

Project Traffic FORECASTING

HANDBOOK 2019



STATE OF FLORIDA
DEPARTMENT OF TRANSPORTATION

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Chapter 1 Introduction and Overview

1.1 Introduction

Project traffic estimates are required for planning, Project Development and Environment (PD&E) studies, and Resurfacing, Restoration and Rehabilitation (RRR) projects. Traffic analyses of the Project Traffic Process evaluate the impacts of proposed transportation facilities and assess the effectiveness of the improvements. The [FDOT Design Manual \(Chapter 306\)](#) requires traffic data consistent with the data used for pavement design to be included for each typical section. The Project Traffic Forecasting Handbook offers guidelines and techniques for Corridor Traffic Forecasting studies, Project-Level Traffic Forecasting studies, and 18-KIP Equivalent Single Axle Load (ESAL) studies.

CORRIDOR

Corridor projects usually require the development of traffic projections that are used to make decisions with important capacity and capital investment implications. The Corridor Traffic Forecasting is required before establishing a new alignment or widening of an existing facility.

PROJECT

The Project Traffic projections are commonly used to develop lane configuration requirements for intersection designs, and to evaluate the operational efficiency of proposed improvements. Project Traffic Forecasting is also required for reconstruction, resurfacing, lane addition, bridge replacement, new roadway projects, and major intersection improvements. This process differs from Corridor Traffic Forecasting in that it is site specific and covers a limited geographic area.

ESAL

The ESAL Forecasting Process is required for the pavement design for new construction, reconstruction, and resurfacing projects that require a structural loading forecast.

Project level travel demand forecasting plays an important role in the project development and delivery process. Project traffic and traffic parameters are needed in developing performance measures to prioritize transportation improvements, conducting alternative analysis to select the preferred alternative, providing design parameters to support geometric and structural design, and developing traffic management plans to mitigate the negative impact during construction.

Corridor Traffic Forecasting and Project Traffic Forecasting projects require forecasts of Annual Average Daily Traffic (AADT) and Design Hour Volumes (DHV). AADT and DHV are related to each other by the ratio commonly known as the K-factor.

The overall truck volume and AADT are related to each other by the T-factor. The total impact of truck traffic on pavement design is expressed in units of ESALs, which represent truck axle weights converted into 18,000-pound (18-KIP) loads carried by a single, four-tire axle.

RRR projects only require the ESAL process to determine the appropriate Load Equivalency Factor for the pavement to be laid. Traffic improvement projects, such as improving shoulders or turn lanes and restriping roads are not covered under the ESAL forecasting process.

1.2 Purpose

The purpose of the Handbook is to describe policies and procedures accepted by the Florida Department of Transportation (FDOT) and offer guidelines on principles and techniques for preparing project traffic required by various stages of the project development process. The objective is to help standardize the traffic forecasting process that will result in consistent and defensible project traffic on all applicable transportation projects. The intended audience is transportation engineers and planners who develop project traffic for various highway projects for FDOT and its partner agencies in the state of Florida. This Handbook may be used by local governments and other agencies to review, accept, or approve project traffic developed for highway projects within their jurisdictions. This Handbook provides directions for *Corridor Traffic Forecasting*, *Project Traffic Forecasting*, and *Equivalent Single Axle Load (ESAL) Forecasting*. This handbook supplements the Project Traffic Forecasting Procedure Topic No. 525-030-120.

1.3 Organization

This Handbook consists of eight (8) chapters and three (3) Appendices:

Chapter 1 Introduction and Overview

This chapter outlines the traffic forecasting processes for corridor, project, and Equivalent Single Axle Load (ESAL) studies and describes general guidelines and techniques to be used in the Project Traffic Forecasting Process.

Chapter 2 Traffic Data Sources and Factors

This chapter describes the different types of traffic counters in operation, the current traffic data collection methodologies used in the State of Florida, and the estimation and tabulation of: Seasonal Factors (SF), Axle Correction Factors (ACF), estimates of Annual Average Daily Traffic (AADT), K-Factor (K) and Standardized K, Directional Distribution Factor (D), and Percent Trucks (T) for the current year.

Chapter 3 Forecasting with Travel Demand Models

This chapter provides guidance on the application of models to develop traffic projections for facility specific PD&E studies, corridor studies, and RRR projects. This chapter also provides an overview of modeling for traffic engineers and an overview of traffic forecasting requirements for modelers.

Chapter 4 Forecasting Without Travel Demand Models

This chapter provides a description of the appropriate methods of performing trend analysis and examination of local land use plans, and other indicators of future growth in the project traffic forecasting process.

Chapter 5 Directional Design Hourly Volumes

This chapter describes the appropriate methods for converting model volume outputs to Annual Average Daily Traffic (AADT) volumes and then into Directional Design Hourly Volumes (DDHVs), which are used in the evaluation of roadway points, links, and facility analyses.

Chapter 6 Estimating Intersection Turning Movements

The purpose of this chapter is to provide a method for developing balanced turning movement volumes at intersections. The TURNS5-V2014 spreadsheet and TMTTool are explained in detail and reviews of other techniques are summarized.

Chapter 7 Equivalent Single Axle Load Forecast

This chapter describes the guidelines and techniques of forecasting Equivalent Single Axle Load (ESAL) volumes for use in pavement design.

Chapter 8 Project Traffic for Corridors with Priced Managed Lanes

This chapter provides general discussions on unique issues in the Express Lanes project development process and offers guidance on the methodologies and processes for design traffic development.

Appendix A

FHWA Letter – Use of Standard K-Factors for Traffic Forecasting

Appendix B

References used in the Handbook

Appendix C

Glossary – list of terms and definitions used in the Handbook

1.4 Authority

Sections 20.23(3)(a) and 334.048(3); [Florida Statutes](#) (F.S.).

1.5 Truth in Data Principle

The controlling “Truth-in-Data” principle for making project traffic forecasts is to express the sources and uncertainties of the forecast. The goal of the principle is to provide the user with the information needed to make appropriate choices regarding the applicability of the forecast for particular purposes. For the traffic forecaster, this means clearly stating the input assumptions and their sources and providing the forecast in a form that the user can understand and use. For the user (e.g., project designer), this could mean compensating for uncertainty in projections of the total axle loading by using a reliability design factor.

1.6 Precision of Data

To reflect the uncertainty of estimates and forecasts, volumes should be rounded. Practical guidance is to round the volumes according to the rounding convention as follows.

Forecast Volume	Round to Nearest
<100	10
100 to 999	50
1,000 to 9,999	100
10,000 to 99,999	500
> 99,999	1,000

The rounding convention was adapted from *AASHTO Guidelines for Traffic Data Programs* published in 2009. The convention was revised to be more stringent to address situations where growth is low and future volumes after rounding appear to be the same.

Chapter 2 Traffic Data Sources and Factors

2.1 Introduction

The Florida Department of Transportation (FDOT) collects and stores a broad range of traffic data to assist highway engineers in maintaining and designing safe, state-of-the-art, and cost-effective facilities. Traffic data is collected by the FDOT's Central Office and district offices, local governments, and consultants. Traffic data collection efforts include traffic volume, speed, vehicle classification counts, and/or truck weight. The FDOT Transportation Data and Analytics (TDA) Office is responsible for providing installation guidance, collecting, processing, storing traffic data and finalization process (known as the end of the year process) to generate traffic count data to be used in Department administration of highway programs along with published data sets and reports. The purpose is to provide the Department with a basis to meet FHWA's reporting requirements to sustain the funding of federal transportation programs, and to provide critical data required for engineering analysis of existing facilities and to identify the need for expansion in the road network.

2.2 Purpose

Traffic data is the foundation of highway transportation planning and is used in making numerous decisions. Accurate traffic data is a crucial element in the transportation planning process; therefore, uniform understanding and implementation of the process can lead to better design decisions. This chapter describes the following:

- Types of traffic counting equipment installed and programs used
- Traffic data collection methods used in Florida
- Seasonal Factors (SF)
- Axle Correction Factors (ACF)
- Annual Average Daily Traffic (AADT)
- Design Hour Factor (K)
- Directional Distribution Factor (D)
- Percent Trucks (T)
- Estimating AADT
- Existing Traffic Condition Information

2.3 Traffic Adjustment Data Sources

The continuous count and classification program is designed to collect vehicular and classification traffic counts 24 hours a day throughout the year. The short-term seasonal classification program is designed to collect classification counts for a short period of time (24 to 72 hours). In addition, TDA has a Weigh-in-Motion (WIM) count program which collects vehicle classification and truck

weights. The various types of traffic monitoring sites used in Florida during 2017 are presented in **Figure 2-1**. As shown below, the FDOT TDA and district offices collected traffic count and traffic factor information at 18,603 sites throughout Florida.

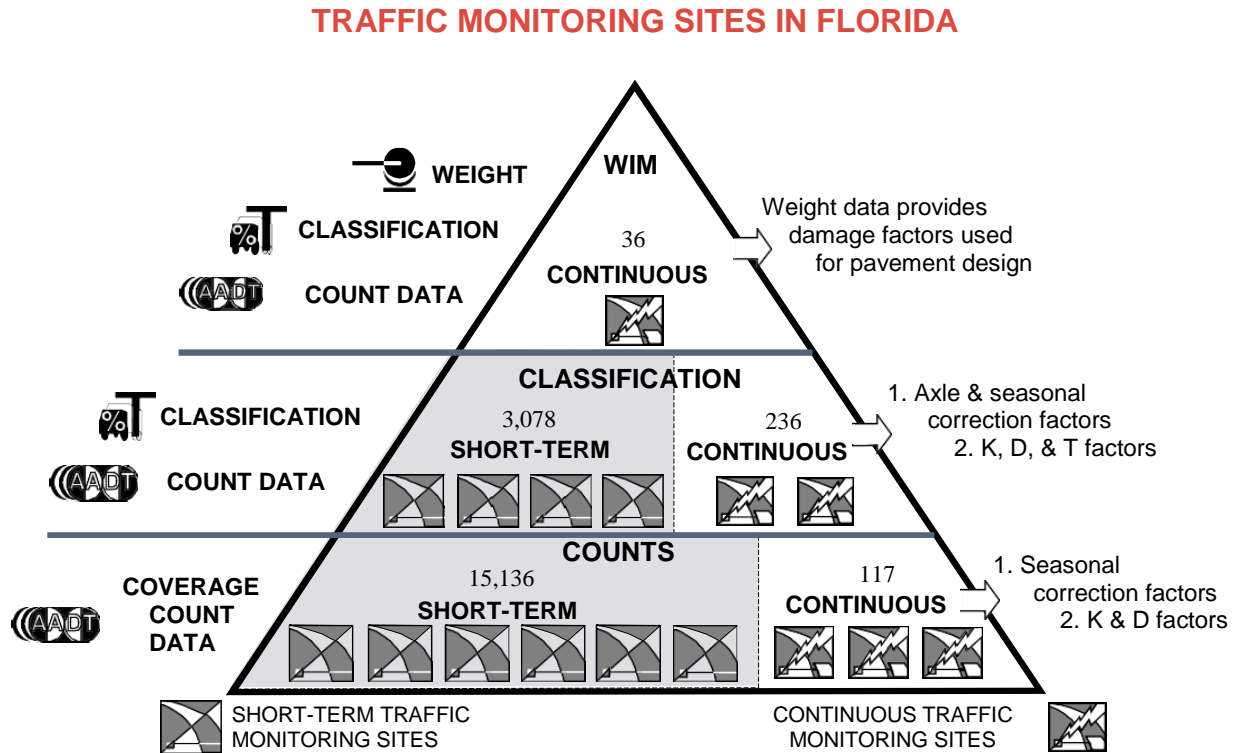


Figure 2-1 Florida's Traffic Monitoring Sites Used in 2017

2.3.1 Continuous Vehicle Counts

The FDOT's TDA Office collects traffic data through permanently installed traffic counters located throughout the state. The Continuous Traffic Monitoring Sites (Continuous TMSs) collect and record the distribution and variation of traffic flow by hour of the day, day of the week, and month of the year from year to year and transmit the data daily to TDA via wireless cellular devices. Florida's continuous count program has 353 sites. The TDA or district office will determine when and where new continuous sites are required. Often when major road construction projects are undertaken, a count site will be included in the design plans at the request of the TDA or district office. Generally, 3 to 4 new sites are installed each year and several others receive equipment upgrades. The continuous counters provide the user with day-to-day traffic information throughout the year and information collected is used to produce AADT, K, and D factors.

2.3.2 Continuous Classification Counts

FDOT has approximately 236 permanently installed continuous classification counters. The TDA Office collects classification data based on the classification of the vehicle according to FHWA Vehicle Classification Scheme F. (See **Figure 2-2**). Truck traffic data is collected through vehicle classification counts, which may be either part of FDOT's Vehicle Classification Reporting Program or a special Vehicle Classification study. There are currently 13 vehicle classification types ranging from motorcycles (Class 1) to Multi-Trailer 7 or more-axle Trucks (Class 13). In addition, TDA has a WIM count program which collects vehicle classification and truck weights.

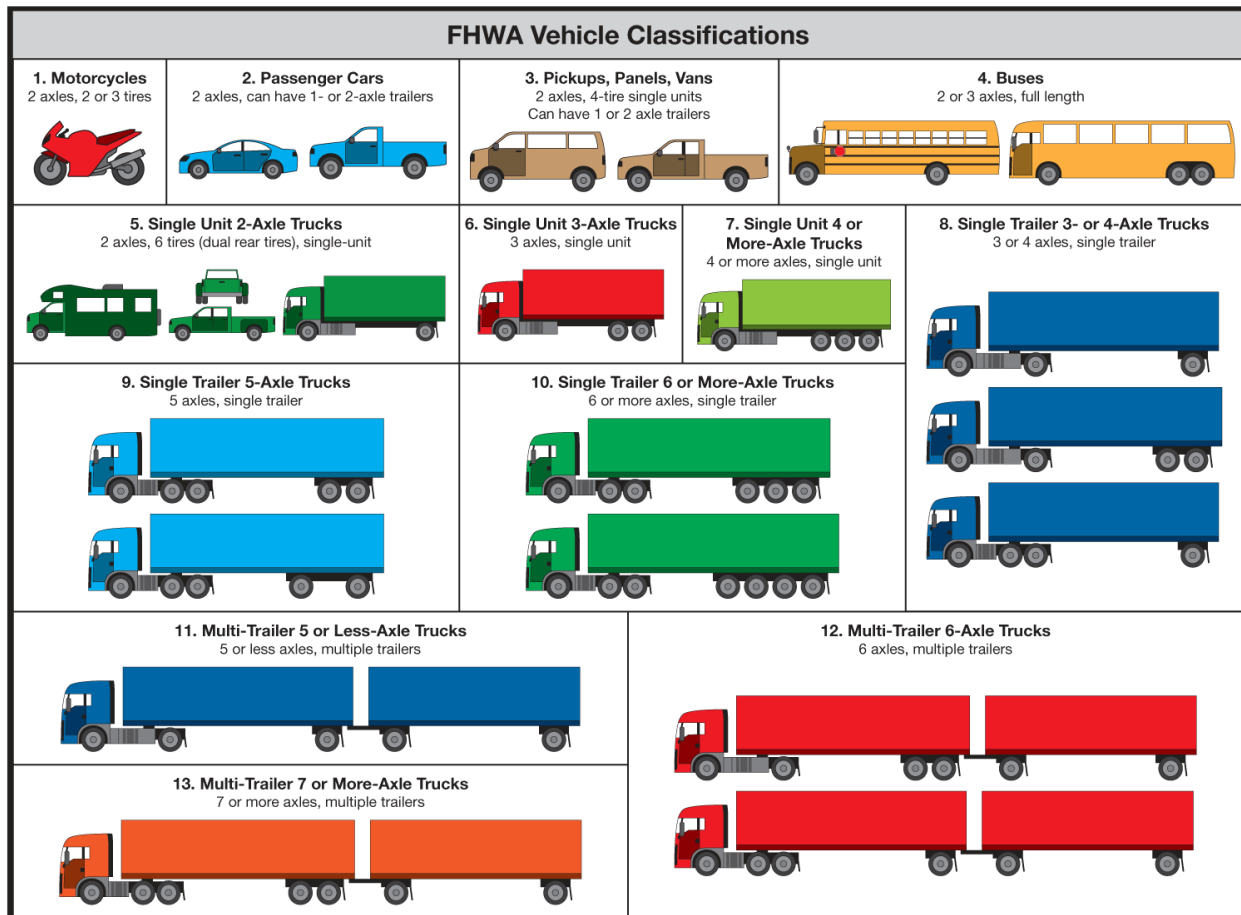


Figure 2-2 FHWA Vehicle Classification Scheme F

2.3.3 Short-Term Seasonal Classification Counts

FDOT has approximately 3,100 locations where short-term seasonal classification counts are performed. These Short-term Traffic Monitoring Sites (Short-term TMSs) are automatic traffic recorders that are temporarily placed at specific locations throughout the state to record the distribution and variation of traffic flow. Toll data is also collected to supplement volume counts. *Seasonal classification counts are used to develop axle correction factors and truck percentages*

during the year. These counts are performed one or more times a year (24-hour or 48-hour each) as deemed necessary to capture the seasonal truck variation. The classification counts will be used to estimate the axle correction factor and determine the percentage of trucks.

2.4 Short-Term Traffic Counts

Short-term traffic counts are primarily performed by the FDOT districts offices, local agencies and consultants. It is the responsibility of each district to determine the location of short-term non-continuous traffic monitoring sites. The exact location and count type should be determined by the physical geometry of the road. Each time a count is made, the technician will re-evaluate the site to determine if field conditions are still suitable for obtaining an accurate count. Factors that should be considered when selecting site locations include the presence of curves, crests, valleys, driveways, intersections, schools, number of lanes, medians, shoulders, or turn lanes.

Short-term counts are typically collected using portable axle counters and/or vehicle counters. Portable traffic counters frequently use rubber hoses that record by sensing the number of axles. These counters are small enough to be transported, contain a power source, and may be easily secured to a telephone pole, fence post, signpost, tree, etc. They may include time-period recording or cumulative counts. Some traffic volume counters with axle sensors record volumes on punched tape or printed paper tape. Newer units utilize electronic storage and require special software and/or hardware to download the collected data. The downloaded data can be transferred directly to a computer or may be printed in a report format. Another type of portable unit adheres to the road surface in the middle of a lane. The unit uses magnetic vehicle detectors rather than axle sensors and records bumper to bumper length and speed in a variety of length and speed groups. The unit requires a special computer to download the data. In recent years, Internet Protocol (IP) cameras have been used to record vehicles and specialized vehicle recognition software is used to identify and enumerate number of vehicles.

2.4.1 Portable Axle Counters

Axle volume counts are obtained when a single road tube is set across a road. The portable counters simply divide the number of axles (number of hits) by two to derive a count. This type of count is connected to the road tube and the device measures the “number of axles”, an axle correction factor (ACF) is assigned to the specific count location based on the trucking characteristics of that location. The ACF is applied to the count and then the count is seasonally adjusted to produce AADT.

2.4.2 Vehicle Volume Counters

Vehicle volume counts are obtained from counters using sensors such as inductive loops, microwave devices, and magnetic vehicle detectors. These counters detect an entire vehicle, not simply its axles. If the counting device counts the “number of vehicles”, the count is known as vehicle classification count. The count site will not require an axle correction factor.

2.5 Traffic Adjustment Factors

The two traffic adjustment factors, Seasonal and Axle Correction, are calculated by the TDA Office and can be accessed through either the Traffic Characteristics Inventory (TCI) database or the Florida Traffic Online (FTO) website (<https://tdaappsprod.dot.state.fl.us/fto/>). Both TCI and FTO contain current and historical information. Continuous counts and seasonal classification counts provide the necessary information to establish traffic adjustment factors. In the absence of any continuous counts within a county, TDA applies seasonal factors from adjacent counties and develops seasonal factors for those counties. These adjustment factors are later applied to the short-term counts to estimate AADT, K, D, and T factors. Actual AADT, K, D, and T data are collected from permanent, continuous counters. **Figure 2-3** shows the process of developing traffic adjustment factors and applying them to estimate AADT and other traffic parameters from short-term traffic counts.



IMPORTANT NOTE:

All short-term counts need to be adjusted using Seasonal Factors, but only short-term counts obtained from portable axle counters need to be adjusted using Axle Correction Factors.

2.5.1 Seasonal Factor (SF)

All short-term counts must be adjusted to reflect the seasonal changes in traffic volumes. The TDA Office determines the Seasonal Factor Category using traffic data collected from permanent count locations. The FDOT districts assign a Seasonal Factor Category to each short-term traffic count site. The basic assumption is that seasonal variability and traffic characteristics of short-term and permanent continuous counts are similar.

The Monthly Seasonal Factor (MSF) for a particular month at a particular location is derived from the Annual Average Daily Traffic (AADT) for a location divided by the Monthly Average Daily Traffic (MADT) for a specific month at that count site as shown in **Equation 2-1**.

$$MSF = \frac{AADT}{MADT}$$

Equation 2-1

Weekly Seasonal Factors (SF) are developed by interpolating between the monthly factors for two consecutive months as shown in **Equation 2-2**. The SFs are calculated for each week of the year for each continuous count station and recorded in a Peak Season Factor Report available on FTO website.

$$SF = MSF_i + \frac{MSF_{i+1} - MSF_i}{N} \times n$$

Equation 2-2

Where:

SF = Weekly Seasonal Factor

MSF_i = Monthly Seasonal Factor for a particular month i . The MSFs are assigned to the week of the year that contains the midpoint of the month

MSF_{i+1} = Monthly Seasonal Factor for the following month $i+1$

N = Number of weeks between the midpoint of month i and the midpoint of the following month $i+1$, usually 4

n = Number of weeks between the midpoint of the month i and the week for SF, usually between 1 and 4

2.5.2 Axle Correction Factor (ACF)

Axle Correction Factors (ACF) are developed from classification counts by dividing the total number of vehicles counted by the total number of axles on these vehicles. ACF are determined by using the data from continuous and short-term classification counts following the guidelines as described in the FHWA *Traffic Monitoring Guide*.

The information collected from Traffic Adjustment Data Sources is used to determine the traffic adjustment factors such as Axle Correction Factors, Percent Trucks, and Seasonal Volume Factors. These adjustment factors are applied to short-term traffic counts taken by portable axle and vehicle counters to estimate AADT, K, D, and T for every section break of the State Highway System as shown in **Figure 2-3**.

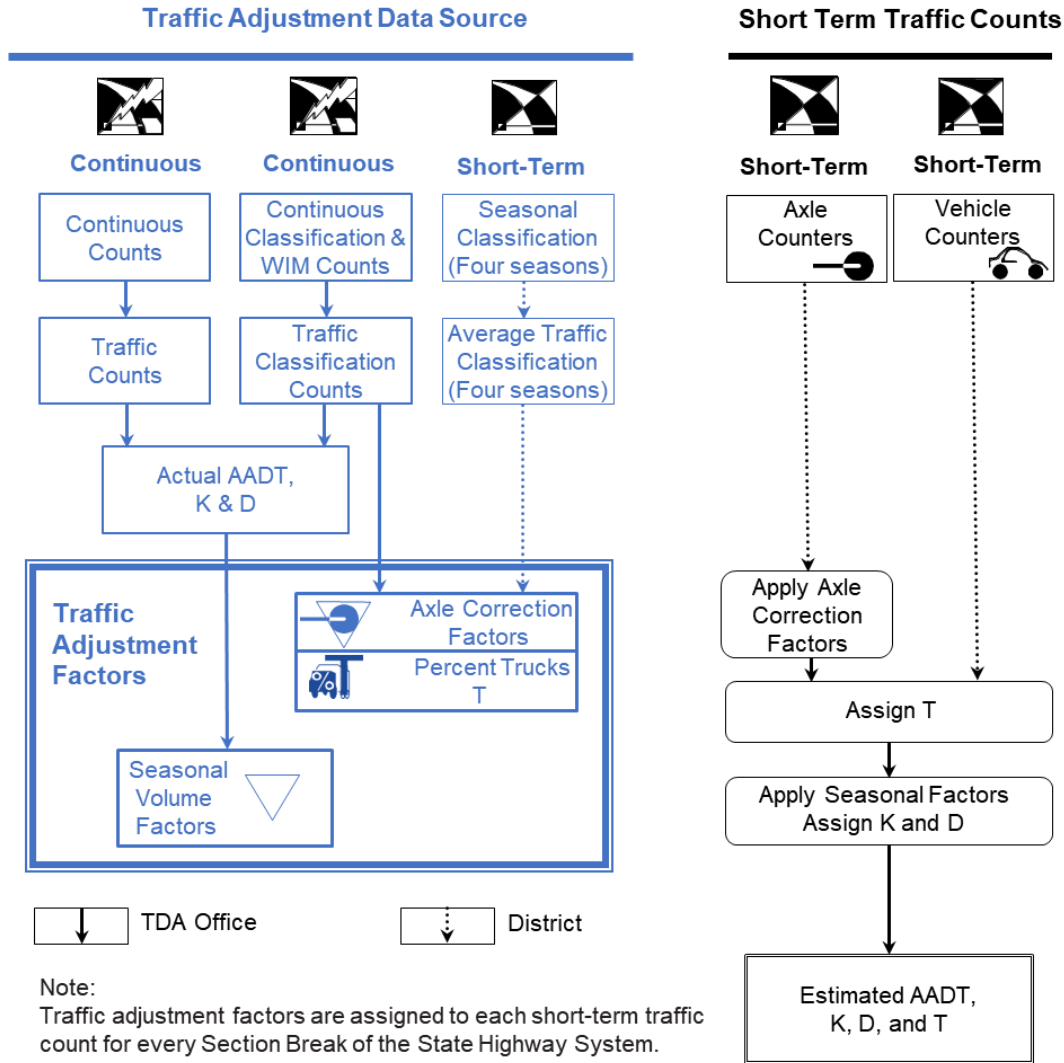


Figure 2-3 Development and Application of Traffic Adjustment Factors

2.6 AADT, K, D, and T

The AADT, the peak-to-daily ratio or the design hour factor (K), the directional distribution factor (D), and the percent trucks (T) are critical numbers that determine the geometric configuration of a roadway. In addition, the T factor is critical for determining the type and thickness of pavement during design.

The actual AADT and other traffic factors can only be measured through Continuous Traffic Monitoring Sites (Continuous TMSs) that collect data 365 days a year. In most cases, traffic parameters have to be estimated from short-term traffic counts. The information collected from Continuous TMS locations provides a statistical basis for estimating traffic parameters for the short-term traffic counts.

2.6.1 Annual Average Daily Traffic (AADT)

AADT

The **Annual Average Daily Traffic (AADT)** is the estimate of typical daily traffic on a road segment for all seven days of the week from Sunday to Saturday, over the period of one year. AADT is determined by dividing the total number of vehicles on a roadway segment for one year by the number of days (365 days, except Leap Year which has 366 days) in the year. The AADT is the best measure of the total use of a road, because it includes all traffic for an entire year.

Average Daily Traffic (ADT) is obtained by a short-term traffic count. Short-term traffic counts are commonly referred to as “raw counts” or simply “traffic count.” ADT is typically a 72-hour traffic counts collected on Tuesdays, Wednesdays, and Thursdays. However, ADT can be based on the simple average of any short-term traffic counts at least 24 hours long. The 24-hour and 48-hour traffic counts are often taken to measure ADT and converted to AADT for traffic forecasting projects. For traffic forecasts, the Seasonal Factor (SF) and Axle Correction Factor (ACF), where applicable, should be used to convert ADT to AADT as shown in **Equation 2-3**.

$$AADT = ADT \times SF \times ACF$$

Equation 2-3



IMPORTANT NOTE:

Axle Correction Factors (ACF) should only be applied to short-term counts obtained from portable axle counters, not vehicle classification counts.

When the ADT is adjusted by SF and ACF assigned to that site, it will provide a statistically accurate estimate of AADT at that location.

2.6.2 Standard K Factor

The K factor is defined as the proportion of AADT occurring in the peak hour. It is one of the most critical traffic factors in roadway planning and design. The K factor is often referred to as the **Design Hour Factor** as it relates to the proportion of the AADT during the design hour for the design year. The **Design Hour Volume (DHV)** is total traffic in both directions expected to occur during the design hour for the design year, and it is determined by multiplying the AADT by the K factor. **Equation 2-4** shows the relationship between AADT, DHV, and K:

$$DHV = AADT \times K$$

Equation 2-4

Based on comprehensive analyses and extensive public outreach, FDOT has established statewide “Standard K Factors” that should be applied to develop project traffic forecast from the planning phase through the design phase of the project. Standard K Factors are fixed K parameters predetermined based on area type and facility type with consideration to typical peak periods of the day. The Standard K Factors also reflect urban development patterns and economic activities. FDOT’s recommended standard K factors are presented in **Table 2-1**. The Standard K Factors are also reported in the [FDOT Traffic Information Online Web Application](#). Use of statewide Standard K Factors promotes better transportation policies and projects, reduces time and effort developing peak hour numbers, offers consistency and simplicity, and represents a sensible approach relating to development and transportation improvements.

IMPORTANT NOTE:



There is not a single Standard K Factor to be applied to every roadway in the state; however, there are multiple standard K factors depending upon the area type and facility type.

IMPORTANT NOTE:



Standard K Factors for planning and design analyses are not directly applicable to toll facilities.

Special considerations exist in urban and urbanized areas; both are addressed in the footnotes of **Table 2-1**. In the state’s largest urbanized areas, FDOT has designated “core” freeways. These are major, non-toll freeways going into/through the urbanized core areas (i.e., I-4 in the Orlando area). As these freeways pass through an urbanized area, the Standard K Factors generally range from 8.0% to 9.0%, depending upon proximity to the central core or central business district. Standard K Factors for these freeways are set and typically updated every ten years as part of the urban/urbanized area boundary process. A 7.5% K factor is applicable for state arterials and highways in approved Multimodal Transportation Districts (MMTD), where secondary priority is given to auto vehicle movements. This lower factor represents the promotion of a multi-hour peak period rather than a single peak hour analysis. The same K factor as the project roadway on the state highway system is applied to intersecting roadways that are non-state maintained unless other values are derived from special counts.

There are also cases where Standard K Factors may not directly apply. Examples include highway facilities in tourist areas or roadways providing access to cruise ports where heaviest traffic may occur on the weekend and peak-to-daily ratios are higher than the Standard K Factors. In such cases, short-term traffic counts that include both weekdays and weekends should be collected. K Factors should be developed by analyzing the short-term traffic counts and relevant

traffic information from Florida Traffic Information Online, if available. The project team should present the analysis results and recommendations to FDOT Central Office for approval.

Table 2-1 FDOT Standard K Factors

Area (Population)	Facility Type	Standard K Factor (% AADT)*	Representative Time Period
Large Urbanized Areas with Core Freeways (1,000,000+)	Freeways	8.0 - 9.0 ***	Typical weekday peak period or hour
	Arterials & Highways	9.0 **	Typical weekday peak hour
Other Urbanized Areas (50,000+)	Freeways	9.0 **	Typical weekday peak hour
	Arterials & Highways		
Transitioning to Urbanized Areas (Uncertain)	Freeways	9.0	Typical weekday peak hour
	Arterials & Highways		
Urban (5,000-50,000)	Freeways	10.5	100th highest hour of the year
	Arterials & Highways	9.0**	Typical weekday peak hour
Rural (<5,000)	Freeways	10.5	100th highest hour of the year
	Arterials	9.5**	
	Highways	9.5	

* Some smoothing of values at area boundaries/edges would be desirable.

** Value is 7.5% in approved Multimodal Transportation Districts where automobile movements are deemphasized. This lower value represents an extensive multi-hour peak period rather than a peak hour.

*** Value is 8.0% for FDOT-designated urbanized core freeways and may either be 8.5% or 9.0% for non-core freeways. Values less than 9% essentially represent a multi-hour peak period rather than a peak hour.

IMPORTANT NOTE:



FDOT has adopted a Context Classification System comprising eight context classifications in its efforts to plan, design, construct, and operate a context-sensitive system of Complete Streets. The context classification of a roadway, together with its transportation characteristics, will provide information about the users along the roadway, the regional and local travel demand of the roadway, and the challenges and opportunities of each user. The context classification of a roadway should be considered when selecting a Standard K Factor for the project.

2.6.3 D Factor

2.6.3.1 Directional Distribution

The Directional Distribution (D) is the percentage of the total, two-way design hour traffic traveling in the peak direction. In addition to traffic information such as AADT and K Factor, D is an essential parameter used to determine the Directional Design Hour Volume (DDHV). The DDHV is the basis of geometric design. A highway with a high percentage of traffic in one direction during the design hour may require more lanes than a highway having the same AADT but with a lower percentage. DDHV is determined by multiplying the Design Hour Volume (DHV) with the Directional Distribution Factor (D), as shown in **Equation 2-5**:

$$DDHV = DHV \times D$$

Equation 2-5

Directional distribution is an important factor in highway capacity analysis. This is particularly true for two-lane rural highways. Capacity and LOS vary substantially based on directional distribution because of the interactive nature of directional flows on such facilities. Queuing, delays, land use impact and capacity are some of the factors that affect the directional distribution.

Although there is no explicit consideration of directional distribution in the analysis of multilane facilities, the directional distribution has a significant impact on both design and the calculation of the LOS of a facility. For example, urban commuting routes have been observed to have up to two-thirds of their peak hour traffic in a single direction. The peaking occurs in one direction in the morning and in the opposite direction in the evening. The facilities need to provide sufficient capacities to accommodate the peak flows for both directions. This phenomenon has led to the use of reversible lanes on some urban freeways and arterials.

The FDOT TDA Office is responsible for calculating and estimating D factors at continuous and short-term traffic monitoring sites. For continuous sites, the D factor is the median D factor of the 200 highest hours. For short-term sites, a D factor is assigned based on either the Seasonal Factor Category or Districtwide Functional Classification Category that the site belongs to ([FDOT Traffic Monitoring Handbook](#)). The D factors are reported in the [Florida Traffic Online \(FTO\) Web Application](#). **Figure 2-4** shows an example of traffic information available at Continuous TMS 360317, located on I-75 in Marion County. It includes detailed information about the site, AADT, K, D, and T factors. A number of Traffic Reports are also available for the site, including Annual Average Daily Traffic, Annual Vehicle Classification, Directional AADTs, Highest 200 Hours, Historical AADT Data, Hourly Continuous Counts, and Vehicle Class History.

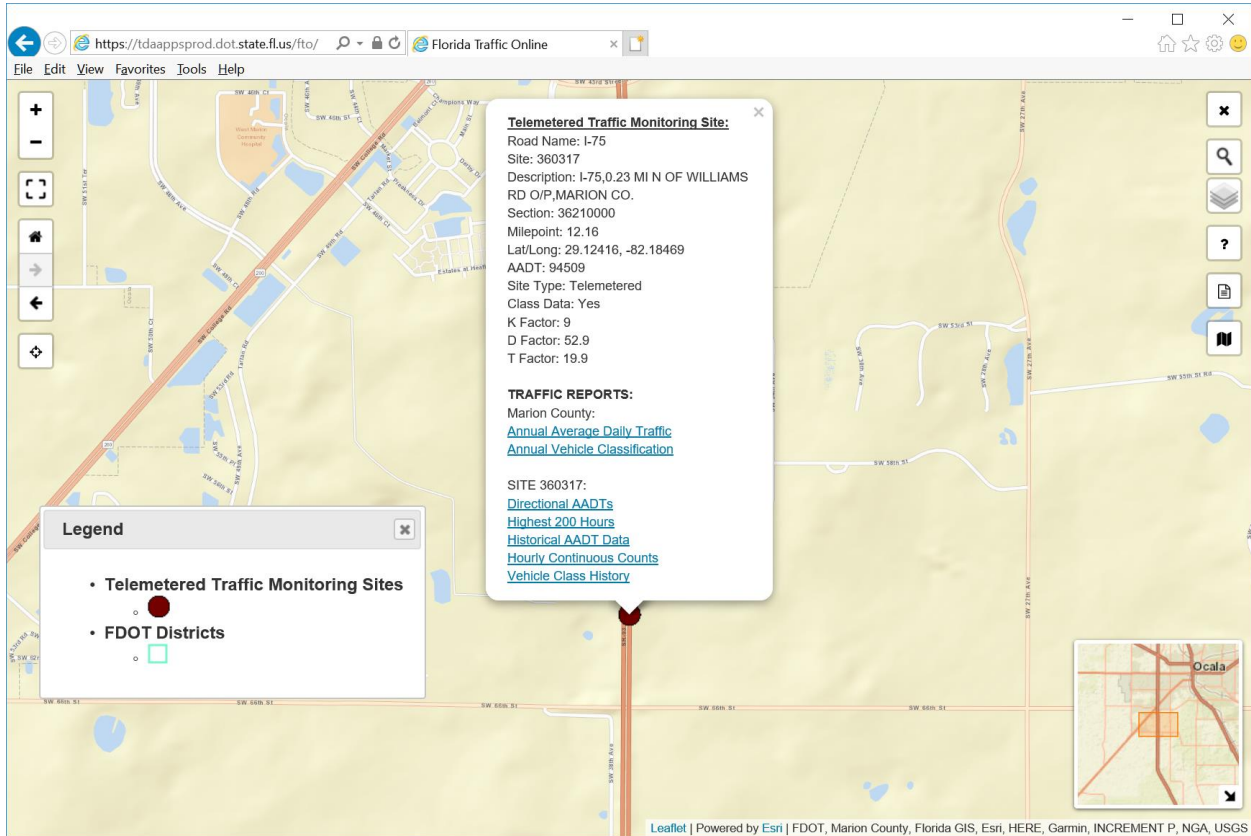


Figure 2-4 Florida Traffic Online Application: Continuous TMS 360317

2.6.3.2 Acceptable D Values

The D-Factors for continuous and short-term sites can be obtained from the [Florida Traffic Online \(FTO\) Web Application](#). The D values are also available from FDOT’s RCI and TCI databases. If traffic counts for the project site are not available, obtain short-term traffic counts to determine hourly traffic volume distribution. This will allow the identification of the peak hour of the day and peak direction during the peak hour. If no counts are available, the intersecting roadways that are non-state maintained will use the same D-Factor as the project roadway on the state highway system. The D-Factors should be checked to see if they are within the allowable range. The recommended D-Factors are shown in **Table 2-2**.

Table 2-2 Recommended D-Factors for Project Traffic Forecasting

Road Type	Low	D	High	Standard Deviation
Rural Freeway	52.3	54.8	57.3	1.73
Rural Arterial	51.1	58.1	79.6	6.29
Urban Freeway	50.4	55.8	61.2	4.11
Urban Arterial	50.8	57.9	67.1	4.60

Note: In some special cases, the D-Factor for urban freeways may be higher, e.g., Veterans Expressway.

2.6.3.3 Percent Trucks (T)

% Trucks

The most critical factor in pavement design is the amount of truck traffic using a roadway. The structural design is primarily dependent upon the heavy axle loads generated by commercial trucks. The estimated future truck volume is needed for calculating the 18-KIP ESALs for pavement design.

There are ten (10) classes of trucks, including buses, according to the current FHWA vehicle classification scheme (see **Figure 2-2**). Truck data are used in many different applications. As a result, various definitions of truck percentages exist (i.e., T_f , T24, 24T+B, 24T, DHT, DH2, and DH3) and they are all calculated as percentages of trucks in total traffic. Detailed definitions for these truck factors can be found in **Appendix C – Glossary**.

The traffic forecasting “T” is the same as T24 or 24T+B. It includes trucks and buses from Class 4 to Class 13. The truck volume and AADT are related to each other by a ratio commonly known as “T”. The Daily Truck Volume (DTV) is the total number of trucks traversing a roadway segment during a 24-hour period. It can be derived by multiplying AADT by T as shown in **Equation 2-6**.

$$DTV = AADT \times T$$

Equation 2-6

For traffic forecasting purposes, the Design Hour Truck (DHT) is defined as T divided by two, based on the assumption that only half as many trucks travel on the roadway during the peak hour. The DHT is determined by the **Equation 2-7**.

$$DHT = \frac{T}{2}$$

Equation 2-7

The truck percentage is usually assumed to be constant over time.

2.7 Existing Traffic Condition Information

Existing traffic condition information includes traffic data that describes the current travel demand for existing roadway facilities, such as daily traffic volumes, peak hour volumes, directional distribution during peak hours, and percent trucks. The existing traffic information is obtained by conducting short-term traffic counts. To ensure the data is representative of average (typical) traffic conditions, traffic counts should not be collected during the summer or on holidays, since travel patterns during these times cannot be assumed to be representative of typical weekdays. However, for studies near recreational facilities summer or holidays may provide the traffic analyst with more accurate “typical” pattern of travel.

2.7.1 Seasonal Adjustments

Data for existing roadways are collected at established traffic monitoring sites within the project’s limit. A classification count should be taken at the established traffic monitoring site in each of the current traffic breaks included in the project’s limits. When the traffic monitoring site for a traffic break is located outside the project’s limits, the data may still be collected at the established site. As an alternative, the traffic break can be subdivided at the project boundary and a new traffic monitoring site established within the project’s limits. Subdivision of a traffic break must be approved in advance by the TDA and the district.

Directions on conducting classification counts are provided in the [Traffic Monitoring Handbook](#). Traffic counts cannot be accepted without seasonal adjustments. These adjustments are applied as described in **Section 2.5** (Traffic Adjustment Factors). Acceptable data should be uploaded to the Traffic Characteristics Inventory (TCI) for use in making the annual AADT estimate and for later use in making the project traffic forecast. Only those classification counts made during the last 12 months should be used as base year traffic data. Surveys made by individuals other than FDOT personnel should follow FDOT’s procedures.

2.7.2 D Factors

FDOT requires the use of two different directional distribution factors: capacity analysis (D) and pavement design (D_F). The D described in traffic monitoring site reports are the ones used for capacity analysis.

A roadway near the center of an urban area often has traffic volumes equal for both directions, and therefore a D Factor near 50 percent. A rural arterial may exhibit a significantly higher D Factor because traffic is either traveling toward an urban area (AM) or traveling away from an urban area (PM).

The D factor used for pavement design (D_F) is typically 50 percent for two-way roadways. It is assumed that an equal amount of loaded trucks operates in both directions of traffic flow. For a one-way roadway, the D_F is 100 percent since all the trucks are moving in the same direction.

The project traffic forecaster may elect to change the D_F upwards from 50 percent if there is a good reason for doing so (e.g., unequal number of lanes for the two directions). Base year directional bias in pavement loading will be used to determine the ESAL forecast D_F . Whether a different directional bias exists for loaded trucks can be found by visually monitoring the traffic using the road to identify any repeating traffic and seeking the origin or destination of the traffic. For example: a concrete delivery truck traffic whose origin is a concrete mixing plant down the road, or a railroad siding serving as a destination for pulpwood trucks. In both cases, the D_F used for ESAL forecasting and subsequent pavement damage will be between 50 and 100 percent. (See **Section 7.4.2.**)

2.7.3 Roadway Data

Existing number of lanes (a.k.a., Feature 212) and functional classification (a.k.a., Feature 121) of roadways can be found in the [Roadway Characteristics Inventory \(RCI\)](#) for the Roadway ID and Mile Post of the roadway under design.

2.8 Level of Service (LOS) Analysis

The Level of Service (LOS) analysis should be performed in accordance with the most recent versions of the FDOT Quality/Level of Service Handbook and Highway Capacity Manual methodology. LOS analysis is not performed for Express Lanes projects.

2.9 Number of Lanes Required

Project traffic forecasts should be used to determine how many lanes a roadway may require. The required number of lanes can be estimated using the best available current year data and projecting future values of DDHV, Service Flow (SF) rate, and Peak Hour Factor (PHF).

2.10 Estimation of AADT From Short-Term Traffic Counts

The AADT, K, D, and T for the current year are available in RCI database under Feature 331 (Traffic Flow Breaks). The information is updated annually and the most current version of the traffic information should always be used for project traffic forecasting.

To estimate AADTs along state roadways where no Continuous- or Short-term sites are available, or roadways not on the state system, a field data collection of short-term traffic counts must be conducted using either portable axle counters or portable vehicle counters. Appropriate SF and/or ACF should be applied to adjust the short-term ADT to obtain AADT using **Equation 2-3**.

2.10.1 Seasonal Factor Category Report

Seasonal Factors (SF) are provided in the Peak Season Factor Category Reports that can be generated and downloaded from the Florida Traffic Online Web Application. Seasonal Factor Categories are groupings of continuous stations whose data are used to develop the seasonal

factors. Seasonal factor categories are designed to be county specific with at least one “Countywide” Seasonal Factor Category for each County and one Seasonal Factor Category for each Interstate Road within each County. Additional Seasonal Factor Categories are developed to handle geographic differences within a single county (e.g., beach traffic vs. urban traffic). Seasonal categories are represented by a 4-digit number, where the first two digits correspond to the county codes, and the second two digits are a sequence number or an interstate number. It contains a verbal description of its intended use, and a maximum of eight continuous count station numbers. Details of Seasonal Factor Categories are included in the Volume Factor Category Summary Report.

Figure 2-5 shows the volume factor categories for Hillsborough County (County Code 10). There are four (4) seasonal factor categories for Hillsborough County, one for Hillsborough Countywide represented by Code 1000, and the other three for the three interstate highways in Hillsborough County, I-4, I-275, and I-75, represented by 1004, 1027, and 1075, respectively. The Volume Factor Category Report also contains information on K and D factors. Only Category 1000 and Category 1004 reports are shown in **Figure 2-5**.

The weekly seasonal adjustment factors are presented in the Peak Season Factor Category Reports by category and by week. There can be 52 to 54 weekly factors, depending upon which day-of-week January 1 falls.

If the Seasonal Factor (SF) is greater than 1, then the raw counts were collected during low traffic volumes and must be adjusted upward to reach the annual average.

If the SF is less than 1, then the raw counts were collected during high traffic volumes and must be adjusted downward to reach the annual average. **Figure 2-6** shows the Peak Season Factor Category Report for Hillsborough Countywide Category 1000.

Chapter 2 – Traffic Data Sources and Factors

2017 VOLUME FACTOR CATEGORY SUMMARY REPORT - REPORT TYPE: ALL

CATEGORY: 1000 - HILLSBOROUGH COUNTYWIDE

COSITE DIR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	SUN	MON	TUE	WED	THU	FRI	SAT	STD "K"	MEDIAN "D"	AADT
100080 E	0.97	0.89	0.88	0.98	1.03	1.08	1.09	1.02	1.08	0.99	1.03	1.02	1.35	0.99	0.96	0.95	0.94	0.86	1.08			
100080 W	0.96	0.89	0.87	0.99	1.05	1.09	1.08	1.02	1.08	1.00	1.02	1.00	1.29	1.00	0.96	0.95	0.95	0.90	1.04			
100080 B	0.97	0.89	0.88	0.99	1.04	1.09	1.09	1.02	1.08	1.00	1.03	1.01	1.32	1.00	0.96	0.95	0.95	0.88	1.06	9.0	56.0	13301
100106 E	1.02	0.98	0.94	0.96	0.97	1.02	1.00	1.02	1.14	0.98	1.00	1.00	1.11	1.04	1.02	1.00	0.97	0.92	0.96			
100106 W	1.02	0.98	0.93	0.97	0.98	1.01	1.00	1.03	1.14	0.98	1.00	0.99	1.10	1.04	1.03	1.00	0.97	0.90	0.98			
100106 B	1.02	0.98	0.94	0.97	0.98	1.02	1.00	1.03	1.14	0.98	1.00	1.00	1.11	1.04	1.03	1.00	0.97	0.91	0.97	9.0	51.0	140975
100162 E	0.99	0.95	0.95	0.91	0.98	0.98	1.01	0.99	1.16	0.99	1.06	1.08	1.55	0.97	0.91	0.90	0.89	0.87	1.20			
100162 W	1.02	0.97	0.97	0.91	0.99	0.99	0.97	0.96	1.12	0.99	1.07	1.09	1.72	0.96	0.90	0.88	0.88	0.85	1.24			
100162 B	1.01	0.96	0.96	0.91	0.99	0.99	0.99	0.98	1.14	0.99	1.07	1.09	1.64	0.97	0.91	0.89	0.89	0.86	1.22	9.0	55.5	28599
100276 E	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			
100276 W	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			
100276 B	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	9.5	0.0	7308
100321 E	1.03	0.95	0.94	0.95	1.02	1.05	1.06	0.99	1.06	0.92	1.00	1.05	1.38	1.00	0.94	0.92	0.92	0.88	1.09			
100321 W	1.02	0.96	0.95	0.96	1.02	1.05	1.05	0.99	1.05	0.93	1.00	1.04	1.41	1.00	0.94	0.92	0.92	0.88	1.09			
100321 B	1.03	0.96	0.95	0.96	1.02	1.05	1.06	0.99	1.06	0.93	1.00	1.05	1.40	1.00	0.94	0.92	0.92	0.88	1.09	9.0	59.8	54010
100372 E	1.03	0.98	0.96	0.96	0.98	1.00	1.03	0.99	1.10	0.96	1.01	1.02	1.52	0.96	0.91	0.90	0.89	0.89	1.19			
100372 W	1.02	0.98	0.96	0.96	0.98	1.01	1.03	0.99	1.08	0.97	1.01	1.03	1.44	0.97	0.93	0.91	0.91	0.89	1.13			
100372 B	1.03	0.98	0.96	0.96	0.98	1.01	1.03	0.99	1.09	0.97	1.01	1.03	1.48	0.97	0.92	0.91	0.90	0.89	1.16	9.0	62.9	61274
100373 N	1.03	0.98	0.98	0.98	1.01	1.03	1.04	0.98	1.08	0.94	0.97	0.99	1.93	0.94	0.87	0.85	0.85	0.84	1.35			
100373 S	1.05	0.99	0.98	0.96	1.00	1.01	1.03	0.97	1.11	0.95	0.97	1.00	1.83	0.94	0.87	0.85	0.86	0.86	1.36			
100373 B	1.04	0.99	0.98	0.97	1.01	1.02	1.04	0.98	1.10	0.95	0.97	1.00	1.88	0.94	0.87	0.85	0.86	0.85	1.36	9.0	72.4	30711

CATEGORY:	1.02	0.96	0.95	0.96	1.00	1.03	1.04	1.00	1.10	0.97	1.01	1.03	1.47	0.99	0.94	0.92	0.92	0.88	1.14	9.1	59.6	

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2017 VOLUME FACTOR CATEGORY SUMMARY REPORT - REPORT TYPE: ALL

CATEGORY: 1004 - HILLSBOROUGH I4

COSITE DIR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	SUN	MON	TUE	WED	THU	FRI	SAT	STD "K"	MEDIAN "D"	AADT
100080 E	0.97	0.89	0.88	0.98	1.03	1.08	1.09	1.02	1.08	0.99	1.03	1.02	1.35	0.99	0.96	0.95	0.94	0.86	1.08			
100080 W	0.96	0.89	0.87	0.99	1.05	1.09	1.08	1.02	1.08	1.00	1.02	1.00	1.29	1.00	0.96	0.95	0.95	0.90	1.04			
100080 B	0.97	0.89	0.88	0.99	1.04	1.09	1.09	1.02	1.08	1.00	1.03	1.01	1.32	1.00	0.96	0.95	0.95	0.88	1.06	9.0	56.0	13301
100106 E	1.02	0.98	0.94	0.96	0.97	1.02	1.00	1.02	1.14	0.98	1.00	1.00	1.11	1.04	1.02	1.00	0.97	0.92	0.96			
100106 W	1.02	0.98	0.93	0.97	0.98	1.01	1.00	1.03	1.14	0.98	1.00	0.99	1.10	1.04	1.03	1.00	0.97	0.90	0.98			
100106 B	1.02	0.98	0.94	0.97	0.98	1.02	1.00	1.03	1.14	0.98	1.00	1.00	1.11	1.04	1.03	1.00	0.97	0.91	0.97	9.0	51.0	140975

CATEGORY:	1.00	0.94	0.91	0.98	1.01	1.06	1.05	1.03	1.11	0.99	1.02	1.01	1.22	1.02	1.00	0.98	0.96	0.90	1.02	9.0	53.5	

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Figure 2-5 Seasonal Factor Categories for Hillsborough County

2017 PEAK SEASON FACTOR CATEGORY REPORT - REPORT TYPE: ALL
 CATEGORY: 1000 HILLSBOROUGH COUNTYWIDE

WEEK	DATES	SF	MOCF: 0.96 PSCF
1	01/01/2017 - 01/07/2017	1.03	1.07
2	01/08/2017 - 01/14/2017	1.02	1.06
3	01/15/2017 - 01/21/2017	1.02	1.06
4	01/22/2017 - 01/28/2017	1.00	1.04
5	01/29/2017 - 02/04/2017	0.99	1.03
* 6	02/05/2017 - 02/11/2017	0.97	1.01
* 7	02/12/2017 - 02/18/2017	0.96	1.00
* 8	02/19/2017 - 02/25/2017	0.96	1.00
* 9	02/26/2017 - 03/04/2017	0.95	0.99
*10	03/05/2017 - 03/11/2017	0.95	0.99
*11	03/12/2017 - 03/18/2017	0.95	0.99
*12	03/19/2017 - 03/25/2017	0.95	0.99
*13	03/26/2017 - 04/01/2017	0.95	0.99
*14	04/02/2017 - 04/08/2017	0.96	1.00
*15	04/09/2017 - 04/15/2017	0.96	1.00
*16	04/16/2017 - 04/22/2017	0.97	1.01
*17	04/23/2017 - 04/29/2017	0.98	1.02
*18	04/30/2017 - 05/06/2017	0.99	1.03
19	05/07/2017 - 05/13/2017	0.99	1.03
20	05/14/2017 - 05/20/2017	1.00	1.04
21	05/21/2017 - 05/27/2017	1.01	1.05
22	05/28/2017 - 06/03/2017	1.02	1.06
23	06/04/2017 - 06/10/2017	1.02	1.06
24	06/11/2017 - 06/17/2017	1.03	1.07
25	06/18/2017 - 06/24/2017	1.03	1.07
26	06/25/2017 - 07/01/2017	1.03	1.07
27	07/02/2017 - 07/08/2017	1.03	1.07
28	07/09/2017 - 07/15/2017	1.04	1.08
29	07/16/2017 - 07/22/2017	1.03	1.07
30	07/23/2017 - 07/29/2017	1.02	1.06
31	07/30/2017 - 08/05/2017	1.01	1.05
32	08/06/2017 - 08/12/2017	1.01	1.05
33	08/13/2017 - 08/19/2017	1.00	1.04
34	08/20/2017 - 08/26/2017	1.02	1.06
35	08/27/2017 - 09/02/2017	1.05	1.09
36	09/03/2017 - 09/09/2017	1.08	1.13
37	09/10/2017 - 09/16/2017	1.10	1.15
38	09/17/2017 - 09/23/2017	1.08	1.13
39	09/24/2017 - 09/30/2017	1.05	1.09
40	10/01/2017 - 10/07/2017	1.02	1.06
41	10/08/2017 - 10/14/2017	1.00	1.04
42	10/15/2017 - 10/21/2017	0.97	1.01
43	10/22/2017 - 10/28/2017	0.98	1.02
44	10/29/2017 - 11/04/2017	0.99	1.03
45	11/05/2017 - 11/11/2017	1.00	1.04
46	11/12/2017 - 11/18/2017	1.01	1.05
47	11/19/2017 - 11/25/2017	1.02	1.06
48	11/26/2017 - 12/02/2017	1.02	1.06
49	12/03/2017 - 12/09/2017	1.03	1.07
50	12/10/2017 - 12/16/2017	1.03	1.07
51	12/17/2017 - 12/23/2017	1.03	1.07
52	12/24/2017 - 12/30/2017	1.02	1.06
53	12/31/2017 - 12/31/2017	1.02	1.06

* PEAK SEASON

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Figure 2-6 Peak Season Factor Category Report for Hillsborough Countywide

2.10.2 Axle Factor Category Report

Axle Factor Categories are groupings of vehicle classification stations whose data are used to develop the Axle Correction Factors. The Axle Factor Categories are county specific denoted by 4-digit numbers with the first two digits representing the county codes, and the second two digits a sequence number. The Axle Factor Category Reports are facility specific and contain one or more groups. Care should be taken when selecting the Axle Correction Factors to ensure factors from correct categories are used. **Figure 2-7** shows an example of Axle Correction Factors for Hillsborough County for 2017.

The Axle Correction Factors are also reported by category and by week. There could be 52 to 54 weekly factors depending upon which day-of-week January 1st falls. *All axle adjustment factors are less than or equal to 1. The axle adjustment factors are multiplied by the raw counts to lower axle counts into vehicle count estimates.*

2017 WEEKLY AXLE FACTOR CATEGORY REPORT - REPORT TYPE: ALL						
COUNTY: 10 - HILLSBOROUGH						
WEEK	DATES	1000 HILLSBOROUGH - COUNTY WID	1001 HILLSBOROUGH RURAL	1002 HILLSBOROUGH URBAN	1003 I75, MANATEE- US301	
1	01/01/2017 - 01/07/2017	0.96	0.83	0.96	0.92	
2	01/08/2017 - 01/14/2017	0.96	0.83	0.96	0.92	
3	01/15/2017 - 01/21/2017	0.96	0.82	0.96	0.92	
4	01/22/2017 - 01/28/2017	0.96	0.82	0.96	0.92	
5	01/29/2017 - 02/04/2017	0.96	0.83	0.96	0.93	
6	02/05/2017 - 02/11/2017	0.96	0.83	0.96	0.93	
7	02/12/2017 - 02/18/2017	0.96	0.83	0.96	0.93	
8	02/19/2017 - 02/25/2017	0.96	0.83	0.96	0.93	
9	02/26/2017 - 03/04/2017	0.96	0.84	0.96	0.93	
10	03/05/2017 - 03/11/2017	0.96	0.84	0.96	0.92	
11	03/12/2017 - 03/18/2017	0.96	0.84	0.96	0.92	
12	03/19/2017 - 03/25/2017	0.96	0.84	0.96	0.92	
13	03/26/2017 - 04/01/2017	0.96	0.84	0.96	0.93	
14	04/02/2017 - 04/08/2017	0.96	0.83	0.96	0.93	
15	04/09/2017 - 04/15/2017	0.96	0.83	0.96	0.93	
16	04/16/2017 - 04/22/2017	0.96	0.83	0.96	0.93	
17	04/23/2017 - 04/29/2017	0.96	0.83	0.96	0.93	
18	04/30/2017 - 05/06/2017	0.95	0.82	0.96	0.92	
19	05/07/2017 - 05/13/2017	0.95	0.82	0.96	0.92	
20	05/14/2017 - 05/20/2017	0.95	0.82	0.96	0.92	
21	05/21/2017 - 05/27/2017	0.95	0.82	0.96	0.92	
22	05/28/2017 - 06/03/2017	0.95	0.83	0.96	0.93	
23	06/04/2017 - 06/10/2017	0.95	0.83	0.96	0.93	
24	06/11/2017 - 06/17/2017	0.95	0.83	0.96	0.93	
25	06/18/2017 - 06/24/2017	0.95	0.84	0.96	0.93	
26	06/25/2017 - 07/01/2017	0.95	0.84	0.96	0.93	
27	07/02/2017 - 07/08/2017	0.95	0.85	0.96	0.93	
28	07/09/2017 - 07/15/2017	0.95	0.85	0.96	0.93	
29	07/16/2017 - 07/22/2017	0.95	0.85	0.96	0.93	
30	07/23/2017 - 07/29/2017	0.95	0.85	0.96	0.93	
31	07/30/2017 - 08/05/2017	0.95	0.84	0.96	0.93	
32	08/06/2017 - 08/12/2017	0.95	0.84	0.96	0.93	
33	08/13/2017 - 08/19/2017	0.95	0.84	0.96	0.93	
34	08/20/2017 - 08/26/2017	0.95	0.85	0.96	0.93	
35	08/27/2017 - 09/02/2017	0.96	0.86	0.96	0.93	
36	09/03/2017 - 09/09/2017	0.96	0.86	0.96	0.93	
37	09/10/2017 - 09/16/2017	0.96	0.87	0.96	0.93	
38	09/17/2017 - 09/23/2017	0.96	0.86	0.96	0.93	
39	09/24/2017 - 09/30/2017	0.96	0.86	0.96	0.93	
40	10/01/2017 - 10/07/2017	0.96	0.85	0.96	0.92	
41	10/08/2017 - 10/14/2017	0.96	0.85	0.96	0.92	
42	10/15/2017 - 10/21/2017	0.96	0.84	0.96	0.92	
43	10/22/2017 - 10/28/2017	0.96	0.84	0.96	0.92	
44	10/29/2017 - 11/04/2017	0.96	0.84	0.96	0.92	
45	11/05/2017 - 11/11/2017	0.96	0.83	0.96	0.92	
46	11/12/2017 - 11/18/2017	0.96	0.83	0.96	0.92	
47	11/19/2017 - 11/25/2017	0.96	0.83	0.96	0.92	
48	11/26/2017 - 12/02/2017	0.96	0.83	0.96	0.92	
49	12/03/2017 - 12/09/2017	0.96	0.83	0.96	0.92	
50	12/10/2017 - 12/16/2017	0.96	0.83	0.96	0.92	
51	12/17/2017 - 12/23/2017	0.96	0.83	0.96	0.92	
52	12/24/2017 - 12/30/2017	0.96	0.82	0.96	0.92	
53	12/31/2017 - 12/31/2017	0.96	0.82	0.96	0.92	

Figure 2-7 Axle Correction Factors for Hillsborough County

2.10.3 Example of Estimating AADT from Short-Term Traffic Counts

The following example shows the steps to be performed to estimate AADT from a short-term traffic counts conducted along a highway section. In this example, three-day 72-hour traffic counts were taken by portable axle counters on Lantana Road approximately 550 feet east of High Ridge Road from Tuesday, 9/26/2017 to Thursday, 9/28/2017 in Palm Beach County.

IMPORTANT NOTE:

Short-term traffic counts should be reviewed for reasonableness and consistency before applying adjustment factors to estimate the AADT. Follow the tips below to check the short-term counts:



- *Check consistency in daily counts if counts are taken for multiple days. Discard the bad daily counts. Recount if necessary.*
- *Check differences between daily counts and historical counts from FTO if available.*
- *Check daily counts vs turning movement counts (TMC) during the same hour or 15 minutes interval if the TMCs are taken on the same day.*
- *Check differences between directional hourly volumes and departure/approach volumes from the turning movement counts at adjacent intersections.*

Step 1 Review Traffic Counts for Consistency and Reasonableness

Figure 2-8 shows the 3-day short-term traffic counts collected on Lantana Road. The directional counts and the total daily counts collected for the three weekdays are consistent. Hourly volumes for the three days also show a similar pattern. Therefore, traffic counts from all three days will be used to calculate the ADT.

$$ADT = \frac{52845 + 51772 + 51243}{3} = 51953$$

Step 2 Assign a Seasonal Factor from the Peak Season Factor Category Report

There are four volume factor categories for Palm Beach County, three for the different geographic areas of the county, and one for I-95:

- Category: 9300 EAST- A1A TO US1
- Category: 9301 CEN.-W OF US1 TO SR7
- Category: 9327 WEST-W OF SR7
- Category: 9395 PALM BEACH I95

Chapter 2 – Traffic Data Sources and Factors

The short-term traffic counts were collected in Central Palm Beach between West of US 1 and SR 7, an area covered by Category 9301. Therefore, the seasonal factor from Category 9301 corresponding to the week of 09/24/2017 - 09/30/2017 was assigned to this location and the value of SF is **1.09**. (See **Figure 2-9**.)

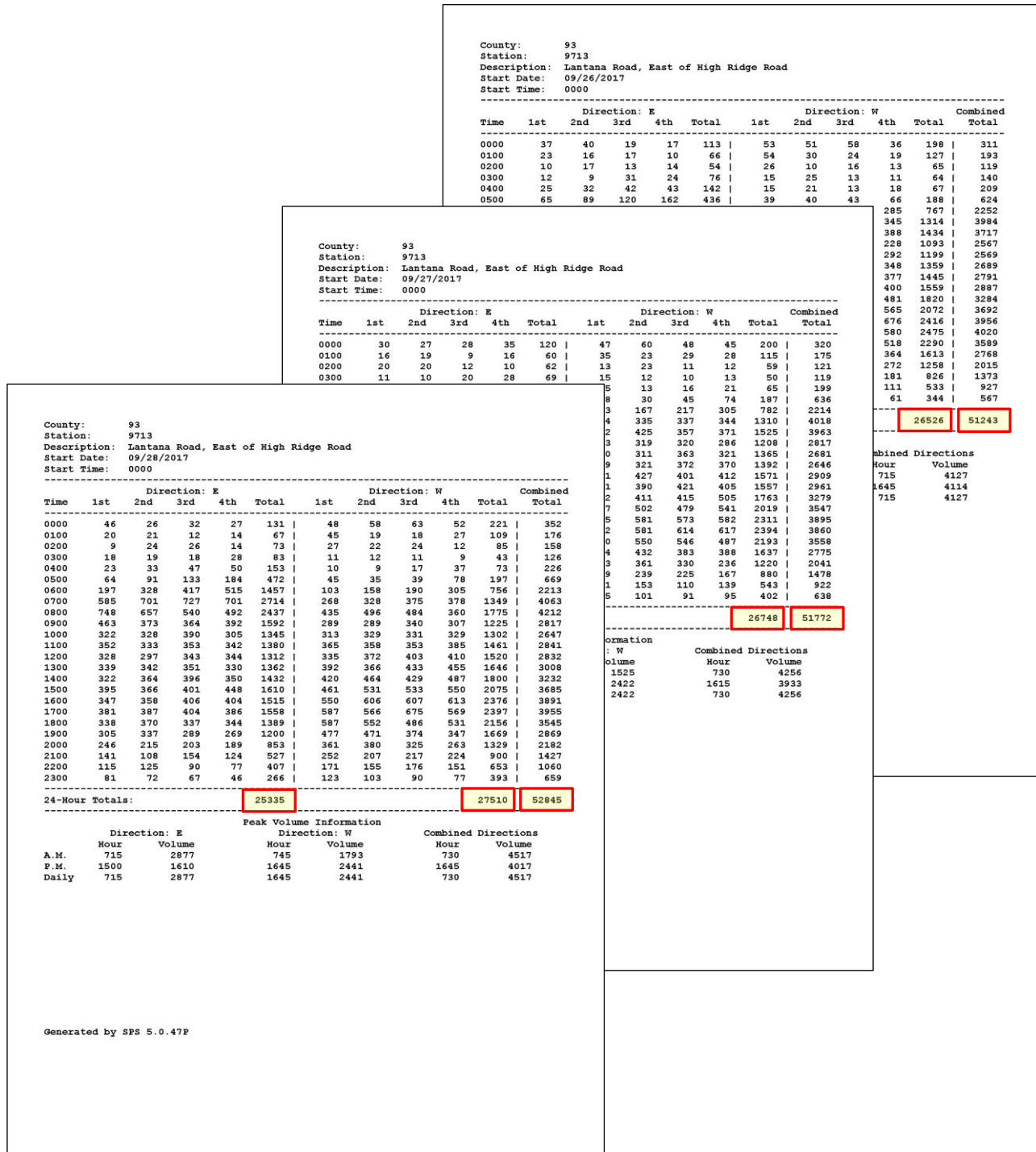


Figure 2-8 Sample Short-Term Traffic Counts

Chapter 2 – Traffic Data Sources and Factors

2017 PEAK SEASON FACTOR CATEGORY REPORT - REPORT TYPE: ALL				
CATEGORY: 9301 CEN.-W OF US1 TO SR7				
WEEK	DATES	SF	MOCF: 0.96	PSCF
1	01/01/2017 - 01/07/2017	0.98		1.02
2	01/08/2017 - 01/14/2017	0.98		1.02
3	01/15/2017 - 01/21/2017	0.98		1.02
4	01/22/2017 - 01/28/2017	0.98		1.02
* 5	01/29/2017 - 02/04/2017	0.97		1.01
* 6	02/05/2017 - 02/11/2017	0.96		1.00
* 7	02/12/2017 - 02/18/2017	0.95		0.99
* 8	02/19/2017 - 02/25/2017	0.95		0.99
* 9	02/26/2017 - 03/04/2017	0.95		0.99
*10	03/05/2017 - 03/11/2017	0.95		0.99
*11	03/12/2017 - 03/18/2017	0.94		0.98
*12	03/19/2017 - 03/25/2017	0.95		0.99
*13	03/26/2017 - 04/01/2017	0.95		0.99
*14	04/02/2017 - 04/08/2017	0.96		1.00
*15	04/09/2017 - 04/15/2017	0.96		1.00
*16	04/16/2017 - 04/22/2017	0.97		1.01
*17	04/23/2017 - 04/29/2017	0.97		1.01
18	04/30/2017 - 05/06/2017	0.98		1.02
19	05/07/2017 - 05/13/2017	0.98		1.02
20	05/14/2017 - 05/20/2017	0.99		1.03
21	05/21/2017 - 05/27/2017	1.00		1.04
22	05/28/2017 - 06/03/2017	1.01		1.05
23	06/04/2017 - 06/10/2017	1.02		1.06
24	06/11/2017 - 06/17/2017	1.03		1.07
25	06/18/2017 - 06/24/2017	1.04		1.08
26	06/25/2017 - 07/01/2017	1.05		1.09
27	07/02/2017 - 07/08/2017	1.05		1.09
28	07/09/2017 - 07/15/2017	1.06		1.10
29	07/16/2017 - 07/22/2017	1.05		1.09
30	07/23/2017 - 07/29/2017	1.04		1.08
31	07/30/2017 - 08/05/2017	1.03		1.07
32	08/06/2017 - 08/12/2017	1.02		1.06
33	08/13/2017 - 08/19/2017	1.02		1.06
34	08/20/2017 - 08/26/2017	1.05		1.09
35	08/27/2017 - 09/02/2017	1.09		1.14
36	09/03/2017 - 09/09/2017	1.12		1.17
37	09/10/2017 - 09/16/2017	1.15		1.20
38	09/17/2017 - 09/23/2017	1.12		1.17
39	09/24/2017 - 09/30/2017	1.09		1.14
40	10/01/2017 - 10/07/2017	1.05		1.09
41	10/08/2017 - 10/14/2017	1.02		1.06
42	10/15/2017 - 10/21/2017	0.99		1.03
43	10/22/2017 - 10/28/2017	0.99		1.03
44	10/29/2017 - 11/04/2017	0.99		1.03
45	11/05/2017 - 11/11/2017	0.99		1.03
46	11/12/2017 - 11/18/2017	0.99		1.03
47	11/19/2017 - 11/25/2017	0.99		1.03
48	11/26/2017 - 12/02/2017	0.98		1.02
49	12/03/2017 - 12/09/2017	0.98		1.02
50	12/10/2017 - 12/16/2017	0.98		1.02
51	12/17/2017 - 12/23/2017	0.98		1.02
52	12/24/2017 - 12/30/2017	0.98		1.02
53	12/31/2017 - 12/31/2017	0.98		1.02

* PEAK SEASON

02-MAR-2018 15:35:06 830UPD 4_9301_PKSEASON.TXT

Figure 2-9 2017 Peak Season Factor Category Report for Category 9301

Step 3

Assign an Axle Correction Factor (ACF) from the Weekly Axle Correction Factor Category Report

Similar to Seasonal Factors, the Axle Correction Factor (ACF) is obtained from the Weekly Axle Correction Factor Category Report. The ACFs are reported by facility, segment, and week. For roadways that do not belong to any of the included facility categories, the ACF for countywide rural, countywide urban, or countywide category can be used. There are 51 ACF categories for Palm Beach County. The category that is most suitable for Lantana Road is Category 9370-County Road (Urban). The ACF for Category 9370 corresponding to the week of 09/24/2017- 09/30/2017 is **0.99**. (See Figure 2-10.)

2017 WEEKLY AXLE FACTOR CATEGORY REPORT - REPORT TYPE: ALL						
COUNTY: 93 - PALM BEACH						
WEEK	DATES	9351 SR 15, HOOKER H-SR700	9355 SR 7, SOUTHERN-OKEECHO	9366 SR 786, CANAL -W OF TPK	9370 COUNTY ROADS (URBAN)	
1	01/01/2017 - 01/07/2017	0.94	0.95	0.98	0.99	
2	01/08/2017 - 01/14/2017	0.94	0.95	0.98	0.99	
3	01/15/2017 - 01/21/2017	0.94	0.95	0.98	0.99	
4	01/22/2017 - 01/28/2017	0.94	0.95	0.98	0.99	
5	01/29/2017 - 02/04/2017	0.94	0.95	0.98	0.99	
6	02/05/2017 - 02/11/2017	0.94	0.95	0.98	0.99	
7	02/12/2017 - 02/18/2017	0.94	0.95	0.98	0.99	
8	02/19/2017 - 02/25/2017	0.94	0.95	0.98	0.99	
9	02/26/2017 - 03/04/2017	0.94	0.95	0.98	0.99	
10	03/05/2017 - 03/11/2017	0.94	0.95	0.98	0.99	
11	03/12/2017 - 03/18/2017	0.94	0.95	0.98	0.99	
12	03/19/2017 - 03/25/2017	0.94	0.95	0.98	0.99	
13	03/26/2017 - 04/01/2017	0.94	0.95	0.98	0.99	
14	04/02/2017 - 04/08/2017	0.94	0.95	0.98	0.99	
15	04/09/2017 - 04/15/2017	0.94	0.95	0.98	0.99	
16	04/16/2017 - 04/22/2017	0.94	0.95	0.98	0.99	
17	04/23/2017 - 04/29/2017	0.94	0.95	0.98	0.99	
18	04/30/2017 - 05/06/2017	0.94	0.95	0.98	0.99	
19	05/07/2017 - 05/13/2017	0.94	0.95	0.98	0.99	
20	05/14/2017 - 05/20/2017	0.94	0.95	0.98	0.99	
21	05/21/2017 - 05/27/2017	0.94	0.95	0.98	0.99	
22	05/28/2017 - 06/03/2017	0.94	0.95	0.98	0.99	
23	06/04/2017 - 06/10/2017	0.94	0.95	0.98	0.99	
24	06/11/2017 - 06/17/2017	0.94	0.95	0.98	0.99	
25	06/18/2017 - 06/24/2017	0.94	0.95	0.98	0.99	
26	06/25/2017 - 07/01/2017	0.94	0.95	0.98	0.99	
27	07/02/2017 - 07/08/2017	0.94	0.95	0.98	0.99	
28	07/09/2017 - 07/15/2017	0.94	0.95	0.98	0.99	
29	07/16/2017 - 07/22/2017	0.94	0.95	0.98	0.99	
30	07/23/2017 - 07/29/2017	0.94	0.95	0.98	0.99	
31	07/30/2017 - 08/05/2017	0.94	0.95	0.98	0.99	
32	08/06/2017 - 08/12/2017	0.94	0.95	0.98	0.99	
33	08/13/2017 - 08/19/2017	0.94	0.95	0.98	0.99	
34	08/20/2017 - 08/26/2017	0.94	0.95	0.98	0.99	
35	08/27/2017 - 09/02/2017	0.94	0.95	0.98	0.99	
36	09/03/2017 - 09/09/2017	0.94	0.95	0.98	0.99	
37	09/10/2017 - 09/16/2017	0.94	0.95	0.98	0.99	
38	09/17/2017 - 09/23/2017	0.94	0.95	0.98	0.99	
39	09/24/2017 - 09/30/2017	0.94	0.95	0.98	0.99	
40	10/01/2017 - 10/07/2017	0.94	0.95	0.98	0.99	
41	10/08/2017 - 10/14/2017	0.94	0.95	0.98	0.99	
42	10/15/2017 - 10/21/2017	0.94	0.95	0.98	0.99	
43	10/22/2017 - 10/28/2017	0.94	0.95	0.98	0.99	
44	10/29/2017 - 11/04/2017	0.94	0.95	0.98	0.99	
45	11/05/2017 - 11/11/2017	0.94	0.95	0.98	0.99	
46	11/12/2017 - 11/18/2017	0.94	0.95	0.98	0.99	
47	11/19/2017 - 11/25/2017	0.94	0.95	0.98	0.99	
48	11/26/2017 - 12/02/2017	0.94	0.95	0.98	0.99	
49	12/03/2017 - 12/09/2017	0.94	0.95	0.98	0.99	
50	12/10/2017 - 12/16/2017	0.94	0.95	0.98	0.99	
51	12/17/2017 - 12/23/2017	0.94	0.95	0.98	0.99	
52	12/24/2017 - 12/30/2017	0.94	0.95	0.98	0.99	
53	12/31/2017 - 12/31/2017	0.94	0.95	0.98	0.99	

Figure 2-10 Weekly Axle Factory Category Report for Category 9370

Step 4 Estimating AADT by Applying Adjustment Factors

$$AADT = ADT \times SF \times ACF$$

$$AADT = 51,953 \times 1.09 \times 0.99 = 56,062$$

$$AADT = 56,500 \text{ (After applying Rounding)}$$

Step 5 Estimating Design Hour Factors (K, D, and T)

The values of K and D can be found in the Volume Factor Category Summary Report. As indicated earlier, the short-term count location is represented by Category 9301 and **Figure 2-11** shows the 2017 Volume Factor Category Summary Report for Category 9301. The reported Standard K Factor is 9.0%. The reported D value is 59.5%, which is the average of D factors for all sites in the category.

The T factors are typically determined by classification counts, and the truck percentages obtained from the field are compared with those reported in the FTO website for reasonableness. If classification counts are not available, the T factor can be estimated by selecting a continuous or short-term station that best represents the study location. The T Factor from the Annual Average Daily Traffic (AADT) Report can be used as an estimate. In this example, Site 930076 is located near the short-term count location and the reported T factor is 3.70%. This estimated T factor for the short-term count location is 3.70%. The following shows a summary of the estimated design hour factors:

$$K = 9.0, D = 59.5, T = 3.70$$

2017 VOLUME FACTOR CATEGORY SUMMARY REPORT - REPORT TYPE: ALL																													
CATEGORY: 9301 - CEN.-W OF US1 TO SR7																													
COSITE DIR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	SUN	MON	TUE	WED	THU	FRI	SAT	STD "K"	MEDIAN "D"	AADT							
860255 E	1.00	0.98	0.92	0.96	0.98	1.00	1.02	1.01	1.16	1.03	0.99	0.97	1.31	0.99	0.97	0.94	0.94	0.90	1.05										
860255 W	0.96	0.96	0.95	0.98	1.00	1.01	1.03	1.01	1.14	0.99	0.99	0.97	1.29	1.00	0.96	0.94	0.94	0.91	1.05										
860255 B	0.98	0.97	0.94	0.97	0.99	1.01	1.03	1.01	1.15	1.01	0.99	0.97	1.30	1.00	0.97	0.94	0.94	0.91	1.05	9.0	51.6	42597							
930099 N	0.97	0.92	0.93	0.95	1.00	1.05	1.08	1.03	1.18	0.97	0.98	1.00	1.61	0.97	0.91	0.88	0.88	0.85	1.23										
930099 S	0.97	0.92	0.92	0.94	0.99	1.05	1.08	1.02	1.20	0.96	1.00	1.01	1.60	0.96	0.89	0.88	0.88	0.88	1.24										
930099 B	0.97	0.92	0.93	0.95	1.00	1.05	1.08	1.03	1.19	0.97	0.99	1.01	1.61	0.97	0.90	0.88	0.88	0.87	1.24	9.0	69.2	21457							
930101 E	1.00	0.97	0.96	0.97	0.98	1.04	1.06	1.01	1.12	0.98	0.98	0.96	1.29	1.00	0.96	0.95	0.95	0.91	1.05										
930101 W	1.00	0.96	0.96	0.97	0.98	1.04	1.06	1.01	1.12	0.98	0.98	0.96	1.27	1.00	0.96	0.95	0.95	0.92	1.04										
930101 B	1.00	0.97	0.96	0.97	0.98	1.04	1.06	1.01	1.12	0.98	0.98	0.96	1.28	1.00	0.96	0.95	0.95	0.92	1.05	9.0	57.8	71847							
=====																													
CATEGORY:	0.98	0.95	0.94	0.96	0.99	1.03	1.06	1.02	1.15	0.99	0.99	0.98	1.40	0.99	0.94	0.92	0.92	0.90	1.11	9.0	59.5								

Figure 2-11 Volume Factor Category Summary Report for Category 9301

Chapter 3 Forecasting with Travel Demand Models

3.1 Introduction

This chapter provides guidance on the application of travel demand models to develop project traffic. It covers the fundamentals of travel demand modeling, selection of an appropriate model, project-level model validation and reasonableness check, and refinement of model output to obtain consistent traffic forecasts. If an acceptable model is not available for a project, then refer to **Chapter 4**.

3.2 Corridor and Project Traffic Forecasting

3.2.1 Corridor Traffic Forecasting

CORRIDOR

Corridor Traffic Forecasting produces the information needed for traffic engineers to determine the required geometric configurations within a corridor to meet the future traffic demand. Traffic forecasting is required before establishing a new alignment or improving existing facilities. Corridor models are special application models that are validated to forecast traffic for a certain corridor and usually include more details than an urban or regional model. *The models validated to forecast general corridor traffic for systems planning purposes should be checked to ensure that they have the required project details for project traffic forecasting using design traffic criteria.*

Corridor Traffic Forecasting is needed to determine future traffic volumes and long-range system data needed for the areawide highway or transportation network. A corridor may be designated by a local government in its Comprehensive Plan.

A corridor study containing a Corridor Traffic Forecast may document the purpose and need for new or upgraded transportation facilities within the corridor. Corridor Traffic Forecasting is needed for Strategic Intermodal System (SIS) Master and Action Plan reports, and the major transportation investments required by federal regulations in metropolitan areas. For planning applications, the model is often used for changing or amending approved plans such as the Metropolitan Planning Organization (MPO), also known as Transportation Planning Organization (TPO) or Transportation Planning Agency (TPA)'s Long-Range Transportation Plan (LRTP), the Local Government Comprehensive Plan (LGCP), or Work Program Administration (WPA). Projects identified through the Corridor Traffic Forecasting Process will require a Project Traffic Forecast. The appropriate District Director or his/her designee(s) will be responsible for carrying out the Corridor Traffic Forecasting Process unless assigned elsewhere by the District Secretary or his/her designee(s).

Figure 3-1 below illustrates the seven-step Corridor Traffic Forecasting Process.

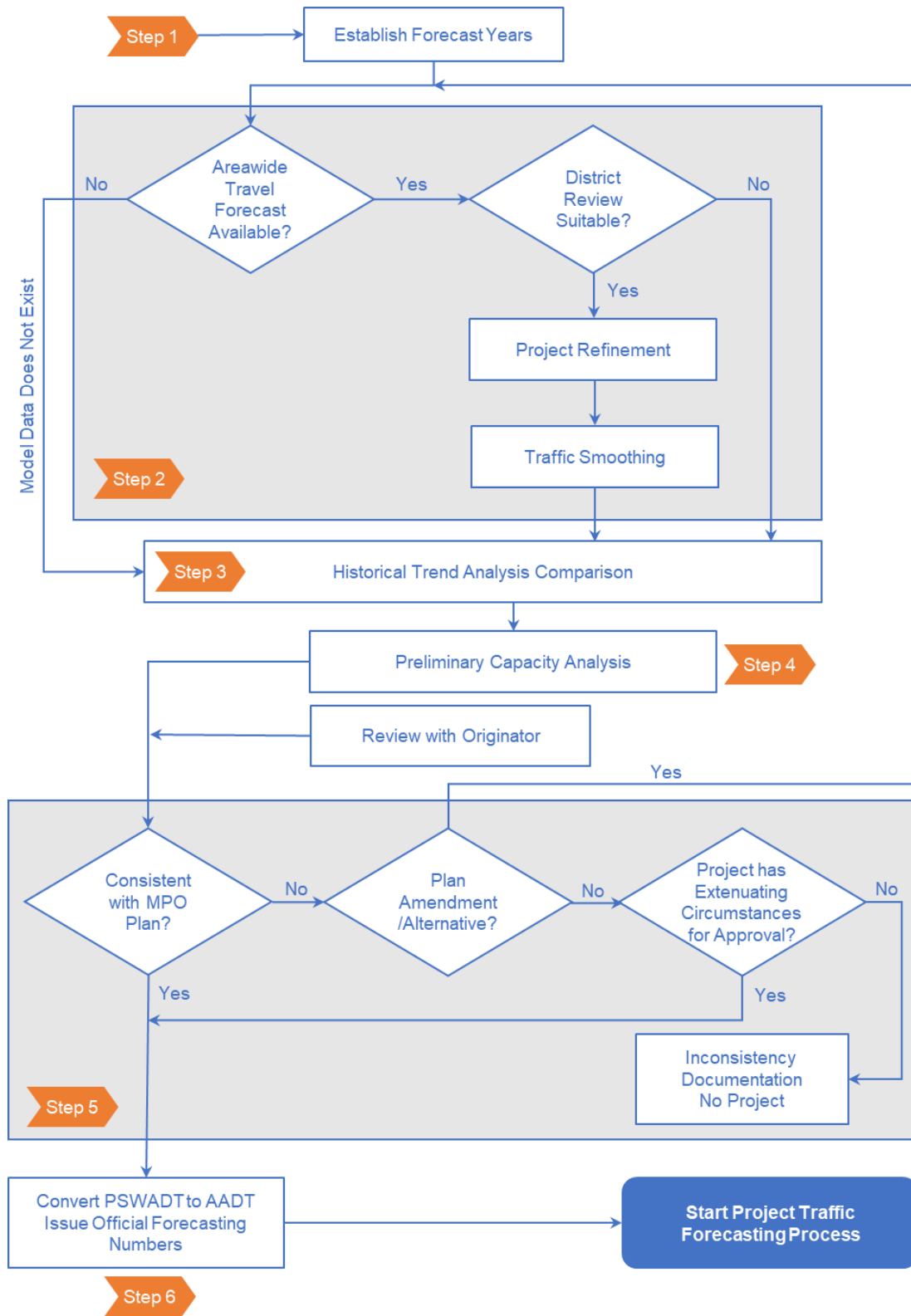


Figure 3-1 Corridor Traffic Forecasting Process

3.2.2 Project Traffic Forecasting Process

PROJECT

Project Traffic Forecast projections use the Corridor Traffic Forecast. The Project Traffic Forecast Process estimates traffic conditions used for determining the geometric design of a roadway and/or intersection and the number of 18-KIP ESALs that pavement will be subjected to over its design life. This process is different from Corridor Traffic Forecast in that it is site specific, covers a limited geographic area, and is more refined.

The Project Traffic Forecasting Process consists of nine steps which are shown in **Figure 3-2** and explained in greater detail throughout this Handbook. While the Corridor Traffic Forecast may be detailed enough to identify the needs for specific improvements, the final project traffic forecasting data needed for a specific project, such as a link or an intersection, may require more refined or specific project traffic analysis. Project traffic studies identify specific link volumes, turning movements, and other project-specific data necessary for the geometric design of, and operational improvements to roadways or intersections. The project traffic process helps identify traffic conditions and turning movement volumes used for designing the configuration and number of lanes for proposed projects as defined in the [FDOT Adopted Five Year Work Program](#). Project traffic forecasts are used to identify the project traffic requirements for the state highway system, Interchange Access Requests (IAR), Master and Action Plans for SIS facilities, RRR projects, adding lanes, bridge replacement, approaches to bridges, new roadway projects, and major intersection improvements.

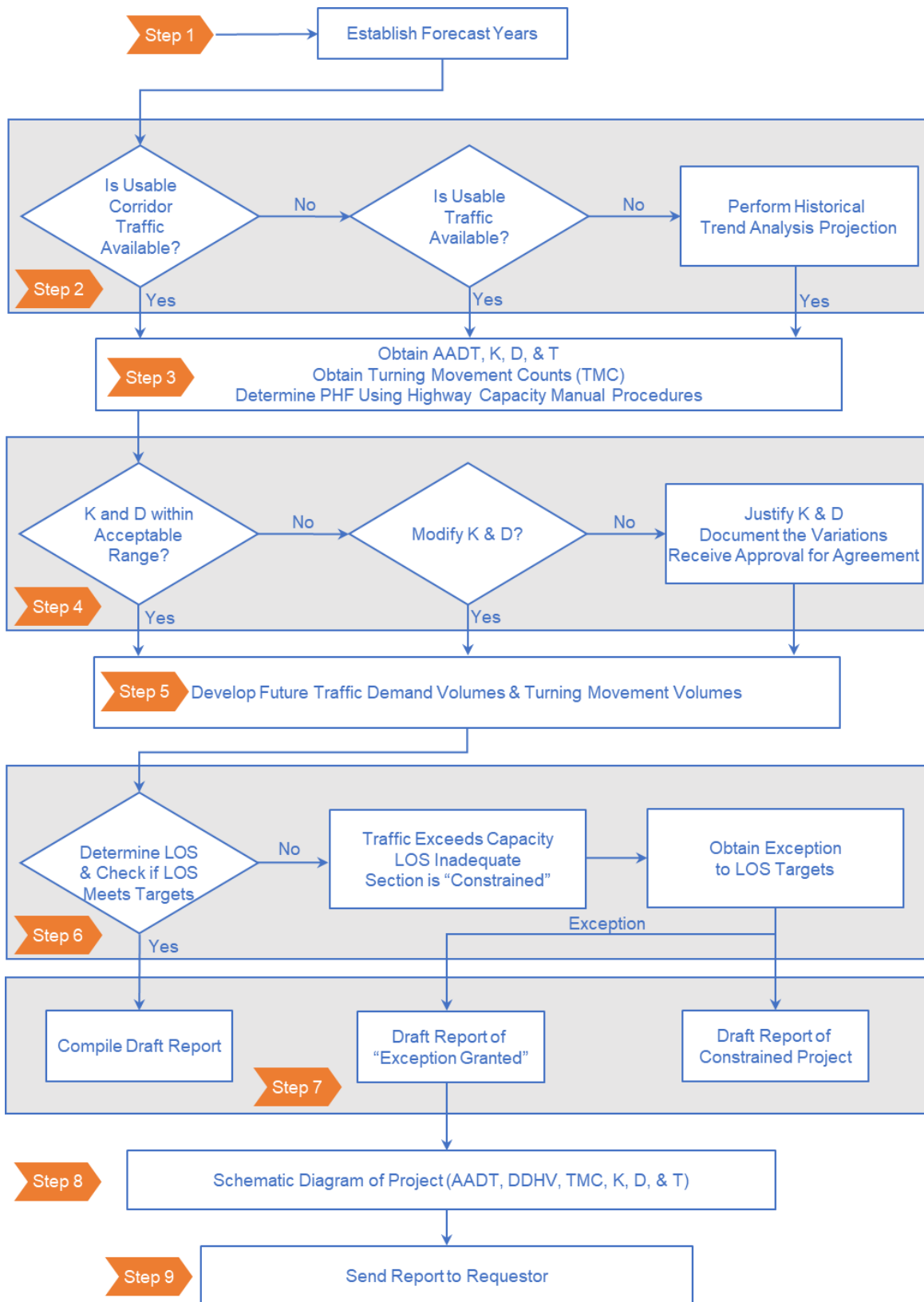


Figure 3-2 Project Traffic Forecasting Process

3.2.3 Establishing Forecast Years

For project traffic forecasting purposes, the base year is the year when system data is collected to evaluate the existing conditions and establish the purpose and needs of a project. The system data typically includes roadway conditions, traffic counts, traffic controls such as signal timing plans, delays and queue lengths, and crash data. In most cases, the base year coincides with the year when the study is conducted, but it could be one or two years earlier. It serves as the reference point for future year traffic forecasting.

For model development purposes, the base year is the year whose traffic conditions the model is adjusted to replicate. The base year of a model is often associated with the MPO/TPO/TPA's LRTP update cycle, and the most recent Census year is often used as the base year due to the availability of accurate population information. In many cases, the model base year is different from the project base year. Likewise, the forecast year of the model could be different than the design year of the project. Standard data processing procedures, such as linear interpolation or extrapolation, should be used to ensure that the model provides traffic forecasts for both the opening and design year of the project.

The following guidelines should be followed to establish traffic forecasting years and develop traffic forecasts for the opening and design years.

Existing Year – the most recent year when traffic counts and other traffic operational data (e.g., O-D, travel time, and delays) are collected or available. It is typically the year when the study is conducted or one year before the study is conducted.

Opening Year – one year after a project is scheduled to be open to public and when the new traffic pattern stabilizes.

Interim Year – a year between the Opening Year and the Design Year, typically ten (10) years after the opening year.

Design Year – the year for which a roadway is designed. It is usually twenty years from the opening year.

The FDOT Project Manager and other relevant stakeholders should be consulted to establish analysis years before the project begins.

3.3 Modeling Background for Traffic Forecasting

The primary purpose of travel demand forecasting models is to provide system level traffic forecasts used to identify transportation needs in the development of long-range transportation plans. The resulting transportation plans provide a basis for more detailed evaluation required for specific project developments. Project Traffic Forecasting Reports document the procedure, methodology, and data used to develop traffic forecasts that serve as the basis in establishing specific improvements such as cross section requirements, lane calls for corridors, intersection/interchange geometry, and pavement design.

Models can be useful tools in developing the traffic projections necessary for the Project Traffic Forecasting Report. However, before using traffic projections from a model, a careful examination of the performance of the model within the project area should be conducted to evaluate reasonableness and consistency of the model results. If necessary, additional model refinement and validation should be performed to ensure the model reflects the observed traffic conditions within the study area.

The travel demand forecasting models used in the State of Florida for projecting systems traffic are developed based on the modeling standards set forth by the Florida Model Task Force known as the Florida Standard Urban Transportation Model Structure (FSUTMS). MPO/TPO/TPAs used to develop and maintain their own individual models. However, with the increase in interregional travel and hence the need for coordinated transportation planning, with a few exceptions, most MPO/TPO/TPAs have their own models as part of a larger regional model. These regional models usually encompass multiple counties within an FDOT District. The District Planning Office, in coordination with each of the local Metropolitan Planning Organizations (MPO), is responsible for the development and maintenance of these models.

Models are typically calibrated and validated to reflect the travel behaviors as observed for a “base year”. The input data used for the model are population, employment, number of housing units, school enrollment, and the transportation network. The data sources needed to derive the observed travel characteristics include regional household travel surveys, National Household Travel Surveys (NHTS), most recent U.S. Census, American Community Survey (ACS), Census Transportation Planning Package (CTPP), the Longitudinal Employer-Household Dynamics (LEHD) data provided by the U.S. Census Bureau, local origin-destination surveys, external station survey, transit on-board survey, and other special purpose surveys. In recent years, “big data” provided by third party commercial vendors obtained from Global Positioning System (GPS) devices or Location Based Services (LBS) have been routinely used for model validation purposes because of the relative low cost and large sample size associated with the data. A model is considered validated when traffic volumes generated by the model match the traffic counts reasonably well for the base year, and the model is sensitive to changes in input data and respond

to changes appropriately. After a model is validated, it can be used to forecast future traffic using the projected population and employment data and the transportation network for a future year.

Models that have been adopted by the FDOT districts and MPO/TPO/TPAs should be used first to develop future project traffic. Depending on the location of the project, the Florida Statewide Model or the Florida Turnpike Model can also be used. The parameters and coefficients in the validated models should not be modified without the consent and approval of the responsible agencies. Since the availability of models varies from district to district, users should contact the District Modeling Coordinator to obtain the available models.

3.4 Model Selection

Consideration should be given to the scope, location, and the nature of the project when selecting a model to be used for project traffic forecasting. If a project and its influencing area lie completely within an urbanized MPO/TPO/TPA area, the adopted MPO/TPO/TPA model should be used unless there is a good reason to use a different model and all involved parties reach an agreement before the project starts. If a project and its area of influence (AOI) lie outside or cross MPO/TPO/TPA planning boundaries, a regional model that covers the entire project area should be used. If a project lies in a rural area or an urban area not covered by an MPO/TPO/TPA or regional model, the Florida Statewide Model or Florida Turnpike Model can be used as a starting point to develop a subarea model. In addition to the system-level regional LRTP models, some districts also develop and maintain project specific models that can be customized for the project at hand. These could be models validated to a different base year, having features that allow for evaluating different travel options such as toll roads or transit services that have direct impact on the project, or including a different horizon year with updated model input data and transportation network. Using these models could significantly reduce the time and costs for modeling work. District Planning Offices should always be consulted regarding the availability, capability, and applicability of these models. The [Florida's modeling web portal \(www.fsutmsonline.net\)](http://www.fsutmsonline.net) has a list of available models for all MPO/TPO/TPAs and districts in the state and can be used as a source of information for this purpose.

3.4.1 Review of Model Applicability

Users should verify that the latest version of the model is obtained and conduct a review of the base year validation and forecast year projections within the project study area. This is to determine if the model reasonably reflects the current travel conditions and the projections are consistent with the expected growth in population and employment. If the level of accuracy in the base year model is deemed to be unacceptable for the purposes of forecasting traffic for a project, then the model should not be used until the District Planning Office and/or the agency having jurisdiction over the model has addressed the situation.

Models are generally calibrated on a system-wide level and not on a corridor or project specific level. The Project Traffic Report stage is NOT the appropriate place to perform a recalibration of the base year model. Should the calibration of the model remain an issue, it is suggested that the procedure in **Chapter 4** for Forecasting Without a Traffic Model be followed instead.

3.4.2 Model Applicability Revision

All models used for project traffic forecasting must be approved by the District Planning Manager or his/her designee and determined to be suitable for forecasting traffic for the project. The suitability check should include Percent-Root-Mean-Square-Error (%RMSE) and screenline volumes in base year evaluations. If the model is acceptable, perform project refinement. If not, perform historical trend analysis comparison.

3.4.3 Model Refinement

After the initial review of the model to verify its usability for the project, further refinement of the model is usually needed. Model refinement involves correcting any errors in the socioeconomic data and model network, adding more details that are not included in the regional model by splitting traffic analysis zones (TAZs), coding more local facilities into the network, and creating new centroid connectors. In some cases, further adjustments to the model parameters are needed to produce a better match between the model outputs and observed conditions within the study area. However, adjustments can only be made with supporting evidence that demonstrates the implied travel behavior. Adjustments made to the model should also comply with the established FSUTMS standards and should be fully documented. This document should then be reviewed with the District Planning Office and the agency responsible for the model to obtain consensus on the results.

3.5 Use of Model Outputs in Traffic Forecasting

The refined model can be used as a basis to develop future year scenario models. Model results should always be checked for reasonableness. In many cases, post model processing is required to “smooth” the differences across the network and account for any errors associated with model output. Most FSUTMS models are set to forecast and report the Peak Season Weekday Average Daily Traffic (PSWADT). The PSWADT must be converted to AADT before being used for project traffic forecasting applications using design traffic criteria. Refer to **Section 3.16** for a discussion on converting PSWADT to AADT. The process for applying the model to project traffic is described as follows:



IMPORTANT NOTE:

Model results should always be checked for reasonableness. In many cases, a post model processing procedure is required to “smooth” the differences across the network and account for any errors associated with model output.

3.5.1 Develop Interim and Forecast Year Network/Land Use Scenarios

In forecasting interim and design year traffic, it may be necessary to incorporate recent changes in land use and/or changes in the network that are not reflected in the approved interim and design year data sets. These changes should be made with coordination and approval from the appropriate District Director or his/her designee(s) and the agency responsible for the model (i.e., MPO/TPO/TPA or local agency).

3.5.2 Execute the Model Stream

Execute the model stream by selecting the corresponding scenarios using the appropriate key values from Cube Scenario Manager in accordance with the model's User's Manual. The modeled traffic volumes can be obtained from the loaded highway network using Cube's Network Editor.

3.5.3 Evaluate Model Traffic Output

The forecasted model traffic must be evaluated for reasonableness. The best method of evaluation is to develop a traffic forecast based on historical trends following the steps referred to in **Chapter 4**. This trend-based forecast should then be compared to those generated by the model. Differences in volume in excess of 10% in high volume areas or 4,000 vehicles per day in lower volume areas should be further evaluated to explain the discrepancy. Other data sources include, but are not limited to, population estimates from Bureau of Economic and Business Research (BEBR) at the University of Florida, U.S. Census data products, and local economic activity data.

When comparing future model volumes with trends analysis results, it is important to remember that trends analysis assumes that future growth pattern will follow the same historical pattern in the past and the roadway facilities in the project area remain largely unchanged in the future. If future land uses are dramatically different from the existing ones, or if the future model includes major improvements on existing facilities or new facilities, the basic assumptions for trends analysis no longer hold. A direct comparison between model output and trends analysis results is not recommended. The user is advised to refer to Section 3.10.2 for reasonableness checks on future year forecasts.

Complete documentation of the traffic projection process, including reasonableness evaluation, should be included in the Traffic Report. Where the forecasted model traffic is to be utilized for alternative corridor assignments, additional evaluation for reasonableness should be performed. Screenlines and overall distribution of traffic assignments within the evaluated areas should also be considered.

3.5.4 Document the Traffic Forecast

Tabulation of the forecasts for the interim and design year with appropriate documentation of the methodology and reasonableness evaluation should be included in an individual section of the Traffic Report. This information should then be utilized in the development of forecast year turning movement volumes and axle loadings as described in this Handbook.

3.6 Traffic Forecasting Background for Modelers

The following sections provide guidance on the use of models to develop traffic projections for project, corridor, and resurfacing type projects. This section applies only to areas where an adopted/endorsed model is available. Data requirements and the level of modeling effort vary by the type of project.

CORRIDOR

Corridor projects usually require the development of travel projections for either new or existing corridors and are used to make decisions which have important capacity and capital investment implications. An evaluation of the model's ability to accurately project travel demand in the corridor area should be made prior to its use. Based on the results of this evaluation, additional corridor specific validation and/or model refinement efforts may be necessary.

PROJECT

Specific project travel demand projections require the highest accuracy. These projections are commonly used to develop lane requirements and intersection designs and evaluate the operational efficiency of proposed improvements. An evaluation of the model's ability to accurately project travel demand in the project area should be made prior to its use. Based on the results of this evaluation, additional project specific (subarea and/or corridor) model refinement efforts may be necessary.

ESAL

Resurfacing projects require the development of future AADT projections only and require the least accuracy. As a result, the modeling effort required to develop travel projections for resurfacing projects is the least involved of the project types. Generally, a properly calibrated (area-wide) model can be directly applied without the need for additional evaluation or validation efforts.

3.7 General Travel Demand Forecasting Model Issues

This section presents an overview of modeling issues as they relate to project traffic development. It covers basic travel demand forecasting procedures and modules used in various models in Florida, advanced modeling techniques, state-of-the-practice input and output data, accuracy assessment of model results, and the available models in Florida. For detailed methodological discussions, refer to various textbooks, National Cooperative Highway Research Program (NCHRP) reports such as [NCHRP 365](#), and relevant modeling reports.

3.7.1 Travel Demand Forecasting Basics

All travel demand models start with a geographical representation of the transportation system which consists of two parts. One is the demand side of the transportation system represented by geographic areas or zones and the traveling public that reside or work within the areas. The information needed to describe the traveling public is commonly known as the zonal data and it includes household, person, vehicle, and travel related characteristics. The other is the supply side of the transportation systems represented by multimodal transportation networks. The information used to describe the transportation networks and associated services include number of lanes, capacity, type of facilities, speed limit, service schedule, etc. Travel demand models simulate the interactions between the supply side and demand side of the transportation system in different time slices based on observed or assumed travel behavioral principles and produce statistics that reflect the performance of the transportation system such as volumes, congested speeds, travel times and delays, and others. Models are typically developed for regional long-range transportation planning purposes. For many regional models, the zone size tends to be large, the transportation network could be sparse, and the model is often validated at a higher aggregate level. For project traffic purposes, a fine-grained zone system coupled with a high-level network detail is needed to properly reflect the traffic conditions within the project area. Model refinement and model adjustment are often needed.

3.7.2 Four-Step Travel Demand Modeling

There are different types of models based on planning requirements, data availability, and underlying assumptions about people's travel decision making process. The sequential or four-step travel forecasting procedure is the most commonly used model for transportation engineering and planning purposes. The four-step model assumes that travelers make travel decisions in the following order:

- **Trip Generation:**
 - determines the frequency of origins or destinations of trips in each zone by trip purpose
 - “what do I need to do, going to work, school, or shopping?”
- **Trip Distribution**
 - matches origins with destinations
 - “where would I go, office, primary school, hospital?”
- **Mode Choice**
 - computes the proportion of trips between each origin and destination that use a particular transportation method
 - “how should I go, driving, getting a ride, or using public transit?”
- **Trip Assignment**
 - allocates trips between an origin and destination by a particular mode to a route
 - “what route should I take, shortest, fastest, cheapest, most familiar, safest?”

The four-step model is often referred to as the trip-based model because the primary unit of analysis is a single trip interchange between two geographic locations or an origin-destination pair. Even though there are different behavioral assumptions and mathematical formulations for each step, the primary function of the trip-based models is to estimate the total number of trips in a region, classify them by location and mode, and predict their use of transportation networks. **Figure 3-3** illustrates a conceptual four-step modeling process with main model components, input data, output data, and data flows among the model components. The model structure also includes a feedback loop used in some more advanced models to demonstrate possible improvements and enhancements to the model chain. Most of the travel demand models used in Florida are trip-based four-step models with various special features specifically designed to address the unique characteristics and planning needs in their modeling areas.

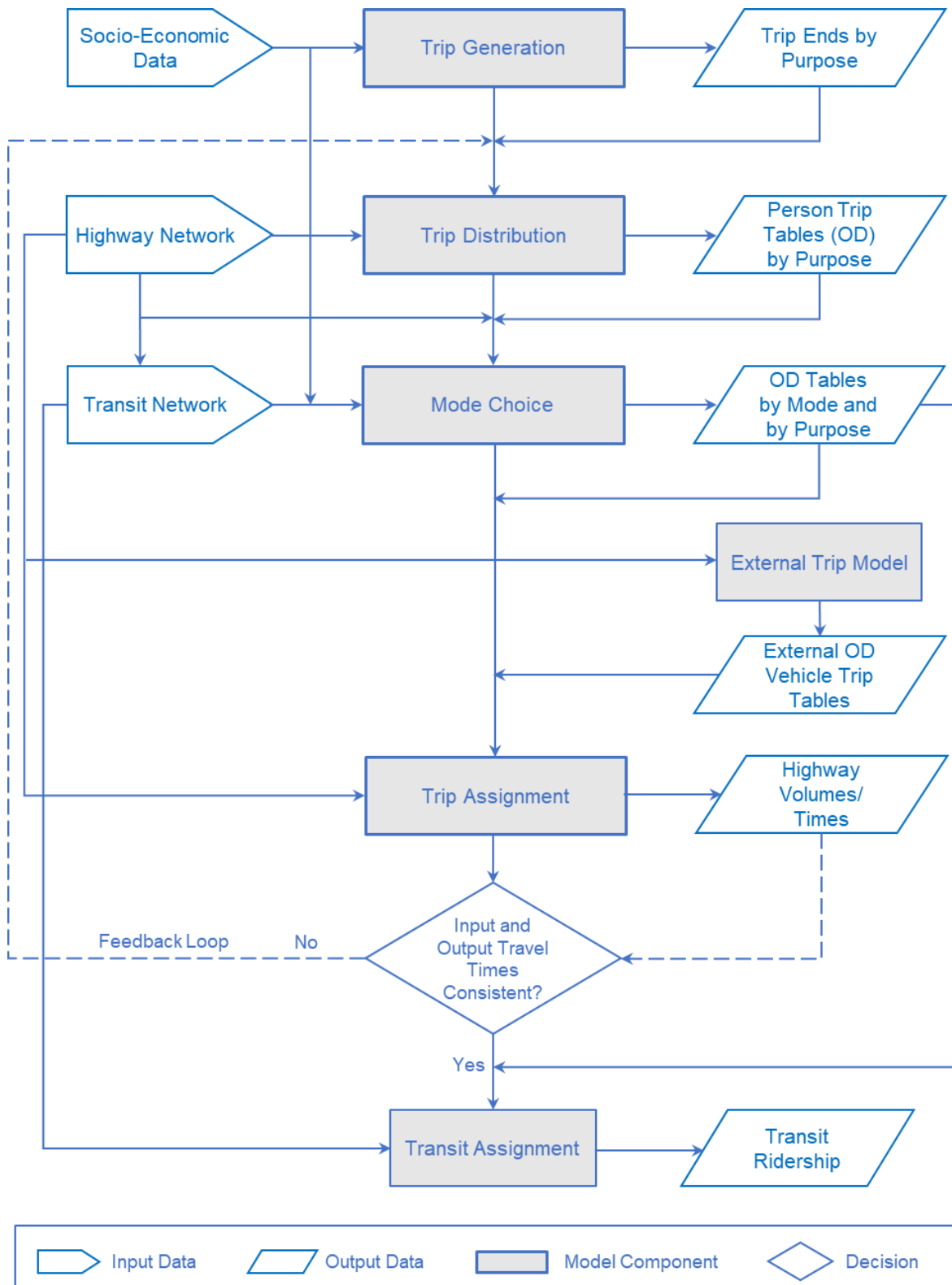


Figure 3-3 Four-Step Travel Forecasting Process

3.7.3 Four-Step Model Enhancements

There have been many enhancements within the four-step model framework to improve the accuracy and usability of the model. Examples include feedback loops that addresses the internal consistency issues within the model, time-of-day models that focus on travels during different time periods of the day, and various techniques that estimate trip tables directly from traffic counts or “big data” sources.

3.7.3.1 Feedback Loops

One of the common concerns about the sequential four-step models is the inconsistencies between the four steps, particularly the discrepancies between the travel times used for trip distribution and mode choice models and travel times produced by the trip assignment model. One way of resolving the inconsistencies is to implement the feedback loop in the model. The feedback loop is an iterative process where congested travel times from the trip assignment model are “fed back” to earlier steps of the model until the differences between the steps are reduced to an acceptable level.

3.7.3.2 Time-of-Day Modeling

In most urban areas where traffic congestion is a daily occurrence, travelers respond to congestion by adjusting their departure time to avoid the heaviest traffic and thus prolonging the peak period, a phenomenon known as peak spreading. In recent years, increasing flexibility with work schedule and the availability of telecommuting further contribute to the changes in temporal distribution of travel demand. Many of the Travel Demand Management measures or pricing policies are designed to reduce peak period traffic and alleviate traffic congestion. Various time-of-day (TOD) procedures and strategies have been employed to accurately capture the diurnal variations in travel demand and properly represent the traffic conditions during different time of the day.

Many of the models in Florida use TOD factors to disaggregate travel demand into different time periods. The TOD factors are developed either from household travel surveys or from traffic counts in the region. Within the four-step modeling framework, there are typically two ways of applying the TOD factors. One is to apply the TOD factors after trip assignment to allocate daily volumes into different time periods, the other is to apply the TOD factors before trip assignment to determine the travel demand separately for each period. In the latter case, separate trip assignment procedures are performed for different time periods to obtain traffic volumes for each period, and the daily volume is the sum of all period volumes.

There are also models in Florida that use more advanced techniques such as TOD choice models. The TOD choice models focus on predicting trip departure times based on preferred arrival time, expected and experienced travel times, and sometimes arrival delay penalties.

3.7.3.3 Direct Estimation of Origin-Destination Trip Table

The origin-destination (O-D) trip table or O-D matrix is a crucial element in describing the travel pattern in a region or for a study corridor. A well calibrated trip distribution model should be able to produce a trip table that properly represents the observed travel pattern. However, in many cases, the trip table obtained from the model may not meet the requirements for a study, it is often necessary to estimate the O-D table from other sources. One of the most commonly used method is to estimate the trip table from traffic counts. The method tries to find a reasonable O-D table that will match the traffic counts when assigned to the transportation network. On large networks, there are multiple O-D tables that will reproduce traffic counts equally well, so additional information is needed to help determine the “best match”. The additional information is often supplied in the form of a “seed matrix” that could be an observed trip table in the past or an “educated” approximation of the desired outcome. This process is sometimes referred to as Origin-Destination Matrix Estimation (ODME) and is included in many modeling software packages.

The ACS/CTPP data and LEHD data are often used to directly estimate work-related trip tables for existing years. Bluetooth and Wi-Fi technologies are used to collect vehicle information and develop trip tables based on matched Media Access Control (MAC) addresses, particularly for a small study area or a corridor. In recent years, third party commercial data offer a cost-effective alternative to develop trip tables for areas of all sizes.

It is important to remember that the O-D tables directly estimated from these data sources represent trip interchanges for the base year or existing year. The base year O-D tables need to be scaled up using growth factors developed from socioeconomic data or other data sources to obtain O-D tables for future years. A set of trip interchange differences and ratios need to be computed between the original and ODME trip table and then use the developed deltas to adjust future year model trip table. Additionally, some capping is required for deltas to not completely overwrite the demand model distributions.

3.7.4 Activity-Based Models

Activity-based models (ABM) represent a paradigm shift from the traditional four-step models for travel demand forecasting. Instead of focusing on individual trip exchanges, ABM models consider people’s daily activities as the primary source of travel demand and individual modules are developed to predict the time, location, duration, partners or companions of these activities and travel choices people make to conduct the activities.

ABM models share some similarities with the traditional four-step models: activities are generated, locations for the activities are identified, travel modes are determined, and the specific routes used for each trip are predicted. However, activity-based models offer significant advantages over the trip-based four-step models. Both the geographic area and time slices are much smaller

allowing for more realistic representation of space and time. Daily activities and travel choices are joint decisions made by household members. An ABM model typically begins with a population synthesizer that uses statistical procedures and census data to create a synthetic population for the entire modeling area. The model will then simulate activity patterns of each person in the synthetic population, effectively generating individual travel records similar to those obtained from a household travel survey. The activity travel records can then be aggregated into trip tables for either traditional static trip assignment or more advanced Dynamic Traffic Assignment (DTA) procedures. The disaggregate nature of the ABM models provides a full range of quantitative measures to represent travel activities and choices and makes it easier to evaluate the effectiveness of some of the TDM strategies and pricing policies such as telecommuting and managed lanes. ABM models have been developed for some of the urbanized areas throughout the state, even though the actual implementation is somewhat different for each of those models.

3.7.5 Travel Demand Models used in Florida

The Florida Model Task Force (MTF), in coordination with FDOT Central Office and districts, MPO/TPO/TPAs, and other local planning agencies, develop and maintain modeling standards and guidelines for the state of Florida collectively referred to as the Florida Standard Urban Transportation Model Structure (FSUTMS). FSUTMS establishes common frameworks including methodologies, file structure, naming convention, and model calibration/validation standards while allowing special features to model unique travel characteristics and address special planning needs in each district. The availability of models varies from district to district, the District Planning Office should be contacted to obtain the most suitable model for project analysis. (See Appendix A for the Central Office and District Planning and Modeling Contacts). **Figure 3-4** shows the models that are currently being used in Florida including the type of model and modeling area associated with its model. The Florida web portal also has a list of available models on its “[Model Download](#)” page. Users are advised to always consult with District Planning Offices for any change or update of these models.

The primary factors to be considered when selecting an appropriate model are as follows:

- Does the model comply with FSUTMS standards?
- Is the model designed for the type of project?
- Is the model the officially released version?
- Does the model include a future year alternative with approved socioeconomic data and transportation network?
- At what level is the model validated (system-wide, district, corridor)?

The use of a non-FSUTMS model is normally not acceptable in areas where an FSUTMS-based model has been developed. However, if all adopted/endorsed FSUTMS models are shown to be inadequate for future travel demand forecasts, a non-FSUTMS model may be recommended, or

a combination of approaches may be used. In such cases, it should be documented why any of the adopted/endorsed FSUTMS models cannot be used. The District Planning Office should be contacted for approval prior to the use of a non-FSUTMS model.

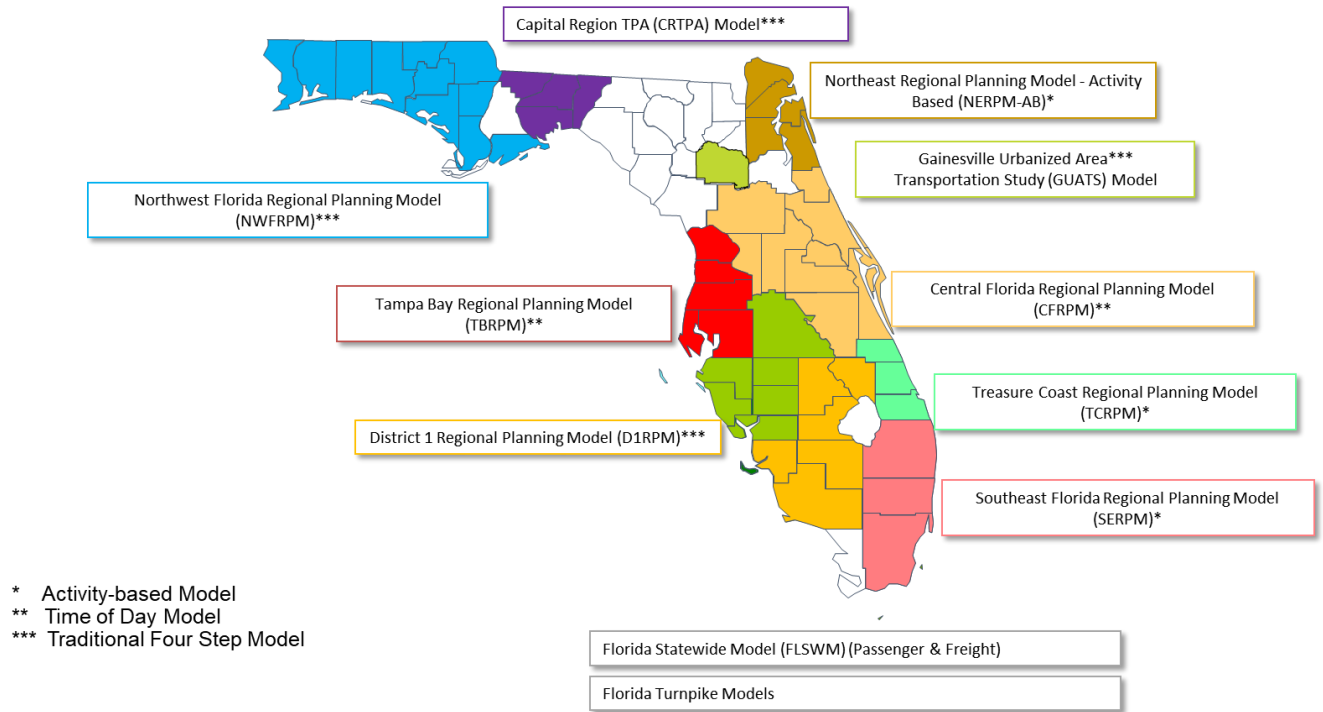


Figure 3-4 Available Models in Florida

3.8 Travel Demand Model Accuracy Assessment

The travel demand model used for project traffic development should be evaluated to determine its accuracy at both the regional and project levels. In many cases, additional validation work will be needed within the AOI. The validation process should include a review of all available land use, socioeconomic and transportation network data to be used in the model. The District Planning Office should approve all data inputs used in the validation process, and the validation effort must be completely documented and approved prior to its use. This section discusses the general approach which should be followed to properly validate a sub area of the model for a project (site specific) analysis.

3.8.1 Evaluation of Base Year Conditions

The selected model should be run using base year data to evaluate its ability to accurately replicate base year ground conditions both regionwide and within the study area. Both the socioeconomic data and transportation network as well as the traffic counts should be checked for accuracy and currency.

3.8.1.1 Base Year Land Use

The base year land use data should be evaluated within the project AOI for its accuracy and consistency with local comprehensive plans. Local planning agencies and MPO/TPO/TPAs should be contacted to verify the land use within the project. All existing TAZs should be analyzed in terms of their size and the number of trips or activities generated. In some cases, it may be necessary to refine the existing TAZ structure to achieve a better trip assignment. Special care must be taken when coding new centroid connectors to properly represent realistic loading locations.

3.8.1.2 Base Year Network Data

The base year model network within the project AOI should be checked for connectivity, directionality, and turn penalties to make sure all vehicle movements are properly represented. Additional roadways may need to be coded into the network to provide better loading points for newly created TAZs, and to allow for an improved path building process. The roadway attributes should be checked regarding area type, facility type, number of lanes, and free flow speeds.

3.8.1.3 Base Year Traffic Counts

An analysis should be conducted to identify whether sufficient coverage counts are available within the project AOI. If critical links are missing counts, then additional counts should be obtained. If any roadways have been added to the network, the availability of counts should be checked for these added roadways. An analysis should be conducted to add screenlines, which might require additional counts, within the project AOI, to create the ability to quickly analyze the accuracy of the distribution patterns. These additional counts would have to be adjusted to the base year of the study as well as to the units the model uses (AADT or PSWADT). Note that this may be a costly endeavor, and not always feasible or desirable.

3.8.2 Base Year Model Volume Evaluation Criteria

The accuracy of the base year model is measured by the difference between the model's outputs and existing conditions. There are many tests to determine the level of accuracy of a model, but for project-level travel forecasting purposes, the focus is on the quality of traffic volumes produced by the model. The [FSUTMS-Cube Framework Phase II – Model Calibration and Validation Standards](#) establishes guidelines for model validation at regional as well as corridor levels. There are two measures that are often used to quantify the differences between model volumes and traffic counts. One is the **Volume-Over-Count (V/C) Ratio** expressed as a decimal or a percent. V/C ratios can be summarized by area type, facility type, and number of lanes; daily or peak periods; screenlines, cutlines, and cordon lines; and using estimates based on Vehicle Miles Traveled (VMT) and Vehicle Hour Traveled (VHT) calculations.

The other measure to quantify the difference between model volumes and traffic counts in the **Root Measure Square Error (RMSE)**. RMSE is a measure of dispersion and it tends to normalize model error better than volume-over-count ratios that allow for high ratios to offset low ratios. The RMSE is often calculated as percent RMSE versus average traffic counts. The formula for calculating %RMSE is shown as follows:

$$\%RMSE = \frac{\left(\sqrt{\frac{\sum_{i=1}^n (V_i - C_i)^2}{n - 1}} \right)}{\left(\frac{\sum_{i=1}^n C_i}{n} \right)} \times 100$$

Equation 3-1

Where

V_i = model volume for a roadway segment

C_i = traffic count for the same roadway segment

n = number of roadway segments with traffic counts

3.8.2.1 Regionwide Model Accuracy Assessment

3.8.2.1.1 Volume-Over-Count Ratios by Facility Types and Screenlines

Table 3-1 presents the acceptable and preferable V/C ratios expressed as percentages for regionwide model validations as recommended in the [FSUTMS-Cube Framework Phase II Model Calibration and Validation Standards](#). Prior to using a travel demand forecasting model for project traffic analysis, it is important to verify that the model has been validated to meet the validation standards. The Highway Evaluation Report (HEVAL) module or similar routines are included in FSUTMS models to perform system evaluation activities and to assist in validating a model. The output includes information such as VMT, VHT, average travel speed, comparisons of model volumes with observed traffic counts, and summary statistics that can be used to evaluate the model validation results.

3.8.2.1.2 Percent RMSE by Volume Groups

Percent errors have historically reflected a “plus or minus one lane” criteria in Florida. This concept means that highway assignment accuracy should minimize incorrect future lane calls resulting from projected traffic. Percent error standards are typically established by volume groups with small percent errors allowed for high-volume groups and larger percent errors for low-volume groups. **Table 3-2** depicts a range of accepted and preferable accuracy ranges for eight (8) volume groups as recommended in the [FSUTMS-Cube Framework Phase II Model Calibration and Validation Standards](#). RMSE can also be summarized by screenlines if needed. In addition, the volume differences can also be reviewed visually by using scatter plots of model estimated volumes versus counts.

Table 3-1 Regionwide Model Accuracy Volume-Count-Ratios

Volume-Over-Count Ratios	Standards	
	Acceptable	Preferable
Facility Type		
Freeway Volume-over-Count (FT1x, FT8x, FT9x)	+/- 7%	+/- 6%
Divided Arterial Volume-over-Count (FT2x)	+/- 15%	+/- 10%
Undivided Arterial Volume-over-Count (FT3x)	+/- 15%	+/- 10%
Collector Volume-over-Count (FT4x)	+/- 25%	+/- 20%
One way/Frontage Road Volume-over-Count (FT6x)	+/- 25%	+/- 20%
Peak Period		
Freeway Peak Volume-over-Count	75% of links @ +/-20%	50% of links @ +/-10%
Major Arterial Peak Volume-over-Count	75% of links @ +/-30%	50% of links @ +/-15%
VMT/VHT		
Assigned VMT-over-Count Areawide	+/-5%	+/-2%
Assigned VHT-over-Count Areawide	+/-5%	+/-2%
Assigned VMT-over-Count by FT/AT/NL	+/- 25%	+/- 15%
Assigned VHT-over-Count by FT/AT/NL	+/- 25%	+/- 15%
Screenlines/Cut lines		
External Model Cordon Lines	+/- 1%	-
Screenlines with greater than 70,000 AADT	+/- 10%	-
Screenlines with 35,000 to 70,000 AADT	+/- 15%	-
Screenlines with less than 35,000 AADT	+/- 20%	-

Source: [FSUTMS-Cube Framework Phase II Model Calibration and Validation Standards](#), Table 2.9, “Volume-Over-Count Ratios and Percent Error”, and discussions on Page 2-19.

Table 3-2 Regionwide Model Accuracy Assessment Percent RMSE

Volume Range, Vehicles Per Day	Standards	
	Acceptable	Preferable
LT 5,000	100%	45%
5,000-9,999	45%	35%
10,000-14,999	35%	27%
15,000-19,999	30%	25%
20,000-29,999	27%	15%
30,000-49,999	25%	15%
50,000-59,999	20%	10%
60,000+	19%	10%
Areawide	45%	35%

Source: [FSUTMS-Cube Framework Phase II Model Calibration and Validation Standards](#), Table 2.11, “Root Mean Square Error (RMSE)”, Page 2-21.

3.8.2.2 Project Level Model Accuracy Assessment

Project level model validation is typically focused on network details within the project AOI. Many of the same validation checks for regional models still apply. Highway validation checks will require more stringent accuracy standards for volume-over-count ratios for various facilities and screenlines. **Table 3-3** shows the link volume-over-count accuracy standards for validation by facility type within a project study area. This is based on the recommendations in the [FSUTMS-Cube Framework Phase II Model Calibration and Validation Standards](#) for corridor level validation.

Table 3-3 Project Level Model Accuracy Assessment V/C Ratios

Volume-Over-Count Ratios	Standards	
	Acceptable	Preferable
Facility Type		
Freeway Volume-over-Count (FT1x, FT8x, FT9x)	+/- 6%	+/- 5%
Divided Arterial Volume-over-Count (FT2x)	+/- 10%	+/- 7%
Undivided Arterial Volume-over-Count (FT3x)	+/- 10%	+/- 7%
Collector Volume-over-Count (FT4x)	+/- 15%	+/- 10%
One way/Frontage Road Volume-over-Count (FT6x)	+/- 20%	+/- 15%
Screenlines/Cut lines		
External Model Cordon Lines	+/- 0%	-
Screenlines with greater than 70,000 AADT	+/- 5%	-
Screenlines with 35,000 to 70,000 AADT	+/- 10%	-
Screenlines with less than 35,000 AADT	+/- 15%	-

3.8.3 Base Year Model Refinement

The commonly used model refinements include the following:

- The network should be updated to ensure proper representation of traffic patterns through the inclusion of parallel roadway links, collectors, and other secondary roads within the project AOI. Acceptable refinements include changes in facility type, area type and number of lanes.
- The TAZ centroid connectors and their location need to be examined and adjusted if necessary.
- The socio-economic data in the TAZs or other geographic analysis units should be updated to reflect the existing year.
- Trips generated by prominent activity centers should be compared and evaluated with the actual traffic counts (where appropriate). If differences exist, adjustments will be needed, such as revising the special generator file (ZDATA3) if applicable.
- Travel characteristic data should be modified within the zones using updated household travel surveys, recent origin and destination surveys, and other data sources.

- All adjustments should be made based on solid evidence and all changes should be properly documented.

Once all refinements have been completed, the entire model should be rerun. An analysis should first be conducted on the entire model to ensure that the refinements in the project AOI did not negatively impact the overall model validation. When it has been established that the entire model operates on the same level of accuracy or perhaps at an improved level, the project AOI should be analyzed on its accuracy (see **Table 3-1** to **Table 3-3** for standards) and its size. If significant changes occur outside the preliminary project AOI, determine whether changes to the project AOI are required. Based on this analysis it should be determined if the project should be expanded to include the affected facilities and if other development mitigation infrastructure improvements are required.

Expansion of the project AOI may also require reexamination of the base year model volumes with the base year counts throughout the expanded project. If the project model evaluation is not acceptable through the entire expanded project AOI.

It may be required to make further base year model refinements to achieve acceptable volumes and repeat travel demand forecasting. Close coordination should take place with the District Planning Office to reach an acceptable level of accuracy.

3.9 Consistency with the Adopted LRTPs and LGCPs

There are three steps that need to be performed to verify the project consistency with the MPO/TPO/TPAs' Long Range Transportation Plan (LRTP) or a Local Government's Comprehensive Plan (LGCP): Consistency with the Plan(s), Plan Amendment/Alternative, and Inconsistency Documentation/No Project.

3.9.1 Consistency with the Plan(s)

The number of lanes needed to accommodate future travel demands shall be compared with the existing MPO/TPO/TPA Long Range Transportation Plans in metropolitan areas and local government comprehensive plans and plan amendments. If the project is not consistent with the approved plans, go to the Plan Amendment/Alternative.

3.9.2 Plan Amendment/Alternative

If the corridor traffic forecast results are inconsistent with the LRTP and/or LGCP, or a plan approved by FDOT, the proposed transportation alternatives (such as public transportation alternatives or parallel routes) need to be reexamined. If this analysis does not resolve the inconsistency issue, requests need to be made to the appropriate District Director or his/her designee(s) to modify either the existing FDOT plans (such as Action or Master Plans) or initiate the process to request the local government to amend the LGCP or the MPO/TPO/TPA to revise

its LRTP. In any event, the party that requested the corridor study should be notified of the inconsistency and be involved in the decision to remedy it. If alternative transportation improvements are to be tested, redo the project traffic forecast process and perform calculations for the new alternative. If the local government and/or the MPO/TPO/TPA or the FDOT does amend or revise the applicable plans, prepare the necessary forecast. If the local government and/or the MPO/TPO/TPA or the FDOT does not amend or revise applicable plans, go through the steps as described in **Section 3.9.3**.

3.9.3 Inconsistency Documentation/No Project

If the appropriate District Director or his/her designee(s) approves the project due to extenuating circumstances, include a statement in the Corridor or adopted plan. State in the report the process that was used in **Section 3.9.2** and the decisions made. Include in the document any written letters or agreements generated as part of the activities in **Section 3.9.2**. If the project is not viable, indicate in the conclusion of the report that the study resulted in a “No Project.”

3.10 Development of Future Travel Demand

After the base year model validation is approved, and appropriate validation refinements and future land use data revisions have been incorporated into the forecast year model(s), the model is ready to determine future year traffic forecasts for resurfacing projects. If the model is used for corridor or project analysis, additional validation procedures may need to be executed.

3.10.1 Evaluation of Future Year Conditions

To develop project traffic for a given year, appropriate future year data inputs are required. For each of the future analysis years, the following model inputs should be summarized:

- Transportation network
- Socio-economic/land use data

Each of these data items should be updated to reflect the approved elements of the MPO/TPO/TPA cost feasible long-range transportation plan, master plans and planned development mitigation infrastructure improvements anticipated to be in place in each analysis year.

3.10.2 Reasonableness Checks for Future Years

Future year traffic volumes cannot be validated against existing traffic counts. The model output must be checked and certified. The modeled volume changes for each year of analysis and for each alternative network should be evaluated against the expected changes. Although expected changes cannot be accurately quantified, approximate changes should be estimated. For example, if the region’s growth is expected to continue, freeway volumes should increase with some relationship to the trend. The average percent of change between years should be relatively

constant unless some special factors affect the growth, such as roadway improvements along parallel facilities.

The model-generated volumes for the future years should be reviewed for logical traffic growth rates. The general growth trends prevalent in the area should be determined and compared with the modeled traffic volumes. The future year model volumes should be compared against the appropriate historical count data. If an unexplained growth rate exists, a thorough review of the base and future year land use, socio-economic data and network coding should be performed.

Logical reasons for any anomalies should be documented. A careful comparison is required, especially for urbanized areas where growth may be higher along undeveloped corridors while on an area-wide basis it may be much lower.

3.10.3 Acceptable Model Refinements for Future Years

Models frequently provide insights into traffic route selection that may not be readily apparent. However, where model results do not appear to be reasonable, the deviations must either be explained or acceptable revisions to the network, land use, or socio-economic data need to be made. If the model results are not reasonable and cannot be corrected, then use the historical traffic forecasting processes described in **Chapter 4**.

3.10.4 Adjusting Future Year Model Volumes Due to Base Year Model Volume Deviations

There are inherent discrepancies between base year model volumes and base year traffic counts. Future year model volumes are often adjusted to account for possible traffic assignment errors. The underlying assumption is that errors associated with base year model assignment results could continue to occur proportionally in any future year forecasts. **NCHRP Report 255** offers guidelines for making such adjustment and the methods are still valid and frequently used in practice. For convenience purposes, these guidelines are repeated here.

A future year link volume is adjusted using two factors: the ratio of the actual base year traffic count to the base year model volume and the numerical difference between the actual base year traffic count and the base year model volume. The two factors are then applied to the future year model volumes using **Equation 3-2** and **Equation 3-3**.

Ratio Adjustment:

$$V_{r_adj} = \frac{Count}{V_b} \times V_f$$
Equation 3-2

Difference Adjustment:

$$V_{d_adj} = (Count - V_b) + V_f$$
Equation 3-3

Where

V_{r_adj} – adjusted future year model volume by ratio method

V_{d_adj} – adjusted future year model volume by difference method

$Count$ – base year traffic count

V_b – base year model volume

V_f – future year model volume

The final adjusted future year traffic forecast, V_{adj} , is then the average of the two adjusted model volumes V_{r_adj} and V_{d_adj} , as shown in **Equation 3-4**.

$$V_{adj} = (V_{r_adj} + V_{d_adj})/2 \quad \text{Equation 3-4}$$

Two issues may occur with either the ratio adjustment method or the difference adjustment method. If V_{d_adj} is a large negative number and its absolute value is higher than V_{r_adj} , the adjusted future volume V_{adj} could be a negative number. In this case, it is suggested that only the ratio adjustment method be used. On the other hand, if the base year count is significantly higher than the base year model volume, the adjusted future year volume could be excessively high. In this case, it is suggested that only the difference adjustment method be used.

These adjustments should only be applied to roadways that are not expected to experience significant increase in capacity in the future. Where major capacity change will occur (i.e., greater than 25 percent), there are usually other extraneous factors such as land use implicit in the future year model results. The assumption that the base year assignment errors will carry over proportionally in future year forecasts may no longer hold. The user must exercise professional judgement when applying these methods.

3.11 Documentation of Traffic Forecast

When using model output for determining project traffic forecasting, plots of the study area should be maintained in the file. Tabulation of the forecasts for the interim and design year with appropriate documentation of the methodology and reasonableness evaluation should be included in an individual section of the Project Traffic Forecasting Report. This information should then be utilized in the development of forecast year turning movements and axle loadings as defined in this handbook.

3.11.1 Turning Movements Schematics

Schematic diagrams of the project should be completed if turning movements are involved. These diagrams should show AADTs, turning movements, K, D, and T factors.

3.11.2 Certification

A certified report including K, D, T, base year AADT, forecasted AADTs, and an 18-KIP ESAL forecast (if applicable) should be sent to the requestor with copies sent to the appropriate district personnel. The project traffic shall be certified using the certification statement form shown in **Figure 3-5**. If an 18-KIP ESAL is requested, use the certification form shown in **Figure 3-6**. All assumptions used in the estimation process and all the conditions to be considered when using the data should be included in the final report.

Form 130-B

Project Traffic

Financial Project ID _____
 State Road No. _____
 County _____

I have reviewed the Project Traffic to be used for design on this project. I hereby attest that it has been developed in accordance with the FDOT **Project Traffic Forecasting Procedure** using historical traffic data and other available information.

Name

Signature

Title

Organizational Unit

Date

Source: FDOT Design Manual, Chapter 103.

Figure 3-5 Project Traffic Forecasting (PTF) Certification Statement

Form 130-A

18 KIP Equivalent Single Axle Loads (ESAL)

Financial Project ID _____
 State Road No. _____
 County _____

I have reviewed the 18 KIP Equivalent Single Axle Loads to be used for pavement design on this project. I hereby attest that these have been developed in accordance with the FDOT **Project Traffic Forecasting Procedure** using historical traffic data and other available information.

Name

Signature

Title

Organizational Unit

Date

Source: FDOT Design Manual, Chapter 103.

Figure 3-6 18-KIP ESAL Forecasting Certification Statement

3.12 The Model Output Conversion

Most of the models used in the State of Florida are validated to peak season travel conditions. The traffic volumes generated by the model represent the Peak Season Weekday Average Daily Traffic (PSWADT). The peak season is defined as the thirteen (13) consecutive weeks of the year with the highest traffic volume demand. The exceptions are the Southeast Regional Planning Model (SERPM), the Treasure Coast Regional Planning Model (TCRPM), and the Florida Statewide Model (FLSWM), where the model is validated to average daily travel conditions and the model generated traffic volumes represent the Average Annual Daily Traffic (AADT). While PSWADT can be used for planning purposes, AADT is required to estimate the design hour traffic for design and operational analysis.

A Model Output Conversion Factor (MOCF) can be used to convert PSWADT to AADT. The MOCF is site specific and should be obtained from the Peak Season Factor Report provided by the FDOT Transportation Data and Analytics Office. The following sections describe how to obtain the necessary conversion factors to convert daily traffic counts to PSWADT and AADT, and how to convert PSWADT to AADT.

3.12.1 Model Output Conversion Factor (MOCF) and Peak Season Conversion Factor (PSCF)

As mentioned in **Section 2.5.1**, Seasonal Factors (SF) are calculated for each week of the year for each permanent count station and reported in a Peak Season Factor Category Report. Peak Season Factor Category Reports are prepared by volume category and by county and are available through the Florida Traffic Online Web Application. Seasonal Factors are used to convert an average weekday 24-hour traffic count to AADT. (See **Equation 3-5**.)

$$AADT = ADT \times SF$$

Equation 3-5

Figure 3-7 shows an example Peak Season Factor Category Report for Category 4800 covering the entire Escambia County that is not covered by other categories in the county.

The weekday Peak Season Factor Category Reports also include Model Output Conversion Factors (MOCF). The MOCF is the average of Season Factors for the 13 consecutive weeks during which the highest weekday volumes occur and when the sum of SFs for those 13 weeks are the lowest. In this example, MOCF is the average of the 13 SFs from Week 27 to Week 39, which is equal to 0.99 for this category. The MOCF is used to convert the traffic volumes generated by a travel demand forecasting model (PSWADT) to AADT. (See **Equation 3-6**.)

$$AADT = PSWADT \times MOCF$$

Equation 3-6

Weekly factors obtained from FDOT continuous count stations around the state are used to prepare annual updates of the Peak Season Conversion Factors (PSCFs). PSCFs are obtained

by dividing the SFs by the MOCF for the same week. For example, for the first week of 2017 from January 1, 2017 to January 7, 2017 for Category 4800 in Escambia County (**Figure 3-7**), the SF is 1.01, the MOCF for the category is 0.99. The corresponding PSCF can be calculated by dividing SF of 1.01 by MOCF of 0.99, which yields 1.02. The PSCFs are used to convert a 24-hour count, representing the average weekday daily traffic, to PSWADT. (See **Equation 3-7**.)

$$PSWADT = ADT \times PSCF$$

Equation 3-7

3.12.2 Converting Short-Term Counts, PSWADT, and AADT

Validating a project level travel demand model often requires collecting additional traffic counts in the study area. Depending on the model being used, the short-term traffic counts will need to be converted to either AADT or PSWADT before coded into the model network. For example, a 24-hour traffic count of 25,841 was taken on a roadway in Escambia County on Wednesday, February 7, 2018 for a corridor study. The Northwest Florida Regional Planning Model (NWFRPM) is being used for the study. Since the NWFRPM model is a PSWADT based model, the short-term count needs to be converted to PSWADT before being included in the model network for model validation purposes. Since the Peak Season Factor Category Reports for Year 2018 are still not available, the reports from the previous year (2017) have to be used. According to **Figure 3-7**, the PSCF for the 6th week of February 5 – 11, 2017 is 1.04. The short-term counts can be converted to PSWADT as follows:

$$\text{Daily Count} \times \text{Peak Season Conversion Factor} = \text{PSWADT}$$

$$25,841 (\text{daily Count}) \times 1.04 (\text{PSCF}) = 26,875 \rightarrow 27,000 (\text{PSWADT})$$

The SF is used to convert any weekday 24-hour count to AADT. For example, the same count above could be converted to AADT and rounded using AASHTO Standards as follows:

$$\text{Daily Count} \times \text{Seasonal Factor} = \text{AADT}$$

$$25,841 (\text{daily Count}) \times 1.03 (\text{SF}) = 26,616 \rightarrow 27,000 (\text{AADT})$$

The MOCF is used to convert model output to AADT when necessary. Based on **Figure 3-7**, the MOCF for Category 4800 in Escambia equals to 0.99. In the same example, after the model is validated, the model is used to forecast future travel demand. If the model volume for the same location for the design year is 31,526, the AADT can be obtained by applying MOCF as follows:

$$PSWADT \times MOCF = AADT$$

$$31,526 (\text{PSWADT}) \times 0.99 (\text{MOCF}) = 31,211 \rightarrow 31,500 (\text{AADT})$$

Chapter 4 Forecasting Without a Travel Demand Model

4.1 Introduction

This section provides a description of appropriate methods and examples for forecasting future traffic in areas without a travel demand model and provides a basis of comparison to model forecasts in areas with a model.

For areas without a travel demand model, forecasting is normally based on historical trends. Growth rates may be developed utilizing census data, employment data, and by working with the relevant county, city, and other local government agencies and using information from their comprehensive plans. When historical AADT data is used, a regression analysis is performed using the most recent ten years of data, when available. Even though linear growth pattern is normally assumed, care should be taken to examine the growth trend in the past and any constraints or policy changes that may alter the development pattern in the future. Other forms of growth patterns such as exponential, decaying exponential, or composite growth patterns can also be used for analysis. The historical data need to be reviewed to check for consistency and reasonableness. Outliers should be reviewed and removed from the analysis if no logical reasons could be found for the inconsistencies.

4.2 Purpose

The purpose of this section is to suggest methods for using trend analysis results, local land use plans, and other indicators of future development in the project traffic forecasting process.

4.3 Unconstrained Versus Constrained Demand

Forecasters rely on different techniques depending on the available information. Growth rates from historic traffic counts, adjusted to AADT by application of appropriate factors, are derived and checked for reasonableness. The growth rates are then applied to a base year volume and projected forward to the design year. Projections obtained this way represent unconstrained demand for the future.

A constrained forecast is for the final design of a facility where expected traffic volumes will be limited by the ultimate capacity of the facility. When using constrained forecasts, the future demand is “sized” to the design of the facility and not the “true” traffic demand. For example, if the demand is for a six-lane facility and a four-lane is being designed, it should be noted in the Project Traffic Forecasting Report that four lanes will not be adequate for a 20-year design, and steps should be taken to address the potential short fall.

4.4 Project Traffic Forecasting Without a Travel Demand Model

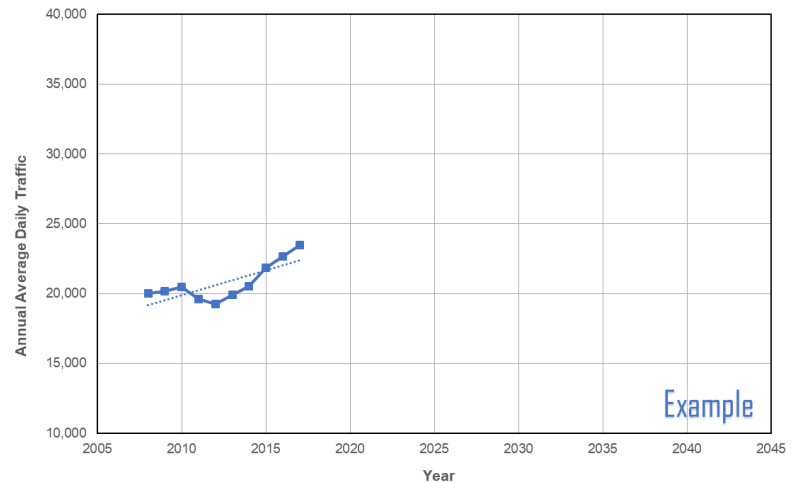
4.4.1 Data Assembly

When a travel demand model is not available, the following items should be assembled when available and checked for their applicability for preparing a Project Traffic Forecast:

1. Mapping or other roadway location drawings of the facility requiring traffic projections (Project Location Map)
2. Graphical representation of existing lane configuration (i.e., straight line diagram (SLD), aerial photography, intersection diagrams, etc.)
3. Data needed to determine traffic growth trends
 - a) Historical traffic count data (current year plus nine earlier years of mainline traffic data preferred; but if ten years of data is not available, current year plus four or more earlier years of mainline traffic and/or intersection approach volumes)
 - b) Existing and future land uses which contribute traffic that would use the proposed facility.
4. Traffic factors:
 - a) K – the Standard K Factor
 - b) D – This factor can be derived from one of the following sources: the Volume Factor Category Summary Report for the roadway category that the study location belongs to, an FDOT count station in or near the study area where a Synopsis Report is available, or a 24-hour to 72-hour project specific classification count taken within the project limits.
 - c) T – The T factor can be obtained from either an FDOT Classification Station in or near the study area or a 24-hour to 72-hour project specific classification count taken within the project limits.
5. Local Government Comprehensive Plan (land use and traffic circulation elements)
6. Adopted MPO/TPO/TPA Long Range Transportation Plans (LRTPs)
7. Current Highway Capacity Manual (HCM) and relevant software
8. Current FDOT Quality/Level of Service (LOS) Handbook and relevant worksheets based on the HCM methods
9. Current and historical population data.
10. Current and historical employment data.
11. The project opening and design years.

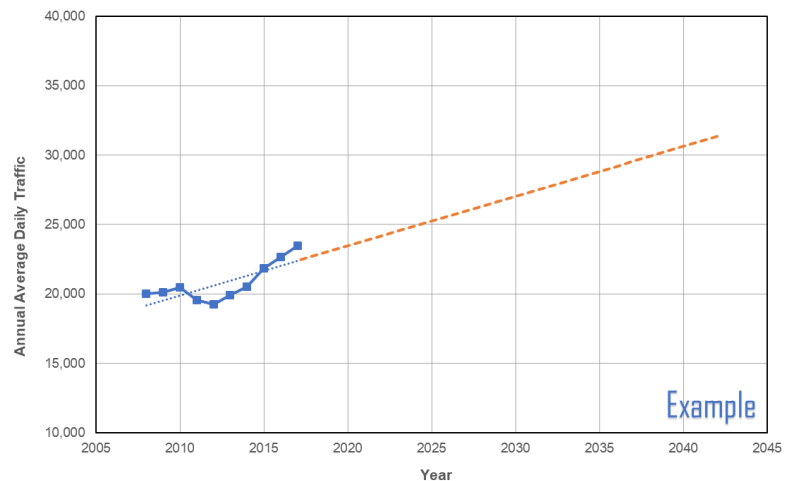
4.4.2 Establish Traffic Growth Trend

1. Plot historical AADT at a convenient scale with traffic volume on y axis and year of count on x axis (leaving room for future year and traffic growth).
2. Use least squares regression analysis combined with graphical representation of traffic growth trends.
3. If historical count data are insufficient, prepare a similar analysis of alternative indicators (population data, employment).



4.4.3 Develop Preliminary Traffic Projection

1. Use empirically derived traffic growth trend equation to compute design year traffic volume.
- OR,**
2. Use graphical methods to project traffic volume from growth trend history to the design year.



4.4.4 Check Traffic Forecast for Consistency and Reasonableness

1. If future year geometric and traffic control design characteristics are firmly established (i.e., fixed by adopted plan(s) or constraints) determine the future capacity of the roadway section. If design is flexible enough to satisfy unconstrained demand, skip to #3.

2. Compare the projected demand traffic volume to the available capacity. A constrained volume may be given, instead of an unattainable volume (e.g., a four-lane facility is 15 percent over capacity today and the project is for a six-lane facility, with trend analysis projections exceeding capacity for a six-lane facility). It should be noted in the Project Traffic Forecasting Report that the facility being designed will not be adequate for a 20-year design period.
3. Review expected land use changes in the vicinity and determine whether projected traffic growth is consistent with the projected growth of population, employment or other variables and adjust if necessary. For example, if a new shopping center, office park, tourist attraction, etc., is expected to be built prior to the design year, then projections based on historical traffic trends would underestimate the design year traffic. In such cases, ITE trip generation rates could be used to establish daily and peak hour trips for the new land uses. A logical distribution of resulting site generated trips to available roadways should be based on knowledge of local travel patterns and used to adjust the traffic forecast. Conversely, the closing of an existing traffic generator would be expected to cause a reduction of the traffic forecast.

4.4.5 Develop Project Traffic Forecast Detail

1. If the subject roadway intersection exists, use observed daily turning movement percentages at existing intersection(s) to convert future year link volumes to turning movement forecasts. Otherwise, logical turning movement percentages must be derived from observation of other roadways located in similar environments and/or specialized software that will calculate turning percentages utilizing the approach volumes. Note that the observed turning percentages are valid for future year forecasts only if land use and transportation network characteristics remain constant or if projected changes in those characteristics are proportional to the existing pattern.
2. Review daily turning movements for consistency with special traffic generators, and transportation network characteristics in the vicinity. Use the ITE generation and logical trip distribution approach to adjust, if necessary.
3. Balance adjusted daily turning movement volumes to achieve directional symmetry. A simple way to do this is to sum the opposing traffic movements and divide by two. There may be some situations when balancing the intersection may not be appropriate. See **Chapter 6** for a more detailed discussion about estimating intersection turning movements.
4. Use K and D factors to develop directional design hour traffic projections in the peak periods. The AM and PM forecasts usually involve reversing the peak direction of flow.

5. Review the AM and PM design hour volumes for consistency with the trip generation activity pattern of the projected land uses in the vicinity and adjust volumes as necessary. Such adjustments are made with reference to observed differences in travel characteristics such as numbers of trips and directional splits that occur during morning and evening peak periods. Directional traffic counts collected at local land use sites may provide the necessary data or the ITE Trip Generation Manual may be used to obtain the peak period trip generation characteristics of various land use/special generator sites.

4.4.6 Analysis of Projections

1. For Project Traffic and Intersection Analysis Reports for use in district planning and PD&E studies, the following analysis should be performed:
 - a) Perform intersection analysis utilizing the most recent version of the HCS software. Adjust signal timing plans and lane configurations as necessary to obtain an acceptable LOS. Justification must be made for all lanes added above and beyond the existing conditions.
 - b) Perform arterial analysis utilizing the most recent version microsimulation software. Adjust intersection analysis as necessary to obtain an acceptable LOS.
2. For ESAL forecasting to be used in pavement design, perform LOS analysis utilizing the appropriate LOS spreadsheet. The LOS “D” volume derived for the appropriate number of lanes can be utilized in calculating the 18-KIP ESAL.

4.4.7 Final Review and Documentation

1. Perform final quality control (QC) review for consistency and reasonableness of projections. The assessment of reasonableness should examine traffic projections in comparison with observed traffic and historical trends, prospective roadway improvements, and land use projections. The QC review should also perform error checks to ensure that input numbers have been correctly transcribed and traffic forecasting computations have been done correctly.
2. Prepare Project Traffic Forecasting Memorandum documenting procedures, assumptions, and results.
3. Prepare Project Traffic Forecasting Certification Statement and 18-KIP ESAL Forecasting Certification Statement. (See **Figure 3-5** and **Figure 3-6**). Refer to Project Traffic Forecasting Procedure, Topic No. 525-030-120, and obtain all authorized signatures.

4.5 Available Resources

In areas where a model is not available, resources have to be identified for assisting in the preparation of traffic forecasts. The following list presents available resources for developing future traffic projections for areas without models and for checking traffic forecasts for areas with models:

- Population Studies Program, The Bureau of Economic and Business Research (BEBR), University of Florida (<https://www.bebr.ufl.edu/content/population-studies>)
- Demographic Analysis, FDOT Forecasting and Trends Office (FTO) (<http://www.fdot.gov/planning/demographic/>)
- American FactFinder, U.S. Census Bureau (<https://factfinder.census.gov/faces/nav/jsf/pages/index.xhtml>)
- Labor Market Information, Florida Department of Economic Opportunities (FDEO) (<http://www.floridajobs.org/labor-market-information>)
- Historical traffic counts, [Florida Traffic Online Web Application](#), the [Transportation and Data Analytics Office \(TDA\)](#)
- NCHRP Report 255, “Highway Traffic Data for Urbanized Area Project Planning and Design”
- [NCHRP Report 365, “Travel Estimation Techniques for Urban Planning”](#)
- [NCHRP Report 765, “Analytical Travel Forecasting Approaches for Project-Level Planning and Design”](#)
- Property appraisal data, Property Appraisal Office
- Local Government Comprehensive Plans (land use, traffic circulation, and transportation elements), FDOT district office/local government office
- Land use maps
- Area Applications for Development Approval (ADA), FDOT district office, regional planning councils
- “Trip Generation Manual”, Institute of Transportation Engineers (ITE) (Current Version)
- Motor vehicle registrations, Department of Highway Safety and Motor Vehicles (DMV)
- MPO/TPO/TPA Long Range Transportation Plans (LRTPs) and Transportation Improvement Program (TIP)

Other factors that should be considered when making forecasts for areas without a travel demand model include the following:

- Density
- Area size
- LOS (existing and targets)
- Transit alternatives
- Auto ownership
- Household income

- Residential/non-residential mix
- Freeway diversion
- Other unique area considerations

4.6 Example Traffic Projection for I-10/SR-8 in Columbia County

The following example shows the steps to be performed to develop project traffic for a road widening project in Columbia County. Columbia County is not currently covered by any of the regional models in Florida. To forecast future year traffic for roadways in Columbia County, trend projection procedures will be used.

Step 1 Assemble Available Data

1) Project Location Map

The project is located on I-10/SR-8 near CR-250 Overpass in Columbia County. It currently has two-lanes in each direction. The project requires Year 2042 AADT at this location to determine the number of lanes needed in the future. **Figure 4-1** shows the project location.



Figure 4-1 I-10/SR-8 Project Location Map

2) Historical Traffic Counts

Based on [Florida Traffic Information Online](#), Continuous TMS 299936 is located within the study area, and historical traffic counts are available from 2002 to 2017. (See **Figure 4-2** and **Figure 4-3**.)

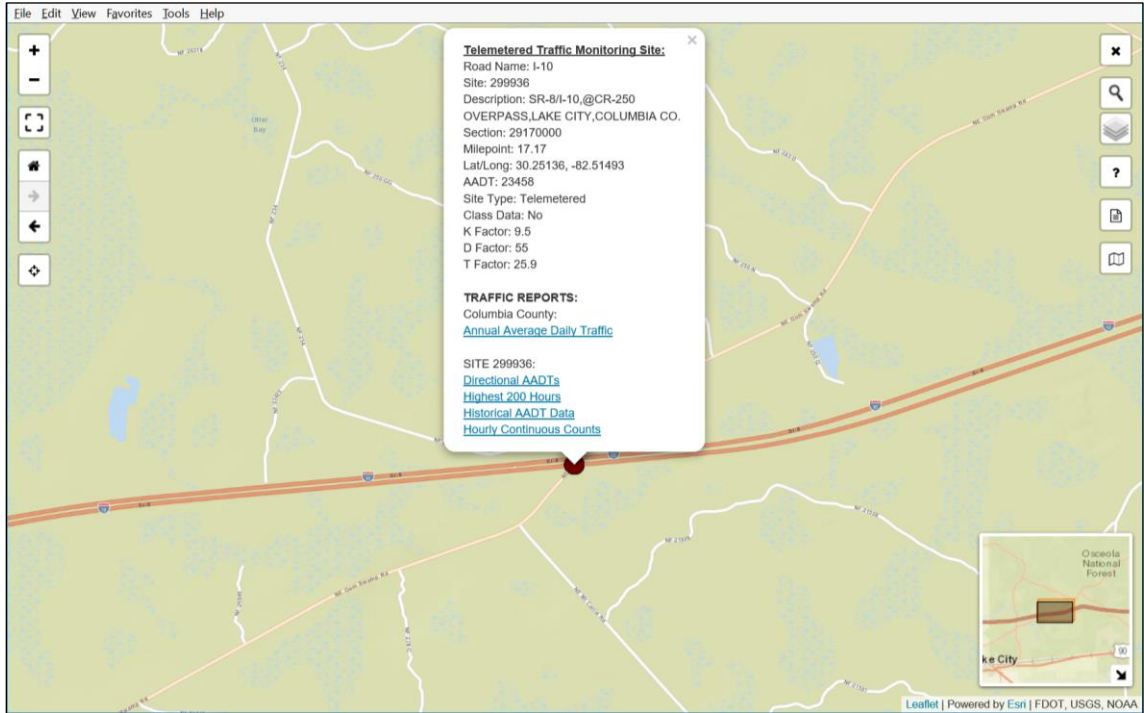


Figure 4-2 - Continuous Count Site within Study Area

FLORIDA DEPARTMENT OF TRANSPORTATION
TRANSPORTATION STATISTICS OFFICE
2017 HISTORICAL AADT REPORT

COUNTY: 29 - COLUMBIA
SITE: 9936 - SR-8/I-10,@CR-250 OVERPASS, LAKE CITY, COLUMBIA CO.

YEAR	AADT	DIRECTION 1	DIRECTION 2	*K FACTOR	D FACTOR	T FACTOR
2017	23458 C	E 11655	W 11803	9.50	55.00	25.90
2016	22652 C	E 11330	W 11322	10.50	55.00	25.90
2015	21826 C	E 10964	W 10862	10.50	54.90	24.10
2014	20540 C	E 10241	W 10299	10.50	54.70	24.30
2013	19908 C	E 9940	W 9968	10.50	55.00	26.40
2012	19239 C	E 9627	W 9612	10.50	54.10	25.30
2011	19580 C	E 9805	W 9775	10.50	54.10	24.00
2010	20476 C	E 10242	W 10234	12.36	56.07	23.30
2009	20140 C	E 10090	W 10050	11.94	57.52	22.30
2008	20000 F	E 0	W 0	11.34	53.25	16.80
2007	21151 C	E 10565	W 10586	11.34	53.25	16.80
2006	21751 C	E 10855	W 10896	11.34	53.25	16.80
2005	21404 C	E 10710	W 10694	11.80	54.80	27.50
2004	20838 C	E 10416	W 10422	11.30	54.50	25.40
2003	20161 C	E 10143	W 10018	11.80	57.60	24.00
2002	20287 C	E 10104	W 10183	12.50	57.00	27.10

Figure 4-3 - Historical Counts at Continuous Site 299936

3) Historical Population Data

Both [Bureau of Economic and Business Research \(BEBR\)](#) and [FTO](#) publishes annual population estimates by county by district on their websites. Historical population data can be obtained from these sources. **Table 4-1** shows the historical population for Columbia County for the ten years from 2008 to 2017.

Table 4-1 - Historical Population Estimates for Columbia County

Year	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017
Population	66,121	66,409	67,531	67,528	67,729	67,489	17,826	68,163	68,566	68,943

4) FDOT Population Projections from 2020 to 2045

The FTO publishes population projections by county by district on its [Demographic Analysis Website](#). The most recent available data is for Years 2020 to 2045 in five-year increment adjusted based on 2016 population estimates. **Table 4-2** shows the population for Columbia County for Census Year 2010, Year 2016, and projections for years 2020 to 2045.

Table 4-2 - FDOT Population Projections for Columbia County

Year	2010	2016	2020	2025	2030	2035	2040	2045
Population	67,531	68,566	71,100	73,700	75,800	77,600	79,100	80,300

Step 2

Conduct Regression Analysis using Historical Traffic Data

The linear regression analysis using AADT data from Year 2008 to Year 2017 showed an average annual growth of 358 AADT. The growth trend that occurred between 2008 and 2017 was assumed to be applicable for forecasting existing traffic for Year 2042. Based on that assumption, traffic on this segment is expected to increase from 23,458 AADT in 2017 to 32,408 AADT in 2042. This growth rate calculates to an average of 1.53% in linear growth per year. (See **Figure 4-4.**)

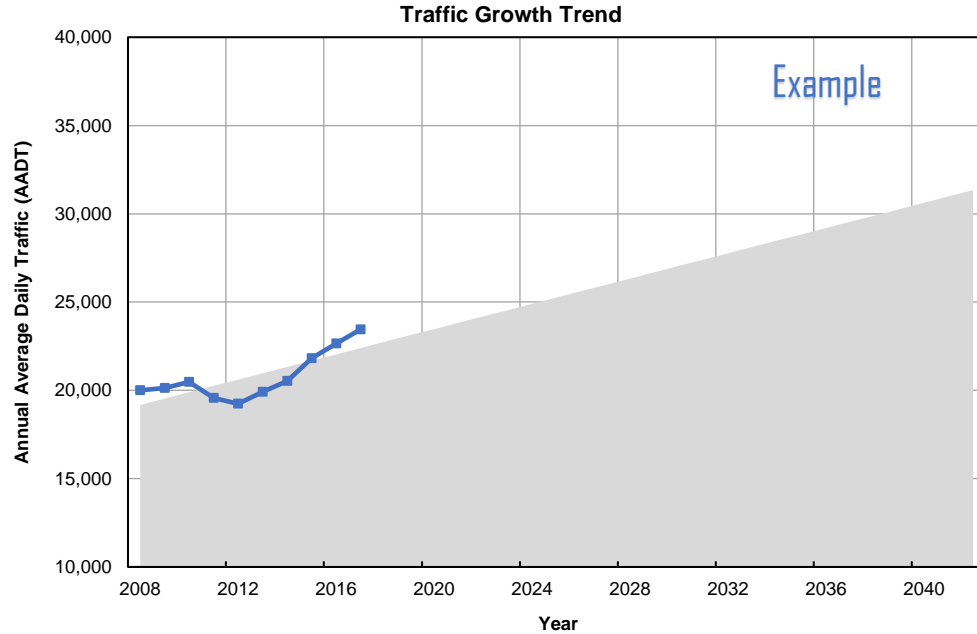


Figure 4-4 Traffic Growth Trends

Step 3 Review Traffic Projections for Reasonableness

According to FDOT’s Population Projections from 2016 to 2045, the population of Columbia County is expected to increase from 68,566 in 2016 to 80,300 in 2045 (See **Figure 4-5**.) This is an average of 0.59% in linear growth per year.

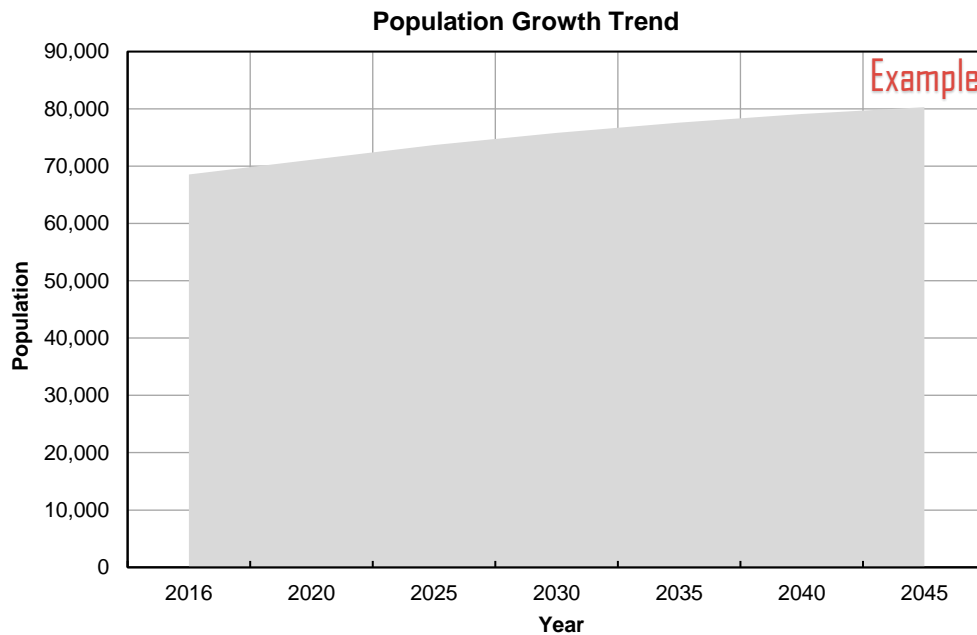


Figure 4-5 - Population Growth Trends

A comparison was then made to historical data. Using BEBR population estimates, Columbia County’s population increased from 66,121 in 2008 to 68,943 in 2017. This was an 4.3% increase over a 10-year period, or an average of 0.43% in linear growth per year. By comparison, traffic increased from 20,000 in 2008 to 23,458 in 2017. This is a 17.3 % linear increase over a 10-year period, or an average of 1.73% in linear growth year. Therefore, it is apparent that the trend forecast showing future traffic increasing at a rate higher than the rate of population growth is consistent with the past trend between 2008 and 2017. (See **Figure 4-6.**)

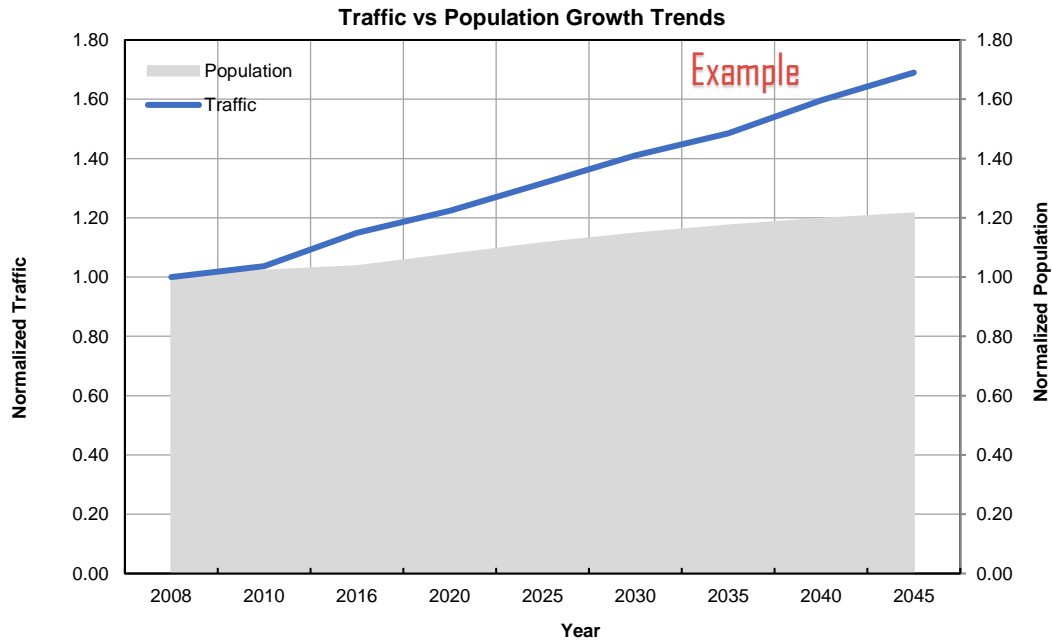


Figure 4-6 Traffic Vs. Population Trends

4.7 Summary

A project traffic forecast estimated without a travel demand model should reflect an evaluation of the effect of future traffic growth relative to historical trends, the addition of major development, the diversion of traffic to nearby facilities and the impact of capacity constraints. The traffic forecast should be made using the best available resources and engineering judgment. Also, results obtained from travel demand forecasting models should be compared to forecasts by alternative procedures, such as a simple trends analysis, to check for reasonableness.

All FDOT districts rely on trend analyses for areas where models do not exist and as a guide for checking the model projections.

Chapter 5 Directional Design Hour Volumes

5.1 Introduction

The Annual Average Daily Traffic (AADT) obtained from the model or trend analysis provides a general indication of the travel demand for a transportation facility, but it does not reflect the hourly variation of travel demand. If the design is based on AADT, there could be many hours of a day when the facility will fail. Traditionally, it is accepted that taking a peak hour represents a balance between choosing a very short peak period (e.g., 5 minutes) and choosing a very long peak period that will result long failure time. The volume corresponding to the peak hour is the design hour traffic (DHV). The DHV however, does not capture the spatial variation in traffic demand between the two directions. The traffic in the peak direction represents the least variation in travel demand and therefore is used to determine the number of lanes required for the facility. Furthermore, considering the temporal variation of traffic within an hour, there could be time periods where the facility could still fail. One way to measure the sub-hour traffic variation is to calculate the Peak Hour Factor (PHF), which equals to the hourly volume divided by the peak 15-minute traffic within the hour timed by four. The DDHV and PHF are used together with heavy vehicle parameters to compute equivalent hourly flow rate. The flow rate is then used to estimate the LOS for the facility.

As mentioned earlier, DDHV can be obtained by multiplying AADT by K and D factors. DDHV can be used for design and design hour traffic operational analysis. In most cases, it is necessary to estimate directional peak hour volumes for AM and PM peak period for a typical day. If the design hour happens to coincide with either the AM or PM peak hour of a typical day, and if AM and PM happen to be the mirror image of each other, then no additional work is needed. If not, the peak period volumes for the AM and PM peak periods need to be estimated separately. The directional design hour volumes can then be used to further estimate turning movement volumes for intersection operational analysis.

5.2 Purpose

This chapter describes methods used for developing Directional Design Hour Volumes (DDHV). It also discusses methodologies for estimating directional peak hour volumes for both design hour and other peak periods.

5.3 Development of DDHV Volumes from AADT

5.3.1 General Procedure

DDHV is obtained by applying K and D factors to AADT projections as outlined in this Handbook. The AADT projections may be the result of the conversion of model generated traffic projections (PSWADT) or they may be produced by means of other techniques, such as trend analysis or growth factor application.

The K factor converts the 24-hour AADT to an estimate of two-way traffic in the analysis hour of the year which is required for design purposes. The result is called the Design Hour Volume or DHV. Standard K Factors are shown in **Section 2.6.2**.

The D factor converts two-way traffic volume DHV to an estimated Directional Design Hour Volume or DDHV. Appropriate D factors are developed as described in **Chapter 2**. By convention, the D factor always pertains to the peak direction of traffic flow during the design hour.

Project specific data are used to derive factors for obtaining DDHV from AADT. Project specific factors should be within the ranges of factors developed by FDOT from permanent count stations. In most instances, the range of factors provided by the FDOT should be adequate for most individual projects.

Using both (i.e., K and D) factors, the estimated DDHV is obtained by the following equations:

$$DDHV(\text{Peak Direction}) = AADT \times K \times D \quad \text{Equation 5-1}$$

$$DDHV(\text{Opposite Direction}) = AADT \times K \times (1 - D) \quad \text{Equation 5-2}$$

Using the above procedures, DDHV project traffic forecasts are generated for roadway links and then intersection turning movements as needed to satisfy project development and design requirements.

5.3.2 Development of DDHVs from Model PSWADTs Example

As an example, assume that an urban arterial in Orlando is being studied for future widening. Existing roadway within the study area is to be widened from four lanes to six lanes. Following a mini-calibration within the study area, the Central Florida Regional Planning Model (CFRPM) (with a base year 2015) projects a PSWADT of 78,500 vehicles per day (vpd) for the roadway segment being studied for Year 2040 based on the adopted cost-feasible network in the future. Using the [FTO Website](#), the Volume Factor Category Summary Report for 2017 includes five volume categories for Orange County listed as follows:

- Category 7500 – Orange Countywide
- Category 7528 – Orange Beachline
- Category 7544 – Orange I-4 Urban
- Category 7547 – Orange TPK
- Category 7549 – Orange I4 Disney

As the facility does not fall on any of the facilities (Beachline, I-4, Turnpike, or I-4 Disney), the adjustment factors for Category 7500 – Orange Countywide are used. From Peak Season Factor

Category Report for Category 7500, the MOCF is 0.98. Therefore, AADT for the roadway segment is calculated as follows:

$$AADT = PSWADT \times MOCF = 78,500 \times 0.98$$

$$AADT = 76,930 \rightarrow 77,000 \text{ vpd}$$

The design factors can be obtained from the Volume Factor Category Summary Report for Orange County if no current traffic counts are available. The Standard K Factor of 0.9 will be used for this roadway segment. The D factor for Category 7500 from the Volume Factor Category Summary Report is 52.6%. With these factors, DHV and DDHV are derived below:

$$DHV = AADT \times K = 76,930 \times 0.90$$

$$DHV = 69,237 \text{ vph}$$

$$DDHV = DHV \times D = 69,237 \times 0.526$$

$$DDHV = 36,419 \text{ vph}$$

5.4 Development of Directional Peak Hour Volumes

The DDHV is the traffic volume expected to travel in the peak direction during the design hour. However, for many transportation projects, particularly PD&E or Interchange Access Request (IAR) projects, it is often necessary to forecast traffic volumes for multiple peak hours for a typical day such as AM Peak, PM Peak, and occasionally, Mid-Day Peak in order to perform traffic operational analysis. Depending on the characteristics of the study area, the AM Peak and PM Peak periods may have significantly different hourly volumes. Furthermore, the AM peak hour or the PM peak hour may or may not coincide with the design hour. The development of directional volumes for the peak hours requires knowledge of hourly volume distributions. For existing facilities, the best way to obtain hourly volume distribution at the project site is to conduct short-term traffic counts for 24- to 72-hours. If traffic counts cannot be collected, traffic synopsis reports at nearby traffic monitoring sites on similar facilities from Florida Traffic Online can be downloaded and hourly volumes distribution factors can be developed. If traffic synopsis reports are not available, or the project is for a new facility where no such information exists, general hourly volume distributions published in [NCHRP Report 765](#) can be used for facilities characterized by area type, facility type, and area size. **Table 5-1** presents traffic diurnal distribution factors, or hourly volume distribution factors, for an average weekday included in the NCHRP Report. Users are encouraged to refer to the NCHRP Report for more detailed descriptions of the factors.

Table 5-1 Traffic Diurnal Distribution Factors by Functional Class for Weekday

Hour Begin	Urban, small: Pop <200K			Urban, medium: Pop 200K–1 million				Urban, large: Pop > 1 million				Rural Area		
	Interstate	Arterial	Collector	Interstate	Arterial CBD	Arterial Others	Collector	Interstate	Arterial CBD	Arterial Others	Collector	Interstate	Arterial	Collector
12:00 AM	1.07	0.59	0.47	0.95	0.81	0.71	0.61	0.96	1.22	0.78	0.59	1.43	0.72	0.57
1:00 AM	0.79	0.39	0.29	0.65	0.47	0.46	0.36	0.61	0.75	0.48	0.38	1.12	0.49	0.36
2:00 AM	0.70	0.30	0.23	0.57	0.41	0.40	0.31	0.51	0.58	0.37	0.30	0.99	0.43	0.31
3:00 AM	0.76	0.33	0.26	0.61	0.31	0.46	0.34	0.53	0.57	0.37	0.33	1.02	0.51	0.38
4:00 AM	1.10	0.58	0.30	0.96	0.43	0.77	0.60	0.85	0.79	0.61	0.59	1.31	0.93	0.84
5:00 AM	2.20	1.44	1.16	2.10	0.98	1.80	1.32	2.13	1.74	1.70	1.16	2.12	2.28	2.19
6:00 AM	4.16	3.21	2.93	4.67	2.67	4.05	3.63	5.11	4.23	4.17	2.72	3.58	4.54	4.36
7:00 AM	5.69	6.09	6.27	7.17	5.90	6.40	6.70	7.27	6.31	6.58	5.92	4.89	6.63	6.55
8:00 AM	5.26	5.53	5.75	6.16	5.79	5.75	6.60	6.61	6.24	6.08	6.05	4.95	5.55	5.58
9:00 AM	5.04	5.12	4.95	5.13	4.96	5.18	5.60	5.27	5.43	5.04	5.82	5.23	5.24	5.25
10:00 AM	5.27	5.55	5.24	5.10	5.19	5.36	5.49	4.86	5.18	4.96	5.78	5.64	5.41	5.44
11:00 AM	5.60	6.31	6.01	5.37	6.22	5.76	5.92	5.01	5.40	5.39	6.55	5.92	5.67	5.71
12:00 PM	5.89	6.74	6.66	5.59	7.10	6.11	6.33	5.20	5.72	5.81	7.08	6.02	5.91	6.05
1:00 PM	6.12	6.72	6.72	5.78	6.95	6.25	6.40	5.39	5.77	5.93	6.95	6.26	6.13	6.24
2:00 PM	6.78	7.07	7.63	6.32	6.75	6.70	6.74	6.02	6.07	6.31	7.20	6.63	6.68	6.78
3:00 PM	7.60	8.29	8.65	7.22	7.18	7.46	7.44	7.05	6.66	7.05	7.97	7.04	7.53	7.63
4:00 PM	7.88	8.30	9.22	7.86	7.91	8.05	7.82	7.78	7.07	7.85	7.94	7.25	8.02	8.15
5:00 PM	7.54	7.91	8.45	7.97	8.27	8.14	8.18	7.98	7.45	8.33	7.60	7.07	7.98	8.16
6:00 PM	5.63	5.96	5.96	5.69	6.06	6.10	6.05	6.11	6.12	6.52	5.66	5.68	5.95	6.17
7:00 PM	4.32	4.49	4.49	4.10	4.72	4.42	4.33	4.27	4.72	4.80	4.20	4.47	4.21	4.37
8:00 PM	3.57	3.50	3.38	3.34	3.89	3.48	3.42	3.37	3.77	3.88	3.29	3.71	3.30	3.41
9:00 PM	2.99	2.63	2.46	2.88	3.18	2.82	2.71	2.97	3.30	3.17	2.66	3.13	2.62	2.59
10:00 PM	2.31	1.77	1.54	2.19	2.27	2.00	1.89	2.41	2.77	2.28	1.97	2.54	1.94	1.77
11:00 PM	1.71	1.16	0.98	1.61	1.57	1.36	1.24	1.73	2.14	1.53	1.28	1.99	1.34	1.14

Source: [NCHRP Report 765: Analytical Travel Forecasting Approaches for Project-Level Planning and Design](#), Chapter 8.

Directional peak hour volumes can be estimated using period volumes and peak-to-period ratios when a travel demand model with a time-of-day component is used. This is often the case for corridor studies with Express Lanes where time-of-day information is critical.

For example, the Southeast Florida Regional Planning Model (SERPM) has a three-hour period for AM Peak, and a four-hour period for PM Peak. The one-hour AM and PM peak hour directional volumes can be estimated from the period model volumes by applying appropriate *peak-to-period* diurnal factors. However, if a model only produces 24-hour daily volumes, or the daily volumes are estimated from trends analysis or other non-model-based methodologies, directional peak hour volumes can be obtained by using the daily volumes and appropriate *peak-to-daily* diurnal factors and D factors. In both cases, the resulting directional peak hour volumes must be checked for effective peak-to-daily ratios and directional distribution to ensure they are within the allowable range as specified in **Chapter 2** of the Handbook.

5.5 Use of Design Hour Traffic Volumes

Project traffic forecasting has broad application throughout the Department and is generally applicable to later planning stages through the design phase of highway projects. Its main application is in the project development phase in which location and design concept approvals occur. It is usually during this phase where most highway capacity and Level of Service (LOS) analyses are conducted leading to final design of the roadways. For specifics on highway capacity and LOS analyses refer to the Department's LOS Policy, Topic No. 000-525-006 and the Quality/Level of Service Handbook. Other applications include detailed corridor studies and interchange access studies.

Chapter 6 Estimating Intersection Turning Movements

6.1 Introduction

Future year estimates of peak hour intersection turning movements are required for intersection design, traffic operations analyses, and site impact evaluations. In most urban areas, traditional FSUTMS-based travel demand forecasting models can be used to develop intersection turning movement volumes with proper scripting and processing of model volumes. Model turning volumes should be used in cases where new alignments are being developed. Manual methods have also been used in both urban and rural areas where models are not available or when model results are not considered accurate. Because of the difficulties involved in generating peak hour volumes directly from an urban area model for every possible intersection within a given study area, various methods and procedures have been developed to estimate peak hour turning movement volumes from daily traffic volumes. Most of these methods rely on existing intersection turning movement count data and professional judgment.

Turning movement forecasts should reflect the logical effects of future year land use and transportation network improvements on the traffic pattern at a given location. In general, if the pattern of land use and transportation system characteristics is expected to change, turning movement patterns are also likely to change over time. Existing turning movements and model simulation results (when available) provide useful starting points for the turning movement forecasting process. The need for turning movement forecast refinements should be determined by careful review of the chosen starting point. The forecaster must use K, D, and current turning percentages, if available, for each approach for each leg of the intersection to calculate turning volumes during the design hour.

6.2 Purpose

The purpose of this chapter is to provide guidance on methodologies that can be used for estimating intersection turning movements and techniques for balancing turning movements.

This chapter highlights the practices for developing future year intersection turning movements, including a user's guide to TURNS5-V2014 and TMTTool. It explains the following:

- Background
- TURNS5-V2014
- TMTTool
- Methods in NCHRP Report 765
- Manual Method
- Summary of techniques

6.3 Background

A review of the methods currently available for use in developing intersection turning movements indicates that many of the methods can be categorized as “intersection balancing” methods. The degree of accuracy that can be obtained from “intersection balancing” methods depends on the magnitude of incremental change in land use and travel patterns expected to occur between the base year and future design year conditions.

These balancing techniques are used to adjust existing counts as well as model generated volumes. The balancing techniques are also used for corridor development. The assignment of future turn paths is estimated, and often the departure and arrival volumes between intersections on the same link need to be balanced. The algorithms used for the balancing may not be capable of achieving the desired convergence criteria. Existing counts need to be balanced because the turning movements occurring at some driveways may not be included in traffic counts. The driveways which may not be counted are often commercial strip centers, gas stations, and other curb cuts which influence the traffic at intersections.

The roadway network coded in the model generally includes all important roadways. However, some collectors and local roads that are not coded may be the key roadways serving the specific project influence area. To account for the missing roadways and missing driveway information, balancing techniques are used to estimate turning movement traffic volumes.

Most algorithms that have been developed to date are somewhat interrelated and involve the application of an iterative procedure that balances future year turning movements based on existing turning movement counts, approach volumes and/or turn proportions. Spreadsheets are usually utilized for the efficient implementation of “intersection balancing” methods. These balancing methods can be used for peak hour volumes required by traffic operations engineers, future traffic movements for traffic forecasting engineers, or any other application which requires balanced intersection movements.

The following sections of this chapter present an overview of each of the primary methodologies used by FDOT including the input data required and the relative ease of application. The pertinent methods included in the [NCHRP Report 765](#) are also discussed. The estimation of future turning movement volumes requires collection of existing year turning movement counts. The time period, location, and duration of the turning movement counts depend on the travel characteristics of the study area. Roadways serving commercial uses, shopping centers, and schools may peak during the midday period or during the weekends. Turning movement counts outside the typical AM Peak and PM Peak periods such as Mid-Day Peak for either weekdays or weekends should be collected to capture the peak traffic for the study area. When collecting the turning movement counts, it should be noted that most turning movement counts at signalized intersections are performed by counting vehicles as they pass through the intersection and ignoring the unmet demand. This produces unrealistic data in oversaturated conditions that do not represent the true demand at

the intersection. Performing capacity analyses using data collected this way can severely underestimate the delay and back-of-queue results and yield inaccurate levels of service. For congested signals, arrival demand (not departure flows) must be used for the capacity analysis to accurately match field conditions.

In some cases, if existing turning movement counts are available and no major changes in land use patterns are expected, a growth factor method can be used to develop future turning movement volumes. However, approval from the District Planning Office or Project Manager is required before applying the simple methodology.

6.4 TURNS5-V2014

6.4.1 Background

Generally, the accepted program for determining future year turning movements is TURNS5-V2014. It is used to develop future year turning movements based on one of two methods. The first method allows for the user to enter an existing year AADT and specify simple growth for three other periods (normally project opening, mid-design and design years). The second method allows for the user to input an existing year AADT and model forecast year AADT. The program will then interpolate or extrapolate for two other periods. It provides output of AADTs and DHVs and allows for comparisons and smoothing to ensure that the user is producing reasonable results.

TURNS5-V2014 was developed as a tool for the estimation of future turning volumes. TURNS5-V2014 is an Excel template which was developed by merging two other programs in use by several FDOT districts and creating a user driven menu and “file folder” windows for easier use. TURNFLOW¹ and TURNS3² form the basic framework of the TURNS5-V2014 program.

TURNFLOW is an Excel template that provides a spreadsheet structure for estimating intersection turning movements when only approach volumes are known. The spreadsheet uses a technique for solving and balancing turning movement volumes based on an initial estimate of turning proportions entered by the user. The program iteratively balances volumes until a minimum tolerance is reached. This procedure was developed by E. Hauer, E. Pagitsas and B.T. Shin³. TURNFLOW and its documentation can be obtained from the McTrans Center of the University of Florida. It should be noted that the software is copyrighted and the TURNS5 program creators have secured its use for FDOT.

¹ TURNFLOW (Copyright 1988, Mark C. Schaefer), supported and distributed by the McTrans Center, University of Florida, 512 Weil Hall, Gainesville, FL 32611-2083

² TURNS3, developed by FDOT, District 1, 801 Broadway Avenue, Bartow, Florida 33830

³ Estimation of Turning Flows from Automatic Counts," Transportation Research Board, Record No. 795, 1981

TURNS5-V2014 combines the intersection balancing component of TURNFLOW with the same basic setup relating to output, menu options and format similar to TURNS3. TURNS3 provides estimates of intersection turning movements and produces traffic volume outputs in a format suitable for use in various traffic analysis reports associated with preliminary engineering, planning, and Design studies.

6.4.2 TURNS5 Methodology

TURNS5-V2014 is designed to develop future turning volumes based on AADT volumes for the existing year and growth rates or by using an existing year AADT and a model year AADT. When using a model year, the program can calculate (interpolate/extrapolate) AADT for project years (normally opening, interim and design years). The program will also develop AADT volumes for three future years based on the existing year volumes and user specified growth rates for each projection year.

The TURNS5-V2014 program will project future year AADT volumes and balance each year's future turning movement distribution based on an initial guess of turning percentages for each approach. Each year requested will be balanced using these initial guesses. It is recommended that the user input for these percentages be based on actual approach counts for the intersection. If existing turning movement counts are not available, the TURNS5-V2014 has two other "first guess turning percentages" methodologies available, Existing Year AADTs or FSUTMS Model Year AADTs. These methodologies utilize the AADTs input by the User.

It is important to note that the accuracy of predicted volumes is a function of the implied accuracy of user inputs. Existing and model year AADTs should be closely evaluated and checked for consistency with actual or proposed conditions for the roadway system under evaluation. Traffic counts should be checked for reasonableness of volumes and evaluated to identify vehicle flows into and out of the system for the existing condition. Reasonable assumptions for the model year must also be determined by the user. Random input of unchecked volumes or turning percentages will lead to program errors (turning movement balancing) or unrealistic output values.

In addition to this Handbook, TURNS5-V2014 has a companion [Tool Documentation](#) that explains the inner workings of TURNS5. It provides more details on each tab and what the 'Run Turn Counts Macro' button really does. The following text will serve as a User's Manual and should be sufficient for normal use of TURNS5-V2014.

6.4.3 TURNS5-V2014 Spreadsheet Tabs (Worksheets)

Upon loading the program in EXCEL, the program will automatically be positioned at the main menu (MainMenu tab) as shown in **Figure 6-1**. The following tabs are contained within the workbook:

MainMenu

MainMenu – Contains the Main Menu where all of the macro driven buttons are located.

InputSheet

InputSheet – Contains all of the data that the user entered into the ‘Enter Data’ menus. The user may also individually edit the gray boxes of information within this tab but it is recommended that the ‘Enter Data’ menu system is used to ensure that the correct types of values are entered. However, if any information is changed by manually entering values into the tab or using the ‘Enter Data’ menus, the ‘Run Turn Counts Macro’ button should be selected in order to run the macro with the updated information.

Enter Data

Calcs

**Run Turn
Counts Macro**

Calcs – Contains placeholder cells and the information necessary for the iterative process of the ‘Run Turn Counts Macro’. This tab is where the macro will perform the balancing calculations for each study year. No information within this tab should be altered

OutputSheet

OutputSheet – Contains the initial turning volume summary. This is one of three output graphics where the calculated turning percentages and volumes are displayed in a table for each study year. No information within this tab should be altered.

TurnSheets

TurnSheets – Contains the second and third output graphics. The second output graphic contains the design hour turning movements along with the turning distributions, AADTs, DDHVs, and traffic factors. The third and last output graphic compares the base year turning movement volumes to the future year turning movement volumes. No information within this tab should be altered.

Data

Data – Contains information that helps the menu system and ‘Run Turn Counts Macro’ run.

XML

XML – Contains the information that will be exported to a .XML file.

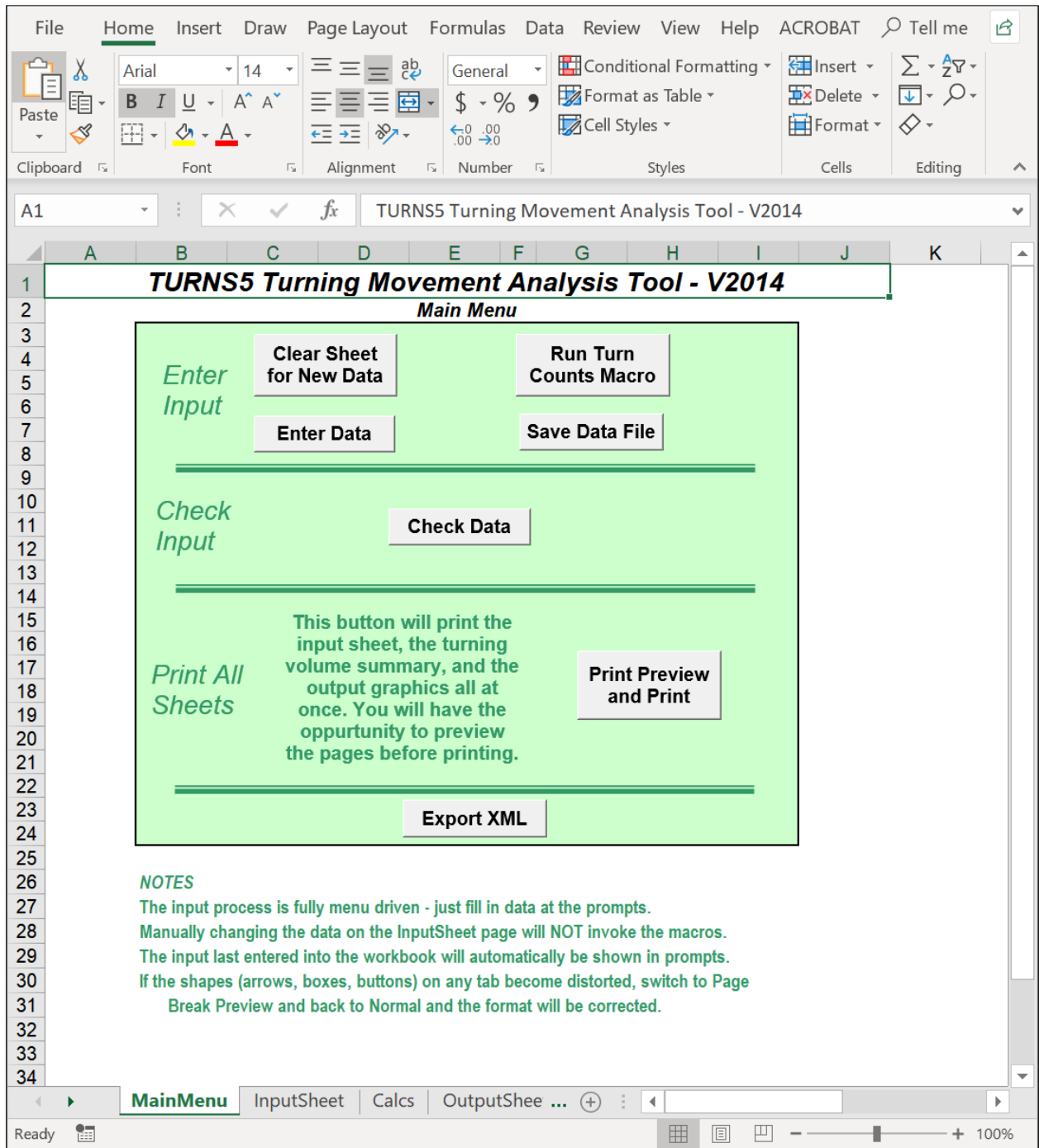


Figure 6-1 TURNS5-V2014 Turning Movement Analysis Tool

6.4.3.1 Main Menu Options

The Main Menu contains the following buttons:

**Clear Sheet
for New Data**

Clear Sheet for New Data – erases any previous information input into the spreadsheet. This action cannot be ‘undone’.

Enter Data

Enter Data – prompts the pop-up input menus where the user can input data. The menus will reference the data currently in the workbook, presumably the information the user last input. If the workbook is blank the ‘Enter Data’ menus will be blank.

**Run Turn
Counts Macro**

Run Turn Counts Macro – activates the iterative macro. This action cannot be ‘undone’.

Save Data File

Save Data File – activates the Excel Save As menu.

Check Data

Check Data – searches for any error messages previously generated by the iterative macro. For example, if the ‘Run Turn Counts Macro’ has not been run since reactivating the ‘Enter Data’ menu and proceeding to page 2, the message “Turn counts macro was not run after changing input. Click the ‘Run Turn Counts Macro’ button” will appear. The macro assumes that information was changed since the ‘Enter Data’ menu was activated and the information from page 1 was rewritten into the appropriate cells. However, if information was not changed through the ‘Enter Data’ menu but by manually editing the ‘InputSheet’ tab, the previously mentioned error message will not appear. Nevertheless, if any input data has been changed, click the ‘Run Turn Counts Macro’ button.

**Print Preview
and Print**

Print Preview and Print – activates Print Preview within Excel. The input sheet, the turning volume summary and the output graphics will be available to preview before printing. If ready to print, click the ‘Print’ button and select the desired printer. To exit Print Preview, click ‘Close Print Preview’.

Export XML

Export XML – exports to an XML file.

6.4.4 ‘Enter Data’ Menus

The Main Menu has a macro driven button called ‘Enter Data’. Clicking this button will activate the input menus.

6.4.4.1 ‘Enter Data’ Page 1

TURNS5 Analysis Input - Page 1 of 2

North/South Road Name

East/West Road Name

Project

Analyst

PIN

County

Is the mainline oriented North/South?
 Yes
 No

Is this a 4 or a 3 way intersection?
 4 way intersection
 3 way intersection

Do you have FSUTMS model year traffic?
 Yes
 No

Existing Year 2018
Opening Year 2028
Mid-Year 2038
Design Year 2048
FSUTMS Model Year 2048

K Factors
Mainline 0.09
Side Street 0.09

D Factors
Mainline Westbound (WB) 0.5
Mainline Eastbound (EB) 0.5
Side Street Northbound (NB) 0.5
Side Street Southbound (SB) 0.5

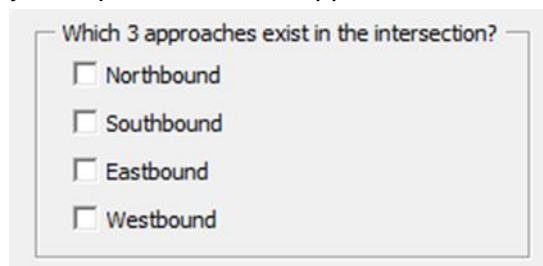
OK **Cancel**

Will be grayed out if Selecting "No" for FSUTMS Model Year Traffic

Figure 6-2 TURNS5-V2014 ‘Enter Data’ Page 1

Road Name: Enter Name of North/South and East/West Roadways.
 Project: Enter Project Description/Name.
 Analyst: Enter Name of the person/firm entering data.
 PIN: Enter Project Identification Number.
 County: Enter Name of the county where project is located.
 N/S Orientation of Mainline: Select 'Yes' will orient mainline from bottom to top.
 Select 'No' will orient mainline from left to right.
 This selection will also determine the 'Highway' and 'Intersection' assignment within the 'InputSheet' tab. The 'Highway' label will be assigned to the mainline while the 'Intersection' label will be assigned to the side street.

Intersection Type: Select 4-way or 3-way intersection
 Available approaches: If a 3-way intersection is chosen, the User must select all 3 approaches that exist at the intersection. The menu will not allow you to proceed until 3 approaches are chosen.



TURNS5-V2014 is not designed to be used for grade-separated interchanges. However, it has been used in some cases to "mimic" single-point urban intersections with manipulation of the movements.

FSUTMS: FSUTMS model year traffic available? Select Yes or No.
 If "Yes" is selected the model year will be required.
 Years: Enter Existing Year, Opening Year, Mid-Year and Design Year or FSUTMS Model Year (when Yes is selected above).
 K Factors: Enter K values for Mainline and Side Street. A value between 0.01 and 0.99 must be entered.
 D Factors: Enter D values for Mainline and Side Street. A value between 0.01 and 0.99 must be entered. D values for both directions of mainline and side street must add to one.

Click '**OK**' to proceed to Page 2 of the 'Enter Data' Menu. The information just entered will fill in the 'InputSheet' tab. Select '**Cancel**' to exit the menu.

No information entered into the menu will change the 'InputSheet' tab.

6.4.4.2 ‘Enter Data’ Page 2

Figure 6-3 TURNS5-V2014 ‘Enter Data’ Page 2 (Growth Rate Option Chosen)

If using FSUTMS Model Year Traffic (chosen from Page 1):

Existing Year: Enter existing year AADTs by direction (approach)

Model Year: Enter model year FSUTMS AADTs by direction (approach)

If using traffic developed from growth rates (chosen from Page 1):

- Existing Year: Enter existing year AADTs by direction (approach)
- Growth Rate: Enter Annual Growth Rate as a percentage for the Mainline and Side Street
- Growth Factor: Select type of growth factor to be used for the mainline and side street. Choose from Linear, Exponential, and Decaying Exponential.
- Maximum Error: User default is 0.01 as the desired closure. Represents the cut-off point for balancing of AADT turning movements in the program.
***Note:** The value of 0.01 is the maximum tolerance. Values <0.01 may be used but will provide minimal benefit in the balancing calculations. Values >0.01 are not recommended.*
- First Guess Turning %'s: Select whether the initial turning percentages are based on Existing Year AADT's, Existing Turning Movement Counts, or FSUTMS Model Year AADTs.
***Note:** It is recommended that the initial turning percentages be **the existing** turning movements counts. If existing turning movement counts are not available, then the Existing Year AADTs or FSUTMS Model Year AADTs (if model data is available) options can be utilized.*
- Existing Year AADTs** – The turning movement percentages are based off a ratio of departure volumes calculated from the entered Existing Year AADTs and K and D factors entered in the first page of the menu.
- Existing Turning Movement Counts** – The actual turning volumes counts are entered into the white text boxes in the appropriate approach, the gray text boxes will automatically update with the value of the turning percentage. This is the FDOT recommended method.
- FSUTMS Model Year AADTs** – The turning movement percentages are based on a ratio of departure volumes calculated from the entered FSUTMS Model Year AADTs and K and D factors entered in the first page of the menu.

Click '**OK**' to finish entering information into the '**Enter Data**' Menus. The information just entered will fill in the '**InputSheet**' tab. Select '**Cancel**' to exit the menu.

No information entered into page 2 of the menu will change the '**InputSheet**' tab. Select '**Back**' in order to return to page 1 of the menus. No information entered into page 2 will be saved.

The Input Analysis Sheet shown in **Figure 6-4** lists the project information, analysis years, growth rates/type calculations, approach volumes, model information (when applicable), and initial turn percentages for the existing year. The type of first guess turning percentage is also displayed.

Figure 6-5 shows the tabulated output of balanced volumes for each year (Base, Opening, Mid and Design). The table provides initial (user input) turning percentages, adjusted turning percentages and DDHVs for each movement.

TURNS5 INITIAL TURNING VOLUME SUMMARY

Highway:	Main Street	County:	Leon
Intersection:	Cross Road	Analyst:	ABC Engineering
Project:	Corridor Capacity Improvement	Date:	18-Jul-18

Approach-To-Approach	2018	2018		2025		2035		2045	
	Initial Estimate	Final Estimate	Calculated Volume	Final Estimate	Calculated Volume	Final Estimate	Calculated Volume	Final Estimate	Calculated Volume
West-To-North (LT)	0.120	0.157	230	0.153	243	0.148	259	0.143	275
West-To-East (Thru)	0.825	0.791	1161	0.796	1261	0.803	1408	0.810	1557
West-To-South (RT)	0.055	0.052	76	0.051	81	0.049	86	0.047	90
Total Flow From West:			1467		1585		1753		1922
East-To-South (LT)	0.235	0.120	291	0.117	306	0.113	327	0.110	349
East-To-West (Thru)	0.621	0.779	1888	0.784	2054	0.791	2292	0.796	2528
East-To-North (RT)	0.144	0.101	245	0.099	259	0.096	278	0.094	299
Total Flow From East:			2424		2619		2897		3176
North-To-East (LT)	0.348	0.284	171	0.289	181	0.295	195	0.300	209
North-To-South (Thru)	0.493	0.399	240	0.391	245	0.381	252	0.373	259
North-To-West (RT)	0.159	0.317	191	0.320	200	0.324	214	0.327	228
Total Flow From North:			602		626		661		696
South-To-West (LT)	0.174	0.300	251	0.303	264	0.307	283	0.310	300
South-To-North (Thru)	0.458	0.441	370	0.433	378	0.424	390	0.416	403
South-To-East (RT)	0.368	0.259	217	0.264	230	0.269	248	0.274	266
Total Flow From South:			838		872		921		969

Figure 6-5 TURNS5-V2014 Initial Turning Volume Summary

Figure 6-6 shows the turning movement volumes and percentages calculated by the **Run Turn Counts Macro**, DDHVs, AADTs, and the K and D factors used. All four study years are printed.

Figure 6-7 shows the comparison between the Base Year turning volumes entered by the users with turning volumes calculated by the macro. All four study years are printed.

Chapter 6 – Estimating Intersection Turning Movements

PROJECT TRAFFIC FOR Main Street AT Cross Road

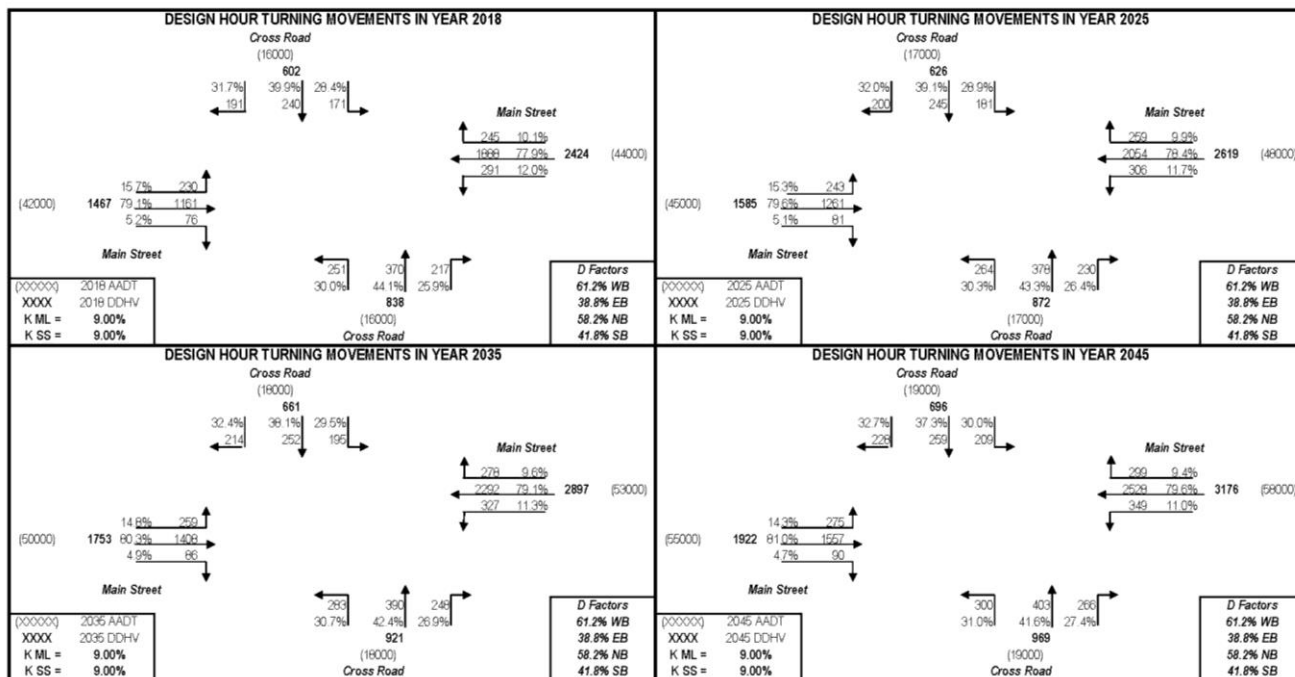


Figure 6-6 Project Traffic (TURNS5-V2014 Design Hour Turning Movements)

PROJECT TRAFFIC FOR Main Street AT Cross Road

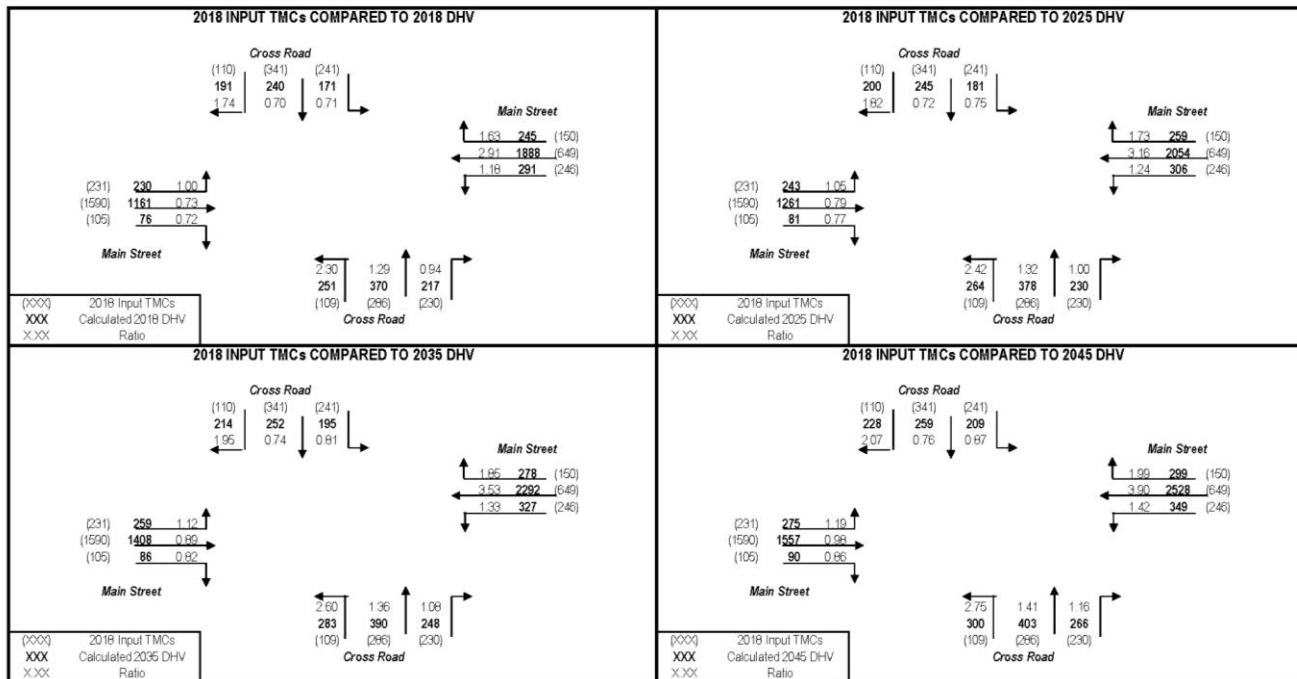


Figure 6-7 Project Traffic (TURNS5-V2014 Comparison of Base Year Turning Movement)

6.5 TMTTool

The TMTTool was developed by District 4 and it consists of a single Excel spreadsheet with an input, output, and calculations tab. The main spreadsheet (District 4 TMTTool v2.xlsm) is set up for intersection turning movement forecasts where detailed information is available. The TMTTool utilizes base year and projected future year AADT volumes together with existing year turning movement counts to calculate the future turning movement volumes. It also includes error checking mechanisms to verify if forecasted volumes show negative growth as is the case with many iterative procedures. The TMTTool can be used for both existing and planned intersections.

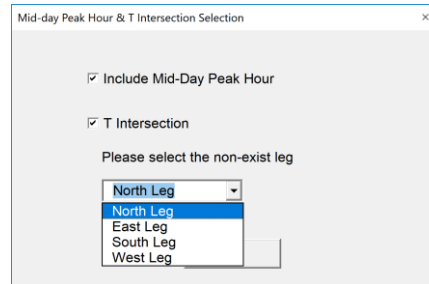
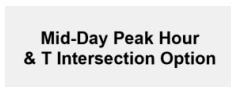
6.5.1 TMTTool “Input” Tab

Figure 6-8 shows the TMTTool Input tab for the TMTTool spreadsheet application. The Input Tab includes seven (7) sections and one macro.

Project Description

Information regarding the project including SECTION NO, FM NO, PROJECT LIMITS, DESIGN YEAR, and description of the study INTERSECTION. For documentation purposes, information regarding the analyst, FILE version, and DATE can also be provided.

Macro



TMTTool has the capability of estimating turning volumes for Mid-Day peak hour and for T Intersections. Select the “Mid-Day Peak Hour & T Intersection Option” button will activate this option.

Historical AADTs

Historical AADTs for the most recent four years and model volume in terms of AADT.

Growth Rates

Growth rates calculated using the following three methods:

- Historical AADT
- Historical AADT and the Future Year Model Volume
- Base Year Model Volume to Future Year Model Volume

Enter final recommended growth rate used for traffic forecasting based on the analysis of the three growth rates.

Choose Methodology for Calculating Growth Factor on Each Leg (Input 1, 2 or 3)

Select type of growth factor to be used for each leg of the intersection.

- 1 = Compound Growth Throughout All Years
- 2 = Linear Growth Throughout All Years
- 3 = Blend of Compound Growth First Ten Years, Linear Growth Thereafter (Based Upon the Base Year AADT)

Future Year AADTs will be calculated based on the base year AADT and corresponding growth factors.

Chapter 6 – Estimating Intersection Turning Movements

TMT00L INPUT SHEET														
Project Description:														
SECTION NO:	88000000			PREPARED BY:										
FM NO.:	123456-1			FILE:	Version 1									
PROJECT LIMITS:	from MP 1.200 to MP 3.200			DATE:	1/12/2015									
DESIGN YEAR:	2040			MID-DAY PEAK HOUR:	Included									
INTERSECTION:	Green Road and Red Boulevard													
NOTES:														
Historical AADTs:														
	YEAR	NORTH LEG AADT		EAST LEG AADT		SOUTH LEG AADT		WEST LEG AADT						
	2011	20,000		20,000		20,000		20,000						
	2012	21,000		21,000		21,000		21,000						
	2013	22,000		22,000		22,000		22,000						
	2014	23,000		23,000		23,000		23,000						
	Model Volume:	2035		23,000		23,000		23,000						
Growth Rates:														
		NORTH LEG		EAST LEG		SOUTH LEG		WEST LEG						
	Historic Trend GR =	3.00%	CGR	3.00%	CGR	3.00%	CGR	3.00%	CGR					
	Historic + Model Trend GR =	2.00%	CGR	2.00%	CGR	2.00%	CGR	2.00%	CGR					
	Base Year Model to Future Year Model GR =	1.00%	CGR	1.00%	CGR	1.00%	CGR	1.00%	CGR					
	Recommended Growth Rate:	1.00%	CGR	1.00%	CGR	1.00%	CGR	1.00%	CGR					
Choose Methodology for Calculating Growth Factor on Each Leg (Input 1, 2 or 3)														
	1 = Compound Growth Throughout All Years	1		1		1		1						
	2 = Linear Growth Throughout All Years													
	3 = Blend of Compound Growth First Ten Years, Linear Growth Thereafter (Based Upon the Base Year AADT)													
		YEAR	FACTOR	AADT	FACTOR	AADT	FACTOR	AADT	FACTOR	AADT				
		2014		23,000		23,000		23,000		23,000				
NO. YEARS	6	2020	1.062	24,400	1.062	24,400	1.062	24,400	1.062	24,400				
NO. YEARS	16	2030	1.173	27,000	1.173	27,000	1.173	27,000	1.173	27,000				
NO. YEARS	26	2040	1.295	29,800	1.295	29,800	1.295	29,800	1.295	29,800				
Percent Turns Calculated From Base Year TMCs:														
TURN STUDY		FROM NORTH LEG (Southbound)			FROM EAST LEG (Westbound)			FROM SOUTH LEG (Northbound)			FROM WEST LEG (Eastbound)			TOTAL
		RIGHT	THRU	LEFT	RIGHT	THRU	LEFT	RIGHT	THRU	LEFT	RIGHT	THRU	LEFT	
A.M.	2-Way Pk Hr Vol:	1,280			1,280			1,280			1,280			
7/20/2014		20	600	20	20	600	20	20	600	20	20	600	20	2,560
% TURNS:		3%	94%	3%	3%	94%	3%	3%	94%	3%	3%	94%	3%	
MID-DAY	2-Way Pk Hr Vol:	1,500			1,500			1,500			1,500			
7/20/2014		25	700	25	25	700	25	25	700	25	25	700	25	3,000
% TURNS:		3%	93%	3%	3%	93%	3%	3%	93%	3%	3%	93%	3%	
P.M.	2-Way Pk Hr Vol:	1,720			1,720			1,720			1,720			
7/20/2014		30	800	30	30	800	30	30	800	30	30	800	30	3,440
% TURNS:		3%	93%	3%	3%	93%	3%	3%	93%	3%	3%	93%	3%	
Est. % Turns Calculated From Base Year AADTs & TMCs:														
SUGGESTED STARTING POINTS														
		NORTH LEG			EAST LEG			SOUTH LEG			WEST LEG			
		RIGHT	THRU	LEFT	RIGHT	THRU	LEFT	RIGHT	THRU	LEFT	RIGHT	THRU	LEFT	
A.M.	2014	3%	94%	3%	3%	94%	3%	3%	94%	3%	3%	94%	3%	
	2020	6%	88%	6%	6%	88%	6%	6%	88%	6%	6%	88%	6%	
	2030	7%	86%	7%	7%	86%	7%	7%	86%	7%	7%	86%	7%	
	2040	8%	84%	8%	8%	84%	8%	8%	84%	8%	8%	84%	8%	
MID-DAY	2014	3%	93%	3%	3%	93%	3%	3%	93%	3%	3%	93%	3%	
	2020	6%	87%	6%	6%	87%	6%	6%	87%	6%	6%	87%	6%	
	2030	7%	86%	7%	7%	86%	7%	7%	86%	7%	7%	86%	7%	
	2040	8%	83%	8%	8%	83%	8%	8%	83%	8%	8%	83%	8%	
P.M.	2014	3%	93%	3%	3%	93%	3%	3%	93%	3%	3%	93%	3%	
	2020	6%	87%	6%	6%	87%	6%	6%	87%	6%	6%	87%	6%	
	2030	7%	86%	7%	7%	86%	7%	7%	86%	7%	7%	86%	7%	
	2040	8%	83%	8%	8%	83%	8%	8%	83%	8%	8%	83%	8%	
K & D FACTORS:														
		NORTH LEG			EAST LEG			SOUTH LEG			WEST LEG			
		AM	MID	PM	AM	MID	PM	AM	MID	PM	AM	MID	PM	
K FACTOR	2014	5.6%	6.5%	7.5%	5.6%	6.5%	7.5%	5.6%	6.5%	7.5%	5.6%	6.5%	7.5%	
	2020	5.6%	6.5%	7.5%	5.6%	6.5%	7.5%	5.6%	6.5%	7.5%	5.6%	6.5%	7.5%	
	2030	5.6%	6.5%	7.5%	5.6%	6.5%	7.5%	5.6%	6.5%	7.5%	5.6%	6.5%	7.5%	
	2040	5.6%	6.5%	7.5%	5.6%	6.5%	7.5%	5.6%	6.5%	7.5%	5.6%	6.5%	7.5%	
D FACTOR	2014	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	
	2020	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	
	2030	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	
	2040	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	


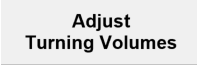

Mid-Day Peak Hour
& T Intersection Option

Figure 6-8 TMT00l Input Tab

Percent Turns Calculated from Base Year TMCs:	Enter existing turning movement counts for AM, MID-DAY (if selected), and PM peak period. The program will calculate the corresponding turning percentages automatically.
Est. % Turns Calculated from Base Year AADTs & TMCs:	Existing and estimated future turning percentages calculated from future year AADTs and existing turning movement counts. These are used as first “guesses” for the iterative process to estimate future turning volumes. These are protected cells and users are not allowed to modify the values.
K & D FACTORS:	K and D factors used to calculate DHV and DDHV. K and D factors for the base year are calculated from the existing year AADT and turning movement counts. K and D for the design year should use design hour factors determined using procedures described in Chapter 2 . K and D factors for interim years are calculated by linear interpolation between the base year and design year values. The K and D factors can be modified if there are good reasons to do so. Prior approval from District Planning Office or Project Manager is required.

6.5.2 TMTTool “Output” Tab

Figure 6-9 shows the Output Tab for the TMTTool spreadsheet application. In addition to the project and analyst information provided in the Input Tab, the Output Tab includes three sections and three volume verification macros. The macros are used to determine if the projected future turning movement volumes have zero or negative growth. If yes, the program will adjust the forecasted volume with a minimal amount of growth.

Estimated Two-Way 24 Hour AADT for Each Leg of the Intersection	Future AADT volumes estimated from base year AADT, recommended growth rates, and selected growth factor method. It also includes turning percentages calculated based on AADTs.
AM, Mid-Day, and PM Design Hr. Turns	Estimated turning movement volumes for the AM, Mid-Day (if selected), and PM peak hours.
Link Volume Check	Verify if link volumes calculated from estimated turning volumes match the directional design hour volumes calculated from AADT, K, and D factors for each period.
	Macro to check if the estimated turning volumes produce zero or negative growth for any of the turning movements. These volumes are highlighted in blue.
	Macro to adjust the projected turning volumes to correct zero or negative growth. The adjusted volumes are highlighted in yellow.
	Macro to remove the volume adjustment and reset the forecasted volumes to original projected volumes.

Chapter 6 – Estimating Intersection Turning Movements

TMTOL "TURNS" REPORT													
DESIGN HOUR TURNS CALCULATIONS													
SECTION NO: 88000000 FM NO.: 123456-1 PROJECT LIMITS: from MP 1.200 to MP 3.200 DESIGN YEAR: 2040 INTERSECTION: Green Road and Red Boulevard PREPARED BY: FILE: Version 1				DATE: 1/12/2015 NOTES:									
ESTIMATED TWO-WAY 24 HOUR AADT FOR EACH LEG OF THE INTERSECTION:													
	YEAR	NORTH LEG			EAST LEG			SOUTH LEG			WEST LEG		
24 HR EST. AADT	2014	23,000			23,000			23,000			23,000		
24 HR EST. AADT	2020	24,400			24,400			24,400			24,400		
24 HR EST. AADT	2030	27,000			27,000			27,000			27,000		
24 HR EST. AADT	2040	29,800			29,800			29,800			29,800		
Percent Turns Calculated From Base Year AADTs:													
JKTURNS		FROM NORTH LEG			FROM EAST LEG			FROM SOUTH LEG			FROM WEST LEG		
	2014 2-WAY ADT	RIGHT	THRU	LEFT	RIGHT	THRU	LEFT	RIGHT	THRU	LEFT	RIGHT	THRU	LEFT
		23,000	23,000	23,000	23,000	23,000	23,000	23,000	23,000	23,000	23,000	23,000	23,000
		33%	33%	33%	33%	33%	33%	33%	33%	33%	33%	33%	33%
	2020 2-WAY ADT	24,400	24,400	24,400	24,400	24,400	24,400	24,400	24,400	24,400	24,400	24,400	24,400
		33%	33%	33%	33%	33%	33%	33%	33%	33%	33%	33%	33%
	2030 2-WAY ADT	27,000	27,000	27,000	27,000	27,000	27,000	27,000	27,000	27,000	27,000	27,000	27,000
		33%	33%	33%	33%	33%	33%	33%	33%	33%	33%	33%	33%
	2040 2-WAY ADT	29,800	29,800	29,800	29,800	29,800	29,800	29,800	29,800	29,800	29,800	29,800	29,800
		33%	33%	33%	33%	33%	33%	33%	33%	33%	33%	33%	33%
A.M. DESIGN HR. TURNS													
		NORTH LEG			EAST LEG			SOUTH LEG			WEST LEG		
		RIGHT	THRU	LEFT	RIGHT	THRU	LEFT	RIGHT	THRU	LEFT	RIGHT	THRU	LEFT
2014	EST. TURNS	20	600	20	20	600	20	20	600	20	20	600	20
2020	EST. TURNS	42	597	42	42	597	42	42	597	42	42	597	42
2030	EST. TURNS	52	646	52	52	646	52	52	646	52	52	646	52
2040	EST. TURNS	68	695	68	68	695	68	68	695	68	68	695	68
MID-DAY DESIGN HR. TURNS													
2014	EST. TURNS	25	700	25	25	700	25	25	700	25	25	700	25
2020	EST. TURNS	50	693	50	50	693	50	50	693	50	50	693	50
2030	EST. TURNS	62	755	62	62	755	62	62	755	62	62	755	62
2040	EST. TURNS	81	807	81	81	807	81	81	807	81	81	807	81
P.M. DESIGN HR. TURNS													
2014	EST. TURNS	30	800	30	30	800	30	30	800	30	30	800	30
2020	EST. TURNS	59	794	59	59	790	59	59	790	59	59	790	59
2030	EST. TURNS	73	864	73	73	864	73	73	864	73	73	864	73
2040	EST. TURNS	94	927	94	94	927	94	94	927	94	94	927	94
LINK VOLUME CHECK													
DESIGN HOUR A.M.:													
		NORTH LEG			EAST LEG			SOUTH LEG			WEST LEG		
		FROM	TO	LINK	FROM	TO	LINK	FROM	TO	LINK	FROM	TO	LINK
CONTROL LINK VOLUMES	2014	640	640	1,280	640	640	1,280	640	640	1,280	640	640	1,280
	TURN SUMMARY	640	640	1,280	640	640	1,280	640	640	1,280	640	640	1,280
CONTROL LINK VOLUMES	2020	679	681	1,360	679	681	1,360	679	681	1,360	679	681	1,360
	TURN SUMMARY	681	681	1,362	681	681	1,362	681	681	1,362	681	681	1,362
CONTROL LINK VOLUMES	2030	751	749	1,500	751	749	1,500	751	749	1,500	751	749	1,500
	TURN SUMMARY	749	749	1,498	749	749	1,498	749	749	1,498	749	749	1,498
CONTROL LINK VOLUMES	2040	829	831	1,660	829	831	1,660	829	831	1,660	829	831	1,660
	TURN SUMMARY	831	831	1,662	831	831	1,662	831	831	1,662	831	831	1,662
DESIGN HOUR MID-DAY:													
CONTROL LINK VOLUMES	0	750	750	1,500	750	750	1,500	750	750	1,500	750	750	1,500
	TURN SUMMARY	750	750	1,500	750	750	1,500	750	750	1,500	750	750	1,500
CONTROL LINK VOLUMES	0	796	794	1,590	796	794	1,590	796	794	1,590	796	794	1,590
	TURN SUMMARY	794	794	1,588	794	794	1,588	794	794	1,588	794	794	1,588
CONTROL LINK VOLUMES	0	880	880	1,760	880	880	1,760	880	880	1,760	880	880	1,760
	TURN SUMMARY	880	880	1,760	880	880	1,760	880	880	1,760	880	880	1,760
CONTROL LINK VOLUMES	0	972	968	1,940	972	968	1,940	972	968	1,940	972	968	1,940
	TURN SUMMARY	968	968	1,936	968	968	1,936	968	968	1,936	968	968	1,936
DESIGN HOUR P.M.:													
CONTROL LINK VOLUMES	2014	860	860	1,720	860	860	1,720	860	860	1,720	860	860	1,720
	TURN SUMMARY	860	860	1,720	860	860	1,720	860	860	1,720	860	860	1,720
CONTROL LINK VOLUMES	2020	912	908	1,820	912	908	1,820	912	908	1,820	912	908	1,820
	TURN SUMMARY	911	908	1,819	908	908	1,816	908	911	1,819	908	908	1,816
CONTROL LINK VOLUMES	2030	1,010	1,010	2,020	1,010	1,010	2,020	1,010	1,010	2,020	1,010	1,010	2,020
	TURN SUMMARY	1,010	1,010	2,020	1,010	1,010	2,020	1,010	1,010	2,020	1,010	1,010	2,020
CONTROL LINK VOLUMES	2040	1,114	1,116	2,230	1,114	1,116	2,230	1,114	1,116	2,230	1,114	1,116	2,230
	TURN SUMMARY	1,116	1,116	2,232	1,116	1,116	2,232	1,116	1,116	2,232	1,116	1,116	2,232
Note: Boxed number indicates manual adjustment.													

Check Turning Volumes

Adjust Turning Volumes

Reset Turning Volumes

Figure 6-9 TMTol Output Tab

6.5.3 TMTTool “Calc” Tab

The TMTTool “Calc” Tab contains all the interim results and calculations performed in the spreadsheet application. All cells are protected, the user is not allowed to modify the cell values. However, the user can review the values and better understand the underlying theories and assumptions incorporated in the application.

6.6 Methods in the NCHRP Report 765

[NCHRP Report 765](#) provides alternative ways to develop turning movement forecasts from assigned traffic volumes from a travel demand model. It is important to recognize that most travel demand models do not have sufficient details to produce accurate turning movement volumes directly from the model output. On the one hand, not all roadways connecting to intersections for which turning movement forecasts are desired are coded in the model network. In some cases, some intersections may include an approach that is in fact a centroid connector, either as a replacement for one of the intersections legs or a surrogate for a number of other local roadways; thus, an artificial set of turning movements is introduced at the intersection. When traffic assignment is performed, the turning movements at the node representing the intersection may vary considerably from observed intersection turning movements. On the other hand, turning movement analyses are typically required for an hour, but traffic assignment results are either 24-hour volumes or period volumes depending on the type of the models being used. While directional volumes are reported in the model, they are more of a function of trip balancing than of actual directional distribution. The user is advised to exercise caution when using the model output to develop turning movement volumes. Nevertheless, there are three (3) categories of procedures for forecasting turning movements from model output, and these procedures can be applied using either daily or period traffic assignment results, directional or non-directional volumes, and with or without model turning movement assignments:

- Factoring procedures
- Iterative procedures
- “T” intersection procedures

6.6.1 Factoring Procedures

Factoring procedures require base year turning movement counts, base year turning movement assignments, and future year turning movement assignments. Factoring procedures assume that traffic patterns will remain relatively constant between the base year and forecast year. Based on this assumption, future year turning movements can be estimated by comparing either the relative ratios or relative differences between base year and future year turning movement assignments and then applying the same ratios or differences to base year turning movement counts. However, when travel patterns are expected to change significantly (for example, a major new development near one of the intersection approaches), other procedures may be more appropriate.

6.6.2 Iterative Procedures

Iterative procedures employ the traditional Iterative Proportional Fitting (IPF) or Fratar method, which has been widely used in practice to balance trip tables. The iterative method is based on an incremental procedure of applying implied growth between base year and future year to actual traffic counts. Growth rates are derived from the model. The iterative procedures would require observed turning movements for all intersections under study. This method is not applicable to new intersections for which base year counts are not available. The Fratar method would produce reasonable results for either developed areas or areas expected to experience moderate growth in land use.

Iterative procedures differ depending on whether directional or non-directional volumes are used for the approach links. The directional volume procedure adjusts future year turning movements based on either base year turning movement counts or future year turning movement estimates and the ratio of approach link forecasts to link counts. The non-directional volume procedure is more subjective and requires the analyst to produce a reasonable estimate of turning percentages as an input to the process. The procedure should be used mainly for planning and preliminary engineering applications, not for design.

6.6.3 “T” Intersection Procedures

“T” intersection procedures are used for intersections with only three approach legs. Directional turning volumes can be computed if the approach volumes and at least one turning movement are known. Where only two-way turning movements are available, a unique solution can be found if directional approach volumes are known. **Table 6-1** presents a summary on procedures and input elements for turning movement volume forecasting.

Table 6-1 Turning Movement Forecasting Procedures and Input Elements

Input Elements	Procedure			
	Factoring (Ratio or Difference Method)	Iterative – Directional Volume Method	Iterative – Non-Directional Volume Method	“T” Intersection
Turning Movements Forecasting	Base Year Count Base Year Assignment Future Year Assignment	Base Year Count or Estimated Turning Percentages	Estimated Turning Percentages	Future Year Directional (one turning movement known or estimated)
Link Volumes Forecasting		Base Year Directional Volume Future Year Directional Assignment	Base Year Bi-Directional Assignment Future Year Bi-Directional Assignment	Base or Future Year Bi-Directional Base or Future Year Directional

Source: [NCHRP Report 765, Analytical Travel Forecasting Approaches for Project Level Planning and Design, 2014](#)

Users are advised to consult **Chapter 6** of the [NCHRP Report 765](#) for detailed discussions on these procedures. Users must always exercise professional judgment during and after the applications of these procedures. Reasonableness checks, involving stakeholders, and applying local knowledge are recommended to properly develop turning movement forecasts.

6.7 Manual Method

The District 2 manual procedure consists of a simple calculation technique for obtaining **balanced turning movement volumes from approach volumes at three-legged and four-legged intersections**. **Appendix D** shows an example of the methodology used by District 2. The required input data, output produced, and associated features of the District 2 manual procedure are summarized below. Users are advised that district approval is required when applying the manual method.

Required Input Data

- Approach volumes
- Possibly K and D factors

Output Data

- One set of balanced turning movement forecasts

Features

- Simple application
- Relatively time consuming
- Manually calculated

6.8 Summary of Techniques

In summary, there are some differences inherent to each of the turning movement methods. Each of the methods differs in the amount of data input and the information generated. The following observations can be made regarding the two main tools used in Florida for developing turning movement volumes:

- TURNS5-V2014 is an improved version incorporating the best of all the spreadsheets being used by the Districts. It can be used to develop turning movements for existing and planned intersections.
- TURNS5-V2014 can provide turning movement projections where detailed existing and future year data input parameters are available and applicable.

- TURNS5-V2014 is also well suited for obtaining preliminary balanced turning movement projections where only approach volume information is available and/or applicable.
- TMTTool provides an easy-to-use application that can estimate future turning volumes for multiple periods at the same time.
- TMTTool incorporates volume verification procedures to prevent zero or negative growth.

Procedures recommended in NCHRP Report 765 offer alternative ways of estimating turning movement volumes.

Users are advised to review the available data and applicability of the tools and select a method that is best suited for the project. If budget and schedule permit, use more than one method to evaluate the projected turning movement volumes. Professional judgement should always be exercised to check the reasonableness of the traffic projections.

Chapter 7 Equivalent Single Axle Load (ESAL) Forecasting

7.1 Introduction

ESAL

It is important to determine the number and types of wheels/axle loads that the pavement will be subject to over its design life when designing pavement for a roadway. The primary concern is the damage to the pavement caused by the wheel loads. Given the types of wheels and axles in the mixed traffic, a common approach is to convert the damage from wheel loads of various magnitudes and repetitions to damage from an equivalent number of “standard” loads. The most commonly used equivalent load is the 18,000 lbs (80KN) single axle load, or the 18 KIP Equivalent Single Axle Load (ESAL).

The ESAL Forecasting Process is necessary for pavement design for new construction, reconstruction, lane addition, or resurfacing projects. While the total volume of traffic influences the geometric requirements of the highway, the percentage of commercial traffic and frequency of heavy load applications have major impacts on the structural design of the roadway. Truck traffic and damage factors are needed to calculate axle loads expressed as ESALs.

7.2 Purpose

This chapter provides guidance on calculating the Design Equivalent Single Axle Load ($ESAL_D$). The ESAL forecast is critical in determining the Structural Number Required (SNR) for flexible pavement and the Depth Required (DR) for rigid pavement. Proper attention to input and good engineering judgement should be used when developing the ESAL forecast. The following topics will be covered in this chapter:

- Truck Forecasting Process
- $ESAL_D$ Equation
- Steps for producing yearly 18-KIP ESALs

7.3 ESAL Forecasting Process

Figure 7-1 shows the ESAL Forecasting Process and identifies the steps to be taken to develop the expected ESALs for the life of a highway project. The design period for a project should be at least 20 years from the anticipated year the project is open to traffic. The ESAL forecasting process involves developing heavy truck traffic, determining damage factors, and generating ESAL estimates.

Some of the FSUTMS-based models such as the Florida Statewide Freight Model (FreightSim) has the capability of forecasting truck traffic. The percentage of truck traffic is assumed to hold the same relationship to AADT unless some anticipated development changes the future truck traffic pattern.

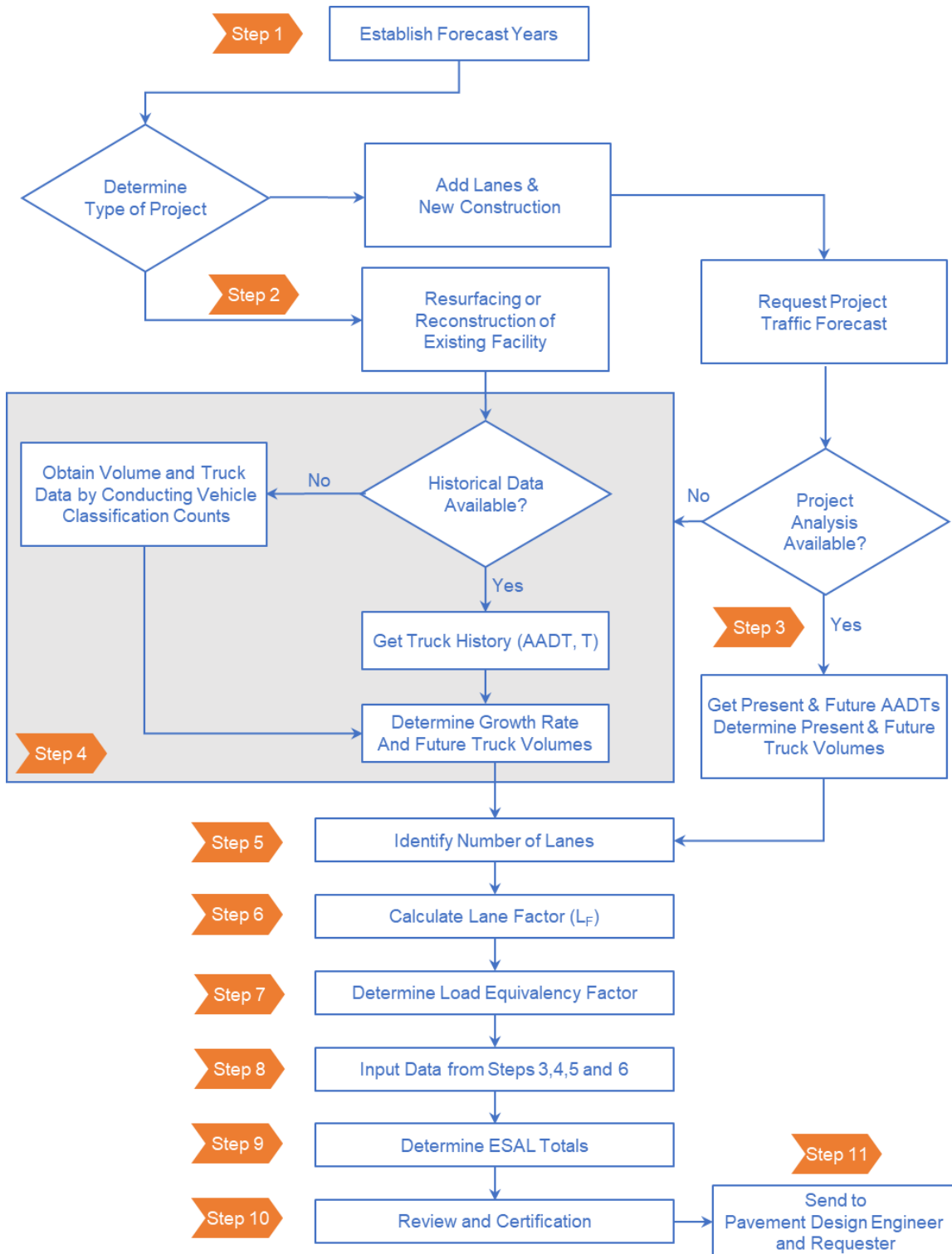


Figure 7-1 - ESAL Forecasting Process

Truck data is collected through vehicle classification counts and vehicle classes 4 through 13 are used for the purpose of determining and forecasting ESALs and truck traffic (see **Figure 2-2** Vehicle Classification Scheme “F”).

The damage factor estimates are based on analysis of historical traffic weight data collected from “Weigh-In-Motion” (WIM) surveys. The survey data is combined with other data such as functional classification, roadway type, number of lanes, highway direction (D_F), percent trucks (T), lane factor (L_F), and truck equivalency factor (E_F or E_{80}), to estimate the accumulated 18-KIP ESALs from the opening year to the design year of the project. An Excel Spreadsheet is developed to facilitate the ESAL estimates.

7.3.1 Projections

Predictions of future truck volumes are often based on historical traffic data. Several factors can influence future truck volumes such as land use changes, economic conditions and new or competing roadways. Truck volumes may decrease, remain constant, or increase. The change may be described as a straight line, an accelerating (compound) rate, or a decelerating rate.

A pavement design may be part of new construction or reconstruction with the addition of lanes, where a diversion effect from other facilities may be a concern. Such a project, where the growth pattern is expected to differ from the historical pattern, will be subject to a “Project Analysis”. This project analysis should include consideration of historical trends (area-wide or project location specific), land use changes, and an evaluation of competing roadways.

7.3.2 Accumulations

The accumulation process calculates a series of truck volumes, corresponding to successive years, by interpolating between the base (opening) year and the design year. The 18-KIP ESALs to be used for pavement design are calculated for each year, accumulated, and reported in a table as shown in **Figure 7-2**.

7.3.3 Traffic Breaks

If a project has two or more traffic breaks within the project limits and the determined current volumes differ significantly, the project is split where appropriate and separate forecasts are prepared for the Pavement Design Engineer.

Chapter 7 – Equivalent Single Axle Load (ESAL) Forecasting

18 kip EQUIVALENT SINGLE AXLE LOAD ANALYSIS - LOCATION 1							
PROJECT TRAFFIC FOR PD&E and DESIGN ANALYSIS INFO / FACTORS							
YEARS: 2012 to 2034							
SECTION #: 79002000	COUNTY: Volusia			PIN #: 428855-1			
FLEXIBLE PAVEMENT URBAN FREEWAY		0.900					
SN=5/THICK	SR 9 (I-95)						
YEAR	AADT	ESAL (1000S)	ACCUM (1000s)	D	T	LF	EF
2012	85000	1285	0	0.5	16.34%	0.563	0.900
2013	86500	1304	0	0.5	16.34%	0.562	0.900
2014	88000	1323	1323	0.5	16.34%	0.560	0.900
2015	89700	1345	2668	0.5	16.34%	0.559	0.900
2016	91400	1367	4035	0.5	16.34%	0.557	0.900
2017	93100	1389	5424	0.5	16.34%	0.556	0.900
2018	94800	1410	6834	0.5	16.34%	0.554	0.900
2019	96500	1432	8266	0.5	16.34%	0.553	0.900
2020	98200	1453	9719	0.5	16.34%	0.551	0.900
2021	99900	1474	11193	0.5	16.34%	0.550	0.900
2022	101600	1496	12689	0.5	16.34%	0.548	0.900
2023	103300	1517	14206	0.5	16.34%	0.547	0.900
2024	105000	1538	15744	0.5	16.34%	0.546	0.900
2025	107000	1563	17307	0.5	16.34%	0.544	0.900
2026	109000	1587	18894	0.5	16.34%	0.542	0.900
2027	111000	1612	20506	0.5	16.34%	0.541	0.900
2028	113000	1637	22143	0.5	16.34%	0.540	0.900
2029	115000	1661	23804	0.5	16.34%	0.538	0.900
2030	117000	1686	25490	0.5	16.34%	0.537	0.900
2031	119000	1710	27200	0.5	16.34%	0.535	0.900
2032	121000	1734	28934	0.5	16.34%	0.534	0.900
2033	123000	1758	30692	0.5	16.34%	0.533	0.900
2034	125000	1782	32474	0.5	16.34%	0.531	0.900
Opening to Mid-Design Year ESAL Accumulation (1000s):							14421
Opening to Design Year ESAL Accumulation (1000s):							31151
I have reviewed the 18 kip Equivalent Single Axle Loads (ESAL's) to be used for pavement design on this project. I hereby attest that these have been developed in accordance with the FDOT Project Traffic Forecasting Procedure using historical traffic data and other available information.							
Prepared by:							
Name		Title		Org. Unit or F		Date	
Signature _____							
Reviewed By:							
Name		Title		Org. Unit or F		Date	
Signature _____							

Figure 7-2 18-KIP Equivalent Single Axle Load Analysis

7.4 Truck Forecasting Process

This section describes the process of forecasting future truck traffic volumes. The process corresponds to Step 3 and Step 4 of the ESAL Forecasting Process as shown in **Figure 7-1**.

7.4.1 Type of Project

18-KIP ESAL analysis primarily depends on truck traffic data. However, future truck traffic depends on the type of the proposed project, and hence the type of project dictates the methodology to be used in the 18-KIP ESAL analysis. The type of projects to consider are new construction (adding lanes), resurfacing or reconstruction projects.

7.4.2 New Construction Project

If the project involves the construction of a new road which includes additional lanes that will affect the future traffic characteristics, the Project Traffic Forecast Process should be performed prior to calculating the 18-KIP ESAL.

The project engineer must request a project traffic forecast for the facility in accordance with the Project Traffic Forecast Process.

7.4.3 Resurfacing, Reconstruction and Rehabilitation Projects

If the project involves the resurfacing, reconstruction or rehabilitation (RRR) of an existing roadway and does not include additional lanes, the historical trend analysis should be performed if historical data is available.

7.4.4 Project Traffic Forecast

Determine if a project traffic forecast for the facility has been completed. If a project traffic forecast is available, check the validity of the data to be used in the ESAL calculation. If data are acceptable, obtain existing and future AADTs from the project traffic forecasting report. If the project traffic forecast is not available or invalid, determine the type of project.

7.4.5 Historical Data Availability

Obtain existing and future AADTs, and number of lanes from the project traffic forecast analysis. If available, determine present and future truck traffic using appropriate T factors from the Annual Vehicle Classification Report. If historical data is not available, or the data cannot be used for the project, obtain truck data by conducting a 48-hour to 72-hour vehicle classification counts in accordance with the Traffic Monitoring Handbook. Determine the truck traffic growth.

7.4.6 Historical and Current Truck Volume

Historical and current truck volume data are available from FDOT's Vehicle Classification Program (use Traffic Characteristics Inventory data, known as TCI). This may be used for

estimating future truck traffic for projects whose limits encompass an FDOT classification station location. They may also be used for comparing roadways with similar characteristics (e.g., traffic, land use, etc.).

7.4.7 Historical Trend Analysis

If an FDOT vehicle classification station is located within the project limits and the truck traffic forecast is not available from a FSUTMS-based travel demand model, a truck growth factor may be used to estimate future truck traffic.

To determine the growth rate for a specific FDOT vehicle classification station, a historical trends analysis should be performed using the least square approximation (regression analysis) method. If the result of this analysis is reasonable, it may be used for calculating future truck volumes. (See **Figure 7-3.**)

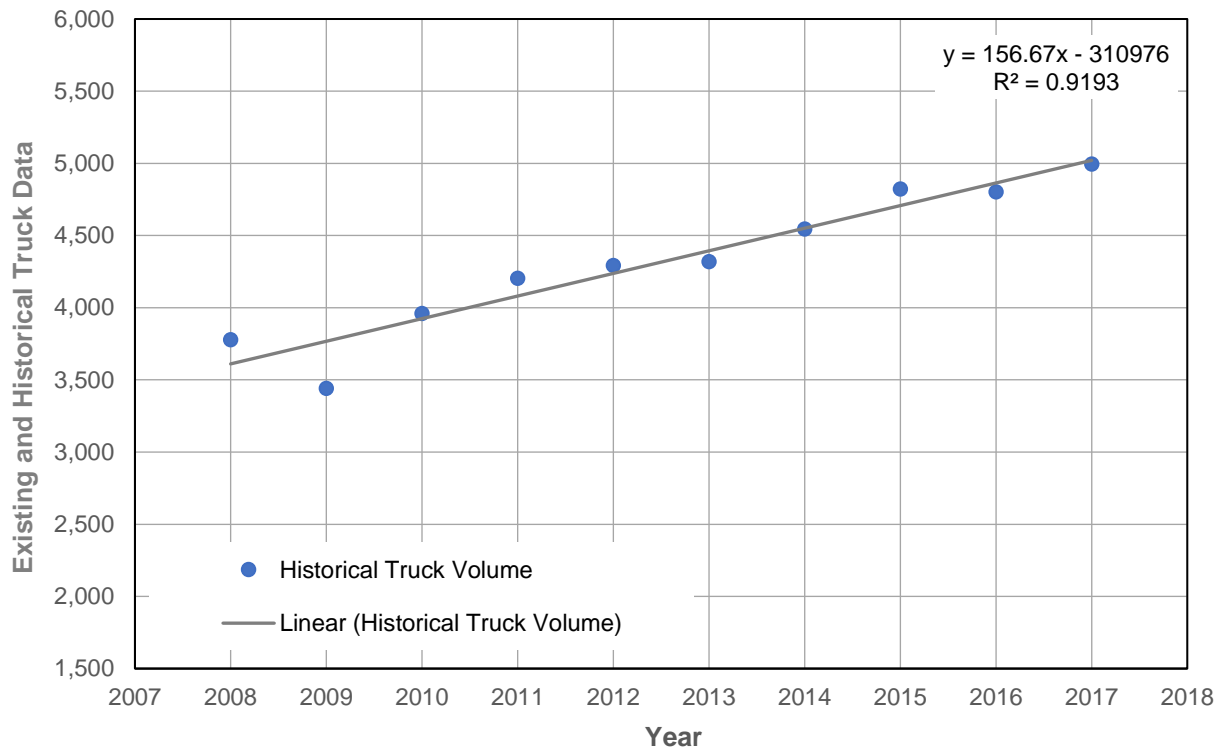


Figure 7-3 Truck Traffic Trend Analysis Example

Determine the traffic growth rate by performing a historical trend analysis projection based on available historical counts, population growth, or other appropriate growth indicators. The future truck traffic shall be determined by applying the growth rate to the base year truck traffic for the desired number of years. There are several methodologies used for traffic growth which include Linear Growth, Exponential Growth and Decaying Exponential Growth.

7.4.7.1 Linear Growth

Linear growth predicts the future traffic based on a straight line developed from historic traffic growth as shown in **Equation 7-1**. This method assumes a constant amount of growth in each year and does not consider a capacity restraint. The equation for Linear growth is as follows:

$$Volume_{FY} = G_{Linear} \times N + Volume_{BY} \quad \text{Equation 7-1}$$

Where:

G = Linear growth rate (volume)

N = Years beyond the base year

FY = Future Year

BY = Base Year

7.4.7.2 Exponential Growth

Exponential growth predicts the future traffic based on a percentage of growth from the previous year as shown in **Equation 7-2**. This method is most suitable where there is rapid growth and capacity available. The equation for Exponential growth is as follows:

$$Volume_{FY} = Volume_{BY} \times (1 + G_r)^{(FY-BY)} \quad \text{Equation 7-2}$$

Where:

G_r = Geometric growth rate

FY = Future Year

BY = Base Year

7.4.7.3 Decaying Exponential Growth

Decaying Exponential growth is used to project future traffic in areas with a declining rate of growth over the analysis period as shown in **Equation 7-3**. This method is recommended for site impact analysis in mature areas when build-out is approaching.

$$Volume_{FY} = Volume_{BY} \times \sum_{BY}^{FY} \frac{X}{FY - BY} \sum_{BY}^{FY} \frac{X}{FY - BY} \quad \text{Equation 7-3}$$

Where:

X = Normal straight-line growth from trend data

FY = Future year

BY = Base Year

Figure 7-4 shows an example of Truck Traffic Trend Analysis. The figure represents Historical and Existing Truck Volume, Linear Growth, Exponential Growth and Decaying Exponential Growth Patterns.

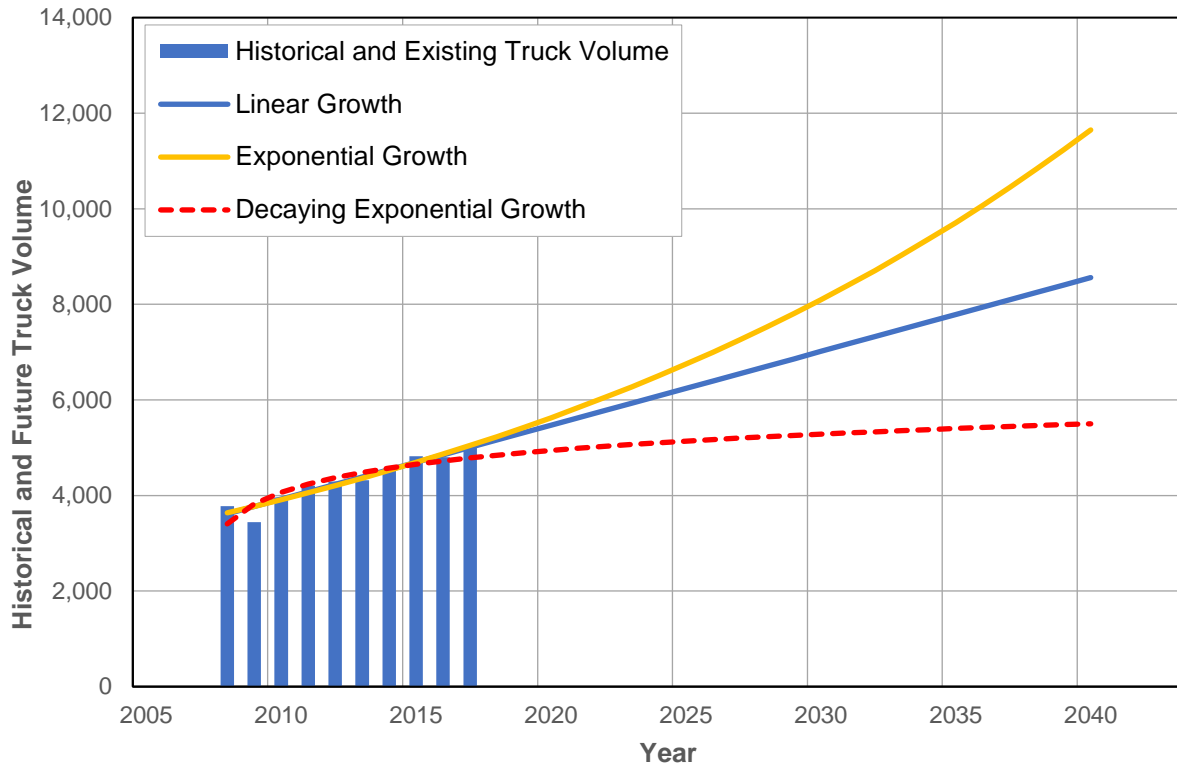


Figure 7-4 Truck Traffic Trends Analysis Growth Patterns

The use of a particular growth pattern depends on the “goodness-of-fit” between the regression equation and the historical data as measured by R-Squared. The land use plans for the future, available land, and economic conditions are also factors to be considered.

7.4.8 Percent Trucks (T)

T can be determined using the following methods:

- a) Vehicle classification count data – If a FDOT vehicle classification station is located within the project limits, the Percent Trucks (T_{24}) is available in the TCI database or on the Florida Traffic Online Web Application. The total percent of Class 4 to 13 vehicles can be applied to the traffic projections to determine future truck volumes.

- b) Vehicle classification data collection – If there is no “active” FDOT vehicle classification station located within the project limits, then field data should be collected. Prior to implementing the field data collection, care should be taken to identify reasonable traffic breaks. The duration of the study should be scheduled to ensure data collection that would reflect an average day of truck traffic within the study area. Be sure to consider seasonal differences which may significantly increase the average traffic counts. For example, a count taken when numerous trucks are transporting produce to a market may dramatically increase the T_{24} average for the year.

Note: Prior to accepting the field counts, the count data should be checked by comparing them to FDOT's TCI or RCI data. If there is a minor difference, use the higher value. If the difference is large, then the field data should be reviewed for possible causes for the difference. Any unresolved differences should be documented.

The results obtained by either of the above methods should provide the total percent of vehicles in Classes 4 to 13. This can be applied to the project traffic projections to determine the future truck volumes.

7.4.9 Future Truck Volumes

Future truck volumes can be calculated using the following formula assuming a linear growth pattern as shown in **Equation 7-4**:

$$\text{Future Truck Volume} = (\text{Base Year Average}) \times [1 + (\text{Years} \times \text{Rate})] \quad \text{Equation 7-4}$$

Example

Assume that the base year truck traffic for a roadway segment for Year 2017 equals to 4,994. A growth factor of 3.2% has been determined based on trend analysis of truck traffic from the past ten years. Truck traffic for year 2040 is desired.

In this example, the growth period equals 23 years (2040 - 2017 = 23). The base year truck traffic is factored by the 23 years and by the rate of 3.2 percent.

$$\begin{aligned} \text{Future Truck Volume} &= (4,994) \times [1 + (23 \times 0.032)] \\ &= 4,994 \times 1.736 \\ &= 8,669 \rightarrow 8,700 \end{aligned}$$



IMPORTANT NOTE:

FDOT has developed a trend analysis spreadsheet application (TREND-V03a.xls) to forecast future AADTs based on historical AADTs and user selected growth pattern (Linear, Exponential, Decaying Exponential). The spreadsheet can be used to forecast truck traffic volume too. The application can be downloaded from FDOT [website](#).

7.5 Design Requirements

7.5.1 ESAL_D Equation

The predicted traffic loading to be furnished by the planning group is the cumulative 18-KIP ESAL axle applications expected on the design lane.

The designer must factor the project traffic forecast by direction and by lanes (if more than two lanes). The following equation is used to determine the traffic in the design lane for the design period:

$$ESAL_D = \sum_{i=1}^n AADT_i \times L_F \times T_{24} \times D_F \times E_F \times 365$$

Equation 7-5

Where:

$ESAL_D$	The number of accumulated 18-KIP Equivalent Single Axle Loads in the design lane for the design period.
i :	The year for which the calculation is made. When $i = 1$, all the variables apply to year 1. Some of the variables remain constant while others, such as AADT, L_F , and T_{24} , may change from year to year. Other factors may change when changes in the system occur. Such changes include parallel roads, shopping centers, truck terminals, etc.
n :	The number of years the design is expected to last. (e.g., 20, 10, ...).
$AADT_i$:	Annual Average Daily Traffic for the year i .
T :	Percent heavy trucks during a 24-hour period. Trucks with six tires or more are considered in the calculations (Class 4-13).
D_F :	Directional Distribution Factor. Use 1.0 if one-way traffic is counted or 0.5 for two-way traffic. This value is not to be confused with the Directional Factor (D) used for planning capacity computations.
L_F :	Lane Factor converts directional trucks to the design lane trucks. Lane factors can be adjusted to account for unique features known to the designer such as roadways with designated truck lanes. L_F values can be determined from Table 7-1 .
E_F :	Equivalency Factor is the damage caused by one average heavy truck measured in 18-KIP ESALs. These factors should be provided by the Planning Department for each project. They will be reviewed annually and updated if needed by FDOT TDA Office based on WIM data. An example of E_F (E_{80}) values for different types of facilities is shown in Table 7-2 .

7.5.2 Directional Distribution Factor (D_F)

Since the number of trucks represents the total for all lanes and both directions of travel, this number must be distributed by direction and by lanes for design purposes. Two-way directional distribution is usually made by assigning 0.5 (50 percent) of the traffic to each direction. One-ways are assigned 1.0 (100 percent).

Although D_F is generally 0.5 (50 percent) for most roadways, there are instances where more weight may be moving in one direction than the other. In such cases, the side with heavier vehicles should be designed for a greater number of ESAL units. For example, D_F may be assigned as 0.7 to account for trucks heavily loaded in one direction. (In practice, both directions of an undivided road would probably be designed for the heavier traffic.)

7.5.3 Lane Factor (L_F)

The L_F is calculated by using the Portland Cement Concrete Pavement Evaluation System (COPES) equation as described in NCHRP No. 277, Transportation Research Board (TRB), September 1986, as shown in **Equation 7-6**.

$$L_F = 1.567 - 0.0826 \times \ln(\text{OneWay AADT}) - 0.12368 \times LV \quad \text{Equation 7-6}$$

Where:

L_F = Proportion of all one directional trucks in the design lane.

$LV = 0$ if the number of lanes in one direction is 2.

$LV = 1$ if the number of lanes in one direction is 3 or more.

\ln = Natural Logarithm.

Example

Assume: One-Way AADT = 25,000 and One-Way Lanes = 3 (meaning $LV = 1$)

$$L_F = 1.567 - 0.0826 \times \ln(25000) - 0.12368 \times 1$$

$$L_F = 1.567 - 0.0826 \times 10.127 - 0.12368 = 1.567 - 0.836 - 0.12368$$

$$L_F = 0.607$$

Table 7-1 provides sample L_F values calculated using the lane factor equation.

Table 7-1 Lane Factors (L_F) for Different Types of Facilities

AADT (One Direction)	Number of Lanes in One Direction	
	Two Lanes	Three or More Lanes
2,000	0.939	0.815
4,000	0.882	0.758
6,000	0.848	0.725
8,000	0.825	0.701
10,000	0.806	0.683
20,000	0.749	0.625
40,000	0.692	0.568
60,000	0.658	0.535
80,000	0.634	0.511
100,000	0.616	0.492

As traffic approaches capacity, the lane factor for all lanes tends to equal out. Drivers in congestion will follow the path of least impedance and tend to move to the shortest line. The L_F should be determined for each year that the ESAL is calculated. FDOT has developed the Equivalent Single Axle Load Analysis Tool, which is an Excel spreadsheet application to facilitate the ESAL calculations. A copy of the spreadsheet can be downloaded from FDOT website:

(<http://www.fdot.gov/planning/systems/programs/SM/ptf/>).

7.5.4 Load Equivalency Factor (E_F or E_{80})

The results of the AASHTO Road Test have shown that the damaging effect of the passage of an axle of any mass (commonly called load) can be represented by a number of 18-KIP ESALs (E_F). For example, on flexible pavement, four applications of a 12-KIP single axle were required to cause the same damage (or reduction in serviceability) as one application of an 18-KIP single axle. One 24-KIP axle caused pavement damage equal to three 18-KIP axles. The determination of design ESALs is a very important consideration for the design of pavement structures.

A load equivalency factor represents the ratio of the number of repetitions of an 18-KIP single axle load necessary to cause the same reduction in the Present Serviceability Index (PSI) as one application of any axle load and axle number and configuration (single, tandem, tridem).

$$E_{80} = \frac{\# \text{ of } 18 - \text{ Kip ESALs causing a given loss of serviceability}}{\# \text{ of } x - \text{ Kip ESALs causing the same serviceability loss}}$$

Equation 7-7

Different axle loads and axle configurations are converted to equivalent damage factors and averaged over the mixed traffic stream to give a load equivalency factor E_F for the average truck in the stream. This factor is available as a feature of TLFS. E_F values used in 18-KIP ESAL calculations can be obtained from TDA Office. To calculate the damage factor using TLFS, it is necessary to select either flexible or rigid E_F factors. The rigid E_F is based on 12-inch-thick pavement with a Terminal Serviceability Index (PT) of 2.5. The flexible E_F is based on a structural number of 5 with a Terminal Serviceability Index (PT) of 2.5.

It should be noted that load equivalency factors are functions of the pavement parameters, type (rigid or flexible) and thickness. These pavement factors will usually give results that are sufficiently accurate for design purposes, even though the final design may be somewhat different.

When more accurate results are desired and the computed design parameter is appreciably different from the assumed value, the new value should be assumed, the design 18-KIP traffic load ($ESAL_D$) should be recomputed, and the structural design determined for the new $ESAL_D$. The procedure should be continued until the assumed and computed values are as close as desired. **Table 7-2** show some example equivalency factors for different types of facilities as suggested by the FDOT Rigid Pavement Design Manual and Flexible Pavement Design Manual.

Table 7-2 Equivalency Factors for Different Type of Facilities

	Flexible Pavement	Rigid Pavement
Freeways		
Rural	1.05	1.60
Urban	0.90	1.27
Arterials and Collectors		
Rural	0.96	1.35
Urban	0.89	1.22

Source: FDOT Topic #625-010-006 Rigid Pavement Design Manual
 FDOT Topic #625-010-002 Flexible Pavement Design Manual

7.6 Steps for Producing 18-KIP ESALS

The following steps are used to generate the 18-KIP ESAL_D.

Step 1 Receive request for 18-KIP ESAL estimation.

The request for ESAL estimation could come as a stand-alone request, or as part of the general project traffic request. Each FDOT district has a different format and specific time framework to complete the work. Users are advised to consult with District Planning Office and/or individual Project Mangers before starting the work. Figure 7-5 shows an example of Project Traffic Request form. Typical information requested includes AADT for project analysis years, K, D, and T factors, turning movement volumes, and 18-KIP ESAL Report.

PROJECT TRAFFIC REQUEST	
<input type="radio"/> <p>RRR 18 KIP E.S.A.L. Minor Project Traffic</p> <p>This option includes:</p> <ul style="list-style-type: none"> ● Flexible and Rigid Pavement ESALs ● Existing, Opening, Interim & Design Yearly AADTs ● K ● T24 ● D30 ● 24 Hour Synopsis Report 	<input checked="" type="radio"/> <p>Project Traffic Report Major Project Traffic</p> <p>This option includes:</p> <ul style="list-style-type: none"> ● 18 KIP ESAL Report <ul style="list-style-type: none"> ○ Flexible and Rigid Pavement ESALs ○ Existing, Opening, Interim & Design Yearly AADTs ○ K ○ T24 ○ D30 ○ 24 Hour Synopsis Reports ● Existing Opening, Interim & Design Year, Peak Year Intersection, Turning Movement Forecast Volumes <p>Please enter the intersection (s) where turning movement counts need to be collected if any: <input style="width: 100%;" type="text" value="Boynton Beach Blvd. @ Platina Ave./Cedar Point Blvd."/></p> <p style="text-align: center;">FM No. for Job Cost Accounting if applicable: <input style="width: 100%;" type="text" value="432344-1-32-01"/></p> <p><input checked="" type="checkbox"/> Need Intersection Future Design Year Turn Lane Queue Length Information</p>
Additional comments	
Right turn lane is requested by Sheriff. Please conduct TMC to justify right turn lane.	
PL&EM requires 30 days to complete an 18 KIP Report and 60 days to complete a Project Traffic Report. The due date will be calculated automatically based on today's date. If you have a need to have the work completed by a different date please enter it below and provide justification	

Figure 7-5 18-KIP ESAL Request Example

Step 2 Collect Traffic and Geometric Information about the Facility.

Additional information including Functional Classification (RCI Feature 121), Thru Lanes (RCI Feature 212), Median (RCI Feature 215), Speed Limits (RCI Feature 311) and Traffic Flow Breaks (RCI Feature 331) can be accessed through the DOT INFONET Enterprise Web Application or Straight-Line Diagram (SLD). (See **Figure 7-6**).

Check Florida Traffic Information Online for Continuous TMS or Short-Term TMS stations within the project limits or in close proximity (one mile on either side of the limits). Download the Historical AADT Report. This report also contains T_{24} , and Design Hour Truck factor. Depending on the budget or schedule, request 24-hour to 72-hour short-term vehicle classification counts at the study location.

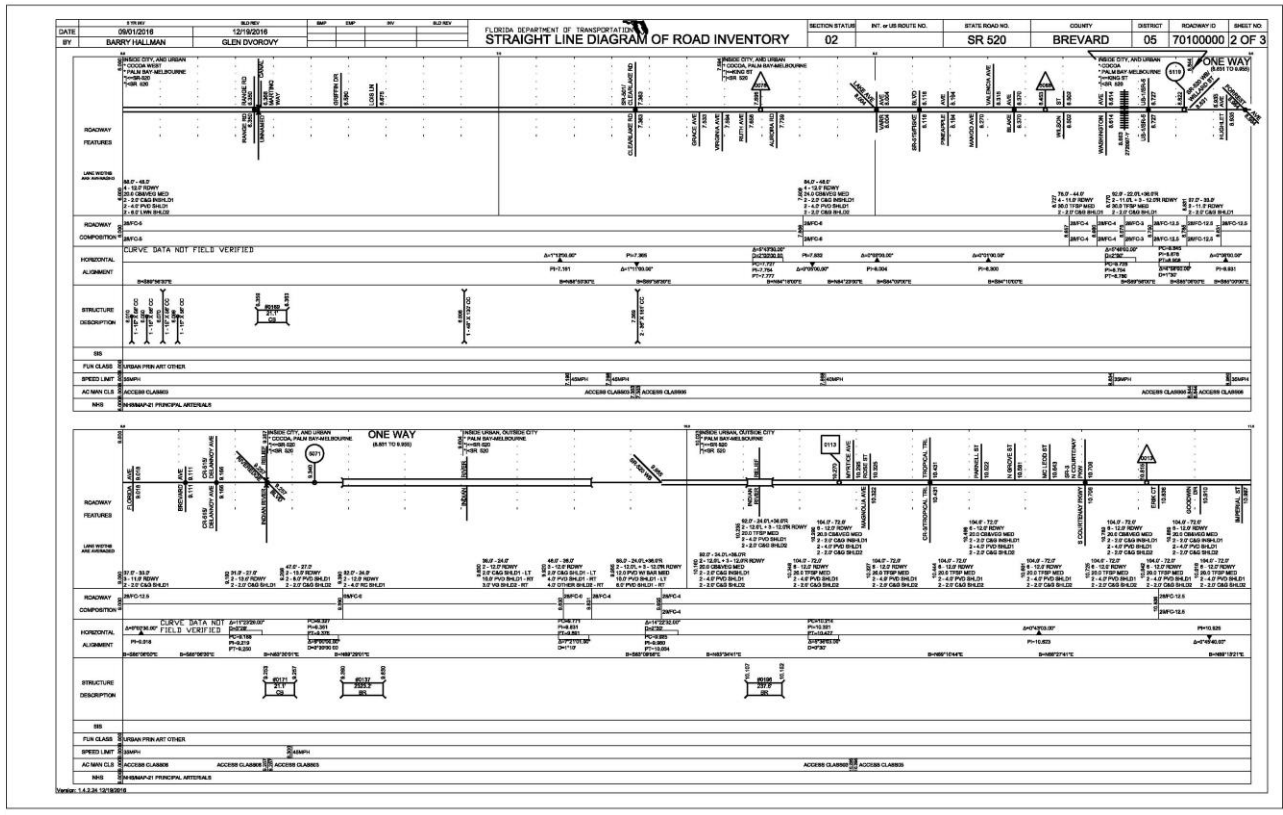


Figure 7-6 Straight Line Diagram Example

Step 3 Request Model Volumes

Request the modeling staff to provide adopted model volumes for both base year and future year for the project area. If the model volumes are not readily available, request a copy of the model and run the model to generate model volumes. Convert the model data from PSWADT to AADT using MOCF if needed. **Figure 7-7** shows an example of model volume plot displaying assigned traffic volume along the study corridor in Brevard County.

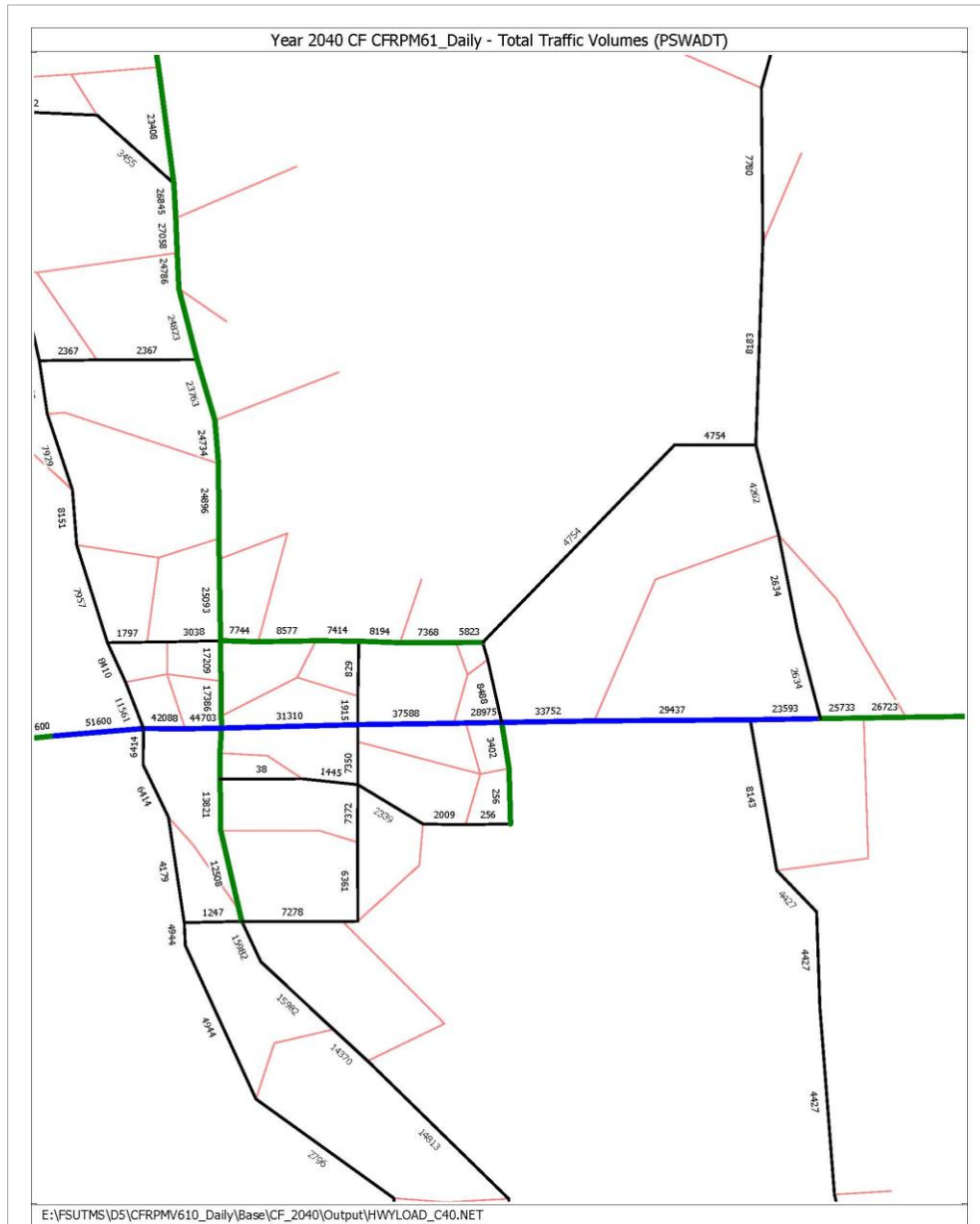


Figure 7-7 Future Year Model Volumes from CFRPM 6.1 Example

Step 4**Determine Existing Year AADT**

Calculate average daily traffic volumes from short-term vehicle classification counts. Apply an appropriate Seasonal Factor to convert the ADT to AADT. No axle adjustment is needed if vehicle classification counts are collected. If short-term traffic counts are not collected, estimate existing year AADT using information from Florida Traffic Information Online, other studies, or similar facilities nearby.

Example:

48-hour classification counts were taken on August 15 and 16, 2017. The daily counts for the two days are 23,583 and 23,542. The corresponding Season Factor is 1.05. The Existing Year AADT is calculated as follows:

$$ADT = \frac{(23,583 + 23,542)}{2} = 23,563$$

$$AADT = ADT \times SF = 23,563 \times 1.05 = 24,741$$

$$AADT = 25,000$$

Step 5**Determine Design Traffic Characteristics**

Develop design hour factors K, D, and T₂₄ following the guidelines described in **Chapter 2**. The Standard K Factor is usually recommended for the project location. The D and T factors are determined by comparing the measured factors from the short-term vehicle classification counts with the respective factors reported in the FDOT RCI database. The recommended values should be within the allowable range and reflect the typical travel characteristics observed in the past and expected in the future.

Example:

The “D” value based on the short-term classification counts was 52.89% for the study location described above. The FDOT RCI database reported a D value of 51.22% for a FDOT Short-Term TMS site nearby. The measured daily truck factor (T₂₄) from the classification count was 5.44%. The FDOT RCI database reported a daily truck factor of 5.26% for the same FDOT Site. Based on the comparison, the daily truck factor (T₂₄) of 5.44% based on measured count and “D” value of 52.89% based on the field measured for the study location are recommended.

Table 7-3 Determine Design Hour Factors Example

Roadway Characteristics	Study Location
Peak-to-Daily Ratio (Measured)	7.94%
D (Measured)	52.12%
Standard K Factor	9.00%
D (From FDOT RCI)	53.40%
Truck Percentages	
T ₂₄ (Measured)	5.01%
T ₂₄ (From FDOT RCI)	4.50%
Recommended Values	
Standard K Factor	9.00%
D Factor	52.76%
T ₂₄	5.01%

Step 6

Develop Future Year Traffic Forecast

Verify if a Project Design Traffic Report was prepared within the last two years, covering the limits of the request for the 18-KIP ESALs. Information contained in the Project Design Traffic Report will be the most reliable and the data should be utilized. If a traffic report is not available, the historical data and model data will be used to develop traffic projections for future years.

Example:

In the same example, historical AADT volumes were available at a Short-Term TMS site within the project limits. Trends analysis was conducted first to determine the growth pattern and growth rate to be used for traffic forecasting. **Figure 7-8**, **Figure 7-9**, and **Figure 7-10** show the trend analysis results using Straight Line Growth Option, Exponential Growth Option, and Decaying Exponential Growth Option, respectively. It is clear from the three charts that none of the growth patterns fit the historical data adequately, with R-Squared values ranging from 45.31% to 59.32, and more importantly, all three growth options results in negative growth rates

Chapter 7 – Equivalent Single Axle Load (ESAL) Forecasting

in the future. Thus, historical AADTs were not used for future travel forecasting.

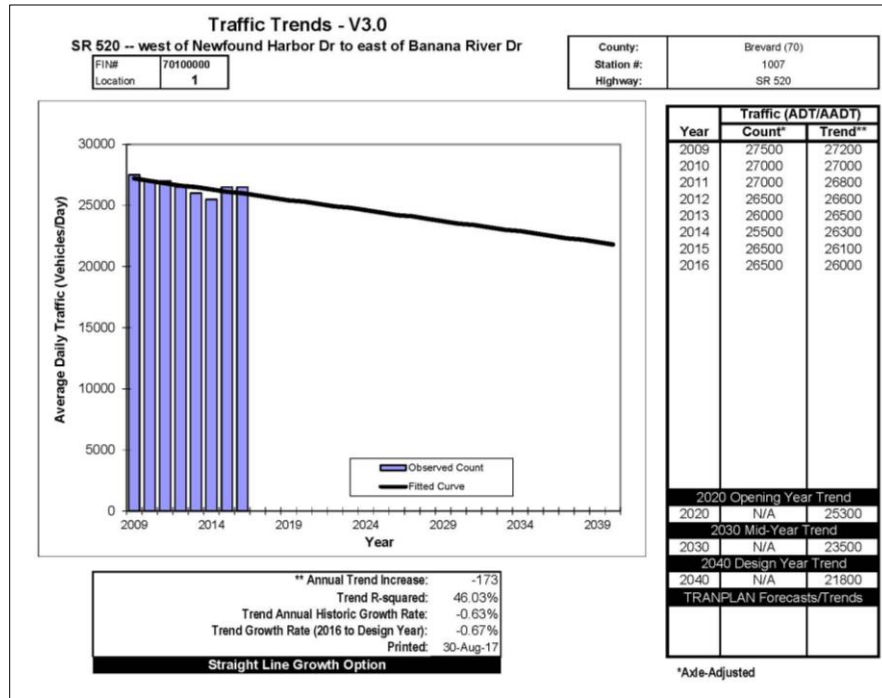


Figure 7-8 Straight Line Growth Option Example

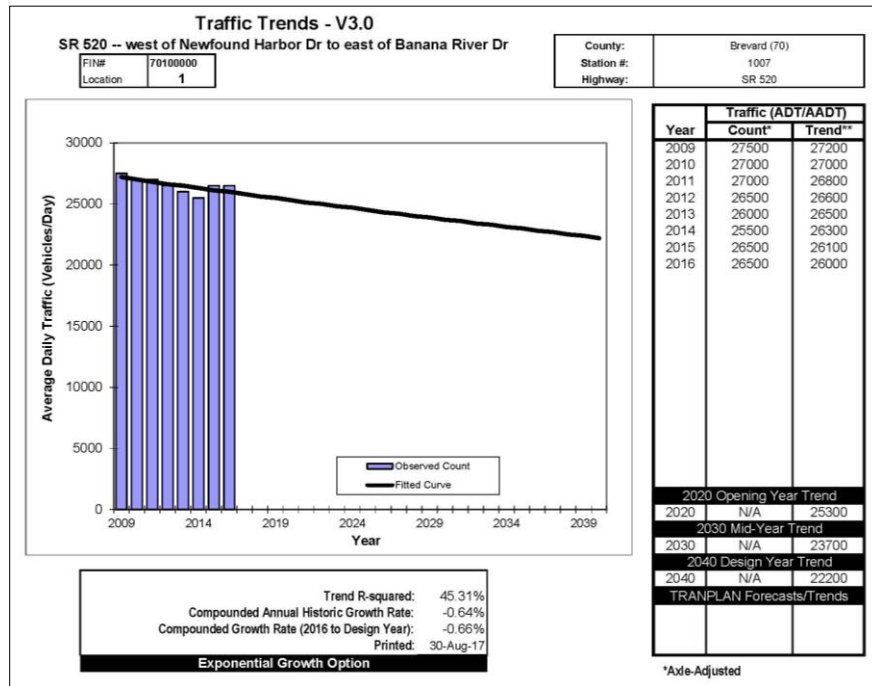


Figure 7-9 Exponential Growth Option Example

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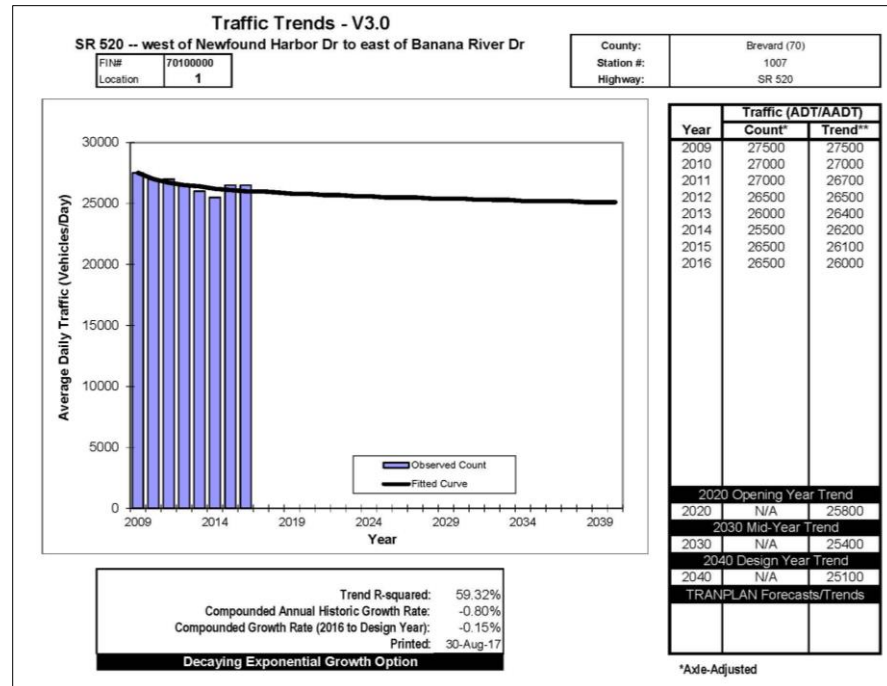


Figure 7-10 Decaying Exponential Growth Option Example

Other sources of data were evaluated to calculate the growth rate. The growth rate calculated based on base year and future model data was 0.40%. In addition, Year 2016 and Year 2040 population projections were obtained from the BEBR at University of Florida, and the population growth rate was 1.53%. Based on the comparison of growth rates obtained from various sources and in consultation with the FDOT, an annual growth rate of 1.20% was recommended to obtain the Opening Year 2020, Mid-Year 2030 and Design Year 2040 projections for the study location.

With base year (2017) AADT of 25,000 and a growth rate of 1.20%, future year AADTs can be estimated using simple linear growth option as follows:

Design Factors:	K=9.0%, D=52.76%, T ₂₄ =5.01%			
Study Location AADT Volumes				
Year	2017	2020	2030	2040
AADT	25,000	26,000	29,000	32,000

Figure 7-11 Project Future Year AADT Volumes

Step 7

Prepare Input Data for ESAL Calculation Spreadsheet

Open ESAL-V02_XML.XLS. This Excel spreadsheet is a user-friendly menu/macro driven tool for input, calculation, and printing of ESALs. The input process is fully menu driven. Enter the required information obtained from previous steps, and select the pavement type and Daily Directional Split, the spreadsheet will automatically calculate the required ESALs. **Figure 7-12** shows an example of the input screens for the sample project.

Example:

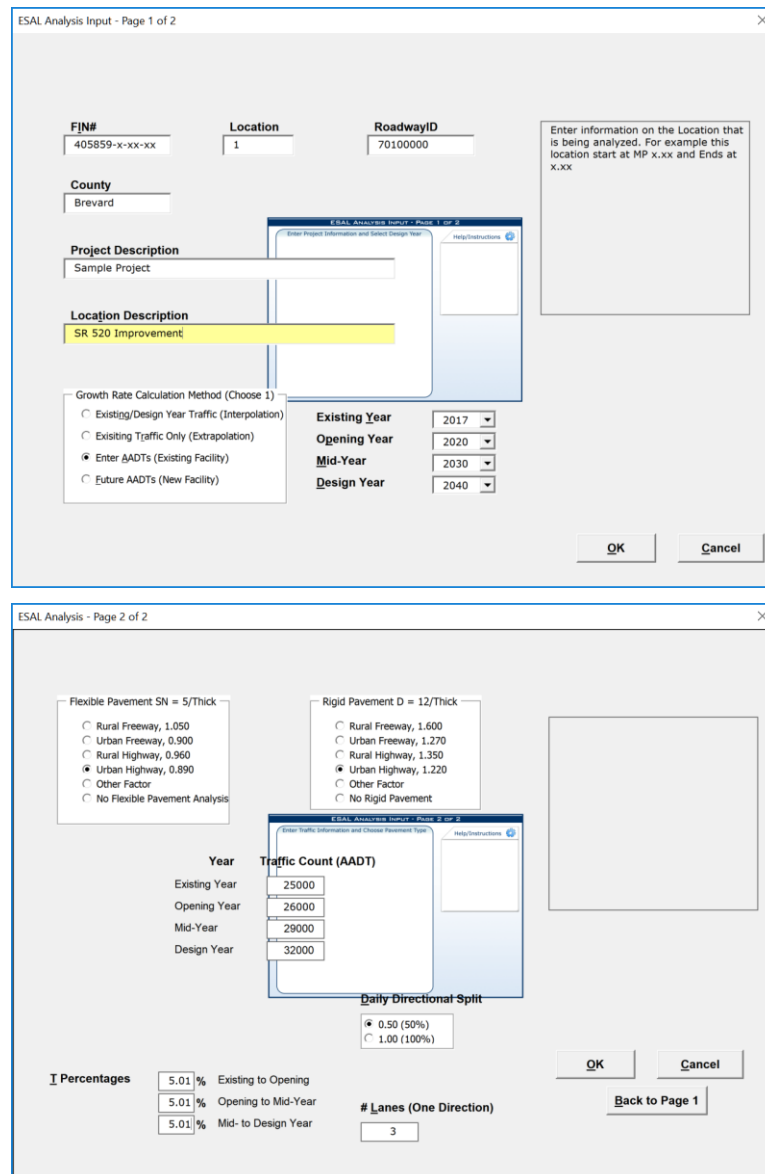


Figure 7-12 ESAL Input Screen Example

Step 8

Print Output Report from ESAL Calculation Spreadsheet

Print out the 18-KIP Report and prepare the transmittal memo. Have the designated traffic engineer review and sign the memo and 18-KIP Report. **Figure 7-13** shows an example of the Output screens for the sample project.

Example:

18 kip EQUIVALENT SINGLE AXLE LOAD ANALYSIS - LOCATION 1							
PROJECT TRAFFIC FOR PD&E and DESIGN ANALYSIS INFO / FACTORS							
YEARS: 2017 to 2040							
SECTION #: 70100000		COUNTY: Brevard			FIN #: 439777-1		
FLEXIBLE PAVEMENT URBAN HIGHWAY 0.890							
SN=5/THICK		SR 520 from west of Newfound Harbor Dr to east of Banana River Dr					
YEAR	AADT	ESAL (1000S)	ACCUM (1000s)	D	T	LF	EF
2017	25000	136	0	0.5	5.01%	0.664	0.890
2018	25300	137	0	0.5	5.01%	0.663	0.890
2019	25600	138	0	0.5	5.01%	0.662	0.890
2020	26000	140	140	0.5	5.01%	0.661	0.890
2021	26300	142	282	0.5	5.01%	0.660	0.890
2022	26600	143	425	0.5	5.01%	0.659	0.890
2023	26900	145	570	0.5	5.01%	0.658	0.890
2024	27200	146	716	0.5	5.01%	0.657	0.890
2025	27500	147	863	0.5	5.01%	0.656	0.890
2026	27800	149	1012	0.5	5.01%	0.655	0.890
2027	28100	150	1162	0.5	5.01%	0.654	0.890
2028	28400	152	1314	0.5	5.01%	0.654	0.890
2029	28700	153	1467	0.5	5.01%	0.653	0.890
2030	29000	154	1621	0.5	5.01%	0.652	0.890
2031	29300	156	1777	0.5	5.01%	0.651	0.890
2032	29600	157	1934	0.5	5.01%	0.650	0.890
2033	29900	158	2092	0.5	5.01%	0.649	0.890
2034	30200	160	2252	0.5	5.01%	0.649	0.890
2035	30500	161	2413	0.5	5.01%	0.648	0.890
2036	30800	163	2576	0.5	5.01%	0.647	0.890
2037	31100	164	2740	0.5	5.01%	0.646	0.890
2038	31400	165	2905	0.5	5.01%	0.645	0.890
2039	31700	167	3072	0.5	5.01%	0.645	0.890
2040	32000	168	3240	0.5	5.01%	0.644	0.890
Opening to Mid-Design Year ESAL Accumulation (1000s):							1481
Opening to Design Year ESAL Accumulation (1000s):							3100
I have reviewed the 18 kip Equivalent Single Axle Loads (ESAL's) to be used for pavement design on this project. I hereby attest that these have been developed in accordance with the FDOT Project Traffic Forecasting Procedure using historical traffic data and other available information.							
Prepared by:				Reviewed by:			
_____				_____			
Name				Title Org. Unit or Firm			
_____				_____			
Signature				Signature			
10/17/2017				Date			
Date				Date			

Figure 7-13 Report Print out for ESAL-V02_XML.XLS

Step 9 **Documentation and Distribution**

Make necessary copies for distribution as follows:

- a) Original transmittal memo and original 18-KIP ESAL Report to requestor.
- b) Copy of transmittal memo to the designated traffic engineer or transportation planner.
- c) Copy of transmittal memo and 18-KIP ESAL Report to reading files.
- d) Copy of transmittal memo, 18-KIP ESAL Report, and all backup documentation to 18-KIP ESAL project files.
- e) Distribute approved copies of the reports to outside parties requesting the information.

7.7 Summary

The 18-KIP ESAL forecast is vitally important in determining the Structural Number Required (SNR) for flexible pavement and the Depth Required (DR) for rigid pavement. Attention should be placed on truck percentages, especially when there are high variations of truck traffic over a short period of time (i.e., 2-3 years). High truck factor percentages can contribute greatly to the reduction of the pavement life cycle. Proper attention to input and good engineering judgement should be used when developing the ESAL forecasting process steps shown in this chapter.

Chapter 8 Project Traffic for Tolled Managed Lanes

8.1 Introduction

Managed lanes are a TSM&O solution where highway facilities or sets of lanes within a highway facility use management strategies to provide congestion relief. The three primary management strategies used are access control, vehicle eligibility, and tolling. When tolling is an option for immediate or future use, the managed lane is an express lane. Express Lanes are a type of managed lanes where pricing through electronic tolling is applied to lanes. Project traffic forecasts for Express Lanes require an additional level of effort compared with the forecasting methods provided in this Handbook. If the managed lanes do not incorporate tolling, then this chapter is not applicable

**IMPORTANT NOTE:**

If the managed lanes do not incorporate tolling, then this chapter is not applicable. Also, this chapter is not intended for use in traffic and revenue studies.

Managed lanes limit access points, which affects trip eligibility and potential demand for the facility. In addition, since Express Lanes use tolling to manage congestion, there is varying demand for the facility. As such, *Express Lanes traffic cannot be forecasted using a typical project traffic forecast procedure that applies Standard K and D factors to AADTs*. This chapter provides general discussions on unique issues in the Express Lanes project development process and offers guidance on the methodologies and processes for project traffic development.

As Express Lanes are developed and various operating strategies are assessed around the state, it is apparent that the complexity of the Express Lanes operations is greater than those of the traditional roadways. FDOT is developing a Managed Lanes Manual to provide guidance on the planning and implementation processes of managed lanes projects and associated technical, organizational, and outreach requirements. The intent of this chapter of the Project Traffic Forecasting Handbook is to supplement the FDOT Managed Lanes Manual once published and provide additional guidance on the development of project traffic during the project development process for Express Lanes. *This chapter is not intended for use in traffic and revenue studies.*

8.2 Travel Demand Forecasting for Express Lanes

The determination of the feasibility of an Express Lanes project and evaluation of alternatives for the Express Lanes require a travel demand forecasting tool that is capable of assessing the impact of tolling on traffic volumes and patterns. Depending on the complexity of the project or the phases in the project development process, a simple spreadsheet application may suffice. However, in most cases, a comprehensive travel demand model is needed to forecast the level of demand for the Express Lanes facility, the impacts of pricing on corridor and regional travel, and the impacts of tolling on different groups of travelers.

8.2.1 Desirable Features for Travel Demand Models

The demand to use Express Lanes is affected by a number of factors. Traveler's sociodemographic characteristics, the trip origin and destination and associated highway network configurations, trip length, actual and perceived travel time savings, travel time reliability, and most importantly, the travelers' Value of Travel Time Savings (VTTS) for the benefits of using the Express Lanes all affect the existing and future travel demand for Express Lanes. How well a travel forecasting model predicts demand for an Express Lanes facility depends on whether the model is structured to capture these factors that influence the travel demand, how well it is calibrated and validated to reflect existing conditions if an Express Lanes facility already exists in the region, and how it is applied to quantify the uncertainty in the future. When evaluating a travel demand model for Express Lanes, the following features are desirable:

- **Time-of-Day** – the model produces travel demand by different times of a day and allows changing the time of travel in response to variable toll amounts.
- **Route Choice** – model assigns traffic to general-use lanes and the Express Lanes explicitly based on varying toll amounts.
- **Mode Choice** – mode choice structure allows formation or dissolution of carpools in response to toll policies or switching to or from competitive transit modes.
- **Travel Cost** – accurate representation of the cost of using Express Lanes.
- **Value of Travel Time Savings (VTTS)** – VTTS is the implied toll value that travelers would be willing to pay for a given savings in travel time.
- **Value of Reliability (VOR)** – VOR is the implied toll a traveler would pay to reduce the variability of a trip's travel time.

Many of the advanced travel demand models in Florida already include some or all of these features. However, having these features alone is not sufficient to use the model for an Express Lanes project. The underlying assumptions used in the model should be identified, and sensitivity analyses may be needed to examine how changes in key assumptions would affect the results of traffic modeling.

8.2.2 Data Used in Express Lanes Modeling

Travel demand models used for Express Lanes also use data from regional household travel surveys, Census population estimates and employment projections, origin-destination surveys, and traffic counts. However, a critical parameter for forecasting Express Lanes demand is the VTTS for the travel population. If Express Lanes facilities already exist in an area, the VTTS can be obtained by collecting traffic volumes, travel times, toll rates, and travel behavior data from travelers using the Express Lanes facilities. However, in areas where such facilities do not exist, stated preference surveys can be conducted to gather information about potential users of the new facility. Stated preference surveys from other areas could also be considered after a careful evaluation of the socioeconomic and travel characteristics of the areas determines substantial similarities between the area and project area exist. Stated preference surveys attempt to elicit VTTS information by asking travelers to state the travel choices they would make when given a set of hypothetical scenarios. Under carefully constructed experimental designs and data analysis techniques, these surveys provide information on VTTS that can be used in a travel demand model.

8.3 Methods for Forecasting Express Lanes Project Traffic

There are three approaches to forecasting project traffic for Express Lanes:

8.3.1 Manual Estimation Using Peak Hour Origin-Destination (O-D)

This method uses a manual estimation of the Express Lanes volume by applying a fixed percentage of the Express Lanes share of traffic to future year peak hour origin-destination (O-D) volumes. The shares of the Express Lanes can be derived from observed data on existing corridors, such as I-95 Express. The future year O-D volumes are developed through use of observed data and corridor forecasts from a travel demand model.

8.3.2 Travel Demand Model (TDM) Based

1. Regional TDM with Dynamic Toll Function or VTTS Curve Assignment

Some Florida travel demand models have embedded highway assignment scripting to specifically estimate Express Lanes traffic. The Southeast Regional Planning Model (SERPM) uses a generalized cost assignment and a logit function that dynamically calculates the toll after each iteration based on the volume to capacity (v/c) ratio in the Express lanes. The Tampa Bay Regional Planning Model (TBRPM) uses predefined VTTS curve to estimate the probability of the user to pay given the marginal cost/minute saved, and a toll policy curve to describe how the toll varies by congestion as measured by the volume to capacity ratio.

2. Regional TDM with ELToD Static Assignment Model

ELToD is a traffic assignment tool used in conjunction with a regional travel demand model to split traffic between Express Lanes and general use or general toll lanes. The ELToD toll choice model uses travel time savings, costs, reliability, and trip distance to calculate the percentage of travelers choosing the Express Lanes. ELToD estimates the volume of traffic by hour on both the general use and the Express Lanes using a highway trip table from any travel demand model. In addition, it estimates the Express Lanes dynamic toll and congested speeds by hour based on traffic conditions.

8.3.3 Microsimulation Model

This method uses modules within microscopic simulation software packages to dynamically assign traffic to the Express Lanes. Microscopic simulation models use a pricing component to estimate the toll amount based on measured conditions such as travel time savings and speed. An embedded decision model determines the probability of choice to use the Express Lanes given the travel time savings and costs. When using microsimulation models, the decision model should be modified so that it is **consistent** with ELToD's toll choice model (**Equation 8-1**). In addition, the model has to be a DTA model which is based on the regional network. This method requires O-D matrices from a macro- or meso-scopic model as an input to perform the traffic assignment and can be part of a multi-resolution approach.

A core function of Express Lanes forecasting is to accurately account for traveler preferences to choose the Express Lanes. This preference is largely influenced by the model inputs, such as VTTS, VOR, and the dynamic toll amount. **Table 8-1** summarizes the model inputs for the various Express Lanes forecasting methods described above, along with some pros and cons for each method. It also includes the appropriate phase(s) in the project development process where the method is recommended to use. Each project's needs should be evaluated against the various forecasting methods.

Manual estimation can be used to quickly approximate the anticipated range in traffic projections for an Express Lanes segment. The manual method is typically suited for sketch level activities on a simplified Express Lanes corridor and is generally not for project traffic forecasting at the PD&E or Design level. Regional travel demand models with customized highway assignment scripting can provide an estimation of Express Lanes demand at the period or daily level. However, the models do not account dynamic pricing fluctuations at the design hour level. In addition, the choice component used to calculate the Express Lanes share typically includes the VTTS and costs but excludes the VOR. Microsimulation models can provide the sensitivity to dynamic pricing but requires specialized scripting to include the VOR and the additional effort to properly calibrate the existing conditions model. As stated earlier, each project's needs should be evaluated against the various forecasting methods.



IMPORTANT NOTE:

Both ELToD and microsimulation models are only “assignment” models. Neither can be used without appropriate trip tables or O-D matrices produced by either a TDM or observed data with proper expansion to account for future growth.

8.4 ELToD Method for Forecasting Express Lanes Project Traffic

The use of a regional travel demand model **in combination with** the ELToD Static Assignment Model is the preferred method to prepare project traffic forecasts for Express Lanes. ELToD is a stand-alone application that follows the FSUTMS standards and works in conjunction with all Florida’s travel demand models. ELToD was initially calibrated using 2011 data from I-95 Express Phase 1. Since then, ELToD has been re-validated against observed data in Broward County on both I-95 Express Phase 2 and I-595 Express. Florida’s Turnpike Enterprise has used ELToD for project traffic forecasting for numerous projects around the state in the South Florida, Central Florida, and West Central Florida regions.

Table 8-1 Express Lanes Project Traffic Forecasting Methods Used in Florida

Method	Activity /Project Phase	Data Requirements	Pros	Cons
Manual Estimation Using Peak Hour O-D	Sketch-Level	<ul style="list-style-type: none"> - O-D data - EL Access Points Estimated EL Share 	<ul style="list-style-type: none"> - Quick estimation method - Provides expected volume range for EL Ramps 	<ul style="list-style-type: none"> - Supply / demand equilibrium not considered - Aggregate effect of multiple O-Ds not considered
Travel Demand Model Based	Regional Travel Demand Model (TDM) with Dynamic Toll Function or VTTS Curve Assignment	<ul style="list-style-type: none"> - EL Access Points - Number of EL Lanes - Speed & Capacity Info - Dynamic Toll Function/ VTTS Curve 	<ul style="list-style-type: none"> - Estimates Daily or period demand directly from TDM without needing to use another model - Provides a systemwide EL evaluation 	<ul style="list-style-type: none"> - Typically uses generalized cost or predefined share - Dynamic toll calculation typically at period level and not at 15-min or hourly levels - Toll amount not reported or used - VOR not considered - Long model run times for alternative testing - Post processing needed
	Regional Travel Demand Model with ELToD Static Assignment Model	<ul style="list-style-type: none"> - O-D (from TDM) - EL Access Points - Number of EL Lanes - Speed & Capacity Info - Toll Choice Parameters (VTTS, VOR, Toll Constant) 	<ul style="list-style-type: none"> - Proven to be efficient - Quick turnaround time for alternatives testing - Consistent results in controlled environment - Incorporates value of reliability - Calculates tolls, congested speeds, and volumes by hour 	<ul style="list-style-type: none"> - Does not account for queue spillback - EL choice selection at first entry only
Micro-simulation Model	Design	<ul style="list-style-type: none"> - O-D (from TDM or mesoscopic model) - Concept Plans (with EL Access Points and Number of Lanes) - Signal Timings - Pricing Model Parameters - Decision Model Parameters (VTTS, Toll Constant) 	<ul style="list-style-type: none"> - Pricing model customized to match the Statewide Express Lanes Software tolling algorithm - Accounts for complex weaving and geometry - Accounts for queue build-up, spillback and dissipation - Can be integrated with other multi-resolution tools 	<ul style="list-style-type: none"> - Extensive time and effort for model development and validation - Default model does not account for VOR and requires customized scripting - EL choice selection at first entry only - Coding difficulties for unconventional ingress/egress ramp combinations - EL module cannot be run concurrent with the network-wide microscopic dynamic traffic assignment

ELToD estimates the volume of traffic by hour on both general use and Express Lanes by applying **Equation 8-1** to O-D matrices from any travel demand model, including models that already have Express Lanes functionality in the highway assignment process. ELToD also identifies the Express Lanes dynamic toll and congested speeds by hour based on traffic conditions. The ELToD model has a robust choice model component in a controlled environment that can account for various factors that are involved in Express Lanes choice, such as reliability, comfort, safety, lane preference and avoidance of trucks. ELToD provides robust results with quick run times; yet is detailed enough for project traffic forecasting and for Express Lanes ingress/egress traffic operations testing.

In ELToD, the percentage of traffic using the Express Lanes, or Express Lanes share, is calculated using the equation below. The equation reflects the latest representation of the toll choice model.

$$\text{Express Lanes Share} = \frac{1}{1 + e^{(-1 * (\beta_{\text{constant}} + \beta_{\text{Time}} * \text{Time} + \beta_{\text{Toll}} * \text{Toll} + \beta_{\text{Reliability}} * \text{Reliability} - \text{Distance Penalty}))}}$$

Equation 8-1

Where:

β_{Constant} – This parameter determines the Express Lanes share when time, toll, and reliability have a net zero effect.

β_{Time} – This parameter is for the travel time coefficient in the choice model equation defined in the ELToD Model as the Travel Time Coefficient (with units of 1/min). This is the disutility of increasing travel time by one minute.

β_{Toll} – This parameter is for the toll cost coefficient in the choice model equation defined in the ELToD Model as the Toll Coefficient (with units of 1/\$). This is the disutility of increasing the toll by one dollar.

$\beta_{\text{Reliability}}$ – This parameter is calculated from a Reliability Ratio (defined in the ELToD Model as the Reliability Coefficient Ratio) and the travel time coefficient. It indicates the disutility of one unit (one minute) of standard deviation.

Distance Penalty – This parameter is a penalty applied to trips that may use the Express Lanes for a short distance to discourage short Express Lanes trips.

The ELToD Model procedure uses four primary sets of inputs:

- Total estimated subarea project traffic (in a matrix layout) at a period or daily level.
- Hourly distribution of total traffic within the project corridor (by direction), based on observed traffic data.

- Geometric configuration of the subarea network links: link lengths, free flow speed, lane capacity, and link facility type.
- Toll costs: Pricing policy curve, including toll rate limits (minimum and maximum toll rates).

The steps to use ELToD for project traffic forecasting are as follows:

1. Obtain inputs (1, 2, and 3 above) from the validated regional travel demand model.
2. Obtain input (4 above) from the current FDOT toll pricing policy.
3. Create a subarea model with Express Lanes and apply ELToD.
4. Update the ELToD model parameters, consistent with guidance in the *ELToD – User Guide and Documentation*.
5. Run the ELToD model.

The following model output data is extracted from the link data, and summarized by hour and direction:

- Volume
- Time of Day Percent
- Express Lanes Share
- V/C Ratio
- Congested Speed
- Tolls
- Revenue

For more detailed information about the ELToD Static Assignment Model, please refer to the *ELToD – User Guide and Documentation*. This report can be requested through the Florida's Turnpike Enterprise, Toll Studies & Express Lanes Development Department.

It should be recognized that there have been some research efforts to evaluate the use of mesoscopic dynamic traffic assignment (DTA) models, such as Cube Avenue and DTALite, for Express Lanes forecasting. However, these methods would require significant programming and calibration efforts to include the ELToD toll choice model methodology. An ELToD DTA version has been developed by the Florida's Turnpike Toll Studies & Express Lanes Development Department and can be made available upon request.

8.5 Project Forecasting Methodology

All Express Lanes projects include a forecast process to determine both the corridor demand, and the split between general use or general toll lanes and Express Lanes traffic. Project traffic forecasts are initially prepared in the Planning or PD&E phases of the project development process. As part of these phases, every effort is made to accommodate any and all project alternatives so that they can be given full consideration in the development of project traffic. This will help minimize the need to update forecasts during the Design phase, and thus, help reduce the amount of potential rework.

Figure 8-1 presents a general guidance on the tools and the methodologies recommended for each phase of the project development process. When selecting an appropriate methodology or tools to forecast demand for Express Lanes, it is important to note that each project is different and has its unique set of issues and challenges. The tools and methodologies listed for each phase are available options, they can be used individually or jointly to best address the issues. The selection should be made based on the purpose and needs of the project, available data and tools, time and budget, desired level of accuracy of the forecasts. It should also be noted that

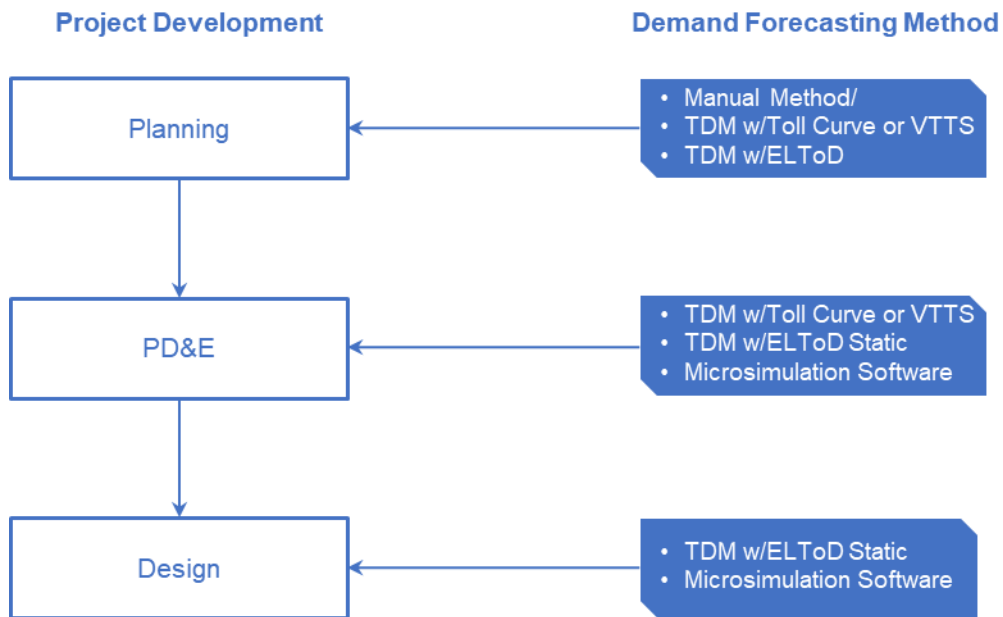


Figure 8-1 - Recommended Project Traffic Forecasting Methodology

Depending on the duration and progression of the project, project traffic for Express Lanes may need to be updated if the major assumptions have changed or there are significant changes in travel patterns in the study area. The project team should consult with the District Project Manager to determine the need to update the project traffic.

Appendix A

FHWA Letter – Use of Standard K-Factors for Traffic Forecasting



U.S. Department
of Transportation
**Federal Highway
Administration**

October 19, 2011

545 John Knox Road, Suite 200
Tallahassee, Florida 32303

Phone: (850) 553-2200
Fax: (850) 942-9691 / 942-8308

www.fhwa.dot.gov/ldiv

In Reply Refer To
HPO-FL

Mr. Ananth Prasad
Secretary of Transportation
Florida Department of Transportation
Tallahassee, Florida

Dear Mr. Prasad:

Subject: Florida – Use of Standard K Factors for Traffic Forecasting

The subject of what constitutes appropriate K factors for traffic forecasting, planning, project development and design is being increasingly discussed between the Florida Department of Transportation (FDOT) and the Federal Highway Administration (FHWA). The K factor represents the proportion of average annual daily traffic occurring in an hour, sometimes referred to as the peaking characteristics of an area.

FDOT's letter dated September 19, 2011 requests FHWA approval for the use of a standard K factor. The issue paper, dated July 15, 2011, prepared by your staff has made a strong case to use predetermined K factors ("standard K factors") as fixed parameters, based on area type and facility type, as a more context sensitive and cost effective practice than continuing to use measured K factors for planning, project development and design of highway facilities. As a result, the FHWA approves the use of FDOT's "standard K factors" for all highway planning through design activities in Florida and the inclusion of them in FDOT's Project Traffic Procedure and Plans Preparation Manual. Our approval is given with the understanding that the standard K factor may not apply in some unique situations and the FDOT proposed process appropriately includes an exception process where the FDOT and FHWA agree to use another K factor. Additionally, use of a K factor lower than FDOT's applicable "standard K factor" on Interstate projects will require FHWA's concurrence prior to the development of the project.

The K factors used on completed traffic analysis, referred to as 'grandfathered in' projects in the issue paper, will need to be reviewed on a case by case basis by our office during the reevaluation process to see if they need to be modified based on a change in the peaking characteristics of the traffic of the area being studied. In addition, the predetermined K factors or "standard K factors" shall be reevaluated by FDOT within the initial three years of implementation.

Sincerely,


For: Martin Knopp
Division Administrator

cc: Mr. Doug McLeod, FDOT (MS-19)

Appendix B

References

[Florida Statutes, Sections 334.03\(25\); 334.046\(1\) and \(2\); 334.063; 334.17; 334.24; and 338.001\(5\)](#)

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[New or Modified Interchange Procedure](#), Florida Department of Transportation, Systems Implementation Office, Topic No. 525-030-160

[Project Development and Environment Manual](#), Florida Department of Transportation, Office of Environmental Management, Topic No. 650-000-001

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[Transportation Site Impact Handbook](#), Florida Department of Transportation, Systems Implementation Office

[FSUTMS-Cube Framework Phase II, Model Calibration and Validation Standards](#), Florida Department of Transportation, Forecasting and Trends Office

[FDOT Design Manual](#), Florida Department of Transportation, Roadway Design Office, Topic No. 625-000-002

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[National Cooperative Highway Research Program \(NCHRP\) Report 765](#), “Analytical Travel Forecasting Approaches for Project-Level Planning and Design”, Transportation Research Board, 2014

[National Cooperative Highway Research Program \(NCHRP\) Report 277](#), “Portland Cement Concrete Pavement Evaluation System (COPEs)”, M. L. Darter, J. M. Becker, M. B. Snyder and R. E. Smith, Transportation Research Board (TRB), September 1985

Appendix C

Glossary

ACTION PLAN – A document identifying both low cost, short-term, and major capacity improvements necessary to bring a controlled access facility to State Highway System (SHS) standards within 20 years.

ADJUSTED COUNT – An estimate of a traffic statistic calculated from a base traffic count that has been adjusted by application of axle, seasonal, or other defined factors. (AASHTO)

AADT **ANNUAL AVERAGE DAILY TRAFFIC** – The total volume of traffic passing a point or segment of a highway facility in both directions for one year divided by the number of days in the year. (HCM)

AOI **AREA OF INFLUENCE** – The geographical transportation network of state and regionally significant roadway segments on which the proposed project would have impact.

Note: The term AOI used for Interchange Access Request (IAR) has a more specific definition. Refer to FDOT [Interchange Access Request User's Guide](#) for more details.

ARTERIAL – A signalized roadway that primarily serves through-traffic and provides access to abutting properties as a secondary function, having signal spacings of two miles or less and turning movements at intersections that usually do not exceed 20 percent (%) of the total traffic.

ADT **AVERAGE DAILY TRAFFIC** – The total traffic volume during a given period in whole days (greater than one day and less than one year) divided by the number of days in that time period. (AASHTO)

AF/ACF **AXLE FACTOR/AXLE CORRECTION FACTOR** – The factor developed to adjust axle counts into vehicle counts. ACF is developed from classification counts by dividing the total number of vehicles counted by the total number of axles on these vehicles.

BASE COUNT – A traffic count that has not been adjusted for axle factors (effects of trucks) or seasonal (day of the week/month of the year) effects. (AASHTO)

BASE DATA – The unedited and unadjusted measurements of traffic volume, vehicle classification, and vehicle or axle weight. (AASHTO)

BASE YEAR – The initial year of the forecast period.

BASE YEAR (MODEL) – The year whose conditions the modeling system was calibrated and/or validated to reflect, from which projections are made.

CALIBRATION (MODEL) – The process of developing basic functional forms of a travel forecasting model and estimating the values of various constants and parameters in the model structure using Census data, surveys, traffic counts, and other information.

CAPACITY – The maximum sustainable hourly flow rate at which persons or vehicles can be expected to traverse a point or a uniform section of a lane or roadway during a given time period under prevailing roadway, environmental, traffic, and control conditions. (HCM 6th Edition)

CONTINUOUS TRAFFIC MONITORING SITE – A statewide system currently consisting of 230 permanent continuous vehicle count stations that collect volume, speed, vehicle classification data and 35 stations that collect weigh-in-motion data 24 hours per day, 365 days per year. The data collected is transmitted using a wireless cellular device to TDA at the FDOT Central Office.

CORE FREEWAY – A conceptual term defining a freeway (major, through, non-toll) routed into or through a large urbanized area's core area (central business districts). The Standard K value may change as it passes through. (FDOT)

CORRIDOR – A linear geographical area that follows a general directional flow connecting centers of economic activity and may contain several alternate transportation alignments and one or more transportation modes.

CORRIDOR TRAFFIC FORECASTING – The process used to determine the required number of lanes within a corridor to meet anticipated traffic demands.

CORRIDOR TRAFFIC STUDY – The long-range system traffic forecast that includes projected link volumes and other data necessary to determine the number of lanes needed on a particular roadway and that includes the analysis of transportation alternatives for the corridor.

COUNT – The data collected as a result of measuring and recording traffic characteristics such as vehicle volume, classification (by axle or length), speed, weight, or a combination of these characteristics. (AASHTO)

COUNTER – Any device that is placed at specific locations to record the duration and variation of traffic flow by hour of the day, day of the week, and/or month of the year.

CUTLINE (MODEL) – A cut line is a line that intersects several parallel roadways that make up a corridor. It is similar to a screenline; however, it is shorter and crosses corridors rather than regional flows.

DTV **DAILY TRUCK VOLUME** – The total volume of trucks on a highway segment in a day.

DAMAGE FACTOR – The number of standard axles per truck. It is calculated by determining the load equivalency factor (LE_F) for each axle and then taking the total of the equivalent standard axles for all the axles in the truck.

DEMAND VOLUME – The traffic volume expected to desire service past a point or segment of the highway system at some future time, or the traffic currently arriving or desiring service past such a point, usually expressed as vehicles per hour.

DESIGN HOUR – An hour with a traffic volume that represents a reasonable value for designing the geometric and control elements of a facility. (HCM Sixth Edition)

DESIGN HOUR FACTOR – The proportion of the AADT that occurs during the design hour (see also K-FACTOR).

DHT **DESIGN HOUR TRUCK** – The percent of trucks expected to use a highway segment during the design hour of the design year. The adjusted, annual design hour percentage of trucks and buses (24T+B).

DHV **DESIGN HOUR VOLUME** – The traffic volume expected to use a highway segment during the design hour of the design year. The DHV is related to AADT by the “K” factor.

DH2 – The adjusted, annual design hour medium truck percentage. The sum of the annual percentages of Class Groups 4 and 5, adjusted to 24 hours.

DH3 – The adjusted, annual design hour heavy truck percentage. Is DHT minus DH2, or the sum of the adjusted annual percentages of Class Groups 6 through 13.

DESIGN PERIOD – The number of years from the initial application of traffic until the first planned major resurfacing or overlay. (AASHTO)

DESIGN YEAR – The year for which the project roadway is designed. It is usually 20 years from the Opening Year.

DDHV **DIRECTIONAL DESIGN HOUR VOLUME** – The traffic volume expected to use a highway segment during the design hour of the design year in the peak direction.

D **DIRECTIONAL DISTRIBUTION** – The percentage of the total, two-way peak hour traffic that occurs in the peak direction.

D_F **DIRECTIONAL DISTRIBUTION FACTOR** – Directional distribution factor used for Equivalent Single Axle Load (ESAL) determination. This value is not to be confused with the Directional Factor (D) used for planning capacity computations.

ESAL **EQUIVALENT SINGLE AXLE LOAD** – A unit of measurement equating the amount of pavement consumption caused by an axle or group of axles, based on the loaded weight of the axle group, to the consumption caused by a single axle weighing 18,000-lbs, known as 18-KIP ESAL. (AASHTO)

ESAL FORECASTING – The process required to estimate the cumulative number of 18-KIP ESALs for the design period; used to develop the structural design of the roadway.

EXPRESS LANES – A type of managed lanes where pricing through electronic tolling is applied to lanes.

FSUTMS **FLORIDA STANDARD URBAN TRANSPORTATION MODEL STRUCTURE** – A standard modeling structure used in Florida for travel-demand forecasting approved by FDOT Model Task Force.

FTP **FLORIDA TRANSPORTATION PLAN** – A statewide, comprehensive transportation plan, updated annually, which is designed to establish long range goals to be accomplished over a 20- or 25-year period and to define the relationships between the long-range goals and short-range objectives and policies implemented through the Work Program.

FORECAST PERIOD – The total length of time covered by the traffic forecast. It is equal to the period from the base year to the design year. For existing roads, the forecast period will extend from the year in which the forecast is made, and thus must include the period prior to the project being completed as well as the life of the project improvement.

FREEWAY – A fully access-controlled, divided highway with a minimum of two lanes (and frequently more) in each direction. (HCM Sixth Edition)

HIGHWAY – A major or significant road, street, or parkway that is capable of carrying reasonably heavy traffic and providing access to residential, commercial, and business areas.

HCM **HIGHWAY CAPACITY MANUAL** – A publication of the [Transportation Research Board of the National Academies of Science](#) that provides concepts, guidelines, and computational procedures to determine the capacity and quality of service for various highway facilities.

HOV **HIGH OCCUPANCY VEHICLE** – Any vehicle carrying two or more passengers.

HOV LANE – A restricted traffic lane reserved for the exclusive use of HOVs and transit vehicles.

INTERIM YEAR – Any future year in the forecast period between the base year and the design year, typically halfway between the two years.

K **K-FACTOR** – The proportion of AADT that occurs during the peak hour (see also Standard K).

Lf **LANE FACTOR** – The percentage of vehicles driving in the design lane. The Lane Factor is used to convert directional trucks to the design lane trucks. Lane factors can be adjusted to account for unique features such as roadways with designated truck lanes.

LOS **LEVEL OF SERVICE** – A quantitative stratification of a performance measure or measures that represent quality of service, measured on an A-F scale, with LOS A representing the best operating conditions from the traveler's perspective and LOS F the worst. (HCM Sixth Edition)

LIMITED ACCESS FACILITY – A street or highway especially designed for through traffic and over, from, or to which owners or occupants of abutting land or other persons have no right or easement, or only a limited right or easement, of access, light, air, or view by reason of the fact that their property abuts upon such limited access facility or for any other reason. Such highways or streets may be parkways from which trucks, buses, and other commercial vehicles are excluded; or they may be freeways open to use by all customary forms of street and highway traffic.

LINK (MODEL) – The spatial representation of a roadway segment in a travel demand model.

E_F **LOAD EQUIVALENCY FACTOR** – The ratio of the number of repetitions of an 18,000-pound single axle load necessary to cause the same degree of pavement damage as one application of any axle load and axle number combination. A Load Equivalency Factor is commonly referred to as a damage factor.

LGCP **LOCAL GOVERNMENT COMPREHENSIVE PLAN** – The plan (and amendments thereto) developed and approved by the local governmental entity pursuant to [Chapter 163, F.S.](#) ([ss. 163.3177](#) and [163.3178](#)), and found in compliance by the Florida Department of Environmental Protection.

L RTP **LONG RANGE TRANSPORTATION PLAN** – A document with a long-term planning horizon, typically ranging from 20 to 35 years, required of each Metropolitan Planning Organization (MPO) that forms the basis for the annual MPO Transportation Improvement Program (TIP), developed pursuant to **Title 23 United States Code 134 and Title 23 Code of Federal Regulations Part 450 Subpart C**.

MASTER PLAN – A document identifying both short- and long-term capacity improvements to limited access highways mainline and interchanges consistent with SIS/State Highway System (SHS) policies and standards to allow for high-speed and high-volume travel.

MANAGED LANES – A TSM&O solution where highway facilities or sets of lanes within a highway facility use management strategies to provide congestion relief. The three primary management strategies used are access control, vehicle eligibility, and tolling.

- MPO** **METROPOLITAN PLANNING ORGANIZATION** – An organization made up of local elected and appointed officials responsible for the development and coordination of transportation plans and programs, in cooperation with the state for metropolitan area containing 50,000 or more residents. (See also TPO/TPA.)
- MOCF** **MODEL OUTPUT CONVERSION FACTOR** – A factor that is used to convert the traffic volumes generated by a travel demand forecasting model in the **Peak Season Weekday Average Daily Traffic** (PSWADT) to AADT. The MOCF is the average of the 13 consecutive weeks during which the highest weekday volumes occur and when the sum of Seasonal Factors (SF) for those 13 weeks are the lowest. MOCF used during model validation to convert traffic counts in AADT to PSWADT for the base year model should also be used for adjusting future year model volumes.
- MADT** **MONTHLY AVERAGE DAILY TRAFFIC** – The estimate of mean traffic volume for a month, calculated by the sum of Monthly Average Days of the Week (MADWs) divided by seven; or in the absence of a MADW for each day of the week, divided by the number of available MADWs during the month. (AASHTO)
- MADW** **MONTHLY AVERAGE DAYS OF THE WEEK** – The estimate of traffic volume mean statistic for each day of the week, over the period of one month. It is calculated from edited-accepted permanent data as the sum of all traffic for each day of the week (Sunday, Monday, and so forth through the week) during a month, divided by the occurrences of that day during the month. (AASHTO)
- MMTD** **MULTIMODAL TRANSPORTATION DISTRICTS** – An area where secondary priority is given to auto vehicle movements. A 7.5% K factor is applicable for state arterials and highways in approved Multimodal Transportation Districts.
- MSF** **MONTHLY SEASONAL FACTOR** – A seasonal adjustment factor derived by dividing the AADT by the MADT for a specific Short-Term TMS count site.
- OPENING YEAR** – One year after a project is scheduled to be open to public and when the new traffic pattern stabilizes This is normally provided by the project manager.
- PD&E** **PROJECT DEVELOPMENT AND ENVIRONMENT** – A phase in project development process to evaluate if the project can meet the requirements of the National Environmental Policy Act.

- PHF** **PEAK HOUR FACTOR** – The hourly volume during the analysis hour divided by the peak 15-minute flow rate within the analysis hour; a measure of traffic demand fluctuation within the analysis hour. (HCM Sixth Edition).
- PEAK HOUR-PEAK DIRECTION** – The direction of travel (during the 60-minute peak hour) that contains the highest percentage of travel.
- PEAK SEASON** – The 13 consecutive weeks of the year with the highest traffic volume.
- PSCF** **PEAK SEASON CONVERSION FACTOR** – A factor used to convert a 24-hour count representing the average weekday daily traffic to PSWADT.
- PSWADT** **PEAK SEASON WEEKDAY AVERAGE DAILY TRAFFIC** – The average weekday traffic during the peak season. Most FSUTMS traffic assignment volumes represent PSWADT projections for the roads represented in the model network. For Project Traffic Forecasting Reports, the PSWADT should be converted to AADT using a MOCF.
- p/d** **PEAK-TO-DAILY RATIO** – The highest hourly volume of a day divided by the daily volume.
- PERMANENT COUNT** – A 24-hour traffic count continuously recorded at a permanent count station.
- PERMANENT COUNT STATION** – Automatic Traffic Recorders that are permanently placed at specific locations throughout the state to record the distribution and variation of traffic flow by hours of the day, days of the week, and months of the year from year to year.
- PROJECT TRAFFIC** – A forecast of the design hour traffic volume for the design year. Project Traffic Forecasting projections are required by FDOT for all design projects.
- PTF** **PROJECT TRAFFIC FORECASTING** – The process to estimate traffic conditions used for determining the geometric design of a roadway and/or intersection and the number of 18-KIP ESALs that pavement will be subjected to over the design life.

- RCI ROADWAY CHARACTERISTICS INVENTORY** – A database maintained by the FDOT Transportation Data and Analytics (TDA) OA database maintained by the FDOT Transportation Data and Analytics (TDA) Office which contains features and characteristics data for the State Highway System. Features and characteristics are assigned and managed by owning offices and data is used throughout many FDOT departments.
- SCREENLINE (MODEL)** – An imaginary line which intercepts major traffic flows through a region, usually along a physical barrier such as a river or railroad tracks, splitting the study area into parts. Traffic counts and possibly roadside interviews are conducted along this line as a means to compare simulated model results to field results as part of the model calibration/validation process.
- SF SEASONAL FACTOR** – Parameters used to adjust base counts which consider traffic fluctuations by day of the week and month of the year. The Seasonal Factor used in Florida is determined by interpolating between the Monthly Seasonal Factors for two consecutive months. (AASHTO)
- SERVICE FLOW RATE** – The maximum directional rate of flow that can be sustained in a given segment under prevailing roadway, traffic, and control conditions without violating the criteria for LOS. (HCM Sixth Edition)
- SHORT-TERM TRAFFIC MONITORING SITE** – A short-term counting program that utilizes traffic count sites that may be permanently or temporarily established. As a part of the statewide count program administered by the FDOT district offices, each road section is generally counted about every three (3) years.
- STANDARD K** – A factor used to convert AADT to a peak hour volume. Standard K values are statewide fixed parameters that depend on the general area types (location) and facility types (roadway characteristics). Multiple Standard K Factors may be assigned depending on the area type/facility type and applied statewide.
- SIS STRATEGIC INTERMODAL SYSTEM** – A statewide network of high-priority transportation facilities, including the State's largest and most significant airports, spaceports, deep water seaports, freight rail terminals, passenger rail and intercity bus terminals, rail corridors, waterways, and highways. These facilities represent the State's primary means for moving people and freight between Florida's diverse regions, as well as between Florida and other states and nations.

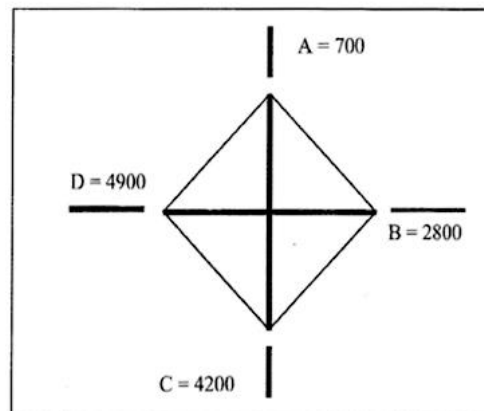
- SIO** **SYSTEMS IMPLEMENTATION OFFICE** – The FDOT [Central Office](#) responsible for SIS through the development and implementation of the SIS Policy Plan and the SIS Funding Strategy. The Systems Implementation Office also develops policies, procedures, tools, training and technical assistance for planning level traffic studies.
- TARGET YEAR** – The final year of the forecast period for which roadway improvements are designed (i.e., the design year or future year)
- T_f** **T-FACTOR** – Truck Factor; the percentage of truck traffic during the peak hour
- T₂₄** – The percentage of truck traffic for 24-hours (one day). (See **Figure 2-2**).
- 24T+B** **24-HOUR TRUCK + BUS PERCENTAGE** – The adjusted, annual 24-hour percentage of trucks and buses. (See **Figure 2-2**).
- 24T** **24-HOUR TRUCK PERCENTAGE** – The adjusted, annual 24-hour percentage of trucks (Classes 5 through 13, see **Figure 2-2**).
- TAZ** **TRAFFIC ANALYSIS ZONE (MODEL)** – Geographic areas dividing the planning region into relatively similar areas of land use and land activity. TAZs serve as the primary unit of analysis in a traditional travel demand forecasting model. They contain socioeconomic data related to land use. TAZs are where trips begin and end.
- TRAFFIC BREAK** – A continuous section of highway that is reasonably homogenous with respect to traffic volume, vehicle classification, and general physical characteristics (e.g., number of through lanes), with beginning and ending points at major intersections or interchanges. Traffic breaks are determined through engineering judgment by the Districts and are recorded in the Roadway Characteristics Inventory (RCI).
- TCI** **TRAFFIC CHARACTERISTICS INVENTORY** – A database maintained by the Transportation Data and Analytics (TDA) Office which contains both historical and current year traffic count information including AADT and the traffic adjustment factors: K, D, and T.
- TDA** **TRANSPORTATION DATA AND ANALYTICS** – The [FDOT Central Office](#) in Tallahassee that monitors and reports statistical traffic information for the State Highway Systems.

- TPA** **TRANSPORTATION PLANNING AGENCY** – same as MPO.
- TPO** **TRANSPORTATION PLANNING ORGANIZATION** – same as MPO.
- TRUCK** – Any heavy vehicle described in FHWA Vehicle Classification Scheme F (See **Figure 2-2**), using 13 classes in the State of Florida.
- VALIDATION (MODEL)** – Validation is the process to verify if the estimated model accurately estimates traffic volumes on transit and roadways. The validation process establishes the credibility of the model by demonstrating its ability to replicate actual traffic patterns.
- VHT** **VEHICLE HOURS OF TRAVEL (MODEL)** – A statistic representing the total number of vehicles multiplied by the total number of hours that vehicles traveled.
- VMT** **VEHICLE MILES OF TRAVEL (MODEL)** – A statistic representing the total number of vehicles multiplied by the total number of miles which are traversed by those vehicles.
- v/c** **VOLUME TO CAPACITY RATIO** – Either the ratio of demand volume to capacity or the ratio of service flow volume to capacity, depending on the particular problem situation.
- WIM** **WEIGH-IN-MOTION** – A system capable of estimating the gross weight of a vehicle and the portion of that weight that is carried by each wheel, axle, and axle group on the vehicle. The WIM equipment collects that volume speed, vehicle classification, vehicle lengths, gross vehicle weight, axle weights, and axle spacing of every vehicle that passes over the sensor.
- WPA** **WORK PROGRAM ADMINISTRATION** – The five-year listing of all transportation projects planned for each fiscal year by FDOT, as adjusted for the legislatively approved budget for the first year of the program.

E.2 Approximation of Turns from End Volumes**Given:** Two-way AADT on each leg of a four-legged intersection**Find:** The two-way turns and through AADT between A&B, A&C, A&D, B&C, B&D, C&D

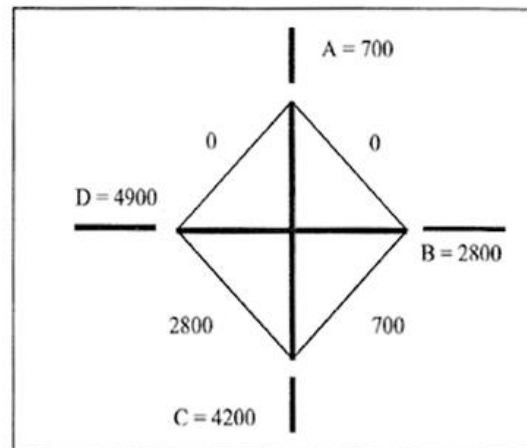
Round all volumes: Current year to nearest 20, future years to nearest 200
(This example assumes current year)

1. From the larger of A or C subtract the smaller of A or C
 $4200 - 700 = 3500$
2. From the larger of B or D subtract the smaller of B or D
 $4900 - 2800 = 2100$
3. From the larger difference subtract the smaller difference, Divide the remainder by 2
 $3500 - 2100 = 1400$
 $1400 / 2 = 700$
This is the first diagonal-turn-volume-difference



4. From the larger difference subtract the last calculated value.
 $3500 - 700 = 2800$
This remainder is the second diagonal-turn-volume-difference.
5. Position the last two calculated diagonal-turn-volume-differences so that the original end volume are satisfied if the two other turning movements are zero

6. Approximate the turns which were taken as zero by prorating the smaller end volume to the other three legs.



$$\begin{aligned} \text{A is smallest} &= 700, \text{ so base} = B + C + D \\ &= 2800 + 4200 + 4900 = 11900 \end{aligned}$$

Proration constant for "A"

$$K_A = \frac{A}{B+C+D} = \frac{700}{11,900} = 0.0588$$

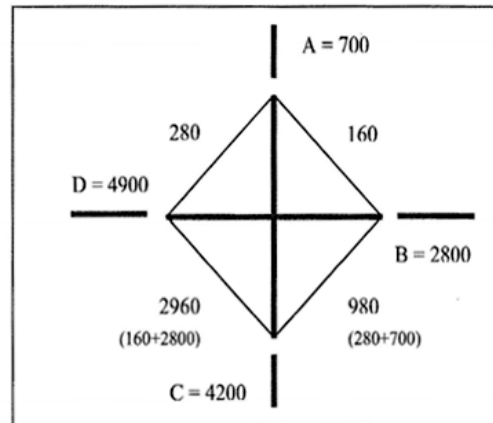
$$\begin{aligned} \text{Turns between A\&B} &= K_A \times B \\ &= 0.0588 \times 2800 = 164 \\ &\text{(20 Round)} \rightarrow 160 \end{aligned}$$

$$\begin{aligned} \text{Turns between A\&D} &= K_A \times D \\ &= 0.0588 \times 4900 = 288 \\ &\text{(20 Round)} \rightarrow 280 \end{aligned}$$

7. To the approximated minor turns add the opposite diagonal-turn-volume-difference to obtain the remaining turn volumes.

$$280 + 700 = 980$$

$$160 + 2800 = 2960$$



8. From the end volumes subtract the turn volumes to obtain the through volumes

$$700 - 280 - 160 = 260$$

$$2800 - 160 - 980 = 1660$$

