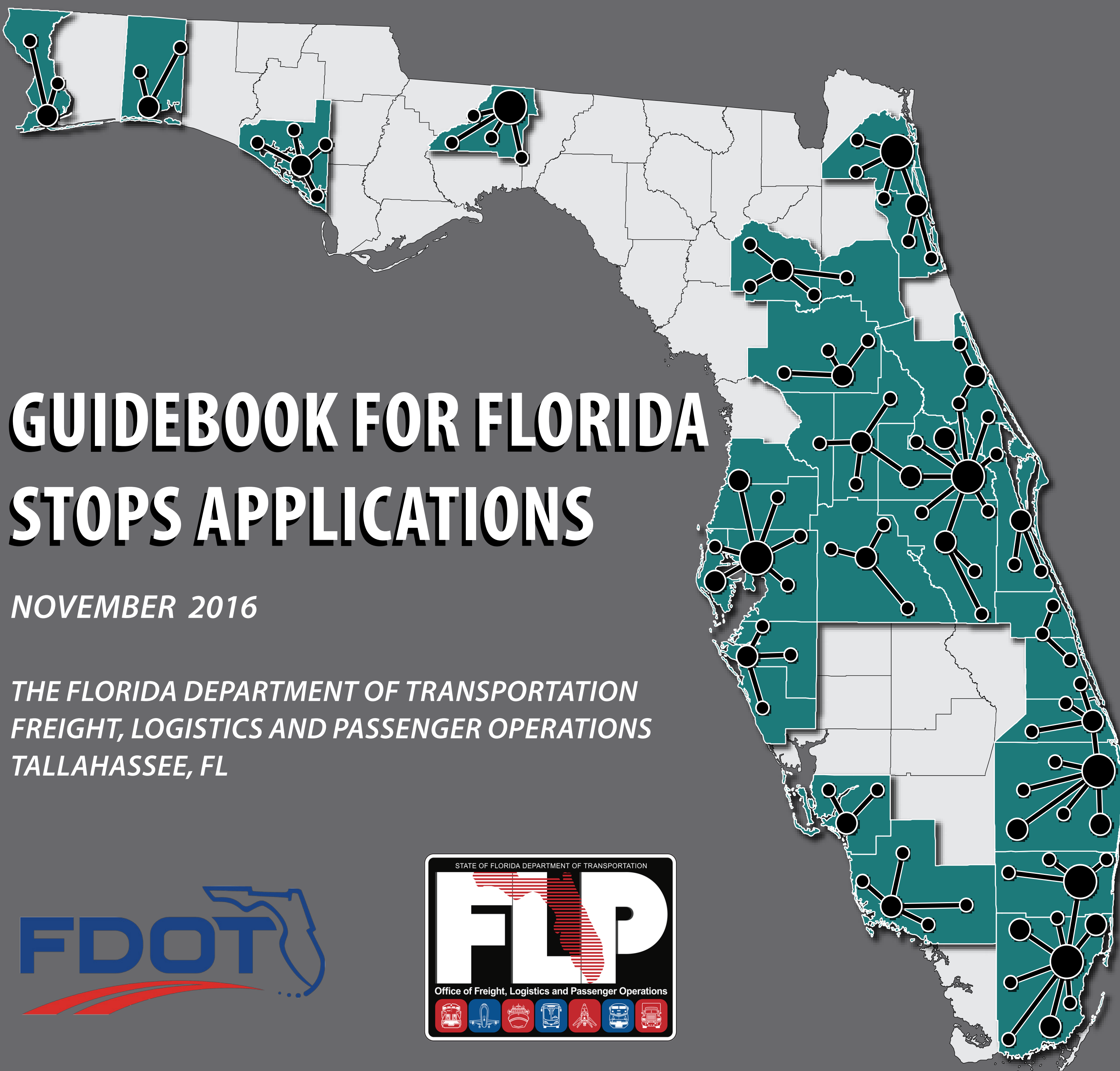
GUIDEBOOK FOR FLORIDA STOPS APPLICATIONS

NOVEMBER 2016

THE FLORIDA DEPARTMENT OF TRANSPORTATION
FREIGHT, LOGISTICS AND PASSENGER OPERATIONS
TALLAHASSEE, FL



FDOT

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION
FLP
Office of Freight, Logistics and Passenger Operations

ACRONYMS AND ABBREVIATIONS

ACS	American Community Survey
APC	Automatic Passenger Counter
APTA	American Public Transportation Association
ASCII	American Standard Cost for Information Interchange
BEBR	University of Florida's Bureau of Economic and Business Research
BRT	Bus Rapid Transit
CBD	Central Business District
CIG	Capital Investment Grant Program
COA	Comprehensive Operations Analysis
CRT	Commuter Rail Transit
CTPP	Census Transportation Planning Package
FDOT	Florida Department of Transportation
FTA	Federal Transit Administration
GTFS	General Transit Feed Specification
HBO	Home-Based Other Trips
HBW	Home-Based Work Trips
JTW	Journey to Work
KNR	Kiss-and-Ride
LRT	Light Rail Transit
LRTP	Long Range Transportation Plan
MPO	Metropolitan Planning Agency
NHB	Non-Home Based Trips
NTD	National Transit Database
NTI	National Transit Institute
PMT	Passenger Miles of Travel
PNR	Park-and-ride
STOPS	Simplified Trips on Project Software
TAZ	Traffic Analysis Zone
TBEST	Transit Boardings Estimation and Simulation Tool
TCAR	Transit Concept and Alternative Review
US	United States
VMT	Vehicle Miles of Travel

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

1.0 INTRODUCTION

This Guidebook is intended to introduce planning directors and transit project managers to the Simplified Trips on Project Software (STOPS). STOPS is a stand-alone computer program that applies a set of travel models to predict detailed transit travel patterns for user-specified scenarios. It is a simplified method, developed by the FTA, that project sponsors of FTA's Capital Investment Grant ("New/Small Starts") program can use, at their option, to predict the trips-on-project measures and the automobile VMT changes required for the environmental measure. STOPS was originally released in 2013, with several updates provided since that release . [1]

This Guidebook focuses on the data preparation and approach issues critical for the successful development of STOPS applications, and on interpreting and applying the STOPS outputs to fulfill the travel data requirements for New/Small Starts projects and other transit planning studies. Chapter 2 provides an overview of STOPS, including required and recommended resources for its successful applications. Chapter 3 discusses common issues that arise during data preparation, STOPS calibration, and forecasting steps. Chapter 4 discusses the three STOPS application approaches, termed "Synthetic", "Synthetic with Special Markets" and "Incremental". Chapter 5 provides an overview of STOPS' extensive reporting and mapping features. Finally, Chapter 6 provides three examples of recent STOPS applications in Florida.

FTA has made available resources to project sponsors on its web page – https://www.transit.dot.gov/funding/grant-programs/capital-investments/stops-%E2%80%93-fta%E2%80%99s-simplified-trips-project-software – that contains further information about STOPS. These include:

1. The STOPS User Guide provides an overview of STOPS, and describes the steps needed to set up, prepare and execute the STOPS software. The most recent User Guide was released April 2015 for STOPS version 1.50;
2. Presentation slides from the STOPS Workshop in Atlantic City, NJ held on May 17, 2015 provide additional details on how STOPS works and how to apply STOPS for forecasts. There are also five application experiences of early STOPS adopters;
3. The STOPS software; and
4. An example STOPS application, currently reflecting a fictional streetcar project in Seattle, WA.

Also, from time to time, NTI will offer a course entitled "Ridership Forecasting with STOPS for Transit Project Planning" that provides many details about STOPS, including how to make STOPS work for individual projects and how to use STOPS forecasts to prepare a narrative of the mobility benefits of projects. This workshop is designed for experienced travel forecasters. [2]

---

[1] *Federal Transit Administration. "An Overview of STOPS". https://www.transit.dot.gov/sites/fta.dot.gov/files/docs/STOPS.overview-web-final.pdf, accessed September 6, 2016.*

[2] *Federal Transit Administration. General email announcement for "Ridership Forecasting with STOPS for Transit Project Planning" Workshop. Received April 19, 2016.*

2.0 STOPS OVERVIEW

FTA's Simplified Trips on Project Software (STOPS) is a stand-alone computer program that applies a set of travel models to predict detailed transit travel patterns for user-specified scenarios. It is a simplified method that agencies can use to predict ridership and the automobile VMT changes due to the addition of a transit project and/or modifications to an existing transit system. Figure 1 shows the STOPS main menu.

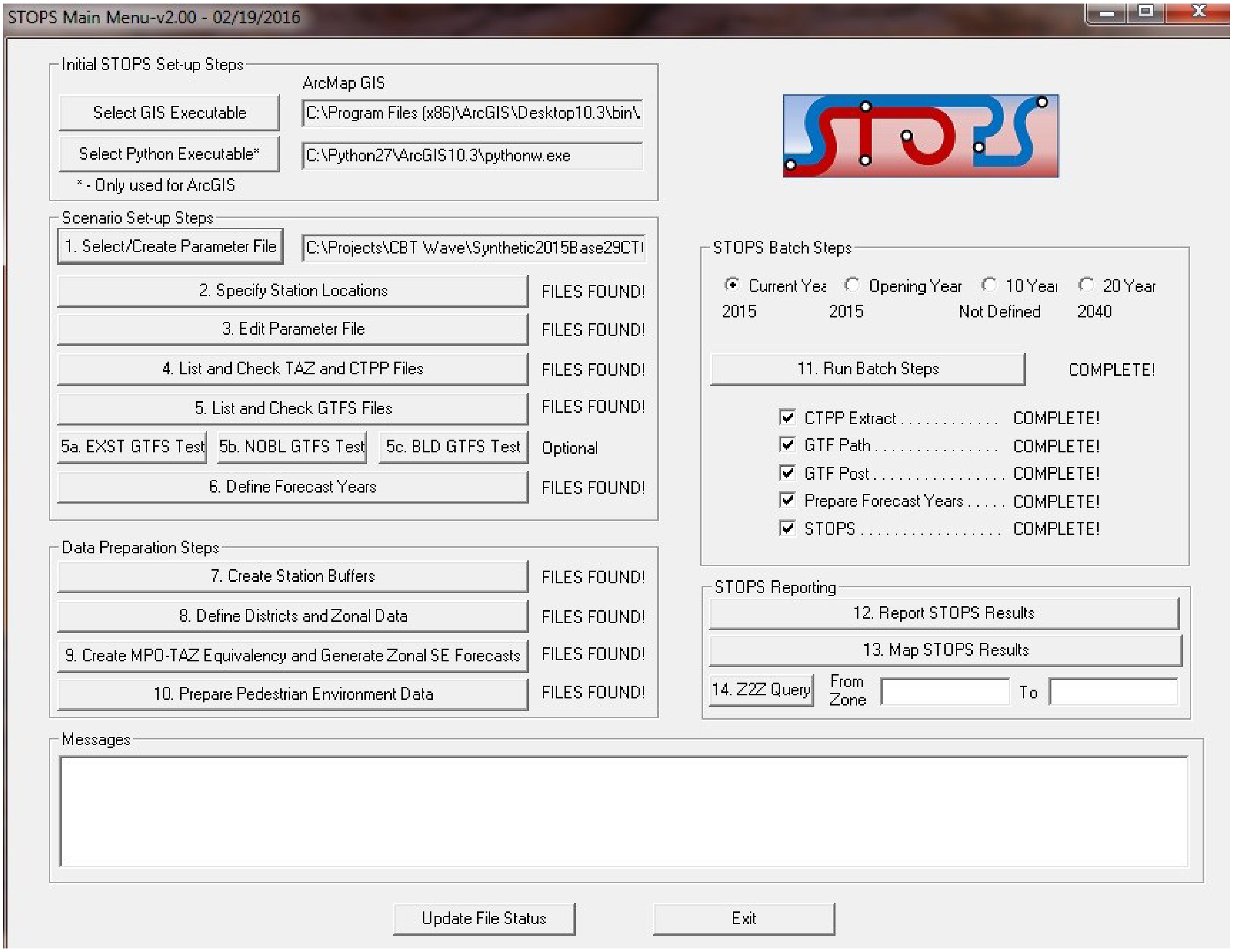
STOPS' primary purpose is to provide a simplified method to produce measures for project sponsors of FTA's Capital Investment Grant ("New/Small Starts") fixed-guideway projects. Its design, nomenclature, and implementation have been tightly focused on this single purpose:

- STOPS reflects the ridership experiences of CIG transit projects constructed around the country. Its internal models have been calibrated and validated against a national collection of over 30 fixed-guideway projects and systems, reflecting streetcar, bus rapid transit, light rail, heavy rail and commuter rail modes.
- STOPS is designed to run No Build and Build scenarios for a user-specified analysis year. The Build generally reflects a corridor transit project, and the No Build and Build meet CIG specifications.
- STOPS is designed to accept roadway travel times and distances calculated by another travel model, usually the MPO's adopted travel model. STOPS does not utilize a roadway network.
- Some STOPS reports and maps are specifically tailored to displaying trips on the project and other CIG evaluation measures, with less detail available for other elements of the transit system (e.g., local buses).

STOPS is recommended for early alternative screenings and evaluations conducted as part of the FDOT's TCAR process.[3] STOPS can be used for transit market analysis, system planning, and COAs. These are analyses and studies that are conducted in early project identification steps. Later in the transit project delivery process, STOPS can be used in Steps 3, 4, 5 and 8 in the TCAR Study Process. The TCAR Study should be completed before requesting entry into FTA's Project Development Phase and a New/Small Starts project rating.

[3] *Transit Concept and Alternatives Review Guidance, FDOT Office of Freight, Logistics and Passenger Operations.*

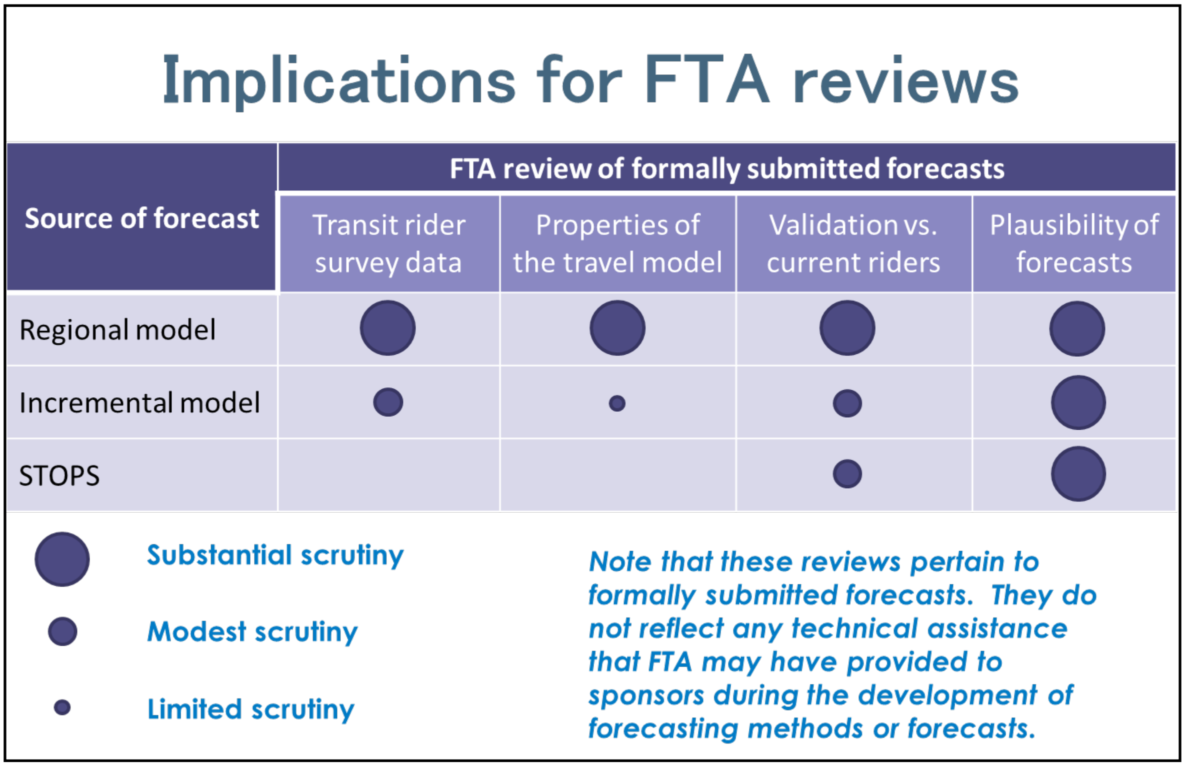
Figure 1 The STOPS Software Menu



2.1 ADVANTAGES TO USING STOPS

While FTA allows project sponsors to develop ridership forecasts for CIG projects using three different methods – regional travel models, incremental models and STOPS – STOPS has many advantages over the other two options. First, FTA requires substantially less review time of STOPS ridership forecasts as compared to forecasts generated by regional or incremental models. Figure 2 shows the level of scrutiny that FTA applies for the three allowable methods. In order to perform its due diligence required by Congress, FTA must scrutinize the underlying data and properties of regional and incremental models. This scrutiny is not required for STOPS since FTA developed it. The STOPS validation efforts and results do require some FTA scrutiny, but this is fairly minor compared to the scrutiny required for the regional model. FTA's main focus of review, when a STOPS forecast is submitted, will be on the plausibility of the forecasts. This scrutiny will mostly be similar regardless of the ridership methods.

Figure 2 FTA Review Levels for Different Forecasting Methods



Source: FTA STOPS Workshop held in Atlantic City, NJ on May 17, 2015.

The lower scrutiny threshold effectively reduces the FTA review time by half, from four months to two. Table 1 provides the recommended timelines for submittal of travel forecasting information to FTA for their review.

Table 1 Timelines for Submittal of Travel Forecasting Information
(in months in advance of anticipated ratings request)

Information for FTA Review	STOPS	Regional Model
Documentation of the model methodology	--	4
Documentation of model testing	--	4
Documentation of project-specific inputs	2	3
Final draft forecasts for the project	1	2

Source: https://www.transit.dot.gov/funding/grant-programs/capital-investments/travel-forecasts, accessed September 7, 2016

Second, and perhaps the most commonly stated benefit of STOPS, is the fact that STOPS models can typically produce more analyses than regional travel models within the same timeframe. Because of its simplified structure and focus on transit impacts, STOPS run times are generally much lower than those from traditional travel models. Also, STOPS executes the No Build and Build scenarios simultaneously. One STOPS model run produces results from two scenarios. Table 2 compares the average running time for selected Florida STOPS applications and regional travel models running No Build and Build alternatives.

Table 2 Comparison of STOPS and Regional Travel Model Running Times for No Build & Build Alternatives

Region	STOPS Run Time (recent experience)	Regional Travel Model Run Time (No Build + Build)
Jacksonville / Northeast Florida	<1 hour	8-16 hours
Miami / Southeast Florida	3-5 hours	3 days (full run)
Orlando / East Central Florida	1-2 hours	8-12 hours
Tampa / West Central Florida	1-2 hours	4.5-7 hours

Third, STOPS has embedded thematic and dot-density mapping routines (detailed discussion in Chapter 5 of this guidebook) that easily display and communicate ridership and travel time results. These maps can be made within a few minutes, and do not require transitioning the data to different users or programs.

The cumulative benefit of STOPS is that CIG project sponsors can now realistically expect to (a) develop a STOPS model ready for analysis within weeks, (b) develop and analyze reliable forecasts within an additional week or two, and (c) achieve FTA concurrence on CIG forecasts within 1-2 months.

2.2 LIMITATIONS TO USING STOPS

STOPS does have some distinct limitations because of its simplified structure and its focus on evaluating CIG projects. One, STOPS does not provide the same level of reporting detail to local buses or non-project stations as it does for project trips. Two, STOPS does not provide a direct interaction with the roadway network. It is not possible for STOPS to reflect changes to highway congestion that result from increased transit ridership. Three, the GTFS editing process can be cumbersome. Currently, a relatively inexpensive software tool to visually edit GTFS networks is not available. Extensive GTFS coding can be much slower than editing of traditional travel model transit networks at this time. Four, STOPS' representation of non-work trips is less certain than its representation of work trips. It is possible that regional travel models may represent non-work trips, especially in terms of the spatial distribution of those trips, better than STOPS. Five, STOPS is limited in its ability to analyze alternatives beyond its supplied metrics. For instance, transit capacity analysis has to be performed offline; transit crowding does not affect STOPS' calculations. Finally, future year travel patterns are based on existing patterns and the user-supplied population and employment forecasts. Variables such as accessibility are not considered in determining future year travel patterns.

2.3 ANCILLARY STOPS APPLICATIONS

The ability to quickly generate reliable transit forecasts has allowed agencies to utilize STOPS for applications beyond its originally designed purpose.

STOPS is being used to provide QC checks on the primary forecast, especially when the primary forecast is not intuitive or the project design has large inherent uncertainties. In these cases, STOPS is applied towards the end of a study to provide an alternate forecast before a final decision is made. An example of using STOPS to provide a QC check is the Tri-Rail Coastal Link example in Chapter 6, which has large inherent uncertainties. QC checks are typically performed in Step 8 of the TCAR Study process.

Agencies are applying STOPS to Systems Planning or pre-Project Development Phase activities. These analyses and studies are conducted in early project identification steps in the TCAR process. These studies analyze potential transit ridership across an entire system, and prioritize corridors for future analyses. STOPS provides a quick, consistent method to evaluate multiple corridors for these studies. An emerging STOPS application are transit operations planning efforts. GTFS files can be easily created through expensive transit scheduling software, such as Trapeze. Consequently, STOPS can help transit analyze travel times and ridership changes between operational changes.

STOPS can be applied for these studies because it has two advantages over TBEST. STOPS accounts for the impact of auto congestion and future changes in auto congestion on transit ridership. TBEST currently is not able to reflect the impacts of auto congestion. STOPS also is heavily focused on estimated ridership using travel movements, or flows. TBEST is a direct demand model; demand is directly determined from supply characteristics, as opposed to computing demand from activity or employment centers and estimating movements between these centers and residential areas.

2.4 RESOURCES

STOPS is designed to run on a laptop or workstation running a 32- or 64-bit version of Microsoft Windows version 7 or later. The laptop or workstation requires at least 4 GB of memory, but 8 GB is recommended. Users should plan for 20-100 GB of hard disk drive storage per scenario. [4]

STOPS also requires an additional software package. To handle the geographic information, STOPS uses a GIS package to process the ESRI shape files. This package can either be inputted in ArcGIS or TransCAD format. Florida agencies are likely to have a copy of ArcGIS, as this software is combined with Citilabs' CUBE software. CUBE is currently the Florida standard travel modeling software. The GIS package must be installed on the same computer as STOPS. The user will inform STOPS which GIS package is installed to use before executing a STOPS model run. Step-by-step instructions on directing STOPS to the location of the GIS package can be found in the STOPS User Guide.

An online GTFS viewer is essential to visualize and evaluate the GTFS networks for STOPS. A commonly used GTFS is Google's ScheduleViewer, which is free and can be found at https://github.com/google/transitfeed/wiki/ScheduleViewer.

It is strongly recommended that STOPS users have a powerful text editor at their disposal. STOPS generates over 3,000 tables of information in the primary report file, which is a text file typically greater than 30 MB. Word processors, whether "lite" or "full" versions, are insufficient for this task because the report file is written in a generic ASCII format that does not recognize the page formatting of word processors. Commonly used text editors are Notepad++, UltraEdit and TSE-Pro.

- Understanding of the mechanics of travel forecasting, including the concept of a "model run", the types of data used as input to the travel forecasting process, and techniques for reviewing model outputs;
- Experience using GIS packages, especially the one being applied with STOPS, to create GIS layers in ESRI shape file format representing station locations and MPO zone systems; and
- Familiarity with the regional transit system including the different agencies providing service and the nature of the schedule service in the region. [5]

It is recommended that the technical staff also have experience using a spreadsheet program (capable of handling files of significant length, such as Microsoft Excel) and a text editor for making modifications to the STOPS text input files. Input files or transit survey data must be revised or modified throughout the analysis, and a spreadsheet program, a text editor or a combination of the two are typically used in these instances. A database or statistical analysis package can be used in lieu of the spreadsheet program.

[4] *Federal Transit Administration. STOPS User Guide for Version 1.5. April 29, 2015. Page 8.*

[5] *Federal Transit Administration. STOPS User Guide for Version 1.5. April 29, 2015. Pages 8-9.*

2.5 SCENARIOS AND ANALYSIS YEARS

STOPS makes predictions for three (3) scenarios simultaneously for a user-specified analysis year. The three scenarios are:

1. "Existing", reflecting all existing conditions the year for which the most recent information is available. Typically, the data for existing conditions are 0-2 years before the present year;
2. "No Build", reflecting the changes in conditions from the "Existing" scenario; and
3. "Build", reflecting the changes in conditions from the "No Build" scenario. Typically, this scenario reflects a significant transit infrastructure investment.

The user is responsible for gathering and preparing the input files reflecting all three scenarios. In the Existing scenario, STOPS uses the input files to calibrate the component models. It is absolutely necessary that all input data be coordinated and internally consistent for a successful calibration.

STOPS users can define up to four analysis years for the No Build and Build scenarios: current year, opening year, a 10-year horizon, and a 20-year horizon. The current year is the year for which the most recent information is available. The current year will usually be 0-2 years before the present year. The opening year is the year the Build project is expected to be in revenue operation. Typically, the opening year will be 2-7 years after the current year.

The 10- and 20-year horizon years represent medium- and long-term future years. The 20-year horizon year usually is the same year as the region's LRTP, and does not have to be exactly 20 years from the current or opening years. The 10-year horizon is some interim horizon year, which could correspond with an interim horizon year from the region's LRTP. It does not have to be exactly 10 years from the current or opening years.

STOPS users are responsible for preparing the input files for all selected analysis years. Only the current and opening years are required for CIG projects.

2.6 INPUT DATA

STOPS has fewer input data requirements than regional travel models:

- Census Transportation Planning Package (2000 or ACS) from FTA,
- GTFS data from your scheduling software,
- Average weekday system-wide unlinked trips from NTD reporting,
- Average weekday boardings by station/stop from your count program (if available),
- Zone-level population, employment, and highway impedances from your regional model,
- Representation of the No Build and Build scenarios in GTFS, and
- Park-ride lot information. [6]

A transit rider survey, also called a transit travel survey, is optional but extremely helpful. The source agency for each of the required input data is shown in Table 3.

[6] *Federal Transit Administration. "Ridership: Counts and STOPS", a session at the FTA's Capital Investment Grant Workshop held on July 26-28, 2016 in Washington DC. Slide 15.*

Table 3 Source Agencies for STOPS Input Data

Data Type	Source Agency (Site)
Census Transportation Planning Package (2000 or ACS)	The Census Bureau via FTA's website or FTA's STOPS coordinator (https://www.transit.dot.gov/funding/grant-programs/capital-investments/stops-data-census)
GTFS data	Transit agency's website or FDOT's GTFS archive (http://ftis.org/Posts.aspx)
Average weekday system-wide unlinked trips	Transit agency, NTD (https://www.transit.dot.gov/ntd/transit-agency-profiles) or APTA (http://www.apta.com/resources/statistics/Pages/ridershipreport.aspx)
Average weekday boardings by station/stop (if available)	Transit agency's count program
Zonal-level population, employment and highway impedances from the regional travel model	The region's MPO or local FDOT district
Representation of the No Build and Build scenarios in GTFS	Study team, transit agency, MPO or other agency
Park-ride lot information	Transit agency's website, or contact the transit agency directly

Most of this information is readily-available and easily obtainable.

2.7 OUTPUT

STOPS produces two types of results: report files in ASCII format and maps that are produced in the user's GIS package. The report file is located in the \Reports sub-folder. One report file is created per analysis year. This file is very large, usually 30 MB in size and over 150,000 lines in length. There are approximately 3,000 different tables in the report file. Six tables provide all of the travel model information needed for a CIG application which are listed in Chapter 5.

STOPS has embedded thematic and dot-density mapping routines that easily display and communicate ridership and travel time results. STOPS users can easily produce maps displaying a wide range of information, including:

- Travel times to/from specific locations (thematic maps),
- Changes in travel times between No Build and Build scenarios,
- Trip gains/losses,
- Trip productions and attractions, and
- Locations of trips made by transit-dependent households.

These maps can be made within a few minutes, and do not require transitioning the data to different users or programs.

2.8 APPLICATION APPROACHES

STOPS can be run using one of three different approaches, which differ on how STOPS produces the transit trips:

1. "Synthetic" – uses STOPS' component models to estimate existing transit travel using CTPP travel patterns and aggregate ridership information, then applies component mode choice models to estimate transit ridership for the No Build and Build scenarios;

2. “Synthetic with Special Markets” – uses the “Synthetic” approach but with an added person trip table provided by the user, usually from a travel survey, to reflect unique travel markets in the area of study. Unique travel markets could include universities, military bases or tourist areas; and

3. “Incremental” – STOPS relies on the transit travel patterns from a rider survey rather than its component models, then applies incremental mode choice models to estimate transit ridership for the No Build and Build scenarios.

These approaches are described in detail in Chapter 4. The approach most appropriate for a particular application primarily depends on the quality and age of the most recent transit rider survey. Recent transit surveys consistent with existing state of practice methods can be used for Incremental approach. Other available surveys can potentially be used for calibrating STOPS model utilizing the Synthetic approach.

3.0 DEVELOPING A STOPS APPLICATION

STOPS is a simplified edition of the four-step travel demand models used in the United States for nearly 50 years. Developing a STOPS application is a simplified process that requires data assembly, preparation and calibration. Forecasting ridership for No Build and Build alternatives immediately follows after calibration. This chapter provides a high-level overview of the STOPS model and describes the process to develop a successful STOPS application.

3.1 MODEL OVERVIEW

The STOPS model components follow the traditional four-step travel modeling process: generation, distribution, mode choice and assignment. The generation and distribution steps are combined into a single step, with CTPP worker flow data and zonal population and employment data as the primary inputs. CTPP worker flow data is survey data collected by the Census Bureau. The generation and distribution models scale the CTPP flows to the zonal population and employment data and compute non-work flows. This produces zone-to-zone person trips by three trip purposes, HBW, HBO and NHB.

The mode choice model is a nested logit structure. Using the output from the generation and distribution steps, it estimates person trips by transit line-haul and access modes using the GTFS transit network data and roadway skims (i.e., zone-to-zone travel distances and times using auto modes). These trips are then assigned to the transit routes in the assignment step. Table 4 summarizes the key inputs and results from each of the four steps.

Table 4 Summary of STOPS' Four-Step Travel Modeling Process

Modeling Step	Key Inputs	Key Results	Temporal Resolution
1-Generation (performed with distribution)	CTPP worker flow data; MPO zonal population and employment data	Zone-to-zone person trips by trip purpose and auto-ownership	Peak and off-peak period, reported at daily level
2-Distribution (performed with generation)			
3-Mode Choice	Zone-to-zone person trips	Zone-to-zone person trips by trip purpose, transit mode, access mode and auto-ownership	
4-Assignment	Zone-to-zone person trips by transit mode and access mode	Boardings by route	

STOPS self-calibrates to local transit information, which is supplied by the user. The user is provided some control over the methods used to calibrate STOPS to local conditions. Table 5 displays the high-level calibration options available to the user. More detailed calibration options are also available; these are discussed in Chapter 3.3.

Table 5 STOPS Self-Calibration to Local Conditions

Modeling Component	Calibration Options	Comments
Generation / Distribution	Trips can be scaled at the zonal or user-specified district-level	Zonal is preferable for urban study areas, district level should be used for high-growth areas
Mode Choice	A system-wide adjustment factor is applied to ensure that STOPS estimate of total transit boardings match user-supplied value	User supplies observed system-wide transit boardings; STOPS develops the adjustment factor
	Transit constants are applied by auto ownership and user-defined district by either (1) attraction district only or (2) both production and attraction district	Generally, calibrating to production and attraction districts is used
	Factors are applied to user-specified station-groups to match user-specified data on daily boardings by stop/station	This is only applied when reliable counts by stop/station are supplied by the user

3.2 DATA PREPARATION ISSUES

Table 3 contains the STOPS data requirements. A common issue that arises is the reconciliation of this data. As can be seen in Table 3, the data for a particular STOPS application can originate from 5-6 different agencies. It is likely that the data collection is not wholly consistent. The data may reflect different years or transit service patterns. The most recent transit surveys may have been collected to 5 or 10 years previously. GTFS networks may reflect existing service – literally the month they were downloaded – but the count and unlinked trip data may reflect service in the previous year or previous quarter. The zonal-level population, employment and highway impedance information may not exactly correspond to the same year as the other transit data.

The ridership data may need to be reconciled beyond chronological consistency. System-wide ridership is sometimes surprisingly different between NTD and APTA reports. The summation of stop/station boarding counts usually do not exactly match system-wide or route-level ridership.

No Build and Build GTFS development can be time consuming if done manually. If they are not available through the transit agency, the study schedule should make sure that sufficient schedule and budget for GTFS development are allocated for successful STOPS application. Hence, a decision on No Build and Build definitions and analysis years should be made upfront during the study.

Table 6 on the following page provides a summary of common issues and problems for each input data type.

Table 6 Common Issues with STOPS Input Data

Data Type	Common Issues / Problems
Census Transportation Planning Package (2000 or ACS)	No issues. Download by state. The Florida file size is 288 MB.
GTFS data	Transit agencies typically alter service 2-3 times a year. So the GTFS file needs to correspond with the ridership data
Average weekday system-wide unlinked trips	Inconsistencies in reporting. This information must be consistent with the GTFS information and other ridership data
Average weekday boardings by station/stop	Count data should reflect average weekday boardings over a broad period of time, preferably weeks or months, to avoid over-stating individual fluctuations or special events. Count data may have missing or extraneous information that the user will have to address before running STOPS. This information must be consistent with the GTFS information and other ridership data. Count data may include significant ridership from special markets. If these markets are substantial, then ridership from those markets should be deducted from the counts until they are reflected accurately in STOPS (see Chapter 4.2).
Zonal-level population, employment and highway impedances from the regional travel model	Need 2000 or 2008 population and employment data consistent with base and horizon year population and employment data. MPOs do not generally make their existing population and employment data methods backward-compatible.
Representation of the No Build and Build scenarios in GTFS	Editing GTFS networks must occur in a database, spreadsheet and/or text editor program.
Park-ride lot information	Must be developed by user. Park-ride locations should correspond with stop/station counts and GTFS information.
Transit travel surveys (optional)	Older surveys may be significantly "out of date" given changes in travel behavior, economic conditions and/or transit service. Surveys may need to be re-expanded to be consistent with other ridership data. Surveys should be geocoded to the same zone system used for population and employment data for consistent observed/estimated comparisons.

Consequently, one of the first steps the user must perform is a review of the timeframes and the systemwide ridership reported by each piece of data. To reconcile the data, the user can apply one or more of the following options:

- Scale stop/station APC counts to the unlinked systemwide boardings,
- Interpolate (in some cases, extrapolate) population, employment and highway impedance data to correspond with the desired current, opening, 10-year and 20-year horizon years,
- Re-expand transit survey data to unlinked systemwide boardings,
- Utilize slightly older GTFS networks that are consistent with rider survey or count data,
- Inform STOPS of only aggregate survey information that has been scaled appropriately to unlinked systemwide boardings, and/or
- Other solutions.

These solutions can take hours, days or weeks to address, depending on the severity of the issue. Table 7 displays three common examples of data consistency issues and the proposed action items.

Table 7 Example Data Consistency Issues and Proposed Solutions

	Example 1	Example 2	Example 3
"Existing" GTFS Information	Fall 2016	Fall 2016	Spring 2016
Transit survey	n/a	Spring 2013	Fall 2010
Stop/station count data	n/a	n/a	Fall 2015
System-wide boarding data	2013	2014 (NTD)	2013 (NTD)
Proposed "Existing" Year & Action Items	2013 Locate archived 2013 GTFS network, and use if found	2014 Re-expand transit survey to system-wide boarding data; Locate archived GTFS 2014 network	2015 Re-compute system-wide boarding data per stop count data; re-expand transit survey to 2015 route-level data

Another major issue is the definition of districts and station-groups (also called stop-groups in STOPS nomenclature). Districts are used in the reporting of person trip flows. STOPS can support up to 50 districts, but 16-30 are most common. They are also the geographic unit used to calibrate transit shares and represent the basis of station-groups. Districts should be focused on the primary corridor, but very broad outside the corridor. In its STOPS course, FTA provided several points on the definition of districts:

1. Using planning parlance, the STOPS model area should be divided into 3-4 "rings" and 6-8 "sectors",
2. The size of the rings and sectors will be smaller near the primary corridor and larger as you move further away,
3. The CBD should be its own district, and
4. Other major activity centers should have their own district.[7]

3.3 CALIBRATION ISSUES

Calibration is the process of matching STOPS results to local conditions. STOPS self-calibrates certain information, as discussed in Chapter 3.1, but the user should use more detailed calibration settings once the data preparation steps have been completed.

While there is no definitive "step by step" process for calibrating a STOPS application, a recommended strategy to focus on the "big picture" items first, then proceeding to smaller details. The general order of calibration importance is shown in Table 8 on the following page.

[7] *Federal Transit Administration. "Ridership Forecasting with STOPS for Transit Project Planning". Orlando and Los Angeles. May/June 2016.*

Table 8 Recommended STOPS Calibration Strategy

#	Issue (in order of importance)	Description	Possible Calibration Improvement Strategies
1	Purposes	Ensure STOPS accurately reflects the amount of observed HBW, HBO and NHB trips	Provide transit linked-trip information to STOPS (via rider survey); Adjust person-trip rates; Add special-market flows
2	Flows	Ensure STOPS accurately reflects the observed transit trip flows	Calibrate to attraction and production transit shares; Use "incremental" approach (requires "good" rider survey)
3	Access modes	Ensure STOPS accurately reflects transit trips by access mode (walk, park-ride, kiss-ride)	Add time penalties by access mode that reflect un-included/qualitative impedances or behaviors
4	Transfers	Ensure STOPS accurately reflects the number of linked transit trips or percentage of linked trips that transfer	Adjust transfer penalty (0-10 minutes, default is 5 minutes)
5	Fixed-guideway share	Ensure STOPS accurately reflects existing share of transit trips that use fixed-guideway modes	Adjust visibility factor
6	Groups	Ensure STOPS applies minimal adjustment factors to achieve reasonable representation of station-group ridership	Review GTFS, PNR and stop/station files for accuracy; Enable station-group calibration
7	Routes	Ensure STOPS accurately reflects routes in corridor (higher scrutiny) and outside corridor (lower scrutiny)	Review GTFS, PNR and stop/station files for accuracy; Add time penalties to stops to reflect substantial fare differences among services or routes; Further detailed or complex adjustments may be needed
8	Stations	Ensure STOPS accurately reflects station boardings, in total and by access mode, within the corridor	

The visibility factor is a setting that approximates the differentiation of fixed-guideway alternatives and regular bus service within a corridor. The visibility factor ranges from 0.0-1.0, where a number close to 0.0 would reflect a BRT project indistinguishable from local bus and 1.0 would reflect a light-rail alternative that operates along exclusive right-of-way. There is a direct correlation between the selected visibility factor and ridership: higher project ridership can be expected with higher visibility factors.

For calibration, the visibility factor should be based on the characteristics of the existing fixed-guideway systems and other methods used to achieve a reasonable share of fixed-guideway trips. The expectation is for visibility factors to remain within an unofficial, but well-known range developed through cumulative STOPS application experience. This range and the associated project modes and characteristics are shown in Table 9.

Table 9 Range of Visibility Factors Given Selected Characteristics

Transit Mode	Selected Characteristics	Initial Visibility Factor Value(s)
BRT ('Corridor-based')	Peak hour/period exclusive lanes/right-of-way; Defined stations; TSP/QJ for transit vehicles; "Schedule-free service"	0.0-0.2
BRT ('Robust')	'Corridor-based' BRT characteristics plus All-day exclusive lanes or reliably faster travel times; Separate and consistent branding	0.3-0.5
Streetcar	Railcar operating in mixed-flow (low-end) or exclusive lanes (high-end) plus Corridor-based BRT characteristics	0.5-0.75
LRT/HRT/LRT	Railcar operating in mixed-flow (low-end), exclusive lanes or railroad right-of-way (high-end)	0.6-1.0

3.4 RIDERSHIP FORECASTING ISSUES

Many of the issues that arise in STOPS applications are identical to those that appear with traditional travel modeling approaches. However, users have noted some issues that require particular attention by agencies due to STOPS' features and design.

A technical issue is the necessary detail and coding of the No Build, Build, and future year transit networks. The GTFS format is very comprehensive, and much more detailed than traditional planning analyses. For the Build and future year transit networks, planning analysts typically provide general routing, identification of selected stops/station, average speeds, and average frequency. However, the GTFS allows for stop-to-stop coding of travel times, the precise location of stops, and enumeration of every bus run. STOPS provides some features that allow direct coding of planning-level details, so that planners do not need to develop detailed run schedules.

Comparison issues tend to arise when the planning-level and GTFS-level routes are interpreted by STOPS. An example is shown in the following table. The GTFS-level of detail specifies the exact bus run. In this example the run begins at 6:53 AM. For a planning-level of detail, the user provides the end-to-end travel time, average frequency (i.e., headway), and start time of the service. In this example, the start time is set to 7:00 AM. Start times are typically coded at the beginning of an hour for easier coding, however, in this example, the start time will create a disconnect between this route and connecting routes at the transfer center since it will arrive two minutes after the connecting routes depart. This can result in a loss of system-wide transit trips and unexpected ridership results. The solution is to investigate all important transfer locations when coding Build or future-year transit networks, at a planning-level of detail, to ensure that transfer connections are uninterrupted. In some circumstances, an easier option is to recode part or all of the existing base network.

Table 10 Example of Differences in GTFS- and Planning-levels of Detail

	GTFS-level of detail	Planning-level of detail	Notes
Description	Precise stop locations Precise stop times Enumeration of all bus runs	Precise stop locations Interpolated stop times Average frequency + start time	
Stop #1	6:53	7:00	
Stop #2	6:55	7:02	
…	…	…	
Stop #9	7:29	7:36	
Stop #10	7:32	7:39	
Arrival Transfer Center	7:35	7:42	
Connecting Routes depart at…	7:40	7:40	Connecting routes are unchanged from agency's GTFS file
STOPS Result	5-minute transfer time to connecting routes	Riders miss connection	Can result in loss of transit trips and poor ridership results

When coding at STOPS' planning-level of detail, particular focus is needed to ensure the end-to-end travel times for a proposed route reflect expected delays or recovery time. A good rule of thumb is to code STOPS with a travel time that would be shown in a public time table. STOPS calibrates to the existing transit service levels as reflected in the GTFS files. These files are often produced by scheduling software. Transit schedules provide reliable estimates of travel times, both for driver scheduling needs and setting rider expectations. Planning efforts typically produce stop-to-stop or station-to-station times devoid of any extra time, delay or recovery time. These artificially faster times can produce artificially higher ridership estimates. FTA may uncover these artificially faster times for New/Small Starts projects, especially if proposed routes are substantially higher than existing routes.

Setting the value of the visibility factor is a common STOPS forecasting issue. As discussed in Chapter 3.3, the visibility factor should be based on the characteristics of the proposed fixed-guideway system. This range and the associated project modes and characteristics are shown in Table 9, however, the visibility factor is not always definitively known. This can cause issues when developing the official metrics for New/Small Starts evaluation. A good strategy is to work with FTA STOPS staff using the following steps:

1. Using the guidelines in Table 9, determine reasonable low, medium and high values for the visibility factor;
2. Run variations of the Build project, each with the low, medium and high visibility factors;
3. Assess the variability of the ridership estimates and share the results with the FTA; and
4. Mutually agree (project sponsor and FTA staff) on the "official" forecasts to be used for New/Small Starts funding evaluation.

3.5 OBSERVATIONS

The amount of resources needed to prepare a STOPS application is directly proportional to the accuracy and consistency of the data inputs. It should be noted that, in many circumstances, the person developing a STOPS application for the first time in an area may be one of the first to review collectively the ridership information, GTFS networks, and travel surveys. It may take some time to uncover the inconsistencies and enact solutions to those inconsistencies. A review of the data inputs should be the first major milestone in developing a successful STOPS application.

Significant calibration efforts may be needed if unreasonable adjustment factors or estimated ridership results persist. In their 2016 STOPS course, FTA mentions more intense solutions such as converting the CTPP data into a more detailed zonal system, such as the one used by the MPO's travel model, subdividing zones, and other methods to improve calibration results. However, it should be noted that transit rider surveys can significantly help in reducing STOPS development and calibration time, as they provide helpful information as to why riders behave in certain ways.

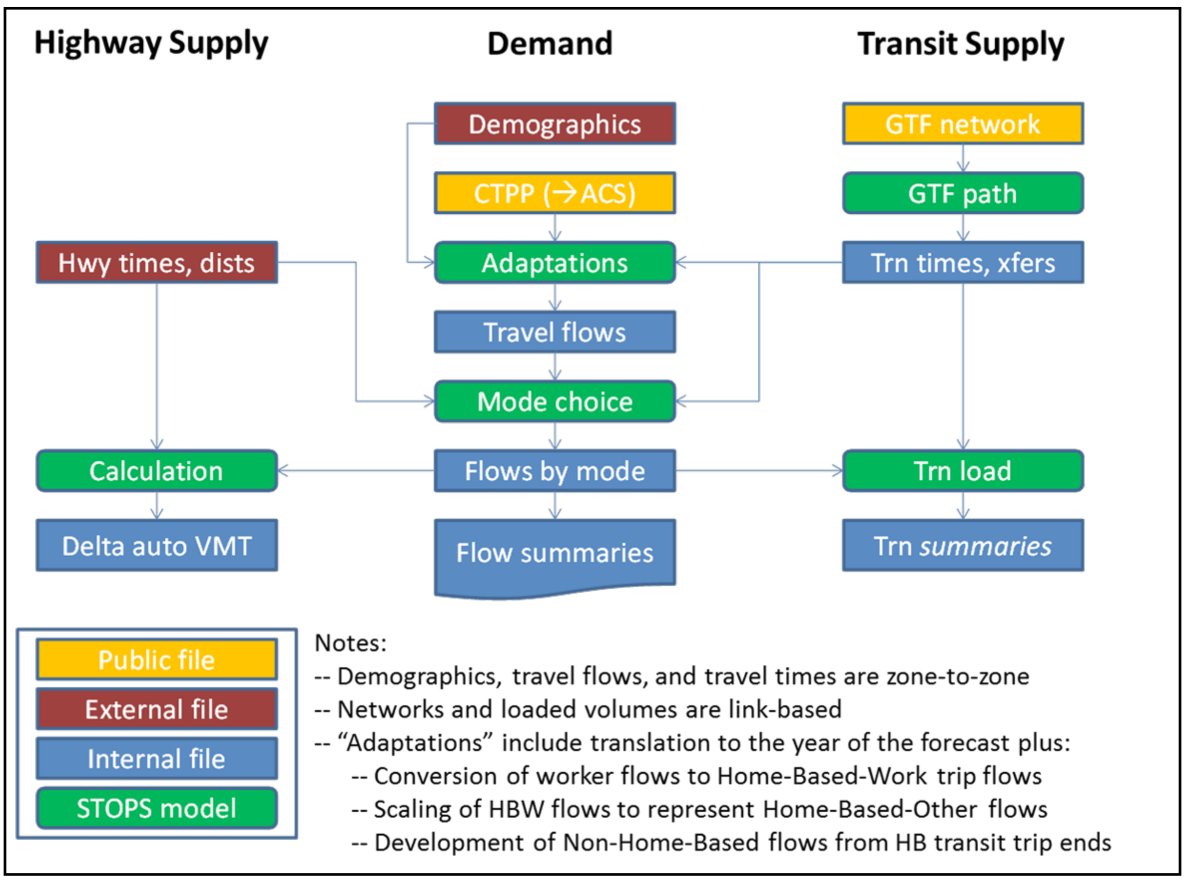
4.0 APPLICATION APPROACHES

STOPS has three approaches that can be used to develop an application: "Synthetic", "Synthetic with Special Markets", and "Incremental". Each approach is discussed in this chapter. Considerations when selecting an approach are also discussed. This chapter builds on the overview provided in Chapter 3.1, and focuses on three distinct approaches.

4.1 "SYNTHETIC"

The "Synthetic" approach relies almost entirely on the STOPS component models to estimate transit demand. Figure 3 shows the inputs, activities and outputs for a typical "Synthetic" STOPS approach. Transit trips are computed first by producing synthesized person trips via simplified trip generation and distribution steps that rely on the county's CTPP data and demographic data from the regional travel model. The mode choice model self-calibrates to local conditions using user-provided aggregate data, transit network information and roadway network information. The trip generation, distribution, mode choice, and assignment steps then estimate transit demand for the No Build and Build scenarios coded by the user.

Figure 3 Workflow for "Synthetic" STOPS Approach



Source: FTA's STOPS Workshop, held at the 15th TRB Planning Applications Conference in Atlantic City, NJ, May 17, 2015.

Up to nine data items can be used in the "Synthetic" approach. Table 11 lists each of the data items. Items 1-7 are required for any application using this approach. If the local transit agency (or agencies) collect reliable information on passenger boardings by station/stop, that data must be used in this or any STOPS application. Linked transit trip information, which originates from a recent and reliable onboard survey of transit riders, can provide STOPS with additional information that should improve its calibration. Linked transit trips can be provided in aggregate, or stratified by trip purpose and auto ownership.

Table 11 “Synthetic” STOPS Data Items

#	Data Type	Required	Optional	Recommended
1	CTPP travel flows	√		
2	Roadway travel times and distances (zone-to-zone)	√		
3	Population and employment (zonal-level)	√		
4	GTFS files	√		
5	Park-ride lot information	√		
6	Total weekday system-wide unlinked trips	√		
7	No Build and Build representation in GTFS and park-ride files	√		
8	Average weekday boardings by station/stop		√	√
9	Total linked transit trips, stratified by trip purpose and auto ownership		√	√

4.2 “SYNTHETIC WITH SPECIAL MARKETS”

The “Synthetic” STOPS approach develops ridership estimates using data and models designed for conventional travel markets: work trips and routine weekday travel. Special markets are unique travel markets not accounted for in the “Synthetic” STOPS input data and models. The CTPP data captures worker flows between their homes and work areas, and STOPS has mechanisms to produce non-work trips associated with those work areas. Consequently, the CTPP data is essentially unaware of activity centers with travel that is not routine, not by residents (predominantly) and not scaled to jobs. Examples of special market include large airports, universities or tourist areas.

Particular attention to special markets and their representation in STOPS is necessary when the travel from these markets is significant in the corridor of interest. STOPS can incorporate travel from special markets in two distinct methods: (1) a direct over-ride of STOPS’ CTPP-based estimate of person trips and (2) add special market trips to a specially created zone in the GIS layer. Either method may be used depending on circumstances, but both methods cannot be used for the same travel market. Both methods require an adjustment to the GIS layer and preparation of a zone-to-zone trip table of the special market flows.

The technical details of importing special market trips will be provided in an upcoming edition of the STOPS User Guide. FTA discussed the details at their “Ridership Forecasting with STOPS for Transit Project Planning” course held in Orlando in May 2016. A crucial item for planning directors and managers is that a survey or data collection effort may be necessary to develop zone-to-zone trip tables of special market flows. These efforts can add days, weeks or months to the STOPS development process, depending on the circumstances. Special market trip tables can be derived from:

- Special market models,
- Special market intercept surveys,
- Special market records from a transit rider survey, and/or
- Other data sources (e.g., ZIP codes of university students).

The data requirements for this STOPS approach are the same as the synthetic approach, but additional information is needed about the special markets.

Table 12 "Synthetic with Special Markets" STOPS Data Items

#	Data Type	Required	Optional	Recommended
1	CTPP travel flows	√		
2	Roadway travel times and distances (zone-to-zone)	√		
3	Population and employment (zonal-level)	√		
4	GTFS files	√		
5	Park-ride lot information	√		
6	Total weekday system-wide unlinked trips	√		
7	No Build and Build representation in GTFS and park-ride files	√		
8	Special market flows	√		
9	Average weekday boardings by station/stop		√	√
10	Total linked transit trips, stratified by trip purpose and auto ownership		√	√

4.3 "INCREMENTAL"

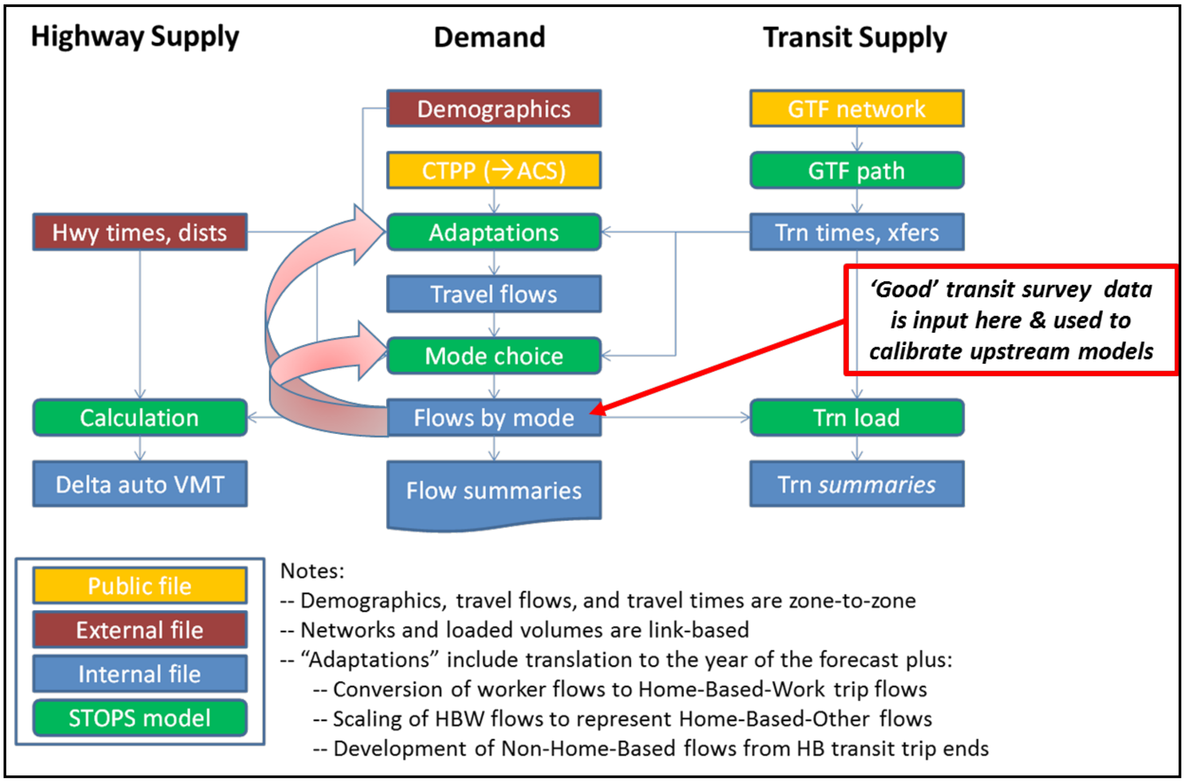
The "Incremental" STOPS approach uses data from a 'good' transit rider survey as the basis for developing person trips and calibrating STOPS instead of relying on the CTPP data and aggregate transit trip information. As Figure 4 shows, in the incremental approach, STOPS uses the transit trip flows to calibrate the mode choice and person trip generation models.

Incremental STOPS approaches generally takes less time to calibrate than synthetic approaches. This is because the rider survey already reflects an accurate representation of transit trips. It does not have to be synthetized via CTPP data and STOPS models, and then calibrated by the user. Forecasting using this approach works well in areas with well-developed corridors, good transit coverage, mature transit ridership responses to service changes and the proposed project is not drastically different from existing service. This approach may not work well where most or all of these conditions do not hold.

If not readily available, 'good' rider surveys can require significant resources to conduct. It can take up to one year from the time of contractor notice to proceed to delivery of final survey dataset. For the purposes of STOPS, a 'good' transit rider survey has the following characteristics:

- Conducted within the past 5-6 years or conducted when transit service coverage and levels were approximately similar to existing transit service coverage and levels,
- Includes a useful number of samples that provide meaningful statistical accuracy levels for trip flows,
- Free of response and sampling biases,
- Expanded to existing ridership levels,
- Includes the following data items:
    - Accurate production/attraction trip information geocoded to TAZ or latitude/longitude coordinates,
    - Trip purpose segmentation that is translatable into HBW, HBO, and NHB purposes,
    - Auto ownership segmentation by at least 0, 1, 2+ autos owned per household,
    - Mode of access categories that can be organized into walk, park-ride and drop-off access modes, and
    - Transit transfer activity.

Figure 4 Workflow Representation for "Incremental" STOPS Approach



Source: FTA's STOPS Workshop, held at the 15th TRB Planning Applications Conference in Atlantic City, NJ on May 17, 2015. Modified here for "Incremental" approach.

The list of data items for the incremental approach, shown in Table 13, is extremely similar to the data items needed for the other approaches.

Table 13 "Incremental" STOPS Data Items

#	Data Type	Required	Optional	Recommended
1	CTPP travel flows	√		
2	Roadway travel times and distances (zone-to-zone)	√		
3	Population and employment (zonal-level)	√		
4	GTFS files	√		
5	Park-ride lot information	√		
6	Total weekday system-wide unlinked trips	√		
7	No Build and Build representation in GTFS and park-ride files	√		
8	Average weekday boardings by station/stop	√	√	√
9	Transit trip flows stratified by trip purpose and auto ownership	√		

4.4 DECIDING ON AN APPROACH

Since each project has varying circumstances and needs, it is imperative that planning directors and managers evaluate which approach is the most applicable. There are three major considerations that can help planning directors and managers decide which STOPS approach is best. These are summarized in Table 14 on the following page. The synthetic approach is most applicable when the project conditions are expected to be significantly different from today, or when 'good' rider survey data is unavailable.

Table 14 Situations That May Favor Certain STOPS Approaches

Category	Synthetic Approach	Incremental Approach
Available transit data	Unavailable 'good' rider survey; Minimum transit rider information available	'Good' rider survey available or forthcoming
Corridor or study area characteristics	Limited transit service currently provided (hourly or higher frequencies); Large demographic or service coverage changes expected in near- or long-term; Modest ridership	Transit service levels are robust and cover well-developed areas; Known ridership responses to past improvements; No large demographic or service changes expected in near- or long-term
Project characteristics	Project represents significant change or increase from existing services (e.g., local bus only to rail, doubling of service area, strong service in currently under-developed area)	Project represents evolutionary change from existing services (e.g., local bus to BRT)

Figure 5 shows a decision tree that planning directors and managers can use to decide on the best approach. The first question is the availability of 'good' rider survey dataset. If one exists, the second question is whether the project, transit or regional characteristics are expected to be dramatically different. The litmus test to determine this is answering the question, "Are conditions expected to change so radically that the rider survey data will be unhelpful in drawing conclusions about future transit travel patterns?" Finally, the third set of questions is whether special markets are a significant component to the corridor or project ridership, and whether existing transit trip information is available for those special markets.

With the exception of rider survey data, both "Synthetic" and "Incremental" approaches require the same level of information. They also take an equivalent amount of time to run scenarios (i.e., their run times are equivalent). Calibrating an "Incremental" STOPS model will, primarily require less time than calibrating a "Synthetic" model. The development timeframes for developing STOPS models are the same for both approaches. Estimated timeframes and key schedule drivers are shown in Table 15. A typical STOPS application can be expected to take 3-6 months, with additional time needed for additional data collection efforts, addressing data inconsistencies or detailed network coding issues. Costs to develop and run STOPS applications can vary, but the variance is not as wide as for regional travel models. In our experience, a STOPS application can be developed and run for 1-2 Build alternatives for approximately $35,000-$60,000. These estimates should not be assumed to apply to every situation, as they are highly dependent on the characteristics of the project, available data, and other factors.

Figure 5 STOPS Approach Decision Tree

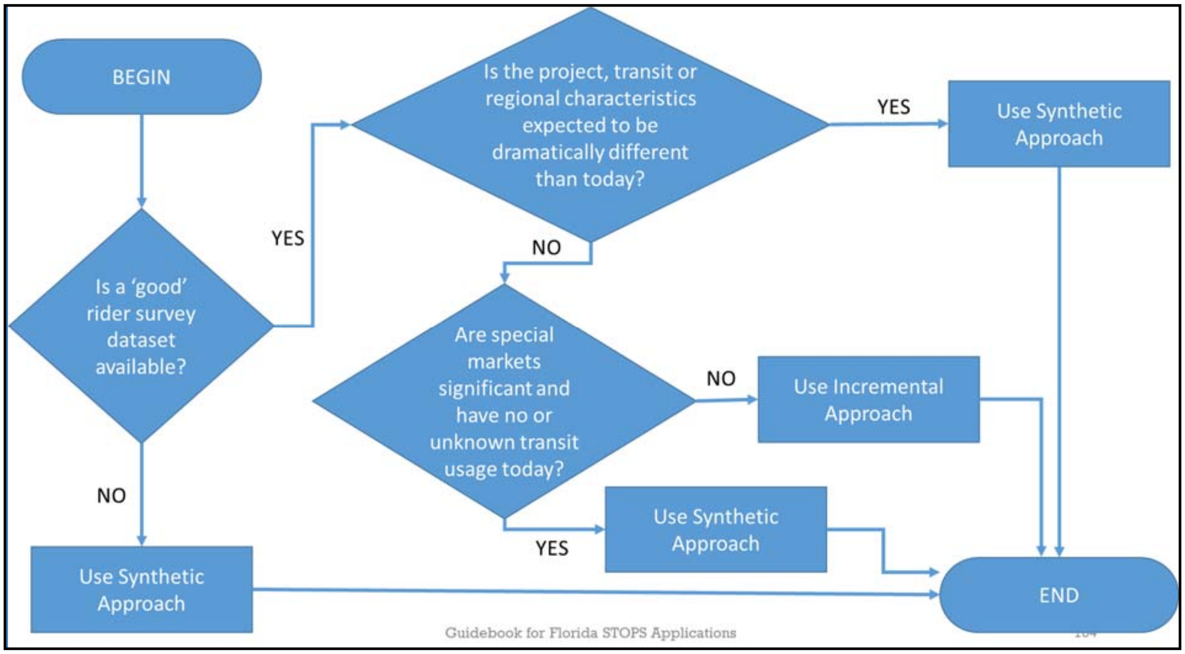


Table 15 Potential STOPS Model Development Timeframes and Schedule Drivers

	Potential Timeframes	Schedule Drivers	Circumstances That Can Significantly Affect Schedule Beyond Potential Timeframes
Hardware / Software Acquisition	Varies	Purchase agreements	If not already available, hardware and GIS software costs can exceed $15,000, which may require lengthy procurement procedures
Data preparation	1-2 months	Data availability and consistency	Basic transit, GTFS data or rider survey is not available; Data items are not consistent in terms of ridership levels and do not correspond with GTFS networks; Special market data collection effort is needed
Calibration	1-2 months	Availability of stop-level count data; Special markets; Data inconsistencies	Special markets may adversely impact calibration if they are significant in key corridors, and may require additional data collection and analysis; Data inconsistencies previously unforeseen in the data preparation stages
Forecasting	1-2 months	Extent of GTFS coding required for No Build and Build networks; Transfer connections	Significant differences between existing, No Build and Build networks, or between existing and future year networks; Previously unforeseen 'broken' transfer connections in No Build and Build alternatives; More than 1-2 Build alternatives
Total	3-6 months plus hardware / software acquisition		

5.0 STOPS REPORTING AND MAPPING FEATURES

5.1 STOPS MAIN OUTPUT REPORT

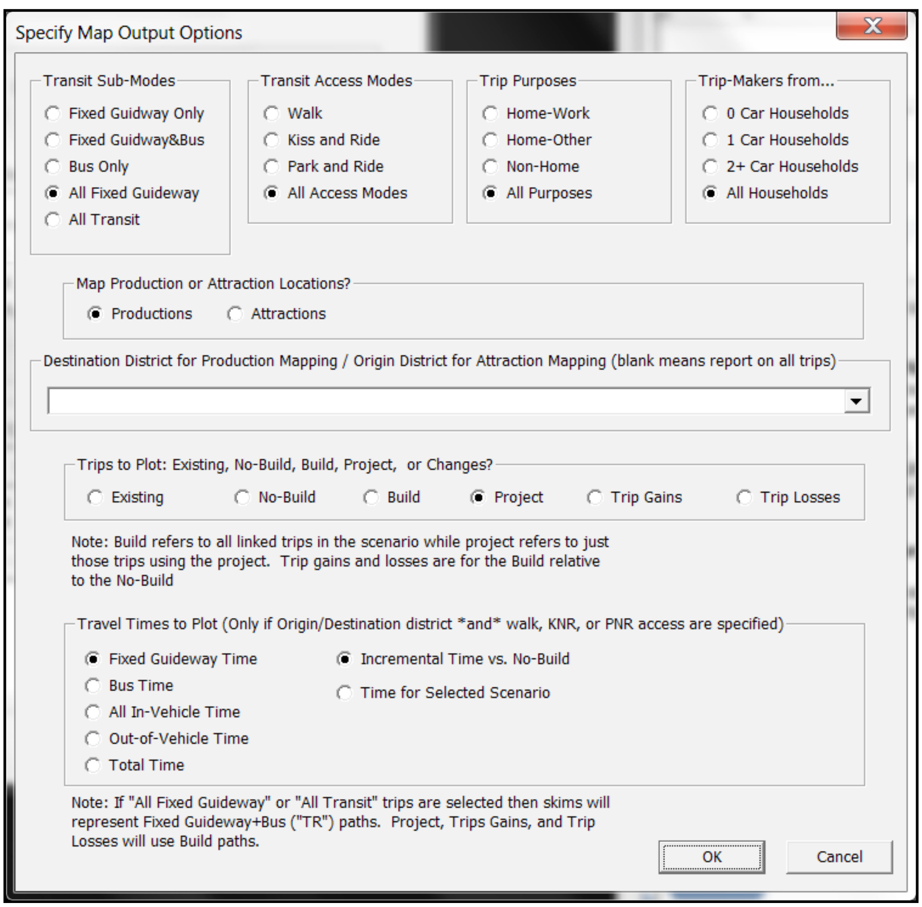
STOPS main output report file is in ASCII format that includes numerous tables to help users analyze and explain the forecasts. The filename varies depending on the name of the input GTFS directory(ies) and the year of analysis but always ends in 'Results.PRN'. This file is located in the \Reports folder of the model. Users can open the file in Notepad, Notepad++ and other ASCII editors. Alternatively, one can click Step 12 in the STOPS main menu to open the file. This main report file is typically over 30 MB in size containing approximately 3,000 tables. The key summary tables are in sections 1 through 14 (i.e. Tables 1.xx through 14.xx) and the detailed result tabulations are in sections 15 through 1022 of the report. The tables have been assembled so that users can analyze the current, no build and build results without having the need to develop additional tabulations on their own. Trips by purpose, car ownership, access modes, transit mode and the three scenarios are readily available. Boardings by route and for all stations/stops are also provided for all three scenarios. A separate ASCII file is generated for each analysis year (i.e. current, opening, 10-year and 20-year).

It is strongly recommended to use a powerful ASCII editor/spreadsheet to read and correctly interpret the tables. Many users find it easier to import the ASCII tables of interest into the spreadsheet to analyze and compare the results between modeled alternatives.

5.2 MAPPING FEATURES IN STOPS

Once a STOPS run is successfully completed, Step 13 of the STOPS main menu ('Map STOPS Results') can be used to generate several thematic and dot density maps within seconds. This feature requires ArcGIS for developing the maps. The interface that shows up after clicking Step 13 is shown in Figure 6.

Figure 6 STOPS' Mapping Options



Some of the available mapping options in STOPS are:

- Travel times to/from specific location
- Changes in travel times between build and no build scenarios
- Trip productions and attractions
- Trip gains/losses
- Locations of trips made by transit dependent households and by access mode

An example thematic map of change in travel time between build and no build conditions is shown in Figure 7 and a dot density plot of project trip attraction locations is shown in Figure 8.

Travel time maps can be very helpful in making sure the input files are correct. Errors in the coded travel time in the GTFS files and potential zonal access issues can be identified using these maps. The maps showing the trip forecasts are helpful in understanding the results and explaining the forecasts.

Figure 7 Example of a Thematic Map Showing Change in Travel Time Between Build and No Build

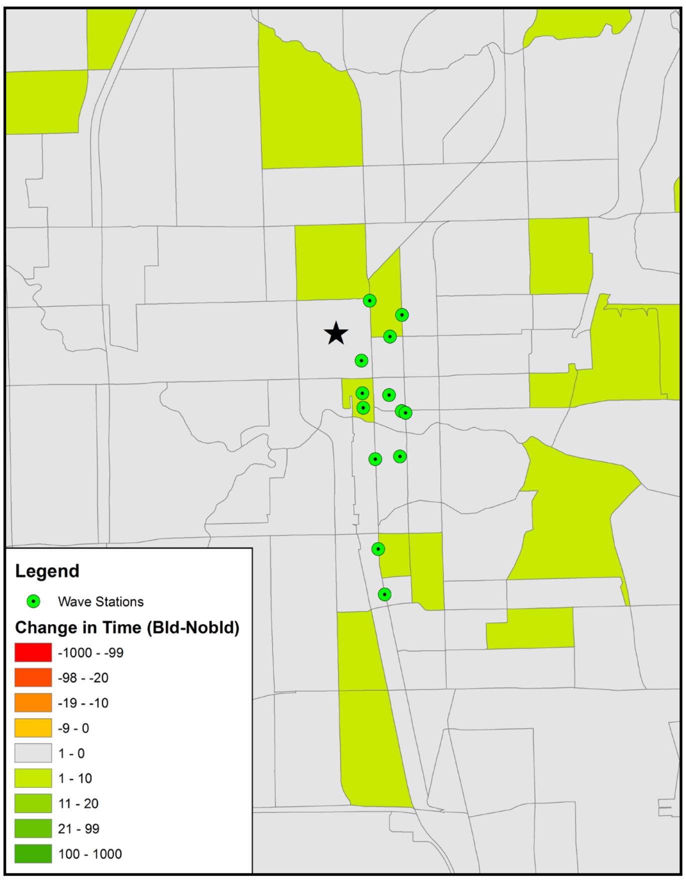
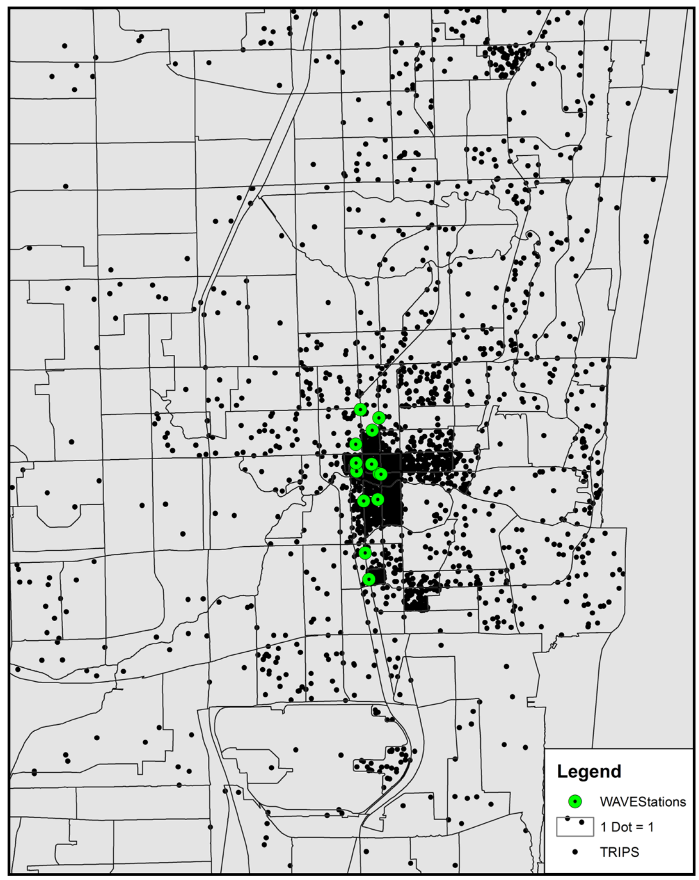


Figure 8 Example of a Dot Density Plot Showing Project Trip Attractions



5.3 NEW/SMALL STARTS EVALUATION

New and Small Starts projects are evaluated and rated according to CIG's project justification criteria that include mobility improvements, environmental benefits, congestion relief, economic development effects, land use, and cost-effectiveness. STOPS was designed to generate the travel forecast related measures used in these project justification criteria. At their discretion, project sponsors can choose to utilize STOPS to calculate trips for the mobility, congestion relief and cost effectiveness measures as well as calculating VMT changes for environmental benefits. Table 16 provides the table number in the STOPS main report file which should be used to obtain the measures for the criteria.

Table 16 STOPS Tables that Provide CIG Evaluation Measures

Justification Category	Measure from Travel Forecast	STOPS Table Number & Description
Mobility Improvement	Trips on Project from transit-dependents; Trips on Project from non-transit-dependents	Note: this information is placed in the New/Small Starts spreadsheet templates by trip purpose and transit/non-transit dependents Table 702.03, HBW project trips from 0-car HHs Table 765.03, HBW project trips from all HHs (subtract total of 702.03 from 765.03 to compute non-transit-dependents) Table 6.03, All project trips from 0-car HHs Table 4.03, All project trips from all HHs (subtract total of 702.03 from 6.03 to compute non-work trips from transit-dependents; subtract total of 765.03 from 4.03, then subtract the total of 6.03 from that difference to compute non-work trips from non-transit-dependents)
Cost-Effectiveness	Total Trips on Project	
Environmental Benefits	Change in Auto VMT	Table 8.01, Incremental District-to-District PMT (note: the results will need to be scaled by an average auto occupancy factor to reflect VMT – usually between 1.2 and 1.3)
Congestion Relief	Incremental linked transit trips (No Build vs. Build)	Table 4.02, Incremental Linked Transit Trips

In instances where project sponsors choose to report opening year or horizon year forecasts as well (in addition to the required current year forecasts), FTA will give a weight of 50 percent to the current year information and 50 percent weight to the opening/horizon year information. As mentioned earlier, STOPS generates separate report files for each analysis year. However, the table numbers in the report file for each analysis year from where the measures are pulled remain the same.

An annualization factor, used to compute annual figures from an average weekday figures, is also required in the template. In most cases, it can be usually obtained using the NTD report by dividing the annual unlinked trips and the average weekday unlinked trips. In some instances, where the project serves special markets and is expected to carry significantly higher (or lower) ridership during the weekends compared to the existing transit service in the region, the factor can be higher (or lower) and should be discussed with the FTA.

5.4 OTHER KEY TABLES IN STOPS REPORT

Apart from the tables required for New/Small Starts templates, several other tables are important to review and understand, including calibration as well as understanding and explaining the forecasts.

During the calibration/validation process, users should focus on the tables that show STOPS' estimates of the existing conditions. It is recommended that users start investigating the summary tables in sections 1 through 14 first before delving into sections 15 and onwards. Any potential issue uncovered in the first 14 sections will determine which tables in the detailed sections to further investigate. Key tables to focus on during the calibration process are listed in Table 17.

Table 17 Key STOPS Tables for Calibration

STOPS Table #	At the minimum, Users should make sure that…
Table 2.01	The district level production/attraction constants are not extremely high; anything beyond +/- 3.0 should be investigated.
Table 2.04	The regional calibration factor is close to 1.0 and the overall estimated transfer rate is close to the observed system-wide transfer rate.
Table 2.05	Adjustment factors are generally between 0.7 and 1.3 and the station pairs that do not fall within this range are due to reasons that can be explained.
Table 3.01	The station group-to-station group table is reasonable, i.e. close to observed numbers, especially in the corridor of interest.
Table 9.01	The station-level boarding by access mode (and the total) are reasonably close to the observed data, especially at the fixed guideway and key bus stop locations within the corridor of interest.
Table 10.01	The route-level boardings are close to the observed ridership.
Tables 10.03 & 10.04	The GTFS files read in by STOPS reasonably represent the peak and off-peak transit service in the region/corridor.
Tables 11.01-11.04	The linked transit trips by trip purpose, by access mode, by transit mode and by market segmentation are close to those from the survey.
Table 12.01	The input population and employment data read in by STOPS are reasonable.
Tables 13-01-13.09	The input auto skim data read in by STOPS are reasonable.

Several tables in STOPS focus on trips on project estimates. Users can start investigation the following tables initially, and if necessary, investigate the detailed tables from sections 15 onwards in order to explain and understand the forecasts.

Table 18 Key STOPS Tables for Understanding and Explaining the Forecasts

STOPS Table #	At the minimum, Users should make sure that…
Table 3.02	The station group-to-station group flow changes between Table 3.01 (existing) and Table 3.02 (no build) are attributable to service and/or land use changes between existing and no build conditions.
Table 3.03	The changes between Table 3.02 (no build) and Table 3.03 (build) are attributable solely to service changes between no build and build conditions.
Table 3.05	The numbers in this table are as close to zero as possible and that STOPS is not heavily relying on station group adjustment factors for forecasting the project trips.
Table 4.01	The district to district table is close to a similar table obtained from the survey.
Table 4.02	The incremental trips between build and no build are explainable and ridership impacts changes are only where transit service are different between the two conditions.
Table 4.03	The trips on project are reasonable and are on interchanges where the project is expected to impact the ridership.
Table 5.01	The district to district table is close to a similar table obtained from the survey (similar to table 4.01 but only for fixed guideway trips).
Table 6.01	The district to district table is close to a similar table obtained from the survey (similar to table 4.01 but transit trips only from zero-car households).
Table 8.01	The average VMT savings per project trip can be explained by the project.

(Table continues on the following page)

Continuation of Table 18 Key STOPS Tables for Understanding and Explaining the Forecasts

STOPS Table #	At the minimum, Users should make sure that…
Table 9.01	The station-level boarding changes between existing and no build and between no build and build can be explained by the changes in the transit service and/or land use changes between the current, no build and build conditions.
Table 10.01	The route-level boarding changes between existing and no build and between no build and build can be explained.
Tables 10.03 & 10.04	The GTFS files read in by STOPS reasonably represent the transit service in the region/corridor and that the changes between the existing and no build and the no build and build are reasonable.
Tables 11.01-11.04	The linked transit trips changes between existing and no build and no build and build are explainable.
Tables 14.01-14.32	The project trip forecasts and the interchanges with major gain or losses in trips are reasonable and can be explained.

6.0 RECENT APPLICATION EXAMPLES

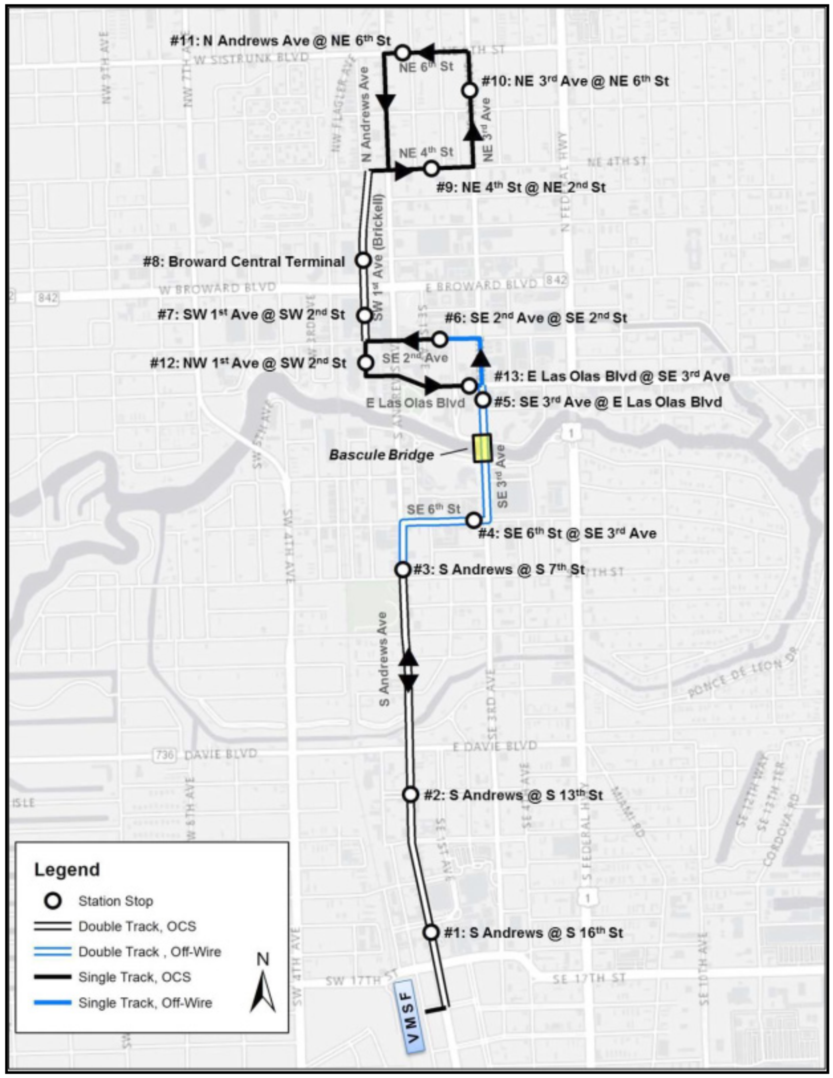
This section provides three examples from recent application of STOPS within Florida. These examples were selected to showcase different purposes of utilizing STOPS.

6.1 ILLUSTRATION 1 – STOPS FOR SMALL STARTS PROJECT EVALUATION

STOPS was used as the primary ridership tool for a recent Small Starts submittal for the WAVE Streetcar project. The project length is approximately 3 miles in length with 13 stations and 10- to 12-minute streetcar service frequency.

Since a good quality recent on-board survey data was not available, STOPS was implemented using the "synthetic" approach. Both current and horizon year forecasts were developed for this application. Broward County served as the modeling area. The estimated time to implement STOPS was less than four weeks and within $30,000. The model computing run time of less than an hour allowed analysts to run multiple scenarios in a day. Two analysts and a project manager were involved in the model implementation efforts.

Figure 9 Wave Streetcar Project



The development team faced two key challenges developing the model. One challenge was the unavailability of stop-level ridership count data. So an additional three-month data collection effort was added to the project schedule to manually conduct counts for each stop in the project corridor. Another challenge was reconciling the STOPS model area, transit data and GTFS information. The modeling area included only Broward County, but the transit operator provides several services outside the county. The system-level targets had to be adjusted to reflect the trips with both boarding and alighting locations within the county. Next, the GTFS file were adjusted to remove the express buses serving outside the county and bus circulator services operated by the City important to the corridor had to be manually added.

The key lessons learned was the importance to identify missing or inconsistent data upfront, or as early as possible, so that project schedule is not adversely impacted by previously unexpected delays.

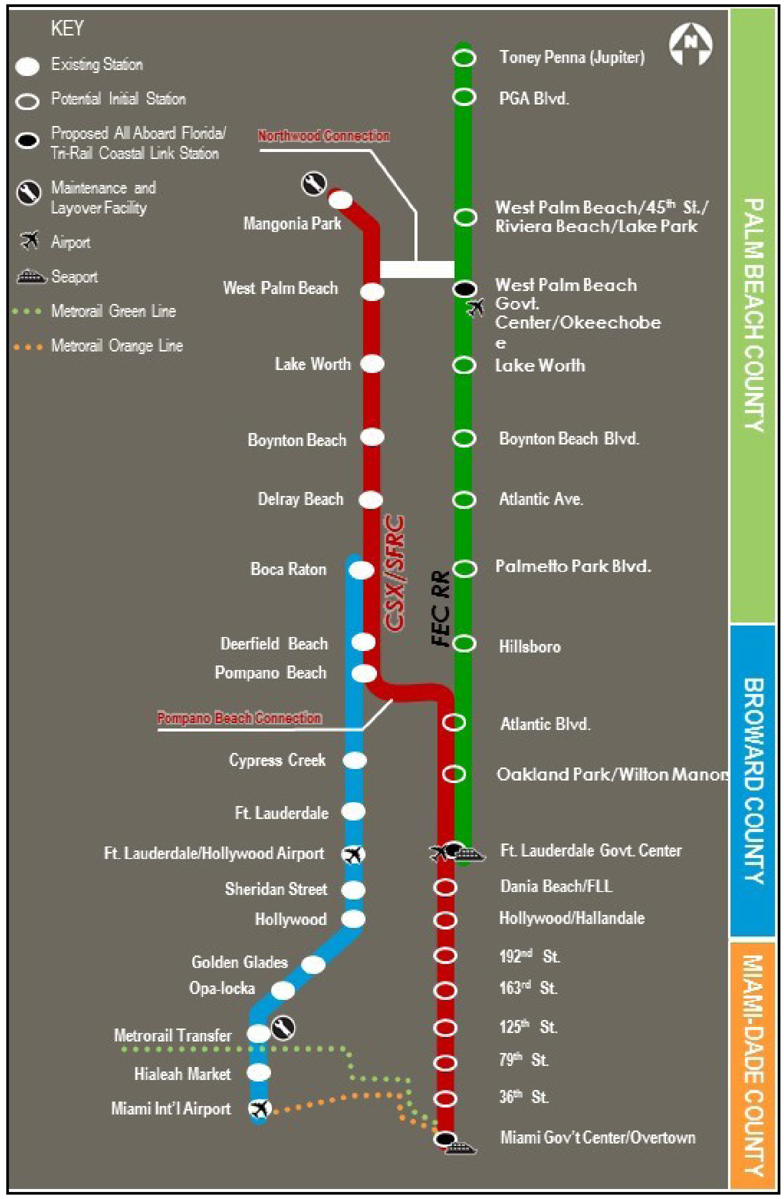
6.2 ILLUSTRATION 2 – STOPS AS A QA/QC TOOL FOR CIG PROJECTS (TRI-RAIL COASTAL LINK)

The Tri-Rail Coastal Link project utilized STOPS as a ridership QA/QC tool for the primary forecasts, which were developed using the regional travel model. This application of STOPS helped the project team to understand project inherent uncertainties and unknowns because of the large-sized project design. The corridor is 85-miles in length with 20-25 project stations.

The model covers three counties in Southeast Florida and four major transit service operators. Recent, good-quality rider surveys were not available from all operators, so STOPS was applied using the "synthetic" approach. The original implementation time was less than 10 weeks, 400 person-hours and approximately $50K. The model was subsequently updated to version 1.50 within one day. The model's computing time is approximately three hours.

The primary challenge was data consistency. The current year ridership data was from year 2013. The transit agencies had a rider survey from different years, ranging between 2004 and 2013. Also, the GTFS file for the Tri-Rail commuter rail was not available at the time of development. So it was manually added for this application. The resulting STOPS forecast results were similar to the primary forecasts. The comparable forecasts gained credibility for the primary forecast with the project sponsor and FTA.

Figure 10 Tri-Rail Coastal Link Build Option



6.3 ILLUSTRATION 3 – STOPS AS A TOOL FOR GENERAL PLANNING PURPOSES (SOUTHEAST FLORIDA STOPS PLANNING MODEL)

The key purpose of this STOPS implementation was to create a common "ready-to-go" platform for multiple ongoing and upcoming premium transit corridor studies in the region. This common platform ensures that various transit corridor studies will utilize reconciled data and assumptions that are consistent to help prioritize their implementation plan. In addition, this will ensure faster turnaround of ridership estimation of the alternatives and provide a basis for FTA's CIG applications.

The model includes three counties in Southeast Florida and four major transit service operators. Since recent, good-quality rider surveys were not available on all systems, STOPS is applied using the "synthetic" approach. The implementation time for this model was about four months' effort, and approximately $60K budget. Most of this effort was devoted to the regional calibration of the model: Southeast Florida has over 500,000 transit boardings per day, and the model area covers 1,500 square miles. Still, the model runs in approximately five hours, although a special interface was developed to allow users the option to run one county instead. A model run for one county consumes less than 3 hours.

The primary challenge was that all the available data could not be included within STOPS, since the data – for over 10,000 individual transit stops across the three counties – exceeded the STOPS software limitation. So a software option was developed to allow the users to run the model for a single county.

7.0 REFERENCES

The following sources served as the basis for much of the information contained in this report.

1. Federal Transit Administration. “Ridership Forecasting with STOPS for Transit Project Planning:
2. A Short Course Sponsored by the Federal Transit Administration”. Conducted in Orlando and Los Angeles in May/Jane 2016.
3. Federal Transit Administration. “STOPS User’s Guide v1.50”. April 29, 2015.
4. Federal Transit Administration. “STOPS Workshop”. Held at the 15th TRB Planning Applications Conference in Atlantic City, NJ on May 17, 2015.

This page intentionally left blank.

For more information please contact:

Chris Wiglesworth
(850) 414-4532
chris.wiglesworth@dot.state.fl.us

FDOT

STATE OF FLORIDA DEPARTMENT OF TRANSPORTATION
FLP
Office of Freight, Logistics and Passenger Operations