Traffic Forecasting

Resource Guidebook

Presented to FDOT District Five

Intermodal Systems Development Unit

November 7, 2006
Purpose of the Guidebook

- Provide an introductory overview of general traffic forecasting techniques
- Develop a traffic forecasting resource inventory for Florida Department of Transportation (FDOT) District Five

After going through this guidebook, the students / professionals will understand the basic concepts of traffic forecasting procedures and will know where to find related information for their purposes.
Target Audience

- Entry level engineering and planning professionals dealing with travel demand forecasting, site impact analysis, PD&E studies, corridor studies, traffic operations, etc.

- This guidebook will be useful not only to FDOT staff but also to professionals with other public agencies and consulting firms.
Contents

• Introduction
  ➢ General
  ➢ Available Handbooks
  ➢ Traffic Forecasting Process

• Existing Conditions
  ➢ Data Collection
  ➢ Traffic Data Sources
  ➢ Traffic Counts for District Five Counties
  ➢ Traffic Factors
  ➢ Adjustment of Short-Term Traffic Counts
  ➢ Precision of Data

• Future Conditions
  ➢ Forecasting Approach
  ➢ Travel Demand Forecasting Models
  ➢ Trends Analysis
  ➢ Development of Directional Design Hour Volumes (*DDHV*)
  ➢ Acceptable $K_{30}$ and $D_{30}$ Values
  ➢ Estimating Intersection Turning Movement Volumes
  ➢ Equivalent Single Axle Loading (*ESAL*) Forecast

• Training Information
• Contact Information
Introduction

General

- Realizing the context – site impact analysis, corridor study, PD&E study, IJR, etc.
- Determining the methodology and level of effort \( \text{(often involves a committee / reviewing agency)} \) – study area, analysis years, analysis periods, use of travel demand model vs. manual methods, etc.
- Analysis years – existing and future years
- Analysis periods – daily, peak hour \( (am/pm) \), peak hour directional
Traffic forecasting involves forecasts of Annual Average Daily Traffic (AADT), Design Hour Volumes (DHV) and Directional Design Hour Volumes (DDHV).

Construction projects require both traffic forecasting and Equivalent Single Axle Loading (ESAL) Process to be performed (ESAL is used to develop the structural design of the pavement).

Traffic forecasts are used for operations analysis (roadway and intersection level of service, delay, measures of effectiveness, etc.) roadway design (number of lanes, geometry, etc.) and other purposes (assessing site impact, air quality analysis, concurrency management, etc.)

Focus of this presentation – Design Traffic Forecasting
Available Handbooks

- Project Traffic Forecasting Handbook
  (http://www.dot.state.fl.us/planning/statistics/pdfs/ptf.pdf)

- Site Impact Handbook
  (http://www.dot.state.fl.us/planning/systems/sm/siteimp/PDFs/site.pdf)

  (http://www.dot.state.fl.us/planning/systems/sm/intjus/trd/complete2003.pdf)

- 2002 Quality/ Level of Service Handbook
  (http://www.dot.state.fl.us/planning/systems/sm/los/pdfs/QLOS2002.pdf)

- NCHRP Report 365, Travel Estimation Techniques for Urban Planning, (and other related NCHRP reports) available online at http://gulliver.trb.org/bookstore/
Traffic Forecasting Process

Purpose & Methodology

Existing Conditions
- Existing land use and transportation system
- Existing traffic counts and traffic characteristics
- Base year travel demand model validation
- Analysis

Projection vs. Forecast → Numeric vs. Judgmental (used interchangeably)

Future Conditions
- Future land use
- Planned and programmed transportation improvements
- Traffic trend projections
- Develop traffic forecasts using travel demand model/ manual methods
- Analysis

Introduction (Continued)
Existing Conditions

Data Collection

Transportation Demand Data -

➢ traffic counts (historical and existing traffic volumes on roadway segments)
➢ turning movement counts (intersections)
➢ vehicle classification counts
➢ traffic factors – example, K,D,T etc.
➢ transit ridership
➢ bicycle and pedestrian usage
➢ other data
Transportation Systems Data -

- roadway characteristics (# of lanes, facility type, area type, etc.)
- transit service characteristics (routes, headways, etc.)
- traffic control data (signal timings, signage, etc.)

Land Use / Demographic Data -

- existing land use/demographics within the study area

Note: The datasets are required to be projected for future years for the future conditions analysis
Traffic Data Sources

• **The Florida Traffic Information (FTI) DVD** contains information on AADT, historical counts, synopsis reports, traffic factors, etc. FDOT collects, updates and distributes traffic data every year.

• **The Highway Data CD** displays data contained in the FDOT Roadway Characteristics Inventory (RCI)

Contact person –

Nabeel Akhtar  
Transportation Statistics Office, Mail Station 27  
Florida Department of Transportation  
605 Suwannee Street  
Tallahassee, Florida 32399-0450  
Telephone: (850) 414-4715  
Fax: (850) 414-4878  
http://www.dot.state.fl.us/planning/statistics/trafficdata/fticd.htm
Existing Conditions – Traffic data Sources (Continued)

- FDOT Transportation Statistics Office (TranStat) also maintains a Roadway Characteristics Inventory (RCI) database, a GIS database, and other highway and traffic data. Visit http://www.dot.state.fl.us/planning/statistics/default.htm for more information.


Existing Conditions (Continued)

Traffic Counts for District Five Counties

- Flagler - [http://www.flaglercounty.org/](http://www.flaglercounty.org/) *(contact information available)*
- Orange - [http://www.orangecountyfl.net/cms/DEPT/pw/traffic/default.htm](http://www.orangecountyfl.net/cms/DEPT/pw/traffic/default.htm)
- Seminole - [http://www.seminolecountyfl.gov/pw/traffic/counts.asp](http://www.seminolecountyfl.gov/pw/traffic/counts.asp)
- Sumter - [http://www.scpw.org/](http://www.scpw.org/) *(contact information available)*
- Volusia - [http://www.volusia.org/traffic/](http://www.volusia.org/traffic/)

Note: Some cities also maintain traffic count programs.
Traffic data for all nine counties in FDOT District Five (also for Polk County and Florida Turnpike) are available at http://www.cfgis.org/trafficdata/. The website also provides access to several maps, contacts for travel demand models, forms, level of service tables, etc.

Contact Simone Babb (simone.babb@dot.state.fl.us) to request traffic data from the Transportation Automated Information Management System (TAIMS), an application available through FDOT intranet.
Traffic Factors

- Permanent continuous counts and seasonal classification counts provide the necessary information to establish traffic adjustment factors.
- Weekly Seasonal Factors (SF) are developed by interpolating between the monthly factors for two consecutive months.
- Axle Correction Factor – factor developed to adjust vehicle axle sensor base data for the incidence of vehicles with more than two axles (refer to FHWA vehicle classification scheme “F”).
- K-Factor - proportion of AADT occurring in an hour.
- D-Factor (Directional Distribution Factor) – percentage of two-way peak hour traffic that occurs in the peak direction.
- T-Factor (Truck Factor) – percentage of truck traffic for a given hour.

Traffic factors are used to adjust short-term traffic counts (to account for seasonal and other variations) to estimate Annual Average Daily Traffic (AADT). K30 and D30 factors are used to develop design hour volumes. T factor is critical for pavement design.
### FHWA Vehicle Classification Scheme “F”

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

Source: FDOT Project Traffic Forecasting Handbook
Existing Conditions (Continued)

Adjustment of Short-Term Traffic Counts

Why do we need to adjust short-term traffic counts?
– Statistical Validity.

Source: FDOT Project Traffic Forecasting Handbook
Annual Average Daily Traffic (AADT) is obtained by adjusting short-term traffic counts/ Average Daily Traffic (ADT) by weekly Seasonal Factor (SF) and Axle Correction Factor. AADT = ADT X SF X Axle Correction Factor

Design Hour Volume (DHV) is related to AADT by the ratio known as $K_{30}$

$DHV = AADT \times K_{30}$

Directional Design Hour Volume (DDHV) is the product of DHV and $D_{30}$

$DDHV = DHV \times D_{30}$

Note – The factors are often expressed as percentages
In order to account for uncertainty of estimates and forecasts, volumes should be reported according to AASHTO* rounding standards –

<table>
<thead>
<tr>
<th>Forecast Volume</th>
<th>Round to Nearest</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;100</td>
<td>10</td>
</tr>
<tr>
<td>100 to 999</td>
<td>50</td>
</tr>
<tr>
<td>1,000 to 9,999</td>
<td>100</td>
</tr>
<tr>
<td>10,000 to 99,999</td>
<td>500</td>
</tr>
<tr>
<td>&gt;99,999</td>
<td>1,000</td>
</tr>
</tbody>
</table>

* AASHTO – American Association of State Highway and Transportation Officials
Forecasting Approach

- Forecasting future traffic volumes require understanding of future land use, demographics, and changes in the transportation system.
- Use of adopted travel demand model for the urbanized area is recommended. The standard model structure for traffic forecasting in the State of Florida is the Florida Standard Urban Transportation Modeling Structure (FSUTMS).
- Currently, there are two adopted travel demand models within District Five – The District-wide model known as the Central Florida Regional Planning Model (CFRPM v 4.02) and the Orlando Urban Area Transportation Study (OUATS) Model. Generally, the CFRPM is the model for non-METROPLAN MPOs. There are also a few local models and a Statewide Model that are used on certain projects depending on the nature of the study.
- Discussions with the reviewing agency is recommended for the selection of the travel demand model.
- If acceptable travel demand model is not available, manual methods can be used.
Travel Demand Forecasting Models

- A travel demand forecasting model is a mathematical expression of the transportation system.
The base year model is validated and calibrated to the existing traffic conditions and then the future year model is developed to forecast future traffic volumes.

Outputs from the travel demand models should be checked for "reasonableness" before using the projected traffic volumes for operational analysis.

Contacts for obtaining FDOT District Five travel demand models:

- For a copy of CFRPM contact Jon Weiss, P.E. at jon.weiss@dot.state.fl.us
- For a copy of the OUATS Model contact Dennis Hooker at dennish@metroplanorlando.com
- For a copy of the Statewide Model contact Yongqiang Wu at yongqiang.wu@dot.state.fl.us
Trends Analysis

- The travel demand model outputs are often checked for reasonableness against existing traffic counts. Historic traffic growth trends are used to project future traffic volumes on roadway segments and compared with the model outputs.

The traffic trends analysis tool is available online at http://www.dot.state.fl.us/planning/systems/sm/siteimp/default.htm
Future Conditions (Continued)

Development of Directional Design Hour Volumes

- Travel Demand Model outputs are “smoothed” using acceptable procedures.
- The traffic volumes generated by the travel demand model are converted to AADT using a Model Output Conversion Factor (MOCF).
  \[ \text{AADT} = \text{PSWADT} \times \text{MOCF} \]
- Directional Design Hour Volume (DDHV) is obtained using K\textsubscript{30} and D\textsubscript{30} factors.
  \[ \text{DHV} = \text{AADT} \times K_{30} \]
  \[ \text{DDHV (peak direction)} = \text{DHV} \times D_{30} \]
  \[ \text{DDHV (reverse direction)} = \text{DHV} \times (1-D_{30}) \]
- DDHV forecasts are used for operational analysis and roadway design projects.
- Note: K\textsubscript{100} is used for planning level analysis.
### Future Conditions (Continued)

#### Acceptable $K_{30}$ and $D_{30}$ Values

<table>
<thead>
<tr>
<th>Road Type</th>
<th>$K_{30}$ Low</th>
<th>$K_{30}$ Average</th>
<th>$K_{30}$ High</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural Freeway</td>
<td>9.60</td>
<td>11.8</td>
<td>14.6</td>
<td>1.43</td>
</tr>
<tr>
<td>Rural Arterial</td>
<td>9.40</td>
<td>11.0</td>
<td>15.6</td>
<td>1.42</td>
</tr>
<tr>
<td>Urban Freeway</td>
<td>9.40</td>
<td>9.7</td>
<td>10.0</td>
<td>0.28</td>
</tr>
<tr>
<td>Urban Arterial</td>
<td>9.20</td>
<td>10.2</td>
<td>11.5</td>
<td>0.92</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Road Type</th>
<th>$D_{30}$ Low</th>
<th>$D_{30}$ Average</th>
<th>$D_{30}$ High</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural Freeway</td>
<td>52.3</td>
<td>54.8</td>
<td>57.3</td>
<td>1.73</td>
</tr>
<tr>
<td>Rural Arterial</td>
<td>51.1</td>
<td>58.1</td>
<td>79.6</td>
<td>6.29</td>
</tr>
<tr>
<td>Urban Freeway</td>
<td>50.4</td>
<td>55.8</td>
<td>61.2</td>
<td>4.11</td>
</tr>
<tr>
<td>Urban Arterial</td>
<td>50.8</td>
<td>57.9</td>
<td>67.1</td>
<td>4.60</td>
</tr>
</tbody>
</table>

Source: FDOT Project Traffic Forecasting Handbook
Estimating Intersection Turning Movement Volumes

• Several methods of developing turning movement volumes are discussed in the FDOT Project Traffic Forecasting Handbook.

• Travel demand models can be used to generate turning movement volumes. It is advisable to check reasonableness of model projected turns before using the results.

• Intersection balancing techniques are also used to develop intersection turning movement volumes.

• Intersection balancing algorithms use existing turning movement counts to generate future turning movement volumes.

• NCHRP Report 255, Highway Traffic Data for Urbanized Area Project Planning and Design (now out of print), discusses post processing of travel demand model outputs and developing turning movement volumes (Turns W32 Software, available online at www.dowlinginc.com).
Majority of the FDOT districts use TURNS5, a spreadsheet based intersection turning movement balancing tool, for developing intersection turning movement volumes.

TURNS5 is designed to develop future turning volumes based on existing AADT (turn volumes) and growth rates or existing AADT (turn volumes) and future year AADT (from the travel demand model).

Other FDOT tools/ methods – TURNS3, TMTOOL (District Four), TURNFLOW, District Two Manual Method.
Future Conditions – Estimating Intersection Turning Movement Volumes (Continued)

Example from TURNS5

To obtain a copy of TURNS5 contact Nabeel Akhtar at nabeel.akhtar@dot.state.fl.us
Equivalent Single Axle Loading (ESAL) Forecast

- Involves truck forecasting for use in pavement design
- Required for all resurfacing, new construction, and reconstruction projects

ESAL analysis tool is used for 18-KIP (80-kN) ESAL forecasts. To obtain a copy of the tool contact Nabeel Akhtar at nabeel.akhtar@dot.state.fl.us
Training Information

• For information on FDOT travel demand modeling workshops, visit http://www.dot.state.fl.us/planning/systems/stm/training/default.htm. Contact Sandy Colson at sandy.colson@dot.state.fl.us (850-414-4937) for additional information. Also visit the recently launched modeling web portal at http://www.fsutmsonline.net/modeling_training.aspx. The web portal is currently under development and is intended for sharing information (model documentations, model downloads, travel data, training information, Model Task Force activities, modeling research, etc.) within the Florida modeling community.

• For information on level of service training, visit http://www.dot.state.fl.us/planning/systems/sm/los/default.htm#training Contact Martin Guttenplan at 850-414-4906 for more information.

• For information on traffic data maintained by the FDOT TranStat office, contact James W. Golden at (850-414-4848)

• For information on FDOT TranStat Workshop, visit http://www.dot.state.fl.us/planning/transtat/default.htm
For Further Information Related to this Resource Guidebook, Please Contact:

John Zielinski
Intermodal Systems Supervisor
133 S. Semoran Blvd.
Orlando FL 32807
407-482-7868  SC 335-7868
FAX 407-275-4188
john.zielinski@dot.state.fl.us

Mansoor Khuwaja or Santanu Roy
HDR Engineering, Inc.
315 E Robinson Street, Suite 400
Orlando, FL 32801-1949
Phone: (407) 420-4200
mansoor.khuwaja@hdrinc.com
santanu.roy@hdrinc.com