Guidelines for Planning Level Traffic and the Use of Models for Project Traffic Forecasting

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**Introduction**

Project level traffic forecasts involve volumes on specific roadway segments or for specific turning movements and related parameters such as K, D, T24 etc. or related measures of effectiveness such as V/C, LOS, pollutant levels, user benefits etc. These forecasts are often distinguished as either "Planning Level Traffic" or "Design Traffic". The distinction relates to the level of manual effort used to evaluate and process the forecasts that result from automated procedures and statistical analysis. The implication of this distinction is that each is intended for a different level of project analysis. A curious distinction between the two is that planning level traffic involves a significant amount of preliminary work but little additional effort to produce many MOE’s, alternatives etc., while design traffic requires little preliminary work but much additional effort for each additional parameter, location or alternative desired. The result of this distinction should be obvious; namely planning level traffic is only used on large projects and to narrow down alternatives, while design traffic is used directly on small projects and only on the feasible (or a very small number of) alternatives on large projects. These guidelines seek to clarify this distinction to ensure users of traffic forecasts use them appropriately.

In addition, models are often used to aid in the production of these forecasts (indeed planning level traffic and use of models are nearly synonymous). Note that “aid in the production” implies that the model volumes are not used directly as project level forecasts; rather they are input to a subsequent process for producing final forecast numbers (see the section on volume reporting). Models, as defined here, generally refers to travel demand forecasting (TDF) models, usually using the four step paradigm of Trip Generation, Trip Distribution, Mode Choice and Traffic Assignment. Models can also refer to more modern related techniques such as activity based or tour based models. In addition, more recent techniques that allow TDF model results to tie to operational level models such as VISSIM, CORSIM, Synchro etc. are also addressed. Currently, each of the 17 Metropolitan Planning Organizations (MPO) in Ohio has a TDF model. In addition, ODOT maintains a statewide model.

These TDF models were designed for system-wide planning analysis and are not necessarily accurate enough at any given location for production of segment specific volumes, let alone turn volumes, direction factors etc. When used carefully, these models are an invaluable source of information for creation of project forecasts. When not used carefully they can produce incorrect or illogical results. The following guidelines seek to lay out the proper use of models for creation of project level traffic forecasts in an attempt to avoid potential problems with their use for this purpose. If followed carefully, these guidelines will help ensure that project level forecasts produced throughout the project development process are reasonably consistent with the final certified design traffic.
The following guidelines will focus on highway capacity type projects since they represent the majority of projects analyzed. Projects involving transit system changes, tolling, freight system changes, transportation demand management, managed lanes and intelligent transportation all require special consideration that is generally outside the scope of this document. In general transit system changes will involve looking at transit ridership forecasts and ensuring the models both function well and meet the various FTA requirements related to transit funding requests\(^1\). Tolling can be accommodated in any of the travel demand models, however, a distinction must be made between the planning level estimates producible by agency staff using existing models and investment grade toll analysis requiring the use of specialized consulting firms (which start with the areas travel demand model and then use proprietary procedures unavailable to public agencies to produce their analysis). Freight system changes might be analyzed by switching to the statewide model. Managed lanes can be accommodated in some of the large MPO models that assign traffic by occupancy class and could be accommodated in others with significant updating. Other types may or not be able to be analyzed and need to be considered on a case by case basis.

The following guidelines are divided into two major sections; the first deals with definitions and processes and is intended for both modelers and project managers who need to obtain traffic forecasts for their projects. The second contains detailed project level model usage guidelines for modelers.

I. DEFINITIONS & PROCESSES

A. Project Types

Before delving into specific guidelines on the use of models for project forecasting, the question must be answered: “What projects actually require/benefit from the use of models?” The ODOT Project Development Process (PDP) defines 5 levels (paths) of projects. As detailed below, special modeling activity usually only occurs for PDP path 4 and 5 projects (and some path 3) which are categorized as standard, complex and very complex modeling projects for the purposes of determining the level of traffic analysis/modeling necessary.

1. Paths 1 and 2 Projects

Sections 4.1 and 4.2 of the PDP manual define paths 1 and 2. These projects are routine maintenance (1) or resurfacing, minor widening, culvert replacement etc. (2). Path 1 and 2 projects require no modeling whatsoever. If a project forecast is even necessary, the analyst will simply produce design traffic directly, using past count trends or the results from an existing model (typically the "model of record" defined in the next section) to aid in the determination of growth rates. ODOT Districts often produce such forecasts themselves using the Simple Highway Forecasting Tools provided by the Modeling and Forecasting Section (M&F) of the ODOT Office of Statewide Planning and Research (OSPR). The model traffic volume itself is not used since the model results for the subject roadway are passed through no or minimal QA/QC.

2. Path 3 Projects

Section 4.3 of the PDP manual defines path 3 as projects generally on existing alignment, it can involve major intersection/interchange upgrades such as new ramps or turn lanes and new travel lanes. Path 3 projects are typically treated the same way as path 1-2 projects, i.e. they don’t require any specific model work though the analyst may consult existing models (typically the "model of record" defined in the next section) to aid in the determination of growth rates to produce design traffic. However, projects involving new ramps or travel lanes would generally result in significant traffic diversion and thus would require modeling as discussed under path 4-5 projects below.

3. Path 4 and 5 Projects

Sections 4.4 and 4.5 of the PDP states that path 4 projects are mostly rural improvements while path 5 projects are mostly urban improvements. It further defines them to have (among other things) “a significant impact to the highway’s public access, level of service, traffic flow, mobility patterns, or mode shares” and
they typically involve things such as “relocating a major portion of a highway” or “developing a new highway alignment” or “constructing a new or significant modification to an existing interchange”. Thus they will typically involve modeling activity to aid in the determination of the traffic forecasts since travel models are often the best method available for assessing changes to traffic flow and mobility patterns.

In terms of categorization for modeling, lane widening, addition of turn lanes or auxiliary lanes and minor realignments would be termed standard model projects and don’t require the full set of model checks and refinements as shown in part 2 of these guidelines.

On the other hand, projects that include any of the following:

- Major New Bridge
- New Interchange
- Removal/Addition of Connections for Certain Movements at an Interchange
- Building New Roads (or closing roads)
- Increase of 50% or More to the Number of Through Lanes
- Changes in Transit Service
- Changes in Toll Rates
- Implementation of Transportation Demand Management, Managed Lanes or Intelligent Transportation Systems
- Complex Traffic Operations interactions such as occur in the CBD of a large urban area

would be considered complex modeling projects and should employ the additional checks and refinements as documented in part 2 of these guidelines (though the analyst should not feel constrained to limit themselves to the simpler procedures on projects not including these elements).

Most path 5 projects will be of such large magnitude that more detailed and refined traffic analysis is justified to aid the decision making process as will be documented in part 2 of the guidelines, these would be considered very complex model projects.

**B. Types of Traffic Forecasts**

The various activities documented in these guidelines can produce increasingly refined traffic estimates. The amount of analysis conducted and at what stage in the PDP depends not only upon the magnitude of the project but also upon the level of the decisions that will be made. The users of traffic forecasts need to be cognizant of this fact and avoid using traffic forecasts produced early in the PDP process to make more refined decisions later without consulting with the analyst who produced the forecast. Conversely, those who provide forecasts must be
diligent in specifying the limitations of the forecasts they have provided. Traffic forecasts generally fall within the following four categories: Raw Model Output, Planning Level Traffic, Refined Alternative Level Traffic and Design Traffic.

1. Raw Model Output

Raw model outputs have not been subjected to any of the checking/adjusting/refining documented in these guidelines. Raw model results typically come from the “Model of Record”. For urban areas, the model of record is that model which served as the basis of the current MPO long range transportation plan. It actually consists of at least 3 model runs, the base year validated model run and the long range plan year build and no build (existing + committed) model runs. In most areas intermediate year model runs will also exist which are used for air quality conformity analysis. From the model of record, growth rates are often calculated by comparing the base year and a forecast year volume for use on path 1, 2 and most path 3 projects. Even in this case, some reasonableness checking of the model at the project location will be made when making the decision on whether to use the model derived growth rate versus some other growth rate. Unless otherwise directed by ODOT M&F, raw model results should not be used for reporting actual location specific volumes.

2. Planning Level Traffic

Planning level traffic consists of traffic forecasts produced for projects expected to cause traffic diversion (paths 4, 5 and some path 3) and usually involving multiple alternatives using traffic models to quantify that diversion. It is used in the project planning process (PDP Phase 1) and the preliminary engineering process (PDP Phase 2) unless either of the subsequent categories is obtained for this purpose. Planning level traffic uses model output but involves various checks and adjustments as documented in the second part of these guidelines. However, it has not necessarily been refined to produce reasonable values at all locations within the study area. If the checks, refinements, adjustments and volume reporting guidelines in this manual are followed, planning level traffic should be suitable for all decision making in the project planning process and the Feasibility Study (PDP Task 2.1.A) of the preliminary engineering phase (unless refined alternative level traffic is deemed necessary or if more detailed design activities are moved forward as discussed in the next section). In addition, following these procedures will make it much more likely that design traffic and planning level traffic are consistent. However, it should always be remembered that planning level traffic is designed to answer questions on the order of magnitude of the addition of a general purpose travel lane in a certain location. If more detailed decisions such as location and length of turn lanes, auxiliary lanes, traffic control devices etc. are being made; refined alternative level or design traffic is required. Generally these types of decisions are deferred until certified design traffic is available, if not, the project
manager (or designee) should work with ODOT M&F to identify the appropriate analysis procedures.

3. Refined Alternative Level Traffic

Refined alternative level traffic only occurs in certain rare cases where additional model work beyond the TDF model has occurred for certain types of projects. This model work typically involves using matrix estimation techniques (other techniques are possible as well) to refine travel demand to more precisely match study area traffic counts so that the results are accurate enough for use in operational level traffic models. Since this is extremely labor intensive, this level of traffic is generally only produced for very complex model projects. Before attempting to produce refined alternative level traffic, all of the appropriate checking/adjusting/refining procedures documented herein should have been applied first. This traffic is suitable for making more detailed decisions on alternatives in a Feasibility Study (PDP Task 2.1.A) (note, most projects will use Planning Level Traffic for the feasibility study as mentioned previously) and potentially in an Alternative Evaluation Study (PDP Task 2.3) as well.

4. Design Traffic

Design traffic consists of the final traffic forecasts and related information including turn volumes, direction factors, 30th highest hour factors etc. needed to inform the final detailed design of a project. For projects requiring model work, all of the checking/adjusting/refining documented herein (as appropriate for the project type) will have been conducted for the feasible alternatives (or just the preferred alternative) to serve as inputs to the design traffic forecasting process. That process involves labor intensive manual checking and adjusting of location specific volumes to produce final forecasts that are consistent both internally and with counts. Design traffic is said to be “certified” when the ODOT Office of Statewide Planning and Research, Modeling & Forecasting Section transmits a certification memo. Design traffic is requested in the Planning Phase (task 1.3.E) for path 1, 2 and most path 3 projects, and for larger projects as part of the Alternatives Evaluation Study (per PDP Task 2.3.B.A) or in the absence of said study (or if it is determined that planning level traffic is suitable for use in the Alternatives Evaluation Study) generated in PDP task 2.5.B for subsequent use in Stage 1 Design (PDP Task 2.7). The production of certified design traffic forecasts is its own topic and will not be discussed further here.

C. Process for Obtaining TDF Model Traffic Forecasts

The method for obtaining model based traffic forecasts is the same as obtaining a non-model based traffic forecast, a request is made to ODOT M&F using the Traffic Forecast Request Form. However, while non-modeled projects (path 1, 2 and most 3) require only one certified traffic request as Task 1.3.E of the PDP, more complex projects require several steps as documented below.
1. PDP Phase 1 Planning

It is during the planning phase that the model itself should be prepared for use in the project analysis, thus most of the checking/ refinign/ adjusting process documented in these guidelines should occur at this step. The project manager (or designee) should submit a request for planning level traffic to ODOT M&F as Task 1.3.D of the PDP. This will occur after or in conjunction with PDP Task 1.3.C to obtain traffic counts (the status of which are indicated on the traffic forecast request form). It should be recognized that selection of appropriate modeling tools and model refinement strategies requires knowledge of the types of alternatives that will be tested, hence, the No Build Planning level traffic request should be accompanied by some indication of the types of alternatives to be analyzed (or deferred until this is known if project scheduling permits.)

Once a request is received, the M&F staff person will help coordinate responsibility for conduct of necessary modeling work and related traffic analysis. The general protocol that ODOT M&F will follow for all but very complex model projects is:

1. Determine which if any model to use (see below).
2. If the MPO model is used, contact the MPO to conduct the model work unless a memorandum of understanding (MOU) exists between the MPO and ODOT that ODOT conducts all model work, in which case, the MPO will simply be notified that work is commencing and then provided the results of model work when completed.
3. If the MPO cannot conduct the model work within the agreed upon time frame (see below), ODOT M&F will conduct model work.
4. If ODOT is unable to conduct the work within the necessary time frame, either an existing consultant on call agreement will be used or negotiation with the project consultant (via the project manager) will occur to include appropriate scope language in the project contract.

Very complex model projects will typically be handled differently. Most of these projects will require sufficiently complex analysis that the modeling work will be conducted by the project consultant (or their sub-consultant). ODOT M&F should assist the project manager in scoping model work for these projects. Also, if the MPO model is to be used, their representative will typically be included in this discussion unless the aforementioned MOU exists.

Beyond selection of which model will be used and who will use it, various other related items must be coordinated at this time (many of which can/should be included on the planning level traffic request) including:
• Analysis years needed, typically the project opening year and a design year 20 years hence, however, some projects with long construction times may require phased opening year analyses.
• Definition of the project “no build”, the no build situation is liable to include various other future projects in the model networks.
• Land use assumptions, typically the official MPO land use data is the starting point, however, project managers (or designee) are responsible for supplying maps and size variables (employment, square footage, population etc.) for proposed developments as well as an indication of whether the developments occur only in the build alternatives or in the no build as well. Care must be taken to identify whether the MPO already represented such developments in their official forecast.
• Whether or not previous forecasting efforts or other traffic studies have been conducted on this project/study area and the degree to which consistency with those efforts is desired.
• Identification of nearby forecasting efforts for other projects and the degree to which consistency with those efforts is desired.
• Identify modeling data needs including: link counts, turning movement counts, travel time/speed data, land development data, special generator trip rates, origin destination data, employment data, census data, area growth rate expectations etc.
• Identify desired forecast data products/locations including: daily volumes, sub-daily volumes (hourly, 15 min. etc.), turning movement volumes, classified volumes (car, truck, by weight, by trip purpose, by vehicle occupancy etc.), directional volumes, LOS, V/C or other related measures, transit ridership, air quality analysis by pollutant, user benefit analysis etc.

2. PDP Phase 2 Preliminary Engineering

Planning level traffic can be used to satisfy the need for traffic projections up to and including the Feasibility Study (PDP task 2.1.A). Technically planning level traffic for build alternatives is requested as PDP task 2.1.A.A though this request can be combined with 1.3.D. If the alternatives are known ahead of time both could be requested at 1.3.D or if the project manager finds the additional delay at task 2.1.A.A is acceptable both could be requested at that time (see turn-around time below). Traffic dependent activities that occur at this time, according to Section 1403.3 of the Location and Design (L&D) Manual, include the designation of 1000’-2000’ corridors, interchange locations and development of typical sections. All of these activities easily fall within the scope of planning level traffic as defined in the previous section. A problem arises, however, when project managers take advantage of the flexibility offered by the PDP to move more detailed design activities earlier in the process. In these instances, it may be necessary to obtain certified design traffic earlier, however, it should be remembered that design traffic is highly labor intensive so the number of
alternatives and magnitude of the project should be considered when making this
decision (consultation with ODOT M&F is recommended if in doubt).

For some projects additional work to link TDF model results to operational
models will occur. When such occurs, a “Refined Alternatives Model” is said to
exist and the traffic resulting from such is termed “Refined Alternative Level
Traffic” as defined in the previous section. Refined alternative level traffic can
help bridge the gap between planning level traffic and design traffic for very
complex projects. Due to its expense, however, the usual process is either to
use planning level traffic or to obtain design traffic earlier than normal (the latter
is more expensive than producing refined alternative level traffic for large study
areas but lower for smaller ones).

If a project is large enough to require an Alternative Evaluation Study (PDP task
2.3) which generally only applies to path 4 and 5 projects, certified design traffic
will generally be requested per PDP task 2.3.B.A due to the likelihood of more
detailed design decisions necessary to determine the preferred alternative (such
as traffic controls, task 2.3.B and signals, task 2.3.E). This is requested with the
Traffic Forecast Request Form on which the previously developed planning level
traffic can be indicated. In some instances planning level traffic or refined
alternative level traffic can be used in the Alternative Evaluation Study (planning
level traffic should only be used for this purpose if the previously mentioned
conditions for its use continue to hold.)

If the Feasibility Study results directly in a preferred alternative (usually on path 3
projects) or if planning level traffic continued to be used for the Alternative
Evaluation Study, certified design traffic is requested in PDP task 2.5.B for use in
Stage 1 Design (PDP Task 2.7) and beyond.

D. Selection of Model

The first consideration in selecting a model for use in the analysis of a project is
whether or not that model is actually sensitive to the projects and policies that are
envisioned as potential alternatives. While all of the travel demand models in the
state are able to adequately model changes in highway capacity, some are more
limited in their ability to deal with minor operational changes, transit system
changes, changes in land development, freight system changes, transportation
demand management, tolls, managed lanes and intelligent transportation
systems. In each of these cases, ODOT M&F may be consulted to determine the
suitability of the various models to address these questions (or the level of effort
necessary to modify them to be able to do so).

Additionally, as previously mentioned, Ohio has 17 MPO’s, each with a TDF
model and ODOT maintains a statewide TDF model. ODOT M&F in consultation
with the relevant MPO will determine the choice between these for a given
project based on the following criteria:
• If the project and its impacts lie entirely within an MPO model area, the MPO model will be used, unless specific information that can only be obtained from the statewide model related to freight or land use/economic impacts is required.

• Otherwise the statewide model will be used; however, if any of the project lies within an MPO area, ODOT M&F will still consult with the relevant MPO on this decision and will provide model results as requested.

This protocol is followed for 2 reasons. First, the MPO model produces a more refined estimate of passenger car traffic in their areas due to their more refined network and zone structures. Second, the MPO has the primary responsibility for transportation planning in their area and thus is deferred to by ODOT in the area of traffic modeling.

E. Time Frames for Model Work

Turn-around time for model work depends upon the following factors:

• Data availability
• Staff work flow management
• Magnitude of project and required analyses

Typically, ODOT M&F can turn around any model request in 1 or 2 weeks (less for standard model projects) IF all necessary data is available and IF ODOT Central Office management wishes to reset section priorities to work on the project immediately at the expense of others.

One turn-around time for all modeling work cannot be given since this work often occurs at various times throughout the PDP. For project planning purposes, project managers should count upon the following turn-around times for most cases:

Prepare Model for Standard Model Project 3 weeks
Prepare Model for Complex Model Project 2 months
Model Alternatives on a Standard Project 2 weeks plus 1 wd. per Alt.
Model Alternatives on a Complex Project 2 weeks plus 2 wd. per Alt.
Very Complex Project Negotiated case by case

Note that these turn-around times are from the date ODOT M&F receives all the data necessary to make model checks/refinements and adjustments. For many projects some additional count information or land use data will be needed which might take 2 months or more to obtain. The project manager must anticipate the time necessary to collect, assemble and provide this data and understand that it is the project sponsor’s responsibility to obtain. The implication of these times
when M&F is contacted later in the project development process should be noted. If, for example, ODOT M&F is first contacted by the project manager during the Feasibility Study with a series of 8 alternatives for analysis on a complex project and no counts or other data have been assembled, the turn-around time might be about 5 months (2 months + 2 months + 2 weeks + 8*2 wd.). On the other hand, if ODOT M&F is involved in the Planning Phase so that data collection and model preparation are already complete, a request to analyze some alternatives can be turned around in a week or two.

For path 1-2 and most path 3 projects, there is typically no project specific model work so there is no model turn-around time, the standard turn-around time for production of certified design traffic is all that is relevant.

Since these turn-around times are based largely upon work flow management, not the actual amount of time it takes to conduct the analysis for a given project, ODOT M&F will work with the project sponsor to provide expedited turn-around time if necessary. As mentioned earlier, this may involve ODOT Central Office Management if the staff is to reprioritize their time from other projects.
II. PROJECT LEVEL MODEL USAGE

The sections to follow will assume the reader has knowledge of travel demand forecasting models. It should also be remembered that “running the travel demand forecasting model" for project level analysis can imply various things besides running the entire TDF model. For example, most standard model projects (and some complex) can be analyzed by only running the traffic assignment portion of the model (possibly in conjunction with a Fratar step to project the trip table forward in time) in which case checks on socio-economic (SE) data, trip distribution etc. would be irrelevant. Also, most model projects can be run without the mode choice model (barring specific project analysis requirements such as might pertain to an MIS) thus making any transit checking irrelevant.

A. Definition of Model Checking/Refining/Adjusting

All project level modeling will begin with the validated model of record as defined in Section I-B. However, the raw results from this model, while useful for system level analysis are not necessarily suitable for producing the location specific forecasts needed for planning level traffic or above. A process of checking, refining and adjusting is used to overcome this limitation. **It is important to note, that it is not enough to simply conduct the processes described below, these must be documented!** All checks, refinements and adjustments made to models for use in project forecasting must be documented. If model work for ODOT projects is not conducted by ODOT M&F, then the documentation should be provided to ODOT M&F (which will provide them to any relevant MPO) along with the refined/adjusted model and its inputs and outputs. ODOT M&F cannot certify final design traffic without this information.

1. Model Checking

**Model checking** is defined as the process of comparing model results to base conditions and model trends to independently estimated trends to determine their suitability for use.

2. Model Refining

**Model refining** includes, both correcting errors in the network and zonal data discovered during model checking and adding additional detail to the model, either by subdividing traffic analysis zones, creating special generator zones, adding network links or adding additional detail to network links.

3. Model Adjusting

**Model adjusting** is the process of changing the model to produce better results. The key difference between model refinements and model adjustments is that
refinements involve correcting, subdividing or adding detail to model inputs based on specific data while adjustment involve changes to model inputs OR parameters to make the model behave more realistically (note, in the modeling world this would typically be called “calibration”, however, we use the word adjustment here to distinguish the more ad hoc changes made during typical projects from a more rigorous model calibration exercise). The most common type of model adjustment is the changing of network speeds to produce better assignments. Typically, model checks lead to refinements; adjustments are only made as a last resort and their use for project analysis is strictly controlled.

The following sections will detail these three components and are given in the general order that they are conducted. Many of the guidelines will be given in terms of those conducted within the study area versus those conducted on the entire model. As such, definition of the study area is of primary importance and will be discussed next.

B. Defining Traffic Analysis Study Areas

Care should be taken to distinguish the project study area defined by the project manager (PDP task 1.2.A) from the traffic analysis study area (or traffic impact area) defined by the traffic forecasting analyst. The project study area will most likely have been based on other factors such as environmental impacts while the traffic analysis study area should encompass all areas whose traffic will be significantly impacted by any of the project alternatives (consider, for example, remediation of a short bottleneck such as a narrow bridge within existing right of way whose project study area might be quite small while its traffic impacts could be regional). When the two study areas are different, coordination should occur to determine if the project study area should be revised. If the project study area ends up larger than the traffic analysis study area, the project study area should be used for traffic analysis, otherwise the traffic analysis study area (henceforth simply called the study area) is used.

A study area should at a minimum include the following parts of the network:

- The next parallel facility to either side of the project facility
- Two intersections or interchanges before and after the last one physically impacted by the project and one beyond the parallel facilities on cross routes
- All of the remaining network facilities connected to and bounded by these

For complex model projects, a preliminary traffic assignment using the alternative likely to produce the greatest impact can be compared to the base case to determine links with “significant impact”. In this case, the study area could be defined to include the links with more than a 10% change in traffic volumes between the base case and the alternative scenario, but at a minimum would still include the area defined by the three bullet points above.
C. Model-wide Checks

All model work should begin with the validated model of record and thus system-wide statistics should initially fall within the required bounds. However, the base year for a project analysis may be different from the validation year, necessitating system checks with respect to available base year counts. In addition, model checking/refining/adjusting is an iterative process, when adjustments are made for the project, the overall model should be rechecked to ensure that it still performs well overall. This is not to say that a complete revalidation of the TDF model occurs, rather that some of the key validation criteria, as mentioned below, should be checked and reported upon. Typically, refinements do not require the overall model to be rechecked unless they are significant. Significant refinements are those that involve the same types of changes to the model network as those that define a complex project as defined in Section I-A.

ODOT’s “Traffic Assignment Procedures” manual requires the following checks on the overall model assignments:

- %RMSE Check
- VMT Check
- Screen-line Check
- V/G Ratio Check

1. %RMSE Check

%RMSE check is reported either graphically or in tabular format showing achieved versus desired level by volume group. This check is typically ignored altogether for directional volumes under 500 per day (i.e. volume group 1). Because it is crucial to both this check and several others discussed in this document, the desired %RMSE for daily directional volumes is shown below:

<table>
<thead>
<tr>
<th>Volume Group</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group Midpoint</td>
<td>250</td>
<td>1000</td>
<td>2000</td>
<td>3000</td>
<td>4000</td>
<td>5000</td>
<td>6250</td>
<td>7750</td>
<td>9250</td>
</tr>
<tr>
<td>Desired Max. %RMSE</td>
<td>NA</td>
<td>100%</td>
<td>62%</td>
<td>54%</td>
<td>48%</td>
<td>45%</td>
<td>42%</td>
<td>39%</td>
<td>36%</td>
</tr>
<tr>
<td>Volume Group</td>
<td>10</td>
<td>11</td>
<td>12</td>
<td>13</td>
<td>14</td>
<td>15</td>
<td>16</td>
<td>17</td>
<td>18</td>
</tr>
<tr>
<td>Group Midpoint</td>
<td>11250</td>
<td>13750</td>
<td>16250</td>
<td>18750</td>
<td>22500</td>
<td>30000</td>
<td>45000</td>
<td>65000</td>
<td>97500</td>
</tr>
<tr>
<td>Desired Max. %RMSE</td>
<td>34%</td>
<td>31%</td>
<td>30%</td>
<td>28%</td>
<td>26%</td>
<td>24%</td>
<td>21%</td>
<td>18%</td>
<td>12%</td>
</tr>
</tbody>
</table>

---

2 Travel Demand Forecasting Manual 1, Traffic Assignment Procedures, ODOT, Division of Planning, Office of Technical Services, August 2001 (http://www.dot.state.oh.us/urban/data/assmtdoc/assign2000.zip)
2. VMT Check

VMT check is reported by at least the following categories (showing the acceptance criteria in parenthesis): Freeway (7%), Arterial Streets (10%), Other Streets (15%) and Total (3%) for links with counts showing the counted VMT, model VMT and percent difference versus the desired levels.

3. Screen-line Check

The screen-line check reports the counted and model volumes and percent difference and maximum allowed percent difference for all screen-lines defined for the model validation.

4. V/G Ratio Check

The V/G ratio check (volume divided by ground count) is shown as a link map colored as follows:

- V/G<0.5, Dark Blue
- V/G<0.75, Medium Blue
- V/G<1.0, Light Blue
- V/G<1.33, Pink
- V/G<2.0, Medium Red
- V/G>=2.0, Dark Red

Furthermore it should be annotated with the directional assigned volume and count.

5. Other Checks

Besides the overall model assignment checks, there are a variety of additional checks related to other components of the travel demand forecasting model. If model adjustments or recalibration are performed, additional checks should be conducted identical to the relevant checks reported in the subject models validation report. The only other checks pertaining to model refinements or adjustments covered in these guidelines are when the model’s trip distribution is altered through the use of K factors or screen-line penalties or when the model’s trip generation is altered through use of special generators, all other additional checks would only apply if a full recalibration effort were embarked upon (generally not recommended). Additional details on some of these checks are provided in the Study Area Check listing below.
D. Study Area Checks for All Projects

Model checking has 2 main components, checking model base year results with respect to actual conditions and checking the reasonableness of forecast growth rates. The checking within the study area actually begins with data collection as additional and potentially more detailed counts will be needed. Counts from this data collection are coded to the network in the study area before beginning study area checks.

For all projects, the study area should be subjected the following checks:

**Base Year Checks**
- Network Coding Check
- Land Use Checking
- Percent Difference Check
- VMT Check
- Screen-line Check

**Forecast Checks**
- Forecast Land Use Checking
- Growth Rate Check

1. **Network Coding Check**

Several key network attributes should be checked within the study area including: posted speed (POSTSPD), facility type (FACTYPE), area type (AREATYPE) and number of lanes (LANES). Additional attributes such as roadway width (WIDTH), intersection type (IXTYPE), turn lanes (TURNLANE), on street parking (PARKING) and two way left turn lanes (MEDTURN) might be indicated for some projects. Network checking is simply a comparison of the coded attributes with known conditions, obtained either from field inspection, ODOT roadway information database, video log, aerial photos or other sources.

2. **Land Use Checking**

The zonal socio-economic (SE) data should be checked for accuracy within the study area. It is not unusual for the model of record SE data to exclude new developments that have occurred or been announced since the last long range plan update. The level of checking for standard model projects will typically be very cursory but will be much more extensive for complex projects. Comparisons with Census data, QCEW, field studies, Traffic Impact Studies and other sources should be used to verify the accuracy of the SE data. GIS maps and tabular comparisons of these checks and changes should be provided. Ratio checks with respect to households such as population, workers, vehicles etc. are a useful means of pointing out gross errors in SE data. Trip rates from the model
versus ITE Trip Generation\textsuperscript{3} or driveway counts should be compared to
determine the need for special generator rates for important land uses in the
study area.

3 Percent Difference Check

The percent difference check is analogous to the %RMSE check conducted for
the entire model. This check is simply check 4 of Chapter 4 in NCHRP 255\textsuperscript{4}. An
examination of Figure A-3 in this document shows that "Maximum Desirable
Deviation" in individual link volumes is exactly the same curve as the maximum
desirable %RMSE curve used for the entire model. Thus, the percent error of the
daily directional volume of individual links in the study area is simply compared to
the allowable %RMSE curve to determine their acceptability. This is done for 2
reasons: 1. Location specific accuracy is desired for project forecasting rather
than the broader volume group based accuracy of the overall model, 2. There
aren't necessarily enough links in any given volume group within the study area
to calculate volume group based %RMSE. Note that this check, as with %RMSE
is always done by direction.

There is no particular requirement that all or even any link in the study area meet
these criteria. Rather, such discrepancies should be reported and probably lead
to additional refining and adjusting. Volumes for links not meeting these criteria
should not be reported via simple application of the NCHRP 255 volume
adjustment procedure when they are significantly impacted by the project
alternatives but should be subjected to additional scrutiny to identify the cause
and corrective action. This is generally reported in tabular format. For complex
projects, the percent difference check should also be reported using a map
coloring links that don't meet the criteria (red for over assigned, blue for under
assigned similar to the V/G ratio check map) and annotating the model volume,
count and percent difference. This check can also be applied to sub-daily and
truck volumes if the modifications to the allowable percent error curve discussed
in Section II-F are made.

4 VMT Check

The VMT check is exactly analogous to that conducted on the entire model area.

5 Screen-line Check

The Screen-line check uses the same criteria and reporting requirements as that
for the entire model area. The main difference is that additional screen-lines will
most likely need to be defined within the study area for complex projects, while

\textsuperscript{3} Trip Generation, 7\textsuperscript{th} Edition, Institute of Transportation Engineers, 2003
\textsuperscript{4} Appendix A (Users Guide), NCHRP 255, Highway Traffic Data for Urbanized Area Project Planning and Design,
Transportation Research Board, December 1982
for standard projects; the screen-line check need not be formalized but can simply be evidenced by the percent difference check.

6. Forecast Land Use Checking

Forecast year SE data should be checked versus the base year data to ensure the assumed land use changes are reasonable. Ratio and difference checks comparing the various SE variables between base year and forecast year conditions are used to check this data.

7 Growth Rate Check

The growth rate check simply involves listing the resultant growth rate produced by the model against growth rates computed by independent methods such as from count trends, population growth, employment growth, HPMS VMT growth, ODOT congestion management system growth or ODOT annual adjustment factors. Not all of these sources need to be used for every project, the analyst has some flexibility in choosing comparison data to match the needs of the project; the key issue is simply to conduct some kind of checking of the reasonableness of model growth rates. Growth rate checking for planning level traffic only needs to be conducted on the key routes in the study area.

E. Additional Study Area Checks for Complex Projects

Larger, more important projects require more detailed model checking. In addition, if the model will be used to produce “Refined Alternative Level Traffic” for operational level analysis, the checks in this section should be conducted. Not every check listed here need be conducted for every project; those selected depend on the nature of the project and the analysis needed. These additional checks include:

Travel Time Check
Path Check
Select Link Check
Distribution Checks
Modal Checks
Generation Checks

1. Travel Time Check

Travel times from the model can be compared to known travel times (either from field studies or from the purchased travel time data available from ODOT) for important routes in the study area or at least reported for reasonableness. Both the coded free-flow and final “congested” model speeds should be reported versus independent time/speed values and the model volume that produced the “congested” speed. The SPEEDMOD field should also be analyzed in
conjunction with this check to ensure the modeler understands where the model has been adjusted in the past.

2. Path Check

Network routing problems can sometimes be ascertained through V/G ratio plots or percent difference checks. In some cases, however, more detailed analysis of paths is needed. Checking specific paths between origins and destinations is sometimes necessary for this purpose. The paths between certain important OD pairs in the study area can be checked (and plotted) to demonstrate that these OD movements utilize the expected routes. Two useful applications of this check are to make sure a freeway to freeway movement through the study area doesn’t illogically exit the freeway onto surface streets and to make sure a surface street through movement follows a logical path (such as the signed state route) through the study area. Path maps showing the routes used between OD pairs are the best way to report this information.

3. Select Link Check

Select link checking is a further check that may be indicated on certain links that are diagnosed with problems in one of the other checks or that are extremely important to the study. This check helps clarify where the traffic using a link is coming from and is best shown through a band width based select link map. Select link analysis will often be conducted for its own sake to provide useful information to the project team for the evaluation of alternatives and to aid in weave analysis. Select zone checks might also be used in conjunction with select link checks.

4. Distribution Checks

Trip distribution is usually checked for most projects by simply analyzing screen lines. However, for some larger projects, a more in depth review of trip distribution patterns is in order, particularly if K Factors or screen-line penalties are employed. Origin-destination surveys or CTPP Journey to Work data are the most likely data sources for checking the distribution patterns of the model. Desire line maps, trip length frequency distributions (TLFD) and average trip length comparisons are the best way to show these comparisons. The criteria used to judge trip distribution models is that average trip lengths should be within 3% of the validation data, TLFD coincidence ratio at least 70% and the percent difference of individual OD pairs should follow the same criteria used for link flows in the previous section (note: most OD pairs have extremely low volume and thus aren’t much constrained by this curve). Note that as with assignment percent differences, there is no particular requirement that these criteria be met, however, they provide a base line for how well the model is performing and should be reported and possibly lead to additional refining or adjusting.
5. Modal Checks

While the focus of this document is highway projects due to their preponderance and the large number of special circumstances involved with transit projects, checks of trips by mode should be made whenever transit or other modes are a significant component of the study. Typically, the transit system will need to be evaluated system-wide (i.e. it is less amenable to study area focus) however, certain transit routes can be isolated and given special attention. Route specific checks would include route ridership (possibly by various rider types) and boarding and alighting volumes versus known data supplied by the transit operator. System-wide checks should include transfer rates, route ridership, trips by mode by purpose by socio-economic class by time of day and distribution pattern checking using desire line maps as compared to CTPP Journey to Work data. No specific guidance on what is acceptable for these checks is given here; it will need to be determined on a case by case basis.

6. Generation Checks

Study area trip generation checks should generally be made when special generators are added (or in the rare cases when the model is recalibrated by changing its default trip generation). Checks of trip rates by purpose with respect to zonal socio-economic data (population/employment) and production/attraction balancing factors are the standard checks. Trip end intensity maps using thematic maps to highlight the amount of traffic generated in zones overlaid with aerial photography can be useful in pinpointing locations where special generators or zonal data correction may be needed. Comparisons of generated trip ends with row/column totals in the final origin-destination trip table can also be useful for finding locations where subsequent models have changed things in unexpected ways.

F. Special Requirements for Use of Model Data Other Than 24 Hour Link AADT

TDF models are capable of producing various other traffic data besides 24 hour link volumes. The most common of these are:

- Turn Movement Volumes
- Model Period (sub-daily) Volume
- Directional Volumes
- Truck Volumes

The use of these more detailed data requires additional consideration and checking. If any of these checks result in refinements/adjustments to the model, then the 24 hour link volume checks must be repeated.
1. Turn Movement Checks

Model turn movements are typically not used for project level traffic forecasts unless the turn movement does not exist in the existing conditions. Rather, the NCHRP 255 methodology for producing turn volumes is employed. This is mainly because TDF model turn movements are not validated (nor will they in the foreseeable future due to the expense that would be involved to do so). If model turn volumes are to be used for project traffic (either at new or existing locations), volume checks at the turn movement level should be conducted. While the “add a lane/drop a lane” philosophy behind the allowable percent error curve used for link volumes does not really apply to individual turn movements, this curve still serves as a useful bench mark of the relative accuracy of turn movement volumes and should be used as such. As with link checking, turn volumes not meeting this criterion help point the analyst to locations needing refinement or adjustment and also serve a cautionary function when determining the final forecast volume to report for turning movements. Turn volume checks are typically shown in tabular format or on turning movement diagrams. A potential map format is to color intersection nodes based on the number of turn movements not meeting the turn percent difference criteria.

2. Model Period Volume Checks

Today’s TDF models include several independent sub-daily model period assignments, which when summed together produce the total daily traffic. This formulation allows peak demand periods and the resultant route selection and directionality to be segregated from other times of day. There is a natural desire to take advantage of such information in the development of project specific design hour volumes. Before doing so, however, it is important that the period level volumes be subjected to the same validation tests as the daily volumes. If the entire model has been validated with respect to a given time period (say the PM peak period) then this assignment may be used with appropriate study area enhancement as documented for daily link volumes. If not, then a new period level validation must be conducted within the study area at a minimum. The model periods typically cover from 3 to 12 hours, thus hourly count data would need to be obtained, aggregated and coded to the period level network. All the cautions and requirements discussed with respect to daily volume checking/refining/adjusting apply to sub-daily volumes when they are used.

The maximum allowable percent error curve (Table 1) must then be adjusted to reflect the hours contained in the model period. The following table showing the 2005 percent traffic by time of day may be used to adjust these targets. The “Period” column shows the model periods used in the Ohio Standard MPO model. Thus for example, since 16.6% of daily traffic occurs during the AM peak period of the standard model, the target volumes would be multiplied by 0.166 to determine the maximum allowable percent error for a given volume, so a
maximum allowable percent error of 100% would apply to an AM period volume of 166 instead of a daily volume of 1000.

Table 2.  
2005 Urban Daily Traffic Distribution

<table>
<thead>
<tr>
<th>Period</th>
<th>Hour</th>
<th>AADT</th>
<th>Truck</th>
</tr>
</thead>
<tbody>
<tr>
<td>NT</td>
<td>0</td>
<td>0.9%</td>
<td>1.9%</td>
</tr>
<tr>
<td>NT</td>
<td>1</td>
<td>0.6%</td>
<td>1.7%</td>
</tr>
<tr>
<td>NT</td>
<td>2</td>
<td>0.5%</td>
<td>1.6%</td>
</tr>
<tr>
<td>NT</td>
<td>3</td>
<td>0.5%</td>
<td>1.8%</td>
</tr>
<tr>
<td>NT</td>
<td>4</td>
<td>0.8%</td>
<td>2.1%</td>
</tr>
<tr>
<td>NT</td>
<td>5</td>
<td>2.0%</td>
<td>2.7%</td>
</tr>
<tr>
<td>AM</td>
<td>6</td>
<td>4.4%</td>
<td>3.9%</td>
</tr>
<tr>
<td>AM</td>
<td>7</td>
<td>6.5%</td>
<td>5.2%</td>
</tr>
<tr>
<td>AM</td>
<td>8</td>
<td>5.8%</td>
<td>5.7%</td>
</tr>
<tr>
<td>MD</td>
<td>9</td>
<td>4.9%</td>
<td>5.9%</td>
</tr>
<tr>
<td>MD</td>
<td>10</td>
<td>5.0%</td>
<td>6.2%</td>
</tr>
<tr>
<td>MD</td>
<td>11</td>
<td>5.5%</td>
<td>6.4%</td>
</tr>
<tr>
<td>MD</td>
<td>12</td>
<td>5.8%</td>
<td>6.4%</td>
</tr>
<tr>
<td>MD</td>
<td>13</td>
<td>5.8%</td>
<td>6.4%</td>
</tr>
<tr>
<td>PM</td>
<td>14</td>
<td>6.5%</td>
<td>6.5%</td>
</tr>
<tr>
<td>PM</td>
<td>15</td>
<td>7.5%</td>
<td>6.3%</td>
</tr>
<tr>
<td>PM</td>
<td>16</td>
<td>8.0%</td>
<td>5.7%</td>
</tr>
<tr>
<td>PM</td>
<td>17</td>
<td>7.8%</td>
<td>5.1%</td>
</tr>
<tr>
<td>NT</td>
<td>18</td>
<td>5.9%</td>
<td>4.1%</td>
</tr>
<tr>
<td>NT</td>
<td>19</td>
<td>4.5%</td>
<td>3.6%</td>
</tr>
<tr>
<td>NT</td>
<td>20</td>
<td>3.8%</td>
<td>3.2%</td>
</tr>
<tr>
<td>NT</td>
<td>21</td>
<td>3.2%</td>
<td>2.9%</td>
</tr>
<tr>
<td>NT</td>
<td>22</td>
<td>2.3%</td>
<td>2.6%</td>
</tr>
<tr>
<td>NT</td>
<td>23</td>
<td>1.6%</td>
<td>2.3%</td>
</tr>
</tbody>
</table>

Thus, when model period volumes are to be used to aid in the forecasting of design hour volumes; the same study area checks as for 24 hour volumes are used, namely:

- Model period percent difference by link
- Model period VMT
- Model period screen-line

Typically, the growth rate check would still only be conducted for 24 hour volumes (since most independent trend data will only be available at that level). However, the following additional check should be made when using model period volumes:

- Model periods proportion check comparing the proportion of traffic occurring in the model period for the forecast to its base year value. Changes of more than 3 percentage points should be flagged on a link map (thus for example, if 26% of daily traffic occurs on a given link in the
PM peak in the validated base network and 30% in the forecast scenario, the link should be flagged and investigated to ensure the change is logical).

If these procedures are not followed, development of project level K (30th highest hour factors) should follow the traditional method based on permanent automatic traffic recorder (ATR) station counts. Even in cases where these procedures are used, a conversion from model period volumes to K are necessary (even if the model period is a single hour, recall that a conversion from peak hour to design hour is necessary since they are not the same). Use of the model period data in essence simply provides information that allows the analyst to select a forecast K that is different from the base condition.

3. Directional Split Check

Link checking, whether at daily or period level is always done directionally. Thus a properly validated model can be used to provide directional split information. This would typically only apply to the use of a period level model since directional split information from the daily model is less useful. If directional split information will be used, 2 additional checks should be reported:

- Map of model vs. count directional split in base year coloring links off by over 3 percentage points (for example 60% split versus 56%).
- Map of base year vs. forecast year directional split coloring links where the directional split changes by more than 3 percentage points

These checks should be used to ensure the directional splits are reasonable and to make model refinements or adjustments if necessary.

4. Truck Volume Check

Most of the current TDF models have truck components. Some of these have been validated on a daily basis and thus can be used to provide daily percent truck information so long as all cautions and requirements related to AADT volumes presented in these guidelines are also followed for trucks. If the model has not been validated with respect to trucks, then it must be so within the study area at a minimum to be used in this manner. Note that since the maximum allowable percent error curve has its basis in capacity considerations, the curve (Table 1) must be adjusted using truck passenger car equivalents (PCE) prior to use. Thus for example, if a PCE of 2 were used, then the maximum allowable percent error of 100% would apply to a daily truck volume of 500 instead of an AADT volume of 1000. Truck directional splits, turn volumes and period level volumes can all be used from the model if the applicable procedures from this section are successfully applied to trucks as well (note that applying percent difference checks to period level trucks would require 2 adjustments to the maximum allowable percent error curve).
G. Model Refinements for All Projects

Model refinements are changes to the model to either fix incorrect data or add additional detail to the model in the area of the project. Refinements should normally be made to the base year data and then carried forward to forecast years (either by recoding forecast year projects and land use to the refined base year or by modifying the original forecast data by using log files or database tools). Refinements are typically only carried out within the study area based on the results of the study area checking. For standard model projects, model refining will mainly involve correcting the current model coding as listed here. Occasionally, standard projects will also require some minor additions of roadway links or special generators, these are documented in the next section.

Analysts need to keep in mind the nature of the alternatives to be analyzed and the level of information to be provided when deciding what model refinements to make. In general, freeway projects require less refinement, particularly of land use, special generators, zone splits etc. because they draw traffic from a large area and are less affected by specific errors of this kind. Conversely, local street projects require careful attention to access issue near the local street and generally require centroid connector changes, zone splits etc. to provide reasonable results. Likewise, forecasted daily link volumes require less rigorous refinement than turn movement volumes or class volumes or hourly volumes, due to the higher aggregation level. Finally, large capacity additions like lane additions and new roads require less refinement than operational level projects like turn lanes, signal coordination etc. where it often becomes necessary to refine the models to an extreme level for input to subsequent traffic operations models.

1. Correct Network Coding

Correct network coding of fields: Posted speed (POSTSPD), facility type (FACTYPE), area type (AREATYPE), number of through (LANES), roadway width (WIDTH), intersection type (IXTYPE), turn lanes (TURNLANE), on street parking (PARKING) and two way left turn lanes (MEDTURN) as well as any period specific over-rides.

When network coding is updated, it is important that the ODOT network calculators\(^5\) (capacity, speed, turn penalty) be rerun on the corrected network.

2. Correct Centroid Connectors

Centroid connector locations should be checked versus actual zonal access points and reconnected appropriately.

\(^5\) ODOT Capacity Calculator Documentation, http://www.dot.state.oh.us/urban/data/odotdoc2.zip
3. Correct Zonal SE Data

There are a couple things to keep in mind with regard to SE data corrections. First, while the state (ODOT and ODOD) require that the model of record respect county wide control totals for population, there is no particular requirement that the SE data used for project analysis respect such control totals. Second, maintenance and updating of SE data is primarily an MPO task, so they should be coordinated with closely in the updating of such data.

Any such corrections should be documented in detail and transmitted to ODOT M&F via both the updated network or SE file and a list of each specific change that was made.

H. Additional Model Refinements for Complex Projects

Larger projects or those requiring very detailed results may require additional refinements to the model of record. These include:

1. Adding additional network detail in the study area

Additional roads, ramps etc. not included in the model might be added in the study area to give more refined results. When using intersection based delay modeling (as in the Ohio Standard model) additional network coding may be necessary to properly represent some signalized intersections at driveways or other low type facilities, this coding may point to the need for zone splits (and vice versa). Any added network must contain all of the fields specified in the previous section and the ODOT network calculators should be rerun on the refined network.

2. Splitting zones

Zones should be subdivided, when necessary, so that the vast majority of land uses within the same zone access the public street system the same way. Each individual access point does not have to be unique; rather the centroid connectors for the zone should connect to the roadway links that all or most of the development in the zone can access directly.

3. Adding special generators

Important developments in the study may need to be made special generators if indicated by the trip end or link volume checks. This might also be done for a smaller project if the focus of the project is the development in question.
4. Coding more detailed intersection operating characteristics

When intersection level delay modeling is used, the network data related to this (besides those data maintained on the links) can be updated. Currently, Cube’s Junction modeling capability is used for the standard models. However, while the intersection type and physical turn lanes are maintained on the link coding, details regarding the signal phasing and timing are assumed. This information can be entered using Cube’s Junction editor if it is known. Since hard coded signal operations are not flexible and therefore cannot respond to future changes, another method is to adjust the FACTYPE and IXTYPE coding of the links entering each intersection so that the default characteristics are more reflective of the actual operations (this requires more knowledge of the ODOT capacity/junction calculators^4).

I. Model Adjustments

Model adjustments are changes to the model to make it produce better results. These adjustments are not based on incorrect/better data but rather are changes to model operation and thus should be viewed as a last resort. While a whole range of model adjustments are possible, parameter changes within the model itself are generally not recommended. Such changes constitute recalibration of the model and can involve: trip rates, trip length (friction factors), vehicle occupancy factors, mode specific constants, time of day percentages etc. If such changes are necessary, say for example for a major transit project, consultation with ODOT M&F would be necessary, the very complex model project process would probably be followed and additional validation reporting as mentioned previously would be required. Adjustments that might commonly be used where necessary include:

1. Adjustment of network link speeds via the SPEEDMOD field

Small adjustments (say within 2 or 3 MPH) are not a major cause for concern because network speeds are coded from a speed table of averages and the expected variances in speed on individual links are well within this range. More severe changes should be made with care. Speed adjustments should be made using the SPEEDMOD field and then rerunning the ODOT speed calculator. If other speed fields are modified directly instead, the next time the calculators are run, any adjustments will be lost. This method also helps to keep speed adjustments well documented on the network.

2. Addition of screen line penalties or K factors

Problems with screen-line volumes or otherwise noted in distribution checking can sometimes be solved with screen line penalties or K factors. The Ohio
Standard model has provision for the addition of screen-line penalties where needed.

Any adjustments of this nature should be documented with a map showing the links changed and a listing of all changes with justification for the change.

**J. Feedback of Refinements/Adjustments to the Regional Model & Impact on Previous Analysis**

Model adjustments should usually be made to the overall model and their impact checked on overall model validation. As documented previously, large refinements resulting from major errors/omissions in the model, should also be reflected and checked in the overall model. Small refinements do not need to be checked in this way. If ODOT M&F does not conduct the model work, then when the adjusted/refined model meets the validation criteria mentioned previously, the adjusted/refined model, documentation of the changes, and documentation of the revised validation results should be transmitted to ODOT M&F who will send them along to the relevant MPO if necessary.

In addition, any adjustment or refinement, even those too small to require revalidation of the regional model may require reanalysis of any project alternatives completed prior to the change. In general, it is good practice to reanalyze any such alternatives; however, this may not always be practical. Instead, analysts can compare the change (or a range of changes via a sensitivity analysis) wrought by any such refinement or adjustment to results obtained from previous alternatives analysis to demonstrate when this is not necessary.

**K. Development of Refined Alternative Level Traffic**

Refined alternative level traffic is only needed for some very rare cases as defined in Section I-B. Since such projects tend to be unique, only some very general guidelines are offered here.

Matrix estimation (ME) techniques are a common way to further refine the TDF model results to better match traffic counts in the study area. This technique should only be applied after the previously described checking/refining/adjusting process has been carried out with the travel demand forecasting model itself. There are two important reasons for this; 1. the ME process is rather static, i.e. the adjustments that result cannot respond to changes in the transportation system or the land use the way the TDF model can; 2. ME is meant to produce changes to the input demand model (trip table), however, if applied to a model with network problems, it will adjust the demand data in strange ways to compensate for this.
Some software can apply ME at the turn volume level (as opposed to link level). If turn volumes are to be the final product of refined alternative level traffic then this should be done rather than link level ME.

Some software allows confidence levels to be attached to various input data to the ME process. If this is the case, the confidence levels for those data should have approximately the following relationship (these are given as relative values, note the order of magnitude relationships):

Trip table cell values: 1
Zonal trip ends for most zones: 10
Older or not so good counts: 50-75
External zone trip ends based on counts (50-100 depending on how new/good the count)
Zonal trip ends for a special generator zone based on driveway counts: 100
Newer or better counts: 100

These values represent a starting point only, a good understanding of the particular ME process being used and how each data element and the amount of data impacts the final results is necessary for proper application of an ME process.

Count consistency is extremely important to ME processes (particularly those based on turning counts). Before an ME process is applied, all counts in the study area must be checked for consistency with one another. For example, counts on adjacent links with no centroid connectors between shouldn’t be different, one link entering an intersection, shouldn’t have a higher count than all the other links combined etc.

When an ME process is used, a method for translating those adjustments to the forecast year is needed. There are two methods that have been used successfully:

- Calculate the cell by cell differences between the TDF model trip table and the ME trip table and apply this delta matrix to the TDF forecast trip table (note, ratios are generally not used for this because of their instability at the relatively low volumes of individual trip table cells)
- Fratar the ME trip table to the forecast year trip ends of the TDF model

The advantage of the first method is that changes in the underlying trip distribution of the TDF model will be reflected in the forecast, however its disadvantage is that the static “delta” adjustments reflect neither these changes nor changes in zonal land use that may impact trip generation. In addition the differences can produce negative values and removing these via a zero floor will produce changes to overall volumes that are inconsistent with either source.
More advanced cell by cell adjustment methods such as the ODOT modified NCHRP 255 volume adjustment process or the method proposed by Daly\textsuperscript{6} can alleviate these difficulties. The Fratar method’s advantage is that the lack of a delta adjustment allows the adjusted matrix to be fit to future land use patterns more precisely; its disadvantage is that it does not allow the TDF model itself to say anything about changes in distribution patterns. When employing the Fratar method, if the ME process did not conserve zonal trip end totals, the modeled forecast and base year trip ends should be divided to produce a ratio that can be applied as a growth factor. The Fratar method is preferred.

Often times, a sub-area model will be created for use in the development of refined alternative level traffic. There are a couple of important points related to this. First, before extracting a sub-area, at least some review of the study area assumptions should have been made to ensure the sub-area is large enough (extracting a sub-area somewhat larger than the study area isn’t a bad idea either). Second, count data (which could include truck counts and period level counts depending on what model information will be used as documented in the previous section) must exist on every link crossing the sub-area boundary. Third, it is a good idea to Fratar the sub-area trip table to match external volumes before conducting the study area checks/refinements/adjustments. This is because the creation of the sub-area model implies an a priori assumption that the known conditions at the sub-area boundary are fixed and the subsequent refinements and adjustments should not be compensating for problems at this boundary.

\textbf{L. Volume Reporting}

Generally, regardless of whether planning level or design traffic is being provided, the adjusting process in NCHRP 255 (Chapter 4) can be used to adjust project volumes from those reported by the models. These can be applied in bulk on a link by link basis for planning level traffic. However, it is important to keep in mind the capacity constraint of links when bulk applying these adjustments as there is no inherent restraint to the volumes that can result from the NCHRP process as there is within the TDF model itself.

As mentioned previously, turn volumes from the model are usually not used except for new locations or if turning movement level matrix estimation was used to produce refined alternative traffic. In other cases the process documented in NCHRP 255 (Chapter 8) is employed.

Traffic forecast volumes should be rounded to the nearest 10. Even greater rounding of larger volumes to emphasize the degree of confidence in the numbers is prudent but not required.

M. Model Versioning

Maintaining a model versioning system and reporting on the version used for each project analysis is an important aspect of the project modeling process to ensure the results can be reproduced. While this system need not be particularly formal, the following information should be contained in the project modeling documentation:

- Vendors version number for modeling software employed (example: QRSII Version 5.02)
- Version number and/or date for the particular travel demand model employed (example: Ohio Standard Model Version 5.4, 11/17/10)
- Source model data sets/validation version (example: Akron Year 2000 Validation/2008 LRP Update Model of Record, 05/29/08)

N. Documentation

As mentioned previously, merely following the procedures discussed in these guidelines is not sufficient, careful documentation of the process and results is essential. Any project analyzed with the travel demand models should result in a technical memorandum that accomplishes the following three objectives:

- Why the work was conducted.
- How it was conducted so another person could replicate the results.
- Show the results requested.

The first bullet is best accomplished by first listing project identifiers in the title and/or introduction to the technical memorandum and including references to the original request and documentation of subsequent conversations and agreements all of which should be placed in an appendix. The second bullet should tell exactly what was done. Including sections such as:

Assemble Data
Refine Model
Check Model
Adjust Model
Create Alternatives

is a useful way to organize the work. This section should include detailed references to the sources of the model inputs (this could be in various forms such as a Windows folder/file reference, reference to an email, or a web address) and the versioning information discussed previously as well as specifically what was changed in these source files to produce the project inputs. The last bullet is handled by including whatever charts, tables, maps etc. are necessary depending on what was requested. Example technical memoranda are available from ODOT M&F upon request.