PROJECT TRAFFIC FORECASTING

HANDBOOK 2024

FDOT

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Chapter 1

Introduction and Overview

1.1 Introduction

Project traffic is the amount of multimodal traffic with respective characteristics that is expected in an existing or proposed transportation facility in the future. Project traffic estimates are required for planning, Project Development and Environment (PD&E) studies, design, construction, and pavement design including Resurfacing, Restoration, and Rehabilitation (RRR) projects, and traffic engineering studies. Project Traffic Forecasting is used to evaluate the performance, design, and impact of a transportation facility and its effect on the surrounding network and the environment. A project traffic report is routinely prepared as part of most PD&E Studies to document the existing conditions and the development of future project traffic data. The 2024 FDOT Design Manual (Chapter 913) requires traffic data consistent with the data used for pavement design to be included in each typical section. Pavement design considers the total amount of truck traffic accumulated during the expected service life of a roadway segment.

Project Traffic Forecasting is a complex and resource-intensive process that requires a large amount of data, detailed analysis, and specialized expertise. It often involves making reasonable assumptions and judgments based on the available information and methods. Project Traffic Forecasting is subject to uncertainty and variability, as there are many factors that can affect the future traffic demand and behavior, such as economic conditions, population growth, land use changes, travel preferences, technology innovations, and policy interventions. Therefore, Project Traffic Forecasting should be done with caution and transparency.

Project Traffic Forecasting plays an integral role in the project development process. It helps decision-makers evaluate their options and select the best alternatives to meet project goals and objectives. It is critical that the forecasting is done in a logical, consistent, and transparent manner throughout the entire project development process. The Project Traffic Forecasting Handbook offers guidelines and techniques to facilitate the implementation of a consistent traffic forecasting approach in the state. It describes the three (3) forecasting processes, which include Corridor, Project, and the 18-KIP Equivalent Single Axle Load (ESAL), in detail.

CORRIDOR

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

PROJECT

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 18-KIP ESAL Forecasting Process is required for the pavement design for new construction, reconstruction, and Resurfacing, Restoration and Rehabilitation (RRR) projects that require a structural loading forecast.

1.2 Purpose

The purpose of this 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 defendable 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 ESAL Forecasting. This handbook supplements the Project Traffic Forecasting Procedure Topic No. 525-030-120.

1.3 Organization

This Handbook consists of nine (9) chapters and four (4) appendices:

Chapter 1 Introduction and Overview

This chapter outlines the traffic forecasting processes for Corridor, Project, and 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 existing traffic data collection methodologies used in the state of Florida, and the estimation and tabulation of: Seasonal Factor (SF), Axle Correction Factor (ACF), estimates of Annual Average Daily Traffic (AADT), K Factor (K) and Standard K Factor, Directional Distribution Factor (D), and Percent Trucks (T) for the current year.

Chapter 3 Scoping for Project Traffic Forecasting

This chapter provides guidance on scope development for Project Traffic Forecasting. It covers factors to be considered when preparing a scope, how to determine applicable forecasting methods, how to identify the best sources of data, schedule guidelines, and document requirements and deliverables.

Chapter 4 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 provides an overview of travel demand models, describes basic model calibration and validation techniques, and discusses the use of model output for traffic forecasting.

Chapter 5 Forecasting Without a Travel Demand Model

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 6 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 7 Estimating Intersection Turning Movements

The purpose of this chapter is to provide a method for developing balanced turning movement volumes at intersections. The FDOT Turning Movement Tool (TMTool) and TURNS5 Turning Movement Analysis Tool (TURNS5-V2014) spreadsheets are explained in detail, and reviews of other techniques are summarized.

Chapter 8 Equivalent Single Axle Load Forecasting

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

Chapter 9 Project Traffic for Tolled Managed Lanes

This chapter provides general discussions on unique issues in the Tolled Managed Lanes Project Development process and offers guidance on the methodologies and processes for design traffic development.

Appendix

Appendix A

Project Traffic Forecasting Procedure Topic No. 525-030-120

FHWA Approval Letter: Use of Standard K Factors for Traffic Forecasting in Florida

FDOT White Paper: Standard K Evaluation

Appendix B

References used in the Handbook

Appendix C

Glossary - List of terms and definitions used in the Handbook

Appendix D

Example of District 2 Manual Method

1.4 Authority

Sections 20.23(3)(a) and 334.048(3) of Florida Statutes (F.S.).

- 20.23 (3)(a) F.S.: The Central Office shall establish departmental policies, rules, procedures, and standards and shall monitor the implementation of such policies, rules, procedures, and standards in order to ensure uniform compliance and quality performance by the districts and Central Office units that implement transportation programs. Major transportation policy initiatives or revisions shall be submitted to the Commission for review.
- 334.048 (3) F.S.: The Central Office shall adopt policies, rules, procedures, and standards which are necessary for the Department to function properly, including establishing accountability for all aspects of the Department's operations.

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 means reviewing the forecast itself and its sources to consider these limitations and traffic details when designing or implementing changes to a transportation facility or network. For example, this could mean compensating for uncertainty in projections of the total axle loading by using a reliability design factor or considering an upcoming new development which may attract a large number of heavy vehicles; thus, larger turning radii may need to be considered when designing the transportation facility.

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 **Table 1-1** Rounding Convention.

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

Table 1-1 Rounding Convention

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

Chapter 2

Traffic Data Sources and Factors

2.1 Introduction

Data sources are an essential component for traffic forecasting to provide an understanding of current conditions, evaluate the impacts of different scenarios, and develop traffic estimates for future conditions. Different types of data can be used for a project, depending on the objectives, selected forecasting methodology, scope, and budget of the project. Common data types include traffic data, socioeconomic factors, land use patterns, and transportation network characteristics. Data sets can be collected or compiled from a variety of different sources, such as traffic sensors installed in the field, household travel surveys, research institutions, U.S. Census Bureau, and various state and local government agencies. With the advancement of technology, the proliferation of mobile devices, and the innovation of data analytics, new and novel types of data, or emerging "Big Data," are accessible. These "Big Data" sources offer new insights into travel behaviors and provide new travel-related information that was not previously available.

The FDOT Transportation and Data Analytics (TDA) Office is the central clearinghouse and principal source for traffic, roadway, and multimodal freight and passenger data. The data and information cover a range of time periods: historic, current, and future. The TDA Office gathers data directly through automated means and indirectly through district field personnel or others. Third party vendors are sometimes used to provide supplemental data. TDA provides tools and training to record, process, analyze, and report data. The TDA Office also publishes informational documents and responds to special requests for data inside and outside the agency. Users are advised to check TDA's website most up-to-date information available.

Traffic data are among the most critical in the project traffic development process. The Traffic Monitoring Program within the TDA Office is designed to ensure that the collection and processing of needed traffic data is efficient, effective, and consistent. The Traffic Monitoring Program coordinates the collection of traffic data on the State Highway System (SHS) and many highways not on the SHS. Depending on location, traffic data may include volume, vehicle speed, vehicle classification, and vehicle weight data. Traffic data is collected from January through December of each year, and then converted into annual statistics during the first quarter of the following year. The annual traffic statistics are posted on Florida Traffic Online Web Application by late spring/early summer of each year.

2.2 Purpose

The purpose of this chapter is to introduce various traffic statistics that characterize the use and performance of the multimodal roadways traveled by the public. In addition, it provides an overview of the methodologies and processes used to collect various types of traffic data, and offer guidelines on how to analyze and evaluate the data and determine the most appropriate values to be used for project traffic development. A brief discussion on the sources and usage of "Big Data" is also included. Specifically, the following topics are covered in the chapter:

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

2.3 Traffic Data Collection Program

The FDOT Traffic Data Collection Program covers both vehicular traffic (e.g., trucks, automobiles, and motorcycles) on the roadways and non-motorized traffic, such as bicycles and pedestrians on sidewalks, bikeways, and trails. While it is important to collect and analyze non-motorized traffic data, the focus of this chapter is motorized traffic data. Users are advised to refer to the 2023 Florida Traffic Monitoring Handbook for details on non-motorized traffic data collection.

2.3.1 Traffic Count Site Types

FDOT operates two types of traffic count site: Continuous Traffic Monitoring Site (Continuous TMS) and Short-term Traffic Monitoring Site (Short-term TMS).

The continuous sites are designed to collect various traffic data 24 hours per day, 365 days per year. The data collected is transmitted to TDA Office using a wireless cellular device. Information from these sites is used to determine traffic growth and tendencies, as well as develop pavement design input, seasonal adjustment factors used in determining estimates of AADT, axle correction factors for road tube counts, and Directional Design Hour Volumes (DDHV). In 2022, there were 386 active continuous sites in the State. There were also an additional 46 sites that collect information on vehicle classification and truck weights, known as Weigh-in-Motion (WIM). The TDA Office will determine when and where new Continuous TMS 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 Office. Generally, three (3) to four (4) new sites are installed each year and several others receive equipment upgrades. Continuous counters provide the user with day-to-day traffic information throughout the year.

The Short-term TMS are designed to collect traffic counts for a short period of time, usually between 24 and 72 hours. Short-term TMS can 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 approximately every three (3) years. 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, and turn lanes. In 2022, there were 18,746 active short-term counts sites across the State. Short-term counts are used to develop growth factors for estimating current year counts from known prior year counts and determine Vehicle Miles Traveled (VMT).

The various types of traffic monitoring sites used in Florida in 2022 are illustrated in **Figure 2-1.** The FDOT TDA Office and District Offices collected traffic counts at 19,178 sites throughout Florida, providing important information for all aspects of transportation decision making, including both program and project development.

TRAFFIC MONITORING SITES IN FLORIDA

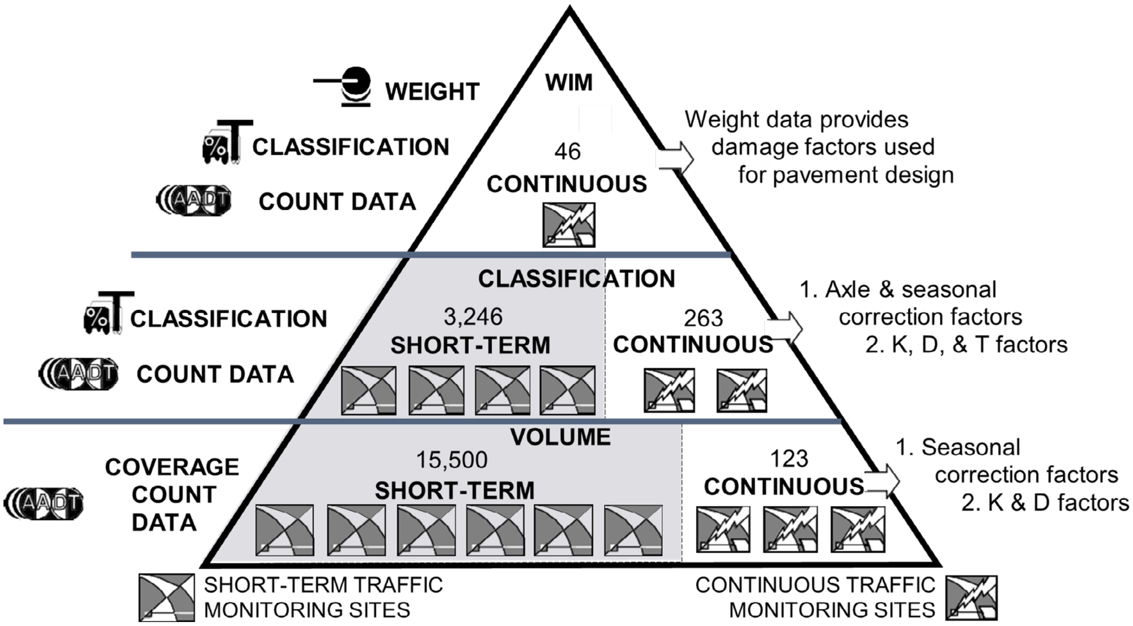

Figure 2-1 Florida's Traffic Monitoring Sites Used in 2022

2.3.2 Types of Traffic Counts

2.3.2.1 Volume Counts

There are two (2) different types of volume counts that can be collected:

1. **Axle Volume Counts** are obtained when a single road tube is set across a road. The counter connected to this road tube divides the number of axles (number of hits) on the tube by two (2) to derive a count. This type of count data requires an ACF to calculate the vehicle count. An ACF is assigned to the specific count location based on the characteristics of the truck traffic at that location.

2. **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 solely its axles. If the counting device counts the "number of vehicles," the count is known as vehicle count. The count site will not require an axle correction factor. All of Florida's continuous traffic monitoring sites can collect vehicle volume data. The data is collected for each lane, and usually in one-hour intervals. In addition, all toll facilities collect continuous traffic counts at the tolling locations.

2.3.2.2 Vehicle Classification Counts

Vehicle classification consists of collecting traffic data with counters that detect axles and measure the distances between axles on each vehicle. The vehicle is then classified per the criteria contained in FHWA Vehicle Classification Scheme "F" (**Figure 2-2**). Classification data is usually collected using a combination of presence (loops) and piezoelectric axle sensors.

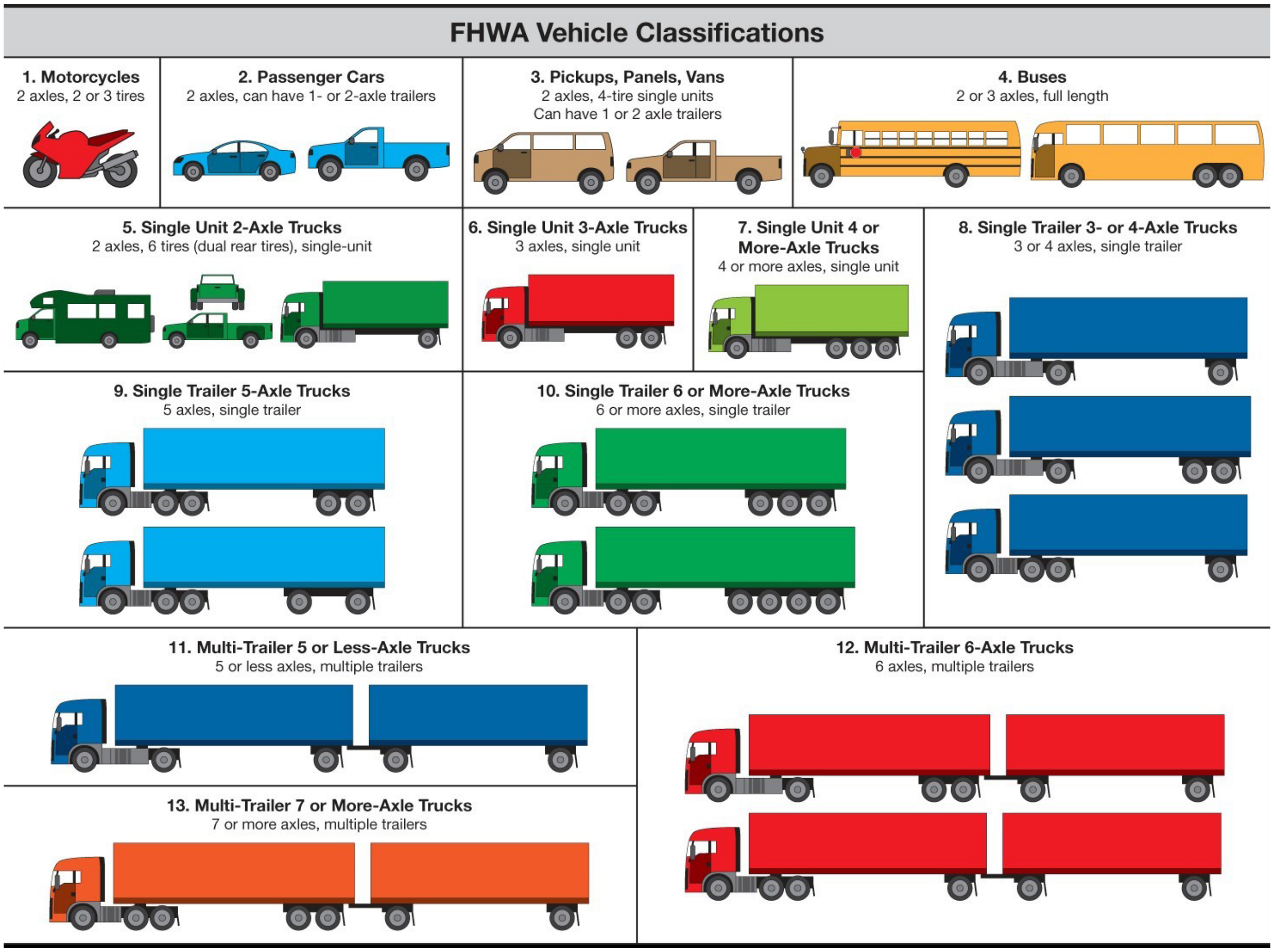

Figure 2-2 FHWA Vehicle Classification Scheme F

Vehicle classification counts obtained at approximately two-thirds of the count locations are used to develop axle correction factors. Axle correction factors are computed for each highway functional classification category in each FDOT region. Limited Speed data is also collected during vehicle classification counts. The Continuous Traffic Monitoring sites are built to collect vehicle classification, volume, and speed counts.

2.3.2.3 Traffic Speed Counts

All Continuous traffic monitoring sites can collect vehicle speed data. Equipment required to collect speed data are two (2) inductive loop sensors. Since 1995, all such sites have been routinely programmed to collect this data in binned files. Florida currently bins the speed data into 15 categories from below 20 mph to over 86 mph, in 5 mph intervals.

2.3.3 Acceptable Time Periods and Duration for Data Collection

Traffic counts should be collected during a time period when traffic patterns are representative for the project. For most studies, this means peak periods during typical weekdays from Tuesdays to Thursdays. Traffic counts should not be collected when the schools are closed. However, for special studies in recreational or tourist areas, especially in areas near cruise ports, traffic counts can be collected during the weekends including Fridays, Saturdays, or Sundays. Collecting data prior to, during, or right after holidays or special events should be avoided.

The duration of the volume or classification count is dependent on the requirements of the District, as well as the project. For the Annual Count Programs throughout the Districts, count locations are identified by the functional classification of the road on which they are located as either 'Rural' or 'Urban'. Because there is more day-to-day variation in the traffic flow in rural areas, a longer count duration is required to minimize this variation. The minimum requirements for Rural and Urban counts are as follows:

- Rural: minimum of 48-hours of continuous data in 15-minute intervals
- Urban: minimum of 24-hours of continuous data in 15-minute intervals

2.3.4 Short-Term Seasonal Classification Counts

FDOT has approximately 3,200 locations where short-term seasonal classification counts are performed. These Short-term TMS are automatic traffic recorders that are temporarily placed at specific locations throughout the State to record the distribution and variation of traffic flow. These counts are performed one (1) or more times a year (24-hour or 48-hour each), as deemed necessary, to capture the seasonal truck variation. The seasonal classification counts, together with classification counts collected at Continuous TMS, are used to estimate the axle correction factors and determine the percentage of trucks.

2.4 Traffic Adjustment Factors

The two (2) 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 FTO website. Both TCI and FTO contain current and historical data. 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 Office 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 ACFs. FTO counts do not need to be adjusted using ACFs.

2.4.1 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 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 (2) 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.

2.4.2 Axle Correction Factor (ACF)

ACFs are developed from classification counts by dividing the total number of vehicles counted by the total number of axles on these vehicles. ACFs 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 the traffic monitoring sites is used to determine the traffic adjustment factors, such as ACFs, 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 SHS as shown in **Figure 2-3**.

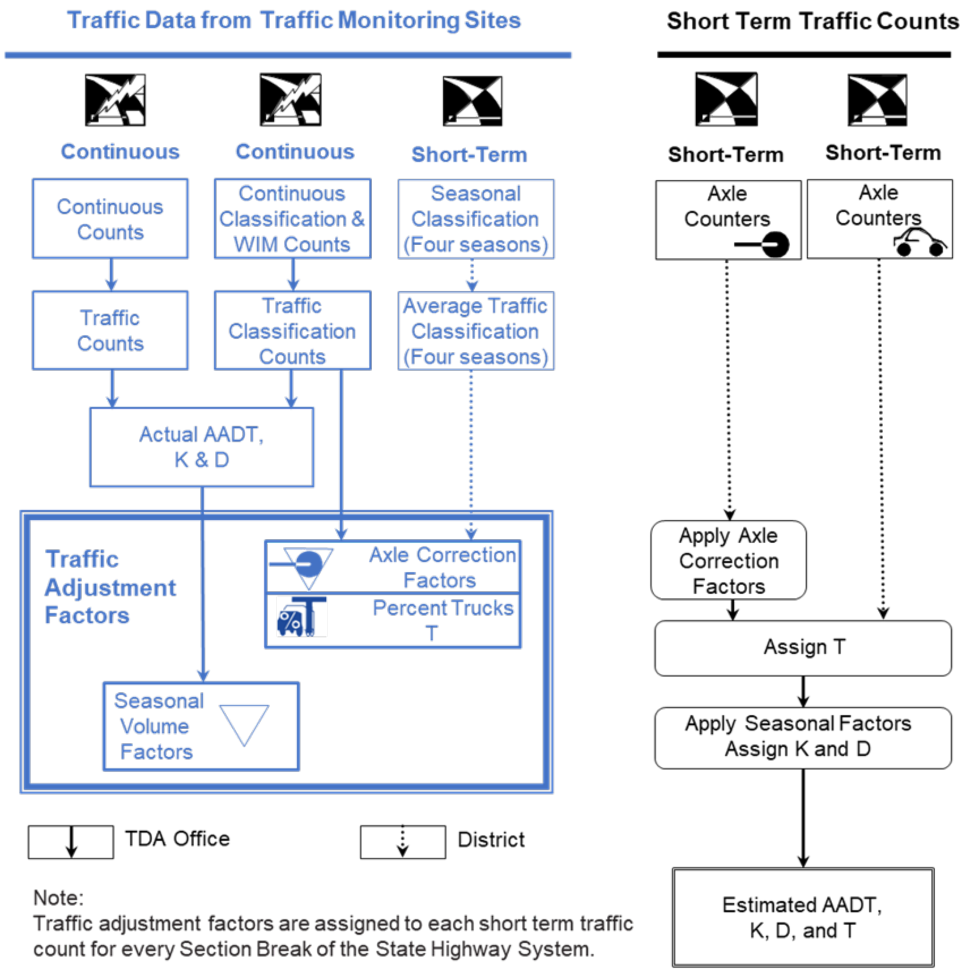

Figure 2-3 Development and Application of Traffic Adjustment Factors

2.5 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 TMS locations 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 short-term traffic counts.

2.5.1 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 (7) days of the week from Sunday to Saturday, over the period of one (1) year. AADT is determined by dividing the total number of vehicles on a roadway segment for one (1) 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, as it includes all traffic for an entire year.

Average Daily Traffic (ADT) is obtained from 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 count 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 SF and ACF, where applicable, should be used to convert ADT to AADT as shown in **Equation 2-3**.

$$AADT = ADT \times SF \times ACF \quad \text{(Equation 2-3)}$$

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.

2.5.2 K Factor and Standard K Factor Range

2.5.2.1 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:

$$DHV = AADT \times K \quad \text{(Equation 2-4)}$$

2.5.2.2 Standard K Factor Range

The traditional practice of determining the K Factor has been using the hourly volume during the 30^{th} highest hour in a year and dividing the hourly volume by AADT. This was first introduced in the 1950 Highway Capacity Manual (HCM) and the 30^{th} highest hour was referred to as the design hour. It was inferred that designing a facility based on the 30^{th} highest hourly volume of the year would be most cost-effective. Other peak hours, such as 100^{th} highest hours, or 200^{th} highest hour, have also been used to determine the K Factor. Even though the most accurate way to develop the K Factor is to have a Continuous TMS station on every roadway segment, this is very unlikely due to costs associated with maintaining and operating such a system. It is often necessary to estimate the K Factor using short-term traffic counts.

In 2011, based on comprehensive analyses and extensive public outreach, FDOT established statewide "Standard K Factors" that was applied to develop project traffic forecast from the planning phase through the design phase of the project. Standard K Factors were fixed parameters predetermined based on area type and facility type with consideration to typical peak periods of the day. The Standard K Factors also reflected urban development patterns and economic activities. The purpose of using the statewide Standard K Factors was to promote better transportation policies and projects, reduce time and effort developing various peak hour numbers, and provide consistency and simplicity in project traffic development.

Over the last decade, there have been significant changes in travel patterns as the State experienced varying economic cycles. There has also been documented need for deviation from the Standard K Factors. In 2021, the FDOT Systems Implementation Office (SIO) initiated a review of the statewide practice to determine if a modification to the Standard K Factors is needed. The study concluded that there was indeed a need to update the current Standard K values. Based on the analysis performed using information obtained from the TDA Office and field count data, FDOT SIO developed a new approach and proposed changes to the current Standard K Factors. The approach and the recommendations are documented in the **FDOT White Paper - Standard K Evaluation (Appendix A)**. The recommended changes to the Florida Standard K Factors were formally approved by the Federal Highway Administration (FHWA) on July 12, 2023. The approval letter can also be found in **Appendix A**.

The new approach to developing the Standard K Factors considers context classification, area type, and facility type of a roadway segment. The FDOT Context Classification System comprises eight (8) context classifications in its efforts to plan, design, construct and operate a context-sensitive system. The Context Classification System broadly identifies the various built environments existing in Florida. FDOT's Context Classification System describes the general characteristics of the land use, development patterns, and roadway connectivity along a roadway, providing cues as to the types of uses and user groups that will utilize the roadway. The context classification of a roadway should be considered when selecting a Standard K Factor for the project. These context classifications are described and shown in **Figure 2-4.**

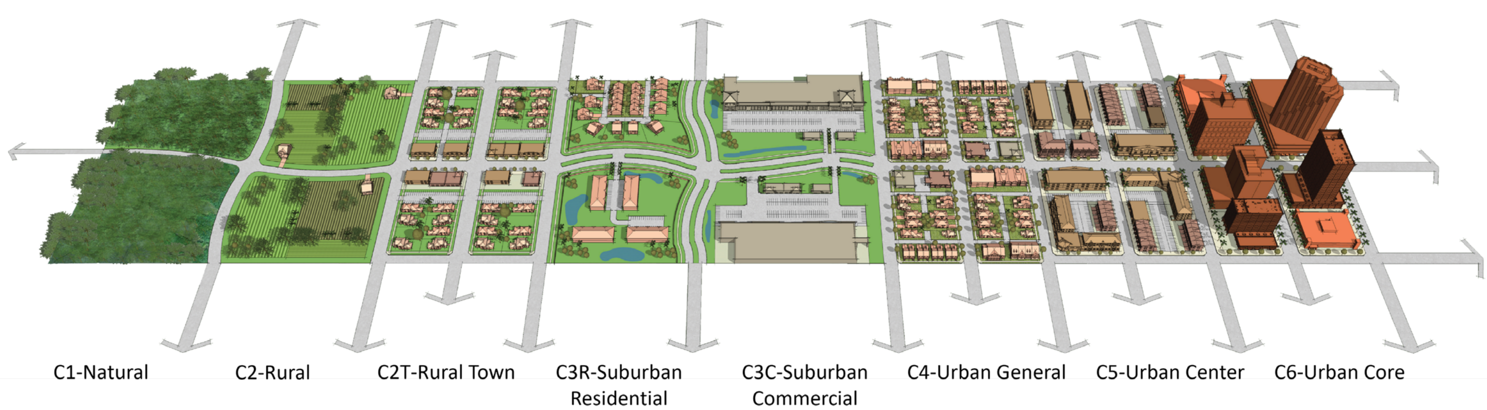

Figure 2-4 FDOT Context Classification

The following changes to the current Standard K are recommended:

- The Standard K should be converted from a single value to a Standard K Factor Range of two (2) percentage points.
- The roadway context classifications should be used when determining the Standard K Factor Range. Roadway classifications are defined based on context classifications where they are located. Based on roadway classifications having similar area types and the same recommended K Factor Range, the following roadway classifications are combined:
    - C1-Natural, C2-Rural and C2T-Rural Town
    - C3C-Suburban Commercial, C3R-Suburban Residential and C4-Urban General
    - C5-Urban Center and C6-Urban Core
- Three (3) additional roadway classifications are included for limited access facilities:
    - Limited Access-Rural
    - Limited Access-Urban
    - Limited Access-Urban Core

Urban and urban core areas are defined as an approved boundary, which encompasses the entire Census Urbanized Area, as well as the surrounding geographic area likely to become urbanized within the next 20 years, as agreed on by FDOT, FHWA, and the MPOs. Urban core area types are distinguished by whether the area's population is greater than or less than one (1) million. Currently, the grouping of more than one (1) million applies to the urban areas that include central cities: Fort Lauderdale, Jacksonville, Miami, Orlando, St. Petersburg, Tampa, and West Palm Beach. The minimum population for an urban area is 5,000. Generally, for a rural area, the population is less than 5,000 and it is not immediately adjacent to an urban core or urban areas.

FDOT's recommended standard K Factor Ranges are presented in **Table 2-1**. The single Standard K Factor currently provided on Florida Traffic Online for each count location will be replaced with the recommended K Factor Range based on the count locations roadway context classification in the future, in coordination with the TDA Office.

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.

Table 2-1 Recommended FDOT Standard K Factors[1,4]

Roadway Classification[2]	Area Type	Facility Type	Recommended K Factor Range (%)[3]
C1 – Natural C2 – Rural C2T– Rural Town	Rural	Highways and Arterials	8.5 – 10.5
C3C – Suburban Commercial C3R – Suburban Residential C4 – Urban General	Suburban and Urban	Arterials	7.5 – 9.5
C5 – Urban Center C6 – Urban Core	Urban Core	Arterials	7.0 – 9.0
Limited Access (LA)	Rural	Freeways	8.5 – 10.5
	Urban	Freeways	7.5 – 9.5
	Urban Core	Freeways	7.0 – 9.0

Approved by Federal Highway Administration (FHWA) on July 12, 2023.

Notes:

[1]A single K Factor, within the range, should be selected based on the project's conditions.

[2]Refer to FDOT Context Classification Guide when determining roadway context classification.

[3]A K factor has a theoretical minimum value of 4.17%, or 1/24, which corresponds to the condition where there is no peaking during the entire 24-hour period. K factors outside the recommended K Ranges would need to be discussed and approved by the Systems Implementation Office (SIO). K Factors lower than 4.17% will not be accepted.

[4]K factors are not applicable for the planning, design or operation of toll facilities or managed lanes.

It is recommended that the selected K Factor for a project falls within the K Factor Range. The selected K Factor should be representative of the project study area. With the new K Factor Range, there could still be cases where the K Factor Range may not directly apply. Examples include highway facilities in tourist areas or roadways providing access to cruise ports where the heaviest traffic may occur on the weekend and peak-to-daily ratios are higher than the 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 FTO, if available. The K Factor Range in **Table 2-1** would not be applicable for the planning, design, or operation of toll facilities (e.g., Turnpike), interchange ramps, or managed lanes. Once a K Factor is selected, the same K Factor should be used for all future scenarios for the same analysis year. Different K Factors are allowed for interim years; however, discretion should be exercised when determining the K Factors for the interim years by examining the growth pattern between existing year and future years.

IMPORTANT NOTE:

Standard K Factors for planning, design, or operational analyses are not directly applicable to toll facilities (e.g., Turnpike) or managed lanes.

2.5.2.3 Standard K Factor Selection Process

For any project, a single K Factor should be selected based on context classification, area type, facility type, and field data if available. A summary of the K Factor selection process is shown in **Figure 2-5** and further explained in detail below.

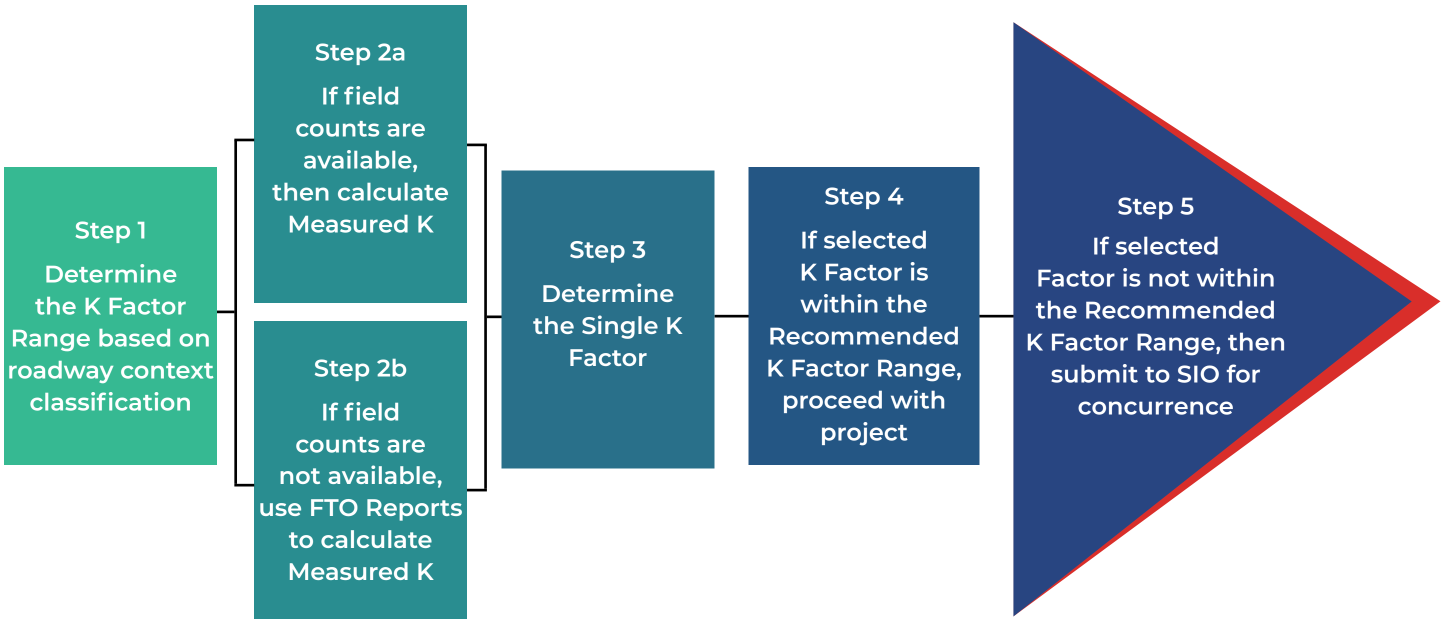

Figure 2-5 Standard K Factor Selection Process

Step 1: Based on roadway context classification, determine the K Factor Range for roadways within the study area.

Step 2a: If field counts are available for the project, then calculate the K Factor using the daily field hose counts. Peak hour/period counts should not be used to calculate the K Factor.

Step 2b: If field counts are not available for the project, counts from the Florida Traffic Online count stations can be utilized to calculate the measured K Factor. Two (2) types of count sites, Continuous and Short-term, are provided. To calculate the K Factor using these two (2) types of count sites, the following reports can be used:

- For Continuous TMS, the "Hourly Continuous Counts Final Report" can be used to calculate the K Factor. The K Factor should be calculated using count data collected during the project time period.
- For Short-term TMS, the "Synopsis Report" for the count site can be used to calculate the K Factor.

Step 3: Determine the single K Factor value for the project roadways.

Step 4: If the selected K Factor value is within the recommended K Factor Range, then proceed with design hour project traffic development.

Step 5: If the selected K Factor value is not within the recommended K Factor Range, then the project team should present the K Factor recommendation along with supporting documentation to the District and SIO for concurrence. Supporting documentation could include observed and historical counts, detailed analysis of peaking characteristics, and data from similar facilities.

2.5.3 D Factor

2.5.3.1 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**:

$$DDHV = DHV \times D \qquad \text{Equation 2-5}$$

Directional distribution is also an important factor in highway capacity analysis. This is particularly true for two-lane rural highways. Capacity and Level of Service (LOS) vary substantially based on directional distribution because of the interactive nature of directional flows on such facilities. Queuing, delays, land use, 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 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 (2023 Traffic Monitoring Handbook). The D factors are reported in the Florida Traffic Online Application. **Figure 2-6** 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, Standard K (which will be replaced in the future with Standard K Range), D, and T factors. A number of Traffic Reports are also available on the site, including Annual Average Daily Traffic, Annual Vehicle Classification, Directional AADTs, Highest 200 Hours, Historical AADT Data, and Hourly Continuous Counts.

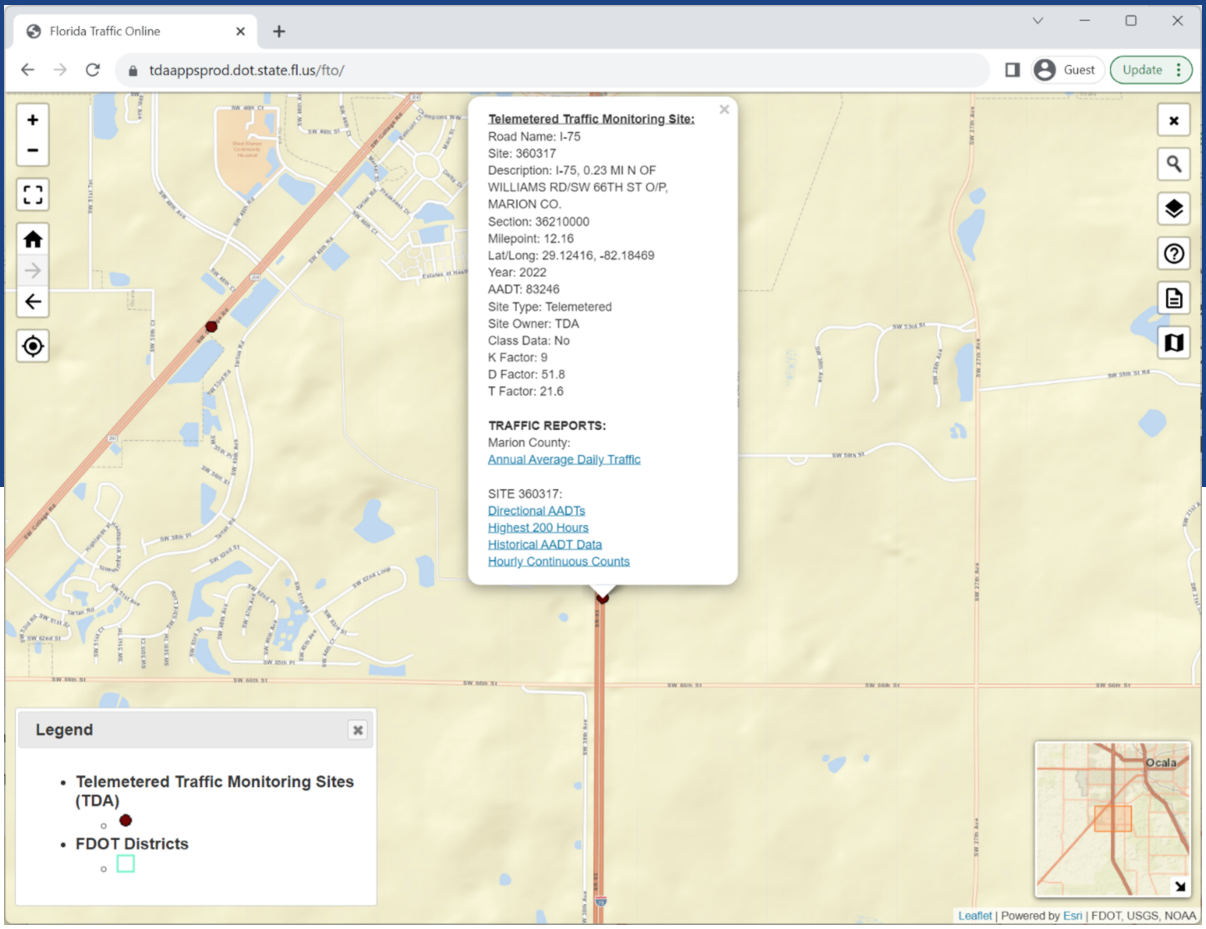

Figure 2-6 Florida Traffic Online: Continuous TMS 360317

2.5.3.2 Acceptable D Values

The D Factors for continuous and short-term sites can be obtained from Florida Traffic Online. 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).*

2.5.4 Percent Trucks (T)

% Trucks The most critical factor in pavement design is the amount of truck traffic using the 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 F (see **Figure 2-2**). Truck data is 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**.

$$DTV = AADT \times T \quad \text{Equation 2-6}$$

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, illustrated in **Equation 2-7**. However, if traffic counts exist to show a higher peak hour truck factor, the observed truck factor can be used as DHT.

$$DHT = \frac{T}{2} \quad \text{Equation 2-7}$$

It should be noted that truck percentage is usually assumed to be constant over time.

2.6 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, as 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" patterns of travel.

2.6.1 Seasonal Adjustments

Data for existing roadways are collected at established traffic monitoring sites within the project's limits. 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 count station established within the project's limits. Directions on conducting classification counts are provided in the 2023 Traffic Monitoring Handbook. Traffic counts cannot be accepted without seasonal adjustments. These adjustments are applied as described in **Section 2.4** (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.

2.6.2 D Factors

FDOT requires the use of two (2) 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. A different directional bias exists for loaded trucks, which 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 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 8.4.2.**)

2.6.3 Roadway Data

GIS Shapefiles of existing number of lanes (Through Lanes - Feature 212) and functional classification (Feature 121) of roadways can be downloaded from the TDA Office website in the Roadway Characteristics Inventory (RCI) section. The Roadway ID and mile points of the roadway under design can be identified from the Shapefiles.

2.7 Estimation of AADT From Short-Term Traffic Counts

The AADT, K, D, and T for the current year are available in the 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 are 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**.

2.7.1 Seasonal Factor Category Report

Seasonal Factors (SF) are provided in the Peak Season Factor Category Reports that can be generated and downloaded from Florida Traffic Online. 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 four-digit number, where the first two (2) digits correspond to the county codes, and the second two (2) digits are a sequence number or an interstate number. It contains a verbal description of its intended use, and a maximum of eight (8)continuous count station numbers. Details of Seasonal Factor Categories are included in the Volume Factor Category Summary Report.

Figure 2-7 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. Only Category 1000 and Category 1004 reports are shown in **Figure 2-7.**

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 the week January 1st falls.

If the Seasonal Factor (SF) is greater than one (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 one (1), then the raw counts were collected during high traffic volumes and must be adjusted downward to reach the annual average. **Figure 2-8** shows the Peak Season Factor Category Report for Hillsborough Countywide Category 1000.

2022 VOLUME FACTOR CATEGORY SUMMARY REPORT - REPORT TYPE: ALL

CATEGORY: 1000 - HILLSBOROUGH COUNTYWIDE

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	SUN	MON	TUE	WED	THU	FRI	SAT
100080 E	1.03	0.91	0.89	0.97	1.00	1.06	1.08	1.02	1.05	0.98	1.05	1.00	1.30	0.98	0.95	0.96	0.96	0.88	1.08
100080 W	1.03	0.92	0.87	0.98	1.00	1.05	1.08	1.02	1.08	0.98	1.04	1.00	1.24	0.99	0.97	0.97	0.97	0.90	1.01
100080 B	1.03	0.92	0.88	0.98	1.00	1.06	1.08	1.02	1.07	0.98	1.05	1.00	1.27	0.99	0.96	0.97	0.97	0.89	1.05
100162 E	1.08	0.97	0.96	0.96	0.97	1.00	1.01	0.98	1.08	0.96	1.03	1.01	1.47	0.97	0.92	0.92	0.92	0.87	1.15
100162 W	1.09	0.96	0.96	0.95	0.97	1.01	1.02	0.98	1.09	0.96	1.03	1.01	1.59	0.97	0.91	0.91	0.91	0.85	1.16
100162 B	1.09	0.97	0.96	0.96	0.97	1.01	1.02	0.98	1.09	0.96	1.03	1.01	1.53	0.97	0.92	0.92	0.92	0.86	1.16
100276 E	1.06	0.96	0.94	0.96	0.98	1.07	1.07	1.01	1.05	0.94	1.00	0.98	1.35	0.99	0.94	0.92	0.94	0.88	1.10
100276 W	1.07	0.96	0.95	0.96	0.97	1.09	1.08	1.02	1.07	0.92	0.99	0.96	1.39	0.98	0.93	0.93	0.93	0.87	1.12
100276 B	1.07	0.96	0.95	0.96	0.98	1.08	1.08	1.02	1.06	0.93	1.00	0.97	1.37	0.99	0.94	0.93	0.94	0.88	1.11
100321 E	1.04	0.96	0.96	0.96	1.00	1.05	1.06	0.99	1.05	0.91	1.02	1.03	1.28	1.00	0.96	0.95	0.95	0.90	1.04
100321 W	1.03	0.95	0.96	0.96	1.01	1.04	1.06	0.99	1.04	0.92	1.02	1.03	1.29	1.00	0.95	0.95	0.95	0.89	1.06
100321 B	1.04	0.96	0.96	0.96	1.01	1.05	1.06	0.99	1.05	0.92	1.02	1.03	1.29	1.00	0.96	0.95	0.95	0.90	1.05
100372 E	1.03	0.97	0.97	0.97	0.99	1.02	1.03	0.98	1.07	0.95	1.03	1.02	1.44	0.96	0.91	0.91	0.93	0.89	1.15
100372 W	1.03	0.98	0.97	0.97	0.98	1.02	1.04	0.97	1.07	0.95	1.02	1.01	1.41	0.96	0.92	0.92	0.93	0.89	1.13
100372 B	1.03	0.98	0.97	0.97	0.99	1.02	1.04	0.98	1.07	0.95	1.03	1.02	1.43	0.96	0.92	0.92	0.93	0.89	1.14
100373 N	1.03	0.94	0.96	0.95	0.99	1.02	1.04	0.99	1.12	0.95	1.02	1.01	1.68	0.94	0.88	0.88	0.90	0.86	1.25
100373 S	1.01	0.92	0.94	1.16	0.99	1.00	1.02	0.98	1.10	0.94	1.01	0.99	1.61	0.94	0.89	0.89	0.90	0.87	1.26
100373 B	1.02	0.93	0.95	1.06	0.99	1.01	1.03	0.99	1.11	0.95	1.02	1.00	1.65	0.94	0.89	0.89	0.90	0.87	1.26
109953 N	1.05	0.97	0.94	0.94	0.98	1.03	1.03	1.02	1.11	0.98	1.00	0.98	1.17	1.01	0.99	0.99	0.97	0.90	1.00
109953 S	1.04	0.96	0.95	0.98	1.00	1.03	1.02	1.02	1.11	0.95	1.00	0.96	1.11	1.00	1.00	1.01	0.98	0.92	1.00
109953 B	1.05	0.97	0.95	0.96	0.99	1.03	1.03	1.02	1.11	0.97	1.00	0.97	1.14	1.01	1.00	1.00	0.98	0.91	1.00
109955 N	1.08	0.98	0.94	0.95	0.99	1.02	1.02	1.02	1.07	0.99	1.00	0.97	1.15	1.00	1.00	1.00	0.99	0.90	1.00
109955 S	1.07	0.99	0.96	0.98	1.00	1.02	1.01	1.01	1.08	0.96	0.99	0.95	1.17	1.01	1.01	1.00	0.97	0.88	1.00
109955 B	1.08	0.99	0.95	0.97	1.00	1.02	1.02	1.02	1.08	0.98	1.00	0.96	1.16	1.01	1.01	1.00	0.98	0.89	1.00
CATEGORY:	1.05	0.96	0.95	0.98	0.99	1.04	1.05	1.00	1.08	0.96	1.02	1.00	1.36	0.98	0.95	0.95	0.95	0.89	1.10

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2022 VOLUME FACTOR CATEGORY SUMMARY REPORT - REPORT TYPE: ALL

CATEGORY: 1004 - HILLSBOROUGH I4

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	SUN	MON	TUE	WED	THU	FRI	SAT
109962 E	1.04	0.97	0.95	0.97	0.98	1.00	1.01	1.01	1.10	0.99	1.01	0.99	1.06	1.01	1.02	1.01	1.01	0.94	0.97
109962 W	1.04	0.98	0.97	0.99	0.99	1.00	1.00	1.00	1.09	0.98	1.00	0.98	1.07	1.01	1.02	1.01	0.99	0.92	0.99
109962 B	1.04	0.98	0.96	0.98	0.99	1.00	1.01	1.01	1.10	0.99	1.01	0.99	1.07	1.01	1.02	1.01	1.00	0.93	0.98
CATEGORY:	1.04	0.98	0.96	0.98	0.99	1.00	1.01	1.01	1.10	0.99	1.01	0.99	1.07	1.01	1.02	1.01	1.00	0.93	0.98

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Figure 2-7 Volume Factor Categories for Hillsborough County

2022 PEAK SEASON FACTOR CATEGORY REPORT - REPORT TYPE: ALL
CATEGORY: 1000 HILLSBOROUGH COUNTYWIDE

MOCF: 0.97

WEEK	DATES	SF	PSCF
1	01/01/2022 - 01/01/2022	1.00	1.03
2	01/02/2022 - 01/08/2022	1.02	1.05
3	01/09/2022 - 01/15/2022	1.05	1.08
4	01/16/2022 - 01/22/2022	1.03	1.06
5	01/23/2022 - 01/29/2022	1.01	1.04
6	01/30/2022 - 02/05/2022	1.00	1.03
* 7	02/06/2022 - 02/12/2022	0.98	1.01
* 8	02/13/2022 - 02/19/2022	0.96	0.99
* 9	02/20/2022 - 02/26/2022	0.96	0.99
*10	02/27/2022 - 03/05/2022	0.95	0.98
*11	03/06/2022 - 03/12/2022	0.95	0.98
*12	03/13/2022 - 03/19/2022	0.95	0.98
*13	03/20/2022 - 03/26/2022	0.95	0.98
*14	03/27/2022 - 04/02/2022	0.96	0.99
*15	04/03/2022 - 04/09/2022	0.97	1.00
*16	04/10/2022 - 04/16/2022	0.98	1.01
*17	04/17/2022 - 04/23/2022	0.98	1.01
*18	04/24/2022 - 04/30/2022	0.98	1.01
*19	05/01/2022 - 05/07/2022	0.99	1.02
20	05/08/2022 - 05/14/2022	0.99	1.02
21	05/15/2022 - 05/21/2022	0.99	1.02
22	05/22/2022 - 05/28/2022	1.00	1.03
23	05/29/2022 - 06/04/2022	1.01	1.04
24	06/05/2022 - 06/11/2022	1.02	1.05
25	06/12/2022 - 06/18/2022	1.04	1.07
26	06/19/2022 - 06/25/2022	1.04	1.07
27	06/26/2022 - 07/02/2022	1.04	1.07
28	07/03/2022 - 07/09/2022	1.04	1.07
29	07/10/2022 - 07/16/2022	1.05	1.08
30	07/17/2022 - 07/23/2022	1.04	1.07
31	07/24/2022 - 07/30/2022	1.03	1.06
32	07/31/2022 - 08/06/2022	1.02	1.05
33	08/07/2022 - 08/13/2022	1.01	1.04
34	08/14/2022 - 08/20/2022	1.00	1.03
35	08/21/2022 - 08/27/2022	1.02	1.05
36	08/28/2022 - 09/03/2022	1.04	1.07
37	09/04/2022 - 09/10/2022	1.06	1.09
38	09/11/2022 - 09/17/2022	1.08	1.11
39	09/18/2022 - 09/24/2022	1.05	1.08
40	09/25/2022 - 10/01/2022	1.02	1.05
41	10/02/2022 - 10/08/2022	0.99	1.02
42	10/09/2022 - 10/15/2022	0.96	0.99
43	10/16/2022 - 10/22/2022	0.97	1.00
44	10/23/2022 - 10/29/2022	0.98	1.01
45	10/30/2022 - 11/05/2022	0.99	1.02
46	11/06/2022 - 11/12/2022	1.01	1.04
47	11/13/2022 - 11/19/2022	1.02	1.05
48	11/20/2022 - 11/26/2022	1.01	1.04
49	11/27/2022 - 12/03/2022	1.01	1.04
50	12/04/2022 - 12/10/2022	1.00	1.03
51	12/11/2022 - 12/17/2022	1.00	1.03
52	12/18/2022 - 12/24/2022	1.02	1.05
53	12/25/2022 - 12/31/2022	1.05	1.08

* PEAK SEASON

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Figure 2-8 Peak Season Factor Category Report for Hillsborough Countywide

2.7.2 Axle Factor Category Report

Axle Factor Categories are groupings of vehicle classification stations whose data is used to develop the Axle Correction Factors. The Axle Factor Categories are county specific, denoted by four-digit numbers with the first two (2) digits representing the county codes, and the second two (2) 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 2-9** shows an example of Axle Correction Factors for Hillsborough County for 2022.

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 the week January 1st falls. *All axle adjustment factors are less than or equal to one (1). The axle adjustment factors are multiplied by the raw counts to lower axle counts into vehicle count estimates.*

2022 WEEKLY AXLE FACTOR CATEGORY REPORT - REPORT TYPE: ALL

COUNTY: 10 - HILLSBOROUGH

WEEK	DATES	1000 I75, US301 - SR582	1001 I75, SR582 - PASCO C	1002 I275, PINELLAS-I4	1003 SR569/599,SR618-US92
1	01/01/2022 - 01/01/2022	0.94	0.94	0.97	0.96
2	01/02/2022 - 01/08/2022	0.95	0.94	0.97	0.95
3	01/09/2022 - 01/15/2022	0.95	0.94	0.97	0.93
4	01/16/2022 - 01/22/2022	0.95	0.94	0.97	0.93
5	01/23/2022 - 01/29/2022	0.95	0.94	0.97	0.93
6	01/30/2022 - 02/05/2022	0.95	0.93	0.97	0.93
7	02/06/2022 - 02/12/2022	0.95	0.93	0.97	0.93
8	02/13/2022 - 02/19/2022	0.95	0.93	0.97	0.93
9	02/20/2022 - 02/26/2022	0.95	0.93	0.97	0.93
10	02/27/2022 - 03/05/2022	0.95	0.94	0.97	0.93
11	03/06/2022 - 03/12/2022	0.95	0.94	0.97	0.93
12	03/13/2022 - 03/19/2022	0.95	0.94	0.97	0.93
13	03/20/2022 - 03/26/2022	0.95	0.94	0.97	0.93
14	03/27/2022 - 04/02/2022	0.96	0.94	0.97	0.93
15	04/03/2022 - 04/09/2022	0.96	0.94	0.97	0.93
16	04/10/2022 - 04/16/2022	0.96	0.94	0.97	0.93
17	04/17/2022 - 04/23/2022	0.96	0.94	0.97	0.93
18	04/24/2022 - 04/30/2022	0.96	0.94	0.97	0.93
19	05/01/2022 - 05/07/2022	0.96	0.94	0.97	0.92
20	05/08/2022 - 05/14/2022	0.96	0.94	0.97	0.92
21	05/15/2022 - 05/21/2022	0.96	0.94	0.97	0.92
22	05/22/2022 - 05/28/2022	0.96	0.94	0.97	0.92
23	05/29/2022 - 06/04/2022	0.96	0.94	0.97	0.92
24	06/05/2022 - 06/11/2022	0.95	0.93	0.97	0.92
25	06/12/2022 - 06/18/2022	0.95	0.93	0.97	0.92
26	06/19/2022 - 06/25/2022	0.95	0.93	0.97	0.92
27	06/26/2022 - 07/02/2022	0.95	0.93	0.97	0.93
28	07/03/2022 - 07/09/2022	0.95	0.93	0.97	0.93
29	07/10/2022 - 07/16/2022	0.95	0.93	0.97	0.93
30	07/17/2022 - 07/23/2022	0.95	0.93	0.97	0.93
31	07/24/2022 - 07/30/2022	0.95	0.93	0.97	0.93
32	07/31/2022 - 08/06/2022	0.95	0.93	0.97	0.92
33	08/07/2022 - 08/13/2022	0.95	0.93	0.97	0.92
34	08/14/2022 - 08/20/2022	0.95	0.93	0.97	0.92
35	08/21/2022 - 08/27/2022	0.95	0.93	0.97	0.92
36	08/28/2022 - 09/03/2022	0.96	0.94	0.97	0.93
37	09/04/2022 - 09/10/2022	0.96	0.94	0.97	0.93
38	09/11/2022 - 09/17/2022	0.96	0.94	0.97	0.93
39	09/18/2022 - 09/24/2022	0.96	0.94	0.97	0.93
40	09/25/2022 - 10/01/2022	0.95	0.94	0.97	0.93
41	10/02/2022 - 10/08/2022	0.95	0.94	0.97	0.92
42	10/09/2022 - 10/15/2022	0.94	0.94	0.97	0.92
43	10/16/2022 - 10/22/2022	0.94	0.94	0.97	0.92
44	10/23/2022 - 10/29/2022	0.94	0.94	0.97	0.93
45	10/30/2022 - 11/05/2022	0.94	0.94	0.97	0.93
46	11/06/2022 - 11/12/2022	0.94	0.94	0.97	0.94
47	11/13/2022 - 11/19/2022	0.94	0.94	0.97	0.94
48	11/20/2022 - 11/26/2022	0.94	0.94	0.97	0.95
49	11/27/2022 - 12/03/2022	0.94	0.94	0.97	0.95
50	12/04/2022 - 12/10/2022	0.94	0.94	0.97	0.96
51	12/11/2022 - 12/17/2022	0.94	0.94	0.97	0.96
52	12/18/2022 - 12/24/2022	0.95	0.94	0.97	0.95
53	12/25/2022 - 12/31/2022	0.95	0.94	0.97	0.93

Figure 2-9 Axle Correction Factors for Hillsborough County

2.7.3 Example of Estimating AADT from Short-Term Traffic Counts

The following example shows the steps to be performed to estimate AADT from 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 Kenner Highway, approximately 550 feet north of Central Parkway from Tuesday, March 21, 2023 to Thursday, March 23, 2023 in Martin 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 Florida Traffic Online if available.
- Check daily counts against turning movement counts (TMC) during the same hour, or 15-minute intervals 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 2-10 shows the three-day short-term traffic counts collected on Kenner Highway. 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.

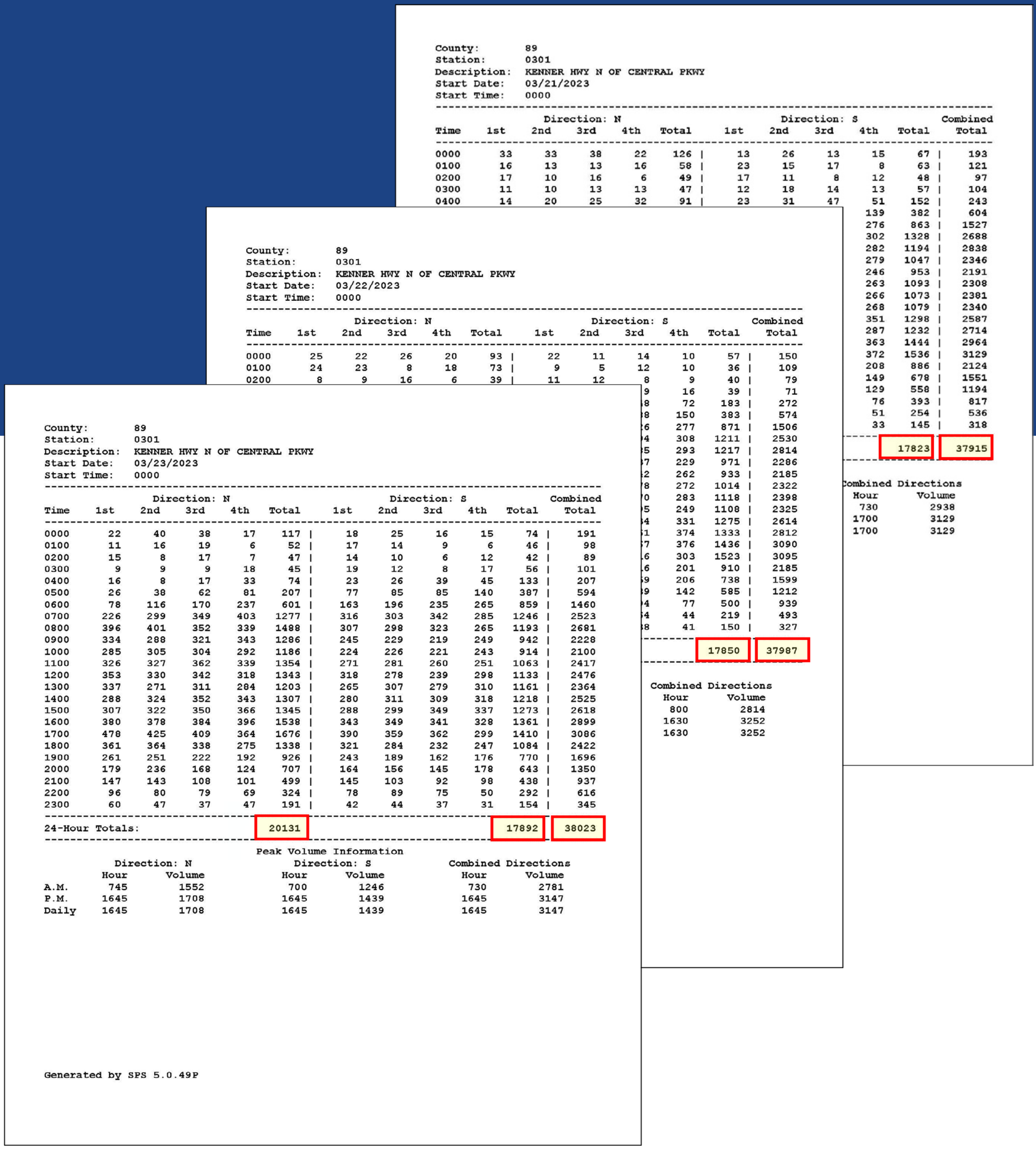
$$ADT = \frac{37{,}915 + 37{,}987 + 38{,}023}{3} = 37{,}975$$

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: 8900 EAST- A1A TO US 1
- Category: 8901 CEN.-W OF US 1 TO I-95
- Category: 8927 WEST-W OF I-95
- Category: 8995 MARTIN I-95

The short-term traffic counts were collected in central Martin County between west of US 1 and I-95, an area covered by Category 8901. Therefore, the seasonal factor from Category 8901 corresponding to the week of March 20, 2022 - March 26, 2022 was assigned to this location and the value of SF is **0.95** (see **Figure 2-11**).



County: 89
Station: 0301
Description: KENNER HWY N OF CENTRAL PKWY
Start Date: 03/23/2023
Start Time: 0000

	Direction: N					Direction: S					Combined
Time	1st	2nd	3rd	4th	Total	1st	2nd	3rd	4th	Total	Total
0000	22	40	38	17	117	18	25	16	15	74	191
0100	11	16	19	6	52	17	14	9	6	46	98
0200	15	8	17	7	47	14	10	6	12	42	89
0300	9	9	9	18	45	19	12	8	17	56	101
0400	16	8	17	33	74	23	26	39	45	133	207
0500	26	38	62	81	207	77	85	85	140	387	594
0600	78	116	170	237	601	163	196	235	265	859	1460
0700	226	299	349	403	1277	316	303	342	285	1246	2523
0800	396	401	352	339	1488	307	298	323	265	1193	2681
0900	334	288	321	343	1286	245	229	219	249	942	2228
1000	285	305	304	292	1186	224	226	221	243	914	2100
1100	326	327	362	339	1354	271	281	260	251	1063	2417
1200	353	330	342	318	1343	318	278	239	298	1133	2476
1300	337	271	311	284	1203	265	307	279	310	1161	2364
1400	288	324	352	343	1307	280	311	309	318	1218	2525
1500	307	322	350	366	1345	288	299	349	337	1273	2618
1600	380	378	384	396	1538	343	349	341	328	1361	2899
1700	478	425	409	364	1676	390	359	362	299	1410	3086
1800	361	364	338	275	1338	321	284	232	247	1084	2422
1900	261	251	222	192	926	243	189	162	176	770	1696
2000	179	236	168	124	707	164	156	145	178	643	1350
2100	147	143	108	101	499	145	103	92	98	438	937
2200	96	80	79	69	324	78	89	75	50	292	616
2300	60	47	37	47	191	42	44	37	31	154	345
24-Hour Totals:					20131					17892	38023

Peak Volume Information

	Direction: N		Direction: S		Combined Directions	
	Hour	Volume	Hour	Volume	Hour	Volume
A.M.	745	1552	700	1246	730	2781
P.M.	1645	1708	1645	1439	1645	3147
Daily	1645	1708	1645	1439	1645	3147

Generated by SPS 5.0.49P

Figure 2-10 Sample Short-Term Traffic Counts

2022 PEAK SEASON FACTOR CATEGORY REPORT - REPORT TYPE: ALL
CATEGORY: 8901 CEN.-W OF US1 TO I95

MOCF: 0.96

WEEK	DATES	SF	PSCF
1	01/01/2022 - 01/01/2022	0.98	1.02
2	01/02/2022 - 01/08/2022	0.99	1.03
3	01/09/2022 - 01/15/2022	1.00	1.04
4	01/16/2022 - 01/22/2022	0.99	1.03
5	01/23/2022 - 01/29/2022	0.98	1.02
* 6	01/30/2022 - 02/05/2022	0.97	1.01
* 7	02/06/2022 - 02/12/2022	0.96	1.00
* 8	02/13/2022 - 02/19/2022	0.95	0.99
* 9	02/20/2022 - 02/26/2022	0.95	0.99
*10	02/27/2022 - 03/05/2022	0.95	0.99
*11	03/06/2022 - 03/12/2022	0.95	0.99
*12	03/13/2022 - 03/19/2022	0.95	0.99
*13	03/20/2022 - 03/26/2022	0.95	0.99
*14	03/27/2022 - 04/02/2022	0.96	1.00
*15	04/03/2022 - 04/09/2022	0.96	1.00
*16	04/10/2022 - 04/16/2022	0.97	1.01
*17	04/17/2022 - 04/23/2022	0.97	1.01
*18	04/24/2022 - 04/30/2022	0.98	1.02
19	05/01/2022 - 05/07/2022	0.98	1.02
20	05/08/2022 - 05/14/2022	0.99	1.03
21	05/15/2022 - 05/21/2022	1.00	1.04
22	05/22/2022 - 05/28/2022	1.01	1.05
23	05/29/2022 - 06/04/2022	1.02	1.06
24	06/05/2022 - 06/11/2022	1.03	1.07
25	06/12/2022 - 06/18/2022	1.05	1.09
26	06/19/2022 - 06/25/2022	1.05	1.09
27	06/26/2022 - 07/02/2022	1.05	1.09
28	07/03/2022 - 07/09/2022	1.05	1.09
29	07/10/2022 - 07/16/2022	1.06	1.10
30	07/17/2022 - 07/23/2022	1.05	1.09
31	07/24/2022 - 07/30/2022	1.05	1.09
32	07/31/2022 - 08/06/2022	1.04	1.08
33	08/07/2022 - 08/13/2022	1.04	1.08
34	08/14/2022 - 08/20/2022	1.04	1.08
35	08/21/2022 - 08/27/2022	1.05	1.09
36	08/28/2022 - 09/03/2022	1.06	1.10
37	09/04/2022 - 09/10/2022	1.08	1.13
38	09/11/2022 - 09/17/2022	1.09	1.14
39	09/18/2022 - 09/24/2022	1.07	1.11
40	09/25/2022 - 10/01/2022	1.04	1.08
41	10/02/2022 - 10/08/2022	1.02	1.06
42	10/09/2022 - 10/15/2022	1.00	1.04
43	10/16/2022 - 10/22/2022	1.00	1.04
44	10/23/2022 - 10/29/2022	1.00	1.04
45	10/30/2022 - 11/05/2022	1.00	1.04
46	11/06/2022 - 11/12/2022	1.00	1.04
47	11/13/2022 - 11/19/2022	1.01	1.05
48	11/20/2022 - 11/26/2022	1.00	1.04
49	11/27/2022 - 12/03/2022	0.99	1.03
50	12/04/2022 - 12/10/2022	0.98	1.02
51	12/11/2022 - 12/17/2022	0.98	1.02
52	12/18/2022 - 12/24/2022	0.99	1.03
53	12/25/2022 - 12/31/2022	1.00	1.04

* PEAK SEASON

23-FEB-2023 09:11:22 830UPD 4_8901_PKSEASON.TXT

Figure 2-11 2022 Peak Season Factor Category Report for Category 8901

Step 3: Assign an Axle Correction Factor (ACF) from the Weekly Axle Correction Factor Category Report

Similar to Seasonal Factors, the 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 17 ACF categories for Martin County. The category that is most suitable for Kenner Highway is Category 8909 - SR 76, I-95 - SR A1A. The ACF for Category 8909 corresponding to the week of March 20, 2023 - March 26, 2022 is 0.98 (see **Figure 2-12**).

2022 WEEKLY AXLE FACTOR CATEGORY REPORT - REPORT TYPE: ALL

COUNTY: 89 - MARTIN

WEEK	DATES	8908 SR76, SR710 TO I-95	8909 SR76, I95 - SR A1A	8911 SR 76, SR700-SR 710	8915 SR5,COVE -ST.LUC.CO.
1	01/01/2022 - 01/01/2022	0.93	0.98	0.80	0.98
2	01/02/2022 - 01/08/2022	0.93	0.98	0.80	0.98
3	01/09/2022 - 01/15/2022	0.92	0.98	0.80	0.98
4	01/16/2022 - 01/22/2022	0.92	0.98	0.80	0.98
5	01/23/2022 - 01/29/2022	0.92	0.98	0.80	0.98
6	01/30/2022 - 02/05/2022	0.91	0.98	0.80	0.98
7	02/06/2022 - 02/12/2022	0.91	0.98	0.80	0.98
8	02/13/2022 - 02/19/2022	0.91	0.98	0.80	0.98
9	02/20/2022 - 02/26/2022	0.92	0.98	0.80	0.98
10	02/27/2022 - 03/05/2022	0.93	0.98	0.80	0.98
11	03/06/2022 - 03/12/2022	0.94	0.98	0.80	0.98
12	03/13/2022 - 03/19/2022	0.95	0.98	0.80	0.98
13	03/20/2022 - 03/26/2022	0.94	0.98	0.80	0.98
14	03/27/2022 - 04/02/2022	0.93	0.98	0.80	0.98
15	04/03/2022 - 04/09/2022	0.92	0.98	0.80	0.98
16	04/10/2022 - 04/16/2022	0.91	0.98	0.80	0.98
17	04/17/2022 - 04/23/2022	0.91	0.98	0.80	0.98
18	04/24/2022 - 04/30/2022	0.91	0.98	0.80	0.98
19	05/01/2022 - 05/07/2022	0.90	0.98	0.80	0.98
20	05/08/2022 - 05/14/2022	0.90	0.98	0.80	0.98
21	05/15/2022 - 05/21/2022	0.90	0.98	0.80	0.98
22	05/22/2022 - 05/28/2022	0.90	0.98	0.80	0.98
23	05/29/2022 - 06/04/2022	0.90	0.98	0.80	0.98
24	06/05/2022 - 06/11/2022	0.90	0.98	0.80	0.98
25	06/12/2022 - 06/18/2022	0.90	0.98	0.80	0.98
26	06/19/2022 - 06/25/2022	0.91	0.98	0.80	0.98
27	06/26/2022 - 07/02/2022	0.91	0.98	0.80	0.98
28	07/03/2022 - 07/09/2022	0.92	0.98	0.80	0.98
29	07/10/2022 - 07/16/2022	0.92	0.98	0.80	0.98
30	07/17/2022 - 07/23/2022	0.92	0.98	0.80	0.98
31	07/24/2022 - 07/30/2022	0.92	0.98	0.80	0.98
32	07/31/2022 - 08/06/2022	0.91	0.98	0.80	0.98
33	08/07/2022 - 08/13/2022	0.91	0.98	0.80	0.98
34	08/14/2022 - 08/20/2022	0.91	0.98	0.80	0.98
35	08/21/2022 - 08/27/2022	0.92	0.98	0.80	0.98
36	08/28/2022 - 09/03/2022	0.92	0.98	0.80	0.98
37	09/04/2022 - 09/10/2022	0.93	0.98	0.80	0.98
38	09/11/2022 - 09/17/2022	0.93	0.98	0.80	0.98
39	09/18/2022 - 09/24/2022	0.93	0.98	0.80	0.98
40	09/25/2022 - 10/01/2022	0.93	0.98	0.80	0.98
41	10/02/2022 - 10/08/2022	0.92	0.98	0.80	0.98
42	10/09/2022 - 10/15/2022	0.92	0.98	0.80	0.98
43	10/16/2022 - 10/22/2022	0.92	0.98	0.80	0.98
44	10/23/2022 - 10/29/2022	0.92	0.98	0.80	0.98
45	10/30/2022 - 11/05/2022	0.93	0.98	0.80	0.98
46	11/06/2022 - 11/12/2022	0.93	0.98	0.80	0.98
47	11/13/2022 - 11/19/2022	0.93	0.98	0.80	0.98
48	11/20/2022 - 11/26/2022	0.93	0.98	0.80	0.98
49	11/27/2022 - 12/03/2022	0.93	0.98	0.80	0.98
50	12/04/2022 - 12/10/2022	0.93	0.98	0.80	0.98
51	12/11/2022 - 12/17/2022	0.93	0.98	0.80	0.98
52	12/18/2022 - 12/24/2022	0.93	0.98	0.80	0.98
53	12/25/2022 - 12/31/2022	0.92	0.98	0.80	0.98

Figure 2-12 Weekly Axle Factory Category Report for Category 8909

Step 4: Estimating AADT by Applying Adjustment Factors

$AADT = ADT \times SF \times ACF$

$AADT = 37{,}975 \times 0.95 \times 0.98 = 35{,}345$

$AADT = 35{,}500$ (After applying Rounding)

2.8 Additional Data Sources

In addition to traffic data, other travel behavior data is important for travel demand forecasting. Origin-Destination (O-D) data is one of the most important pieces of information for any model development and planning study, particularly for managed lanes, Interchange Access Requests (IARs), and transit studies. Products from the US Census Bureau, such as Census Transportation Planning Products (CTPP), derived from American Community Survey (ACS), Longitudinal Employer-Household Dynamics (LEHD) data, and National Household Travel Survey (NHTS). O-D data developed by the Federal Highway Administration (FHWA) offers free and current information at Census Block level or Traffic Analysis Zone (TAZ) level. Regional household travel surveys and transit on-board surveys offer another major source of information.

2.9 Application of "Big Data" for Traffic Data Analysis

Recent technological advances provide new opportunities for transportation professionals to retrieve and analyze large quantities of travel related data, often from location-based services (LBS) on mobile devices, connected vehicle data, and/or GPS navigation units. The "Big Data" come in large volumes, at a higher speed, from a variety of sources, with varying levels of accuracy and reliability. Because they are large and complex, analytical tools are often needed to analyze and visualize the data. There are several vendors that currently provide a variety of traffic data, including O-D, multimodal traffic volumes, travel speeds, travel times, trip trajectory, and even turning movement volumes. It is important to note that both "traditional data" and "Big Data" are sample data. Traditional data, such as link counts, and turning movement counts, sample all people on some days, whereas "Big Data" sample some people on all days. Because they are all sample data, caution must be exercised when using the data to make sure they are consistent with real-world ground conditions. Different vendors use different methodologies to "factor up" original data to represent traffic parameters for the entire population. It is advisable to understand the algorithms and validate the data before using "Big Data" for travel demand forecasting.

Chapter 3

Scoping for Project Traffic Forecasting

3.1 Introduction

Scoping is a critical step in the Project Traffic Forecasting process. It involves defining the project's objectives, identifying the required resources, and determining the scope of work needed to complete the forecasting. Scoping provides a roadmap for the entire project and helps ensure that the project is completed on time, within budget, and to the satisfaction of all stakeholders.

Effective scoping is particularly important in traffic forecasting because it helps ensure that the project's forecasts are accurate, reliable, and useful for traffic analysis and the following phases of the project. The process of scoping involves identifying key variables that will impact the project's forecasts and ensuring that the appropriate data and forecasting methods are used to produce reliable results.

In this chapter, a detailed overview of the Project Traffic Forecasting scoping process is provided. The detailed overview will outline key factors to be considered, the scoping process, and the suggested documentation for traffic forecasting. These key considerations may include the project's objectives, project limits, data requirements, available resources, timelines, and forecasting methods, among others. This chapter aims to provide the guidance to successfully scope a project's traffic forecasting and support the production of reliable, accurate, and useful forecasts for transportation planning and decision-making purposes.

IMPORTANT NOTE:
Scoping provides a roadmap for the entire project and helps ensure that the project is completed on time, within budget, and meets the goals and objectives of the project.

3.2 Factors to be Considered in the Scoping Process

When scoping for Project Traffic Forecasting, it is important to consider a wide range of factors to ensure that the project is properly focused, appropriately resourced, and can achieve its intended outcomes. The following factors should be considered.

3.2.1 Project Purpose and Need

The purpose and need of a project are initially developed from transportation planning documents or processes such as Long Range Transportation Plan (LRTP) update, planning studies, and the Efficient Transportation Decision Making (ETDM) screening process. The purpose defines the transportation issues to be solved and outlines the goals of the project. The need arises from roadway deficiencies, issues, and/or concerns that currently exist or are expected to occur and serves as the foundation for developing and evaluating alternatives.

3.2.2 Project Limits

The project limits refer to the geographic extent of the study area, which can be defined by the physical boundaries of the roadway elements (segments, intersections, or interchanges) or by other factors, such as land use patterns or development areas. The geographical coverage area should be large enough to include all roadway segments that are anticipated to be influenced by the project. Defining the project limits helps focus the project on the most relevant areas and issues, and establishes the data collection requirements, forecasting scope, and expected outcomes of the project.

3.2.3 Data Requirements

The data that is needed to conduct the traffic forecasting should be identified, and a data collection plan should be developed considering all existing and expected multimodal modes of transportation within the project limits to support the project's purpose and need. The data may include historical and existing traffic data, demographic information, land use data, and other relevant data on planned development and transportation projects.

3.2.4 Forecasting Methods

The appropriate forecasting methods should be identified based on the project scope, availability of traffic forecasting models, data requirements, and stakeholder needs. This may involve forecasting with or without travel demand models, depending on the location and specific requirements of the project.

3.2.5 Project Plan

A project plan should be developed to outline the specific tasks, timelines, and resources needed to complete the project on schedule and within budget. This may include data collection and analysis, model refinement, forecasting development, staffing requirements, stakeholder coordination, documentation, and review time.

3.2.6 Quality Control and Review Processes

Processes for quality control and review of the traffic forecasting should be established, to ensure that the forecasting results are checked and certified for accuracy. This approach will help identify issues and their resolutions early in the process and consequently avoid delays.

By considering these factors, the Project Traffic Forecasting can be effectively scoped and used to develop design requirements and evaluate the operational analyses measures of effectiveness to ensure that the scope is aligned with the goals and objectives of the project.

3.3 Determine Applicable Forecasting Methods

When scoping a project for traffic forecasting, the appropriate forecasting methods should be identified based on the project scoping limits, data requirements, project timeline, and stakeholder needs. The steps to determine applicable forecasting methods are listed, as follows:

Step 1: Identify the purpose and need of the project

The purpose and need of the project should be clearly defined, including the specific transportation issues that the project aims to address. This will help determine what type of forecasting methods are applicable.

Step 2: Determine the data availability and requirements

The data needs to support the traffic forecasting should be identified, including historical traffic data, demographic information, land use data, and information on planned development and transportation projects. Traffic and forecasting data from other traffic engineering-related studies in and around the project area could also be considered.

Step 3: Identify the forecasting methods available

There are several forecasting methods available, including travel demand models, traffic growth trends, and land use data analysis. Each method has its own strengths and weaknesses, and the appropriate method will depend on the project scope and data requirements.

Step 4: Determine the forecasting methods

The available forecasting methods should be evaluated based on their suitability for the project. This may involve considering factors such as accuracy, reliability, ease of use, and the ability to incorporate different types of data. Based on the evaluation, the appropriate forecasting method or combination of methods can be selected for the project.

There are different types of forecasting methods, each with its own strengths and weaknesses. The method using travel demand models involves analyzing the relationship between transportation supply and demand, and predicting how transportation supply and demand changes will impact future traffic patterns. Trend analysis involves identifying relationships between variables, such as traffic volumes in terms of "time of day" or "day of week," and can be used to predict future traffic patterns based on historical data. The appropriate method will depend on the specific forecasting issue and data available. To determine which forecasting method to use, it is important to consider the following factors:

- **Data availability and quality:** The forecasting method used should be appropriate for the type and quality of data available. Some methods using demand models require more data than others, and some using collected data are more sensitive to the quality of the data.
- **Scope and complexity of the forecasting issue:** The forecasting method used should be appropriate for the scope and complexity of the project purpose and need. Some methods applying traffic growth rates are more suitable for simple forecasting issues of intersections, while others are more suitable for complex issues, such as corridor and subarea studies.
- **Analysis years:** The analysis years for the forecasting should be considered. Methods like trend analysis are better suited for short-term forecasting, while other methods, like travel demand models, are better suited for long-term forecasting.
- **Accuracy and reliability:** The accuracy and reliability of the forecasting method should also be considered. Some methods are more accurate and reliable than others, and the appropriate method will depend on the level of accuracy and reliability required for the specific project's purpose and need.

By considering these factors, the appropriate forecasting method can be selected for the specific forecasting scope. It may also be useful to use a combination of methods to take advantage of their strengths and overcome their weaknesses.

3.4 Identify Available and Needed Data Types

There are several potential types of data that can be used for traffic forecasting, such as traffic counts, land use, demographic data, and public transportation data. It is important to identify and document the data types and determine whether the data is available and accessible for the project. Data types available for traffic forecasting include:

- **Traffic count data:** This data provides information about the volume of vehicles on a given road segment or at an intersection, which should be collected during typical weekdays, excluding weeks that contain holidays. Typical traffic count data collection includes turning movement counts for peak periods, approach/departure vehicle volume counts, and classification counts as needed. The duration of data collection should meet FDOT requirements depending on the project type. The FDOT Manual on Uniform Traffic Studies (MUTS) provides further guidance on field data collection.

- **Land use data:** This data includes information on the current and planned land uses in the area being analyzed, such as residential, commercial, and industrial developments. Land use data can be used to understand how future changes in land use may impact traffic patterns. Land use data can be obtained from FDOT and local municipalities.
- **Demographic data:** This data provides information on population, employment, income, education, and other demographic characteristics of the area being analyzed. Demographic data can be used to understand how population and employment changes may impact traffic patterns and to estimate future transportation demand. Demographic data can be obtained from the Bureau of Economic and Business Research (BEBR) of the University of Florida and US Census Bureau.
- **Public transportation data:** This data includes information on transit ridership, such as passenger counts, route schedules, and service frequencies, which can be obtained from the transit agency official website.

The availability of these data types may vary depending on the location and scope of the traffic forecasting, as well as the resources available to the project team. It is important to carefully evaluate the quality, relevance, and availability of each data type before using it for traffic forecasting. There are several data types that may be needed for traffic forecasting, depending on the specific scope of the project. Here are some of the most common data types and sources:

- **Historical traffic data:** This data includes information on traffic volumes, speeds, and congestion levels for a specific period in the past. Historical traffic data can be used to identify trends and patterns in traffic behavior, and evaluate forecasting. This data can be obtained from the FTO website and Regional Integrated Transportation Information System (RITIS).
- **Transportation project data:** This data provides information on planned and ongoing transportation projects, such as new roadways, transit expansions, bicycle/pedestrian infrastructure, interchanges, and the timing of the future transportation improvements. Transportation project data can be used to understand how changes in the transportation network may impact traffic patterns. The potential sources for this data may include the appropriate travel demand model, LRTP, and FDOT Five-Year Work Program.
- **Origin-Destination (O-D) data:** This data shows information for understanding vehicular movement patterns within a transportation network, including trip origins and destinations, travel times, and route choices. O-D datasets may be needed for complex traffic forecasting projects to accurately model travel behavior. When scoping for traffic forecasting that requires O-D data, it is important to define the scope and acceptable methods of data collection. This involves discussing the data collection approach with FDOT Coordinator and obtaining their approval for the methods used. Collecting O-D data can be a challenging and resource-intensive process, as it typically requires significant investment in data collection technologies and infrastructure, as well as planning and execution to ensure that data quality and reliability meet the needs of the forecasting project. As such, it is important to consider the cost-benefit tradeoffs of collecting O-D data for a given project and to prioritize its collection based on the specific needs and objectives of the project.

By using these data types, traffic forecasting can be developed that reasonably predicts future traffic patterns. It is important to understand the various types of data that are available and needed for traffic forecasting. The user should recognize the critical role that data plays in traffic forecasting and the importance of taking a thoughtful and thorough approach to identifying the necessary data types. It is worth noting that these are general guidelines, and the data needs and applicable projects may vary depending on the specific project purpose and need, as well as the context in which the project traffic data is being used.

3.5 Schedule Guidelines

Developing a traffic forecasting schedule will depend on the specific project and the complexity of the forecasting methods being used. However, following are some general schedule guidelines for scheduling development:

- **Define the scope and objectives of the project:** This should be done at the beginning of the project and should clearly define the goals and objectives of the traffic forecasting effort.
- **Identify data needs and sources:** Determine the types of data that will be needed for the forecasting effort and identify potential sources of that data.
- **Collect and process data:** Once the data sources have been identified and the data has been collected, the data can be processed into a usable format.
- **Select forecasting methods:** Choose the appropriate forecasting methods based on the data available, the project scope and objectives, and other relevant factors.
- **Develop forecasting methods:** Once the forecasting methods have been selected, develop and/or refine the selected traffic forecasting method(s) for forecasting as needed based on the complexity of the project.
- **Produce forecasts:** Use the developed methods or refined travel demand models to produce traffic forecasts.
- **Evaluate and document results:** Evaluate the accuracy of the forecasts and document the results.

The duration of each of these steps will depend on the complexity of the project and the forecasting methods being used. It is important to set realistic timelines and to adjust the schedule as needed to ensure that the project is completed on time and within budget. **Table 3-1** shows an estimated duration for each step in the traffic forecasting process:

Table 3-1 General Guidelines for Developing Traffic Forecasting Schedules

Steps	Estimated Duration
Define the scope and objectives of the project	1-2 weeks
Identify data needs and sources	1-2 weeks
Collect and process data	4-8 weeks*
Select forecasting methods	1-2 weeks
Develop forecasting methods	4-8 weeks*
Produce forecasts	8-12 weeks*
Evaluate and document results	4-6 weeks

** Depending on the complexity of the project, the duration of the task may vary and can be longer for major projects involving model development and validation.*

It is important to note that these are just approximations, and the actual duration of each step will depend on the complexity of the project, the availability of data, and other factors. Additionally, some steps may need to be repeated or revisited if issues arise during the forecasting process. It is important to be flexible and adaptable throughout the process to ensure that the final forecasts are accurate and reliable.

3.6 Suggested Documentation and Deliverables

The following are suggested documentation that may be needed to describe the Project Traffic Forecasting process:

- **Project Plan:** A document outlining the scope of the project, objectives, timeline, and resources required.
- **Data Sources and Methodology:** A document that outlines the data sources used for the project and the methodology used to forecast traffic.
- **Data Collection Plan:** A plan for collecting and organizing the necessary data for the project, including maps showing the location and type of data collected.
- **Forecasting Method:** A document outlining the selected forecasting method including any assumptions and limitations. The forecasting method may or may not involve a travel demand model.
- **Forecasting Development:** Detailed documentation of the forecasting development and results. Where appropriate, include descriptions of model refinement and suitability checks to make the model match the observed traffic conditions within the study area. The forecasting results should include, but not be limited to: existing AADT; future projections for opening year, interim year, and design year in terms of link level AADT; design hour volume (DHV); turning movement volumes; and design traffic factors, such as Standard K Factor, Directional (D) factor, and Truck (T) factor.
- **Project Traffic Forecasting Documentation:** Detailed technical documentation of traffic data collection and analysis, model development, and traffic projections process for the project.

It is important to identify document requirements and deliverables early in the project and to ensure that stakeholders are aware of what to expect in terms of project deliverables and timelines. Typical document deliverables and outlines for traffic forecasting are recommended, as follows:

Project Plan

- Introduction: A brief overview of the project and its objectives.
- Scope and Objectives: Detailed description of the project scope and objectives, including any assumptions or limitations.
- Timeline and Schedule: A detailed timeline for the project, including major milestones and deliverables.
- Resources: Description of the resources required for the project, including personnel, equipment, and funding.

Data Sources and Methodology

- Introduction: Brief overview of the data sources and methodology used for the project.
- Data Sources: Description of the data sources used for the project, including any limitations or challenges associated with those sources.
- Data Collection Plan: A detailed plan for collecting and organizing the necessary data for the project.
- Forecasting Methodology: A description of the methodology used for traffic forecasting, including any assumptions or limitations, and quality checks performed to ensure the forecasting is reliable.

Forecasting Method

- Introduction: A brief overview of the forecasting models, if used for the project.
- Model Development: A detailed description of the development of the forecasting models, including any programming code or software used.
- Model Validation: A description of the accuracy testing and validation of the forecasting models. May include accuracy testing results.
- Trends Analysis: A description of trends analysis performed using historical traffic or demographic data where appropriate.
- Assumptions and Limitations: Identification of any assumptions or limitations associated with the forecasting models.

Forecasting Development

- Introduction: A brief overview of the forecasting development and results.
- Development and Results: A detailed report on the traffic forecasting development and results, including any accuracy metrics and recommendations for transportation planning.
- Implications: A description of the implications of the forecasting results for traffic analysis and following phases of the project.

Project Traffic Forecasting Documentation

- A Technical Memorandum including the items described above. For large and complex projects that involve multiple improvement alternatives, it may be necessary to prepare a separate Project Traffic Forecasting Memorandum that can be incorporated by reference into the final project report. The Project Traffic Forecasting Memorandum should include data sources, forecasting process, proposed alternatives, and traffic forecasts for each analyzed alternative.

Chapter 4

Forecasting with Travel Demand Models

4.1 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 5.**

The following sections provide guidance on the use of models to develop traffic projections for corridor, project, and RRR projects. This guidance 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 for longer segments. 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.

4.2 Corridor and Project Traffic Forecasting

4.2.1 Corridor Traffic Forecasting

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 reviewed 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 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 Local Government Comprehensive Plan (LGCP) or the Long Range Transportation Plan (LRTP), provided by the local Metropolitan Planning Organization (MPO), Transportation Planning Organization (TPO), or Transportation Planning Agency (TPA). 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 their respective designee(s).

Figure 4-1 illustrates the seven-step Corridor Traffic Forecasting Process.

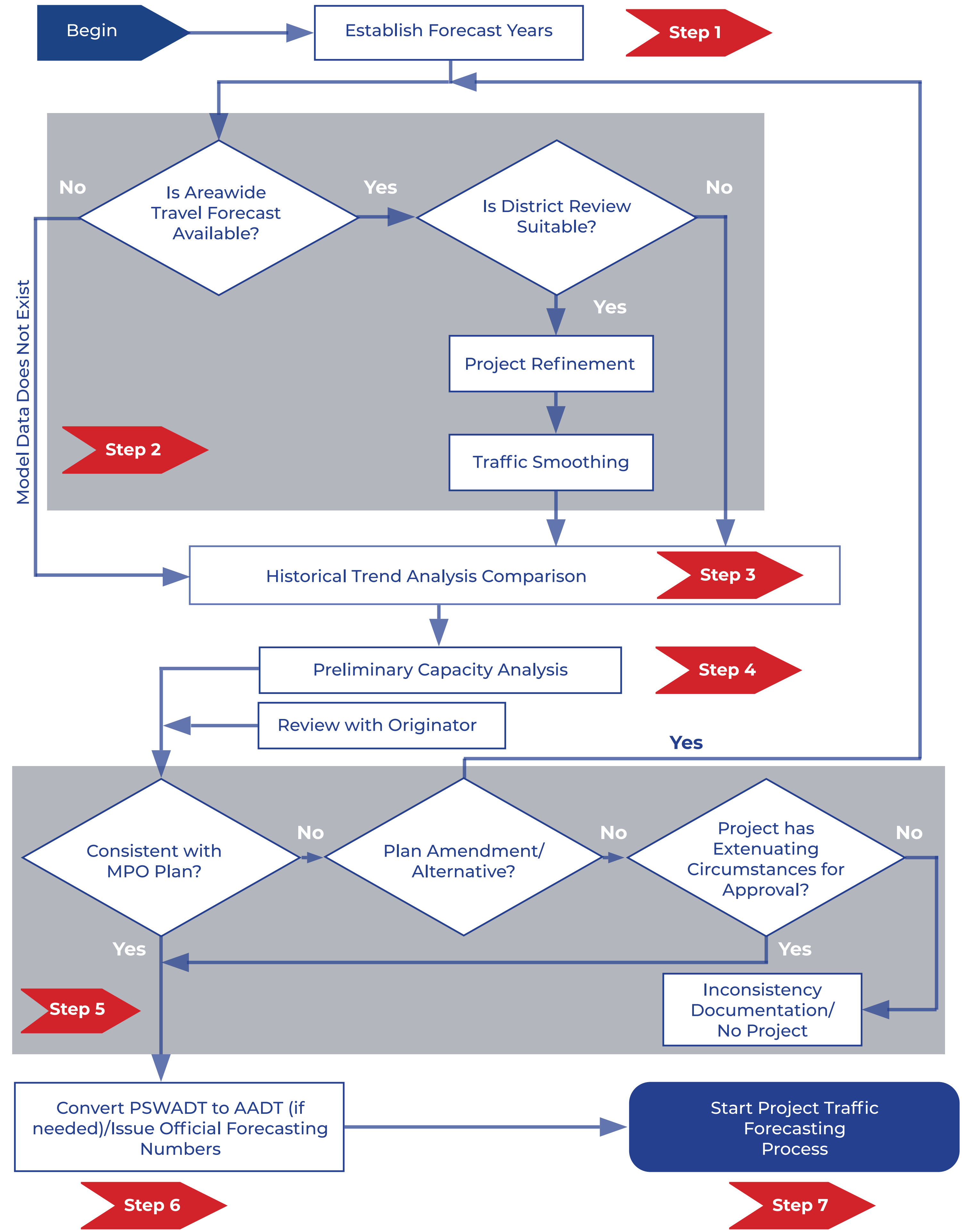


Figure 4-1 Corridor Traffic Forecasting Process

4.2.2 Project Traffic Forecasting Process

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 the 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 4-2** 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 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 developments for the SHS, Interchange Access Requests (IAR), PD&E studies, Master and Action Plans for SIS facilities, RRR projects, lane repurposing, bridge replacement, approaches to bridges, new roadway projects, and major intersection improvements.

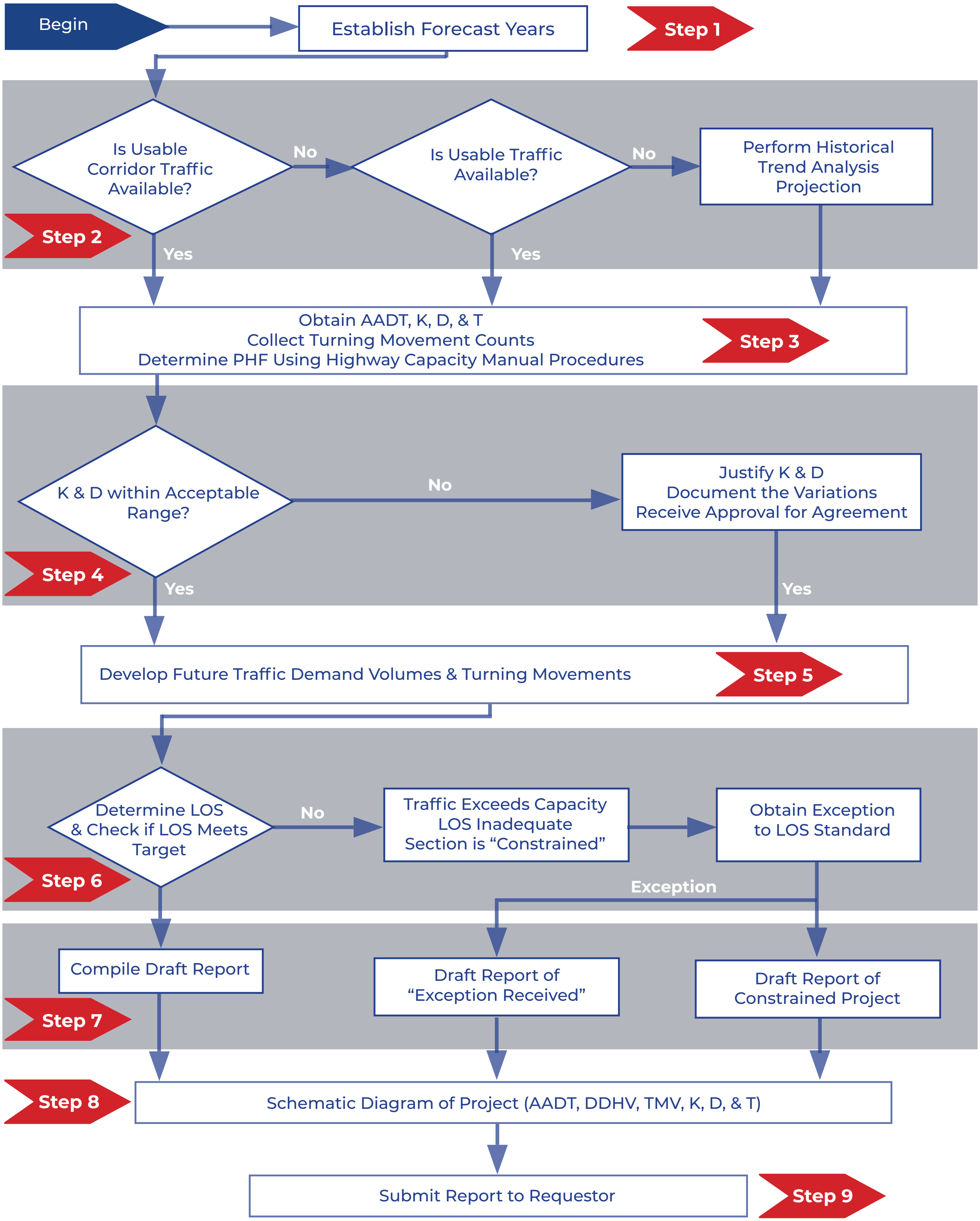


Figure 4-2 Project Traffic Forecasting Process

4.2.3 Establishing Forecast Years

For Project Traffic Forecasting purposes, the existing 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 some cases, the model base year coincides with the year when the study is conducted, but it could be several 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 US 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** – the first year after a project is scheduled to be open to the public and when the new traffic pattern stabilizes.

- **Interim Year(s)** – years 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 20 years for capacity projects and 10 years for operational projects from the Opening Year.

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

4.3 Fundamentals of Travel Demand Models

The primary purpose of travel demand 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 Memorandum. 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 Florida for projecting systems traffic are developed based on the modeling standards set forth by the Florida Model Task Force (MTF) known as the Florida Standard Urban Transportation Model Structure (FSUTMS). MPO/TPO/TPAs previously developed and maintained 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 MPO/TPO/TPA, are 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 US Census, American Community Survey (ACS), Census Transportation Planning Package (CTPP), the Longitudinal Employer-Household Dynamics (LEHD) data provided by the US 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 responds 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 and/or purpose of the project, the Turnpike State 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.

This section presents an overview of modeling fundamentals 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, NCHRP 716, or NCHRP 735, and relevant modeling reports.

4.3.1 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 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 includes 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, and travel times and delays. 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.

4.3.2 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: Go to work, school, 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: Drive, get a ride, or use 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 4-3** illustrates a conceptual four-step modeling framework 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.

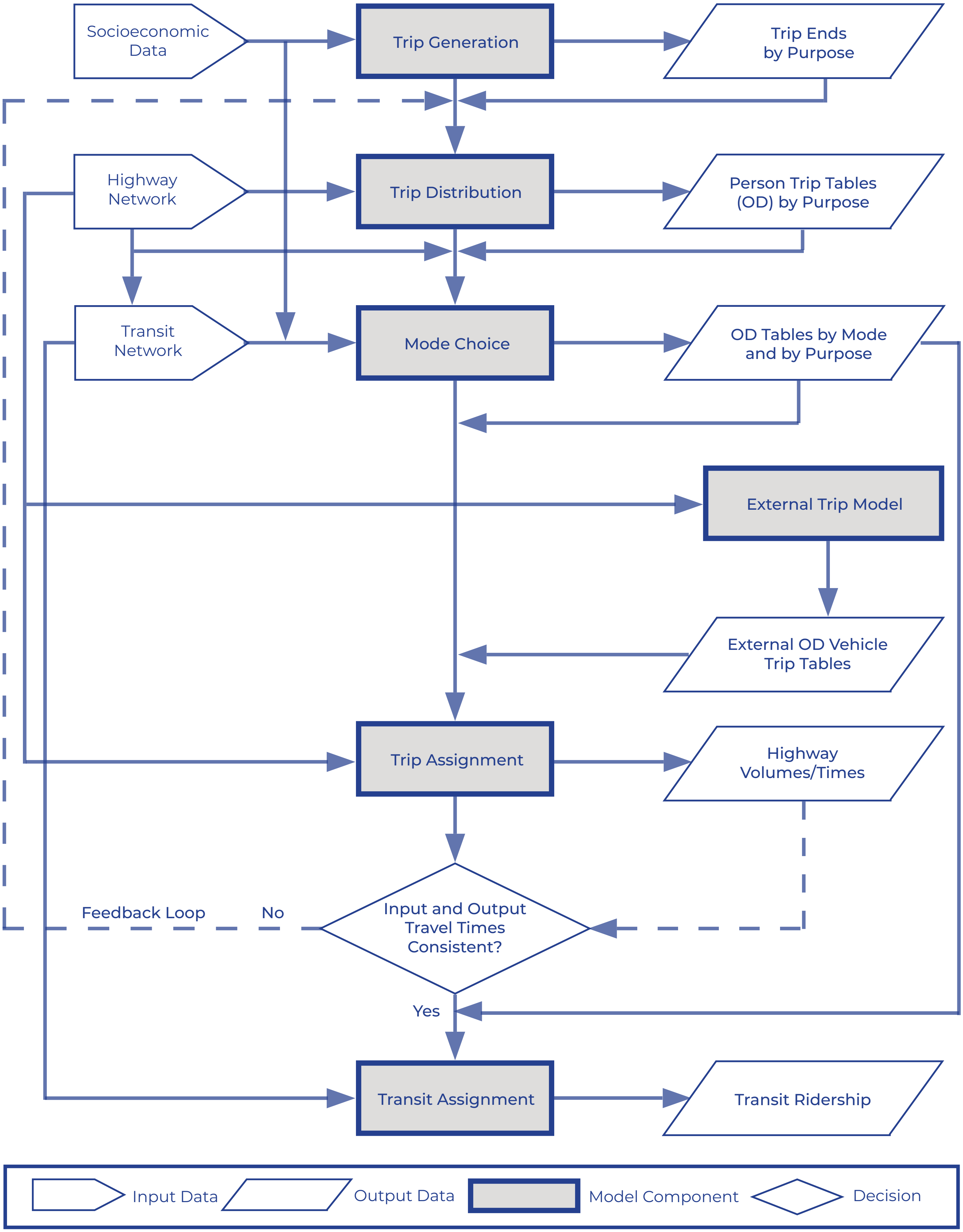


Figure 4-3 Four-Step Travel Forecasting Framework

4.3.3 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 address 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.

4.3.3.1 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.

4.3.3.2 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, 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 (TDM) 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 times 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. TOD choice models focus on predicting trip departure times based on preferred arrival time, expected and experienced travel times, and sometimes, arrival delay penalties.

4.3.3.3 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, and it is often necessary to estimate the O-D table from other sources. One of the most commonly used methods 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". 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 has offered 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 needs to be computed between the original and ODME trip table, and then use the developed deltas to adjust the future year model trip table. Additionally, some capping is required for deltas so as not to completely overwrite the demand model distributions.

4.3.4 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/companions, 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.

4.3.5 Travel Demand Models Available in Florida

The Florida Transportation Forecasting Forum (TFF), formerly 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 Florida, collectively referred to as 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. **Figure 4-4** shows the models that are currently being used in Florida, including the type of model and modeling area associated with its model.

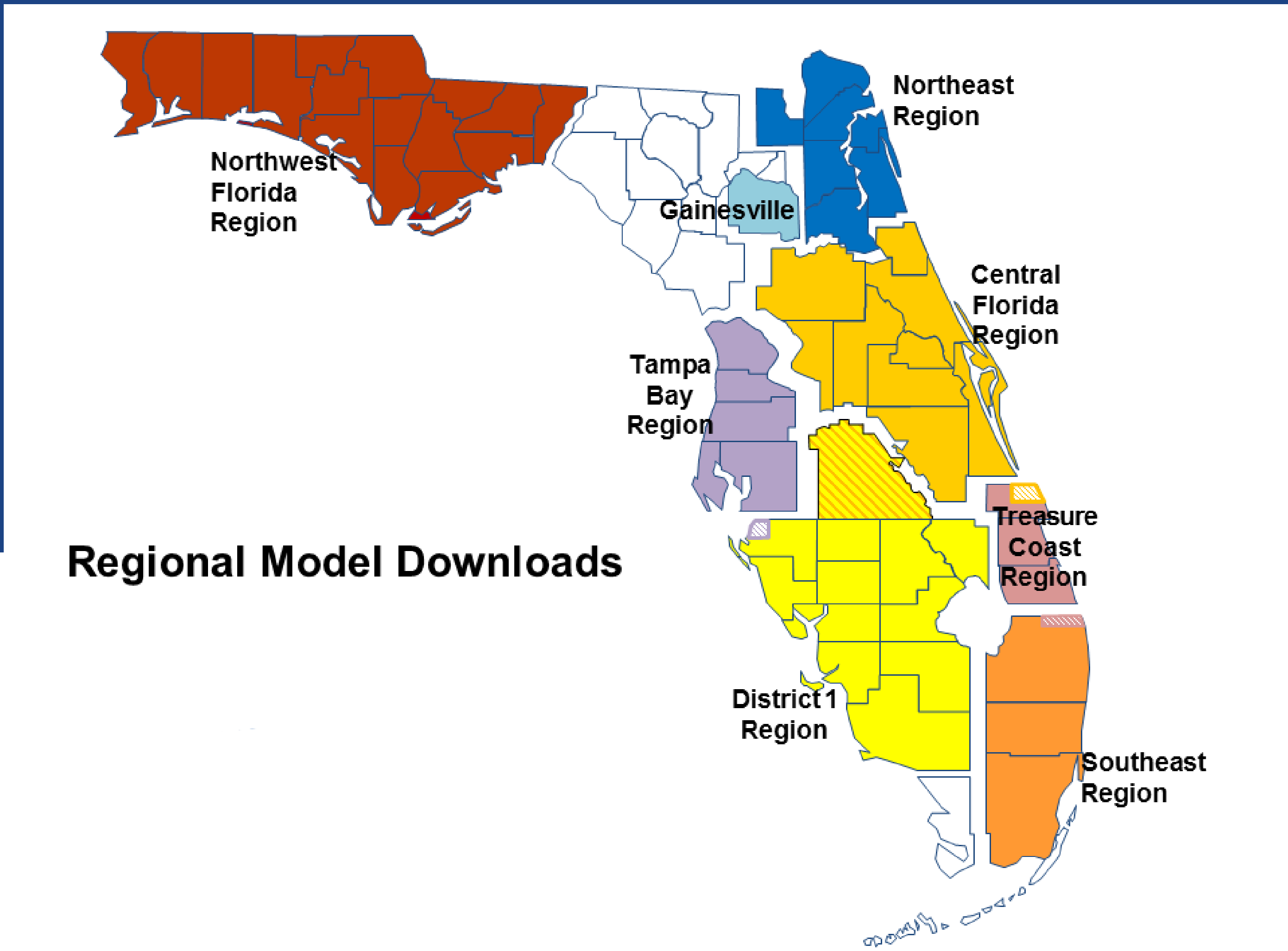


Figure 4-4 Available Models in Florida

The Florida web portal also has a list of available models on its Statewide and Regional Models Downloads page. Users are advised to always consult with District Planning Offices for any change or update of these models. It is noted that there is a change in modeling platform from Cube to PTV Visum and TransCAD. The [Transportation Forecasting Resource Hub]() replaces FSUTMS Online and offers downloads of travel demand models and modeling guidance and training resources, as well as information on the Florida Transportation Forecasting Forum (formerly the Florida Model Task Force). The available models in Florida for download include:

- **Northwest Florida Regional Planning Model (NWFRPM)**
  Coverage: Entirety of District 3
  Model Type: Four-step
  Model Output: Peak Season Weekday Average Daily Traffic (PSWADT)

- **Northeast Florida Regional Planning Model (NERPM)**
  Coverage: Nassau, Baker, Duval, St. Johns, Clay, and Putnam Counties
  Model Type: Activity-based
  Model Output: AADT

- **Gainesville/Alachua County Model**
  Coverage: Alachua County
  Model Type: Four-step
  Model Output: PSWADT

- **Central Florida Regional Planning Model (CFRPM)**
  Coverage: All District 5 MPOs, including Polk County and a portion of Indian River County
  Model Type: Four-step
  Model Output: PSWADT

- **Tampa Bay Regional Planning Model (TBRPM)**
  Coverage: Citrus, Hernando, Pasco, Pinellas, and Hillsborough Counties, as well as a portion of Manatee County
  Model Type: Four-step
  Model Output: PSWADT

- **Treasure Coast Regional Planning Model (TCRPM)**
  Coverage: Indian River, St. Lucie, and Martin Counties, as well as a portion of Palm Beach County
  Model Type: Activity-based
  Model Output: AADT

- **District 1 Regional Planning Model (D1RPM)**
  Coverage: Entirety of District 1
  Model Type: Four-step
  Model Output: AADT

- **Southeast Regional Planning Model (SERPM)**
  Coverage: Palm Beach, Broward, and Miami-Dade Counties
  Model Type: Activity-based
  Model Output: AADT

- **Turnpike State Model (TSM)**
  Coverage: Statewide
  Model Type: Tour-based
  Model Output: PSWADT

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 (systemwide, district, corridor)?

The use of a non-FSUTMS model is normally not acceptable in areas where a 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 none of the adopted/endorsed FSUTMS models can be used. The District Planning Office should be contacted for approval prior to the use of a non-FSUTMS model.

4.3.6 Florida Transportation Forecasting Forum (TFF)

To ensure that travel forecasting in Florida continues to provide valuable information, FDOT Systems Forecasting & Trends Office (SFTO) engaged a working group to brainstorm the next generation of travel demand modeling and travel forecasting. The working group met several times between September 2022 and July 2023, to provide ideas on how to develop Florida's travel forecasting practice moving forward. These contributions culminated in the identification of three core principles:

- Relevancy & Timeliness
- Accessibility & Communication
- Consistency & Efficiency

Placing these core principles at the center of travel forecasting and modeling work ensures that the state of the practice advances in ways that support the public interest and provide added value to decision-makers.

The Florida TFF, formerly the Florida MTF, employs task-oriented committees made up of volunteer members charged with developing guidance, tools, and other products to advance the state of the practice. SFTO provides technical staff support to each committee. This collaboration between SFTO and the TFF allows for an incremental and iterative process ensuring Florida's travel forecasting and modeling practice is effectively meeting the needs of users now and in the future.

For additional information of the Florida TFF, please check the Transportation Forecasting Resource Hub. This hub provides information to support transportation-related forecasting, including travel demand modeling. The users can find guidance and manuals, download models, access shared data, and register for upcoming training events.

4.4 Model Calibration and Validation

The process of Model Calibration and Validation is vital to producing defensible travel demand forecasts. Florida standards for Model Calibration and Validation were initially defined as part of the Model Update series of studies in the early 1980s. It is recognized that different model applications require a variety of model validation checks and, in some cases, accuracy standards and guidelines. The FDOT has led the development of a validation checklist organized by model application type and the four steps generally used in Travel Demand Modeling, identifying calibration and validation checks, standards, and benchmarks for LRTPs, subarea studies, FTA New Starts, and corridor studies. Models serve engineering and planning applications, each with distinct requirements for sophistication and accuracy, driving the standards based on application needs and requirements. Through this process, Travel Demand Models gain credibility, ensuring they accurately inform decisions in Transportation Planning and Project Development. Model Calibration and Validation serves several purposes, such as providing a level of comfort to modelers, planners, policy and decision makers, and, to some extent, the general public that the model is able to produce accurate results; provide evidence that model results are accurate enough to be used for the desired planning analyses; and account for the errors in observed data used for comparisons. Balancing model complexity and fidelity through this process empowers decision-makers to shape future mobility and project development with reliability.

4.4.1 Overview of Model Calibration and Validation

In Florida, the terms "calibration" and "validation" have typically been distinguished as follows:

- Model Calibration – A process where models are adjusted to simulate or match observed household travel behavior in the study area for a base (calibration) year.
- Model Validation – The procedure used to adjust models to simulate base year observed data, such as traffic counts and transit ridership figures.

Model Calibration implies the availability of household travel survey data to adjust the model constants and parameters to match observed trip generation rates, trip length frequency distributions, aggregate trip movements, and mode shares. Model validation could include some components of calibration if household survey data is available; however, survey data is not required in adjusting the model to match traffic counts. The calibration and validation guidelines and standards represent optimum levels of accuracy. Achieving the accuracy standards and benchmarks does not ensure that the model was developed correctly, as all assumptions and adjustments to model parameters during calibration and validation must be defensible and documented.

Validation also consists of reasonableness and sensitivity checks beyond matching base year travel conditions. The standards therefore include such checks as the reasonableness of model outputs and the elasticities of demand, with respect to input variables. It should always be remembered that the purpose of the travel model is to estimate or forecast travel conditions for some alternative scenario(s) other than the existing situation. Inclusion of factors, constants, or parameters that do not vary between the base and alternative scenarios implies that what is represented by these parameters does not change between the scenarios. The more a model relies on such parameters, the less explanatory capability it has.

4.4.2 Subarea Model Validation for Project Traffic Forecasting

Subarea transportation studies are becoming increasingly popular in addressing growth management issues at the local level, including Local Government Comprehensive Plans (LGCPs), master plans, subarea studies, proportionate share, and impact fees. Subarea transportation models often include splitting of the regional model TAZs, reevaluating base year and future year socioeconomic estimates, and adding roadways to the model network that are important for local traffic circulation, but not necessarily needed at the regional level.

Validation of the Regional Transportation Model should be completed and approved for use by the FDOT and the local MPO prior to developing a subarea model. Not all model validation checks required for LRTPs and FTA New Starts projects are needed at the subarea level as some of these would potentially be redundant. The subarea should be defined within the model by designating districts and sectors to summarize TAZ and network information for the subarea. Some statistics should be compared between the subarea and regional level to ensure the subarea model validation does not disrupt regional model accuracy should the subarea model be used later for other purposes. A sample of validation measures to compare between subarea and regional levels may include the following:

- Input Data – A primary focus of validating a subarea model and include review of socioeconomic data and highway and transit networks.
- Trip Generation – Review and comparison of subarea against the regional model based on aggregate trip rates (e.g., trips/person, trips/DU, Home Based Work trips/employee).

- Trip Distribution – Comparisons on average trip length and percent intrazonal trips by purpose.
- Mode Choice – If the subarea includes transit access, mode shares should be reviewed within the subarea against local data or use professional judgment.
- Trip Assignment – Highway validation checks on volume-over-count, VMT-over-count, VHT-over-count, screenline volume-over-count, RMSE, and percent error.

It may be desirable to add cutlines or modify screenlines to better assess trip patterns into, out of, and through the subarea. If the subarea has major freight generators, a review of percent trucks or truck VMT should also be conducted. If there is significant growth between the model base year and the existing year, it is recommended to use the existing year for subarea model validation.

4.4.3 Model Validation Standards in Florida

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 is the **Root Mean Square Error (RMSE)**. RMSE is a measure of dispersion and 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 4-1

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

4.4.3.1 Regionwide Model Accuracy Assessment

4.4.3.1.1 *Volume-Over-Count Ratios by Facility Types and Screenlines*

Table 4-1 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.

4.4.3.1.2 *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 4-2** 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 4-1 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 4-2 Regionwide Model Accuracy Assessment Percent RMSE

Volume-Over-Count Ratios	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.

4.4.3.2 Project Level Model Accuracy Assessment

Project Level Model Validation is typically focused on network details within the project Area of Influence (AOI) or subarea. 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 4-3** 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. It is also recommended that the percent RMSE by volume groups be compared between the project/corridor and regional level to ensure the Project Level Model Validation does not disrupt regional model accuracy.

Table 4-3 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%	-

4.5 Model Assessment and 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 AOI lie outside or cross MPO/TPO/TPA planning boundaries, a regional model that covers the entire 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 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.

4.5.1 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 whether 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 systemwide 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 5**, Forecasting Without a Traffic Model, be utilized instead.

4.5.2 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.

4.5.3 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.

4.6 Travel Demand Model Development and Application

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 subarea of the model for a project (site specific) analysis.

4.6.1 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 timeliness.

4.6.1.1 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.

4.6.1.2 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.

4.6.1.3 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.

4.6.2 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 socioeconomic data in the TAZs or other geographic analysis units should be updated to reflect the base 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 4-1** to **Table 4-3** 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 re-examination 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. Expanding the project AOI will have impact on schedule and budget.

4.6.3 Evaluation of Future Year Conditions

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.

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
- Socioeconomic/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.

4.6.4 Consistency with the Adopted LRTPs and LGCPs

There are three (3) 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.

4.6.4.1 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.

4.6.4.2 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 their 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 4.6.4.3**.

4.6.4.3 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 4.6.4.2** and the decisions made. Include in the document any written letters or agreements generated as part of the activities in **Section 4.6.4.2**. If the project is not viable, indicate in the conclusion of the report that the study resulted in a "No Project."

4.6.5 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, socioeconomic 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.

4.6.6 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 socioeconomic 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 5.**

4.7 Use of Model Outputs in Traffic Forecasting

A 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 4.7.3** for a discussion on converting PSWADT to AADT. The process for applying the model to project traffic is described as follows:

4.7.1 Develop Interim and Forecast Year Land Use and Network 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 their designee(s) and the agency responsible for the model (i.e., MPO/TPO/TPA or local agency). Execute the model stream by selecting the corresponding scenarios using the appropriate key values from Scenario Manager in accordance with the model’s User’s Manual. The modeled traffic volumes can be obtained from the loaded highway network.

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.

4.7.2 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 5.** 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 the Bureau of Economic and Business Research (BEBR) at the University of Florida, US 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 4.6.5** 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.

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

Most of the models used in 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 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), District 1 Regional Planning Model (D1RPM), and the Florida Statewide Model (FLSWM), where the models are 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.

As mentioned in **Section 2.4.1**, 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 (in vehicle) to AADT (see **Equation 4-2**).

$$AADT = ADT \times SF$$

Equation 4-2

Figure 4-5 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 is the lowest. In this example, MOCF is the average of the 13 SFs from Week 19 to Week 31, which is equal to 0.97 for this category. The MOCF is used to convert the traffic volumes generated by a travel demand forecasting model (PSWADT) to AADT (see **Equation 4-3**).

$$AADT = PSWADT \times MOCF$$

Equation 4-3

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 second week of 2022 from January 2, 2022 to January 8, 2022 for Category 4800 in Escambia County (**Figure 4-5**), the SF is 1.08, the MOCF for the category is 0.97. The corresponding PSCF can be calculated by dividing SF of 1.08 by MOCF of 0.97, which yields 1.11. The PSCFs are used to convert a 24-hour count, representing the average weekday daily traffic, to PSWADT (see **Equation 4-4**).

$$PSWADT = AADT \times PSCF \qquad \text{Equation 4-4}$$

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 35,487 vehicles was taken on a roadway in Escambia County on Wednesday, February 7, 2022 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. According to **Figure 4-5**, the PSCF for the 7^{th} week of February 6 – 12, 2022 is 1.07. The short-term counts can be converted to PSWADT as follows:

Daily Count x Peak Conversion Factor = PSWADT

35, 487 *(daily count)* x 1.07 *(PSCF)* = 37, 971 ⟶ 38, 000 *(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:

Daily Count x Seasonal Factor = AADT

35, 487 *(daily count)* x 1.04 *(SF)* = 36, 906 ⟶ 37, 000 *(AADT)*

The MOCF is used to convert model output to AADT when necessary. Based on **Figure 4-5**, the MOCF for Category 4800 in Escambia equals to 0.97. 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 42,349, the AADT can be obtained by applying MOCF as follows:

PSWADT x MOCF = AADT

42, 349 *(PSWADT)* x 0.97 *(MOCF)* = 41, 079 ⟶ 41, 500 *(AADT)*

Note that this conversion must be made for Project Traffic Forecasting using design traffic criteria. If the traffic forecast is based on historical trend analysis where historical AADT volumes are used, the process does not require any data conversion.

2022 PEAK SEASON FACTOR CATEGORY REPORT - REPORT TYPE: ALL
CATEGORY: 4800 ESCAMBIA COUNTYWIDE

MOCF: 0.97

WEEK	DATES	SF	PSCF
1	01/01/2022 - 01/01/2022	1.04	1.07
2	01/02/2022 - 01/08/2022	1.08	1.11
3	01/09/2022 - 01/15/2022	1.12	1.15
4	01/16/2022 - 01/22/2022	1.10	1.13
5	01/23/2022 - 01/29/2022	1.08	1.11
6	01/30/2022 - 02/05/2022	1.06	1.09
7	02/06/2022 - 02/12/2022	1.04	1.07
8	02/13/2022 - 02/19/2022	1.02	1.05
9	02/20/2022 - 02/26/2022	1.01	1.04
10	02/27/2022 - 03/05/2022	1.01	1.04
11	03/06/2022 - 03/12/2022	1.00	1.03
12	03/13/2022 - 03/19/2022	0.99	1.02
13	03/20/2022 - 03/26/2022	0.99	1.02
14	03/27/2022 - 04/02/2022	0.98	1.01
15	04/03/2022 - 04/09/2022	0.98	1.01
16	04/10/2022 - 04/16/2022	0.98	1.01
17	04/17/2022 - 04/23/2022	0.97	1.00
18	04/24/2022 - 04/30/2022	0.97	1.00
*19	05/01/2022 - 05/07/2022	0.97	1.00
*20	05/08/2022 - 05/14/2022	0.97	1.00
*21	05/15/2022 - 05/21/2022	0.97	1.00
*22	05/22/2022 - 05/28/2022	0.97	1.00
*23	05/29/2022 - 06/04/2022	0.98	1.01
*24	06/05/2022 - 06/11/2022	0.98	1.01
*25	06/12/2022 - 06/18/2022	0.98	1.01
*26	06/19/2022 - 06/25/2022	0.98	1.01
*27	06/26/2022 - 07/02/2022	0.97	1.00
*28	07/03/2022 - 07/09/2022	0.96	0.99
*29	07/10/2022 - 07/16/2022	0.96	0.99
*30	07/17/2022 - 07/23/2022	0.96	0.99
*31	07/24/2022 - 07/30/2022	0.97	1.00
32	07/31/2022 - 08/06/2022	0.98	1.01
33	08/07/2022 - 08/13/2022	0.99	1.02
34	08/14/2022 - 08/20/2022	1.00	1.03
35	08/21/2022 - 08/27/2022	1.00	1.03
36	08/28/2022 - 09/03/2022	1.00	1.03
37	09/04/2022 - 09/10/2022	0.99	1.02
38	09/11/2022 - 09/17/2022	0.99	1.02
39	09/18/2022 - 09/24/2022	0.99	1.02
40	09/25/2022 - 10/01/2022	0.99	1.02
41	10/02/2022 - 10/08/2022	0.99	1.02
42	10/09/2022 - 10/15/2022	0.99	1.02
43	10/16/2022 - 10/22/2022	0.99	1.02
44	10/23/2022 - 10/29/2022	1.00	1.03
45	10/30/2022 - 11/05/2022	1.01	1.04
46	11/06/2022 - 11/12/2022	1.01	1.04
47	11/13/2022 - 11/19/2022	1.02	1.05
48	11/20/2022 - 11/26/2022	1.02	1.05
49	11/27/2022 - 12/03/2022	1.03	1.06
50	12/04/2022 - 12/10/2022	1.03	1.06
51	12/11/2022 - 12/17/2022	1.04	1.07
52	12/18/2022 - 12/24/2022	1.08	1.11
53	12/25/2022 - 12/31/2022	1.12	1.15

* PEAK SEASON

23-FEB-2023 09:11:20 830UPD 3_4800_PKSEASON.TXT

Figure 4-5 Peak Season Factor Category Report for Category 4800 in Escambia County

4.7.4 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 adjustments 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 (2) 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 (2) factors are then applied to the future year model volumes using **Equation 4-5** and **Equation 4-6**.

Ratio Adjustment:

$$V_{r\_adj} = \frac{Count}{V_b} \times V_f$$

Equation 4-5

Difference Adjustment:

$$V_{d\_adj} = (Count - V_b) + V_f$$

Equation 4-6

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 (2) adjusted model volumes V_{r_adj} and V_{d_adj}, as shown in **Equation 4-7.**

$$V_{adj} = (V_{r\_adj} + V_{d\_adj})/2$$

Equation 4-7

Two (2) 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 a 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.

4.8 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 movement volumes and axle loadings as described in this Handbook.

4.8.1 Turning Movement 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. The user can use output figures from TURNS5 or TMTool, as described in Chapter 7, as potential templates to show the turning movement volumes.

4.8.2 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 provided to the appropriate District personnel. The project traffic shall be certified (typically by the District Planning Office) using the fillable portable document format (PDF) of the standard form shown in **Figure 4-6**. If an 18-KIP ESAL is requested, use the certification form shown in **Figure 4-7**. All assumptions used in the estimation process and all 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

Figure 4-6 Project Traffic Forecasting (PTF) Certification Statement

Source: [2024 FDOT Design Manual, Chapter 103]

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

Figure 4-7 18-KIP ESAL Forecasting Certification Statement

Source: [2024 FDOT Design Manual, Chapter 103]

Chapter 5

Forecasting Without a Travel Demand Model

5.1 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 US 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 reason(s) could be found for the inconsistencies.

5.2 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.

5.3 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, this fact should be noted in the Project Traffic Forecasting Report that four lanes will not be adequate for a 20-year design, and necessary steps should be taken to address the potential shortfall.

5.4 Project Traffic Forecasting Without a Travel Demand Model

5.4.1 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 (9) earlier years of mainline traffic data is preferred; but if ten years of data is not available, current year plus four (4) 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 – Selected K Factor from the acceptable Standard K Factor Range
   b. D – This factor can be derived from one of the following sources: 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. The project opening and design years
6. Current and historical population data within the study area
7. Current and historical employment data within the study area
8. Local Government Comprehensive Plan (land use and traffic circulation elements)
9. Adopted MPO/TPO/TPA Long Range Transportation Plans (LRTPs)
10. Current Transportation Improvement Program (TIP) from the relevant MPOs
11. Current version of the FDOT Trend Analysis Tool

5.4.2 Establish Traffic Growth Trend

There are several methodologies that can be used to determine the growth pattern, which include Linear Growth, Exponential Growth and Decaying Exponential Growth.

5.4.2.1 Linear Growth

Linear growth predicts the future traffic based on a straight line developed from historic traffic growth as shown in **Equation 5-1**. 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:

Equation 5-1

$$Volume_{FY} = Volume_{BY} \times (1+(FY-BY) \times G_{Linear})$$

Where:

G_{Linear} = Linear growth rate

FY = Future Year

BY = Base Year

5.4.2.2 Exponential Growth

Exponential growth predicts future traffic based on a percentage of growth from the previous year, as shown in **Equation 5-2**. This method is most suitable where there is rapid growth with no capacity restraints.

$$Volume_{FY} = Volume_{BY} \times (1+G_r)^{(FY-BY)}$$

Equation 5-2

Where:

- Gr = Geometric growth rate
- *FY* = Future Year
- *BY* = Base Year

5.4.2.3 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 5-3**. This method is recommended for site impact analysis in mature areas when build-out is approaching.

The equation for Decaying Exponential Growth is as follows:

$$Volume_{FY} = Volume_{BY} \times \sum_{BY}^{FY} \frac{X}{FY - BY} \sum_{BY}^{FY} \frac{X}{FY - BY}$$

Equation 5-3

Where:

- X = Normal straight-line growth from trend data
- *FY* = Future Year
- *BY* = Base Year

The use of a particular growth pattern depends on the "goodness-of-fit," as measured by the R-Squared value based on the regression analysis of the historical data. If historical count data are insufficient, prepare a similar analysis using alternative indicators such as population, employment, or other socioeconomic factors that influence travel decisions.

It is important to check for outliers in historical data before performing a linear regression analysis. Outliers are data points that deviate significantly from the rest of the data and can affect the accuracy and validity of the regression model. Traffic counts collected during special events or unusual times that do not represent normal traffic patterns, such as those during severe weather conditions or other unexpected interruptions, should be carefully evaluated before including them in the analysis. There are different methods to detect outliers, such as using boxplot or a scatterplot to identify outliers visually, or conducting statistical tests to quantify the degree of deviation of each data from the rest of the data. The outliers can be removed from the data, but it should be done with caution and justification, as it may introduce bias and reduce variability in the data.

In some cases, the regression analysis may result in negative growth. Unless there is strong evidence to indicate that the area will continue to experience a decline in economic activities or travel demand in the future, use of negative growth is not recommended. Under these circumstances, the project team should consult with the District or relevant local government agencies to assess the possible future growth patterns, and determine a reasonable growth rate. Some Districts have established minimum acceptable growth rates, and the project team should follow the District practices when developing the growth rates.

IMPORTANT NOTE:

It is important to check for outliers in historical data before performing trend analysis.

5.4.3 Develop Preliminary Traffic Projection

After growth patterns are analyzed and growth rates are established, future year traffic volumes can be computed by using the empirically derived growth trend equations. Alternatively, the FDOT Trend Analysis Tool has built-in formulae that perform the calculations automatically.

5.4.4 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.

5.4.5 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 divided by two (2). There may be some situations when balancing the intersection may not be appropriate. See **Chapter 7** 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.

5.4.6 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.

5.4.7 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 Report documenting procedures, assumptions, and results.
3. Prepare Project Traffic Forecasting Certification Statement and 18-KIP ESAL Forecasting Certification Statement (see **Figure 4-6 and Figure 4-7**). Refer to Project Traffic Forecasting Procedure, Topic No. 525-030-120, and obtain all authorized signatures.

5.5 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
- Demographic Analysis, FDOT Systems Forecasting and Trends Office (SFTO)
- US Census Bureau Data
- Florida workforce statistics data, Florida Department of Commerce
- Historical traffic counts, Florida Traffic Online Web Application, the Transportation Data and Analytics (TDA) Office
- NCHRP Report 255, "Highway Traffic Data for Urbanized Area Project Planning and Design"
- NCHRP Report 365, "Travel Estimation Techniques for Urban Planning"
- NCHRP Report 716, "Travel Demand Forecasting: Parameters and Techniques"
- NCHRP Report 735, "Long-Distance and Rural Travel Transferable Parameters for Statewide Travel Forecasting Models"
- 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 from county and municipal government agencies
- "Trip Generation Manual", 11th Edition, Institute of Transportation Engineers (ITE)
- MPO/TPO/TPA Long Range Transportation Plans (LRTPs) and Transportation Improvement Program (TIP)

5.6 Other Factors to Consider

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 characteristics

5.7 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. This example also serves as a demonstration of the use of the FDOT Trend Analysis Tool.

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 2045 AADT at this location to determine the number of lanes needed in the future. **Figure 5-1** shows the project location.

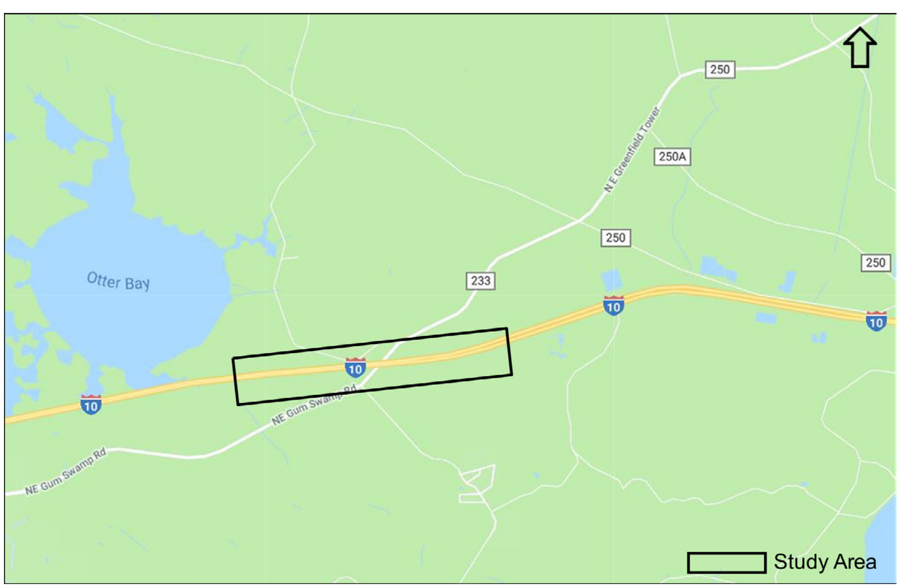


Figure 5-1 I-10/SR-8 Project Location Map

2. Historical Traffic Counts

Based on Traffic Information Online, Continuous TMS 299936 is located within the study area, and historical traffic counts are available from 2007 to 2022. (See **Figure 5-2** and **Figure 5-3).**

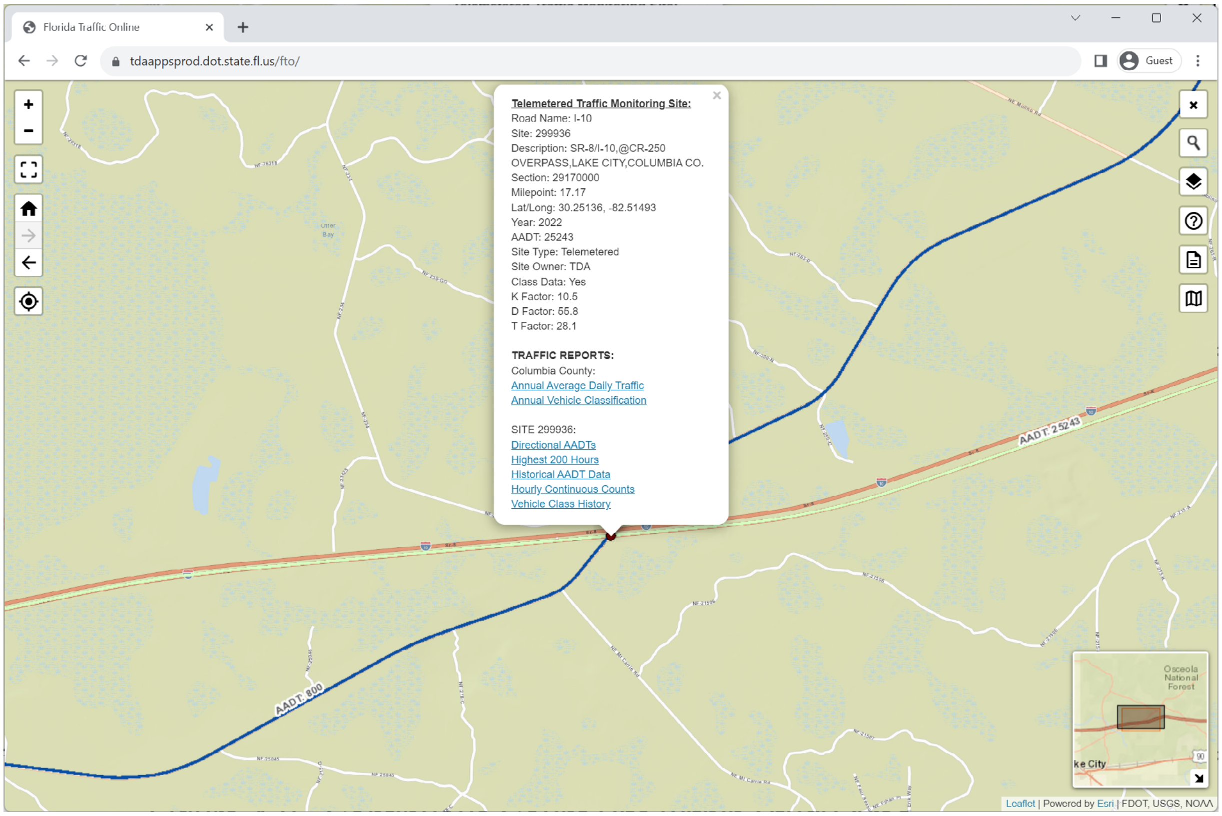


Figure 5 -2 Continuous Count Site within Study Area

FLORIDA DEPARTMENT OF TRANSPORTATION
TRANSPORTATION STATISTICS OFFICE
2022 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
2022	25243 C	E 12591	W 12652	10.50	55.80	28.10
2021	25119 C	E 12442	W 12677	10.50	55.50	28.10
2020	21119 C	E 10468	W 10651	10.50	54.60	30.80
2019	24066 C	E 11888	W 12178	10.50	54.90	26.40
2018	23991 C	E 11910	W 12081	9.50	54.80	23.10
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

Figure 5-3 Historical Trend Analysis Summary

3. Historical Population Data

The Bureau of Economic and Business Research (BEBR) publishes annual population estimates by county by district on their websites. Historical population data can be obtained from these sources. **Table 5-1** shows the historical population for Columbia County for the ten years from 2013 to 2022.

Table 5-1 Historical Population Estimates for Columbia County

Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022
Population	67,489	67,826	68,163	68,566	68,943	69,721	70,492	69,698	69,809	71,525

4. FDOT Population Projections from 2025 to 2045

The SFTO publishes population projections by county. The most recent available data is for Years 2020 to 2045 in five-year increment adjusted based on 2022 population estimates. **Table 5-2** shows the population for Columbia County for Census Year 2020, Year 2022, and projections for the years 2025 to 2050.

Table 5-2 FDOT Population Projections for Columbia County

Year	2020	2022	2025	2030	2035	2040	2045	2050
Population	69,698	71,525	73,300	75,400	77,000	78,400	79,500	80,600

Step 2: Conduct Regression Analysis using Historical Traffic Data

The Traffic Trends Analysis Tool is a macro-based spreadsheet application developed by FDOT to perform historical trend analysis from specified FDOT sites or user defined locations. The tool can be downloaded from the FDOT Systems Implementation Office (SIO)'s website. This Excel spreadsheet includes tabs of Instructions, Main Menu, Output, and Summary. The steps for trends analysis are described as follows:

1. Open Main Menu and click Data Input, then enter Project Information. The project information includes FM number, County, location of the Florida Traffic Online (FTO) Database. The FTO database can be downloaded from the TDA website. This information is optional and only for project identification purposes. Future projection years include opening year, interim year, and design year. Up to 10 FDOT count stations can be analyzed at one

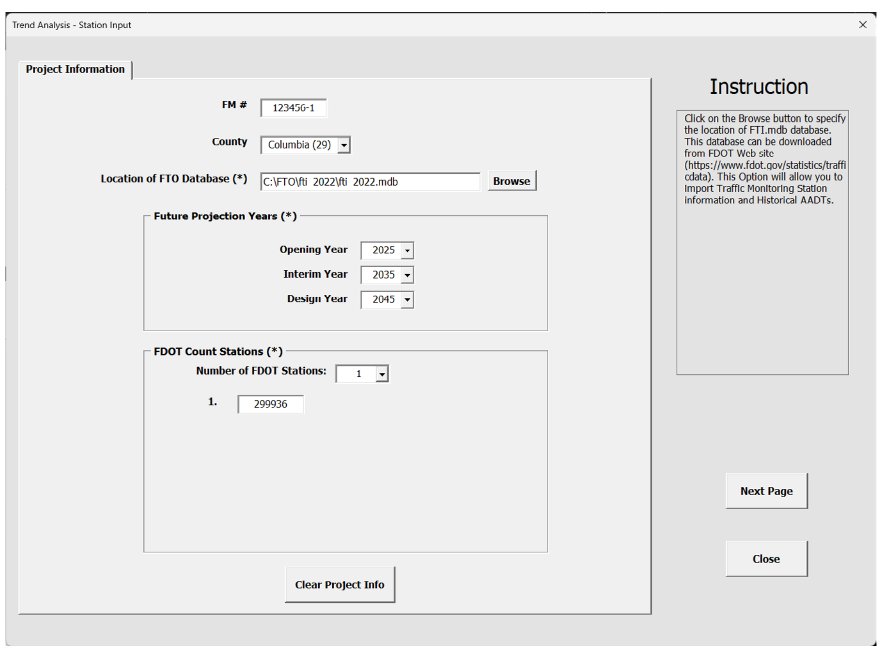


Figure 5-4 Trend Analysis Tool Project Information Input Screen

time. FDOT count station numbers need to be entered. **Figure 5-4** shows the Project Information screen for Count Station 299936.

2. Enter Station Information. The station information will be automatically filled in if the FDOT count station is specified. The station information can be typed in if the site is not an FDOT count station. Project Location, Roadway Section ID, Axle Correction Factor are the input for the project if the information needs to be changed for the project. The first year and last year of AADT volumes are the first year and last year of the AADT used for the historical trend analysis. Once the first year and last year of AADT volumes are specified, click on the **"Import Historical AADT"** button to load the historical AADTs from first year to last year from the FTO database. If the database location is not specified, a dialog will prompt to show that the database is not specified and will go back to Project Information tab. FSUTMS model data includes the availability of FSUTMS model volumes, number of years of the FSUTMS model, years of each model, and model volumes.

   In this example, a typical 10-year AADT dataset from 2010 to 2019 was used. More recent data from 2020 to 2022 was not used because a careful examination of the data determined that those data were still under unusual conditions. The use of AADT data during abnormal conditions for historical trend analysis requires careful consideration, contextual analysis, and potentially adjustments to account for anomalies. Long-term forecasting should recognize the unique circumstances of the abnormal conditions when making decisions. **Figure 5-5** shows the Input Data screen for Site 299936.

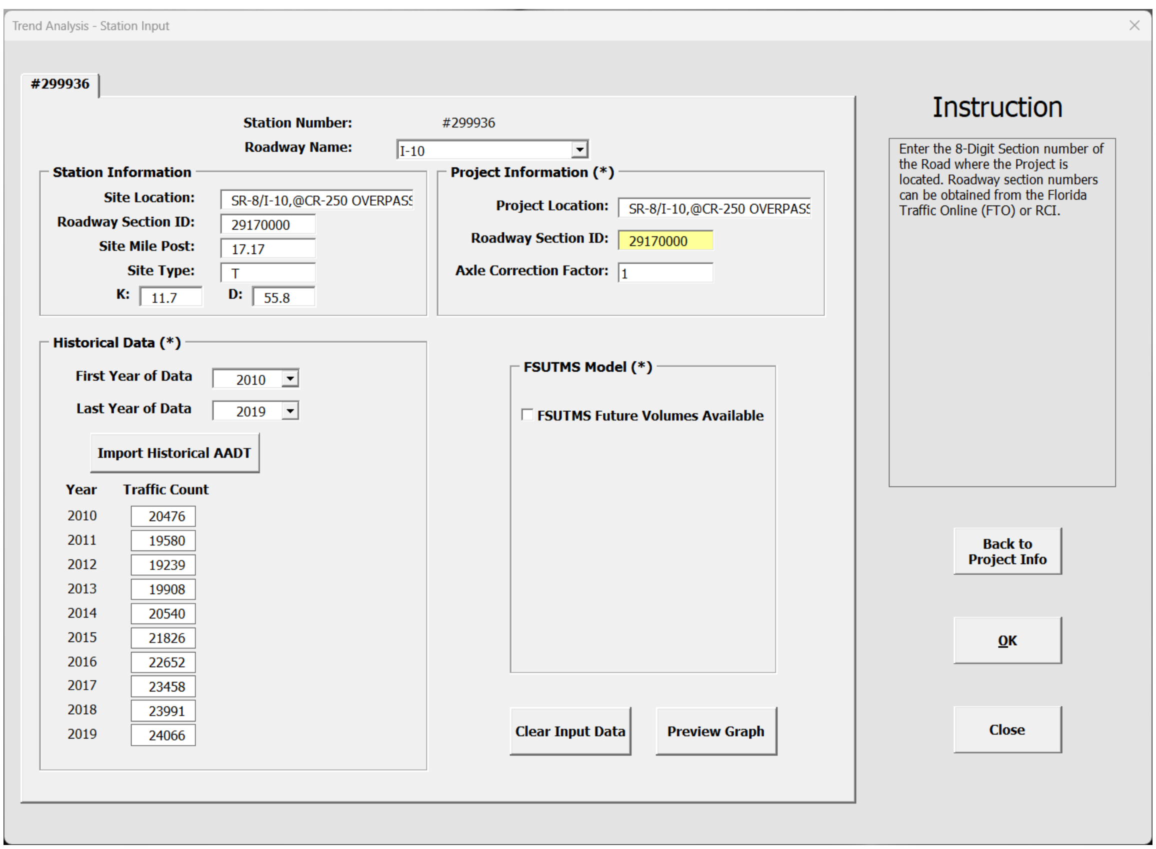


Figure 5-5 Trend Analysis Station Information Example

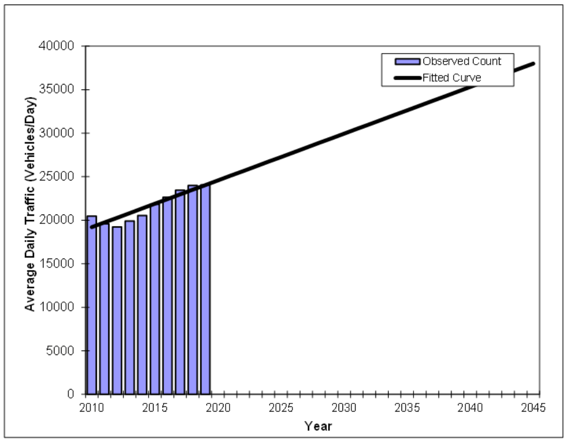
3. Once the historical data is imported or typed in, click on the "**Preview Graph**" Button to preview the trends analysis graphs using Linear, Exponential, and Decaying Exponential methods. **Figures 5-6 to 5-8** show an example of three trends analysis graphs for the FDOT count station 299936.

Traffic Trends - V2023

I-10 -- SR-8/I-10,@CR-250 OVERPASS,LAKE CITY,COLUMBIA CO.

FM #	123456-1
Location	1

County:	Columbia (29)
Station #:	299936
Roadway:	I-10



Year	Traffic (ADT/AADT) Count*	Trend
2010	20,476	19,210
2011	19,580	19,750
2012	19,239	20,280
2013	19,908	20,820
2014	20,540	21,360
2015	21,826	21,900
2016	22,652	22,430
2017	23,458	22,970
2018	23,991	23,510
2019	24,066	24,040
2025 Opening Year Trend		
2025	N/A	27,260
2035 Interim Year Trend		
2035	N/A	32,630
2045 Design Year Trend		
2045	N/A	38,000
FSUTMS Forecasts/Trends		

*Axle-Adjusted

Annual Trend Increase:	537
Trend R-squared:	86.44%
Trend Annual Historic Growth Rate:	2.79%
Trend Growth Rate (2019 to Design Year)	2.23%
Printed:	9/13/2023
Linear Growth Option	

Figure 5-6 Trend Analysis Linear Growth Pattern

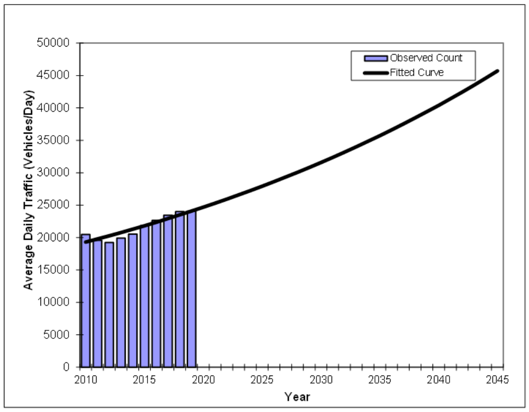
Traffic Trends - V2023

I-10 -- SR-8/I-10,@CR-250 OVERPASS,LAKE CITY,COLUMBIA CO.

FM #	123456-1
Location	1

County:	Columbia (29)
Station #:	299936
Roadway:	I-10

Figure 5-7 Trend Analysis Exponential Growth Pattern



Year	Traffic (ADT/AADT) Count*	Trend
2010	20,476	19,300
2011	19,580	19,780
2012	19,239	20,280
2013	19,908	20,780
2014	20,540	21,300
2015	21,826	21,830
2016	22,652	22,370
2017	23,458	22,930
2018	23,991	23,500
2019	24,066	24,090
2025 Opening Year Trend		
2025	N/A	27,930
2035 Interim Year Trend		
2035	N/A	35,720
2045 Design Year Trend		
2045	N/A	45,700
FSUTMS Forecasts/Trends		

*Axle-Adjusted

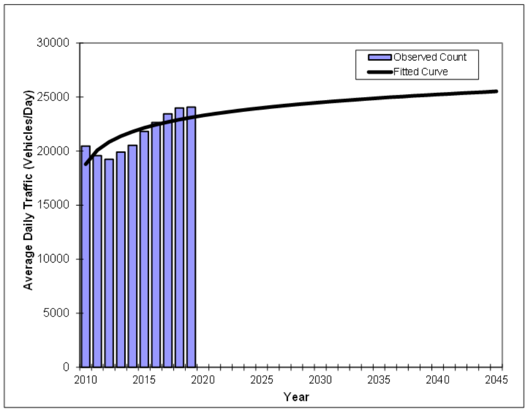
Trend R-squared:	86.05%
Compounded Annual Historic Growth Rate:	2.49%
Compounded Growth Rate (2019 to Design Year)	2.49%
Printed:	9/13/2023
Exponential Growth Option	

Traffic Trends - V2023

I-10 -- SR-8/I-10,@CR-250 OVERPASS,LAKE CITY,COLUMBIA CO.

FM #	123456-1
Location	1

County:	Columbia (29)
Station #:	299936
Roadway:	I-10



Year	Traffic (ADT/AADT) Count*	Trend
2010	20,476	18,790
2011	19,580	20,090
2012	19,239	20,850
2013	19,908	21,390
2014	20,540	21,810
2015	21,826	22,160
2016	22,652	22,450
2017	23,458	22,700
2018	23,991	22,920
2019	24,066	23,120
2025 Opening Year Trend		
2025	N/A	24,000
2035 Interim Year Trend		
2035	N/A	24,910
2045 Design Year Trend		
2045	N/A	25,530
FSUTMS Forecasts/Trends		

*Axle-Adjusted

Trend R-squared:	62.20%
Compounded Annual Historic Growth Rate:	2.33%
Compounded Growth Rate (2019 to Design Year)	0.38%
Printed:	9/13/2023
Decaying Exponential Growth Option	

Figure 5-8 Trend Analysis Decaying Exponential Growth Pattern

4. Print results. Click on the "**Print**" button to print the trend analysis graphs for all the sites at one time.

5. View Results summary: open Main Menu and click "**Analysis Summary**" button to show the summary of the trend analysis results for all the sites. **Table 5-3** shows the analysis summary for Site 299936.

Table 5-3 Historical Trend Analysis Summary

Historical Trend Summary					
FDOT Site	Location	Year of Historical AADT	Historic Trend Analysis		
			Type	R Square	Annual Growth Rate
#299936	1-10 SR-8/1-10,@CR-250 OVERPASS, LAKE CITY,C	2010 t0 2019	Linear	86.44%	2.79%
			Exponential	86.05%	2.49%
			Decaying Exponential	62.20%	2.33%

Step 3: Review Traffic Projections for Reasonableness

According to FDOT's Population Projections from 2020 to 2045, the population of Columbia County is expected to increase from 69,698 in 2020 to 79,500 in 2045 (See Figure 5-9). This is an average of 0.56% in linear growth per year.

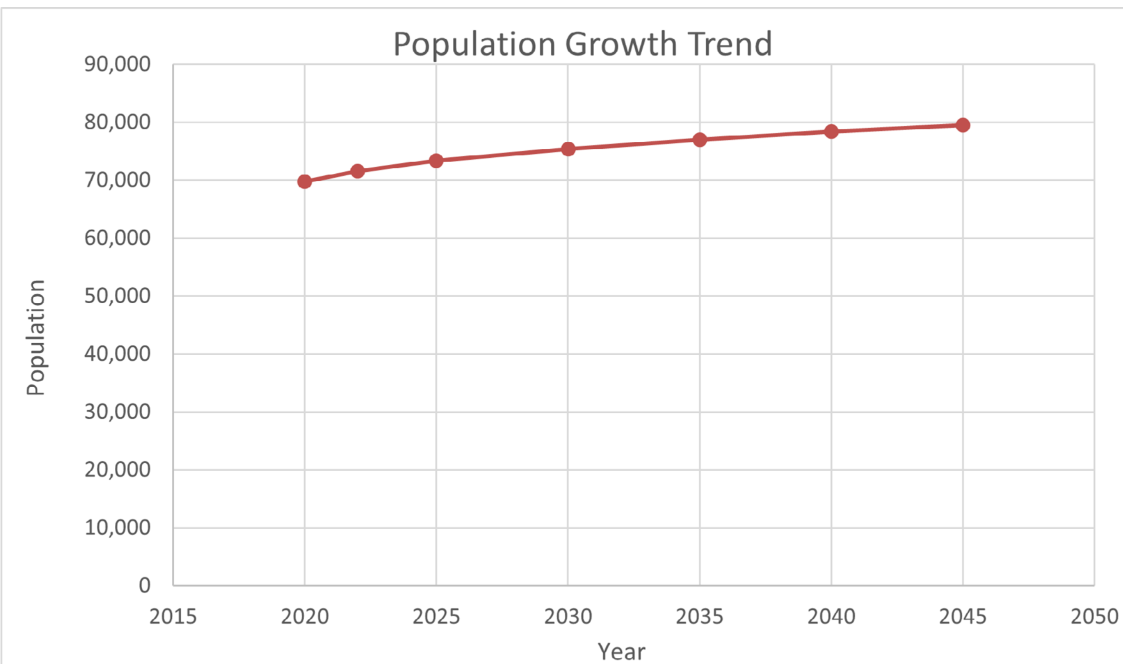


Figure 5-9 Population Growth Trends

A comparison was then made to historical population data. Using BEBR population estimates, Columbia County's population increased from 67,489 in 2013 to 71,525 in 2022. This was a 6.0% increase over a 10-year period, or an average of 0.60% in linear growth per year. By comparison, traffic increased from 20,476 in 2010 to 24,466 in 2019. This is a 17.5 % linear increase over a 10-year period, or an average of 1.75% 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 over the last 10 years. It should be noted that population growth is typically used for reasonableness checks unless traffic growth data is unavailable or deemed unreasonable.

5.8 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, the methodologies described in this chapter can be used in areas where a travel demand model is available as an additional source of information for checking the reasonableness of the traffic forecasts.

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

Chapter 6

Directional Design Hour Volumes

6.1 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; however, 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., five (5) minutes] and choosing a very long peak period that will result in a long failure time. The volume corresponding to the peak hour is the design hour volume (DHV). However, the DHV does not capture the spatial variation in traffic demand between the two directions. The traffic in the peak direction represents the highest demand for travel and therefore is used to determine the number of lanes required to accommodate the traffic flow. Furthermore, considering the temporal variation of traffic within an hour, there may 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 the hourly volume divided by the peak 15-minute traffic within the hour multiplied by four. The Directional Design Hour Volume (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 Level of Service (LOS) for the facility.

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

6.2 Purpose

This chapter describes methods used for developing DDHVs. It also discusses methodologies for estimating directional peak-hour volumes for both design hour and other peak periods.

6.3 Development of DDHV Volumes from AADT

6.3.1 General Procedure

DDHV is obtained by applying K and D factors to AADT projections, as outlined in this Handbook. AADT projections may be the result of the model generated traffic projections or they may be produced by means of other techniques, such as trend analysis or growth factor application. If the travel demand model produces Peak Season Weekday Average Daily Traffic (PSWADTs) rather than AADTs, apply the Model Output Conversion Factor (MOCF) to convert PSWADT to AADT.

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 2.5.2** and D Factors are shown in **Section 2.5.3**.

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

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

$$DDHV(Peak\ Direction) = AADT \times K \times D \quad \text{Equation 6-1}$$

$$DDHV(Non\text{-}Peak\ Direction) = AADT \times K \times (1-D) \quad \text{Equation 6-2}$$

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.

6.3.2 Development of DDHVs from Model PSWADTs Example

As an example, assume that an urban arterial in Orlando is being studied for future widening. The 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 68,100 vehicles per day (vpd) for the roadway segment being studied for Year 2045, based on the adopted cost-feasible network. Using the Florida Traffic Online, the Peak Season Factor Category Report for 2022 includes five volume categories for Orange County, listed as follows:

- **Category 7500:** Orange Countywide
- **Category 7528:** Orange Beeline
- **Category 7544:** Orange I-4 Urban
- **Category 7547:** Orange Turnpike
- **Category 7549:** Orange I-4 Disney

As the facility does not fall on any of the facilities (Beeline, I-4 Urban, Florida's 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:

$$AADT = PSWADT \times MOCF = 68{,}100 \times 0.98$$

$$AADT = 66{,}738 \rightarrow 67{,}000\ vpd$$

If the Standard K Factor has been determined to be 9.0%, and D Factor 53.5%, then DHV and DDHV are derived below:

$$DHV = AADT \times K = 67{,}000 \times 0.09$$

$$DHV = 6{,}030\ vph$$

$$DDHV = DHV \times D = 6{,}030 \times 0.535$$

$$DDHV = 3{,}226\ vph$$

6.4 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, Midday 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 6-1** 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.

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.

6.5 Use of Directional 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 2023 Multimodal Quality/Level of Service Handbook. Other applications include detailed corridor studies and interchange access studies.

Table 6-1 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.

6.5.1 Determination of Number of Lanes Required for Target LOS Example

An example of practical application of DDHV is to calculate the number of lanes needed for a given LOS. The FDOT LOS Policy stipulates that automobile mode LOS targets for the State Highway System (SHS) during peak hours are "D" in urbanized areas and "C" outside urbanized areas. Assume that a multilane highway in an urbanized area (Context Classification C4 - Urban General) is expected to be widened in the year 2045. The following traffic and roadway conditions have been established:

- Demand volume DDHV = 3,500 vph
- Peak Hour Factor (PHF) = 0.92
- Heavy Vehicle Adjustment Factor f_{hv} = 0.925
- Observed Free Flow Speed (FFS) = 55 mph
- Target LOS = D

Based on the Highway Capacity Manual (HCM), 7th Edition (HCM 7), the number of lanes can be calculated using the following formula:

$$N= \frac{DDHV}{MSF_i \times PHF \times f_{hv}}$$

Equation 6-3

Where MSF_i is the Maximum Service Flow rate for a given LOS *i*, a value of the maximum service flow rate can be selected from **Table 6-2** for an FFS of 55 mi/h and LOS D. The corresponding maximum service flow rate is 1,790 pc/h/ln.

Table 6-2 Maximum Service Flow Rates for Multilane Highway Segments Under Base Conditions

FFS (mi/h)	Maximum Service Flow Rates for Target LOS (pc/h/ln)				
	A	B	C	D	E
60	660	1,080	1,530	1,890	2,200
55	600	990	1,430	**1,790**	2,100
50	550	900	1,300	1,680	2,000
45	490	810	1,170	1,550	1,900

Source: Highway Capacity Manual, 7th Edition, Exhibit 12-38.

$$N= \frac{3500}{1{,}790 \times 0.92 \times 0.925} = 2.3$$

It is not possible to build 2.3 lanes. To provide a minimum of LOS D, it will be necessary to provide three lanes in each direction, or a six-lane facility.

Chapter 7

Estimating Intersection Turning Movements

7.1 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. Another approach is to use peak period model turns from a Time-of-day travel demand models as a reference source for turning movement splits, particularly for now movements where existing traffic count data is not available. 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.

7.2 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 TMTool. It explains the following:

- Background
- TURNS5-V2014
- TMTool
- Methods in NCHRP Report 765
- Manual Method
- Summary of Techniques

7.3 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.

7.4 TURNS5-V2014

7.4.1 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. TURNFLOW[1] and TURNS3[2] 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. Shin[3]. 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.

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.

7.4.2 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.

[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

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.

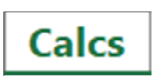
7.4.3 TURNS5-V2014 Spreadsheet Tabs (Worksheets)

Upon loading the program in EXCEL, the program will automatically be positioned at the main menu (MainMenu tab) as shown in **Figure 7-1**. The following tabs are contained within the workbook:

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

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.

<u>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.</u>



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 – 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 – 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.

TurnSheets – Contains information that helps the menu system and "**Run Turn Counts Macro**" run.

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

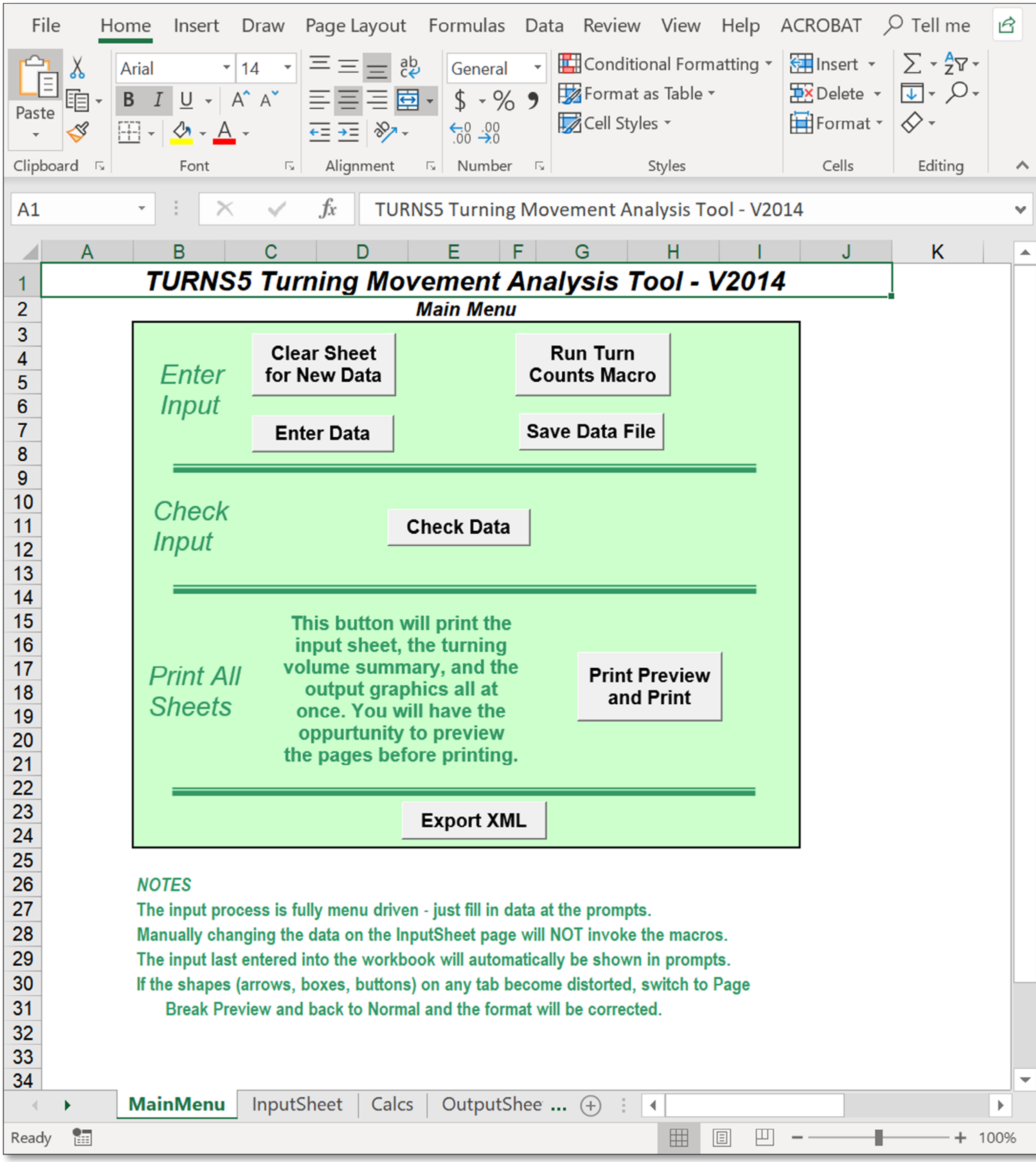


Figure 7-1 TURNS5-V2014 Turning Movement Analysis Tool

7.4.3.1 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. When 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.

7.4.4 "Enter Data" Menus

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

7.4.4.1 "Enter Data" Page 1

The "Enter Data" Page 1 is shown in Figure 7-2.

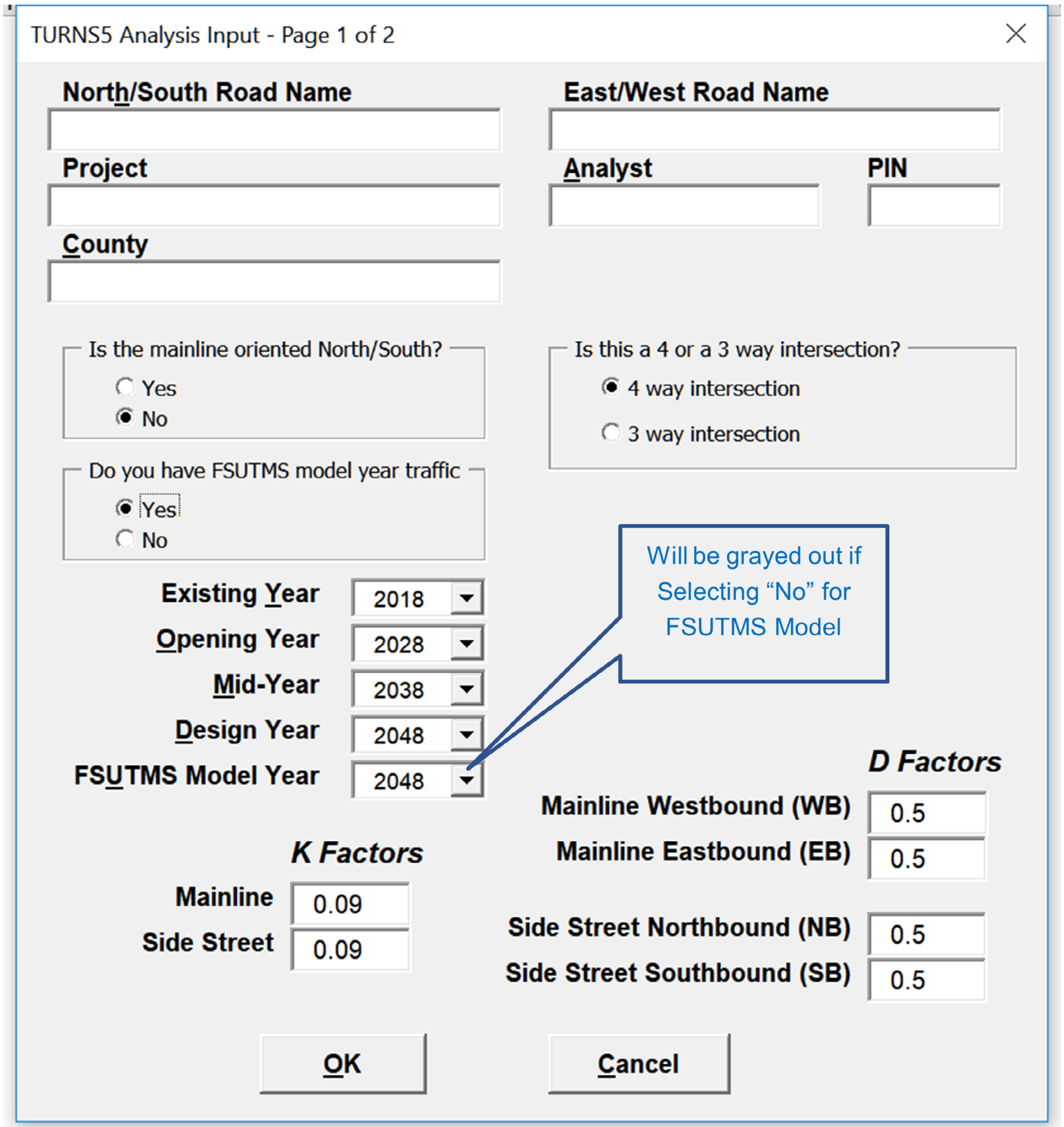


Figure 7-2 TURNS5-V2014 "Enter Data" Page 1

Road Name: Enter Name of North/South and East/West Roadway names.

Project: Enter Project Description/Name.

Analyst: Enter Name of the person/firm entering data.

PIN: Enter Project Identification Number.

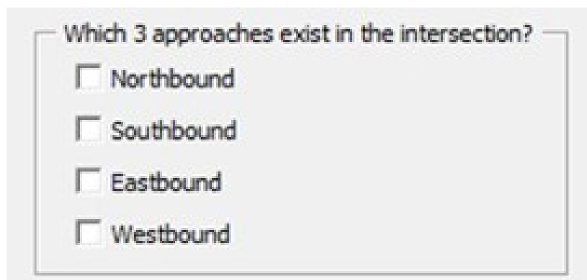
County: Enter Name of the county where project is located.

N/S Orientation of Mainline: Select "**Yes**" if the mainline is oriented from bottom to top.

Select "**No**" if the mainline is oriented 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: 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.

7.4.4.2 "Enter Data" Page 2

The "Enter Data" Page 2 is shown in Figure 7-3.

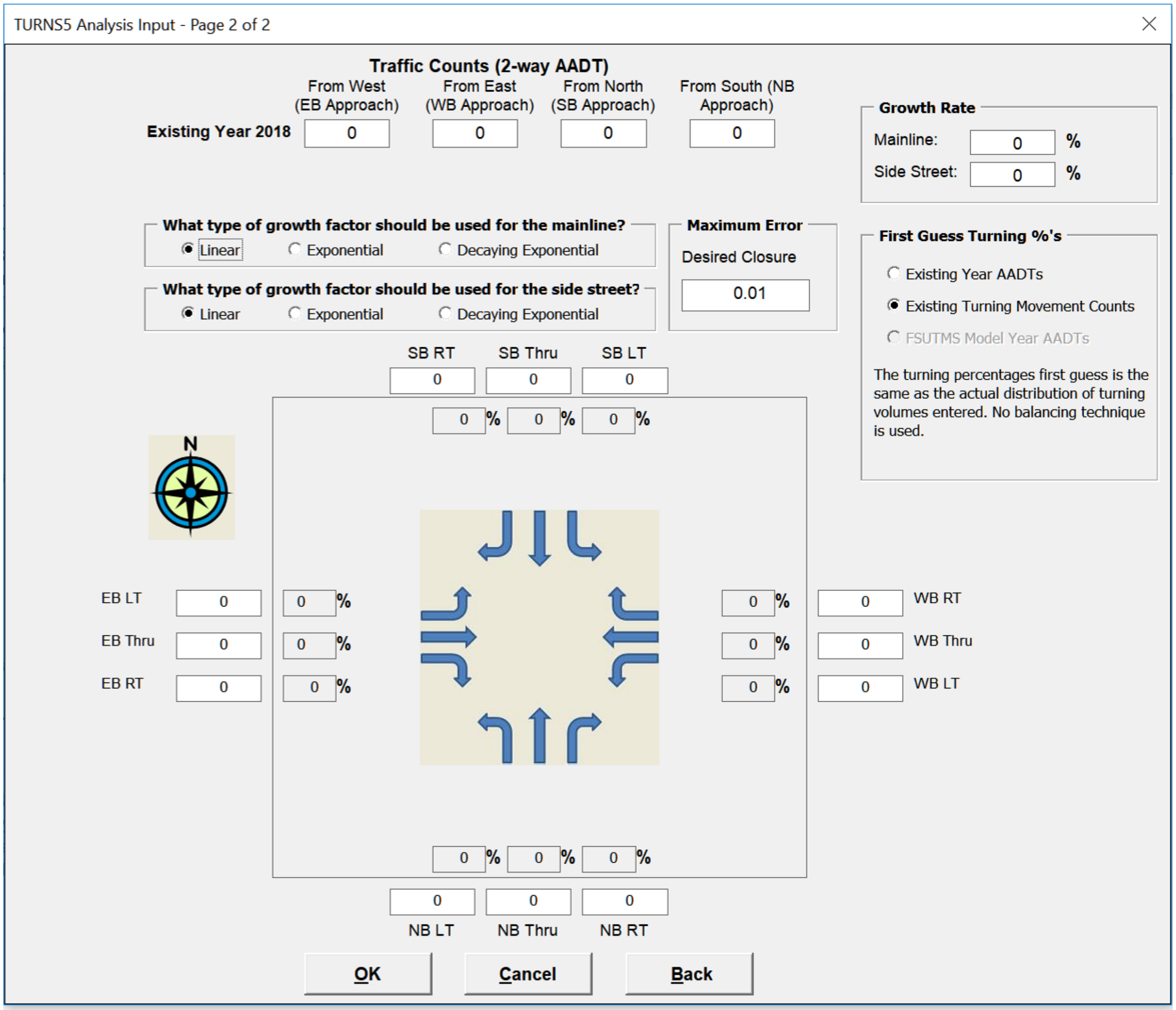


Figure 7-3 TURNS5-V2014 'Enter Data' Page 2 (Growth Rate Option Chosen)

This input tab has to be completed 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)

This input tab has to be completed if using traffic developed from growth rates (chosen from Page 1):

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

Growth Rate: Enter 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 AADTs, 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.

7.4.5 Program Output

The following pages shown in **Figures 7-4** to **7-7** will be printed when the "**Print Preview and Print**" button on the "**Main Menu**" tab is selected.

TURNS5 ANALYSIS SHEET - INPUT

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

Is this a 4 way intersection?
- Yes, my intersection has four approaches

If not, which 3 approaches exist in the
- EB, WB, and SB
- EB, WB, and NB
- EB, SB, and NB
- WB, SB, and NB

Is the Mainline Oriented North/South?

Enter Yes or No
- Yes
- No

K Factors		**D Factors**	
Mainline			*Mainline*
9.00%		Westbound (WB)	61.2%
Side street		Eastbound (EB)	38.8%
9.00%			*Side street*
		Northbound (NB)	58.2%
		Southbound (SB)	41.8%

Do you have FTSUTMS Model Year traffic from which you would like to interpolate/extrapolate for project years? (Y/N)

Enter Yes or No
- Yes
- No

If "Yes" go to cell C47 If "No" go to cell C31

Enter Year and Growth Rates from Base Year:

	Year	*Rate* (1.0% = 0.01) Mainline	Side Street
Base	2018	1.15%	0.58%
Opening	2025		
Mid	2035		
Design	2045		

Mainline Growth Function
- Linear
- Exponential
- Decaying

Side Street Growth Function
- Linear
- Exponential
- Decaying

Enter Base Year AADTs for Volume Comparison:

(growth rates are used to calculate other project years)

From West: EB Approach	*From East: WB Approach*	*From North: SB Approach*	*From South: NB Approach*	***TOTAL***
42000	44000	16000	16000	118000

Enter Project and Model Years

	Year
Base	
Opening	
Mid	
Design	
Model	

Enter Base and Model Year AADTs for Volume Comparison:

(volumes for other project years are calculated by interpolation)

	From West: EB Approach	*From East: WB Approach*	*From North: SB Approach*	*From South: NB Approach*	***TOTAL***
0	0	0	0	0	0
0	0	0	0	0	0

		1st Guess Turning %'s for AADT Balancing	**Actual/Counted Traffic for 2018**
(EB LT)	*West-to-North*	12.0%	231
(EB THRU)	*West-to-East*	82.5%	1590
(EB RT)	*West-to-South*	5.5%	105
(WB LT)	*East-to-South*	23.5%	246
(WB THRU)	*East-to-West*	62.1%	649
(WB RT)	*East-to-North*	14.4%	150
(SB LT)	*North-to-East*	34.8%	241
(SB THRU)	*North-to-South*	49.3%	341
(SB RT)	*North-to-West*	15.9%	110
(NB LT)	*South-to-West*	17.4%	109
(NB THRU)	*South-to-North*	45.8%	286
(NB RT)	*South-to-East*	36.8%	230
Desired Closure:		0.01	

First Guess Turning % Option Used
Existing Turning Movement Counts

Existing Year AADTs — Only the existing year total departure volumes [AADT*K*(1-D)] will be used to calculate the turning percentages first guess.

Existing Turning Movement Counts — The turning percentages first guess is the same as the ***actual distribution of turning volumes entered***. No balancing technique is used.

FSUTMS Model Year AADTs — Only the FSUTMS model year departure volumes [AADT*K*(1-D)] will be used to calculate the turning percentages first guess.

Figure 7-4 TURNS5-V2014 Analysis Sheet – INPUT

The Input Analysis Sheet shown in **Figure 7-4** 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 7-5 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, adjusted turning percentages and DDHVs for each movement.

TURNS5 INITIAL TURNING VOLUME SUMMARY

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

Approach-To-Approach	2018 Initial Estimate	2018 Final Estimate	2018 Calculated Volume	2025 Final Estimate	2025 Calculated Volume	2035 Final Estimate	2035 Calculated Volume	2045 Final Estimate	2045 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 7-5 TURNS5-V2014 Initial Turning Volume Summary

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

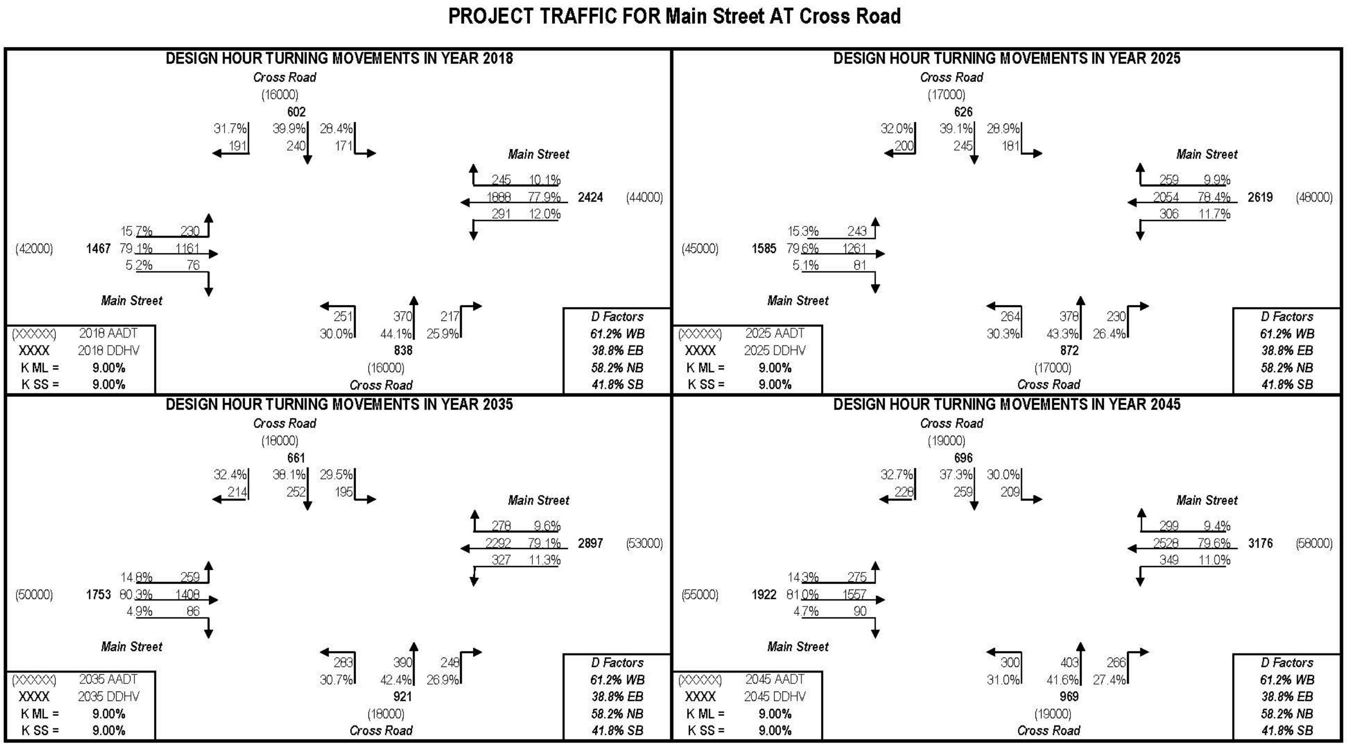


Figure 7-6 Project Traffic (TURNS5-V2014 Design Hour Turning Movements)

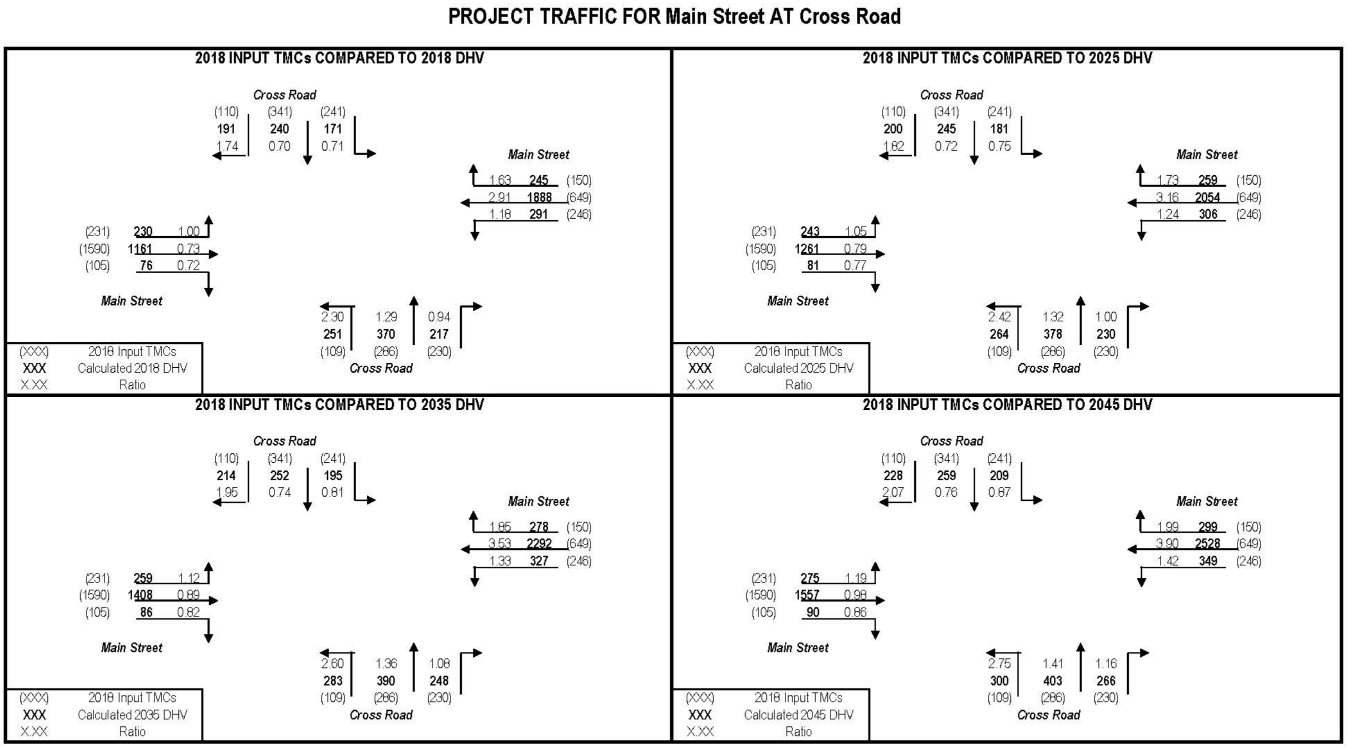


Figure 7-7 Project Traffic (TURNS5-V2014 Comparison of Base Year Turning Movement)

7.5 TMTool V2023

TMTool was initially developed by FDOT District 4 to estimate future turning movement volumes. Compared to TURNS5, TMTool has the capability of estimating turning movement volumes for multiple time periods at the same time, and it also handles special intersection configurations such as T-Intersections. In 2023, FDOT Central Office updated TMTool (TMTool v2023) to allow up to six (6) intersections to be processed simultaneously. It also provides a separate screen to allow users to enter the selected K Factors based on the new K-Factor Ranges. More detailed instructions are provided in this section to guide the users to work through the different tabs in the spreadsheet. Output functions are also enhanced to provide graphic representation of intersection turning movement volumes for different time periods and different analysis years to facilitate corridor level traffic volume smoothing and balancing. The new version also provides examples on how to use TMTool to estimate turning movement volumes at an interchange. **Figure 7-8** shows the main menu of TMTool v2023.

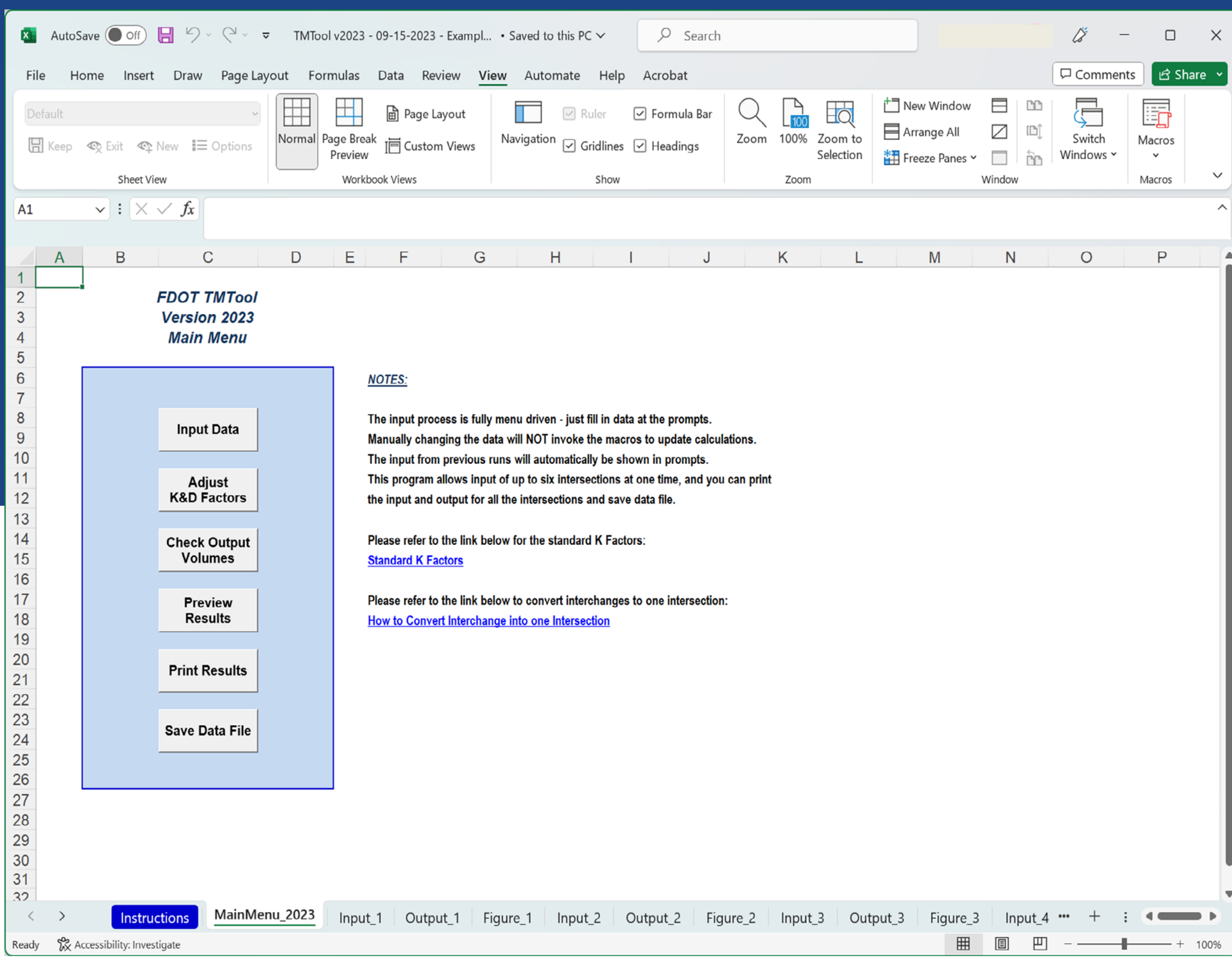


Figure 7-8 TMTool v2023 – Main Menu Screen

TMTool 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 TMTool can be used for both existing and planned intersections. The following sections describe menu items and general process to develop future turning movement volumes using TMTool v2023.

7.5.1 TMTool v2023 "Input Data" Menu

The "**Input Data**" Menu allows the user to provide general project information and specific information for all study intersections. The project information includes roadway section number, FM number, project limits, person prepared analysis, file number and date. The information is optional and only for project identification purposes. Enter existing year, opening year, interim year, and design year. The existing year is required. Opening year, interim year, and design year are required only if the traffic forecast is needed for these future years. **Figure 7-9** shows an example of the project information input screen.

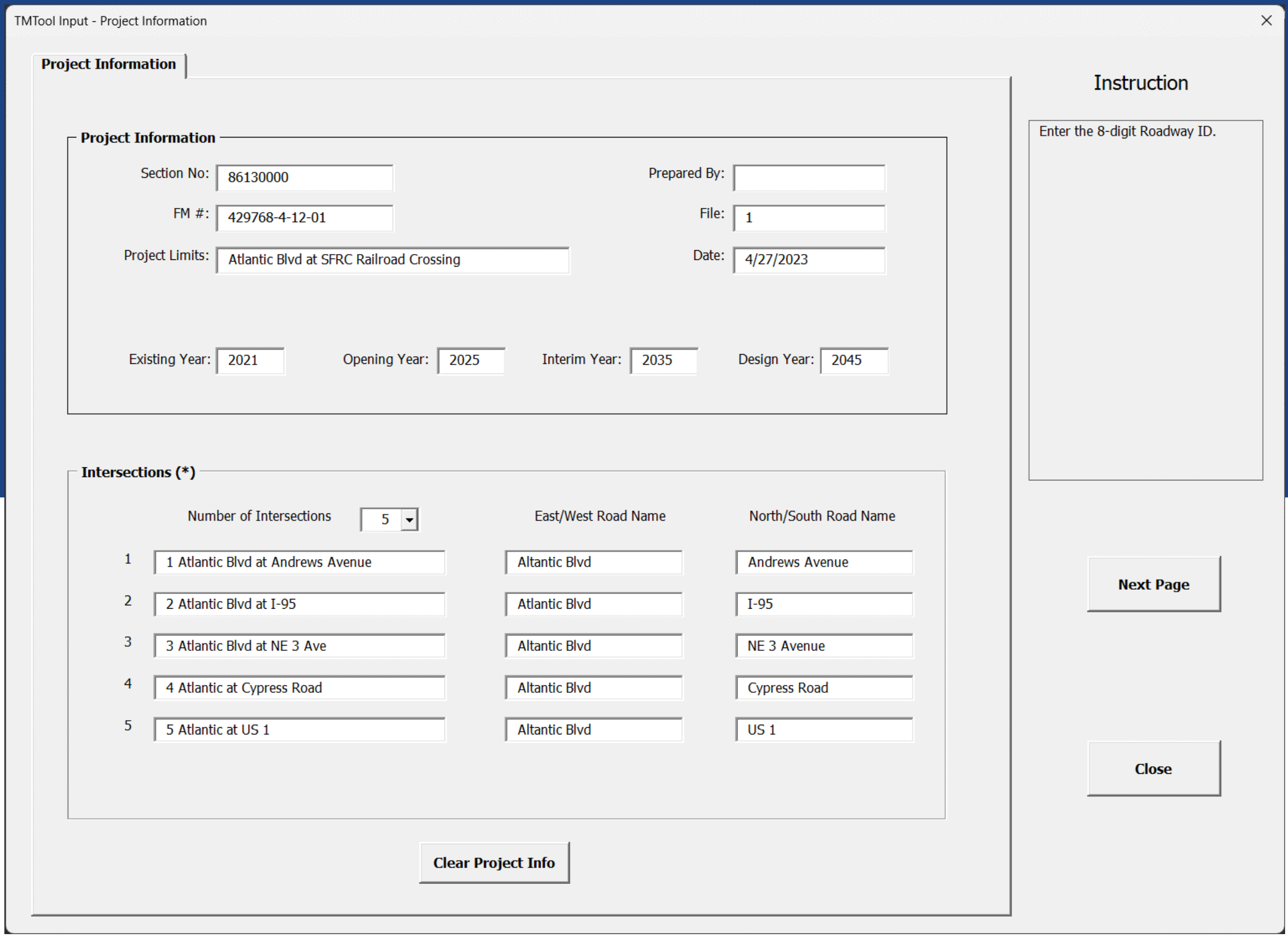


Figure 7-9 TMTool Project Information Input Screen

After the project information is entered, the user can move on to the "**Intersections**" section to provide information for the study intersections. First, click on the drop-down menu "**Number of Intersections**" to specify how many intersections will be analyzed. Up to six (6) intersections can be analyzed at one time. The user then needs to provide a name for each intersection and identify the names of two crossing streets of the intersection. The user will continue to provide traffic related information for all study intersections by clicking the "**Next Page**" button. The information includes T-Intersection, Mid-day peak hour, existing year AADT, recommended growth rates, methodology for calculating growth factor, and existing turning movement volumes. Click on "Intersection #" (# represents intersection number) tabs on the top of the screen to enter information for different intersections. **Figure 7-10** shows an example of the intersection information input screen.

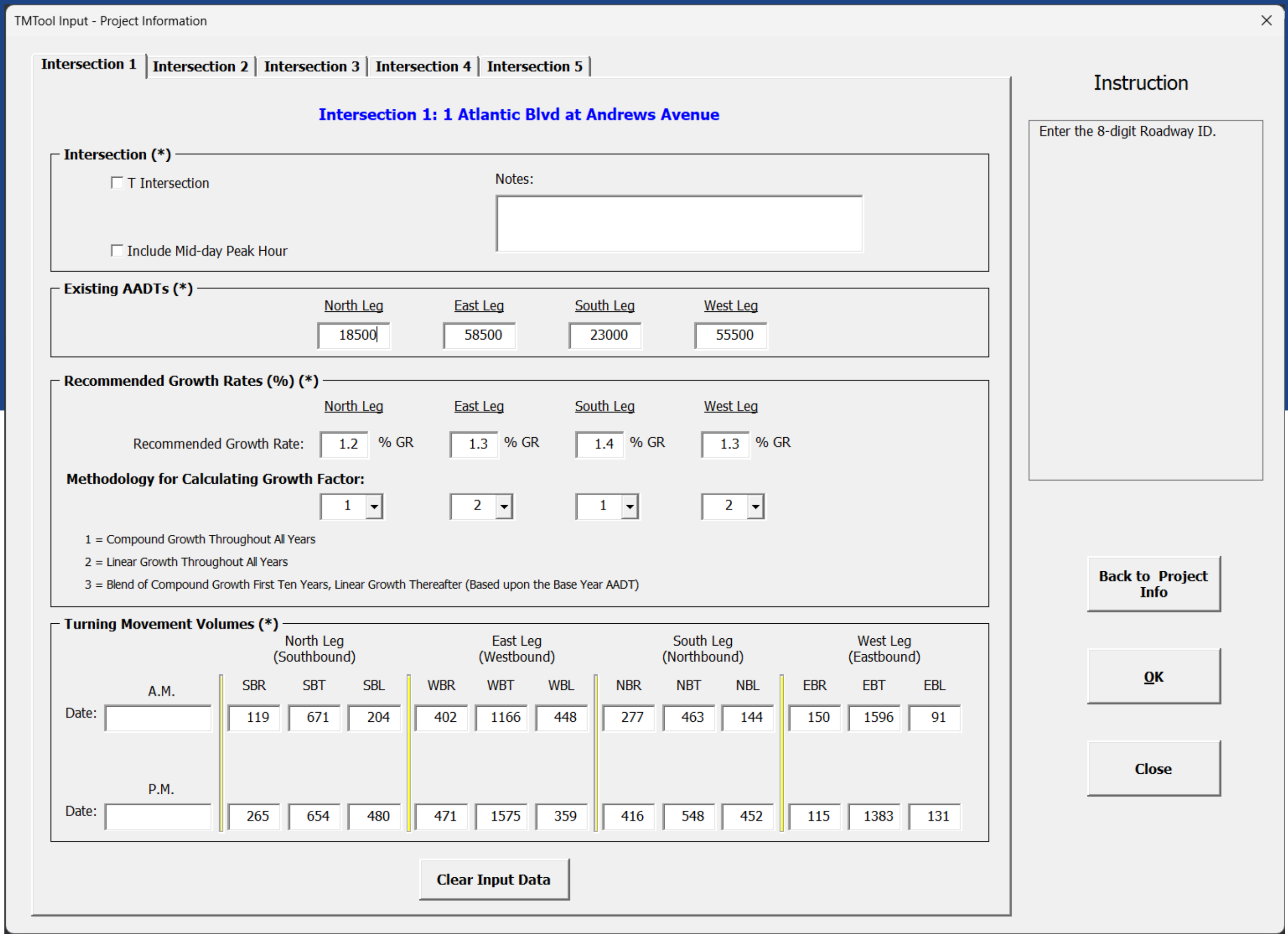


Figure 7-10 TMTool Intersection Information Input Screen

TMTool has the capability of estimating turning movement volumes for T-Intersections and for Mid-Day peak hour. Check the "**T Intersection**" or "**Include Mid-day Peak Hour**" option box to activate this option. **Figure 7-11** shows an example of the T-Intersection information input screen. Click on the "**Back to Project Info**" button if the user wishes to change the Project Information on the previous screen. Click on the "**Clear Input Data**" to erase all the data entered in this screen and re-enter the information. Click the "**Close**" button to close the current screen.

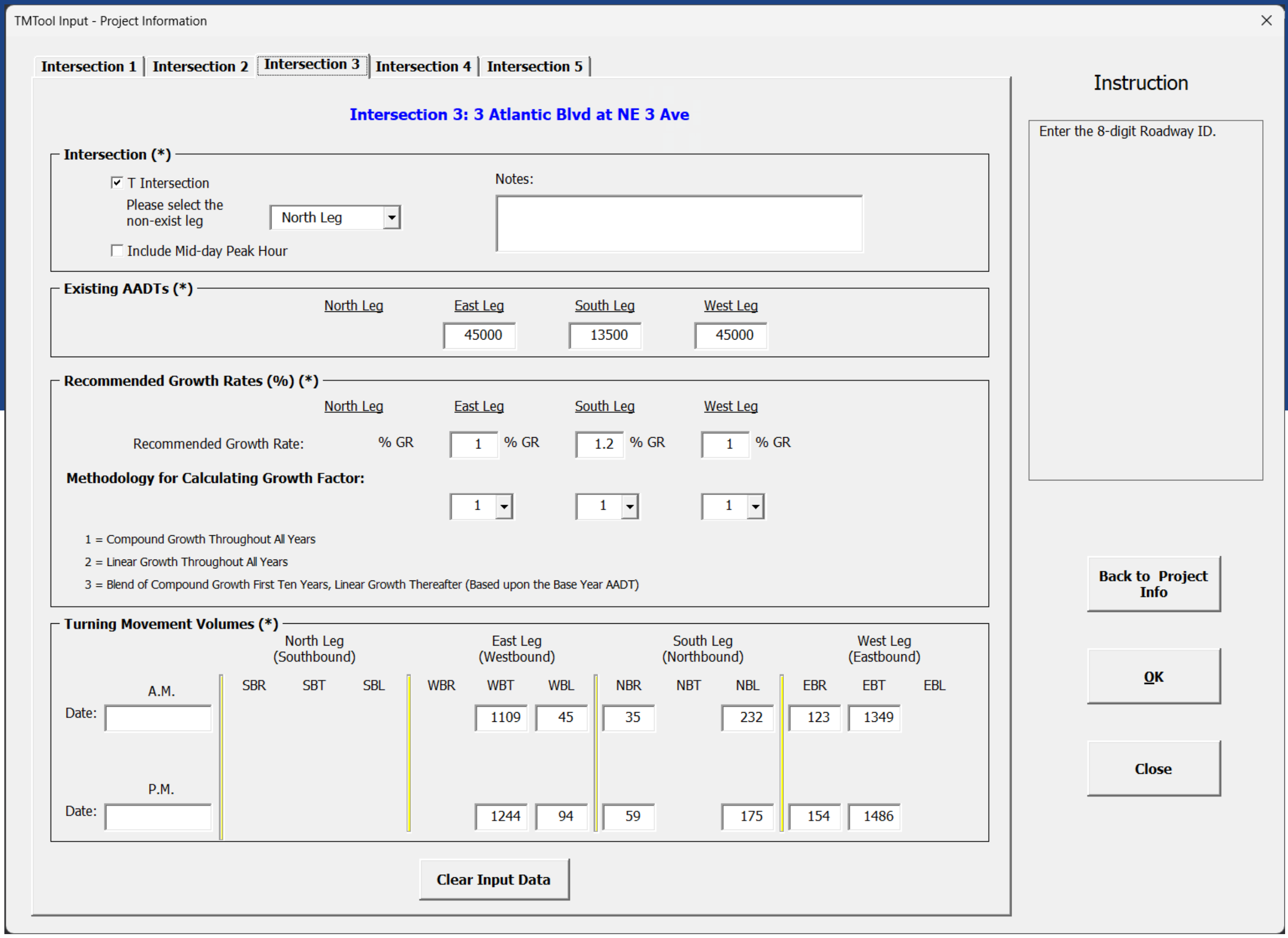


Figure 7-11 TMTool v2023 T-Intersection Information Input Screen

7.5.2 TMTool v2023 "Adjust K and D Factors" Menu

The next step is to provide acceptable K and D factors for different analysis years. K and D factors for the base year are calculated from the existing year AADT and turning movement counts. The future K and D factors need to be adjusted for future years based on the K and D factors range specified in **Chapter 2.5**. It should be noted that the roadway context classification for the intersection location needs to be determined in order to select a single K factor within the range. K and D factors for interim years are calculated by linear interpolation between the base year and design year values but can be modified when justified. Prior approval from the District Planning Office or Project Manager is required. Click on the "**Reset to Field K&D**" button to reset K and D factors to the values based on field data. **Figure 7-12** shows an example of the K & D Adjustment input screen. In this example, the context classification is C3C – Suburban Commercial. Therefore, a single K factor of 9.0 within the range of 7.5 – 9.5 is selected. The D factors remain unchanged since they are within the range for urban arterial. If the K and D factors for the opening year and interim year for an intersection need to be changed, please go to the corresponding intersection tab ("**Intersection_#**") and make the changes.

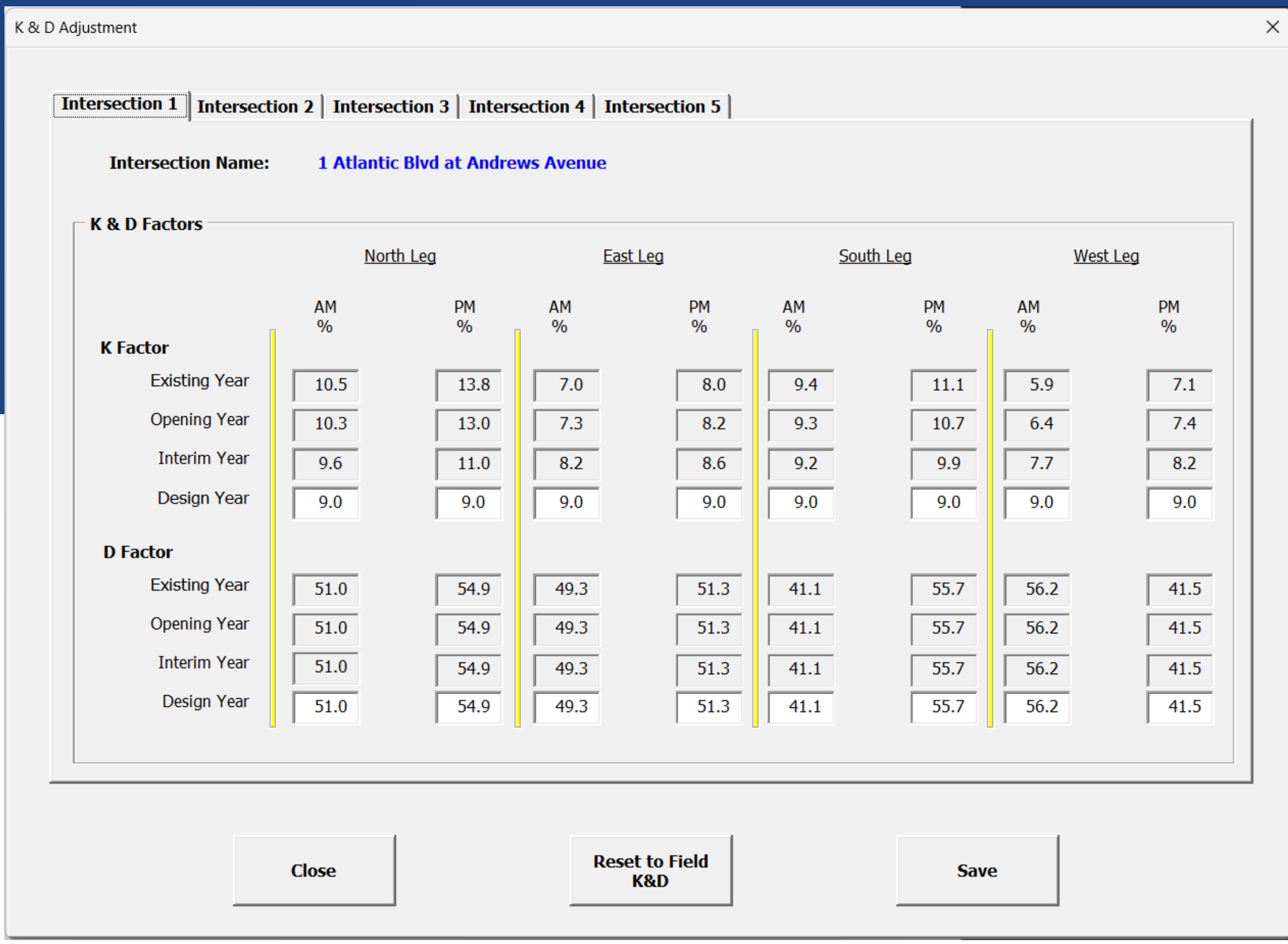


Figure 7-12 TMTool K&D Adjustment Input Screen

7.5.3 TMTool v2023 "Check Output Volume" Menu

The future year turning movement volumes need to be checked and adjusted. There are three buttons on each output sheet. The future turning movement volumes will be shaded in blue color if the volume is lower than the previous year volume once "**Check Volume**" button is clicked. The future turning movement volumes will be adjusted so that the turning movement volumes will be increasing from the existing year through the design year. The volumes will be reset to the original forecasted volume if the "**Reset Volume**" button is clicked. **Figure 7-13** shows the Output Tab for Intersection 1 – Atlantic Blvd at Andrews Avenue before any action was taken. After clicking the "**Check Volume**" button, cells with volumes lower than earlier years are highlighted in blue, as shown in **Figure 7-14**. After clicking the "**Adjust Volume**" button, those volumes that have been adjusted are highlighted in yellow, shown in **Figure 7-15**. All the adjusted volumes are graphically displayed in the Figure_# tab for each study intersection as shown in **Figure 7-16**. The User can copy and paste the figures for each intersection to a single worksheet and arrange the intersections based on their original relative location to each other. This will facilitate the smoothing and balancing of the traffic volumes so that the volumes between adjacent intersections are within the tolerance level along each roadway.

TMTOOL "TURNS" REPORT

DESIGN HOUR TURNS CALCULATIONS

SECTION NO: 86130000
FM NO.: 429768-4-12-01
PROJECT LIMITS: Atlantic Blvd at SFRC Railroad Crossing
DESIGN YEAR: 2045
INTERSECTION: 1 Atlantic Blvd at Andrews Avenue
PREPARED BY:
FILE: 1

DATE: 4/27/2023
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	2021	18,500	58,500	23,000	55,500
24 HR EST. AADT	2025	19,500	61,500	24,500	58,500
24 HR EST. AADT	2035	22,000	69,000	28,000	65,500
24 HR EST. AADT	2045	24,500	77,000	32,000	73,000

Percent Turns Calculated From Base Year AADTs:

JKTURNS

	FROM NORTH LEG RIGHT	FROM NORTH LEG THRU	FROM NORTH LEG LEFT	FROM EAST LEG RIGHT	FROM EAST LEG THRU	FROM EAST LEG LEFT	FROM SOUTH LEG RIGHT	FROM SOUTH LEG THRU	FROM SOUTH LEG LEFT	FROM WEST LEG RIGHT	FROM WEST LEG THRU	FROM WEST LEG LEFT
2021 2-WAY ADT		18,500			58,500			23,000			55,500	
	55,500	23,000	58,500	18,500	55,500	23,000	58,500	18,500	55,500	23,000	58,500	18,500
	41%	17%	43%	19%	57%	24%	44%	14%	42%	23%	59%	19%
2025 2-WAY ADT		19,500			61,500			24,500			58,500	
	58,500	24,500	61,500	19,500	58,500	24,500	61,500	19,500	58,500	24,500	61,500	19,500
	40%	17%	43%	19%	57%	24%	44%	14%	42%	23%	58%	18%
2035 2-WAY ADT		22,000			69,000			28,000			65,500	
	65,500	28,000	69,000	22,000	65,500	28,000	69,000	22,000	65,500	28,000	69,000	22,000
	40%	17%	42%	19%	57%	24%	44%	14%	42%	24%	58%	18%
2045 2-WAY ADT		24,500			77,000			32,000			73,000	
	73,000	32,000	77,000	24,500	73,000	32,000	77,000	24,500	73,000	32,000	77,000	24,500
	40%	18%	42%	19%	56%	25%	44%	14%	42%	24%	58%	18%

		NORTH LEG RIGHT	NORTH LEG THRU	NORTH LEG LEFT	EAST LEG RIGHT	EAST LEG THRU	EAST LEG LEFT	SOUTH LEG RIGHT	SOUTH LEG THRU	SOUTH LEG LEFT	WEST LEG RIGHT	WEST LEG THRU	WEST LEG LEFT
A.M. DESIGN HR. TURNS													
2021	EST. TURNS	119	671	204	402	1,166	448	277	463	144	150	1,596	91
2025	EST. TURNS	132	643	258	459	1,216	543	339	437	154	172	1,649	107
2035	EST. TURNS	123	651	348	602	1,423	741	457	431	144	160	1,861	97
2045	EST. TURNS	116	633	455	757	1,637	986	599	411	136	155	2,065	90
P.M. DESIGN HR. TURNS													
2021	EST. TURNS	265	654	480	471	1,575	359	416	548	452	115	1,383	131
2025	EST. TURNS	315	655	526	510	1,619	398	459	561	488	148	1,407	162
2035	EST. TURNS	377	752	616	593	1,784	447	520	650	552	174	1,550	195
2045	EST. TURNS	449	849	712	681	1,951	512	596	743	629	211	1,692	236

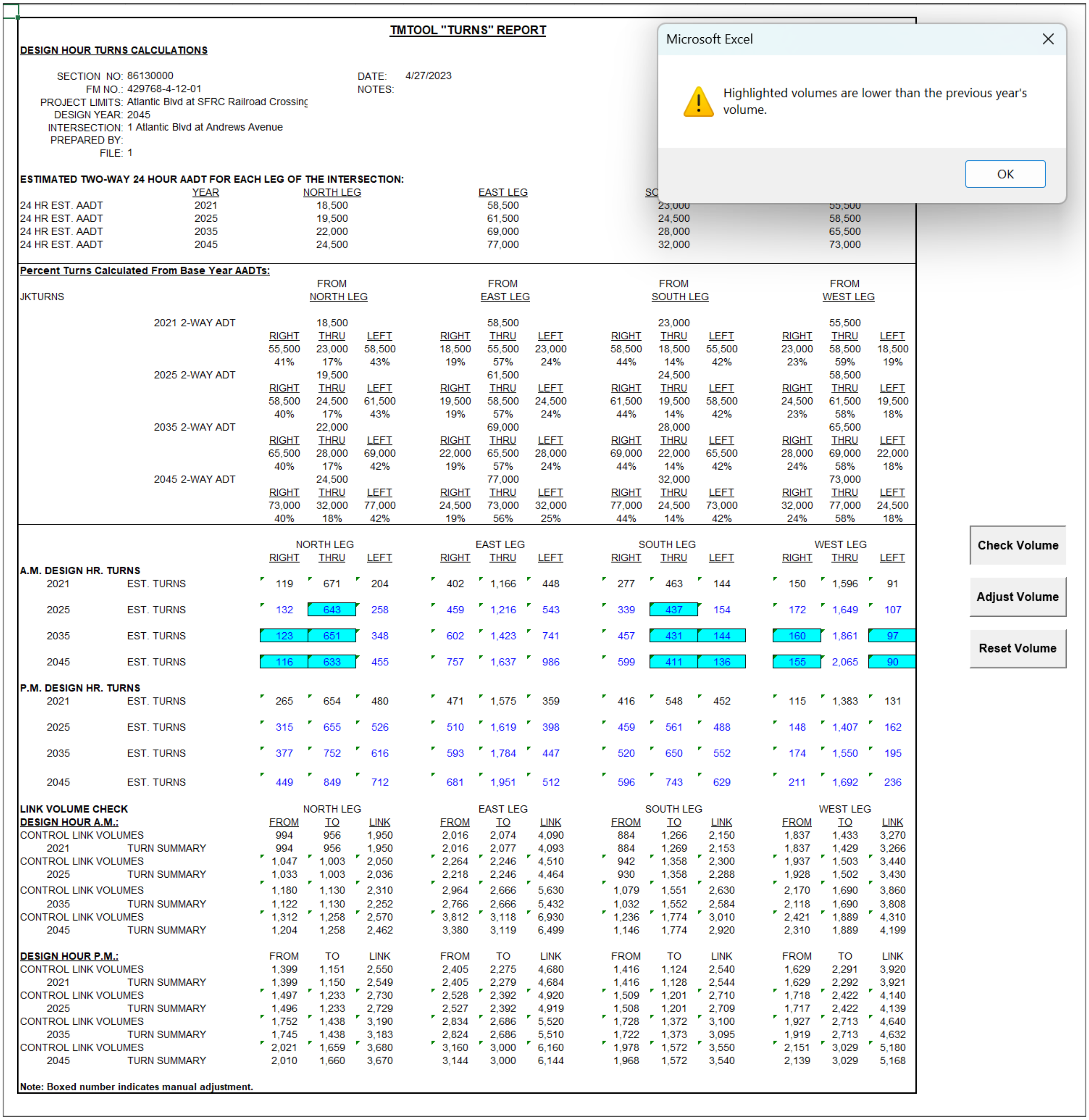
LINK VOLUME CHECK

		NORTH LEG FROM	NORTH LEG TO	NORTH LEG LINK	EAST LEG FROM	EAST LEG TO	EAST LEG LINK	SOUTH LEG FROM	SOUTH LEG TO	SOUTH LEG LINK	WEST LEG FROM	WEST LEG TO	WEST LEG LINK
DESIGN HOUR A.M.:													
CONTROL LINK VOLUMES		994	956	1,950	2,016	2,074	4,090	884	1,266	2,150	1,837	1,433	3,270
2021	TURN SUMMARY	994	956	1,950	2,016	2,077	4,093	884	1,269	2,153	1,837	1,429	3,266
CONTROL LINK VOLUMES		1,047	1,003	2,050	2,264	2,246	4,510	942	1,358	2,300	1,937	1,503	3,440
2025	TURN SUMMARY	1,033	1,003	2,036	2,218	2,246	4,464	930	1,358	2,288	1,928	1,502	3,430
CONTROL LINK VOLUMES		1,180	1,130	2,310	2,964	2,666	5,630	1,079	1,551	2,630	2,170	1,690	3,860
2035	TURN SUMMARY	1,122	1,130	2,252	2,766	2,666	5,432	1,032	1,552	2,584	2,118	1,690	3,808
CONTROL LINK VOLUMES		1,312	1,258	2,570	3,812	3,118	6,930	1,236	1,774	3,010	2,421	1,889	4,310
2045	TURN SUMMARY	1,204	1,258	2,462	3,380	3,119	6,499	1,146	1,774	2,920	2,310	1,889	4,199
DESIGN HOUR P.M.:		FROM	TO	LINK	FROM	TO	LINK	FROM	TO	LINK	FROM	TO	LINK
CONTROL LINK VOLUMES		1,399	1,151	2,550	2,405	2,275	4,680	1,416	1,124	2,540	1,629	2,291	3,920
2021	TURN SUMMARY	1,399	1,150	2,549	2,405	2,279	4,684	1,416	1,128	2,544	1,629	2,292	3,921
CONTROL LINK VOLUMES		1,497	1,233	2,730	2,528	2,392	4,920	1,509	1,201	2,710	1,718	2,422	4,140
2025	TURN SUMMARY	1,496	1,233	2,729	2,527	2,392	4,919	1,508	1,201	2,709	1,717	2,422	4,139
CONTROL LINK VOLUMES		1,752	1,438	3,190	2,834	2,686	5,520	1,728	1,372	3,100	1,927	2,713	4,640
2035	TURN SUMMARY	1,745	1,438	3,183	2,824	2,686	5,510	1,722	1,373	3,095	1,919	2,713	4,632
CONTROL LINK VOLUMES		2,021	1,659	3,680	3,160	3,000	6,160	1,978	1,572	3,550	2,151	3,029	5,180
2045	TURN SUMMARY	2,010	1,660	3,670	3,144	3,000	6,144	1,968	1,572	3,540	2,139	3,029	5,168

Note: Boxed number indicates manual adjustment.

Check Volume
Adjust Volume
Reset Volume

Figure 7-13 TMTool v2023 Output Tab



TMTOOL "TURNS" REPORT

DESIGN HOUR TURNS CALCULATIONS

SECTION NO: 86130000
FM NO.: 429768-4-12-01
PROJECT LIMITS: Atlantic Blvd at SFRC Railroad Crossing
DESIGN YEAR: 2045
INTERSECTION: 1 Atlantic Blvd at Andrews Avenue
PREPARED BY:
FILE: 1

DATE: 4/27/2023
NOTES:

Microsoft Excel
Highlighted volumes are lower than the previous year's volume.
OK

ESTIMATED TWO-WAY 24 HOUR AADT FOR EACH LEG OF THE INTERSECTION:

	YEAR	NORTH LEG	EAST LEG	SO	
24 HR EST. AADT	2021	18,500	58,500	23,000	55,500
24 HR EST. AADT	2025	19,500	61,500	24,500	58,500
24 HR EST. AADT	2035	22,000	69,000	28,000	65,500
24 HR EST. AADT	2045	24,500	77,000	32,000	73,000

Percent Turns Calculated From Base Year AADTs:

JKTURNS

	FROM NORTH LEG			FROM EAST LEG			FROM SOUTH LEG			FROM WEST LEG		
2021 2-WAY ADT		18,500			58,500			23,000			55,500	
	RIGHT	THRU	LEFT	RIGHT	THRU	LEFT	RIGHT	THRU	LEFT	RIGHT	THRU	LEFT
	55,500	23,000	58,500	18,500	55,500	23,000	58,500	18,500	55,500	23,000	58,500	18,500
	41%	17%	43%	19%	57%	24%	44%	14%	42%	23%	59%	19%
2025 2-WAY ADT		19,500			61,500			24,500			58,500	
	RIGHT	THRU	LEFT	RIGHT	THRU	LEFT	RIGHT	THRU	LEFT	RIGHT	THRU	LEFT
	58,500	24,500	61,500	19,500	58,500	24,500	61,500	19,500	58,500	24,500	61,500	19,500
	40%	17%	43%	19%	57%	24%	44%	14%	42%	23%	58%	18%
2035 2-WAY ADT		22,000			69,000			28,000			65,500	
	RIGHT	THRU	LEFT	RIGHT	THRU	LEFT	RIGHT	THRU	LEFT	RIGHT	THRU	LEFT
	65,500	28,000	69,000	22,000	65,500	28,000	69,000	22,000	65,500	28,000	69,000	22,000
	40%	17%	42%	19%	57%	24%	44%	14%	42%	24%	58%	18%
2045 2-WAY ADT		24,500			77,000			32,000			73,000	
	RIGHT	THRU	LEFT	RIGHT	THRU	LEFT	RIGHT	THRU	LEFT	RIGHT	THRU	LEFT
	73,000	32,000	77,000	24,500	73,000	32,000	77,000	24,500	73,000	32,000	77,000	24,500
	40%	18%	42%	19%	56%	25%	44%	14%	42%	24%	58%	18%

		NORTH LEG			EAST LEG			SOUTH LEG			WEST LEG		
		RIGHT	THRU	LEFT	RIGHT	THRU	LEFT	RIGHT	THRU	LEFT	RIGHT	THRU	LEFT
A.M. DESIGN HR. TURNS													
2021	EST. TURNS	119	671	204	402	1,166	448	277	463	144	150	1,596	91
2025	EST. TURNS	132	643	258	459	1,216	543	339	437	154	172	1,649	107
2035	EST. TURNS	123	651	348	602	1,423	741	457	431	144	160	1,861	97
2045	EST. TURNS	116	633	455	757	1,637	986	599	411	136	155	2,065	90
P.M. DESIGN HR. TURNS													
2021	EST. TURNS	265	654	480	471	1,575	359	416	548	452	115	1,383	131
2025	EST. TURNS	315	655	526	510	1,619	398	459	561	488	148	1,407	162
2035	EST. TURNS	377	752	616	593	1,784	447	520	650	552	174	1,550	195
2045	EST. TURNS	449	849	712	681	1,951	512	596	743	629	211	1,692	236

LINK VOLUME CHECK		NORTH LEG			EAST LEG			SOUTH LEG			WEST LEG		
DESIGN HOUR A.M.:		FROM	TO	LINK	FROM	TO	LINK	FROM	TO	LINK	FROM	TO	LINK
CONTROL LINK VOLUMES		994	956	1,950	2,016	2,074	4,090	884	1,266	2,150	1,837	1,433	3,270
2021	TURN SUMMARY	994	956	1,950	2,016	2,077	4,093	884	1,269	2,153	1,837	1,429	3,266
CONTROL LINK VOLUMES		1,047	1,003	2,050	2,264	2,246	4,510	942	1,358	2,300	1,937	1,503	3,440
2025	TURN SUMMARY	1,033	1,003	2,036	2,218	2,246	4,464	930	1,358	2,288	1,928	1,502	3,430
CONTROL LINK VOLUMES		1,180	1,130	2,310	2,964	2,666	5,630	1,079	1,551	2,630	2,170	1,690	3,860
2035	TURN SUMMARY	1,122	1,130	2,252	2,766	2,666	5,432	1,032	1,552	2,584	2,118	1,690	3,808
CONTROL LINK VOLUMES		1,312	1,258	2,570	3,812	3,118	6,930	1,236	1,774	3,010	2,421	1,889	4,310
2045	TURN SUMMARY	1,204	1,258	2,462	3,380	3,119	6,499	1,146	1,774	2,920	2,310	1,889	4,199
DESIGN HOUR P.M.:		FROM	TO	LINK	FROM	TO	LINK	FROM	TO	LINK	FROM	TO	LINK
CONTROL LINK VOLUMES		1,399	1,151	2,550	2,405	2,275	4,680	1,416	1,124	2,540	1,629	2,291	3,920
2021	TURN SUMMARY	1,399	1,150	2,549	2,405	2,279	4,684	1,416	1,128	2,544	1,629	2,292	3,921
CONTROL LINK VOLUMES		1,497	1,233	2,730	2,528	2,392	4,920	1,509	1,201	2,710	1,718	2,422	4,140
2025	TURN SUMMARY	1,496	1,233	2,729	2,527	2,392	4,919	1,508	1,201	2,709	1,717	2,422	4,139
CONTROL LINK VOLUMES		1,752	1,438	3,190	2,834	2,686	5,520	1,728	1,372	3,100	1,927	2,713	4,640
2035	TURN SUMMARY	1,745	1,438	3,183	2,824	2,686	5,510	1,722	1,373	3,095	1,919	2,713	4,632
CONTROL LINK VOLUMES		2,021	1,659	3,680	3,160	3,000	6,160	1,978	1,572	3,550	2,151	3,029	5,180
2045	TURN SUMMARY	2,010	1,660	3,670	3,144	3,000	6,144	1,968	1,572	3,540	2,139	3,029	5,168

Note: Boxed number indicates manual adjustment.

Figure 7-14 TMTool v2023 Output Tab with "Check Volume"

TMTOOL "TURNS" REPORT

DESIGN HOUR TURNS CALCULATIONS

SECTION NO: 86130000
FM NO.: 429768-4-12-01
PROJECT LIMITS: Atlantic Blvd at SFRC Railroad Crossing
DESIGN YEAR: 2045
INTERSECTION: 1 Atlantic Blvd at Andrews Avenue
PREPARED BY:
FILE: 1

DATE: 4/27/2023
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	2021	18,500	58,500	23,000	55,500
24 HR EST. AADT	2025	19,500	61,500	24,500	58,500
24 HR EST. AADT	2035	22,000	69,000	28,000	65,500
24 HR EST. AADT	2045	24,500	77,000	32,000	73,000

Percent Turns Calculated From Base Year AADTs:

JKTURNS

	FROM NORTH LEG			FROM EAST LEG			FROM SOUTH LEG			FROM WEST LEG		
2021 2-WAY ADT		18,500			58,500			23,000			55,500	
	RIGHT	THRU	LEFT	RIGHT	THRU	LEFT	RIGHT	THRU	LEFT	RIGHT	THRU	LEFT
	55,500	23,000	58,500	18,500	55,500	23,000	58,500	18,500	55,500	23,000	58,500	18,500
	41%	17%	43%	19%	57%	24%	44%	14%	42%	23%	59%	19%
2025 2-WAY ADT		19,500			61,500			24,500			58,500	
	RIGHT	THRU	LEFT	RIGHT	THRU	LEFT	RIGHT	THRU	LEFT	RIGHT	THRU	LEFT
	58,500	24,500	61,500	19,500	58,500	24,500	61,500	19,500	58,500	24,500	61,500	19,500
	40%	17%	43%	19%	57%	24%	44%	14%	42%	23%	58%	18%
2035 2-WAY ADT		22,000			69,000			28,000			65,500	
	RIGHT	THRU	LEFT	RIGHT	THRU	LEFT	RIGHT	THRU	LEFT	RIGHT	THRU	LEFT
	65,500	28,000	69,000	22,000	65,500	28,000	69,000	22,000	65,500	28,000	69,000	22,000
	40%	17%	42%	19%	57%	24%	44%	14%	42%	24%	58%	18%
2045 2-WAY ADT		24,500			77,000			32,000			73,000	
	RIGHT	THRU	LEFT	RIGHT	THRU	LEFT	RIGHT	THRU	LEFT	RIGHT	THRU	LEFT
	73,000	32,000	77,000	24,500	73,000	32,000	77,000	24,500	73,000	32,000	77,000	24,500
	40%	18%	42%	19%	56%	25%	44%	14%	42%	24%	58%	18%

		NORTH LEG			EAST LEG			SOUTH LEG			WEST LEG		
		RIGHT	THRU	LEFT	RIGHT	THRU	LEFT	RIGHT	THRU	LEFT	RIGHT	THRU	LEFT
A.M. DESIGN HR. TURNS													
2021	EST. TURNS	119	671	204	402	1,166	448	277	463	144	150	1,596	91
2025	EST. TURNS	132	679	258	459	1,216	543	339	468	154	172	1,649	107
2035	EST. TURNS	135	699	348	602	1,423	741	457	482	158	176	1,861	113
2045	EST. TURNS	138	719	455	757	1,637	986	599	496	162	180	2,065	119
P.M. DESIGN HR. TURNS													
2021	EST. TURNS	265	654	480	471	1,575	359	416	548	452	115	1,383	131
2025	EST. TURNS	315	655	526	510	1,619	398	459	561	488	148	1,407	162
2035	EST. TURNS	377	752	616	593	1,784	447	520	650	552	174	1,550	195
2045	EST. TURNS	449	849	712	681	1,951	512	596	743	629	211	1,692	236

Check Volume

Adjust Volume

Reset Volume

LINK VOLUME CHECK		NORTH LEG			EAST LEG			SOUTH LEG			WEST LEG		
DESIGN HOUR A.M.:		FROM	TO	LINK	FROM	TO	LINK	FROM	TO	LINK	FROM	TO	LINK
CONTROL LINK VOLUMES		994	956	1,950	2,016	2,074	4,090	884	1,266	2,150	1,837	1,433	3,270
2021	TURN SUMMARY	994	956	1,950	2,016	2,077	4,093	884	1,269	2,153	1,837	1,429	3,266
CONTROL LINK VOLUMES		1,047	1,003	2,050	2,264	2,246	4,510	942	1,358	2,300	1,937	1,503	3,440
2025	TURN SUMMARY	1,069	1,034	2,103	2,218	2,246	4,464	961	1,394	2,355	1,928	1,502	3,430
CONTROL LINK VOLUMES		1,180	1,130	2,310	2,964	2,666	5,630	1,079	1,551	2,630	2,170	1,690	3,860
2035	TURN SUMMARY	1,182	1,197	2,379	2,766	2,666	5,432	1,097	1,616	2,713	2,150	1,716	3,866
CONTROL LINK VOLUMES		1,312	1,258	2,570	3,812	3,118	6,930	1,236	1,774	3,010	2,421	1,889	4,310
2045	TURN SUMMARY	1,312	1,372	2,684	3,380	3,119	6,499	1,257	1,885	3,142	2,364	1,937	4,301
DESIGN HOUR P.M.:		FROM	TO	LINK	FROM	TO	LINK	FROM	TO	LINK	FROM	TO	LINK
CONTROL LINK VOLUMES		1,399	1,151	2,550	2,405	2,275	4,680	1,416	1,124	2,540	1,629	2,291	3,920
2021	TURN SUMMARY	1,399	1,150	2,549	2,405	2,279	4,684	1,416	1,128	2,544	1,629	2,292	3,921
CONTROL LINK VOLUMES		1,497	1,233	2,730	2,528	2,392	4,920	1,509	1,201	2,710	1,718	2,422	4,140
2025	TURN SUMMARY	1,496	1,233	2,729	2,527	2,392	4,919	1,508	1,201	2,709	1,717	2,422	4,139
CONTROL LINK VOLUMES		1,752	1,438	3,190	2,834	2,686	5,520	1,728	1,372	3,100	1,927	2,713	4,640
2035	TURN SUMMARY	1,745	1,438	3,183	2,824	2,686	5,510	1,722	1,373	3,095	1,919	2,713	4,632
CONTROL LINK VOLUMES		2,021	1,659	3,680	3,160	3,000	6,160	1,978	1,572	3,550	2,151	3,029	5,180
2045	TURN SUMMARY	2,010	1,660	3,670	3,144	3,000	6,144	1,968	1,572	3,540	2,139	3,029	5,168

Note: Boxed number indicates manual adjustment.

Figure 7-15 TMTool v2023 Output Tab with "Adjust Volume"

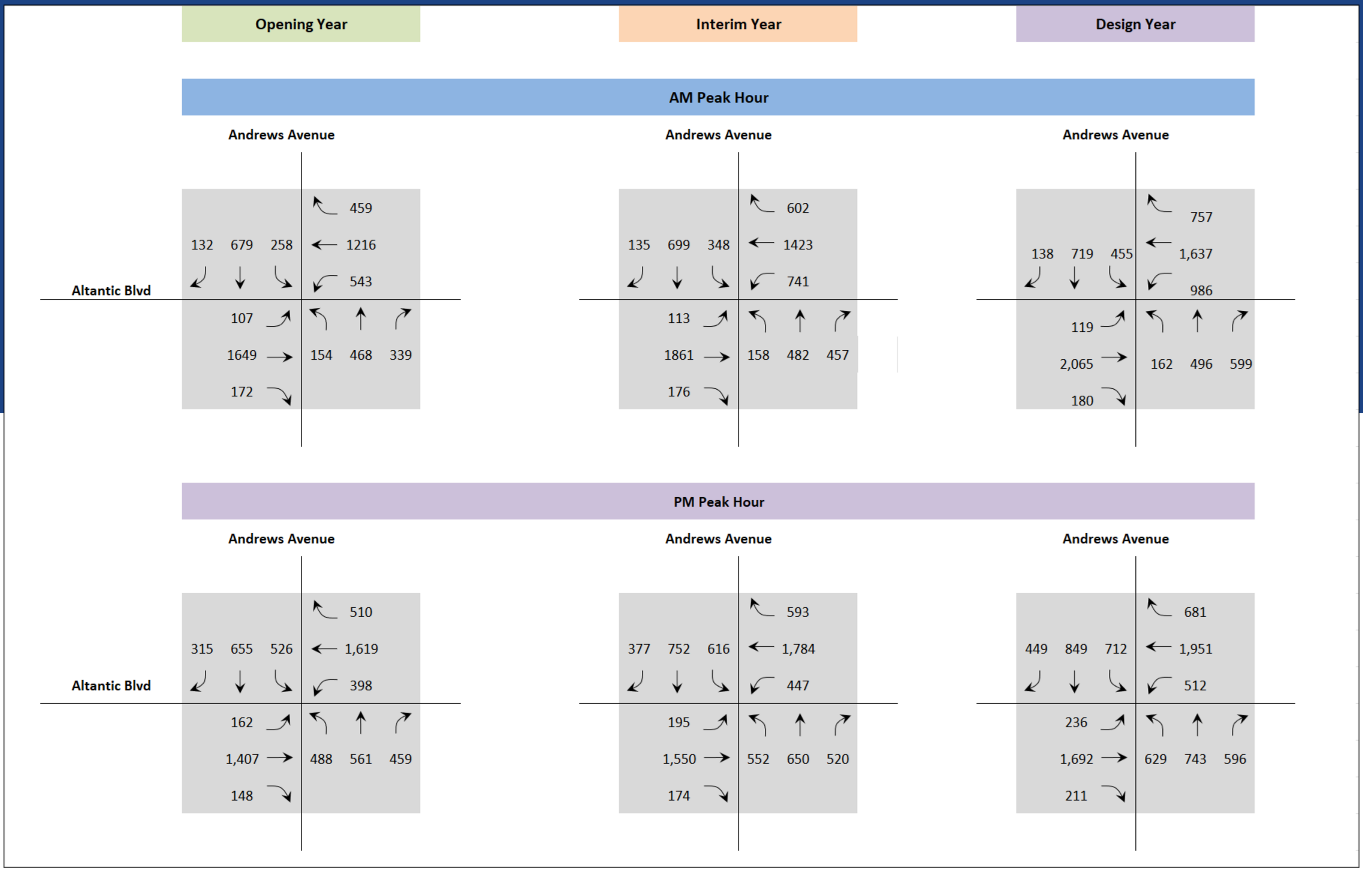


Figure 7-16 TMTool v2023 Figure Tab Showing Intersection Turning Movement Volumes

7.5.4 TMTool v2023 "Preview" Button

The "**Preview**" button will preview all the input and output for each intersection.

7.5.5 TMTool v2023 "Print" Button

The "**Print**" button will print the input and output of all intersections at one time. It is recommended to set the default printer to Adobe PDF or other printer that can generate PDF files so the output files can be further reviewed and incorporated into the study report.

7.5.6 TMTool v2023 "Save Data File" Button

The "**Save Data File**" function allows the user to save the data entered and generated during the study to the same data file. Alternatively, the user can save it to a different file name so the file can be later modified for other studies.

7.6 Methods in the NCHRP Report 765

NCHRP Report 765 provides alternative procedures to develop turning movement forecasts 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 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 start from existing turning movement counts and 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

7.6.1 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.

7.6.2 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.

7.6.3 "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 7-1** presents a summary on procedures and input elements for turning movement volume forecasting.

Table 7-1 Turning Movement Forecasting Procedures and Input Elements

	Procedure			
Input Elements	Factoring (Ratio or Difference Method)	Iterative Directional Volume Method	Iterative Non-Directional Volume Method	"T" Intersection
Turning Movements Forecast	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 Volume 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 the NCHRP Report 765, **Chapter 6** 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.

7.7 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.

- Factoring Procedures
  - Approach volumes
  - Possible K and D factors
- Output Data
  - One set of balance turning movement forecasts
- Features
  - Simple application
  - Relatively time consuming
  - Manually calculated

7.8 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 version incorporates the best of all the spreadsheets being used by the Districts. It can provide turning movement projections where detailed existing and future year data input parameters are available and applicable. It is suited for obtaining preliminary balanced turning movement projections where only approach volume information is available and/or applicable.
- TMTool v2023 is an improved version that provides an easy-to-use application that can estimate future turning volumes for multiple periods at the same time, and for up to six (6) intersections to be processed simultaneously. Output functions are also enhanced to provide graphic representation of intersection turning movement volumes for different time periods and different analysis years to facilitate corridor level traffic volume smoothing and balancing. TMTool v2023 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 8

Equivalent Single Axle Load (ESAL) Forecasting

8.1 Introduction

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 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.

8.2 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

8.3 ESAL Forecasting Process

Figure 8-1 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.

Many of the FSUTMS-based models, such as the Tampa Bay Regional Planning Model (TBRPM) have 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.

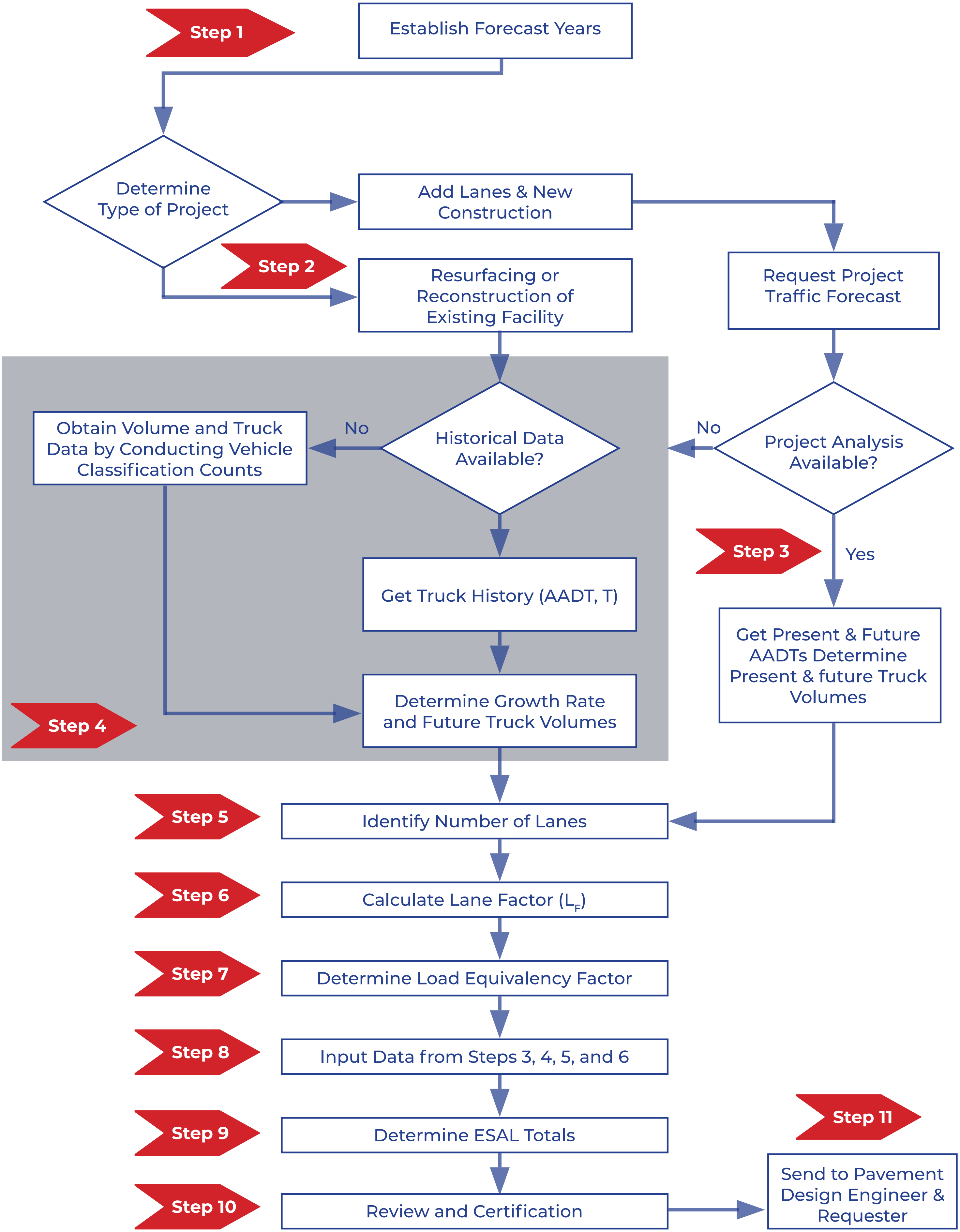


Figure 8-1 ESAL Forecasting Process

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 Chapter 2 **Figure 2-1** FHWA 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.

8.3.1 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.

8.3.2 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 8-2**.

8.3.3 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.

18 kip EQUIVALENT SINGLE AXLE LOAD ANALYSIS - LOCATION 1

PROJECT TRAFFIC FOR PD&E and DESIGN ANALYSIS INFO / FACTORS

FM #: 428855-1
COUNTY: Broward
ROADWAY ID: 86070000
PROJECT DESCRIPTION: I-95
LOCATION: I-95
PAVEMENT TYPE Flexible Pavement Rural Freeway
SN: 5 Inch Thick
YEARS: 2023 to 2048

YEAR	AADT	ESAL (1000S)	ACCUM (1000s)	D	T	LF	EF
2023	165,000	804	0	0.5	5.00%	0.508	1.050
2024	167,600	815	0	0.5	5.00%	0.507	1.050
2025	170,200	825	0	0.5	5.00%	0.506	1.050
2026	172,800	836	0	0.5	5.00%	0.504	1.050
2027	175,400	846	0	0.5	5.00%	0.503	1.050
2028	178,000	857	857	0.5	5.00%	0.502	1.050
2029	179,700	863	1,720	0.5	5.00%	0.501	1.050
2030	181,400	870	2,590	0.5	5.00%	0.500	1.050
2031	183,100	877	3,467	0.5	5.00%	0.500	1.050
2032	184,800	884	4,351	0.5	5.00%	0.499	1.050
2033	186,500	891	5,242	0.5	5.00%	0.498	1.050
2034	188,200	897	6,139	0.5	5.00%	0.497	1.050
2035	189,900	904	7,043	0.5	5.00%	0.497	1.050
2036	191,600	911	7,954	0.5	5.00%	0.496	1.050
2037	193,300	918	8,872	0.5	5.00%	0.495	1.050
2038	195,000	924	9,796	0.5	5.00%	0.494	1.050
2039	194,000	920	10,716	0.5	5.00%	0.495	1.050
2040	193,100	917	11,633	0.5	5.00%	0.495	1.050
2041	192,100	913	12,546	0.5	5.00%	0.496	1.050
2042	191,200	909	13,455	0.5	5.00%	0.496	1.050
2043	190,300	906	14,361	0.5	5.00%	0.496	1.050
2044	189,300	902	15,263	0.5	5.00%	0.497	1.050
2045	188,400	898	16,161	0.5	5.00%	0.497	1.050
2046	187,400	894	17,055	0.5	5.00%	0.498	1.050
2047	186,500	891	17,946	0.5	5.00%	0.498	1.050
2048	185,600	887	18,833	0.5	5.00%	0.499	1.050

Opening to Interim Year ESAL Accumulation (1000s): **8,939**
Opening to Design Year ESAL Accumulation (1000s): **17,976**

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 Firm | Date

____
Signature

Reviewed by: ______________________
Name | Title | Org. Unit or Firm | Date

____
Signature

Figure 8-2 18-KIP Equivalent Single Axle Load Analysis

8.4 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 8-1.**

8.4.1 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.

8.4.2 New Construction Project

If the project involves the construction of a new road which includes additional lanes that will affect 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.

8.4.3 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.

8.4.4 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, then collect data and perform traffic forecasting.

8.4.5 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 truck traffic growth.

8.4.6 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 count station. They may also be used for comparing roadways with similar characteristics (e.g., traffic, land use, etc.).

8.4.7 Historical Trend Analysis

In many cases, future truck volumes can be obtained from regional models where regional economic conditions are considered. 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. There are several methodologies that can be used, including Linear Growth, Exponential Growth, and Decaying Exponential Growth. **Figure 8-3** shows an example of Truck Traffic Trend Analysis. 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 value. The FDOT Trend Analysis Spreadsheet Application can be used to perform the analysis. Detailed descriptions of the Spreadsheet Application can be found in **Section 5.4.2 – Establish Traffic Growth Trend**. Future land use changes and economic conditions should also be considered when determining the most appropriate growth rate. Future truck traffic shall be determined by applying the growth rate to the base year truck traffic for the desired number of years.

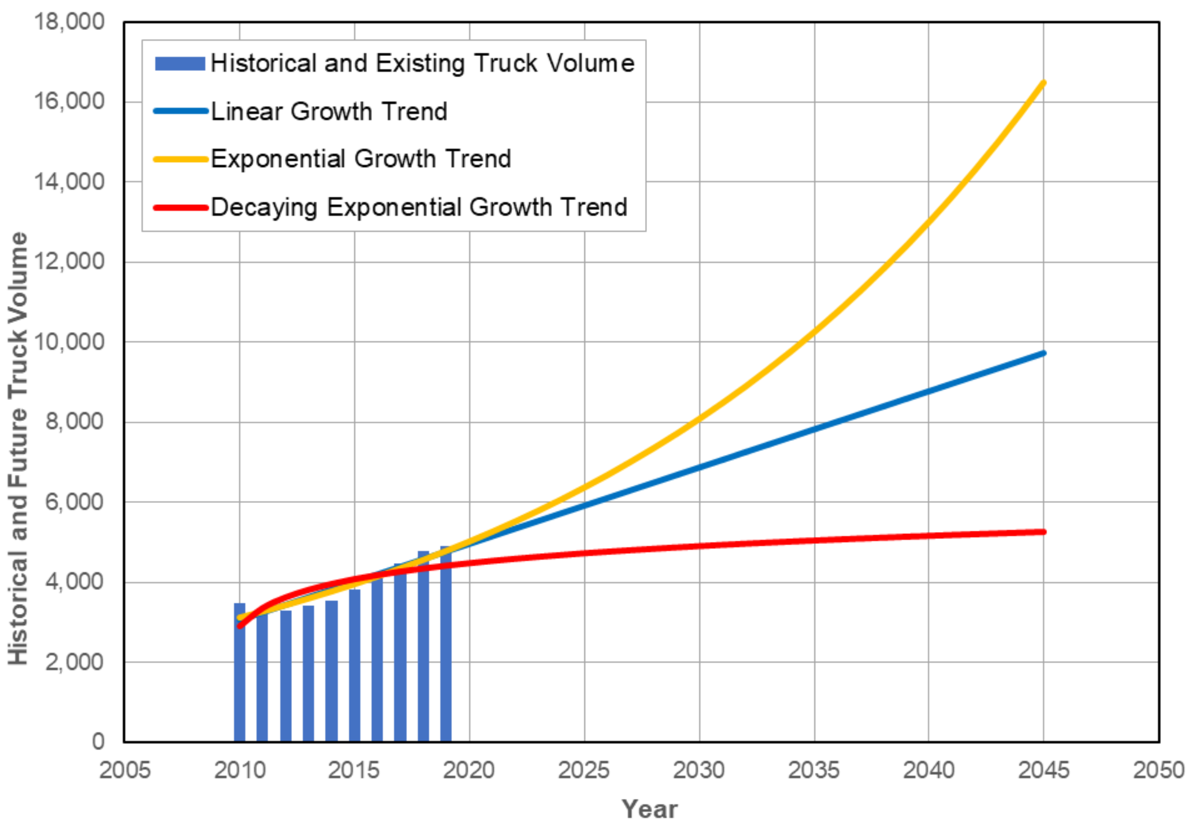


Figure 8-3 Truck Traffic Trend Analysis Example

IMPORTANT NOTE:

FDOT has developed a trend analysis spreadsheet application (Trend Analysis v2023.xlsm) 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.

8.4.8 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 (FTO) Web Application. The total percentage 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.

8.4.9 Future Truck Volumes

Future truck volumes can be calculated using the following formula assuming a linear growth pattern as shown in **Equation 8-1**:

$$\textit{Future Truck Volume} = (\textit{Base Year Average}) \times [1 + (\textit{Years} \times \textit{Rate})] \qquad \text{Equation 8-1}$$

Example

Assume that the base year truck traffic for a roadway segment for Year 2022 is 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 2045 is desired.

In this example, the growth period equals 23 years (2045 - 2022 = 23). The base year truck traffic is factored by 23 years and by the rate of 3.2%.

$$\textit{Future Truck Volume} = (4{,}994) \times [1 + (23 \times 0.032)]$$

$$= 4{,}994 \times 1.736$$

$$= 8{,}669 \longrightarrow 8{,}700$$

8.5 Design Requirements

8.5.1 $ESAL_D$ 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). **Equation 8-2** on 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 8-2

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., 10, 20, ...).

$AADT_i$ = Annual Average Daily Traffic for 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 8-1**.

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 8-2.**

8.5.2 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.)

8.5.3 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 8-3**.

$$L_F = 1.567 - 0.0826 \times Ln\ (OneWay\ AADT) - 0.12368 \times \mathrm{LV}$$ Equation 8-3

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 8-1 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 LF 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: (https://www.fdot.gov/planning/systems/systems-management/systems-management-documents).

8.5.4 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) (see **Equation 8-4**).

$$E_{80} = \frac{\textit{\# of 18 KIP ESALs causing a given loss of serviceability}}{\textit{\# of any KIP ESALs causing the same serviceability loss}} \qquad \text{Equation 8-4}$$

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 EF 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 8-2** 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 8-2 Equivalency Factors for Different Types 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

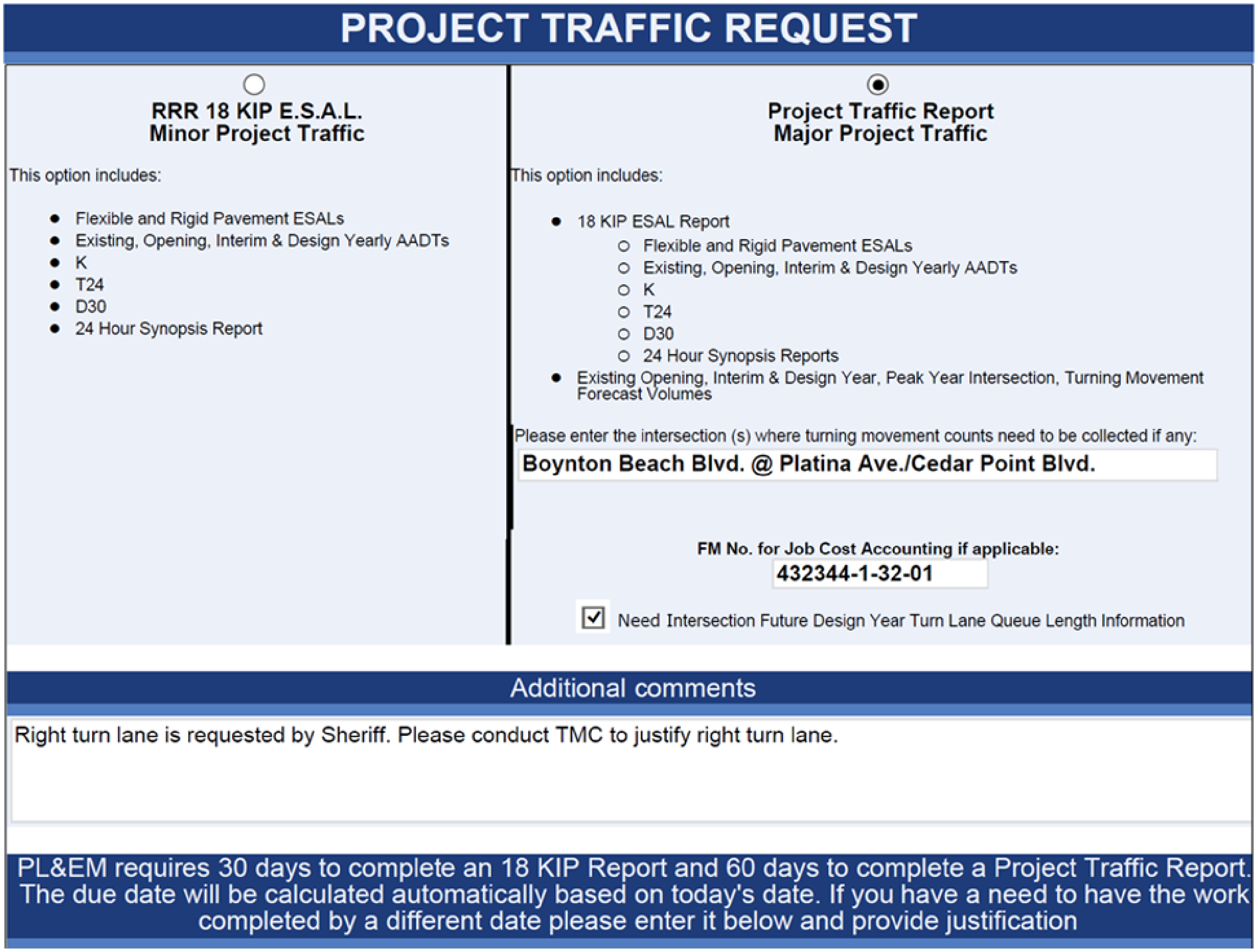
8.6 Steps for Producing 18-KIP ESALS

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 8-4** 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

○ RRR 18 KIP E.S.A.L. Minor Project Traffic	◉ Project Traffic Report Major Project Traffic

This option includes:
• Flexible and Rigid Pavement ESALs
• Existing, Opening, Interim & Design Yearly AADTs
• K
• T24
• D30
• 24 Hour Synopsis Report
	This option includes:
	• 18 KIP ESAL Report
	  ○ 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
	Please enter the intersection (s) where turning movement counts need to be collected if any:
	Boynton Beach Blvd. @ Platina Ave./Cedar Point Blvd.
	FM No. for Job Cost Accounting if applicable:
	432344-1-32-01
	☑ Need Intersection Future Design Year Turn Lane Queue Length Information

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 8-4 18-KIP ESAL Request Example

Step 2

Collect Traffic and Geometric Information about the Facility

Additional information including Functional Classification (RCI Feature 121), Through Lanes (RCI Feature 212), Median (RCI Feature 215), Speed Limits (RCI Feature 311) and Traffic Flow Breaks (RCI Feature 331) can be accessed through Straight-Line Diagrams Online GIS Web Application (See **Figure 8-5**).

Check Florida Traffic Online (FTO) 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 T24, 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.

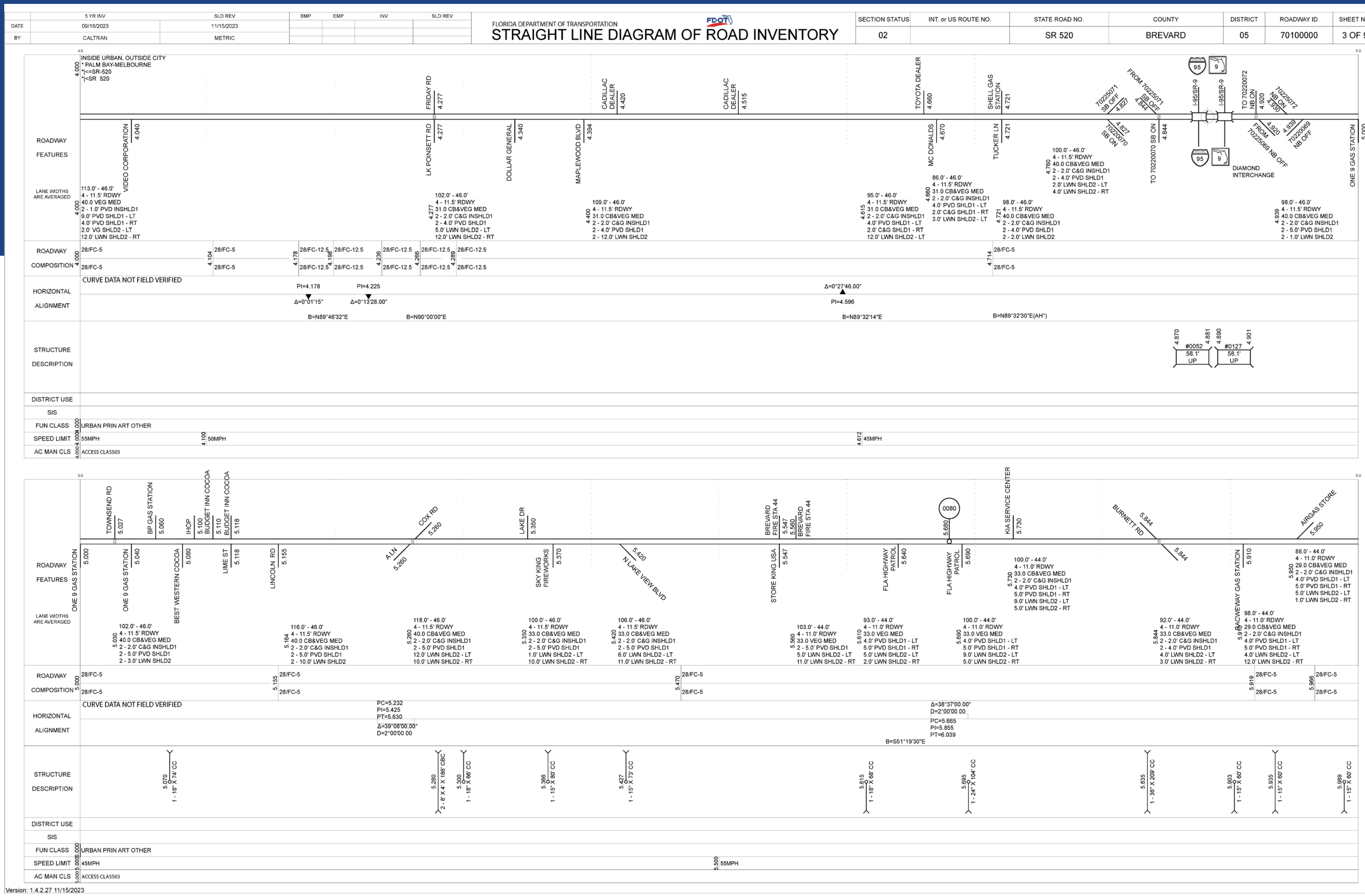


Figure 8-5 Straight Line Diagram Example

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 8-6** shows an example of model volume plot displaying assigned traffic volume along the study corridor in Brevard County.

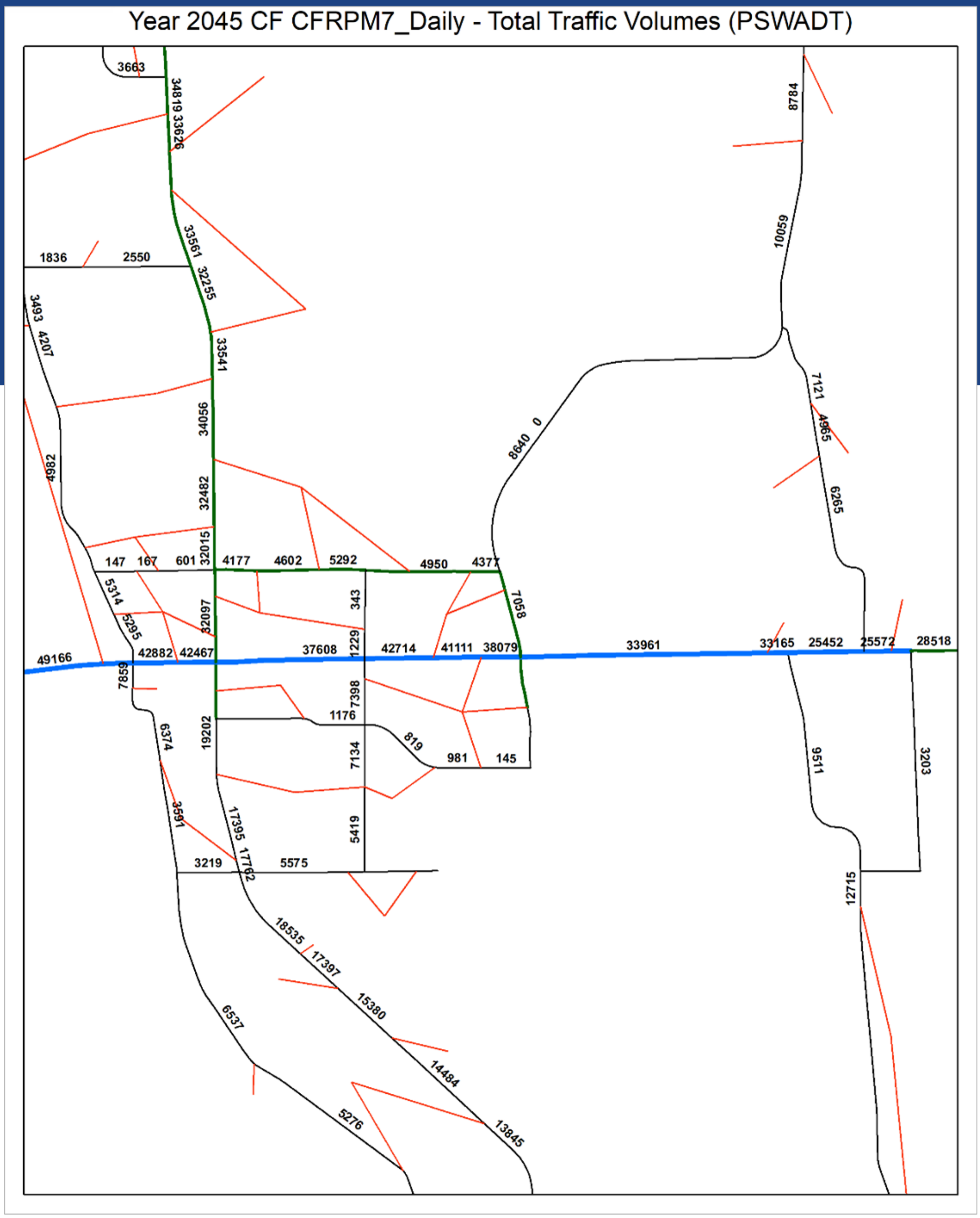


Figure 8-6 Future Year Model Volumes from CFRPM 7.0 Example

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 Online (FTO), other studies, or similar facilities nearby.

Example

48-hour classification counts were taken on August 23 and 24, 2022. The daily counts for the two days are 32,572 and 32,553. The corresponding Season Factor is 1.05. The Existing Year AADT is calculated as follows:

$$ADT = \frac{(32{,}572 + 32{,}553)}{2} = 32{,}563$$

$$AADT = ADT \times SF = 32{,}563 \times 1.05 = 34{,}191$$

$$AADT = 34{,}000$$

Step 5

Determine Design Traffic Characteristics

Develop design hour factors K, D, and T24 following the guidelines described in **Chapter 2.** The subject facility is a suburban arterial and the roadway context classification is Suburban Commercial (C3C). The K Factor should be a single value within the Standard K Factor Range as shown in **Table 2-1** based on the context classification, area type, and facility type. 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 measured Peak-to-Daily ratio was 7.94%, which is within the Standard K Range for the facility. The "D" value based on the short-term classification counts was 52.76% for the study location. The FDOT RCI database reported a D value of 53.40% for a FDOT Short-Term TMS site nearby. The measured daily truck factor (T_{24}) from the classification count was 5.01%. The FDOT RCI database reported a daily truck factor of 4.50% for the same FDOT Site. Based on the comparison, the Standard K-Factor of 8.00%, the D Factor of 52.76%, and the daily truck factor (T_{24}) of 5.01% are recommended, all based on field measured data at the site.

Table 8-3 Determine Design Hour Factors Example

Freeways	Study Location
Peak-to-Daily Ratio (Measured)	7.94%
Standard K Factor Range	7.50% - 9.50%
D (Measured)	52.76%
D (From FDOT RCI)	53.40%
Arterials and Collectors	
T_{24} (Measured)	5.01%
T_{24} (From FDOT RCI)	4.50%
Arterials and Collectors	
K Factor	8.00%
D Factor	52.76%
T_{24}	5.01%

Step 6

Develop Future Year 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. The 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

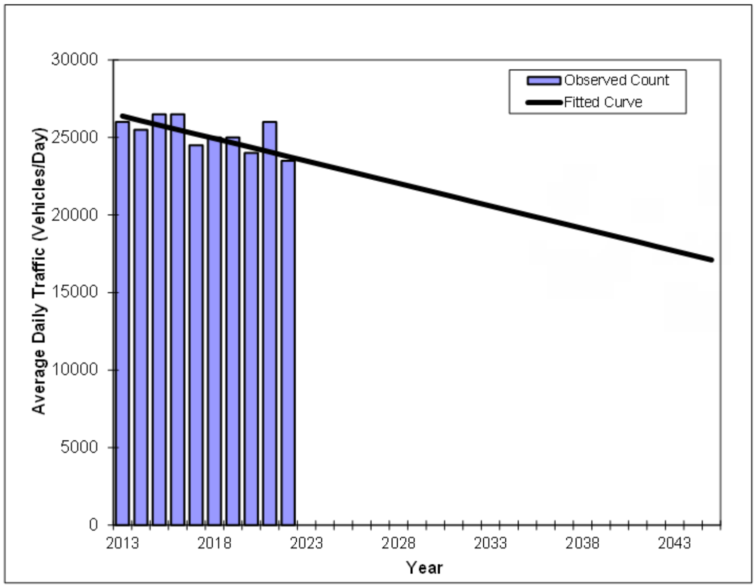
In the same example, historical AADT volumes are available at a Short- Term TMS site within the project limits. The AADT volumes for the past ten years from 2013 to 2022 are used for Trend Analysis. It should be noted that the reported AADT for 2020 is still used even though it is under abnormal conditions. A careful evaluation of the 2020 AADT indicates that there are no significant differences in volumes between the adjacent years and the 2020 AADT generally follows the growth trend. Trend analysis was conducted first to determine the growth pattern and growth rate to be used for traffic forecasting. **Figure 8-7**, **Figure 8-8**, and **Figure 8-9** show the trend analysis results using Linear Growth Option, Exponential Growth Option, and Decaying Exponential Growth Option, respectively. The R-Squared values for the three growth options are all higher than 70%, indicating a good fit in all cases. However, all three options show a negative growth. Thus, historical AADTs were not used for future travel demand forecasting.

Traffic Trends - V2023

SR 520 -- ON SR-520, 0.095 MI. E OF MILFORD PT

FM #	**123456-1**
Location	**1**

County:	Brevard (70)
Station #:	701007
Roadway:	SR 520



Year	Traffic (ADT/AADT) Count*	Trend
2013	26,000	26,380
2014	25,500	26,090
2015	26,500	25,800
2016	26,500	25,510
2017	24,500	25,220
2018	25,000	24,940
2019	25,000	24,650
2020	24,000	24,360
2021	26,000	24,070
2022	23,500	23,780
2025 Opening Year Trend		
2025	N/A	22,910
2035 Interim Year Trend		
2035	N/A	20,010
2045 Design Year Trend		
2045	N/A	17,110
FSUTMS Forecasts/Trends		

*Axle-Adjusted

Annual Trend Decrease:	290
Trend R-squared:	89.50%
Trend Annual Historic Growth Rate:	-1.10%
Trend Growth Rate (2022 to Design Year)	-1.22%
Printed:	9/21/2023

Linear Growth Option

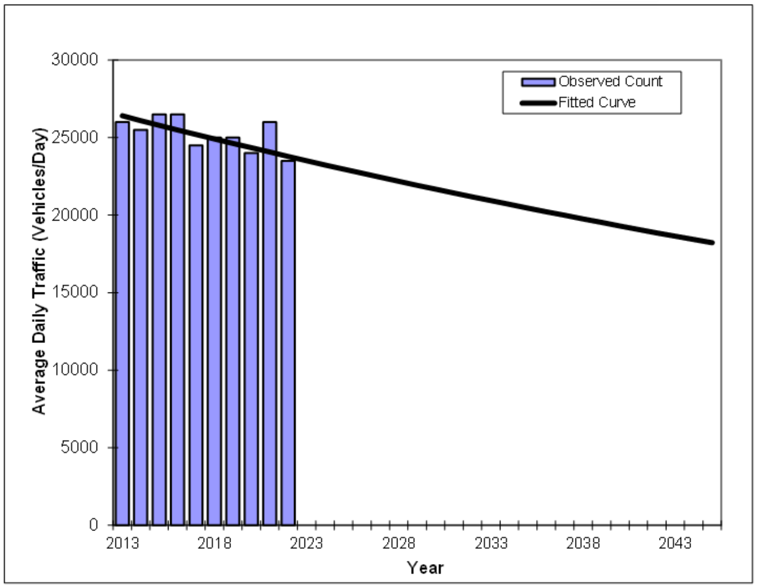
Figure 8-7 Linear Growth Option Example

Traffic Trends - V2023

SR 520 -- ON SR-520, 0.095 MI. E OF MILFORD PT

FM #	**123456-1**
Location	**1**

County:	Brevard (70)
Station #:	701007
Roadway:	SR 520



Year	Traffic (ADT/AADT) Count*	Trend
2013	26,000	26,410
2014	25,500	26,100
2015	26,500	25,800
2016	26,500	25,500
2017	24,500	25,210
2018	25,000	24,920
2019	25,000	24,630
2020	24,000	24,350
2021	26,000	24,070
2022	23,500	23,790
2025 Opening Year Trend		
2025	N/A	22,970
2035 Interim Year Trend		
2035	N/A	20,460
2045 Design Year Trend		
2045	N/A	18,220
FSUTMS Forecasts/Trends		

*Axle-Adjusted

Trend R-squared:	89.22%
Compounded Annual Historic Growth Rate:	-1.15%
Compounded Growth Rate (2022 to Design Year)	-1.15%
Printed:	9/21/2023

Exponential Growth Option

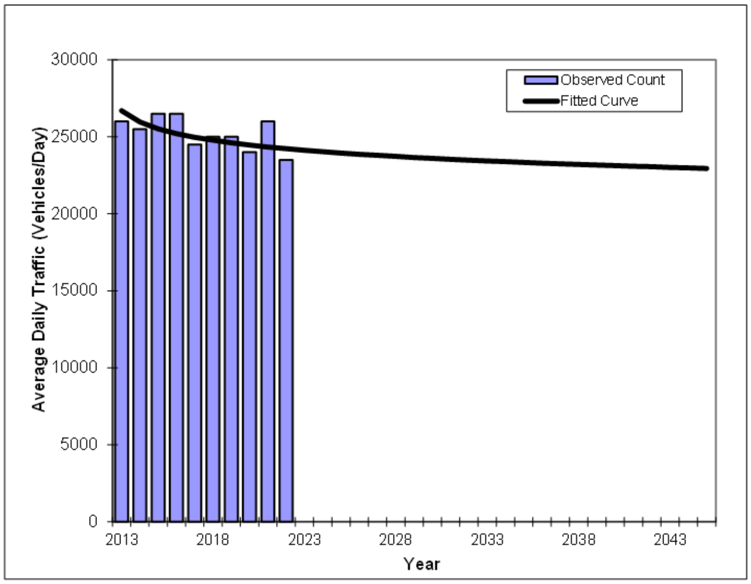
Figure 8-8 Exponential Growth Option Example

Traffic Trends - V2023

SR 520 -- ON SR-520, 0.095 MI. E OF MILFORD PT

FM #	**123456-1**
Location	**1**

County:	Brevard (70)
Station #:	701007
Roadway:	SR 520



Year	Traffic (ADT/AADT) Count*	Trend
2013	26,000	26,700
2014	25,500	25,960
2015	26,500	25,520
2016	26,500	25,210
2017	24,500	24,970
2018	25,000	24,780
2019	25,000	24,610
2020	24,000	24,470
2021	26,000	24,340
2022	23,500	24,230
2025 Opening Year Trend		
2025	N/A	23,950
2035 Interim Year Trend		
2035	N/A	23,340
2045 Design Year Trend		
2045	N/A	22,950
FSUTMS Forecasts/Trends		

*Axle-Adjusted

Trend R-squared:	71.70%
Compounded Annual Historic Growth Rate:	-1.07%
Compounded Growth Rate (2022 to Design Year)	-0.24%
Printed:	9/21/2023

Decaying Exponential Growth Option

Figure 8-9 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 2022 population estimate and Year 2025 to 2045 population projections were obtained from the BEBR at University of Florida, and the population growth rate was determined to be 0.82%. Based on the comparison of growth rates obtained from various sources and in consultation with the FDOT, an annual growth rate of 0.60% was recommended to obtain the Opening Year 2025, Interim Year 2035 and Design Year 2045 projections for the study location.

With base year (2022) AADT of 34,000 and a growth rate of 0.60%, future year AADTs can be estimated using simple linear growth option as shown in Figure 8-10.

Design Factors: K = 8.0%, D = 52.76%, T_{24} = 5.01%

Study Location AADT Volumes

Year	2022	2025	2035	2045
AADT	34,000	35,000	37,000	42,000

Figure 8-10 Project Future Year AADT Volumes

Step 7

Prepare Input Data for ESAL Calculation Spreadsheet

Open ESAL_V2023.XLSM. This Excel spreadsheet is a user-friendly menu/macro driven tool for input, calculation, and printing of ESALs. It can process up to five (5) roadway segments at the same time. **Figure 8-11** shows the main menu of the ESAL Tool, Version 2023. 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.

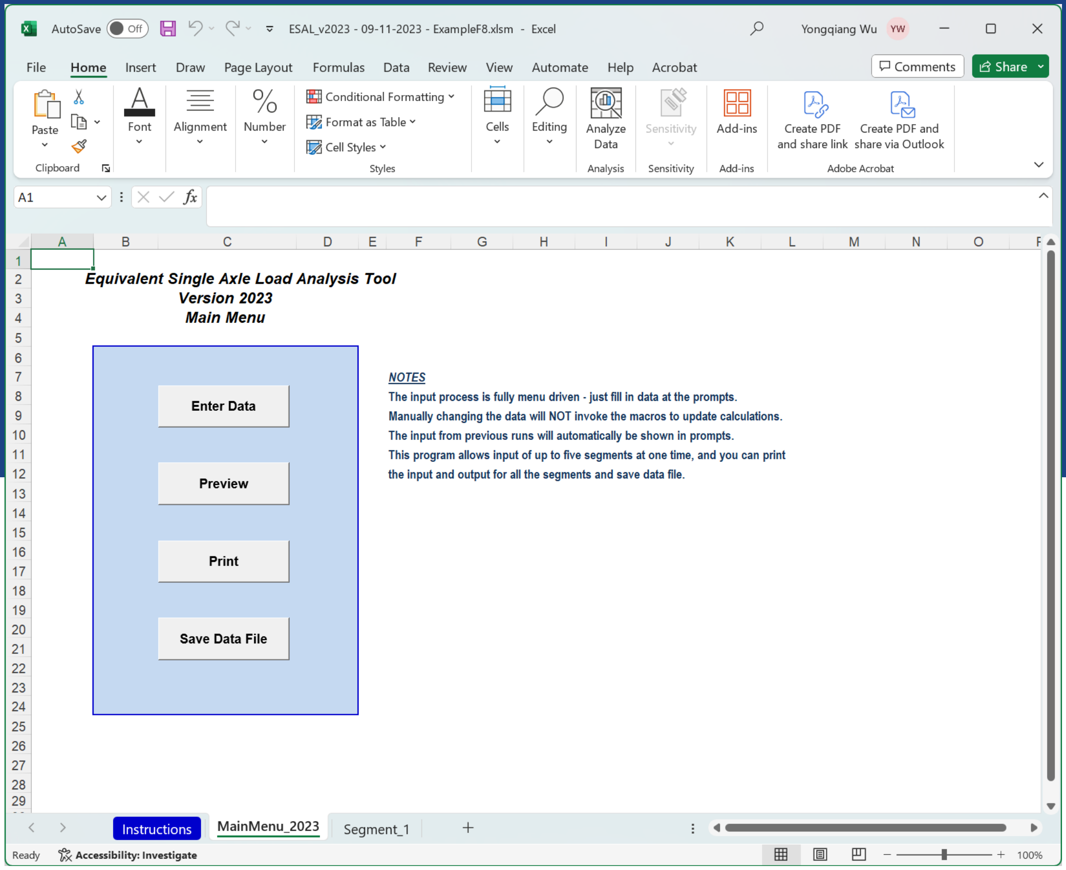


Figure 8-11 ESAL Tool Main Menu

Example

1. Enter project information. The project information includes FM number, project description, and number of segments. The information is optional and only for project identification purposes. Number of segments is a required input. Click on the button "Clear Project Info" button to clear all the project information, including the data for the old roadway segment. The number of segments is set to 1 for this example. The Project Information input screen is shown in **Figure 8-12**.

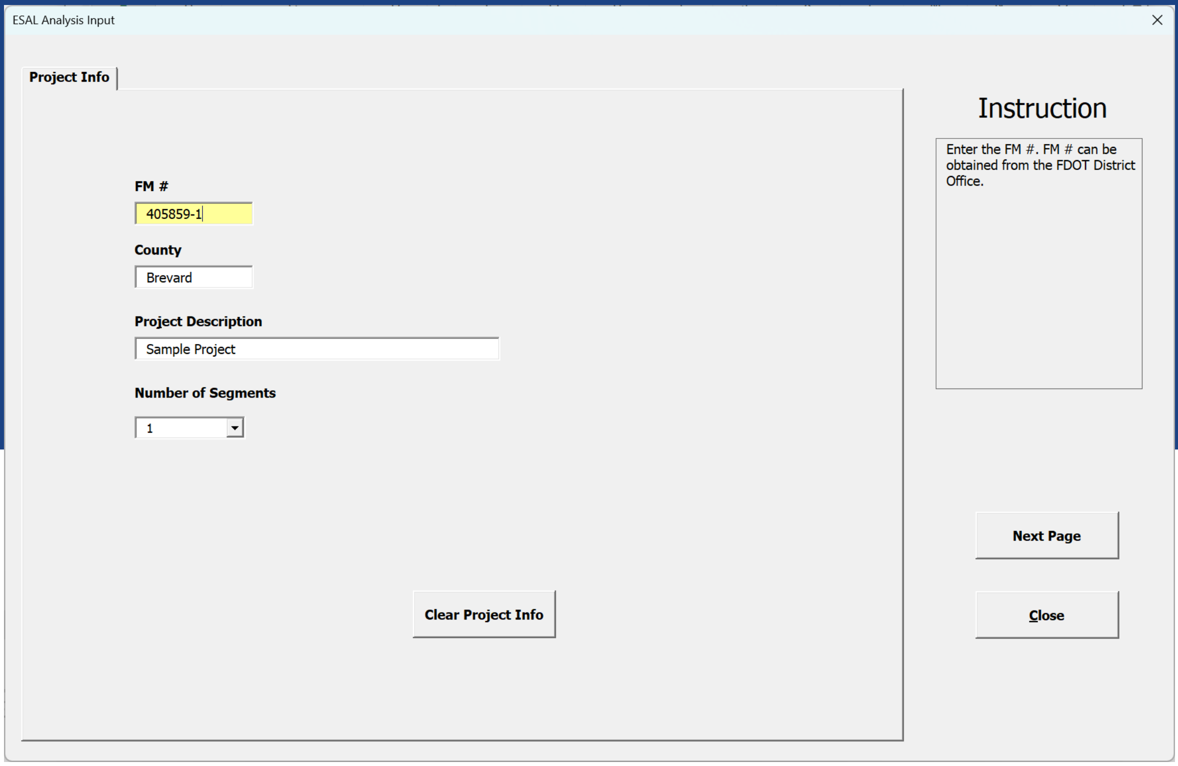


Figure 8-12 ESAL Tool Project Information Input Screen

2. Enter roadway segment information for all segments, which may include Roadway ID, Location Description, Type of Roadway for Flexible Pavement, Type of Roadway for Rigid Pavement, Growth Rate Calculation Method, Years, Number of Lanes, Growth Option, AADT Volumes, Growth Rate, and Truck Percentages. If the new data for the segment is needed, click on the "Clear Input Data" button to clear the data for the segment. If the number of segments need to be changed, click on "Back to Project Info" button to go back to Project Info page, then change the number of segments and go to the next page to enter all information. Once the data for all segments is finished, click the "OK" button to complete the ESAL analysis. The roadway Segment Information input screen is shown in **Figure 8-13**.

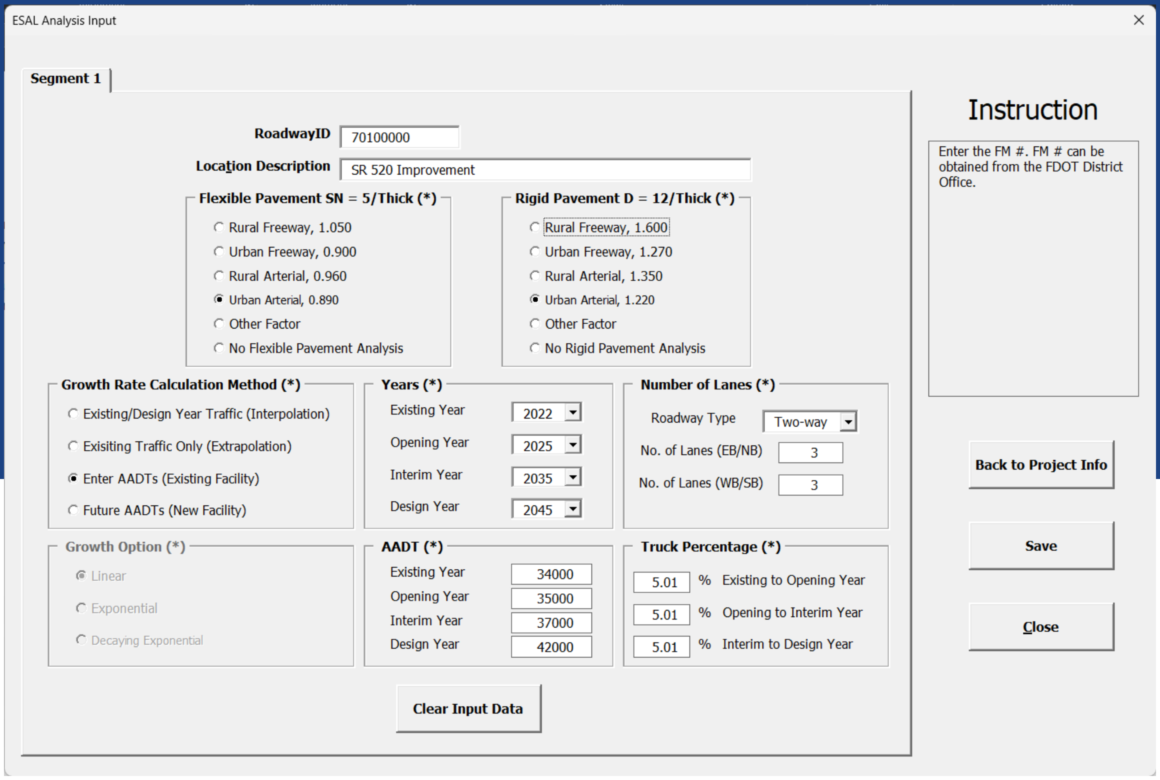


Figure 8-13 ESAL Tool Segment Information Input Screen

3. Preview results: click the “Preview” button to show all the input and output for each roadway segment.

4. Print results: click the "Print” button to print out the input and output for all the roadway segments.

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 8-14** 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

FM #: 405859-1
COUNTY: Brevard
ROADWAY ID: 70100000
PROJECT DESCRIPTION: Sample Project

LOCATION: SR 520 Improvement
PAVEMENT TYPE Flexible Pavement Urban Arterial
SN: 5 Inch Thick
YEARS: 2022 to 2045

YEAR	AADT	ESAL (1000S)	ACCUM (1000s)	D	T	LF	EF
2022	34,000	177	0	0.5	5.01%	0.639	0.890
2023	34,300	179	0	0.5	5.01%	0.638	0.890
2024	34,600	180	0	0.5	5.01%	0.637	0.890
2025	35,000	182	182	0.5	5.01%	0.636	0.890
2026	35,200	183	365	0.5	5.01%	0.636	0.890
2027	35,400	184	549	0.5	5.01%	0.635	0.890
2028	35,600	184	733	0.5	5.01%	0.635	0.890
2029	35,800	185	918	0.5	5.01%	0.634	0.890
2030	36,000	186	1,104	0.5	5.01%	0.634	0.890
2031	36,200	187	1,291	0.5	5.01%	0.634	0.890
2032	36,400	188	1,479	0.5	5.01%	0.633	0.890
2033	36,600	189	1,668	0.5	5.01%	0.633	0.890
2034	36,800	190	1,858	0.5	5.01%	0.632	0.890
2035	37,000	191	2,049	0.5	5.01%	0.632	0.890
2036	37,500	193	2,242	0.5	5.01%	0.631	0.890
2037	38,000	195	2,437	0.5	5.01%	0.630	0.890
2038	38,500	197	2,634	0.5	5.01%	0.628	0.890
2039	39,000	200	2,834	0.5	5.01%	0.627	0.890
2040	39,500	202	3,036	0.5	5.01%	0.626	0.890
2041	40,000	204	3,240	0.5	5.01%	0.625	0.890
2042	40,500	206	3,446	0.5	5.01%	0.624	0.890
2043	41,000	208	3,654	0.5	5.01%	0.623	0.890
2044	41,500	211	3,865	0.5	5.01%	0.622	0.890
2045	42,000	213	4,078	0.5	5.01%	0.621	0.890

Opening to Interim Year ESAL Accumulation (1000s): 1,867
Opening to Design Year ESAL Accumulation (1000s): 3,896

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 Firm | Date

____
Signature

Reviewed by: ____________________

Name | Title | Org. Unit or Firm | Date

____
Signature

Figure 8-14 18-KIP ESAL Report Printout

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.

8.7 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 9

Project Traffic for Tolled Managed Lanes

9.1 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 projects do not incorporate tolling, then this chapter is not applicable. Also, this chapter is not intended for use in traffic and revenue studies.

9.2 Purpose

Express 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 has developed a Managed Lanes Guidebook 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 Guidebook 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.

9.3 Travel Demand Forecasting for Express Lanes

The determination of the feasibility of an Express Lanes project and evaluation of alternatives for the Express Lanes requires 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.

9.3.1 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.

9.3.2 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. 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 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. If a stated preference survey cannot be conducted for the study area, similar surveys from other areas could also be considered after a careful evaluation of the socioeconomic and travel characteristics determines substantial similarities with the project area.

9.4 Methods for Forecasting Express Lanes Project Traffic

There are three (3) approaches to forecasting project traffic for Express Lanes:

9.4.1 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.

9.4.2 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 user payment 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 Express Lanes Time of Day (ELToD) 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 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.

9.4.3 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 9-1**). In addition, the model has to be a Dynamic Traffic Assignment (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 9-1** summarizes the model inputs for the various Express Lanes forecasting methods previously described, 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 require 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.

9.5 ELToD Method for Forecasting Express Lanes Project Traffic

The use of a regional travel demand model **in combination with** the ELToD 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-calibrated against observed data in Broward and Palm Beach Counties on both I-95 Express Phase 1-4 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.

ELToD estimates the volume of traffic by hour on both general use and Express Lanes by applying **Equation 9-1** 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.

Table 9-1 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	· O-D data · EL Access Points · Estimated EL Share	· Quick estimation method · Provides expected volume range for EL Segments and Access Points	· 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	Corridor Planning/ PD&E/Design	· EL Access Points · Number of EL Lanes · Speed & Capacity Info · Dynamic Toll Function/ VTTS Curve	· Estimates Daily or period demand directly from TDM without needing to use another model · Provides a systemwide EL evaluation	· 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
Travel Demand Model Based	Regional Travel Demand Model with ELToD Assignment Model	Corridor Planning/ PD&E/Design	· O-D (from TDM) · EL Access Points · Number of EL Lanes · Speed & Capacity Info · Toll Choice Parameters (VTTS, VOR, Toll Constant)	· 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	· Does not account for queue spillback · EL choice selection at first entry only
	Microsimulation Model	PD&E/ Design	· 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)	· 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	· 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

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.

Equation 9-1

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

Where:

- βConstant – This parameter determines the Express Lanes share when time, toll, and reliability have a net zero effect.
- βTime – 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.
- βToll – 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.
- βReliability – 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 Assignment Model, please refer to the ELToD – User Guide and Documentation. This report can be requested through Florida's Turnpike Enterprise, Toll Studies & Forecasting 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 Florida's Turnpike Enterprise, Toll Studies & Forecasting Department and can be made available upon request.

9.6 Project Forecasting Methodology

All Express Lanes projects include a forecast process to determine both the corridor demand, and the split between general use 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 9-1 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, and the desired level of accuracy of the forecasts. It should also be noted that, 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.

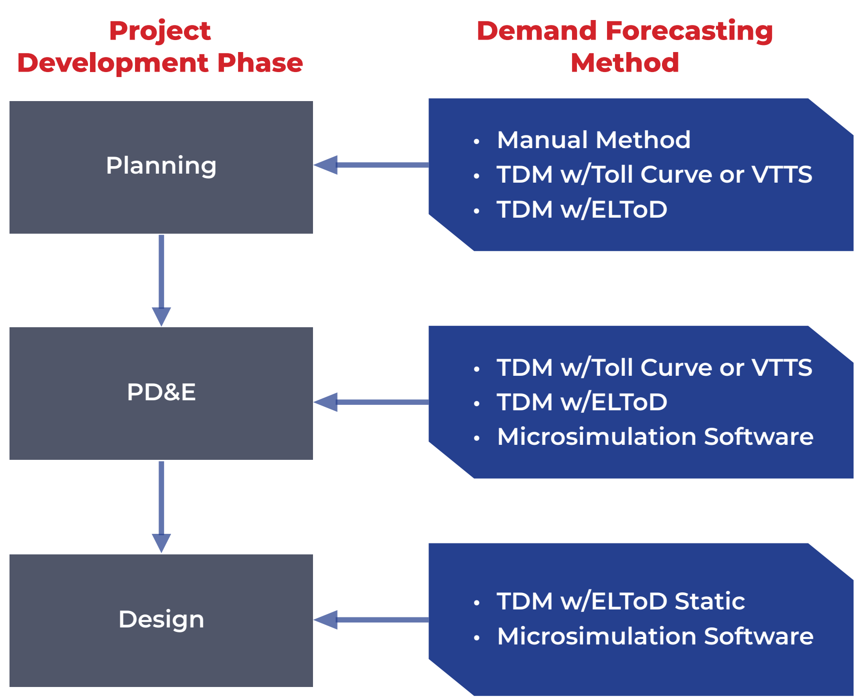


Figure 9-1 Recommended Project Traffic Forecasting Methodology

Appendix A

Project Traffic Forecasting Procedure
FHWA Approval Letter: Use of Standard K
FDOT White Paper: Standard K Evaluation

Approved:

Effective: March 28, 2023
Office: Systems Implementation Office
Topic No.: 525-030-120-l

DocuSigned by:
Chris Edmonston
7114473052D3466...
Department of Transportation

PROJECT TRAFFIC FORECASTING

AUTHORITY:

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

REFERENCES:

Sections 334.03(25), 334.046(1) and (2); 334.063, 334.17, 334.24, and 338.001(5); F.S.

Project Traffic Forecasting Handbook, Florida Department of Transportation (FDOT), Systems Implementation Office

General Interest Roadway Data (GIRD) Procedure, FDOT, Transportation Data and Analytics Office, Topic No. 525-020-310

Florida Traffic Online, FDOT, Transportation Data and Analytics Office

Florida Standard Urban Transportation Model Structure (FSUTMS) Cube Framework Phase II, Model Calibration and Validation Standards, FDOT, Forecasting and Trends Office

New or Modified Interchanges Procedure, FDOT, Systems Implementation Office, Topic No. 525-030-160

Project Development and Environment (PD&E) Manual, FDOT, Office of Environmental Management, Topic No. 650-000-001

Manual on Uniform Traffic Studies, FDOT, Traffic Engineering and Operations Office, Topic No. 750-020-007

FDOT Design Manual (FDM), FDOT, Roadway Design Office, Topic No. 625-000-002,

Flexible Pavement Design Manual, Topic No. 625-010-002, FDOT, Roadway Design Office

A Policy on Geometric Design of Highways and Streets, American Association of State Highway and Transportation Officials (AASHTO), 7th Edition, 2018

AASHTO Guidelines for Traffic Data Programs (2nd Edition), AASHTO, 2009

Federal Highway Administration Traffic Monitoring Guide (TMG), U.S. Department of Transportation, Federal Highway Administration (FHWA), October 2016

Highway Capacity Manual (HCM), Transportation Research Board (TRB)

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, TRB September 1985

PURPOSE:

The objective is to standardize the traffic forecasting process that will result in consistent and defendable project traffic on all applicable transportation projects. Project traffic forecasting estimates are needed for planning, Project Development and Environmental (PD&E) studies, design, construction, traffic improvements, and pavement design projects. The procedure includes information about the associated state and federal requirements related to the traffic forecasting process.

SCOPE:

This procedure is directed to traffic engineers and planners from the Department who develop project traffic used in forecasting for various highway projects for FDOT and its partner agencies.

DEFINITIONS:

Terms in this procedure, other than those defined below, are used as defined in the ***Highway Capacity Manual (HCM)*** by TRB and ***A Policy on Geometric Design of Highways and Streets*** as stated by AASHTO.

Equivalent Single Axle Load (ESAL): 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)

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.

K Factor: the proportion of Annual Average Daily Traffic (AADT) that occurs during the peak hour.

Local Government Comprehensive Plan (LGCP): 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.

Long Range Transportation Plan (LRTP): 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 highspeed and high-volume travel.

Strategic Intermodal System (SIS): 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.

PROCEDURE:

1. USERS OF PROJECT TRAFFIC STUDIES

The following District offices are involved in the preparation and use of project traffic forecasting reports and studies:

(A) Planning and Environmental Management Office (PLEMO)
(B) Roadway Design Office
(C) Traffic Engineering and Operations Office
(D) Consultant Management Office
(E) Project Management Office

This procedure is not intended to be used for traffic engineering studies. However, this procedure will apply to the extent that certain traffic operations, such as major intersection movements, are involved in corridor or other project traffic studies and analyses.

This procedure outlines three processes used to meet three different traffic forecasting needs:

(A) corridor traffic forecasting studies,
(B) project level traffic forecasting studies, and
(C) 18-KIP Equivalent Single Axle Load (ESAL) studies.

Although these three types of studies have different approaches and tools, they use the same methodology to determine some of the project traffic forecasting characteristics, specifically: design year, directional design hourly volume (DDHV), and future traffic and truck volume forecasts.

2. TYPES OF TRAFFIC FORECAST STUDIES

Corridor traffic forecasting is required before establishing a new alignment or making improvements to existing facilities, such as widening or transportation system management and operation (TSM&O) strategies. Corridor traffic forecasting is used in the analysis of transportation alternatives in order to identify the type of improvements needed to meet future anticipated traffic demands.

Project traffic forecasting studies identify specific link volumes, turning movements, and other project-specific data necessary for the geometric design and operational improvements to roadways or intersections. They can also identify the project traffic requirements for the state highway system, the Interchange Access Requests (IAR), Master Plans for the SIS, Resurfacing, Restoration and Rehabilitation (RRR) projects, repurposing lanes, new roadway projects, and major intersection improvements.

The 18-KIP ESAL forecast is required for the pavement design of new construction, reconstruction, and resurfacing projects. The pavement design for new alignment, reconstruction, and resurfacing projects will require a structural loading forecast using the 18-KIP ESAL process.

3. PROJECT TRAFFIC FORECASTING HANDBOOK

The ***Project Traffic Forecasting Handbook*** provides guidelines and techniques on the traffic forecasting process. The Handbook supplements this procedure by providing directions for producing the design traffic parameters, AADT, Standard K, D, and T.

4. CENTRAL OFFICE RESPONSIBILITIES

4.1 SYSTEMS IMPLEMENTATION OFFICE

The Central Office, Systems Implementation Office is responsible for:

(A) Providing the required tools and general guidelines for performing traffic forecast studies.

(B) Maintaining and updating the ***Project Traffic Forecasting Handbook*** and Procedure No. 525-030-120.

(C) Maintaining and improving traffic forecasting tools. These are Excel spreadsheets which can be used to perform historical trend analysis, estimate forecast year’s turning movements, and 18-KIP ESAL estimates.

(D) Developing required computer-based training and testing materials to help explain the project traffic forecasting terminologies and processes.

4.2 TRANSPORTATION DATA AND ANALYTICS OFFICE

The Central Office, Transportation Data and Analytics Office is responsible for:

(A) Maintaining and updating the Traffic Characteristics Inventory (TCI) framework, including providing AADT, Standard K Factor, Directional Factor (D), and Truck Factor (T), based on site-specific counts through the Traffic Count Program.

(B) Publishing and updating the Florida Traffic Online website.

5. DISTRICT OFFICE RESPONSIBILITIES

The District is responsible for carrying out the traffic forecasting process consistent with this procedure and the ***Project Traffic Forecasting Handbook***. Traffic forecasting reports are developed in coordination with requesting offices such as Planning and Environmental Management, Design, and Consultant Management. The traffic forecast reports are generally prepared by, or under the direction of the District offices.

These responsibilities include:

(A) Monitoring the Department's Work Program (WP) to identify the projects that require traffic forecasts.

(B) Establishing the forecast years of the project.

(C) Determining the traffic model suitability and the consistency of the traffic forecast process and its outputs with the adopted MPO Long Range Plan and/or Local Government Comprehensive Plan (LGCP).

(D) Determining the design hour volume (DHV), Directional Design Hour Volume (DDHV), and Design Hour Truck Percentage (DHT) by assigning appropriate Standard K, D, and T Factors for the project, and estimating the AADT for the project.

(E) Performing historical trend analysis and testing its reasonableness. The trend analysis shall include a statement of the method, and the assumptions used to perform the analysis.

(F) Determining the 18-KIP ESAL when required and checking its validity if the forecast has previously been performed.

(G) Performing turning volume forecasts, as required for planning and management purposes.

(H) Preparing the traffic forecasting report based on the comparison of the FHWA and FDOT's Level of Service (LOS) Targets. This report should include all supporting documents used and statements for the traffic forecasting process. If turning movements are involved, schematics diagrams should be included.

(I) Transmitting the traffic forecast reports and its supplemental materials to the requesting office or person.

6. TRAINING

Training related to traffic forecasting process or ***Project Traffic Forecasting Handbook*** can be found on the following websites:

http://cbt.dot.state.fl.us/ois/ProjectTrafficForecasting/index.html

http://wbt.dot.state.fl.us/ois/ProjectTrafficForecasting/index.html

This Virtual Training has material to supplement the ***Project Traffic Forecasting Handbook***. The material includes workable examples for the attendee to apply the lessons learned.

More information available in the Systems Implementation Office Website:
https://www.fdot.gov/planning/systems/training.shtm

7. FORMS

No forms are required by this procedure.

Florida Department of Transportation

RON DESANTIS
GOVERNOR

605 Suwannee Street
Tallahassee, FL 32399-0450

JARED W. PERDUE, P.E.
SECRETARY

July 12, 2023

Jose J. Ortiz
Project Delivery Team Leader
Federal Highway Administration
3500 Financial Plaza, Suite 400
Tallahassee, Florida 32312

JOSE J ORTIZ-ALEMANY
Digitally signed by JOSE J ORTIZ-ALEMANY
Date: 2023.07.12 07:54:30 -04'00'

Re: Project Traffic Forecasting, Florida Standard K

Dear Mr. Ortiz:

We have submitted, for your approval, modification to the approved Florida "Standard K". The current Standard K values used in Florida projects were developed using data that is more than 10 years old. The current Standard K values were determined using traffic data from a time period that included the State experiencing varying economic cycles including the great recession. Recently, several projects documented a need for deviation from the Standard K based on collected field counts.

The Department undertook a review and update to these values and provided the attached white paper to FHWA and is proposing an update to this practice. The new approach is to provide K factor ranges consistent with the FDOT's adopted Context Classification System. The new approach will provide flexibility to the planners, designers and analysts as they proceed with their project. The new proposed K Factor Ranges have also been developed using traffic data and studies that are more consistent with the recent development across the state of Florida.

FDOT request FHWA's approval of these updated "K Factor Ranges", by your concurrence on this letter. If you have any questions relating to this change, please call me at (850) 414-4909.

Sincerely,

DocuSigned by:
Jenna Bowman
4AD03E6A337F4C1...

Jenna Bowman, P.E.
Systems Management Administrator

jb/jb
Attachment

FDOT White Paper

Standard K Evaluation

Prepared for: Florida Department of Transportation

Systems Implementation Office

January 2022

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I. Introduction

In 2011, based on comprehensive analyses and extensive public outreach, the Florida Department of Transportation (FDOT) established statewide "Standard K Factors" that are applied to develop project traffic forecasts from the planning phase through the design phase of the project. The Standard K Factors also reflect urban development patterns and economic activities. The existing 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 current Standard K values used in Florida projects were developed using data that is more than 10 years old. The current Standard K values were determined using traffic data from a time period that included the State experiencing varying economic cycles including the great recession. Recently, several projects documented a need for deviation from the Standard K based on collected field counts. The purpose of this White paper is to:

i) Determine if the Standard K in Florida should be recalculated to a new value that would better reflect project field conditions.
ii) Investigate if the Standard K should be changed from an absolute value to a new K Factor Range from which a single K Factor, within the range, can be determined based on the project's conditions.
iii) Classify the K Factor Range based on FDOT Context Classification.

A. *What is the K Factor?*

The K Factor is defined as the proportion of annual average daily traffic (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. The Design Hour Volume (DHV) is total traffic in both directions expected to occur during the design hour, and it is determined by multiplying the AADT by the K Factor. For roadways with a high peak period and relatively low off-peak flows, the K Factor is expected to be higher. Conversely, for roadways that demonstrate consistent and heavy flows for many hours of the day, the K Factor is likely to be lower. The equation below shows the relationship between AADT, DHV, and K:

$$DHV = AADT \times K$$

The K Factor was originally developed by arranging hourly volumes in descending order of magnitude and the use of the 30th highest hour in relation to AADT. This was introduced in the 1950 Highway Capacity Manual. It was inferred that designing roads to the 30th highest hourly traffic volume of the year with an emphasis on rural areas was highly cost-effective. The term developed for the practice of converting daily volumes to the 30th highest volume became K30, commonly referred to as the "design hour." In subsequent years the terms, K30 and "design hour" were extended into urban areas as well as rural areas. The K30 has appeared in later editions of the Highway Capacity Manual and is routinely referenced in college traffic engineering textbooks. In Florida, prior to the Standard K, the K30 was used to establish design traffic for planning, Project Development and Environment (PD&E) and design studies.

B. *What is the Existing Standard K?*

Based on comprehensive analyses and agency coordination, FDOT established statewide "Standard K Factors" that should be applied to develop project traffic forecast from the planning phase through the design phase of a project. FDOT's existing Standard K Factors are presented in the FDOT Project Traffic Forecasting Handbook and provided below in **Table 1**. The Standard K Factors are also reported in the Florida Traffic Online (FTO) Web

Application. The Standard K Factor is used as a means to define the design of highway facilities to accommodate a target level of operations under a specific traffic loading. The use of statewide Standard K Factors promotes better transportation policies and projects, reduces time and effort in developing peak hour numbers, offers consistency and simplicity and represents a sensible approach relating to development and transportation improvements. Standard K Factors for planning and design analyses are not directly applicable to toll facilities. This is due to the toll facilities calculating their own K Factors based on counts at their toll locations and the difference in operations of a toll facility and the general freeway. The existing Standard K Factors are categorized by roadway and area types.

Table 1: FDOT's Existing 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 approval 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.

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-95 in the Miami area). Core areas are expected to have unique lower Standard K Factors as a result of heavy flows for many hours of the day. These are further explained in the Roadway Classification section of this White Paper. A lower 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.

When there have been cases where the Standard K Factors may not directly apply, short-term traffic counts that include both weekdays and weekends should be collected. The K Factors for these projects should then be developed by analyzing the short-term traffic counts and relevant traffic information from FTO, if available. If it is determined based on the counts or other project information, that the project K Factor should deviate from the Standard K, then the data should be presented to the respective District's Planning Department and FDOT Systems Implementation Office (SIO) for approval.

II. K Factor Analysis and Findings

Recently, FDOT SIO has received several projects requesting a deviation from the Standard K Factor. The proposed deviation from the Standard K Factor has been supported with the field count information to approve altering the Standard K factor. As a result of these requests, FDOT SIO has initiated this review of the statewide Standard K Factors. The purpose of this study is to determine if a modification to the Standard K Factors is needed. In order to perform the analysis and make this determination, two (2) data sources were used:

a) Count data from the FDOT Transportation Data & Analytics Office (TDA) and
b) Field counts from recent project studies performed across the State.

A. *Roadway Classifications*

FDOT has adopted a Context Classification System comprising eight context classifications in its efforts to plan, design, construct and operate a context-sensitive system. The context classification system broadly identifies the various built environments existing in Florida. FDOT's context classification system describes the general characteristics of the land use, development patterns, and roadway connectivity along a roadway, providing cues as to the types of uses and user groups that will utilize the roadway. The context classification of a roadway should be considered when selecting a K Factor for the project. The eight types of context classifications are described and shown in **Figure 1**.

Figure 1: FDOT Context Classifications

C1-Natural
Lands preserved in a natural or wilderness condition, including lands unsuitable for settlement due to natural conditions.

C2-Rural
Sparsely settled lands; may include agricultural land, grassland, woodland, and wetlands.

C2T-Rural Town
Small concentrations of developed areas immediately surrounded by rural and natural areas; includes many historic towns.

C3R-Suburban Residential
Mostly residential uses within large blocks and a disconnected or sparse roadway network.

C3C-Suburban Commercial
Mostly non-residential uses with large building footprints and large parking lots within large blocks and a disconnected or sparse roadway network.

C4-Urban General
Mix of uses set within small blocks with a well-connected roadway network. May extend long distances. The roadway network usually connects to residential neighborhoods immediately along the corridor or behind the uses fronting the roadway.

C5-Urban Center
Mix of uses set within small blocks with a well-connected roadway network. Typically concentrated around a few blocks and identified as part of a civic or economic center of a community, town, or city.

C6-Urban Core
Areas with the highest densities and building heights, and within FDOT classified Large Urbanized Areas (population >1,000,000). Many are regional centers and destinations. Buildings have mixed uses, are built up to the roadway, and are within a well-connected roadway network.

The measured K values obtained from the FDOT TDA and K values calculated from project studies were categorized into roadway classifications based on the context classifications discussed above. All roadway classifications were determined using the FDOT Preliminary Context Classification GIS shapefile and following the guidance in the 2020 FDOT Context Classification Guide.

In addition to the FDOT context classification, three additional roadway classifications were included for limited access facilities - Limited Access-Rural, Limited Access-Urban and Limited Access-Urban Core.

Urban and urban core areas are defined as an approved boundary, which encompasses the entire Census Urbanized Area, as well as the surrounding geographic area likely to become urbanized within the next 20 years, as agreed on by FDOT, Federal Highway Administration (FHWA), and the Metropolitan/Transportation Planning Organization (MPO/TPO). Urban core area types are distinguished by whether the area's population is more or less than one million. Currently, the grouping of more than one million applies to the MPO areas that include central cities: Fort Lauderdale, Jacksonville, Miami, Orlando, St. Petersburg, Tampa, and West Palm Beach. These are referred to as "urban core." The minimum population for an urban area is 5,000. Generally, for a rural area, the population is between 500 and 5,000 and not immediately adjacent to the urban core or urban areas

B. *FDOT Transportation Data & Analytics Office*

Two forms of measured K data were obtained from the FDOT TDA Office:

i) 200 Highest Hour Reports from continuous traffic monitoring sites and
ii) Roadway measured K value from all sites, also known as the K30.

200 Highest Hour Reports

The 200 Highest Hour Reports provide K Factors for the 200 highest hours of the year. The 200 Highest Hour Reports, for all permanent or continuous traffic monitoring sites across the state from 2017 to 2019, were obtained from the FDOT TDA. The Reports provide directional and bidirectional counts for 200 highest hour. The Reports also provide the measured Directional (D) Factor and K Factor for each of the 200 highest peak hours. Using the 200 measured K Factors, an approximate K Factor range for each type of roadway classification was determined. The year 2020 200 Highest Hour Reports were also reviewed for approximately fifty percent of the permanent count stations across the state. After a review of the 2020 K Factor values, it was determined the 2020 data was not representative of normal conditions due to the COVID-19 pandemic. As a result, the 2020 data was not incorporated in this K Factor analysis.

To determine a range of K Factor values using the 200 Highest Hour Reports, the following methodology was used. 271 permanent count sites were used across the state to determine the K1, K30 and K200 factors. The K100 value was considered but not mapped for the purpose of this analysis. By using all available permanent count sites, it ensured a good sample size for most of the context classifications and limited access facilities. C5-Urban Center and C6-Urban Core were not reviewed using the 200 Highest Hour Reports. These roadway classifications were not included because there is a small sample size of permanent count stations for these roadway classifications. A small number of permanent stations are located in C5-Urban Central and C6-Urban Core roadways because of the high volume of traffic they experience that requires regular maintenance. These roadways were reviewed using the K30 and project studies measured K Factors and are discussed in later sections.

The 200 Highest Hour Reports were then reviewed and the K1, K30 and K200 were extracted from the text file reports. These K values were then imported into excel for the years 2017 to 2019. Once all the data was input into the excel spreadsheet, each count station was assigned its appropriate roadway classification.

For each year, an average K1, K30 and K200 was then calculated for the roadway segments with the following classifications: C1-Natural, C2-Rural, C2T-Rural Town, C3R-Suburban Residential, C3C-Suburban Commercial, C4-Urban General, Limited Access-Rural, Limited Access-Urban and Limited Access-Urban Core. To summarize all the analysis years, the individual year values were averaged to determine the K1, K30 and K200. The results are provided in **Table 2**. **Table 2** also includes the existing Standard K Factor assigned to these count stations.

Table 2: Summary of 200 Highest Hour Report K Factors

Roadway Classification	# of Stations**	Existing Standard K	K1	K30	K200
C1-Natural	7	9.50%	20.33%	12.30%	9.92%
C2-Rural	87	9.50%	16.56%	11.51%	9.50%
C2T-Rural Town	10	9.0 – 9.5%*	12.77%	10.66%	9.29%
C3R-Suburban Residential	56	9.0 – 9.5%*	10.86%	9.70%	8.96%
C3C-Suburban Commercial	26	9.0%	11.48%	10.10%	9.26%
C4-Urban General	20	9.0%	10.28%	9.39%	8.73%
Limited Access-Rural	25	10.5%	14.65%	11.42%	9.56%
Limited Access-Urban	27	9.0%	9.98%	9.07%	8.36%
Limited Access-Urban Core	11	8.0%	8.91%	8.49%	8.07%

* Stations have an existing Standard K of 9.0 or 9.5
**Two (2) sites for C5-Urban Central Roadway were not included because of the small sample size
**No sites for C6-Urban Core were available

K30

In addition to the 200 Highest Hour Reports, the FDOT TDA provided the measured K from 2017 to 2019 for all sites (continuous and short-term traffic monitoring) in Florida. The measured K Factor provided by the FDOT TDA is the same or close to the K30 value. The K30 was singled out because the K30 has appeared in the Highway Capacity Manual and is routinely referenced in college traffic engineering textbooks. In addition, prior to implementation of the Standard K, the K30 was used to establish design traffic. Using the measured K or K30, an approximate K Factor range for each type of roadway classification was determined. Similar to the 200 Highest Hour Reports, the 2020 K30 values were reviewed but not used as it was determined it was not representative of normal conditions due to the COVID-19 pandemic.

By summarizing all the design hour measured K Factors across the state, a range could be determined for each roadway classification. Using this range based on K30 values, a K Factor range was determined.

To determine a range of K Factor values using the K30, the following methodology was used. The provided K30 values were plotted on a map using the Roadway ID, Begin Milepost and End Milepost. After the K30 values were mapped, the FDOT Preliminary Context Classification GIS shapefile was overlayed in the map and each roadway segment was assigned its corresponding roadway classification. After the roadway classifications were assigned, the roadway segment miles were summed for the measured K30 values within each roadway classification category, including all three analysis years 2017 through 2019. Finally, within each roadway classification category, the percentage of roadway miles for each measured K30 value was calculated. It should be noted that the C1-Natural K30 range is not consistent with the 200 Highest Hour Reports. This could be attributed to the small sample size of 200 Highest Hour Reports for C1-Natural roadways in the state. The 200 Highest Hour Reports are prepared using permanent count stations which are not commonly placed on C1-Natural roadways.

Once the percentage of roadway miles was calculated, it was quickly noted that the majority of the K30 factors for each roadway classification were within two percentage points. This range for each roadway classification is highlighted in **Table 3**. In addition, the ranges of measured K factors are shown in **Figure 2** to **Figure 12**.

Table 3: K30 Value by Percentage of Roadway Miles

K30	C1	C2	C2T	C3R	C3C	C4	C5	C6	Limited Access Rural	Limited Access Urban	Limited Access Urban Core
6.5	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	9%
7.0	3%	0%	0%	0%	0%	2%	4%	4%	0%	1%	12%
7.5	3%	0%	0%	1%	2%	7%	8%	13%	1%	2%	2%
8.0	0%	0%	0%	1%	2%	9%	8%	20%	1%	7%	5%
8.5	1%	1%	0%	8%	11%	15%	17%	22%	1%	12%	16%
9.0	6%	5%	8%	18%	22%	17%	11%	14%	8%	20%	22%
9.5	25%	18%	21%	38%	21%	28%	24%	16%	10%	20%	24%
10.0	20%	25%	24%	12%	17%	7%	14%	3%	6%	19%	0%
10.5	12%	14%	11%	11%	10%	11%	8%	8%	11%	12%	4%
11.0	7%	7%	7%	4%	8%	3%	3%	1%	15%	5%	0%
11.5	8%	10%	8%	4%	4%	2%	2%	0%	16%	2%	2%
12.0	2%	9%	9%	1%	1%	0%	0%	0%	14%	0%	3%
> 12.0	14%	11%	13%	2%	2%	0%	0%	0%	16%	1%	1%

Figure 2: K30 Value by Percentage of Roadway Miles for C1-Natural Roadways

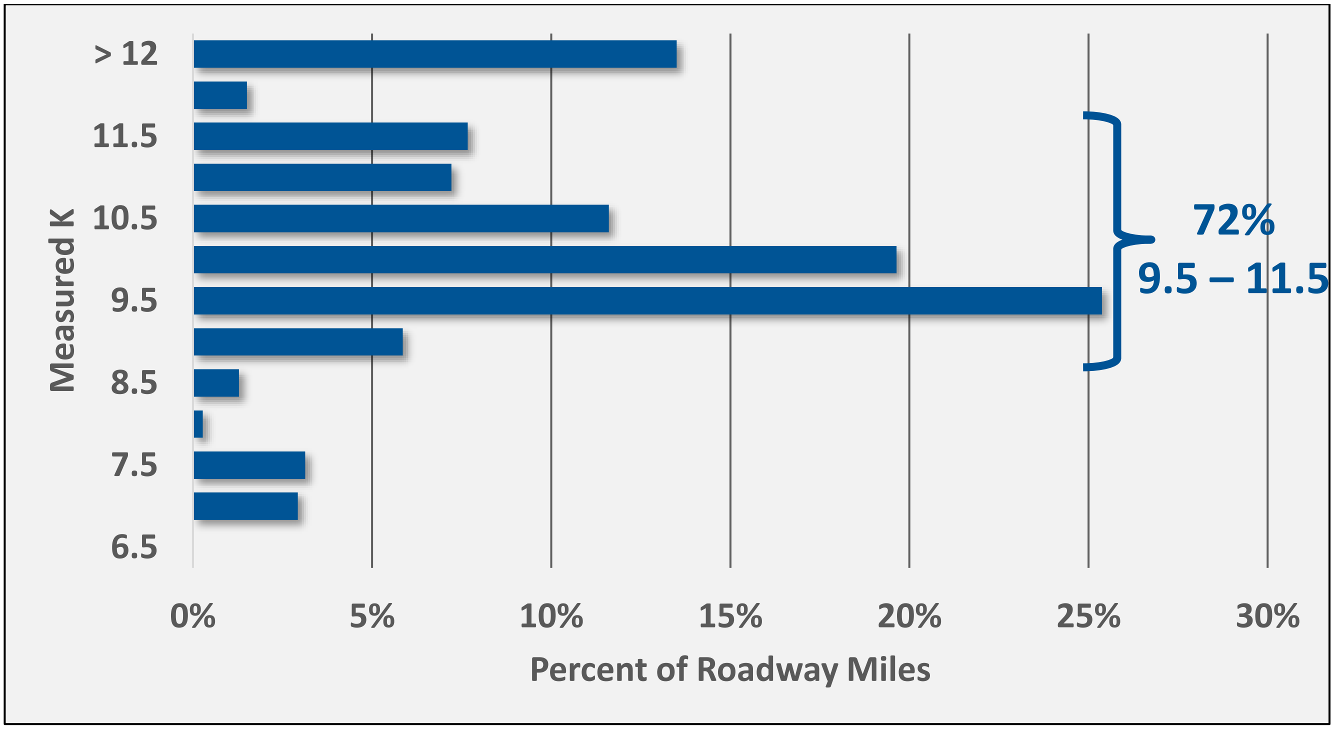


Figure 3: K30 Value by Percentage of Roadway Miles for C2-Rural Roadways

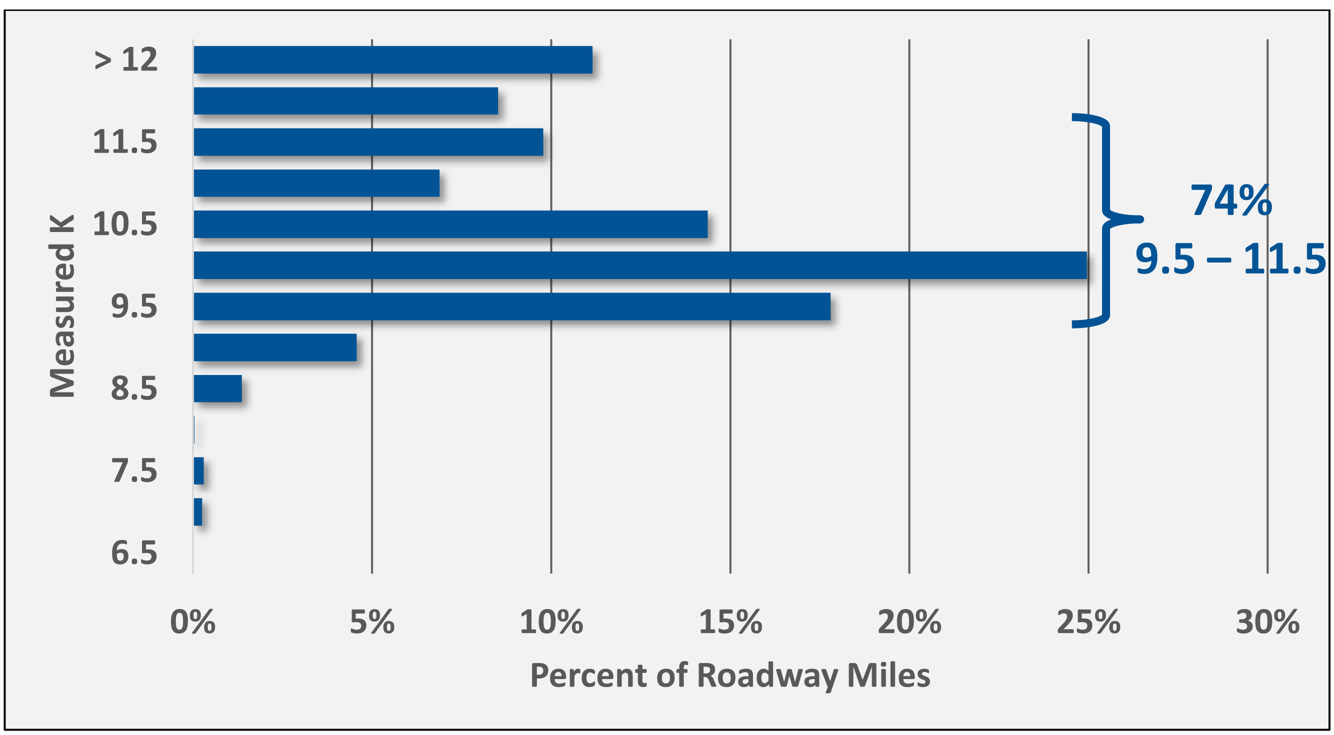


Figure 4: K30 Value by Percentage of Roadway Miles for C2T-Rural Town Roadways

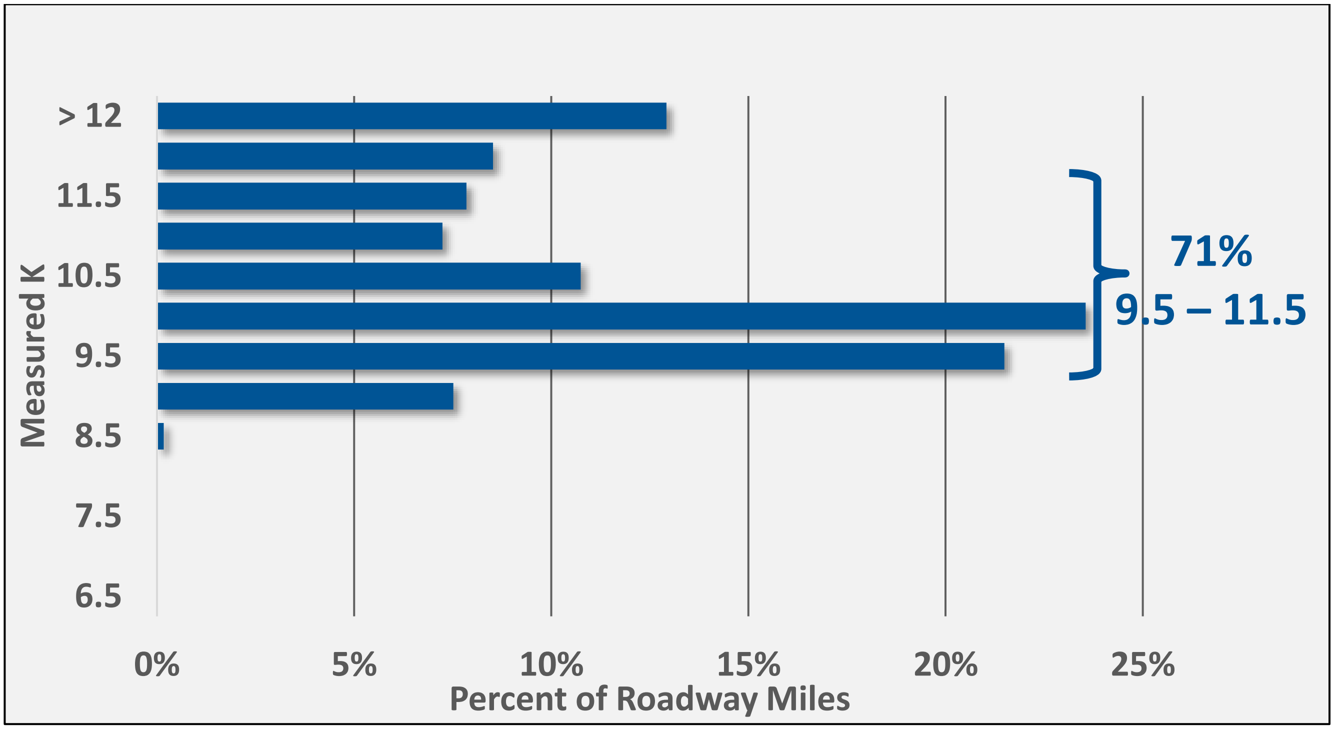


Figure 5: K30 Value by Percentage of Roadway Miles for C3R-Suburban Residential Roadways

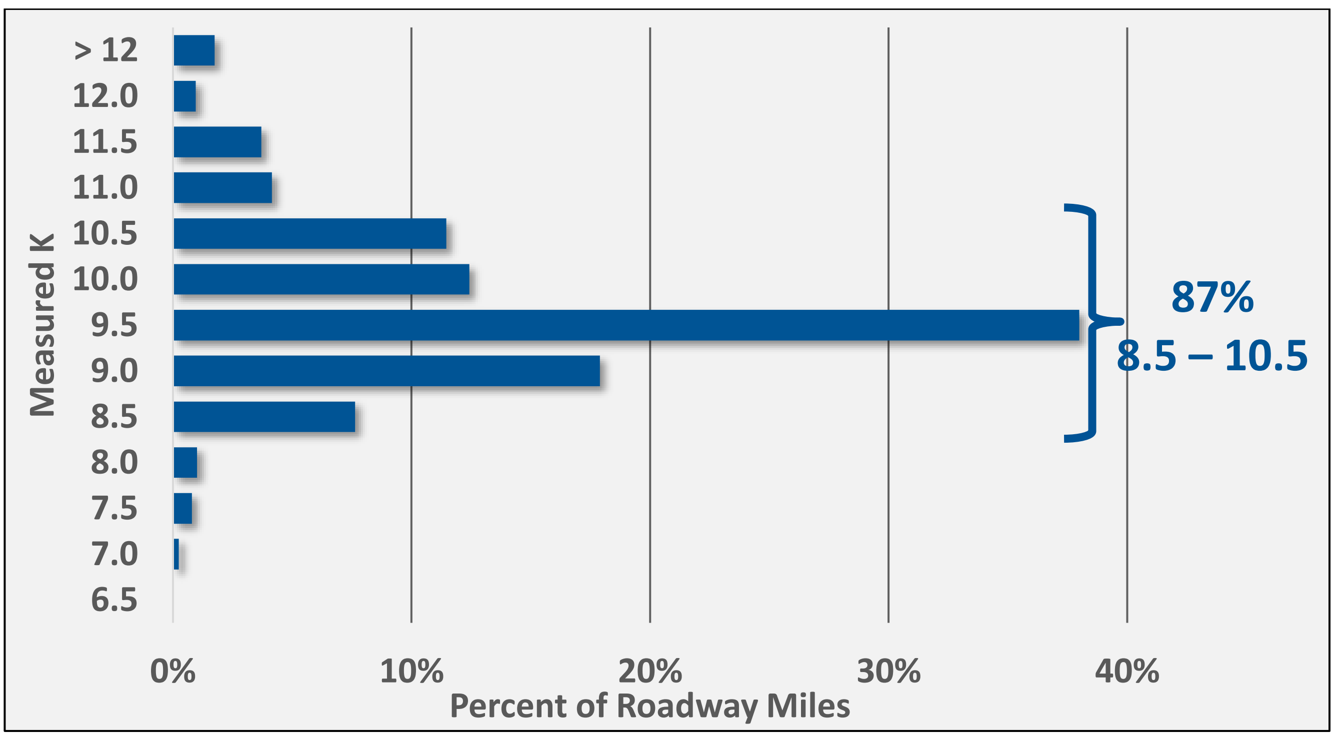


Figure 6: K30 Value by Percentage of Roadway Miles for C3C-Suburban Commercial Roadways

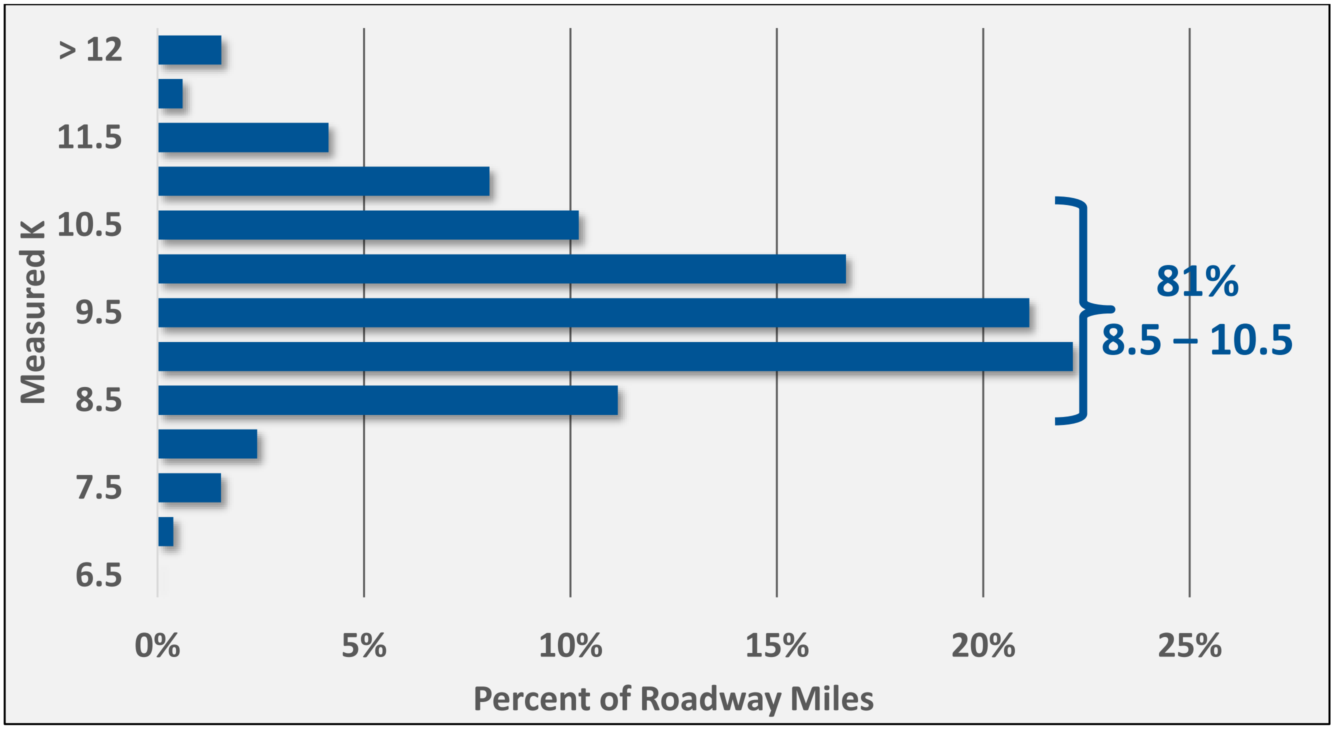


Figure 7: K30 Value by Percentage of Roadway Miles for C4-Urban General Roadways

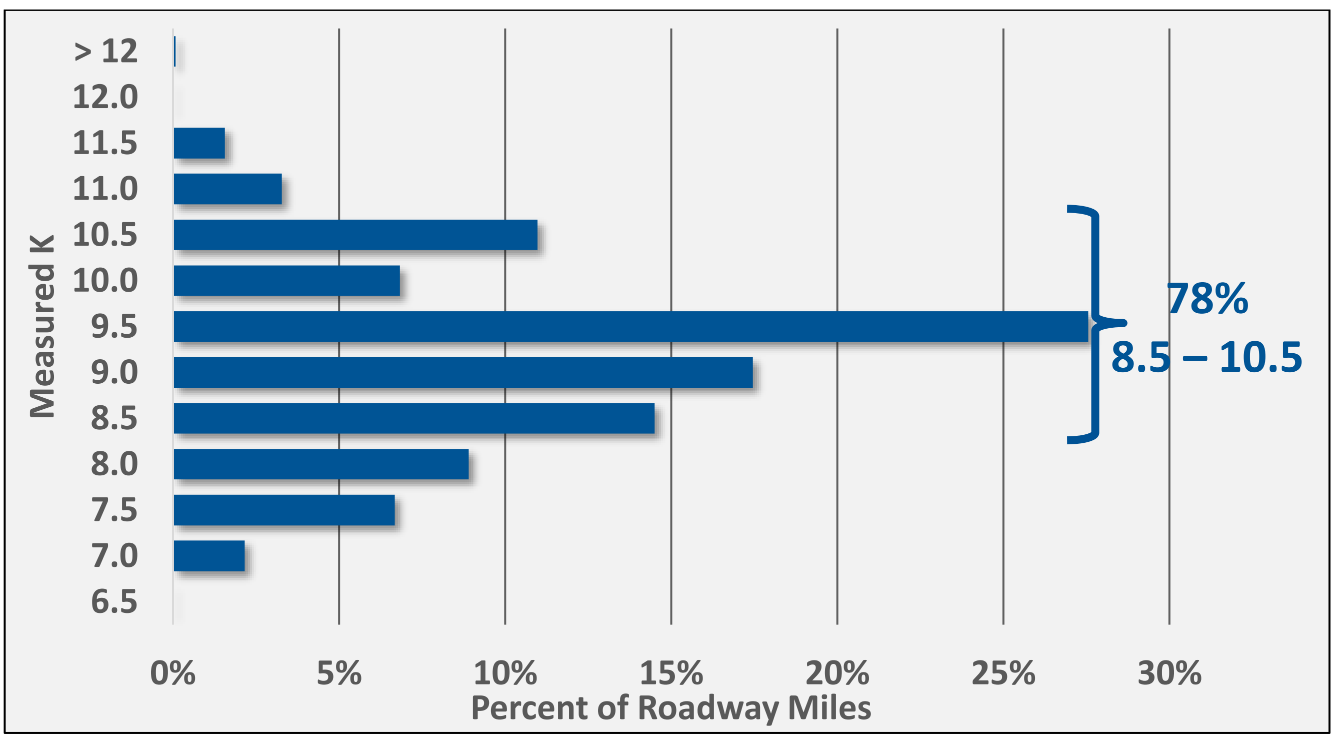


Figure 8: K30 Value by Percentage of Roadway Miles for C5-Urban Center Roadways

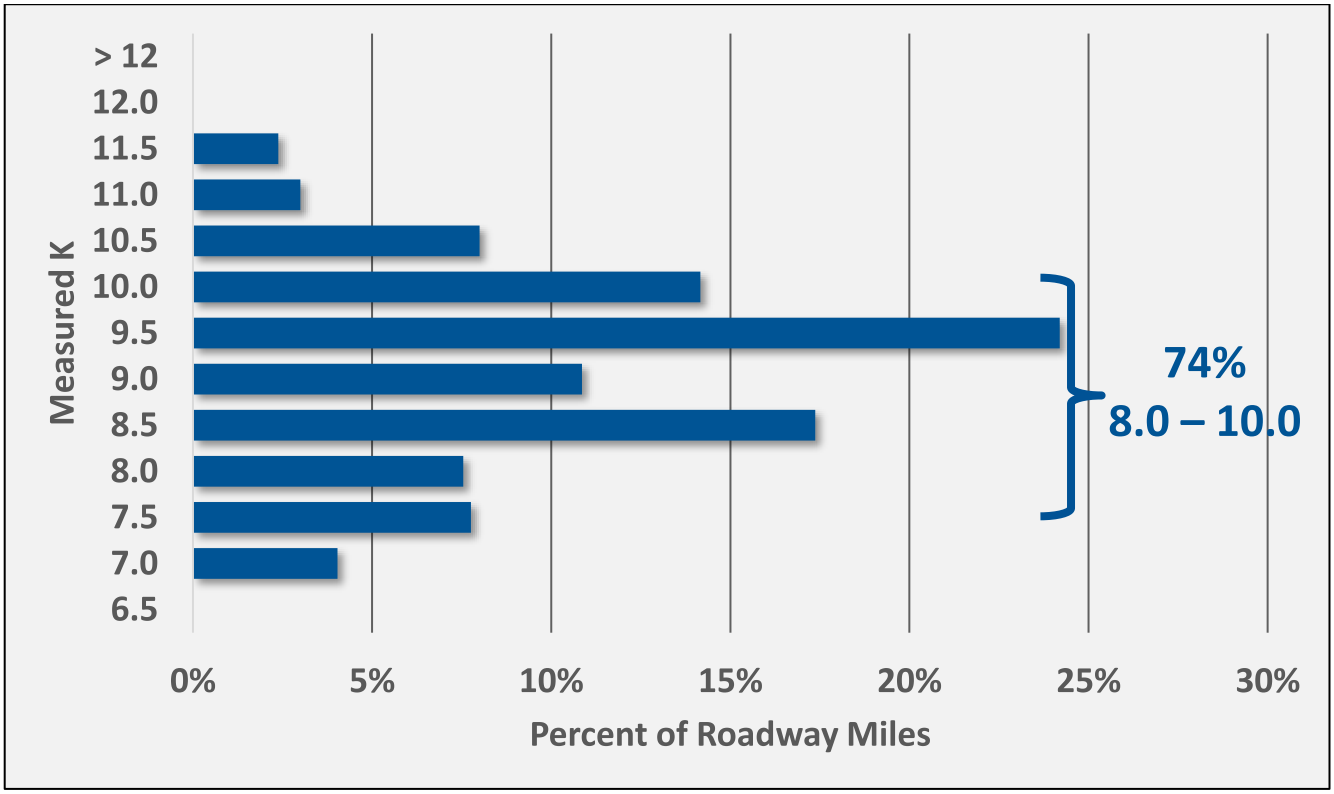


Figure 9: K30 Value by Percentage of Roadway Miles for C6-Urban Core Roadways

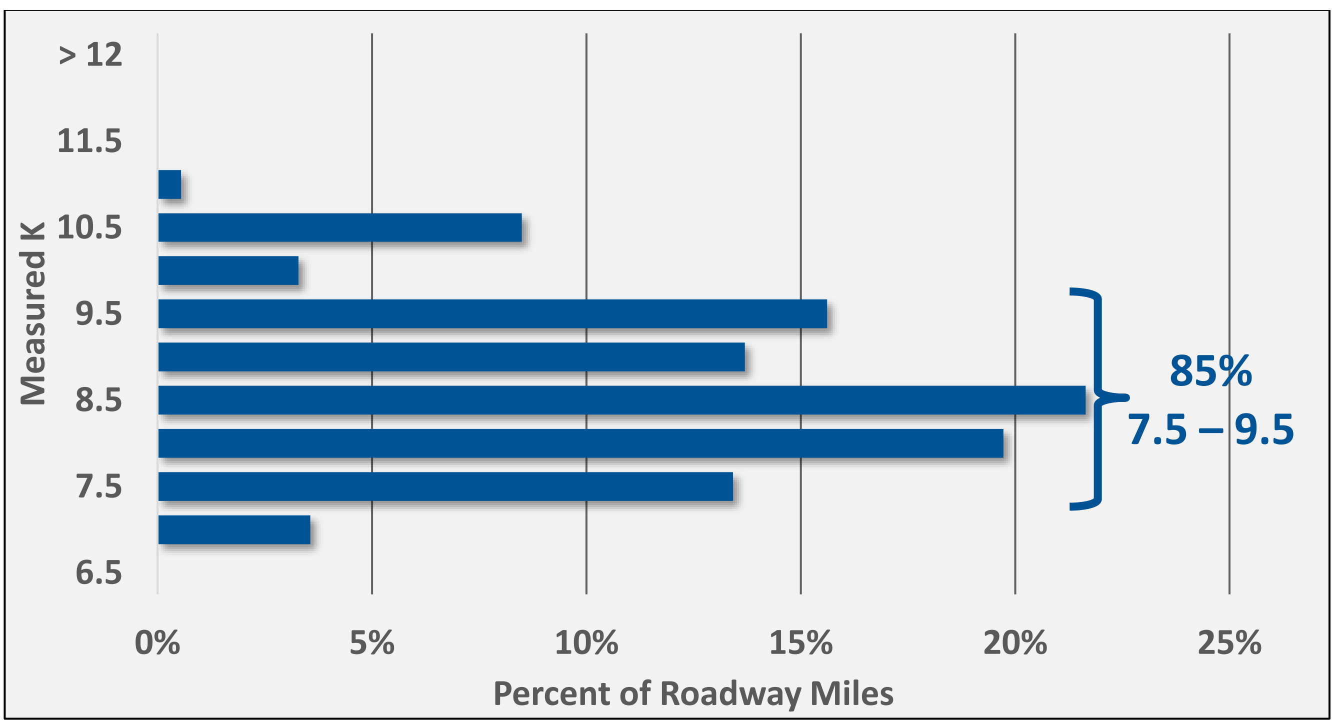


Figure 10: K30 Value by Percentage of Roadway Miles for Limited Access-Rural

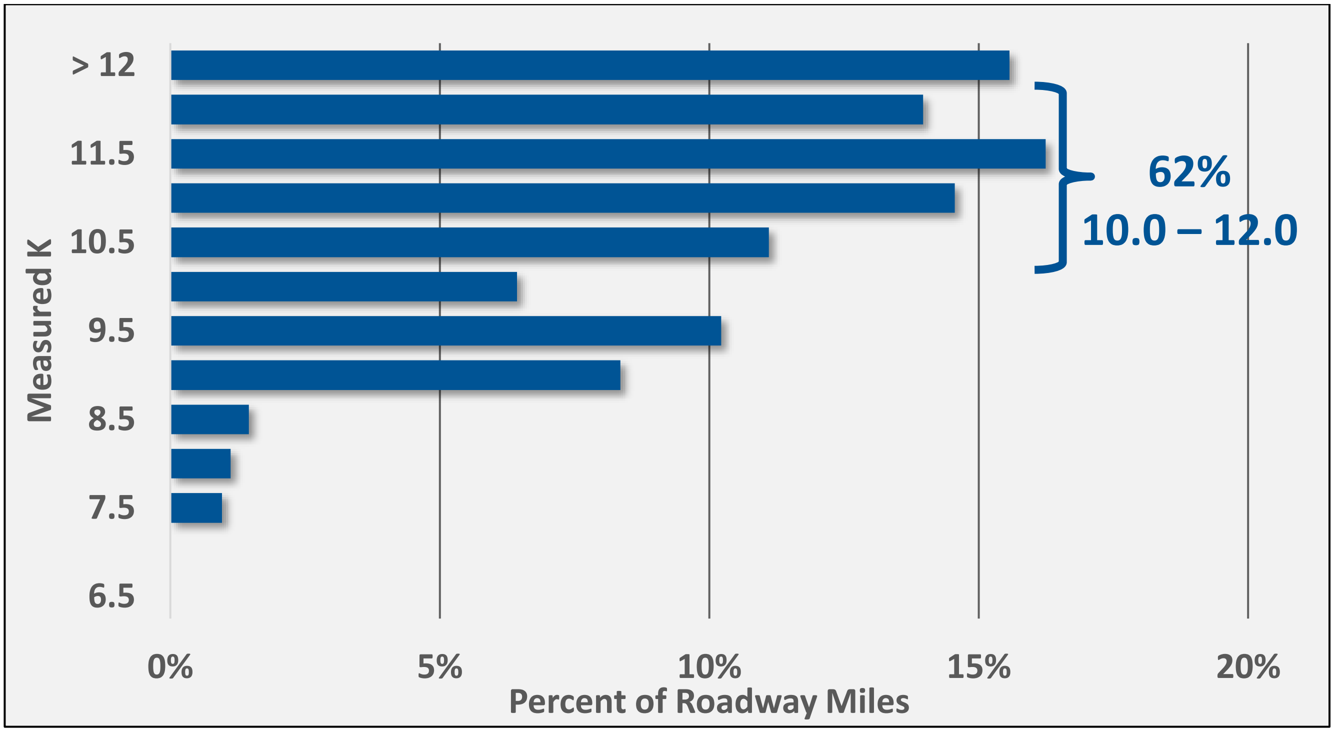


Figure 11: K30 Value by Percentage of Roadway Miles for Limited Access-Urban

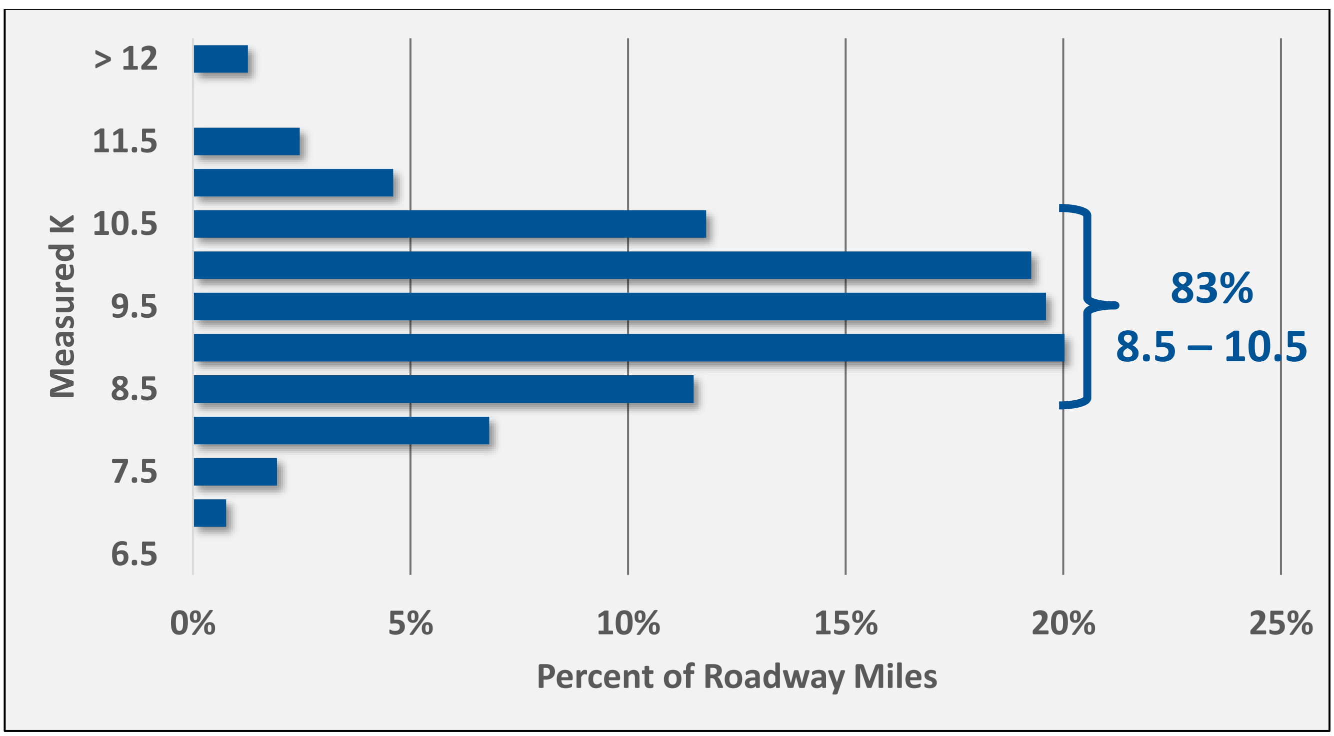
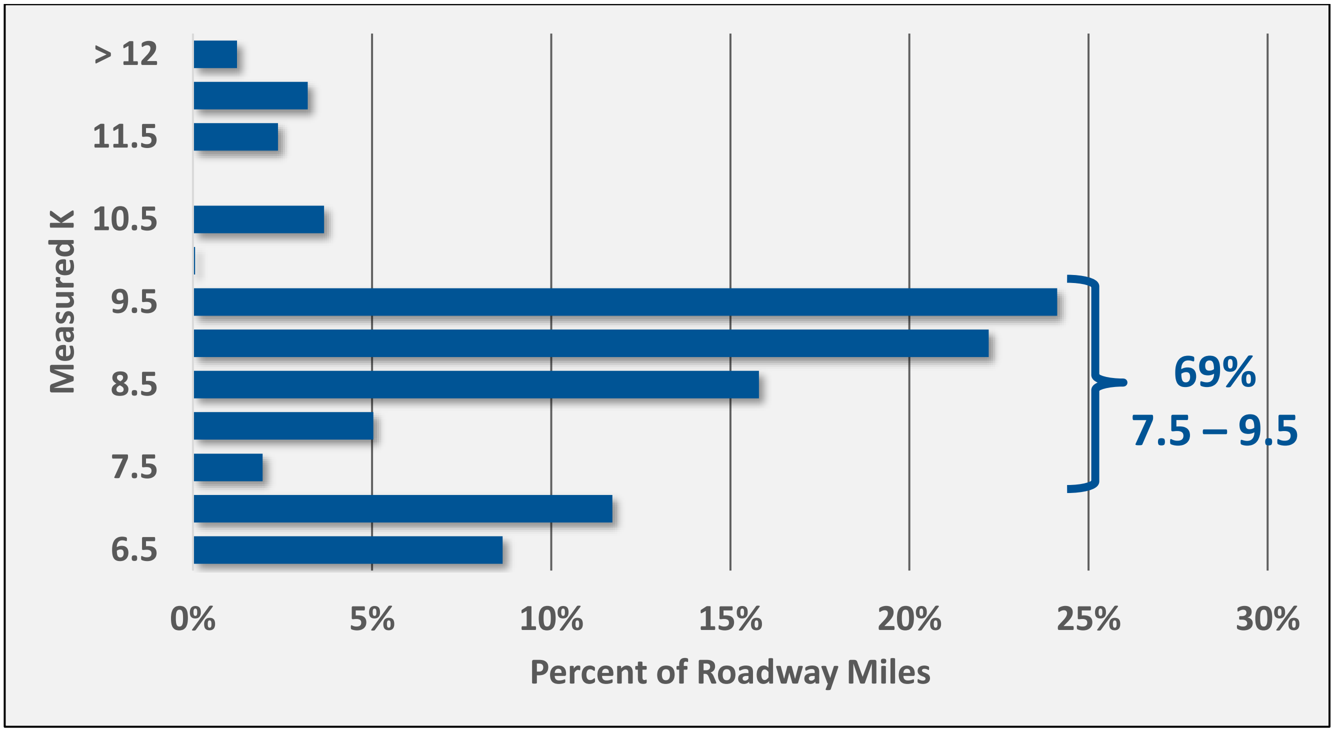


Figure 12: K30 Value by Percentage of Roadway Miles for Limited Access-Urban Core



C. *Project Studies*

In addition to the count data provided by the FDOT TDA, recent daily field counts performed for various studies throughout the state were obtained and analyzed. The field counts allow for an additional perspective of traffic that should be considered to provide judicious recommendations. The daily field counts were obtained from recent project studies requested from all FDOT Districts.

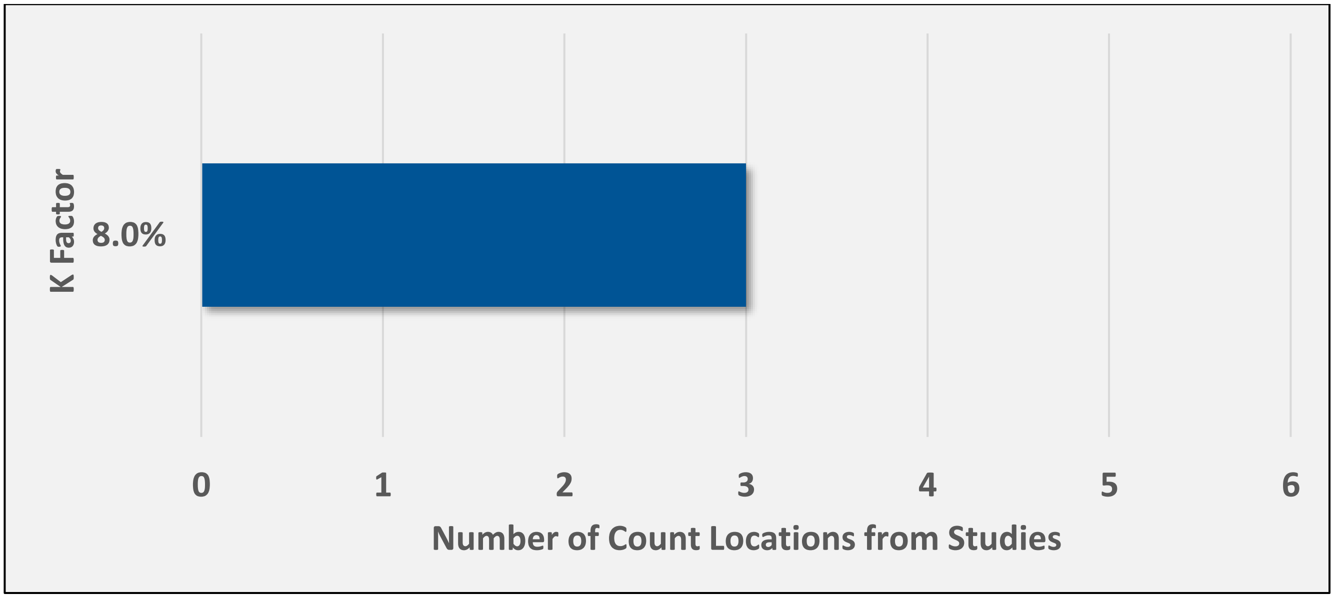
To calculate the measured K Factors based on field count data, the following methodology was used. To calculate the measured K, it was determined that 24-hour, 48-hour, 72-hour or 7-day counts could be used. Several studies were reviewed to see if the appropriate count data was available. The studies and District count data, shown in **Table 4**, provided a diverse collection of roadways and area types across the state.

Table 4: Project Studies

District	Study Name
1	I-75 at SR 884 (Colonial Boulevard) IMR
1	I-4 at SR 557 IMR
1	I-75 at Pine Ridge Road IOAR
1	D1 Counts
2	I-295 East Express Phase 1 SIMR
2	I-95 from I-10 to MLK SIMR
2	I-10 at SR 121 IMR
2	I-95 Express from I-295 to Atlantic
3	I-10 at SR 99 (Beulah Road) IJR
3	I-10 at Antioch Road IJR
3	I-10 at SR 85 IMR
4	I-95 at 10th Avenue N IMR
4	I-75 at SR 820 (Pines Boulevard) IMR
4	I-95 at Woolbright Road IMR
4	I-95 from S of SR 870 to N of Cypress Creek Road SIMR
5	I-4 at Sand Lake Road IMR
5	SR 535 PTAR
5	I-75 PD&E North
5	I-75 PD&E South
5	I-95 at US 1 IMR
5	I-95 at LPGA IMR
5	I-95 at Pioneer Trail IJR
5	D5 Counts
6	I-95 at SW 7th & 8th Street IMR
6	I-195 at N Miami Avenue IMR
6	SR 826 Data Collection Report
7	I-75 at Big Bend Road IMR
7	I-75 at US 301 IMR

Using the field counts performed for each of the studies, the peak hour was determined and a K Factor was calculated. After the K Factor was calculated for each count location, the roadway classification was assigned to the count location. Then, within each roadway classification category, the total number of count locations with the same measured K were summed. For example, three separate count locations for context classification of C3C-Suburban Commercial had a measured K of 7.5%. This process was performed for all applicable roadway classifications that were included in the project studies. **Figure 13** to **Figure 22** summarize the K Factors for C1-Natural, C2-Rural, C2T-Rural Town, C3R-Suburban Residential, C3C-Suburban Commercial, C4-Urban General, C5-Urban Center and Limited Access facilities. The studies did not include count locations along C6-Urban Core roadways.

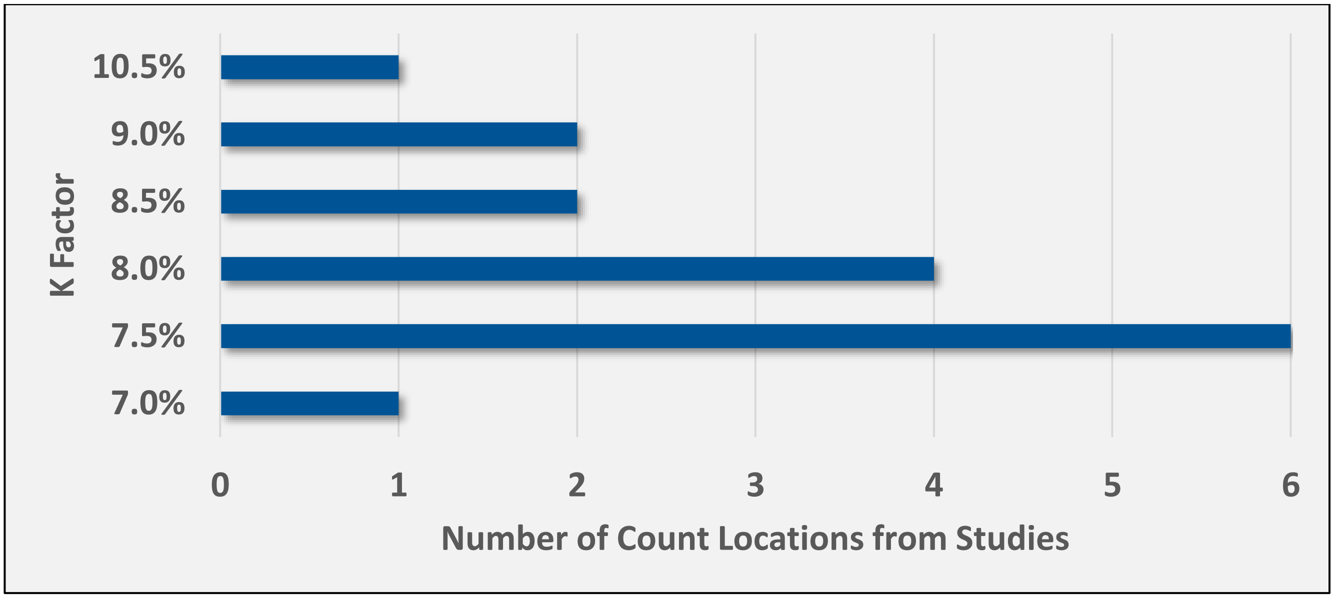
Figure 13: Project Studies K Factors for C1-Natural Roadways



K Factors were calculated for three C1-Natural count locations. It was determined that all three locations had a K Factor of 8.0. The K Factor from these three count locations was found to be significantly lower than the K Factor calculated using data from FDOT TDA. This is mainly because of the immediate land use surrounding the project sites. These project sites are from Interchange Access Request projects and the areas have more developed land use surrounding the interchange compared to the typical characteristics shown by C1 Natural Roadways. Also, it was found that even though these projects occurred in rural areas, they were surrounded by some highly developed areas. These developed areas generated high traffic that utilized the rural facility resulting in a lower K Factor. One project example is the I-4 at SR 557 Interchange Modification Report. The study area for this project is in a rural area but connected by two developed areas, Winter Haven and Celebration on either end.

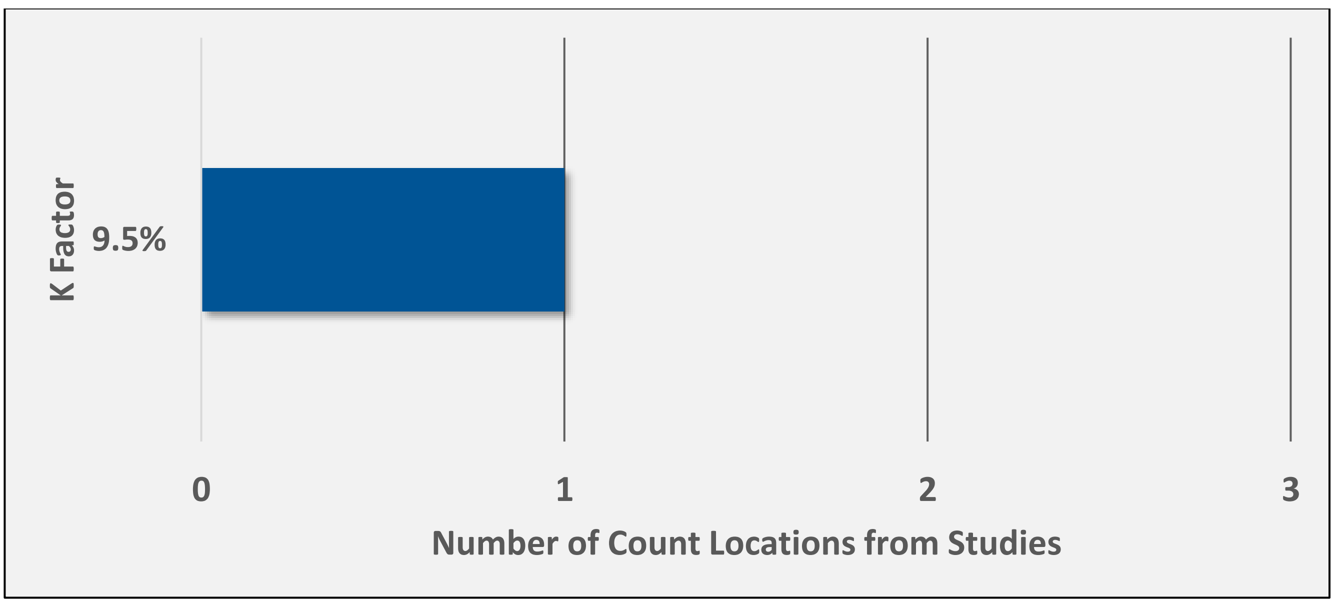
Due to the above-mentioned issues and lack of project count data for C1 Natural Roadways, the K Factor from count sites was given less weight versus the 200 Highest Hour Reports when recommending the final K Factor.

Figure 14: Project Studies K Factors for C2-Rural Roadways



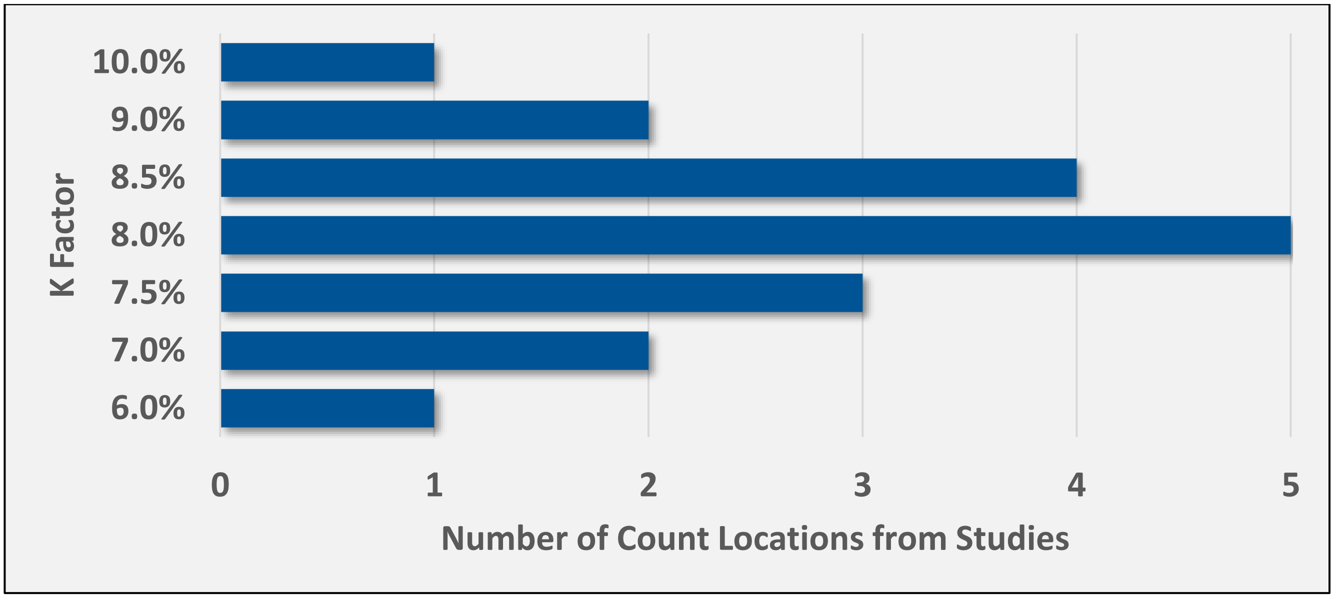
K Factors were calculated for sixteen C2-Rural count locations. It was determined the majority of the count locations had a K factor between 7.5 and 9.0. The K Factors from these sixteen count locations are lower than the data from FDOT TDA.

Figure 15: Project Studies K Factors for C2T-Rural Town Roadways



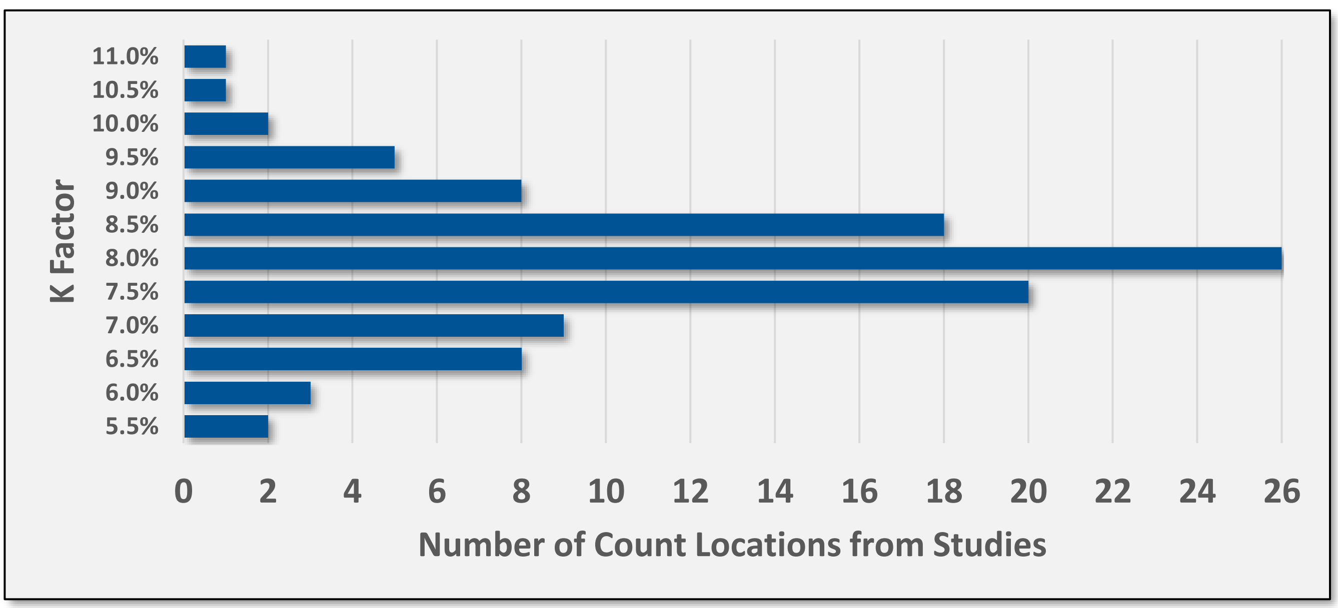
A K Factor was calculated for one C2T-Rural Town count location. It was determined the location had a K Factor of 9.5. The K Factor from this count location is comparable with the count data from FDOT TDA. Due to a lack of project count data for C2T-Rural Town Roadways, the K from count sites was given less weight versus the 200 Highest Hour Reports when recommending the final K Factor.

Figure 16: Project Studies K Factors for C3R-Suburban Residential Roadways



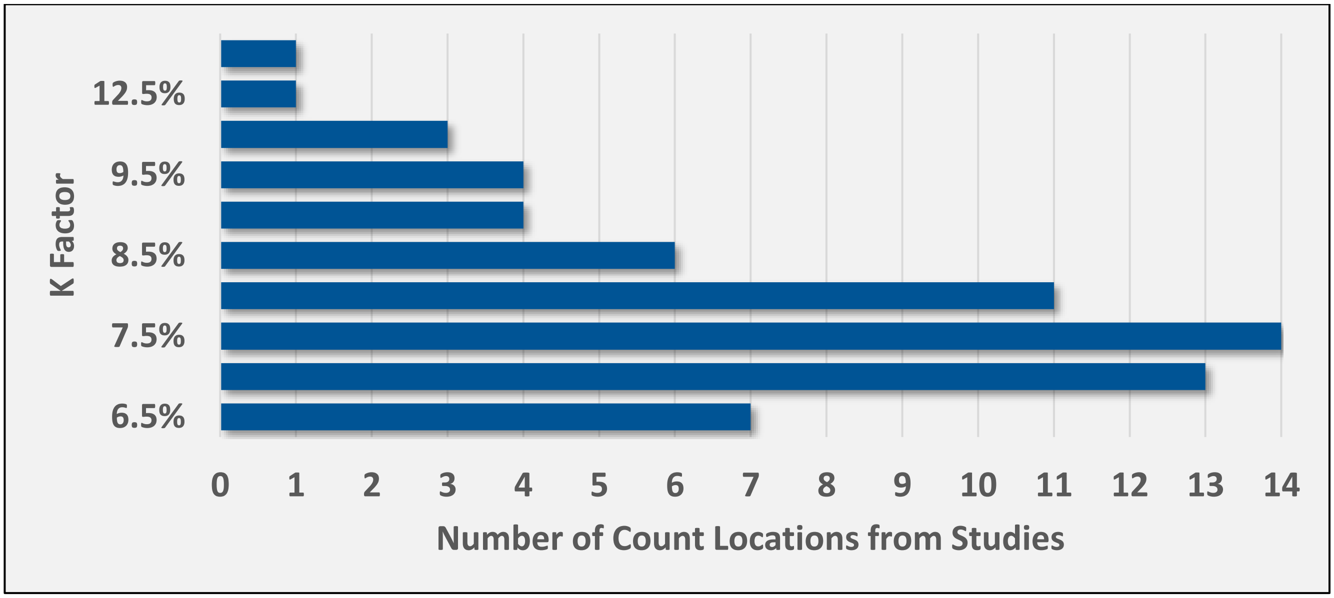
K Factors were calculated for eighteen C3R-Suburban Residential count locations. It was determined the majority of the K Factors are between 7.0 and 9.0. The K Factors from these count locations are lower than the count data from FDOT TDA.

Figure 17: Project Studies K Factors for C3C-Suburban Commercial Roadways



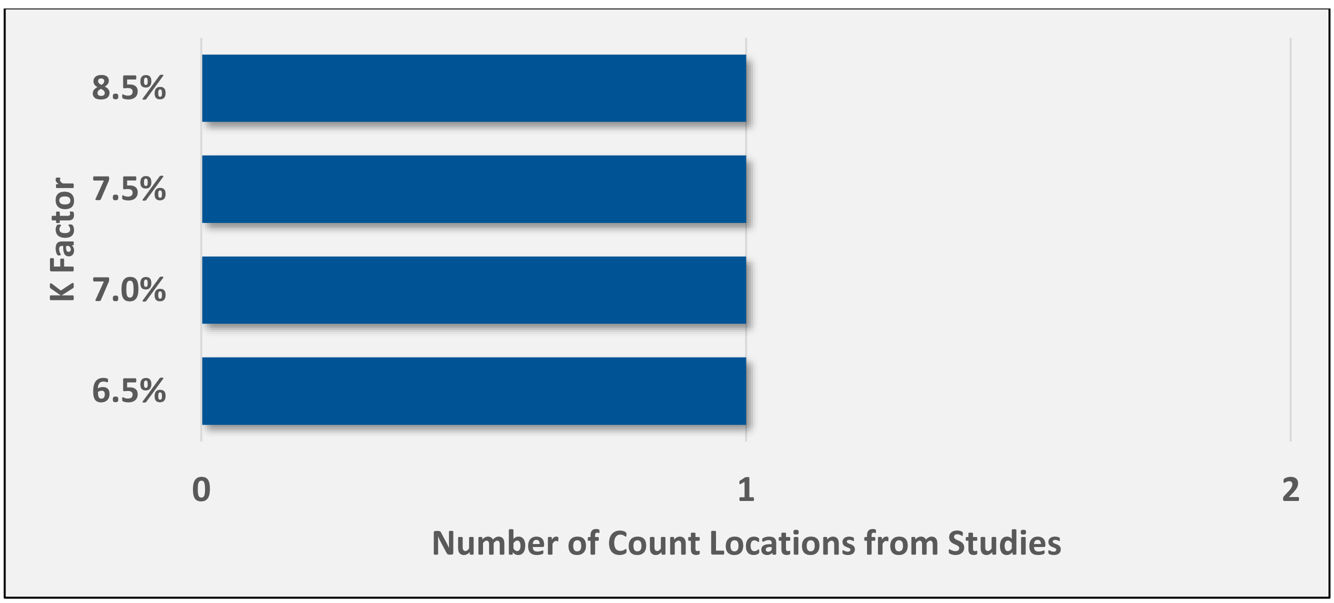
K Factors were calculated for 103 C3C-Suburban Commercial count locations. It was determined the majority of the count locations K Factor was between 7.0 and 9.0. The K Factors from these count locations are lower than the count data from FDOT TDA.

Figure 18: Project Studies K Factors for C4-Urban General Roadways



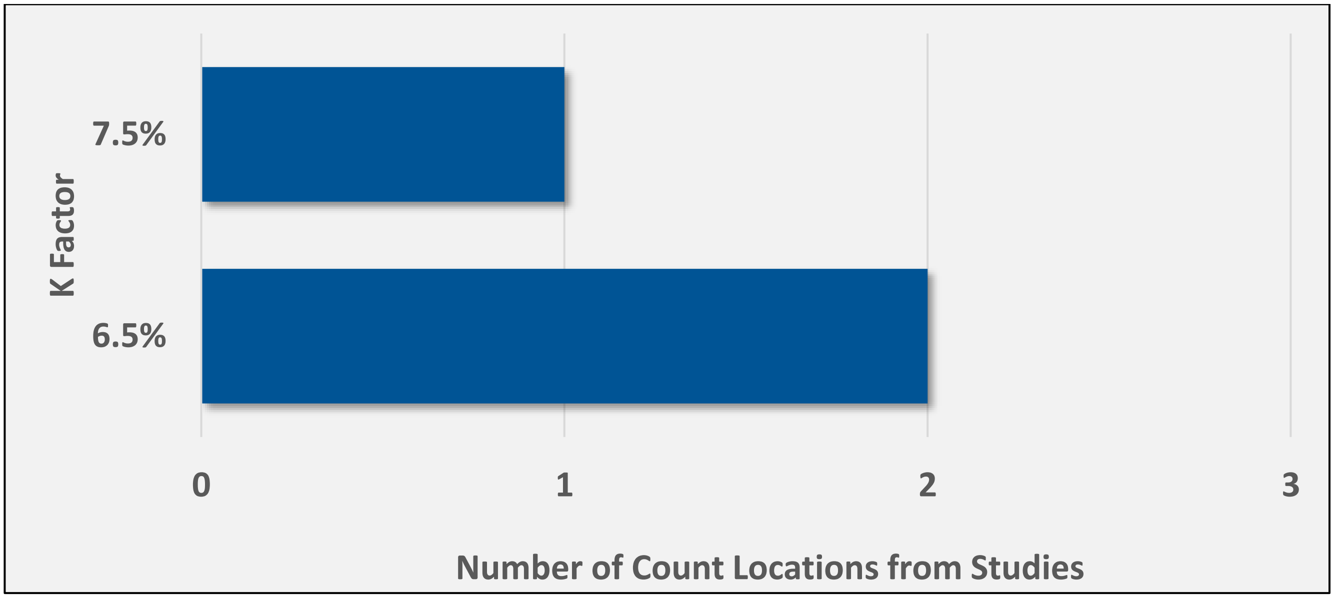
K Factors were calculated for sixty-four C4-Urban General count locations. It was determined the majority of the count locations had a K Factor between 6.5 and 8.5. The K Factors from these count locations are slightly lower compared to the count data from FDOT TDA.

Figure 19: Project Studies K Factors for C5-Urban Center Roadways



K Factors were calculated for four C5-Urban Center count locations. It was determined the count locations K Factor was between 6.5 and 8.5. The K Factors from these count locations are slightly lower compared to the count data from FDOT TDA. Due to a lack of project count data for C5-Urban Center Roadways, the K from count sites was given less weight versus the 200 Highest Hour Reports when recommending the final K Factor.

Figure 20: Project Studies K Factors for Limited Access-Rural Roadways

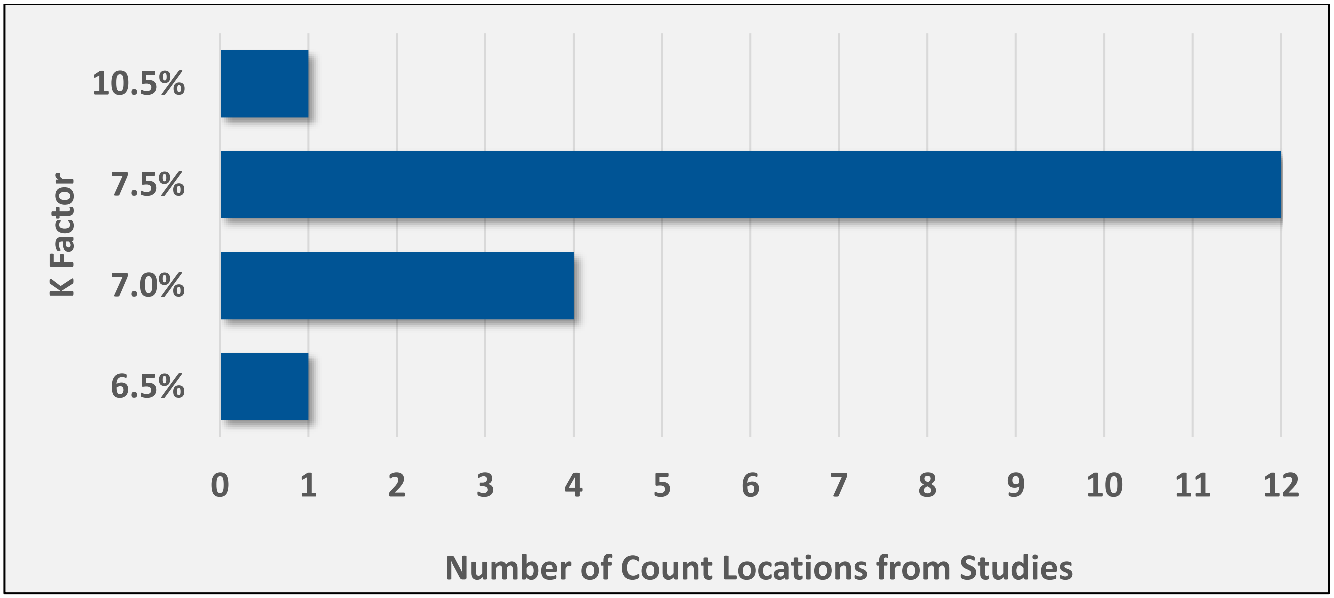


K Factors were calculated for three Limited Access-Rural count locations. The count locations have a K Factor between 6.5 and 7.5. The K Factors for these locations are lower compared to the K factors from the FDOT TDA.

This is mainly because of the immediate land use surrounding the project sites. These project sites are from Interchange Access Request projects and the areas have more developed land use surrounding the interchange compared to the typical characteristics shown by Limited Access-Rural Roadways. Also, it was found that even though these projects occurred in rural areas, they were surrounded by some highly developed areas. These developed areas generated high traffic that utilized the rural facility resulting in a lower K Factor. One project example is the I-4 at SR 557 Interchange Modification Report. The study area for this project is in a rural area but connected by two developed areas, Winter Haven and Celebration on either end.

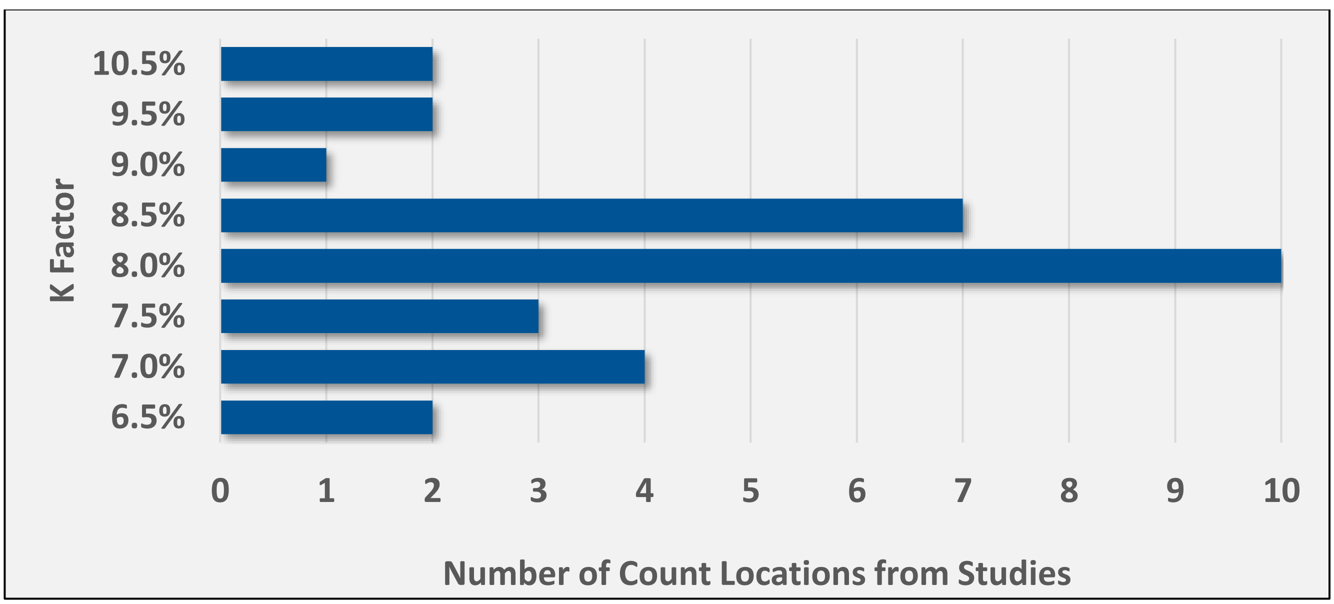
Due to the above-mentioned issues and lack of project count data for Limited Access-Rural Roadways, the K from count sites was given less weight versus the 200 Highest Hour Reports when recommending the final K Factor.

Figure 21: Project Studies K Factors for Limited Access-Urban Roadways



K Factors were calculated for eighteen Limited Access-Urban count locations. The majority of the count locations had a K Factor between 7.0 and 7.5. The K factors for these locations are lower compared to the K Factors from the FDOT TDA.

Figure 22: Project Studies K Factors for Limited Access-Urban Core Roadways



K Factors were calculated for thirty-one Limited Access-Urban Core count locations. The majority of the K Factors are between 6.5 and 8.5. The K Factors for these locations are slightly lower compared to the results from the FDOT TDA.

III. Recommendations

Based on the analysis performed using information obtained from the FDOT TDA and field count data, it has been established that there is a need to update the current Standard K values. The results and charts further showed that it makes sense to change the one (1) value Standard K to a K Factor Range based on context classification of the roadway. This section discusses the recommended changes to the current Standard K Factor and how it could impact project traffic forecasts.

A. *Changes to the Current Standard K*

The following changes to the current Standard K are recommended:

- The Standard K should be converted from a single value to a K Factor Range of two percentage points
- The following roadway classifications should be used when determining the K Factor Range
    - C1-Natural
    - C2-Rural
    - C2T-Rural Town
    - C3R-Suburban Residential
    - C3C-Suburban Commercial
    - C4-Urban General
    - C5-Urban Center
    - C6-Urban Core
    - Limited Access-Rural
    - Limited Access-Urban
    - Limited Access-Urban Core
- Based on roadway classifications having similar area types and the same recommended K Factor Range, some roadway classifications could be combined. The following roadway classifications are proposed to be combined:
    - C1-Natural, C2-Rural and C2T-Rural Town
    - C3R-Suburban Residential, C3C-Suburban Commercial and C4-Urban General
    - C5-Urban Center and C6-Urban Core

The single Standard K Factor currently provided in FTO for each count location would be replaced with the recommended K Factor Range in this White Paper based on the count locations' roadway context classification.

Table 5 provides the recommended K Factor Ranges for various context classifications. These recommended ranges were derived based on analysis results of the FTO data and the field count sites from project studies. A single K Factor, within the range, should be selected based on the project's conditions. The process for selecting this K Factor value from the range is discussed later in this Section.

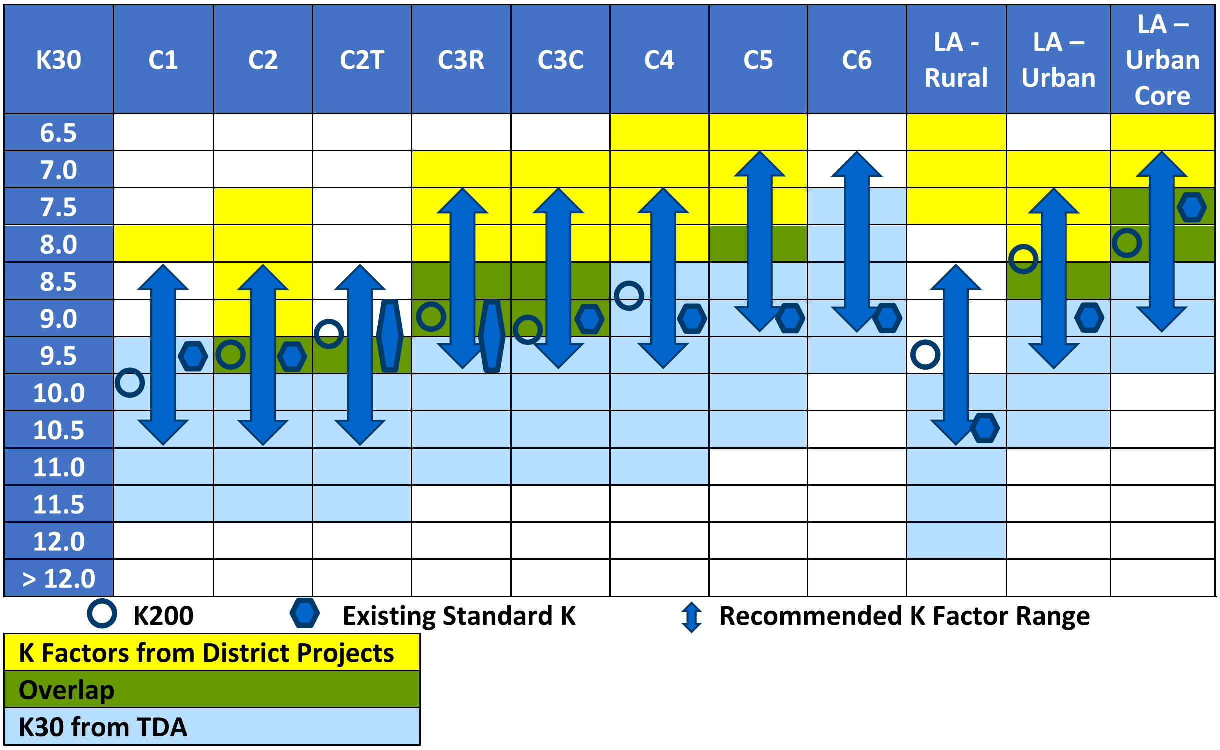
Table 5: Recommended K Factor Range

Roadway Classification*	Area	Facility Type	Recommended K Factor Range
C1-Natural, C2-Rural and C2T-Rural Town	Rural	Highways and Arterials	8.5 – 10.5
C3C-Suburban Commercial, C3R-Suburban Residential and C4-Urban General	Suburban and Urban	Arterials	7.5 – 9.5
C5-Urban Center and C6-Urban Core	Urban Core	Arterials	7.0 – 9.0
Limited Access (LA)	Rural	Freeways	8.5 – 10.5
	Urban	Freeways	7.5 – 9.5
	Urban Core	Freeways	7.0 – 9.0

A single K Factor, within the range, should be selected based on the project's conditions.
*Refer to FDOT Context Classification Guide when determining roadway context classification
**Not applicable for the planning, design or operation of toll facilities (e.g. Turnpike) or managed lanes

For easy reference, **Figure 23** shows a comparison of the recommended K Factor Range with the existing Standard K Factor, K30/K200 from the TDA and calculated K Factors from the district projects. Both the existing Standard K and K200 Factors fall within the recommended K Factor Ranges, which is reasonable. One reason for recommending a 2 percentage range is because the majority of the K30 Factors fall within the blue highlighted range. However, because of the low measured K values from the district projects, the recommended ranges were shifted upwards slightly to account for the lower measured K values.

Figure 23: Comparison of Standard K, Recommended K Factor Range and Other K Factors

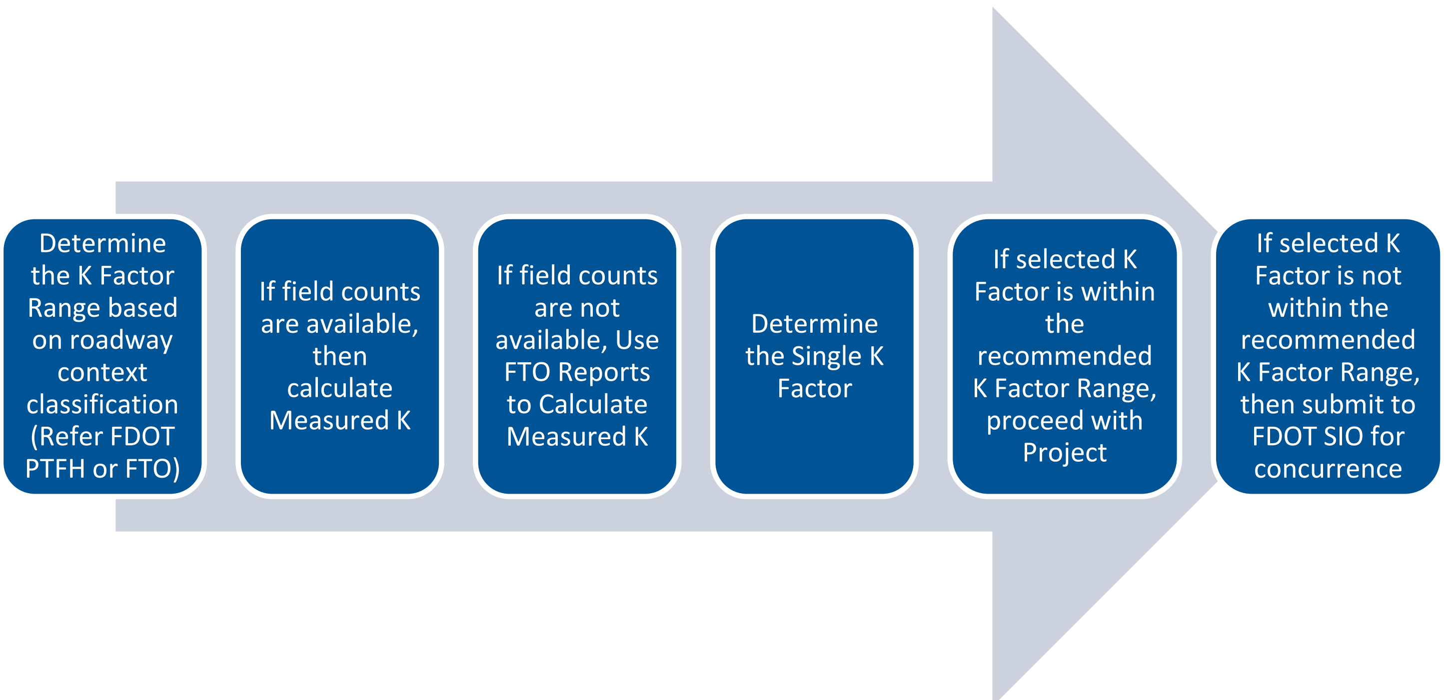


It is recommended that the selected K Factor for a project fall within the K Factor Range. The selected K Factor should be representative of the project study area. With the new K Factor Range, there could still be cases where the K Factor Range may not directly apply. Examples include highway facilities in tourist areas or roadways providing access to cruise ports where the heaviest traffic may occur on the weekend and peak-to-daily ratios are higher than the 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 FTO, if available. If the project selected K Factor is outside the recommended K Factor Range presented in **Table 5** above, the project team should present the analysis results and recommendations to FDOT SIO for approval. The K Factors in **Table 5** would not be applicable for the planning, design or operation of toll facilities (e.g. Turnpike) or managed lanes.

B. *K Factor Selection Process*

For projects, a single K Factor should be applied to develop the design hour traffic for the roadways within the study area. This section summarizes the general process for determining the single K Factor to be used for traffic development from the recommended K Factor Ranges in **Table 5.** A summary of the K Factor selection process is shown in **Figure 24** below and explained later in the Section.

Figure 24: K Factor Selection Process



Step 1. Based on roadway context classification, determine the K Factor Range for roadways within the study area. The K Factor Range can be obtained from the FDOT Project Traffic Forecasting Handbook or FTO for each count location.

Step 2. If field counts are available for the project, then calculate the K Factor using the daily field hose counts. Peak hour/period counts should not be used to calculate the K Factor.

Step 3. If field counts are not available for the project, counts from the FTO count stations can be utilized to calculate the measured K Factor. Two types of count sites, permanent/continuous and short-term, count sites are provided in FTO. To calculate the K Factor using these two types of count sites, the following reports can be used:

a. For permanent/continuous count sites, the "Hourly Continuous Counts Final Report" can be used to calculate the K Factor. The K Factor should be calculated using count data collected during the project time period.

b. For short-term count sites, the "Synopsis Report" for the count site can be used to calculate the K Factor.

Step 4. Determine the single K Factor value for the project roadways.

Step 5. If the selected K Factor value is within the recommended K Factor Range, then proceed with design hour project traffic development. Traffic development should follow the guidelines and procedures outlined in the FDOT Project Traffic Forecasting Handbook.

Step 6. If the selected K Factor value is not within the recommended K Factor Range, then the project team should present the K Factor recommendation along with supporting documentation to the District and SIO for concurrence.

C. *Impact of K Factor Range on Traffic Forecasts*

FDOT's recommended K Factor Ranges were developed with the intent to make the K Factor consistent with the ever-changing Florida traffic patterns. However, this change does raise the question: "How will the K Factor Range affect traffic forecasts prepared for projects?" **Table 6** and **Table 7** contain a preliminary comparison of planning level maximum service volumes for some of the typical state roadway classifications using the existing Standard K Factors and recommended K Factor Range. For the K Factor Range, the lowest and highest K Factors were used to calculate the Directional Design Hour Volume (DDHV). Lane call was determined using the Highway Capacity Manual (HCM) 6^{th} Edition. Single lane arterial capacities are based on HCM Exhibit 16-16. Single lane limited access basic freeway capacity is based on HCM Exhibit 12-4. The number of lanes, in one direction, was determined based on the DDHV using the existing Standard K and recommended K Factor Range. A D factor of 0.55 was assumed for all DDHV calculations.

Table 6: Traffic Forecasts and Lane Call Comparison: Existing Standard K versus Lower Limit of the Recommended K Factor Range

Roadway Classification	Speed Limit (mph)	Existing Standard K	AADT	Existing Standard K DDHV	Number of Lanes Required*	Recommended K Factor Range	Recommended K Factor DDHV (Using Lower Limit)	Number of Lanes Required*	Difference in DDHV
C2-Rural	55	9.5	9,000	470	1	8.5 - 10.5	420	1	-50
C3R-Suburban Residential	45	9.0	18,900	940	2	7.5 - 9.5	780	2	-160
C6-Urban Core	30	9.0	26,500	1,310	3	7.0 - 9.0	1,020	2	-290
Limited Access-Rural	70	10.5	50,600	2,920	2	8.5 - 10.5	2,370	1	-550
Limited Access-Urban	60	9.0	62,000	3,070	2	7.5 - 9.5	2,560	2	-510
Limited Access-Urban Core	55	8.0	199,700	8,790	4	7.0 - 9.0	7,690	4	-1,100

*Lanes required in one direction of traffic

Table 7: Traffic Forecasts and Lane Call Comparison: Existing Standard K versus Upper Limit of the Recommended K Factor Range

Roadway Classification	Speed Limit (mph)	Existing Standard K	AADT	Existing Standard K DDHV	Number of Lanes Required*	Recommended K Factor Range	Recommended K Factor DDHV (Using Upper Limit)	Number of Lanes Required*	Difference in DDHV
C2-Rural	55	9.5	9,000	470	1	8.5 - 10.5	520	1	50
C3R-Suburban Residential	45	9.0	18,900	940	2	7.5- 9.5	990	2	50
C6-Urban Core	30	9.0	26,500	1,310	3	7.0 - 9.0	1,310	3	0
Limited Access-Rural	70	10.5	50,600	2,920	2	8.5 - 10.5	2,920	2	0
Limited Access-Urban	60	9.0	62,000	3,070	2	7.5 - 9.5	3,240	2	170
Limited Access-Urban Core	55	8.0	199,700	8,790	4	7.0 - 9.0	9,890	5	1,100

*Lanes required in one direction of traffic

A comparison of the traffic forecasts (shown above in **Tables 6** and **7**) developed by applying the existing Standard K and proposed K Factor range showed that minimal change should be expected in traffic forecasts and the number of required lanes. When traffic was developed using the lower limit of the proposed K Factor Range, the traffic slightly decreased compared to the existing Standard K Factor for all roadway classifications. The number of lanes required in the example did not change except for the C6-Urban Core and the Limited Access-Rural facilities. When traffic was developed using the higher limit of the proposed K Factor Range, the traffic did slightly increase compared to the existing Standard K Factor for all roadway classifications except for Limited Access-Urban Core.

It can be concluded, based on the brief analysis, that in the majority of the situations, the lane requirements based on the proposed K Factor Range and the lane requirements based on the existing Standard K value would remain unchanged.

IV. Conclusion

There are numerous highly constructive aspects to the recommended K Factor Range approach that remain from the existing Standard K Factor. For one, it promotes better transportation policies and projects by leading to more cost-effective plans and designs. In doing so, this practice can better support future growth in existing developed areas to focus more on multimodal solutions. In addition, the practice of using a K Factor Range can reduce time and effort spent getting approval for deviations if the project K Factor is different from the single Standard K Factor. This translates into time and cost savings through improved production times.

The new approach will provide flexibility to the planners, designers and analysts as they proceed with their project. This new flexibility is a result of the range versus single value that eliminates the need to go through the approval of a K Factor that is changed during the project. The new proposed K Factor Ranges have also been developed using traffic data and studies that are more consistent with the recent development across the state of Florida. The new approach also makes the recommended K Factor Range consistent with the FDOT's adopted Context Classification System.

It is recommended the new K Factor Ranges be implemented and a single K Factor, from within the range, be selected based on the project's conditions. The process for selecting a K Factor for the project is described in **Section III.B** of this White Paper. If the selected K Factor falls within the recommended K Factor Range for a context classification, then a submittal for concurrence is not required. Submittal for concurrence with FDOT SIO will only be required in situations where the selected K Factor falls outside the recommended K Factor Range. The selected K Factor should then be applied to develop project traffic forecasts as described in the FDOT Project Traffic Forecasting Handbook from the planning phase through the design phase of projects.

Appendix B

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Appendix C

Glossary

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)

Context Classification

A classification assigned to a roadway that broadly identifies the various built environments in Florida, based on existing or future land use characteristics, development patterns, and the roadway connectivity of an area.

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 (LEF) 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)

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 typically 20 years for capacity projects and 10 years for operational projects 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.

DF — **Directional Distribution Factor**

Directional distribution factor used for Equivalent Single Axle Load (ESAL) determination. This value is not to be confused with the Directional Distribution (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)

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)

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.

EF — **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.

LRTP **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 Strategic Intermodal System (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 resident (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.

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 (NEPA).

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)

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.

PTAR — **Project Traffic Analysis Report**

A report documents the assumptions, methods, traffic forecasts, design traffic, and results of the traffic analysis for the PD& E Study in plain language and in an easily understood format. It summarizes the data collection effort, input parameters, traffic analysis tools, existing conditions, development of future traffic forecasts, and traffic operational and safety analyses of project alternatives.

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)

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 **Truck Factor/T-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.

Appendix D

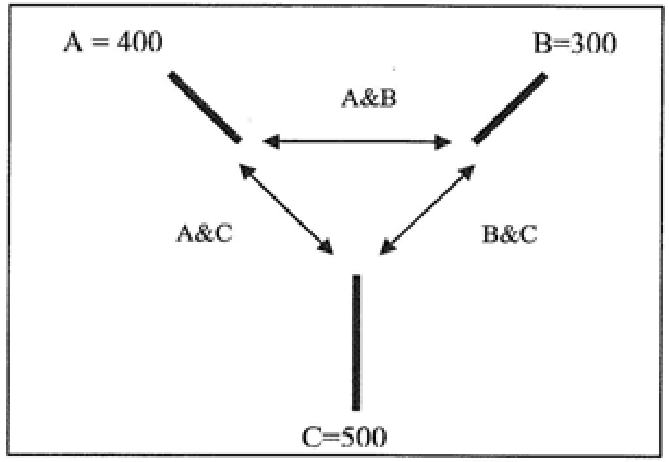
Example of District 2 Manual Method

Example of District 2 Manual Method

E.1 Calculation of Turns at "T" or "Y" intersection from End Volumes

Given: Two-way AADT on each leg of a "T" or "Y" intersection
A=400, B=300, C=500

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



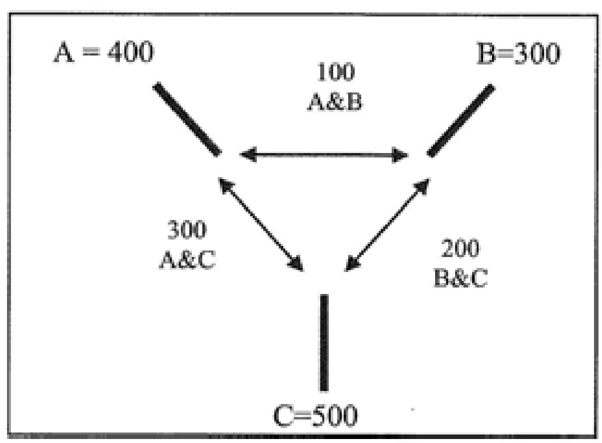
Rule: To find the two-way volume moving between two legs of a three-legged intersection, add the two-way volumes on the two legs concerned and subtract the two-way volume on the third leg, then divide by 2

Find: Two-way turning volumes

$$\text{between A \& B} = \frac{A + B - C}{2} = \frac{400 + 300 - 500}{2} = 100$$

$$\text{between B \& C} = \frac{B + C - A}{2} = \frac{300 + 500 - 400}{2} = 200$$

$$\text{between A \& C} = \frac{A + C - B}{2} = \frac{400 + 500 - 300}{2} = 300$$



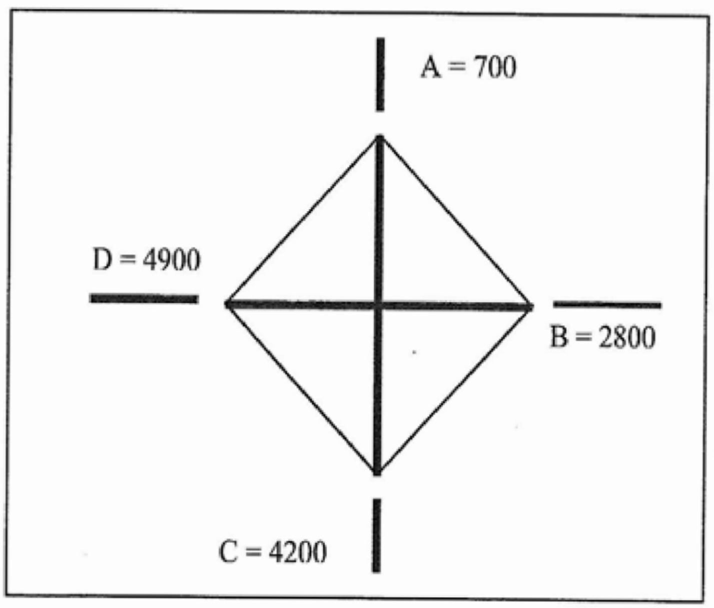
E.2 Approximation of Turns from End Volumes

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

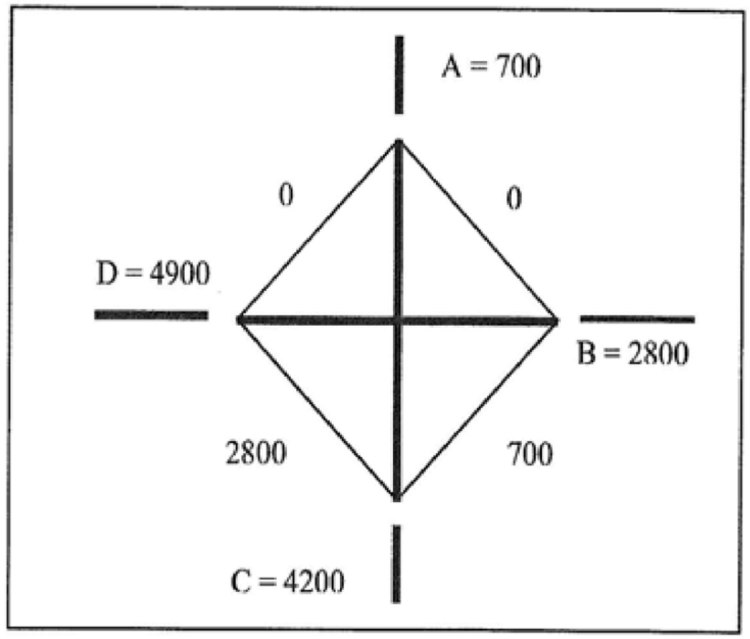
Round all volumes: Current year to nearest 20, future years to nearest 200 (This example assumes current year)

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.



A is smallest = 700, so base = B + C + D

$$= 2800 + 4200 + 4900 = 11900$$

Proration constant for "A"

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

Turns between A&B = $K_A \times B$

$$= 0.0588 \times 2800 = 164$$

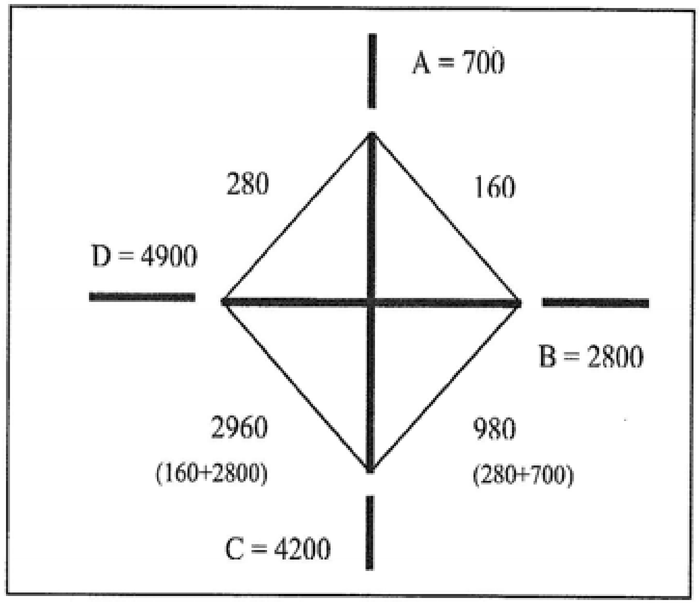
(20 Round) → 160

Turns between A&D = $K_A \times D$

$$= 0.0588 \times 4900 = 288$$

(20 Round) → 280

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