South Florida East Coast Corridor Transit Analysis Study

Final Travel Demand Model Methodology and Results Technical Memorandum September 2006

The Southeast Regional Planning Model, Version 5 (SERPM5) is a tri-county regional planning tool that was utilized as the travel demand forecasting model for the South Florida East Coast Corridor Transit Analysis (SFECCTA) Study.

The SERPM5 was validated to the year 1999 and was subsequently revised as part of another transit study in Broward County. These revisions have already been discussed with Federal Transit Administration staff, and as such, are considered to be a valuable addition to the SFECCTA study. The following is a brief outline of both the revisions already implemented in the SERPM5 (by AECOM Consult, Inc. and The Corradino Group) and further revisions implemented by Gannett Fleming, Inc. in order to bring the model up to date with respect to county transportation plans and 2000 U.S. Census data.

The use of an updated, validated model is critical to the accuracy of the forecasts that will be generated for the SFECCTA study. Any travel demand model, however, is dependent on the validity of the assumptions and data that are used as inputs to the modeling process. It is important to note these assumptions and sources of the input data in order to understand fully the components of the model. The inputs to the future year model, as outlined below, are based on the most recently adopted data, including the 2030 Long Range Transportation Plans for the three counties and the datasets projected by demographers from the 2000 U.S. Census.

The first section below is a summary of the assumptions and sources of uncertainty that are inherent in the travel demand modeling process. Subsequent sections summarize model enhancements incorporated by the Corradino Group, followed by a summary of the updates to the input files and validity checks completed by Gannett Fleming, Inc. Also included are a brief description of the alternatives that were tested using this model and the results of those tests.

I. Uncertainties in Travel Demand Modeling

There are numerous sources of uncertainty that exist in the travel demand modeling process, both in the model inputs, and in the process itself. The most obvious and perhaps the most important is simply the fact that the goal of travel demand modeling is to predict human behavior 20 to 30 years in the future. This is a daunting task that, at best, results in approximations of the patterns of travel and its characteristics in the context of the future.

A more specific source of uncertainty concerns various inputs in the model stream, including the auto operating cost, socioeconomic data, and transit parameters for non-existing transit modes. The auto operating cost input into the model is reflective of validation year conditions and, in theory, is reflective of the conditions at any given time, relative to other inputs. The problem with this variable is that the cost of gasoline is very volatile. As such, it is extremely difficult to predict in the future. A potentially profound uncertainty in the model, then, is the assumption of a given auto operating cost.

The uncertainty involved in the projection of socioeconomic data is tempered by the expertise of demographers who are trained to forecast land use patterns and intensities based on documented trends. Despite the knowledge and experience that goes into the projection of land use data, it is still an uncertain science that is dependent, to some extent, on human behavior and sociopolitical, sociocultural, and socioeconomic trends that cannot always be foreseen.

A final and important source of uncertainty in travel demand modeling that is of particular importance in transit modeling involves the forecasting of ridership for a transit mode that does not exist in the base year validated model. This is problematic in that the given mode cannot be validated against observed data, making it difficult to measure the performance of the model as it pertains to that mode. The Federal Transit Administration has commented on this problem in the past, and has advised that similar modes be used to judge the performance of a mode that does not exist in the validation year.

The model utilized to forecast patronage for the SFECCTA alternative testing provides reliable forecasts in general terms, despite the uncertainties involved in modeling. The following section of this report describes the improvements made to the SERPM5 and the updates that were implemented for this project.

II. Model Structure Update

Several structural changes were implemented in the SERPM5, most of which relate to the transit or mode choice components of the model. The revisions are the result of a need to improve the model for use in transit corridor studies in ways that maximize the validity of forecasts and follow FTA New Starts requirements. The original mode choice program was critically reviewed by FTA and was modified accordingly. Revision of the mode choice program triggered many other changes in transit network, path and assignment steps, as outlined below.

- **Transit Network, Transit Path, Transit Skim, and Transit Fare –** The enhancements that were implemented in the transit network, path and fare building steps are geared toward facilitating the revised mode choice model and meeting the requirements of FTA's New Starts program. This section describes the enhancements that were incorporated in the revised transit and associated modules.

  - One of the enhancements to the transit network module was the addition of a new mode, defined as Bus Rapid Transit / Light Rail Transit (BRT/LRT). The purpose of adding the new mode was to accommodate one of the structural revisions of the mode choice model, to code all bus modes as one mode. This required the creation of a new mode for special bus routes that should not be treated as bus routes. This is described in more detail below.

  - New highway-to-transit speed curves were created that distinguish the relationship of highway speeds to transit speeds in the peak period and the midday period. Previously, the same linear curves were utilized for both the peak and midday networks.

  - The transit path "cliffs" that defined minimum run times for respective modes were eliminated and replaced with distances. This was done to eliminate discrepancies caused by changes in transit levels of service. For instance, if two alternatives were tested with FTA's Summit program, a difference in speed between two different alternatives could result in a path change for very short trips simply because of the MINRUN factor. By substituting speed with distance, this problem is minimized.

  - An extended sidewalk connector program (SIDEXTD) implements the generation of sidewalks in addition to those generated by the sidewalk connector program (SIDECON). The purpose of this enhancement was to supplement the SIDECON program. The SIDEXTD program includes an input file similar to the one utilized by the other access programs (STATDATA).

- A new "dummy" fare matrix was created for use in the transit path module to facilitate special treatment for new BRT and LRT services and special premium bus services. This allows for all bus modes to be treated equally in the mode choice model, but at the same time recognizing that, for at least specific segments of certain bus routes (express, limited or skip stop service) special treatment is in order. This new mechanism isolates the segments of special bus routes that operate differently than local bus routes, rather than treating entire express bus routes as an entirely different mode than local bus. This is discussed further in the mode choice section of this report.

➢ **Mode Choice –** The enhancements that were implemented in the mode choice model focus on implementation of the upstream revisions, as well as specific mode choice issues that are concerns of the FTA and transit modelers in general. This section describes briefly the enhancements that were incorporated in the revised mode choice model.

  - The structural revision of the mode-choice model includes an "incremental/grouped" structure with significantly fewer constants to validate. The revised model utilizes only 18 targets for each trip purpose, as opposed to 49 targets in the original mode choice model. This is a significant reduction, and much more consistent with available data that must be used to calibrate the constants. The revised structure allows for better evaluation as to whether the constants make sense and would produce a reasonable forecast.

  - A key revision of the mode choice model, as mentioned above, involves the treatment of all bus modes as one mode. This includes local bus, express bus, and limited or skip stop bus service. The reasoning behind this is that the differences in the vehicles and facilities on which these modes operate is not enough to warrant mode specific constants for the respective modes. However, there are differences in speeds for at least portions of certain bus routes in the study area, so special flags were created that provide an extra benefit to paths on segments that operate faster or with less stops.

  - The use of geographic, or CBD specific constants in the SERPM5, which typically relate only to the production end of trips, were revised to relate to district pairs. This allows for more control and flexibility in the calibration of the mode choice model. It, of course, requires observed origin-destination data to calibrate against, which was available in a 2000 travel characteristics survey that included a transit on-board data collection component.

  - The revised SERPM5 includes a separate distribution for zero-auto households, resulting in seven trip tables output by distribution and input into mode choice. The purposes include three auto-ownership categories for both HBW and HBNW and one for NHB trips. The mode choice model was modified slightly to accommodate the new inputs.

- A new mode was added to the mode choice model to make up for the loss of the express bus mode. The new BRT/LRT mode is reserved for future service (there is none in the base year) that does warrant special consideration rather than being treated as local bus. Examples of this could be 100% fixed guideway routes or BRT routes that mimic fixed guideway.

- A logit model routine was added to the SERPM5 (between Distribution and Mode Choice) that estimates the number of non-motorized trips, thus separating them from the motorized trips. The utility computations used in this routine are based on factors such as bicycle/pedestrian friendliness, spatial separation, and area type and are applied to seven trip purposes. These include the three standard trip purposes in mode choice (HBW, HBNW, NHB) stratified by auto ownership for the first two purposes.

III. Model Inputs Update

The currently adopted SERPM5 includes a validation year model representing the year 1999 and a horizon year model representing the 2025 LRTP's of the three counties. Due to the recent update of the counties' LRTP's to the year 2030 and the use of a 2000 validation year, the SERPM5 2025 inputs are dated. This section describes the process of updating the input data and preserving the structure of the SERPM5.

➢ **Socioeconomic Data** – The problem with the 2025 socioeconomic datasets is that, not only is it five years shy of the most recently adopted LRTP's, but it is projected based on the 1999 datasets, which were projected from the 1990 U.S. Census. The individual MPO's developed and adopted base year datasets in their most recent LRTP updates that are based on the 2000 U.S. Census. Demographers also forecast future year data based on the Census and other credible sources. The update revealed significant differences between the 1999-2000 and 2025-2030 datasets, respectively, clearly pointing to the need for an update.

Because of zonal structure revisions, particularly in Palm Beach County, the geographic correlation of the data between the two structures was completed carefully in order to preserve the integrity of the data.

The methodology to update the socioeconomic data can be described in three parts. The first involves situations in which a zone in the 2025 structure was split into two zones in the 2030 structure. In such a case, the data for the two resulting 2030 zones were aggregated to represent the 2025 zone. The second scenario involves two zones in the 2025 structure that are combined in the 2030 structure, in which case the zonal proportions of the data for the two zones in the 2025 structure were applied to the 2030 data, thus disaggregating the 2030 data appropriately. The third context, in which zonal boundaries in the two structures overlap, was handled on a case by case basis. In most cases, the overlap involves a small sliver of a zone, which is more often than not the result of an inconsistency in the geographic files, not a true division or aggregation of a zone(s).

- **Highway Network Data** – For the highway network update, network difference (NETDIF) plots were generated in TranPlan, which compare two networks based on the same node numbering system and report the differences in terms of a range of possibilities, including revised number of lanes, area type, facility type, etc. These plots were generated for the 2025 and 2030 county models individually and the differences coded in the SERPM5, effectively updating it to the 2030 LRTP's.

- **Transit Network Data** – For the transit network update, premium transit corridors were coded in the SERPM5 as they were coded in the individual 2030 county models. An obvious exception to this includes the projects in the respective LRTPs that make up parts of the SFECCTA. These include the Northeast Corridor in Miami-Dade County, the FEC Trirail Extension in Broward County, and the Jupiter and SCRIPPS extension projects in Palm Beach County. Feeder bus routes were not coded in the network for the Tier I phase of the study, but will be evaluated in Tier II.

After the socioeconomic and network data were updated to reflect the 2030 LRTP's, appropriate quality control measures were applied, including cross-referencing model output with both original SERPM5 results as well as county model results to confirm that the new model is operating appropriately. Results of a corridor trip generation analysis indicate that the model is performing reasonably well with the updated socioeconomic data. Table 1 below depicts the productions and attractions within 1 mile of the FEC railroad by county. While the trip generation in Palm Beach County far surpasses that of the either two counties in terms of real numbers, this is due to the disproportionate share of linear coverage in Palm Beach County. Trip generation density, on the other hand, is lowest in Palm Beach County. These results are consistent with the relative development patterns and intensities in the three counties, respectively.

Table 1. 2030 FEC Corridor Trip Generation

County	Linear Miles	2030 Corridor Trip Productions	2030 Corridor Trip Attractions	Production Density*	Attraction Density*
Palm Beach County	40	2,130,000	2,817,000	53,200	70,400
Broward County	25	1,727,000	1,860,000	69,100	74,400
Miami-Dade County	15	1,107,000	1,556,000	73,800	103,700

*Productions and Attractions within 1 mile of the FEC railroad (per linear mile)

Further validity checks were implemented, as outlined below, to prepare the model for Alternatives Analysis.

IV. Validity Checks

The SERPM5 model was reexamined in light of existing data compiled for this study, including two surveys implemented by Gannett Fleming, Inc. in the corridor. These include an on board bus and license plate surveys, as described below. The purpose of the surveys was to collect new origin/destination data on roadway and transit facilities serving the corridor including Miami Dade Transit, Broward County Transit, Palm Tran, and Tri-Rail.

The surveys were designed to serve several technical purposes. Since the SERPM5 is already validated, the surveys were not be used to validate or calibrate the model. However, they were used to perform validity checks on the model to ensure that it performs at a level consistent with the needs of the SFECCTA study. In addition, the survey results were utilized in the development of alternatives to relate the needs of travelers in the corridor to the potential solutions that will be studied in Tier II of the SFECCTA study. Among the key issues that were analyzed using the surveys are the following:

- **Travel Patterns** – The travel patterns documented in the survey based on origin and destination data are consistent with the model. The surveys indicate that between 1% and 50% of highway travelers surveyed are traveling to and from locations within 1 mile of the FEC railroad. The model indicates that between 1% and 57% of trips using the links that were surveyed have origins and destinations within 1 mile of the FEC. The variation in both the model and the survey is a function primarily of facility type. For example, the highest proportion of trips using I-95 that have origins and destinations within 1 mile of the FEC is 15% in the survey and 14% in the model, whereas the trips on the other two facilities are much more likely to be local trips, with up to 50% and 57% occurring within 1 mile of the FEC in the survey and model, respectively.

- **Trip Purpose** – Proportionate shares of trips by trip purpose were analyzed in the model with reference to the survey data. According to the highway survey, home based work trips represent between 20% and 51%, varying by site. Home based non-work trips represent between 33% and 62% of total trips, and finally non-home based trips represent between 12% and 23% of total surveyed highway trips. These ranges are consistent with the aggregate model trip breakdown by purpose, which allocates 24% of all trips to the home based work purpose, 49% to the home based non-work purpose, and the remaining 27% of total trips to the non-home based purpose.

  In the case of transit trips, 43% of surveyed transit riders are home based work trips, versus 41% of total model transit trips in that purpose. Home based non-work trips represent 43% of surveyed riders, whereas the modeled transit trips are 41% home based non-work trips. Non-home based trips represent 15% of surveyed trips and 18% of total modeled transit trips.

- **Trip Lengths** – Trip length patterns extracted from the survey data indicate that average trip lengths of surveyed highway trips were 12.3 and 14.9 miles in length for work and non-work trips, respectively. The average trip lengths in the model are 13.1 and 15.9 miles for work and non-work trips, respectively. The model is performing well with respect to average trip length, with only a 6% difference between the model and observed data.

Overall, the travel survey data supports the SERPM. The following section describes the application of the SERPM to forecast patronage on

V. Model Application

Once the model was updated and checked for validity with respect to the survey data, it was utilized to test regional transit alternatives that were designed to serve the following purposes:

- Determine if passenger transit investments within the defined 2-mile wide SFECCTA (including transit investments located within the FECR right-of-way) are prudent and feasible;

- Perform a Tier 1 alternatives analysis (Conceptual definition of alternatives) to eliminate non-viable options; and

- Identify the logical and independent subareas of the corridor that should be advanced into Sectional Alternatives Analyses (AA).

A series of viable alternatives that address the identified project needs were developed and evaluated. The Alternatives Analysis process was designed to follow a traditional tiered approach, progressing from many alternatives evaluated at a conceptual level of detail supported by data, to evaluation of a limited number of alternatives evaluated at a quantitative level of detail. The Regional Transit Alternatives Analysis addresses the Tier 1 Analysis of alternatives at the corridor level. This includes the initial definition of alternatives, their conceptual analysis, and technical and public review.

Significant travel patterns/markets were identified and corridor transit alternatives that serve those movements were developed and tested in the SERPM5. The initial alternatives include corridor alignments, transit mode/technologies, preliminary sites of potential transit stations/hubs and potential sites for urban redevelopment in generic terms. Alternatives include a "No Build" and Baseline/TSM alternatives for comparative purposes and to meet FTA New Starts requirements.

A total of 15 alternatives (1 No Build, 1 TSM, and 13 Alternatives) were developed. The 13 build alternatives represent different combinations of alignments, technologies and distances. The three alignment variations include the FEC, US1 and I95 corridors. The technologies include Regional Bus (RGB), Semi-Rapid Transit (SRT), Regional Rail (RGR), and Rail Rapid Transit (RRT). Distances, or segments, covered by the alternatives vary from short Trirail extensions from Mangonia Park to the Palm Beach / Martin county line to alternatives covering the entire corridor from Martin County to downtown Miami.

All the build alternatives were coded with two-way service and stations were coded for each stop on every alternative, allowing for auto access, as well as walk access. The operating speeds for the alternatives were coded according to technology, and none of them are subject to highway speeds. For the regional bus alternatives that operate on existing highway facilities, speeds were coded that reflect conservative estimates of highway speeds on those facilities. The following provides detailed descriptions of the alternatives that were developed and tested.

- The first alternative is a no-build scenario. This includes only the cost feasible transit projects in the respective county long rang transportation plans.

- Alternative 1 represents a TSM alternative that includes transit improvements in the FEC corridor that do not require major capital improvements. For this alternative, headways for Trirail and selected bus routes along the FEC were identified for improvements. Trirail headways were improved from 20 minutes to 15 minutes in the peak and from 60 minutes to 30 minutes in the off-peak. The bus routes with improved headways include those routes that provide significant service in the north/south direction within the corridor.

- Alternative 2 represents a build alternative using commuter rail technology (Mode 8 in SERPM) with operating speeds of 30 mph. The alignment follows the existing FEC alignment, beginning in Tequesta in Palm Beach County and terminating in downtown Miami at the Government Center. This alternative has 57 stations and headways of 15 minutes during the peak and 30 minutes during the off-peak.

- Alternative 3 represents a build alternative using commuter rail technology (Mode 8 in SERPM) with operating speeds of 30 mph. The alignment follows the existing FEC alignment, beginning in Tequesta in Palm Beach County and terminating at the Miami Intermodal Center (MIC). This alternative has 51 stations and headways of 15 minutes during the peak and 30 minutes during the off-peak.

- Alternative 4 represents a realignment of the existing Trirail line from the Miami Intermodal Center (MIC) to Downtown Miami. The Trirail alignment is diverted south of the Opa-locka Station where it follows an eastbound alignment that connects to the FEC alignment. From that point it follows the FEC alignment to the Government Center in downtown Miami. The operating speed is 36 mph. This alternative has 6 stations (south of the Opa-locka Trirail Station) and the headways on the entire Trirail line are 20 minutes in the peak and 60 minutes in the off-peak.

- Alternative 5 represents a build alternative using Bus Rapid Transit/Light Rail Transit technology (Mode 6 in SERPM) with an operating speed of 25 mph. This alignment begins in Tequesta, FL and follows the FEC alignment southbound to the Mangonia Park Trirail Station in West Palm Beach, FL. This alternative has 8 stations with 15-minute headways in the peak and 30-minute headways in the off-peak.

- Alternative 6 represents an extension of the existing Trirail line (Mode 8 in SERPM) with an operating speed of 36mph. This alignment begins in Tequesta, FL and follows the FEC alignment southbound to the Mangonia Park Trirail Station in West Palm Beach, FL where it connects with the existing Trirail alignment. This alternative has 7 stations (north of the Mangonia Park Trirail Station) with 20-minute headways in the peak and 60-minute headways in the off-peak.

- Alternative 7 represents a build alternative using regional bus (Mode 4 in SERPM) with an operating speed of 35 mph. This alignment begins in Tequesta, FL and follows the I-95 alignment southbound to the Mangonia Park Trirail Station in West Palm Beach, FL. This alternative has 6 stations and the headways are 15 minutes in the peak and 30 minutes in the off-peak.

- Alternative 8 represents a build alternative using regional bus (Mode 4 in SERPM) with an operating speed of 25 mph. This alignment begins in Tequesta, FL and follows the US-1 alignment southbound to the Mangonia Park Trirail Station in West Palm Beach, FL. This alternative has 8 stations and the headways are 15 minutes in the peak and 30 minutes in the off-peak.

- Alternative 9 represents a build alternative using Bus Rapid Transit/Light Rail Transit technology (Mode 6 in SERPM) with an operating speed of 15mph. This alignment begins in Tequesta, FL and follows the US-1 alignment southbound to the Mangonia Park Trirail Station in West Palm Beach, FL. This alternative has 8 stations and the headways are 15 minutes in the peak and 30 minutes in the off-peak.

- Alternative 10 represents a build alternative using regional bus (Mode 4 in SERPM) with operating speeds of 25 mph. The alignment for this alternative begins in Tequesta, FL and follows the existing FEC alignment southbound to the Government Center in downtown Miami. This alternative has 60 stations and the headways are 15 minutes in the peak and 30 minutes in the off-peak north of Ft. Lauderdale. South of Ft. Lauderdale, the headways are 7 ½ minutes in the peak and 15 minutes in the off-peak.

- Alternative 11 represents a build alternative using commuter rail technology (Mode 8 in SERPM) with operating speeds of 30 mph. The alignment for this alternative begins in Tequesta, FL and follows the existing FEC alignment southbound to the Government Center in downtown Miami. This alternative has 60 stations and the headways are 15 minutes in the peak and 30 minutes in the off-peak north of Ft. Lauderdale. South of Ft. Lauderdale, the headways are 7 ½ minutes in the peak and 15 minutes in the off-peak.

- Alternative 12 represents a build alternative using Bus Rapid Transit/Light Rail Transit technology (Mode 6 in SERPM) with an operating speed of 15 mph. The alignment for this alternative begins in Tequesta, FL and follows the US-1 alignment southbound to the Government Center in downtown Miami. This alternative has 61 stations and headways of 15 minutes in the peak and 30 minutes in the off-peak north of Ft. Lauderdale. South of Ft. Lauderdale, the headways were 7 ½ minutes in the peak and 15 minutes in the off-peak.

- Alternative 13 represents a build alternative using rapid rail transit technology (Mode 7 in SERPM) with an operating speed of 35 mph. The alignment for this alternative begins at NW 15th Street in Pompano Beach, FL and follows the existing FEC alignment southbound to the Government Center in downtown Miami.. This alternative has 31 station and the headways are 15 minutes in the peak and 30 minutes in the off-peak north of Ft. Lauderdale. South of Ft. Lauderdale, the headways are 7 ½ minutes in the peak and 15 minutes in the off-peak.

- Alternative 14 represents an extension of the existing Trirail line (Mode 8 in SERPM) with an operating speed of 36 mph. This alignment begins at Indiantown Road, following the I95 alignment to the Mangonia Park Trirail Station in West Palm Beach, FL where it connects with the existing Trirail alignment. This alternative has 5 stations (north of the Mangonia Park Trirail Station) with 20-minute headways in the peak and 60-minute headways in the off-peak.

The following section of this report outlines some recommended improvements to the model that are intended to provide more reliable forecasts in Tier II of the SFECCTA study.

VI. Future Model Improvements

The transit alternatives described above are designed to serve potential market segments that can benefit from transportation improvements in the north-south corridor of the model area. There are market segments that, while they are accounted for in the model, could be better represented. These include the external trip market from north of Palm Beach County and the tourist trip market.

The external trip market is accounted for in the model by external stations that are connected to the highway network and, in the case of Palm Beach County, to the transit networks as well. External trips are represented by inputs that define the number of trips entering the study area at a given point. The model would be vastly improved by the addition of at least a portion of the county to the north of Palm Beach County to the model. This would provide the model with the data to more accurately represent this market segment, as it relates to the transit improvements being studied in the SFECCTA study.

The second market segment that could possibly be underrepresented in the model is the tourist market. The model currently accounts for tourists as a function of hotel/motel inputs and special generator inputs. A more specific accounting of the tourist market could be accomplished by implementing a more detailed breakdown of both inputs. For example, hotels that cater to the tourist market, or resort style hotels, may have different trip making characteristics than business or economy hotels. By segregating hotels by type in the model, the tourist market could be singled out and replicated more accurately. An alternative to this approach could be to implement an off-model technique to estimate the impact of tourist trips.

A final important input that should be reviewed and possibly updated is the zonal parking cost data in the SERPM5, which is used by the mode choice model to compute the cost of parking in the utility expression. A review, and update if necessary, of these elements of the model should be considered as a starting point for the Tier II Alternatives Analysis task of the SFECCTA study.