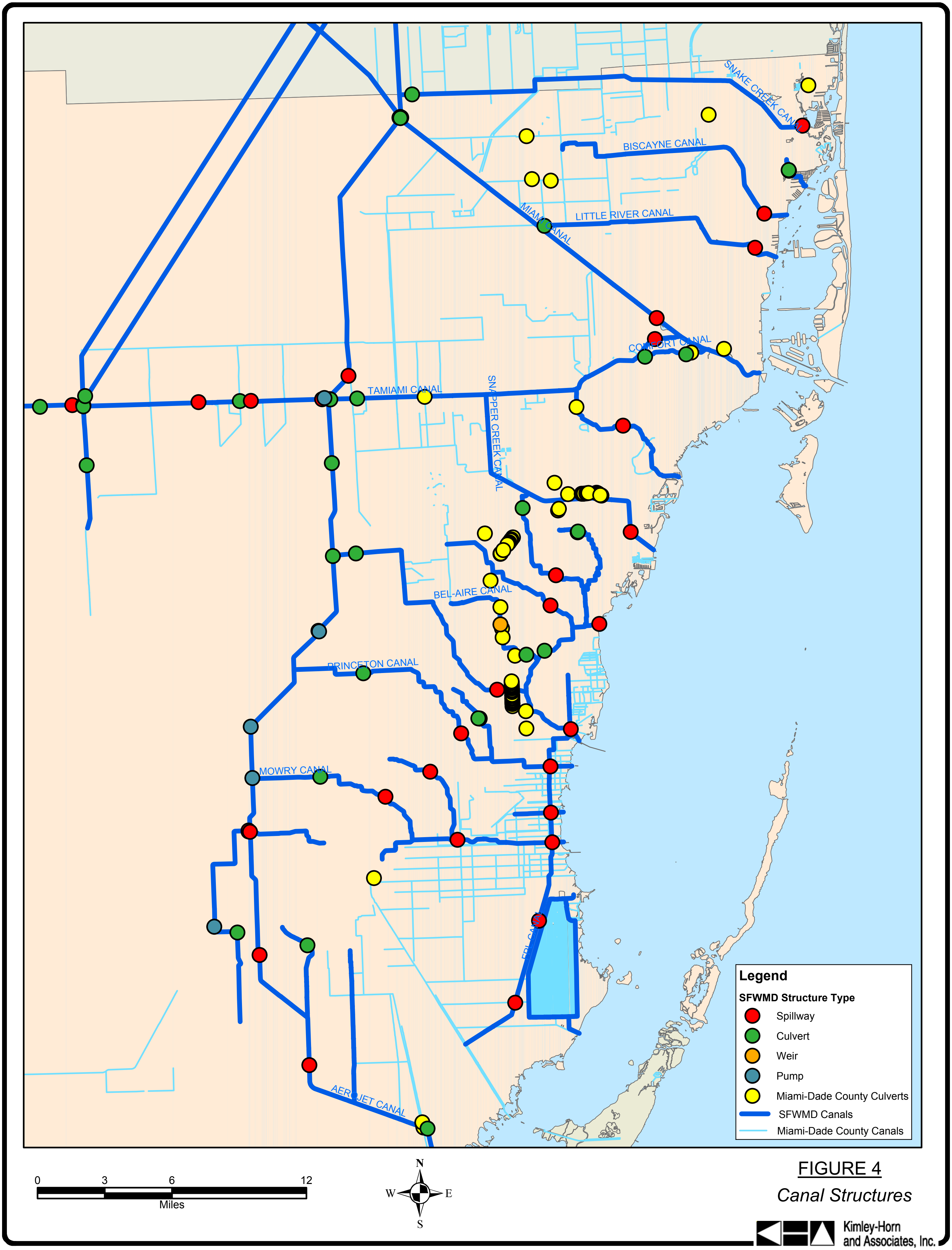


FIGURE 4

*Canal Structures*

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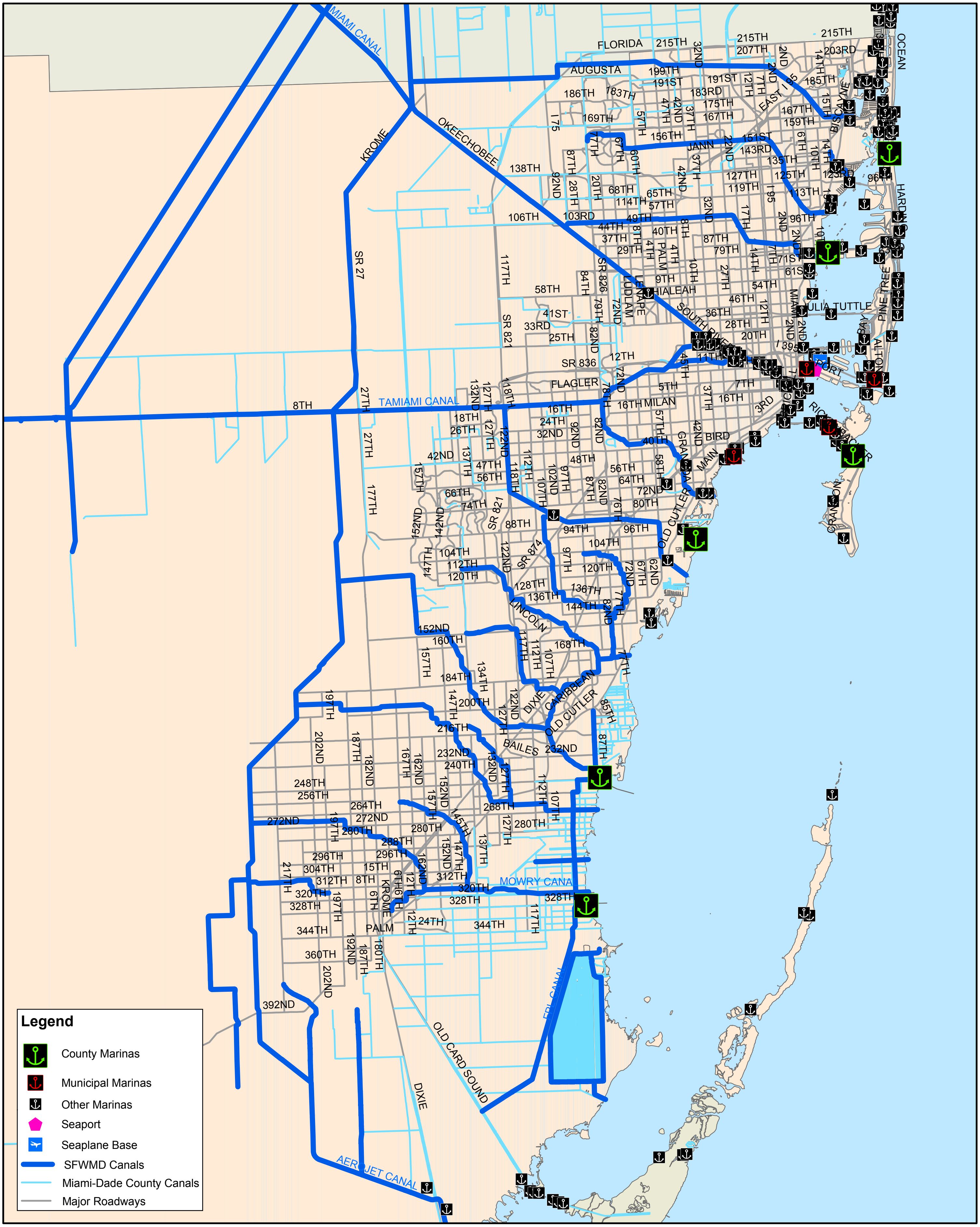


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# FIGURE 5

*Marinas and Ports*

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## Public Parks and Recreational Spaces

Parks and public recreation area data were obtained from FDEP, NOAA, the Miami-Dade County Parks and Recreation Department, and the National Park Service. The locations of national wildlife refuges were obtained from the NOAA; FDEP provided the locations of state preservation areas; the Miami-Dade County Parks and Recreation Department provided the locations of parks within the County; the National Park Service provided information regarding Biscayne National Park in the southern portion of the County. Figure 6 presents the locations of parks and recreation areas within Miami-Dade County.

Metro Aqua Cats developed a proposal to provide waterborne transit services within Miami-Dade County (discussed in more detail in the Background Research chapter of this report). The Metro Aqua Cats proposal recommended using existing parks and recreation areas as stations for the water transit system. Several parks contain existing marinas and/or docks that physically could be employed as water transit stops or stations. However, the Metro Aqua Cats proposal suggests that in order to positively impact roadway congestion in Miami-Dade County, supporting facilities such as park-n-ride lots and larger docking facilities would be necessary. This is entirely appropriate for providing access to transit, and highly desired in such an auto travel-oriented area as Miami-Dade County. It is, however, both physically and policy-wise, antagonistic towards the recreational purposes of parks, potentially taking up valuable park facilities if additional parking facilities are constructed, and introducing non-park traffic to the facilities and neighborhoods around them, and possibly violating rules, regulations, laws, and covenants governing not only National and State Parks and their uses, but local park uses as well.

The expansion or construction of new docks within parks would have to conform with DERM and FDEP regulations that limit the spacing and size of docks and marinas, as well as U.S. Coast Guard and Department of Fish and Wildlife regulations. Furthermore, the conversion of land designated as a public recreational park to a transportation use, including boat landings for public transit or park-n-ride facilities, conflicts with federal regulations preserving the existence of parks and open spaces that have been financed through federal funds. Transportation projects that require the conversion of public recreational space to transportation-related purposes are commonly required to replace the amount of park space that was lost due to the transportation project. In some instances, transportation agencies are required to pay for additional improvements to the park in exchange for the use of the land. Specifically, the financial plan provided in the Metro Aqua Cats proposal does not appear to account for improvements to public lands that may be required, or for mitigation of public land acquisitions that may also be required to replace public recreational space.

Finally, the land on which some public recreational parks are located is required by covenant with the original landowner(s) to be used for the purpose of recreational space. An attempt to change the land use to provide transportation infrastructure may trigger deeding the property back to the original owner(s) or heir(s), or present other legal interventions, and delay to the point of infeasibility any proposed applications of park land to prospective waterborne transit uses.

## Biscayne Bay Data

Biscayne Bay is the primary water feature within Miami-Dade County; indeed, it dominates County recreation and plays a dominant role in its economy. In the northern portion of the County, Biscayne Bay is a largely inland bay approximately one to three miles wide that separates mainland Miami-Dade County from the barrier islands of Miami Beach, several bay communities, and the beach communities. The Atlantic Intracoastal Waterway is a strategic navigation channel running through the western portion of Biscayne Bay, stretching the length of the county from the Broward County line in the north to Monroe County in the south. South of Key Biscayne, Biscayne Bay is characterized by shallow waters, numerous sea grass habitats, mangrove shorelines, and several preservation areas. The latter three are environmentally

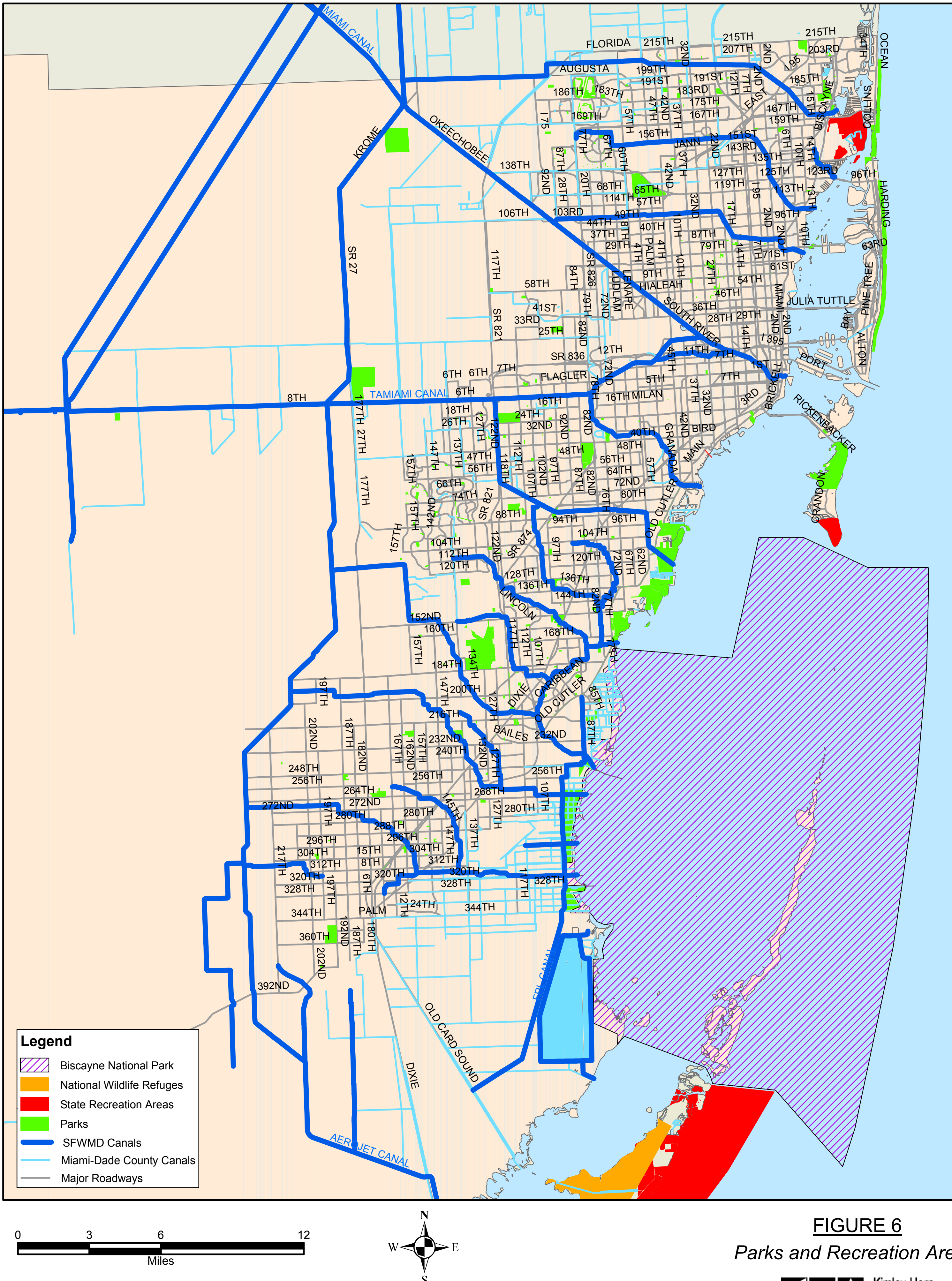


FIGURE 6

*Parks and Recreation Areas*

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protected. An outer band of shoals and reefs separate Biscayne Bay from the open waters of the Atlantic Ocean from Key Biscayne south to the Ragged Keys, which has the effect of screening the waters of Biscayne Bay from large waves and enhances wildlife and sea grass habitation. Figure 7 presents the location of protected areas within Biscayne Bay including sea grass habitats and manatee protection zones.

The data obtained from the BTS included a line shapefile of the National Waterway Network representing actual shipping lanes. The National Waterway Network is a geographic database of navigable waterways in and around the United States, maintained for analytical studies of waterway performance, for compiling commodity flow statistics, and for mapping purposes. Figure 8 presents the alignment of the National Waterway Network within and adjacent to Miami-Dade County. The Atlantic Intracoastal Waterway and Government Cut, the large ship channel access to the Port of Miami, are clearly depicted on Figure 8.

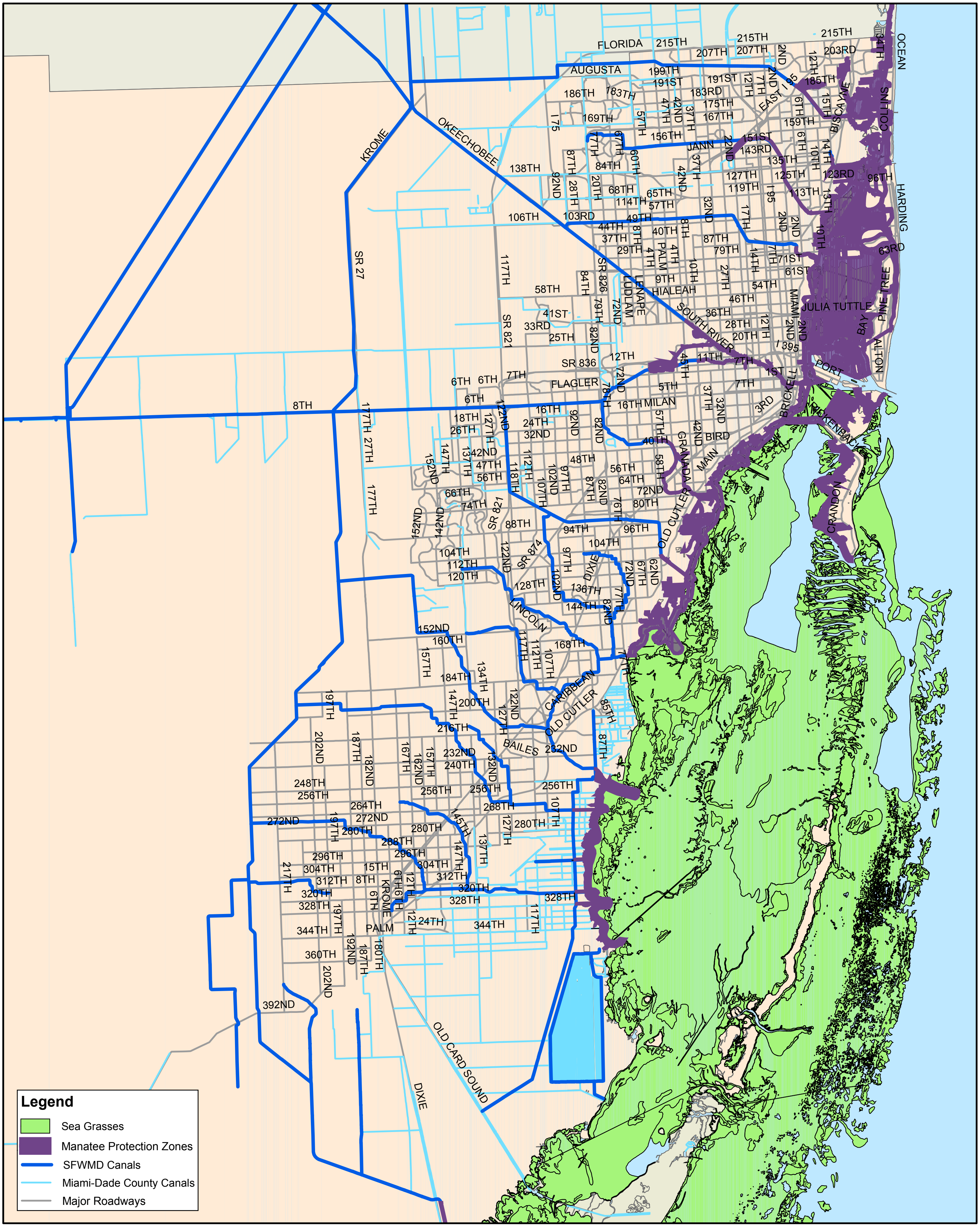
Figure 9 presents the location of reefs within Biscayne Bay and under nearby County and adjacent coastal waters, and depicts sites of both natural reefs and artificial reefs. Reefs provide an environment in which marine life can flourish and are therefore sensitive areas. Artificial reefs, created out of a wide variety of objects including sunken ship hulls, commercial aircraft, partly disassembled metal towers, and concrete pipes, have been placed around both the shallow waters of Biscayne Bay as well as in deeper offshore oceanic waters. These are designed to provide additional marine habitats, support local and regional recreational economic enterprises such as fishing and diving, and help protect natural reefs from the stress of excessive human interaction. All boat operators, including potential waterborne transit vehicle operators, must exercise caution around reefs in shallow waters.

Figure 10 presents bathymetry data obtained from the FDEP. The bathymetry data describes the water depth of Biscayne Bay and the Atlantic Ocean immediately adjacent to Miami-Dade County. Bathymetry data indicates those sections of Biscayne Bay that are more appropriate for use as navigation channels, and thus possible water transit routes, and those sections of the Bay where water depth is more shallow and less or altogether unsuitable for routing. Some areas close to the shoreline exhibit a water depth of less than three feet, which would inhibit the ability of water transit vessels from operating in these shallow locales.

### Navigable Waterways for Potential Transit Routes

The data obtained from the sources described in this section of the report were analyzed to develop a map showing the navigable and non-navigable sections of waterways that have been identified as potential water transit routes within Miami-Dade County. Figure 11 presents the navigable and non-navigable sections of waterways evaluated in this study, as it relates to potential water transit operations. Most non-navigable sections of canals have spillways, culverts, or low bridges with insufficient clearance that cause the canal to be non-navigable. In addition, other canals have short navigable sections that are not long enough to provide truly "navigable" service for water transit purposes; therefore, these canals are essentially non-navigable from the standpoint of a transit assessment. Connectivity with Biscayne Bay is also important from a practical sense for system integration as most of the water transit system length identified in the *Feasibility Study* is within Biscayne Bay.

The sections of non-navigable canals within Miami-Dade County limit the ability to provide an interconnected water transit network using inland canals. The most feasible water transit network from the standpoint of physical waterway characteristics consists of routes within Biscayne Bay and the portion of canals seaward of the salinity dams. This finding will be utilized to develop the conceptual route network assumed to be in place for patronage estimation purposes, discussed further in the next section of this chapter.




0 3 6 12
Miles

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FIGURE 7

*Protected Areas*

Kimley-Horn and Associates, Inc.

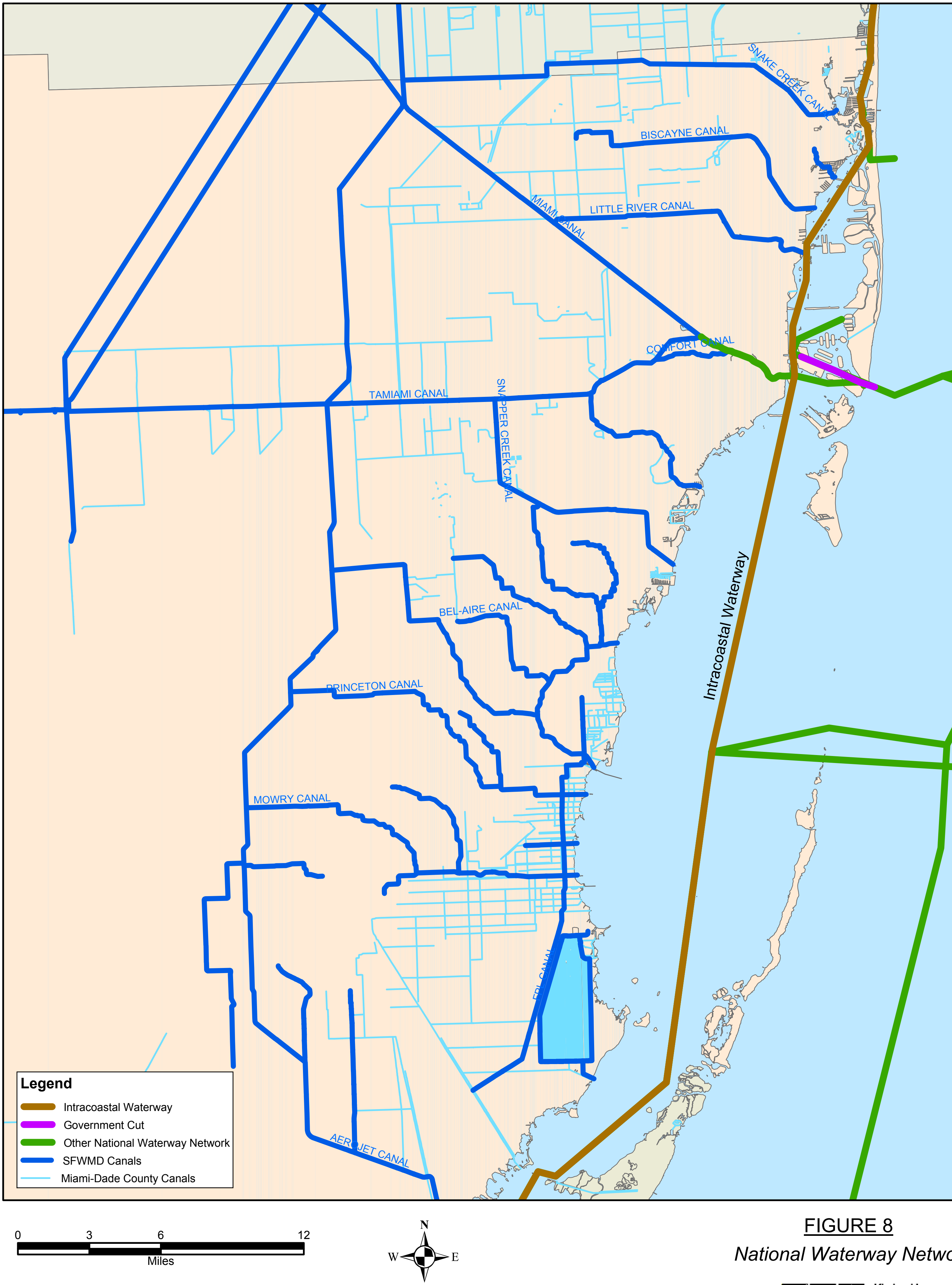
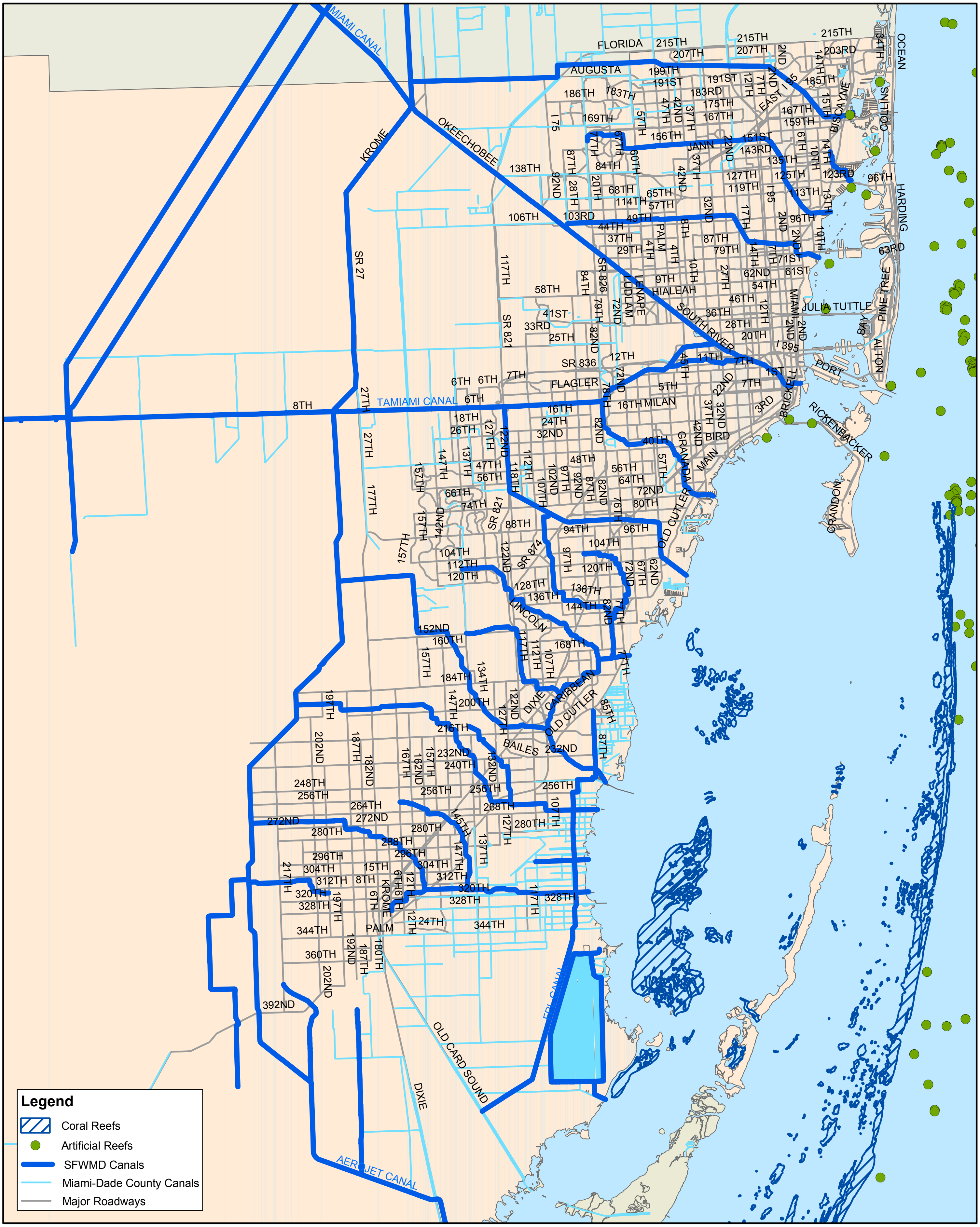



FIGURE 8

*National Waterway Network*

Kimley-Horn and Associates, Inc.




0 3 6 12
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N S E W

FIGURE 9
*Reefs*

Kimley-Horn and Associates, Inc.

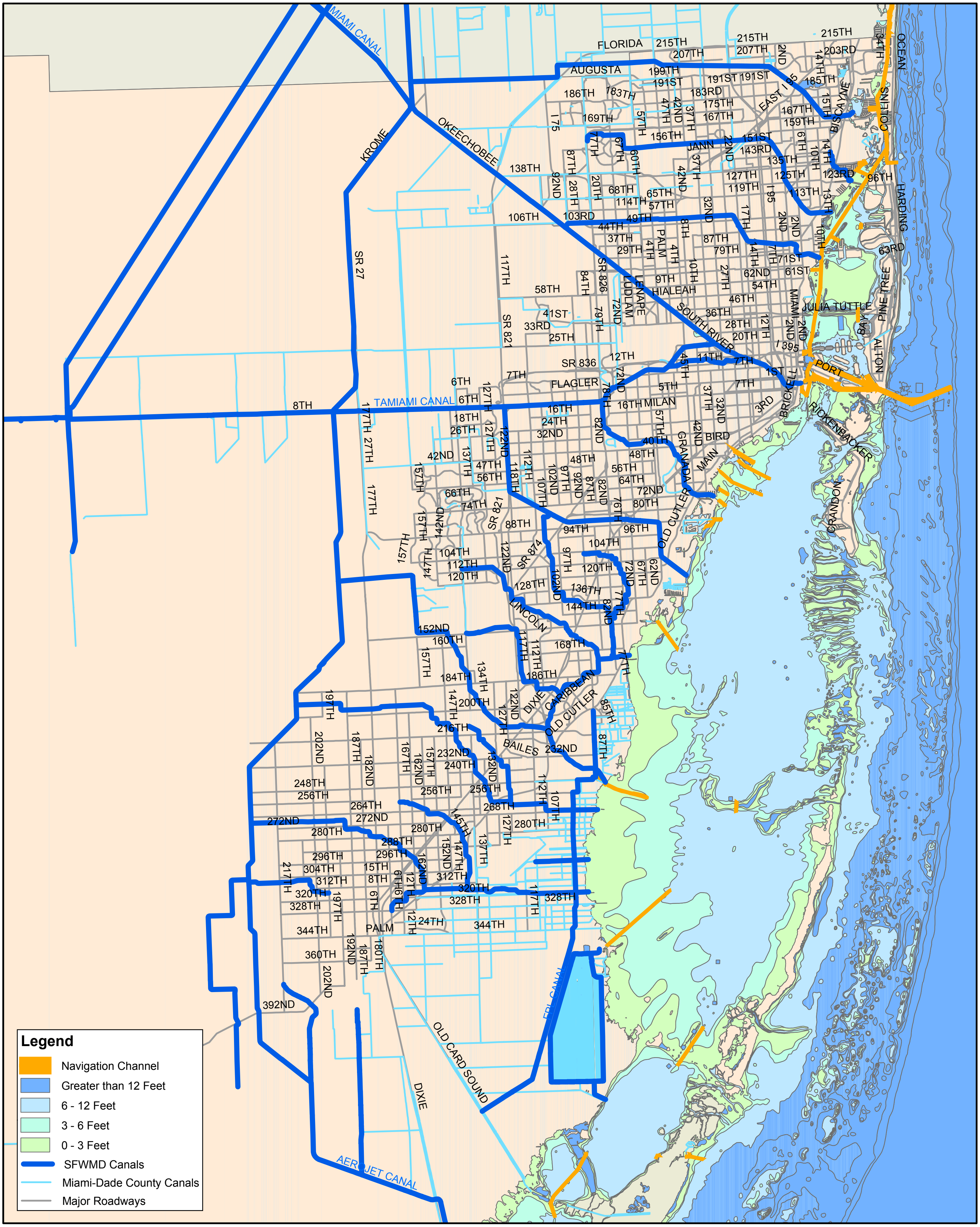




FIGURE 10

*Bathymetry*

Kimley-Horn and Associates, Inc.

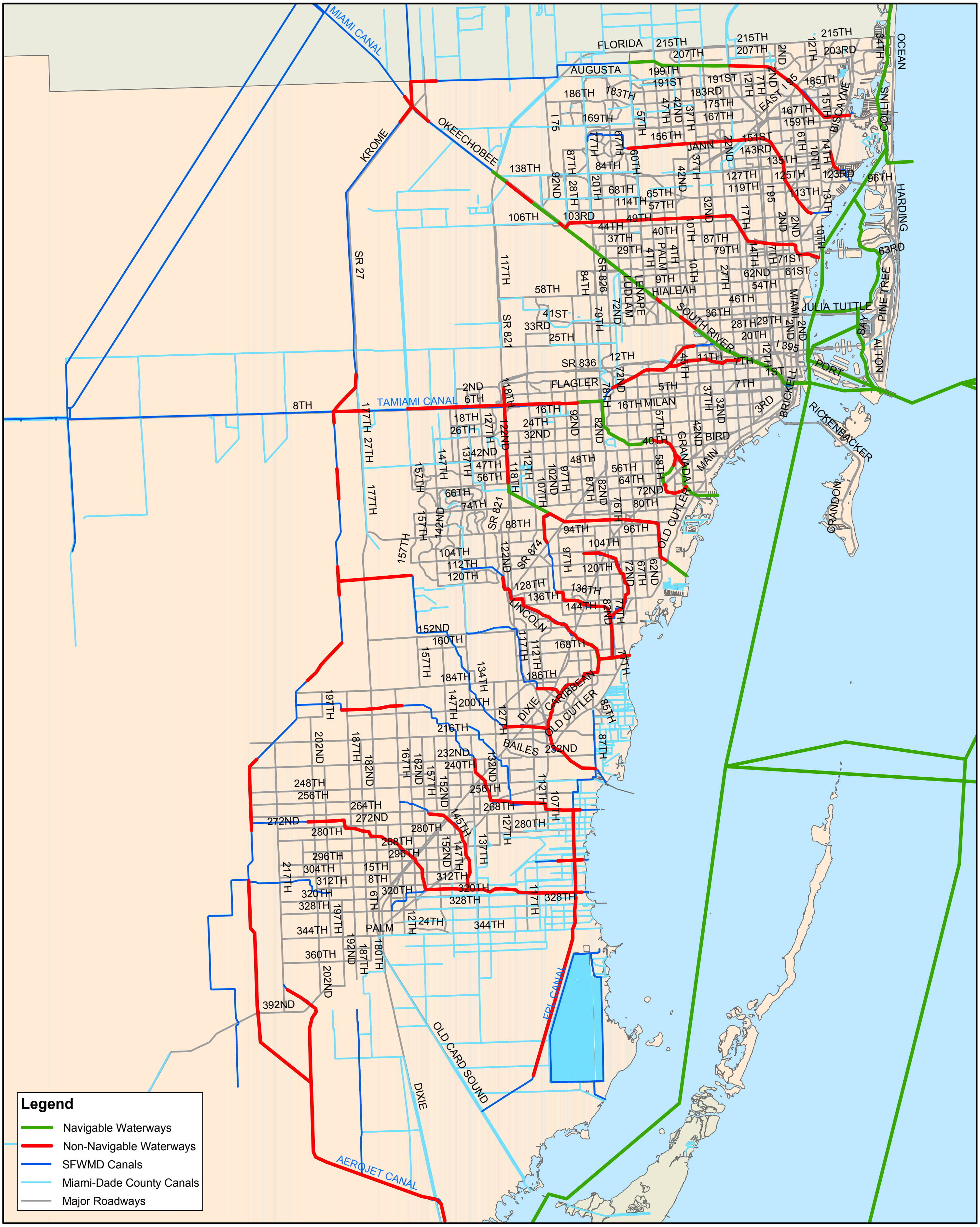



FIGURE 11

*Navigable Canals and Waterways for Waterborne Transit Potential*

Kimley-Horn and Associates, Inc.

## Patronage Estimation

Data were collected to estimate patronage for the potential water transit system and align proposed water transit routes to serve major travel flows within the study area. Included in this section of the report is a review of potential water transit patronage estimation methods, a review of travel demand patterns within Miami-Dade County, and a forecast of water transit patronage using the selected estimation method(s).

### Review of Patronage Estimation Methods

Patronage estimation methods were researched before beginning the forecasting effort to determine which methods may be appropriate for developing forecasts of patronage for the proposed waterborne transit system in Miami-Dade County. Six methods were identified based on traditionally acceptable transit forecasting methodology and observations from other water transit planning studies. More than one method may be applied to take advantage of particular benefits offered by individual methods and to provide a cross check for forecasted patronage.

#### Method 1 - Utilization of Land-Based Transit System Patronage Forecasting Models

As the water transit system under study has many parallels to land-based transit systems, it may be possible to apply patronage forecasting methodologies used in traditional transit planning. These methodologies typically forecast patronage based on the socioeconomic characteristics of the service area including population and employment levels in the area's analysis zones, the transit services offered and the levels of service they provide, mode choice propensities of those living in the area being studied for several modes (not solely transit) of travel available, and the background transportation system network, i.e., highways, transit, railroads, etc. These methodologies are typically a series of computer-based mathematical models whose algorithms are a relatively standardized set of equations describing the choices travelers make under varying conditions of land use, travel purpose, and transportation systems and elements available to the traveler. These models are calibrated and validated for each area in which they are applied based upon local travel and traveler data collection efforts (individual's travel survey responses, census data, roadway vehicle counts, transit boarding counts, etc.)

Experience has shown that these models will variably under predict the patronage that a water transit system will actually experience. This is because the processes of Method 1 are driven purely by mathematical algorithms that have not taken into account a number of characteristics of the waterborne services, including the intrinsic appeal that water transit possesses (its 'mode bias'), as the overwhelming majority of these models have been developed, and subsequently calibrated and validated, for land-based systems only. Most water transit systems in the United States will draw patronage not only because they offer a 'transit mode', but also due to the appeal of traveling via interesting, if not indeed scenic waterways. Thus, the water transit system itself may create some trips, usually from tourists who may consider the system to be one of the local tourist attractions. This is especially true in operations such as Fort Lauderdale that operate in popular tourist areas. Even ferry systems such as those in Washington State are often ranked as popular tourist draws for that state. Thus, if generic land-based mode choice models were to be utilized, their patronage forecasts would need to be increased by a certain factor to account for this intrinsic water mode attractivity, and tourist trip attraction.

It is easy enough to develop and specify such a model, at least from a theoretical standpoint. Difficulties arise in practical applications. Travel characteristic surveys - usually large, logistically complex, and costly undertakings - would need to be designed, conducted, and analyzed. Then the data would need to be used to integrate an additional mode into existing local mode choice models, and appropriately located within the overall model structure. Compounding the effort is that there would be no actual local experience in waterborne transit, so all responses would need to be carefully solicited via a 'stated preference' survey methodology, and a series of equation variable coefficients introduced after having been borrowed from other areas where there already was experience with waterborne transit.. As can be seen, it is a problematic approach.

Method 2 - Utilization of Actual Patronage Data from Existing Land-Based Systems

Useful patronage data is normally available from existing land-based transit systems such as commuter rail, heavy rail, light rail, and bus transit systems. The existing routes that parallel the proposed water transit routes, or that serve the same origins and destinations, can be seen as surrogates for the volume of transit patrons that can be reasonably expected for such a similar water transit route, with planning judgment and local experience applied based on how closely the two types of transit systems' characteristics resemble each other. In addition, other factors that would need to be considered when applying Method 2 include the percentage of the land-based transit route that parallels the proposed water transit route, the accessibility of the land-based transit system (which is often higher than the accessibility of the proposed water transit system), and the intrinsic appeal of water transit compared to other locally available traditional forms of transit, especially with tourists.

Method 3 - Utilization of Estimated and/or Forecast Patronage Data from Proposed Land-Based Systems

Patronage estimates and projections may be available from proposed land-based transit systems that have been recently studied and are pending federal funding, which can then be applied to the water transit system via ratios derived from service differences such as headways, service spans, and system speed differentials. Again, judicial application of this data is required, based on the similarities and differences of the characteristics of the proposed services compared and contrasted with those of existing ones. Furthermore, the relative intrinsic similarities and differences of the areas, the areas' geographies, and perhaps most importantly, the similarities and differences of the socioeconomic profiles, and travel behaviors and choices, of the populations of the areas who were the objects of the transit studies when compared to those of the local area, will need to be carefully assessed.

Method 4 - Utilization of Data from Other Existing Water Transit Systems

Patronage data may be obtained from other existing water transit systems, both in the United States and in other countries of the world. Well-developed and mature systems, similar to what is being considered for Miami-Dade County, exist in Australia (in both Sydney and Brisbane), and in the Netherlands. Water transit systems also exist in several domestic cites, including Baltimore, New York, San Francisco, Seattle, and Fort Lauderdale.

An estimated Miami-Dade County fully-matured patronage can be forecast based on similar systems' patronage. 'Borrowed data' must be distilled and adjusted by comparing service characteristics (e.g., the number of days of service per year, daily service span(s), fleet size, and vessel capacity. As noted above for other methods, demographic characteristics of the comparison cities should be considered and compared to demographic characteristics of the study area within Miami-Dade County and included in the development of estimates and projections. Services that utilize similar capacity vessels to those anticipated to be put in service in Miami-Dade are especially useful. It is important when analyzing such systems that vehicle-ferry patronage, if present, must be discounted if the person drove aboard since the system being proposed in Miami-Dade County would be passenger only. Indeed, vehicle ferry operations will need to be most highly and critically analyzed because of the enormous advantage car ferry auto drivers have with respect to having their own personal vehicle available at both ends of what is essentially a transit trip, contrary to the overwhelming majority of both domestic and international transit trips, waterborne or not.

This, in turn, creates a mode bias that will not be appropriate for use for the services sought for Miami-Dade County.

Method 5 - Utilization of Data from a Survey

Various forms of surveys can be utilized to forecast patronage including an on-line Internet survey, a telephone survey, a home-interview survey and a mail-back survey.

An on-line Internet survey can be utilized to forecast patronage of transit systems. Establishment of a project website is required for Internet surveys. A press release to the local media, including both general circulation and local circulation newspapers, radio, and television, can help make the public aware of the survey, and direct them to the website. Useful data could thus be obtained on a continuous basis with moderate effort.

Another form of conducting a survey to estimate and forecast patronage is via telephoning. The salient features of the survey are the same as for an Internet website survey; however, there are certain advantages in performing a telephone survey over an Internet-based survey as described below.

- First, with use of RDD (random digit dialing) techniques, self-selection bias is eliminated.
- Second, oversampling of sub-populations known from past experience or anticipated from parallel experience elsewhere to raise response rates to statistically valid levels can be rather easily accomplished.
- Third, use of CATI (Computer-Assisted Telephone Interviews) to directly collect and/or retrieve data can improve response validity and increase sample size, or decrease costs.
- Fourth, associations between exchanges and geography can assist in development of spatially-appropriate targeting.
- Fifth, blocks of numbers (usually exchanges) reserved for non-targets (e.g., government and education institutional numbers) can usually easily be eliminated from canvassing and make the process that much more efficient while still retaining an unbiased sampling approach.
- And sixth, the degree to which the respondent understands the proposed new service can be gauged by the telephone surveyor, and misunderstandings rectified and further objective clarifications describing the proposed services provided.

Enough phone calls would need to be conducted to obtain a statistically significant sample at an acceptable level of accuracy with an acceptable level of error. Biases in phone surveys include limitations associated with non-respondents, those members of the population who may not have a telephone, and response bias from those members of the population who are simply more likely to respond to surveys.

While telephone surveys are much more labor intensive than Internet surveys, they are far less intensive and far more efficient than home interview surveys, the most accurate but also most expensive and time-consuming survey method. Because of fiscal and time constraints, home interview surveys are rarely presently conducted. Mail-back surveys are commonly used for measuring existing travel patterns but may suffer from similar biases as other survey categories when used to gauge future patronage of a proposed transit system.

It is important to adequately describe the proposed water transit system, to adequately and objectively inform the respondent of potential advantages and disadvantages the system would have with respect to not only other modes of transit, but with other modes of *travel*, and to elicit from the respondent a reasonably reliable assessment of whether or not they would patronize it. The survey instrument should gather enough information from the respondent to determine at a minimum the person's travel/commuting pattern, their general socioeconomic status (including the nature of their household and their employment), their consideration of transit in general, and indications of their time and cost elasticities for daily travel.

The possibility of survey bias is high for Method 5. First, most survey types extract data from a self-selecting respondent pool. It is likely that most of the Internet survey respondents would be comprised of those who have access to one of the media on which the survey has been advertised and a computer, and possibly those who would actually feel positively inclined to ride the system, or in contrast, those who were adamantly against such a proposal. Sound planning and conservative, experienced survey judgment would be required to develop a ratio of the population of potential respondents to the total population within the study area. Method 5 would require some initial planning to develop the survey, advertise the survey and publish an accurate description of the system.

Method 6 - Working Backwards from Proposed Fleet Build-Out

As major metropolitan cities such as New York and Seattle, which are situated on extensive waterways, tend to fully utilize existing water transit services during peak periods, it could be reasoned that Miami-Dade County would also fully utilize a water transit system at the same stage of not only waterborne system maturity, but at similar stages of urbanized area and regional development, metropolitan and regional transportation system, network maturity, and need.

In this scenario, patronage usually is constrained by the capacity of the fleet, and is directly proportional to average vessel capacity and the number of ferries in the fleet. Patronage is related to spare availability and fleet storage capacity as well, and capacity will also be constrained by the relationship of the fleet size and the schedule. Peak hour patronage can be estimated by assuming 100 percent patronage of seat capacity with shoulder traffic at a somewhat lower load factor, and off-peak/off-shoulder traffic at a very low load factor. Assumptions related to the hours of service per day (weekdays, weekends, and holidays), and their expansions annually, can then estimate annual patronage. Estimates may be transformed into forecasts with application of growth and development assumptions.

It is important to note that limitations to Method 6 include that it does not consider demographic characteristics of the study area, prevailing travel patterns, travel demand forecasts, or actual landside transit patronage as guides and/or adjustment factors. Therefore, Method 6 is not useful for assisting with scheduling or route aligning. Method 6 assumes that doubling the transit level of service (e.g., doubling the service frequency) will lead to doubling the ridership.

### Review of Travel Demand Patterns within Miami-Dade County

Existing data sources for determining travel demand patterns include the 2000 United States Census, the *Southeast Florida Regional Travel Characteristics Study*, and the *Miami Urban Area Transportation Study* (MUATS) travel demand model. Other related but indirect data include transit ridership records, on-board surveys, ride checks, and route-by-route patronage estimates developed by Miami-Dade Transit. Other indirect data include highway vehicle ground counts taken by Miami-Dade Public Works, Florida DOT District 6, and a variety of ad hoc transportation studies conducted by the MPO, Miami-Dade Transit, Miami-Dade Public Works, FDOT, and municipalities.

2000 United States Census

The United States Bureau of the Census collects data on commuter trip characteristics during the decennial census. Journey-to-work (JTW) data from the 2000 United States Census available for this study includes mean travel time to work and modal choice. Census Journey-to-Work data also includes O-D travel data by including the place of residence and the place of employment, the assumption being that there was travel between the two for the work trip. Data were examined by census block group for relevant areas of the County to determine travel characteristics that may affect potential waterborne transit service.

Potential water transit stations were researched from both the *Feasibility of Utilizing Miami-Dade County Waterways for Urban Commuter Travel* (*Feasibility Study*) and *Rapid Mass Transit*, the proposal by Metro Aqua Cats, Inc. for providing high speed ferry service. A list of the potential stations identified in the Metro Aqua Cats report was included in the Background Research chapter of this report and is reproduced in Appendix A along with the station number identified in the report. Additional stations identified in the *Feasibility Study* are also included in Appendix A.

Census JTW data were collected for the census block groups that contain the potential stations identified in Appendix A.

Indicators of potential waterborne transit ridership for residents within the census block group where potential stations are located include high percentages of existing transit use, low percentages of single occupant vehicle (SOV) use for work trips, and lengthy work trips. Appendix B presents four sets of rankings of the potential water transit stations sorted by the following criteria.

- Percentage of residents who ride transit to work
- Percentage of residents who carpool to work
- Percentage of residents who drive alone to work
- Mean travel time to work

The data presented in Appendix B can be used to identify census block groups that exhibit demographic characteristics that may indicate an increased reliance on public transit for mobility. It is important to note that this type of information, while relevant, is not the only consideration that will be made for desired water transit terminal placement, since park-n-ride lots and accessibility from other transit modes are important linkages for the proposed water transit system that will increase the area size from which potential boardings at the terminals are drawn. In other words, water transit ridership is not intended to be constrained only to neighborhoods adjacent to terminals.

Several proposed station locations appeared to provide consistently high feasibility for providing potential water transit ridership based on work-trip characteristics of the population near the station (within the census block group).

- NE 20th Street @ North Bayshore Drive (Margaret Pace Park)
- Byron Avenue @ Tatum Waterway (Tatum Park in Miami Beach)
- NE 55th Terrace @ North Bayshore Court (Morningside Park)
- City of Miami Riverside Administration Center
- 79th Street Causeway West (the area west of North Bay Island Marina)
- Riverwalk / James L. Knight Convention Center
- NW 17th Avenue @ NW 14th Street (west of the Civic Center near the Miami River)

Several proposed station locations appeared to provide consistently low feasibility for providing potential water transit ridership based on work-trip characteristics of the population near the station (within the census block group), such as low percentages of existing transit or carpool use.

- NE 94th Street (North Bayshore Park in Miami Shores)
- Founders Park (NE 190th Street in Aventura)
- Ingraham Park (Cocoplum Circle in Coral Gables just south of Coconut Grove)
- Waterways Markets (Turnberry Isle Country Club in Aventura)
- Charles Deering Estate (in Palmetto Bay)
- Chapman Field Park

Southeast Florida Travel Characteristics Study

The 2000 *Southeast Florida Regional Travel Characteristics Study* (SEFTCS) provided observed travel information through household survey travel logs, on-board transit surveys, visitor surveys, and commercial trucking establishments. Travel logs were solicited from 5,100 households, 11,000 transit riders, 79 hotels, and 848 commercial trucking establishments within Miami-Dade, Broward, and Palm Beach Counties. In addition, employee surveys were conducted at seven major employment centers in the three counties.

Findings relevant to this study from the SEFTCS travel characteristics survey include regional comparisons that tend to indicate slightly more favorable conditions for developing transit ridership in Miami-Dade County than in Broward or Palm Beach. Even though a non-home-based trip was the largest category for South Florida as a whole (24.4 percent), home-based-work was the largest category for Miami-Dade County (26.6 percent). Work trips form a primary component of system-wide daily transit trips. Miami-Dade County also exhibited a slightly higher automobile occupancy rate than the region as a whole and a lower vehicle availability rate. Since a form of water transit currently exists in Broward County, travel conditions in Miami-Dade County should be at least as favorable for water transit service assuming similar service characteristics and marketing activities.

Primary travel patterns in Miami-Dade County that appear to generally parallel waterways (or may reasonably be served by waterways) include the following generalized pairs of locations.

- Downtown Miami and Miami Beach (Biscayne Bay)
- Downtown Miami and northeastern Miami-Dade County (Biscayne Bay)
- Downtown Miami and Miami International Airport (Miami River and Tamiami Canal)
- Downtown Miami and South Dade (Biscayne Bay)

It is important to note that several sub-areas within Downtown Miami function as separate work trip destinations, such as Brickell, the Government Center, and Omni. Therefore, it is important to consider the many sub-areas of Downtown Miami and that one “Downtown node” is not an accurate representation of travel demand nor travel characteristics for the area. In addition, several sites within Downtown Miami serve as recreational trip destinations, such as Bayside. Miami is currently experiencing a “return-to-the-city” movement that may increase the number of recreational destinations within Downtown. Furthermore, current redevelopment may increase the number of work-trip origins that are generated within Downtown, thereby potentially increasing the reverse-commute demand that could potentially be served by a water transit system.

Biscayne Bay and the Miami River (east of the salinity dam located south of NW 36$^{th}$ Street) are navigable waterways that may be suitable for some form of water transit service. However, the Tamiami Canal is non-navigable east of the Coral Gables Canal and may present an extreme challenge in serving Miami International Airport (MIA) or the Miami Intermodal Center (MIC) without introducing transfers from additional transit modes.

Miami Urban Area Transportation Study (MUATS) Travel Demand Model

The *Miami Urban Area Transportation Study* (MUATS) travel demand model is the standard macroscopic travel demand forecasting tool for planning purposes in Miami-Dade County. The model is based on a validation year of 1999 and was updated for the 2025 Long-Range Transportation Plan. Interim data sets exist for short-range horizons, such as 2010. While the model has been revalidated and projections developed to 2030 for the development of the 2030 Long Range Transportation Plan for Miami-Dade County, the data were not available at the time this study was conducted.

The 2010 MUATS model was used to examine travel patterns within Miami-Dade County by performing a series of "select zone" model runs for primary potential station locations identified in this study. A "select zone" model run allows the user to observe the percentage of trips from a specific traffic analysis zone (TAZ) that utilize each link in the roadway network.

The application for this study was to record major travel vectors from potential water transit station locations to determine if significant travel demand exists for potential route alignments. Appendix C presents the results of the MUATS travel demand analysis from various potential service locations within Miami-Dade County to other potential service locations. Appendix C includes a series of maps that depict the percentage of modeled transportation trips from various locations that pass through proposed primary station locations along the potential water transit network.

Please note that for the select zone analysis, a single TAZ was chosen as the primary TAZ for each potential service location. While each potential service location is not actually represented by just one TAZ, choosing one that is considered representative of the service location simplified the study analysis. Furthermore, trips patterns to and from adjacent TAZs will more likely than not be similar to trip patterns to and from the primary TAZ. In addition, the select zone analysis demonstrated in Appendix C is used to analyze trip patterns (directions or vectors) rather than the magnitude of trips.

The highest concentration of trips according to the MUATS model occur east-west across Biscayne Bay rather than north-south along the shoreline. Miami Beach (South Beach) to Downtown Miami is a major origin-destination pair when considering the percentage of zonal trips and the number of trips in the TAZ. Currently this origin-destination pair is served by two causeways and five Metrobus routes. Downtown Miami to Coral Gables (near the potential water transit station site along the Coral Gables Waterway at U.S. 1) is another travel pattern of note for its concentration of trips along the U.S 1 / Metrorail corridor, although it is unlikely that major trip destinations in the area, such as the University of Miami, can be efficiently accessed from the navigable portion of the Coral Gables Canal. Metrorail already provides efficient transit service along this corridor and serves other destinations as far south as Dadeland South. It is improbable that water transit vehicles, which would be required to slow to idle speeds within the Coral Gables Canal, could compete with speeds achieved on Metrorail between Coral Gables and Downtown Miami.

Other segments of routes identified in the *Feasibility of Utilizing Miami-Dade County Waterways for Urban Commuter Travel* were examined in the MUATS travel demand model through select zone analyses to determine if the alignment of the route corresponded with a significant origin and destination travel pattern. The western portion of the Coral Gables Canal, which joins with the Tamiami Canal at SW 8$^{th}$ Street, was included in the *Feasibility Study* as a potential route even though a section of non-navigable canal prevented connectivity with the remainder of the Coral Gables Canal. Upon performing a "select zone" model run, this potential route, from Red Road @ Bird Road to SW 8$^{th}$ Street @ SW 82$^{nd}$ Avenue, did not appear to serve a significant travel pattern identified by the MUATS travel model. Therefore, this route was eliminated from consideration for the initial service implementation.

The Miami Canal, which essentially forms the continuation of the Miami River northwest of the salinity dam spillway, was also evaluated. This route parallels a fairly significant travel flow along Okeechobee Road. Connections to Metrorail could be possible at the Okeechobee Station if the station were expanded to include a water landing. This route is not appropriate for the initial service implementation schedule due to connectivity and mobility limitations. However, if water transit service in other portions of the County proves successful, demand for the Miami Canal route may warrant further study in the future.

## Water Transit Patronage Projection

Patronage projection was performed for the potential water transit network in Miami-Dade County through a combination of Methods 1, 2 and 4, as described previously in this section of the report.

Waterborne transit ridership from other metropolitan areas was collected for existing systems. In addition, demographic data that are usually considered as indicators of water transit system patronage were also collected and compiled in a database. A screening process was undergone for the data from other cities to limit the data to describe those sections of the metropolitan area that can reasonably be considered to be within the service area of the existing water transit system. A series of regression analyses was performed to develop a relationship between service area characteristics of existing water transit systems and their existing ridership numbers. Then, the regression results were applied to Miami to estimate ridership based on Miami's characteristics; the statistical significance of the regression results was tested to determine applicability.

Table 1 presents demographic data collected for cities that operate waterborne transit services. Data were collected for six cities including Fort Lauderdale, Baltimore, Oklahoma City, New York, Seattle, and Brisbane. Two sets of regression analyses were performed - one set including the data from Seattle and one set that did not include the data from Seattle. Seattle was evaluated separately in this analysis because its waterborne transit system exhibits a fundamental difference from those in other metropolitan areas included in this study in that little if any viable competition exists from other travel modes. No bridges exist across Puget Sound that link Seattle with the communities on the western shore of the Sound; therefore, ferries possess a fundamental travel time advantage across Puget Sound.

Demographic data were collected for the portion of Miami-Dade County considered a reasonable service area for the proposed waterborne transit system. Census county divisions (CCDs) were used to aggregate data for a characterization of the practical study area for waterborne transit services within the County. Three CCDs were considered within the study area: Miami, Miami Beach, and Key Biscayne. This area includes the municipalities and unincorporated areas along the main barrier islands, the Biscayne Bay shoreline from Aventura to as far south as the Coral Gables Waterway in Coral Gables, and the island municipality of Key Biscayne.

The population within these three CCDs is 986,042 according to the Unites States Bureau of the Census. The land area is 140 square miles, which yields a population density of approximately 7,000 persons per square mile. Employment data, according to the United States Bureau of Labor Statistics, indicated nearly 271,000 persons employed within municipalities of these three CCDs. According to the Miami-Dade County State Attorney's Office, over 10,000,000 people visit Miami-Dade County on an annual basis. Because the study area includes the vast majority of tourist destinations within the County, the number of visitors within the County was assumed to be the number of visitors within the study area.

Figure 12 presents the conceptual route network assumed for patronage projection. The conceptual route network was derived from a combination of (1) the analysis of physical waterway characteristics presented earlier in this chapter of the report and (2) the travel patterns and apparent transit propensity analyzed in the Review of Travel Demand Patterns within Miami-Dade County subsection of this chapter. The conceptual route network includes navigable waterways along which locations for potential water transit terminals are expected to be available, waterways that will minimize impact to sensitive marine species and habitats, and areas that are expected to serve significant travel flows within Miami-Dade County.

Table 1. Demographic Data Collected from Selected Metropolitan Areas

| City | Peak Headways (minutes) | Daily Service Span (hours) | Year of Data | Land Area (1) | Population | Population Density | Employees | Employment Density | Visitors | Visitor Density | Annual Water Transit Ridership |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Fort Lauderdale | 60 | 15.5 | 2003 | 35.5 | 166,821 | 4699.2 | 102,471 | 2886.5 | 6,500,000 | 183098.6 | 508,800 |
| Baltimore | 15 | 14 | 2000 | 80.8 | 651,154 | 8058.8 | 266,962 | 3304.0 | 11,000,000 | 136138.6 | 250,000 |
| Oklahoma City | 15 | 13 | 2000 | 607.0 | 506,132 | 833.8 | 254,526 | 419.3 | 7,000,000 | 11532.1 | 197,000 |
| New York | 30 | 18 | 2000 | 303.3 | 8,008,278 | 26403.8 | 3,381,502 | 11149.0 | 35,300,000 | 116386.4 | 20,000,000 |
| *Seattle (2)* | *30* | *18* | *2000* | *83.9* | *563,374* | *6714.8* | *340,624* | *4059.9* | *12,500,000* | *148986.9* | *5,705,000* |
| Brisbane | 20 | 18 | 2001 | 469.2 | 898,480 | 1914.9 | 422,883 | 901.3 | 13,000,000 | 27706.7 | 3,600,000 |

Notes:

(1) - Land area expressed in square miles.

(2) - Two sets of regression analyses were performed - one set that included the Seattle data and one set that did not include Seattle data. Seattle's waterborne transit system is fundamentally different than a potential system in Miami because little or no competition exists from other travel modes across Puget Sound west of Seattle.

Sources:

- Broward County Office of Planning and Redevelopment
- United States Bureau of the Census
- United Stated Bureau of Labor Statistics
- Greater Fort Lauderdale Chamber of Commerce
- Baltimore Area Convention and Visitors Association
- Greater Oklahoma City Chamber of Commerce
- Greater San Antonio Chamber of Commerce
- New York City Convention and Visitor's Bureau
- Seattle's Convention and Visitors Bureau
- "A Statistical Portrait of Brisbane" by the City of Brisbane City Council and the Queensland Planning Information and Forecasting Unit (PIFU)
- "Economic Development Framework for Action" by the City of Brisbane City Council
- Brisbane City Council Annual Report 2001-2002

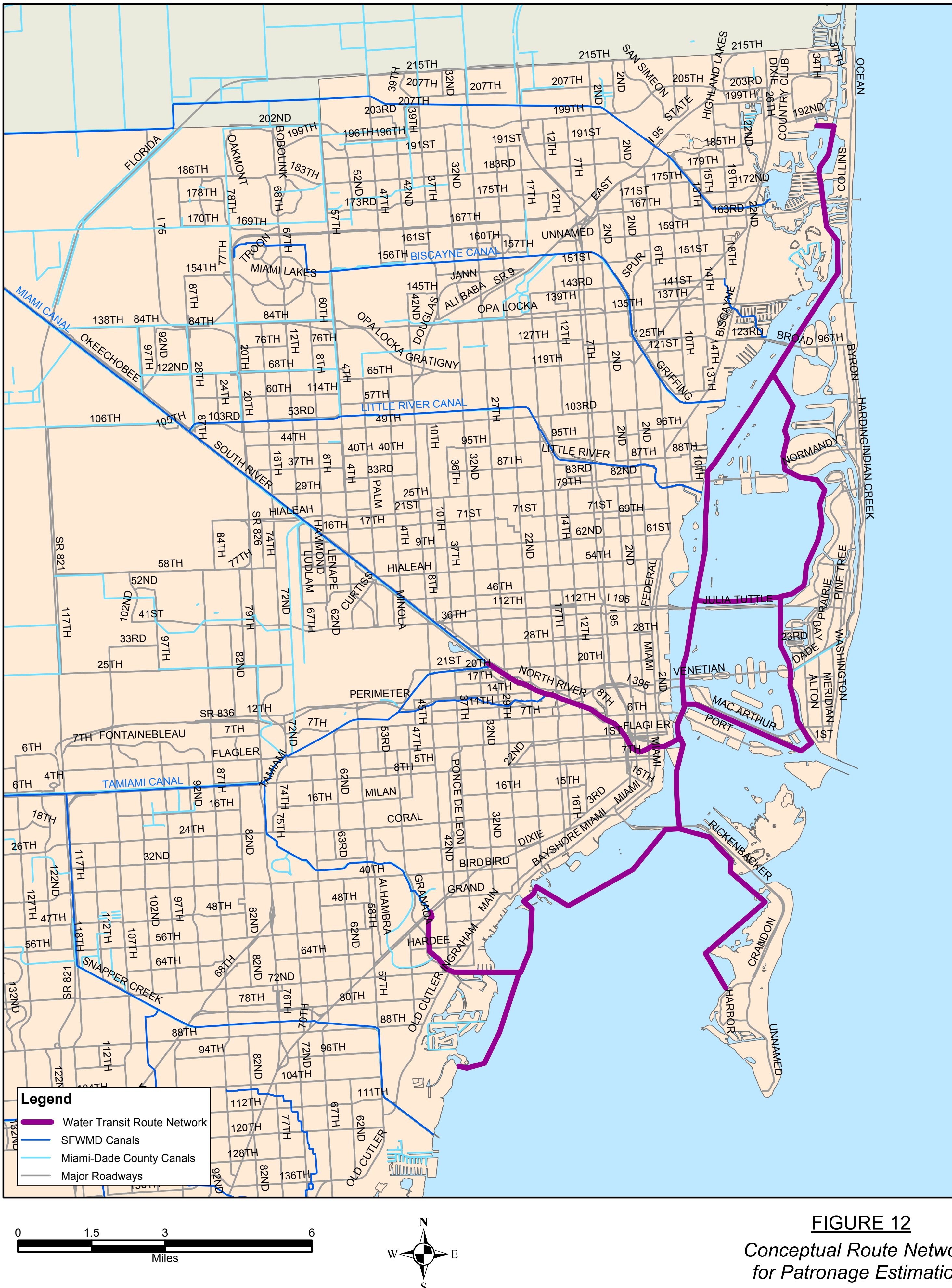



FIGURE 12

*Conceptual Route Network for Patronage Estimation*

Kimley-Horn and Associates, Inc.

Please note that the map in Figure 12 will be further refined during the System Needs and Characteristics chapter of this report. For purposes of patronage estimation and projections, the map in Figure 12 is intended to approximate the service routes assumed to be in place for developing the projections. The map in Figure 12 is not meant to show terminal locations; however, it is assumed for patronage projections that water transit terminals will be spaced similarly to other metropolitan areas examined in this analysis. Terminal spacing of one to two miles is common for regional waterborne transit systems.

Table 2 presents the results of the regression analysis for demographic variables used in this study. The variable that predicts water transit ridership to the highest degree of statistical significance is number of visitors. The ridership equation with visitors as the independent variable exhibits the highest R-squared value and contains statistically significant coefficients. This result makes intuitive sense because waterborne transit systems seem to hold an intrinsic appeal for tourists. Water transit ridership in some cities is based on the tourist industry rather than transporting local commuters.

The regression results presented in Table 2 are from the set of regression analyses that does not include the metropolitan area data from Seattle. The regression equations yielded more satisfactory results for the set of regression analyses that did not include the Seattle data. Furthermore, the fact that Seattle's waterborne transportation system has little or no competition from other travel modes was deemed to be a fundamental difference between Seattle and Miami that rendered ridership predictions based on data from Seattle to be highly questionable.

Table 3 presents ridership estimates for the base year, and projections for 5-year and 20-year horizons.

Table 2. Summary of Regression Analysis for Water Transit Ridership

| | | P-value [3] | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Variable [1] | R-Squared Value [2] | Intercept | Population | Population Density | Employment | Employment Density | Visitors | Visitor Density | Miami Predicted Ridership |
| Population | 0.98 | 0.702 | 0.001 | | | | | | 2,220,103 |
| Population Density | 0.87 | 0.537 | | 0.021 | | | | | 3,885,789 |
| Employment | 0.99 | 0.515 | | | 0.001 | | | | 1,179,350 |
| Employment Density | 0.86 | 0.472 | | | | 0.024 | | | 1,621,766 |
| Visitors | 0.98 | 0.018 | | | | | 0.002 | | 1,674,608 |
| Visitor Density | 0.01 | 0.649 | | | | | | 0.886 | 4,663,362 |

Notes:
(1) - Regression equations using combinations of multiple variables were examined; however, regression analyses using multiple independent variables did not produce acceptable results.
(2) - The R-Squared Value is a unitless number between 0 and 1 that indicates how closely the estimated values predicted by the regression analysis correspond to the actual data. The regression analysis is most reliable when the R-Squared Value is at or near 1.0.
(3) - The P-value reports the probability that the overall slope of the line is actually zero. The closer the P-value is to 0, the greater the statistical significance of the regression results.

Table 3. Water Transit Patronage Estimation

| Base Year | 5-Year Horizon | 20-Year Horizon [1] |
|---|---|---|
| 600,000 | 1,700,000 | 1,900,000 |

Note:
(1) - Twenty-year horizon forecast based on the percentage difference between production and attraction socioeconomic data in the 2010 MUATS travel demand model and the 2025 MUATS travel demand model.

The projected water transit ridership based on the regression analysis presented in Table 2 is approximately 1,700,000 annual passengers, which can be considered realistic for systems that have achieved a certain level of maturity. The cities for which water transit data were collected have all operated water transit systems for at least four years. Therefore, it is not expected that Miami-Dade County could achieve 1,700,000 passengers in the first year of operation. Based on experience in other cities such as Fort Lauderdale, where ridership has risen substantially since implementing fixed route "Water Bus" service, initial ridership estimates may range from 25 to 50 percent of a five-year old system.

In addition to developing patronage estimates based on existing water transit services, Metrobus routes that serve similar travel paths as proposed water transit routes were examined. A methodology was developed to estimate the potential water transit patronage based on existing Metrobus patronage for similar routes. Appendix D presents detailed results of the potential water transit patronage based on existing Metrobus patronage. The analysis presented in Appendix D indicates approximately 1,200,000 estimated annual patrons for water transit service based on existing Metrobus routes.

Another important result that can be obtained from patronage projections based on existing Metrobus routes is that these projections can serve as a proxy for providing a relative estimate of which segments of proposed water transit routes may serve more potential patrons. Appendix E presents a map that projects waterborne transit ridership for several potential route segments based on the patronage projections and the existing Metrobus ridership proxy.

As presented in Appendix D, not all existing riders on Metrobus routes that approximate potential water bus routes can be assumed to be potential water bus riders. Bus transit offers far more enroute accessibility than water transit because bus stops are provided more frequently, and land use patterns dictate that activity centers must have (vehicle) access from urban streets and not from urban waterways to be successful. Therefore, many trips ends are more directly accessible from buses than from waterborne vessels. However, this accessibility disadvantage for waterborne transit could at the same time represent a strong advantage from a mobility standpoint if fewer stops allow the water transit service to act as a limited stop transit service, have far fewer stop-associated delays along a water transit route, and have a potentially advantageous travel time. Transit patrons making long trips may prefer the water transit option if service speeds are such that transit travel time savings, and perhaps even highway travel-competitive overall travel time savings, can be achieved over longer distances.

The following factors were used to approximate the percentage of existing transit ridership that may serve as an indicator for potential water bus patronage, as presented in Appendix D.

§ Alignment Factor - This factor represents the percentage of the linear length of the Metrobus route that parallels a potential water transit route.
§ Land Transit Accessibility - This factor accounts for the increased accessibility of bus transit over water transit. A factor of 0.10 was applied to most bus transit routes in this analysis since the spacing of water transit stops is typically 10 times farther than the spacing of bus stops on regional bus routes. This factor was increased to 0.25 for bus routes that serve long causeways since accessibility is not as much of a limiting factor. In addition, a 20 percent reduction was applied to the land transit accessibility factor for bus routes that are already limited stop routes since bus patrons already receive a mobility advantage on these routes.
§ Stop Proximity Factor - This factor accounts for the relative proximity of potential water transit stations on either end of the analyzed segments to any of the stops along corresponding bus routes. A value of 1.00 was assigned as the Stop Proximity Factor if the existing Metrobus route serves both endpoints of an analyzed water transit segment within a one-quarter mile walking distance. A value of 0.75 was applied if the existing Metrobus route serves both endpoints of an analyzed water transit segment, but one water transit station endpoint is outside a one-quarter mile walking distance from a stop along the bus route. A value of 0.50 was applied if the existing

Metrobus route serves only one endpoint of a potential water transit segment. A value of 0.25 was applied if the existing Metrobus route serves only one endpoint of an analyzed water transit segment, with the Metrobus route located more than a one-quarter mile walking distance from a potential water transit station.

§ Tourist Factor - This factor accounts for the intrinsic appeal water transit may enjoy over bus transit, especially with tourists who may actually view the water transit service as a recreational activity. A 20 percent increase in ridership was applied to water transit segments that serve areas deemed to be "tourist areas," such as Coconut Grove, Virginia Key, Bayside, Miami Beach, and the remainder of the barrier island north of Miami Beach.

Summary

The projected water transit patronage based on the analysis performed for this study is approximately 1,700,000 annual passengers for a system with approximately a 5-year maturity. This patronage figure assumes a service that operates primarily within Biscayne Bay from Coral Gables to Aventura, including the barrier islands (between the William Lehman Causeway and South Beach), and may also serve the portion of the Miami River downstream of the salinity dam located near NW 36th Street. Service to Key Biscayne is also assumed to be implemented for purposes of this projection. Initial annual patronage is expected to be approximately 600,000 with larger percentage increases in the first five years of service than are expected thereafter. After approximately five years of service, it is expected that the percentage increase in water transit ridership may approximate the percentage increase in various demographics such as population, employment, and/or number of annual visitors.

Approximately 1,200,000 annual passengers are expected to ride waterborne transit based on existing land-based transit patronage and tourists who may find intrinsic appeal from riding along Miami-Dade County's waterways. The remaining 500,000 annual passengers are expected based on private automobile-to-transit mode shifts. Based on the analysis of this study, the expected breakdown of waterborne transit patronage by source is as follows.

| | |
|---|---|
| § Existing Metrobus patrons - | 1,000,000 |
| § Private automobiles - | 500,000 |
| § Tourists riding strictly for pleasure - | 200,000 |
| TOTAL PROJECTED BOARDINGS AT 5-YEAR MATURITY - | 1,700,000 |

The initial water transit patronage estimate and the five-year maturity patronage projection developed in this study are dependent upon similar if not improved transit service characteristics being implemented in Miami-Dade County as in the metropolitan areas used for comparison purposes. In the comparison metropolitan areas, service characteristics are generally high with typical headways ranging from 20 to 60 minutes and daily service spans that range from 15 to 18 hours. In addition, if the service area implemented in Miami is different from that described in Figure 12, patronage estimates and projections will need to be adjusted accordingly. For example, if a pilot project is implemented that serves only a small portion of the service area on 90-minute headways for 12 hours per day, ridership estimates and projections must be significantly reduced.

# SYSTEM NEEDS AND CHARACTERISTICS

Waterborne transit system needs and characteristics were analyzed for the *Development of a Service Plan for Waterborne Transit Services in Miami-Dade County* by examining probable terminal requirements, service characteristics, vessel characteristics, staffing requirements, and real estate characteristics of what is initially considered the needs of the potential waterborne transit system in Miami-Dade County. The purpose of this chapter of the report is to provide guidance for the type of facilities and service characteristics that would be appropriate for offering water transit service that represents a true mobility option for residents and visitors of Miami-Dade County.

This chapter of the report presents system characteristics from waterborne transit systems in other metropolitan areas that have been in place for at least five years. Many of the system examples are from Australia since modern technologies have been used there for waterborne transportation systems that are successfully serving as viable regional transportation alternatives for commuters, which has been identified as an objective for the potential system in Miami-Dade County. Furthermore, few if any examples of waterborne transit systems with linear route structures that serve regional transportation mobility needs can be found in the United States, where most ferry systems shuttle passengers across a wide bay or back and forth across a river. Many of the proposed system needs for Miami-Dade County are similar to the characteristics of these successful Australian water transit systems. This chapter discusses the applicability of various system characteristics for the potential system in Miami-Dade County.

This chapter is divided into three sections as follows:

§ <u>Terminal Requirements</u> - including the sizing, vessel handling, passenger handling, connectivity, and right-of-way needs of passenger ferry terminals),

§ <u>Vessel Requirements</u> - including vessel technology, capacity, and environmental design factors, and

§ <u>System Operating Characteristics</u> - including service characteristics and staffing requirements.

## <u>Terminal Requirements</u>

Terminal requirements were identified for a passenger-only, commuter and tourist ferry service on Biscayne Bay serving Miami and its surrounding communities. First-hand research for this task was performed by conducting field reviews in both Brisbane and Sydney, Australia, where such ferry services have been in successful operation for several years, on waters and in a climate similar to that of Biscayne Bay. Furthermore, experience and knowledge of passenger-only ferry terminals in the San Francisco Bay Area and in Puget Sound, Washington, contributed to the identification of typical terminal requirements for waterborne transportation serving both commuters and visitors. Please note that in the Puget Sound area, both passenger-only and passenger-with-automobile ferry service is currently in operation. The analysis presented in this report concentrates on the passenger-only ferry service as it is more applicable to expected water transit operations within Miami-Dade County.

### Sizing and Facilities of Passenger-Only Ferry Terminals

Three types of ferry terminals are considered based on the surrounding land use served by the terminal.

§ Central Business District Ferry Terminals

§ Suburban Ferry Terminals

§ Small Community Ferry Terminals

Central Business District Ferry Terminals

A metropolitan area's ferry system is typically designed and operated to bring commuters and tourists into, and out of, the Central Business District (CBD), in as fast, efficient, and reliable manner as feasible. The CBD is typically a high-volume travel destination and a centrally located hub, as is the case with Downtown Miami. Thus, the CBD ferry terminal is typically required to be the largest terminal in the ferry system, having to handle the most vessels and patrons. Downtown Miami is the ideal location within Miami-Dade County to provide a CBD ferry terminal.

Sydney's CBD terminal complex, the Circular Quay Ferry Terminal, has five large wharves each consisting of a dock, a transfer span, and a vessel-docking float. Each wharf measures approximately 243 feet by 60 feet. A sixth wharf, of similar size to the others, is dedicated to serving harbor tour cruising vessels and water taxi operations, which is not the primary focus of this analysis. Each large wharf consists of a dock on pilings that extends perpendicular into the harbor from the city's sea wall, and a full-width hinged transfer span (hinged gangway) leading down to a large float that the ferries tie to during docking. The floats can accommodate two ferries simultaneously (one on either side), and the dock can accommodate two additional ferries held in reserve while being prepared for an upcoming run. Therefore, each wharf in Sydney can accommodate a total of four ferries simultaneously.

Exhibit 1. A Wharf at Sydney's CBD Ferry Terminal

The facilities on each wharf consist of the following.

- Staff and Crew Office
- Ticket Sales and Information Office
- Food Service Facility
- Gift Shop
- Inclement Weather Shelter
- Automated Magnetic Strip Card Ticket Vending Machines
- Automated Magnetic Strip Card Controlled Entrance and Exit Gates
- Waste and Recycling Containers
- Benches
- Safety Rails on All Sides
- Electronic Schedule Boards
- Variable and Fixed Signage
- Vessel Mooring Cleats
- Float Fendering
- Night Lighting

Restrooms, retail shops, and restaurants are located in a main terminal building that fronts the six wharves of the Circular Quay Ferry Terminal.

In Brisbane, the Riverside CBD terminal, which serves as the central station for CityCat and other ferry services along the Brisbane River. The Riverside CBD terminal consists of a long float and gangway arranged parallel to the river wall. The CBD terminal is sized to simultaneously accommodate two of the eight vessels in the fleet. Overall, the Riverside terminal is approximately 167 feet by 33 feet.

The facilities at the Brisbane CBD Riverside terminal include the following.

- Ticket Sales and Information Office
- Inclement Weather Shelter
- Waste and Recycling Containers
- Safety Rails on All Sides
- Fixed Signage
- Vessel Mooring Cleats
- Float Fendering
- Night Lighting

Exhibit 2. Brisbane's CBD Riverside Ferry Terminal

Suburban Ferry Terminals

The terminals for suburban water transit stations (sometimes referred to as in-city ferry terminals), which would provide passenger access to the water transit system at various points along the route and help feed the CBD terminal, typically need to accommodate only one ferry. Therefore this terminal type is smaller in size when compared to a CBD terminal. However, landside facilities at these stations still should be appropriately sized according to the expected passenger traffic flows and access requirements.

Most suburban ferry terminals along the Brisbane River have approximately equal passenger traffic flows and thus have been able to exhibit a standardized design and appearance at approximately 1,325 square feet.

The majority of the suburban ferry terminals serving communities along the Parramatta River in Sydney approximate the same square footage as the Brisbane suburban terminals. However, the Homebush Bay terminal was built much larger to accommodate large passenger traffic flows associated with being the riverside access portal to the venues of the 2000 Olympics. The city of Parramatta, which is the terminus for this Sydney passenger-only ferry route, is sizable compared to the intermediate suburban communities, and thus its terminal is larger to also accommodate the increased commuter traffic flow in the area.

Exhibit 3. A Standardized Brisbane Suburban or In-City Ferry Terminal

The facilities of these Australian in-city and suburban terminals typically include the following.

- Weather Shelter Over Passenger Waiting Area
- Gangway (Sheltered from Inclement Weather)
- Vessel Docking Float (Sheltered from Inclement Weather)
- Benches
- One Drinking Fountain
- One Public Telephone
- One Set of Trash and Recycling Containers
- One Life Ring with Throwing Rope
- One System Map & Schedule Board
- One Firefighting Apparatus
- Safety Rails on All Sides
- Fixed Signage
- Vessel Mooring Cleats
- Float Fendering
- Safety Rails on all Sides
- Night Lighting

Only one suburban terminal, the large terminal at Homebush Bay serving the Olympic venues, has additional amenities such as restrooms, a soft drink vending machine, and backlit advertising signboards.

The "footprint" of most suburban ferry terminals is largely over water, as depicted in Exhibit 3. In Miami-Dade County, this design would minimize the amount of valuable real estate adjacent to the water that would be utilized for the construction of the water transit terminal. However, ancillary passenger facilities and important passenger access features, such as parking and bus access, would have to be supplied on the landside portion of the suburban water transit terminal.

An aspect of suburban terminals that would be especially important in Miami-Dade County is the provision of parking facilities at some, if not most, of the suburban terminals. In addition, bus service should be provided to the suburban terminals with bus turnarounds near the water transit terminal. Multimodal connections to water transit stations will be addressed in subsequent portions of this chapter.

<u>Small Community Terminals</u>

In Australia, even some of the smaller communities with their corresponding smaller traffic flows have a ferry terminal; however, these locations would be more accurately referred to as ferry "stops" rather than "terminals," as the facilities provided are quite minimal. Most of these ferry stops are not new construction, but are simply upgrades of existing infrastructure such as a former pier that may predate modern passenger ferry service. Little more is added to the existing pier other than a gangway and a vessel float, with its associated fendering. Usually little or no inclement weather sheltering features are provided at small community terminals.

### Vessel Handling at Terminals

Vessel handling at terminals in Miami-Dade County is expected to be similar to systems in other metropolitan areas that utilize modern passenger ferries. Special consideration will be required for manatee-protection zones, wake-restricted areas, and other sensitive environments that exist within Miami-Dade County waterways.

Vessel Approach Speed Profiles

In general, cruising vessel speed can be expected to be in the range of 25 to 35 miles per hour. Ferries will normally reduce their velocity from cruising service speed to a 1/3-power setting when beginning their approach to a terminal. The vessels may already have been at a 2/3- or 1/2-power setting if already in a wake-restricted zone, which often is in effect in the CBD portion of the waterway. In Miami-Dade County, manatee protection zones are relevant examples of wake-restricted zones. Please note that vessel speed is discussed in more detail in the section of this chapter presenting vessel requirements.

Propulsion System Operations

Passenger ferry vessels common in Australia are catamarans with widely separated demi-hulls and propulsors instead of propellers. The rationale for and the choice of these designs and operating features will be addressed later in this report. These marine transit craft have an excellent turning ability, which enhances vessel handling performance near terminals. However, their propulsion equipment, and especially their reduction gears, should be of a robust design and be well-maintained to cope with the repeated cycling of forward and reverse motions required at each terminal docking, executed repeatedly throughout the service day.

Wake Wash Minimization

The wake wash experienced by the vessel docking float and the shoreline in the vicinity of the ferry terminal can be minimized by requiring the ferry approach to and depart from the terminal at acute angles, rather than gradually sidling up to the float. This vessel handling requirement around terminals will reduce wake wash, but increase the time required to service each terminal.

Dock Fendering

Ferries typically employ a rubber rub rail on the sides of their hulls to make contact with the docks to which they moor, thus preserving the painted finish. The docks, or the pilings of the docks, or the sides of docks, are themselves protected by their own, larger and more flexible rub rail-like devices, called fenders. Fendering is normally accomplished by either protective wraps around piles in the water or via bumpers attached to the vessel-docking float. Exhibit 4 depicts both pile wrap fenders and dock float fenders, which should be required for vessel handling at potential water transit terminals in Miami-Dade County.

Exhibit 4. Pile Wrap Fenders and Dock Float Fenders

Vessel Mooring and Unmooring

Mooring and unmooring must be achieved to handle passenger vessels at water transit terminals. This process is typically accomplished by a ferry crewmember throwing a heavy mooring line or rope over a cleat on the edge of the vessel docking float and a bollard on the deck of the ferry near the gate in its bulwark. Therefore, the presence of and placement of bollards along the dock and bulkhead is crucial to vessel handling at terminals. Typical nautical ropes include braided polyester and twisted nylon ropes.

## Passenger Handling at Terminals

Passenger handling at terminals in Miami-Dade County is expected to be vital to encouraging ridership through passenger ease and comfort.

Ticketing Dispensing and Fare Collection Methods

In Sydney, large automated ticket dispensing machines are prevalent only at the major CBD terminals such as Circular Quay and the Manly terminal. On each wharf of Circular Quay, five banks of automated ticket dispensing machines are situated just before the entrance gates. The CBD Terminal in Miami will initially require only two or three ticket dispensing machines before the water transit system grows toward becoming a mature transit system. Each machine can typically process 100 to 150 patrons per hour. A staffed ticket sales office and information desk is also located on each wharf of the Circular Quay in Sydney for the convenience of the patrons.

Exhibit 5. Sydney's Circular Quay Automated Ticket Dispensing Machines

For passengers boarding at the outlying suburban terminals, ticket sales are conducted onboard the ferry by a crewmember that circulates through the cabin. In Brisbane, ticket sales are handled primarily onboard the vessels by crewmembers, although tickets can be purchased ashore at either the CBD Riverside Terminal's staffed ticket office or at convenience stores throughout the city.


Exhibit 6. Brisbane's Riverside Terminal Ticket Booth

Embarking Brisbane passengers enter the ferry's cabin past a fare box or a small cash register stand that occupies the equivalent space of a single seat and is staffed by a crewmember cashier. Because the transit fares are zone-based, a public address system will periodically broadcast a message to all passengers to pay the correct fare to the cashier depending on how many zones they will pass through, concluding with a warning that they will be assessed a sizeable fine if caught by a crewmember trying to cheat the system.

Waterside Passenger Queuing Areas

Passengers arriving at a ferry terminal for departure queue on a passenger platform that is protected overhead from inclement weather. Appropriate fixed signage instructs the passengers not to queue on the gangway or vessel-docking float.

Exhibit 7. Brisbane Ferry Terminal Passenger Queuing Platforms

Bench seats, a public telephone, a drinking fountain, trash and recycling receptacles, a ferry system map board, a schedule board, and plentiful night lighting are all amenities normally located within the weather-sheltered passenger platform. The passenger queuing platforms depicted in Exhibit 7 can accommodate 40 to 60 passengers.

Protection from inclement weather is particularly important in Miami-Dade County, where extreme heat and heavy rainfall are common throughout at least six months of the year. Other important passenger infrastructure to include in Miami-Dade County include benches, trash receptacles, a system map and schedule showing connections to other transit systems, and adequate lighting to provide a sense of security for night operations.

Gangways

When a ferry arrives at the terminal vessel-docking float, a gangway allows passengers to reach the float from the passenger platform, which is at a higher elevation. Protected from inclement weather, the gangways are usually 5.5 feet in width, allowing for two opposing lanes of foot traffic. Most gangways are approximately 65 feet in length. If a ferry docks at an existing pier, there will probably be no need for a docking float, and the gangway described here could be eliminated in favor of the simple docking brow for a direct ship-to-shore connection over which passengers would board and alight from the vessel.

The walkway of the gangway is covered with a non-slip material. Handrails extend the full length of the walkway. At the top of the gangway, automatic sensor and crewmember-operated swing gates may be present to control access from the passenger platform.

Exhibit 8. Tensioned Canvas Weather-Sheltered Gangways

For water transit systems in the United States, passenger handling infrastructure must be compliant with the Americans with Disabilities Act (ADA). The ADA is a comprehensive civil rights law that prohibits discrimination on the basis of disability. The ADA requires that newly constructed and altered state and local government facilities, places of public accommodation, and commercial facilities be readily accessible to, and usable by, individuals with disabilities. For gangways, this requirement dictates a width of at least 8 feet for opposing directions of traffic and a slope of no more than 8.33 percent if the gangway is shorter than 30 feet. There is no maximum slope requirement for gangways longer than 30 feet. However, designers are encouraged to provide the least possible gangway slope to give independent access to persons with disabilities. Gangway slopes should be calculated at the lowest reasonable water level, as slopes will rise and fall with varying water levels.

Vessel-Docking Floats

The lower end of the gangway is supported by the vessel-docking float to which the ferry moors upon its arrival. Unless the terminal is a large CBD facility, the vessel-docking float is not intended to have many passengers on it at any one time, being a transitional element from the ferry to the gangway. Thus, its size is modest - usually on the order of 23.5 feet by 17 feet, or approximately 400 square feet.

The float rises and falls with the tide level on two guide piles, which also prevent lateral movement of the float. The float, or the guide piles, as well as other adjacent piles that serve as mooring dolphins for the ferry vessel, have fendering materials attached to them to prevent damage to the docking ferry's side plating. The tall piles also serve to support large overhead signage boards, which prominently display the terminal's name. The terminal name display can be illuminated at night. Adequate lighting for safety purposes is required on the vessel-docking floats for passenger operations at night.

Exhibit 9. Vessel-Docking Float

Portable Boarding Brow

As a small gap exists between the vessel-docking float and the deck edge of the moored ferry, a crewmember must put in place a portable brow (docking brow) to safely bridge this gap. The brow is a small shallowly arched bridge with handrails. Small, light, and having nylon rollers, the brow is designed to be easily tipped up and pushed out of the way, or just as easily pulled and lowered to the ferry's deck by a crewmember. The brow is commonly stowed on the vessel-docking floats but can also be stowed onboard the vessels. As presented previously, a docking brow may also be used to bridge the gap between the ferry and the shore if the ferry docks at a pier, a sea wall, or a similar fixed facility.

Exhibit 10. Portable Boarding Brow

## Links to Activities at Passenger-Only Ferry Terminals

Providing water transit terminals in appropriate locations based on surrounding land use and connectivity is vital to serving desired trip patterns of potential patrons.

Central Business District Ferry Terminals

CBD ferry terminals are normally in the heart of the primary employment areas of a metropolitan area. Thus, CBD terminals are often the primary destination that serves commuters utilizing the system for work trips. The primary hotel and entertainment areas of the city are often located proximal to the CBD. As an integral feature of a city's vibrant waterfront, these terminals are usually within a short stroll of convention centers, restaurants, and clubs. Therefore, the CBD terminal often serves as a primary water transit trip origin and destination for many visitors and commuters.

In Brisbane and in Sydney, CBD terminals are well-situated to serve the city's primary employment, business, and entertainment areas from one terminal. While Downtown Miami is certainly the primary employment and business location within the County, many excellent entertainment and recreational opportunities are available in other locations, such as South Beach and Coconut Grove. In addition, other employment centers are situated elsewhere in the County such as the Civic Center, Dadeland, and Miami International Airport. Even Brickell, just south of the mouth of the Miami River, should be considered an employment center that would be served by a separate water transit terminal. Therefore, while the Downtown Terminal is expected to serve the most trip ends within the County, other terminals within Miami-Dade County should also be considered vital to serving trip patterns of potential water transit patrons.

Suburban Ferry Terminals

Suburban terminals are usually within a short walk of office buildings, hotels, apartments, restaurants, clubs, parks, and other similar uses in metropolitan areas with existing water transit systems. Since these terminals must also serve commuters wishing to access the CBD, some of these terminals are located near a park-and-ride lot or a multi-level parking garage within a block or two of the ferry terminal.

One fundamental difference between the travel characteristics of the Australian metropolitan areas discussed in this study and the travel characteristics of Miami-Dade County is the reality of the prevailing automobile-dominated society in the United States, especially in South Florida, where most parts of the metropolitan area is less dense than other major metropolitan areas leading to even more reliance on private automobiles for mobility. Even those commuters willing to utilize public mass transportation often rely on personal vehicles to link homes and transit stations for the first and last links of daily commutes. Unless reasonably-priced parking located at or very near suburban water transit terminals with easy access to the terminal can be developed or provided through shared resource arrangements, achieving significant ridership for waterborne transit in Miami-Dade County will be difficult.

#### Small Community Terminals

These ferry stops are usually sited anywhere where there is existing infrastructure to take advantage of, such as an existing bulkhead, or a former pier in a small community. Thus, they are not normally sited to be specifically close to any particular type of activity or business, but are still in proximity to serve their communities quite effectively without involving long walking distances. Quite often, these stops are situated on a public right-of-way such as at a street-end, within a public park, or on formerly private property that has been subsequently deeded to a local government.

Small community terminals are not as relevant to Miami-Dade County as in other metropolitan areas. However, in some instances public right-of-way such as a street-end or the area under a causeway may be considered for a water transit landing if an activity or employment center is located nearby.

### Intermodal Connectivity and Accessibility of Passenger-Only Ferry Terminals

The most effective waterborne transportation systems utilize ferry terminals as intermodal hubs, providing efficient connections to regional bus routes, local circulators, park-n-ride facilities, bike routes, and the roadway network. High levels of accessibility is critical for fostering an environment in which the waterborne transportation system can compete with other modes of transportation, namely private automobiles, in vital characteristics such as travel time and reliability.

#### Central Business District Ferry Terminals

Research demonstrates that, as is expected, CBD ferry terminals typically have the highest degree of intermodal connectivity. It is of vital importance that the ferry system be developed with efficient connections to both the roadway network and to the alternative mode network within a metropolitan area to ensure true travel mobility options. As another way to manage congestion, integrated transit systems linking modes, including ferry systems, facilitate multimodal transfers and increase the attractiveness of the modes and may successfully increase transit use and decrease that of the personal vehicle.

As one example, Sydney's Circular Quay Ferry Terminal exhibits outstanding intermodal connections. A freeway is situated over the terminal with ingress-ramps and egress-ramps leading automobile traffic to the terminal parking area. In addition, over the terminal building and directly underneath the freeway is the CityRail terminal, which links the Circular Quay rail/ferry station with all other rail stations throughout the downtown and greater-Sydney areas. A three-lane street in front of the Circular Quay Ferry Terminal building allows for multiple bus stops on one side, taxi queuing and kiss-and-ride stops on the other side, and a free-flowing central lane for vehicular circulation.

In Brisbane, the CBD Riverside Terminal is within a one-minute walk of the main waterfront avenue, which has nearby bus transit stops. The Riverside Terminal is also within a four-city block distance of the Central railway station, which serves the suburbs of the greater-Brisbane area with commuter rail trains.

In Miami, it may be impossible to provide direct freeway ramps into a parking area for the CBD ferry terminal based on the location of existing freeways and land use patterns surrounding the freeways. Therefore, intermodal connections to the alternative mode network will be of vital importance for the CBD ferry terminal. It is recommended that the CBD Terminal be located within walking distance of Metrobus and one or more Metromover stations. A bus turnaround loop should be provided if at all possible as a landside design amenity of the CBD Terminal. Locating the CBD Terminal near Bayside or Bayfront Park will increase accessibility to popular entertainment districts within Downtown.

Please note that a handful of other potential water transit stops may function more similar to a CBD Terminal than a suburban terminal - namely Brickell, Pace Park / Omni, Lincoln Road / South Beach, and possibly Coconut Grove.

Suburban Ferry Terminals

Suburban terminals are also typically located within a short walk of city rail stations in the Australian systems reviewed for this study. In Sydney, the Aquarium Ferry Terminal is within a short walk of the Sydney Monorail, which runs on a circuit through the downtown and waterfront entertainment and business districts. The Sydney Monorail is analogous to the Metromover in Miami.

Suburban Australian ferry terminals normally have a bus stop located in front of the terminal. Normally this is either a one- or two-bus transit bay, but the larger terminals can have up to three or four bays. Normally, no separate space is provided for kiss-and-ride drop-offs or pickups, or for taxis at suburban ferry terminals. Kiss-and-rides and taxis instead normally make use of the bus bays when no bus is present.

Exhibit 11. Suburban Ferry Terminal Transit Bus Stop

While most Australian ferry terminals do not have park-and-ride facilities located at or nearby the terminals, the situation is different in several areas of the United States. In the San Francisco Bay Area, for example, park-and-ride lots are often an integral part of a suburban ferry terminal. Excellent examples of these intermodal ferry terminals are the Alameda Ferry Terminal near the City of Oakland and the Bay Farm Island Ferry Terminal near the Oakland Airport. A 250-vehicle park-and-ride lot is located within the Alameda Ferry Terminal, where a 344-passenger ferry docks. The Bay Farm Island Ferry Terminal contains a 200-car park-and-ride lot, where a 250-passenger ferry docks. And while the New York City DOT's Staten Island Ferry is a vehicle as well as passenger ferry, the main imperative in the operations of these vessels is passenger transport, and not that of vehicles. In a typical daily operation, five ferry boats in three classes (ranging in capacity from 1,300 through 1,500 to 6,000 passengers) carry about 65,00 daily riders. Two parking lots are provided at Staten Island for these ferries; one lot has a capacity of 287 spaces and the other lot has 624 spaces. This serves to underscore the importance of automobile access to transit, even in the dense, heavily industrialized and commercialized, transit-supportive environment of the Greater New

York metropolitan area. In a Sunbelt city like Miami, such auto-oriented access needs can be expected to be even more critical.

Small Community Terminals

A single bay bus transit stop is usually located in front of the small community terminals or within a short walk. As with suburban terminals, kiss-and-rides and taxis share the curbside bus transit bay when a bus is not present. Being typically located near waterfront access pathways, these terminals also cater to bicyclists, although all system terminals and vessels should also provide adequate pathways and amenities for bicyclists. No park-and ride facilities are normally associated with these small terminals.

Sprawling development patterns in Miami-Dade County, as in many Sunbelt metropolitan areas, tends to enmesh small communities within the greater overall urban fabric of the metropolitan area. Community boundaries are blurred to the point that the small community terminals found in Australian systems are not widely applicable in Miami-Dade County.

### Space Requirements for Intermodal Facilities

As presented in the previous section of this chapter, effective waterborne transportation systems utilize ferry terminals, especially CBD terminals, as intermodal hubs. This enhancement of passenger mobility options is achieved only through dedicating appropriate space to providing passenger transfer infrastructure.

Central Business District Ferry Terminals

CBD terminals, with their high passenger traffic flows and multiple vessel arrivals, typically have a whole curbside lane devoted to bus transit stops with up to four transit bays and four single or double-sized bus shelters. A similarly sized lane area is usually devoted to taxi queues and kiss-and-ride drop-off areas. CBD terminals are often connected to commuter rail trains and automated circulator systems such as the Miami Metromover. In addition, it is important that a clear pedestrian path is visible from the water transit terminal to the major thoroughfare within the CBD so that water transit patrons can gain a sense of place upon disembarking in the downtown area. In addition, enhanced ticketing facilities are often provided at CBD terminals.

Although the space required to implement the passenger boarding infrastructure can often be constructed over water, which conserves valuable land within the CBD, the provision of intermodal facilities at or adjacent to the CBD Terminal typically requires devoting several acres of land.

In Miami, several automated people mover stations are located within walking distance of Biscayne Bay and the Miami River. In addition, U.S. 1 (Biscayne Boulevard) parallels Biscayne Bay and serves as a primary thoroughfare within Downtown Miami. Providing the CBD Terminal adjacent to U.S. 1 would probably help patrons develop a sense of place when disembarking in Downtown. Several Metrobus routes already serve U.S. 1, although the CBD Terminal could be better served by re-routing the Metrobus routes through a dedicated bus transfer facility at the CBD Terminal.

Suburban Ferry Terminals

Suburban terminals, with their single vessel arrivals and proportionately smaller passenger traffic flows versus CBD terminals will normally have a curbside bus transit stop with two transit bays and a bus shelter. The transit bays should be indented into the sidewalks to create a transit bay that is entirely separated from the outside lane of street traffic. Taxis and kiss-and-rides will typically utilize these same bays when buses are not present.

Most passenger boarding infrastructure is typically built over water at suburban ferry terminals as depicted in Exhibits 3, 7, 8, and 9. The primary landside space need for suburban ferry terminals is to serve terminal accessibility. As mentioned previously, parking should be provided at most suburban ferry terminals unless exceptional transit service is provided to the terminal or the terminal is located at an activity center that could serve as a likely destination for a significant number of transit trips, such as a university, a hospital, or an entertainment center like Lincoln Road or Coconut Grove. The amount of parking provided should be based on several factors such as availability of existing parking, availability of underutilized land to convert to parking, and whether the terminal is expected to serve a significant amount of commuters who may wish to utilize park-and-ride facilities.

Small Community Terminals

Small community terminals will typically have just a single bay curbside bus transit stop and may or may not have a single bus shelter. No parking is typically provided at small community terminals, unless a public parking facility is already situated nearby.

## Design and Configuration of Terminal Facilities

An overview of terminal design elements is provided to present probable requirements for a potential waterborne transit system in Miami-Dade County based on systems that serve both commuter and visitor trips.

Structural Requirements

Structurally, terminals need to be designed for the loads they are expected to experience due to passenger loads and queuing, and vessel docking stresses, including wave and tidal or current action, winds, and piloting preferences and recommendations for vessel-dock impacts. For the transfer spans, weather shelters, gangways and floats, metals such as steel, stainless steel, and aluminum, as well as concrete for some applications, are used extensively, rather than wood, for durability and ease of maintenance. Metal construction is representative of existing ferry system examples in the United States, Europe, and Australia. Docks and dockside facilities exist in a corrosive environment, so methods of metallic corrosion prevention are an important consideration in construction specifications and structural design.

Piling and Dock Anchoring

The primary components of passenger-only ferry terminals are: (1) a transfer span linking the shore to the passenger platform, (2) a spacious passenger platform, (3) a gangway linking the passenger platform with the vessel-docking float, and (4) a vessel docking float that is responsive to variable water and tide levels. The transfer span can vary greatly in length depending upon the length from shore the boat-handling portion(s) of the terminal facilities need to be located; the number of piles supporting the transfer span depends on this length. The passenger platform is supported by piles of a quantity commensurate with its floor area (usually a minimum of six piles). Gangways usually require no piles. The typical vessel-docking float is linked to two piles and rises and falls following the rise and fall of the tide. Two to four additional piles may provide lateral support and fendering for the docking vessel. Two additional piles are driven approximately a half-vessel length on either side of the float's centerline to serve as guide dolphins with fendering for the vessels to dock against and to push off of when departing the terminal.

Gangway Adjustment

Terminal gangways are hinged at the passenger platform and have contact with the vessel-docking float by means of rollers, usually nylon, to adjust to the rise and fall of the float with the varying water level. Gangways are long to decrease their slope. Although in the United States, meeting Americans with Disabilities Act (ADA) requirements for dock facilities is only required when a ferry's capacity is 150 or more passengers, adhering to ADA requirements should be a design goal in the development of local Miami-Dade County ferry facilities from the inception of the system. ADA requirements for gangways are presented in the Passenger Handling at Terminals subsection of this chapter.

Weather Sheltering

Sydney's suburban terminals are sheltered from the weather by means of arched corrugated ferrous sheet metal roofs covering the transfer spans, the passenger platforms, and the gangways. Although painted, they have not stood up well to the elements over time and rusted areas resulting from iron-based materials and infrequent maintenance have left them somewhat unsightly.

With respect to weather sheltering, the terminals in Brisbane have a better solution. The passenger platforms are covered with a running seam roof that doesn't show signs of corrosion. The gangways, which are essentially walkways supported by small bridge trusses, are protected from the weather by a stretched and tensioned canvas awning. The vessel docking floats have an aesthetically pleasing swooping canopy made of the same suspended and tensioned canvas material.

Restroom Facilities

In Australia, only the CBD ferry terminals and the very largest suburban terminals have restroom facilities. This may be because the ferries have handicapped-accessible restrooms onboard. In the San Francisco Bay and Puget Sound areas, about half of the passenger-only ferry terminals have restroom facilities.

Vending Facilities

In Sydney, only the largest suburban terminal incorporated a vending machine. None of the terminals in Brisbane have such machines. Outside of one terminal in Puget Sound, west coast passenger-only ferry terminals generally do not have vending machines either.

There are no such vending machines on board most passenger ferry vessels due to their significant weight and space requirements; however, large ferries designed to carry more than 150 people can more easily accommodate vending machines.

Signage

In the Australian ferry systems researched for this study, wayfinding, informational, cautionary, safety, and security signage is provided in standardized format, presenting a uniform corporate look and utilizing universally understood pictograms in addition to text. In the United States, many of these signs also include Braille text to comply with ADA requirements, and may be presented in several languages as locally needed or required.

The major CBD terminals often employ electronic variable message signage. In Sydney at the Circular Quay Ferry Terminal, variable signage is quite effectively utilized to list the various ferry destinations and departure times, as there are so many throughout the service day from this large central station. Exhibit 12 depicts signage located at the Circular Quay Ferry Terminal. Please note the system map located near the top of the variable schedule board resembles the route structure of a typical heavy rail transit system, indicative of the regional transportation role waterborne transportation serves in Sydney.


Exhibit 12. Fixed Wayfinding Signage and Variable Signage

Night Lighting

Providing true mobility options for trip purposes such as commuter trips requires pre-dawn, dusk, and evening operations, especially during winter months. Tourist and recreational trips often require night operations as entertainment districts are often popular destinations for waterborne transit operations. Shore side walkways, transfer spans, passenger platforms, gangways, and vessel docking platforms must therefore all be adequately lit at night. This lighting also aids ferry crewmembers in navigating to, and docking at, the terminals at night.

Safety Features

All terminals should have fire safety equipment including fire extinguishers in lighted storage boxes and a fire main manifold. Also, depending on the size of the terminal, one or more life ring buoys with throwing ropes attached are usually located in container boxes mounted to the safety railing. Safety railings should extend around all exposed sides of the terminals. Non-skid walking surfaces should be provided on gangways and vessel docking floats. Emergency call boxes should be provided at water transit terminals to provide increased passenger security.

Waste Handling Facilities

As most Australian terminals do not have restrooms, the only waste handling facilities provided are normally trash and recycling containers. Ferries, with their onboard restrooms, have waste holding tanks, which are pumped out once per day at the fueling dock facility. Ferries have refuse containers and trash receptacles on board as well.

Fueling Facility

One terminal in most Australian ferry systems also serves as the fueling station. However, fueling could be handled at the maintenance facility if it is located in a place vessels could access on a daily basis while maintaining service schedules. Ferries typically fuel once per service day. Fuel is supplied by tanker trucks to underground storage tanks shore side, similar to those of a gas station, and is then piped to a pier side fueling stand. Fuel spill handling equipment is stored in boxes on the pier to quickly respond to any accidental spill. Since safety, security, and environmental concerns regarding the fueling station must be accommodated, the fueling station for the potential Miami-Dade County system should be located at an existing marina that already provides fueling facilities.

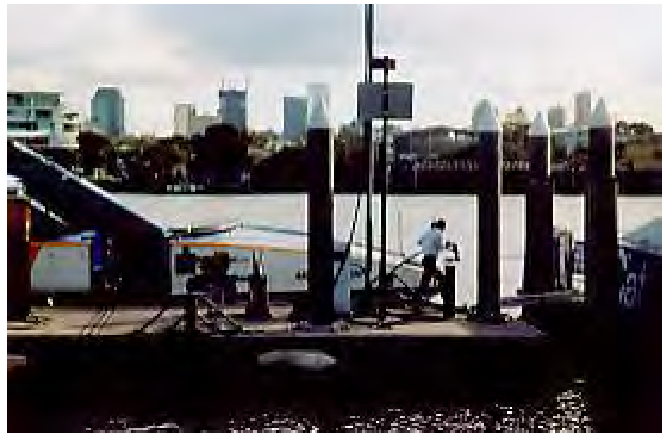


Exhibit 13. Brisbane Fuel Dock at Hawthorne Terminal

Maintenance Facility

A ferry system must have a dedicated maintenance facility. A ferry system must also have spare vessels, although fewer spare vessels are typically required than in bus and rail transit systems. Having spare vessels allows each service vessel to be rotated through the maintenance facility on a regularly scheduled basis to perform preventative maintenance, to facilitate the reliability that a ferry system requires, and to respond to emergency situations.

The maintenance facility should be of a size, and have the means to: (1) dock a ferry pier side, (2) haul the ferry out of the water, (3) transfer the vessel over a short land distance, (4) maintain the vessel under a weather-protected shed or building, (5) have the required maintenance equipment and tools on-site, (6) have the space to store spare parts, (7) have adequate administrative office space, and (8) the means to contain and collect pollutants for proper disposal per environmental regulations. The maintenance facility should be located as close as possible to the service route(s) to minimize distance constraints, especially if the fueling station and the maintenance facility are located together.

Exhibit 14. Brisbane Maintenance Facility With Travelift

Real Estate Needs and Selection of Preferred Terminal Locations

Field reviews were conducted of potential Miami-Dade terminal locations identified in the Data Collection and Patronage Estimation chapter of this report. Field reviews were beneficial for screening potential terminal locations and narrowing the list of terminals expected to be served by waterborne transit operations in Miami-Dade County. The identified sites include a variety of land uses including existing public marinas, private marinas, parks, and vacant land. Elements that were examined during field reviews included existing site layout, roadway network accessibility, transit accessibility and connectivity, nearby parking availability, ability to include waterside operations requirements, spacing from adjacent terminals, and surrounding land uses. Potential sites were examined to gauge whether retrofitting the existing site layout was necessary to accommodate passenger ferry waterside and landside facilities. Aerial photography obtained from Miami-Dade County was also helpful in screening terminal locations. Appendix F presents the terminal locations analyzed from field reviews to be possible for providing waterborne transit service. Notes in Appendix F provide detail about the terminal locations.

Information gathered during the Terminal Requirements section of the report was relied upon during field reviews of potential water transit stations in Miami-Dade County to develop expected real estate needs for providing waterborne transit operations.

Where possible, terminals should be sited at the ends of public streets such as cul-de-sacs and/or dead ends. In some cases, a terminal site may be recommended that will need to make use of existing park land. Terminal footprints will be minimal if the design follows the standardized terminal in Brisbane, as many of the terminal components will be "offshore," which may decrease possible objections to using parks. As discussed previously in this chapter, much of the passenger handling facilities associated with Australian water transit terminals is typically located over water including passenger platforms, gangways, and moors (vessel docking floats). Therefore, many of the mandatory water transit facilities do not require using significant land right-of-way for the waterborne transit system facilities; parking, transit access, and drop-off areas are another matter and will need to be carefully evaluated when considering use of parks for waterborne terminals, and is considered below. As noted previously, environmental concerns focusing on marine and water table impacts will also need to be understood and mitigated in evaluating real estate sites.

Other important support facilities such as bus stations (including some combination of turnarounds, bays, shelters, and benches), park-and-ride lots, pedestrian access paths, and ticketing facilities will require right-of-way. Maximizing use of existing facilities for bus access and park-and-ride lots will be crucial to minimize right-of-way requirements, especially at larger facilities where intermodal connections will be critical. Parks that are used as water transit terminals should provide parking only if arrangements can be made to use existing parking lots or to convert existing underutilized paved surfaces to parking. Water transit terminals within parks should be designed to incorporate the environment of the surrounding park space and should not significantly compromise the experience of park guests.

Park-and-ride lots, auto drop-off zones, bus turnarounds, and bus bays may simply not be feasible at some smaller terminals due to land ownership restrictions and/or the need to be sensitive to the surrounding community. However, some form of intermodal connection, such as a bus stop for a dedicated terminal shuttle, should be provided if parking is not available and walking to the terminal is not a feasible connection for water transit patrons. Terminal shuttles should circulate the area near the terminal to facilitate access to and from the water transit terminal.

Public property owned by the State, County, or a municipal government is the most desirable for water transit terminals to reduce implementation costs. However, individual agreements will have to be reached with other governmental organizations, particularly municipalities, for the County to provide water transit terminals on their property. Intergovernmental coordination between Miami-Dade County, and municipalities in which stations are located should be initiated early in the waterborne transit system development process to determine if providing stations on municipal property is feasible. Intergovernmental coordination should include and stress positive discussions concerning the benefits of waterborne transportation, opportunities for terminal area redevelopment, and the ability to incorporate water transit terminals in a pleasing and positive way into existing public spaces. Intergovernmental coordination of course should not ignore constraints and drawbacks that will need to be addressed and mitigated as well.

For acquiring terminal rights-of-way on private property, lease agreements (and/or purchase agreements, if feasible and advantageous) will have to be negotiated with private landowners to provide terminals that are not located on public property. Experience has shown that private landowners are typically willing to negotiate for water transit terminals if the benefit to them, their organization, or their business interests is clearly presented. For instance, a private developer who owns a waterside activity center consisting of shopping and dining establishments may be happy to provide land (or dock space) for a water transit terminal and/or assist in the capital construction costs of a terminal. As presented in Appendix F, two hospitals located directly on Biscayne Bay are excellent candidates for water transit terminals. Hospitals are large employment centers; ensuring convenient transportation for employees is often an important consideration for hospital management. Furthermore, water transit vessels can be used to provide emergency transportation for the hospital if a terminal facility is provided. Please note that Mt. Sinai Hospital could be of particular importance to the provision of water transit services given its location near the Middle Beach area of Miami Beach and Arthur Godfrey Road.

## Vessel Requirements

Vessel requirements for passenger-only commuter and tourist ferry services on Biscayne Bay to serve Miami and its surrounding communities were researched using data from other locations around the world where these types of ferry services are operational. Vessel requirements presented in this section of the report include vessel technology, vessel capacity, environmental concerns, flora and fauna, and air quality. Please note that these vessel requirement elements are synergistic concerns; therefore, changing one or more of the parameters is likely to have effects on other vessel requirement element, and perhaps some dockside attributes as well.

### Appropriate Vessel Technology Considerations

#### Hull Form

Wake wash is a concern for potential water transit implementation in Miami-Dade County, especially near Bayside, bulkheaded residential areas, and around sensitive environmental areas on Biscayne Bay. A specialized catamaran hull form with a very low wake wash signature has been steadily developed over the past 17 years. This special hull form is called a Low Wash Catamaran. Ordinary catamaran ferries operating in the displacement and semi-displacement speed procedures will have a waterline length-to-beam ratio of their demi-hulls on the order of 12 to 1 and, generally, do not exhibit true low wake wash properties, even if they claim to. To achieve truly low wake wash properties, the demi-hulls of catamarans need to be much longer with respect to their breadths - approximately 20 to 1 or greater. This high length-to-beam property of the demi-hulls is what defines a Low Wash Catamaran and is the primary contributor to low wake wash properties.

The concept of long slender hulls has been well established and was known as far back as Polynesian times in the South Pacific Ocean. More recently, these principles have been applied in the context of rapid ferries from an observation by Robert Trillo, who in 1987 saw that the rowing shells of the famous Oxford and Cambridge rowing race on the River Thames were producing virtually no wash, but were being followed by an armada of press and spectator boats producing a 'tidal wave' of wake wash. This was an illustration of the naval architectural principal of lengthening a displacement hull's waterline in order to reduce the magnitude of the wavemaking component of water resistance. Hence, the less the wavemaking resistance is of any given hull, the less will be the wake wash and the energy contained in those waves.

Historical Low Wash Hull Developmental Steps

In 1992, the FBM Marine Group delivered the first such Low Wash Catamaran ferry to The River/Bus Partnership for service on the River Thames in London. The 23-meter (75.5-foot) by 5.7-meter (18.7-foot), 62-seat, *Riverbus* design has a demi-hull length-to-beam ratio of 20:1. Two Scania diesel engines, each rated at 253 kW (340 hp), provide the ferries with a service speed of 24 knots. These Low Wash Catamaran ferries have a wake wash height of just 300 millimeters (11.8 inches) at 30 meters (98.4 feet) from the path of the ferry.

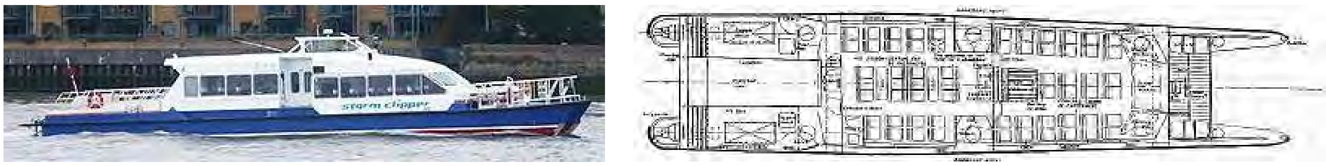


Exhibit 15. 62-Passenger London Low Wash Catamaran Ferry *Riverbus*

In the same time period, eight Low Wash Catamaran ferries were under construction by the Cairns, Australia, shipyard, NQEA, for the New South Wales State Transit Authority to serve a 14-terminal route on the Parramatta River, from Downtown Sydney to the City of Parramatta. Wake wash considerations had previously prevented the use of high speed ferries on this route. This 36.8-meter (120.7-foot) by 10.5-meter (34.4-foot), 200-passenger, *Rivercat* design has an even greater length-to-beam ratio of 33:1. Two Detroit Diesel 8V 92TA engines, each rated at 367 kW (492 hp), provide the *Rivercat* with a service speed of 22.5 knots.

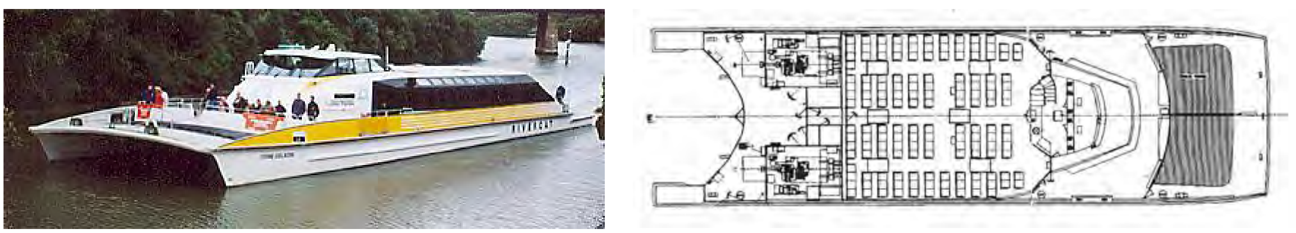


Exhibit 16. 200-Passenger Sydney Low Wash Catamaran Ferry *Rivercat*

In 1996, the Brisbane City Council had eight Low Wash Catamaran ferries built by Brisbane Ship Constructions to serve a 14-terminal service route throughout Brisbane's Central Business District (CBD) and suburbs along the Brisbane River. These *CityCat* ferries have a length of 25 meters (82 feet), a breadth of 7.2 meters (23.6 feet), and can carry 108 passengers. Two Scania DSI 11 60M diesel engines, each rated at 280 kW (375 hp) provide the *CityCat* ferries with a service speed of 24 knots.


Exhibit 17. 108-Passenger Brisbane Low Wash Catamaran Ferry *CityCat*

In 1998, NQEA built the first in a series of Low Wash Catamaran ferries known as the *River Runner*. The first two vessels of the model, called the *River Runner 150*, were constructed for Bora Bora Navettes to shuttle passengers from an airport to their resort hotels on the atoll of Bora Bora, near Tahiti. These ferries have a length of 30 meters (98.4 feet), a breadth of 7 meters (23 feet), and carry 115 passengers. Two Caterpillar 3196 DITA diesel engines provide the ferries with a service speed of 22 knots.

Exhibit 18. 115-Passenger Bora Bora Low Wash Catamaran *River Runner 150*

In 1999 the Damen Shipyard built, under license from NQEA, six *River Runner 150* ferries for service on rivers in the Netherlands. This was an initiative of the Netherlands government to help relieve traffic congestion on roadways by having workers commute by ferries, which is a similar objective for the potential water transit system in Miami-Dade County. The six ferries measure 30.5 meters (100 feet) by 7 meters (23 feet), and carry 130 passengers. These Low Wash Catamaran ferries have a wake wash height of just 240 mm (9.45 inches). Two Caterpillar 3196 DITA diesels, each rated at 330 kW (442 hp), provide the ferry with a service speed of 20 knots.

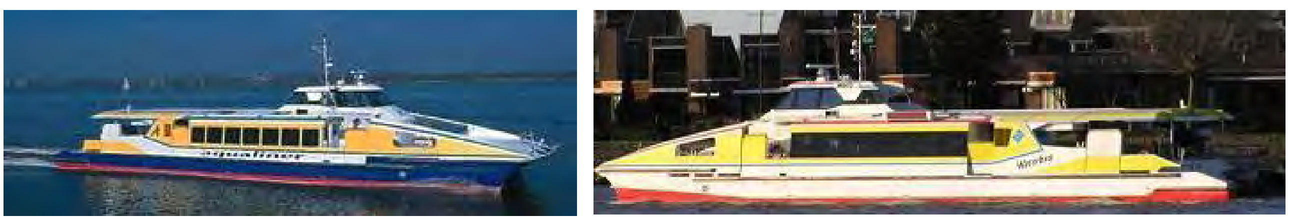


Exhibit 19. 130-Passenger Netherlands Low Wash Catamaran *River Runner 150 Mk II*

Also in 1999, NQEA built and exported two *River Runner 200* ferries for service in the Netherlands between Rotterdam, Ridderkerk, and Dordrecht. These vessels measure 37 meters (121.4 feet) by 8.3 meters (27.2 feet), and carry 150 passengers. The hulls are aluminum and the superstructure is constructed of composites. Two Deutz TBD 616V16 engines, each rated at 1,920 kW provide the ferries with a service speed of 28 knots.

Exhibit 20. 150-Passenger Netherlands Low Wash Catamaran *River Runner 200*

In 1999, the New South Wales Transit authority contracted for the construction of 12 *Supercat* Low Wash Catamarans in preparation for the Sydney 2000 Olympic Games. Transfield built the aluminum hulls, Bass Boats built the composite superstructures, and Australian Defence Industries managed the project, mating the hulls and superstructures at its shipyard at Garden Island. The length-to-beam ratio of their demi-hulls is 29:1. These vessels were designed for operations in waves up to 2 meters (6.6 feet). The *Supercats* measure 34.2 meters (112.2 feet) in length by 8.5 meters (27.9 feet) in breadth, carry 250 passengers, have a service speed of 23.5 knots, and a wake wash height of just 250 millimeters (9.8 inches) in 3 meters (9.8 feet) of water.

Exhibit 21. 250-Passenger Sydney Low Wash Catamaran *Supercat*

In 1991, NQEA built two *River Runner 150 Mk III* ferries for the Northern Ireland operator LoughLink for service on the Belfast Lough linking Bangor, Belfast, and Carrickfergus. The Low Wash Catamarans measure 31.7 meters (104 feet) in length by 7.8 meters (25.6 feet) in breadth, and carry 114 passengers. With 448 kW (600 Hp) of power per demi-hull, which have a length-to-beam ratio of 27:1, and utilizing the Servogear Propulsion System, the ferries have a service speed of 24 knots.

Exhibit 22. 114-Passenger Northern Ireland Low Wash Catamaran *River Runner Mk III*

The vessels outlined above illustrate the historical development of the Low Wash Catamaran hull form over the last 12 years. These are not the only such Low Wash Catamarans that have been built. In fact, more than 60 of these types of vessels are known to be currently in service around the world. For a larger listing of such vessels built in the past 12 years, see Appendix G of this report.

### Vessel Passenger Capacity Recommendation for Biscayne Bay Service

Vessel passenger design capacity is reflective of the sum of many considerations such as ridership estimates/projections, the temporal distribution of ridership forecasts, the frequency of service, acceptable passenger service standards, and physical constraints such as vertical and horizontal clearance that may affect the size of vessels. In addition, the selection of vessel capacity is in part affected by the desired fleet size. For instance, systems with large fleets operating with frequent headways may be able to operate with smaller vessels and still adequately serve passenger demand. As previously noted, a certain number of "spares," or additional vessels is universally recommended to be built and held in reserve in case of breakdowns to an in-service ferry and so that all vessels may be rotated through the maintenance facility on a regular basis without affecting the level of service. In general, water transit systems require fewer spares per fleet size than other forms of urban public transportation such as bus and heavy rail. Typical practiced spare ratios in Australia and Europe for urban public transportation applications range from 8:1 to 12:1.

A vessel capacity of 149 passengers is a regulatory cut-off for United States Coast Guard requirements according to Title 46, United States Code, Subchapter K, Part 114. Crew requirements, structural fire protection, life-saving equipment, and other aspects of the design and operation of ferries is much more involved with associated higher costs at vessel capacities of 150 or more passengers.

It has been shown above that to achieve a capacity of 149 interior cabin passenger seats in a Low Wake Wash Catamaran requires a vessel length of approximately 121 feet and a breadth of 27 feet when 20 bicycles are also carried exterior to the cabin. This is illustrated in the general arrangement plan of the *River Runner 200* presented in Exhibit 23.

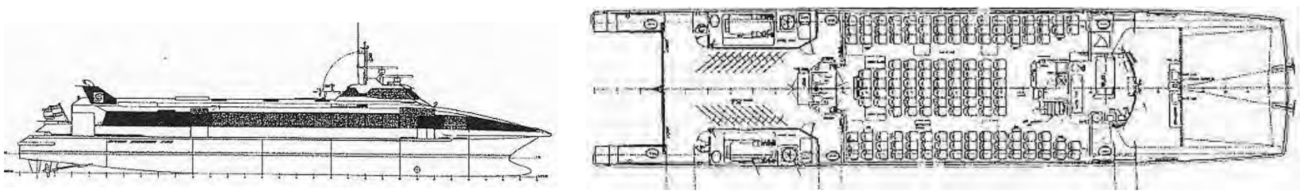


Exhibit 23. Low Wake Catamaran *River Runner 200* General Arrangement Plans

The ridership forecast for this study indicates that some catamarans of similar size to the *River Runner 200* and other vessels described in this section of the report may be necessary if the appropriate level of service and passenger infrastructure is provided similar to systems in cities such as Sydney, Brisbane, Seattle, and the San Francisco Bay Area. Catamarans of this size may be utilized during peak travel periods, especially on route segments that exhibit high travel demand flow, such as Miami to Miami Beach. However, the height of a vessel similar to the *River Runner 200* is such that operation within the Miami River and under the Venetian Causeway would be impossible unless drawbridges were opened for the passage of the vessel, which is not practical to meet the desired water transit service frequencies. In addition, the 149-passenger catamarans require much more powerful engines relative to their smaller counterparts, which would significantly increase costs. Therefore, smaller vessels than the 149-passenger catamarans should be utilized in Miami-Dade County. Table 4 illustrates viable options for smaller vessels, with their associated vessel sizes and capacities, service speeds, and power requirements, compared to the larger catamaran at the bottom of the table. The measurements provided are English units.

Table 4. Characteristics of Small Water Transit Vessels

| Passengers | Length (feet) | Beam (feet) | Power (hp) | Speed (knots) |
|---|---|---|---|---|
| 62 | 75.5 | 18.7 | 2 x 340 | 24 knots |
| 108 | 82.0 | 23.6 | 2 x 375 | 24 knots |
| 114 | 104.0 | 25.6 | 2 x 600 | 24 knots |
| 115 | 100.0 | 23.0 | 2 x 442 | 22 knots |
| 150 | 121.4 | 27.2 | 2 x 2,575 | 28 knots |

As demonstrated in Table 4, 24 knots is a common service speed for Low Wake Wash Catamarans up to a passenger capacity of approximately 115. A service speed of 24 knots is almost 28 miles per hour (mph). This is a sound speed on the water for a commuter/tourist ferry, especially in areas of congestion or where manatees would need to be detected in time for executing avoidance routing. Please note that 24 knots is a cruising speed; the actual systemwide speed will be lower when accounting for the time required to stop at terminals along the route (dwell time at terminals and the time spent decelerating and accelerating for each terminal along the route). Therefore, express water transit service or limited stop service may need to be implemented for long commuter runs, such as Aventura to Miami.

Table 4 also demonstrates the tremendous increase in engine power required to travel just 4 knots faster at 28 knots. This is due to the fact that water resistance, and therefore the power and fuel consumption required to overcome the resistance, increase at exponential rates with increased speed. For operating and maintenance cost efficiencies, the cruising speed goal should be no higher than 25 knots (28.77 miles per hour).

A more compact design can be obtained if approximately 20 percent of the seats are placed exterior to the cabin. In this case, this vessel length can be approximately 100 feet, and the beam around 23 feet. The exterior seating is protected from inclement weather by the superstructure. This arrangement is illustrated by the *River Runner 150* shown in Exhibit 24.

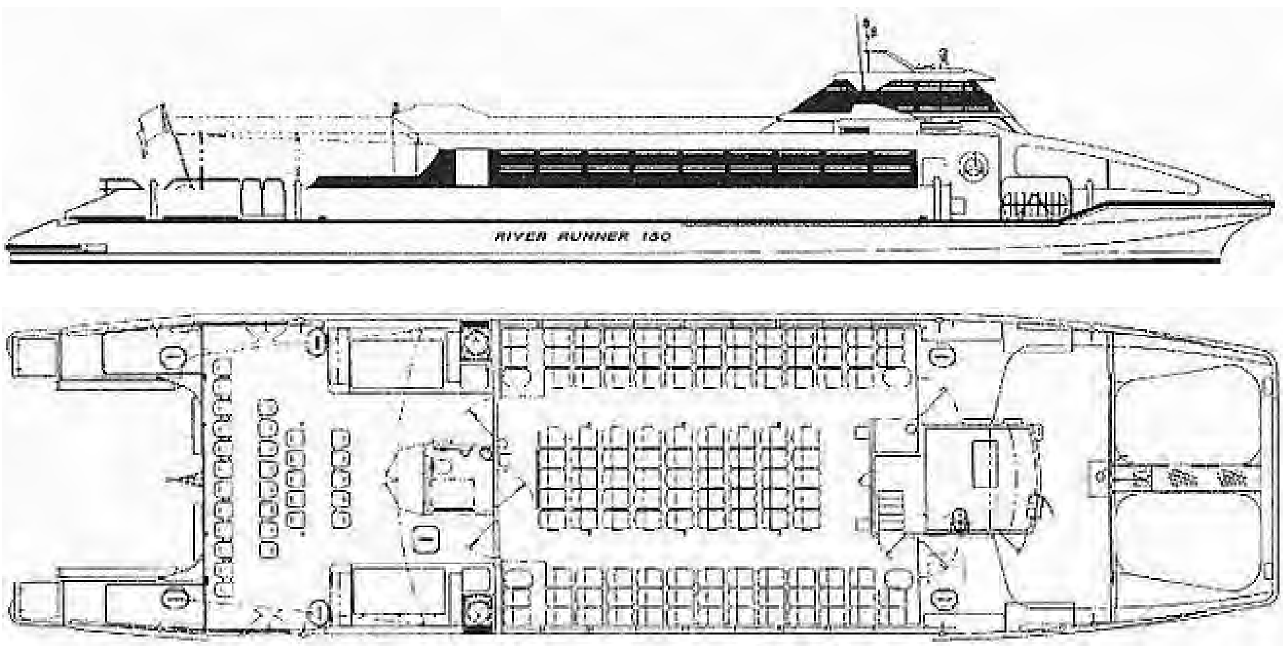



Exhibit 24. Low Wake Wash Catamaran *River Runner 150* General Arrangement Plans

## Environmental and Other Factors That Influence Vessel Requirements

### Climate and Weather Considerations

Biscayne Bay's subtropical climate is characterized by warm, wet summers (June through November) and mild, dry winters (December through May), with abundant sunshine and high humidity year round. High temperatures average in the high 80s and low 90s in summer and in the mid 70s and low 80s in winter. Annual rainfall fluctuates greatly, but 65 inches or more is common with 2.17 inches in January and 3.95 inches in July. Most of the precipitation falls in summer in brief, intense afternoon thunderstorms.

The ferry vessel should have a sizeable area, or areas, of seating outside of its cabin for fair weather enjoyment of its passengers. These exterior seating areas, where possible, should be provided with an overhead weather shelter. The interior of the ferry's passenger cabin must be provided with air conditioning, with the system carefully chosen to minimize its weight, due to the long periods of high temperature and humidity experienced in Miami-Dade County.

Exhibit 25. Outside Seating and Roof & Window Ventilation

<u>Seaworthiness Considerations</u>

Although usually calm, trade winds of 10-20 knots are not uncommon on Biscayne Bay, especially in the fall and winter months. Summer and fall (between June 1st and November 30th) are peak seasons for tropical storms and hurricanes. In the fall and winter, winds blow at 22 knots or above for 7 to 12 percent of the time. Above 22 knots, wave conditions are considered "rough." From fall through spring, conditions would be considered approaching "rough" approximately 1 to 3 percent of the time.

The ferry vessel should be designed for safe and effective operation in waves up to four feet high. Above this height, temporary cancellation of the service would likely be understood and accepted by the public. A catamaran hull form, with its widely spaced demi-hulls, would provide appropriate stability in waves. The demi-hulls should be long to span consecutive wave crests, thereby minimizing the motions experienced by passengers. The bows of the catamaran should have a generous amount of sheer and freeboard to cope with waves. As well, the bridging deck structure connecting the demi-hulls of the catamaran should have an adequate height clearance above the water to reduce wave impacts. The stems of the catamaran should be narrow to slice through waves while incorporating a bulbous bow to reduce bow accelerations and motions in waves due to the bulb's buoyancy. These vessel features are illustrated in Exhibit 26.

<u>Water Depths</u>

Water depths in the middle portions of Biscayne Bay are 9 to 11 feet (2.7 to 3.4 meters). Towards the shore these depths shoal gradually to approximately 1 foot (0.3 meters). Most bay approaches near the entrance to canals have a narrow dredged channel through these shoals of a depth of 5 to 7 feet (1.5 to 2.1 meters).

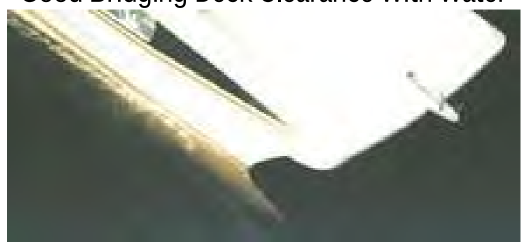
Widely Spaced Demi-Hulls for Stability

Long Hull Length to Span Consecutive Wave Crests

Generous Sheer and Freeboard for Waves

Good Bridging Deck Clearance With Water

Narrow Stems for Slicing Through Waves



Bulbous Bows for Vertical Motion Reduction

Exhibit 26. Vessel Stability Features

Due to the minimal depths of Biscayne Bay near its shorelines, the ferry vessel should have shallow draft properties. To this end, the weights of all systems should be designed to be light weight in nature. Fuel tanks and water tanks should be sized to supply only a single day's worth of service with a 20 percent margin to save weight and to keep the operating draft of the vessel to a minimum. Passenger seats should be of a lightweight design and not the heavier standard ferry type seats, as depicted in Exhibit 27.

Heavy Ferry Seating

Lightweight Interior Seating

Lightweight Exterior Seating

Exhibit 27. Vessel Seating

The passenger boarding infrastructure used in Australian water transit systems is typically built over the water, as presented in the Terminal Requirements section of this chapter and depicted in Exhibit 3. A similar design will be necessary for many potential water transit terminals within Biscayne Bay to not only conserve landside space, but also to keep vessels operating in deeper areas of the Bay and to minimize dredging along the shorelines. The information presented in Appendix G of this report includes draft requirements for various waterborne transportation vessels. The range of vessels considered practical for applications within Miami-Dade County typically exhibit drafts of 3 to 4 feet. According to bathymetry data provided by FDEP and presented in Figure 10, most of Biscayne Bay is of adequate depth for operation by water transit vessels. Localized dredging associated with certain terminals may be required and should be held to an absolute minimum to minimize environmental concerns.

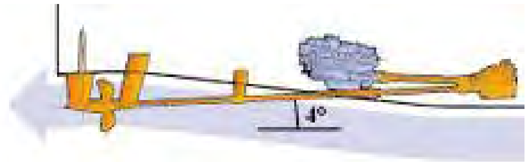
Aluminum has traditionally been the material of choice for shallow draft rapid ferries. Recently, many shallow draft fast ferries have had their cabin superstructures and main decks constructed of composites to even further lighten the vessel and lessen its draft. In the future, the hulls may also be constructed of composites to further save weight and minimize operational vessel drafts. At least one of these new composite materials is also demonstrating a strong resistance to fire - another big advantage when compared to aluminum, which needs a separate structural fire protection material attached to it to gain an approximately similar degree of fire resistance.

Exhibit 28. Aluminum Hulls and Composite Superstructures for Low Navigational Drafts

Flora and Fauna Considerations

Bay bottom seagrass beds and shoreline mangrove communities are the dominant flora of Biscayne Bay. The major sea grasses are Turtle Grass, Cuban Shoal Grass, and Manatee Grass. These plants function as a food source and provide shelter for a rich variety of marine life, many of which are the juveniles of species that make South Florida a fine fishing area and an important contributor to the local economy in addition to providing stabilization for sediments. An increasing problem in Biscayne Bay is the scarring of seagrass beds. For this reason, water jets should not be selected as a propulsion system component for ferries on Biscayne Bay. Even in much deeper waters, water jets are known to scour and scar seagrass beds when the reversing buckets are deployed to make the ferry travel backward and then forward, maneuvers that are required at most dockings. What is required for seagrass protection is a propeller shaft line that is as close to being horizontal with the water surface as possible. Normal propeller shaft angles are usually 10 degrees or more. The Servogear Propulsion System is a complete state-of-the-art packaged propulsion system that decreases the propeller shaft angle to just 4 degrees by employing specialized reverse-angle reduction gears and a stern tunnel in the hull that recesses the propeller.

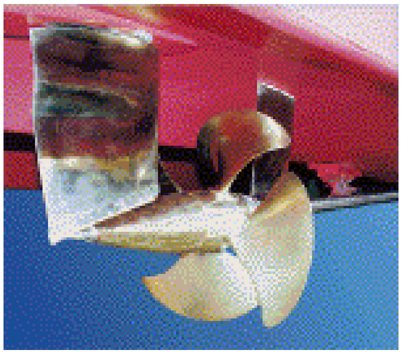

Usual Propeller Shaft Angles




The Servogear System's Shaft Angle

Exhibit 29. Propeller Shaft Angles

Having the propeller raised up inside the stern tunnel affords protection to the Florida, or West Indian, Manatee from propeller strikes. A propeller guard would complete the manatee protection. The Servogear Propulsion System is highly efficient in the mid-twenty knot speed range, whereas water jet efficiency suffers at these speeds, which are at the bottom of their performance envelopes. The system also employs a controllable pitch propeller (CPP) so that the shaft does not have to be stopped, and its rotation reversed, every time a forward or reverse maneuver is required. The Servogear's state-of-the-art effect rudder and thin airfoil-shaped shaft brackets add to the overall excellent propulsive efficiency of the system. Exhibit 30 illustrates the Servogear Propulsion System.



The Servogear Propulsion System:

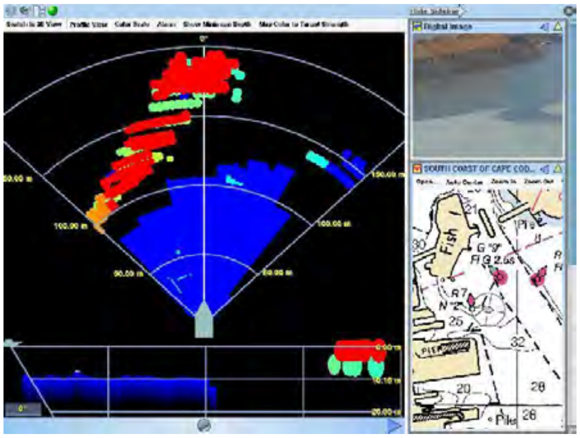
- Stern Tunnel
- 4-Degree Shaft Angle
- CPP Propeller
- Highly Skewed Blades
- Effect Rudder
- Thin Airfoil Shaft Brackets

Exhibit 30. The Servogear Propulsion System

The highly-skewed propeller blades reduce vibrations and noise imparted to the water making the Servogear Propulsion System much quieter than water jets, an important environmental consideration for manatee and other marine life, as well as for human habitats along the ferry route. Servogear, developed in Norway, has been well-proven over several years and is highly regarded with ferry vessel applications in 32 countries worldwide.

Another desired ferry vessel device for Biscayne Bay is a manatee detection and collision avoidance system. Bioacoustical research in this field is currently underway in Florida. The most promising technology appears to be forward scanning sonar used in a way similar to that used by fishermen to locate fish. This technology will allow vessel operators to successfully locate manatees and determine an effective course of action to avoid them. Presently, two commercial sonar-based products are on the market that can provide detection of whales. These products may be able detect manatees as well. Although adding sound to the underwater environment, these forward-looking sonar systems are considered safe for animals as they are of a frequency that is well above the hearing range of manatees.

EchoPilot markets the CASS (Collision Avoidance Sonar System) which transmits a swept chirp of 20-80 KHz with 1.5 seconds between pings combined with a range of up to 4,000 feet (1,200 meters), ensuring an immediate assessment of the waters ahead of the vessel. The color display presents the user with the range, bearing, and depth of objects ahead, and the CASS computes if any of these objects are on a collision course.



The FarSounder FS-3 Sonar


The Echo Pilot CASS

Exhibit 31. Forward-Scanning Sonar

FarSounder markets the FS-3, a forward looking three-dimensional (3D) sonar that operates at 60 kHz and records the range and depth of detected objects. Detection ranges for whales have been between 700 and 900 feet. The National Marine Fisheries Service sponsored the development of the FS-3 sonar to non-invasively study whales. It would be expected that manatee detection with the FS-3 would be possible only at closer distances than the 700 to 900 feet required for detection of whales.

<u>Air Quality Considerations</u>

To minimize harmful environmental air emissions, diesels employed by ferries operating on Biscayne Bay should meet the Environmental Protection Agency (EPA) 2007 emissions requirements and be electronically controlled. The fleet should be operated on low-sulfur fuel.

<u>Wake Wash Considerations</u>

Biscayne Bay's rapidly shoaling bottom accentuates a vessel's wake wash height and energy over that of open-water conditions. The resulting wake wash can cause coastline erosion, bulkhead degradation, disturbances to marinas, and danger to smaller watercraft. In shallow water, where wave wash heights are most accentuated, the impact may disturb the Bay bottom and cause ecological and environmental impacts as well. Therefore, very low wake wash properties must be an essential element of any ferry vessel operating on the Bay. For ferries operating on Biscayne Bay, wake heights of 250 millimeters (9.8 inches), trough to crest, would be considered an acceptable and low level of wake wash.

<u>Air Draft Considerations</u>

The maximum air draft, or height of the vessel, measured from its waterline to its topmost point, must be lower than the minimum structure clearance on the service routes. This maximum air draft will occur at a very light vessel loading condition, such as when a minimum number of passengers are carried and when most of the fuel has been expended, at high tide. To present the lowest vertical profile, there should be only one passenger level to the cabin, the navigational light mast should be designed to be pivotally raised and lowered automatically from the vessel's conning station, and the con should be at the minimal needed elevation.

The minimum vertical clearance found along the potential route structure presented in Figure 12 is 9 feet under the Venetian Causeway's eastern span over the Miami Beach Channel between Belle Island and Rivo Alto Island. Water transit vessels considered in this study would not be able to pass under the Venetian Causeway at this location without the drawbridge being raised. Operating restrictions on the Venetian Causeway drawbridge limit raising the bridge to once every thirty minutes during peak travel periods. Therefore, headways on water transit routes passing under the Venetian Causeway are limited to a minimum of 30 minutes. Water transit vessels would have to maintain strict schedule adherence in the area of the Venetian Causeway to avoid missing drawbridge openings. A route structure that precludes the need for raising drawbridges is most desirable for both water transit and roadway operations. Therefore, water transit routes may need to avoid the eastern span of the Venetian Causeway over the Miami Beach Channel.

The second lowest vertical clearance found along the potential route structure presented in Figure 12 is 12 feet under the Venetian Causeway's western span over the Intracoastal Waterway. Water transit vessels considered for service in Miami-Dade County should exhibit a maximum air draft of 12 feet to pass under the Venetian Causeway in the Intracoastal Waterway without the drawbridge being raised. This will allow the most scheduling and headway flexibility without causing detrimental impacts to traffic flow on the Venetian Causeway.

## System Operating Characteristics

System operating characteristics envisioned as being appropriate for passenger-only commuter and tourist ferry services on Biscayne Bay serving Miami and its surrounding communities were developed using data researched from other ferry systems located around the world where these types of ferry services are successfully operating. These characteristics were evaluated based on local service goals and travel flows developed during the travel demand analysis portion of this study. System operating characteristics for the proposed waterborne transit service within Miami-Dade County were then fashioned to meet environmental, operating, and demand needs.

### Service Characteristics

#### Route Structures

Two basic types of route structures are common along successful waterborne transit operations that have been reviewed for this study - point-to-point service (such as back and forth across a bay) and linear route service (such as a standard urban bus or rail transit route). Point-to-point service is common for linking across a wide bay or sound where few if any bridges may exist to serve travel demand, such as in Seattle. Linear route service is more common for providing a travel option in long, relatively narrow bodies of water, such as a river or a narrow bay. Examples of linear route service include the Water Bus in Fort Lauderdale and the CityCat in Brisbane, Australia. Both types of service may have applications in Miami-Dade County; however, most water transit routes envisioned in this study are linear routes that operate in both directions due to the width of Biscayne Bay and the presence of several bridges that provide access to the bay islands and the barrier islands from the mainland.

Non-stop point-to-point service is applicable for routes such as Downtown Miami to Miami Beach and Downtown Miami to Virginia Key and/or Key Biscayne. These routes serve cross-bay travel that is currently served by roadways and causeways with bridges. Both of these routes would likely cater to tourists who typically seek out convenient means of transportation between popular tourist destinations. Commuter demand for these direct water transit routes may be somewhat limited by the routing and subsequent travel time constraints imposed by the bridges that link these destinations. In Seattle, the lack of a direct roadway bridge across Puget Sound produces high demand for water ferry operations between Seattle and the northern communities along the west of Puget Sound; waterborne transportation is all but mandatory for reaching some of the other, totally disconnected, islands within Puget Sound. Furthermore, the proposed Baylink rail transit line planned to connect Miami and Miami Beach presents the potential for inter-transit mode competition should both serve cross-Bay trips.

A linear route structure that operates in both directions is the most common route structure in locations such as London, Sydney, and Brisbane. These systems serve as extensions of other forms of public transportation, such as buses and trains, and have route structures and operations that mimic bus and train operations. With more efficient spacing of stops sited farther apart than with a typical local bus system, the route structure and scheduling of the waterborne transit system will most closely resemble a Metrorail line or a limited stop bus route, rather than a local bus route. It is expected that water transit terminals would be spaced approximately one to two miles apart. Closer spacing of stations is expected in more dense areas such as in the vicinity of Downtown Miami. Station spacing of two miles is more appropriate in less dense areas, such as north of the 79th Street (John F. Kennedy) Causeway.

A water bus system (sometimes referred to as a water taxi system), with a route structure that resembles a downtown circulator, is appropriate for the densest areas such as Downtown Miami. Downtown water bus-type circulators are envisioned as operating with smaller vessels having seating capacities that could range from 20 to perhaps 50 passengers. A downtown circulator route should have a hub at the main CBD Terminal, utilizing the same facility as the larger ferry routes. Passengers may transfer from the main ferry routes to the downtown circulator at the main CBD Terminal to provide convenient access to waterside Downtown destinations.

A circulating route service is typical of water bus operations in a city's central business district, where there is a need for relatively closely-spaced water transit stops, and where many of these transit stops may be in places that are cumbersome for the large commuter ferry to access. This type of route often employs high-speed planing vessels that have minimal wake wash at planing speeds. Because frequency of service is high, the passenger capacity of each water bus vessel need not be great.


Exhibit 32. Potential Vessel Type for a Downtown Circulator Route

The downtown circulator conceived for the Miami CBD should serve the parks and entertainment district along Biscayne Bay, the Brickell area, and the Miami River east of I-95. It is anticipated that the only infrastructure necessary to provide a downtown circulator stop would be a moor to dock the boat and allow passenger access. Several locations along the downtown circulator route already provide moors for water vessels. Dedicated park-and-ride lots and dedicated water bus-meeting shuttle buses are not appropriate for stops that are only served by the downtown circulator. However, the location of the proposed Riverwalk circulator stop should facilitate convenient connections to Metromover. With the passage of the recent County bond initiative, a funding source is in place for museums proposed for Bicentennial Park, which would provide a logical destination should water taxi services be implemented. In addition, several riverfront residential condominiums are being planned, for which circulator water bus service could provide a convenient local travel option. Stops along the downtown circulator are envisioned at the following locations.

- Bicentennial Park
- American Airlines Arena
- Bayside
- Bayfront Park
- CBD Terminal (Chopin Plaza) - connections to main ferry system
- Brickell Key
- James L. Knight Convention Center / Riverwalk
- SE 5th Street
- City of Miami Riverside Administration Building
- SE 10th Street
- Brickell Terminal (SE 14th Street) - connections to ferry system

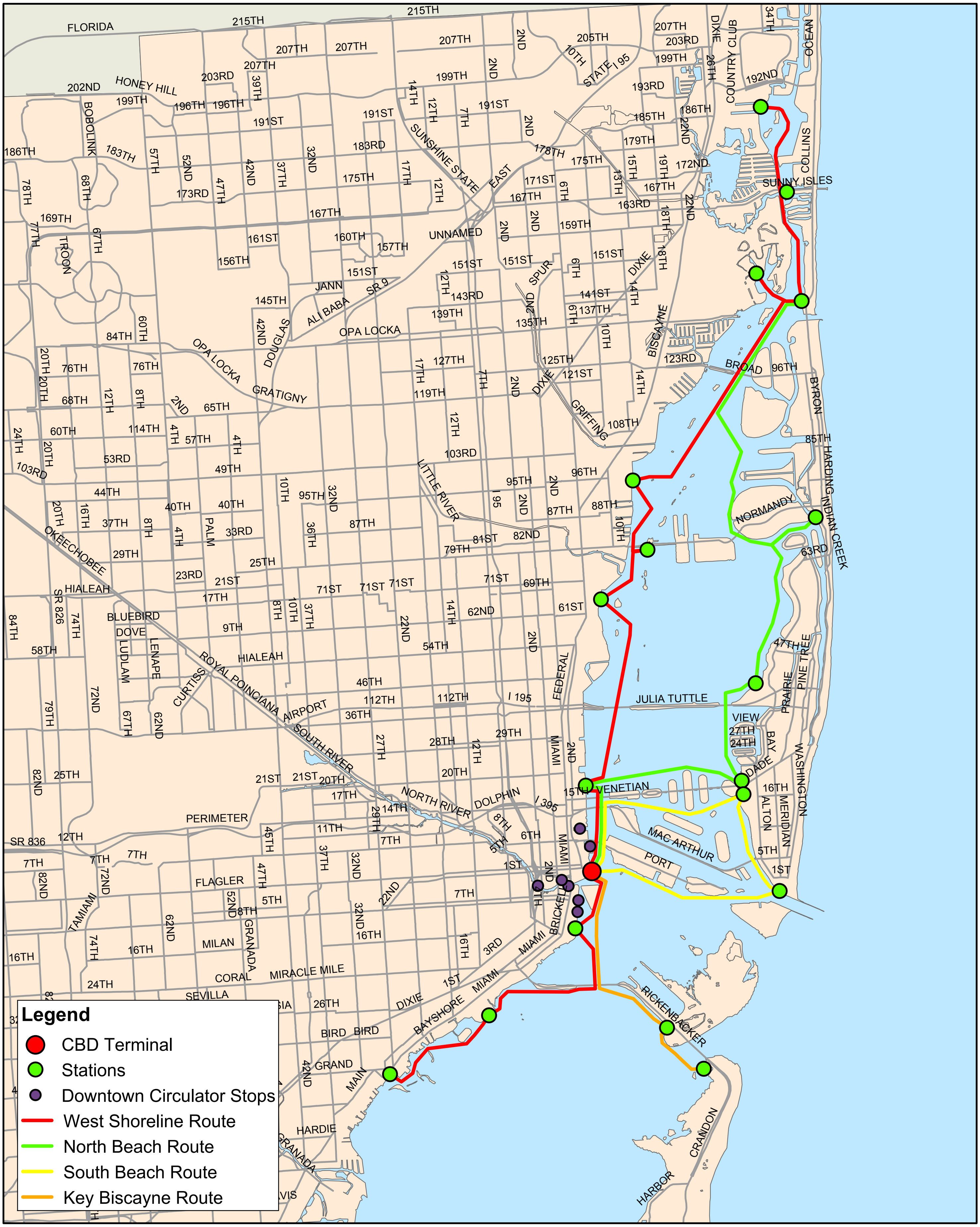
Figure 13 presents a potential route structure along with the proposed terminal sites for water transit services in Miami-Dade County. A preliminary route structure was presented in the previous chapter for purposes of ridership estimation. The map in Figure 13 is more detailed as it includes proposed terminal sites. Furthermore, Figure 13 was developed following a field review of many potential station sites identified in previous studies to determine the practicality of utilizing the sites. Several sites were removed from consideration due to various operating and physical constraints. In addition, Figure 13 divides the proposed service map into individual routes. Figure 13 shows the locations of the terminals included in Appendix F and four water transit routes linking the terminals. The proposed downtown circulator stops are also included in Figure 13. Please note that the Miami Beach routes are divided into a north route and a south route at the Venetian Causeway due to the low height of the eastern Venetian Causeway drawbridge span, and severe restrictions on its opening during peak periods.

Service Frequencies

Headways of approximately 15 to 20 minutes (service every 15 to 20 minutes) are common for the Australian systems in Sydney and Brisbane that serve as linear transit routes. Providing convenient headways is a primary attractor of patronage to urban transit systems, especially for attracting local commuters to switch modes from private automobiles. Commuter ridership is especially high on the Australian systems, where headways are varied throughout the day to match travel demand.

Headways of 20 minutes during peak travel periods are desired for ferries in Miami-Dade County. Headways during non-peak portions of the day may range from 30 minutes to 60 minutes for the primary linear routes, much as is done with surface transit routes. Headways for downtown circulator water buses should be coordinated to match arrival and departure ferry schedules at the CBD Terminal, which should ideally produce 10- to 15-minute water bus headways throughout most of the day.

Longer headways may be more appropriate for non-stop point-to-point ferry services. However, these routes may be supplemented by more frequent routes that serve more than two destinations. Headways of 30 to 60 minutes are more appropriate for the non-stop point-to-point service during peak periods; headways of 60 to 120 minutes are appropriate for these point-to-point ferries during non-peak travel periods.




0 1 2 4
Miles

N
W E
S

FIGURE 13
*Recommended Routes and Terminals*

Kimley-Horn and Associates, Inc.

The service frequencies recommended in this study would require the raising of drawbridges more than allowable based on existing opening restrictions. Therefore, the Miami Beach route was divided into a north route and a south route due to the height restrictions on the eastern end of the Venetian Causeway where the drawbridge is located on the Miami Beach Channel. Headways of 30 minutes in each direction present the possibility of a water transit vessel passing by a certain location every 15 minutes. Because large water transit ferries would require the opening of the drawbridge between Rivo Alto Island and Belle Island for passage during most water level conditions, the route was divided into a north route and a south route.

Interlining

Interlining of routes may be appropriate in Miami-Dade County based on the physical geography of the shoreline and the location of popular destinations. Interlining water transit routes in Miami-Dade County would involve extending a route from the northern part of the County through a central terminal, most likely located in Downtown Miami, and then into the southern part of the County. Interlining of routes can increase passenger convenience by allowing passengers to make some trips through the central terminal of a transit system without transferring.

The interlining of transit routes thus raises the possibility of a service disruption on one end of a route affecting passengers on the other end of that route, and a delay becomes even more disruptive and pervasive when interlined routes are subsequently delayed as well. However, in a system such as the proposed water transit system in Miami-Dade County, the benefits of interlining outweigh the disadvantages. Since the shoreline of Biscayne Bay provides a linear path for the water transit routes to follow, interlining a north route and a south route may provide continuous service for many travel patterns. Combining two routes end-to-end into one route would avoid the disruption of having passengers transfer between the two - in this case, from a north route to a south route (or vice-versa). In addition, combining the routes reduces the need for timed transfer networks where passengers could miss a connection if one of the water transit vessels suffers a deviation from the planned schedule.

The route network proposed in Figure 13 provides one continuous route (the West Shoreline Route) from Aventura to Coconut Grove. This is the result of interlining the portion of the route north of the CBD Terminal and the portion of the route south of the CBD Terminal. The Coconut Grove route south of the CBD Terminal could be considered a fifth route.

Service Spans

Successful water transit systems are well-integrated with other metropolitan area transit systems, such as bus networks and rail transit lines. Connections from the water transit system terminals to bus and rail transit are typically provided at numerous stations. As such, the daily service span for the water transit system should ideally approximate the service spans of the other transit services in Miami-Dade County, especially Metrobus and Metromover, to provide true mobility options. Therefore, it is expected that service will be provided from approximately 5:30 AM until 12:00 midnight. A reduced mid-day schedule may be appropriate as commuter trip occurrences are concentrated during the morning and afternoon peak periods. On Fridays and Saturdays, the service span may be extended by one or two hours to serve popular nightlife destinations within Miami Beach, Miami, and Coconut Grove. Sunday operations may have a shortened schedule based on reduced demand for commuter and entertainment trips. Sunday schedules of 8:00 AM until 10:00 PM are common.

Future Expansion

The route network presented in Figure 13 is meant to be a “Phase 1” network designed to serve major travel flows and the most popular waterside destinations by providing a potentially attractive alternative to the usual mix of transit modes, as well as the personal vehicle. If water transit in Miami-Dade County proves to be successful, the system may be expanded to include other routes or extensions of existing routes, and more frequent services for routes not requiring drawbridge openings. These "Phase 2" projects may include a primary ferry route along the Miami River following construction of the Miami Intermodal Center (MIC); the Miami River ferry would also serve the Civic Center area and provide waterborne access to the Orange Bowl for special events. In addition, extending the Coconut Grove route to the south into less densely populated areas may provide moderate numbers of commuters to major CBD and Brickell waterfront or adjacent employment centers in Downtown Miami; the southern extension may be warranted if the water transit service proves successful. A future circulator route using smaller water buses could be considered within Aventura to link the many condominium communities with recreation, shopping, and employment opportunities if the system becomes popular in that community. Limited stop routes such as Aventura to Miami may be introduced if warranted by ridership patterns.

In addition, terminal locations may be added to routes to serve destinations not included during the initial phase of service. However, experience in Brisbane has shown that adding terminals within existing routes may cause unhappiness with existing riders who experience longer trip times when new stops are added and travel times are extended. The need for increased accessibility must always be contrasted with the need for system speed, attractive and competitive route travel times, and net mobility advantages. New terminals should likely be considered in conjunction with other system improvements such as more frequent service or the introduction of limited stop or perhaps even skip-stop service.

### Staffing Requirements

The primary types of personnel needed to operate a waterborne transit system in Miami-Dade County include vessel personnel, vessel maintenance, terminal staff, security, and administrative personnel. Some staff members already employed within Miami-Dade Transit (MDT) may be able to be also used within the water transit system. For example, some administrative staff and possibly terminal and maintenance staff might be able to be shared with MDT to save costs through sharing of personnel resources. Further information regarding staffing is provided in the next chapter including an estimate of labor costs as part of potential system operating costs.

#### Vessel Staffing

A captain and two crew members are required for operating the catamaran vessels recommended if waterborne transit service is implemented in Miami-Dade County. Smaller vessels such as those presented in Table 4 may require only two crew: a captain and one mate.

At least two shifts would be required to complete a typical daily service span as described above. When accounting for five-day work weeks and vacation schedules, it is likely that three full shifts of captains and vessel crews would be required to operate a successful waterborne transit system that serves Miami-Dade County in a similar manner as the operations in Sydney and Brisbane serve their respective metropolitan areas.

Waterborne passenger service operating companies are normally experienced at operating/managing either large ferries or small water buses, but not both. Thus, operationally, it is best to separate the water bus operations from the large ferry operations and bring in both types of operators to run their respective vessel types and operations most efficiently, based upon their respective first-hand experiences.

Terminal Staffing

It is likely that ticketing will be automated at most if not all water transit stations. Ticketing duties could also be assigned to a vessel mate or deckhand. Therefore, no ticketing personnel are expected to be utilized at most water transit terminals. However, an information booth at the primary CBD Terminal, staffed by a ticketing agent, may be required to provide assistance as needed. In total, five ticketing agents may be expected to be employed within the potential water transit system in Miami-Dade County.

Vessel Maintenance

Maintenance personnel will be required as the management plan includes a regular rotation of vessels through the maintenance facility. It is expected that a total of three maintenance personnel, four mechanics, and one engineer may be required for the potential water transit system in Miami-Dade County.

Terminal Maintenance

It is expected that terminal maintenance personnel can be shared with existing MDT labor arrangements to save costs through sharing of personnel resources.

Landside Operations

Landside operations personnel are expected to include three dispatchers working from a central control facility.

Security

Security personnel will likely be contracted to an independent security provider, or perhaps integrated with the existing MDT contract security firm.

Administrative Personnel

Administrative personnel include various managers and their associated staff members such as planners, technicians, and administrative assistants. It is likely that department heads will include Operations, Maintenance, Safety, and Marketing. The large ferry routes and the water taxi routes will likely have different contracted-out service staffs working in a complimentary manner. An Executive Staff Director will likely be employed to supervise the entire system. It is expected that approximately 25 to 30 administrative personnel may be required to operate, manage, and maintain the waterborne transit system.

# ESTIMATION OF COSTS FOR WATERBORNE TRANSIT SERVICE

Various approaches for establishing a waterborne transit system in Miami-Dade County have been examined as part of the *Development of a Service Plan for Waterborne Transit Services in Miami-Dade County*. A critical component of the evaluation process is the estimation of costs and revenues associated with the proposed system. The purpose of this chapter of the report is to provide a broad, planning-level estimate of system capital costs, as well as operating and maintenance costs.

This chapter is divided into three sections: (1) Implementation Plan (including route prioritization, schedule, and fare analysis); (2) System Capital Costs (including vessels, terminals, and real estate/right-of-way); and (3) System Operating and Maintenance Costs (including on-water operations personnel, landside operations personnel, engine maintenance costs, fuel, and administrative costs. The Implementation Plan section presents a potential plan for system implementation based on the data collection, patronage estimation, and analysis of system needs and characteristics. The System Capital Costs section and the System Operating and Maintenance Costs section present the expected expenditures to implement the system described in the Implementation Plan section of this chapter.

## Implementation Plan

A preliminary plan has been drafted to better estimate various service characteristics, components, quantities, and sizing, of the waterborne transit system that would in turn shape the estimation of system costs and revenues, such as the number and configuration of routes, the vessels in operation, and the staffing requirements needed to run them.

Routing and scheduling analyses performed for this study indicate twenty-three (23) water transit passenger vessels (21 vessels in service plus two spare vessels in reserve) would be required to implement the entire recommended "Phase I" waterborne transit system in Miami-Dade County, assuming peak period headways of 20 minutes on the four routes recommended in Figure 13 that would serve the potential terminal locations depicted in Figure 13 and described in Appendix F. This would represent a significant level of capital investment for Miami-Dade County if the entire system were to be implemented simultaneously. A more realistic implementation option would be to phase-in the service over time by inaugurating individual routes, or portions of individual routes, in successive order based on expected travel demand and expected service costs. Another implementation option is to reduce peak period service frequency to reduce the peak fleet requirements, which is the maximum required number of vessels. This option is not desirable as it reduces the convenience of the system, reduces its attractivity, and would likely have far less influence over modal shift.

### Route Prioritization

Priorities were analyzed for the routes developed in the System Needs and Operating Characteristics Report to provide a phased implementation plan for waterborne transit services in Miami-Dade County. The prioritization order is based on two primary factors: travel demand to estimate potential ridership, and infrastructure characteristics such as the presence of existing facilities to ease start-up investments. The following list catalogs the prioritization recommendations:

1. South Beach Route - The proposed South Beach Route serves the Downtown Miami CBD Terminal and two stations in the South Beach area of Miami Beach. This cross-bay route parallels two roadways (the McArthur Causeway and the Venetian Causeway), which serve travel between

Miami and Miami Beach. A connection to Miami Beach would serve as a logical initial destination from the proposed Downtown CBD Terminal.

2. West Shoreline Route (South) - For implementation purposes, the West Shoreline Route could be split into two routes at the CBD Terminal in order to implement the much shorter southern segment first. The proposed West Shoreline Route (south of the CBD Terminal) is a short segment that connects Downtown Miami with Brickell, Mercy Hospital, and Coconut Grove. Brickell and Mercy Hospital are large employment centers that provide significant ridership potential. The proposed Coconut Grove Station at the Dinner Key Marina is located within two blocks of a large activity center popular with both locals and tourists. Implementing the first two routes of this proposed prioritization schedule would augment entertainment trip mobility by linking Miami Beach with Coconut Grove through Downtown Miami. One drawback of this route is that it primarily serves trip attractors and not producers, which typically include residential areas. Local ridership on this route would be dependent on residents of Brickell, Coconut Grove, transfers from the proposed South Beach Route, and transfers from bus routes.

3. West Shoreline Route (North) - The proposed West Shoreline Route (north of the CBD Terminal) is the longer segment of the parent West Shoreline Route; this variant is intended to serve the Biscayne Bay communities north of Downtown. Although ridership on this route segment is projected to be higher than south of the CBD Terminal, the route is much longer and would require more intensive capital investment including more vessels to maintain the same levels of service along a longer route. Furthermore, new construction activities are required around many of the proposed station locations north of the CBD Terminal.

4. North Beach Route - The proposed North Beach Route serves the area from Haulover to the Venetian Causeway. Opportunity for providing parking facilities appears to be more limited along this route than along the West Shoreline Route. Potential station locations are father apart on this route due to waterway characteristics and the private residential character of much of the eastern Biscayne Bay shoreline. A proposed station at Mount Sinai Medical Center could potentially generate a significant level of commuter ridership.

5. Key Biscayne Route - The proposed Biscayne Bay route likely will serve primarily tourists traveling from locations such as Miami Beach and Coconut Grove to Virginia Key and Crandon Park. A possibility for a park-and-ride facility exists at the Crandon Park Marina. Coordination with the Miami-Dade County Park and Recreation Department is important to determine the feasibility of allocating any existing parking spaces (or underutilized land) to waterborne transit parking at several of the proposed station locations. The western shoreline of the Village of Key Biscayne includes mostly upscale private residential neighborhoods and a private yacht club; therefore, opportunities for providing direct service to the Village appear limited at best.

### Schedule

Implementation of the waterborne transit system, including initiation of the startup routes described above, is recommended to occur over several years and include several phases.

The initial phase of development includes securing funding for the construction of the initial route and stations. A marketing and public involvement campaign should be initiated to inform the public of the proposed system, solicit input from potential users, and to develop community support for the proposed water transit service. One of the objectives of the marketing campaign should be to develop a base of potential users for the service. This phase is crucial to the future success of the system.

Following the initial funding and public involvement phase, the design and permitting phase will occur. Design and permitting of the initial "demonstration" route is expected to last one to two years. Following the route prioritization presented above, the South Beach Route and the southern portion of the Western Shoreline Route are scheduled to be the initial phases of service and would be the first portions of the system to experience the design and permitting phase. Following the design and permitting phase, the construction of the facilities necessary for the "demonstration" route; including terminals, docks, and vessels; will occur.

Phase I (secure funding and public involvement), Phase II (design and permitting), and Phase III (construction or retro-fitting of terminals and construction or leasing of vessels) are expected to occur over a period of 3 to 5 years. Once the "demonstration" route is in place and successfully operating, other routes may be designed and implemented. It is expected that implementation phases will begin overlapping in the future. For instance, the design and permitting phase of the North Beach Route could overlap with the construction of the West Shoreline Route's northern segment.

## Fare Analysis

The analysis of fares from other locations where waterborne transportation service is provided indicates a fundamental difference depending on whether the ferry system is subsidized. Typical one-way single-ride fares range from $5.50 to $9.50 in locations where the system is subsidized. In locations where operations are not subsidized, farebox revenues represent the majority of funding. Fares range from $19 to $37 in these locations. A waterborne transit system in Miami-Dade County would almost certainly need government subsidies to provide a locally acceptable fare structure.

One way of encouraging consistent ridership and improved farebox revenues is to provide daily, weekly, monthly, and annual passes, good for unlimited rides for the specified period. Other flexible passes that are commonly offered are variable, limited multiple ride passes; these could include five-ride, ten-ride, etc., passes. Such passes reduce the per trip cost for patrons while encouraging more ridership, and ridership across multiple trips. A significant means of integrating the proposed water transit service into the County's multimodal network is to offer passes that work interchangeably with Miami-Dade Transit's transit pass program and the County's Metrobus, Metrorail, and Metromover systems.

According to ridership projections developed in the Data Collection and Patronage Estimation Report, approximately 35 percent of the potential waterborne transit patronage is expected to be riders who shift from automobiles. This group is likely comprised primarily of commuters who shift from private automobiles to take advantage of the usual transit benefits of not driving in congested traffic, being able to work (using PDAs and notebook computers), taking advantage of potentially improved travel times, and who also are participating in a potential intrinsically interesting and beneficial travel mode. Most of these transit patrons are also likely to be potential weekly, monthly, or annual pass customers.

The remaining waterborne transit passengers are expected to be patrons who connect from existing Metrobus or Metromover routes, or tourists who ride the system for sightseeing purposes. It is expected that about half of this group of riders may utilize passes. Those who ride a water transit ferry to experience the intrinsic appeal are less likely to purchase passes while regular Miami-Dade Transit riders are more likely to utilize passes. Indeed, there will probably be those who already take transit and further already take advantage of a Metro-Dade Transit Pass to use MDT modes. Waterborne transit should be encouraged to join with and participate in, cross-transit passes.

Based on the above insights, approximately two-thirds of the potential water transit patronage is expected to be potential weekly, monthly, or annual pass customers.

## System Capital Costs

Capital costs are generally incurred before a new transit system (or vehicle) is operational and represent the cost of purchasing and implementing the related infrastructure. One advantage of most waterborne transportation systems is that the "guideway" already exists, so it does not have to be constructed, purchased, or leased. Therefore, waterborne transit systems generally incur much lower per mile capital construction costs than urban rail transit systems. Capital costs for the entire "Phase I" operation, as depicted in Figure 13, have been estimated for this analysis.

### Vessel Capital Costs

For the proposed water transit system to perform effectively and at the service levels described in the System Needs and Operating Characteristics Report, route scheduling analysis indicates that a total of twenty-three (23) passenger vessels and eleven (11) smaller water taxis be utilized to implement the "Phase 1" operation. Please refer to the routes depicted in Figure 13 and the terminal descriptions provided in Appendix F. The estimated cost for the design of the passenger vessel is $180,000. The construction of these vessels is projected to cost $2,000,000 each for a total sum of $46,000,000. The design of the water bus (for use in the downtown circulator) is estimated to cost $100,000. The construction of the water bus vessels is projected to cost $250,000 each. The total cost to design and construct the large ferries and smaller water bus vessels is estimated to be $49,030,000. Table 5 summarizes these vessel costs. Please note that if the waterborne transit system described in the System Needs and Operating Characteristics Report is implemented in phases, vessel capital costs will likely be incurred over several years.

Table 5. Vessel Capital Costs

| Description | Cost | Number | Total Cost |
|---|---|---|---|
| Passenger Ferry Design Cost | $ 180,000 | 1 | $ 180,000 |
| Passenger Ferry Vessel | $ 2,000,000 | 23 | $ 46,000,000 |
| Water Bus (Circulator) Design Cost | $ 100,000 | 1 | $ 100,000 |
| Water Bus (Circulator) Vessel | $ 250,000 | 11 | $ 2,750,000 |
| Total Vessel Costs | | | $ 49,030,000 |

Because the waterborne transit application is specialized, it is practical to purchase the vessels rather than leasing them. The financing costs are discussed in the financial feasibility analysis of this report.

### Terminal Costs

The proposed route network requires the development of a CBD Terminal supplemented by suburban terminals and smaller water bus landings to support the downtown circulator. Additionally, for an operation of this magnitude, it is recommended that a dedicated maintenance facility be constructed for the servicing of the vessels on a continuous, rotational basis. The facility would include a building to fully enclose one vessel, a pier facility, a Travelift ferry lift, parts storage area(s), and crew facilities such as locker rooms, rest rooms, break rooms, and potentially a dining area.

The CBD main terminal is expected to cost $10,000,000, excluding any real estate purchases, easements, or shared resource agreements that may be required. The CBD main terminal as described in the previous chapter of this report will be required to dock up to at least five ferries simultaneously as well as multiple water buses for the downtown circulator route. The suburban terminals and water taxi landings are estimated to cost $1,000,000 and $150,000 each, respectively. Included in these estimates are construction of waterside facilities and landside facilities including passenger amenities. Downtown water bus landings are not expected to include significant landside facility costs. The expected cost for the maintenance facility is approximately $2,000,000. This estimate does not include land for the maintenance facility, which is expected to be located either along the Miami River or within the Port of Miami, as waterfront industrial land in other locations is quite limited within Miami-Dade County. The estimated capital costs projected for the terminals and maintenance facility are $31,200,000. Terminal costs are summarized in Table 6.

Table 6. Terminal Capital Costs

| Description | Cost | Number | Total Cost |
|---|---|---|---|
| CBD Main Terminal | $ 10,000,000 | 1 | $ 10,000,000 |
| Suburban Terminal | $ 1,000,000 | 18 | $18,000,000 |
| Water Taxi Landing | $ 150,000 | 8 | $ 1,200,000 |
| Maintenance Facility | $ 2,000,000 | 1 | $ 2,000,000 |
| Total Terminal Costs | | | $31,200,000 |

It is important to note that the capital costs stated above are an estimation of the total costs required to implement the water transit system described in the System Needs and Operating Characteristics Report. As the operations plan may be implemented in phases, the costs associated with the acquisition of the vessels and construction of the terminals may be phased as well, and result in significantly lower initial capital outlay requirements.

### Rights-of-Way/Land Acquisition Costs

The feasibility evaluation for waterborne transit service requires assessing the value of the land that will probably be needed to site the physical landside facilities. The best way to gauge these real estate costs is to review assessments of land in the immediate vicinity of the proposed terminal facilities. In addition, property owner(s) will need to be identified to know with whom lease or purchase negotiations will be conducted. Land value assessments and ownership information for the proposed terminal locations are presented in Table 7.

The value identified in Table 7 is the 2004 appraised value of the respective properties. Please note that this is not the market value, which is almost always higher than appraised values. Appraised land values are typically the lowest potential estimation of real estate costs assuming properties are even available for purchase or lease agreements. As presented in the System Needs and Operating Characteristics chapter of this report, only a portion of the typical property would need to be used for the implementation of the water transit terminal.

Leasing or easement arrangements with the landowners are recommended to be pursued as the methodology for utilizing the land. Agreements that may be reached with public sector landowners and some private landowners may include maintenance of the property and shared resource arrangements such as parking, bus service access, and pedestrian access ways.

Table 7. Terminal Locations Property Value

| Location | Land Value | Owner |
|---|---|---|
| Downtown Wharf (Chopin Plaza) | $26,034,940 | City of Miami |
| Aventura Community Recreation Facility | $1,806,384 | City of Aventura |
| Sunny Isles Causeway | $384,219 | FDOT |
| Haulover Marina | $83,123,301 | Miami-Dade County |
| FIU North Miami (Biscayne Bay) Campus | $25,101,503 | State of Florida |
| North Bayshore Park | $587,208 | City of Miami Shores |
| Pelican Harbor Park | $652,180 | Miami-Dade County |
| Legion Park | $3,622,915 | City of Miami |
| Margaret Pace Park | $422,813 | City of Miami |
| Brickell @ SE 14$^{th}$ Street | $3,080,000 | South Bayshore Tower, LLP |
| Mercy Hospital | $1,349,970 | Sisters of St. Joseph |
| Coconut Grove (Dinner Key Marina) | $7,406,010 | City of Miami |
| North Beach 69$^{th}$ Street | $1,181,250 | City of Miami Beach |
| Mt. Sinai Hospital | $17,958,008 | Mt. Sinai Hospital of Miami, Inc |
| Island View Park | $7,791,259 | City of Miami Beach |
| Lincoln Road Biscayne Bay | N/A | City of Miami Beach |
| South Pointe Park | $21,565,710 | City of Miami Beach |
| Virginia Key | $2,808,325 | Miami-Dade County |
| Crandon Park Marina | $1,091,614 | Miami-Dade County |

## Operating and Maintenance Costs

A crucial element in assessing the feasibility of the development of a transit system is the estimation of the costs to operate and maintain the system. The major cost components for waterborne transit systems will include personnel, fuels and expendables, maintenance, and administrative costs.

### On-Water Operations Personnel

For this study, it is assumed that vessel crewmembers will be licensed and non-union. Although federal funding is expected to be utilized to capitalize the construction of the vessels and terminals, there is no federal requirement attached to those funds that specify use of unionized crewmembers regarding the system operation. Furthermore, as the operation of the service will most likely be procured through a competitive bidding Request for Proposals (RFP) process, the respondents will most likely propose employment of licensed non-union crewmembers to lower the costs of the proposals.

A single-deck ferry would require a Captain to pilot the vessel; a Mate to assist in navigation, engine maintenance, and ticketing; and a Deckhand to perform mooring operations and to assist in passenger handling activities. Water bus vessels (for the downtown circulator) should be designed with the goal of single-crewmember operation by a licensed Captain; however, this is subject to future United States Coast Guard (USCG) approval. Until such time as that is obtained, and for the purposes of this study, it is assumed that one additional crewmember, a Deckhand, will be required for the water taxis. Table 8 provides current national averages for non-union maritime personnel wages with benefits included.

Table 8. On-Water Personnel Wages

| Position | Hourly Wages | Annual Wages |
|---|---|---|
| Captain | $20 - $22 | $45,000 - $50,000 |
| Mate/Engineer | $16 - $18 | $32,000 - $35,000 |
| Deckhand | $10 - $14 | $22,000 - $28,000 |

The number of passenger vessels operating in the base year, 5-year, and 20-year period is projected to be 7, 23, and 23, respectively, based on the proposed implementation schedule described earlier in this report. Note that other vessels may be required in the 20-year period if the system is expanded beyond the proposed "Phase I" routes. Additionally, 3, 11, and 11 water taxis are expected to be needed in the base year, 5-year, and 20-year period, respectively. Based on the assumptions described above and in the Staffing Requirements section of the System Needs and Operating Characteristics Report, 81, 249, and 249 on-water personnel would be needed to operate the fleet in the base year, 5-year, and 20-year period. Annual salary expenditures for on-water operations personnel are projected to be $2,878,500, $8,853,000, and $11,570,500 in the base year, 5-year, and 20-year period, respectively, based on the wages presented in Table 8. These numbers are indexed by an assumed annual rate of two percent.

Operating and maintenance costs, including annual salary expenditures, are presented in Table 9 following the description of other cost components.

### Landside Operations Personnel

The recommendation for the number of landside personnel for the maintenance and operation of the fully implemented water transit system in Miami-Dade County is to provide three general maintenance personnel, four mechanics, one engineer, three dispatchers, and five ticketing agents. The wages for landside personnel were estimated using the Miami-Dade County *May 2003 National Occupational Employment and Wage Estimates*. As shown in Table 9, the annual expenditures projected for the base year, 5-year, and 20-year period are $286,000, $632,000, and $826,000, respectively. These numbers are indexed by an assumed annual rate of two percent.

### Engine Maintenance Costs

The passenger ferries would have engines that typically require an overhaul when 100,000 gallons of fuel have been consumed. With a typical fuel consumption rate of 22.2 gallons per hour at cruise speed, and around 15 gallons per hour overall when low speed and idling times are factored in, this equates to a time-between-overhauls (TBO) of approximately 6,667 hours. With an average 16-hour operating day, this TBO is approximately one year. Each engine overhaul costs approximately $20,000, and with two engines per vessel, each vessel's annual engine overhaul cost would be approximately $40,000. As full implementation of the water transit system will be conducted in phases, the annual expenditures for the maintenance of engines will vary. However, the expected expenditures for engine maintenance are approximately $280,000 in the base year, and $920,000 in the 5-year and 20-year periods.

### Fuels and Expendables

As fuel costs have fluctuated dramatically in recent years, it is prudent to use a higher estimate to be prepared for a worst-case scenario. Ferries the size of the 100-149 passenger vessels typically consume fuel at a rate of approximately 22.2 gallons per hour. Each vessel is projected to operate an average of 16 hours per day, 365 days per year, for a total of 5,840 annual hours. At a cost of $1.82 per gallon for marine diesel, projected expenditures for fuel are $1,651,700, $5,899,000, and $7,939,000 in the base year, 5-year, and 20-year period, respectively. These costs are summarized in Table 9. Please note that marine diesel prices may vary substantially over a period of twenty years. The current price for marine diesel is at a relatively high level and so is used as a reasonable starting value. Arrangements may be reached through Miami-Dade County contracting to receive volume discounts that may reduce fuel expenditures.

### Administrative Costs

Administrative costs include salaries for administrative personnel, management, marketing, and legal/ accounting, as well as miscellaneous office expenses. The marketing costs shown reflect a higher figure initially for marketing, advertising, and the public campaign required to effectively promote the new water transit service. Estimated administrative costs are summarized in Table 9.

Table 9. Operating and Maintenance Costs

| | Base Year | Year 5 | Year 20 |
|---|---|---|---|
| Direct Operating Costs | | | |
| On-Water Personnel | $ 2,878,500 | $ 8,853,000 | $ 11,570,500 [A] |
| Landside Personnel | $ 286,000 | $ 632,000 | $ 826,000 [A] |
| Fuel | $ 1,651,700 | $ 5,899,000 | $ 7,939,000 [A] |
| Parts and Supplies | $ 36,000 | $ 100,000 | $ 130,700 [A] |
| Engine Maintenance | $ 280,000 | $ 920,000 | $ 920,000 |
| Insurance | $ 261,000 | $ 909,000 | $ 909,000 |
| Total Direct Costs | $ 5,393,200 | $ 17,313,000 | $ 22,295,200 |
| | | | |
| Administrative Costs | | | |
| Salaries | $ 1,200,000 | $ 4,200,000 | $ 5,600,600 [A] |
| Marketing | $ 500,000 | $ 200,000 | $ 250,000 |
| Legal/Accounting | $ 20,000 | $ 40,000 | $ 50,000 |
| Miscellaneous | $ 200,000 | $ 200,000 | $ 220,000 |
| Total Administrative Costs | $ 1,920,000 | $ 4,640,000 | $ 6,120,600 |
| Total Operating and Maintenance Costs | $ 7,313,200 | $ 21,953,000 | $ 28,415,800 |

Note:
(A) - Expenses are projected to increase at an average annual rate of 2 percent after year 5.

# FINANCIAL FEASIBILITY ANALYSIS

A profitable water ferry system is one in which the revenues derived from operations exceed the costs incurred, and provides a return on investment. Typically, the only profitable water ferry systems operating without subsidy serve an extremely limited trip purpose such as connecting an island resort destination with an airport. However, it is a virtual certainty that some form of subsidies will be required to offset operating costs for urban public transportation purposes, thus making it possible to offer reasonable fares for the users of the system. Therefore, other, non-farebox potential sources of revenue should be explored to ensure that the potential system in Miami-Dade County operates at an acceptable financial performance level while maintaining a realistic fare structure and attracting a reasonable ridership.

This chapter is divided into two sections: annual operating revenues and subsidies (including fares, excursions and charters, and other revenue opportunities) and funding sources (including federal, state, and local funding sources).

## Annual Operating Revenues and Subsidies

In general, transit fares cover only a fraction of transit operating costs, and basically no capital costs are recovered by the farebox revenues. Farebox recovery ratios are typically less than 40 percent nationwide, according to the American Public Transportation Association; locally, Metrobus exhibits a farebox recovery ratio of 33%, and the MDT multimodal transit system as a whole exhibits a 27% farebox recovery ratio. Furthermore, TEA-21 continues the federal legislative trend of phasing out federal support for operating assistance. The availability of federal capital assistance stands in stark contrast to the lack of federal assistance provided for transit operations. A transit project sponsor's operating plan should demonstrate an ability to rely on non-federal funding sources to operate and maintain the entire transit system after the proposed transit project is in revenue service.

### Fares

Fares are expected to serve as a primary source of revenue for the water transit system in Miami-Dade County. The one-way single-ride fares for subsidized ferry systems typically range from $5.50 to $9.50. As a water transit system in Miami-Dade County would certainly anticipate subsidization, an analysis on estimated funding requirements based on fare levels of $5.50, $8.00, and $9.50 was conducted for the base year, 5-year, and 20-year periods. The results of these analyses are presented in Tables 10, 11, and 12.

In addition to the fare analyses presented in Tables 10, 11, and 12, a fare analysis was conducted for comparative purposes using the current "premium" fare charged by MDT for an express bus boarding ($1.50 per boarding). The operating deficit based on a fare of $1.50 was calculated as $12,277,545; $24,608,940; and $27,601,426, respectively in the base year, 5-year, and 20-year periods.

Table 13 presents a summary of the operating deficit for the base year, 5-year, and 20-year periods, based on the four fare levels analyzed in this study.

Table 10. Financial Analysis Based on $5.50 One-Way Fare

| | Base Year | Year 5 | Year 20 |
|---|---|---|---|
| Passenger Forecast | 600,000 | 1,700,000 | 1,900,000 |
| Fares | $ 5.50 | $ 5.50 | $ 7.00 |
| Annual Operations Revenues | $ 3,300,000 | $ 9,350,000 | $ 13,300,000 |
| | | | |
| Direct Costs | | | |
| Depreciation - 149-Psngr Ferry Vsl (A) | $ 2,300,000 | $ 2,300,000 | $ 2,300,000 |
| Depreciation - Water Taxi Vessel (A) | $ 25,000 | $ 25,000 | $ 25,000 |
| Insurance | $ 261,000 | $ 909,000 | $ 909,000 |
| Interest Expense (B) | $ 3,239,345 | $ 2,880,940 | $ 160,626 |
| Fuel | $ 1,651,700 | $ 5,899,000 | $ 7,939,000 |
| Parts and Supplies | $ 36,000 | $ 100,000 | $ 130,700 |
| Engine Maintenance | $ 280,000 | $ 920,000 | $ 920,000 |
| On Water Personnel | $ 2,878,500 | $ 8,853,000 | $ 11,570,500 |
| Landside Personnel | $ 286,000 | $ 632,000 | $ 826,000 |
| Direct Costs | $ 10,957,545 | $ 22,518,940 | $ 24,780,826 |
| | | | |
| Administrative Costs | | | |
| Salaries | $ 1,200,000 | $ 4,200,000 | $ 5,600,600 |
| Marketing | $ 500,000 | $ 200,000 | $ 250,000 |
| Legal/Accounting | $ 20,000 | $ 40,000 | $ 50,000 |
| Miscellaneous | $ 200,000 | $ 200,000 | $ 220,000 |
| Total Administrative Costs | $ 1,920,000 | $ 4,640,000 | $ 6,120,600 |
| | | | |
| Total Expenses | $ 12,877,545 | $ 27,158,940 | $ 30,901,426 |
| Surplus (Deficit) | $ (9,577,545) | $ (17,808,940) | $ (17,601,426) |
| Breakeven Fare | $ 21.46 | $ 15.98 | $ 16.26 |

Notes:

(A) - Depreciated over 20 years.

(B) - Based on interest rate of 7 percent.

Table 11. Financial Analysis Based on $8.00 One-Way Fare

| | Base Year | Year 5 | Year 20 |
|---|---|---|---|
| Passenger Forecast | 600,000 | 1,700,000 | 1,900,000 |
| Fares | $ 8.00 | $ 8.00 | $ 10.00 |
| Annual Operations Revenues | $ 4,800,000 | $ 13,600,000 | $ 19,000,000 |
| | | | |
| Direct Costs | | | |
| Depreciation - 149-Psngr Ferry Vsl [(A)] | $ 2,300,000 | $ 2,300,000 | $ 2,300,000 |
| Depreciation - Water Taxi Vessel [(A)] | $ 25,000 | $ 25,000 | $ 25,000 |
| Insurance | $ 261,000 | $ 909,000 | $ 909,000 |
| Interest Expense [(B)] | $ 3,239,345 | $ 2,880,940 | $ 160,626 |
| Fuel | $ 1,651,700 | $ 5,899,000 | $ 7,939,000 |
| Parts and Supplies | $ 36,000 | $ 100,000 | $ 130,700 |
| Engine Maintenance | $ 280,000 | $ 920,000 | $ 920,000 |
| On Water Personnel | $ 2,878,500 | $ 8,853,000 | $ 11,570,500 |
| Landside Personnel | $ 286,000 | $ 632,000 | $ 826,000 |
| Direct Costs | $ 10,957,545 | $ 22,518,940 | $ 24,780,826 |
| | | | |
| Administrative Costs | | | |
| Salaries | $ 1,200,000 | $ 4,200,000 | $ 5,600,600 |
| Marketing | $ 500,000 | $ 200,000 | $ 250,000 |
| Legal/Accounting | $ 20,000 | $ 40,000 | $ 50,000 |
| Miscellaneous | $ 200,000 | $ 200,000 | $ 220,000 |
| Total Administrative Costs | $ 1,920,000 | $ 4,640,000 | $ 6,120,600 |
| | | | |
| Total Expenses | $ 12,877,545 | $ 27,158,940 | $ 30,901,426 |
| Surplus (Deficit) | $ (8,077,545) | $ (13,558,940) | $ (11,901,426) |
| Breakeven Fare | $ 21.46 | $ 15.98 | $ 16.26 |

Notes:
(A) - Depreciated over 20 years
(B) - Based on interest rate of 7 percent.

Table 12. Financial Analysis based on $9.50 One-way Fare

| | Base Year | Year 5 | Year 20 |
|---|---|---|---|
| Passenger Forecast | 600,000 | 1,700,000 | 1,900,000 |
| Fares | $ 9.50 | $ 9.50 | $ 12.00 |
| Annual Operations Revenues | $ 5,700,000 | $ 16,150,000 | $ 22,800,000 |
| | | | |
| Direct Costs | | | |
| Depreciation - 149-Psngr Ferry Vsl (A) | $ 2,300,000 | $ 2,300,000 | $ 2,300,000 |
| Depreciation - Water Taxi Vessel (A) | $ 25,000 | $ 25,000 | $ 25,000 |
| Insurance | $ 261,000 | $ 909,000 | $ 909,000 |
| Interest Expense (B) | $ 3,239,345 | $ 2,880,940 | $ 160,626 |
| Fuel | $ 1,089,043 | $ 3,889,440 | $ 5,234,500 |
| Parts and Supplies | $ 36,000 | $ 100,000 | $ 130,700 |
| Engine Maintenance | $ 244,000.00 | $ 244,000.00 | $ 244,000.00 |
| On Water Personnel | $ 2,878,500 | $ 8,853,000 | $ 11,570,500 |
| Landside Personnel | $ 286,000 | $ 632,000 | $ 826,000 |
| Direct Costs | $ 10,957,545 | $ 22,518,940 | $ 24,780,826 |
| | | | |
| Administrative Costs | | | |
| Salaries | $ 1,200,000 | $ 4,200,000 | $ 5,600,600 |
| Marketing | $ 500,000 | $ 200,000 | $ 250,000 |
| Legal/Accounting | $ 20,000 | $ 40,000 | $ 50,000 |
| Miscellaneous | $ 200,000 | $ 200,000 | $ 220,000 |
| Total Administrative Costs | $ 1,920,000 | $ 4,640,000 | $ 6,120,600 |
| | | | |
| Total Expenses | $ 12,877,545 | $ 27,158,940 | $ 30,901,426 |
| Surplus (Deficit) | $ (7,177,545) | $ (11,008,940) | $ (8,101,426) |
| Breakeven Fare | $ 21.46 | $ 15.98 | $ 16.26 |

Notes:
(A) - Depreciated over 20 years
(B) - Based on interest rate of 7 percent.

Table 13. Summary of Operating Deficit for Various Fare Levels

| Fare | Base Year | Year 5 | Year 20 |
|---|---|---|---|
| $1.50 | $ (12,000,000) | $ (24,600,000) | $ (28,100,000) |
| $5.50 | $ (9,600,000) | $ (17,800,000) | $ (17,600,000) |
| $8.00 | $ (8,100,000) | $ (13,600,000) | $ (11,900,000) |
| $9.50 | $ (7,200,000) | $ (11,000,000) | $ (8,100,000) |

At the fare levels considered in this analysis, the expenses exceed the projected revenue, hence the need for outside funding in every case. The breakeven single-ride one-way fare is $21.46 in the base year, $15.98 in the fifth year, and $16.26 in the twentieth year. The breakeven fare is too high to expect to attract residents and tourists to regularly patronize the system. The analysis shows that at a fare of $5.50, with an increase to $7.00 in Year 20, the ‘make-up’ funding that would be required to break even is approximately $9,600,000; $17,800,000; and $17,600,000 in the base year, 5-year, and 20-year periods, respectively. An initial rate of $9.50, with an increase to $12.00 in Year 20, requires funding of $7,200,000; $11,000,000; and $8,100,000, respectively, in the base year, 5-year, and 20-year periods.

The financial analyses performed for this study indicate that between the 5-year and 20-year analysis period, the breakeven fare tends to approach an equilibrium of approximately $16. Since this fare is higher than can reasonably be charged to patrons, operating subsidies will be required. The annual operating deficit at a base fare level of $5.50 tends to approach an equilibrium ranging from $17 million to $18 million.

The revenues presented in Tables 10, 11, and 12 reflect patronage based on single-ride, one-way fares. To encourage use of the system, the fare could be structured such that patrons realize cost savings by purchasing weekly, monthly, or annual passes, or multi-ride passes. The daily rate could be used as the base rate, then varying fares offered as a factor of that rate. Table 14 presents a model that could be used as a guideline for structuring fares. The all day pass is represented as 'X' and other fares shown as a factor of 'X'. While a fare structure similar to the one presented in Table 14 is recommended to encourage ridership, the revenues generated by fares may vary somewhat from the single-ride one-way fare analysis presented in Tables 10, 11, and 12. Note that the fare model presented in Table 14 represents a significant advantage for patrons purchasing 6-month and annual passes. While it is unusual for such 'deep-cut' passes to be offered by urban public transportation agencies, significant fare advantages are typically offered by waterborne transportation systems in the United States and abroad. Experience from existing waterborne transportation systems was used to develop Table 14.

Table 14. Fare Model

| Category | Fare |
|---|---:|
| Single One Way | .75 - .80X |
| All Day Pass | X |
| 7 Day Pass | 4-5X |
| 1 Month Pass | 7-10X |
| 6 Month Pass | 17-20X |
| Annual Pass | 30-35X |

### Excursions and Charters

It is important to consider alternative sources of revenue such that revenue opportunities are maximized. In addition to offering regularly scheduled trips, the possibility of having non-scheduled trips, such as excursions and charters, should be explored. Excursions are trips to a specific destination as part of an event or may be a trip that originates and terminates at the same location as part of a round-trip tour. Riders on excursions are often part of a group, such as school and community groups. Examples of excursions are dinner and sunset cruises, and site-seeing tours. Vessels that are underutilized could be used for these special excursions and tours, particularly during the off-peak season. Charter services could be offered for private special occasions, like weddings, and parties. While offering excursions and making some vessels available for charter may not be the primary source of revenue, they provide a realistic and promising option for developing an additional source of income.

### Other Revenue Opportunities

Concessions are products and services that are offered in addition to the actual travel (the ride), and present another opportunity for generating additional revenue. Typical concession items include coffee, soft drinks, pastries, and other pre-packaged, easily prepared foods. Concessions could also include the sale of souvenir items, disposable cameras, and other products as the market dictates. The availability of concessions could provide a consistent stream of additional income, particularly on trips with longer duration. Concession opportunities are often available both onboard the water transit vessels and in the vicinity of terminals and passenger waiting areas. In addition to concessions, ads may be displayed on terminal and vessel interior surface, and on the exterior of the boats; this will probably be a relatively minor income generator, but it has, for the most part, proved successful throughout North America, and many other places abroad as well.

## Funding Sources

The following potential funding sources are expected to be available for funding a potential waterborne transit system in Miami-Dade County. Federal funding sources delivered through the Federal Transit program are presented first, followed by state and local funding sources.

### Federal Funding Sources

The United States Department of Transportation (USDOT) Maritime Administration offers a loan program pursuant to Title XI of the Merchant Marine Act guaranteed by the United States Government for the construction of new waterborne vessels. Title XI is now being used in the construction of small passenger ferries in other parts of the country. The primary purpose of the Title XI Program is to promote the growth and modernization of the U.S. waterborne fleet and shipyards. Vessels eligible for Title XI assistance generally include commercial vessels such as passenger, bulk, container, cargo, tankers, tugs, towboats, barges, dredges, oceanographic research, floating power barges, offshore oil rigs, and floating drydocks. Eligible technology generally includes proven technology, techniques and processes to enhance the productivity and quality of shipyards, novel techniques and processes designed to improve shipbuilding, and related industrial production that advances the U.S. shipbuilding state-of-the-art. The engineering design of the vessels must be approved by USDOT. The Title XI Program generally pays for 87 ½ percent of most vessel types; however, other vessel types are limited to 75 percent financing.

The Safe, Accountable, Flexible, and Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) was enacted in August 2005, with the objective of implementing programs that promote efficient and flexible transportation, while meeting the challenges of improving transportation safety, and protecting and enhancing communities and the environment. SAFETEA-LU re-authorized the Ferry Boat Discretionary (FBD) Program that provides funding for the construction of ferry boats and ferry terminal facilities. The FBD Program is administered through the Federal Highway Administration (FHWA).

The FBD Program provides a special funding category for the construction of ferry boats and ferry terminal facilities. In fiscal year 2005, FBD provided $38 million in annual funding, although only $18 million is available for open competition for projects in states other than Alaska, New Jersey, and Washington. A water transit system in Miami-Dade County would be eligible to compete for the $18 million in openly available funding under the FBD Program. Competition for FBD funding is typically formidable. One promising aspect of the SAFETEA-LU re-authorization of the FBD Program is that FBD funding is scheduled to increase every year during the five-year life of the bill. The total funding authorization between 2005 and 2009 is as follows.

- 2005 - $38 million
- 2006 - $55 million
- 2007 - $60 million
- 2008 - $65 million
- 2009 - $67 million

## State Funding Sources

In 2003, the State of Florida legislature enacted Florida Statutes 339.61-64 that created the Florida Strategic Intermodal System (SIS). The SIS was developed in an effort to accomplish a plan that included the following goals:

- § A system that is comprised of statewide and regionally significant facilities and services.
- § A system that includes all modes of transportation for moving both people and goods, including linkages that provide for smooth and efficient transfers between modes and major facilities.
- § Integrate individual facilities, services, forms of transportation and linkages into a single, integrated transportation network.

The SIS designates hubs, corridors, and intermodal centers that would assist the State in accomplishing these goals as part of an overall system. The Florida Department of Transportation (FDOT) allocates a minimum of $60 million annually for the purpose of funding projects under this program. The proposed water transit terminals are envisioned to be intermodal centers that allow passengers to transfer from other travel modes to waterborne transit and are consistent with the goals and objectives of the SIS. Please note that SIS funding is allocated across all SIS corridors and nodes throughout the state. Therefore, a water transit system may have little chance to compete against roadway projects in this milieu.

Three discretionary grant programs are currently offered by FDOT for multimodal funding assistance including the Park and Ride Lot Program, the Public Transit Service Development Grant Program, and the Intermodal Development Program. These programs may provide opportunities to fund components of the waterborne transit system such as park-n-ride lots adjacent to water transit terminals and dedicated shuttle buses that serve water transit terminals.

The Park and Ride Lot Program provides for the purchase and/or leasing of private land for the construction of park and ride lots or the promotion of these lots. This program is an integral part of the commuter assistance program efforts to encourage the use of transit, carpools, vanpools, and other high occupancy modes. Eligible costs include planning, design, right-of-way acquisition, engineering, marketing, and construction of park and ride lots. This funding can be up to 100 percent state funds for projects. Only $1,000,000 is available statewide from the park and ride lot program.

The Public Transit Service Development Grant Program was enacted by the Florida Legislature to provide initial funding for new transit projects. The program is selectively applied to determine whether a new or innovative technique or measure can be used to improve or expand public transit. Eligible costs include operating and capital costs. Up to one-half of the non-federal share of project costs may be awarded. Toll revenue credits may not be used as a match. Local funds or private funds may be used as a match. For projects including operating costs, fares do not count as a match and must be deducted from the project budget. Dedicated shuttle buses that serve water transit terminals should compete well for this funding, as improving or expanding pubic transit is used as a selection criteria. Three drawbacks of the Public Transit Service Development Grant Program are (1) that funding is only provided for the first three years of a project, at which point alternative funding sources will be necessary to continue the service, (2) there are limited funds and many applicants, and (3) there is a waiting list of worthy projects already in line.

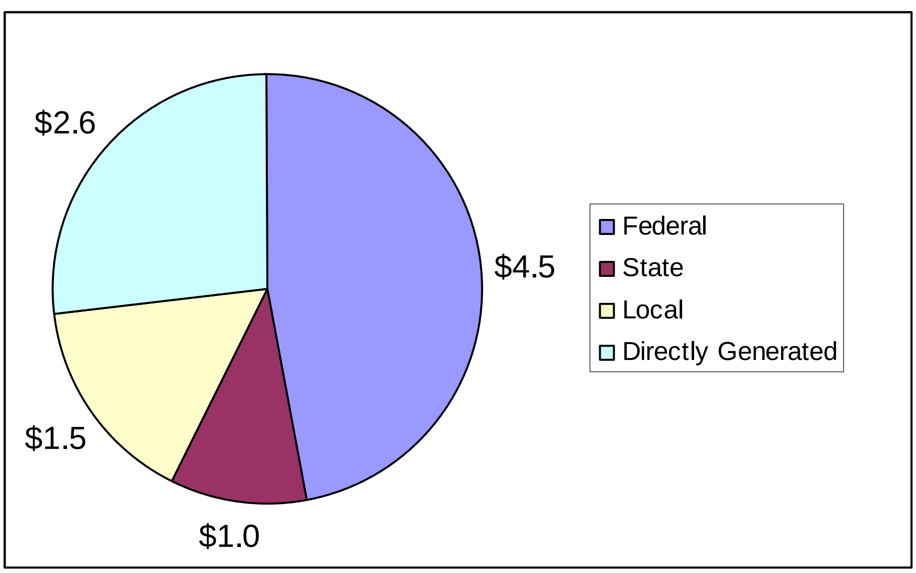
The Intermodal Development Program provides a resource for major capital investment in fixed-guideway transportation systems, access to seaports, airports, and other transportation terminals, providing for the construction of intermodal or multimodal terminals, and to otherwise facilitate the intermodal or multimodal movement of people and goods. Intermodal Development Program funds are allocated to FDOT districts by a formula. Projects that are eligible for funding under this program include major capital investments in public rail and fixed-guideway transportation facilities and systems that provide intermodal access and which have complied with the requirement of the Department's major capital investment policy. These include road, rail, or fixed-guideway access to, from, or between seaports, airports, and other transportation terminals. Construction of multimodal hubs and the development of dedicated bus lanes that facilitate multimodal movement are also eligible to receive Intermodal Development Program funds. Funding for water transit terminals, especially the CBD Terminal, may be possible from this program. However, FDOT typically provides funding for roadway projects that address freight transportation needs through this grant program.

### Local Match

Most Federal funding sources for transit capital improvements have a condition that the Federal share of the eligible capital and program administrative costs can not exceed 80 percent of the net cost of the program. Therefore, at least 20 percent local match is often required to supplement the Federal funds. All of the local share must be from sources other than Federal funds. It is anticipated that the local match will be required for the implementation of waterborne transit service in Miami-Dade County.

Since federal funding sources for transit capital improvements often provide 80/20 match arrangements, a perception exists that the vast majority of funding for transit capital improvements can be obtained from the federal government. In reality, approximately 50 percent of funding for transit capital improvement projects has been generated from federal sources in recent years. Federal legislation such as the Intermodal Surface Transportation Efficiency Act (ISTEA) and the Transportation Equity Act for the 21$^{st}$ Century (TEA-21) has gradually increased the funding level for mass transit projects; however, total expenditures on transit projects continues to escalate nationally as more metropolitan areas look to transit to alleviate travel congestion and mobility deficiencies. Figure 14 presents an overview of the sources of transit capital funding and the percentage of total transit capital expenditures generated by each source. Figure 14 underscores the importance of securing both federal and non-federal sources of funding for transit capital improvement projects. In addition, the federal government seeks to provide capital funding for projects that demonstrate sustainable local sources of operating and maintenance funds to ensure maintaining the level of service of the transit system.

Figure 14. Transit Capital Funding by Source, 2000 ($ Billion)




Source: American Public Transportation Association. *Capital Funding Sources*.

Examples of non-Federal sources include state or local appropriations from general funds, dedicated tax revenues, the sale of revenue bonds, and private equity investment.

Dedicated sales taxes for funding transit projects are increasingly common, particularly for larger mass transit agencies. Miami-Dade County voters recently approved the People's Transportation Plan, which provides funding for transportation projects through a one-half cent increase in sales tax. The People's Transportation Plan is primarily designed to fund mass transit projects, although municipalities receive funds for other transportation projects. Approximately $160 million per year is generated from the one-half cent sales tax in Miami-Dade County, of which $32 million is provided to municipalities. The majority of funds to be generated from the People's Transportation Plan are projected to be used to enhance the Metrobus system and to construct Metrorail lines in multiple transportation corridors.

TEA-21 allows the use of proceeds from the sale of revenue bonds as part of local matching funds for a transit capital project, which increases the flexibility of providing local funds for transit infrastructure improvements. In fact, issuance of long-term debt is the most commonly applied approach to financing of public infrastructure. Long-term debt financing allows transit agencies to develop projects faster than a pay-as-you-go approach by improving short-term cash flow. Debt does have to be repaid with interest, which may reduce a transit agency's ability to invest in further transit capital improvements and may limit resources available to fund system operations.

Bonds are long-term negotiable debt instruments that signify an issuer's obligation to repay a specified principal amount at a specified time at a stated interest rate. Municipal bonds are generally issued on a tax-exempt basis such that the interest earned by investors is exempt from federal income tax. Bonds have proven to be an enduring source of funding in many areas of public finance, including public transportation projects. The recent bond referendum proved successful for Miami-Dade County, whose electorate passed eight Bond issues in November 2004, and illustrates how funding might be raised for waterborne transit financing.

Private equity investment includes strategic public-private partnerships that work for the benefit of multiple parties. The primary rationale for private equity investment in public transportation can be partitioned into three broad categories.

§ Financial - Private parties invest their own money purely for financial return on their investment.
§ Tax - Private parties invest money in a project based on tax benefits they can realize.
§ Strategic - Private parties, such as developers or vendors, may invest in a project in order to help secure business for themselves.

Potential investors who have no relation to a public infrastructure project have very little incentive for investment because the returns are generally not as favorable as can be found in other investment opportunities and the perceived risks are high. While strictly independent "outside investment" in transit projects faces formidable barriers, private participation in transit capital projects on what can be considered a partnership basis is considered more regularly.

For instance, private developers are often contracted to jointly develop transit stations and related facilities. Joint development is a broad term that refers to opportunities in which private investment in and around transit facilities can be harnessed to the benefit of both the private party and the transit agency. Joint development arrangements often involve the private partner making payments to the public entity or the private partner sharing directly in the capital costs with the public sector agency. The private entity is generally willing to share in the costs because of the enhanced real estate or market potential associated with proximity to the transit station.

Joint development arrangements are used primarily by transit agencies to generate revenue, to lower costs, or to enhance services. However, some arrangements have been made by various jurisdictions to utilize joint development agreements to provide upfront capital financing, although this is not as common. Joint development projects are eligible for federal funding and provide a source for matching funds.

Private participation also allows transit agencies to take advantage of the market value of transit assets and for public agencies to share risks associated with acquiring these assets with private partners. Turnkey procurements are one example of such as an arrangement. The premise of a turnkey project is that a public agency hires private contractors to design and construct a facility for a specific price in a specified period of time. Financial risks associated with project delays are usually borne by the contractor but are balanced by financially attractive incentives that are provided to the contractor for early completion. This arrangement is particularly beneficial for agencies developing new facilities with which they are not familiar.

Turnkey procurements encompass a variety of specific legal and fiscal structures including several parties such as a sponsoring agency, an equipment manufacturer, an engineering design firm, a general contractor, and other associated specialty professional firms and subcontractors. In some cases, the assets of a project are turned over to the sponsoring agency following construction; in other cases, the private entities that are a party to the turnkey procurement agree to operate and/or maintain facilities following construction. A partial list of the most common structures of turnkey arrangements is provided below.

- Build-transfer
- Design-build-transfer
- Design-build-operate-transfer
- Design-build-operate-maintain
- Design-build-operate-maintain-finance (also known as “super turnkey” or DBOMF)

Common benefits of turnkey procurements include allowing public funds to be used more efficiently, reducing project costs through the expertise and application of private sector management, contract structures that transfer project risks away from the public sector, and enhanced ability to attract alternative funding sources such as vendor financing and joint development as part of the turnkey transaction. The first phase of the Las Vegas Monorail project is one example of a turnkey transit project in the United States.

It is expected that local funding sources, such as sales tax revenues, bond revenues, joint development arrangements, and turnkey procurement arrangements will need to be utilized to provide adequate funding for the proposed waterborne transit system in Miami-Dade County.

# RECOMMENDED WATERBORNE TRANSIT BUSINESS MODEL

The process of recommending an appropriate business model for the operation of a water transit system in Miami-Dade County involves borrowing or developing, and then evaluating, various management scenarios. For the purposes of this study, three management scenarios were evaluated including a public structure, a private structure, and a public-private structure.

In the context of waterborne transit business models evaluated in this study, 'public' refers to Miami-Dade County, represented by a Management Agency, whose roles and responsibilities will be discussed further in this chapter of the report. In the present case, the term 'private' refers to a waterborne transit service operator that is neither a government-owned nor a government-subsidized enterprise. The options and scenarios presented in this report demonstrate varying levels of public and private involvement and, consequently, control over the establishment of schedules, service standards, and fare levels.

## Public Model

In some situations where the establishment of a water transit system is a result of an objective to comply with public policy initiatives, such as promotion of clean air transportation alternatives or to offer travel alternatives to increasing roadway congestion, the capital facilities, vehicles, and operating expenses for all aspects of both landside and waterside operations are financed by a public agency. If a public business model is chosen, extensive financial burden is placed on the public, as the capital costs for infrastructure, vessels, and other start-up costs, plus the continuing operations and management costs, would be borne by the local government via its Management Agency. In the context of Miami-Dade County, it is likely that the Management Agency, at least initially, would be Miami-Dade Transit (MDT). Furthermore, the County's Code of Ordinances specifically grants the County jurisdiction over virtually all transportation services.

The major variable and risk associated with the public business model is the Management Agency's ability to secure and maintain funding sufficient to cover the required costs. Potential public sector funding and financing sources for waterborne transportation were previously presented in the Financial Feasibility chapter.

An advantage of the public business model option is that the Management Agency would have full control over the operations, schedules, standards of service, and fare structure, etc., of the service. However, the principal disadvantage is that all costs would be borne by the Management Agency, which would place the financial burden on the public.

### Operating Scenarios

Two operating scenarios are available with the public business model. The public agency responsible for the service could operate and maintain the system (the owner-operator model) or the public agency could contract the day-to-day operation of the service to a private transportation provider (the owner *with* operator model) that has no financial responsibility for the system, though their remuneration could be tied to achieving service performance measures.

Owner-Operator - Miami-Dade County owns and operates the system by acquiring the vessels through purchase or lease and maintains the vessels at County maintenance facilities. The County is responsible for staffing the service including administrative personnel, maintenance personnel, and vessel captains, mates, and deckhands. A separate division within MDT may be formed to perform these tasks, with some potential savings realized by overlapping parallel processes, procedures, or purchasing with some existing

MDT functions. Activities such as general and financial administration, personnel and payroll administration, some aspects of maintenance, and offices supplies and furnishings, might be able to be fully or partially merged with those already undertaken by MDT to realize cost-savings and economies of scale. The owner-operator model would also require the use of union employees to operate the system, which would indicate higher labor costs than non-union, private employees.

Owner with Operator - Miami-Dade County contracts the day-to-day operation of the water transportation system to a private transportation provider that operates the system for a fee. Miami-Dade County owns the system and bears financial responsibility for the system including securing funding. Public sector agencies typically pay for operations and maintenance under these arrangements, but leave most of the details to the contracted operator. There is some local history of such endeavors and numerous examples within the transit industry that can be used to refine a possible 'contracted out' approach.

## Private Model

A private business model for waterborne transportation service is one in which the capital costs, including costs for infrastructure and vessel acquisition, maintenance, and operation expenditures, would be the responsibility of a private ferry operator. In this scenario, the ferry operator would necessarily be one that is well-established and has a strong financial position as the initial capital investment would be significant. Additionally, the operator would have to be one that has long term investment objectives, as the returns on initial capital outlay would assuredly not be immediately realized with the establishment of the new service. With no significant investment in establishment and operation of the new service, local government would not be in a particularly favorable position to request concessions regarding schedules, service standards, and fare levels. Furthermore, local government - in this case, most likely Miami-Dade County, but also the municipalities that facilities are located in - would have limited influence should the operator cease operations as a result of the market not responding favorably to the new service.

A major variable with a private business model is the fare level. As there would be no financial assistance in the form of subsidies from the public sector, the fares would have to be set at levels such that all capital and operating expenses are eventually recuperated within some defined measure of time, and that in addition to repaying debt and paying expenses, a profit is realized as well. In most cases, these fares would be at high levels, and potential patrons may be discouraged from utilizing the new service. Exclusively utilizing fares to pay for operating expenses, financing capital outlays, and providing profits for investors is typically a difficult proposition, especially when considering that fares must be kept low enough such that the service provided for the cost to the patron is attractive enough to draw sufficient patronage to produce revenue adequate to meet objectives. Private business models for waterborne transit service can typically only succeed in locations where little or no viable competition is present from other travel modes, which is most certainly not the case in Miami-Dade County.

An advantage of the private business model is that it would require the least capital expenditure by the public sector because the private operator would have full responsibility for operations and service. However, the disadvantages are that the private business model would represent the highest fare structure, as there would be no public financial assistance to offset capital and operating expenditures. Furthermore, local government would have little control over the establishment of service standards, schedules, and fare structure. Finally, and most tellingly, with no financial incentives in place, it would be difficult to attract an independent operator to a system not yet established.

## Public/Private Model

A combination of the public and private business models typically takes the form of the local government establishing a Management Authority or, more usually, an Agency who has the responsibility of providing fixed facilities and usually some aspects of system operations. The Management Agency typically provides administrative functions, while vessels and enroute operating costs are borne by the private operator. In the case of waterborne transit in Miami-Dade County, local government's Management Agency would handle terminal capital expenditures and landside operations, while vessel capital costs and service operating costs are borne by the ferry operator. By having provided landside capital and operating costs, the Management Agency would have some authority to establish acceptable service standards and schedules, and would be better positioned to request concessions regarding the length of contract period. Providing capital and landside operations assistance (such as shuttle bus connections and parking arrangements) offers an incentive for attracting a ferry operator, as the start up costs and risk of the new service would be reduced.

Federal and state transportation grants can be competitively sought to reduce at least a significant portion of infrastructure capital costs that would be borne by the Management Agency. The availability of funding sources for capital project costs is much greater than the availability of non-local operating assistance, though as already noted capital assistance levels remain below applicants' requests. Therefore, the primary advantage of the public/private model is that the Management Agency can attempt to secure more readily-available capital funding sources and the private ferry operator is supplied with much of the infrastructure needed to operate the water transit system.

The major concern in the public/private model is the ability of the Management Agency to secure funding for capital investment and for ancillary operations assistance.

### Contract

Besides the US DOT's Federal Transit Agency's general preference for dealing with only one primary transit provider per jurisdiction, the Miami-Dade County Code of Ordinances specifically grants the County jurisdiction over virtually all transportation services within its boundaries. In a public/private arrangement, the roles of the County and the private transportation provider must be established to specify and clarify respective functions and responsibilities and provide operational and administrative efficiency. Miami-Dade County should enter into an agreement with a private transportation provider that allows the County some oversight and influence over operating and service characteristics. Any such contract should at a minimum include items such as the general description and requirements of the transportation service that the private provider will offer, a description of financial assistance provided by the County including ancillary services, and insurance/indemnification for liabilities associated with the waterborne transit system.

## Recommended Business Model Form

The public/private business model presents the greatest opportunity for the facilitation of the implementation of the waterborne transportation system in Miami-Dade County described in previous chapters of this report.

The major advantage of this model is that securing public funding would make it possible to offer lower fares for the waterborne transportation service, which would encourage residents and visitors to patronize the new service. Because the Management Agency would be responsible for securing funding for the initial capital investment, it may be easier to attract a ferry operator, as those costs would be borne by another source. The ferry operator may be asked to provide or construct vessels for the service. Additionally, in the public/private business model, the Management Agency would have more authority to establish service standards, schedules, and negotiate desired fare levels than in the private business model.

The Management Agency would have the responsibility of negotiating the leases, easements, and/or purchase agreements for the land upon which the CBD Terminal and other terminal facilities will be built. By having made the investment in the infrastructure, and by being the owner/lessee of the terminal facilities, the Agency would most probably reserve the ability to offer long term franchise agreements with the operator. This arrangement would also facilitate the attraction of new operators, should the initial operator cease operations. Furthermore, this could attract state and federal grants, as well as local funding through instruments such as bond issues and other means, as discussed previously in the Financial Feasibility chapter of the report.

The disadvantage of the public/private model is the increased level of funding that the local government acting through its Management Agency would be required to secure for at least the initial capital investment and to maintain portions of the landside operations of the service that integrate into the larger transportation system of Miami-Dade County.

The benefits of utilizing the public/private model outweigh the cost of selecting this business model form. The expected benefits of the public/private model include the following.

- Patrons would likely experience lower fares.
- The Management Agency would have more control of the establishment of service standards and levels than in a private model.
- Existing tax revenue sources are less likely to be used to cover the annual cost of operating the system.
- By not having made significant capital investment, the ferry operator would have a lower exposure to the risk of a new service.

## The Management Agency

To both endorse and ensure the establishment of waterborne transit service, it is crucial that a management structure be put in place to perform four vital functions: (1) to secure necessary funding, (2) to oversee the operations of the service, (3) to ensure that service standards are at appropriate levels, and (4) to actively promote patronage of the new service. The recommended system includes the establishment of an agency that has the authority and ability to efficiently and effectively manage a ferry system. Key management positions should be filled with individuals that are experienced in the management and operations of water transportation services.

One key to the success of the water transit service is to have the ferry operator obligated to one agency. As the public organization, the Management Agency would have several responsibilities including, but not limited to the following.

- Making agreements with respective municipalities and organizations regarding terminal locations, ferry docking, and loading and unloading of passengers.
- Preparing and processing Request for Proposals for the selection of a ferry operator.
- Negotiating franchise agreement with the ferry operator.
- Reviewing operations to ensure compliance.
- Ensuring contract compliance by the ferry operator.
- Promoting and advocating the benefits, and thus encouraging patronage of the new service.

# STUDY SUMMARY AND CONCLUSION

The objective of this study is to develop an appropriate service plan for potential implementation of waterborne transit services in Miami-Dade County that would meet certain mobility goals such as providing a viable transportation alternative to the single occupant automobile for local commuters.

The initial step of this study was performing background research on the utilization of waterways in Miami-Dade County for public passenger transportation. Task work included the in-depth review of the previous feasibility study and a careful analysis of a proposal for waterborne transit service submitted by a private operator, Metro Aqua Cats. In addition, existing waterborne transportation services in neighboring Broward County were reviewed. Other domestic and overseas passenger ferry systems were also reviewed.

The next step in the study process was data compilation and collection. Data from several sources were compiled to analyze existing waterways within Miami-Dade County. Physical and environmental characteristics were assessed for determining both absolute and relative navigability. Most non-navigable sections of canals in Miami-Dade County have spillways, culverts, or low bridges with insufficient clearance that cause sections of the canal to be non-navigable. Unconnected sections of such waterways were subsequently deemed non-navigable because of these breaks in the continuity of the waterways. The most feasible water transit network from the standpoint of physical waterway characteristics consists of routes within Biscayne Bay, the Miami River, and the portion of canals seaward of the salinity dams.

Patronage estimates were developed for base year, and projections were forecast for 5-year, and 20-year planning horizons. Initial patronage is expected to be on the order of 600,000 annual patrons if a system of four to five routes is developed and implemented that serves the portion of the County depicted in Figure 12 (from Coconut Grove to Aventura, including Key Biscayne and Miami Beach), with larger percentage increases in ridership during the first few years following implementation than in subsequent years. Forecast water transit system patronage based on the analysis performed for this study is approximately 1,700,000 annual passengers for a system with approximately a 5-year maturity. It is expected that approximately 20 to 30 percent of water transit patrons may switch main travel modes from private automobiles.

Waterborne transit system needs and characteristics were then analyzed for the *Development of a Service Plan for Waterborne Transit Services in Miami-Dade County* by examining probable terminal requirements, service characteristics, vessel characteristics, staffing requirements, and real estate characteristics for the initially proposed system. Important system characteristics that were developed included the approximate sizing of vessels and terminals, appropriate multimodal links, staffing requirements, and service characteristics. Potential terminal sites were identified and reviewed. A preliminary route structure was developed to link the terminals, and more importantly, link origins and destinations providing a potentially viable commute alternative for travelers. The need for a downtown circulator to complement the regional water transit routes was identified based on travel patterns, service characteristics, and the presence of existing landings along the downtown waterfront. A map of potential routes and terminal locations was developed during this portion of the study and is presented in this report as Figure 13.

Following the development of needs and characteristics, estimates of waterborne service costs were developed. A potential implementation plan was presented that prioritized the implementation of routes, based on the concept that routes would be phased in over time, and therefore so would the system capital assets, rather than amassing, dedicating, and investing the capital required to implement the entire recommended system at once. Incremental and build-out terminal and vessel capital costs were estimated based on the needs developed in the previous chapters of the report. Expected capital costs of the system are estimated to range from $125 to $150 million, assuming that of the real estate needed to construct the terminals, only the portions needed to construct the terminal can be purchased, leased, or utilized through a shared resource arrangement. Annual operations and maintenance (O&M) costs were estimated to provide general guidance on the annual financial commitment required to run the system once it is implemented. The break-even fare for waterborne transportation services was estimated to be approximately $16, which just covers O&M and doesn't offer a financial return on investment. It is realized that this fare is too high to charge patrons and to also expect reasonable ridership performance for the system. Therefore, significant operating subsidies will be required. Operating deficits in the 20-year planning horizon range from approximately $8 million to $18 million per year based primarily on various fare levels that may be selected as the initial passenger revenue source.

A financial feasibility analysis was next performed to determine if funding sources were expected to be available to provide for both capital construction funding and operating subsidies for the waterborne transit service. Although federal funding sources exist, competition is formidable and areas with existing services have a significantly better chance of securing funding. A strong legislative lobby at the federal level would be required to attempt to designate discretionary funding for a water transit start-up service in Miami. Based on the level of federal funding allocated nationwide for water transit systems, there is very little chance of securing funding to cover a significant portion of the estimated $125 to $150 million capital outlay required. Therefore, it is extremely unlikely that the entire system can be constructed at once. Implementing smaller components of the system over time with a combination of federal, local, and perhaps private sector funds is a more realistic approach.

Self-generating forms of revenue include those typical of various landside transit operations: fares, excursion and charter fees, concessions, and advertising. Capital funding may be applied for from the federal government through sources such as Title XI of the Merchant Marine Act and the Ferry Boat Discretionary (FBD) Program. State funding sources include the Strategic Intermodal System (SIS) and discretionary grant programs, which may be more applicable to fund some of the ancillary services associated with the proposed waterborne transit system. Examples of local funding sources include appropriations from general funds, dedicated tax revenues, the sale of revenue bonds, and private equity investment, such as joint development arrangements and turnkey procurements. However, based on national funding data, federal funding typically covers only approximately 50 percent of capital construction costs. Furthermore, no operating assistance is provided from the federal level. Therefore, it is expected that local funding sources will be needed to provide at the very least 50 percent of capital funding for the proposed waterborne transit system in Miami-Dade County, and to make up basically all the operating and maintenance cost shortfall once the system is in place.

Finally, various business models were considered for operating the potential waterborne transportation system in Miami-Dade County. The public/private business model presents the greatest opportunity for an efficient implementation of the waterborne transportation system in Miami-Dade County while maintaining the possibility of offering competitive fares. Although the County would have less control over the operation of the service than in the conventional public sector business model, some influence could be maintained by the County through carefully structured contractual agreements. In addition, the County would benefit from partnering with an experienced waterborne transit operator since there is little or no experience with operating this type of public transportation by the County.

## Conclusion

Waterborne transit services implemented in Miami-Dade County in the past have failed to become a viable public transportation option. A recent feasibility study, *Feasibility of Utilizing Miami-Dade County Waterways for Urban Commuter Travel*, concluded that by appropriately addressing a number of heretofore underaddresed issues, waterborne transportation might be able to be successfully implemented and developed in Miami-Dade County.

The study described in this report provides a service plan that addresses many pertinent issues related to waterborne transit implementation and develops a route structure and service characteristics that are intended to provide adequate service to attract commuters from personal automobiles and provide visitors with a reliable transportation system that may address genuine tourist travel opportunities as well as offering a waterfront "tourist attraction." The service is meant to integrate with Metrobus routes, Metromover, and potential shuttle buses that would be associated with individual terminals. Integrating the potential waterborne transportation system into the County's larger transportation system is one important key to its success. The information presented in this report from other systems around the world that provide service convenient enough for use by a significant percentage of commuters indicates that significant investment in these positive service attributes is required to entice local commuters to frequently utilize the system.

As is the case with public transportation system services, frequent service and long daily service spans increase the operating costs associated with the system. However, per mile construction costs of waterborne transportation systems compare rather advantageously when contrasted with light rail or heavy rail transit, largely due to the use of existing waterways as a "guideway," eliminating typical expensive real estate right-of-way and route construction costs. Per mile implementation costs for waterborne transit are expected to range from one to five percent of heavy rail transit. However, heavy rail transit has the potential to transport at least 10 times more people per hour than the type of water transit vessels described in this report as being appropriate for consideration in Miami-Dade County.

Although per mile capital construction costs are advantageous for waterborne transit, operating and maintenance (O&M) costs are higher for water transit than for other forms of public transportation. This is especially alarming because O&M costs continue indefinitely once a system has been initiated. Table 15 presents a comparison of selected passenger and cost efficiency measures for waterborne transit and existing public transportation services in Miami-Dade County. The information presented in Table 15 for waterborne transit are derived from analyses performed in this study for projected water transit characteristics in Miami-Dade County including the projected service schedule, fare analysis, and the subsequent cost estimates needed to provide for a system capable of generating the patronage projected. Information for Metrobus and Metrorail were derived from data provided by Miami-Dade County and the 2002 National Transit Database (NTD).

Table 15. Comparison of Passenger and Cost Efficiency Measures

| Measure | Water Transit | Metrobus | Metrorail |
|---|---|---|---|
| Passengers per Revenue Mile | 1.0 | 2.4 | 1.9 |
| Operating Expense per Revenue Mile | $12.23 | $6.25 | $8.34 |
| Operating Expense per Passenger | $12.91 | $2.59 | $4.47 |
| Farebox Recovery Ratio | 43.0% | 33.3% | 16.1% |
| Full Fare | $5.50 | $1.25 | $1.25 |

In general, water transit is less expensive to implement than heavy rail transit but more expensive to operate and is not expected to carry as many passengers per revenue mile of service as either rail or bus.

Despite projected statistical shortcomings, experience with existing waterborne transit services demonstrates a certain inherent appeal not found with other forms of public transportation. This certainly enhances the appeal of waterborne transportation for tourists and other Downtown visitors and perhaps for commuters as well if convenient service schedules are provided as described in the system needs chapter. Sleek, modern vessels may enhance the image of the public transportation system and can serve as a source of civic pride for the community.

A demonstration route (waterborne transit pilot program), described in the following chapter, is recommended to be pursued through a public/private partnership to assess the feasibility of providing a suitable water transit service in Miami-Dade County.

# DEMONSTRATION PROJECT

Funding is an acknowledged constraint whenever extending, augmenting, or creating new modes of public transit is considered. Funding is a significant factor when addressing existing transit services and facilities, let alone when developing wholly new modes. In Miami-Dade County, the People's Transportation Plan (PTP) has provided a much needed influx of new funding for existing Miami-Dade transit services, and is also expected to underwrite local applications to the Federal Transit Agency for major capital expansion programs in several prime transit corridors around Miami-Dade by providing the local match for federal transit capital construction funds. But even the significant monies made available by the PTP can only extend so far. For that reason, after deliberating the waterborne transit possibilities, a start-up, 'demonstration' approach was developed to present this novel passenger ferry waterborne transit mode for consideration for initial implementation.

A demonstration water transit project is recommended to be pursued to provide a firsthand assessment of the performance and utilization of water transit in Miami-Dade County. To serve the most germane travel needs associated with waterborne transit, the demonstration route should serve the segment(s) of the proposed system determined to exhibit the highest existing travel flows during the data collection and patronage estimation portion of the service planning study. The demonstration route should connect Miami Beach and Downtown Miami similar to the route described as the South Beach Route on Figure 13 of the report. The use of existing marinas rather than constructing new terminals or performing significant retrofitting to existing marinas is recommended to realize low costs for the demonstration route.

For the Miami CBD water transit stop, a scaled-down version of the CBD Terminal recommended in this study could be utilized along Chopin Plaza, or the existing docking facility within Bayfront Park could be used as well. One advantage of the dock at Chopin Plaza is that small buses could use the turn-around within the City of Miami parking lot to serve the water transit stop and provide enhanced access to downtown destinations. Terminal infrastructure for a demonstration project can be as minimal as two to four shelters, a docking pier, and informational signage displaying pertinent characteristics, including a system map and the destinations served. The waterborne transit terminals for the demonstration project should be provided in locations to which people are already naturally drawn, since less infrastructure is to be built associated with the terminal, making it less visible and identifiable.

The existing Miami Beach Marina may be utilized as a terminal in Miami Beach in lieu of a terminal facility being constructed at South Pointe Park. Coordination with Miami-Dade Transit and the City of Miami Beach is vital to have bus service connect to the water transit station in Miami Beach. Alternatively, a dedicated shuttle bus route could be established to provide connectivity to popular destinations along Collins Avenue and the Lincoln Road Mall.

The demonstration route should also travel to Dinner Key Marina to serve Coconut Grove since an extensive public marina already exists within a two-block walk of an activity center popular with both locals and visitors. It is important to note that the demonstration project should be operated for enough time to allow a fair assessment of its performance. Experience from other metropolitan areas indicates ridership may build gradually over at least the first two to three years of operation.

If the decision is made to develop waterborne services, the County should partner with a private transportation provider to operate the demonstration project. However, the County should insist that the vessel adhere to the requirements outlined in the service planning report, including being fitted with manatee detection equipment. The recommended vessel is a low-wash catamaran with the following characteristics:

- § Minimal draft (3 to 4 feet maximum)
- § Low wake wash (demi-hull length-to-beam ratio of 20 to 1 or greater)
- § Blunt, hemispherical bows
- § Maximum height of 12 feet
- § Vessel capacity of 100 to 125 patrons
- § On-board fare collection to minimize terminal infrastructure needs of the demonstration route

The demonstration route vessel should be a prototype of the eventual fleet design to serve as a true "demonstration" of the ultimate vessel type that is recommended in the service planning report for operating in Miami-Dade County. The vessel should incorporate aesthetic design features that capture the imagination of the public and include environmentally-friendly design features sensitive to the unique aspects of Biscayne Bay and compliant with the 2007 Environmental Protection Agency (EPA) emission requirements.


Low-Wash Catamaran

The opinion of probable capital cost associated with the demonstration ferry vessel is approximately $3 million per vessel. Therefore, the opinion of probable capital cost for a two-vessel demonstration program is approximately $6 million. Traditional leasing is not an option because of the scarcity of leasing companies that provide such a vessel. An existing vessel would not have the required physical characteristics described above. Furthermore, the ferry vessels recommended in this study would have an excellent cost recovery potential if the service was found to be unfeasible following the proper demonstration period. The state-of-the-art vessels could likely be sold for approximately 60 to 65 percent of the original cost. Approximately $700,000 of infrastructure improvements to piers are recommended including shelters, signage, railings, and brows that are compliant with the Americans with Disabilities Act (ADA). Demonstration route operating costs are estimated at approximately $2 million annually.

The demonstration project should be accompanied by a public information and marketing campaign that portrays the water transit service as modern, clean, relaxing, and convenient - and the service should be just that, as well. The importance of marketing the service cannot be understated. The marketing campaign should attempt to make the service easily identifiable and visible to the public. The marketing campaign should also include a description of the destinations served by the water transit line. If residents and visitors do not have a clear understanding of where the system goes, they will be reluctant to use the system.

It is expected that approximately 200,000 annual passengers would utilize a demonstration water transit route during the initial two to three years. Annual passenger activity significantly higher than 200,000 is a strong indication that the demonstration route should be systematically expanded into a larger system as funding becomes available. If significantly lower ridership numbers are realized during the first two to three years, the system should not be expanded and consideration should be given to discontinuing the service. It is important to exercise patience with the demonstration project and to not make decisions regarding whether to continue or terminate the service after only a few months or even one year of service.

One important advantage of implementing a demonstration route is that it allows the opportunity to request and receive feedback from actual patrons of a water transit service in Miami-Dade County regarding important issues such as (1) areas where service should be extended to, (2) new passenger amenities, and (3) any other ideas for improvements.  The feedback of actual passengers is very important and can obviously only be gained once service has been implemented.  Feedback from demonstration route patrons should be collected and analyzed before making decisions regarding whether to extend waterborne transit service, and if so, to what locations and at what frequencies.

To summarize, after having examined the potential of waterborne transit in Miami-Dade County, and found it feasible, a recommendation is forwarded to seek arrangements to develop a private-public partnership to create a demonstration project for such services in Biscayne Bay.  It is believed that there is a chance of success for these services, but that it must also be realized that it is highly unlikely they will provide any revenues, they will assuredly need to be subsidized ad infinitum, and that the benefits derived from these services will have small and incremental effects on roadway congestion, though they may well add to the image and panache of Greater Miami and the Beaches.

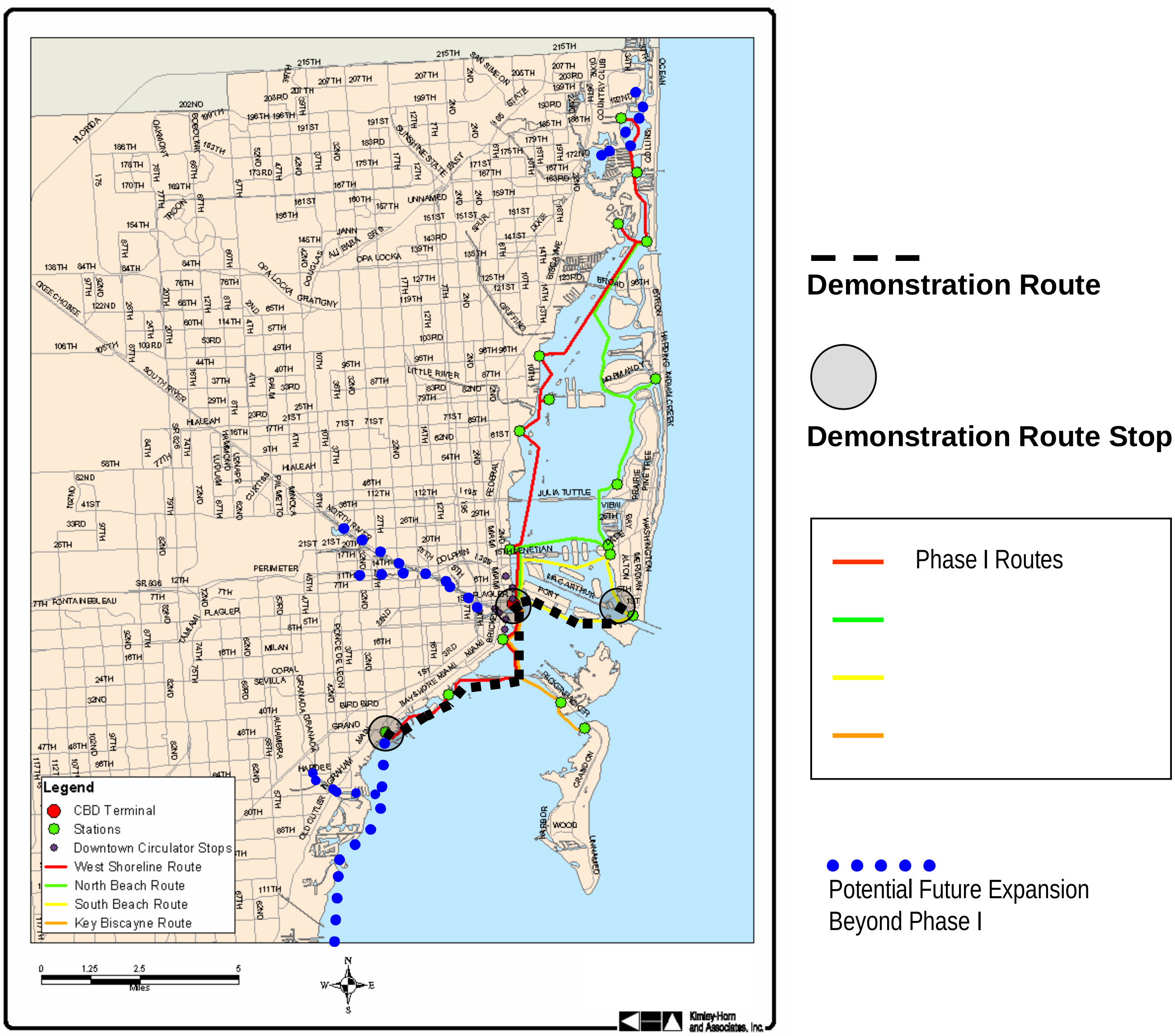



Figure 15.  Potential Water Transit System in Miami-Dade County

# APPENDIX A

# POTENTIAL WATER TRANSIT STATIONS IDENTIFIED IN PREVIOUS STUDIES

## Potential Water Transit Stations Identified in Previous Studies

### West Shoreline

| Station Number | Station Name |
|---|---|
| 1 | Waterways Markets (Turnberry Isle) |
| 2 | Lehman Aventura Wharf |
| 3 | Founders Park (NE 190th Street) |
| 4 | NE 163rd Street Wharf |
| 5 | Haulover Wharf |
| 6 | FIU Biscayne |
| 7 | NE 109th Street @ North Bayshore Drive |
| 8 | NE 94th Street (North Bayshore Park) |
| 9 | 79th Street Causeway (North Bay Island) |
| 10 | NE 64th Street (Legion Park) |
| 11 | NE 55th Terrace (Morningside Park) |
| 12 | NE 20th Street (Margaret Pace Park) |
| 13 | Miami Herald / Omni Bus Terminal |
| 14 | Bicentennial Park |
| 15 | American Airlines Arena |
| 16 | Bayside Marketplace Wharf |
| 17 | Downtown Wharf / Inter-Continental Hotel |
| 18 | James L. Knight Convention Center |
| 19 | City of Miami Riverside Administration Bldg |
| 20 | Riverwalk Metromover Station |
| 21 | Financial District Metromover Station |
| 22 | Mercy Hospital |
| 23 | Coconut Grove / Kennedy Park |
| 24 | Coconut Grove Marina |
| 25 | Coconut Grove / McFarlane Avenue |
| 26 | St. Gaudens Court |
| 27 | Matheson Hammock Park |
| 28 | Gables by the Sea |
| 29 | Chapman Field Park |
| 30 | Charles Deering Estate |
| 31 | Black Point Marina |

### Miami Beach

| Station Number | Station Name |
|---|---|
| B1 | Fisher Island |
| B2 | Washington Avenue @ South Pointe Drive |
| B3 | 10th Street |
| B4 | 14th Street |
| B5 | Lincoln Road |
| B6 | Dade Boulevard @ Island View Park |
| B7 | Mount Sinai Hospital |
| B8 | 65th Street / Indian Creek Park |
| B9 | Normandy Shores Municipal Golf Course |
| B10 | Byron Avenue @ Tatum Waterway |
| | **Miami River** |
| M1 | NW 17th Avenue @ NW 14th Street |
| M2 | Miami River @ Tamiami Canal |
| | **Coral Gables Canal** |
| CG0 | Cocoplum Circle / Ingraham Park |
| CG1 | Coral Gables Canal @ U.S. 1 |
| | **Tourist** |
| T1 | Parrot Jungle |
| T2 | Miami Seaquarium |
| T3 | Crandon Park Tennis Center |
| T4 | Cape Florida Lighthouse |
| T5 | Vizcaya |
| T6 | Deering Bay |
| | **Key Biscayne** |
| K1 | Crandon Boulevard |
| K2 | Key Biscayne Yacht Club |

# APPENDIX B

# POTENTIAL WATER TRANSIT STATION RANKINGS BASED ON WORK TRIP CHARACTERISTICS

Potential Water Transit Stations sorted by Percent Transit

| Rank | Station | Location Description | Census Tract | Census Block Group | Mean Travel Time to Work | % Drove Alone | % Carpool | % Transit |
|---|---|---|---|---|---|---|---|---|
| 1 | 19 | City of Miami Admin. | 003601 | 3 | 38.0 | 24.6 | 15.9 | 50.7 |
| 2 | 11 | E 55th Terrace | 002100 | 4 | 48.9 | 42.5 | 7.3 | 46.6 |
| 3 | 17 | Downtown Wharf | 003701 | 1 | 20.1 | 30.8 | 0.0 | 38.0 |
| 4 | 20 | Riverwalk Metro Mover Station | 003701 | 1 | 20.1 | 30.8 | 0.0 | 38.0 |
| 5 | 18 | Convention Center | 006702 | 1 | 29.6 | 44.5 | 9.2 | 32.9 |
| 6 | 12 | 20th Street Park | 002701 | 4 | 36.0 | 34.8 | 28.9 | 27.5 |
| 7 | B8 | 65th Street/Indian Creek | 003907 | 4 | 26.8 | 56.6 | 7.3 | 25.4 |
| 8 | B10 | Byron Avenue | 003901 | 4 | 26.8 | 46.2 | 16.4 | 24.1 |
| 9 | B9 | M.B. Golf Course | 003905 | 2 | 29.8 | 59.0 | 11.0 | 21.8 |
| 10 | B10 | Byron Avenue | 003901 | 5 | 27.9 | 57.6 | 13.1 | 20.3 |
| 11 | B7 | Mt. Sinai Hospital | 004000 | 5 | 18.2 | 56.0 | 8.1 | 20.2 |
| 12 | B10 | Byron Avenue | 003901 | 3 | 37.6 | 48.9 | 21.1 | 18.7 |
| 13 | B8 | 66th Street/Indian Creek | 003907 | 5 | 23.3 | 65.9 | 6.9 | 18.2 |
| 14 | B10 | Byron Avenue | 003901 | 1 | 31.5 | 56.1 | 19.4 | 17.3 |
| 15 | B9 | M.B. Golf Course | 003905 | 4 | 29.7 | 56.8 | 20.4 | 17.1 |
| 16 | 9 | 79th Street Causeway | 001301 | 2 | 33.5 | 62.5 | 17.0 | 16.8 |
| 17 | M1 | NW 17th Ave @ NW 14th St. | 003004 | 2 | 27.8 | 53.6 | 21.3 | 16.7 |
| 18 | 12 | 20th Street Park | 002701 | 3 | 36.1 | 50.7 | 19.2 | 16.6 |
| 19 | B10 | Byron Avenue | 003901 | 2 | 32.1 | 47.1 | 34.0 | 16.2 |
| 20 | 14 | Bicentennial Park | 003702 | 1 | 22.3 | 64.5 | 13.6 | 13.3 |
| 21 | 15 | American Airlines Arena | 003702 | 1 | 22.3 | 64.5 | 13.6 | 13.3 |
| 22 | 16 | Bayside Center Wharf | 003702 | 1 | 22.3 | 64.5 | 13.6 | 13.3 |
| 23 | T1 | Parrot Jungle | 003702 | 1 | 22.3 | 64.5 | 13.6 | 13.3 |
| 24 | 10 | Legion Park | 001302 | 3 | 29.2 | 66.3 | 20.6 | 11.4 |
| 25 | 31 | Black Point Marina | 010602 | 9 | 31.8 | 63.9 | 22.5 | 11.1 |
| 26 | B9 | M.B. Golf Course | 003905 | 3 | 28.6 | 62.7 | 14.1 | 11.0 |
| 27 | 8 | 94th Street | 001202 | 3 | 28.0 | 64.2 | 18.8 | 10.3 |
| 28 | 10 | Legion Park | 001302 | 1 | 26.0 | 66.0 | 19.2 | 10.1 |
| 29 | M1 | NW 17th Ave @ NW 14th St. | 003003 | 1 | 27.5 | 50.4 | 35.2 | 9.3 |
| 30 | B3 | 10th Street | 004401 | 1 | 23.3 | 64.9 | 5.7 | 8.4 |
| 31 | 7 | 109th Street | 001204 | 1 | 28.5 | 71.4 | 10.6 | 8.2 |
| 32 | 9 | 79th Street Causeway | 001301 | 1 | 28.5 | 52.2 | 36.7 | 8.0 |
| 33 | 24 | Coconut Grove | 007100 | 3 | 23.6 | 79.1 | 7.6 | 7.8 |
| 34 | B4 | 14th Street | 004201 | 3 | 19.1 | 58.3 | 10.3 | 7.4 |
| 35 | B5 | Lincoln Road | 004201 | 3 | 19.1 | 58.3 | 10.3 | 7.4 |
| 36 | M2 | Tamiami Canal | 001703 | 2 | 25.0 | 61.1 | 18.0 | 7.1 |
| 37 | CG1 | Gables @ US-1 | 007400 | 2 | 24.0 | 85.6 | 7.5 | 7.0 |
| 38 | 24 | Coconut Grove | 007100 | 1 | 21.8 | 75.7 | 1.0 | 6.9 |
| 39 | B3 | 10th Street | 004300 | 7 | 21.8 | 66.8 | 6.0 | 6.7 |
| 40 | 13 | Herald/Omni Bus Terminal | 002701 | 5 | 21.7 | 63.1 | 5.5 | 6.7 |
| 41 | K2 | Key Biscayne | 004602 | 1 | 20.2 | 62.9 | 17.8 | 6.5 |
| 42 | 11 | E 55th Terrace | 002100 | 3 | 24.2 | 80.0 | 5.6 | 5.9 |
| 43 | B4 | 14th Street | 004201 | 4 | 28.4 | 57.4 | 10.5 | 5.5 |
| 44 | B9 | M.B. Golf Course | 003905 | 1 | 31.4 | 69.2 | 14.3 | 5.4 |
| 45 | 9 | 79th Street Causeway | 003904 | 1 | 27.4 | 73.2 | 15.4 | 5.2 |
| 46 | 4 | 163rd Street Wharf | 000108 | 1 | 35.2 | 68.9 | 14.9 | 4.9 |
| 47 | 5 | Haulover Wharf | 000108 | 1 | 35.2 | 68.9 | 14.9 | 4.9 |
| 48 | 24 | Coconut Grove | 007100 | 2 | 25.0 | 65.6 | 13.5 | 4.5 |
| 49 | 22 | Mercy Hospital | 006800 | 2 | 20.0 | 77.9 | 11.5 | 4.2 |
| 50 | T5 | Vizcaya | 006800 | 2 | 20.0 | 77.9 | 11.5 | 4.2 |
| 51 | 4 | 164th Street Wharf | 000116 | 1 | 31.2 | 75.6 | 16.2 | 4.0 |
| 52 | 9 | 79th Street Causeway | 001301 | 3 | 30.1 | 77.6 | 9.6 | 3.4 |
| 53 | M1 | NW 17th Ave @ NW 14th St. | 003003 | 2 | 26.2 | 71.4 | 21.5 | 3.1 |
| 54 | 18 | Convention Center | 006701 | 2 | 19.1 | 72.1 | 4.3 | 3.1 |
| 55 | 21 | Financial District Metro Mover | 006701 | 2 | 19.1 | 72.1 | 4.3 | 3.1 |
| 56 | CG1 | Univ. of Miami | 007502 | 2 | 12.2 | 16.0 | 4.2 | 3.1 |
| 57 | 23 | Coconut Grove | 006800 | 5 | 22.8 | 82.7 | 3.9 | 3.1 |
| 58 | 25 | Coconut Grove | 006800 | 5 | 22.8 | 82.7 | 3.9 | 3.1 |
| 59 | 1 | Waterways Markets | 000112 | 1 | 29.4 | 84.8 | 4.3 | 2.3 |
| 60 | K2 | Key Biscayne | 004602 | 2 | 23.7 | 74.8 | 6.2 | 2.0 |
| 61 | B7 | Mt. Sinai Hospital | 004000 | 6 | 24.1 | 84.0 | 5.8 | 2.0 |
| 62 | 25 | Coconut Grove | 006800 | 3 | 14.0 | 83.3 | 8.1 | 1.6 |
| 63 | 22 | Mercy Hospital | 006800 | 1 | 17.8 | 83.2 | 4.1 | 1.5 |
| 64 | 25 | Coconut Grove | 006800 | 1 | 17.8 | 83.2 | 4.1 | 1.5 |

Potential Water Transit Stations sorted by Percent Transit

| Rank | Station | Location Description | Census Tract | Census Block Group | Mean Travel Time to Work | % Drove Alone | % Carpool | % Transit |
|---|---|---|---|---|---|---|---|---|
| 65 | K1 | Key Biscayne (East Side) | 004601 | 1 | 24.0 | 76.3 | 9.5 | 1.4 |
| 66 | 30 | Deering Estate Add. South | 008204 | 1 | 35.0 | 84.4 | 7.7 | 1.3 |
| 67 | CG1 | Gables @ US-1 | 007400 | 3 | 21.0 | 81.9 | 5.3 | 1.1 |
| 68 | 3 | Founders Park | 000113 | 2 | 30.7 | 80.1 | 11.2 | 0.9 |
| 69 | 26 | St. Gaudens Road | 007300 | 1 | 18.5 | 74.1 | 1.0 | 0.8 |
| 70 | 8 | 94th Street | 001202 | 1 | 28.2 | 85.6 | 6.8 | 0.7 |
| 71 | 2 | William Lehman Causeway | 000115 | 2 | 35.9 | 81.1 | 6.4 | 0.5 |
| 72 | 27 | Matheson Hammock Park | 008000 | 2 | 32.8 | 79.7 | 5.8 | 0.5 |
| 73 | CG0 | Cocoplum Circle | 008000 | 2 | 32.8 | 79.7 | 5.8 | 0.5 |
| 74 | M2 | Tamiami Canal | 004800 | 1 | 23.1 | 43.8 | 56.3 | 0.0 |
| 75 | M2 | Tamiami Canal | 001703 | 3 | 22.0 | 75.0 | 21.3 | 0.0 |
| 76 | 11 | E 55th Terrace | 002100 | 2 | 20.6 | 66.0 | 16.7 | 0.0 |
| 77 | T4 | Key Biscayne (Lighthouse Pt.) | 004602 | 3 | 24.2 | 79.9 | 16.6 | 0.0 |
| 78 | T6 | Deering Bay | 008201 | 3 | 25.8 | 79.9 | 16.4 | 0.0 |
| 79 | B1 | Fisher Island | 004500 | 2 | 21.9 | 47.3 | 14.3 | 0.0 |
| 80 | B2 | Washington Avenue | 004500 | 2 | 21.9 | 47.3 | 14.3 | 0.0 |
| 81 | 10 | Legion Park | 001302 | 2 | 31.5 | 73.9 | 10.8 | 0.0 |
| 82 | 1 | Waterways Markets | 000111 | 2 | 26.6 | 84.5 | 8.2 | 0.0 |
| 83 | CG1 | Gables @ US-1 | 007400 | 5 | 22.7 | 85.7 | 7.4 | 0.0 |
| 84 | 28 | Gables by the Sea | 008000 | 3 | 26.7 | 82.5 | 7.3 | 0.0 |
| 85 | 29 | Chapman Field Park | 008000 | 3 | 26.7 | 82.5 | 7.3 | 0.0 |
| 86 | B7 | Mt. Sinai Hospital | 004000 | 7 | 21.7 | 69.6 | 5.8 | 0.0 |
| 87 | B6 | Island View Park | 004101 | 5 | 23.0 | 78.6 | 5.7 | 0.0 |
| 88 | 8 | 94th Street | 001202 | 2 | 21.3 | 90.2 | 5.3 | 0.0 |
| 89 | CG0 | Ingraham Park | 008000 | 1 | 27.6 | 85.2 | 4.4 | 0.0 |
| 90 | 3 | Founders Park | 000113 | 1 | 29.7 | 87.8 | 3.9 | 0.0 |
| 91 | T2 | Miami Seaquarium | 004601 | 2 | 0.0 | 0.0 | 0.0 | 0.0 |
| 92 | T3 | Key Biscayne (Crandon) | 004601 | 2 | 0.0 | 0.0 | 0.0 | 0.0 |
| 93 | 6 | FIU Biscayne | 000109 | 2 | 13.5 | 43.9 | 0.0 | 0.0 |
| 94 | CG1 | Gables @ US-1 | 007400 | 4 | 19.6 | 89.8 | 0.0 | 0.0 |
| 95 | 2 | William Lehman Causeway | 000115 | 3 | 25.5 | 100.0 | 0.0 | 0.0 |
| 96 | B7 | Mt. Sinai Hospital | 004000 | 8 | 20.8 | 100.0 | 0.0 | 0.0 |

Potential Water Transit Stations sorted by Percent Carpool

| Rank | Station | Location Description | Census Tract | Census Block Group | Mean Travel Time to Work | % Drove Alone | % Carpool | % Transit |
|---|---|---|---|---|---|---|---|---|
| 1 | M2 | Tamiami Canal | 004800 | 1 | 23.1 | 43.8 | 56.3 | 0.0 |
| 2 | 9 | 79th Street Causeway | 001301 | 1 | 28.5 | 52.2 | 36.7 | 8.0 |
| 3 | M1 | NW 17th Ave @ NW 14th St. | 003003 | 1 | 27.5 | 50.4 | 35.2 | 9.3 |
| 4 | B10 | Byron Avenue | 003901 | 2 | 32.1 | 47.1 | 34.0 | 16.2 |
| 5 | 12 | 20th Street Park | 002701 | 4 | 36.0 | 34.8 | 28.9 | 27.5 |
| 6 | 31 | Black Point Marina | 010602 | 9 | 31.8 | 63.9 | 22.5 | 11.1 |
| 7 | M1 | NW 17th Ave @ NW 14th St. | 003003 | 2 | 26.2 | 71.4 | 21.5 | 3.1 |
| 8 | M1 | NW 17th Ave @ NW 14th St. | 003004 | 2 | 27.8 | 53.6 | 21.3 | 16.7 |
| 9 | M2 | Tamiami Canal | 001703 | 3 | 22.0 | 75.0 | 21.3 | 0.0 |
| 10 | B10 | Byron Avenue | 003901 | 3 | 37.6 | 48.9 | 21.1 | 18.7 |
| 11 | 10 | Legion Park | 001302 | 3 | 29.2 | 66.3 | 20.6 | 11.4 |
| 12 | B9 | M.B. Golf Course | 003905 | 4 | 29.7 | 56.8 | 20.4 | 17.1 |
| 13 | B10 | Byron Avenue | 003901 | 1 | 31.5 | 56.1 | 19.4 | 17.3 |
| 14 | 12 | 20th Street Park | 002701 | 3 | 36.1 | 50.7 | 19.2 | 16.6 |
| 15 | 10 | Legion Park | 001302 | 1 | 26.0 | 66.0 | 19.2 | 10.1 |
| 16 | 8 | 94th Street | 001202 | 3 | 28.0 | 64.2 | 18.8 | 10.3 |
| 17 | M2 | Tamiami Canal | 001703 | 2 | 25.0 | 61.1 | 18.0 | 7.1 |
| 18 | K2 | Key Biscayne | 004602 | 1 | 20.2 | 62.9 | 17.8 | 6.5 |
| 19 | 9 | 79th Street Causeway | 001301 | 2 | 33.5 | 62.5 | 17.0 | 16.8 |
| 20 | 11 | E 55th Terrace | 002100 | 2 | 20.6 | 66.0 | 16.7 | 0.0 |
| 21 | T4 | Key Biscayne (Lighthouse Pt.) | 004602 | 3 | 24.2 | 79.9 | 16.6 | 0.0 |
| 22 | B10 | Byron Avenue | 003901 | 4 | 26.8 | 46.2 | 16.4 | 24.1 |
| 23 | T6 | Deering Bay | 008201 | 3 | 25.8 | 79.9 | 16.4 | 0.0 |
| 24 | 4 | 164th Street Wharf | 000116 | 1 | 31.2 | 75.6 | 16.2 | 4.0 |
| 25 | 19 | City of Miami Admin. | 003601 | 3 | 38.0 | 24.6 | 15.9 | 50.7 |
| 26 | 9 | 79th Street Causeway | 003904 | 1 | 27.4 | 73.2 | 15.4 | 5.2 |
| 27 | 4 | 163rd Street Wharf | 000108 | 1 | 35.2 | 68.9 | 14.9 | 4.9 |
| 28 | 5 | Haulover Wharf | 000108 | 1 | 35.2 | 68.9 | 14.9 | 4.9 |
| 29 | B1 | Fisher Island | 004500 | 2 | 21.9 | 47.3 | 14.3 | 0.0 |
| 30 | B2 | Washington Avenue | 004500 | 2 | 21.9 | 47.3 | 14.3 | 0.0 |
| 31 | B9 | M.B. Golf Course | 003905 | 1 | 31.4 | 69.2 | 14.3 | 5.4 |
| 32 | B9 | M.B. Golf Course | 003905 | 3 | 28.6 | 62.7 | 14.1 | 11.0 |
| 33 | 14 | Bicentennial Park | 003702 | 1 | 22.3 | 64.5 | 13.6 | 13.3 |
| 34 | 15 | American Airlines Arena | 003702 | 1 | 22.3 | 64.5 | 13.6 | 13.3 |
| 35 | 16 | Bayside Center Wharf | 003702 | 1 | 22.3 | 64.5 | 13.6 | 13.3 |
| 36 | T1 | Parrot Jungle | 003702 | 1 | 22.3 | 64.5 | 13.6 | 13.3 |
| 37 | 24 | Coconut Grove | 007100 | 2 | 25.0 | 65.6 | 13.5 | 4.5 |
| 38 | B10 | Byron Avenue | 003901 | 5 | 27.9 | 57.6 | 13.1 | 20.3 |
| 39 | 22 | Mercy Hospital | 006800 | 2 | 20.0 | 77.9 | 11.5 | 4.2 |
| 40 | T5 | Vizcaya | 006800 | 2 | 20.0 | 77.9 | 11.5 | 4.2 |
| 41 | 3 | Founders Park | 000113 | 2 | 30.7 | 80.1 | 11.2 | 0.9 |
| 42 | B9 | M.B. Golf Course | 003905 | 2 | 29.8 | 59.0 | 11.0 | 21.8 |
| 43 | 10 | Legion Park | 001302 | 2 | 31.5 | 73.9 | 10.8 | 0.0 |
| 44 | 7 | 109th Street | 001204 | 1 | 28.5 | 71.4 | 10.6 | 8.2 |
| 45 | B4 | 14th Street | 004201 | 4 | 28.4 | 57.4 | 10.5 | 5.5 |
| 46 | B4 | 14th Street | 004201 | 3 | 19.1 | 58.3 | 10.3 | 7.4 |
| 47 | B5 | Lincoln Road | 004201 | 3 | 19.1 | 58.3 | 10.3 | 7.4 |
| 48 | 9 | 79th Street Causeway | 001301 | 3 | 30.1 | 77.6 | 9.6 | 3.4 |
| 49 | K1 | Key Biscayne (East Side) | 004601 | 1 | 24.0 | 76.3 | 9.5 | 1.4 |
| 50 | 18 | Convention Center | 006702 | 1 | 29.6 | 44.5 | 9.2 | 32.9 |
| 51 | 1 | Waterways Markets | 000111 | 2 | 26.6 | 84.5 | 8.2 | 0.0 |
| 52 | B7 | Mt. Sinai Hospital | 004000 | 5 | 18.2 | 56.0 | 8.1 | 20.2 |
| 53 | 25 | Coconut Grove | 006800 | 3 | 14.0 | 83.3 | 8.1 | 1.6 |
| 54 | 30 | Deering Estate Add. South | 008204 | 1 | 35.0 | 84.4 | 7.7 | 1.3 |
| 55 | 24 | Coconut Grove | 007100 | 3 | 23.6 | 79.1 | 7.6 | 7.8 |
| 56 | CG1 | Gables @ US-1 | 007400 | 2 | 24.0 | 85.6 | 7.5 | 7.0 |
| 57 | CG1 | Gables @ US-1 | 007400 | 5 | 22.7 | 85.7 | 7.4 | 0.0 |
| 58 | 11 | E 55th Terrace | 002100 | 4 | 48.9 | 42.5 | 7.3 | 46.6 |
| 59 | B8 | 65th Street/Indian Creek | 003907 | 4 | 26.8 | 56.6 | 7.3 | 25.4 |
| 60 | 28 | Gables by the Sea | 008000 | 3 | 26.7 | 82.5 | 7.3 | 0.0 |
| 61 | 29 | Chapman Field Park | 008000 | 3 | 26.7 | 82.5 | 7.3 | 0.0 |
| 62 | B8 | 66th Street/Indian Creek | 003907 | 5 | 23.3 | 65.9 | 6.9 | 18.2 |
| 63 | 8 | 94th Street | 001202 | 1 | 28.2 | 85.6 | 6.8 | 0.7 |
| 64 | 2 | William Lehman Causeway | 000115 | 2 | 35.9 | 81.1 | 6.4 | 0.5 |

Potential Water Transit Stations sorted by Percent Carpool

| Rank | Station | Location Description | Census Tract | Census Block Group | Mean Travel Time to Work | % Drove Alone | % Carpool | % Transit |
|---|---|---|---|---|---|---|---|---|
| 65 | K2 | Key Biscayne | 004602 | 2 | 23.7 | 74.8 | 6.2 | 2.0 |
| 66 | B3 | 10th Street | 004300 | 7 | 21.8 | 66.8 | 6.0 | 6.7 |
| 67 | B7 | Mt. Sinai Hospital | 004000 | 7 | 21.7 | 69.6 | 5.8 | 0.0 |
| 68 | 27 | Matheson Hammock Park | 008000 | 2 | 32.8 | 79.7 | 5.8 | 0.5 |
| 69 | CG0 | Cocoplum Circle | 008000 | 2 | 32.8 | 79.7 | 5.8 | 0.5 |
| 70 | B7 | Mt. Sinai Hospital | 004000 | 6 | 24.1 | 84.0 | 5.8 | 2.0 |
| 71 | B3 | 10th Street | 004401 | 1 | 23.3 | 64.9 | 5.7 | 8.4 |
| 72 | B6 | Island View Park | 004101 | 5 | 23.0 | 78.6 | 5.7 | 0.0 |
| 73 | 11 | E 55th Terrace | 002100 | 3 | 24.2 | 80.0 | 5.6 | 5.9 |
| 74 | 13 | Herald/Omni Bus Terminal | 002701 | 5 | 21.7 | 63.1 | 5.5 | 6.7 |
| 75 | CG1 | Gables @ US-1 | 007400 | 3 | 21.0 | 81.9 | 5.3 | 1.1 |
| 76 | 8 | 94th Street | 001202 | 2 | 21.3 | 90.2 | 5.3 | 0.0 |
| 77 | CG0 | Ingraham Park | 008000 | 1 | 27.6 | 85.2 | 4.4 | 0.0 |
| 78 | 18 | Convention Center | 006701 | 2 | 19.1 | 72.1 | 4.3 | 3.1 |
| 79 | 21 | Financial District Metro Mover | 006701 | 2 | 19.1 | 72.1 | 4.3 | 3.1 |
| 80 | 1 | Waterways Markets | 000112 | 1 | 29.4 | 84.8 | 4.3 | 2.3 |
| 81 | CG1 | Univ. of Miami | 007502 | 2 | 12.2 | 16.0 | 4.2 | 3.1 |
| 82 | 22 | Mercy Hospital | 006800 | 1 | 17.8 | 83.2 | 4.1 | 1.5 |
| 83 | 25 | Coconut Grove | 006800 | 1 | 17.8 | 83.2 | 4.1 | 1.5 |
| 84 | 23 | Coconut Grove | 006800 | 5 | 22.8 | 82.7 | 3.9 | 3.1 |
| 85 | 25 | Coconut Grove | 006800 | 5 | 22.8 | 82.7 | 3.9 | 3.1 |
| 86 | 3 | Founders Park | 000113 | 1 | 29.7 | 87.8 | 3.9 | 0.0 |
| 87 | 26 | St. Gaudens Road | 007300 | 1 | 18.5 | 74.1 | 1.0 | 0.8 |
| 88 | 24 | Coconut Grove | 007100 | 1 | 21.8 | 75.7 | 1.0 | 6.9 |
| 89 | T2 | Miami Seaquarium | 004601 | 2 | 0.0 | 0.0 | 0.0 | 0.0 |
| 90 | T3 | Key Biscayne (Crandon) | 004601 | 2 | 0.0 | 0.0 | 0.0 | 0.0 |
| 91 | 17 | Downtown Wharf | 003701 | 1 | 20.1 | 30.8 | 0.0 | 38.0 |
| 92 | 20 | Riverwalk Metro Mover Station | 003701 | 1 | 20.1 | 30.8 | 0.0 | 38.0 |
| 93 | 6 | FIU Biscayne | 000109 | 2 | 13.5 | 43.9 | 0.0 | 0.0 |
| 94 | CG1 | Gables @ US-1 | 007400 | 4 | 19.6 | 89.8 | 0.0 | 0.0 |
| 95 | 2 | William Lehman Causeway | 000115 | 3 | 25.5 | 100.0 | 0.0 | 0.0 |
| 96 | B7 | Mt. Sinai Hospital | 004000 | 8 | 20.8 | 100.0 | 0.0 | 0.0 |

Potential Water Transit Stations sorted by Percent Drove Alone

| Rank | Station | Location Description | Census Tract | Census Block Group | Mean Travel Time to Work | % Drove Alone | % Carpool | % Transit |
|---|---|---|---|---|---|---|---|---|
| 1 | T2 | Miami Seaquarium | 004601 | 2 | 0.0 | 0.0 | 0.0 | 0.0 |
| 2 | T3 | Key Biscayne (Crandon) | 004601 | 2 | 0.0 | 0.0 | 0.0 | 0.0 |
| 3 | CG1 | Univ. of Miami | 007502 | 2 | 12.2 | 16.0 | 4.2 | 3.1 |
| 4 | 19 | City of Miami Admin. | 003601 | 3 | 38.0 | 24.6 | 15.9 | 50.7 |
| 5 | 17 | Downtown Wharf | 003701 | 1 | 20.1 | 30.8 | 0.0 | 38.0 |
| 6 | 20 | Riverwalk Metro Mover Station | 003701 | 1 | 20.1 | 30.8 | 0.0 | 38.0 |
| 7 | 12 | 20th Street Park | 002701 | 4 | 36.0 | 34.8 | 28.9 | 27.5 |
| 8 | 11 | E 55th Terrace | 002100 | 4 | 48.9 | 42.5 | 7.3 | 46.6 |
| 9 | M2 | Tamiami Canal | 004800 | 1 | 23.1 | 43.8 | 56.3 | 0.0 |
| 10 | 6 | FIU Biscayne | 000109 | 2 | 13.5 | 43.9 | 0.0 | 0.0 |
| 11 | 18 | Convention Center | 006702 | 1 | 29.6 | 44.5 | 9.2 | 32.9 |
| 12 | B10 | Byron Avenue | 003901 | 4 | 26.8 | 46.2 | 16.4 | 24.1 |
| 13 | B10 | Byron Avenue | 003901 | 2 | 32.1 | 47.1 | 34.0 | 16.2 |
| 14 | B1 | Fisher Island | 004500 | 2 | 21.9 | 47.3 | 14.3 | 0.0 |
| 15 | B2 | Washington Avenue | 004500 | 2 | 21.9 | 47.3 | 14.3 | 0.0 |
| 16 | B10 | Byron Avenue | 003901 | 3 | 37.6 | 48.9 | 21.1 | 18.7 |
| 17 | M1 | NW 17th Ave @ NW 14th St. | 003003 | 1 | 27.5 | 50.4 | 35.2 | 9.3 |
| 18 | 12 | 20th Street Park | 002701 | 3 | 36.1 | 50.7 | 19.2 | 16.6 |
| 19 | 9 | 79th Street Causeway | 001301 | 1 | 28.5 | 52.2 | 36.7 | 8.0 |
| 20 | M1 | NW 17th Ave @ NW 14th St. | 003004 | 2 | 27.8 | 53.6 | 21.3 | 16.7 |
| 21 | B7 | Mt. Sinai Hospital | 004000 | 5 | 18.2 | 56.0 | 8.1 | 20.2 |
| 22 | B10 | Byron Avenue | 003901 | 1 | 31.5 | 56.1 | 19.4 | 17.3 |
| 23 | B8 | 65th Street/Indian Creek | 003907 | 4 | 26.8 | 56.6 | 7.3 | 25.4 |
| 24 | B9 | M.B. Golf Course | 003905 | 4 | 29.7 | 56.8 | 20.4 | 17.1 |
| 25 | B4 | 14th Street | 004201 | 4 | 28.4 | 57.4 | 10.5 | 5.5 |
| 26 | B10 | Byron Avenue | 003901 | 5 | 27.9 | 57.6 | 13.1 | 20.3 |
| 27 | B4 | 14th Street | 004201 | 3 | 19.1 | 58.3 | 10.3 | 7.4 |
| 28 | B5 | Lincoln Road | 004201 | 3 | 19.1 | 58.3 | 10.3 | 7.4 |
| 29 | B9 | M.B. Golf Course | 003905 | 2 | 29.8 | 59.0 | 11.0 | 21.8 |
| 30 | M2 | Tamiami Canal | 001703 | 2 | 25.0 | 61.1 | 18.0 | 7.1 |
| 31 | 9 | 79th Street Causeway | 001301 | 2 | 33.5 | 62.5 | 17.0 | 16.8 |
| 32 | B9 | M.B. Golf Course | 003905 | 3 | 28.6 | 62.7 | 14.1 | 11.0 |
| 33 | K2 | Key Biscayne | 004602 | 1 | 20.2 | 62.9 | 17.8 | 6.5 |
| 34 | 13 | Herald/Omni Bus Terminal | 002701 | 5 | 21.7 | 63.1 | 5.5 | 6.7 |
| 35 | 31 | Black Point Marina | 010602 | 9 | 31.8 | 63.9 | 22.5 | 11.1 |
| 36 | 8 | 94th Street | 001202 | 3 | 28.0 | 64.2 | 18.8 | 10.3 |
| 37 | 14 | Bicentennial Park | 003702 | 1 | 22.3 | 64.5 | 13.6 | 13.3 |
| 38 | 15 | American Airlines Arena | 003702 | 1 | 22.3 | 64.5 | 13.6 | 13.3 |
| 39 | 16 | Bayside Center Wharf | 003702 | 1 | 22.3 | 64.5 | 13.6 | 13.3 |
| 40 | T1 | Parrot Jungle | 003702 | 1 | 22.3 | 64.5 | 13.6 | 13.3 |
| 41 | B3 | 10th Street | 004401 | 1 | 23.3 | 64.9 | 5.7 | 8.4 |
| 42 | 24 | Coconut Grove | 007100 | 2 | 25.0 | 65.6 | 13.5 | 4.5 |
| 43 | B8 | 66th Street/Indian Creek | 003907 | 5 | 23.3 | 65.9 | 6.9 | 18.2 |
| 44 | 10 | Legion Park | 001302 | 1 | 26.0 | 66.0 | 19.2 | 10.1 |
| 45 | 11 | E 55th Terrace | 002100 | 2 | 20.6 | 66.0 | 16.7 | 0.0 |
| 46 | 10 | Legion Park | 001302 | 3 | 29.2 | 66.3 | 20.6 | 11.4 |
| 47 | B3 | 10th Street | 004300 | 7 | 21.8 | 66.8 | 6.0 | 6.7 |
| 48 | 4 | 163rd Street Wharf | 000108 | 1 | 35.2 | 68.9 | 14.9 | 4.9 |
| 49 | 5 | Haulover Wharf | 000108 | 1 | 35.2 | 68.9 | 14.9 | 4.9 |
| 50 | B9 | M.B. Golf Course | 003905 | 1 | 31.4 | 69.2 | 14.3 | 5.4 |
| 51 | B7 | Mt. Sinai Hospital | 004000 | 7 | 21.7 | 69.6 | 5.8 | 0.0 |
| 52 | 7 | 109th Street | 001204 | 1 | 28.5 | 71.4 | 10.6 | 8.2 |
| 53 | M1 | NW 17th Ave @ NW 14th St. | 003003 | 2 | 26.2 | 71.4 | 21.5 | 3.1 |
| 54 | 18 | Convention Center | 006701 | 2 | 19.1 | 72.1 | 4.3 | 3.1 |
| 55 | 21 | Financial District Metro Mover | 006701 | 2 | 19.1 | 72.1 | 4.3 | 3.1 |
| 56 | 9 | 79th Street Causeway | 003904 | 1 | 27.4 | 73.2 | 15.4 | 5.2 |
| 57 | 10 | Legion Park | 001302 | 2 | 31.5 | 73.9 | 10.8 | 0.0 |
| 58 | 26 | St. Gaudens Road | 007300 | 1 | 18.5 | 74.1 | 1.0 | 0.8 |
| 59 | K2 | Key Biscayne | 004602 | 2 | 23.7 | 74.8 | 6.2 | 2.0 |
| 60 | M2 | Tamiami Canal | 001703 | 3 | 22.0 | 75.0 | 21.3 | 0.0 |
| 61 | 4 | 164th Street Wharf | 000116 | 1 | 31.2 | 75.6 | 16.2 | 4.0 |
| 62 | 24 | Coconut Grove | 007100 | 1 | 21.8 | 75.7 | 1.0 | 6.9 |
| 63 | K1 | Key Biscayne (East Side) | 004601 | 1 | 24.0 | 76.3 | 9.5 | 1.4 |
| 64 | 9 | 79th Street Causeway | 001301 | 3 | 30.1 | 77.6 | 9.6 | 3.4 |

Potential Water Transit Stations sorted by Percent Drove Alone

| Rank | Station | Location Description | Census Tract | Census Block Group | Mean Travel Time to Work | % Drove Alone | % Carpool | % Transit |
|---|---|---|---|---|---|---|---|---|
| 65 | 22 | Mercy Hospital | 006800 | 2 | 20.0 | 77.9 | 11.5 | 4.2 |
| 66 | T5 | Vizcaya | 006800 | 2 | 20.0 | 77.9 | 11.5 | 4.2 |
| 67 | B6 | Island View Park | 004101 | 5 | 23.0 | 78.6 | 5.7 | 0.0 |
| 68 | 24 | Coconut Grove | 007100 | 3 | 23.6 | 79.1 | 7.6 | 7.8 |
| 69 | 27 | Matheson Hammock Park | 008000 | 2 | 32.8 | 79.7 | 5.8 | 0.5 |
| 70 | CG0 | Cocoplum Circle | 008000 | 2 | 32.8 | 79.7 | 5.8 | 0.5 |
| 71 | T6 | Deering Bay | 008201 | 3 | 25.8 | 79.9 | 16.4 | 0.0 |
| 72 | T4 | Key Biscayne (Lighthouse Pt.) | 004602 | 3 | 24.2 | 79.9 | 16.6 | 0.0 |
| 73 | 11 | E 55th Terrace | 002100 | 3 | 24.2 | 80.0 | 5.6 | 5.9 |
| 74 | 3 | Founders Park | 000113 | 2 | 30.7 | 80.1 | 11.2 | 0.9 |
| 75 | 2 | William Lehman Causeway | 000115 | 2 | 35.9 | 81.1 | 6.4 | 0.5 |
| 76 | CG1 | Gables @ US-1 | 007400 | 3 | 21.0 | 81.9 | 5.3 | 1.1 |
| 77 | 28 | Gables by the Sea | 008000 | 3 | 26.7 | 82.5 | 7.3 | 0.0 |
| 78 | 29 | Chapman Field Park | 008000 | 3 | 26.7 | 82.5 | 7.3 | 0.0 |
| 79 | 23 | Coconut Grove | 006800 | 5 | 22.8 | 82.7 | 3.9 | 3.1 |
| 80 | 25 | Coconut Grove | 006800 | 5 | 22.8 | 82.7 | 3.9 | 3.1 |
| 81 | 22 | Mercy Hospital | 006800 | 1 | 17.8 | 83.2 | 4.1 | 1.5 |
| 82 | 25 | Coconut Grove | 006800 | 1 | 17.8 | 83.2 | 4.1 | 1.5 |
| 83 | 25 | Coconut Grove | 006800 | 3 | 14.0 | 83.3 | 8.1 | 1.6 |
| 84 | B7 | Mt. Sinai Hospital | 004000 | 6 | 24.1 | 84.0 | 5.8 | 2.0 |
| 85 | 30 | Deering Estate Add. South | 008204 | 1 | 35.0 | 84.4 | 7.7 | 1.3 |
| 86 | 1 | Waterways Markets | 000111 | 2 | 26.6 | 84.5 | 8.2 | 0.0 |
| 87 | 1 | Waterways Markets | 000112 | 1 | 29.4 | 84.8 | 4.3 | 2.3 |
| 88 | CG0 | Ingraham Park | 008000 | 1 | 27.6 | 85.2 | 4.4 | 0.0 |
| 89 | 8 | 94th Street | 001202 | 1 | 28.2 | 85.6 | 6.8 | 0.7 |
| 90 | CG1 | Gables @ US-1 | 007400 | 2 | 24.0 | 85.6 | 7.5 | 7.0 |
| 91 | CG1 | Gables @ US-1 | 007400 | 5 | 22.7 | 85.7 | 7.4 | 0.0 |
| 92 | 3 | Founders Park | 000113 | 1 | 29.7 | 87.8 | 3.9 | 0.0 |
| 93 | CG1 | Gables @ US-1 | 007400 | 4 | 19.6 | 89.8 | 0.0 | 0.0 |
| 94 | 8 | 94th Street | 001202 | 2 | 21.3 | 90.2 | 5.3 | 0.0 |
| 95 | 2 | William Lehman Causeway | 000115 | 3 | 25.5 | 100.0 | 0.0 | 0.0 |
| 96 | B7 | Mt. Sinai Hospital | 004000 | 8 | 20.8 | 100.0 | 0.0 | 0.0 |

Potential Water Transit Stations sorted by Mean Travel Time to Work

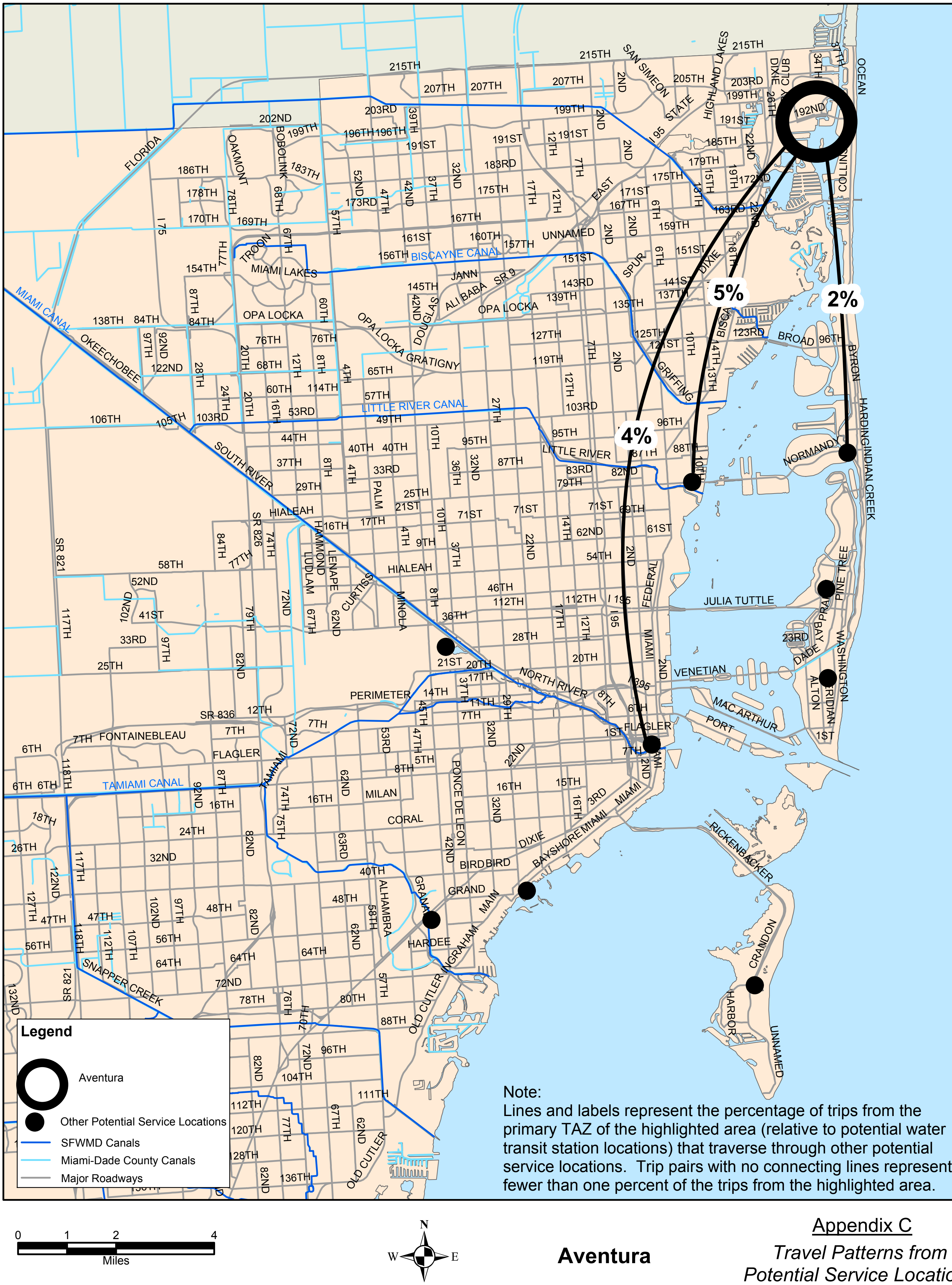
| Rank | Station | Location Description | Census Tract | Census Block Group | Mean Travel Time to Work | % Drove Alone | % Carpool | % Transit |
|---|---|---|---|---|---|---|---|---|
| 1 | 11 | E 55th Terrace | 002100 | 4 | 48.9 | 42.5 | 7.3 | 46.6 |
| 2 | 19 | City of Miami Admin. | 003601 | 3 | 38.0 | 24.6 | 15.9 | 50.7 |
| 3 | B10 | Byron Avenue | 003901 | 3 | 37.6 | 48.9 | 21.1 | 18.7 |
| 4 | 12 | 20th Street Park | 002701 | 3 | 36.1 | 50.7 | 19.2 | 16.6 |
| 5 | 12 | 20th Street Park | 002701 | 4 | 36.0 | 34.8 | 28.9 | 27.5 |
| 6 | 2 | William Lehman Causeway | 000115 | 2 | 35.9 | 81.1 | 6.4 | 0.5 |
| 7 | 4 | 163rd Street Wharf | 000108 | 1 | 35.2 | 68.9 | 14.9 | 4.9 |
| 8 | 5 | Haulover Wharf | 000108 | 1 | 35.2 | 68.9 | 14.9 | 4.9 |
| 9 | 30 | Deering Estate Add. South | 008204 | 1 | 35.0 | 84.4 | 7.7 | 1.3 |
| 10 | 9 | 79th Street Causeway | 001301 | 2 | 33.5 | 62.5 | 17.0 | 16.8 |
| 11 | 27 | Matheson Hammock Park | 008000 | 2 | 32.8 | 79.7 | 5.8 | 0.5 |
| 12 | CG0 | Cocoplum Circle | 008000 | 2 | 32.8 | 79.7 | 5.8 | 0.5 |
| 13 | B10 | Byron Avenue | 003901 | 2 | 32.1 | 47.1 | 34.0 | 16.2 |
| 14 | 31 | Black Point Marina | 010602 | 9 | 31.8 | 63.9 | 22.5 | 11.1 |
| 15 | 10 | Legion Park | 001302 | 2 | 31.5 | 73.9 | 10.8 | 0.0 |
| 16 | B10 | Byron Avenue | 003901 | 1 | 31.5 | 56.1 | 19.4 | 17.3 |
| 17 | B9 | M.B. Golf Course | 003905 | 1 | 31.4 | 69.2 | 14.3 | 5.4 |
| 18 | 4 | 164th Street Wharf | 000116 | 1 | 31.2 | 75.6 | 16.2 | 4.0 |
| 19 | 3 | Founders Park | 000113 | 2 | 30.7 | 80.1 | 11.2 | 0.9 |
| 20 | 9 | 79th Street Causeway | 001301 | 3 | 30.1 | 77.6 | 9.6 | 3.4 |
| 21 | B9 | M.B. Golf Course | 003905 | 2 | 29.8 | 59.0 | 11.0 | 21.8 |
| 22 | 3 | Founders Park | 000113 | 1 | 29.7 | 87.8 | 3.9 | 0.0 |
| 23 | B9 | M.B. Golf Course | 003905 | 4 | 29.7 | 56.8 | 20.4 | 17.1 |
| 24 | 18 | Convention Center | 006702 | 1 | 29.6 | 44.5 | 9.2 | 32.9 |
| 25 | 1 | Waterways Markets | 000112 | 1 | 29.4 | 84.8 | 4.3 | 2.3 |
| 26 | 10 | Legion Park | 001302 | 3 | 29.2 | 66.3 | 20.6 | 11.4 |
| 27 | B9 | M.B. Golf Course | 003905 | 3 | 28.6 | 62.7 | 14.1 | 11.0 |
| 28 | 7 | 109th Street | 001204 | 1 | 28.5 | 71.4 | 10.6 | 8.2 |
| 29 | 9 | 79th Street Causeway | 001301 | 1 | 28.5 | 52.2 | 36.7 | 8.0 |
| 30 | B4 | 14th Street | 004201 | 4 | 28.4 | 57.4 | 10.5 | 5.5 |
| 31 | 8 | 94th Street | 001202 | 1 | 28.2 | 85.6 | 6.8 | 0.7 |
| 32 | 8 | 94th Street | 001202 | 3 | 28.0 | 64.2 | 18.8 | 10.3 |
| 33 | B10 | Byron Avenue | 003901 | 5 | 27.9 | 57.6 | 13.1 | 20.3 |
| 34 | M1 | NW 17th Ave @ NW 14th St. | 003004 | 2 | 27.8 | 53.6 | 21.3 | 16.7 |
| 35 | CG0 | Ingraham Park | 008000 | 1 | 27.6 | 85.2 | 4.4 | 0.0 |
| 36 | M1 | NW 17th Ave @ NW 14th St. | 003003 | 1 | 27.5 | 50.4 | 35.2 | 9.3 |
| 37 | 9 | 79th Street Causeway | 003904 | 1 | 27.4 | 73.2 | 15.4 | 5.2 |
| 38 | B8 | 65th Street/Indian Creek | 003907 | 4 | 26.8 | 56.6 | 7.3 | 25.4 |
| 39 | B10 | Byron Avenue | 003901 | 4 | 26.8 | 46.2 | 16.4 | 24.1 |
| 40 | 28 | Gables by the Sea | 008000 | 3 | 26.7 | 82.5 | 7.3 | 0.0 |
| 41 | 29 | Chapman Field Park | 008000 | 3 | 26.7 | 82.5 | 7.3 | 0.0 |
| 42 | 1 | Waterways Markets | 000111 | 2 | 26.6 | 84.5 | 8.2 | 0.0 |
| 43 | M1 | NW 17th Ave @ NW 14th St. | 003003 | 2 | 26.2 | 71.4 | 21.5 | 3.1 |
| 44 | 10 | Legion Park | 001302 | 1 | 26.0 | 66.0 | 19.2 | 10.1 |
| 45 | T6 | Deering Bay | 008201 | 3 | 25.8 | 79.9 | 16.4 | 0.0 |
| 46 | 2 | William Lehman Causeway | 000115 | 3 | 25.5 | 100.0 | 0.0 | 0.0 |
| 47 | 24 | Coconut Grove | 007100 | 2 | 25.0 | 65.6 | 13.5 | 4.5 |
| 48 | M2 | Tamiami Canal | 001703 | 2 | 25.0 | 61.1 | 18.0 | 7.1 |
| 49 | 11 | E 55th Terrace | 002100 | 3 | 24.2 | 80.0 | 5.6 | 5.9 |
| 50 | T4 | Key Biscayne (Lighthouse Pt.) | 004602 | 3 | 24.2 | 79.9 | 16.6 | 0.0 |
| 51 | B7 | Mt. Sinai Hospital | 004000 | 6 | 24.1 | 84.0 | 5.8 | 2.0 |
| 52 | K1 | Key Biscayne (East Side) | 004601 | 1 | 24.0 | 76.3 | 9.5 | 1.4 |
| 53 | CG1 | Gables @ US-1 | 007400 | 2 | 24.0 | 85.6 | 7.5 | 7.0 |
| 54 | K2 | Key Biscayne | 004602 | 2 | 23.7 | 74.8 | 6.2 | 2.0 |
| 55 | 24 | Coconut Grove | 007100 | 3 | 23.6 | 79.1 | 7.6 | 7.8 |
| 56 | B3 | 10th Street | 004401 | 1 | 23.3 | 64.9 | 5.7 | 8.4 |
| 57 | B8 | 66th Street/Indian Creek | 003907 | 5 | 23.3 | 65.9 | 6.9 | 18.2 |
| 58 | M2 | Tamiami Canal | 004800 | 1 | 23.1 | 43.8 | 56.3 | 0.0 |
| 59 | B6 | Island View Park | 004101 | 5 | 23.0 | 78.6 | 5.7 | 0.0 |
| 60 | 23 | Coconut Grove | 006800 | 5 | 22.8 | 82.7 | 3.9 | 3.1 |
| 61 | 25 | Coconut Grove | 006800 | 5 | 22.8 | 82.7 | 3.9 | 3.1 |
| 62 | CG1 | Gables @ US-1 | 007400 | 5 | 22.7 | 85.7 | 7.4 | 0.0 |
| 63 | 14 | Bicentennial Park | 003702 | 1 | 22.3 | 64.5 | 13.6 | 13.3 |
| 64 | 15 | American Airlines Arena | 003702 | 1 | 22.3 | 64.5 | 13.6 | 13.3 |

Potential Water Transit Stations sorted by Mean Travel Time to Work

| Rank | Station | Location Description | Census Tract | Census Block Group | Mean Travel Time to Work | % Drove Alone | % Carpool | % Transit |
|---|---|---|---|---|---|---|---|---|
| 65 | 16 | Bayside Center Wharf | 003702 | 1 | 22.3 | 64.5 | 13.6 | 13.3 |
| 66 | T1 | Parrot Jungle | 003702 | 1 | 22.3 | 64.5 | 13.6 | 13.3 |
| 67 | M2 | Tamiami Canal | 001703 | 3 | 22.0 | 75.0 | 21.3 | 0.0 |
| 68 | B1 | Fisher Island | 004500 | 2 | 21.9 | 47.3 | 14.3 | 0.0 |
| 69 | B2 | Washington Avenue | 004500 | 2 | 21.9 | 47.3 | 14.3 | 0.0 |
| 70 | 24 | Coconut Grove | 007100 | 1 | 21.8 | 75.7 | 1.0 | 6.9 |
| 71 | B3 | 10th Street | 004300 | 7 | 21.8 | 66.8 | 6.0 | 6.7 |
| 72 | 13 | Herald/Omni Bus Terminal | 002701 | 5 | 21.7 | 63.1 | 5.5 | 6.7 |
| 73 | B7 | Mt. Sinai Hospital | 004000 | 7 | 21.7 | 69.6 | 5.8 | 0.0 |
| 74 | 8 | 94th Street | 001202 | 2 | 21.3 | 90.2 | 5.3 | 0.0 |
| 75 | CG1 | Gables @ US-1 | 007400 | 3 | 21.0 | 81.9 | 5.3 | 1.1 |
| 76 | B7 | Mt. Sinai Hospital | 004000 | 8 | 20.8 | 100.0 | 0.0 | 0.0 |
| 77 | 11 | E 55th Terrace | 002100 | 2 | 20.6 | 66.0 | 16.7 | 0.0 |
| 78 | K2 | Key Biscayne | 004602 | 1 | 20.2 | 62.9 | 17.8 | 6.5 |
| 79 | 17 | Downtown Wharf | 003701 | 1 | 20.1 | 30.8 | 0.0 | 38.0 |
| 80 | 20 | Riverwalk Metro Mover Station | 003701 | 1 | 20.1 | 30.8 | 0.0 | 38.0 |
| 81 | 22 | Mercy Hospital | 006800 | 2 | 20.0 | 77.9 | 11.5 | 4.2 |
| 82 | T5 | Vizcaya | 006800 | 2 | 20.0 | 77.9 | 11.5 | 4.2 |
| 83 | CG1 | Gables @ US-1 | 007400 | 4 | 19.6 | 89.8 | 0.0 | 0.0 |
| 84 | 18 | Convention Center | 006701 | 2 | 19.1 | 72.1 | 4.3 | 3.1 |
| 85 | 21 | Financial District Metro Mover | 006701 | 2 | 19.1 | 72.1 | 4.3 | 3.1 |
| 86 | B4 | 14th Street | 004201 | 3 | 19.1 | 58.3 | 10.3 | 7.4 |
| 87 | B5 | Lincoln Road | 004201 | 3 | 19.1 | 58.3 | 10.3 | 7.4 |
| 88 | 26 | St. Gaudens Road | 007300 | 1 | 18.5 | 74.1 | 1.0 | 0.8 |
| 89 | B7 | Mt. Sinai Hospital | 004000 | 5 | 18.2 | 56.0 | 8.1 | 20.2 |
| 90 | 22 | Mercy Hospital | 006800 | 1 | 17.8 | 83.2 | 4.1 | 1.5 |
| 91 | 25 | Coconut Grove | 006800 | 1 | 17.8 | 83.2 | 4.1 | 1.5 |
| 92 | 25 | Coconut Grove | 006800 | 3 | 14.0 | 83.3 | 8.1 | 1.6 |
| 93 | 6 | FIU Biscayne | 000109 | 2 | 13.5 | 43.9 | 0.0 | 0.0 |
| 94 | CG1 | Univ. of Miami | 007502 | 2 | 12.2 | 16.0 | 4.2 | 3.1 |
| 95 | T2 | Miami Seaquarium | 004601 | 2 | 0.0 | 0.0 | 0.0 | 0.0 |
| 96 | T3 | Key Biscayne (Crandon) | 004601 | 2 | 0.0 | 0.0 | 0.0 | 0.0 |

# APPENDIX C

# TRAVEL DEMAND ANALYSIS MAPS



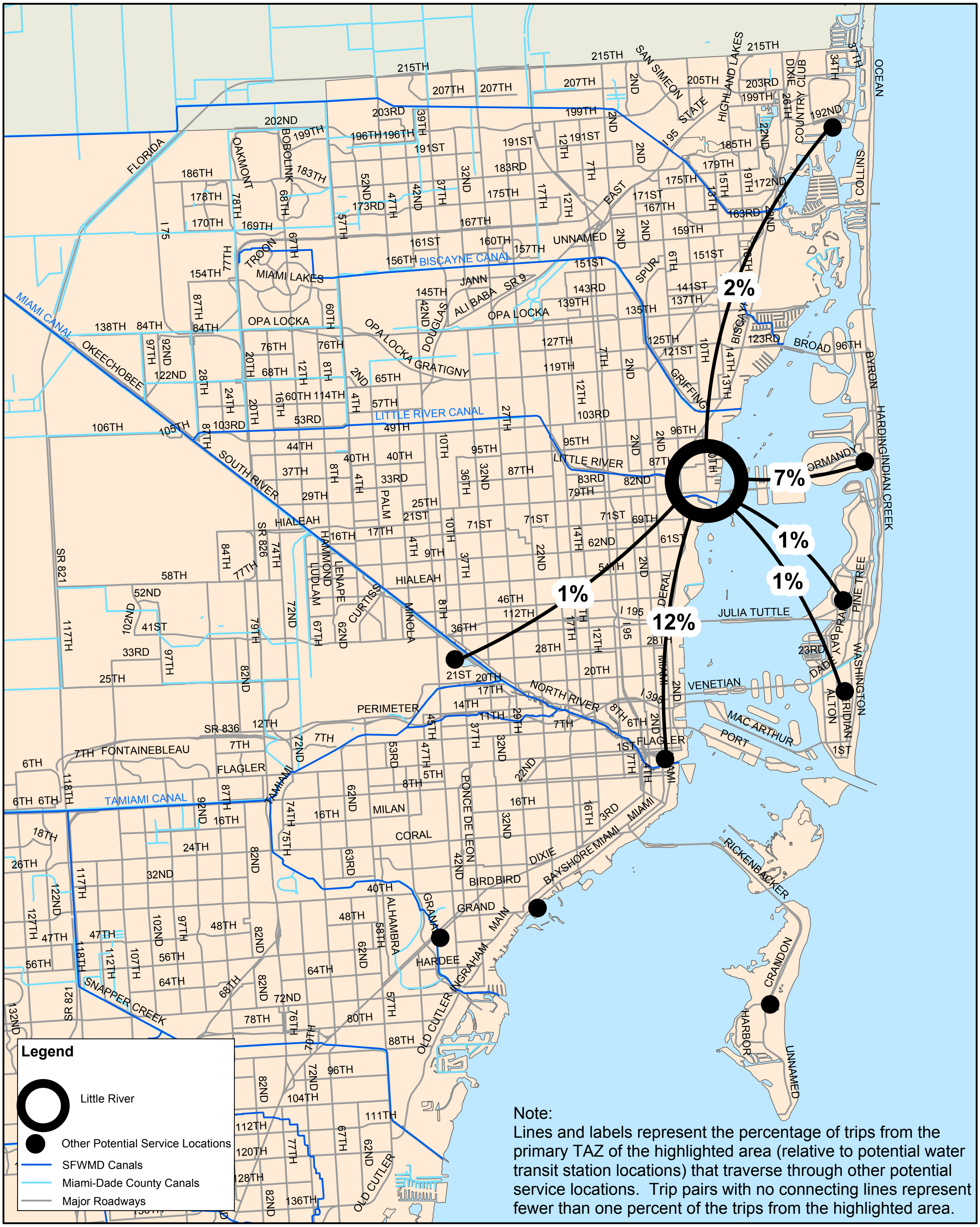

Note:
Lines and labels represent the percentage of trips from the primary TAZ of the highlighted area (relative to potential water transit station locations) that traverse through other potential service locations. Trip pairs with no connecting lines represent fewer than one percent of the trips from the highlighted area.

**Aventura**

Appendix C

*Travel Patterns from Potential Service Locations*

Kimley-Horn and Associates, Inc.




0 1 2 4
Miles

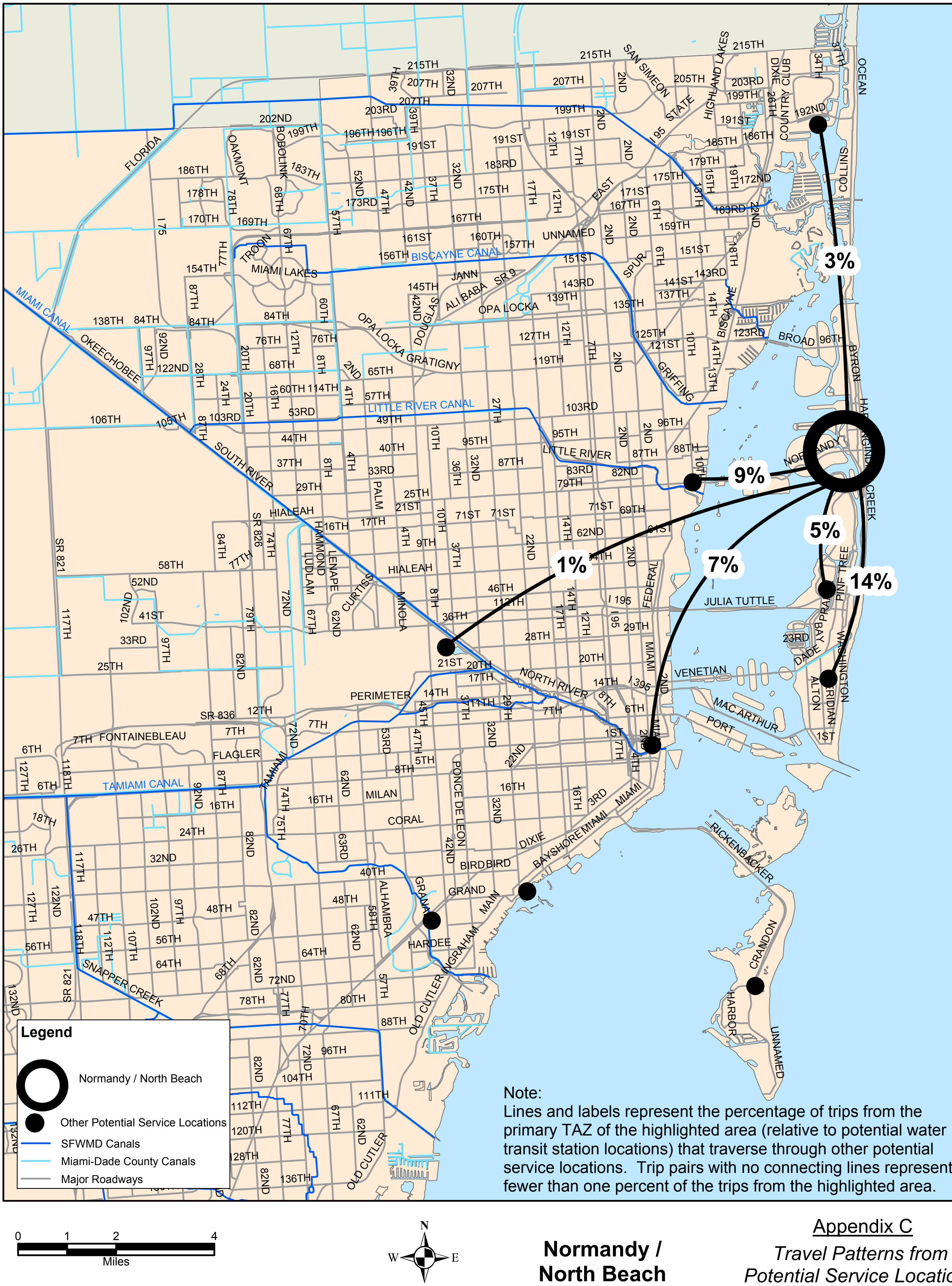
N W E S

**Little River (Mainland side of 79th Street Cswy)**

Appendix C

*Travel Patterns from Potential Service Locations*

Kimley-Horn and Associates, Inc.



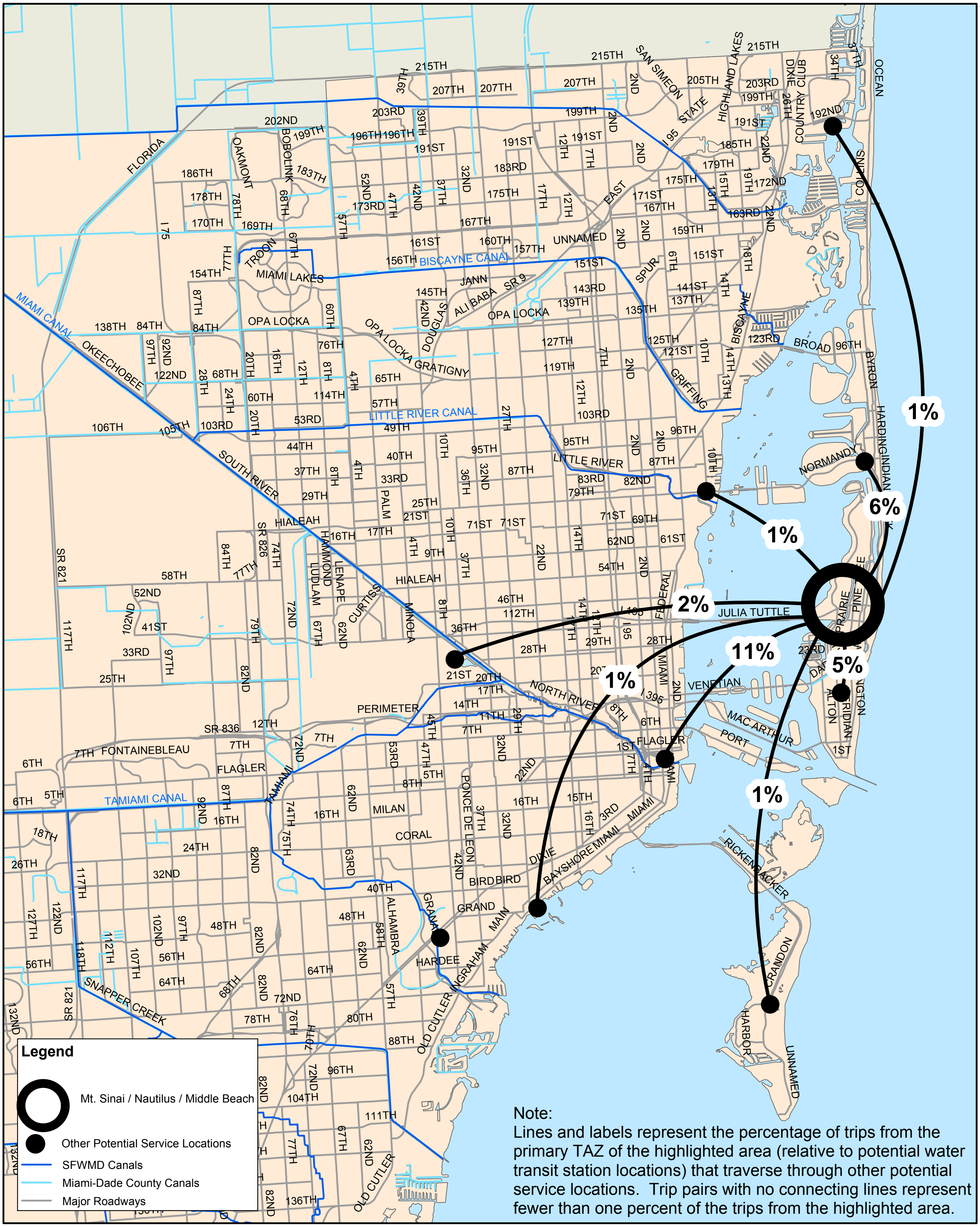

Note:
Lines and labels represent the percentage of trips from the primary TAZ of the highlighted area (relative to potential water transit station locations) that traverse through other potential service locations. Trip pairs with no connecting lines represent fewer than one percent of the trips from the highlighted area.

**Normandy / North Beach**

Appendix C

*Travel Patterns from Potential Service Locations*

Kimley-Horn and Associates, Inc.




Note:
Lines and labels represent the percentage of trips from the primary TAZ of the highlighted area (relative to potential water transit station locations) that traverse through other potential service locations. Trip pairs with no connecting lines represent fewer than one percent of the trips from the highlighted area.

0 1 2 4
Miles

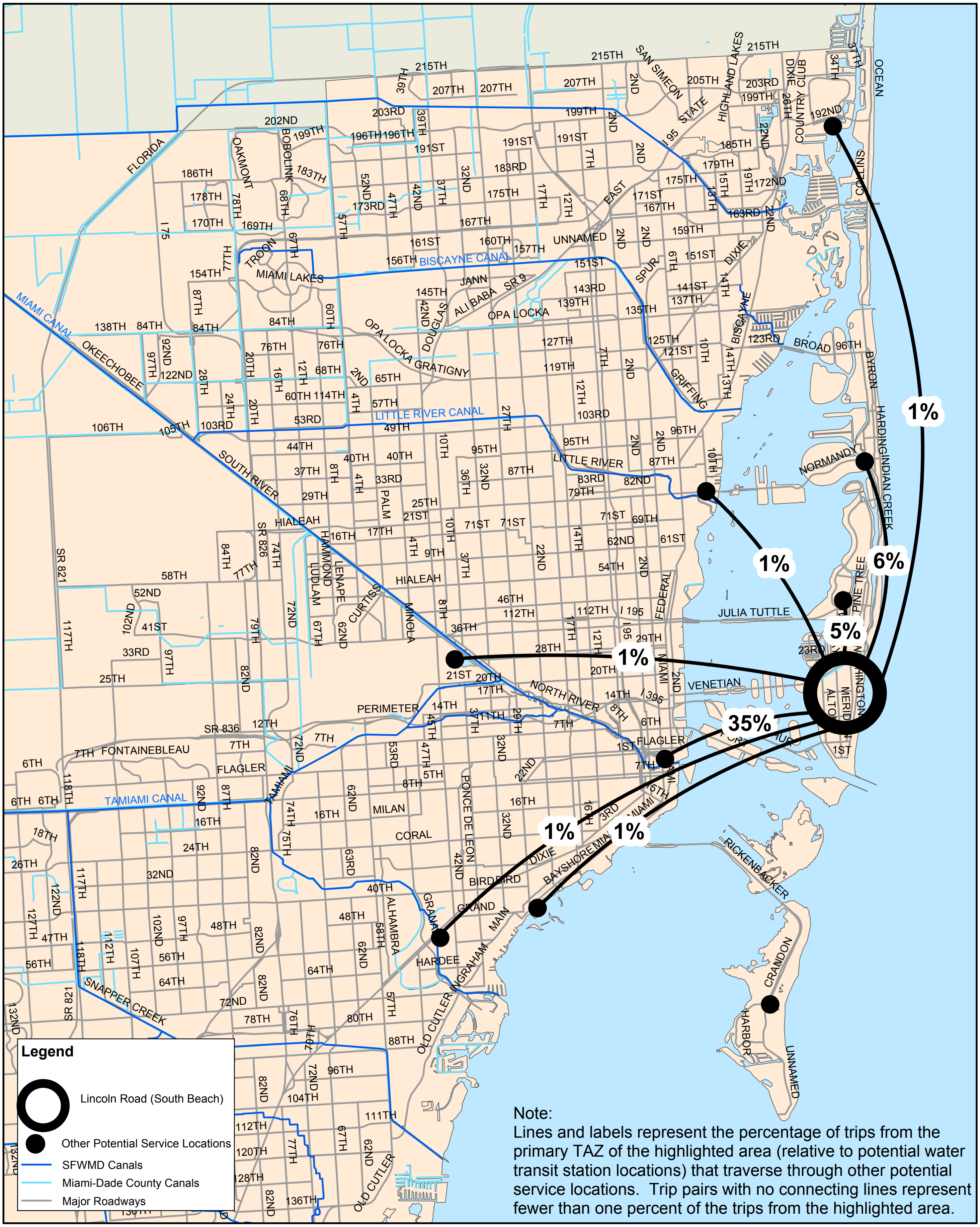
N W E S

**Mt. Sinai / Nautilus / Middle Beach**

Appendix C

*Travel Patterns from Potential Service Locations*

Kimley-Horn and Associates, Inc.



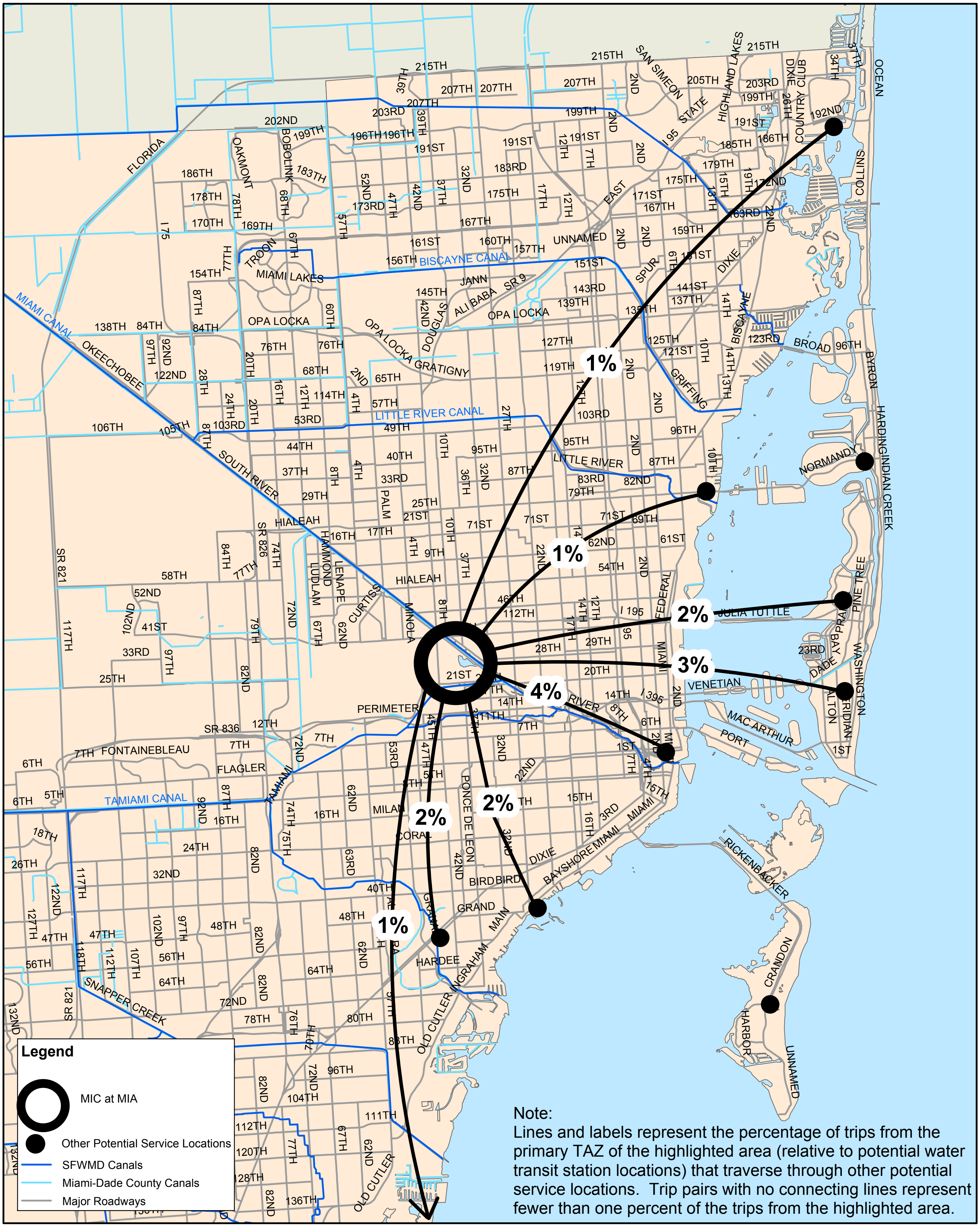

Note:
Lines and labels represent the percentage of trips from the primary TAZ of the highlighted area (relative to potential water transit station locations) that traverse through other potential service locations. Trip pairs with no connecting lines represent fewer than one percent of the trips from the highlighted area.

**Lincoln Road (South Beach)**

Appendix C

*Travel Patterns from Potential Service Locations*

Kimley-Horn and Associates, Inc.




0 1 2 4
Miles

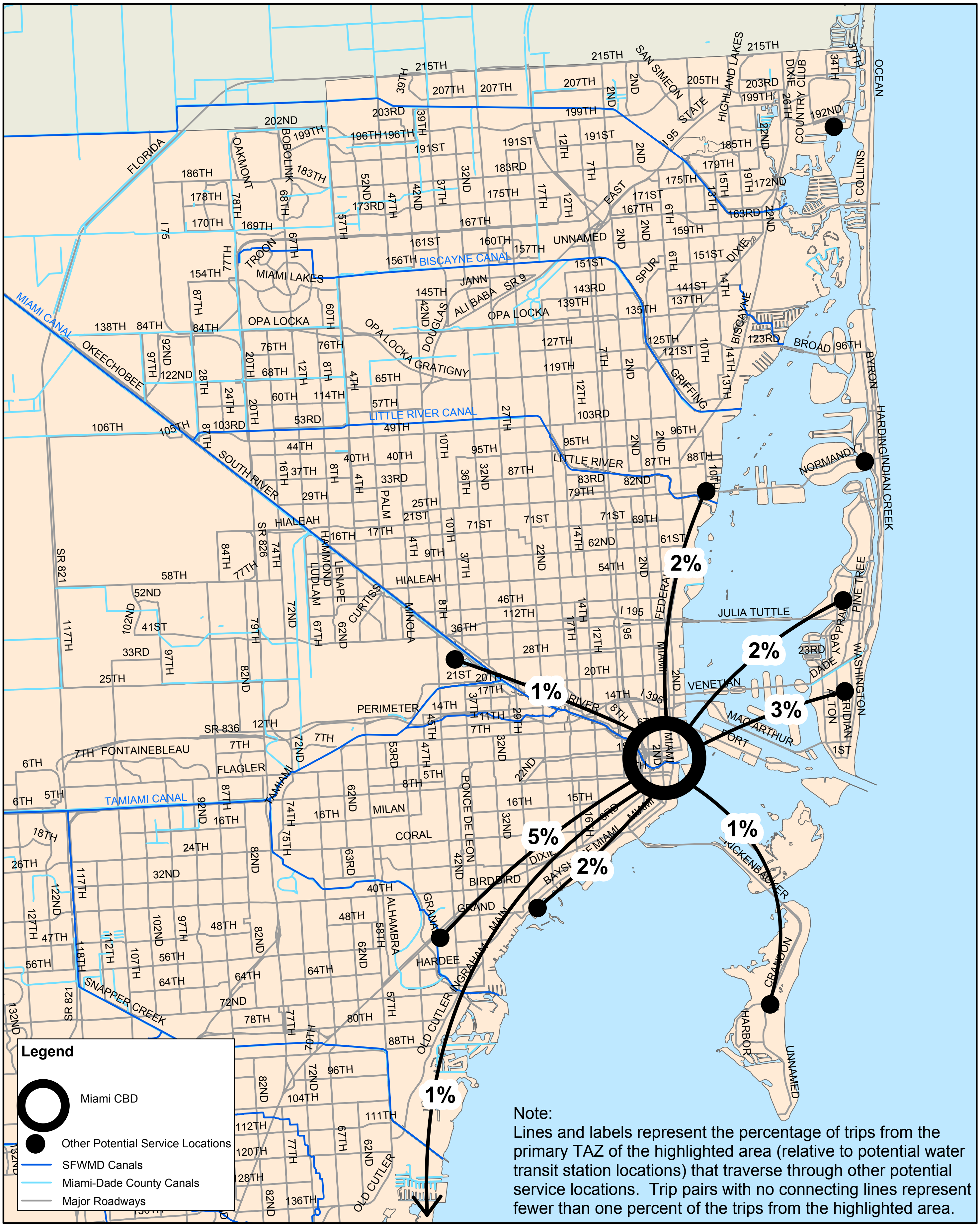
N
W E
S

**MIC at MIA**

Appendix C

*Travel Patterns from Potential Service Locations*

Kimley-Horn and Associates, Inc.




0 1 2 4
Miles

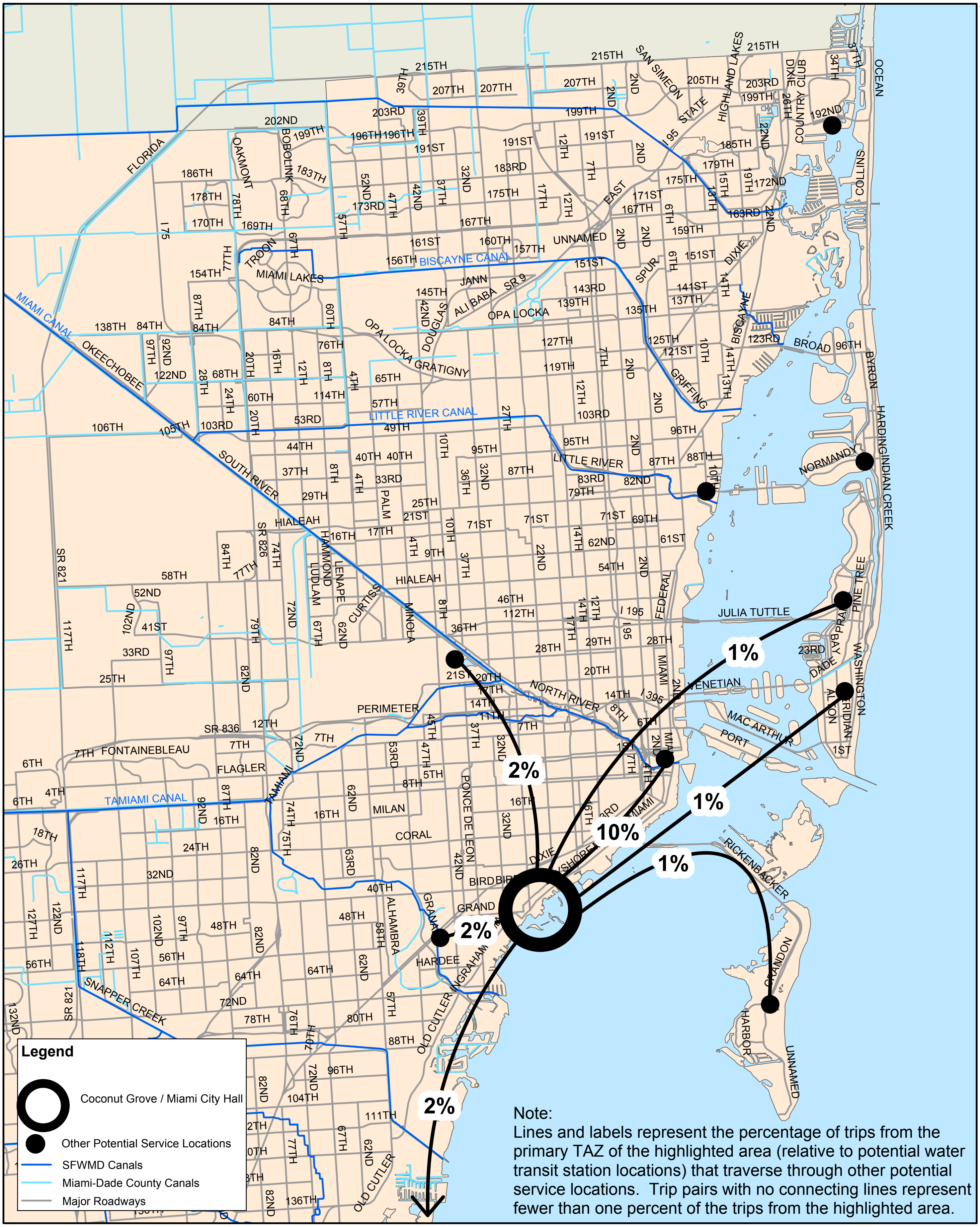
N W E S

**Miami CBD**

<u>Appendix C</u>

*Travel Patterns from Potential Service Locations*

Kimley-Horn and Associates, Inc.




0 1 2 4
Miles

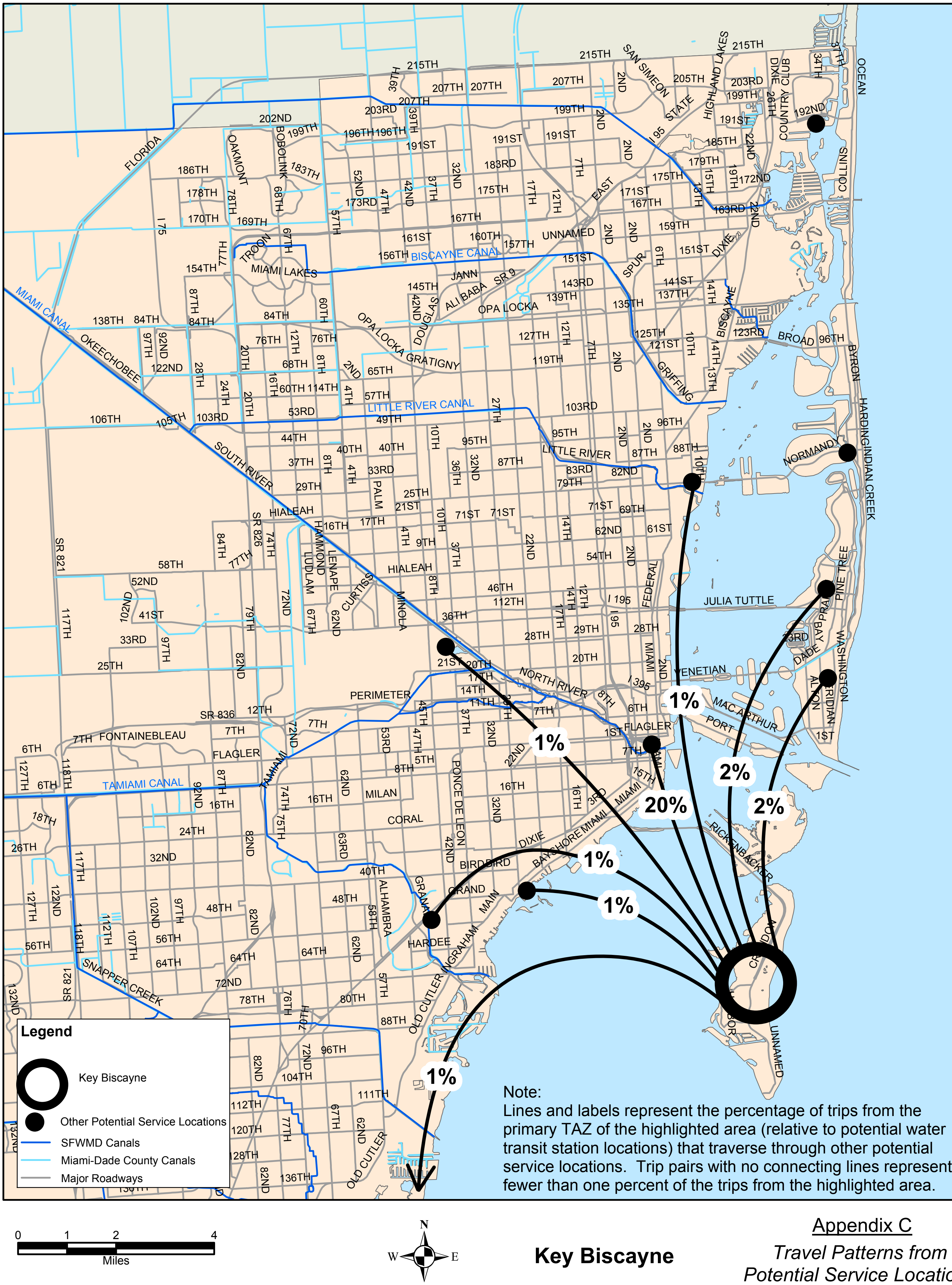
N W E S

**Coconut Grove / Miami City Hall**

Appendix C

*Travel Patterns from Potential Service Locations*

Kimley-Horn and Associates, Inc.

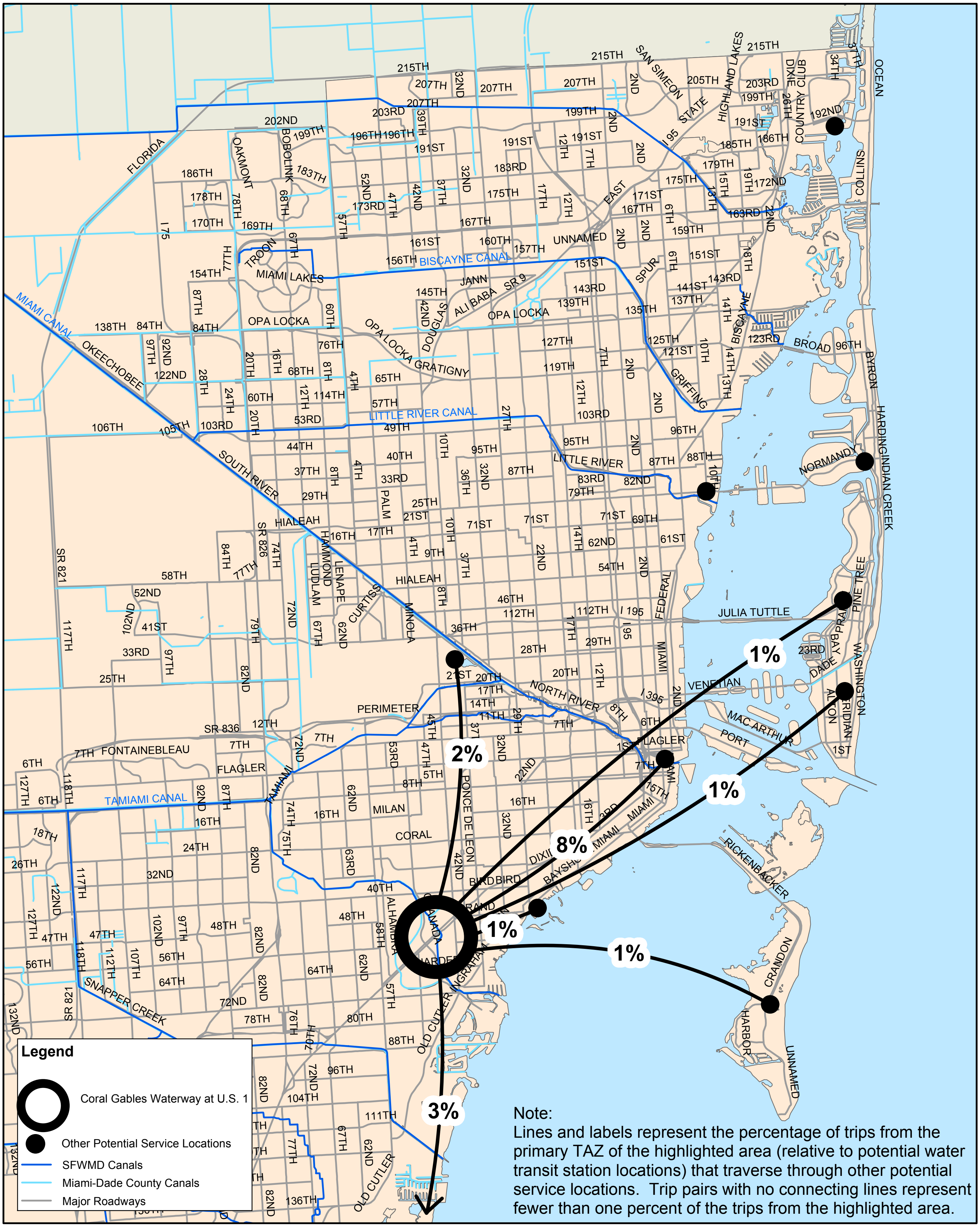



## Key Biscayne

Appendix C

*Travel Patterns from Potential Service Locations*

Kimley-Horn and Associates, Inc.



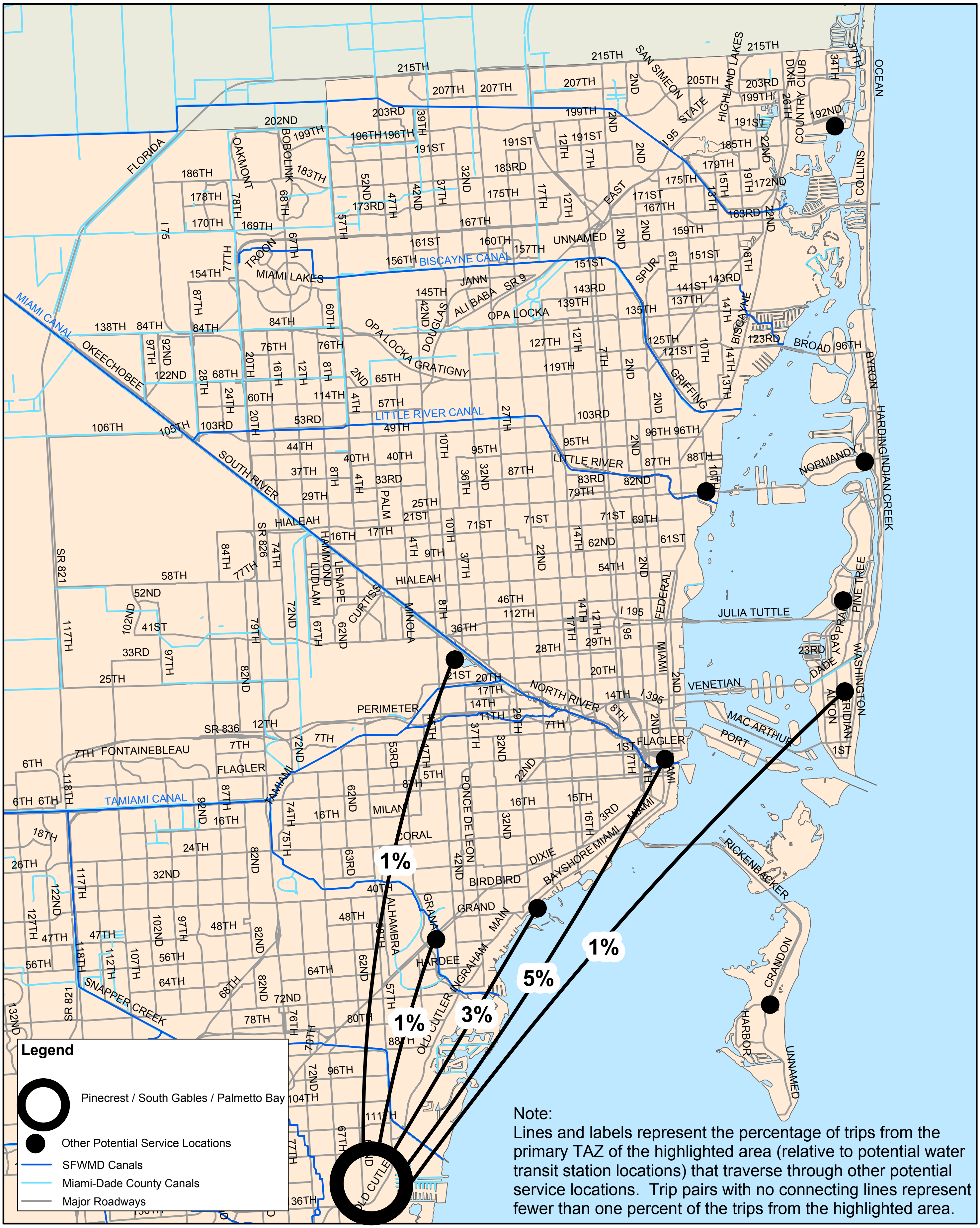

0 1 2 4
Miles

**Coral Gables Waterway at U.S. 1**

Appendix C

*Travel Patterns from Potential Service Locations*

Kimley-Horn and Associates, Inc.




0 1 2 4
Miles

N W E S

**Pinecrest / South Gables / Palmetto Bay**

Appendix C

*Travel Patterns from Potential Service Locations*

Kimley-Horn and Associates, Inc.

# APPENDIX D

# PATRONAGE ESTIMATION FROM EXISTING TRANSIT ROUTES

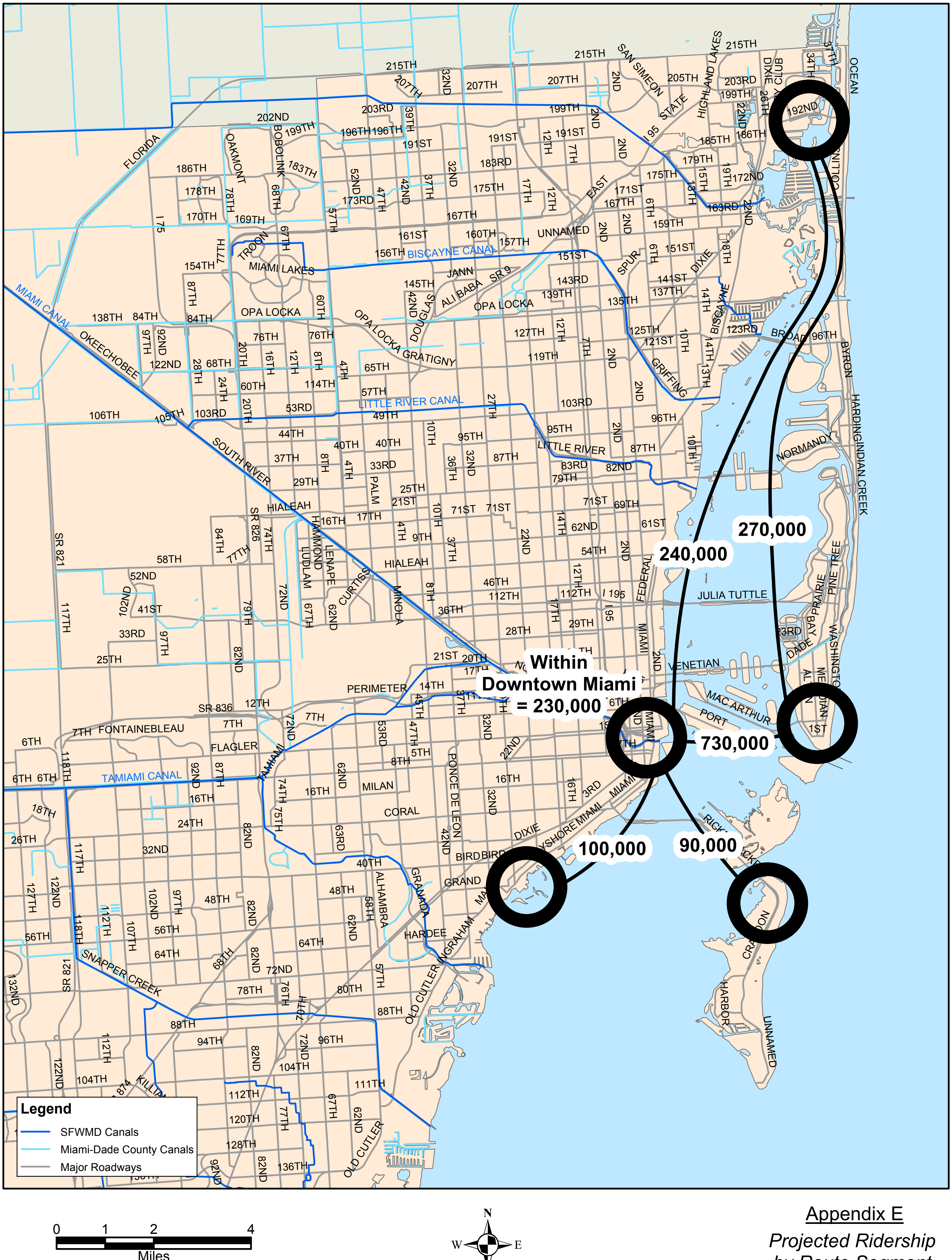
**MDT Transit routes approximated by potential Water Bus routes**

| Water Transit Segment | MDT Route | Fraction of Route | Tourist Areas | Existing Ridership | Align ment Factor | Land Transit Accessibility Factor | Stop Proximity Factor | Tourist Factor | Total Transit Ridership Multiplier | Projected Water Transit Ridership | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Coral Gables to Black Point Marina** | 65 | half of route, peak hour directional service only | | 56,700 | 0.50 | 0.10 | 0.50 | 1.00 | 0.0250 | 1,418 | 1,418 |
| **Coral Gables to Brickell** | Metrorail | University to Brickell | | 14,124,048 | 0.08 | 0.05 | 0.75 | 1.00 | 0.0030 | 42,372 | 56,707 |
| | 48 | University to Omni | Coconut Grove | 119,460 | 1.00 | 0.10 | 1.00 | 1.20 | 0.1200 | 14,335 | |
| Coral Gables to Coconut Grove [(1)] | 42 | southern portion of route | Coconut Grove | 330,216 | 0.10 | 0.10 | 0.50 | 1.20 | 0.0060 | 1,981 | |
| | 48 | southern portion of route | Coconut Grove | 119,460 | 0.25 | 0.10 | 1.00 | 1.20 | 0.0300 | 3,584 | |
| **Coral Gables and Coconut Grove to Key Biscayne** | 48 transfer to B | half of each with transfer | Coconut Grove, Virginia Key, Key Biscayne | 565,680 | 0.50 | 0.25 | 0.50 | 1.20 | 0.0750 | 42,426 | 42,426 |
| **Brickell to Key Biscayne** | B | | Virginia Key, Key Biscayne | 446,220 | 0.70 | 0.25 | 0.50 | 1.20 | 0.1050 | 46,853 | 46,853 |
| **Brickell to Bayfront / Bayside / AAA / Omni** | 48 | | Bayfront Bayside | 119,460 | 0.25 | 0.10 | 1.00 | 1.20 | 0.0300 | 3,584 | 3,584 |
| **Bayfront / Bayside /AAA / Bicentennial Park /Omni** | 48 | portions of | Bayfront Bayside | 119,460 | 0.10 | 0.25 | 1.00 | 1.20 | 0.0300 | 3,584 | 166,421 |
| | 3 | | | 4,203,024 | 0.05 | 0.25 | 1.00 | 1.20 | 0.0150 | 63,045 | |
| | 16 | | | 256,296 | 0.05 | 0.25 | 1.00 | 1.20 | 0.0150 | 3,844 | |
| | C | | | 1,129,416 | 0.10 | 0.25 | 1.00 | 1.20 | 0.0300 | 33,882 | |
| | S | | | 4,137,672 | 0.05 | 0.25 | 1.00 | 1.20 | 0.0150 | 62,065 | |
| **Downtown Miami to Miami Beach** | C | whole route except Beach circulation | Washington Ave Lincoln Rd | 1,129,416 | 0.80 | 0.25 | 0.75 | 1.20 | 0.1800 | 203,295 | 527,811 |
| | K | southern portion of route | Washington Ave Dade Blvd, Pine Tree Dr | 1,537,980 | 0.20 | 0.25 | 0.75 | 1.20 | 0.0450 | 69,209 | |
| | S | southern portion of route | Alton Rd. Lincoln Rd. 5th Street | 4,137,672 | 0.20 | 0.25 | 0.75 | 1.20 | 0.0450 | 186,195 | |
| | M | eastern portion of route | South Pointe Alton Rd Lincoln Rd | 583,104 | 0.40 | 0.25 | 0.75 | 1.20 | 0.0900 | 52,479 | |
| | Flagler MAX | eastern portion of route | Washington Ave Lincoln Rd | 462,000 | 0.20 | 0.20 | 0.75 | 1.20 | 0.0360 | 16,632 | |
| **North-South on Barrier Island** | K | | Bal Harbour North Beach South Beach | 1,537,980 | 0.70 | 0.10 | 0.75 | 1.20 | 0.0630 | 96,893 | 198,158 |
| | S | | Bal Harbour North Beach South Beach | 4,137,672 | 0.25 | 0.10 | 0.25 | 1.20 | 0.0075 | 31,033 | |
| | H | Sunny Isles Blvd to South Beach | Bal Harbour North Beach South Beach | 1,483,548 | 0.25 | 0.10 | 0.25 | 1.20 | 0.0075 | 11,127 | |
| | T | Haulover to Julia Tuttle Cswy | Bal Harbour Arthur Godfrey Rd | 656,196 | 0.20 | 0.10 | 0.50 | 1.20 | 0.0120 | 7,874 | |
| | R | Bal Harbour to South Beach using Bay/Alton | Bal Harbour North Beach Lincoln Rd | 93,516 | 1.00 | 0.10 | 1.00 | 1.20 | 0.1200 | 11,222 | |
| | G | 79th Street Cswy to Lincoln Rd | Bal Harbour North Beach Lincoln Rd | 992,556 | 0.20 | 0.10 | 0.25 | 1.20 | 0.0060 | 5,955 | |
| | L | 79th Street Cswy to Lincoln Rd | Bal Harbour North Beach Lincoln Rd | 3,395,184 | 0.20 | 0.10 | 0.25 | 1.20 | 0.0060 | 20,371 | |
| | J | Bal Harbour to Julia Tuttle Cswy | Bal Harbour North Beach Arthur Godfrey Rd | 1,509,396 | 0.20 | 0.10 | 0.25 | 1.20 | 0.0060 | 9,056 | |
| | 62 | Julia Tuttle Cswy rush-hour only | Arthur Godfrey Rd | 1,542,288 | 0.10 | 0.10 | 0.25 | 1.20 | 0.0030 | 4,627 | |
| **North-South on mainland** | 3 | 192nd Street Cswy to Downtown | | 4,203,024 | 0.70 | 0.10 | 0.50 | 1.00 | 0.0350 | 147,106 | 175,653 |
| | Biscayne MAX | 192nd Street Cswy to Downtown | | 614,988 | 0.90 | 0.08 | 0.50 | 1.00 | 0.0360 | 22,140 | |
| | 16 | 79th Street Cswy to Downtown Miami | | 256,296 | 0.50 | 0.10 | 0.50 | 1.00 | 0.0250 | 6,407 | |
| | | | | | | | | | | **1,219,030** | |

Note:
(1) - The Coral Gables to Coconut Grove analysis is a subset of the Coral Gables to Brickell segment.

# APPENDIX E

# PROJECTED RIDERSHIP BY ROUTE SEGMENT




## Appendix E

*Projected Ridership by Route Segment*

Kimley-Horn and Associates, Inc.

# APPENDIX F

# PROPOSED TERMINAL LOCATIONS

| Routes | Location | Notes |
|---|---|---|
| All | Downtown Wharf (Chopin Plaza) | Excellent location for CBD Terminal<br>Adjacent to Bayfront Park Metromover<br>Adjacent to Biscayne Boulevard<br>Potential to accommodate bus turnaround<br>Some waterside facilities already built<br>Excellent sea wall for locating expanded facilities<br>Alternate location: just north of Chopin Plaza in Bayfront Park |
| West Shore | Aventura (Community Recreation Facility) [eastern end of NE 188th Street] | Nice landside plaza exists<br>Access to Community Center<br>Turnaround already exists, potential for bus or shuttle service<br>Arrangement with City of Aventura could be pursued for sharing parking |
| West Shore | Sunny Isles Causeway | Roadway network already exists under Causeway that could accommodate buses<br>Potential to construct small park-n-ride between eastbound and westbound bridges<br>Undeveloped land under bridges could be used to construct station<br>Close to small business district |
| West Shore<br>North Beach | Haulover Marina | Excellent location for a northern transfer facility<br>Excellent waterside facilities<br>Large parking lot adjacent<br>Some greenspace near marina that is not of park quality could be developed into terminal<br>Metrobus already serves parking lot |
| West Shore | FIU North Mami Campus (Biscayne) | Excellent access for students, faculty, and staff<br>Small existing dock<br>Larger waterside facility could be constructed with minimal greenspace impact if University desires to maintain smaller dock<br>Greenspace with bicycle path exists along Bay |
| West Shore | North Bayshore Park | Linear park along Biscayne Bay<br>Surrounded by a Miami Shores residential neighborhood<br>Community support would be critical |
| West Shore | Pelican Harbor Park Boat Ramp [western end of Kennedy Causeway] | Wharf on south side of island most suitable<br>Excellent waterside facilities<br>Easy access for Metrobus<br>Space to construct bus bays and bus shelters<br>Potential for conversion of some paved areas to a small park-n-ride |

| Routes | Location | Notes |
|---|---|---|
| West Shore | Legion Park<br>[NE 64th Street] | Small existing dock<br>American Legion small existing parking lot<br>Two blocks from Biscayne Boulevard<br>Several redevelopment sites in the area, especially along Biscayne Boulevard<br>Potential for streetscaping project along NE 64th Street, to provide boulevard to station<br>Potential shuttle service to Little Haiti neighborhood |
| West Shore<br>North Beach | Margaret Pace Park | South end of Park located adjacent to Omni<br>Significant redevelopment activity in the area<br>Potential to align Metrobus routes along North Bayshore Drive<br>Attractive pedestrian path exists leading to Bay<br>One block from Omni parking garage<br>Two blocks from Biscayne Boulevard<br>Two blocks from Omni Metromover |
| West Shore<br>Key Biscayne | Brickell<br>[ @ SE 14th Street ] | Access to Financial District<br>Residential redevelopment activity ongoing<br>Two blocks from Brickell Avenue<br>Two blocks from Financial District Metromover<br>Cove exists for potential waterside facilities |
| West Shore | Mercy Hospital | Existing dock<br>Excellent access for employees, visitors<br>Could incorpoprate station into existing greenspace along Bay |
| West Shore | Coconut Grove<br>[Dinner Key Marina] | Boat ramp at western end of Marina most feasible<br>Excellent existing waterside facilities<br>Adjacent to South Bayshore Drive<br>Excellent Metrobus access<br>One block from McFarlane Avenue<br>Two blocks from Grand Avenue<br>Potential to route Coconut Grove Circulator into station facility and provide bus shelters |
| North Beach | North Beach<br>[69th Street] | 69th Street terminates at Biscayne Bay<br>Station could be built at 69th Street or adjacent open space<br>Potential to provide North Beach shuttle<br>Activity center nearby along Collins Avenue and 71st Street |

| Routes | Location | Notes |
|---|---|---|
| North Beach | Mt. Sinai Hospital | Several potential locations within campus<br>Northernmost location may minimize impact to Hospital operations<br>Arrangment could be pursued with Hospital for parking opportunities<br>Metrobus already serves Hospital<br>Potential to provide Middle Beach shuttle |
| North Beach | Island View Park | Excellent waterside facilities already exist<br>Potential to provide shuttle access<br>Venetian Causeway hinders opportunity for a more southern station along North Beach route<br>Desirable service frequencies and service spans will make drawbridge openings unfeasible |
| South Beach | Lincoln Road | Lincoln Road terminates at Biscayne Bay<br>Providing a station at the turnaround is desirable to serve the Lincoln Road Mall and adjacent activity center<br>Excellent Metrobus access along Bay Road<br>Potential to connect to Electrowave<br>Venetian Causeway hinders opportunity for a more northern station along South Beach route |
| South Beach | Washington Avenue<br>[South Pointe Park] | Excellent parkspace at southern terminus of Washington Avenue<br>Potential to connect to Electrowave<br>Three blocks from Ocean Drive<br>Six blocks from 5th Street |
| Key Biscayne | Virginia Key<br>[Miami Seaquarium] | Excellent access to Miami Seaquarium<br>Underutilized shoreline just north of facility<br>Large parking facility<br>Potential shuttle for Virgina Key activities |
| Key Biscayne | Crandon Park Marina | Excellent waterside facilities<br>Large parking facility<br>Potential shuttle for Crandon Park activities, especially during Crandon Park Tennis Center events<br>Potential shuttle to Key Biscayne |

# APPENDIX G

# LOW WASH CATAMARANS OF THE PAST 12 YEARS

| Ferry Model | L.W. Cat. Ferry Photograph | Water Body & Country | Yr. | Qty Built | LOA (m) | LWL (m) | Beam (m) | Draft (m) | Pass | Power (kW) | $V_s$ (kts) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Riverbus |  | Thames River, United Kingdom | ‘91 | 3 | 25.0 | 23.0 | 5.7 | 0.75 | 62 | 506 | 25 |
| Red Jet 1 & 2 |  | Solent River, United Kingdom | ‘91 | 2 | 31.5 | | 8.4 | 1.1 | 120 | 2,720 | 32.5 |
| RiverCat |  | Parramatta River, Australia | ‘91 | 8 | 36.8 | 35.0 | 10.5 | 1.35 | 200 | 734 | 22.5 |
| Trans Cat |  | Tagus River, Portugal | ‘95<br>‘96 | 3<br>1 | 45 | | 11.8 | 1.4 | 500 | | 25 |
| CityCat |  | Brisbane River, Australia | ‘96 | 8 | 25 | | 7.2 | 0.9 | 108 | 560 | 24 |
| River Runner 150 |  | Bora Bora, French Polynesia | ‘98 | 2 | 30 | | 7.0 | | 115 | | 22 |
| Matilda Rocket |  | Sydney Harbor, Australia | ‘98 | 3 | 24.95 | | 7.2 | | 130 | 610 | 24 |
| HarbourCat |  | Sydney Harbor, Australia | | 4 | 24.95 | | 7.2 | | 130 | 610 | 24 |
| Waterbus |  | Maas River, The Netherlands | ‘99 | 4 | 30.5 | | 7.0 | 1.3 | 130 | 1,300 | 20 |
| Aqualiner |  | Maas River, The Netherlands | ‘99 | 2 | 30.5 | | 7.0 | 1.3 | 130 | 1,300 | 20 |
| River Runner 200 |  | Maas River, The Netherlands | ‘99 | 2 | 37.0 | | 8.3 | 1.3 | 150 | 3,840 | 30 |
| Fantasia |  | Tagus River, Portugal | ‘99 | 1 | 26.4 | 24.34 | 7.8 | 1.455 | 153 | 980 | 24 |
| SuperCat |  | Sydney Harbor, Australia | ‘00 | 12 | 34.12 | 32.54 | 8.8 | 1.5 | 250 | 1,200 | 24 |
| Red Jet3 |  | Solent River, United Kingdom | | 1 | 32 | | 8.4 | 1.25 | 188 | 3,000 | 33.7 |
| Transtejo |  | Tagus River, Portugal | ‘02 | 2 | 37.43 | 34.17 | 10.7 | 1.15 | 292 | 2,100 | 27 |
| Soflusa |  | Tagus River, Portugal | ‘03 | 9 | 49.2 | 47.0 | 12.3 | 1.58 | 600 | 4,640 | 25 |