



FLORIDA DEPARTMENT OF TRANSPORTATION | *Transportation Statistics Office*

Use of Multiple Data Sources for Monitoring Mobility Performance

*Assessing Feasibility and Transitioning to
Field-Measured Speed for Performance Measure
Reporting*



final report

Task 17 Final Report

Use of Multiple Data Sources for Monitoring Mobility Performance

Assessing Feasibility and Transitioning to Field-Measured Speed for Performance Measure Reporting

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Table of Contents

Executive Summary	ES-1
1.0 Introduction	1-1
1.1 FDOT’s Mobility Performance Measures Program	1-1
1.2 Study Objectives	1-1
1.3 Organization of The Report.....	1-1
2.0 Review of Existing FDOT MPM Reporting.....	2-1
2.1 TranStat Office Methodology.....	2-1
Travel Time Reliability and Travel Time Variability	2-2
Average Travel Speed, Combination Truck Average Travel Speed	2-6
Vehicle Hours of Delay, Person Hours of Delay, and Combination Truck Delay	2-7
2.2 Traffic Engineering and Operations Office Methodology	2-8
2.3 Coverage and Segmentation	2-9
TranStat Office	2-9
ITS Office.....	2-11
2.4 Conclusion	2-14
3.0 Identification of Field-Measured Data Sources.....	3-1
3.1 Existing Data Sources.....	3-1
3.2 Private Vender Data	3-2
3.3 Recommendations	3-3
4.0 Feasibility of Transitioning to Field-Measured Data for Travel Time Related MPM Reporting	4-1
4.1 Pros and Cons of Modeled Calculations Vs. Field-Measured Data	4-1
4.2 Availability and Accuracy of Measured Data	4-2
4.3 Strategies For Missing Data.....	4-2
4.4 Ability To Produce Quick Turnaround Requests With Measured Data.....	4-2
4.5 Credibility Of Results.....	4-2
5.0 MPM Reporting Using Field-Measured Data	5-1
5.1 Data Integration Procedure.....	5-1

5.2	Probe Data Quality Check	5-3
5.3	MPM Calculation Procedures Using Field-Measured Data	5-3
	Average Speed	5-4
	Basic Segment Computation.....	5-4
	Statewide Aggregation.....	5-4
	Delay.....	5-4
	Basic Segment Computation.....	5-5
	Statewide Aggregation.....	5-5
	Travel Time Reliability and Variability	5-5
	Basic Segment	5-6
	Statewide Aggregation.....	5-6
5.4	Additional/Optional Application of Field-Measured Data	5-6
	LOS Criteria	5-6
6.0	Conclusion	6-1
7.0	Next Steps.....	7-1

List of Tables

Table 1.1	List of Mobility Performance Measures, Source Book 2013	1-1
Table 2.1	Highway MPMs	2-1
Table 2.2	Summary of Delay Threshold Speeds	2-7
Table 2.3	ITS Miles Managed, Roadway Segment Limits	2-12
Table 2.4	ITS Reporting Segments	2-14
Table 3.1	Vendor Comparison	3-3
Table 4.1	State Roads Not Covered by the HERE TMC Network	4-3
Table 5.1	MPMs to Use Field-Measured Travel Time/Speed Data	5-3

List of Figures

Figure 2.1	Reliability Methodology Flowchart.....	2-5
Figure 2.2	Florida Reliability Facilities	2-10
Figure 2.3	Florida State Highway System (SHS).....	2-11
Figure 2.4	ITS Miles Managed	2-13
Figure 4.1	HERE TMC Network Coverage on SHS.....	4-3
Figure 4.2	NPMRDS Data Coverage	4-2
Figure 5.1	Integrating Field-Measured Data to RCI and TCI Databases	5-2

Executive Summary

The Florida Department of Transportation (FDOT) has an established Mobility Performance Measures Program. Through this program a set of performance measures evaluating the quantity, quality, accessibility, and usage of Florida's transportation system are reported. To describe the performance of Florida's State Highway System over 20 metrics related to the mobility of people and goods are reported annually in FDOT's Multimodal Performance Measures Source Book.

Travel time and speed are key inputs in the calculation of numerous performance measures. Instruments in the pavement, roadside radar, and vehicle probe devices collect travel time data through an automated process. Currently speeds used in the calculation of statewide performance measures are based on deterministic models and speed flow curves. Many new robust travel time data sources are emerging that can replace the existing method of calculating travel speeds. In response to the growing availability of field-measured data, FDOT initiated this project to assess the feasibility of using field-measured travel time and speed data in the calculation of statewide mobility performance measures. This study also identifies challenges of transitioning to field-measured data and develops solutions for issues such as data coverage and quality. Using field-measured data also provides an opportunity to develop new calculation procedures for FDOT's mobility performance measures.

This report provides recommendations on a data source to use for mobility performance measures and strategies for filling in missing data. The conclusion supported in this study is that HERE data, purchased by FDOT's Intelligent Transportation System (ITS) Office combined with the National Performance Measure Research Dataset (NPMRDS) should be used as a replacement for modeled travel time/speed data. To support this transition data integration and data processing must occur. This study documents how network conflation and filling in missing data should be included in data processing and integration for Source Book development.

Pros and cons of transitioning to field-measured data were evaluated and the pros outweighed the cons. The feasibility of transitioning was evaluated and the project team concluded that a transition is realistic. Where data is unavailable the project team has developed imputation strategies. Additionally, this report provides general guidance and specific prescriptions for calculating potential MAP-21 (Moving Ahead for Progress in the 21st Century Act) measures. U.S. DOT made vendor data available to all the states for MAP-21 reporting, consequently the use of vendor provided data is the recommended option in Florida. The availability and accuracy of field-measured data supports this recommendation.

1.0 Introduction

Performance measures are widely used by transportation agencies because they provide transparency, informed decision making, and allow for accountability. Measures allow organizations to determine how they are performing. When used in conjunction with targets performance measures allow organizations to assess how well they are meeting their goals. A key focus of the current Federal surface transportation law, Moving Ahead for Progress in the 21st Century Act (MAP-21), is to establish a performance based approach to managing the Federal surface transportation program. When the final rules of MAP-21 are unveiled, both state transportation agencies and metropolitan planning organizations (MPOs) will be required to report on the performance of the Interstate and National Highway Systems (NHS).

Portions of this report contain summary information included in earlier memos. The project team previously provided a description of performance measure calculation methodologies, current data sources, and new data sources. This report revisits some of the content from earlier memos and evaluates the feasibility of transitioning to field-measured data.

1.1 FDOT'S MOBILITY PERFORMANCE MEASURES PROGRAM

Florida's Mobility Performance Measures (MPM) program defines mobility as the movement of people and goods. The definition emphasizes mobility from the user's perspective. Florida's mobility performance measures describe the following primary dimensions of mobility:

- quantity of the travel performed (reflects the magnitude of the use of a facility or service);
- quality of travel performed (describes user's experiences with travel conditions and the effects of congestion);
- accessibility provided by the transportation system (describes the ease with which people can connect to the multimodal system); and
- utilization of a facility or service (indicates whether a transportation system is properly sized from the agency's perspective and the ability to accommodate growth).

A full list of MPMs is shown in Table 1.1. All the MPMs have been calculated and reported annually for the past ten years. This study focuses on highway mobility performance measures for both passenger and heavy vehicles. Travel time reliability and variability are computed for limited access freeways in Florida (as shown in Figure 2.2) while other mobility performance measures are

reported on the larger State Highway System (SHS) represented in Figure 2.3. Some field-measured data in combination with modeled travel times and speeds are used in calculating MPMs. Travel times and speeds are computed using theoretic models based on various assumptions used in Florida's MPM Program.

Table 1.1 List of Mobility Performance Measures, Source Book 2014

MODE	QUANTITY	QUALITY	ACCESSIBILITY	UTILIZATION
PEOPLE				
Auto/ Truck	Vehicle Miles Traveled Person Miles Traveled	% Travel Meeting LOS Criteria % Miles Meeting LOS Criteria Travel Time Reliability Travel Time Variability Vehicle Hours of Delay Person Hours of Delay Average Travel Speed		% Miles Severely Congested % Travel Severely Congested Hours Severely Congested Vehicles Per Lane Mile
Transit	Passenger Miles Traveled Passenger Trips	Average Headway		
Pedestrian		<i>Level of service (LOS)</i>	% Sidewalk Coverage	
Bicycle		<i>Level of service (LOS)</i>	% Bike Lane/Shoulder Coverage	
Aviation	Passengers	Departure Reliability	<i>Highway adequacy (LOS)</i>	<i>Demand to capacity ratios</i>
Rail	Passengers	<i>Departure Reliability</i>		
Seaports	Passengers		<i>Highway adequacy (LOS)</i>	
FREIGHT				
Truck	Combination Truck Miles Traveled Truck Miles Traveled <i>Combination truck tonnage</i> <i>Combination truck ton miles traveled</i>	Travel Time Reliability Travel Time Variability Combination Truck Hours of Delay Combination Truck Average Travel Speed		% Miles Severely Congested Vehicles Per Lane Mile <i>Combination truck backhaul tonnage</i>
Aviation	Tonnage		<i>Highway adequacy (LOS)</i>	
Rail	Tonnage		<i>Highway adequacy (LOS)</i> <i>Active rail access</i>	
Seaports	Tonnage Twenty Foot Equivalent Units		<i>Highway adequacy (LOS)</i> <i>Active rail access</i>	

Bold = FDOT MAP-21 Recommended Measure

Italicized Text = Measures added 2014

1.2 STUDY OBJECTIVES

It is imminent that the use of field-measured data will become accepted throughout the transportation planning profession. The apparent widespread use will lead to establishing best practices for speed and travel time computations within the industry. With the looming MAP-21 requirements, it is in FDOT's best interests to be proactive and transition its MPM Program from modeled travel times to using field-measured travel time/speed data. Such a transition will greatly improve the flexibility, frequency, granularity, effectiveness, and accuracy of performance reporting. In all likelihood, performance measures developed from field-measured data will benefit other FDOT planning and traffic operation efforts as well.

This study encompassed an evaluation of the feasibility of transitioning and documentation of the plan for transitioning. The principle objectives of this task and report were to:

1. Describe and compare the current methodologies used by FDOT to calculate mobility performance measures
2. Identify real time data sources and describe the needed data for mobility performance measures
3. Assess the feasibility of transitioning from modeled data to real time data for mobility performance measurement
4. Develop and describe recommended standard data processes for calculating mobility performance measures
5. Recommend an approach for transitioning from FDOT's current reporting approach to an approach utilizing measured travel time data
6. Provide technical support to FDOT planning offices in developing mobility performance measures

1.3 ORGANIZATION OF THE REPORT

The remainder of this report is organized based on the objectives of this study. Section 2.0 provides a comprehensive review of existing calculation methods where speed and travel times were used. Section 3.0 introduces field-measured data sources available and identifies the most suitable data sources for Florida's mobility performance reporting. Section 4.0 provides in depth evaluation of the chosen data sources, and develops procedures to resolve major challenges related to transitioning from modeled data to field-measured data. Section 5.0 presents revisions to performance measure calculations based on transitioning to field measures data, and the systematic process of using field-measured data for performance measure reporting. Section 6.0 summarizes all the conclusions and recommendations of this study and outlines future steps.

2.0 Review of Existing FDOT MPM Reporting

In order to evaluate the feasibility and develop procedures for transitioning from modeled travel speeds to field-measured data, it was important to understand the existing methods used by FDOT in calculating mobility performance measures. In this section, the speed/travel time estimating methodologies used by the FDOT Transportation Statistics Office (TranStat), and Operations-ITS Offices are reviewed. Factors such as data sources, roadway network coverage and segmentation are also assessed and compared.

2.1 TRANSTAT OFFICE METHODOLOGY

FDOT’s MPM Program is managed through the TranStat Office. A primary product of the program is the Multimodal Mobility Performance Measures Source Book. Among the MPMs reported in 2014 the Source Book, 26 are highway related. Table 2.1 lists the highway measures and identifies whether its calculation uses speed or travel time as an input.

Table 2.1 Highway MPMs

MPMs	Use Speed/Travel Time As Input In Current Methods?
Vehicle-Miles Traveled	
Person-Miles Traveled	
Truck-Miles Traveled	
Combination Truck-Miles Traveled	
Travel Time Reliability	X
Travel Time Variability – 95th Percentile Travel Time Index	X
Combination Truck Tonnage	
Combination Truck Ton Miles Traveled	
Transit Passenger Miles Traveled	
Transit Passenger Trips	
Vehicle Hours of Delay	X
Person Hours of Delay	X
Average Travel Speed	X
% of Travel Meeting Generally Acceptable Operating Conditions	
% of Miles Meeting Generally Acceptable Operating Conditions	
Transit Average Headway	
Travel Time Reliability (Freight)	X
Travel Time Variability – 95th Percentile Travel Time Index (Freight)	X
Combination Truck Delay	X
Combination Truck Average Travel Speed	X

MPMs	Use Speed/Travel Time As Input in Current Methods?
% Miles Severely Congested	
% Travel Severely Congested	
Hours Severely Congested	
Vehicles Per Lane Mile	
% Miles Severely Congested (Freight)	
Vehicles Per Lane Mile (Freight)	
Combination Truck Backhaul Tonnage	

As shown in Table 2.1, there are nine MPMs using speed or travel time as a calculation input. Details on how each MPM is calculated are discussed in the Source Book Calculations Documentation.

Travel Time Reliability and Travel Time Variability

The freeway travel time reliability model that Florida DOT uses was developed by the University of Florida. The model uses a set of linear regression equations for predicting average hourly travel time, fitted to data from freeways in Philadelphia, Ft. Lauderdale, and Jacksonville. Separate equations are applied to each of 24 possible scenarios. Different combinations of levels of congestion, incident types, weather types, and work zones define each scenario. The expected (average) travel time to traverse the full length of the freeway is computed for each scenario for each of the 24 hours in a day. Reliability is then computed by applying probabilities to each of the computed travel times for each of the scenarios and hours of the day.

Figure 2.1 shows the overall procedures to calculate reliability in the FDOT model. Levels of congestion, incident types, weather types, and work zones are defined as the following: Weather is divided into two categories rain and no rain; no rain includes traces of rain. Rain is further subdivided into light rain (at least 0.01 inches per hour) and heavy rain (greater than 0.5 inches per hour). Probabilities were obtained from 5 years of data (2006-2010). The state is divided into three rain regions with associated probabilities of light rain, heavy rain, and no rain. Free flow speeds are reduced 6% for light rain and 12% for heavy rain. There is no capacity reduction for rain. Incidents are split into three types: lane blocking, non-lane blocking, and no incident. The probabilities are based on a 2007 FDOT SunGuide Report and FDOT’s Crash Analysis Reporting System (CARS). Separate incident probabilities are used for scenarios with: no rain/no-work zone, rain/no-work zone, no-rain/work zone, and rain/work zone. There is no free-flow speed reduction for incidents. The average number of lanes blocked by an incident is computed based on the probabilities of one or more lanes being blocked by the incident. Work zones are assumed to block the user specified number of lanes (typically one lane is assumed blocked). The capacity per lane reduction for a work zone is assumed the same as a lane-

blocking incident. Work zones are assumed to not affect free-flow speed. The probabilities of work zones were fixed at 3% for the overnight hours (10 PM to 7 AM) and 1% for the rest of the day. These estimates were made in the absence of data on work zone probabilities. The proportion of weeks in the year when a single hour falls in the congested or uncongested regimes for a given scenario is determined by comparing the hourly demands by week of the year to the capacity for the scenario. Directional hourly volume was obtained by applying a fixed 0.55 D factor to peak direction, 0.45 D factor to non-peak direction, and a set of K factors based on facility and area types to segment annual average daily traffic (AADT). The capacity of a scenario varies by blocking incident type and work zone type.

Two equations are used to compute section travel time rate (TR, seconds per mile):

If demand < capacity:

(Equation 1)

$$TR(d < c) = 3600/FFS(w) + 0.00258 \times d;$$

If demand > capacity:

(Equation 2)

$$TR(d > c) = \text{Max}\{TR(d < c), \\ 3600/FFS(w) + 0.1238 \times d - 0.1243 \times c - 3.46 \times L + 0.67 \times T \\ - 15.24 \times N_{cr} + 0.3964 \times d \times cr - 21.524 \times L \times cr\}$$

Where:

FFS(w) = free-flow speed (mph) adjusted by weather type

d = demand (vphpl)

c = capacity (vphpl),

L = length (miles)

T = time period (min), always set to 60 minutes in the model

N_{cr} = number of lanes when there is a capacity reduction (blocking or nonblocking incident and/or work zone), or 0 for scenarios without capacity reduction

- Average number of lanes affected by a workzone
- Ratio of non-blocking to blocking incidents is factored in calculating N_{cr}

cr = capacity reduction (%) which is a function of:

- Probability of rain
- Average incident duration
- Average incident clearance time

The model provides the entire travel time distribution for all 24 hours for both directions combined. The 2014 version of Source Book reports Travel Time Reliability and Variability as follows:

Travel Time Reliability (TTR) is the percent of VMT for which the travel speed is greater than or equal to the roadway's speed limit.

$$\text{Travel Time Reliability (All Vehicles)} = \frac{\sum(\text{VMT} | \text{Travel Speed} \geq \text{Speed Limit})}{\sum(\text{VMT})} \times 100 \quad (\text{Equation 3})$$

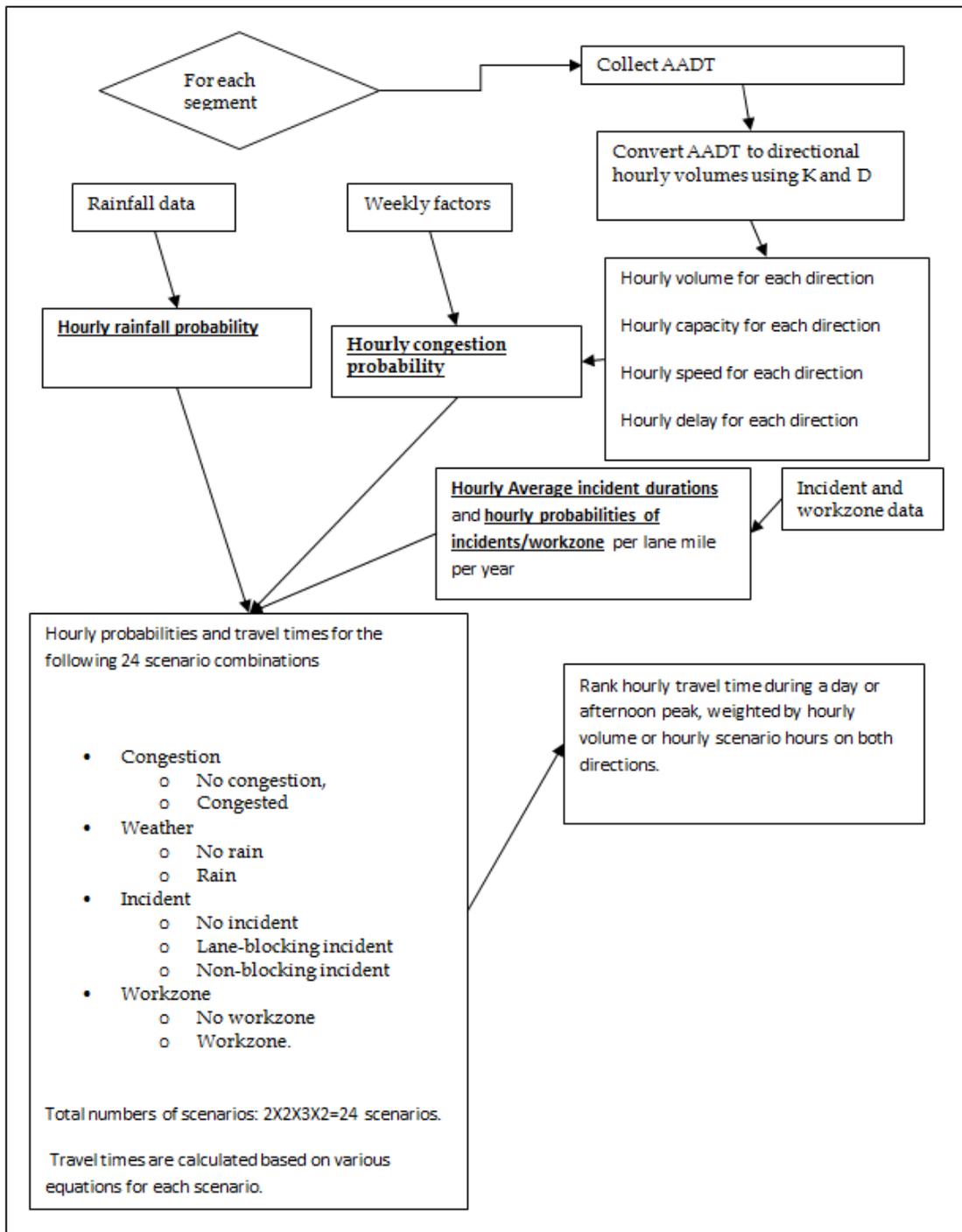
$$\begin{aligned} \text{Travel Time Reliability (Freight)} & \quad (\text{Equation 4}) \\ &= \frac{\sum(\text{VMT} | \text{Combination Truck Travel Speed} \geq \text{Speed Limit})}{\sum(\text{VMT})} \times 100 \end{aligned}$$

Travel Time Variability, or Travel Time Index (TTI) is the ratio of the 95th percentile travel time to the free-flow travel time.

$$\text{Travel Time Index}_{95} = \frac{\text{Travel Time}_{95\text{th percentile}}}{\text{Travel Time}_{\text{freeflow}}} \quad (\text{Equation 5})$$

Travel Time Reliability and Travel Time Variability are reported for both vehicles and freight.

Figure 2.1 Reliability Methodology Flowchart



Average Travel Speed, Combination Truck Average Travel Speed

Average travel speeds are calculated using data such as traffic volume, truck percentage, speed limit, number of lanes, facility type, and area type. The calculation of average daily operating speed requires the determination of operating speeds during each hour of the day. The average travel speed calculations use the latest **FDOT Generalized Service Volumes Tables** that implement **Highway Capacity Manual (HCM) 2010** methods for roadways operating below capacity ($v/c \leq 1$). Because the Generalized Service Volumes Tables lack speed information for over capacity conditions ($v/c > 1$), **speed-volume curves** were used to provide improved accuracy in congested regimes. Speed estimation also accounts for reduced speed due to unserved demand from the preceding hours. During oversaturation, the undischarged queue—the difference between demand and capacity—from an oversaturated hour is added to the next hour. The process is repeated until demand (including that from previous hour(s)) is less than the capacity. These hourly operating speeds are weighted by hourly traffic volume and averaged to determine the average daily operating speed on each segment.

The calculation of Combination Truck Average Travel Speeds is identical to the methodology for (passenger) vehicle average travel speed, except that combination trucks are assumed to have a lower free flow speed. For automobiles, free flow speed is set as the posted speed limit plus 5 mph for all facility types and area types. For combination trucks, the free flow speed is simply the posted speed limit.

Operating speeds are calculated using different methodologies for different facility types:

- For freeways and multilane highways, operating speeds are calculated using the Modified Davidson Curve with parameters applicable to Florida.
- For arterials, different methodologies are used for under-saturated and over-saturated conditions. For under-saturated conditions (demand less than capacity), operating speeds are calculated based on the latest set of Generalized Service Volume Tables (December 2012). For over-saturated conditions (demand greater than capacity), a Bureau of Public Roads (BPR) curve (with Greater Treasure Coast Regional Planning Model parameters) is used to determine average travel speed given vehicle volume and segment capacity. The BPR curve was calibrated such that the $v/c = 1.0$ speed matches the Generalized Service Volume Tables LOS E speed for a Class II arterial (e.g., 10 mph in an Urbanized Area). The $v/c \geq 2.0$ speed was set at a minimum of 7 mph.
- For two-lane highways, the 2010 HCM base relationship between flow and average travel speed are used to calculate operating speeds.
- A minimum speed of 7 mph is set for conditions when $v/c \geq 2.0$ for all facility types.

Vehicle Hours of Delay, Person Hours of Delay, and Combination Truck Delay

In the 2014 version of Source Book, Vehicle Hours of Delay, Person Hours of Delay, and Combination Truck Hours of Delay are estimated on an hourly basis by determining the difference between delay threshold travel time and actual travel time along a facility. Delay is considered the additional travel time experienced by a motorist in addition to what would be experienced under normal conditions. The definition of “normal” conditions is defined as level of service “B”. The delay threshold speed for the 2014 version of the Source Book is provided in Table 2.2. The actual travel time is computed based on the output of average travel speed from the model described in the previous section.

Delay estimation considers unserved demand from the preceding hours for the time periods between 7 and 10 AM and between 4 and 7 PM. During oversaturation, the undischarged queue—the difference between demand and capacity—from an oversaturated hour is added to the next hour. The process is repeated until demand (including that from previous hour(s)) is less than the capacity.

Table 2.2 Summary of Delay Threshold Speeds

Facility	The 2014 Version of Source Book	
	Delay Threshold Speed ¹ (mph)	Basis
Urban Freeway	~ 68	Modified Davidson curve with LOS B to C threshold volume
Rural Freeway	~ 74	Modified Davidson curve with LOS B to C threshold volume
Arterial	31 (Class I or Rural Arterial) / 22 (Class II)	Generalized LOS Table LOS with LOS B to C threshold volume
Multilane Highway	~ 58	Modified Davidson curve with LOS B to C threshold volume
Two-lane Highway	~ 54	HCM 2010 methodology with LOS B to C threshold volume

¹ Delay threshold speeds are not fixed to a particular value, but rather calculated based on the LOS B volume threshold. Therefore, the values provided in this table are averages of the entire data set. For a particular roadway, delay threshold speed may be lower or greater than what is reported here.

Average vehicle delay (in time units per vehicle) is computed as the difference between the actual travel time and the delay threshold travel time. It should be noted that when the actual travel time is less than the delay threshold travel time, there is no delay on the roadway segment. The total vehicle hours of delay (in vehicle-time units) is the product of average vehicle delay and the vehicle volume. On a single segment, for a single hour, the delay calculation is presented in the following equations.

(Equation 6)

$$\begin{aligned} &\text{Vehicle Hours of Delay} \\ &= \sum (\text{Daily or Peak Period/Hour Travel Time} - \text{Travel Time at LOS B}) \end{aligned}$$

(Equation 7)

$$\text{Person Hours of Delay} = \sum \text{Average Vehicle Occupancy} \times \text{Vehicle Hours of Delay}$$

(Equation 8)

$$\begin{aligned} &\text{Combination Truck Hours of Delay} \\ &= \sum (\text{Daily Combination Truck Travel Time} - \text{Travel Time at LOS B}) \end{aligned}$$

The TranStat Office does not have a data archive for travel times. TranStat obtains facility type, area type, number of lanes, and AADT from the level of service data managed by the FDOT Systems Planning Office. Typical hourly volume distributions are calculated by applying K factors based on Automated Traffic Recorder (ATR) data. The ATR data collected and analyzed by FDOT provides hourly factors for eight different facility types. In addition, the ATR data contains weekday and weekend factors to account for the significant differences in demand profiles.

2.2 TRAFFIC ENGINEERING AND OPERATIONS OFFICE METHODOLOGY

The Traffic Engineering and Operations (ITS) Office prepares four quarterly reports and an annual report each year. Each report provides data for six performance measures: 511 Calls, Road Ranger Assists, ITS Miles Managed, Incident Duration, Customer Satisfaction (which is collected and reported once every two years), and Travel Time Reliability. The purpose of these reports is to monitor the performance of ITS program components and to indicate the effectiveness of ITS on improving highway travel in Florida.

Among the performance measures (PMs) reported by ITS office, 511 calls use vehicle probe data purchased from HERE, and travel time reliability uses data from roadside detectors deployed by the FDOT districts and collected by the SunGuide software system in each district. The detectors are primarily roadside radar units; however, there are some districts that deploy in-pavement loop detectors on freeways. The radar and loop detectors are spot detectors that report the volume, occupancy and speed crossing through the detection zone at that point. Although there are small variations in accuracy of speed among the detectors, they essentially produce the same results and spot speed from these detectors must be converted to travel time (an easy conversion since the distance between detectors is known). Currently the FDOT ITS Office reports on 95th

percentile travel time index (TTI) and 80th percentile TTI. The detailed calculation process is described below.

- Compute section-level travel time index and planning time index for non-holiday weekdays during various time periods. Usually five different periods are defined:
 - Morning Off-Peak: from 12 to 6 AM
 - Morning Peak: from 6 to 9 AM
 - Mid-Day: from 9 to 4 PM
 - Afternoon Peak: from 4 to 7 PM
 - Evening Off-Peak: from 7 PM to 12 AM
- Free-flow travel time for each section is defined as the section length divided by 60 mph
- Travel Time Index
 - Calculated as the ratio of average travel time of a specific time period to a free-flow travel time on a section, i.e., the travel time index is equal to 1.00 for all values less than one.
- 95th and 80th Travel Time Index
 - Calculated as the ratio of the 95th and 80th percentile travel time of a specific time period to an off-peak standard travel time on a section.
 - The travel time index is equal to 1.00 for all values less than one.

2.3 COVERAGE AND SEGMENTATION

TranStat Office

TranStat obtains data for and calculates travel time reliability on Florida's limited access highways as shown in Figure 2.2, and calculates all other MPMs on the larger SHS as shown in Figure 2.3. For reporting on travel time reliability, the state's freeway system is divided into 156 reliability facilities based on the following criteria:

1. Strategic Intermodal System (SIS) freeway-to-freeway interchanges
 - Non-SIS freeways are also a major consideration
 - Logical extensions of SIS freeways are considered if a short gap of freeway is missing. (This scenario occurs if a freeway terminates, and a major arterial provides connection to another freeway)
2. Non-adjacent urbanized area boundaries
 - Transitioning and rural boundaries are also considered segmentation points

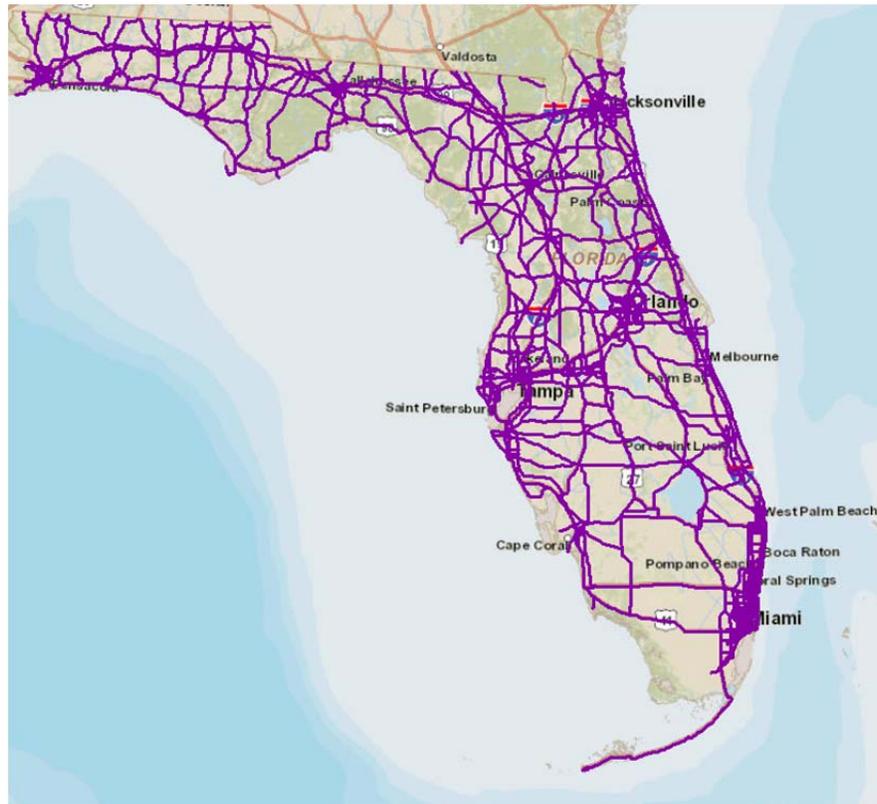
3. SIS intersecting routes
4. Other special considerations
 - Major downtown core areas
 - SIS multimodal hubs
5. Length

Although the basic unit of a facility is a freeway “section” that extends from one interchange to the next, multiple sections are combined in order to analyze and report travel time reliability at a “facility” level. An analyst could alternatively select different termini from FDOT’s initial segmentation. Based on the segmentation criteria, beginning and ending milepost numbers for interchanges are obtained from FDOT’s Roadway Characteristics Inventory. FDOT’s travel time reliability model is then applied.

Figure 2.2 Florida Reliability Facilities



Figure 2.3 Florida State Highway System (SHS)



ITS Office

The ITS Office reports travel time reliability on instrumented segments of limited access highways (Interstate highways and expressways) in Florida. Currently there are no arterials within the ITS Miles Managed coverage. The ITS Office tracks the implementation of ITS Miles Managed each quarter in the ITS quarterly reports. ITS Miles Managed are defined centerline miles of limited access highway that have each of these four attributes:

1. Traffic probes and/or sensors,
2. Real-time traffic information reporting coverage,
3. Real-time incident response capabilities, and
4. Real-time traffic data availability to FDOT.

At the end of fiscal year 2013 (June 30, 2013), FDOT managed 1,337.6 miles of the total 2,106.7 limited-access miles in Florida. This is 63.5% of the limited access highways in Florida.

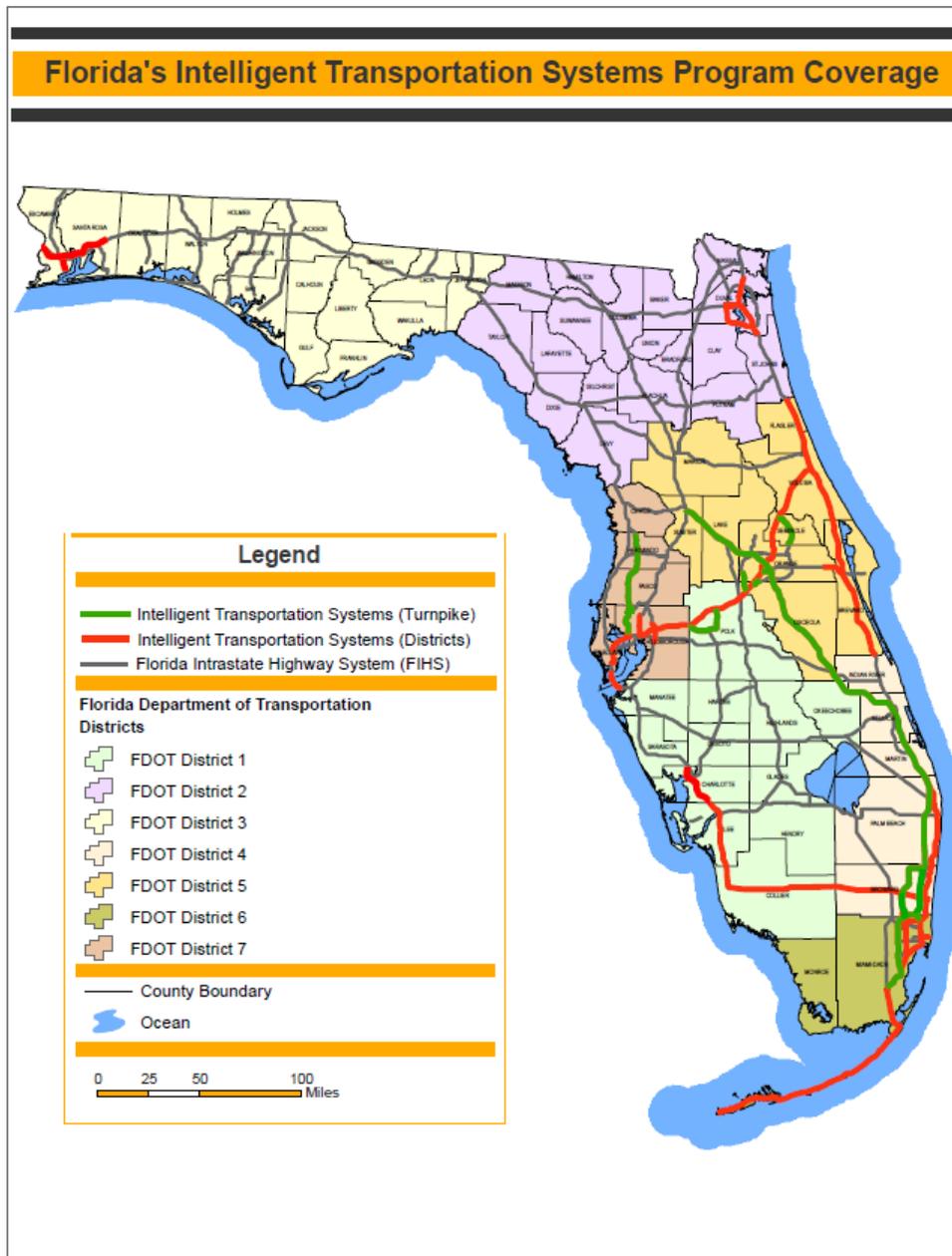
Table 2.3 shows the segments of ITS Miles Managed by the districts.

Table 2.3 ITS Miles Managed, Roadway Segment Limits

Managing District	Roadway	From	To	Length
1	I-75	Broward/Collier Co. Line	Charlotte/Sarasota Co. Line	115.5
2	I-95	Race Track Road	Pecan Park Rd (Duval/St. Johns Co. Line)	33.7
	I-295	I-10	I-95 (south)	20.4
	I-10	I-95 (Exit 363)	West of Chaffee Road (MM 354)	9.0
3	I-10	Florida/Alabama State Line	One mile east of SR 87 (MM 32)	32.0
	I-110	I-110 spur in its entirety		6.0
4	I-95	Indian River/Brevard Co. Line	Broward/Miami-Dade Co. Line	142.6
	I-595	I-75	US 1	12.9
	I-75	Broward/Miami-Dade Co. Line	Broward/Collier Co. Line	45.4
	Sawgrass Expressway	North of I-75		1.9
5	I-4	SR 532 / Polk Co. Line	I-95	74.5
	I-4	US 27	Polk/Osceola Co. Line	3.6
	SR 528	SR 520 East	I-95	11.0
	I-95	Flagler/St. Johns Co. Line	Brevard/Indian River Co. Line	137.2
6	I-195	NW 11 Avenue	Alton Road (SR 907A)	4.9
	SR 826	US 1	I-95	24.6
	I-75	SR 826	Broward/Miami-Dade Co. Line	5.4
	I-95	Broward/Miami-Dade Co. Line	US 1	17.3
	I-395	I-95	West end MacArthur Causeway Bridge	1.3
7	I-275	Skyway Bridge South Toll Plaza	I-75 Apex (Pasco Co Line)	53.2
	I-4	I-275	Hillsborough/Polk Co. Line	25.7
	I-4	Hillsborough/Polk Co. Line	US 27	29.2
	I-75	South of Progress Boulevard	Pasco/Hernando Co Line	40.7
Turnpike	Sawgrass Expressway	I-595	Frontline Road	22.0
	Seminole Expressway (SR 417)	Orange/Seminole Co. Line	I-4	17.0
	Southern Connector (SR 417)	I-4	International Dr.	5.0
	Western Beltway (SR 429)	I-4	Seidel Rd.	10.0
	Polk Parkway (SR 570)	I-4	I-4	24.0
	Veteran's Expressway (SR 589)	SR 60	Suncoast Parkway	16.0
	SR 568	Veteran's Expressway	Dale Mabry Dr.	3.0
	SR 589 (Suncoast Parkway)	Veteran's Expressway	US 98	38.0
	HEFT (Homestead Extension/SR 821)	US 1	Turnpike Mainline	48.0
	Florida's Turnpike (SR 91)	SR 826 (US 441)	Turnpike Mainline	3.0
	SR 408 (East West Expressway)	Turnpike Mainline	SR 50	1.0
	Florida's Turnpike (SR 91)	Sawgrass Expressway	I-75	236.0
	SR 528 (Beachline Expressway)	I-4	Florida Turnpike in Orange Co.	4.0
	Florida's Turnpike (SR 91)	Miramar Parkway	Griffin Road	6.0
	Florida's Turnpike (SR 91)	Broward Blvd. (Broward Co.)	Palm Beach Co. Line	15.0

Figure 2.4 illustrates the current ITS Miles Managed in each district.

Figure 2.4 ITS Miles Managed



Cambridge Systematics developed a list of limited access highway reporting segments in 2012. All segments are interchange-to-interchange and no segment crosses a district boundary. These segments vary in length from 4.4 miles in urban areas to 33 miles in rural areas. Additional segments will be added as the ITS Miles Managed is expanded through the districts. Table 2.4 shows the segments used in 2012.

Table 2.4 ITS Reporting Segments

District	Roadway	Start	End	Approx Miles
1	I-75	Kings Highway	Bayshore Road (SR78)	26.9
	I-75	Bayshore Road (SR78)	Corkscrew Road	20
	I-75	Corkscrew Road	Collier Blvd	21.5
	I-75	Collier Blvd	Broward/Charlotte Co. Line	50.3
2	I-95	Airport Road	I-10	11.8
	I-95	I-10	Race Track Road (MM 332)	19.6
	I-295	I-10	I-95 (south)	20.4
	I-10	I-295	I-95	5
3	I-10	CR 191	Florida/Alabama State Line	26
	I-110	All 6 miles in Pensacola		6
4	I-95 in Broward Co.	Hillsboro Blvd	Commercial Blvd	9.6
	I-95 in Broward Co.	Commercial Blvd	Hallandale Beach Blvd	14.4
	I-595	I-75	US 1	12.9
	I-75	Broward/Miami-Dade Co. Line	I-595	12
	I-75	I-595	Broward/Collier Co. Line	33.4
5	I-4	US 192	SR 408	18.5
	I-4	SR 408	US 17/92	22
	I-95 in Volusia Co.	SR 40	SR 44	19
	I-95 in Brevard Co.	SR 520	SR 192	20.8
6	I-195	I-95	Alton Road	4.4
	SR 826 (Palmetto Exp)	I-95	I-75	8.5
	SR 826 (Palmetto Exp)	I-75	SR 836	10.2
	I-75	SR 826	Broward/Miami-Dade Co. Line	5.4
	I-95	Broward/Miami-Dade Co. Line	US 1	17.3
	SR 826	SR 836	US 1	7.0
7	I-275	SR 60	38th Avenue N in St. Pete	14.5
	I-275	I-4	I-75	16
	I-4	I-275	N. Park Road in Plant City	22.4
	I-275	SR 60	I-4	5.8
	I-75	US 301	I-275 (North side)	20
	I-275	38th Ave North in St. Pete	I-75	24.5
	I-4	N. Park Road in Plant City	CR 557 in Lakeland	25.4

2.4 CONCLUSION

This section reviewed the existing approaches for MPM reporting at FDOT, including calculation methods, data source used, reporting coverage, and segmentation procedures. Here is a summary of the current approaches:

- MPMs reported that use travel time or speed as an input:
 - TranStat Office: delay, average speed, travel time reliability (on time arrival based on pre-defined speed threshold), and travel time variability (95th percentile TTI)

- ITS Office: travel time reliability(95th and 80th percentile TTI)
- Reporting coverage:
 - TranStat Office: travel time reliability and travel time variability are reported on limited access freeways; other MPMs are reported for the State Highway System
 - ITS Office: ITS managed roadways
- Segmentation for travel time reliability
 - TranStat: 156 travel time reliability facilities ranging from $\frac{3}{4}$ miles to 77 miles in length
 - ITS Office: 32 limited access highway reporting segments ranging from 4.4 miles to 50.3 miles
- Data sources for speed/travel time
 - TranStat Office: RCI and TCI databases, HCM based speed estimation models, and the Modified Davidson Curve
 - ITS Office: ITS detector data for travel time reliability, probe data for real time traffic information(511 calls)

3.0 Identification of Field-Measured Data Sources

Several techniques can be used to collect average speed or travel time for vehicles traveling on designated roadway segments. These speed-gathering techniques include floating car, license plate matching, ITS probe vehicles, use of GPS data, cameras, roadside radar, in-pavement detectors, toll tag readers, and Bluetooth sensors. This section will review some of these field-measured data sources available in Florida, describe data requirements, and recommend data sources for FDOT's use in future MPM reporting.

3.1 EXISTING DATA SOURCES

Along with roadside radar and in pavement loop detectors deployed by FDOT districts, several other advanced technologies are being deployed in Florida providing field-measured data for assessing performance. Bluetooth detectors are being deployed in most districts on arterial and freeway segments; these detectors report the travel time of a vehicle between detector stations. Volume and occupancy data are not available from Bluetooth detectors. In-pavement magnetic detectors (primarily produced by Sensys) are also being deployed by some districts to obtain arterial speed data. These Sensys detectors collect volume, speed, and occupancy data at point locations. Additionally, toll tag readers are deployed in District 5 to collect travel time data in the Orlando area. These data sources are not currently archived by FDOT, but could be added to the RITIS archive and fused with SunGuide at a later time. Because these instruments are sparsely deployed throughout the districts, comprehensive data is not available. The project team has determined that none of these data sources sufficiently covers the State Highway System for TranStat MPM reporting.

In Florida, travel time data provided by private vendors is also available. Private data providers combine information from multiple probe technologies such as cell phones, toll tags, crowd-sourcing, and fleet-based GPS probe vehicles, as well as data from existing fixed-sensor networks such as loop- or radar-based detection. The data is then fused to provide real-time travel time estimates and incident information. Private data sources include INRIX, Navteq/HERE Traffic, TomTom, Clear Channel's Total Traffic Network, and American Transportation Research Institute (ATRI).

Recently the Federal Highway Administration procured the National Performance Measurement Research Data Set (NPMRDS) travel time data. This data was purchased from HERE for the National Highway System across the entire country. The data was made available beginning in November 2013 and

includes some historical data going back into 2012. HERE data is a fusion of commercial fleet probe data from commercial truck fleets, roadside detectors owned by HERE, and data gathered from local/state government traffic management centers across the U.S. FDOT's System Planning Office also purchased statewide travel time data from July 1, 2011 - June 30, 2012 from private data vendor INRIX.

Both the detector data from the districts and the vendor probe data are continuous data streams. Currently, the vendor data and detector data are archived by RITIS for FDOT. These data sources also reflect the actual weather conditions over the roadway network and all incidents that occur on the network.

3.2 PRIVATE VENDER DATA

After reviewing all existing data sources, it was determined that private vendor data is the most viable option to replace modeled data for statewide MPM reporting. Vendor data coverage is most comparable to the current TranStat reporting coverage area. The private vendor data also provides separate data sets for freight travel times, which are relevant to the freight MPMs reported by TranStat.

These following factors were considered when assessing field-measured data from different vendors:

- Coverage: Sufficient data coverage for all area and facility types in the state of Florida
- Base data elements: Mean travel time and speed, time stamp, status flag to indicate operation status, and quality indicator to reflect the confidence in the data
- Reporting interval: Data needs to be provided continuously throughout the entire calendar year
- Vehicle types: Probe data should have separate speed data for passenger cars, trucks, and all vehicles
- Data completeness: Data completeness for all time periods especially during peak hours and for urbanized areas
- Ease of integration: Ability to connect to other source data such as FDOT RCI and TCI databases

Requests for Information (RFI) were prepared and sent to three major private data vendors, TomTom, INRIX, and Navteq/HERE. Table 3.1 reflects analysis results using vendor sample data sets and summarizes the responses from all private vendors. All three data vendors provide data on links known as Traffic Message Channels (TMCs). NPMRDS from HERE is the only dataset that

provides separate truck speeds. Sample data was obtained, integrated, and processed to evaluate its use in FDOT’s MPM Program.

Table 3.1 Vendor Comparison

TRAVEL TIME AND SPEED DATA					
<i>Data Set</i>	<i>Completeness</i>	<i>Granularity</i>	<i>Data Availability</i>	<i>Freight</i>	<i>Coverage</i>
NPMRDS	Only uses raw data in generating speeds, where there are no observations there are gaps in the data.	5 minute speed data.	New data is reported monthly - Historical data is made available.	Includes separate truck travel speeds.	Covers the entire National Highway System (NHS)
HERE	Where data is missing, imputed data is used so there are no gaps.	5 minute speed data.	Real time data can be accessed any time – Historical data requires an archiving system e.g. RITIS	Does not include separate truck travel speeds.	Covers the entire TMC network in Florida – 20,000+ miles and provides separate TMCs for HOT lanes
TOM TOM	Roughly 30% of overall travel speeds come from direct field-measured observations.	15 minute speed data could be disaggregated to 5 minute data	Origin/Destination data is available. Travel time data can be provided monthly or annually.	Does not include separate truck travel speeds.	Provides data on a linear referencing system with smaller segment lengths than TMCs. TOM TOM likely provides the widest coverage
INRIX	Approximately 75% of travel speeds in the peak period come from field-measured observations.	Speed data can be provided in 1 min intervals, 1 hour interval, and any interval in-between	INRIX Data Downloader allows the subscriber to download any data at any time.	Captures real time truck speeds which can be used to create a freight profile- No truck travel speed archive	Covers the entire TMC network in Florida – 20,000+ miles. INRIX provides additional data for minor arterials and collectors through the XD system

3.3 RECOMMENDATIONS

Private vendor data from Navteq/HERE is the best overall among all data sources evaluated in the preliminary assessment for following reasons:

- Minimum additional cost to purchase and archive data;
- Free NPMRDS for roadways on the National Highway System is provided through FHWA;
- Free data on an expanded roadway networks provided through ITS Office data contract;
- HERE data is archived at RITIS along with ITS Office detector data; and
- NPMRDS provides separate data sets for freight travel times.

4.0 Feasibility of Transitioning to Field-Measured Data for Travel Time Related MPM Reporting

This section evaluates the feasibility of transitioning from modeled data to field-measured data by comparing the advantages and disadvantages of both approaches. An evaluation of coverage of the chosen field-measured data sources is provided along with a description of strategies for missing data in this section.

4.1 PROS AND CONS OF MODELED CALCULATIONS VS. FIELD-MEASURED DATA

FDOT's TranStat Office monitors mobility performance measures for the Department and reports those measures annually in the Source Book. The detailed methods for calculating each FDOT TranStat mobility performance measure are described in the 2013 Source Book appendix. Travel times and speeds produced by the TranStat Office come from various models.

Immediately observable advantages to continuing with the current process are:

- There is roadway coverage for the entire State Highway System down to the collector level.
- Control over segmentation of roadways, e.g. FDOT defines the reliability segmentation, whereas the measured data segmentation is defined by a vendor probe data industry standard, Traffic Message Channel (TMC) codes.
- Long history based on current processes, e.g. the FDOT TranStat measures based on modeled data have been reported for a number of years, and the measured data methodology may produce different results. Mobility performance measures based on measured data can be reported historically back to 2013.
- FDOT's techniques are generally tied to the HCM (a planning industry standard); the HCM is used for traffic analyses in multiple phases of project analysis.

The potential disadvantages include:

- Travel times are based on a calibrated model making use of numerous defaults and assumptions rather than measured data.
- Travel time reliability is based on assumptions for non-recurring events rather than actual roadway conditions.
- Measured data is collected continuously, whereas modeled data is largely based on annual traffic counts or traffic counts collected once every three years.

The advantages and disadvantages of using measured data are described as follows; the potential advantages are:

- Travel times are based on actual counts and reflect the range of actual conditions experienced by drivers.
- Measured data is collected continuously providing a full range of actual events on the road network.

The potential disadvantages are:

- The measured data obtained from probe data vendors usually includes gaps which are often filled by the imputation of historical data.
- On congested arterial streets, individual links may not reflect actual conditions because traffic signals will only allow a limited amount of traffic flow in a time period. This will not count any volume occurring beyond the roadway's capacity. This problem may possibly be overcome through corridor level analysis since spillback between intersections is accounted for at the corridor level.

4.2 AVAILABILITY AND ACCURACY OF MEASURED DATA

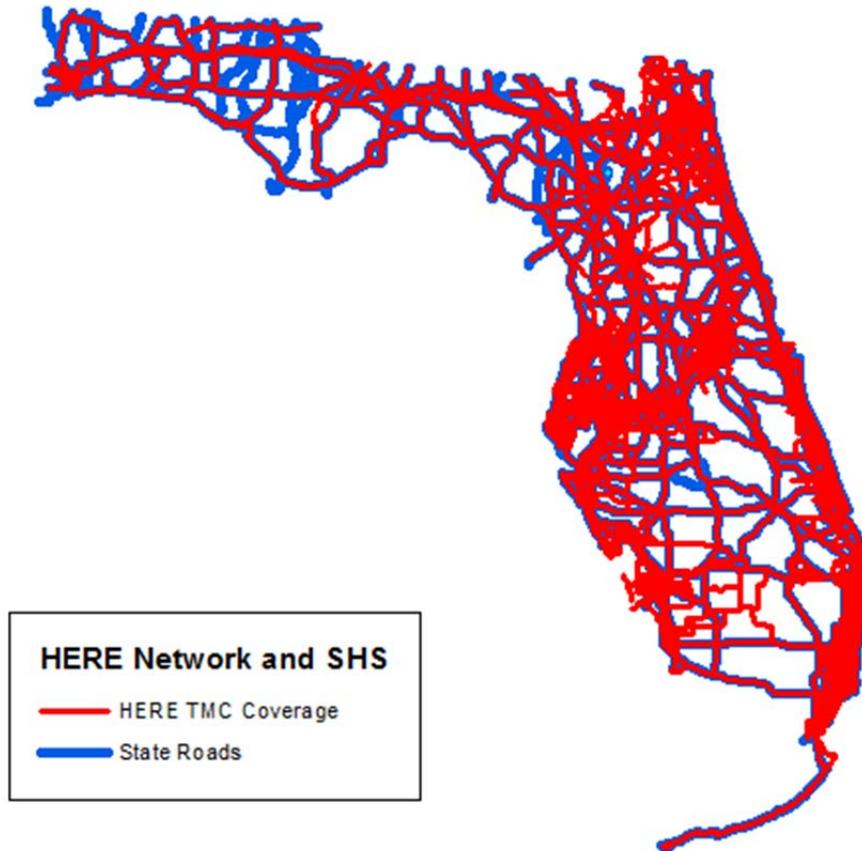
There have been numerous data quality tests and periodic checks on the private vendor travel time data provided by HERE and INRIX. The tests have proven that these data sources are consistently accurate within a tolerance of +/- 5 MPH.

FDOT ITS office datasets from HERE/Navteq cover all links in the TMC network. An additional assessment was conducted to determine the detailed TMC coverage of the Strategic Intermodal System (SIS) and State Highway System (SHS).

For this evaluation, Navteq/HERE provided a detailed street map showing all their "link" segments as of June 2013. A link represents a basic analysis segment that overlaps a TMC. The project team accessed a lookup table showing the relationship between links and TMCs. Speeds reported on TMCs are associated with roadway links through the lookup table. The detailed map has 1,674,184 links in Florida, 228,430 of them have corresponding TMCs. Although this percentage appears low, the actual TMC coverage is greater than 70% of the

network. There are 24,874 TMCs in the sample HERE ITS office dataset. Figure 4.1 shows the TMC coverage for the State Highway System (SHS).

Figure 4.1 HERE TMC Network Coverage on SHS



As can be seen in the map, most of the state roads not covered by the TMC network are in the panhandle (northwest Florida). A detailed list of state roads not covered and their corresponding AADTs are listed in Table 4.1.

Table 4.1 State Roads Not Covered by the HERE TMC Network

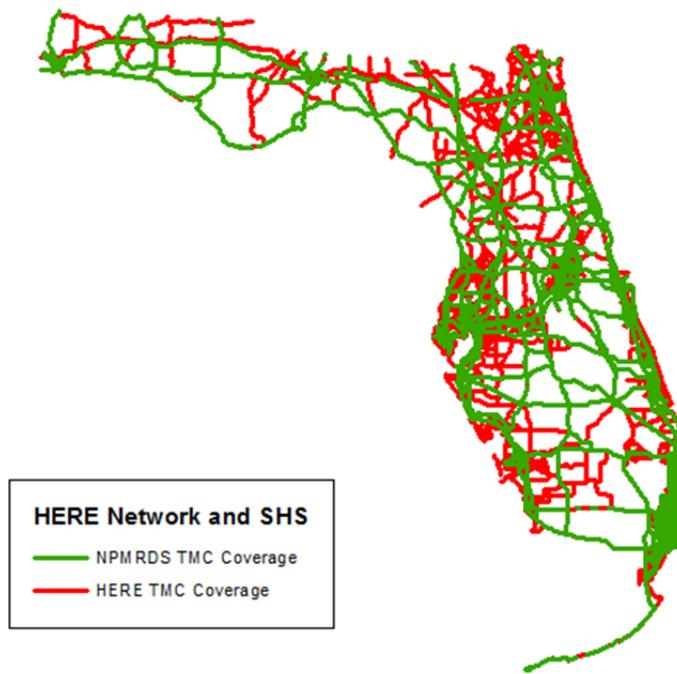
Road Name	AADT	Road Name	AADT	Road Name	AADT
SR 123	15200	SR 281	19100	SR 636	7700
SR 155	13200	SR 289	15200	SR 66	5060
SR 166	8900	SR 291	32500	SR 69	4400
SR 173	22,000	SR 292	25500	SR 71	15400
SR 18	600	SR 293	15500	SR 727	24500
SR 188	27,500	SR 296	39000	SR 73	4400
SR 189	34000	SR 298	13900	SR 742	22000
SR 190	3300	SR 30	34000	SR 750	32500
SR 196	14900	SR 300	3400	SR 77	28730

Road Name	AADT	Road Name	AADT	Road Name	AADT
SR 22	17500	SR 326	9300	SR 79	8800
SR 231	3800	SR 349	5200	SR 83	7000
SR 235	9500	SR 363	21200	SR 89	20500
SR 238	3300	SR 389	14400	SR 9336	21000
SR 247	7600	SR 390	23500	SR 97	5600
SR 265	39000	SR 393	35000	SR 825	44000
SR 276	11000	SR 397	19000		
SR 277	3600	SR 47	9800		

In the evaluation of the sample archived FDOT ITS Office datasets, data completeness is almost 100%. Travel time/speed is provided for all 24,874 TMCs and all time periods. When actual field-measured data is not available HERE uses interpolated speeds to fill the data gaps. The algorithms used are proprietary but data provided are quality checked and validated by Navteq/HERE.

Sample NPMRDS data was also obtained and evaluated. There is a total of 11,733 TMCs in the NPMRDS data set. Only actual field-measured data are provided, if no data are available for a roadway or time interval it will be left as a gap. The project team confirmed that travel times/speeds for passenger cars, trucks, and all vehicles are provided separately. Figure 4.2 shows the coverage of NPMRDS compared to the coverage of FDOT ITS TMC network.

Figure 4.2 NPMRDS Data Coverage



4.3 STRATEGIES FOR MISSING DATA

Although Navteq/HERE is committed to constantly adding more TMC coverage, it is likely some of the roadways will not be covered when the transition to field-measured data takes place. In addition, there is no separate truck data on non-NHS roadways and for the NHS, truck speeds are not available for all time intervals. Data gap filling strategies are needed for a smooth transition to field-measured data.

Following are strategies to fill gaps in NPMRDS data where only actual field-measured data are available.

- Travel times from previous and next timestamps
- Travel times from neighboring TMC links
- Historical averages, free-flow speeds, or speed limits, will also be considered depending on study cases

A travel time/speed model should be developed for state roads not covered by HERE TMCs. The model should consider, among other factors, area type, facility type, volume, and time of day.

For non-NHS roadways where truck speeds are not available the project team recommends the use available truck speeds on NHS roadways to develop relationships between passenger car speeds and truck speeds.

4.4 ABILITY TO PRODUCE QUICK TURNAROUND REQUESTS WITH MEASURED DATA

Once the measured data MPM methodology is established, it will require minimal time and effort to provide performance measures on request. Data from selected TMCs will be uploaded into statistics software and processed. This process will not take more time or effort than the current process using modeled data to fulfill requests.

4.5 CREDIBILITY OF RESULTS

The use of measured data allows for analyses based on actual road conditions whereas the modeled data is based on many assumptions. Since the measured data provided by the private vendors is quality checked and the level of quality is deemed acceptable, results based on the measured data are considered credible by FHWA and many states. There has been little validation of arterial speeds by an independent source.

5.0 MPM Reporting Using Field-Measured Data

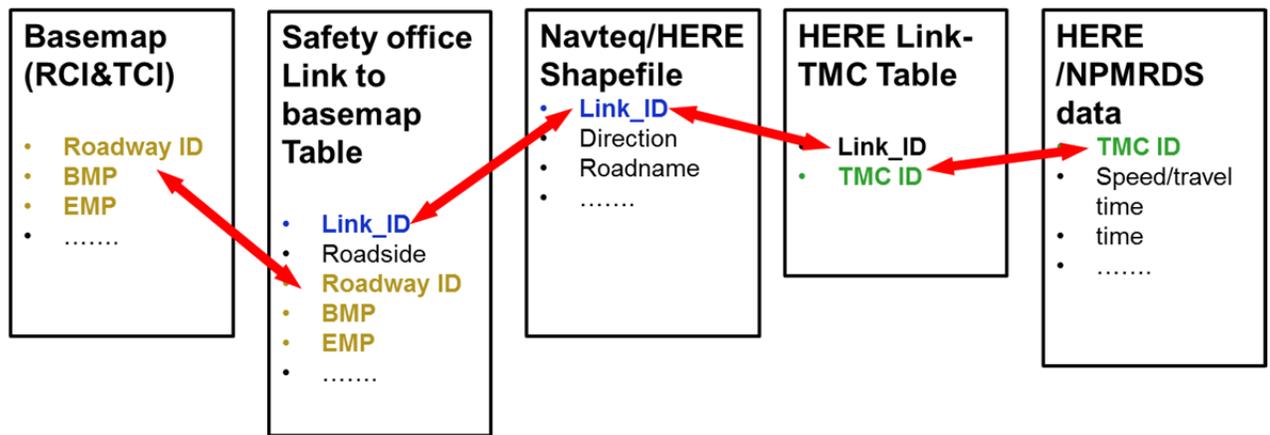
In order to use field-measured data for statewide MPM reporting several critical issues need to be resolved including data integration, data aggregation, and readdressing MPM calculation routines. This section describes a framework for using field-measured data for MPM reporting and develops standard procedures to address integration, calculation routines, and aggregation issues.

5.1 DATA INTEGRATION PROCEDURE

The two main auto/freight highway data elements used in FDOT's Mobility Performance Measures are traffic volume and travel time. The traffic volume source (TranStat Office) is highly reliable and will continue to be the source for traffic volume. Currently, the Source Book uses volumes as a weight in reliability and variability measures and uses volumes directly in delay calculations. Other important data obtained from the RCI database are roadway characteristics such as facility type, speed limit, and number of lanes. One of the key steps will be integrating field-measured travel time data with the existing Linear Referencing System (LRS) basemap. This is a necessary step so that other data such as volume and roadway characteristics can be integrated with travel time and included in the MPM calculations.

After evaluating different network conflation tools available including the linear referencing toolbox in ArcMap, a route based linear referencing toolbox developed by Cambridge Systematics, a dynamic location referencing tool called OpenLR, and a reference table developed and maintained by FDOT's Safety Office, it was concluded the use of FDOT's Safety Office table is the most accurate and efficient way to integrate the Navteq/HERE travel time/speed datasets into other existing FDOT data sources. Figure 5.1 shows how the datasets can be connected using FDOT Safety Office table.

Figure 5.1 Integrating Field-Measured Data to RCI and TCI Databases



As discussed in the previous section, Navteq/HERE provides a link-based GIS map where the links in the map have unique “Link_IDs”. The “Link_ID” to “TMC_ID” lookup table, which is also provided by HERE, is used to cross-reference each TMC in the HERE/NPMRDS datasets with the HERE links that are associated with it. In many cases, a particular TMC will be composed of numerous HERE links. This look-up table allows for the assignment of travel time/speeds to correct HERE/Navteq links in the Navteq/HERE map. The Safety Office link to basemap table allows for the assignment of roadway IDs, beginning mile post (BMP), and end mile post (EMP) to each HERE link. Lastly, the table with roadway ID, BMP, EMP, and speed can be used to directly reference HERE travel time/speed data to the LRS and RCI/TCI.

It is noted that base maps are constantly updated by FDOT to correctly reflect latest field conditions. Navteq/HERE also releases new version of their maps and a HERE link to TMC lookup table every quarter, the quarterly updates can affect up to 5% of the links. FDOT’s Safety Office only updates the HERE link to the base map table once a year. For example, the 2012 version of FDOT’s Safety Office table is based on the 2012 first quarter HERE map and the 2012 FDOT base map. Although this situation may negatively influence the accuracy of the data integration process, using the Safety Office table is still the most accurate and efficient way for data integration

The project team tested the proposed data integration procedure using the 2012 Safety Office table, 2014 second quarter Navteq/HERE map, and the 2014 June HERE ITS dataset. Findings show 24,618 TMCs out of 24,874 TMCs were successfully matched with RCI roadway IDs, BMP, and EMPs. The remaining 256 TMCs will need to be matched manually through fitting TMC segments to RCI segments. Where more than 50% of a RCI segment directly aligns with a TMC segment, those two segments will be matched together.

5.2 PROBE DATA QUALITY CHECK

Although field-measured data are quality checked by the data vendor, the project team designed the following data quality checks criteria to detect major data errors. These checks were designed based on evaluation of sample data, adjustments may be needed when processing final datasets. These checks should be performed on all five-minute speed/travel time records:

- 1) Tukey Method: Rank all travel times for a section, and treat any value greater than the 75th percentile plus 1.5 times the interquartile distance, or less than the 25th percentile minus 1.5 times the inter-quartile distance as an outlier. This technique is robust because it uses the quartile values instead of variance to describe the spread of the data.
- 2) Two consecutive travel times cannot change more than 40%.
- 3) If a travel time is more than one standard deviation above or below the moving average of the 10 previous entries, the travel time will be removed.

Statistics will be gathered on all five-minute records and these values will be aggregated to hourly records to use as the inputs for the MPM database. Volume and speed will have a “completeness” factor to indicate the percentage of valid values used in the aggregate calculation. A value of 1.0 indicates that all records are good. A value ≥ 0 and < 1.0 indicates that some records are bad or missing, if records are removed missing data strategies described in previous sections will be applied to fill data gaps.

5.3 MPM CALCULATION PROCEDURES USING FIELD-MEASURED DATA

Table 5.1 lists all MPMs where field-measured data could be employed. Eight of the measures currently use modeled travel time or speed as an input, and the other six use level of service (LOS) as an input. If speed ranges for LOS A through F are defined, the calculation of these six MPMs will also be based on field-measured travel time/speed data. Detailed procedures are discussed in following sections.

Table 5.1 MPMs to Use Field-Measured Travel Time/Speed Data

Source Book MPMs	Methodology
Travel Time Reliability	Keep source book methodology
Travel Time Variability	Keep source book methodology
Vehicle Hours of Delay	Keep source book methodology
Average Travel Speed	Keep source book methodology
Travel Time Reliability (Freight)	Keep source book methodology
Travel Time Variability (Freight)	Keep source book methodology

Source Book MPMs	Methodology
Combination Truck Hours of Delay	Keep source book methodology
Combination Truck Average Travel Speed	Keep source book methodology
<i>Percent of Travel Meeting LOS Criteria</i>	<i>Speed based LOS criteria</i>
<i>Percent of Miles Meeting LOS Criteria</i>	<i>Speed based LOS criteria</i>
<i>Percent of Miles Severely Congested</i>	<i>Speed based LOS criteria</i>
<i>Percent of Travel Severely Congested</i>	<i>Speed based LOS criteria</i>
<i>Hours Severely Congested</i>	<i>Speed based LOS criteria</i>
<i>Percent of Miles Severely Congested (Freight)</i>	<i>Speed based LOS criteria</i>

Average Speed

Basic Segment Computation

Current FDOT method – the current method estimates speed on each RCI segment using various models, different models are used for different v/c ratios and facility types.

Measured Data method – measured speed data will be assigned to each RCI segment following the described data integration process.

Statewide Aggregation

Once the average speed is calculated on each basic link, there will be no difference in the two methods. Both the current method and the proposed measured data method would aggregate average travel speed to a statewide total using the following equation:

$$\text{Average Travel Speed} = \frac{\sum(\text{VMT} \times \text{Average Travel Speed})}{\sum(\text{VMT})} \quad \text{(Equation 9)}$$

Delay

In the Source Book, vehicle hours of delay are calculated as the product of directional hourly volume and the difference between travel time at “threshold” speeds and travel time at observed speeds. The thresholds are based on LOS B as defined by FDOT and shown in the following equation.

(Equation 10)

Vehicle Hours of Delay

$$= \sum (\text{Daily or Peak Period/Hour Travel Time} - \text{Travel Time at LOS B})$$

Basic Segment Computation

The current method of calculating delay estimates travel times based on the 2010 Highway Capacity Manual, FDOT's Generalized Service Volume Tables, or the Modified Davidson Curve. Then travel time at LOS B is subtracted from the modeled travel times for each RCI segment.

Instead of estimating travel time, the proposed method would calculate the delay on the TMC segmentation using the measured travel times from HERE. Volume and other roadway characteristics information are acquired by the aforementioned method and the LOS B threshold travel times is subtracted from the HERE travel time.

Statewide Aggregation

Once the delay measure is calculated for each basic link, there will be no difference in the two methods. Both the current method and the proposed measured data method will aggregate a statewide delay total in a similar fashion.

Travel Time Reliability and Variability

The Source Book defines travel time reliability as the percentage of travel (VMT) that is greater than a chosen speed threshold on freeways, as shown in the following equation:

$$\text{Travel Time Reliability (All Vehicles)} = \frac{\sum(\text{VMT} | \text{Travel Speed} \geq \text{Speed Limit})}{\sum(\text{VMT})} \times 100 \quad (\text{Equation 11})$$

FDOT is currently considering the use of 45 mph for certain times and in certain areas in addition to the speed limit criterion.

The Source Book also defines travel time variability as the 95th percentile travel time index (TTI₉₅), shown in the following equation:

$$\text{Travel Time Index}_{95} = \frac{\text{Travel Time}_{95\text{th percentile}}}{\text{Travel Time}_{\text{freeflow}}} \quad (\text{Equation 12})$$

Freeway free flow speeds are defined as the posted speed limit plus 5 mph. In both definitions, VMT is used as a weight in the calculations.

Basic Segment

In the current FDOT method travel times are estimated based on volumes, incidents, weather, and workzone information. The FDOT travel time reliability model produces reliability metrics on individual links referred to as *reliability links*.

Instead of estimating travel times, the proposed measured data method calculates the measures on each *TMC link* using the measured travel times from the HERE data file. Additional volume and other roadway characteristics information will be acquired by the aforementioned GIS process and used in the same manner as the current method.

Statewide Aggregation

The current FDOT method computes reliability on roughly 830 segments of limited access highway. Measures on each segment are aggregated to a set of predefined “reliability facilities”, weighted by VMT. Note the reliability measure reported for a facility is not simply the average of the measures on all the segments within the same reliability facility, rather, it is the average measure weighted by the VMT for all the segments. Reliability facility measures are then aggregated into statewide measures also weighted by VMT.

The measured data method is similar to the current method. The primary difference is that it would start with TMC segmentation, which would be correlated to RCI links and rolled up to a statewide average measure weighted by the VMT on each RCI link.

5.4 ADDITIONAL/OPTIONAL APPLICATION OF FIELD-MEASURED DATA

Field-measured data can also be used to replace LOS criteria in these five existing methodologies: percent of travel meeting LOS criteria, percent of miles meeting LOS criteria, percent of miles severely congested, percent of travel severely congested, and hours severely congested.

LOS Criteria

Currently the Source Book uses AADT, K factors, and directional factors to calculate hourly directional volume. These volumes are contrasted against volume thresholds in the Generalized Service Volume Tables to report LOS. With proper speed-volume functions, it is possible to calculate LOS speed thresholds based on volume thresholds. For example, the Source Book uses the Modified Davidson Curve with LOS threshold volume to calculate a delay speed threshold, which is the speed threshold between LOS B and C.

Applying a similar methodology, threshold speeds between LOS C and D, between LOS D and E, and between LOS E and F can be calculated for freeways.

Arterial roadways use travel speed as their service measure per FDOT's methodology. Comparing measured speed to LOS speed based thresholds will improve accuracy as there are only limited traffic count sites, and counts are collected for limited time periods, while measured speeds come from a continuous data stream which more accurately reflects field conditions. For these reasons, measured data should be used for LOS analyses.

6.0 Conclusion

Florida DOT has a well-established Mobility Performance Measures Program to monitor mobility for multiple modes. Current methodologies used in performance reporting are based on nationally-established methods and accepted in Florida. This is an ever-improving process that will be guided by MAP-21 reporting requirements. The Federal Highway Administration is providing travel speed data to support MAP-21 reporting. This is a primary driver behind the effort to transition to using field-measured data for reporting on mobility performance. Field-measured data allows for a straight comparison between municipalities and jurisdiction.

Both the ITS and TranStat Office's performance reporting systems were thoroughly documented in this report. Even within FDOT there are some inconsistencies in the performance computations and segmentation. Using field-measured data for all future FDOT performance reporting resolves issues of inconsistency. Consistent data and methodology should be used by both the Planning and ITS offices. Into the future coverage gaps along rural facilities will need to be addressed. Modeled travel time data may continue to be the preferred method where there are lapses in geographic coverage.

The project team obtained data from multiple vendors and held meetings with the vendors to evaluate their data. Criteria weighed in recommending a data vendor included data completeness, coverage, conflation, and price. Because FDOT already committed resources to HERE, this option became most viable. Data provided by all vendors was compared on an equal platform; HERE and INRIX had similar coverage. The additional benefit of using HERE data from the ITS Office is that the complimentary NPMRDS dataset can be used to fill in gaps because it comes from the same source.

Pros and cons of transitioning to field-measured data were evaluated, the pros outweighed the cons. The feasibility of transitioning was evaluated and the project team concluded that a transition is realistic. Where data is unavailable the project team has figured out imputation strategies. Additionally, this report provides general guidance and specific prescriptions for calculating potential MAP-21 (Moving Ahead for Progress in the 21st Century Act) measures. U.S. DOT made vendor data available to all the states for MAP-21 reporting, consequently the use of vendor provided data is the recommended option in Florida. The availability and accuracy of field-measured data supports this recommendation.

7.0 Next Steps

1. Testing Plan - The two datasets provided by Navteq/HERE (NPMRDS and FDOT ITS real time data feed) will be used to calculate MPMs for select portions of the SHS.

These roadways should mirror roadways used to test performance reporting in the *South Florida Mobility Performance Measures Extraction Procedures* task. Results from the field-measured data calculations will be evaluated and compared against the performance reported for the same geographic boundaries using the existing model based method. A test plan will be developed.

2. Data Processing Procedures - NPMRDS data will be used in combination with ITS Office data in calculating all MPMs reliant on travel time or speed i.e. delay and travel time variability. These computations will occur over the next three months using statistical analysis software. The development of data processing procedures will occur concurrent to the computational process. Data processing procedures will be created based on the assumption that Navteq/HERE datasets will be used in MPM reporting. Coordination with HERE will occur to assess data coverage in District 3.

3. Truck Speed Factor - To ensure accuracy for freight reporting, there will be an ongoing assessment of truck travel time/speed estimation over the next three months. Currently the Source Book assumes truck speeds to be 2 mph slower than passenger car speeds. With the availability of field-measured data, especially the separate truck data on the NHS, a truck speed-passenger car speed model can be developed to estimate truck speeds where field-measured truck speeds are not available. Different model parameters may be needed for different area types and facility types. These observations will be used to establish formal guidance on data collection and processing activities

4. Source Book - As a continuation to this project, the project team will compute performance measures using field-measured data for the 2015 Source Book. All data targeted for use in Source Book performance reporting will undergo additional data quality checks throughout the process of updating the Source Book.