Ohio Traffic Forecasting Manual

Module 2: Traffic Forecasting Methodologies
Training Organization

Module 1: Traffic Forecasting Background
Policy, Administrative and Technical Overview

Module 2: Traffic Forecasting Methodologies
Data and Parameters, Step-by-Step Procedures, Examples

Module 3: Travel Demand Forecast Modeling
Model Selection, Checks and Refinements

Intended Audience
Forecast User
Traffic Forecaster/Modeler
Outline - Part II

- High Risk Design Traffic
  - Review of ODOT Policies
  - Fundamentals of Modeling
  - NCHRP Spreadsheet Adjuster Tool
  - Best Practice Guidance

- Low Risk Design Traffic Procedures
  - Linear Regression
  - Other Methods

- Documentation Guidelines
Documentation and Coordination

Throughout this training, the following symbols indicate:

- **Items that are required or suggested for documentation**

- **Items that are required or suggested for coordination with ODOT M&F**
HIGH RISK DESIGN TRAFFIC

Review of ODOT Policies
RISK-BASED TRAFFIC FORECASTING

Traffic forecasts for more complex projects are considered **high risk**.

- Usually require TDF modeling as a basis
- Design traffic is obtained through a more labor-intensive post-processing effort
- Results may require certification from ODOT M&F (Certified Design Traffic)
HIGH-RISK PROJECTS

- Classified as PDP Path 4 or 5
- Add/remove through lanes
- Add/remove a road
- Add/remove interchange or ramp connections
- Require an IMS/IJS
- Involve land use changes that would meet the criteria for a Level 2 TIS per the State Highway Access Management Manual (SHAMM)
- Any project involving tolling, managed lanes or ITS/connected vehicle technology
Projects that require Certified Design Traffic often involve multiple parties. An **Early Coordination Meeting** is held to ensure that all parties agree on forecast scoping items:

- Study Area
- Analysis Year(s) and Time Periods (i.e. AM, PM)
- Project Alternatives
- Existing count data availability; need for new count data
- Model availability and applicability; need for project level modeling
- Other considerations, such as previous forecast attempts or studies
- Forecast Assignment
- Project Schedule

At a minimum, meeting participants include representatives from ODOT M&F and the District.
Assemble Count Data from Available Sources

Meet Data Collection Guidelines?  
Yes → Estimate AADT Volumes
No → Collect New Data

Collect New Data

Estimate AADT Volumes

Select System Peak Hour

Check/Balance Existing Volume Set(s)

Select K and D Factors

Obtain TDF Model Results

Forecast Link Volumes

Turning Movement Forecasts Needed?  
Yes → Forecast Turning Movement Volumes
No → Design Forecast

Design Forecast

Balance Forecast Volume Set(s)
HIGH RISK DESIGN TRAFFIC
Fundamentals of Modeling
Travel Demand Forecasting (TDF) Models

- Computer-based model used to estimate travel patterns at a future time
- Used when interaction between road network, land-use, and socioeconomic data is complex

Screenshot, Ohio Statewide TDF Model

Model of Record provides default set of raw model traffic forecasts
Error is intrinsic to all TDF model forecasts. **There is no perfect TDF model.**

Even the best models usually do not have the level of temporal and spatial detail needed for project forecasts.

The anticipated error can be reduced by completing a number of checks prior to running the model.

- Covered in Volume 3/Module 3

Model results should be adjusted in relation to realistic constraints and with available traffic count data.
Temporal Relationship

TDF Model Results are usually provided for at least two points in time:

- **Model Base Year** represents existing land uses, road network, and population characteristics at the time it was developed.
- **Model Forecast Year** represents expected land uses, road network, and population characteristics at some point in the future.
- **Model Opening Year** may also be supplied if project-specific modeling is being conducted.
Temporal Relationship

The year for which project count data are available (i.e. Count Year) typically falls between the Model Base Year and the Model Opening Year. However, so long as the count year is within a few years of the model base year, it can be used to adjust the model results whether before or after the model base year. If project count data are more recent than this, then the “recent counts” feature of the adjustment process will be used and it is necessary that those counts adhere to this temporal relationship.
Model adjustments are based on the comparison between traffic counts and Model Base Year Assignments.

Adjustment method options:

1. **Difference** = \( \text{Count} - \text{Model Count Year Assignment} \)

2. **Ratio** = \( \frac{\text{Count}}{\text{Model Count Year Assignment}} \)

3. **Model Growth Ratio (MR)** = \( \frac{\text{Model Count Year Assignment}}{\text{Design Year Model Assignment}} \)

The Difference, Ratio, and Model Growth Ratio are used to calculate the **Modified Ratio**.
GENERAL PROCEDURE FOR MODEL ADJUSTMENT

Assemble Count Data and Model Assignments

Use Difference

Ratio < 2?

Yes

Model Growth Ratio < 1?

Yes

Ratio <= 1?

Yes

Use Average (Difference, Ratio)

No

Use Average (Difference, Modified Ratio)

No

Use Modified Ratio

Yes

Ratio <= 0.5?

Yes

Use Modified Ratio

No

Use Average (Difference, Modified Ratio)
**General Procedure for Model Adjustment**

1. Interpolate line between Model Base Year Assignment \((A)\) and Model Design Year Assignment \((B)\).

\[
\text{A} = \text{Model Base Year Assignment} \\
\text{B} = \text{Model Forecast Year Assignment}
\]
2. Identify the Count Data and the year in which it was collected (C).

Find the Interpolated Count Year Model Assignment (1) along line (A)-(B).

A = Model Base Year Assignment
B = Model Forecast Year Assignment
C = Count Data
1 = Interpolated Count Year Model Assignment
**GENERAL PROCEDURE FOR MODEL ADJUSTMENT**

3. Calculate **Adjustment** by comparing the Interpolated Count Year Model Assignment (1) to the actual Count Data (C).

Apply the same **Adjustment** to the Model Forecast Year Assignment (B) to obtain the Model Forecast Year AADT (2).

Adj. is calculated from either Difference, Ratio, or Modified Ratio Method.

Adj. = Selected Difference Adjustment

A = Model Base Year Assignment
B = Model Forecast Year Assignment
C = Count Data

1 = Interpolated Count Year Model Assignment
2 = Model Forecast Year AADT
GENERAL PROCEDURE FOR MODEL ADJUSTMENT

4. Interpolate line between Count Data (C) and Model Forecast Year AADT (2).

Adj. = Selected Difference Adjustment
A = Model Base Year Assignment
B = Model Forecast Year Assignment
C = Count Data
1 = Interpolated Count Year Model Assignment
2 = Model Forecast Year AADT

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5. Find the Interpolated Project Opening Year AADT (3) and Project Design Year AADT (4) along line (C)-(2).

Adj. = Selected Difference Adjustment
A = Model Base Year Assignment
B = Model Forecast Year Assignment
C = Count Data
1 = Interpolated Count Year Model Assignment
2 = Model Forecast Year AADT
3 = Interpolated Project Opening Year AADT
4 = Interpolated Project Design Year AADT
HIGH RISK DESIGN TRAFFIC
NCHRP Spreadsheet Adjuster Tool
**Spreadsheet Adjuster Tool**

ODOT M&F has created a Microsoft Excel spreadsheet for adjusting TDF model forecasts.

<table>
<thead>
<tr>
<th>Worksheet Tab Name</th>
<th>Description</th>
<th>Design Traffic Outputs</th>
</tr>
</thead>
<tbody>
<tr>
<td>TOC</td>
<td>Description of each of the tabs included in the spreadsheet.</td>
<td>-</td>
</tr>
<tr>
<td>Regression</td>
<td>Utilized to perform a regression analysis using historic AADT and B&amp;C counts for each intersection leg.</td>
<td>AADT Link Forecasts, Opening Year and Design Year</td>
</tr>
<tr>
<td>NCHRP255_link</td>
<td>Adjusts daily TDF forecasts at the link level and establishes link growth rates.</td>
<td>AADT Link Forecasts, Opening Year and Design Year</td>
</tr>
<tr>
<td>PM_turns</td>
<td>Calculates Design Hour intersection turning movement forecasts (assumed PM).</td>
<td>PM DHV Turning Movement Forecasts, Opening Year and Design Year Design Designations: K, D, T24, TD</td>
</tr>
<tr>
<td>AM_turns</td>
<td>Calculates Design Hour intersection turning movement forecasts for an alternate design hour (assumed AM).</td>
<td>AM DHV Turning Movement Forecasts, Opening Year and Design Year</td>
</tr>
<tr>
<td>24_turns</td>
<td>Calculates AADT intersection turning movement forecasts.</td>
<td>AADT Turning Movement Forecasts, Opening Year and Design Year</td>
</tr>
<tr>
<td>IX_Plates</td>
<td>Four-legged intersection plate template that is populated automatically with forecast results.</td>
<td>-</td>
</tr>
</tbody>
</table>

The current version of the spreadsheet tool is titled “nchrp255_revised_volume_adjuster_v7 w_ix_diagram.xlsx”
**Link AADT Estimation (NCHRP Link Tab)**

By default, four (4) rows are shown for link forecasts. Additional rows are hidden, with ten (10) total rows. User can copy & paste rows if more are needed. Yellow cells are generally required, green are optional.

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>AD</th>
</tr>
</thead>
<tbody>
<tr>
<td>USER INPUT</td>
<td>OPTIONAL INPUT</td>
<td>FINAL Refined Forecast</td>
<td>COL</td>
<td>COL</td>
<td>COL</td>
<td>COL</td>
<td>COL</td>
<td>COL</td>
<td>COL</td>
</tr>
<tr>
<td>road/link</td>
<td>in</td>
<td>Dia</td>
<td>RUse SL</td>
<td>near base model</td>
<td>count year</td>
<td>count data</td>
<td>Ab</td>
<td>Ab_interpolate</td>
<td>Af-D</td>
</tr>
<tr>
<td>(east leg)</td>
<td>0.5</td>
<td>2</td>
<td>Enable</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(north leg)</td>
<td>0.5</td>
<td>2</td>
<td>Enable</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(west leg)</td>
<td>0.5</td>
<td>2</td>
<td>Enable</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(south leg)</td>
<td>0.5</td>
<td>2</td>
<td>Enable</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

There are hidden rows if you want more roads in your intersection/screenline.

<table>
<thead>
<tr>
<th>Year</th>
<th>Model Base</th>
<th>Model Opening (opt)</th>
<th>Model Forecast</th>
<th>Project Opening</th>
<th>Project Design</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>if Yo=Yb then also must = Yc (col4)</td>
<td>must be &gt; Yb</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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1. Enter model years and project years under Column B/COL 1.
   - Model years provided by modeler
   - Model Opening Year is special case
   - Project years determined at Early Coordination Meeting

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>AD</th>
</tr>
</thead>
<tbody>
<tr>
<td>USER INPUT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OPTIONAL INPUT</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FINAL Refined Forecast</td>
<td>COL</td>
<td>COL</td>
<td>COLCOL</td>
<td>3.5</td>
<td>COL</td>
<td>COL</td>
<td>COL</td>
<td>COL</td>
<td>COL</td>
<td>COL</td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Road/Link</td>
<td>(east leg)</td>
<td>0.5</td>
<td>2</td>
<td>Enable</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(north leg)</td>
<td>0.5</td>
<td>2</td>
<td>Enable</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(west leg)</td>
<td>0.5</td>
<td>2</td>
<td>Enable</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(south leg)</td>
<td>0.5</td>
<td>2</td>
<td>Enable</td>
<td></td>
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<td>Total</td>
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<td></td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Model Base</td>
<td>2010</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model Opening (out)</td>
<td></td>
<td>2040</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Model Forecast</td>
<td></td>
<td>2040</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project Opening</td>
<td></td>
<td>2020</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Project Design</td>
<td></td>
<td>2040</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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2. Enter road names for each link under Column B/COL 1.
   - Intersection approaches for turning movement forecasts
   - Parallel facilities for screenline analysis
   - Ramps, freeway segments
   - Note that the leg names in column A pertain to intersections but the sheet can be used for any grouping of forecast segments

These example inputs are for a four-legged intersection
3. Enter year of Near Base Model Count Data in Column F/COL 4.
The count year and AADT contained in COL 4/5 should be from a year that is relatively close to the Model Base Year (usually within a few years) --- not always the most recent count data that are available.

<table>
<thead>
<tr>
<th>Year</th>
<th>Model Base Year</th>
<th>Count Year</th>
<th>Near Base Model Year</th>
<th>Data entered in COL 4/5</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td></td>
<td></td>
<td></td>
<td>Data entered in COL 4/5</td>
</tr>
<tr>
<td>2016</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The most recent count data is used in later steps.
The spreadsheet uses interpolation trend lines to move the Base Model to the Count Year. This value is shown in Column I/COL 7. So, the Count Year can be before or after the Model Base Year. A one or two year difference is safe; three to five might be ok; more than five is less certain. You should know the area and its development and evaluate the effect of the interpolation.

If project counts are for a year significantly more recent than the Base Year, either update the Model Base Year during project modeling (as discussed in Manual 3) or use the Recent Counts fields shown later. These apply a less detailed adjustment to ensure the forecast growth from the model is in line with the growth implied by the newer counts.
4. Enter Near Base Model AADT for each link in Column G/COL 5.
5. Enter Model Base Year Assignment for each link in Column H/COL 6.
6. If provided, enter Model Opening Year Assignments.
   - By default, Columns J-AC (COL 7.1-13) are hidden
   - Opening Day No Build = Column N/COL 8a
   - Opening Day Build = Column V/COL 8b
Adjusted model year volumes are always pushed to count and forecast year values along interpolation lines.

If the project causes a large change in traffic, Opening Year No Build & Build traffic are needed to reflect this discontinuity and keep the trend lines correct.

**Adj.** = Selected Difference Adjustment

A = Model Base Year Assignment  
B = Model Forecast Year Assignment  
C = Count Data  
D = Model Opening Year No Build Assignment  
E = Model Opening Year Build Assignment

1 = Interpolated Count Year Model Assignment  
2 = Model Forecast Year AADT  
3 = Model Opening Year AADT  
4 = Interpolated Project Opening Year AADT  
5 = Interpolated Project Design Year AADT

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**MODEL OPENING YEAR INPUTS**

**Scenario 1 (Most Common):**
- No Model Opening Year No Build & Build Assignments
- Interpolations between Count and adjusted Forecast Year Assignment (still get interpolated Open Year Forecast)

**Scenario 2:**
- Model Opening Year No Build Assignments Only
- Use with Model Forecast Year No Build Scenario
- Could use with Build but not usually

**Scenario 3:**
- Model Opening Year No Build & Build Assignments
- Separate interpolation lines pre/post open year

**Scenario 4:**
- Model Opening Year Build Assignments Only
- **NOT USED** unless considering new links that do not exist for No Build condition
7. Enter Model Design Year Assignment for each link in Column AD/COL 8.
8. If applicable (recent counts much newer than base year), enter year of Most Recent Count Data under Column AL/COL 14.

Note: this year must be between (inclusive) the base year and the opening year.
9. If applicable, enter Most Recent AADT for each link under Column AM/COL 15.
**Most Recent Count Adjustment**

Further adjusts the interpolated future year forecasts using the difference from the most recent count data.

Simpler adjustment that just compares the adjusted model based trend lines in the recent count year and just shifts everything by the delta.

Adj. = Selected Difference Adjustment

A = Model Base Year Assignment
B = Model Forecast Year Assignment
C = Count Data
D = Most Recent Count Data

1 = Interpolated Count Year Model Assignment
2 = Model Forecast Year AADT
3 = Interpolated Project Opening Year AADT
4 = Interpolated Project Design Year AADT
10. Find Project Opening Year and Design Year Forecasts in Columns AO-AP/COL 17-18.

- Growth factors in Columns AQ-AR/COL 19-20 are referenced for intersection turning movement forecasts.
- Linear annual growth rates in Column AS/COL 21 are used as a forecast check --- link growth rates greater than 3% per year are highlighted in red.
## Optional Capacity Adjuster (NCHRP Link Tab)

The optional capacity adjuster can be used for screenline traffic forecasts when:

1. A link’s forecasted volume exceeds its capacity, AND
2. There are other parallel roads that could reasonably absorb some of the growth

Enter the total link capacity of each screenline road in Column AU. This is the Daily Capacity and is usually 10x Hourly.
The design year AADT (33,492 vpd) > total link capacity (25,000 vpd) for US-42.

- The design year AADT is limited to 25,000 vpd
- The unserved volume is 33,492 - 25,000 = 8,492 vpd
- 8,492 vpd is distributed amongst the other screenline roads as a proportion of their remaining capacity
TURNING MOVEMENT ESTIMATION (PM_TURNS TAB)

- Use PM_Turns tab for highest peak hour (if AM, change name of sheet and cell B2)
- By default, inputs are shown for an intersection with four (4) legs
- Can unhide additional rows/columns for up to six (6) legs
- For intersections with three (3) legs only, leave inputs blank for non-existent leg

Complete NCHRP_link tab prior to turns tabs for establishing link growth rates
TURNING MOVEMENT ESTIMATION (PM_turns Tab)

1. Enter intersection name and peak hour information in Rows 1&2.
   - If AM > PM, change tab name and adjust information in Row 2.

Always use the PM_turns tab for the highest peak hour, even if AM is higher than PM.
2. Enter AADT for each approach in Column G.
   - Use the AADT associated with the turning movement count
   - Usually an estimated value from partial day count
3. Enter daily B&C volume for each approach in Column H.
   - Used to calculate TD and T24 only
   - Not necessary for turning movement forecasting procedures
TURNING MOVEMENT ESTIMATION (PM turns Tab)

5. Enter peak hour turning movement counts for each approach in Columns G-L.
   - If classified volumes are not available, leave Columns J-L blank and enter total volumes in G-I.
   - If 15-minute volumes are not available, enter hourly volumes in the first row only.
### Turning Movement Inputs

**Scenario 1:**
- Classified traffic count data
- Summarized in 15-minute intervals

<table>
<thead>
<tr>
<th>E LEG</th>
<th>LT (S)</th>
<th>THRU (W)</th>
<th>RT (N)</th>
<th>LT (S)</th>
<th>THRU (W)</th>
<th>RT (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5:00 PM</td>
<td>35</td>
<td>177</td>
<td>26</td>
<td>0</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>5:15 PM</td>
<td>30</td>
<td>213</td>
<td>27</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>5:30 PM</td>
<td>34</td>
<td>219</td>
<td>23</td>
<td>0</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>5:45 PM</td>
<td>29</td>
<td>202</td>
<td>25</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>total</td>
<td>128</td>
<td>811</td>
<td>101</td>
<td>2</td>
<td>10</td>
<td>1</td>
</tr>
</tbody>
</table>

**Scenario 2:**
- Unclassified traffic count data
- Summarized in 15-minute intervals

<table>
<thead>
<tr>
<th>E LEG</th>
<th>LT (S)</th>
<th>THRU (W)</th>
<th>RT (N)</th>
<th>LT (S)</th>
<th>THRU (W)</th>
<th>RT (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5:00 PM</td>
<td>35</td>
<td>180</td>
<td>26</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5:15 PM</td>
<td>30</td>
<td>215</td>
<td>27</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5:30 PM</td>
<td>34</td>
<td>223</td>
<td>23</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5:45 PM</td>
<td>29</td>
<td>203</td>
<td>25</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>total</td>
<td>128</td>
<td>821</td>
<td>101</td>
<td>0</td>
<td>0</td>
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</tr>
</tbody>
</table>

**Scenario 3:**
- Classified traffic count data
- Summarized in hourly intervals

<table>
<thead>
<tr>
<th>E LEG</th>
<th>LT (S)</th>
<th>THRU (W)</th>
<th>RT (N)</th>
<th>LT (S)</th>
<th>THRU (W)</th>
<th>RT (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5:00 PM</td>
<td>128</td>
<td>811</td>
<td>101</td>
<td>2</td>
<td>10</td>
<td>1</td>
</tr>
<tr>
<td>5:15 PM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5:30 PM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5:45 PM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>total</td>
<td>128</td>
<td>811</td>
<td>101</td>
<td>2</td>
<td>10</td>
<td>1</td>
</tr>
</tbody>
</table>

**Scenario 4:**
- Unclassified traffic count data
- Summarized in hourly intervals

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<tr>
<th>E LEG</th>
<th>LT (S)</th>
<th>THRU (W)</th>
<th>RT (N)</th>
<th>LT (S)</th>
<th>THRU (W)</th>
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<tbody>
<tr>
<td>5:00 PM</td>
<td>130</td>
<td>821</td>
<td>102</td>
<td></td>
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<td></td>
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<tr>
<td>5:15 PM</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>5:30 PM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5:45 PM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>total</td>
<td>130</td>
<td>821</td>
<td>102</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
6. Enter selected K-factors for each approach in Column M.
   - Consider calculated DHV factors in Column N (should be ≥ 1.0)

K-factors may be selected using the Statewide Average DHV Factor, Proxy K-factors, or using long-term count data

If a Statewide Average DHV Factor is selected, enter an equation with the DHV Factor. (See Slide 82.)
7. If applicable, enter link volume forcing inputs in Columns AT-BH, Rows 19-27.
   - Used to match directional link volumes from an adjacent intersection

<table>
<thead>
<tr>
<th>AR</th>
<th>AS</th>
<th>AT</th>
<th>AU</th>
<th>AV</th>
<th>AW</th>
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<th>AY</th>
<th>AZ</th>
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</tr>
</tbody>
</table>

Optional Link Volume Forcing
Open Year
1. leq 2(north)
   In  Out
2. leq 3(west)
   Out  In  1000  Out
   In  500
3. leq 5(up)
   In  Out
4. leq 4(south)
   Out  In

Design Year
5. leq 2(north)
   In  Out
6. leq 3(west)
   Out  In  leq 5(down)
   In  leq 3(west) Out
   In  1100
   Out  650
7. leq 5(up)
   In  Out
8. leq 4(south)
   Out  In

Link volume forcing should be limited to one or two legs; never use on all intersection approaches!
TURNING MOVEMENT ESTIMATION (PM TURNS TAB)

8. If applicable, enter TDF model turn inputs in Rows 63-125.
   ▪ Same procedure as NCHRP_link tab, except for individual turning movements.
Model turn movements are usually not validated and should be used only when necessary, unless Refined Alternative Level traffic has been developed.

- Typically only used for project Build conditions that significantly affect travel patterns
- Common application is for new road
- Can be used for No Build condition to check model results
Model Turn Movement Inputs

Model Period to Hour Factor (Cell G72)

- Model periods usually represent more than one hour of day
- Factor scales down model period volumes to peak hour volumes
- Usually provided by modeler
- If not provided, example values for OMS models are shown in Column L
- If you enter hourly model turn movements, the factor is 1.0, you can obtain hourly values by:
  - Using a model that worked at this level. None of the standard Model of Records are, but sometimes during development of Refined Alternative Level traffic this is the case.
  - Using the INT turning movements file and checking the hourly volumes box as shown later
Model Turn Movement Inputs

“Type” (Column M)

- **Both** - Utilizes both travel demand model results and traffic counts
- **Count** - Use of count data only with link growth rates (the standard process when model turns aren’t provided)
- **Model** - Utilizes the travel demand model values directly (Can also be used to force the forecast to a specific value. Most typically this value is 0, i.e. the movement is not allowed for this scenario.)

- Allows user to quickly evaluate the impact of model turn movements without changing inputs
- The process is generally clever enough to deal with common special cases without the need to flip these toggles. (Example: if there are no Counts or No Build Volumes but there are Build Volumes for a turn the spreadsheet will employ the “Model” process whether toggled or not.)
**Example: SR 18 at Mitchell Rd.**

1. Open the Assigned Highway Network
2. Post link info if desired.
Example: SR 18 at Mitchell Rd.

3. Go to the Intersections Tab -> Choose Turn Volume File from the Intersection Files box

4. Choose the appropriate file: MPOyrJTURNSpdSCEN
Example is 2008 PM, N. Bal.
EXAMPLE: SR 18 AT MITCHELL RD.

5. Click on desired node.

6. Hit F3 (or select the “Display Volumes...” tool from the ribbon) to bring up the turning movements.
**Example: SR 18 AT MITCHELL RD.**

7. Click on any cell in Cube to see the movement.

8. Enter turning movements into the spreadsheet
**Example: SR 18 at Mitchell Rd.**

9. Continue entering for the rest of the movements

10. Edit the Model Period to Hour Factor. **Note** that this varies by Model and by Period.

This factor is the Model Peak Hour/Model Period factor. Ask the MPO or ODOT if you are not sure what this value should be.
**Example: SR 18 at Mitchell Rd.**

You can also use the Intersection File (.int) if a Junction Assignment was run.

3. Go to the Intersections Tab -> Choose Output File from the Intersection Files box

4. Choose the appropriate file: MPOyrJTURNSpdSCEN
   Example is 2008 PM, N. Bal.
EXAMPLE: SR 18 at Mitchell Rd.

5. Click on desired node.

6. Click the Intersection button in the top right of the node pop-up. This brings up the intersection.
Example: SR 18 at Mitchell Rd.

7. All movements are displayed directionally.
8. Enter turning movements into the spreadsheet.

Ohio Traffic Forecasting Manual
**Example: SR 18 at Mitchell Rd.**

Note that turning movements are available by class. By default, all movements are selected.

If you select a specific Volume, you must click off Combined Volume, else you are double counting.

Note the double volume.
EXAMPLE: SR 18 at Mitchell Rd.

10. You are able to check the Hourly units box at the bottom to turn the period volume to a peak hour volume. If you do this, you need to place a “1” in the Model Period to Hour Factors box on the spreadsheet.
NOTES

- .dbf files are available for all period and for 24 hours
- .int files are only available by period
- Hence, you may want to use the .dbf files for the 24_turns sheet
EXERCISE #2: OBTAINING MODEL TURN MOVEMENTS

Open the following spreadsheet:

Vol 2 Ex #2 - CUBE Turning Movements.xlsx

Using the turning movements from the previous slides, fill in the N LEG 2008 (Base Year) turning movements on the PM_turns sheet.

Enter 0.260 as the Model Period to Hour Factor.
9. Find Project Opening Year and Design Year Turning Movement Forecasts in Rows 316-426.

- Rows for five- and six-legged intersections are hidden
**Iterative Proportional Fitting (IPF)**

IPF is used to balance traffic entering and exiting the intersection until a convergence is reached.

- Up to 10 iterations
- Convergence check is found in Columns O & BL
- If convergence ($\pm 10\%$) is not reached, cells are highlighted in red

Check and reassess inputs if link volumes do not converge within $\pm 10\%$. 
OTHER TABS

AM_turns and 24_turns Tabs

- Enter inputs following the PM_turns tab procedure
- Several inputs are referenced from the PM_turns sheet and do not need to be re-entered

IX_Plates Tab

- Plate template for standard four-legged intersection
- Values are populated automatically with forecasts from other tabs
- You have to make your diagrams manually for 5/6 approach intersections
**SPREADSHEET SETUP**

**Multiple vs. Single Forecast Sheets**
- Separate workbook should always be created for different project alternatives (No Build and Build)
- Link only forecasts can be combined on one sheet (common application is ramp/freeway segments and screenlines)
- For turning movement forecasts, use a single worksheet for each intersection

**Zero and Blank Values**
- Removal of existing link - values coded as **zero** in Build condition
- New links/movements - values coded as **blank** in No Build condition

*Zero and blank values are treated differently by the tool; if unsure, check both.*
EXERCISE
Standard NCHRP Adjuster Inputs
This is a continuation of the Data Processing Exercise. Certified Design Traffic has been requested for three (3) intersections. The study area is pictured below and includes a diamond interchange and an adjacent t-intersection.
**Exercise #3: Standard NCHRP Adjuster Inputs**

Open the following spreadsheet:

Vol 2 Ex #3 - Standard NCHRP Adjuster Inputs.xlsx

This spreadsheet will develop forecasts for the diamond interchange in the Data Processing exercise. We will cover standard spreadsheet operation including:

1. **NCHRP255_link Tab**
   - Model/Project Year Inputs
   - Count Data Inputs
   - Model Inputs
   - Growth Rate Check

2. **PM_turns Tab**
   - K-Factor Inputs
   - Convergence Check
   - Volume Overrides
EXERCISE #3: STANDARD NCHRP ADJUSTER INPUTS

Tab #1: NCHRP Link - Model/Project Year Inputs

The anticipated Project Opening Year is 2020 and the Project Design Year is 2040. Compare this information to the values in Cell B26 and Cell B27.

If the modeler provides forecasts for 2015 and 2035, what are the inputs for Cell B23 and Cell B25?
EXERCISE #3: STANDARD NCHRP ADJUSTER INPUTS

Tab #1: NCHRP Link - Model/Project Year Inputs

The anticipated Project Opening Year is 2020 and the Project Design Year is 2040. Compare this information to the values in Cell B26 and Cell B27.

If the modeler provides forecasts for 2015 and 2035, what are the inputs for Cell B23 and Cell B25?

Cell B23 = 2015
Cell B25 = 2035

Leave Cell B24 (Model Opening Year) blank unless opening year model runs are provided.
EXERCISE #3: STANDARD NCHRP ADJUSTER INPUTS

Tab #1: NCHRP Link - Count Data Inputs

Note how the filled in values in Cells G10-G12 compare to the AADT values in the Diamond Interchange Conversion Exercise. Fill in the count AADT for the south leg of the “intersection” in Cell G13. (See Exercise#1 diamond solution)
**EXERCISE #3: STANDARD NCHRP ADJUSTER INPUTS**

**Tab #1: NCHRP Link - Count Data Inputs**

Note how the filled in values in **Cells G10-G12** compare to the AADT values in the Diamond Interchange Conversion Exercise. Fill in the count AADT for the south leg of the “intersection” in **Cell G13**.

Notice how the Model Base Year assignment is adjusted to the count year in Column I/COL 7.
EXERCISE #3: STANDARD NCHRP ADJUSTER INPUTS

Tab #1: NCHRP Link - Model Inputs

The unadjusted Design Year TDF model results are pictured to the right. Using this information, fill in the design year assignment for the east leg of the “intersection” in Cell AD10.
EXERCISE #3: STANDARD NCHRP ADJUSTER INPUTS

Tab #1: NCHRP Link - Model Inputs

The unadjusted Design Year TDF model results are pictured to the right. Using this information, fill in the design year assignment for the east leg of the “intersection” in Cell AD10.
**Exercise #3: Standard NCHRP Adjuster Inputs**

Tab #1: NCHRP Link - Growth Rate Check

Column AS/COL 21 contains the resulting growth rates for each link. Cell AS11 is highlighted in red because the linear annual growth rate is over 3%.

The forecaster may find the growth rate to be reasonable, but a note will be made on the final forecast plates.
EXERCISE #3: STANDARD NCHRP ADJUSTER INPUTS

Tab #2: PM Turns - K-Factor Inputs

The K-Factors have been filled into Cells M6-M9. Verify that these values produce the DHV values in the Data Processing Exercise (Exercise #1 K Factor Solution). Note the resulting DHV factors in Cells N6-N9.
EXERCISE #3: STANDARD NCHRP ADJUSTER INPUTS

Tab #2: PM Turns - K-Factor Inputs

As an alternative to entering K-Factors, the forecaster may directly input the DHV factor in Cells M6-M9. This requires using formulas in these cells.

Enter an equation using a value of 1.10 (from the Peak Hour to Design Hour Factor Report) in Cell M6 and Cell M8 and 1.09 in M7 and M9. Highlight the cells to indicate that the formula has been changed.

= existing “K” * DHV Factor
EXERCISE #3: STANDARD NCHRP ADJUSTER INPUTS

Tab #2: PM Turns - K-Factor Inputs

Note how this changes the forecasts in Rows 361-374.
EXERCISE

NCHRP Adjuster Inputs for Special Cases
NCHRP Adjuster Inputs for Special Cases

1. Link Volume Forcing
2. Removal of an existing link
3. Incomplete model assignment data
4. 5/6 leg intersection
5. New intersection on existing link
6. Using Model Opening Year as Model Base Year
7. Additional Functionality for Parallel Roads
   ▪ Screenline Ratio Method
   ▪ Optional Capacity Adjuster
EXERCISE #4: LINK VOLUME FORCING

Open the following spreadsheet:
Vol 2 Ex #4 - Standard NCHRP Adjuster Inputs.xlsx

For this project, forecasts developed for Intersection #3 should be held constant.

Opening Year PM Forecasts

Ohio Traffic Forecasting Manual
Exercise #4: Link Volume Forcing

Enter circled values in Cells AX24-AX25.

Optional Link Volume Forcing
Open Year

Use this to force your forecast to match a link volume total from an adjacent intersection

Opening Year PM Forecasts

Ohio Traffic Forecasting Manual
Exercise #4: Link Volume Forcing

Tab #2: PM Turns - K-Factor Inputs

Note how this changes the Opening Year forecasts in Rows 361-374.
**Removal of an Existing Link**

**NCHRP_link Tab**

- For removed link, enter “0” for
  - Opening Day Build Assignment (Column V/COL 8b)
  - Design Year (Build) Assignment (Column AD/COL 8)

Zero and blank values are treated differently by the tool.
Removal of an Existing Link

PM_turns, AM_turns, and 24_turns Tabs

- Enter model turn inputs (Rows 63+)
- For movements to/from removed link, choose Type = Model (Column M)
- Other legs may use any Type setting; check for desired results
**Removal of an Existing Link**

Check that turn movement forecasts accurately reflect Build conditions
EXERCISE #5: REMOVAL OF EXISTING LINK

Open the following spreadsheet:
Vol 2 Ex #5 - Removal of Existing Link.xlsx

For this project, an existing four-legged intersection will be converted to a three-legged intersection by removing the west leg.
Tab #1: NCHRP Link
Notice that the value in Cell V12 (Opening Year “build” model assignment) is blank, not zero. Even though the Design Year model assignment is set to zero (cell AD12), the forecasts in Cells AO12-AP12 are greater than zero.
EXERCISE #5: REMOVAL OF EXISTING LINK

Tab #1: NCHRP Link

Enter “0” in Cell V12 and see how the forecasts change.
EXERCISE #5: REMOVAL OF EXISTING LINK

Tab #1: NCHRP Link

Enter “0” in Cell V12 and see how the forecasts change.

Opening Year Build Assignment
Left Blank

Remember, blank means “ignore.” A blank Opening Year Build means the non-zero Opening Year No Build input was used as the interpolation point for finding the Project Year Volumes.
Tab #2: PM Turns

Model turn movements were provided to reflect the change in travel patterns from the link removal, as entered in Exercise 2.

By default, Cells M77-M102 are set to use both count data and model turn movements in developing forecasts. However, this results in non-zero volumes on the removed west leg of this intersection.
EXERCISE #5: REMOVAL OF EXISTING LINK

Tab #2: PM Turns

For movements to/from the removed leg, change the setting in Column M to “Model” and note how this changes the forecast.
Exercise #5: Removal of Existing Link

Tab #2: PM Turns

For movements to/from the removed leg, change the setting in Column M to “Model” and note how this changes the forecast.

Also note the change in the convergence.
INCOMPLETE MODEL ASSIGNMENT DATA

NCHRP_link Tab

- For a link that is not represented in the model, manually override Opening Year and Design Year growth factors (Columns AQ&AR/Col 19&20)
- Growth factors can be estimated using linear regression, etc.
- Override formulas to calculate Opening Year and Design Year Forecasts (Columns AO&AP/Col 17&18) as follows:

\[ AADT_{Forecast} = AADT_{Count} \times Growth \ Factor_{Forecast} \]

Manually overridden formulas must be highlighted or otherwise indicated within spreadsheet.
Open the following spreadsheet: 
*Vol 2 Ex #6 - Incomplete Model Assignment Data.xlsx*

This project includes forecasts for a four-legged intersection that is being converted to a five-legged intersection. For the existing intersection, model assignments are not available on the south leg.
**Exercise #6: Incomplete Model Assignment Data**

Tab #1: NCHRP Link - 5/6 Leg Inputs

Unhide **Rows 13-19** to reveal the inputs for the new fifth leg.

<table>
<thead>
<tr>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
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<td>COL</td>
<td>COL</td>
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<td>Count Data</td>
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<td>3751</td>
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<tr>
<td>(north leg)</td>
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<td>Ent</td>
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<td>3433</td>
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<tr>
<td>(west leg)</td>
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<td>2</td>
<td>Ent</td>
<td>2011</td>
<td>546</td>
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<td>2</td>
<td>Ent</td>
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<td>SR 18 (Ridge Ave)</td>
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<td>2</td>
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<td>2011</td>
<td>3720</td>
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<tr>
<td>(north leg)</td>
<td>SR 18 (Main St)</td>
<td>1</td>
<td>2</td>
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<td>3433</td>
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<td>1</td>
<td>2</td>
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<td>546</td>
<td>303</td>
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<td>(south leg)</td>
<td>N. Baltimore Rd</td>
<td>1</td>
<td>2</td>
<td>Ent</td>
<td>2011</td>
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<tr>
<td>(down leg)</td>
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</tbody>
</table>

Ohio Traffic Forecasting Manual
**Exercise #6: Incomplete Model Assignment Data**

Tab #1: NCHRP Link

Notice the forecasts in Cells AO13-AP13. Since there are no model inputs associated with this link, the default formulas will take the forecast to zero in the model forecast year.

Assume that the growth rate on the south leg is the same as the north leg, and override the values in Cells AQ13-AR13.

Use the notes in cells A71-A74 for guidance.
EXERCISE #6: INCOMPLETE MODEL ASSIGNMENT DATA

Tab #1: NCHRP Link
Estimate the forecasts by multiplying the counted AADT and the forecast growth rates.

Opening Year Forecast = AQ13 x G13
Design Year Forecast = AR13 x G13
EXERCISE #6: INCOMPLETE MODEL ASSIGNMENT DATA

Tab #2: PM Turns - 5/6 Leg Inputs
All rows and columns have been unhidden, showing the additional inputs for 5/6 leg intersections.

Model turn movements in Cells I77-L116 are input for the new “up” leg.

The missing leg should either be left blank in the model turns section or switched to COUNT in column M. (It won’t actually matter for this example as the volumes are too low).

You could switch the new “up” leg to MODEL but the spreadsheet knows how to deal with this.
NEW INTERSECTION ON EXISTING LINK

NCHRP_link Tab

- Enter data as normal for existing road links
- Leave existing count and No Build model entries blank for new links (Columns F-G, N/COL 4-6, 8a)

Use the notes in cells A76-A80 for guidance.
**New Intersection on Existing Link**

PM_turns, AM_turns, and 24_turns Tabs

- **PM_turns**: Input K-factors as normal (Column M); DHV Factor is estimated as

\[ DHV \text{ Factor} = \frac{K}{0.08} \]

- Enter the peak hour through movement volumes for the existing link in Columns H and K; no turning movements

- Enter model turn inputs (Rows 63+)

Ohio Traffic Forecasting Manual
Volume 2, Section 3.6
EXERCISE #7: NEW INTERSECTION ON EXISTING LINK

Open the following spreadsheet:

Vol 2 Ex #7 - New Intersection on Existing Link.xlsx

This project includes forecasts for a new four-legged intersection. The existing link, Mitchell Road, runs north to south.
**Exercise #7: New Intersection on Existing Link**

Tab #1: NCHRP Link

The count data in Cells F10, F12, G10 and G12, and the Base and Opening Day No Build model assignments in Cells H10, H12, N10 and N12, are left blank for the new link.

Enter the Opening Day Build model assignments for the new SR 18 Link in Cells V10 and V12:

- East Leg = 3696
- West Leg = 4500
Tab #1: NCHRP Link

Compare the Opening Day Build and Design Year Build model assignments for the new east and west legs. Even though the model does not predict significant growth, the forecasts in Cells AO10-AP10 and AO12-AP12 are much higher than the model assignments.

This is because the spreadsheet is using the Screenline Ratio method for the new legs, since there is no count data available. To prevent this, change the Screenline setting in Cells E10 and E12 from Enable (default) to Disable for the new legs.
**Exercise #7: New Intersection on Existing Link**

**Tab #1: NCHRP Link**

Notice how the forecast changes by disabling the Screenline ratio on the east and west legs.

*Screenline Ratio Enabled on New Legs*

<table>
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<th>Year &amp; Adjust for More Recent Count</th>
<th>AO</th>
<th>AP</th>
<th>AQ</th>
<th>AR</th>
<th>AS</th>
<th>AT</th>
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<td>3.775</td>
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<td>10001</td>
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<td>1.000</td>
<td>0.50%</td>
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<tr>
<td>2022</td>
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<td>1137</td>
<td>1.383</td>
<td>2.022</td>
<td>2.26%</td>
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</table>

*Screenline Ratio Disabled on New Legs*

<table>
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<th>Year &amp; Adjust for More Recent Count</th>
<th>AO</th>
<th>AP</th>
<th>AQ</th>
<th>AR</th>
<th>AS</th>
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<tr>
<td>2018</td>
<td>1874</td>
<td>2235</td>
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<td>3.775</td>
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<td>2022</td>
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<td>1137</td>
<td>1.383</td>
<td>2.022</td>
<td>2.26%</td>
<td></td>
</tr>
</tbody>
</table>

Ohio Traffic Forecasting Manual
EXERCISE #8: USING MODEL OPENING YEAR AS MODEL BASE YEAR

Open the following spreadsheet:

Vol 2 Ex #8 - Base = Opening.xlsx

Tab #1: NCHRP Link

The project shown will expand a current two lane road to an 8 lane freeway. The Project Opening Year is 2018 (Cell B26) and the Project Design Year is 2038 (Cell B27).

The MPO travel model has a base year of 2015 (Cell B23) and a plan out year of 2045 (Cell B25).
Tab #1: NCHRP Link

Row 10 of the worksheet contains the inputs for the existing two lane road. A count from 2015 of 5,000 was coded on the network (Cell G10). The model volume in 2015 is 6,000 (Cell H10) and in 2045 is 10,000 (Cell AD10).
Tab #1: NCHRP Link

Instead of creating an additional Opening Year model run for the project, the modelers simply code the new freeway into the 2015 and 2045 networks that already exist and rerun them.

The Build forecast assignments are 35,000 in 2015 (Cell V12) and 60,000 in 2045 (Cell AD12).
EXERCISE #8: USING MODEL OPENING YEAR AS MODEL BASE YEAR

Tab #1: NCHRP Link

In Cell B24, enter the correct Model Opening Year for this situation. In Cell N12, enter the correct Model Opening Year No Build assignment.
**Exercise #8: Using Model Opening Year as Model Base Year**

**Tab #1: NCHRP Link**

In **Cell B24**, enter the correct Model Opening Year for this situation. In **Cell N12**, enter the correct Model Opening Year No Build assignment.

Use the notes in cells C4 and A40 for guidance.

---

<table>
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<tr>
<th>Year</th>
<th>Model Base</th>
<th>Model Opening</th>
<th>Model Forecast</th>
<th>Project Opening</th>
<th>Project Design</th>
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<tbody>
<tr>
<td>2015</td>
<td>2015</td>
<td>2015</td>
<td>2045</td>
<td>2018</td>
<td>2038</td>
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</tbody>
</table>

**Notes:**

- If you want to use a base year build run to establish trends, set Af-ON = Ab
- Set model open year = base year = count year
- Place build run in Af-OB
- Do not use cols 14-15 in this case

---

*Ohio Traffic Forecasting Manual*
Tab #1: NCHRP Link

Note how the inputs in Row 12 and Row 13 are identical, except that there is no Opening Year No Build input in Cell N13. However, the forecasts in Cells AO12-AP12 and AO13-AP14 are identical. Why is this?
Exercise #8: Using Model Opening Year as Model Base Year

Tab #1: NCHRP Link

Note how the inputs in Row 12 and Row 13 are identical, except that there is no Opening Year No Build input in Cell N13. However, the forecasts in Cells AO12-AP12 and AO13-AP14 are identical. Why is this?

When there is an Opening Year Build assignment, the Opening Year No Build actually only impacts interpolations between Base and Count years. However, as the notes suggest, it should be set equal to the Base Year Model assignment to make it clear they are one and the same.
**Exercise #8: Using Model Opening Year as Model Base Year**

Tab #1: NCHRP Link - More Recent Count Inputs

Let’s say a more recent count of 10,000 was collected in 2017. Code this information into Cells **AL12-AM12**, and note how the forecast changes.

With More Recent Count Data

Without More Recent Count Data
Exercise #8: Using Model Opening Year as Model Base Year

But remember the assumed year relationships. Notes in C24, A44 state not to do this.

In this case, a special Opening Year model run with year 2017 or later would be needed for the interpolation formulas that adjust model year volumes to project year volumes to work correctly.

Thus, count data from a year later than 2015 should not be entered! Only use relatively recent (like those updated for the project) base year models in this way.
**EXERCISE #8: USING MODEL OPENING YEAR AS MODEL BASE YEAR**

Tab #1: NCHRP Link- More Recent Count Inputs

What if the analyst had a 2015 project count of 10,000? Try entering a value of 2015 in **Cell AL12**, 10,000 in **Cell AM12** and 10,000 in **Cell G13** and see what happens. Why are the results different?

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<th>D</th>
<th>E</th>
<th>F</th>
<th>G</th>
<th>H</th>
<th>AL</th>
<th>AM</th>
<th>AN</th>
<th>AO</th>
<th>AP</th>
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<tr>
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<td>0.5</td>
<td>2</td>
<td>Ena</td>
<td>2015</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>New 8 lane highway</td>
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<td>2</td>
<td>Ena</td>
<td>2015</td>
<td>5000</td>
<td>6000</td>
<td></td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>13</td>
<td>(south leg)</td>
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<td></td>
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</tr>
<tr>
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<td>New 8 lane highway</td>
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<td>2</td>
<td>Ena</td>
<td>2015</td>
<td>10000</td>
<td>6000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Ohio Traffic Forecasting Manual
GUIDANCE ON MORE RECENT COUNT INPUTS

Generally, put the count volume considered to be most reliable in Column G/COL 5 as shown in Row 13, as long as it is within a few years of the Model Base Year.

Do not leave the original count in Column G/COL 5 and code the new count in Column AM/COL 15.
GUIDANCE ON MORE RECENT COUNT INPUTS

More recent count fields are only used when the Model Base Year has become rather old and much more recent count data are available. In those cases, use the older Near Base Year counts in Column G/COL 5 as shown in Row 13 for judging model accuracy, but use Column AM/COL 15 for separately correcting the model growth rates to actual observed growth.

Alternatively, a new project base year can be established by refining the model using procedures shown in Part 3.
The NCHRP_link tab has added functionality for developing forecasts on parallel facilities:

1. Screenline Ratio Balancing
2. Capacity Adjuster

These functions should not be used for intersection approaches.
Count data may not be available to calculate volume adjustments using the standard methods (Difference, Ratio, Model Growth Ratio).

The **Screenline Ratio** can be used to adjust model assignments when count data are not available on all links. It is based on the comparison between counts and Model Count Year assignments on all screenline roads and is calculated as:

\[
\text{Screenline Ratio} = \frac{\sum \text{Counts}}{\sum \text{Model Count Year Assignments on Roads with Counts}}
\]

Screenline Ratio balancing does not require any special inputs.
EXERCISE #9: ADDITIONAL FUNCTIONALITY FOR PARALLEL ROADS

Open the following spreadsheet:
Vol 2 Ex #9 - Parallel Road Forecasts.xlsx

Tab #1: NCHRP Link - Screenline Ratio Balancing

The spreadsheet is set up to develop forecasts for five parallel facilities. All five roads have Near Base Year Count Data in Columns F&G/COL 4&5. Note the selected adjustment procedures in Column AJ/COL 12.
**EXERCISE #9: ADDITIONAL FUNCTIONALITY FOR PARALLEL ROADS**

Tab #1: NCHRP Link - Screenline Ratio Balancing

Let’s say that there is no count data available on State Road. Delete the inputs in **Cells F13-G13**. Note how the adjusted model results are changed, and that the selected adjustment in cell AJ13 changes to “SLRATIO”.

**Counts On All Links**

| A | B | C | D | E | F | G | H | I | AD | AE | AF | AG | AH | AI | AJ | AK | AO | AP |
|---|---|---|---|---|---|---|---|---|----|----|----|----|----|----|----|----|----|
| 6 | COL | COL | COL | COL | COL | COL | COL | COL | COL | COL | COL | COL | COL | COL | COL | COL | COL |
| 7 | 1 | 3.5 | 5 | 6 | 6.5 | 9 | 10 | 10.5 | 2040 | 2040 | 2040 | 2040 | 2040 | 2040 | 2040 | 2040 | 2040 |
| 8 | near base model | count year | count data | Ab | Ab | Ai-D | SLRATIO | RATIO | DIFF | NIRATIO | RAF | Adjustment | Volume | opening year | design yr |
| 9 | Road/Link | in Dax | Rise St | count year | count data | Ab | Ab | Ai-D | SLRATIO | RATIO | DIFF | NIRATIO | RAF | Adjustment | Volume | opening year | design yr |
| 10 | (east leg) | US-42 | 0.5 | 2 | Enable | 2017 | 14216 | 13000 | 15496 | 25006 | 34860 | 32325 | 33543 | 33543 | 33543 | 33543 | 33543 | 16017 | 33543 |
| 11 | (north leg) | W. 130th St | 0.5 | 2 | Enable | 2017 | 16938 | 9600 | 9420 | 11000 | 10986 | 12473 | 12288 | 12450 | 12349 | 12349 | 12349 | 11059 | 12349 |
| 12 | (west leg) | SR-3 | 0.5 | 2 | Enable | 2017 | 8214 | 5500 | 5200 | 7000 | 6975 | 7740 | 7594 | 7711 | 7053 | 7053 | 7053 | 6402 | 7053 |
| 13 | (south leg) | State Rd | 0.5 | 2 | Enable | 2017 | 2369 | 3100 | 3172 | 4900 | 3984 | 3685 | 3687 | 3622 | 3555 | 3555 | 3555 | 2903 | 3655 |
| 14 | (up leg) | SR 176 | 0.5 | 2 | Enable | 2017 | 4535 | 5000 | 5000 | 6000 | 5975 | 5568 | 5455 | 5371 | 5413 | 5413 | 5413 | 4850 | 5413 |

**No Count on State Road**

<table>
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<th>D</th>
<th>E</th>
<th>F</th>
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<td>count data</td>
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<td>2</td>
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<td>5371</td>
<td>5413</td>
<td>5413</td>
<td>5413</td>
<td>4850</td>
</tr>
</tbody>
</table>
The **Capacity Adjuster** can be used when:

1. The forecasted volume exceed a link’s capacity, **AND**
2. There are other parallel roads that could reasonably absorb some of the traffic growth.

The adjusted forecasts are found in Columns AX-AY. They are calculated by redistributing the unmet demand across the other parallel roads in proportion to their excess capacity.
**Exercise #9: Additional Functionality for Parallel Roads**

Tab #1: NCHRP Link - Capacity Adjuster

Enter the link capacities for each road into **Column AU**:

- US-42 = 25,000
- W. 130th St = 15,000
- SR-3 = 15,000
- State Rd = 10,000
- SR 176 = 10,000
**Exercise #9: Additional Functionality for Parallel Roads**

Tab #1: NCHRP Link - Capacity Adjuster

The remaining (or deficient) capacity for each link is calculated in **Columns AV-AW**.

Notice how the adjusted forecasts in **Columns AX-AY** compare to the original forecasts in **Columns AO-AP**.

<table>
<thead>
<tr>
<th>Opening Year</th>
<th>Design Year</th>
<th>Yearly Growth Factors</th>
<th>Annual Growth</th>
<th>Capacity</th>
<th>Delta</th>
<th>Revised Volume</th>
<th>Growth Factors</th>
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<td>4.96%</td>
<td>25000</td>
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</table>
EXERCISE #9: ADDITIONAL FUNCTIONALITY FOR PARALLEL ROADS

Tab #1: NCHRP Link - Capacity Adjuster

All roads are under capacity for Opening Year (Column AV), but US-42 is over capacity in the Design Year (Column AW).
**EXERCISE #9: ADDITIONAL FUNCTIONALITY FOR PARALLEL ROADS**

**Tab #1: NCHRP Link - Capacity Adjuster**

For US-42, the design year AADT (33,492 vpd) > total link capacity (25,000 vpd) for US-42.

- The design year AADT is limited to 25,000 vpd
- The unserved volume is 33,492 - 25,000 = 8,492 vpd
- 8,492 vpd is distributed amongst the other screenline roads as a proportion of their remaining capacity

<table>
<thead>
<tr>
<th>AO</th>
<th>AP</th>
<th>AQ</th>
<th>AR</th>
<th>AS</th>
<th>AT</th>
<th>Capacity</th>
<th>Opening yr</th>
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Ohio Traffic Forecasting Manual
Exercise #9: Additional Functionality for Parallel Roads

Tab #1: NCHRP Link - Capacity Adjuster

The excess capacity across all parallel roads is calculated in Cells AV20-AW20.

The total unmet demand is calculated in Cells AV21-AW21.

<table>
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<th>Opening Year</th>
<th>Design Year</th>
<th>Growth Factors</th>
<th>Annual Growth</th>
<th>Capacity</th>
<th>Revisied Volume</th>
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</table>

Ohio Traffic Forecasting Manual
Tab #1: NCHRP Link - Capacity Adjuster

Change the capacity of US-42 to 10,000 in Cell AU10.

In the design year, the total available capacity (Cell AW20) is less than the unmet demand (Cell AW21).

The unmet demand on US-42 is distributed amongst the other roads until they reach their respective capacities.

The result is that the US-42 Design Year forecast (Cell AY10) is still slightly over capacity.
HIGH RISK DESIGN TRAFFIC

Other Considerations
As covered in Part I, an interchange can be treated as one single intersection for input into the spreadsheet.

Example Conversion of Diamond Interchange to Four-Legged Intersection
**WEAVE FORECASTING**

Interstate or limited access highways may require weave movement forecasts.

- Link AADT forecasts are developed as normal using the NCHRP_link tab
- TDF model **select link analysis** is required to complete the weave movement forecast
- The select link model assignment will only have volumes that use the selected link, the modeler will tell you which network attribute to reference

*Example DHVs with Unknown Weave Distribution*
Select link analysis results can be used to calculate weave distributions by:

1. Downstream percentage
2. Upstream percentage

Example Select Link Assignment Results: note that for select link 4-6, 3,900 is the total volume on link 4-6, however, the volumes on the other links are only the portion that eventually uses link 4-6. The total volume on link 3-4 in this case would be 3,900 + 700 = 4,600
Weave Forecasting

1. Calculate weave volumes by downstream percentage

a. Calculate downstream percentages
   (Example: Link 4-5 from Link 1-3)

\[
\text{Downstream Percentage}_{4-5 \text{ from } 1-3} = \frac{40}{40 + 660} \times 100\% = 6\%
\]

<table>
<thead>
<tr>
<th>Destination Link</th>
<th>Origin Link</th>
<th>Percent of Destination Link Traffic</th>
</tr>
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<tbody>
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<td>4-5</td>
<td>1-3</td>
<td>6%</td>
</tr>
<tr>
<td>4-6</td>
<td>1-3</td>
<td>18%</td>
</tr>
<tr>
<td></td>
<td>2-3</td>
<td>82%</td>
</tr>
<tr>
<td>2-3</td>
<td></td>
<td>94%</td>
</tr>
</tbody>
</table>
1. Calculate weave volumes by downstream percentage

b. Hold downstream volumes constant to calculate weave volumes

Compare upstream volumes between the forecasted DHVs (left) and weave calculations (right):

\[
\text{Difference} = 30 \text{ vph}
\]
2. Calculate weave volumes by upstream percentage

a. Calculate upstream percentages
(Example: Link 1-3 to Link 4-5)

\[ Upstream\ Percentage_{1-3\ to\ 4-5} = \frac{40}{40 + 710} \times 100\% = 5\% \]

<table>
<thead>
<tr>
<th>Origin Link</th>
<th>Destination Link</th>
<th>Percent of Origin Link Traffic</th>
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<td>1-3</td>
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<td>5%</td>
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<tr>
<td>1-3</td>
<td>4-6</td>
<td>95%</td>
</tr>
<tr>
<td>2-3</td>
<td>4-5</td>
<td>17%</td>
</tr>
<tr>
<td>2-3</td>
<td>4-6</td>
<td>83%</td>
</tr>
</tbody>
</table>
2. Calculate weave volumes by upstream percentage

b. Hold the upstream volumes constant to calculate weave volumes

DHV Forecasts with Weaves, Upstream Percentage

Compare downstream volumes between the forecasted DHVs (left) and weave calculations (right):

Difference = 120 vph
Downstream percentage has less variation from forecasted DHVs --- use downstream percentage.
STREETLIGHT DATA

An analytics company that organizes and interprets anonymous location data to provide meaningful travel metrics with high spatial accuracy.

In 2017, ODOT completed the purchase of Statewide origin-destination data from StreetLight Data.

- Accessible to any public agency or University within Ohio
- Can be available to consultants on a temporary basis, given permission from the Office of Roadway Engineering
- Data available from January 2014 to present

Origin-destination data obtained from StreetLight Data can be used to validate TDF model results and calculate weave distributions.
HIGH RISK DESIGN TRAFFIC

Best Practice Guidance
GENERAL RULES FOR HIGH RISK DESIGN TRAFFIC

- Balance/smooth forecasts as necessary
- Turning movement traffic forecasts should be rounded to the nearest 10
- Use a minimum volume of 30 & 10 for all allowed ADT and Design Hour movements respectively
- Understanding of area context and travel patterns is important to validate forecasts
  - Compare both the model and the design traffic to the actual land development to ensure volumes are reasonable
The Institute of Transportation Engineers *Trip Generation Manual* may be used to estimate directional factors for new facilities when existing count data are not available.

Forecasts should be treated as estimates rather than actual values.
**CONSISTENCY CHECKS**

**Study Year**
- Design Year Forecast $\geq$ Opening Year Forecast for a given alternative

**Alternative Scenario Check**
- Build Forecast $<$ No Build Forecast for a given study year if traffic diversion is expected
- Build Forecast $=$ No Build Forecast for a given study year if no traffic impact is expected
- Build Forecast $>$ No Build Forecast for a given study year if new development
- Multiple Build Alternatives are consistent with each other (e.g. if scenario differences are only SB, NB traffic should be near identical amongst alternatives.)
Direction Split Imbalance

- AM and PM directional splits are usually similar
- Example:
  - AM peak hour 60% northbound, 40% southbound
  - PM Peak hour 40% northbound, 60% southbound
Low Risk Design Traffic
Traffic forecasts for relatively simple projects are considered **low risk**.

- Projects that do not meet any high risk criterion
  - Simple resurfacing, routine maintenance, and minor widening
- No project-specific TDF modeling
- No involvement from ODOT M&F
Collect Count Data

On US/IR/State Route?

Yes
Use Simplified Highway Forecasting Tool (SHIFT)

No
Use Linear Regression, MPO Growth Rate, or Other Growth Rate Method

Forecast causes design problems?

Yes
High Risk (Certified) Design Traffic Process

No
Design Forecast

Low Risk Design Traffic Forecasting Procedure
LOW RISK DESIGN TRAFFIC
Linear Regression
**Concept - Trend Line Analysis**

Trend line analysis is identifying trends in historic traffic count data and applying that same trend to estimate future traffic forecasts.

It is used for projects that:

- Are located in relatively stable areas
- Have a Build condition that is not likely to change travel patterns

\[ y = bx + a \]

where

- \( y \) = Future Year AADT
- \( x \) = Future Year
- \( a \) = Future Year AADT
- \( b \) = Future Year

Linear regression is the most common application of trend line analysis.
GROWTH RATES FROM LINEAR REGRESSION

Growth rates should be reported as simple, non-compounded annual growth rates.

Nonlinear growth rates may be used if justified.

\[
\text{Growth Rate} = \frac{(\text{End Volume} - \text{Start Volume})}{\text{Start Volume} \times (\text{End Year} - \text{Start Year})}
\]

The growth rate equation can be simplified to incorporate constants obtained from the linear regression line:

\[
\text{Growth Rate} = \frac{b}{(b \times \text{Start Year} + a)} \times 100\%
\]
DATA POINTS

- If possible, use a minimum of 5 data points for establishing trends
- Should only use data from the past 20 years
- Identify and discard outliers that may skew the trend line

Existing land uses and road network should be consistent with what existed at the time data were collected.

Linear regression is not appropriate for areas with major changes in land use and road network, past and/or future.
OTHER CONSIDERATIONS

Review forecasts on nearby/adjacent facilities for consistency.

When DHV turning movements are required, iterative proportional fitting can be used with consideration of both approach and departure link growth rates.

Growth rates:
- Never apply a negative growth rate
- Growth rates in excess of 3% per year for cars, or 4% per year for trucks, will have a major impact on forecasted volumes and should be given additional consideration
LINEAR REGRESSION EXAMPLE

**Ohio Traffic Forecasting Manual**
Volume 2, Section 2.4

Do not use (estimated AADTs)

Do not use (>20 years)

**Growth Rate**

\[ \text{Growth Rate} = \frac{b}{(b \times \text{Start Year} + a)} \times 100\% \]

\[ = \frac{937}{(937 \times 2001 - 1,840,407)} \times 100\% \]

**Growth Rate** = 2.7%
Low Risk Design Traffic

Other Methods
SHIFT can be used for Low Risk Design Traffic forecasts on Interstate or US/State Routes.

- Front-end software application for reporting simplified traffic forecasts
- Uses a Microsoft Access database file containing historic traffic count data and Model of Record results
- Design designations are generated based on historic trend line analysis and/or model results
- SHIFT forecasts are completed by District staff without involvement from ODOT M&F
Other Growth Rate Methods

Some roads (typically in rural areas) may not have any applicable data for estimating traffic forecasts:

- No historic traffic counts
- Not on Interstate or US/State Route
- Not within the boundary of a local MPO

Potential Growth Rate Methods:

- “Borrow” growth rate from nearby route in SHIFT (ODOT-administered projects)
- Develop an areawide growth rate
DOCUMENTATION GUIDELINES
For Certified Design Traffic Forecasts
DOCUMENTATION PACKAGE

▪ Early Coordination Meeting Minutes
▪ Certified Traffic Request Form
▪ Transmittal letter/email with traffic “plates” and design designations
▪ Technical Memoranda
▪ All other relevant correspondence
▪ Technical report with procedures and assumptions
▪ Electronic files in Word, Excel, PDF, and/or MicroStation uploaded to the ODOT SharePoint Site
The **Early Coordination Meeting Checklist** defines all relevant forecast parameters.

- Filled out during the meeting
- Serves as the meeting minutes

Most of this information has to do with modeling needs and is covered in Volume 3.
The Certified Design Traffic Request Form is a two-page document used to transmit requests for traffic forecasts.

Traffic forecasts can be requested in the following categories:

- **NEW**: No previous forecast exists
- **UPDATE**: Previous forecast exists, but update is needed (e.g. change of Design Year, alternative, etc.)
- **REVIEW**: ODOT review of a project forecast developed by a consultant or non-ODOT entity.

Covered in Volume 1.
**CERTIFIED TRAFFIC PLATES**

Unless otherwise directed, the requested forecast link and intersection turning movement volumes should always be displayed on plates.

<table>
<thead>
<tr>
<th>Analysis Year Set</th>
<th>Opening Year</th>
<th>Design Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Balancing Subset</td>
<td>Raw, Unbalanced</td>
<td>Balanced</td>
</tr>
<tr>
<td>Plates</td>
<td>AADT</td>
<td>AM Design Hour</td>
</tr>
</tbody>
</table>

- Can be combined on same plate
- Plate or Summary Table

Ohio Traffic Forecasting Manual  
Volume 2, Section 5.4
CERTIFIED TRAFFIC PLATES

Forecast uncertainties must be noted on traffic plates.

- Documentation not typically reviewed or referenced outside of ODOT M&F
- Plates usually distributed without supporting documentation

<table>
<thead>
<tr>
<th>Uncertainty Type</th>
<th>Note Text</th>
<th>Applicable Plates</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lack of Long Term Count Data</td>
<td>Design traffic conducted without the benefit of long term counts, numbers should be considered within ±15%.</td>
<td>All</td>
</tr>
<tr>
<td>Uncertain Future Development</td>
<td>Design traffic in high growth area, includes growth exceeding 3% per year on indicated links.</td>
<td>AADT Only</td>
</tr>
</tbody>
</table>
Certified Traffic Plates

Forecast volumes should be rounded to indicate level of precision.

<table>
<thead>
<tr>
<th>Volume</th>
<th>Recommended Rounding</th>
<th>Minimum Volume</th>
</tr>
</thead>
<tbody>
<tr>
<td>AADT</td>
<td>Nearest 10</td>
<td>30</td>
</tr>
<tr>
<td>DHV</td>
<td>Nearest 10</td>
<td>10</td>
</tr>
</tbody>
</table>

“Breaks” between traffic forecast locations should be explicitly indicated with break line symbols.

The ODOT M&F provides MicroStation templates available through the Certified Traffic Webpage.

http://www.dot.state.oh.us/Divisions/Planning/SPR/ModelForecastingUnit/Pages/CertifiedTraffic.aspx
TECHNICAL REPORT - SAMPLE OUTLINE

1. Cover Page
2. Introduction
3. Project Description
   ▪ Location, proposed conditions, etc.
4. Forecast Parameters
   ▪ Study intersections, mainline and ramp locations
   ▪ Alternatives, years
   ▪ Volume sets and design designations to be prepared
5. Other Studies
6. Data Sources
   ▪ Counts
   ▪ TDF Modeling
   ▪ Trip generation rates
7. Existing Traffic Volumes
8. Design Traffic Volumes
   ▪ Model adjustments
   ▪ Selection of K-factors
   ▪ Spreadsheet processing
   ▪ Balancing/smoothing
   ▪ Uncertainties
   ▪ TD and T24 Factors
A. Certification Documents
   ▪ Design Traffic Plates
   ▪ Design Designations

B. Technical Memos (if applicable)
   ▪ Count Evaluation Memo
   ▪ Growth Rate Evaluation Memo

C. Exhibits
   ▪ Diagrams of Build alternatives
   ▪ Count data
   ▪ TDF model outputs
   ▪ Hourly Percent by Vehicle Type Reports
   ▪ Seasonal Adjustment Factor Reports
   ▪ Partial count factor forms
   ▪ Spreadsheet adjuster tool printouts
   ▪ Others
**Filesharing and Certification**

To assist in review, files are uploaded electronically using either SharePoint or LiquidFiles.

- Count data
- TDF model information
  - Trip tables
  - Scripts, macros, executables, etc.
- Spreadsheets
  - Partial Count Factor Form
  - Spreadsheet Adjuster Tool
  - Volume Balancing
- Documentation files

Once the forecast and documentation have been reviewed, ODOT M&F will formally certify the forecast.

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Example Certified Design Traffic Approval Letter from ODOT Modeling and Forecasting Section