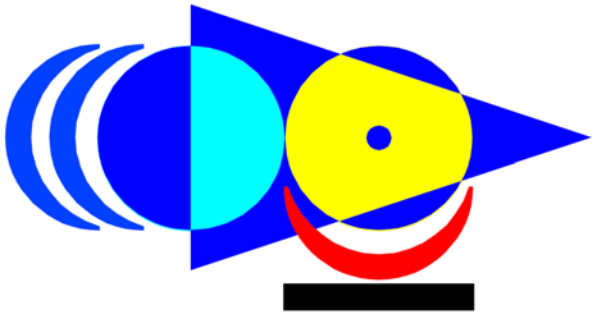
2014

Project Traffic Forecasting Handbook



ACKNOWLEDGMENTS

This Project Traffic Forecasting Handbook offers guidelines and techniques on the Design Traffic Forecasting Process. This Handbook supplements the **Project Traffic Forecasting Procedure Topic No. 525-030-120** by providing more guidance in producing the design traffic parameters AADT, K, D, and T.

This document is a continuation of FDOTs effort to develop an improved traffic forecasting procedure. In order to determine the actual method in use throughout the Districts, and to standardize these methodologies, a statewide survey was conducted by interviewing engineers and planners who produce or use traffic forecasts. A task team was formed to draft a compilation and explanation of the standardized design traffic forecasting methodologies. The result is this Project Traffic Forecasting Handbook. It represents a consensus approach to traffic forecasting.

The major past contributors of this handbook included: Bob McCullough, Emmanuel Uwaibi, Fawzi Bitar, Frank Sullivan, Joey Gordon, John Krane, Lap Hoang, Mike Tako, Susan Sadighi, Bruce Dietrich, Dennis Wood, Frank Broen, Imran Ghani, Jim Baxter, John Kuhl, Louis Reis, Rafael DeArazoza, Ward Swisher and special credit to Harshad Desai for helping the task team reach consensus.

Current contributors included: Rick Reel, Scott Friedman, Vidya Mysore, Terry Corkery, Diana Fields, Frank Tabatabaee, Vladimir Majano, District traffic and modeling staff, and distinct recognition to Douglas McLeod for his perseverance developing and implementing the standardized “K” Factor.

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CHAPTER ONE

INTRODUCTION AND OVERVIEW

1.1 PURPOSE

This handbook offers guidelines and techniques on the **Project Traffic Forecasting Process** for use by FDOT staff and consultants providing traffic parameters required by project design. This handbook may be used by local governments and other agencies to review highway projects. This handbook provides instructions for **Corridor Traffic Forecasting, Project Traffic Forecasting and Equivalent Single Axle Loading (ESAL) Forecasting**.

1.2 INTRODUCTION

This handbook supplements the **Project Traffic Forecasting Procedure Topic No. 525-030-120** and consists of seven Chapters with three Appendices:

Chapter 1 Introduction and Overview

This chapter describes general guidelines, references, definitions, and techniques to be used in the Project Traffic Forecasting Process. In addition, it also outlines the forecasting processes which include Corridor, Project and Equivalent Single Axle Load (ESAL).

Chapter 2 Traffic Data Sources and Factors

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

Chapter 3 Forecasting with Travel Demand Models

This chapter provides guidance in the application of models to develop traffic projections for route specific (PD&E) studies, corridor studies and resurfacing type projects. This chapter also provides an overview of modeling for traffic engineers and an overview of traffic forecasting requirements for modelers.

Chapter 4 Forecasting without a Traffic 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 5 Directional Design Hourly Volumes

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

Chapter 6 Estimating Intersection Turning Movements

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

Chapter 7 Equivalent Single Axle Load Forecast

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

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Central Office and District Planning and Modeling Contacts

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Example - District Two Manual Method–Balancing Turning Movement Volumes

1.3 AUTHORITY

Sections 20.23(4)(a) and 334.048(3); Florida Statutes (F.S.).

1.4 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 Procedure, Florida Department of Transportation, Topic No. 525-030-120, April 17, 2012.

General Interest Roadway Data Procedure, Florida Department of Transportation, Transportation Statistics Office, Topic No. 525-020-310, December 9, 2013.

Florida Traffic Information & Highway Data DVD (2013), Florida Department of Transportation,Transportation Statistics Office.

Quality/Level of Service (Q/LOS) Handbook, 2013, Florida Department of Transportation, Systems Planning Office.

Transportation Impact Handbook, Florida Department of Transportation, Systems Planning Office.

FSUTMS-Cube Voyager Version 6.1.0, Florida Department of Transportation, Systems Planning Office.

FSUTMS-Cube Framework Phase II, Model Calibration and Validation Standards, October 2, 2008.

Roadway Plans Preparation Manual, Volume 1: Design Criteria and Process, Florida Department of Transportation, Roadway Design Office, Topic No. 625-000-007; and Volume 2: Plans Preparation and Assembly, Topic No. 625-000-008.

Manual on Uniform Traffic Studies, Florida Department of Transportation, Traffic Engineering Office, Topic No. 750-020-007, January 2004.

Flexible Pavement Design Manual, Florida Department of Transportation, Pavement Management Office, Topic No. 625-010-002.

Rigid Pavement Design Manual, Florida Department of Transportation, Pavement Management Office, Topic No. 625-010-006.

1.4 REFERENCES - continued

A Policy on Geometric Design of Highways and Streets, American Association of State Highway and Transportation Officials (AASHTO), 5th Edition.

Highway Capacity Manual (HCM 2010), Transportation Research Board.

Traffic Forecasting for Pavement Design, Harshad Desai, et. al., Federal Highway Administration, Washington, D.C., FHWA-TS-86-225, 1988.

Traffic Monitoring Guide, Federal Highway Administration (FHWA), September 2013

ITE Trip Generation Manual, 9th Edition.

National Cooperative Highway Research Program (NCHRP) Report 187, "Distribution of Assigned Volumes Among Available Facilities", Transportation Research Board (TRB).

National Cooperative Highway Research Program (NCHRP) Report 255, "Highway Traffic Data for Urbanized Area Project Planning and Design", 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, Transportation Research Board (TRB), September 1985.

FDOT uses the latest version of each reference listed. These documents can be obtained from the Office of Maps and Publications, (850) 414-4050 or through DOT INFONET under Maps and Publications Internet and Forms and Procedures Intranet.

1.5 GLOSSARY

Terms in this handbook are used as defined in the most recent editions of the **Highway Capacity Manual** (HCM 2010), **A Policy on Geometric Design of Highways and Streets** (AASHTO), and the **Project Traffic Forecasting Procedure**. Modeling terms which are used in Travel Demand Forecasting Models (Chapter 3) are followed by (MODEL). The following terms are defined to reflect their meaning in this **Project Traffic Forecasting Handbook**:

ACTION PLAN — A document identifying low cost, short-term, and major capacity improvements necessary to bring a controlled access facility to Strategic Intermodal System/Florida Intrastate Highway System (SIS/FIHS) 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 on a highway segment for one year, divided by the number of days in the year. This volume is usually estimated by adjusting a short-term traffic count with weekly and monthly factors. (AASHTO)

AAWDT **ANNUAL AVERAGE WEEKDAY TRAFFIC** — The estimate of typical traffic during a weekday (Monday through Friday) calculated from data measured at continuous traffic monitoring sites.

AREA OF INFLUENCE — The geographical transportation network of state and regionally significant roadway segments on which the proposed project would impact five percent or more of the adopted peak hour level of service maximum service volume of the roadway, and the roadway is, or is projected to be, operating below the adopted level of service standard in the future.

ARTERIAL — A signalized roadway that serves primarily 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 does not exceed 20 percent (%) of the total traffic.

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

1.5 GLOSSARY - continued

ACF

AXLE CORRECTION FACTOR — The factor developed to adjust vehicle axle sensor base data for the incidence of vehicles with more than two axles, or the estimate of total axles based on automatic vehicle classification data divided by the total number of vehicles counted. (AASHTO)

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 the modeling system was calibrated, from which projections are made.

CALIBRATION (MODEL) — An extensive analysis of a travel demand forecasting model based on census, survey, traffic count and other information.

CAPACITY — The maximum sustainable hourly flow rate at which persons or vehicles can be expected to traverse a point or uniform section of a lane or roadway during a given time period under prevailing roadway, environmental, traffic and control conditions. (HCM 2010)

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 on this Core Freeway as it passes through the urbanized area. (FDOT)

CORRIDOR — A broad geographical band that follows a general directional flow connecting major origins and destinations of trips and that may contain a number of alternate transportation alignments.

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

1.5 GLOSSARY - continued

CORRIDOR TRAFFIC STUDY — The long range system data 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, speed, weight, or a combination of these characteristics. (AASHTO)

COUNTER —-Any device that collects traffic characteristics data. FDOT utilizes Continuous Count, Classification and Weigh-In-Motion (WIM) Counters, Portable Axle Counters, and Portable Vehicle Counters. (*see* TTMS, PTMS)

CUTLINE — A cutline is similar to a screenline; however, it is shorter and crosses corridors rather than regional flows. Cutlines should be established to intercept travel along only one axis. (MODEL)

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

DAMAGE FACTOR — (*see* Load Equivalency Factor).

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 2010)

DESIGN HOUR FACTOR — The proportion of the AADT that occurs during the design hour. (*see* also K-FACTOR) (HCM 2010)

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).

1.5 GLOSSARY - continued

DHV **DESIGN HOUR VOLUME** — The traffic volume expected to use a highway segment during the design hour of the design year. The Design Hour Volume (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 (*see* Figure 2.2), 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 (*see* Figure 2.2).

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

DESIGN YEAR —- Usually 20 years from the Opening Year, but may be any time within a range of years from the present (for restoration type projects) to 20 years in the future (for new construction type projects). The year for which the roadway is designed.

DRI **DEVELOPMENT OF REGIONAL IMPACT** — Any development which, because of its character, magnitude, or location, would have a substantial effect upon the health, safety, or welfare of citizens of more than one county.
(F.S. 1993 LAND AND WATER MANAGEMENT)

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.

1.5 GLOSSARY - continued

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

D — The proportion of traffic based on the median (average) for the design hour of the design year traveling in the peak direction. D is often used in calculating the level of service for a roadway.

DF — Directional distribution factor for $ESAL_D$ equation. Use 1.0 if one-way traffic is counted or 0.5 for two-way. This value is not to be confused with the Directional Factor (D) used for planning capacity computations.

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

ESAL FORECASTING PROCESS — 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.

FACTOR — A number that represents a ratio of one number to another number. The factors used in this handbook are K, D, T, Design Hour Factor, Peak Hour Factor and Seasonal Factor. The Load Equivalency Factor adjusts pavement damage calculations.

FDOT **FLORIDA DEPARTMENT OF TRANSPORTATION**

FHWA **FEDERAL HIGHWAY ADMINISTRATION**

FIHS **FLORIDA INTRASTATE HIGHWAY SYSTEM** — A system of existing and future limited access and controlled access facilities that have the capacity to provide high-speed and high-volume traffic movements in an efficient and safe manner.

FM **FINANCIAL MANAGEMENT SYSTEM**

FPI **FINANCIAL PROJECT IDENTIFIER**

1.5 GLOSSARY - continued

FSUTMS **FLORIDA STANDARD URBAN TRANSPORTATION MODEL STRUCTURE** — The standard model for projecting traffic flow in the State of Florida.

FTP **FLORIDA TRANSPORTATION PLAN** — A statewide, comprehensive transportation plan, to be annually updated, which is designed to establish long range goals to be accomplished over a 20-25 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 2010)

HIGHWAY — A term that includes roads, streets, and parkways and all appurtenances.

HCM **HIGHWAY CAPACITY MANUAL**

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

IJR **INTERCHANGE JUSTIFICATION REPORT** — The documentation submitted through FDOT to FHWA to determine if a new interchange on an interstate is allowed.

IMR **INTERCHANGE MODIFICATION REPORT** — The documentation submitted through FDOT to FHWA to determine if modification to an existing interchange on an interstate is allowed.

INTERMEDIATE YEAR — Any future year in the forecast period between the base year and the design year, typically halfway between the opening year and the design year.

1.5 GLOSSARY - continued

K-FACTOR— The ratio of the traffic volume in the study hour to the Annual Average Daily Traffic (AADT). (*see also* **Standard K**)

L_f **LANE FACTOR** — Value calculated by a formula that accounts for the proportion of vehicles that use the design lane (commonly the outside lane) of a divided roadway. The percentage of vehicles driving in the design lane is dependent on the directional number of lanes, and the AADT. Lane Factor is used to convert 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.

See COPES equation: (Section 7.4.3)

L_F = (1.567 - 0.0826 x Ln(One-Way AADT) - 0.12368 x LV)

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 representating the best operating conditions from the traveler's perspective and LOS F the worst. (HCM 2010)

LINK — The spatial representation of the transportation system, which may or may not constitute a one-to-one correspondence to the actual major components of the transportation system being modeled. There are three primary attributes which describe a link: facility type, area type, and the number of lanes. (MODEL)

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., and Rule Chapter 9J-5, Florida Administrative Code, and found in compliance by the Florida Department of Community Affairs.

1.5 GLOSSARY - continued

LONG RANGE PLAN — A document with a 20-year planning horizon required of each Metropolitan Planning Organization (MPO) that forms the basis for the annual 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-term and long-term capacity improvements to limited access highways (Interstate, Turnpike and other expressways) consistent with policies and standards to meet SIS/FIHS standards. Master Plans shall also identify potential new or modifications to existing interchanges.

MPO **METROPOLITAN PLANNING ORGANIZATION**

MOCF **MODEL OUTPUT CONVERSION FACTOR** — The MOCF is used to convert the traffic volumes generated by a travel demand forecasting model (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 in validation to convert AADT to PSWADT for the base year model network should be used for adjusting future year model volume. Note: Currently, there are several model outputs throughout the State that require conversion from PSWADT to AADT using MOCF (see page 3-80).

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)

1.5 GLOSSARY - continued

MSF **MONTHLY SEASONAL FACTOR** — A seasonal adjustment factor derived by dividing the AADT by the MADT for a specific TTMS count site.

OPENING YEAR — One year beyond the scheduled beginning of construction as defined in the Adopted Five Year Work Program for a project. This is normally provided by the project manager.

PD&E **PROJECT DEVELOPMENT & ENVIRONMENT/ENVIRONMENTAL**

PHF **PEAK HOUR FACTOR** — The hourly volume during the analysis hour divided by the peak 15-min flow rate within the analysis hour; a measure of traffic demand fluctuation within the analysis hour. (HCM 2010)

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** — 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. FSUTMS traffic assignment volume represents Peak Season Weekday Average Daily Traffic (PSWADT) projections for the roads represented in the model highway network. For Project Traffic Forecasting Reports, the PSWADT should be converted to AADT using a MOCF. Note: Currently, there are several model outputs throughout the State that require conversion from PSWADT to AADT using 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.

1.5 GLOSSARY - continued

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. (*see* TTMS — Telemetered Traffic Monitoring Site)

PTMS **PORTABLE TRAFFIC MONITORING SITE** — Automatic Traffic Recorders that are temporarily placed at specific locations throughout the state to record the distribution and variation of traffic flow.

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.

PROJECT TRAFFIC FORECASTING (PTF) — 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 Transportation Statistics Office (TranStat) which contains roadway and traffic characteristics data for the State Highway System, including current year traffic count information such as AADT and the traffic adjustment factors, K, D, and T.

SCREENLINE — 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 interviews are conducted along this line as a means to compare simulated model results to field results as part of the calibration/validation of a model. (MODEL)

SF **SEASONAL FACTOR** — Parameters used to adjust base counts which consider travel behavior 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)

1.5 GLOSSARY - continued

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*i*. (HCM 2010)

STANDARD K — A conceptual "design" term defining factors within a rural, transitioning, urban or urbanized area that are based on a ratio of peak hour volume to annual average daily traffic (K). Multiple standard K factors may be assigned depending on the area type and facility type and applied statewide.

SIS **STRATEGIC INTERMODAL SYSTEM** — Facilities, including appropriate components of all modes, and services of statewide or interregional significance that meet high levels of people and goods movement, generally supporting the major flows of interregional, interstate, and international trips. Both "Strategic Intermodal System" and "Emerging SIS" are a formal part of "The SIS".

TARGET YEAR — The final year of the forecast period; i.e., the design year, or the future year for which roadway improvements are designed.

T_f **T-FACTOR** — Truck Factor; the percentage of truck traffic during the peak hours.

T_{24} — The percentage of truck traffic for 24 hours (one day). (Categories 4-13, see Figure 2.2)

24T+B **24-HOUR TRUCK + BUS** PERCENTAGE — The adjusted, annual 24-hour percentage of trucks and buses (Categories 4 through 13, *see* Figure 2.2).

24T **24-HOUR TRUCK PERCENTAGE** — The adjusted, annual 24-hour percentage of trucks (Categories 5 through 13, *see* Figure 2.2).

TAZ **TRAFFIC ANALYSIS ZONE** — The basic unit of analysis representing the spatial aggregation for people within an urbanized area. Each TAZ may have a series of zonal characteristics associated with it which are used to explain travel flows among zones. Typical characteristics include the number of households and the number of people that work and/or live in a particular area. (MODEL)

1.5 GLOSSARY - continued

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 TranStat which contains both historical and current year traffic count information including AADT and the traffic adjustment factors, K, D, and T.

TPO **TRANSPORTATION PLANNING ORGANIZATION**

TRAFFIC VOLUME COUNT — Any short-term count taken by a portable axle counter on a roadway.

TranStat **TRANSPORTATION STATISTICS OFFICE** — The FDOT Central Office in Tallahassee that monitors and reports statistical traffic information for the State Highway System.

TTMS **TELEMETERED TRAFFIC MONITORING SITE** — Automatic Traffic Recorders that are permanently placed at specific locations throughout the state to record the distribution and variation of traffic flow by hour of the day, day of the week, and month of the year, from year to year, and transmit the data to the TranStat Office via wireless communication.

TRUCK — Any heavy vehicle described in FHWA Classification Scheme F (*see* Figure 2.2), Classes 4-13; i.e., buses and trucks with six or more tires. Class 14 is available for state definition of a special truck configuration not recognized by Scheme F. At the present time, only Classes 1-13 (Classes 1-3 are motorcycles, automobiles, and light trucks) are used in Florida.

VALIDATION (MODEL) — An analysis of a travel demand forecasting model based on traffic count and other information. A validation is usually less extensive than a calibration.

1.5 GLOSSARY - continued

VHT **VEHICLE HOURS OF TRAVEL** — A statistic representing the total number of vehicles multiplied by the total number of hours that vehicles are traveling. The VHT is most commonly used to compare alternative transportation systems. In general, if alternative "A" reflects a VHT of 150,000 and alternative "B" reflects a VHT of 200,000 it can be concluded that alternative "A" is better in that drivers are getting to their destinations quicker. (MODEL)

VMT **VEHICLE MILES OF TRAVEL** — A statistic representing the total number of vehicles multiplied by the total number of miles which are traversed by those vehicles. The VMT is used on a region-wide basis as a measure of effectiveness to compare system performance to other urbanized areas. (MODEL)

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. This is one of the six factors used to determine the level of service.

WIM **WEIGH-IN-MOTION** — The process of estimating a moving vehicle's static gross weight and the portion of that weight that is carried by each wheel, axle, or axle group or combination thereof, by measurement and analysis of dynamic forces applied by its tires to a measuring device. (AASHTO)

WPA **WORK PROGRAM** — 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.

WPI **WORK PROGRAM ITEM** (First 6-digits of FPI)

1.6 BACKGROUND

Project Traffic Forecasting estimates are needed for Planning and Project Development and Environmental (PD&E) studies and construction plans which lead to construction, traffic improvements, and pavement design projects. A Project Traffic Report is routinely developed as part of most Project Development and Environmental Studies. Primary components of the report are supporting documentation related to the Project Traffic Forecasting Process and highway capacity and level of service (LOS) analyses.

FDOT's Roadway Plans Preparation Manual requires Project Traffic and its major parameters to be posted on the Typical Section sheets. This handbook supplements the information described in the Project Traffic Forecasting Procedure, Topic No. 525-030-120.

The Project Traffic Forecasting Procedure describes in detail the three forecasting processes which include Corridor, Project and Equivalent Single Axle Load (ESAL). Figure 1.1 outlines the relationship between Corridor Traffic Forecasting, Project Traffic Forecasting, and ESAL processes.

Corridor projects usually require the development of travel projections which are used to make decisions which have important capacity and capital investment implications. The traffic forecasting is required before establishing a new alignment or widening of an existing facility. The Corridor Traffic Forecasting Process is further detailed in Chapter 3 of this handbook.

The Project Traffic projections are commonly used to develop laneage requirements for intersection designs, and to evaluate the operational efficiency of proposed improvements. Project Traffic Forecasting is also required for reconstruction, resurfacing, adding lanes, 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. Further details may also be found in Chapter 3 of this handbook.

The Equivalent Single Axle Loading (ESAL) Forecasting Process is necessary for pavement design for new construction, reconstruction, or resurfacing projects. Truck traffic and damage factors are needed to calculate axle loads expressed as ESALs. The ESAL Forecasting Process is detailed in Chapter 8 of this handbook.

The four major types of construction projects are Preservation (resurfacing), Intersection Operational Improvements (add turns lanes), Roadway Capacity Improvements (add through lanes) and New Alignment Projects. Traffic operations projects such as signal

timing, signal phasing and other non-construction type projects are not covered under this procedure.

Construction projects require both the Project Traffic Forecasting Process and the Equivalent Single Axle Load (ESAL) Process to be performed. Preservation Projects, which are usually resurfacing projects, only require the ESAL process to determine the appropriate Load Equivalency Factor for the pavement to be laid. Traffic Operation Improvements, such as improving shoulders or turn lanes and restriping roads are not covered under this procedure.

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

The overall truck volume and AADT are related to each other by the T-factor. The total impact of truck traffic on pavement design is expressed in units of ESALs, which represent truck axle weights converted into 18,000 pound (18-KIP) loads carried by a single, four-tire axle. The metric equivalent is 80,000 newtons .

Traffic Forecasting Process

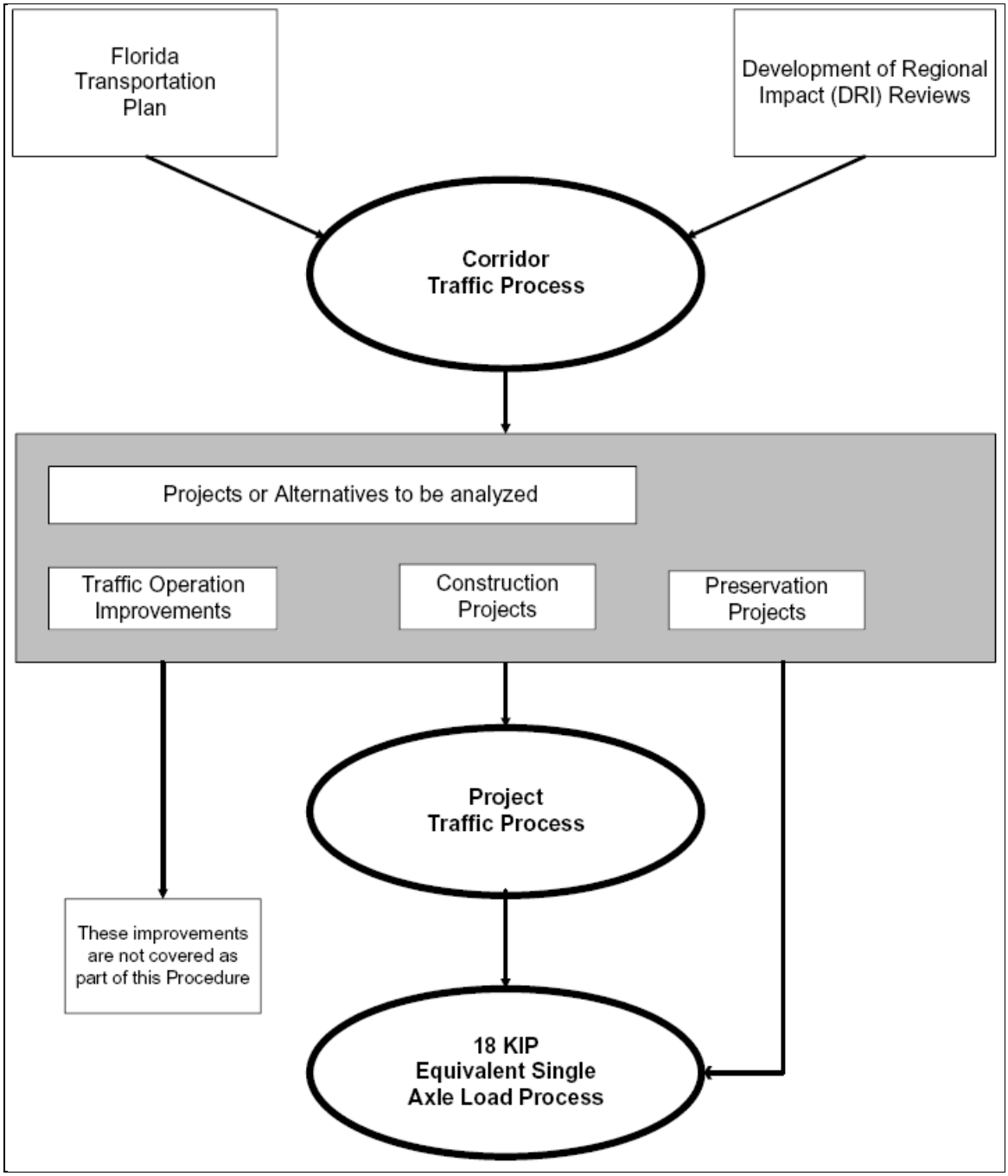

Figure 1.1 Traffic Forecasting Process

1.7 TRUTH IN DATA PRINCIPLE

In accordance with the principle of "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 designer of the project, this means being able to compensate for uncertainty of, for example, projections of total pavement loading by using a reliability design factor. For the producer of the traffic forecast, it means clearly stating the input assumptions and their sources, and providing the forecast in a form that the user can understand and use.

1.8 PRECISION OF DATA

To reflect the uncertainty of estimates and forecast volumes (AADT, DHV and DDHV) should be rounded according to the current AASHTO rounding standards (AASHTO Green Book - A Policy on Geometric Design of Highways and Streets, 6th Edition, 2011).

Forecast Volume	Round to Nearest
0 to 999	10
1,000 to 9,999	100
>=10,000	1,000

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CHAPTER TWO

TRAFFIC DATA SOURCES AND FACTORS

2.1 PURPOSE

Traffic data is the foundation of highway transportation planning and is used in making numerous decisions. Since accurate traffic data is a very crucial element in the transportation planning process, understanding and implementing the process accurately can lead to better design decisions. This chapter describes the following:

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

2.2 BACKGROUND

The Florida Department of Transportation (FDOT) collects and stores a broad range of traffic data to assist highway engineers in maintaining and designing safe, state-of-the-art, and cost effective facilities. Traffic data is collected by the Central Office, Districts, local governments, and consultants. The traffic data collection efforts include traffic volume and vehicle classification counts, speed surveys, and truck weight and configuration measurements. TranStat is responsible for collecting, processing, and storing traffic data from the permanent count locations throughout the State of Florida. The Districts, using road tubes, permanent loop sensors, or other devices, are responsible for collecting traffic data throughout the District, editing the data and uploading the traffic data to the mainframe.

2.3 TRAFFIC ADJUSTMENT DATA SOURCES

The continuous count and classification program is designed to collect vehicular and classification traffic counts 24 hours a day throughout the year. The portable seasonal classification program is designed to collect classification counts for a short term (24 to 72 hours). The various types of traffic monitoring sites used in Florida during 2011 are presented in Figure 2.1. In 2011, FDOT collected traffic count and traffic factor information at 12,416 sites throughout Florida.

2.3.1 Permanent Continuous Counts

The TranStat staff collects traffic data through permanently installed traffic counters located throughout the state. These **Telemetered Traffic Monitoring Sites** (TTMSs) continuously 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 and transmit the data daily to TranStat via wireless communications. Florida's continuous count program has been expanded from the original 10 sites in 1936, to 278 sites. Presently, FDOT is working with local jurisdictions to obtain the data from their continuous counters and thus Florida will have over 350 permanent counters in operation. The permanent counters provide the user with day-to-day traffic information throughout the year. The traffic information collected is used to produce the AADT, K, and D for each permanent counter location.

Permanent traffic counters use inductive loops to detect vehicles and record the traffic volumes for each hour. A single loop is required to collect traffic volume data. Two loops are required to collect speed data. Two loops and an axle sensor are required to collect vehicle classification data, and one loop with two weight sensors (piezo or bending plate) are required to collect vehicle weight data.

There are several count sites throughout the state that have non-intrusive traffic counters that use microwave and magnetic sensors to collect volume counts.

2.3.2 Permanent Continuous Classification Counts

FDOT has approximately 249 permanent continuous classification counters. The TranStat staff collects classification data based on the classification of the vehicle according to FHWA Scheme F (*see* Figure 2.2). In addition, TranStat has a Weigh-in-Motion (WIM) count program which collects vehicle classification and truck weights. These classification counts are collected daily and are used to produce AADT, K, D, and T.

TRAFFIC MONITORING SITES IN FLORIDA

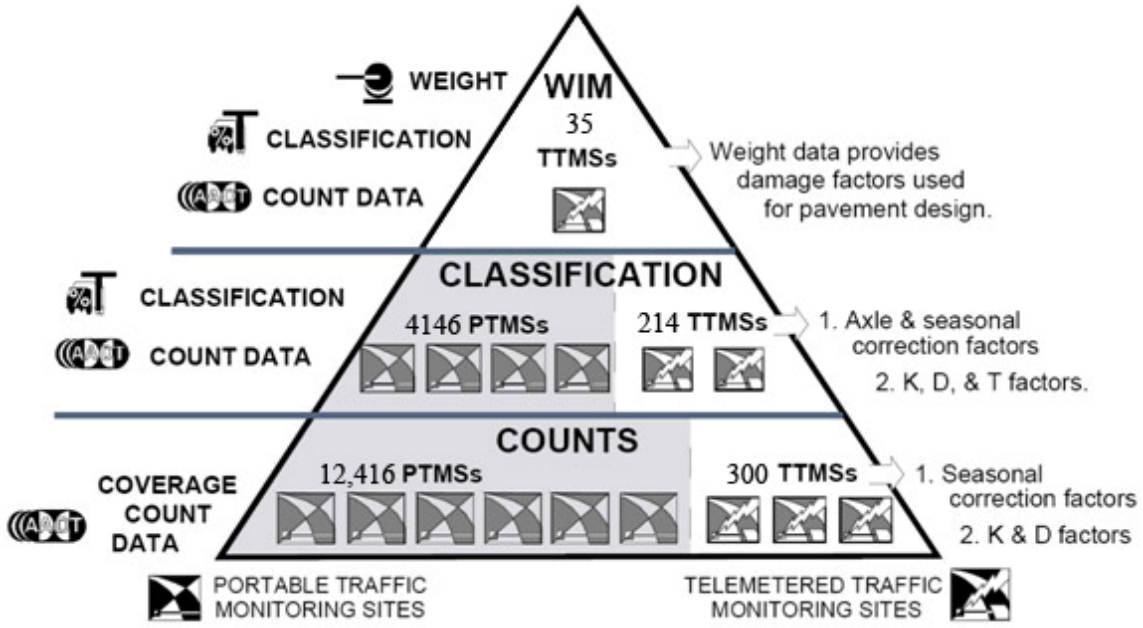


Figure 2.1 Florida's Traffic Monitoring Sites Used in 2011 to collect Traffic Counts and Adjustment Factors

2.3.3 Portable Seasonal Classification Counts

FDOT has approximately 4,150 locations where portable seasonal classification counts are performed. These **Portable Traffic Monitoring Sites** (PTMSs) are automatic traffic recorders that are temporarily placed at specific locations throughout the state to record the distribution and variation of traffic flow. Toll data is also collected to supplement volume counts. Seasonal classification counts are used to develop the axle correction factors and truck percentages during the year. These counts are performed one or more times a year (24-hour or 48-hour each) as deemed necessary to capture the seasonal truck variation. The classification counts will be used to estimate the axle correction factor and determine the percentage of trucks.

FHWA CLASSIFICATION SCHEME "F"

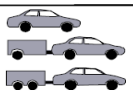
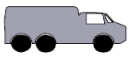
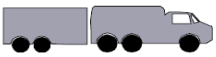
CLASS GROUP		DESCRIPTION	NO. OF AXLES
1		MOTORCYCLES	2
2		ALL CARS CARS W/ 1-AXLE TRAILER CARS W/ 2-AXLE TRAILER	2 3 4
3		PICK-UPS & VANS 1 & 2 AXLE TRAILERS	2, 3, & 4
4		BUSES	2 & 3
5		2-AXLE, SINGLE UNIT	2
6		3-AXLE, SINGLE UNIT	3
7		4-AXLE, SINGLE UNIT	4
8	  	2-AXLE, TRACTOR, 1-AXLE TRAILER (2S1) 2-AXLE, TRACTOR, 2-AXLE TRAILER (2S2) 3-AXLE, TRACTOR, 1-AXLE TRAILER (3S1)	3 4 4
9	 	3-AXLE, TRACTOR, 2-AXLE TRAILER (3S2) 3-AXLE, TRUCK, W/ 2-AXLE TRAILER	5 5
10		TRACTOR W/ SINGLE TRAILER	6 & 7
11		5-AXLE MULTI-TRAILER	5
12		6-AXLE MULTI-TRAILER	6
13	ANY 7 OR MORE AXLE		7 or more
14	NOT USED		
15	UNKNOWN VEHICLE TYPE		

Figure 2.2 FHWA Vehicle Classification Scheme "F"

2.4 SHORT-TERM TRAFFIC COUNTS

These counts are primarily performed by the Districts, local agencies and consultants who are responsible for reporting counts using various portable traffic counting devices. These counts are collected using axle counters and/or vehicle counters.

Portable traffic counters frequently use rubber hoses that record by sensing the number of axles. These counters are small enough to be transported, contain a power source, internal clock, and may be easily secured to a telephone pole, fence post, sign post, tree, etc. All counters utilize electronic storage and require special software and/or hardware to download the collected data. The downloaded data can be transferred directly to a computer or may be printed in a report format. Another type of portable unit adheres to the road surface in the middle of a lane and uses magnetic vehicle detectors rather than axle sensors and records bumper to bumper length and speed in a variety of length and speed groups. The unit requires a special computer to download the data. Other technologies are continually being developed and tested.

2.4.1 Portable Axle Counters

Portable Axle counters are those that have a single rubber hose to sense axles. These counters simply divide the number of axles by two to derive a count. If the counting device measures the "number of axles," an axle correction factor is assigned to the specific count location based on the trucking characteristics of that location. The axle correction factor is applied to the count and then the count is seasonally adjusted to produce AADT.

2.4.2 Portable Vehicle Counters

Examples of Portable Vehicle counters include microwave, magnetic, video, inductive loops, and vehicle classifiers. If the counting device counts the "number of vehicles," the count site will not require an axle correction factor.

2.4.3 Seasonal Adjustments

All short-term counts must be adjusted to reflect the seasonal changes in traffic volumes. TranStat determines the Seasonal Factor Category using traffic data collected from permanent count locations. The 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 counts are similar.

2.5 TRAFFIC ADJUSTMENT FACTORS

The two traffic adjustment factors, Seasonal and Axle Correction, are calculated by the TranStat Office and can be accessed through either the **Traffic Characteristics Inventory (TCI)** database or the **Florida Traffic Online (FTO)** application. Both TCI and FTO contain current and historical information. The continuous counts and the seasonal classification counts provide the necessary information to establish traffic adjustment factors. In the absence of any continuous counts within a county, TranStat borrows 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.

2.5.1 Seasonal Factor (SF)

The Monthly Seasonal Factor (MSF) for a particular month in a particular location is derived from the Annual Average Daily Traffic (AADT) for a location divided by the Monthly Average Daily Traffic (MADT) for a specific month at that count site:

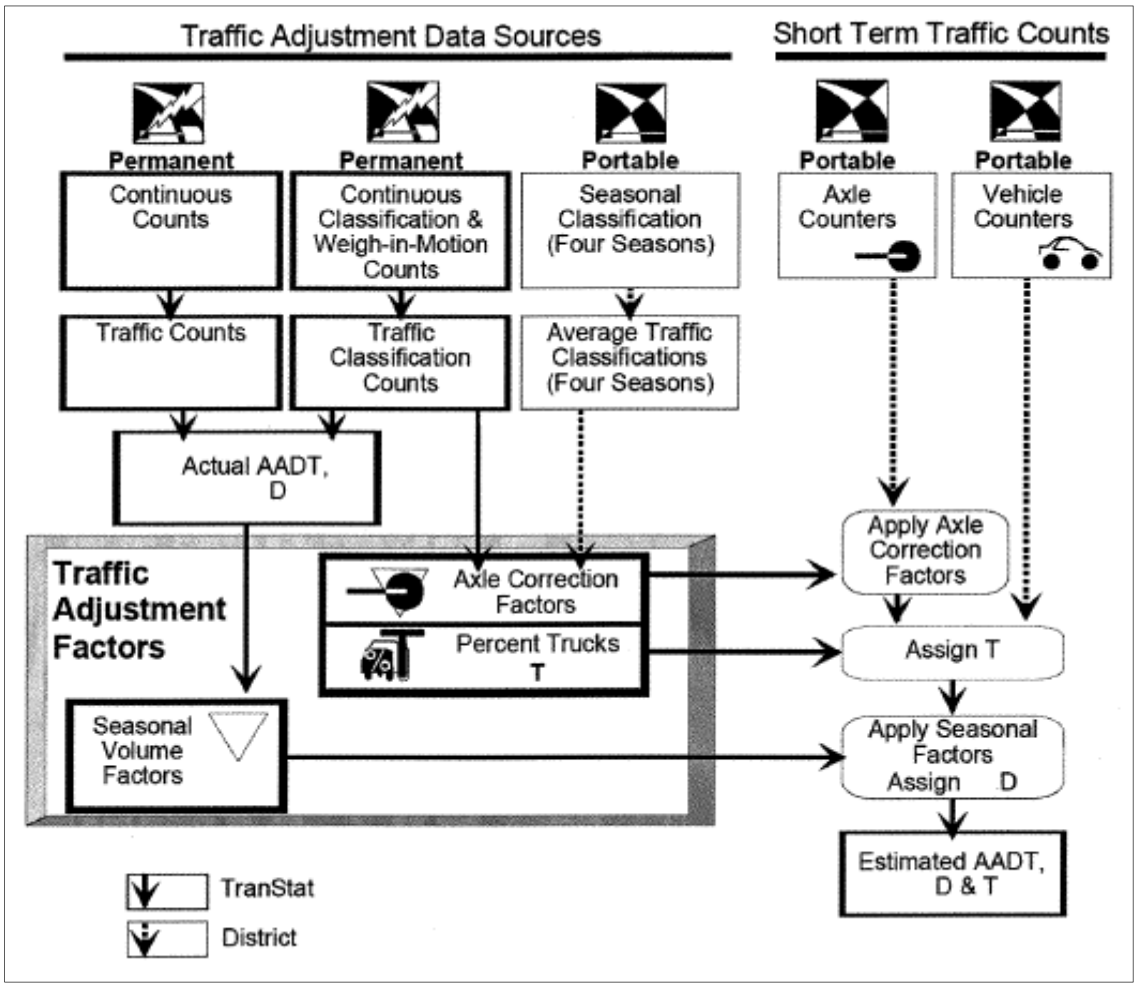
$$MSF = \frac{AADT}{MADT}$$

Weekly Seasonal Factors (SF) are developed by interpolating between the monthly factors for two consecutive months. The Seasonal Factors are calculated for each week of the year for each permanent count station and printed in a Peak Season Factor Report. Figure 3.7 shows an example of a Peak Season Factor Report showing the SF. The SF and Axle Correction Factors are used to convert ADT to AADT.

2.5.2 Axle Correction Factor (ACF)

The Axle Correction Factors are determined by using the data from continuous and portable classification counts following the guidelines as described in the FHWA *Traffic Monitoring Guide*.

TRAFFIC COUNTS, SEASONAL FACTORS, AXLE CORRECTIONS, AND ESTIMATED AADT, D, & T



* Traffic Adjustment Factors are assigned to each Short Term Traffic Count for every Section Break of the State Highway System

Figure 2.3 Process Used to Estimate AADT, D, & T

Actual AADT, D, and T data are measured at continuous counters. At all other locations, the AADT, D, and T are estimated. The data collected at the continuous count stations are used to develop the traffic adjustment factors: Axle Correction Factors, Percent Trucks, and Seasonal Volume Factors. These adjustment factors are applied to short-term traffic counts taken by portable axle and vehicle counters to estimate AADT, D, and T for every section break of the State Highway System.

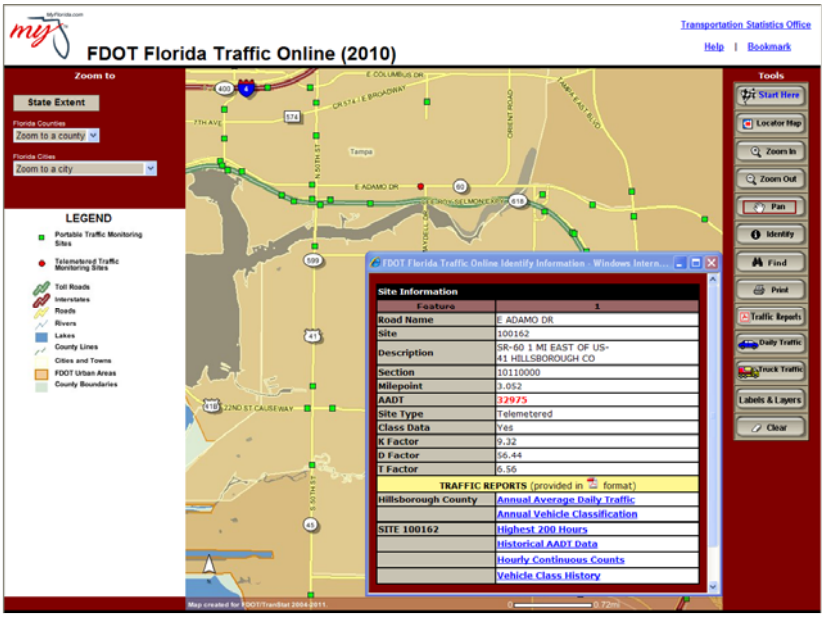
2.6 AADT, K, D, & T

For Project Traffic Forecasting purposes, the data collected on Florida's road system is used to measure the values identified as AADT, D, and T. AADT, and D are critical numbers which determine the geometric design of a road. T is the critical value for pavement design.

Throughout Florida, there are approximately 300 Telemetered Traffic Monitoring Sites (TTMSs) that collect data 365 days a year. For these TTMS sites, actual AADT, D and T are measured. This information provides a statistical basis for estimating AADT, D, and T for all other traffic counts where short-term traffic counts are obtained.

The Project Traffic Forecasting methodology uses information available from the following sources:

- Traffic Characteristics Inventory (TCI) Database
- Roadway Charateristics Inventory (RCI) Database (Feature 331)
- Florida Traffic Online Application (FTO)
- Florida Transportation Information (FTI DVD)
- Annual Vehicle Classification Report (FTI DVD)
- 200th Highest Hour Traffic Count Report (FTI DVD)



2.6.1 Annual Average Daily Traffic (AADT)

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

Average Daily Traffic (ADT) is obtained by a short-term traffic count. Short-term traffic counts are commonly referred to as "raw counts" or simply "traffic counts." ADT is typically a 48-hour traffic count collected on Tuesday, Wednesday, and on Thursday. However, ADT can be based on the simple average of any short-term traffic count at least 24 hours long. 24-hour and 48-hour traffic counts are often taken to measure ADT and converted to AADT for traffic forecasting projects. For traffic forecasts, the Seasonal Adjustment Factor (SF) and Axle Correction Factor (ACF) should be used to convert ADT to AADT.

$$AADT = ADT \times SF \times Axle\ Correction\ Factor$$

When the ADT is multiplied by the Seasonal Factor and Axle Correction Factor assigned to that site, it will provide a statistically accurate count for the entire year at that site known as AADT.

The following process ensures that data is consistent with design traffic criteria. AADT data are based on site specific counts, if available, and the Department's traffic count program. D is based from the median (average) of the ***200th Highest Hour Traffic Count Report*** and T is based on the site specific classification counts, if available, and the ***Annual Vehicle Classification Report***. K, D, and T values are available from the Department's Roadway Characteristics Inventory (RCI) and Traffic Characteristics Inventory (TCI) databases. If traffic counts for the project site are not available, obtain 24-hour (urban) or 48-hour (rural) classification counts to determine hourly traffic volume distribution and T factor. This will allow the identification of the peak hour of the day and the peak direction during that peak hour. Obtain existing turning movement counts from intersection studies or other resources during the identified peak hour. If these are not available, collect turning movement counts for major signalized intersections only using the procedure for Summary of Vehicle Movements described in the FDOT ***Manual on Uniform Traffic Studies***, **Topic No. 750-020-007**.

2.6.2 K

K is the proportion of AADT occurring in an hour. The K-Factor is critical in traffic forecasts because it defines the volume of traffic for which the road is designed to handle.

*The K-factor is **The Design Hour Factor.** It is the ratio of the AADT that occurs during the design hour for the design year. FHWA requires that K be used for all traffic projections used for design projects. It is important to know that the K-factor is descriptive; i.e., it represents the ratio of two numbers (as stated above). K values have been established statewide and should not be computed by using a mathematical equation. K is used to determine the **Design Hour Volume (DHV).***

Traffic projections are expressed as AADT and Design Hour Volume (DHV). AADT and DHV are related to each other by the ratio commonly known as K, as expressed in the equation:

$$DHV = AADT \times K$$

*Capacity analysis focuses on the traffic monitored at an intersection or along a highway during a particular peak hour. The amount of traffic occurring during this hour is called the **Design Hour Volume (DHV)**. K is the ratio of the DHV to the AADT. DHV is derived by multiplying the AADT by K (for the design year).*

The K-factors have been established statewide to represent typical conditions found around the state for area type and facility type during the weekday peak hour for areas with more than a population of 50,000. For the areas of less than a population of 50,000, the K-factors approximate the 100th highest hour of the year. The magnitude of the K-factor is directly related to the variability of traffic over time. Rural and recreational travel routes which are subject to occasional extreme traffic volumes generally exhibit the highest K-factors. The millions of tourists traveling on Interstate highways during a holiday are typical examples of the effect of recreational travel periods. Urban highways, with their repeating pattern of home-to-work trips, generally have lower K-factors.

2.6.2.1 STANDARD K FACTORS

FDOT has decided to replace the K_{30} factors with **Standard K** factors. This has occurred because it has been widely recognized that roadways in urbanized areas cannot be cost effectively designed based on the 30th highest hour demand volumes. Another issue that impacts the use of the K factors is the relationship between demand traffic volumes and measured traffic volumes.

Standard K factors have been established statewide by using the data measured at the continuous count sites. The Standard K factors are based on area type and facility type with consideration to typical peak periods of the day.

For example, on freeways throughout the seven largest urbanized areas in Florida, the peak analysis period is used. For other facilities, the use of a typical peak hour is generally used. Standard K Factors for design analyses are not directly applicable for the Turnpike, other toll roads, and managed lanes. The recommended Standard K factors are reflected in the following Figure 2.4.

FDOT Standard K Factors

Area *(Population) [Examples]*	Facility Type	Standard K Factors* (%AADT)	Representative Time Period
Large Urbanized Areas with Core Freeways *(1,000,000+) [Jacksonville, Miami]*	Freeways	8.0 - 9.0 ***	Typical weekday peak period or hour
	Arterials & Highways	9.0**	Typical weekday peak hour
Other Urbanized Areas *(50,000+) [Tallahassee, Ft. Myers]*	Freeways	9.0 **	Typical weekday peak hour
	Arterials & Highways	9.0 **	Typical weekday peak hour
Transitioning to Urbanized Areas *(Uncertain) [Fringe Development Areas]*	Freeways	9.0	Typical weekday peak hour
	Arterials & Highways	9.0	Typical weekday peak hour
Urban *(5,000-50,000) [Lake City, Key West]*	Freeways	10.5	100th highest hour of the year
	Arterials & Highways	9.0 **	Typical weekday peak hour
Rural *(<5,000) [Chipley, Everglades]*	Freeways	10.5	100th highest hour of the year
	Arterials	9.5 **	100th highest hour of the year
	Highways	9.5	100th highest hour of the year

*	Some smoothing of values at area boundaries/edges would be desirable.
**	Value is 7.5% in approved Multimodal Transportation Districts where automobile movements are deemphasized. Essentially, 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 be 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.

Figure 2.4 FDOT Standard K Factors

Initially, Standard K factors should be used for analyses of points (signalized intersections, interchange ramp terminals). The factors determined from the standard K process should be viewed as approach volumes to these points. Point analyses frequently involve balancing traffic flows and ensuring appropriate operational performance. For example, although it is appropriate for planning and preliminary engineering analyses to generally exclude sub-hourly traffic flow considerations (setting the PHF = 1.0), it is appropriate to use a lower PHF for operational analyses at points where capacity constraints may exist. In the design of left turn bays at signalized intersections or interchange ramp terminals, it would be appropriate to consider peak 15-minute flows if left turning vehicles may back up into through lanes, or operational concerns exist about vehicles backing up on freeway ramps/mainlines, respectively.

Special considerations exist in urban and urbanized areas; both are addressed in the footnotes of Figure 2.4. In the state's largest urbanized areas, FDOT has designated "core" freeways; major, non-toll freeways going into/through the urbanized core areas (I-4 in the Orlando area). As these freeways pass through an urbanized area, the standard K factors generally range from 8.0% to 9.0%, depending upon proximity to the central core or central business district. Standard K factors for these freeways are set and typically updated decennially as part of the urban/urbanized area boundary process. A 7.5% K factor is applicable for state arterials and highways in approved Multimodal Transportation Districts, where secondary priority is given to auto vehicle movements. Essentially, this lower factor represents the promotion of a multi-hour peak period rather than a single peak hour analysis. Intersecting roadways that are non-state maintained will use the same K factor as the project roadway on the state highway system unless other values are derived from special counts.

2.6.3 D

The **Directional Distribution (D)** is the percentage of the total, two-way design hour traffic traveling in the peak direction. **D**, directional distribution, is an essential parameter used to determine the Directional Design Hour Volume (DDHV). The DDHV should be 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. This percentage of traffic in one direction is referred to as **Directional Distribution (D).**

During any particular hour, traffic volume may be greater in one direction than the other. An urban route, serving strong directional demands into the city in the morning and out of it at night, may display an imbalance in directional flows. Figure 2.5 illustrates the directional distribution on US 192 in Lake County.

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

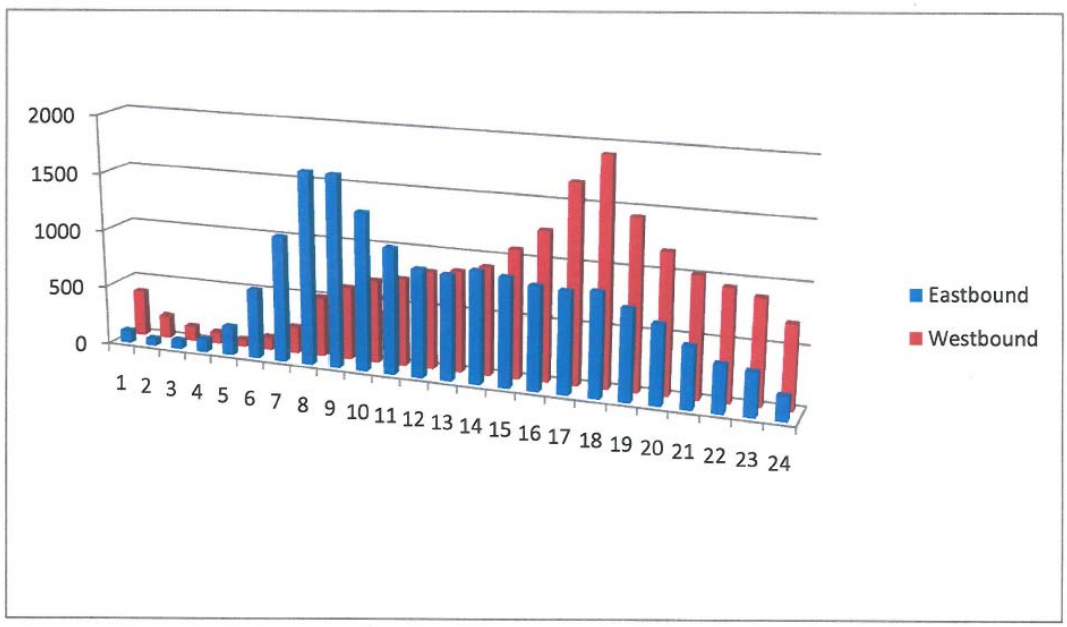


Figure 2.5 Traffic Volume Directional Distribution, US-192, Site 110470

Although there is no explicit consideration of directional distribution in the analysis of multilane facilities, the distribution has a dramatic impact on both design and LOS. As indicated in Figure 2.5, urban radial routes have been observed to have up to two-thirds of their peak hour traffic in a single direction. Unfortunately, this peak occurs in one direction during the morning and in the other in the evening. Thus both directions of the facility must be adequate for the peak directional flow. This characteristic has led to the use of reversible lanes on some urban freeways and arterials.

The directional distribution is an essential traffic parameter used to determine the **Directional Design Hour Volume (DDHV)** for the design year and should be the basis of the geometric design. The DDHV is the product obtained by multiplying the DHV and the Directional Traffic Split (D):

$$DDHV = DHV \times D$$

TranStat is responsible for calculating and estimating the D factor table which will be used for project traffic forecasting and other reporting requirements. This table will include a range of factors of D for each statistically recognized set of road and traffic conditions. The D factor table is derived using the permanent traffic counters located throughout the State of Florida. These data are reported in the 200th Highest Hour Traffic Count Report shown as an example in Figures 2.7 and 2.8.

2.6.3.1 Demand Volume

The term **Demand Volume** means the traffic volume expected to desire service past a point or a 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. When demand exceeds capacity, the peak hour factor will approach 1.0 due to delayed traffic. If this situation of delayed traffic occurs, the observed condition is considered to be a constrained condition.

True demand cannot be directly measured on congested roads, and traffic surveys cannot be used to measure traffic demand during peak traffic hours. Under this situation, demand D is estimated based on FDOT's 200th Highest Hour Traffic Count Reports using the traffic data for unconstrained sites with similar roadway and geographic characteristics. The term “demand traffic” is used to distinguish the resulting DHV projections from those which may be constrained by capacity limitations.

2.6.3.2 Establishing Forecast Years

The following guidelines should be followed to develop opening and design year traffic forecasts.

Project Type	Design Period	Opening Year	Design Year
Roadway Construction	20 years	WP* + 1 year	OY + 20 years
Resurfacing	20 years	WP + 1 year	OY + 20 years**

* WP = 1st year of construction in FDOT Adopted Work Program; OY = Opening Year

** Refer to FDOT Pavement Design Manual for detailed information. Consult the project manager if there is a conflict with requested years.

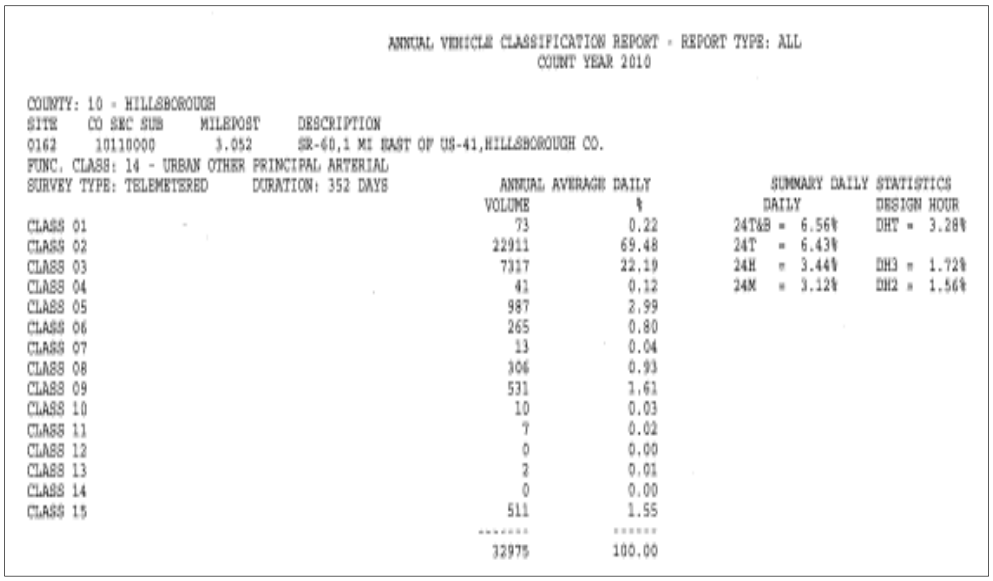
The base year is the first year of the forecast period. For an existing road, the base year is the year in which the forecast is made. For a proposed road, the base year is generally the first year in which the road will be open to traffic. The base year of a new road may be other than the opening year, to match the applicable traffic assignment model, if necessary.

The validated base year of the model will usually be different than the opening year of the proposed project. Likewise, the forecast year of the model may be different than the design year of the project. Standard modeling procedures, such as interpolation and extrapolation, should be employed to ensure that the model will provide traffic assignments for both the opening and design year of the project.

For example:

If a new road is expected to open in 2012 and the travel demand forecasting model is validated to produce 2005 traffic volumes, the base year could be set at 2005. The forecast period would have to be adjusted accordingly to reach the target year.

Figure 2.6 (below) shows the distribution of 15 categories of vehicles per count site station from the report. Each vehicle is classified according to one of the 15 FHWA categories (*see* Figure 2.2), including the Any 7 OR MORE AXLE (13), Not Used (14), and UNKNOWN VEHICLE TYPE (15) categories. The total number of vehicles for all surveys at each station is totaled by vehicle class. The total number of vehicles by class is divided by the combined total volume to generate the percentages of vehicles in each class.



ANNUAL VEHICLE CLASSIFICATION REPORT - REPORT TYPE: ALL
COUNT YEAR 2010

COUNTY: 10 - HILLSBOROUGH
SITE CO SEC SUB MILEPOST DESCRIPTION
0162 10110000 3.052 SR-60,1 MI EAST OF US-41,HILLSBOROUGH CO.
FUNC. CLASS: 14 - URBAN OTHER PRINCIPAL ARTERIAL
SURVEY TYPE: TELEMETERED DURATION: 352 DAYS

	ANNUAL AVERAGE DAILY VOLUME	%	SUMMARY DAILY STATISTICS DAILY	DESIGN HOUR
CLASS 01	73	0.22	24T&B = 6.56%	DHT = 3.28%
CLASS 02	22911	69.48	24T = 6.43%	
CLASS 03	7317	22.19	24H = 3.44%	DH3 = 1.72%
CLASS 04	41	0.12	24M = 3.12%	DH2 = 1.56%
CLASS 05	987	2.99		
CLASS 06	265	0.80		
CLASS 07	13	0.04		
CLASS 08	306	0.93		
CLASS 09	531	1.61		
CLASS 10	10	0.03		
CLASS 11	7	0.02		
CLASS 12	0	0.00		
CLASS 13	2	0.01		
CLASS 14	0	0.00		
CLASS 15	511	1.55		
	32975	100.00		

Figure 2.6 Example of an Annual Vehicle Classification Report (Site 100162)

The Annual 200th Highest Hour Report gives traffic count information on the highest 200 hours for all of the TTMSs where sufficient data was available during the past calendar year. These sites are located throughout Florida, primarily on the State Highway System. The information in this report includes the location, AADT, hourly counts covering the 200 highest hours by direction, the D-factor, and the K-factor for each site. The low count and high count columns provide the directional volumes for the hour shown. The sum of these is tabulated as a total count for the hour. The date, day, and hour when that volume occurred are also reported. Figures 2.7 and 2.8 show an example for Site 140190 in Pasco County.

The listed information provides the basis for determining the DHV and directional split. The DHV is based on the design hour. However, to provide data for the evaluation of annual traffic flow patterns, the K and D factors have been calculated for each of the 200 hours at every site.

FLORIDA DEPARTMENT OF TRANSPORTATION
TRANSPORTATION STATISTICS OFFICE
200 HIGHEST HOUR REPORT - REPORT TYPE: ALL
YEAR 2010

COUNTY: 14 - PASCO
SITE: 0190
DESCRIPTION: SR-93/I-75,0.6 MI S OF SR-54,PASCO CO.
LOCATION: 14140000 MILEPOST 4.50
AADT: 64272

	VALID DATA
HOURS	8088
DAYS	337
WEEKS	52
MONTHS	12

POSITION	TOTAL COUNT	LOW DIR	LOW COUNT	HIGH DIR	HIGH COUNT	DAY	DATE	HOUR	"D" FACTOR	"K" FACTOR
1	6913	S	3438	N	3475	THU	12/23/10	16	50.27	10.76
2	6790	S	3299	N	3491	THU	12/23/10	17	51.41	10.56
3	6742	S	3344	N	3398	THU	12/30/10	17	50.40	10.49
4	6633	S	3107	N	3526	TUE	11/23/10	17	53.16	10.32
5	6572	S	3180	N	3392	THU	12/30/10	16	51.61	10.23
6	6549	N	3267	S	3282	THU	12/23/10	15	50.11	10.19
7	6486	S	3158	N	3328	FRI	10/29/10	18	51.31	10.09
8	6473	S	2945	N	3528	FRI	10/22/10	17	54.50	10.07
9	6464	N	3126	S	3338	WED	11/24/10	17	51.64	10.06
10	6455	N	3174	S	3281	THU	12/30/10	18	50.83	10.04
11	6410	S	2947	N	3463	TUE	11/23/10	18	54.02	9.97
12	6348	S	2901	N	3447	WED	12/22/10	17	54.30	9.88
13	6338	S	2891	N	3447	TUE	11/23/10	16	54.39	9.86
14	6310	N	3096	S	3214	MON	12/27/10	17	50.94	9.82
15	6301	S	2813	N	3488	FRI	12/17/10	17	55.36	9.80
16	6284	N	2836	S	3448	MON	12/27/10	16	54.87	9.78
17	6268	S	2672	N	3596	FRI	11/05/10	17	57.37	9.75
18	6266	S	2740	N	3526	FRI	12/10/10	17	56.27	9.75
19	6263	S	3014	N	3249	THU	11/25/10	12	51.88	9.74
20	6253	S	3085	N	3168	FRI	10/08/10	19	50.66	9.73
21	6250	N	2817	S	3433	THU	12/30/10	14	54.93	9.72
22	6246	N	2941	S	3305	THU	12/30/10	15	52.91	9.72
23	6226	N	2913	S	3313	SUN	11/28/10	16	53.21	9.69
24	6220	N	3030	S	3190	SUN	11/28/10	15	51.29	9.68
25	6211	S	2819	N	3392	WED	12/22/10	18	54.61	9.66
26	6193	S	3046	N	3147	TUE	12/28/10	17	50.82	9.64
27	6190	S	2913	N	3277	SUN	11/28/10	12	52.94	9.63
28	6185	S	2923	N	3262	WED	11/24/10	12	52.74	9.62
29	6177	S	2843	N	3334	FRI	10/15/10	17	53.97	9.61
30	6168	N	2863	S	3305	THU	12/30/10	12	53.58	9.60
31	6163	N	2823	S	3340	THU	12/30/10	13	54.19	9.59
32	6151	N	2899	S	3252	SUN	12/26/10	14	52.87	9.57
33	6148	S	3036	N	3112	SUN	11/28/10	13	50.62	9.57
34	6145	S	2733	N	3412	FRI	10/01/10	17	55.52	9.56
35	6142	S	2891	N	3251	WED	11/24/10	16	52.93	9.56
36	6136	N	2943	S	3193	THU	12/23/10	13	52.04	9.55
37	6124	S	2575	N	3549	FRI	11/12/10	18	57.95	9.53
38	6121	S	2689	N	3432	FRI	10/15/10	18	56.07	9.52
39	6116	S	2634	N	3482	FRI	10/15/10	16	56.93	9.52
40	6111	S	2740	N	3371	FRI	10/22/10	16	55.16	9.51

DESIGN HOUR DATA

DESIGN "D" = 53.47% (AVERAGE OF 28TH-32ND HOUR)
DESIGN "K" = 9.60%
DEMAND "D100" = 56.58% (AVERAGE OF 90TH, 95TH, 100TH, 105TH AND 110TH HOUR)

Figure 2.7 **Hours 1 through 40 for Site 140190 from the 2010 200th Highest Hour Traffic Count Report**

FLORIDA DEPARTMENT OF TRANSPORTATION
TRANSPORTATION STATISTICS OFFICE
200 HIGHEST HOUR REPORT - REPORT TYPE: ALL
YEAR 2010

COUNTY: 14 - PASCO
SITE: 0190
DESCRIPTION: SR-93/I-75,0.6 MI S OF SR-54,PASCO CO.
LOCATION: 14140000 MILEPOST 4.50
AADT: 64272

	VALID DATA
HOURS	8088
DAYS	337
WEEKS	52
MONTHS	12

POSITION	COUNTS					COLLECTION			"D"	"K"
	TOTAL COUNT	LOW DIR	LOW COUNT	HIGH DIR	HIGH COUNT	DAY	DATE	HOUR	FACTOR	FACTOR
45	6091	N	2683	S	3408	SUN	12/26/10	15	55.95	9.48
50	6078	N	2962	S	3116	SUN	12/26/10	13	51.27	9.46
55	6021	N	2917	S	3104	SAT	04/03/10	12	51.55	9.37
60	6004	N	2909	S	3095	SAT	04/03/10	11	51.55	9.34
65	5969	N	2860	S	3109	TUE	12/28/10	16	52.09	9.29
70	5944	S	2883	N	3061	WED	12/22/10	16	51.50	9.25
75	5911	S	2581	N	3330	TUE	12/21/10	17	56.34	9.20
80	5887	N	2678	S	3209	FRI	12/31/10	15	54.51	9.16
85	5855	S	2883	N	2972	THU	11/25/10	13	50.76	9.11
90	5800	N	2349	S	3451	SUN	12/26/10	17	59.50	9.02
95	5786	S	2835	N	2951	SUN	12/26/10	12	51.00	9.00
100	5760	S	2625	N	3135	FRI	09/24/10	18	54.43	8.96
105	5723	S	2294	N	3429	FRI	10/08/10	17	59.92	8.90
110	5708	S	2394	N	3314	FRI	11/12/10	19	58.06	8.88
115	5697	S	2369	N	3328	FRI	12/17/10	18	58.42	8.86
120	5687	S	2686	N	3001	WED	11/24/10	11	52.77	8.85
125	5661	S	2789	N	2872	SAT	11/20/10	11	50.73	8.81
130	5656	N	2329	S	3327	SUN	11/28/10	18	58.82	8.80
135	5627	N	2631	S	2996	SAT	11/20/10	12	53.24	8.75
140	5618	N	2596	S	3022	FRI	04/02/10	18	53.79	8.74
145	5599	S	2528	N	3071	MON	11/29/10	17	54.85	8.71
150	5581	N	2597	S	2984	TUE	12/28/10	13	53.47	8.68
155	5544	S	2357	N	3187	THU	10/14/10	17	57.49	8.63
160	5520	S	2350	N	3170	FRI	09/10/10	19	57.43	8.59
165	5483	S	2538	N	2945	FRI	10/29/10	15	53.71	8.53
170	5468	S	2376	N	3092	THU	10/28/10	17	56.55	8.51
175	5459	N	2610	S	2849	FRI	04/02/10	14	52.19	8.49
180	5447	N	2563	S	2884	FRI	12/24/10	16	52.95	8.47
185	5432	N	2556	S	2876	SAT	11/20/10	13	52.95	8.45
190	5409	S	2465	N	2944	SAT	04/03/10	10	54.43	8.42
195	5396	S	2291	N	3105	WED	12/15/10	17	57.54	8.40
200	5383	S	2320	N	3063	FRI	09/10/10	18	56.90	8.38

DESIGN HOUR DATA

DESIGN "D" = 53.47% (AVERAGE OF 28TH-32ND HOUR)
DESIGN "K" = 9.60%
DEMAND "D100" = 56.58% (AVERAGE OF 90TH, 95TH, 100TH, 105TH AND 110TH HOUR)

Figure 2.8 **Hours 45 through 200 for Site 140190 from the 2010 200th Highest Hour Traffic Count Report**

2.6.3.3 Acceptable D Values

The directional distribution factor, D is based on the median (or average) for the 200th Highest Hour Traffic Count Report and referred to as D, derived from the permanent count stations. The D values are also available from FDOT's RCI and TCI databases. If traffic counts for the project site are not available, obtain 24-hour (urban) or 48-hour (rural) classification 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.

To determine if a D value is acceptable for a project traffic forecasting projection, the following three steps are necessary:

Step 1. First determine if a D value is within an acceptable range of demand D values, using Figure 2.9.

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

Figure 2.9 Recommended D-Factors (D) for Traffic Forecasting

Step 2. The user should use the 200th Highest Hour Traffic Count Report for establishing D for unconstrained sites.

Step 3. If the site is "constrained," **Demand D** should be used. Demand D is estimated based on the 200th Highest Hour Traffic Count Report using traffic data for unconstrained sites with similar roadway characteristics. Select the appropriate D value by analyzing the traffic characteristics and comparing them with unconstrained traffic counts locations. Constrained facilities are determined during the Long Range Transportation Plan update by the MPO in conjunction with District Modeling Staff.

2.6.3.4 Adjusting the D Factor

On highways with more than two lanes and on two-lane roads where important intersections are encountered or where additional lanes are to be provided later, knowledge of the hourly traffic volume in each direction of travel is essential for design.

For the same AADT, a multilane highway with a high percentage of traffic in one direction during the peak hours may require more lanes than a highway having the same AADT with a lesser percentage. During peak hours on most rural highways, from 55 to 70 percent of the traffic is in one direction. For two multilane highways carrying equal traffic, one may have a one-way traffic load 60 percent greater than the other during the peak hours. As an example, consider a rural road designed for 4,000 vehicles per hour (vph) total for both directions. If during the design hour the directional distribution is equally split, or 2,000 vph in each direction, two lanes in each direction may be adequate. If 80 percent of the DHV is in one direction, at least three lanes in each direction would be required for the 3,200 vph; and if the 1,000 vehicles per lane criterion is rigidly applied, four lanes in each direction would be required.

Directional traffic during peak hours is generally consistent from year to year and from day to day on a given rural road, except on some highways serving recreational areas. The measured directional distribution may be assumed to apply to the DHV for the future year for which the facility is designed, except for urban highways. For urban highways, as the land use changes, directional distribution tends to the lower end of the facility type. Ultimately, urban roads reach a value of 50 percent, traffic flowing equally in both directions.

2.6.3.5 Estimating D Example

The following is an actual example which illustrates the process of obtaining the necessary data in order to make a D recommendation.

1. D is based on site-specific data related to either telemetered site(s) located on the facility of the project or on telemetered site(s) located on roads with similar geometric and traffic characteristics. If an existing telemetered site is available, the D data is reported in the 200th Highest Hour Traffic Count Report. Every state road will be assigned to a certain factor category. If the information for D is not reported in the 200th Highest Hour Traffic Count Report, the user should refer to the RCI database to obtain the D_{30} information. This D value is estimated based on system, facility type and Seasonal Factor (SF) category assigned by the District.

2. Document all the available D data and sort them by year. If sufficient data is available the user should report up to 20 years of past data. Along with D data the user must note changes in roadway and land use characteristics for every year; for example, changes in the number of lanes, facility type, and whether the facility is operating under constrained conditions, anticipated land use changes, etc.

SITE 480156 ESCAMBIA COUNTY
I-10, 0.6 mi. west of SR-297 U/P
48260000 – MP 6.455
Rural/Suburban

YEAR	AADT	D	No. of Lanes	Facility
2003	30,546	60.0	4	Freeway
2004	32,252	55.3	4	Freeway
2005	34,122	53.3	4	Freeway
2006	33,760	55.2	4	Freeway
2007	33,853	53.6	4	Freeway
2008	32,768	54.2	4	Freeway
2009	33,730	56.1	4	Freeway
2010	34,265	55.6	4	Freeway

Existing LOS — " A "

1. Summarize the information in a table (if more than one year of data is available) and note the minimum and maximum observed D.

	D I-10 Site 480156
Observed Minimum	**53.3**
Observed Maximum	**60.0**

2. Based on this information and past experience, the user estimates the acceptable D that should be used for this project and makes recommendations through the District Office for final concurrence by the Systems Planning Office and FHWA (if federal funding is involved).

2.6.4 Percent Trucks (T)

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

Because there are numerous classes of trucks (*see* Figure 2.2), and different applications of truck data, various definitions of truck percentages are used. Truck percentage definitions (*see* Section 1.5) include **T_f**, **T_{24}**, **24T+B**, **24T**, **DHT, DH2**, and **DH3**, and are all calculated as percentages.

The traffic forecasting "T" is the same as T_{24} or 24T+B. It includes the trucks and buses from Categories 4 through 13. The truck volume and AADT are related to each other by a ratio commonly known as "T." The **Daily Truck Volume (DTV)** can be derived by multiplying AADT x T.

$$DTV = AADT \times T$$

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

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

The truck percentage is usually assumed to be constant over time. More research is being performed both nationally and in Florida to determine if the current assumptions can be improved.

2.7 EXAMPLE OF ESTIMATION OF AADT

As indicated previously, traffic adjustment factors on the State Highway System are calculated by TranStat based on the continuous count program. These factors are used to estimate AADT, K, D, and T, which can be accessed through the DOT INFONET from RCI or TCI databases. The AADT, K, D, and T for the current year are available in RCI under Feature 331 (Traffic Flow Breaks).

To estimate AADTs along roadways not on the state system, a short-term traffic count must be conducted (as described earlier). For traffic counts obtained using portable axle counters, apply the Axle Correction Factors (ACF) and then apply the Seasonal Factors (SF).

If the counts were obtained using portable vehicle counters, apply the appropriate seasonal factors. Assuming that the truck characteristics are similar to the axle correction category, and traffic characteristics are similar to the seasonal category, then AADT, K, D, and T can be estimated as shown in the following example:

EXAMPLE

To determine traffic parameters for a short-term ADT count conducted along a highway section on the State Highway System, the following example shows the steps to be performed:

Step 1. Determine count location on a state highway section.

Section	Beginning Milepoint	Ending Milepoint
01010000	8.583	10.174

Step 2. Locate a traffic count site which reasonably represents traffic for the defined traffic section break and number the count site for future reference.

Count Site	Section	Milepoint
01-0021	01010000	9.838

Step 3. Assign a Seasonal Factor from the Peak Season Factor Category Report and assign an Axle Correction Factor from the Weekly Axle Correction Factor Category Report for the site defined in Step 2.

Count Site	Section	Milepoint	Seasonal Category	Axle Category
01-0021	01010000	9.838	0103	0108

For the fourth week of January 2010 the following factors are found in the Peak Season Factor Category Report (*see* Figure 2.10) and Weekly Axle Factor Category Report (*see* Figure 2.10).

Seasonal Factor = .92

2010 PEAK SEASON FACTOR CATEGORY REPORT - REPORT TYPE: ALL
CATEGORY: 0103 US41 & 17, W OF I-75

MOCF: 0.88

WEEK	DATES	SF	PSCF
1	01/01/2010 - 01/02/2010	0.98	1.11
2	01/03/2010 - 01/09/2010	0.96	1.09
3	01/10/2010 - 01/16/2010	0.94	1.07
* 4	01/17/2010 - 01/23/2010	0.92	1.04
* 5	01/24/2010 - 01/30/2010	0.91	1.03
* 6	01/31/2010 - 02/06/2010	0.89	1.01
* 7	02/07/2010 - 02/13/2010	0.88	1.00
* 8	02/14/2010 - 02/20/2010	0.86	0.98
* 9	02/21/2010 - 02/27/2010	0.86	0.98
*10	02/28/2010 - 03/06/2010	0.85	0.96
*11	03/07/2010 - 03/13/2010	0.85	0.96
*12	03/14/2010 - 03/20/2010	0.85	0.96
*13	03/21/2010 - 03/27/2010	0.87	0.99
*14	03/28/2010 - 04/03/2010	0.88	1.00
*15	04/04/2010 - 04/10/2010	0.91	1.03
*16	04/11/2010 - 04/17/2010	0.93	1.05
17	04/18/2010 - 04/24/2010	0.95	1.08
18	04/25/2010 - 05/01/2010	0.98	1.11
19	05/02/2010 - 05/08/2010	1.01	1.15

EXAMPLE

Figure 2.10
Peak Season Factor Category Report

Axle Factor = .95

2010 WEEKLY AXLE FACTOR CATEGORY REPORT - REPORT TYPE: ALL

COUNTY: 01 - CHARLOTTE

WEEK	DATES	108 US41,LEE C/L-CR765
1	01/01/2010 - 01/02/2010	0.95
2	01/03/2010 - 01/09/2010	0.95
3	01/10/2010 - 01/16/2010	0.95
4	01/17/2010 - 01/23/2010	0.95
5	01/24/2010 - 01/30/2010	0.95
6	01/31/2010 - 02/06/2010	0.95
7	02/07/2010 - 02/13/2010	0.95
8	02/14/2010 - 02/20/2010	0.95
9	02/21/2010 - 02/27/2010	0.95
10	02/28/2010 - 03/06/2010	0.95
11	03/07/2010 - 03/13/2010	0.95
12	03/14/2010 - 03/20/2010	0.95
13	03/21/2010 - 03/27/2010	0.95
14	03/28/2010 - 04/03/2010	0.95
15	04/04/2010 - 04/10/2010	0.95
16	04/11/2010 - 04/17/2010	0.95
17	04/18/2010 - 04/24/2010	0.95
18	04/25/2010 - 05/01/2010	0.94
19	05/02/2010 - 05/08/2010	0.94

EXAMPLE

Figure 2.11
Weekly Axle Factor Category Report

Step 4. The AADT for the highway section is calculated by multiplying the traffic count by the appropriate Seasonal Factor and the Axle Correction Factor for the week of the year in which the count was collected. K and D are assigned as an average for a volume category and T is assigned as an average for an axle categor y.

AADT = Traffic Count x Seasonal Factor (SF) x Axle CorrectionFactor (ACF)

Note that the previous year's factors are applied to the current year's data.

If the data collected at Milepoint 9.838 on January 20, 2010 is 16,140 vehicles/day, applying the Seasonal Factor 0103 (.92) and Axle Correction Factor 0108 (.95) then AADT can be calculated as follows:

AADT = 16,140 x .92 x .95
AADT = 14,106
AADT = 14,000 (after rounding)

Step 5. The values of K and D can be found in the Volume Factor Category Summary Report (*see* Figure 2.12). T is reported in the Annual Vehicle Classification Report (*see* Figure 2.13). The 2010 reports which apply to this example are shown in the respective figures below.

K = 10.36 D = 54.31 T = 8.25 (factors found in the summary reports)

2010 VOLUME FACTOR CATEGORY SUMMARY REPORT - REPORT TYPE: ALL

CATEGORY: 0103 - US41 & 17, N OF I-75

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	SUN	MON	TUE	WED	THU	FRI	SAT	"K"	"K100"	"D"	AADT
010367 N	0.94	0.85	0.83	0.91	1.05	1.09	1.11	1.11	1.12	1.06	0.98	1.00	1.34	1.01	0.95	0.92	0.92	0.89	1.11				
010367 S	0.93	0.85	0.84	0.93	1.06	1.09	1.11	1.11	1.12	1.04	0.98	0.99	1.27	1.00	0.96	0.92	0.93	0.91	1.11				
010367 B	0.94	0.85	0.83	0.92	1.05	1.09	1.11	1.11	1.12	1.05	0.98	1.00	1.31	1.00	0.95	0.92	0.93	0.90	1.11	10.36	9.63	54.31	14088
170181 N	0.93	0.87	0.86	0.93	1.03	1.09	1.12	1.13	1.15	1.06	0.99	0.96	1.36	1.00	0.95	0.94	0.94	0.90	1.03				
170181 S	0.92	0.86	0.86	0.93	1.03	1.09	1.12	1.14	1.15	1.06	0.99	0.95	1.32	1.00	0.95	0.95	0.94	0.91	1.02				
170181 B	0.93	0.87	0.86	0.93	1.03	1.09	1.12	1.13	1.15	1.06	0.99	0.95	1.34	1.00	0.95	0.94	0.94	0.90	1.02	10.28	10.00	52.29	31068
CATEGORY:	0.94	0.86	0.85	0.93	1.04	1.09	1.12	1.12	1.13	1.05	0.99	0.98	1.33	1.00	0.95	0.93	0.94	0.90	1.07	10.32	9.82	53.30	

Figure 2.12 Volume Factor Category Summary Report

ANNUAL VEHICLE CLASSIFICATION REPORT - REPORT TYPE: ALL
COUNT YEAR 2010

COUNTY: 01 - CHARLOTTE
SITE CO SEC SUB MILEPOST DESCRIPTION
0021 01010000 9.838 SR 45/US 41, SE OF CR 765/ALLIGATOR CREEK CH185
FUNC. CLASS: 14 - URBAN OTHER PRINCIPAL ARTERIAL
SURVEY TYPE: PORTABLE DURATION: 2 DAYS

	ANNUAL AVERAGE DAILY VOLUME	%
CLASS 01	96	0.68
CLASS 02	9423	66.83
CLASS 03	3406	24.15
CLASS 04	12	0.09
CLASS 05	428	3.03
CLASS 06	196	1.39
CLASS 07	38	0.27
CLASS 08	306	2.17
CLASS 09	184	1.30
CLASS 10	9	0.06
CLASS 11	0	0.00
CLASS 12	0	0.00
CLASS 13	3	0.02
CLASS 14	0	0.00
CLASS 15	0	0.00
	14100	100.00

SUMMARY DAILY STATISTICS
DAILY
24T&B = 8.34% DHT = 4.17%
24T = 8.25%
24H = 5.22% DH3 = 2.61%
24M = 3.12% DH2 = 1.56%
DESIGN HOUR

Figure 2.13 Annual Vehicle Classification Report

2.8 EXISTING TRAFFIC CONDITION INFORMATION

2.8.1 Seasonal Adjustments

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

Directions on conducting classification counts are contained in the Traffic Monitoring Procedure. Traffic counts cannot be accepted without seasonal adjustments. These adjustments are applied as described in Section 2.5 (Traffic Adjustment Factors). Acceptable data should be uploaded to the 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 other than FDOT personnel should follow FDOT's procedures.

2.8.2 Factors

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

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

The D-factor used for pavement design (D_F) is typically 50 percent for two-way roads. This is because the assumption is that an equal amount of loaded trucks are operating in both directions of traffic flow. For a one-way road, all of the trucks are moving in the same direction, thus the D_F is 100 percent. The Traffic Forecaster may elect to change the D_F upwards from 50 percent if there is an obvious reason for doing so. Base year directional bias in pavement loading will be used to determine the ESAL forecast D_F. Whether a different directional bias exists for loaded trucks is found by visually monitoring the traffic using the road to identify any repeating traffic, and seeking the source or destination of the traffic. One example might be concrete delivery truck traffic whose source is a concrete mixing plant down the road. Another example would be a railroad siding serving as a destination for pulpwood trucks. In both cases, the D_F used for ESAL forecasting and subsequent pavement damage will be between 50 and 100 percent (*see* Section 7.4.2).

2.8.3 Roadway Data

Number of lanes (Feature 212) and functional classification (Feature 121), can be found in the Roadway Characteristics Inventory (RCI) for the Roadway ID and Milepoint of the road under design.

2.9 LEVEL OF SERVICE (LOS) ANALYSIS

The Level of Service (LOS) analyses should be performed in accordance with the most recent version of the FDOT Quality/Level of Service Handbook Procedures, Highway Capacity Manual procedures, and accompanying software.

2.10 NUMBER OF LANES REQUIRED

Project traffic forecasts ultimately are used to determine how many lanes a corridor or project may require. Using the best available current year data, and projecting future values of DDHV, SF_i, and Peak Hour Factor (PHF), the number of lanes can be estimated.

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CHAPTER THREE

FORECASTING WITH TRAVEL DEMAND MODELS

3.1 PURPOSE

This chapter provides guidance in the application of models to develop traffic projections for route specific (PD&E) studies, corridor studies and resurfacing type projects. This chapter also provides an overview of modeling for traffic engineers and an overview of traffic forecasting requirements for modelers. First, the definition and the components of Corridor Traffic Forecast and Project Traffic Forecast is introduced in Section 3.2. Sections 3.3 through 3.6 discuss what a traffic forecasting user should know about how modeling outputs are used in the development of traffic forecasting. Sections 3.7 through 3.15 discuss what modelers should know about the traffic forecasting process in order to develop traffic projections which meet the needs of traffic forecasting engineers. Some guidance is repeated in each section in order to make each section stand alone. The rest of the chapter explains the process of converting the model outputs into **Annual Average Daily Traffic (AADT).**

This chapter explains the following:

- **Modeling Background for Traffic Forecasting Engineers**
  - How to select a model
  - How to apply a model
- **Traffic Forecasting Background for Modelers**
  - General travel demand forecasting model issues
  - Resurfacing Project modeling methodology
  - Corridor or Project Design modeling methodology
- **Model Output Conversion to AADT**
  - General travel demand forecasting model issues

This method applies only to locations that have adopted/endorsed models available. Specific guidance can be obtained from the appropriate offices listed in Appendix A - District Planning and Modeling Contacts. If an acceptable model is not available, then refer to Chapter 4 – Forecasting Without a Traffic Model.

3.2 CORRIDOR AND PROJECT TRAFFIC FORECASTING

3.2.1 Corridor Traffic Forecasting

Corridor Traffic Forecasting produces the information needed for traffic engineering practioners to determine the required number of lanes within a corridor to meet the future anticipated traffic demands. Traffic forecasting is required before establishing a new alignment or widening of existing facilities. Corridor models are special application models that are usually validated to forecast traffic for a certain corridor and are usually more specific than the urban area or statewide model and less specific than project forecasting models. The validated models to forecast general corridor traffic for systems planning application purposes should be checked to ensure that they have the required specificity for project details required for project traffic forecasting using design traffic criteria.

Corridor Traffic Forecasting Process studies are needed to determine future traffic volumes and long range system data needed (such as link volumes) 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 need for new or upgraded transportation facilities within the corridor. The corridor process may be required for traffic flow analyses of large areas, such as those needed in the preparation of Development of Regional Impact (DRI) applications for development approval, Strategic Intermodal System/Florida Intrastate Highway System (SIS/FIHS) Master and Action Plan reports, and the major transportation investments required by federal regulation in metropolitan areas.

All project traffic projections using the Corridor Traffic Forecasting Process will also require the more rigorous examination of the Project Traffic Forecasting Process. For planning applications, the model is often used with a feedback loop to provide for changing or amending approved plans such as the MPO/TPO Long Range Transportation Plan (LRTP), the Local Government Comprehensive Plan (LGCP), or Work Program (WPA). Revisions to these plans may or may not require more detailed analysis associated with project traffic forecasting using design traffic criteria. The appropriate District Director or his/her designee(s) will be responsible for carrying out the Corridor Traffic Forecasting Process unless assigned elsewhere by the District Secretary or his/her designee(s).

Figure 3.1 Illustrates the seven-step Corridor Traffic Forecasting Process.

Corridor Traffic Forecasting Process

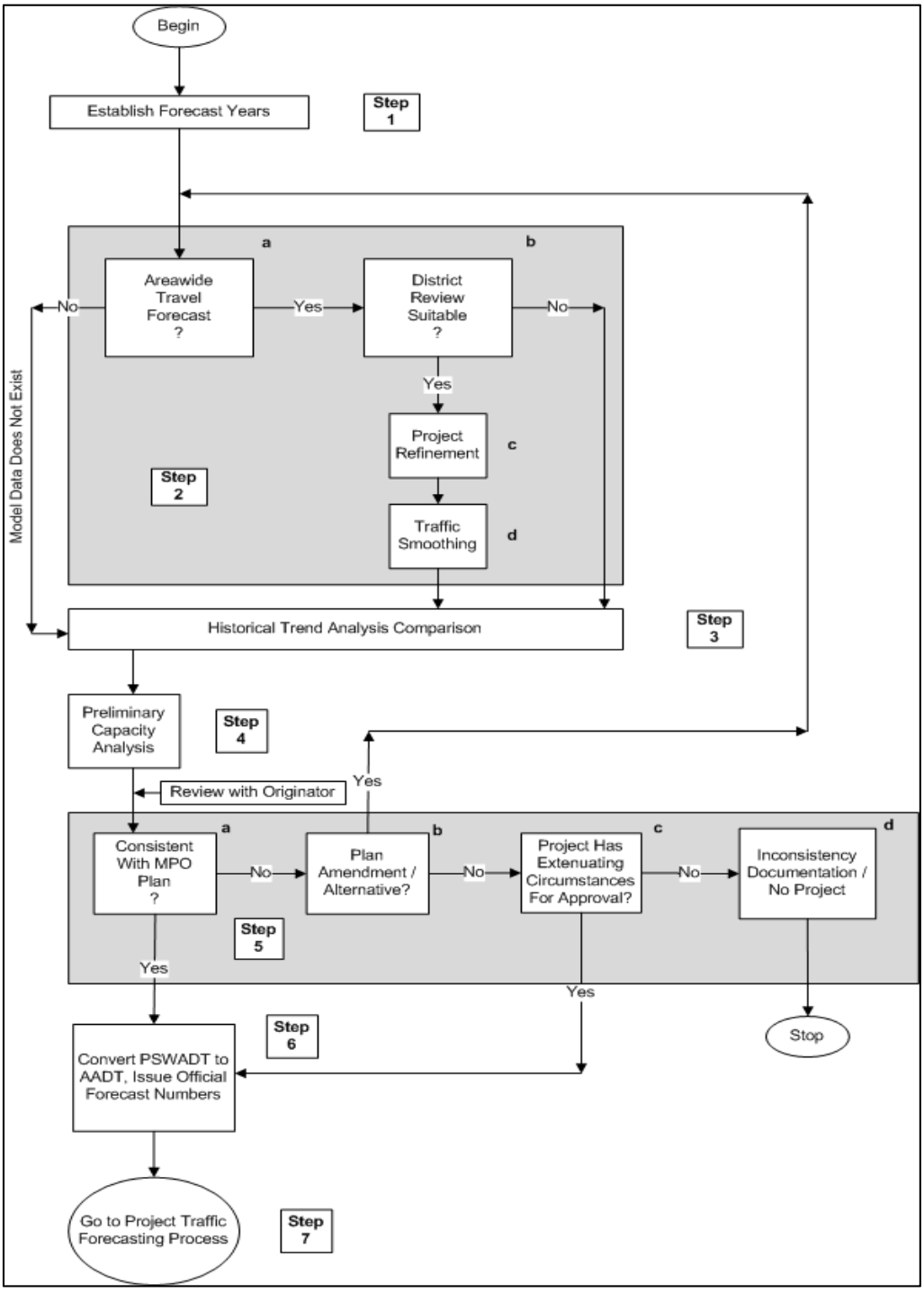


Figure 3.1 Corridor Traffic Forecasting Process

3.2.2 Project Traffic Forecasting

All Project Traffic Forecasting projections using the Corridor Traffic Forecasting Process will also require more rigorous examination of the Project Traffic Forecasting Process. The Project Traffic Forecasting Process estimates traffic conditions used for determining the geometric design of a roadway and/or intersection and the number of 18-KIP ESALs that pavement will be subjected to over the design life. Project Traffic Forecasting is required for reconstruction, resurfacing, adding lanes, bridge replacement, new roadway projects, and major intersection improvements. This process differs from Corridor Traffic Forecasting in that it is site specific, covers a limited geographic area, and is more detailed.

The Project Traffic Forecasting Process consists of nine steps which are outlined in Figure 3.2 and explained in greater detail throughout this handbook.

While the general corridor traffic may be detailed enough to identify the needs for specific improvements, the final project traffic forecasting data needed for a specific project, (such as a link or intersection) may require more refined or specific project traffic analysis. Project traffic studies identify specific link volumes, turning movements, and other project-specific data necessary for the geometric design of, and operational improvements to roadways or intersections. This process is different from the corridor process because of the specific nature of the Project Traffic Forecasting studies. The project traffic process forecasts traffic conditions and turning movements used for designing the configuration and number of lanes for proposed projects as defined in the ***FDOT Adopted Five Year Work Program***. These projects will be selected by the Districts and assigned a Financial Management (FM) Number. Other uses could be to identify the project traffic requirements for the Interstate and Intrastate Highway Systems, the Interchange Justification Report (IJR) process, the Interchange Modification Report (IMR) process, and the Master and Action Plans for the SIS/FIHS.

Project traffic forecasting is usually required for determining the number of lanes required to meet the future anticipated traffic demand. Project traffic forecasting is required for reconstruction, resurfacing, adding lanes, bridge replacement, approaches to bridges, new roadway projects, and major intersection improvements. The appropriate District Director or his/her designee(s) will be responsible for carrying out the project traffic forecasting process unless this responsibility is assigned elsewhere.

The nine steps in the Project Traffic Forecasting Process, shown in Figure 3.2, will assist with the preparation of project traffic to be consistent with design traffic criteria.

Project Traffic Forecasting Process

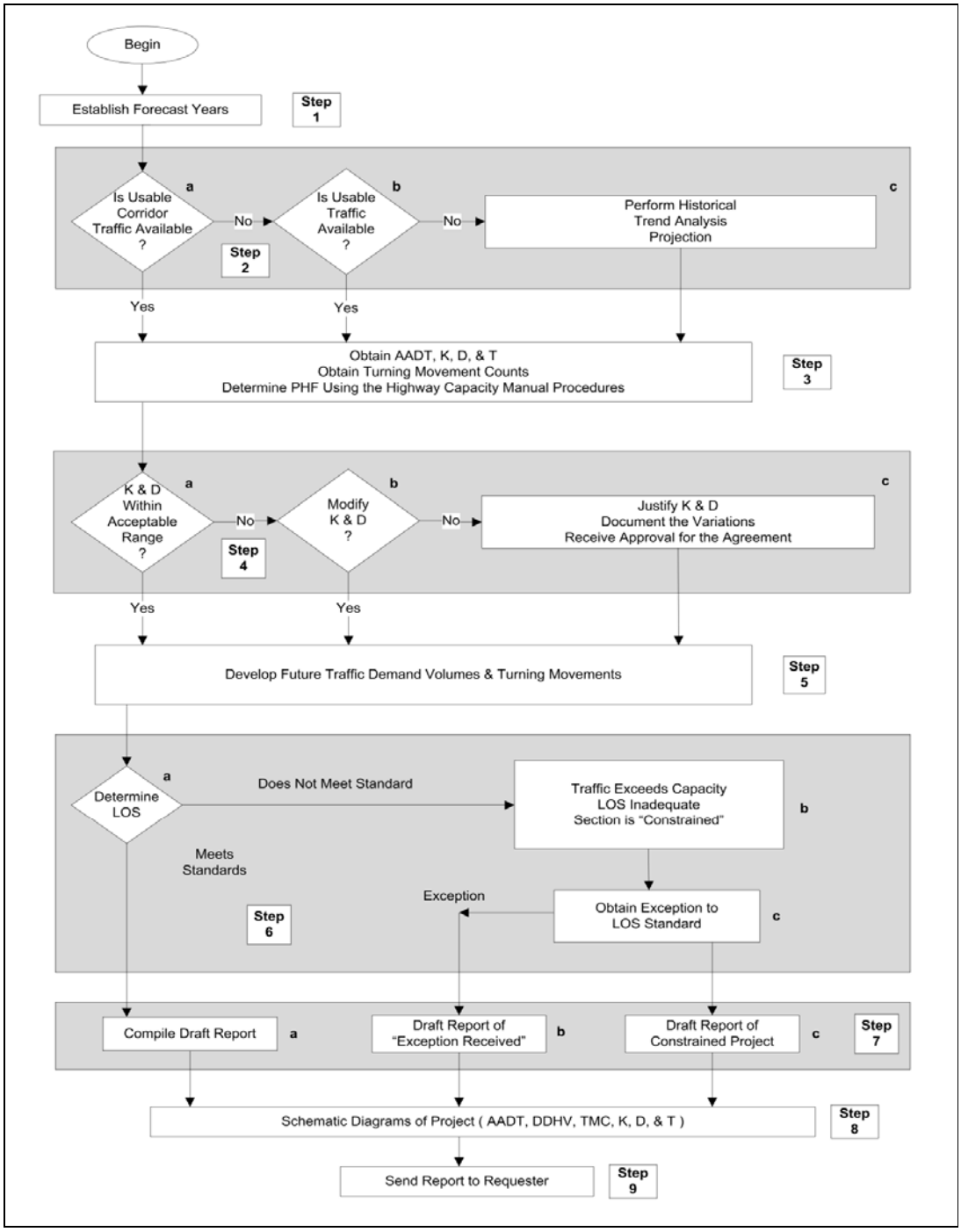


Figure 3.2 Project Traffic Forecasting Process

3.3 MODELING BACKGROUND FOR TRAFFIC FORECASTING

The primary purpose of travel demand forecasting models has been to provide systems level traffic forecasts used to identify transportation needs in the development of long range transportation plans. The resulting transportation plans provide a basis for the more detailed evaluation required for specific project developments. Project Traffic Forecasting Reports are the documents which contain the supporting traffic forecasts used in establishing specific improvements, including cross section requirements, lane calls for corridors, intersection/interchange geometry, and pavement design.

Models can be useful tools in developing the traffic projections necessary for the Project Traffic Forecasting Report. However, since travel demand forecasting models are "planning" vs. "design" tools, the systems level traffic projections must be properly evaluated for reasonableness and consistency in light of current conditions and those indicated by trends (*see* Chapter 4 – Forecasting Without a Traffic Model).

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

Models are typically calibrated and validated to reflect the travel behaviors as observed for a "base year". The base year could be the Census year, the beginning of a Long Range Transportation Planning cycle, or any other year when travel survey data are available. 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 survey data, origin-destination survey data, external station survey data, transit on-board survey data, US Census, National Household Travel Survey (NHTS) Add-on, Census Transportation Planning Package (CTPP), American Community Survey (ACS), and the Longitudinal Employer-Household Dynamics (LEHD) provided by the US Census Bureau. Generally speaking, a model is considered to be validated when traffic volumes generated by the model match the traffic counts for the base year. After a model is validated, the model can be used to forecast future traffic volume using the projected population and employment data for a future year and the transportation network for the same year.

Generally speaking, models that have been adopted by the Districts and MPOs should be used first to develop future project traffic. Depending on the location of the project, the Florida Statewide Model or the Florida Turnpike Model can also be used. The parameters and coefficients used 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 a list of available models. The contact information for District Modeling Coordinators can be found in Appendix A.

3.4 MODEL SELECTION

Selection of the appropriate model to be applied should be made based upon project location limits and the specific roadway. For projects which lie *within* an urbanized MPO area, the MPO adopted model should be used unless otherwise mutually agreed upon by all involved parties. Projects which lie *outside* the MPO area boundaries may be able to utilize other District Planning Offices' approved models such as the Regional, Turnpike, or Statewide (rural areas only) models. Since the availability of models varies from district to district, the District Planning Office should be contacted to confirm the correct model to be used.

3.4.1 Review of Model Applicability

Prior to using a particular model, verify that you are using the latest version of the model and conduct a review of the base and forecast year projections within the project study area to ensure that they are functioning properly within that study area. If the level of accuracy in the calibrated/validated base year model is determined to be unacceptable for the purposes of forecasting traffic for a project, then the model should not be used until the District Planning Office and/or the agency having jurisdiction over the model has addressed the situation. Models are generally calibrated on a system-wide level and not on a particular corridor or project specific level. The Project Traffic Report stage is **NOT** the appropriate place to perform a recalibration of a base year model application. Should the calibration of the model remain an issue, it is suggested that the procedure for Forecasting Without A Traffic Model be followed instead (as in Chapter 4).

3.4.1.1 Area-wide Travel Forecast Model

Determine if the corridor resides in a region with an existing areawide traffic forecast model. If more than one traffic model is available, the selected model should depend on the hierarchy of available models (e.g., master plan, urbanized (MPO) model, Turnpike, county, city, corridor or project). The District Planning Manager or his/her designee can provide the current status of the MPO model, and ensure that the model used for project traffic forecasting is consistent with

the adopted urban area model. Intermodal/ multimodal and HOV modeling should be considered where applicable. If a traffic model is available, perform appropriate District review.

3.4.1.2 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 design project. The suitability check should include percent-root-mean-square-error (%RMSE) and screen line in base year evaluations. If the model is acceptable, perform project refinement. If not, perform historical trend analysis comparison.

3.4.1.3 Project Refinement

The base and future year model forecasts shall be reviewed. Within the corridor study area of influence for the model review, take into consideration parallel facilities, competing facilities, transit services, network revisions, disaggregation of zones, and socioeconomic data when refining the model traffic to be more project specific. After making the needed model revisions to make the model more project specific, apply traffic smoothing. 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. Please refer to Section 3.16 for a discussion on converting PSWADT to AADT.

3.5 SUITABILITY OF OUTPUTS AND MODELS

This step determines if the corridor traffic forecasting outputs or other traffic models are appropriate for the analysis and consists of three sub-steps.

3.5.1 Corridor Traffic Data Usability

Determine if corridor traffic data are available and usable for the Project Traffic Forecasting Process and is consistent with design traffic criteria. Corridor traffic should not be used if the traffic and number of lanes are not consistent with the LGCP and/or the adopted MPO Long Range Plan. If the corridor traffic data are consistent, use the corridor traffic forecast procedure. If corridor traffic is not available, consult the District MPO liaison to determine if other traffic forecasting models are available.

3.5.2 Traffic Model Availability

If a traffic model is available, determine which model to select for the project. The selected model should depend on the hierarchy of available models (e.g. master plan, regional or urbanized area model, and local). The District Planning Manager or his/her designee can provide the current status of the MPO model, and ensure that the model used for project traffic forecasting is consistent with the adopted urban area model. Determine if the selected traffic forecast model is suitable for performing the analysis. When available, compare both historical trend analyses against the model data being used to forecast the project traffic. In some instances, it may be better to use an average rate resulting from the two methodologies depending on the study area. The suitability check should include percent-root-mean-square-error (%RMSE) and screen line in base year evaluations. If the traffic model is usable, then use the corridor traffic forecast. If no traffic model is available or suitable for the project, perform historical trend analysis projection.

3.5.3 Historical Trend Analysis

While not all capacity improvement corridor projects may use a corridor traffic model and some projects may be in geographic areas where such a model does not exist, certain capacity improvement corridor projects, such as additional lanes, should use the corridor traffic model. If the project is not significant enough to cause traffic diversion, and traffic can be shown to follow past history trends, historical trend analysis may be used to forecast future traffic, as in widening or resurfacing projects. Such a project would not cause a traffic diversion and trend forecasting could be justified A statement of the adopted methodology should be included with the final Corridor Traffic Forecasting Report.

When performing a historical trend analysis, care must be taken to compare similar types of traffic outputs, which means that, PSWADT, must be compared to the model's PSWADT, and AADT must be compared to the model's converted AADT. For instance, an estimated ground count (AADT) must be converted to PSWADT before comparing with the model output PSWADT. The model output PSWADT must also be converted to AADT and compared to an AADT ground count. In all cases, the traffic compared consists of both AADT and PSWADT before evaluation. Note: Not all model outputs need to be converted from PSWADT to AADT using MOCF. If the model was set to generate Annual Average Daily Traffic (AADT), conversion of the model output will not be necessary.

A historical trend analysis shall be compared with traffic forecasts from areawide studies, if available, to test for trend analysis reasonableness. Perform a historical trend analysis projection based on available historical counts, population growth, employment, gasoline sales, and other appropriate growth indicators. If the trend analysis fails the test of reasonableness, the causes should be identified. An example of a traffic forecast that could be higher than the historical trend would be the addition of lanes or new land development in the area of influence. An example of a traffic forecast that could be justified to be lower than the historical trend would be a future congested facility identified by the preliminary capacity analysis. Generally speaking, only growth with an R^2 value greater than or equal to 75% should be considered when determining growth factors with trends.

Population estimates by county and for cities and unincorporated areas can be accessed online at the Bureau of Economic and Business Research site at: http://www.bebr.ufl.edu/population. There are also population projections by county. There is no cost assocaited with downloading the current year data.

Current local population information is available through census data online at: http://www.census.gov/main/www/access.html .

3.6 USE OF MODEL OUTPUTS IN TRAFFIC FORECASTING

The process for using the model to project traffic is as follows:

3.6.1 Modify Interim and Forecast Year Network/Land Use

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

Changes made to the model should comply with the established FSUTMS standards and should be fully documented in a manner which would allow another individual to make the same changes and obtain the same results. This material should then be reviewed with the District Planning Office and the agency responsible for the model to obtain consensus on the results. Models used to develop traffic projections for Master Plans, Action Plans, and IJRs/IMRs are good examples of model applications which may require modifications.

3.6.2 Execute the Model Stream

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

3.6.3 Evaluate Model Traffic Output

The forecasted model traffic must be evaluated for reasonableness. The best method of evaluation is to develop a traffic forecast based on historical trends following the steps referred to in Chapter 4. This trend based forecast should then be compared to those generated by the model. Differences in volume in excess of 10% in high volume areas or 4,000 vehicles per day in lower volume areas should be further evaluated in an effort to explain the disparity. Some other data sources include, but nare not limited to, BEBR population estimates, census data, and gasoline sales records.

If valid explanations for the differences cannot be determined, then either the model or the trend volumes may not be appropriate for use in the Traffic Report. Valid explanations for differences between the historical trend and model forecast may include land use changes, new facilities, congested conditions or other considerations which may not be reflected in either the model or the Historical Trend Analyses Projection.

All of these issues must be taken into consideration when evaluating the traffic 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. Screen lines and overall distribution of traffic assignments within the evaluated areas should also be considered.

3.6.4 Document the Traffic Forecast

Tabulation of the forecasts for the interim and design year with appropriate documentation of the methodology and reasonableness evaluation should be included in an individual section of the Traffic Report. This information should then be utilized in the development of forecast year turning movements, axle loadings and LOS analyses as defined in this manual.

3.7 TRAFFIC FORECASTING BACKGROUND FOR MODELERS

The following sections provide guidance for the use of models to develop traffic projections for project, corridor, and resurfacing type projects. This chapter 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 (i.e., resurfacing, corridor, project).

Resurfacing projects require the development of future AADT projections only and, of the project types, 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.

Corridor projects usually require the development of travel projections for either new or existing corridors but, in either case, are used to make decisions which have important capacity and capital investment implications. As a result, 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.

Specific project travel demand projections require the highest accuracy. These projections are commonly used to develop laneage 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.

3.8 GENERAL TRAVEL DEMAND FORECASTING MODEL ISSUES

The standard model for projecting traffic flow in the State of Florida is the Florida Standard Urban Transportation Model Structure (FSUTMS). Most FDOT approved models in urbanized areas are models approved by the local MPOs. Since the availability of models varies from district to district, the District Planning Office should be contacted to obtain a list of the available FSUTMS models. (*see* Appendix A for the Central Office and District Planning and Modeling Contacts)

3.8.1 Travel Demand Forecasting Model Selection

The use of a particular FSUTMS based model will depend on the type of project, the location of the project and the availability of a model for that area. The following FSUTMS models are currently being used throughout the state:

- Individual MPO Models (Polk County TPO, Gainesville/Alachua County MPO, Bay County)
- Regional Multi-County Models (i.e. MetroPlan Orlando MPO, Capital Region TPA (Tallahassee), SERPM,, NERPM/NFTPO, Collier/Lee County MPO, Florida-Alabama TPO(Pensacola Area), NWFRPM, Okaloosa/Walton TPO, Sarasota/Manatee/Charlotte MPO, TCRPM,)
- Districtwide Model (TBRPM, CFRPM)
- Florida Statewide Model
- Turnpike Models

Link: http://www.fsutmsonline.net/index.php?/model_pages/model.pages/

The primary factors to be considered in the selection of an appropriate model are as follows:

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

The use of a non-FSUTMS model is normally not acceptable in areas where an FSUTMS based model has been developed. However, if all adopted/endorsed FSUTMS models are shown to be inadequate for future travel demand forecasts, a non-FSUTMS model may be recommended, or a combination of approaches may be used. In such cases, it should be documented why any of the adopted/ endorsed FSUTMS models cannot be used. The District Planning Office should be contacted for approval prior to the use of a non-FSUTMS model.

3.8.2 Travel Demand Model Accuracy Assessment

An approved model is usually in an acceptable condition. However, if the model is not up to the desired standard, the following are typical steps which should be followed to bring the model up to an acceptable standard. The selected travel

demand forecasting model should be analyzed, modified, and validated, as appropriate, to ensure its capability to accurately forecast future traffic volumes.

The validation process should include a review of all available land use, socio-economic 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.

3.8.2.1 Evaluation of Base Year Conditions

The validation of the base year model is performed to ensure the ability of the model to replicate base year conditions. The validation of the base year model is performed by comparing base year counts to the modeled volumes using the criteria as shown in Figures 3.3 and 3.4.

3.8.2.2 Model Accuracy Assessment

Prior to using a travel demand forecasting model for forecasting, it is important to verify that the entire model has been validated. The model validation should be given a subjective review prior to its use in order to determine if there have been any changes that could affect the model validation. If the validation is outdated, it may be necessary to perform an entire network validation using more recent data or consider using the methods of Chapter 4 in this handbook.

The Highway Evaluation Report (HEVAL) of the FSUTMS program is used in many areas of the state to perform systems evaluation activities and to assist in validating a model. The output includes information on vehicle miles of travel (VMT), vehicle hours of travel (VHT), average travel speed, and comparisons of simulated traffic volumes to observed traffic counts. The FSUTMS model validation process involves several checks of the traffic assignment's accuracy in simulating observed traffic counts.

In general, model simulated link volumes are expected to be accurate enough to correctly determine the required number of lanes for roadway design. This means that the acceptable error should be no more than the service volume (at the design LOS) for one lane of traffic. This reference service volume is a higher percentage of total traffic for low volume roads than for high volume roads.

Statistic	Standards	
	Acceptable	Preferable
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%
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%	
Assigned VMT-over-Count Area-wide	+/-5%	+/-2%
Assigned VHT-over-Count Area-wide	+/-5%	+/-2%
Assigned VMT-over-Count by FT/AT/NL	+/- 25%	+/- 15%
Assigned VHT-over-Count by FT/AT/NL	+/- 25%	+/- 15%
External Model Cordon Lines	+/- 1%	-
Screen lines with greater than 70,000 AADT	+/- 10%	-
Screen lines with 35,000 to 70,000 AADT	+/- 15%	-
Screen lines 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"

Figure 3.3 TRAFFIC ASSIGNMENT ACCURACY LEVELS (VOC)

Statistic	Standards	
	Acceptable	Preferable
RMSE: LT 5,000 VPD	100%	45%
RMSE: 5,000-9,999 VPD	45%	35%
RMSE: 10,000-14,999 VPD	35%	27%
RMSE: 15,000-19,999 VPD	30%	25%
RMSE: 20,000-29,999 VPD	27%	15%
RMSE: 30,000-49,999 VPD	25%	15%
RMSE: 50,000-59,999 VPD	20%	10%
RMSE: 60,000+ VPD	19%	10%
RMSE Area-wide	45%	35%

Source: FSUTMS-Cube Framework Phase II Model Calibration and Validation Standards, Table 2.11, "Root Mean Square Error (RMSE)"

Figure 3.4 TRAFFIC ASSIGNMENT ACCURACY LEVELS (RMSE)

The RMSE of a model prediction with respect to the estimated variable X_{model} is defined as the square root of the mean squared error:

$$RMSE = \sqrt{\frac{\sum_{i=1}^{n} (X_{obs,i} - X_{model,i})^2}{n}}$$

Where X_{obs} is observed values and X_{model} is modeled values at time/place *i*.

3.8.2.3 Base Year Model Refinements

The following is a series of refinements which are commonly used in the validation of the Base Year Network:

- The network should be updated to ensure proper representation of traffic patterns through the inclusion of parallel roadway links, collector, and other secondary roads within the project area of influence. Acceptable refinements include changes in facility type, area type, and the number of lanes.

- The Traffic Analysis Zone (TAZ) centroid connectors and their location should be examined and adjusted if necessary.

- The socio-economic data in the TAZs should be updated within the project area of influence.

- Trips generated by prominent activity generators should be compared and evaluated with the actual traffic counts. If differences exist, TAZ productions or attractions should be adjusted.

- Travel characteristic data should be modified using updated origin and destination surveys and other data sources (where appropriate).

Note that none of the refinements outlined above should be made without just cause.

3.9 CONSISTENCY WITH THE ADOPTED MPO LONG RANGE TRANSPORTATION PLAN (LRTP) and/or THE LOCAL GOVERNMENT COMPREHENSIVE PLAN (LGCP)

There are three steps, Consistency with the Plan(s), Plan Amendment/Alternative, and Inconsistency Documentation/No Project, that need to be performed to verify the project consistency with the MPO's Long Range Transportation Plan (LRTP) or a local government's comprehensive plan. Below is a description of these steps.

3.9.1 Consistency with the Plan(s)

The number of lanes needed to accommodate future travel demands shall be compared with the existing MPO Long Range Transportation Plan in metropolitan areas and local government comprehensive plans and plan amendments found in compliance by the Department of Community Affairs.

If the project is not consistent with the approved plans, go to the Plan Amendment/Alternative.

3.9.2 Plan Amendment/Alternative

If the corridor traffic forecast results are inconsistent with the MPO Long Range Transportation Plan and/or LGCP, or a Department approved plan, the Department may examine transportation alternatives (such as public transportation alternatives or parallel routes). If this analysis does not resolve the inconsistency, request the appropriate District Director or his/her designee(s) to modify either the existing FDOT plans (such as Action or Master Plans) or initiate the process to request the local government to amend the LGCP or the MPO to revise its Long Range Transportation Plan (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 or the FDOT does amend or revise the applicable plans, prepare the necessary forecast in AADT. If the local government and/or the MPO or the FDOT does not amend or revise applicable plans, go through the steps as described in Section 3.9.3.

3.9.3 Inconsistency Documentation/No Project

If the appropriate District Director or his/her designee(s) approves the project due to extenuating circumstances, include a statement in the Corridor Traffic Forecasting Report that the requested project is not consistent with the approved

or adopted plan (insert name of plan). State in the report the process that was used in Section 3.9.2 and the decisions made. Include in the document any written letters or agreements generated as part of the activities in Section 3.9.2. If the project is not viable, indicate in the conclusion of the report that the study resulted in a "No Project."

3.10 DEVELOPMENT OF FUTURE YEAR TRAVEL DEMAND

After the validation for the model, as a whole, is approved, and appropriate future land use data has been assembled, the model is usually ready to determine the future year traffic forecast for resurfacing projects.

If the model is used for corridor or project analysis, additional validation procedures might need to be executed (*see* Section 3.12 for more details).

3.10.1 Evaluation of Future Year Conditions

In order to project traffic for a given year, appropriate future year data inputs are required. For each of the future analysis years, the following travel demand forecasting model inputs should be summarized:

- transportation network
- socio-economic/land use data

Each of these factors should be updated to reflect the approved elements of the MPO financially feasible long range plan, Master Plans and planned development mitigation infrastructure improvements anticipated to be in place in each analysis year.

Since the timing of land use and network changes is not usually a known quantity, it is often appropriate to use the modeled data in a regression analysis with the historical data in order to obtain an AADT for any given year.

3.10.2 Reasonableness Checks for Future Years

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

The model-generated volumes for the future years should be reviewed for logical traffic growth rates. The general growth trends prevalent in the area should be determined and compared with the modeled traffic volumes. The future year model volumes should be compared against the appropriate historical count data (PSWADT, AADT, etc.). If an unexplained growth rate exists, a thorough review of the base and future year land use, socio-economic data and network coding should be performed. Logical reasons for any anomalies should be documented. A careful comparison is required, especially for urbanized areas where growth may be higher along undeveloped corridors while on an area-wide basis it may be much lower.

3.10.3 Acceptable Model Refinements for Future Years

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

3.11 RESURFACING PROJECT TRAFFIC FORECASTING PROCEDURE

Resurfacing projects require the development of future AADT projections only and, of the project types, 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 validated (area-wide) model can be directly applied without the need for additional evaluation or validation efforts.

3.11.1 Travel Demand Forecasting Model Accuracy Assessment

The selected travel demand forecasting model must be analyzed, modified, and validated, as appropriate, to ensure its capability to accurately forecast future traffic volumes. In most cases the Travel Demand Forecasting Model is already in acceptable condition; if not, refer to Section 3.8.2.

3.11.2 Travel Demand Forecasting Model Adjustment Procedures

After the validation of the whole model is approved, the model is ready for determining the future year traffic forecasts for resurfacing projects. Refer to the previous sections for a discussion on Evaluation of Future Year Conditions (Section 3.10.1), Reasonableness Checks for Future Years (Section 3.10.2) and Acceptable Model Refinements for Future Years (Section 3.10.3).

3.11.3 Executing the Model Stream

After receiving consensus from the local planning staff on any proposed modifications for land use/network for the interim and design year, the model stream should be executed to generate the traffic forecasts required for the Project Traffic Forecasting Reports in accordance with the FSUTMS Model's User's Guide.

3.11.4 Documentation of Traffic Forecast

Tabulation of the forecasts for the interim and design year with appropriate documentation of the methodology and reasonableness evaluation should be included in an individual section of the Project Traffic Forecasting Report. This information will then be utilized in the development of axle loadings as defined in this handbook.

3.12 TRAVEL DEMAND FORECASTING MODEL ACCURACY ASSESSMENT

The selected travel demand forecasting model should be evaluated to determine its accuracy at both the model wide and project specific levels. Often, additional validation work will be required in the project area of influence before the model results are acceptable for use in a project analysis. This section discusses the general approach which should be followed to properly validate a sub area of the model for a project (site-specific) analysis. The model validation for the entire network is discussed in Section 3.8.2.

3.12.1 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 counts within the study area. Be sure the counts are in the same units as the model output (*see* Section 3.8.2).

3.12.1.1 Project Model Accuracy Assessment

Prior to using a travel demand forecasting model for forecasting, it is important to verify that the entire model has been validated. The validation process that should be used for the model wide validation is discussed in Section 3.8. Once it has been established that the entire model has been validated properly, the project's area of influence (*see* Section 1.5 — Glossary) needs to be analyzed on its level of accuracy.

3.12.1.2 Base Year Land Use

The base year land use data should be analyzed within the project area of influence for its accuracy and consistency with local comprehensive

plans. Local Planning Agencies and MPOs should be contacted to verify the land use within the project area of influence. Within the project area of influence, all existing Traffic Analysis Zones (TAZs) should be analyzed based on their size and the number of trips they generate. Trip end summaries for zones of interest in the project area of influence should be evaluated for reasonableness. It may be necessary in the project area of influence to refine the existing TAZ structure to obtain a better assignment. Special care must be taken to correctly code the new centroid connectors.

3.12.1.3 Base Year Network Data

The model base year network within the project area of influence should also be evaluated to see if all of the major highways are coded appropriately. Additional roadways might need to be added to the network to provide better loading points for newly created TAZs/centroid connectors, and to allow for an improved path building process. The coding of all roadways within the area of influence should be checked with regard to their facility type and number of lanes.

3.12.1.4 Base Year Counts

An analysis should be conducted to identify whether sufficient coverage counts are available within the project area of influence. 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 area of influence, 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 (axle adjustments, AADT, ADT, PSWADT, etc.). Note that this may be a costly endeavor, and not always feasible or desirable, based on the production schedule of certain projects.

3.12.1.5 Base Year Project Model Evaluation Criteria

Project evaluation compares assigned volumes of the network validated model to observed volumes reported in the model validation year within the project area of influence on a link by link basis. If Planning is not satisfied with the ability of the model to replicate base year traffic volumes on the facilities within the project area of influence, model refinements are required. This project model validation will not constitute a major validation of the model itself. It normally should not

include changes to the speed-flow relationships or the imposition of socio-economic correction (K) factors.

The basis for comparison and the specific criteria are as follows:

- Base year (model) runs should be compared with the base year (model) ground counts in the project area of influence on a link by link basis. The assigned volume comparison will indicate where specific network coding changes may be required. Traffic volumes assigned to a link in the project area of influence that significantly vary from the ground counts could point to a coding problem. The maximum desirable error for link volumes is shown in Figure 3.3. The error is determined as the percent deviation of assigned link volumes from ground counts expressed in the model.

- Screenline comparisons within the project area of influence should be made. These comparisons should confirm the ability of the model to replicate existing travel movement.

- Agreement between model and counted volumes must not be forced by making changes to the model that will significantly affect other areas outside the project area of influence and the network validity. Care must be taken to ensure that "lack of fit" is not simply moved from one link to another.

3.12.2 Existing Year Model Refinements

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 area of influence. Acceptable refinements include changes in facility type, area type and number of lanes.

- The TAZ centroid connectors and their location need to be examined and adjusted if necessary.

- The socio-economic data in the TAZs should be updated to reflect the existing year. The whole model's ZDATA should be updated.

- Trips generated by prominent activity centers should be compared and evaluated with the actual traffic counts (where appropriate). If differences exist, TAZ productions or attractions must be adjusted using the ZDATA3 input file.

- Travel characteristic data should be modified within the TAZs using updated origin and destination surveys and other data sources (where appropriate).

Note that none of the adjustments outlined above should be made without just cause.

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 area of influence did not negatively impact the overall model validation (*see* Section 3.6.2). When it has been established that the entire model operates on the same level of accuracy or perhaps at an improved level, the project area of influence should be analyzed on its accuracy (see Figure 3.3 for standards) and its size. If significant changes occur outside the preliminary project area of influence, determine whether changes to the project area of influence are required. Based on this analysis it should be determined if the project area of influence should be expanded to include the affected facilities and if other development mitigation infrastructure improvements are required.

Expansion of the project area of influence may also require reexamination of the base year model volumes with the base year ground counts throughout the expanded project area of influence. If the project model evaluation is not acceptable through the entire expanded project area of influence, 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 a level of accuracy that is acceptable, as described in Section 3.8.2.

3.13 TRAVEL DEMAND FORECASTING MODEL ADJUSTMENT PROCEDURES

After the validation of the model (as a whole and within the project area of influence) is accepted, the model is ready to use for future year traffic forecasts.

3.13.1 Evaluation of Future Year Conditions

The validated model will require appropriate future year data inputs to perform traffic forecasts for the future years. In each of the future years, the following travel demand forecasting model inputs should be summarized:

- transportation network
- socio-economic/land use data

Each of these factors should be updated to reflect the approved elements of the MPO financially feasible long range plan, Master Plans and planned development mitigation infrastructure improvements anticipated to be in place in each analysis year.

3.13.2 Future Years Land Use

Any land use changes within or adjacent to the project area of influence (different from the land use in the model TAZ input) that could cause a significant change in trip generation should be identified. It is important that the adequacy of the socio-economic data be established and reflected in the project area of influence. ZDATA changes should be coordinated with the agency responsible for the model being used.

3.13.3 Future Years Network

For the future year, the elements of the Five Year Work Program, MPO Transportation Improvement Program (TIP), and committed development mitigation improvements should be considered as planned and programmed improvements. Urban models include improvements for 20 to 25 years in the future. Generally, this is the starting point. It may be appropriate to use this data and to interpolate or extrapolate AADT as necessary.

For discussion on Reasonableness Checks for Future Years and Acceptable Model Refinements for Future Years, refer to Sections 3.10.2 and 3.10.3.

3.14 EVALUATE MODEL TRAFFIC OUTPUT

The forecasted model traffic must be evaluated for reasonableness by the traffic forecasting engineer. The best method of evaluation is to develop traffic forecasts based on historical trends following the steps identified in Chapter 4. These trend based forecasts 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 in an effort to explain the disparity. If valid explanations for the differences cannot be determined, then either the model or the trend volumes may not be appropriate for use in the Project Traffic Forecasting Report. Valid explanations for differences between the historical trend and model forecast may include land use changes, new facilities, congested conditions or other considerations which may not be reflected in either the model or the Historical Trend Analyses Projection. All of these issues must be taken into consideration when evaluating the traffic forecasts.

Where the forecasted model traffic is to be utilized for alternative corridor assignments, additional evaluation for reasonableness must be performed. Screenlines and overall distribution of traffic assignments within the evaluated areas must also be considered.

3.15 DOCUMENTATION OF TRAFFIC FORECAST

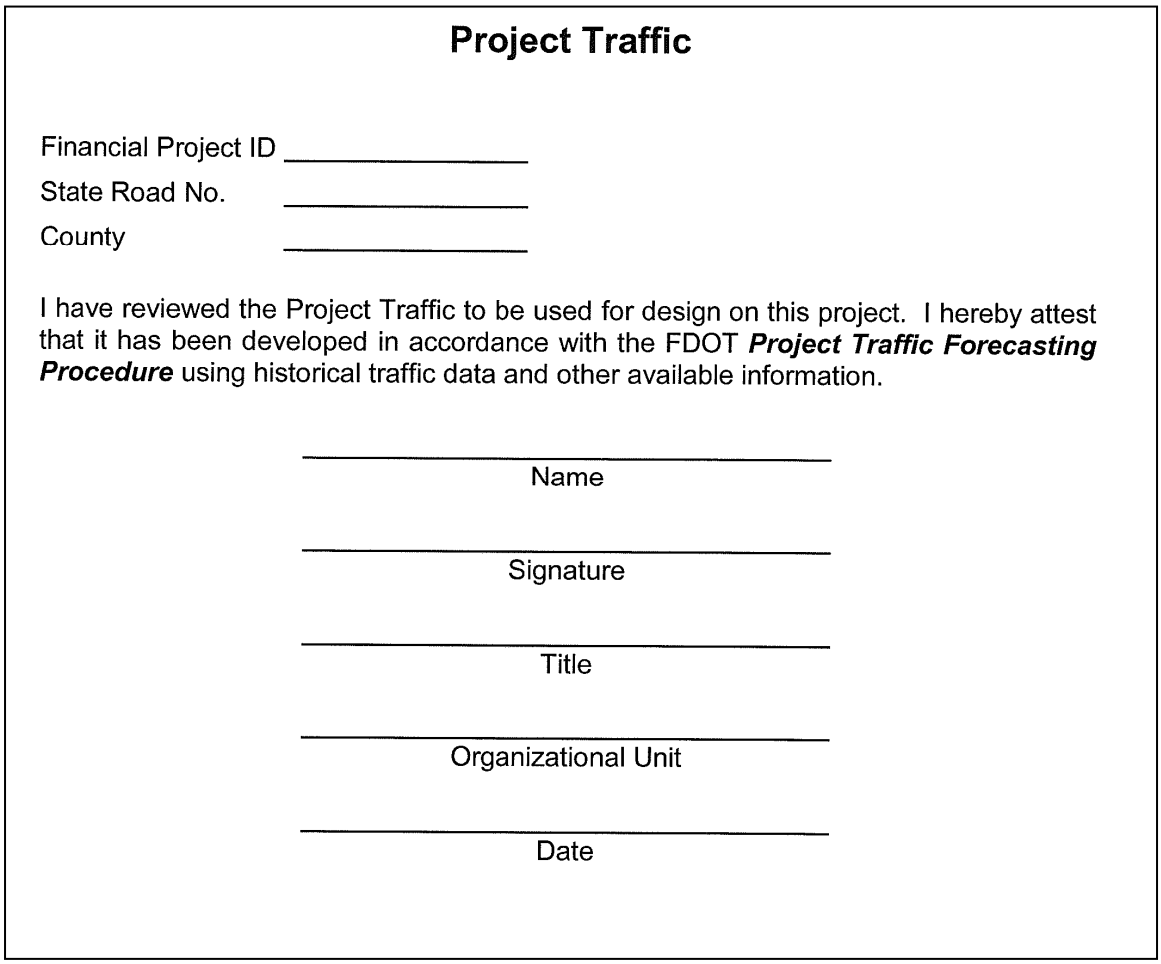
When using model output for determining project traffic forecasting, plots of the study area should be maintained in the file. Tabulation of the forecasts for the interim and design year with appropriate documentation of the methodology and reasonableness evaluation should be included in an individual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

3.15.1 Turning Movements Schematics

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

3.15.2 Certification

A certified report including K, D, T, base year AADT, forecasted AADTs, and an 18-KIP ESAL forecast (if applicable) should be sent to the requestor with copies sent to the appropriate District personnel. The project traffic shall be certified using the certification statement form shown in Figure 3.5. If an 18-KIP ESAL is requested, use the certification form shown in Figure 3.6. All assumptions used in the estimation process and all the conditions to be considered when using the data should be included in the final report.



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 3.5 Project Traffic Forecasting (PTF) Certification Statement

Source: FDOT Roadway Plans Preparation Manual, Vol. 1, Chapter 19

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 3.6 18-KIP ESAL Certification Statement

3.16 THE MODEL OUTPUT CONVERSION

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

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

3.17 PEAK SEASON CONVERSION FACTORS (PSCF) and SEASON FACTORS

Weekly factors obtained from FDOT permanent count stations around the state are used to prepare annual updates of the Peak Season Conversion Factors (PSCFs). The PSCFs are used to convert a 24-hour count, representing the average weekday daily traffic, to PSWADT.

The Peak Season Factor Category Report includes the MOCF for each category. It identifies the 13-week peak season for all TTMS locations assigned within the category and provides a multiplying factor (PSCF) for each week to convert a weekday 24-hour count to a PSWADT. It also provides a Seasonal Factor (SF) for each week to convert 24-hour weekday traffic counts to an AADT. A sample of the Peak Season Factor Category Report is shown in Figure 3.7 for Category 4600 - Bay Recreational.

2010 PEAK SEASON FACTOR CATEGORY REPORT - REPORT TYPE: ALL
CATEGORY: 4600 BAY RECREATIONAL

MOCF: 0.77

WEEK	DATES	SF	PSCF
1	01/01/2010 - 01/02/2010	1.77	2.29
2	01/03/2010 - 01/09/2010	1.64	2.12
3	01/10/2010 - 01/16/2010	1.51	1.96
4	01/17/2010 - 01/23/2010	1.44	1.86
5	01/24/2010 - 01/30/2010	1.38	1.79
6	01/31/2010 - 02/06/2010	1.31	1.70
7	02/07/2010 - 02/13/2010	1.25	1.62
8	02/14/2010 - 02/20/2010	1.18	1.53
9	02/21/2010 - 02/27/2010	1.07	1.39
10	02/28/2010 - 03/06/2010	0.96	1.24
11	03/07/2010 - 03/13/2010	0.86	1.11
12	03/14/2010 - 03/20/2010	0.75	0.97
13	03/21/2010 - 03/27/2010	0.78	1.01
14	03/28/2010 - 04/03/2010	0.81	1.05
15	04/04/2010 - 04/10/2010	0.84	1.09
16	04/11/2010 - 04/17/2010	0.87	1.13
17	04/18/2010 - 04/24/2010	0.88	1.14
18	04/25/2010 - 05/01/2010	0.89	1.15
19	05/02/2010 - 05/08/2010	0.90	1.17
*20	05/09/2010 - 05/15/2010	0.91	1.18
*21	05/16/2010 - 05/22/2010	0.87	1.13
*22	05/23/2010 - 05/29/2010	0.83	1.07
*23	05/30/2010 - 06/05/2010	0.79	1.02
*24	06/06/2010 - 06/12/2010	0.75	0.97
*25	06/13/2010 - 06/19/2010	0.71	0.92
*26	06/20/2010 - 06/26/2010	0.70	0.91
*27	06/27/2010 - 07/03/2010	0.69	0.89
*28	07/04/2010 - 07/10/2010	0.69	0.89
*29	07/11/2010 - 07/17/2010	0.68	0.88
*30	07/18/2010 - 07/24/2010	0.74	0.96
*31	07/25/2010 - 07/31/2010	0.81	1.05
*32	08/01/2010 - 08/07/2010	0.87	1.13
33	08/08/2010 - 08/14/2010	0.94	1.22
34	08/15/2010 - 08/21/2010	1.00	1.29
35	08/22/2010 - 08/28/2010	1.01	1.31
36	08/29/2010 - 09/04/2010	1.02	1.32
37	09/05/2010 - 09/11/2010	1.04	1.35
38	09/12/2010 - 09/18/2010	1.05	1.36
39	09/19/2010 - 09/25/2010	1.08	1.40
40	09/26/2010 - 10/02/2010	1.12	1.45
41	10/03/2010 - 10/09/2010	1.15	1.49
42	10/10/2010 - 10/16/2010	1.18	1.53
43	10/17/2010 - 10/23/2010	1.25	1.62
44	10/24/2010 - 10/30/2010	1.32	1.71
45	10/31/2010 - 11/06/2010	1.40	1.81
46	11/07/2010 - 11/13/2010	1.47	1.90
47	11/14/2010 - 11/20/2010	1.54	1.99
48	11/21/2010 - 11/27/2010	1.60	2.07
49	11/28/2010 - 12/04/2010	1.65	2.14
50	12/05/2010 - 12/11/2010	1.71	2.21
51	12/12/2010 - 12/18/2010	1.77	2.29
52	12/19/2010 - 12/25/2010	1.64	2.12
53	12/26/2010 - 12/31/2010	1.51	1.96

* PEAK SEASON

09-FEB-2011 13:45:05 830UPD [1,0,0,1] 3_4600_PKSEASON.TXT

Figure 3.7 Peak Season Factor Category Report

3.18 CONVERTING DAILY TRAFFIC COUNTS to PSWADT and AADT

The Peak Season Conversion Factor (PSCF) is obtained by dividing the weekly SF by the MOCF. This factor should be used to obtain PSWADT from a short-term traffic count. For example, to convert a 24-hour count of 11,857 taken from Site 469907 on January 5, 2010 to PSWADT, use Figure 3.7 to find the PSCF for the week of January 3-9, 2010, equals 2.12.

Daily Count x Peak Season Conversion Factor = PSWADT
11,857 (Daily Count) x 2.12 (PSCF) = 25,136 ➔ 25,000 (PSWADT)

The SF is used to convert any weekday 24-hour count to AADT (*see* Section 2.4 for more information). For example, the same count above could be converted to AADT and rounded using AASHTO Standards as follows:

Daily Count x Seasonal Factor = AADT
11,857 (Daily Count) x 1.64 (SF) = 19,445 ➔ 19,000 (AADT)

The Peak Season Conversion Factor Report shows the MOCF for a number of sites. Notice that each site has only one MOCF, but there is a PSCF and SF for each site for every week of the year as shown in Figure 3.7. Each District selects which counters are to be used to calculate the MOCF for each segment of the State Highway System. The final conversion factor may come from a single counter or a group of counters chosen by the District staff.

3.19 MODEL OUTPUT CONVERSION FACTOR (MOCF)

The SF for each week is derived by interpolating between the Monthly Seasonal Factors (MSFs). The MSF is derived by dividing the AADT by the Monthly Average Daily Traffic (MADT) (*see* Section 2.5.1). The highest weekday volume occurs when the SF for a week is the lowest. The peak season is the 13 consecutive weeks during which the highest weekday volumes occur. The 13 week highest weekday volume occurs when the sum of SF for those 13 weeks is the lowest. The average SF of the 13 weekly SFs during the peak season is called the MOCF. MOCF used in validation to convert AADT to

PSWADT for the base year model network should also be used for adjusting future year model volume. The MOCF should be used when a model output (PSWADT) needs to be converted to AADT (*see* Section 3.20). (Note: For model input, PSWADT, multiply MOCF with AADT; and PSWADT model output divide PSWADT by MOCF to obtain future year AADT.)

3.20 CONVERTING PSWADT TO AADT

FDOT has developed the MOCF to convert PSWADT volumes obtained from FSUTMS models to AADT volumes. Weekly PSCFs are available for the following seven categories based on the available data:

Category	Roadway Description
1	Urban Arterial
2	Rural Arterial
3	Urban Interstate
4	Tourist/Recreation Interstate
5	Rural Interstate
6	Urban Turnpike
7	Rural Turnpike

A sample of the FDOT Peak Season Conversion Factors is included in Figure 3.8

To obtain AADT, multiply the Peak Season Weekday Average Daily Traffic by the Model Output Conversion Factor.

AADT = PSWADT x MOCF

Using Figure 3.8 which shows the MOCFs by Count Sites (Permanent Count Stations). If the model shows an assigned volume of 30,052 at Site 460053, then AADT is calculated as follows:

	30,052 (Model Output)
x	0.83 (MOCF)
=	24,943 AADT
➔	25,000 AADT

EXAMPLE

CoSite	MOCF
460053	0.83
460166	0.74
460192	0.91
470173	0.96
480082	0.97
480156	0.88
480159	0.98
490060	0.87
500054	0.93
500220	0.94
530050	0.82
530117	0.87
530218	0.90
549901	0.96

Figure 3.8 MOCF Report

EXAMPLE

In another example using Figure 3.9, obtain AADT by multiplying the model assigned link volume (PSWADT) by the appropriate MOCF for Category 7549. If the model link shows an assigned volume of 26,148 daily, AADT is obtained as follows:

26,148 (Model Output) x 0.96 (MOCF) = 25,102 ➔ 25,000 AADT

2010 PEAK SEASON FACTOR CATEGORY REPORT - REPORT TYPE: ALL
CATEGORY: 7549 ORANGE I4 DISNEY

WEEK	DATES	SF	MOCF: 0.96 PSCF
1	01/01/2010 - 01/02/2010	1.03	1.07
2	01/03/2010 - 01/09/2010	1.02	1.06
3	01/10/2010 - 01/16/2010	1.02	1.06
4	01/17/2010 - 01/23/2010	1.01	1.05
5	01/24/2010 - 01/30/2010	1.01	1.05
6	01/31/2010 - 02/06/2010	1.00	1.04
7	02/07/2010 - 02/13/2010	1.00	1.04
8	02/14/2010 - 02/20/2010	0.99	1.03
9	02/21/2010 - 02/27/2010	0.99	1.03
10	02/28/2010 - 03/06/2010	0.98	1.02
11	03/07/2010 - 03/13/2010	0.98	1.02
12	03/14/2010 - 03/20/2010	0.97	1.01
13	03/21/2010 - 03/27/2010	0.97	1.01
14	03/28/2010 - 04/03/2010	0.98	1.02
15	04/04/2010 - 04/10/2010	0.98	1.02
16	04/11/2010 - 04/17/2010	0.98	1.02
17	04/18/2010 - 04/24/2010	0.99	1.03
18	04/25/2010 - 05/01/2010	1.00	1.04
19	05/02/2010 - 05/08/2010	1.02	1.06
20	05/09/2010 - 05/15/2010	1.03	1.07
21	05/16/2010 - 05/22/2010	1.02	1.06
*22	05/23/2010 - 05/29/2010	1.01	1.05
*23	05/30/2010 - 06/05/2010	0.99	1.03
*24	06/06/2010 - 06/12/2010	0.98	1.02
*25	06/13/2010 - 06/19/2010	0.97	1.01
*26	06/20/2010 - 06/26/2010	0.96	1.00
*27	06/27/2010 - 07/03/2010	0.95	0.99
*28	07/04/2010 - 07/10/2010	0.93	0.97
*29	07/11/2010 - 07/17/2010	0.92	0.96
*30	07/18/2010 - 07/24/2010	0.93	0.97
*31	07/25/2010 - 07/31/2010	0.95	0.99
*32	08/01/2010 - 08/07/2010	0.96	1.00
*33	08/08/2010 - 08/14/2010	0.98	1.02
*34	08/15/2010 - 08/21/2010	0.99	1.03
35	08/22/2010 - 08/28/2010	1.01	1.05
36	08/29/2010 - 09/04/2010	1.04	1.08
37	09/05/2010 - 09/11/2010	1.06	1.10
38	09/12/2010 - 09/18/2010	1.08	1.12
39	09/19/2010 - 09/25/2010	1.07	1.11
40	09/26/2010 - 10/02/2010	1.06	1.10
41	10/03/2010 - 10/09/2010	1.04	1.08
42	10/10/2010 - 10/16/2010	1.03	1.07
43	10/17/2010 - 10/23/2010	1.04	1.08
44	10/24/2010 - 10/30/2010	1.04	1.08
45	10/31/2010 - 11/06/2010	1.05	1.09
46	11/07/2010 - 11/13/2010	1.05	1.09
47	11/14/2010 - 11/20/2010	1.06	1.10
48	11/21/2010 - 11/27/2010	1.05	1.09
49	11/28/2010 - 12/04/2010	1.04	1.08
50	12/05/2010 - 12/11/2010	1.04	1.08
51	12/12/2010 - 12/18/2010	1.03	1.07
52	12/19/2010 - 12/25/2010	1.02	1.06
53	12/26/2010 - 12/31/2010	1.02	1.06

* PEAK SEASON

09-FEB-2011 13:45:25 830UPD [1,0,0,1] 5_7549_PKSEASON.TXT

Figure 3.9 Peak Season Factor Category Report

Note that this conversion must be made for project traffic forecasting using design traffic criteria. If the traffic assignment from the model is to be used for corridor forecasting, PSWADT must be converted (e.g., the mean of the 13th peak season weekly factors) to AADT before the traffic assignment is suitable for performing the Project Traffic Forecasting Process required to complete the project traffic forecast. If the traffic forecast is based on historical trend analysis, the process does not require any data conversion.

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CHAPTER FOUR

FORECASTING WITHOUT A TRAFFIC MODEL

4.1 PURPOSE

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

4.2 INTRODUCTION

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

4.3 BACKGROUND

For areas without a model, forecasts are normally based on historical trends; growth rates may also be developed utilizing gasoline consumption reports, census data, and by working with the county, city, and their comprehensive plans. Normally a linear growth is assumed. When historical AADT data is used, a linear regression is calculated using the most recent ten years of data, when available. Special care should be used to negate counts that might be obviously out of sync with other years.

Forecasters rely on different techniques depending on the available information. Growth rates from historic traffic counts, adjusted to AADT by application of factors, are derived and checked for reasonability. The growth rates are then applied to a base year count and projected forward to the design year. Also, it is important to consider the capacity when extrapolating. Projections should show traffic **demand**, and not be constrained.

A constrained forecast is for the final design of a facility where expected traffic volumes will be constrained by the ultimate capacity of the facility. When using constrained forecasts, the future demand is actually "sized" to the design of the facility and not the traffic demand.

The roadway itself does the constraining as traffic becomes congested. If the demand is for a six-lane facility and a four-lane is being designed, it should be noted in the Project Traffic Forecasting Report that four lanes will not be adequate for a 20-year design, and steps should be taken to address the potential short fall. To arbitrarily constrain traffic does nothing to address future congestion.

4.4 PROJECT TRAFFIC FORECASTING PROCEDURE WITHOUT A MODEL

4.4.1 Data Assembly

When a travel demand forecasting model is not available, the following items should be assembled, when available and applicable for preparing a Project Traffic Forecast (*see* also Section 4.5 — Available Resources):

1. Mapping or other roadway location drawings of the facility requiring traffic projections (Project Location Map).

2. Graphical representation of existing lane arrangements (straight line diagram (SLD), aerial photography, intersection sketches, etc.).

3. Resources for determining traffic growth trends:

   a) Historical traffic count data (current plus nine earlier years of mainline traffic preferred but if ten years of data is not available, current plus four or more earlier years of mainline and/or intersection approach volumes).
   b) Gas sales records.
   c) Land use maps.

4. Traffic factors:

   K — This factor is determined as shown in Chapter 2, Section 2.6.2.1.

   D — This factor can be derived from one of the following: the permanent traffic count station that the K factor was taken from, an FDOT Classification Station in or near the study area or a 72-hour project specific classification count taken within the project limits. The Design "D" factor is the median value of the directional factors for the highest 200 hours of each continuous count station.

   T — The T factor, for either 24 hours or the design hour, can be derived from either an FDOT Classification Station in or near the study area or a 72-hour project specific classification count taken within the project limits.

5. Local Government Comprehensive Plan (land use and traffic circulation elements).

6. Description of existing and future land uses which contribute traffic that would use the proposed facility.

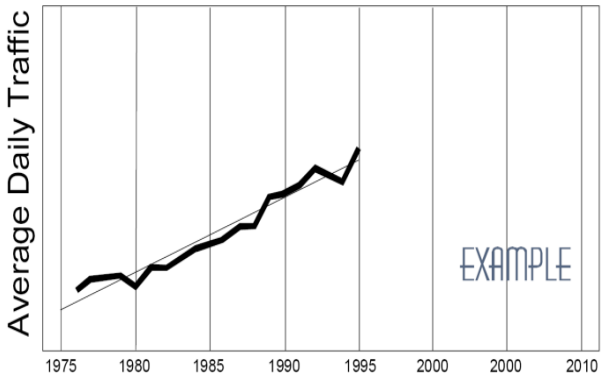
7. Current Highway Capacity Manual (HCM) and relevant software.

8. Current FDOT Level of Service Manual and relevant spreadsheets based on the HCM methods.

9. The opening and design years.

10. Current and historical population data.

4.4.2 Establish Traffic Growth Trend

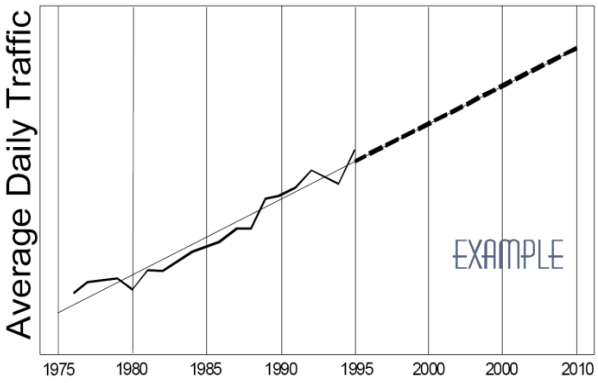


1. Plot historical AADT at a convenient scale with traffic volume on y axis and year of count on x axis (leaving room for future year and traffic growth).

2. Use least squares regression analysis combined with graphical representation of traffic growth trends.

3. If historical count data are insufficient, prepare a similar analysis of alternative indicators (gas sales data, LUMS, population data).

4.4.3 Develop Preliminary Traffic Projection



1. Use empirically derived traffic growth trend equation to compute design year traffic volume.

OR,

2. Use graphical methods to project traffic volume from growth trend history to the design year.

4.4.4 Check Forecast for 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. If, for example, a new shopping center, office park, tourist attraction, etc., is expected to be built prior to the design year, then projections based on historical traffic trends would underestimate the design year traffic. In such cases, ITE trip generation rates could be used to establish daily and peak hour trips for the new land uses. A logical distribution of resulting site generated trips to available roadways should be based on knowledge of local travel patterns and used to adjust the traffic forecast. Conversely, the closing of an existing traffic generator would be expected to cause a reduction of the traffic forecast.

4.4.5 Develop Project Traffic Forecast in Detail

1. If the subject roadway intersection exists, use observed daily turning movement percentages at existing intersection(s) to convert future year link volumes to turning movement forecasts. Otherwise, logical turning movement percentages must be derived from observation of other roadways located in similar environments and/or specialized software that will calculate turning percentages utilizing the approach volumes. Note that the observed turning percentages are valid for future year forecasts only if land use and transportation network characteristics remain constant or if projected changes in those characteristics are proportional to the existing pattern.

2. Review daily turning movements for consistency with special traffic generators, and transportation network characteristics in the vicinity. Use the ITE generation and logical trip distribution approach to adjust, if necessary.

3. Balance adjusted daily turning movement volumes to achieve directional symmetry. A simple way to do this is to sum the opposing traffic movements and divide by two. There may be some situations when balancing the intersection may not be appropriate. See Chapter 6 for a more detailed discussion about projecting intersection turning movements.

Note: The TURNS5-V2014 spreadsheet will balance the turning movements automatically with approach volumes and "first guess" turning percentages.

4. Use K and D factors to develop directional design hour traffic projections in the peak periods. 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 if necessary. Such adjustments are made with reference to observed differences in travel characteristics such as numbers of trips and directional splits that occur during morning and evening peak periods. Directional traffic counts collected at local land use sites may provide the necessary data or the ITE Trip Generation Manual may be used to obtain the peak period trip generation characteristics of various land use/special generator sites.

4.4.6 Analysis of Projections

1. For Project Traffic and Intersection Analysis Reports for use in District Environmental studies, the following analysis should be performed:

   a) Perform intersection analysis utilizing the most recent version of the HCM software. Adjust auxiliary lane requirements as necessary to obtain an acceptable LOS. Justification must be made for any and all lanes added above and beyond the existing conditions. Only Transportation System Management improvements may be necessary to satisfy the projected demands.

   b) Perform arterial analysis utilizing the most recent version of the ART_PLAN software. Adjust intersection analysis as necessary to obtain an acceptable LOS.

2. For ESAL forecasting to be used in pavement design, perform LOS analysis utilizing the appropriate LOS spreadsheet. The LOS “D” volume derived for the appropriate number of lanes can be utilized in calculating the 18-KIP ESAL.

4.4.7 Final Review and Documentation

1. Perform final quality control review for 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 quality control review should also perform error checks to ensure that input traffic numbers have been correctly transcribed and traffic forecasting computations have been done correctly.

2. Prepare Project Traffic Forecasting Memorandum documenting procedures, assumptions, and results.

3. Prepare Project Traffic Certification Statement (*see* Figure 3.5) and 18-KIP ESAL Certification Statement (see Figure 3.6), also refer to Project Traffic Forecasting Procedure, Topic No. 525-030-120, and obtain all authorized signatures.

4.5 AVAILABLE RESOURCES

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

- Historical county traffic growth rates, FDOT TranStat Publications
- Historical traffic counts, FDOT TranStat or district offices
- "National Cooperative Highway Research Program (NCHRP) Report" 255, "Highway Traffic Data for Urbanized Area Project Planning and Design"
- NCHRP 365, "Travel Estimation Techniques for Urban Planning"
- Property appraisal data, Property Appraisal Office
- Local Government Comprehensive Plans (land use, traffic circulation, and transportation elements), FDOT district office/local government office
- Land use maps
- Area DRI/Applications for Development Approval (ADA), FDOT district office/Regional Planning Council
- "Trip Generation Manual", Institute of Transportation Engineers (ITE) (Current Version)
- Gas sales records, Governor's Energy Office
- Motor vehicle registrations, Department of Highway Safety and Motor Vehicles
- MPO Long Range Transportation Plan

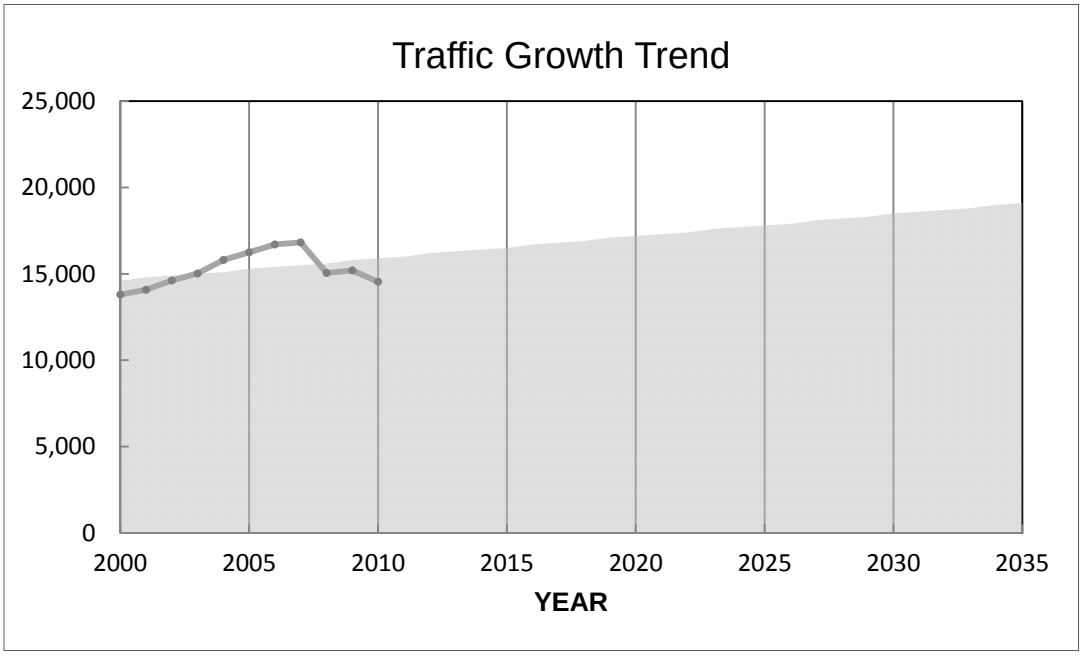
Examples of factors, when available, which need to be taken into consideration in making forecasts for areas where models are not available are as follows:

- Population (current and historical)
- Density
- City size
- LOS (existing)
- LOS standards
- Transit alternatives

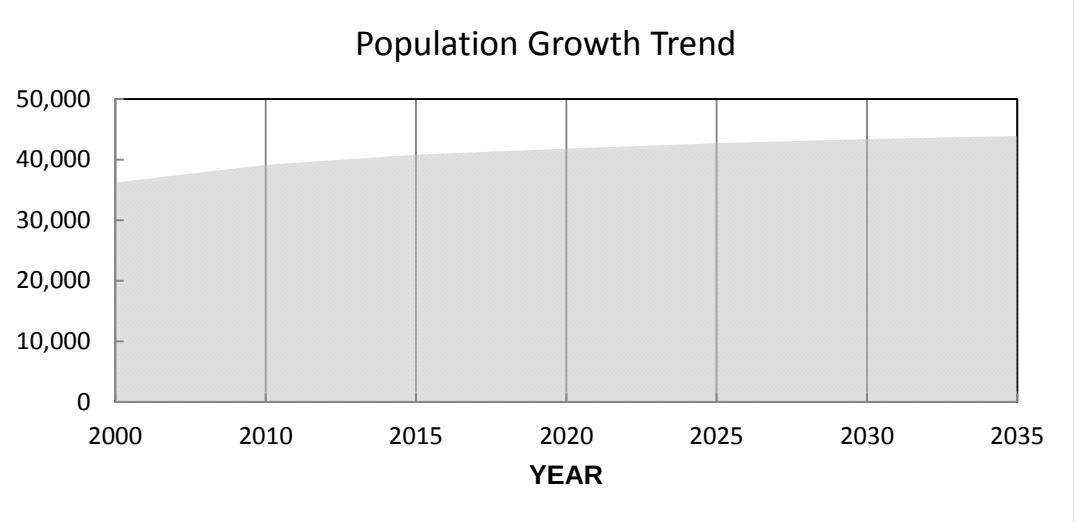
- Auto ownership
- Household income
- Residential/non-residential mix
- Freeway diversion
- Other unique area considerations

4.6 HENDRY COUNTY EXAMPLE

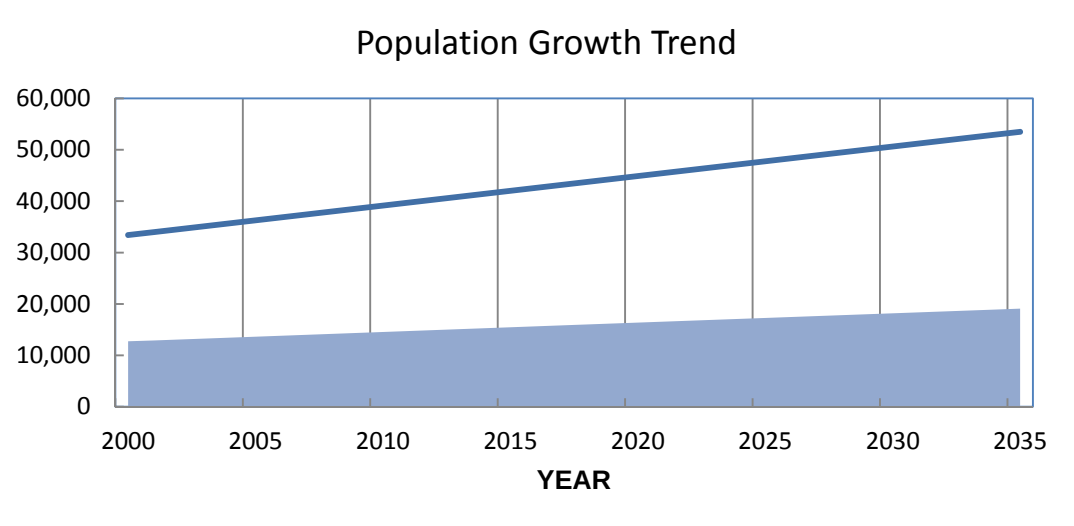
Hendry County is not currently covered by any of the regional models of Florida. To forecast future year traffic for roadways in Hendry County, trend projection procedures discussed in this chapter can be used. For example, if a project requires Year 2035 AADT for US 27/SR 80 between Flag Hole Road and CR 720, the project traffic forecasting process involves the use of trend projections derived from straight-line growth rates based on historical traffic data from FDOT Count Station #07-9918 located on this segment. The linear regression analysis using AADT data from Year 2000 to Year 2010 showed an average annual growth of 182 AADT. The growth trend that occurred between 2000 and 2010 was assumed to be applicable for forecasting existing traffic for Year 2035. Based on that assumption, traffic on this segment is expected to increase from 14,547 AADT in 2010 to 19,100 AADT in 2035. This growth rate calculates to an average of 1.25% in linear growth per year.



According to FDOT's Population Projections from 2010 to 2035, Hendry County is expected to increase in populations from 39,140 in 2010 to 53,500 in 2035. The population projection calculates to an average of 1.47% in linear growth per year.



A comparison was then made to historical data. Using U.S. Bureau of Cencus population data, Hendry County's population increased from 36,210 in 2000 to 39,140 in 2010. This was an 8.1% increase over a 10-year period, or an average of 0.81% in linear growth per year. By comparison, traffic increased from 13,800 in 2000 to 14,547 in 2010. This is 5.4% linear increase over a 10-year period, or an average of 0.54% in linear growth year. Therefore, it is apparent that the trend forecast showing future traffic increasing at a rate slower than the rate of population growth is consistent with the past trend between 2000 and 2010.



4.7 SUMMARY

A project traffic forecast should reflect an evaluation of the effect of future traffic growth relative to historical trends, the addition of major development, the diversion of traffic to nearby facilities and the impact of capacity constraints. The traffic forecast should be made using the best available resources and engineering judgment. Also, results obtained from travel demand forecasting models should be compared to forecasts by alternative procedures, such as a simple trends analysis, to check for reasonableness.

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

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CHAPTER FIVE

DIRECTIONAL DESIGN HOURLY VOLUMES

5.1 PURPOSE

This chapter explains the procedure to convert Annual Average Daily Traffic (AADT) into **Directional Design Hourly Volumes (DDHV)**.

5.2 INTRODUCTION

The methodology of converting **Annual Average Daily Traffic (AADT)** volumes into Directional Design Hourly Volumes (DDHV) is obtained from the conversion of AADT and is used in the evaluation of roadway points, links, or facility analyses.

This evaluation must be completed before analyzing consistency with the MPO Long Range Transportation Plan (LRTP) or the LGCP. If the capacity analysis indicates a potential problem or inconsistency with any approved plans, the analyst needs to inform the District Planning Manager and the Project Manager who requested the project traffic forecast.

5.3 DEVELOPMENT OF DIRECTIONAL DESIGN HOUR TRAFFIC VOLUMES

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

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

The K factor converts the 24-hour AADT to an estimate of two-way traffic in the analysis hour of the year which is required for design purposes. The result is called a Design Hour Volume or DHV. Appropriate K factors are shown in Chapter 2, Section 2.6.2.1.

The D factor converts any DHV two-way traffic volume 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.

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

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

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

5.4 USE OF DESIGN HOUR TRAFFIC VOLUMES

Project traffic forecasting has broad application throughout the Department and is generally applicable to later planning stages through the design phase of highway projects. Its main application is in the project development phase in which location and design concept approvals occur. It is usually during this phase in which 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 the Department's LOS Policy, Topic No. 000-525-006; the LOS Procedure, Topic No. 525-000-006; and the Quality/Level of Service Handbook should be consulted. Other applications include detailed corridor studies and interchange access studies.

5.5 PRACTICAL EXAMPLE

This practical example relates to the development and analysis of traffic forecasting volumes. Section 5.5.1 — "Example - Development of DDHVs from Model PSWADTs," demonstrates how recommended procedures are applied in converting FSUTMS model volumes to project design volumes.

5.5.1 EXAMPLE – Development of DDHVs from Model PSWADTs

Assume, as an example, that an urban interstate highway in Orlando is being studied for future widening. Existing laneage within the study area is to be widened from four lanes to six lanes. Following a mini-calibration within the study area, the Year 2010 Urban Area Transportation Study projects 75,000 PSWADT on the studied link for the existing plus committed network (Year 2000).

Consider the project as an urban freeway. The MOCF for this urban interstate is 0.921. Accordingly, the following AADT derivation applies:

AADT	=	PSWADT x MOCF
	=	75,000 x 0.921
AADT	=	69,000 vpd

As outlined in the FDOT Project Traffic Forecasting Procedure, the design factors for urban freeways range between 0.09 to 0.100 for K (Figure 2.4) and between 0.504 to 0.612 for D. Given the high distribution of tourist trips and existing field traffic counts for the studied link, the observed K factor of 0.08 and D factor of 0.50 indicate constrained roadway conditions. However, the Department's 200th Highest Hour Traffic Count Report indicates a K of 0.094 and a D of 0.55 for unconstrained facilities with the corresponding facility and area types. The resulting unconstrained DHV and DDHV are derived below:

DHV	=	AADT x K
	=	69,075 x 0.094
DHV	=	6,493 vph
DDHV	=	DHV x D
	=	6,493 x 0.55
DDHV	=	3,571 vph

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CHAPTER SIX

ESTIMATING INTERSECTION TURNING MOVEMENTS

6.1 PURPOSE

The purpose of this chapter is to provide a methodology for estimating intersection turning movements and techniques for balancing turning movements.

This chapter highlights the practices for projecting the intersection turning movements, including a user's guide to TURNS5-V2014.

This chapter explains the following:

- Background
- TURNS5-V2014 Background - Methodology
- TMTOOL, J.K. TURNS
- Manual Method
- NCHRP 255
- H. J. Van Zuylen
- Summary of techniques

6.2 INTRODUCTION

Future year estimates of **peak hour intersection turning movements** are required for intersection design, traffic operations analyses and DRI/site impact evaluations. In most major urban areas, traditional travel demand forecasting models such as the Florida Standard Urban Transportation Model Structure (FSUTMS) can provide forecasts of daily intersection turning movement volumes. This section discusses the use of FSUTMS to provide daily intersection turning movement volumes. Model turns are considered to be highly suspect and are used only in cases where new alignments are being developed. Manual methods have also been used in both urban and rural areas where models are not available. 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 heavily on existing intersection turning movement count data and professional judgment.

Turning movement forecasts should reflect the logical effects of future year land use and transportation network improvements on the traffic pattern at a given location. In general, if the pattern of land use and transportation system characteristics is expected to change, turning movement patterns are also likely to change over time. Existing turning

movements and model simulation results (when available) provide useful starting points for the turning movement forecasting process. The need for turning movement forecast refinements should be determined by careful review of the chosen starting point. The forecaster must use K, D, and current turning percentages, if available, for each approach for each leg of the intersection to calculate turning volumes during the design hour..

6.3 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. Generally speaking, 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 counts. The balancing techniques are also done for corridor development. The assignment of future turn paths is estimated, and often the departure and arrival between intersections on the same link will require manual balancing. The algorithms used for the balancing may not be capable of achieving the desired tolerance. 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 freeways, arterials, other collectors, and local roads. 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 generate 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 balancing 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. Additional methodologies that are currently used by FDOT include TMTOOL and the Manual Method. The pertinent methods included in "Highway Traffic Data for Urbanized Area Project Planning and Design" National Cooperative Highway Research Program (NCHRP) 255 Report[1], and methods suggested by H. J. Van Zuylen[2],

1 "Highway Traffic Data for Urbanized Area Project Planning and Design" National Cooperative Highway Research Program (NCHRP), TRB Record No. 255, December 1982.

and applied by Hauer et al.[3], Mark C. Schaefer, and others[4] are further discussed in Sections 6.9 and 6.10, respectively.

6.4 TURNS5-V2014 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(Excel 2007 or later) which was developed by merging together two other programs in use by several districts of FDOT and creating a user driven menu and "file folder" windows for easier use. TURNFLOW[5] and TURNS3[6] form the basic framework of the TURNS5-V2014 program.

TURNFLOW is an Excel 9 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[7],.

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, PD&E/EMO and Design studies. TURNS3 was developed by FDOT's District One Office.

2 "The Estimation of Turning Flows on a Junction," Traffic Engineering Control, Vol. 20, No. 12, Dec. 1979
3 "Estimation of Turning Flows from Automatic Counts," Transportation Research Board, Record No. 795, 1981.
4 "Estimation of Intersection Turning Movements from Approach Counts," ITE Journal, October 1988.
5 TURNFLOW (Copyright 1988, Mark C. Schaefer), supported and distributed by the McTrans Center, University of Florida, 512 Weil Hall, Gainesville, FL 32611-2083
6 TURNS3, developed by FDOT, District 1, 801 Broadway Avenue, Bartow, Florida 33830
7 Estimation of Turning Flows from Automatic Counts," Transportation Research Board, Record No. 795, 1981.

6.5 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 model year AADT. When using a model year the program can calculate (interpolate/extrapolate) project years (normally opening, mid-design and design years). The program will also develop three future years of AADT values by use of the existing year volumes and user specified growth rates for each projection year.

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

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

In addition to this document, the Project Traffic Forecasting Handbook, TURNS5-V2014 has Tool Documentation that goes into more detail on how the workbook functions. It specifies how the workbook utilizes the turn estimating theory. The following text will serve as a User's Manual and should be sufficient for nomal use of TURNS5-V2014.

6.6 SPREADSHEET TABS

Upon loading the program in EXCEL, the program will automatically be positioned at the main menu (MainMenu tab). The following tabs are contained within the workbook:

- MainMenu – Contains the Main Menu where all of 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. 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 clicked in order to run the macro with the updated information.
- Calcs – Contains placeholder cells and the information necessary for the iterative process of the '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 intial 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 turing movement volumes to the future year turning movement volumes. No information within this tab should be altered.
- Data – Contains information that helps the menu system and 'Turn Counts' macro run.
- XML – Contains the information that will be exported to a .XML file.

6.6.1 Main Menu Options:

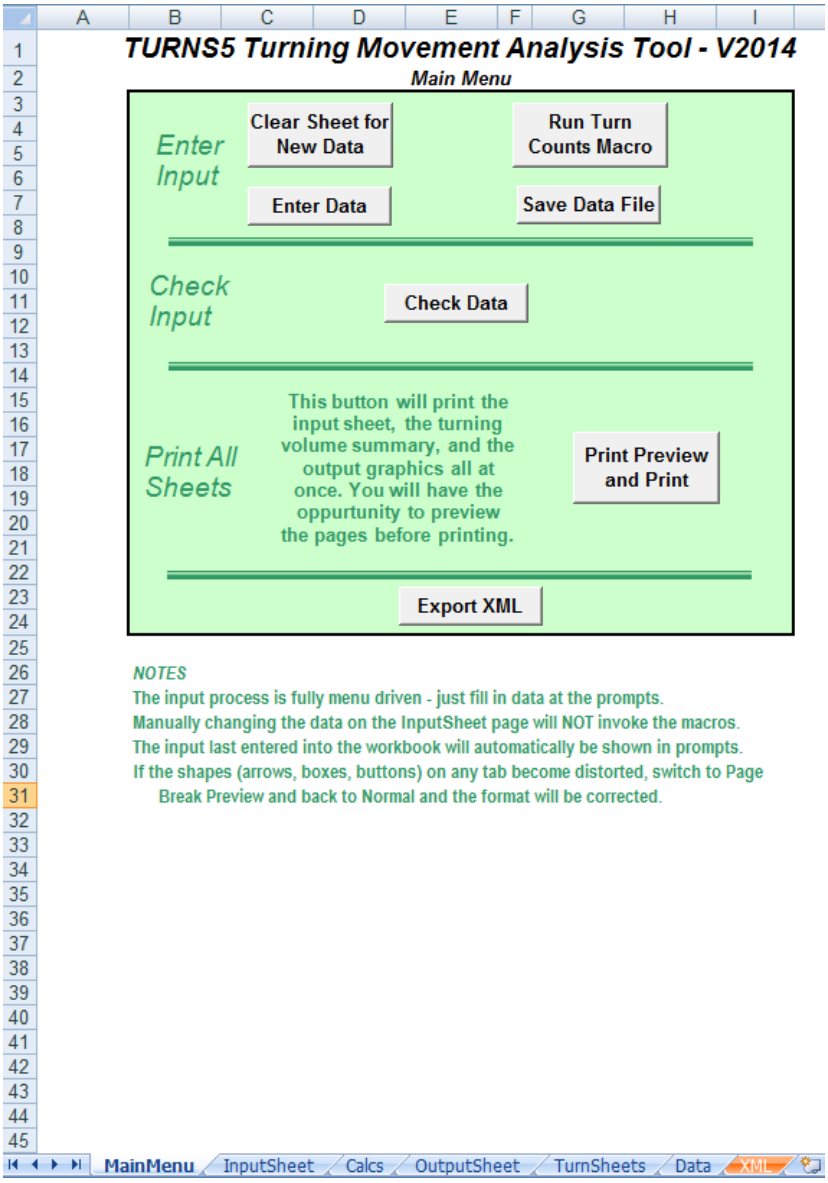

Figure 6.1 TURNS5-V2014 Main Menu

TURNS5 Main Menu

The Main Menu contains the following buttons:

- **'Clear Sheet for New Data**' erases any previous information input into the spreadsheet. This action cannot be 'undone'.
- '**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 work book is blank the 'Enter Data' menus will be blank.
- '**Run Turn Counts Macro**' will activate the iterative macro. This action cannot be 'undone'.
- '**Save Data File**' will activate the Excel Save As menu.
- '**Check Data**' will search for any error messages previously generated by the iterative macro. For example, if the '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**' will activate Print Preview within Excel. The input sheet, the turning volume summary and the output graphics will be available to preview before printing. If ready to print, click the 'Print' button and select the desired printer. To exit Print Preview, click 'Close Print Preview'.
- '**Export XML**' will export an XML file.

6.7 'ENTER DATA' MENUS

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

6.7.1 'Enter Data' Page 1:

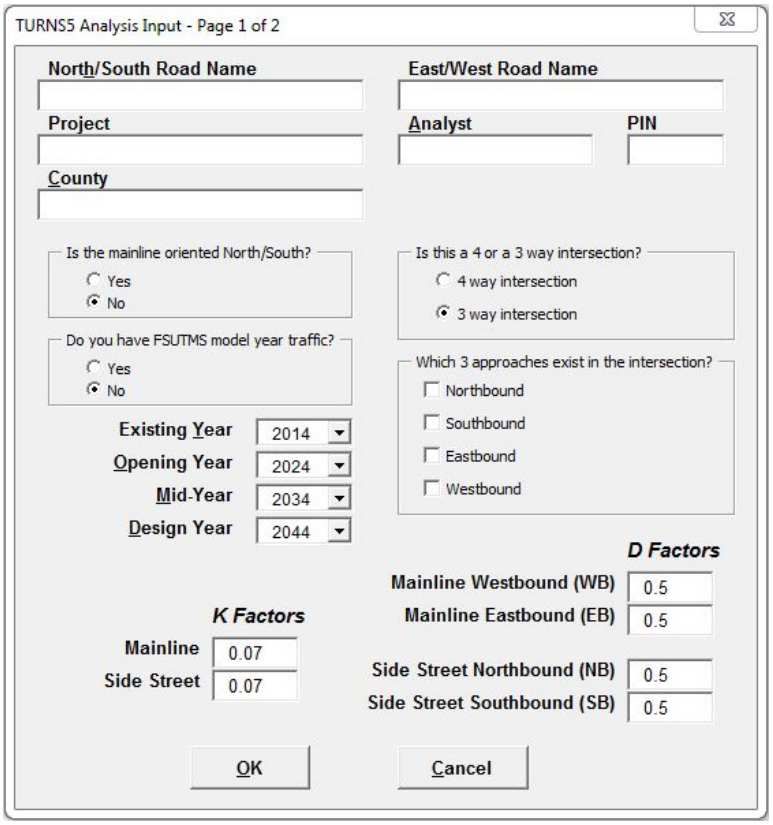

Figure 6.2 TURNS5-V2014 'Enter Data' Page 1

Road Name: Name of North/Sound and East/West Roadways.

Project: Project Description/Name.

Analyst: Name of the person/firm entering data.

PIN: Project Identification Number.

County: Name of the county where project is located.

N/S Orientation of Mainline: 'Yes' will orient mainline from bottom to top. 'No' will orient mainline from left to right. This selection will also determine the 'Highway' and 'Intersection' assignment within the 'InputSheet' tab. The 'Highway' label will be assigned to the mainline while the 'Intersection' label will be assigned to the side street.

Intersection Type: Select 4-way or 3-way intersection: 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.

Available approaches: If a 3-way intersection is chosen, the User must select the 3 approaches that are available. The menu will not allow you to proceed until 3 approaches are chosen.

FSUTMS: FSUTMS model year traffic available? Select Yes or No.

Years: Enter Existing Year, Opening Year, Mid-Year and Design Year and 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. Hit 'Cancel' to exit the menu. No information entered into the menu will change the 'InputSeet' tab.

6.7.2 'Enter Data' Page 2:

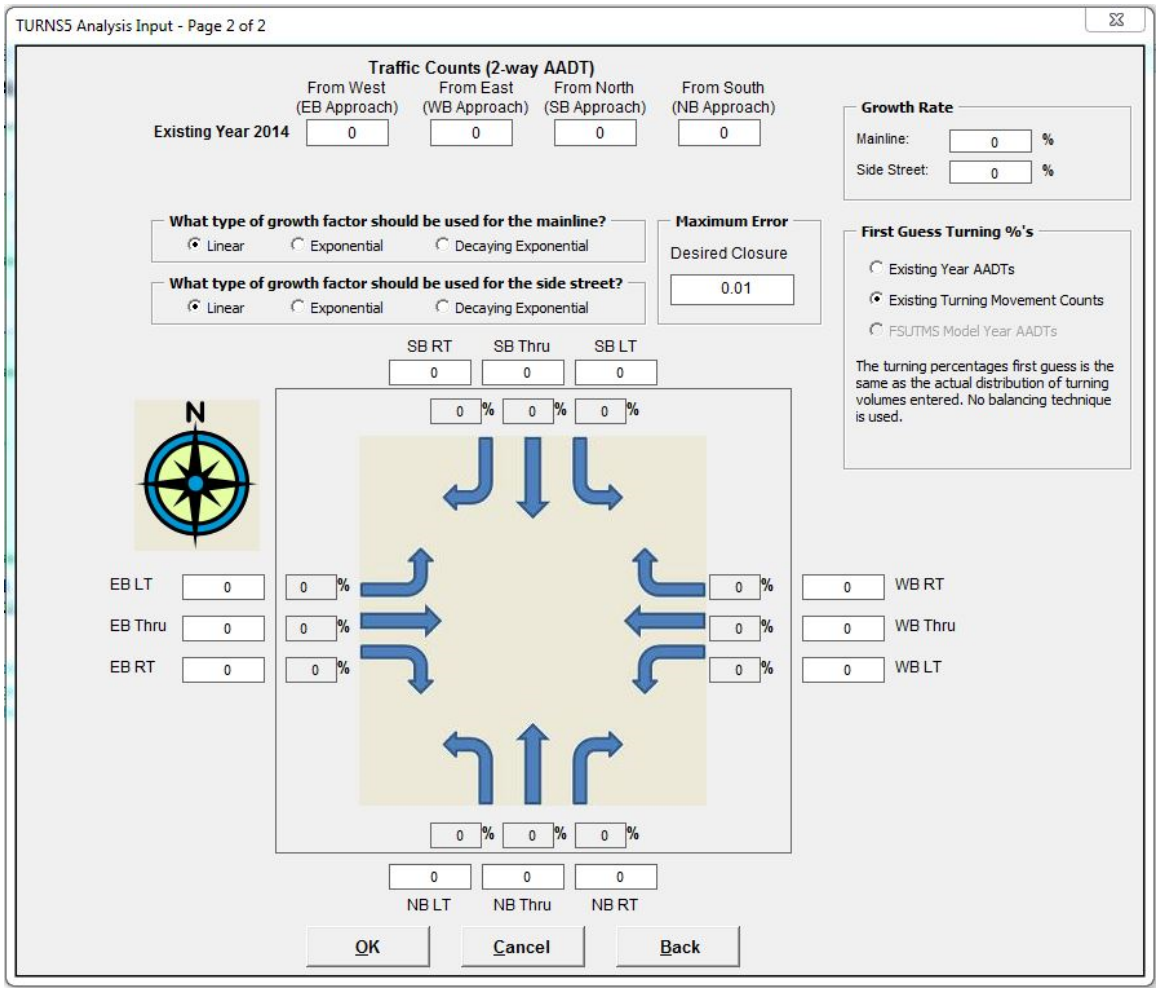

Figure 6.3 TURNS5-V2014 'Enter Data' Page 2 (Growth Rate Option Chosen)

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

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

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

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

Existing Year: Enter Existing Year AADTs by direction (approach).

Growth Rates: Mainline — Annual Growth Rate entered as a percentage (1.0%).

Side Street — Annual Growth Rate entered as a percentage (1.0%).

Next:

Growth factor: Select type of growth factor to be used for the mainline and side street.

Choose from Linear, Exponential, and Decaying Exponential

Desired Closure: User default is 0.01. 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 intial turning percentages are based on Existing Year AADT's, Existing Turning Movement Counts, or FSUTMS Model Year AADTs. It is **recommended** that the initial turning percentages be **actual (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 – As turning movement volumes are entered into the white text boxes in front of each approach, the gray text boxes will update with the value of the turning percentage.

FSUTMS Model Year AADTs – The turning movement percentages are based off 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. Hit 'Cancel' to exit the menu. No information entered into page 2 of the menu will change the 'InputSheet' tab. Hit 'Back' in order to return to page 1 of the menus. No information entered into page 2 will be saved.

6.8 PROGRAM OUTPUTS

The following pages will be printed when the 'Print Preview and Print' button on the Main Menu is clicked.

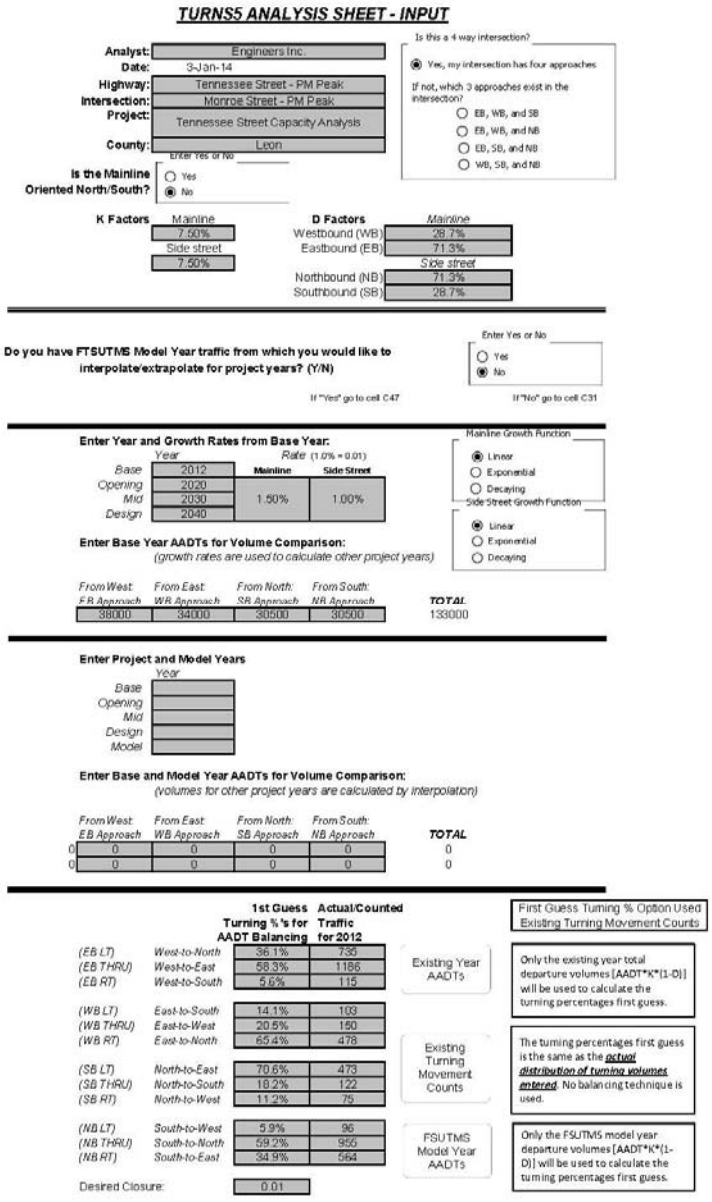

Figure 6.4 TURNS5-V2014 Input Sheet

The Input Sheet shows the project information, analysis years, growth rates/type calculations, approach volumes, model information (when applicable), and initial turn percentages. The type of first guess turning pecentage is also displayed.

TURNS5 INITIAL TURNING VOLUME SUMMARY

Highway:	Tennessee Street - PM Peak	**County:**	Leon
Intersection:	Monroe Street - PM Peak		
Project:	Tennessee Street Capacity Analysis	**Analyst:**	Engineers Inc.
		Date:	3-Jan-14

Approach-To-Approach	2012 Initial Estimate	2012 Final Estimate	2012 Calculated Volume	2020 Final Estimate	2020 Calculated Volume	2030 Final Estimate	2030 Calculated Volume	2040 Final Estimate	2040 Calculated Volume
West-To-North (LT)	0.361	0.313	636	0.307	699	0.301	777	0.297	857
West-To-East (Thru)	0.583	0.537	1091	0.546	1242	0.556	1435	0.563	1625
West-To-South (RT)	0.056	0.150	305	0.147	335	0.143	369	0.140	404
Total Flow From West:			**2032**		**2276**		**2581**		**2886**
East-To-South (LT)	0.141	0.222	163	0.217	178	0.212	197	0.208	216
East-To-West (Thru)	0.205	0.445	325	0.456	374	0.467	434	0.476	495
East-To-North (RT)	0.654	0.333	244	0.327	268	0.321	298	0.316	328
Total Flow From East:			**732**		**820**		**929**		**1039**
North-To-East (LT)	0.706	0.419	275	0.423	300	0.428	332	0.431	362
North-To-South (Thru)	0.182	0.314	207	0.306	217	0.295	228	0.288	242
North-To-West (RT)	0.112	0.267	175	0.271	192	0.277	215	0.281	236
Total Flow From North:			**657**		**709**		**775**		**840**
South-To-West (LT)	0.059	0.207	338	0.212	373	0.217	418	0.221	461
South-To-North (Thru)	0.592	0.487	794	0.478	842	0.468	901	0.460	961
South-To-East (RT)	0.349	0.306	499	0.310	546	0.315	606	0.319	666
Total Flow From South:			**1631**		**1761**		**1925**		**2088**

Figure 6.5 TURNS5-V2014 TURNS5 Initial Turning Volume Summary

This is a tabulated output of balanced volumes for each year. The table provides initial (user input) turning percentages, adjusted turning percentages and DDHVs for each movement.

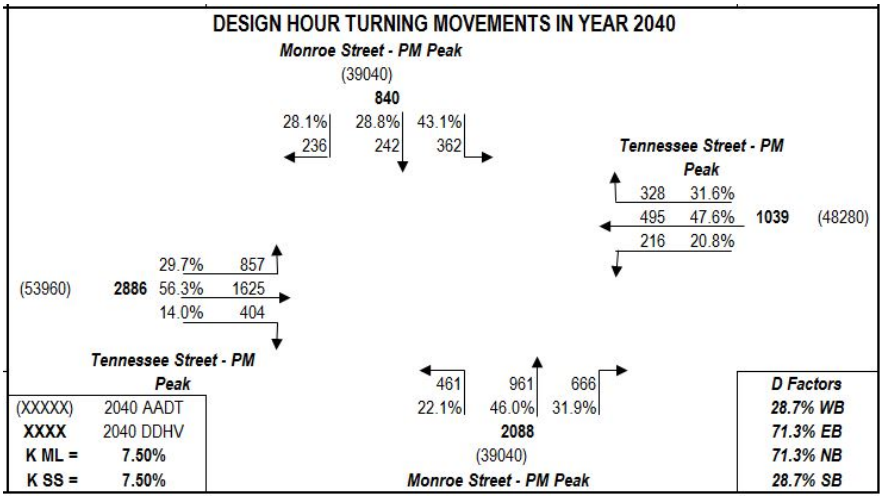

Figure 6.6 TURNS5-V2014 TURNS5 Design Hour Turning Movements

This output graphic provides the turning movement volumes and percentages calcualted by the macro, DDHVs, AADTs, and the K and D factors used. The above image displays the output for the design year only. All four study years will be printed.

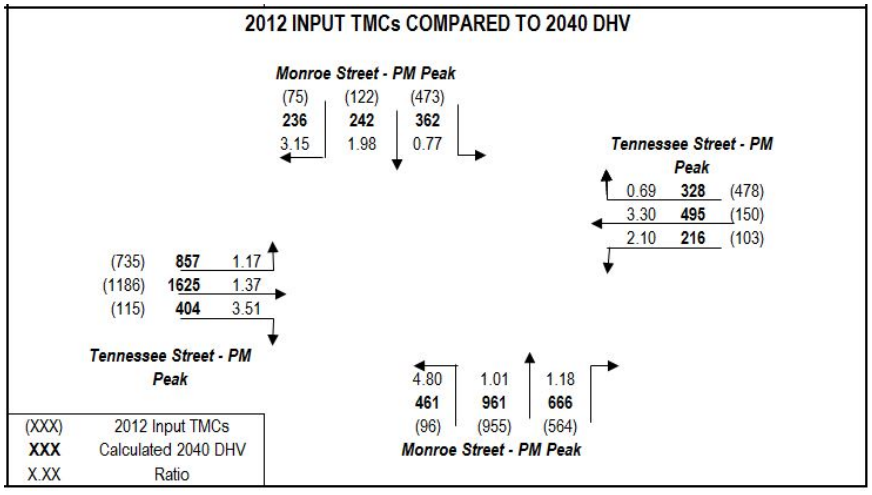

Figure 6.7 TURNS5-V2014 Comparison of Base Year Turning Movement Volumes to Future Years.

This output graphic compares the Base Year turning movement volumes calculated by the macro to the future year turning movement volumes calcualted by the macro. The

above image displays the output for the design year only. All four study years will be printed.

6.9 TURNS5 – V2014 SPREADSHEET

The TURNS5 – V2014 program enables the user to easily operate the spreadsheet and requires only basic knowledge of Windows and Excel. However, the user should have a thorough knowledge of basic traffic engineering principles and be familiar with development of traffic forecasts by non-automated processes. The following observations can be made:

Required Input Data

Existing year AADTs
"First guess" turning movement proportions
Growth rates to be used or model year AADTs
K and D factors for mainline and side streets

Output Produced

Balanced design hour turning movement forecasts
Base (Existing) year, opening (first) year, mid (second) year and design (third) year forecasts

Features

Very user friendly
Quick results
Requires Excel 2007 or later version

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 errors of program closure (turning movement balancing) or unrealistic output values.

6.9.1 Summary Evaluation

TURNS5 – V2014 is based on an acceptable state of practiced methodology for estimation of turning movements.

The TURNS5 – V2014 Application is, however, somewhat constrained for situations where existing turning movement data are not available (i.e., projecting turns for a new intersection without a FSUTMS model). Using a growth factor is recommended where no model exists.

6.10 METHODS IN THE NCHRP 255 REPORT

The NCHRP 255 Report suggests three methods for estimating intersection turning movements. These methods are:

- Ratio Method
- Difference Method
- Iterative Method

The first two methods assume that relative and absolute differences between the estimated and *observed* turn volumes will remain constant over time. Therefore, future turn volumes generated from models are adjusted according to "ratios" or "differences" calculated from base year estimated and observed turn movement volumes. The iterative procedure requires base year counts of intersection approaches. The iterative method employs the traditional 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.

The above methods could also be used for areas without a model (e.g., rural areas) when some information on existing (and/or historical) travel and expected growth are available. Estimates would have to be made for the future approach volumes. Also, existing turning movement data would have to be used judiciously relative to the expected growth characteristics of the area of the proposed roadway improvement.

6.11 H. J. VAN ZUYLEN METHOD

A method suggested by H. J. Van Zuylen involves an iterative balancing of possible turning movements based on the initial estimate of the turning proportions. This method was applied by Hauer *et al* to estimate turning movements for 145 intersections in the Toronto area using proportions from the base year traffic counts. For this application, *average* turning movement proportions were calculated (based on actual counts from 145 intersections) by correlation to the following five facility type approaches:

- CBD
- Arterial to Arterial
- Arterial to Collector
- Collector to Arterial
- Collector to Collector

Hauer applied the averages to the actual peak hour traffic counts by approach and compared the resulting turning movements to actual turning movements. Hauer indicates that, "there appears to be a surprisingly close correspondence between the actual and the estimated flows." Hauer also concludes that, "when the obtainable accuracy is sufficient for the purpose at hand, the method may be an attractive alternative to the conduct of a field survey by observers."

Mark C. Schaefer applied the above methods to estimate turning movements to 58 signalized, four-legged intersections in the Denver, Colorado metropolitan area. Schaefer indicates that "the technique described by Hauer *et al* provides a quick method of estimating intersection turning movements based on pre-specified inbound and outbound link volumes." He concludes that "the algorithm's greatest use [is] in the development of intersection turning movements from the link volumes generated by traffic forecasting models." Van Zuylen's method has also produced reasonable results in England. Mountain and Westwell[8] "tested the accuracy of using historical turning movement records in their analysis of 69 signal-controlled, four-way intersections in Merseyside, England."

The Van Zuylen method relies on the approach volume generated from the model and *average* turning movement proportions calculated from actual counts *by approach type*. This method should produce more accurate results for developed urban areas where only marginal changes in land use are expected.

"The Accuracy of Estimation of Turning Flows from Automatic Counts." Traffic Engineering and Control, January 1983.

6.12 TMTOOL

The TMTool was developed by District Four and it consists of a single Excel spreadsheet with an input, output, and calculations tab, and may be used for existing and planned intersections. The main spreadsheet, TMTOOL.WK1, is set up for intersection turning movement forecasts where detailed information is available. The J. K. TURNS spreadsheet is used to furnish preliminary projections where existing turn information is unavailable, or the intersection is non-existent. There is also a GWBASIC based computer program for calculating initial turning movements.

The following comments relate to the application of the TMTOOL.WK1 spreadsheet:

Required Input Data

Turning movement distributions

Base year daily approach volumes

Future year growth factors

K and D factors

Output Data

Balanced A.M. and P.M. peak hour turning movement forecasts

Base year and up to three future year forecasts

Features

Very user friendly

Quick results

6.13 MANUAL METHOD

The District Two 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 C** shows an example of the methodology used by District Two. The required input data, output produced, and associated features of the District Two manual procedure are reviewed below:

Required Input Data

Approach volumes

Possibly K and D factors

Output Data

One set of balanced turning movement forecasts

Features

Simple application

Relatively time consuming

Manually calculated

6.14 SUMMARY

In summary, there are some differences inherent to each of the used turning movement methods. Specifically, each of the methods differs in the amount of data input and the information which is generated. The following conclusions can be drawn:

- TURNS5-V2014, the spreadsheet being recommended, is an improved version incorporating the best of all the spreadsheets being used by the Districts (TURNS3 & 4, TMTOOL, J.K.TURNS, and GWBASIC). It can be used to develop turning movements *for existing and non-existing intersections.*

- TURNS5-V2014 can provide turning movement projections where detailed existing and future year data input parameters are available and applicable.

- TURNS5-V2014 is also well suited for obtaining preliminary balanced turning movement projections where only approach volume information is available and/or applicable.

Based on their review, the Project Traffic Task Team recommends the use of TURNS5-V2014 to forecast turning movements. If any other balancing method is used, then the input variables required to run TURNS5-V2014 should be provided to the Project Traffic engineers so that TURNS5-V2014 could be used as a comparison.

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Chapter Seven

EQUIVALENT SINGLE AXLE LOADING (ESAL) FORECAST

7.1 PURPOSE

This chapter provides guidance to calculate the Design Equivalent Single Axle Load ($ESAL_D$). The ESAL forecast is vitally important 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 guidelines provide instructions in the techniques of forecasting traffic loads for use in pavement design. This chapter covers:

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

All references to damage units show the U.S. Customary unit (18-KIP).

7.2 BACKGROUND

The Equivalent Single Axle Loading (ESAL) Forecasting Process is necessary for pavement design for new construction, reconstruction, 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 the major effects on the structural design of the roadway. The pavement design for new alignment and reconstruction projects requires a structural loading forecast using the 18-KIP ESAL Forecasting Process. Structural design is primarily dependent upon the heavy axle loads generated by commercial traffic. The pavement design of new roadway construction, reconstruction, or resurfacing is based on accumulated 18-KIP ESALs. Truck traffic and damage factors are needed to calculate axle loads expressed as ESALs.

The 18-KIP ESAL forecasting process outlines steps to be taken to develop the expected ESALs for the life of highway projects. The ***Florida Standard Urban Transportation Model Structure (FSUTMS)*** has the capability of forecasting heavy truck traffic (freight trucks/Class 9 and higher). In addition, the Statewide freight model which is maintained by the System Planning Office also has the capability of forecasting heavy trucks. The percentage of truck traffic is assumed to hold the same relationship to AADT unless some known development will change the future truck traffic. The damage factor estimates are based on analysis of historical traffic weight data collected from "Weigh-In-Motion" surveys.

For purposes of pavement structure design, it is necessary to estimate the cumulative number of 18-KIP ESALs for the design (performance) period. Since truck volume is estimated using the calibrated damage factors, it is important to estimate future truck traffic accurately for the facility during the design period. The District Director for Planning and Programming is responsible for carrying out the 18-KIP ESAL Forecasting Process unless assigned elsewhere by the District Secretary. For certain projects, the 18-KIP ESAL may have been calculated. In this case, check the validity of the previous 18-KIP estimates before proceeding to perform the 18-KIP ESAL Forecasting Process.

While geometric design requires the total volume of traffic, cars and trucks, structural design is primarily dependent upon the heavy axle loads generated by commercial traffic. The pavement design of new roadway construction, reconstruction, or resurfacing is based on accumulated 18-KIP Equivalent Single Axle Loads (ESALs). Truck traffic and damage factors are essential information required to calculate axle loads expressed as ESALs. Therefore, it is very important to determine truck volume for the facility over the design period. Estimates are based on an analysis of historical truck traffic data.

Truck traffic data is collected by means of Vehicle Classification counts, which may be either part of FDOT's Vehicle Classification Reporting Program or a special Vehicle Classification study. There are currently 13 vehicle classification types ranging from motorcycles (Class 1) to seven or more axle multi-trailer trucks (Class 13). However, only vehicle classes 4 through 13 are used for the purpose of determining and forecasting ESALs and truck traffic (*see* Figure 2.2 for a list of vehicle classification types).

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.

ESAL forecasting is required for all resurfacing, new construction, lane addition, or reconstruction projects. It should encompass a period of 20 years from the anticipated year the project is opened to traffic, allowing the designer to select the appropriate design period for pavement design.

The following figure illustrates the ESAL Forecasting Process steps.

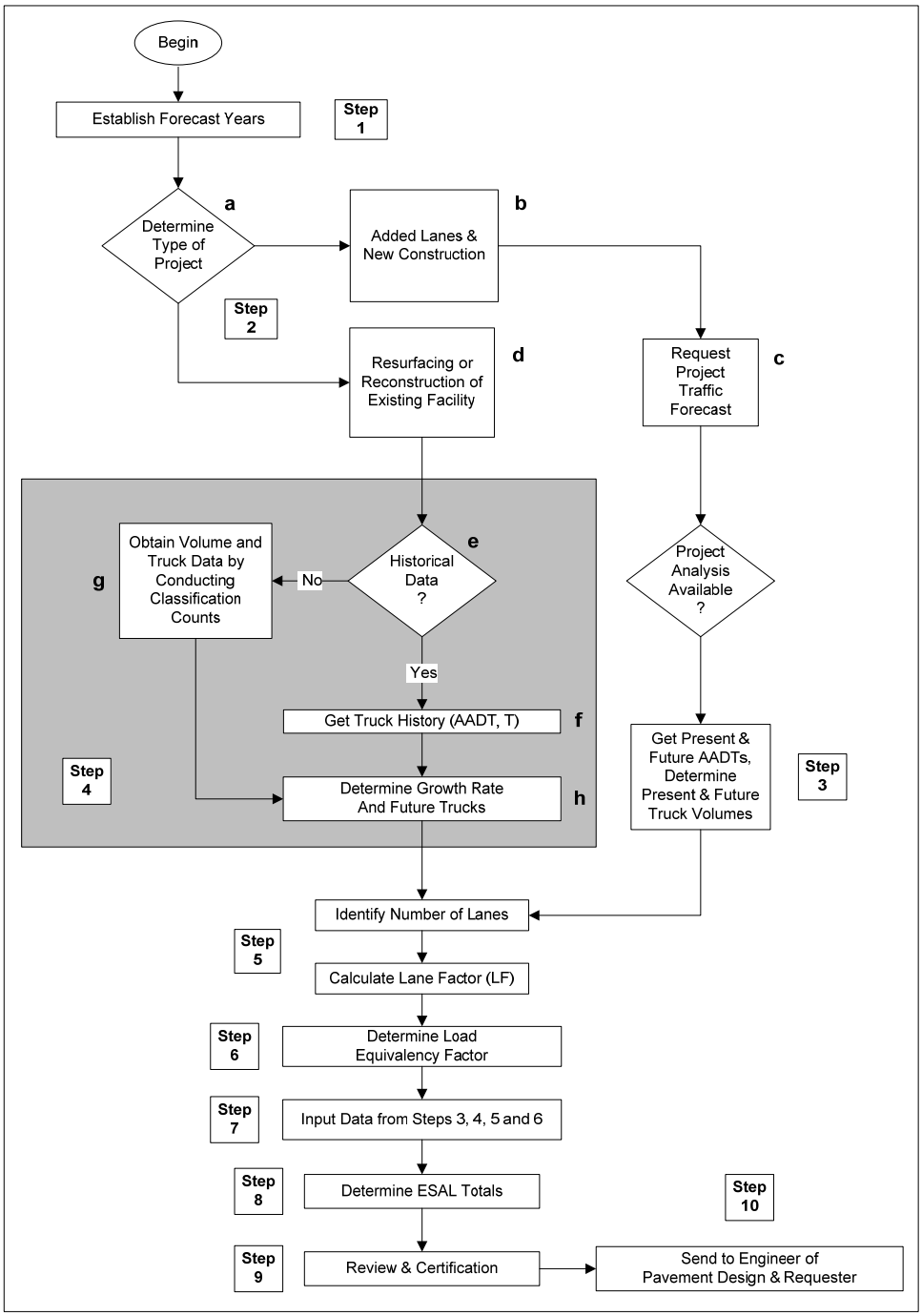


Figure 7.1 ESAL Forecasting Process

7.2.1 Projections

Predictions of future truck volume are often based on traffic history. Several factors can influence future truck volume such as land use changes, economic conditions and new or competing roadways. Truck volume 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 analysis should include consideration of historical trends (area-wide or project location specific), land use changes, and an evaluation of competing roadways.

7.2.2 Accumulations

The accumulations 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 develop the design are calculated for each year, accumulated, and printed in a table (*see* Figure 7.2).

7.2.3 Traffic Breaks

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

Table 4

18 kip EQUIVALENT SINGLE AXLE LOAD ANALYSIS - LOCATION 2

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

YEARS: *1996 to 2022*

SECTION #: 0 **SEGMENT #:** 1 **ITEM #:** 0

FLEXIBLE PAVEMENT URBAN HIGHWAY 0.890

SN=5/THICK S.R. 434/S.R. 414 Interchange C

YEAR	AADT	ESAL (1000S)	ACCUM (1000s)	D	T	LF	EF
1996	48300	105	0	0.5	2.18%	0.610	0.890
1997	49200	106	0	0.5	2.18%	0.608	0.890
1998	50200	108	0	0.5	2.18%	0.607	0.890
1999	51200	110	0	0.5	2.18%	0.605	0.890
2000	52100	112	0	0.5	2.18%	0.603	0.890
2001	53100	114	0	0.5	2.18%	0.602	0.890
2002	54100	116	116	0.5	2.18%	0.600	0.890
2003	55000	117	233	0.5	2.18%	0.599	0.890
2004	56000	119	352	0.5	2.18%	0.597	0.890
2005	56900	121	473	0.5	2.18%	0.596	0.890
2006	57900	122	595	0.5	2.18%	0.595	0.890
2007	58900	124	719	0.5	2.18%	0.593	0.890
2008	59800	126	845	0.5	2.18%	0.592	0.890
2009	60800	128	973	0.5	2.18%	0.591	0.890
2010	61700	129	1102	0.5	2.18%	0.589	0.890
2011	62700	131	1233	0.5	2.18%	0.588	0.890
2012	63700	133	1366	0.5	2.18%	0.587	0.890
2013	64600	134	1500	0.5	2.18%	0.586	0.890
2014	65600	136	1636	0.5	2.18%	0.584	0.890
2015	66600	138	1774	0.5	2.18%	0.583	0.890
2016	67500	140	1914	0.5	2.18%	0.582	0.890
2017	68500	141	2055	0.5	2.18%	0.581	0.890
2018	69500	143	2198	0.5	2.18%	0.580	0.890
2019	70400	145	2343	0.5	2.18%	0.579	0.890
2020	71400	146	2489	0.5	2.18%	0.577	0.890
2021	72400	148	2637	0.5	2.18%	0.576	0.890
2022	73400	150	2787	0.5	2.18%	0.575	0.890

Opening to Mid-Design Year ESAL Accumulation (1000s): 1250
Opening to Design Year ESAL Accumulation (1000s): 2671

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 historical traffic data and other available information.

Prepared by: Luis E. Diaz, P.E.	Planning Manager	TEI	
Name	Title	Org.Unit or Firm	Date
Signature			
Susan Sadighi	Technical Applications Supervisor	FDOT	
Name	Title	Org.Unit or Firm	Date
Signature			

10

Figure 7.2 Printout from ESAL-V02.XLS spreadsheet program

7.3 TRUCK FORECASTING PROCESS

7.3.1 Historical and Current Truck Volume

Historical and Current Truck Volume data is available from FDOT's Vehicle Classification Program (use Traffic Characteristics Inventory data). This may be used for estimating future truck traffic for projects whose limits encompass an FDOT classification station location. They may also be used for comparing roadways with similar characteristics (*e.g.*, traffic, land use, etc.).

7.3.2 Truck Growth Factor (Percent of Growth)

If a FDOT vehicle classification station is located within the project limits and the traffic forecast was not generated by FDOT's Florida Standard Urban Transportation Model Structure (FSUTMS) program, a truck growth factor may be used.

To determine the growth factor for a specific FDOT vehicle classification station, a historical trends analysis should be performed using Percent-Root-Mean-Square (%RMS). If the result of this analysis is reasonable, it may be used for calculating future truck volumes. (*see* Figure 7.3).

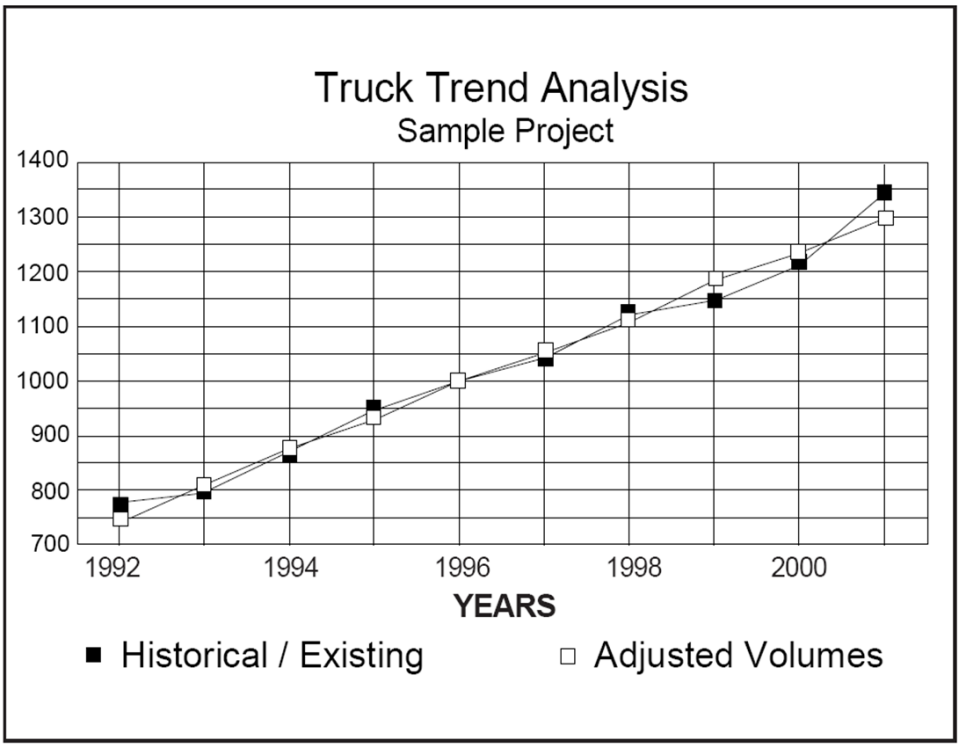


Figure 7.3 Truck Trend Analysis (example)

7.3.3 Project Traffic Forecast

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

7.3.4 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.

7.3.5 New Construction Project

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

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

7.3.6 Resurfacing and Reconstruction Projects

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

7.3.7 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 derived 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 vehicle classification counts in accordance with the Traffic Monitoring Procedure, Topic No. 525-030-150. Determine the vehicle growth.

7.3.8 Historical Trend Analysis

Determine the vehicle growth rate by performing a historical trend analysis projection based on available historical counts, population growth, gasoline sales, or other appropriate growth indicators. The future truck traffic shall be determined by applying the growth rate to the base year truck traffic for the desired number of years. There are

several methodologies used for traffic growth which include Linear Growth, Exponential Growth and Decaying Exponenetial Growth.

7.3.8.1 Linear Growth

Linear growth predicts the future traffic based on a straight line developed from historic traffic growth. 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:

Future Volume = (Linear Growth Rate x Number of Years) + Base Year Volume

$Volume_{FY} = G_{Linear} \times N + Volume_{BY}$

Where: G = Linear growth rate (volume)
N = Years beyond the base year
FY = Future year
BY = Base Year

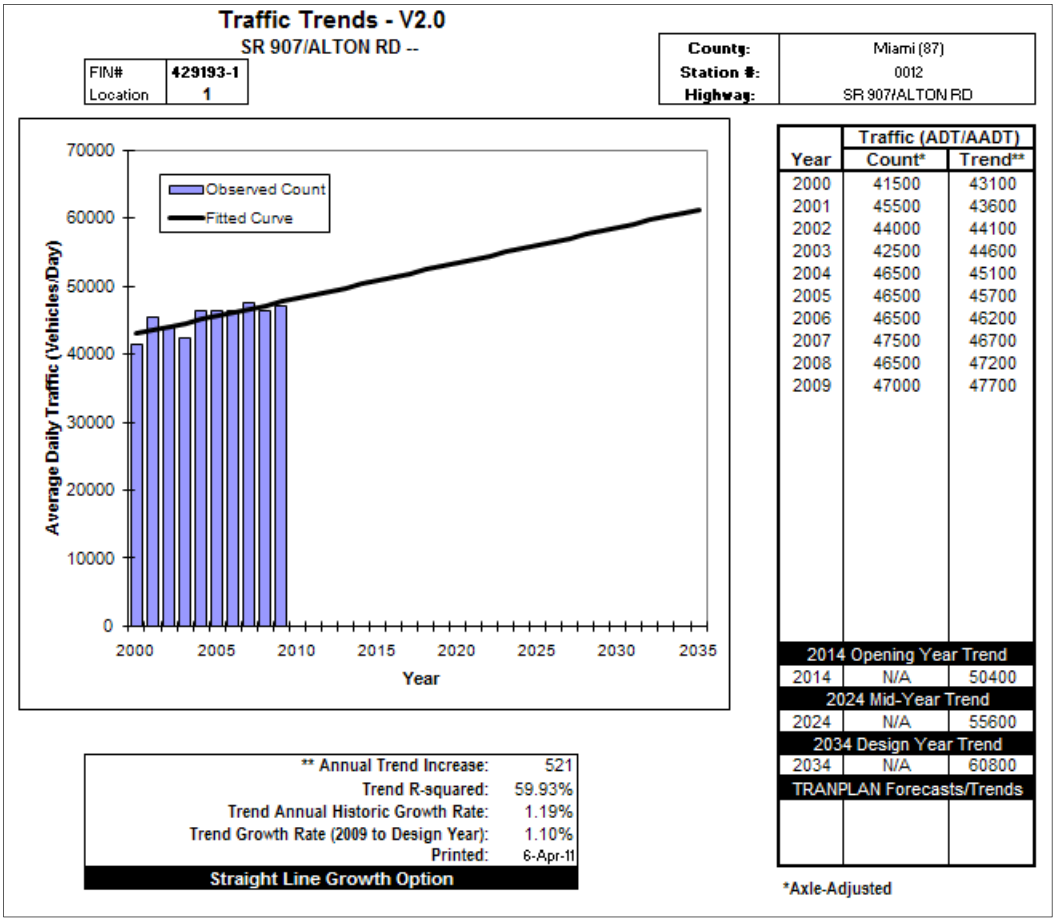


Figure 7.4 Linear Growth Example

7.3.8.2 Exponential Growth

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

Future Volume = Base Year Volume $(1 + \text{Growth Rate})^{\text{Number of Years}}$

$\text{Volume}_{FY} = \text{Volume}_{BY} \times (1 + Gr)^{(FY-BY)}$

Where: Gr = Geometric growth rate
FY = Future year
BY = Base Year

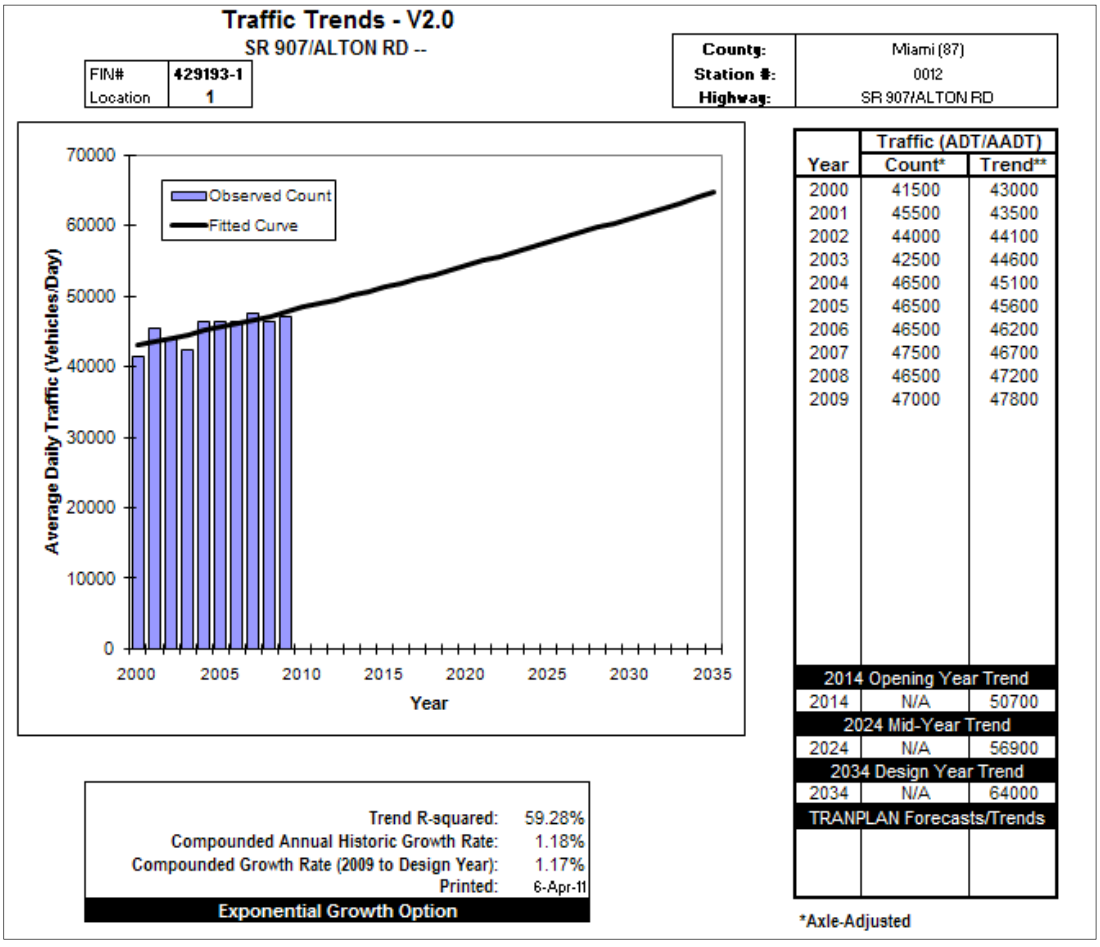


Figure 7.5 Exponential Growth Example

7.3.8.3 Decaying Exponential Growth

Decaying Exponential growth is used to project future traffic in areas with a declining rate of growth over the analysis period. 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:

$$\text{Volume}_{FY} = \text{Volume}_{BY} \times \sum_{BY}^{FY} \frac{X}{FY-BY} \sum_{BY}^{FY} \frac{X}{FY-BY}$$

Where: X = Normal straight line growth from trend data

FY = Future year

BY = Base Year

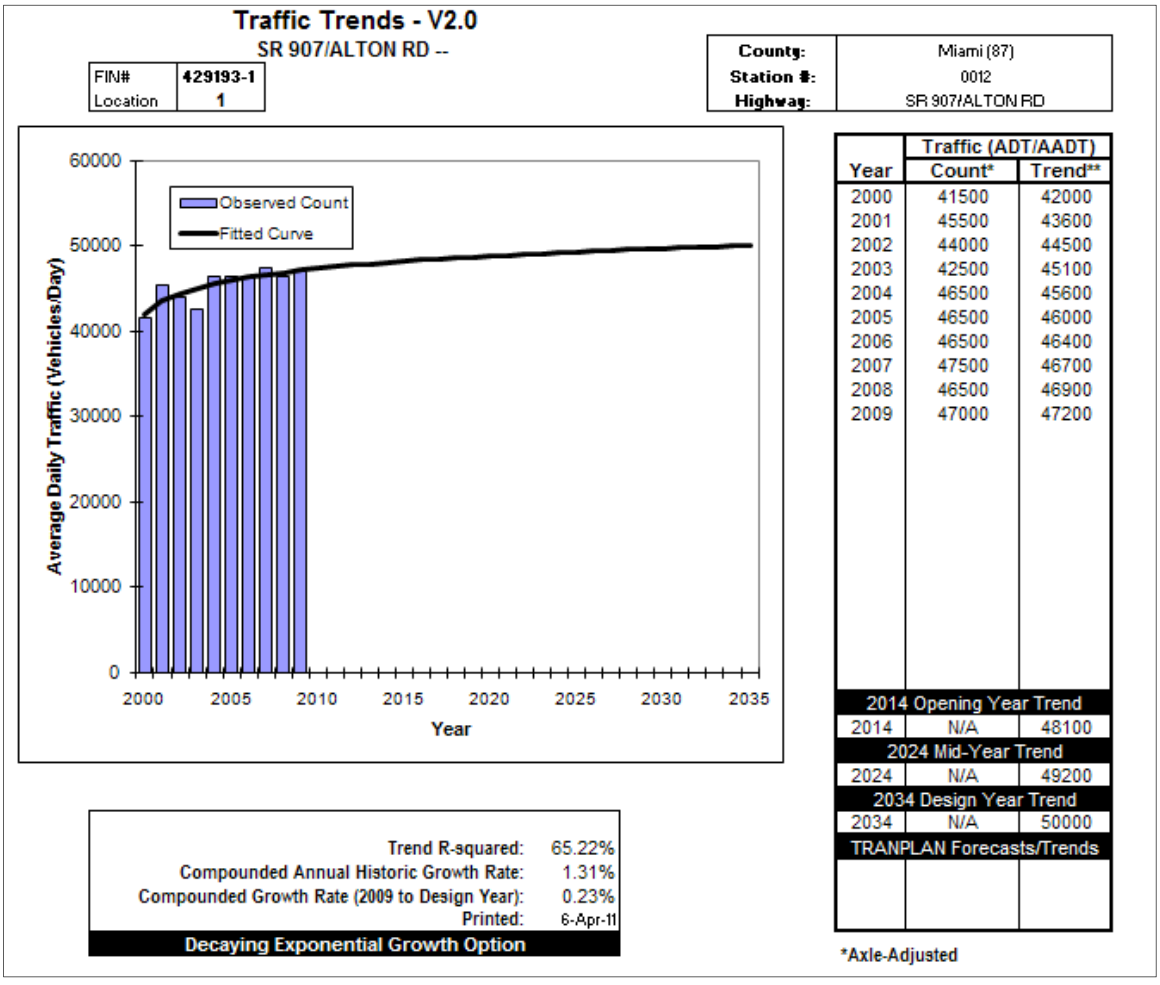


Figure 7.6 Decaying Exponential Growth Example

7.3.9 Percent Trucks (T)

T can be determined using the following methods:

a. Vehicle classification station data — If a FDOT vehicle classification station is located within the project limits, the Percent Trucks (T_{24}) is available in the Traffic Characteristics Inventory (TCI) or on the Florida Transportation Information DVD. The total percent of Class 4 to 13 vehicles can be applied to the project 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 market might dramatically increase the T_{24} average for the year.

   Note: Prior to accepting the field data 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 checked for reasonableness, the differences resolved, and the comments fully documented. The results of the data collection should provide a numeric and percent breakdown of all 13 vehicle classification types.

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.

T is then assumed to hold the same relationship to AADT unless some known development will change the future truck traffic.

7.3.10 Future Truck Volumes

Future truck volumes can be calculated by using the following example below:

a. Multiply the base year average truck volume by a factor of one plus the number of years times the growth rate.

Future trucks = (Base Year Average) x [1 + (Years x Rate)]

Example:

Assume that a year 2015 future truck volume is desired. The growth period equals 19 years (2015 - 1996 = 19). The base year traffic (shown in the Figure 7.3, 1996 average trucks) of 811 is factored by the 19 years and by the rate of 7.5 percent.

Future trucks = (811) x [1 + (19 x .075)]

= (811) x (2.425)

= 1966.7

This results in a year 2015 estimate of 1966.7 which would be rounded to 2000.

Expanding the Percent-Root-Mean Square (%RMS) method by extending the best fit straight-line to the desired design year (*See* Figure 7.4).

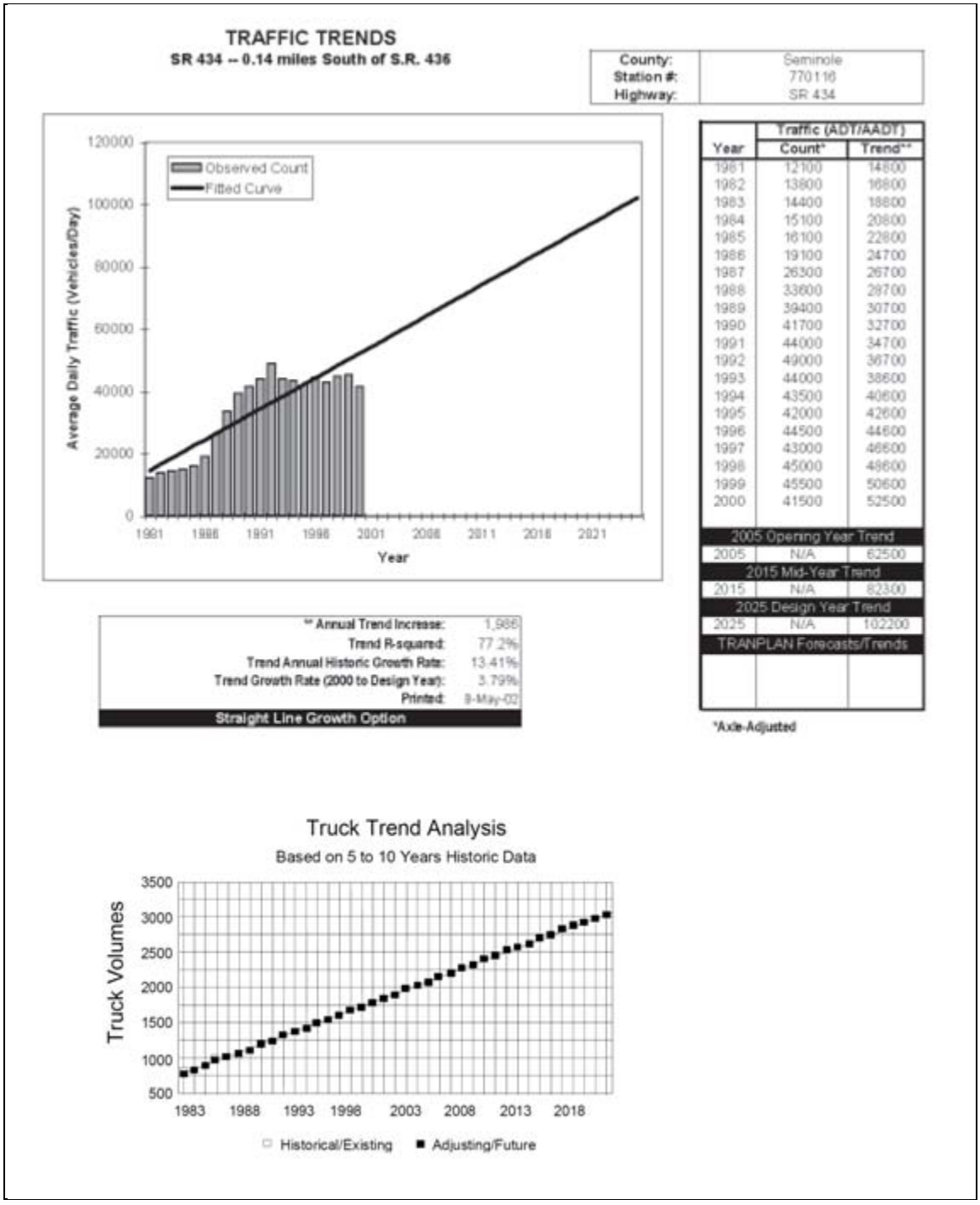


Figure 7.7 Regression Analysis Examples for Future Years

7.4 DESIGN REQUIREMENTS

7.4.1 $ESAL_D$ Equation

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

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

$$ESAL_D = \sum_{i=1}^{n} (AADT_i) \times (L_{Fi}) \times T_{24} \times D_F \times E_F \times 365$$

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 y : 1, all the variables apply to year 1. Some of the variables remain constant while others, such as AADT, L_F, and T_{24}, may change from year to year. Other factors may change when changes in the system occur. Such changes include parallel roads, shopping centers, truck terminals, etc.

n: The number of years the design is expected to last. (e.g. 20, 10, ...).

$AADT_i$: Annual Average Daily Traffic for the year *i*.

T : Percent heavy trucks during a 24-hour period. Trucks with six tires or more are considered in the calculations(Categories 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 Figure 7.9.

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 TranStat based on WIM data. An example of EF (E80) values for different types of facilities is shown in Figure 7.8.

Example of Equivalency Factor E_F (E_{80}) 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

Figure 7.8 Equivalency Factors for Different Types of Facilities

(*Source: FDOT Flexible / Rigid Pavement Design Manual 2008*, (*National Cooperative Highway Research Program Report 277, Portland Cement Concrete Pavement Evaluation System (COPES), Transportation Research Board, September 1986*))

7.4.2 Directional Distribution Factor (D_F)

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

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

7.4.3 Lane Factor (L_F)

The $\mathbf{L_F}$ is calculated by using the COPES equation, the graphic solution to the COPES equation, shown in Figure 7.9, or the LF feature provided by the Traffic Loading Forecasting System (NHCRP No. 277 "Portland Cement Concrete Pavement Evaluation System").

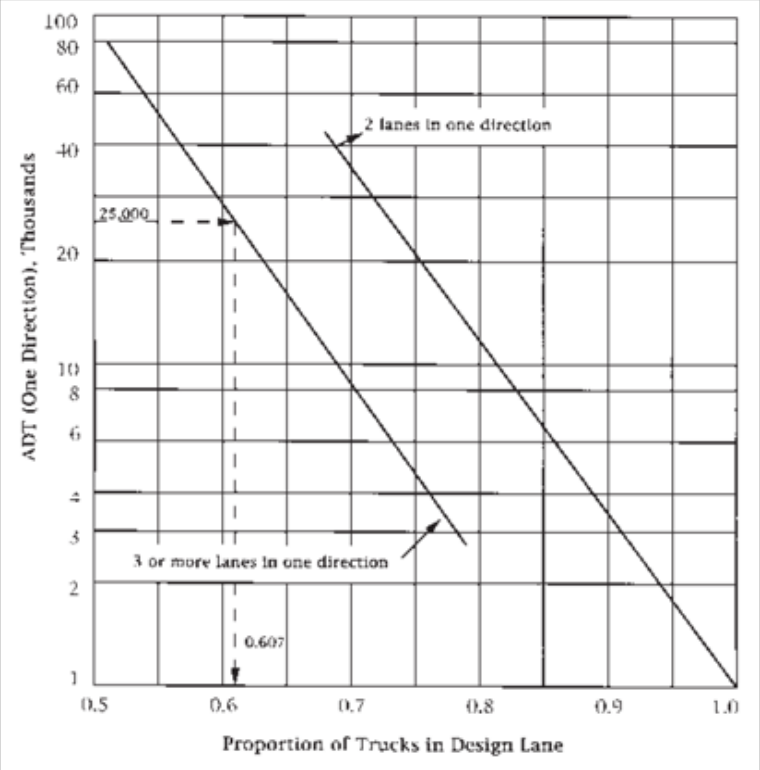


Figure 7.9 COPES Chart

The COPES equation was developed in a research project for the National Cooperative Highway Research Program. The equation for the LF is defined as follows:

$$L_F = (1.567 - 0.0826 \times \text{Ln}(\text{One-Way AADT}) - 0.12368 \times LV)$$

Where:

LF = 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: One-WayAADT = 25000
One-Way Lanes = 3 (LV = 1)

L_F = (1.567 -0.0826 x Ln(25000) - 0.12368 x 1)
= (1.567 - 0.0826 x 10.127 - 0.12368)
= (1.567 - 0.836 - 0.12368)

L_F = 0.607

As traffic approaches capacity the lane factor for all lanes tends to equal out. Drivers in congestion will follow the path of least resistance and tend to move to the shortest line.The LF should be determined for each year that the ESAL is calculated. The Traffic Forecast ESAL-V02.XLS software (an Excel spreadsheet) performs this calculation.

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

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

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

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

Different axle loads and axle configurations are converted to equivalent damage factors and averaged over the mixed traffic stream to give a load equivalency factor E_F for the average truck in the stream. This factor is available as a feature of TLFS. E_F values used in 18-KIP ESAL calculations can be obtained from TranStat. 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 (P_T) of 2.5. The flexible E_F is based on a structural number of 5 with a Terminal Serviceability Index (P_T) of 2.5.

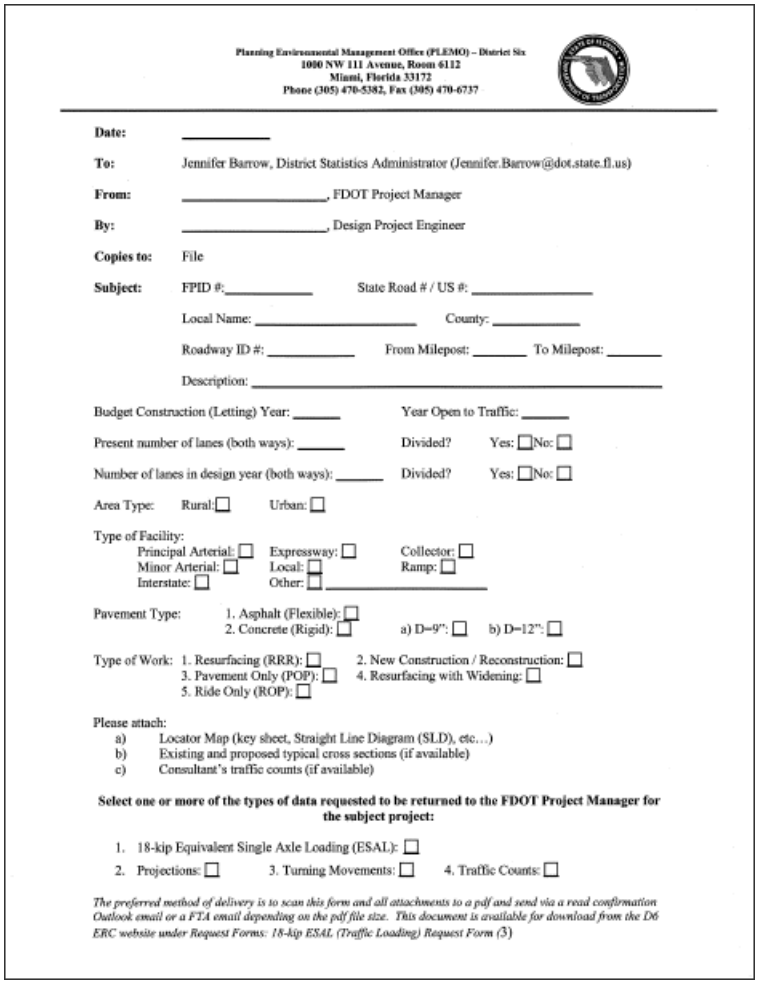
It should be noted that load equivalency factors are functions of the pavement parameters, type (rigid or flexible) and thickness. These pavement factors will usually give results that are sufficiently accurate for design purposes, even though the final design may be somewhat different.

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 loading ($ESAL_D$) 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.

7.5 STEPS FOR PRODUCING 18-KIP

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

1. Receive request for 18-KIP



Planning Environmental Management Office (PLEMO) – District Six
1000 NW 111 Avenue, Room 6112
Miami, Florida 33172
Phone (305) 470-5382, Fax (305) 470-6737

Date: _____

To: Jennifer Barrow, District Statistics Administrator (Jennifer.Barrow@dot.state.fl.us)

From: _____, FDOT Project Manager

By: _____, Design Project Engineer

Copies to: File

Subject: FPID #:_____ State Road # / US #: _____

Local Name: _____ County: _____

Roadway ID #: _____ From Milepost: _____ To Milepost: _____

Description: _____

Budget Construction (Letting) Year: _____ Year Open to Traffic: _____

Present number of lanes (both ways): _____ Divided? Yes: ☐ No: ☐

Number of lanes in design year (both ways): _____ Divided? Yes: ☐ No: ☐

Area Type: Rural: ☐ Urban: ☐

Type of Facility:
Principal Arterial: ☐ Expressway: ☐ Collector: ☐
Minor Arterial: ☐ Local: ☐ Ramp: ☐
Interstate: ☐ Other: ☐ _____

Pavement Type: 1. Asphalt (Flexible): ☐
2. Concrete (Rigid): ☐ a) D=9": ☐ b) D=12": ☐

Type of Work: 1. Resurfacing (RRR): ☐ 2. New Construction / Reconstruction: ☐
3. Pavement Only (POP): ☐ 4. Resurfacing with Widening: ☐
5. Ride Only (ROP): ☐

Please attach:
a) Locator Map (key sheet, Straight Line Diagram (SLD), etc…)
b) Existing and proposed typical cross sections (if available)
c) Consultant's traffic counts (if available)

Select one or more of the types of data requested to be returned to the FDOT Project Manager for the subject project:

1. 18-kip Equivalent Single Axle Loading (ESAL): ☐
2. Projections: ☐ 3. Turning Movements: ☐ 4. Traffic Counts: ☐

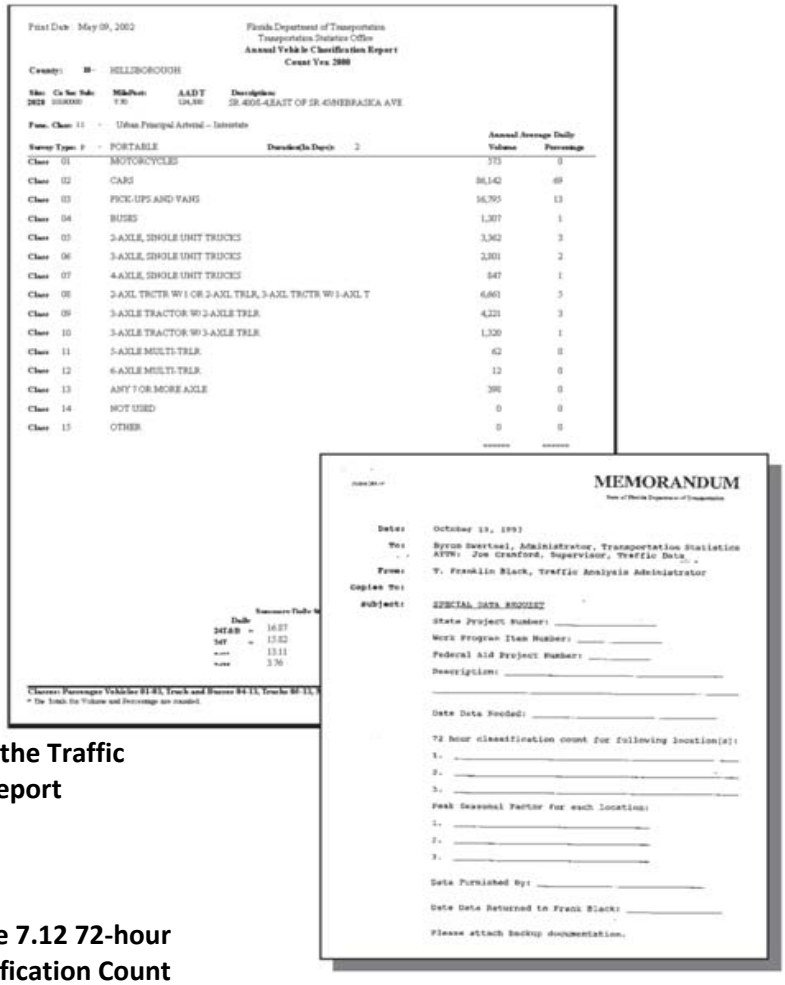
The preferred method of delivery is to scan this form and all attachments to a pdf and send via a read confirmation Outlook email or a FTA email depending on the pdf file size. This document is available for download from the D6 ERC website under Request Forms: 18-kip ESAL (Traffic Loading) Request Form (3)

Figure 7.10 18-KIP Request Memo (example)

2. Additional information including Functional Classification (RCI Feature 121), Number of Lanes (RCI Feature 212), Median (RCI Feature 215), Speed Limits (RCI Feature 311) and Traffic Data (RCI Feature 331) can be accessed through the DOT INFONET Enterprise Web Application – RCI (Roadway Characteristics Inventory).

Print and save these screens as part of the backup documentation.

Check traffic count location maps for classification stations within the project limits of request for 18-KIP ESALs or close proximity (one mile either side of limits). If there is a classification count station within project limits of request for 18-KIP look at the Traffic Classification Report, locate the station and make a copy of the page for that station (*See* Figure 7.13). This printout will give you the T_{24}, and Design Hour Truck percentage. If no classification station is within the project limits of the request for 18-KIP ESALs, complete and submit a request memo (*See* Figure 7.12) to TranStat for a 72-hour classification count.



Print Date: May 09, 2002

Florida Department of Transportation
Transportation Statistics Office
Annual Vehicle Classification Report
Count Yea 2000

County: 29 - HILLSBOROUGH

Site	Co Sec Sub	MilePost	AADT	Description
2028	10000000	7.30	124,500	SR 4606-(EAST OF SR 45)NEBRASKA AVE

Func. Class: 11 - Urban Principal Arterial – Interstate

Survey Type: P - PORTABLE Duration(In Days): 2

			Annual Average Daily Volume	Percentage
Class	01	MOTORCYCLES	375	0
Class	02	CARS	86,142	69
Class	03	PICK-UPS AND VANS	16,795	13
Class	04	BUSES	1,307	1
Class	05	2-AXLE, SINGLE UNIT TRUCKS	3,362	3
Class	06	3-AXLE, SINGLE UNIT TRUCKS	2,801	2
Class	07	4-AXLE, SINGLE UNIT TRUCKS	847	1
Class	08	2-AXL TRCTR W/ 1 OR 2-AXL TRLR, 3-AXL TRCTR W/ 1-AXL T	6,661	5
Class	09	3-AXLE TRACTOR W/ 2-AXLE TRLR	4,221	3
Class	10	3-AXLE TRACTOR W/ 3-AXLE TRLR	1,320	1
Class	11	5-AXLE MULTI-TRLR	62	0
Class	12	6-AXLE MULTI-TRLR	12	0
Class	13	ANY 7 OR MORE AXLE	391	0
Class	14	NOT USED	0	0
Class	15	OTHER	0	0

Daily
24TAB = 16.87
547 = 13.82
= 13.11
= 3.76

MEMORANDUM

Date: October 13, 1993
To: Byron Swartzel, Administrator, Transportation Statistics
ATTN: Joe Cranford, Supervisor, Traffic Data
From: T. Franklin Black, Traffic Analysis Administrator
Copies To:
Subject: SPECIAL DATA REQUEST

State Project Number: _____
Work Program Item Number: _____
Federal Aid Project Number: _____
Description: _____

Date Data Needed: _____

72 hour classification count for following location(s):
1. _____
2. _____
3. _____

Peak Seasonal Factor for each location:
1. _____
2. _____
3. _____

Data Furnished By: _____
Date Data Returned to Frank Black: _____
Please attach backup documentation.

Figure 7.11
Examples from the Traffic Classification Report

Figure 7.12 72-hour Classification Count Request Memo

3. Make a list of count/classification stations within project limits of request for 18-KIP ESALs. Check the traffic trend charts developed by the department or consultant for count/classification stations. Make copies of these charts to be used for comparison and backup documentation. The yearly trend increase is then projected to the design

year (20 years past year of opening). Include the projected calculations for the trends increase in the backup documentation.

4. Request the modeling staff to provide adopted model data for the project area. Post volumes and print the screen. Convert the model data from PSWADT to AADT. Note: Currently, there are several model outputs throughout the State that require conversion from PSWADT to AADT using MOCF. Project the AADT from the existing year to the design year (20 years past year of opening). Figure 7.13 shows the Trends Progression for 18-KIP for the Polk County I-4 example. Include the conversion and projection calculations for the model data in the backup documentation

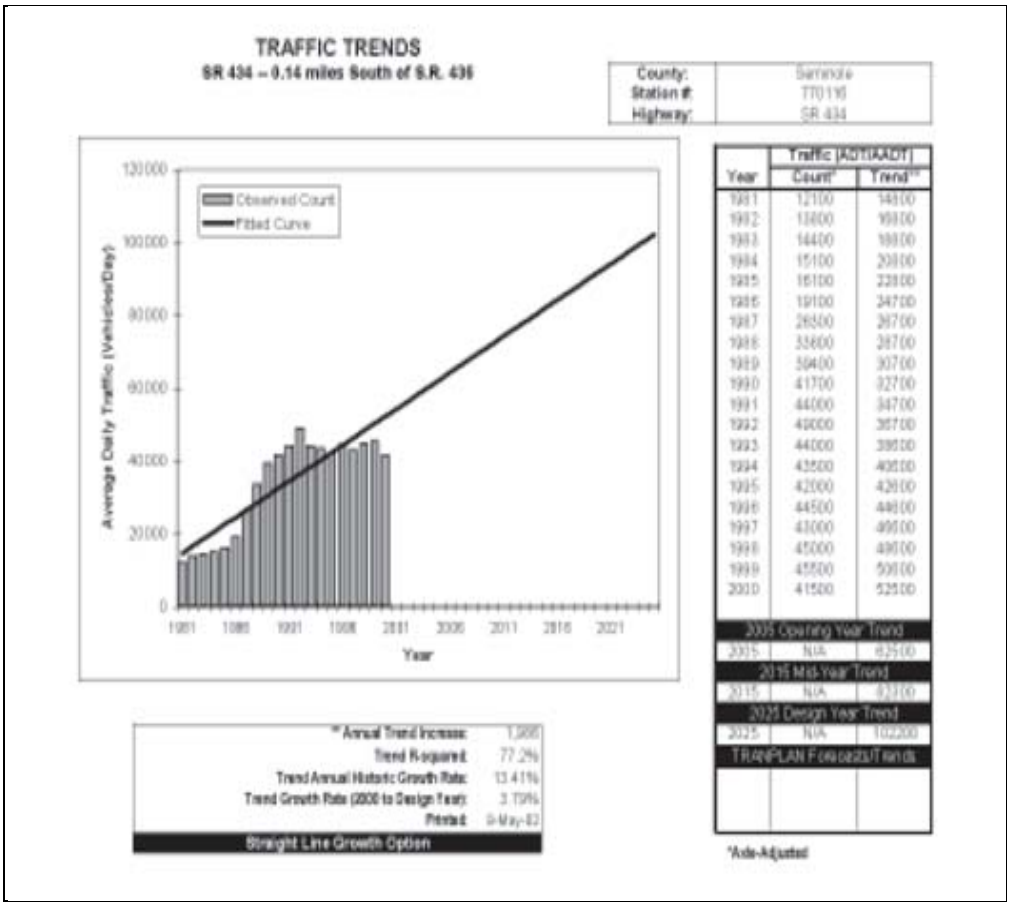


Figure 7.13 Trend Projections

Figure 7.14 Screen from I-4 Polk County Travel Demand Model Projection

5. Check to see if a Project Design Traffic Report was prepared within the last two years, covering the limits of the request for the 18-KIP ESALs. Information contained in the Project Design Traffic Report will be the most reliable and the data should be utilized. If a traffic report is not available, the Trends and Model Data are then checked for continuity and reasonableness. If there is no continuity between the two, a decision on the most reasonable data is made and utilized for the 18-KIP ESALs. In areas where Model Data is available, the Model Data is usually the more reliable. Trends Data does not take into consideration diversion to new facilities and may over estimate future traffic.

Table 4

18 kip EQUIVALENT SINGLE AXLE LOAD ANALYSIS - LOCATION 2

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

YEARS: *1996 to 2022*

SECTION #: 0 **SEGMENT #:** 1 **ITEM #:** 0

FLEXIBLE PAVEMENT URBAN HIGHWAY 0.890

SN=5/THICK S.R. 434/S.R. 414 Interchange C

YEAR	AADT	ESAL (1000S)	ACCUM (1000s)	D	T	LF	EF
1996	48300	105	0	0.5	2.18%	0.610	0.890
1997	49200	106	0	0.5	2.18%	0.608	0.890
1998	50200	108	0	0.5	2.18%	0.607	0.890
1999	51200	110	0	0.5	2.18%	0.605	0.890
2000	52100	112	0	0.5	2.18%	0.603	0.890
2001	53100	114	0	0.5	2.18%	0.602	0.890
2002	54100	116	116	0.5	2.18%	0.600	0.890
2003	55000	117	233	0.5	2.18%	0.599	0.890
2004	56000	119	352	0.5	2.18%	0.597	0.890
2005	56900	121	473	0.5	2.18%	0.596	0.890
2006	57900	122	595	0.5	2.18%	0.595	0.890
2007	58900	124	719	0.5	2.18%	0.593	0.890
2008	59800	126	845	0.5	2.18%	0.592	0.890
2009	60800	128	973	0.5	2.18%	0.591	0.890
2010	61700	129	1102	0.5	2.18%	0.589	0.890
2011	62700	131	1233	0.5	2.18%	0.588	0.890
2012	63700	133	1366	0.5	2.18%	0.587	0.890
2013	64600	134	1500	0.5	2.18%	0.586	0.890
2014	65600	136	1636	0.5	2.18%	0.584	0.890
2015	66600	138	1774	0.5	2.18%	0.583	0.890
2016	67500	140	1914	0.5	2.18%	0.582	0.890
2017	68500	141	2055	0.5	2.18%	0.581	0.890
2018	69500	143	2198	0.5	2.18%	0.580	0.890
2019	70400	145	2343	0.5	2.18%	0.579	0.890
2020	71400	146	2489	0.5	2.18%	0.577	0.890
2021	72400	148	2637	0.5	2.18%	0.576	0.890
2022	73400	150	2787	0.5	2.18%	0.575	0.890

Opening to Mid-Design Year ESAL Accumulation (1000s): 1250
Opening to Design Year ESAL Accumulation (1000s): 2671

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 historical traffic data and other available information.

Prepared by: Luis E. Diaz, P.E. Planning Manager TEI

Name Title Org.Unit or Firm Date

Signature

Susan Sadighi Technical Applications Supervisor FDOT

Name Title Org.Unit or Firm Date

Signature

10

Figure 7.15 Trend Projection Results

6. After receiving the printout for a 72-hour classification count (if necessary), prepare a form for determining T_{24} and Design Hour Truck percentage.

WPI NO.: _____

JOB NO.: _____

DESCRIPTION: _____

72 HOUR TRAFFIC

DIRECTION	CARS	TRUCKS
SUB-TOTAL		
TOTAL		
PERCENTAGE		

DESIGN HOUR TRAFFIC (_____)

DIRECTION	CARS	TRUCKS
SUB-TOTAL		
TOTAL		
PERCENTAGE		

NOTE: TOTAL 72 HOUR TRAFFIC ÷ 3 ÷ WEEKDAY SEASONAL FACTOR = AADT

Figure 7.16 Estimating AADT from a 72 - Hour Count

7. From the 72-hour classification count determine the D-Factor (*not* D_F) for the 18-KIP ESAL request.

ESTIMATING D FACTOR

MEASURED DAY	PEAK HOUR	PEAK HOUR VOLUME	PREDOMINANT DIRECTION PEAK VOLUME	OPPOSITE DIRECTION PEAK VOLUME	D
1/22	5-6 PM	1,700	884	816	0.520
1/23	5-6 PM	1,800	1,152	648	0.640
1/24	5-6 PM	1,900	1,102	798	0.580
SUMS	NA	5,400	3,138	2,262	NA
AVERAGES	NA	1,800	1,046	754	0.581

ESTIMATED D = 0.581

Figure 7.17 Estimating the D-Factor

8. To determine the K and D factors within the project limits of request for 18KIP where a classification station was found, look in the 200th Highest Hour Traffic Count Report for a facility with similar AADT and similar characteristics. Using good engineering judgement, choose the station best representing the 18-KIP request and use the K and D_F factors for that station. Make copies of those pages to be used as backup documentation.

Print Date : May 09, 2002

Florida Department of Transportation
Transportation Statistics Office
Annual Vehicle Classification Report
Count Yea: 2000

County: 10 - HILLSBOROUGH

Site:	Co Sec Sub:	MilePost:	AADT	Description:
2028	:0190000	7.70	124,500	SR 400/I-4,EAST OF SR 45/NEBRASKA AVE

Func. Class: 11 - Urban Principal Arterial -- Interstate

Survey Type: P - PORTABLE **Duration(In Days):** 2

			Annual Average Daily Volume	Percentage
Class	01	MOTORCYCLES	573	0
Class	02	CARS	86,142	69
Class	03	PICK-UPS AND VANS	16,755	13
Class	04	BUSES	1,307	1
Class	05	2-AXLE, SINGLE UNIT TRUCKS	3,362	3
Class	06	3-AXLE, SINGLE UNIT TRUCKS	2,801	2
Class	07	4-AXLE, SINGLE UNIT TRUCKS	847	1
Class	08	2-AXL TRCTR W/ 1 OR 2-AXL TRLR, 3-AXL TRCTR W/ 1-AXL T	6,661	5
Class	09	3-AXLE TRACTOR W/ 2-AXL3 TRLR	4,221	3
Class	10	3-AXLE TRACTOR W/ 3-AXL3 TRLR	1,320	1
Class	11	5-AXLE MULTI-TRLR	62	0
Class	12	6-AXLE MULTI-TRLR	12	0
Class	13	ANY 7 OR MORE AXLE	398	0
Class	14	NOT USED	0	0
Class	15	OTHER	0	0
			======	======
			124,500	100

Summary Daily Statistics

Daily		Design Hour	
24T&B =	16.87	DHT =	8.43
24T =	15.82		
[illegible]	13.11	[illegible]	6.56
[illegible]	3.76	[illegible]	1.88

Classes: Passenger Vehicles 01-03, Truck and Busses 04-13, Trucks 05-13, Medium Trucks 04-05, Heavy Trucks 06-13

* The Totals for Volume and Percentage are rounded.

Page: 1

Figure 7.18 Traffic Classification Report for Site 102028

9. Open ESAL-V02.XLS. This Excel spreadsheet is a user friendly menu/macro driven tool for input, calculation, and printing of ESALs. From the Trends Progression for 18-KIP **(**Figure 7.13), enter the existing year, opening year, mid-design year, and design year AADTs.

EXISTING YEAR:	1994	58,500
OPENING YEAR:	2000	71,712
MID-DESIGN YEAR:	2010	93,732
DESIGN YEAR:	2020	115,752
D:	0.50	
T:	0.1193	

10. At the bottom of the 18-KIP Information Sheet enter the type of pavement, number of lanes and the trends/model increase into the spreadsheet.

11. Complete the ESAL Excel worksheet. The spreadsheet was developed by the District One Planning Department'sTransportation Planning Section. The ESAL Excel worksheet is available from TranStat.

Table 3

18 kip EQUIVALENT SINGLE AXLE LOAD ANALYSIS

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

SECTION #: 0
SEGMENT #: 1
ITEM #: 0
PROJECT DESCRIPTION: S.R. 434/S.R. 414 Interchange

LOCATION #: 2
LOCATION DESCRIPTION: S.R. 434, North of S.R. 414

GROWTH RATE FORMULA

A: Interpolation
B: Enter Growth Rate
C: Enter All AADTs
D: New Facility
If "A" select an interpolation function
If "B" enter rate as decimal (5% = 0.05)
If "C", or "D" continue to next section

Choose A, B, C, or D here: C
Linear Growth Rate
Compounded Growth Rate
Decaying Growth Rate
(select one)

DESIGN INFORMATION

		AADT
Existing Year	1996	48300
Opening Year	2002	54100
Mid-Design Year	2012	63700
Design Year	2022	73400

Note: AADT values have been rounded to the nearest 100

Daily Direction Split (50% or 100%): 50%
Lanes in One Direction: 3

T24 values
Existing to Opening Year: 2.18%
Opening to Mid-Year: 2.18%
Mid-Year to Design-Year: 2.18%

1995 EQUIVALENCY FACTORS u(1)

(selected with an X)	FLEXIBLE PAVEMENT SN = 5/THICK		RIGID PAVEMENT SN = 12/THICK	
RURAL FREEWAY:	1.050		1.600	
URBAN FREEWAY:	0.900		1.270	
RURAL HIGHWAY:	0.960		1.350	
URBAN HIGHWAY:	0.890	X	1.220	
OTHER (Enter Factor and X):				

(1) Equivalency Factors are based on Updated Pavement Damage Factors Memorandum, dated October 1, 1996.
Lane Factors developed by Copes equation

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 historical traffic data and other available information.

	Name	Title	Org. Unit or Firm	Date
Prepared by:	Luis E. Diaz, P.E.	Planning Manager	TEI	
	Signature			
	Susan Sadighi	Technical Applications Supervisor	FDOT	
Reviewed by:	Name	Title	Org. Unit or Firm	Date
	Signature			

9

Figure 7.19 Data Input Sheet for ESAL-V02.XLS

12. Print out the 18-KIP Report and prepare the transmittal memo. Have the designated traffic engineer or transportation planner review and sign the memo and 18-KIP Report.

Table 4

18 kip EQUIVALENT SINGLE AXLE LOAD ANALYSIS - LOCATION 2

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

YEARS: *1996 to 2022*

SECTION #: 0 **SEGMENT #:** 1 **ITEM #:** 0

FLEXIBLE PAVEMENT URBAN HIGHWAY 0.890

SN=5/THICK S.R. 434/S.R. 414 Interchange C

YEAR	AADT	ESAL (1000S)	ACCUM (1000s)	D	T	LF	EF
1996	48300	105	0	0.5	2.18%	0.610	0.890
1997	49200	106	0	0.5	2.18%	0.608	0.890
1998	50200	108	0	0.5	2.18%	0.607	0.890
1999	51200	110	0	0.5	2.18%	0.605	0.890
2000	52100	112	0	0.5	2.18%	0.603	0.890
2001	53100	114	0	0.5	2.18%	0.602	0.890
2002	54100	116	116	0.5	2.18%	0.600	0.890
2003	55000	117	233	0.5	2.18%	0.599	0.890
2004	56000	119	352	0.5	2.18%	0.597	0.890
2005	56900	121	473	0.5	2.18%	0.596	0.890
2006	57900	122	595	0.5	2.18%	0.595	0.890
2007	58900	124	719	0.5	2.18%	0.593	0.890
2008	59800	126	845	0.5	2.18%	0.592	0.890
2009	60800	128	973	0.5	2.18%	0.591	0.890
2010	61700	129	1102	0.5	2.18%	0.589	0.890
2011	62700	131	1233	0.5	2.18%	0.588	0.890
2012	63700	133	1366	0.5	2.18%	0.587	0.890
2013	64600	134	1500	0.5	2.18%	0.586	0.890
2014	65600	136	1636	0.5	2.18%	0.584	0.890
2015	66600	138	1774	0.5	2.18%	0.583	0.890
2016	67500	140	1914	0.5	2.18%	0.582	0.890
2017	68500	141	2055	0.5	2.18%	0.581	0.890
2018	69500	143	2198	0.5	2.18%	0.580	0.890
2019	70400	145	2343	0.5	2.18%	0.579	0.890
2020	71400	146	2489	0.5	2.18%	0.577	0.890
2021	72400	148	2637	0.5	2.18%	0.576	0.890
2022	73400	150	2787	0.5	2.18%	0.575	0.890

Opening to Mid-Design Year ESAL Accumulation (1000s): 1250
Opening to Design Year ESAL Accumulation (1000s): 2671

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 historical traffic data and other available information.

Prepared by: Luis E. Diaz, P.E.	Planning Manager	TEI	
Name	Title	Org.Unit or Firm	Date
Signature			
Susan Sadighi	Technical Applications Supervisor	FDOT	
Name	Title	Org.Unit or Firm	Date
Signature			

10

Figure 7.20 Report Print out for ESAL-V02.XLS

13. Make necessary copies for distribution as follows:

a. Original transmittal memo and original 18-KIP Report to requestor.

b. Copy of transmittal memo to the designated traffic engineer or transportation planner.

c. Copy of transmittal memo and 18-KIP Report to reading files.

d. Copy of transmittal memo, 18-KIP Report, and all backup documentation to 18-KIP project files.

e. As requested and approved, distribute copies of the reports to outside parties.

7.6 SUMMARY

The 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 forecast.

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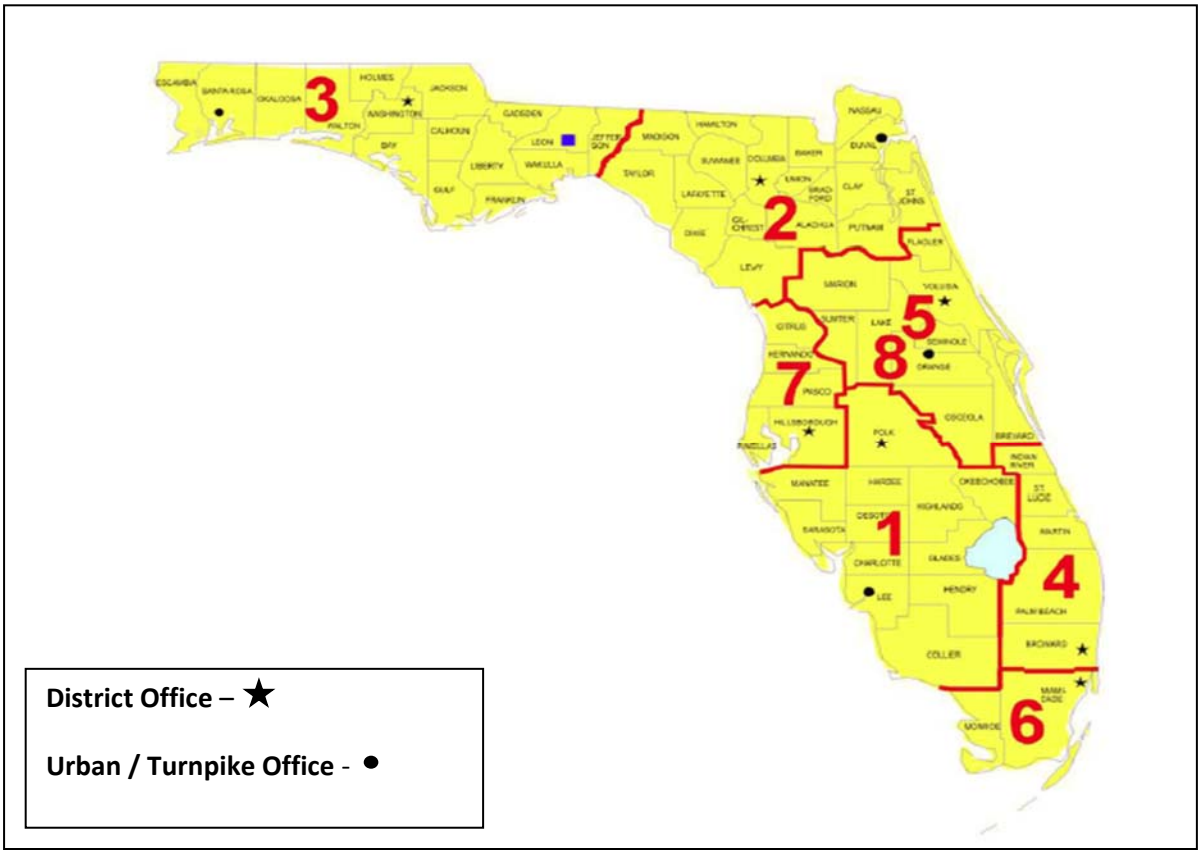
Appendix A

Central Office and District Planning and Modeling Contacts

Central Office Contacts		
Person to Contact	**Title & Phone Number**	
Ed Hutchinson	Transportation Planning Manager	(850) 414-4910
Steven Bentz	Traffic Data Section Manager	(850) 414-4738
Michelle Young	TTMS Manager	(850) 414-7302
Joey Gordon	Traffic Data Quality Control Supervisor	(850) 414-4005
	Traffic Data Analyst	(850) 414-
Huiwei Shen	Systems Planning Manager	(850) 414-4911
Thomas Hill	State Modeling Manager	(850) 414-4924
Paul Fang	SIS Planning GIS Manager	(850) 414-4905



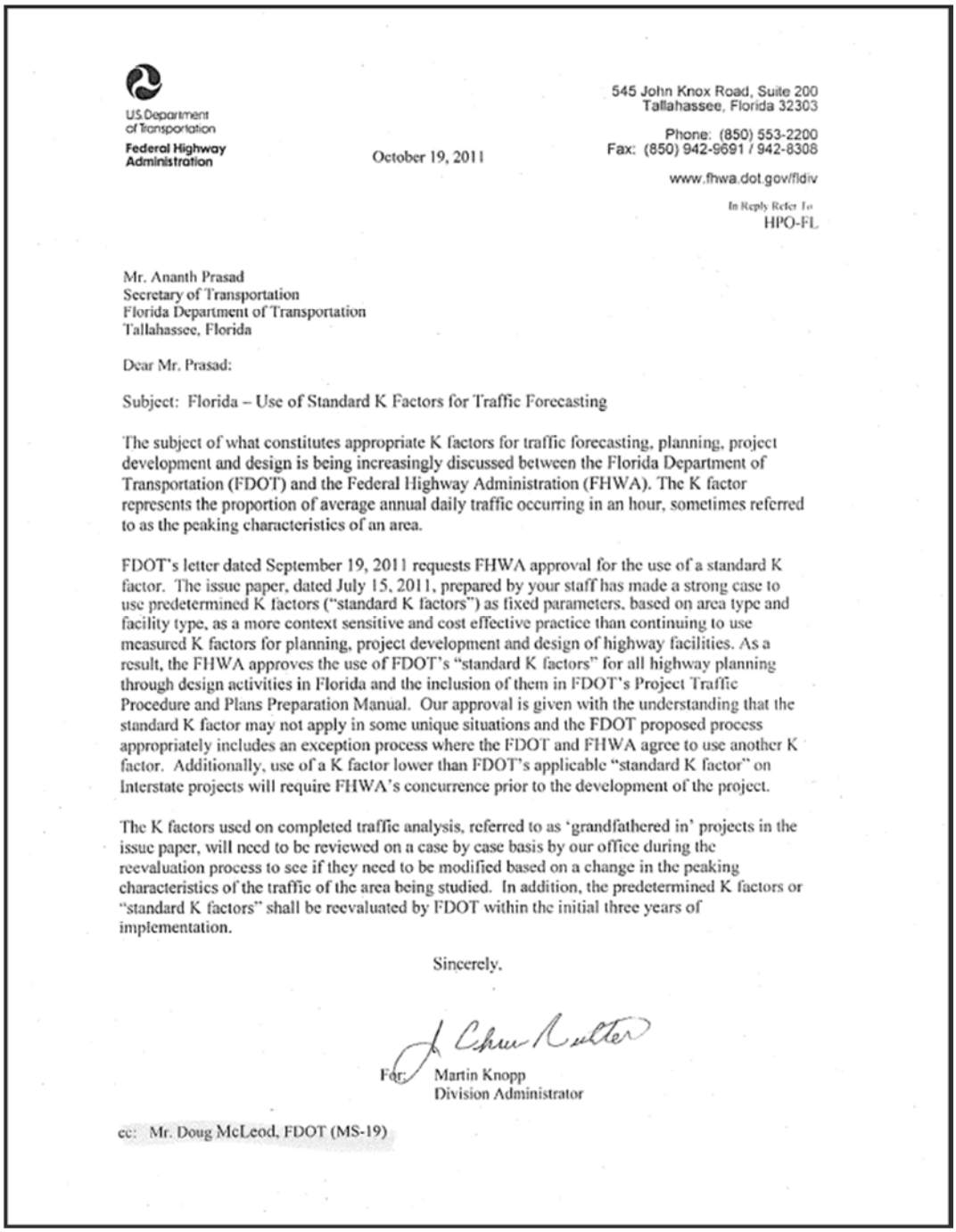
Appendix A – continued

District Office Contacts		
District	**Name**	**Phone Number**
District 1	Jennifer Stults, ISD Manager	(863) 519-2656
District 1	Bob Crawley, Model Coordinator	(863) 519-2395
District 1	Kyle Purvis, Traf. Analysis Coord.	(863) 519-2216
District 1	Kyle Purvis, Traffic Analysis Specialist	(863) 519-2216
District 2	James Knight, Urban Planning Manager	(904) 360-5646
District 2	Jordan Green, Rural Planning Manager	(386) 961-7884
District 2	Ameera Sayeed, Grwth & Dev/Mod. Sup.	(904) 360-5647
District 2	Scott Hardee, Traffic Analysis	(386) 961-7882
District 2	Tommy Hosford, Rural Planning	(386) 961-7871
District 3	Lyle Seigler, Planning Manager	(850) 330-1536
District 3	Linda Little, Model Coordinator	(850) 415-9217
District 3	Quinton Williams, Traffic Analysis	(850) 415-9426
District 4	Shi-Chiang Li, System Planning Manager	(954) 777-4655
District 4	Hui Zhao, Model Coordinator	(954) 777-4635
District4	Cesar Martinez, Traffic Specialist	(954) 777-4653
District 5	Susan Sadighi, ISD Manager	(407) 482-7884
District 5	Jennifer Vreeland, Proj. Manager	(386) 943-5732
District 5	Cheryl Burke, Senior Modeler	(386) 943-5380
District 6	Lisa Colmenares, Planning Manager	(305) 470-5386
District 6	Neil Lyn, Model Coordinator	(305) 470-5373
District 6	Neil Lyn, Dist. Stat. Administrator	(305) 470-5373
District 7	Ming Gao, Planning Manager	(813) 975-6454
District 7	Daniel Lamb, Model Administrator	(813) 975-6437
District 7	Andrew Tyrell, Model Coordinator	(813) 975-6458
Turnpike	Barbara Davis, Planning Manager	(407) 264-3806
Turnpike	Xiao Cui, Traffic Manager	(407) 264-3826

Turnpike	Randy Fox, ISD Manager	(407) 264-3041
Turnpike	Andrew Velasquez, Traf. Eng. Super.	(954) 214-0777

Appendix B

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



U.S. Department of Transportation
Federal Highway Administration

545 John Knox Road, Suite 200
Tallahassee, Florida 32303

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

www.fhwa.dot.gov/fldiv

October 19, 2011

In Reply Refer To
HPO-FL

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

Dear Mr. Prasad:

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

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

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

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

Sincerely,

For: Martin Knopp
Division Administrator

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

Appendix C

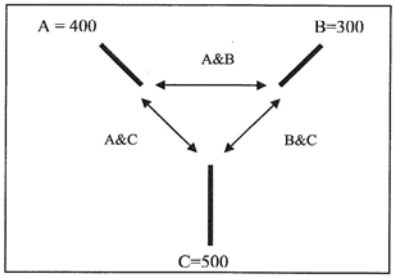
EXAMPLE OF DISTRICT TWO MANUAL METHOD

A simple calculation technique for obtaining balanced turning movement volumes from approach volumes at three-legged and four-legged intersections.

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)



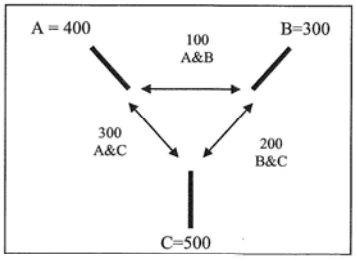
Rule: To find the two-way volume moving between two legs of a three-legged intersection, add the two-way volumes on the two legs concerned and subtract the two-way volume on the third leg, then divide by 2

Find: Two-way turning volumes

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

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

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



Appendix C – continued

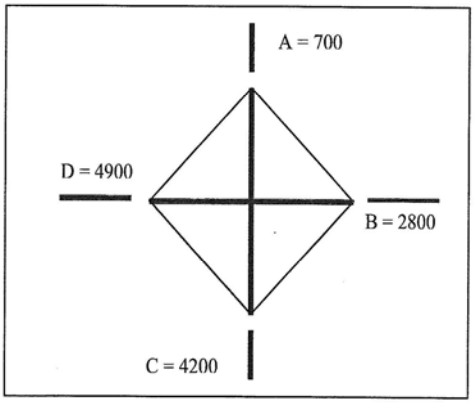
E.2 Approximation of Turns from End Volumes

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)

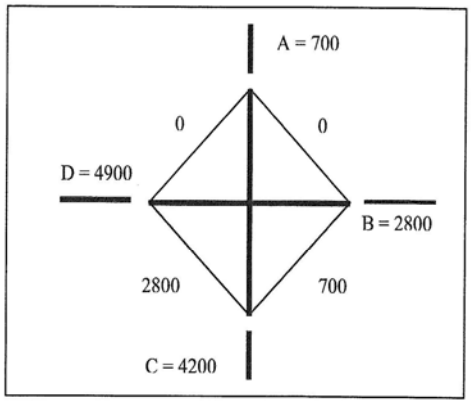
1. From the larger of A or C subtract the smaller of A or C
   4200 – 700 = 3500
2. From the larger of B or D subtract the smaller of B or D
   4900 – 2800 = 2100
3. From the larger difference subtract the smaller difference, Divide the remainder by 2
   3500 – 2100 = 1400
   1400 / 2 = 700
   This is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

Appendix C – continued

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"

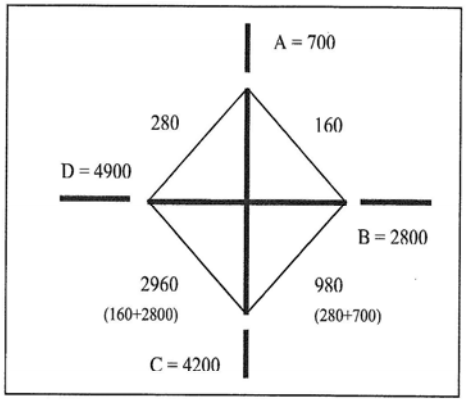
$$K_A = \frac{A}{B+C+D} = \frac{700}{11{,}900} = 0.0588$$

Turns between A&B = $K_A \times B$
= 0.0588 × 2800 = 164
(20 Round) → 160

Turns between A&D = $K_A \times D$
= 0.0588 × 4900 = 288
(20 Round) → 280

Appendix C – continued

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