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I. Introduction

Purpose

The purpose of the Oregon Modeling Protocol is to promote effective and efficient development and use of transportation models that may be used in determining the allocation of state and federal resources for transportation projects and programs within the State of Oregon. The protocol sets requirements for the development and use of the statewide, MPO, and local urban area models to help ensure that these activities are performed at levels of acceptable professional practice and that modeling products conform to federal and state requirements. Other existing modeling guidelines, such as the *ODOT Travel Demand Model Development and Application Guidelines* and the *ODOT Travel Demand Model Development Procedures Manual*,[1] are incorporated by reference in the protocol. It is also the purpose of the protocol to coordinate modeling efforts at the statewide, MPO, and local levels and to increase standardization in the development and use of models throughout the state.

Organization

Separate protocol is defined for the following categories of models available within Oregon: the ODOT statewide model, MPO models, ODOT urban area models, and non-ODOT urban area models. Within each model category, the protocol is further classified as either model development protocol or model use protocol. For purposes of the protocol, the term "model development" means the process used for developing or adjusting models. This may include the definition of model requirements, model specification, model estimation, model calibration, model validation, and model adjustment. Model use refers to model application, including the preparation of model input data, and the use of model output data.

[1] These documents may be viewed at: http://www.odot.state.or.us/tddtpau/modeling.html#General Papers.

II. Statewide Model Protocol

The second generation statewide land use – transport model simulates economic, land use, and transport interactions within the State of Oregon. The model framework is a combination of seven connected modules. These are:

- Economic model
- Demographic model
- Household allocation model
- Production allocation model
- Developer model
- Activity interactions model
- Transportation model

The macro-scale economic and demographic models provide statewide activity totals based upon national and regional trends. Information from other macroeconomic models and demographic forecasts can be included in this component of the model. These areawide total activities are allocated to households and businesses in each zone. The land development module is used to represent the actions and effects of the development of land and space in response to market conditions. An interactions model links up factors of production and consumption in each of the zones, including imports and exports. These activities result in the flow of people and commodities between zones. Finally, the transportation model generates trips from the demographic and economic flows and routes them through a multimodal transportation network.

The system evolves through time in discrete year-by-year steps. Household demographic changes, residential location decisions, employment and associated training choices and daily activity patterns are represented using micro-simulation. Travel tours by household members and commodity movements are also micro-simulated. Each trip is loaded onto the transport supply networks in a link-to-link manner.

Due to the unique nature of the statewide model, the protocol is more limited than that for the MPO models and ODOT urban area models. By definition, the statewide model is the only one of it's kind in Oregon. Due to the hardware requirements for operating the model, it will be centrally located within ODOT's offices only. Also, because of the complexity of the model, it will be applied only by ODOT staff or their consultant or by Metro staff working with ODOT or their consultant.

Model Development Protocol

The statewide model development protocol addresses coordination of statewide model updates with MPOs and local jurisdictions and the preparation of model documentation.

Coordination of Model Updates

Any changes to the statewide model that may affect existing linkages to MPO or local urban area models should be coordinated with the MPOs and local jurisdictions. At a minimum, this would involve providing information about the changes and their effects on existing model linkages and, in some cases, if appropriate, working with the MPOs and local jurisdictions beforehand to determine what form the changes should take. These may include changes to:

- Definition of household segments and employment sectors;
- Trip purpose definition;
- Definition of time periods and modes; and
- TAZ system near the local modeling area boundary.

Changes in the definition of household segments and employment sectors would need to be known in order to maintain consistency between the socioeconomic data used in the local models and the statewide model either at the TAZ or areawide control total level. Changes in the remaining items would need to be known if travel data (trip matrices or link volumes) from the statewide model were to be used in the local models. With regard to TAZ system changes, it is assumed that within the local modeling area boundary these would be initiated by the MPO or local jurisdiction and not at the statewide model level.

Model Documentation

Model documentation should be prepared for all statewide model updates. This should include a description of the technical update process in sufficient detail to allow a basic understanding of how the model was revised and its main characteristics. The documentation should also contain any changes to the step-by-step operating instructions for the revised model components, so that a user who is unfamiliar with the model may apply it properly. Depending on how the model has been modified, this information should be included in either a new model document or as a part of the existing document. The documentation should be prepared according to the guidelines contained in the *Model Development and Application Guidelines*.

Model Use Protocol

As described at the beginning of this section, the statewide model will be applied only by ODOT staff or their consultant or Metro staff working with ODOT staff or their consultant. Forecast data for standard scenarios, such as the base year or future year baseline alternative, will be made available to the MPOs and local jurisdictions free of charge. A standard set of model output will be produced for each of the scenarios. In general, special purpose applications of the statewide model will be performed on an as-requested basis according to an established fee schedule.

As with model updates, certain changes in the application of the statewide model should be coordinated with the MPOs and local jurisdictions. These are primarily:

- Changes to the definition of standard scenarios, such as network modifications near the local modeling area boundary; and
- Changes in socioeconomic data within the local modeling area at the TAZ or areawide control total level.

A copyleft agreement will govern the use of the statewide modeling software by parties outside of Oregon (e.g., other state DOTs). This means that the software will be made available free of charge by ODOT and that users will be allowed to make changes to the software. If users choose to redistribute the software, however, this agreement also requires that it must be passed along with the same freedom to further copy and change it. This prevents conversion of the program into proprietary software, in which case the original freedoms would be removed. The program documentation is also copylefted, with the same redistribution requirements that apply to the software.

III. MPO Model Protocol

Model Development Protocol

Model Development Standards

The standards to be followed in the development of MPO models are embodied within the *ODOT Travel Demand Model Development and Application Guidelines* and the *ODOT Travel Demand Model Development Procedures Manual*. These documents describe the requirements for overall model structure and the required features for individual model components. They also describe the procedures to be followed in the development of models. Separate requirements are presented for models in MPO and non-MPO areas.

The *Model Development and Application Guidelines* and *Model Development Procedures Manual* were developed to meet or exceed federal and state requirements for modeling. Therefore, models developed in accordance with these documents are also considered to be in compliance with the federal and state requirements. These include:

- The 1993 federal Transportation Conformity Rule "Procedures for Determining Regional Transportation-Related Emissions", which includes a list of attributes which network-based transportation demand models must possess in regions with serious, severe, or extreme ozone or carbon monoxide non-attainment.
- The Oregon Transportation Conformity Rule, developed by the Oregon Department of Environmental Quality, which is similar to the federal conformity rule, but more stringent with regard to modeling requirements.
- The Transportation Planning Rule (TPR), established by the Oregon Land Conservation and Development Commission in 1991, which identifies general requirements for transportation planning at the statewide, regional, and local levels. Although the requirements of the TPR are not specific to modeling, they imply certain model features that would be necessary for transportation planning.

Model Development Process

Any changes to the TAZ system within the MPO modeling area should be coordinated with ODOT to maintain consistency between the statewide model and the MPO models. Annual reviews of the statewide model's and MPO models' zone systems should be conducted by ODOT and MPO staff, with more frequent reviews if significant changes have been made to either. Based on the reviews, any updates required to maintain

consistency between the zone systems must be agreed upon and implemented by ODOT and/or the MPOs.

Model documentation should be prepared for all MPO model updates. This should include a description of the technical update process that is sufficient to allow a basic understanding of how the model was revised and its main characteristics. The documentation should also contain any changes to the step-by-step operating instructions for the revised model components, so that a user who is unfamiliar with the model may apply it properly. Depending on how the model has been modified, this information should be included in either a new model document or as a part of the existing document. The documentation should be prepared according to the guidelines contained in the *Model Development and Application Guidelines*.

Determination of the adequacy of MPO models for use in state air quality conformity analysis may be accomplished in either of two ways:

- Through the existing interagency consultation process as required by the Oregon Transportation Conformity Rule (OAR 340-252-0060(2)(e)); or
- Certification by the OMSC.[2]

Model Use Protocol

For purposes of the protocol, model use is separated into the three categories of modeling data, model application, and model output.

Modeling Data Protocol

Modeling data consists of data that is used either as input to travel demand models or for model calibration/validation. (Although model calibration/validation is actually a part of the model development process, this type of data is discussed here for convenience along with the other types of modeling data).

Model input data generally falls into the categories of socioeconomic data and modal system data. Socioeconomic data describes the population that either works or lives in a TAZ. Typical socioeconomic variables include population, households by type and employment by type. Modal system data describes the major features of each modal

[2] The OMSC is the Oregon Modeling Steering Committee, the organization responsible for coordinating transportation modeling efforts of state, regional, and local agencies and promoting state-of-the-art transportation modeling in the State of Oregon. It is comprised of federal and state agencies responsible for receiving and administering federal transportation funds, including the Federal Highway Administration, the Oregon Department of Transportation and other state agencies, and MPOs.

system. For example, roadway data may include the number of travel lanes for each link, travel speeds, and parking characteristics. Transit data may include service frequencies and the location of transit stops., modal use data, and travel cost data.

Model calibration/validation data measures the levels of existing modal use. This consists primarily of traffic counts and transit ridership volumes.

MODELING DATA STANDARDS

Standards for the collection, preparation, and maintenance of modeling data are contained in the *Model Development Procedures Manual*. The standards pertain to the following areas for each data category:

Socioeconomic Data

- Types of data to be collected;
- Acceptable sources of base year data;
- Acceptable forecasting methods for future year data;
- Consistency of data with local comprehensive plans and areawide control totals;
- Data checking and editing; and
- Storage format

Urban Design Data[3]

- Types of data to be collected;
- Measurement methods;
- Acceptable forecasting methods for future year data;
- Data checking and editing; and
- Storage format

Modal System Data

- Types of data to be collected;
- Estimation methods (for data such as parking costs);
- Frequency of updates;
- Data checking and editing; and
- Storage format

[3] For example, the number of local intersections, households, and retail business establishments within a half-mile of each TAZ comprising a composite urban design variable.

Modal Use Data[4]

- Time-of-day, day-of-week, season-of-year;
- Location;
- Vehicle classification;
- Adjustment methods;
- Frequency of updates;
- Data checking and editing; and
- Storage format

Model Application Protocol

The model application protocol describes the way in which MPO models are to be applied and the process that is to be followed in doing so.

MODEL APPLICATION STANDARDS

The MPO model application standards are embodied within the *Model Development and Application Guidelines*. Adherence to these requirements will ensure that the models are applied in a manner that is consistent with their development. This will enhance the accuracy and reliability of the model output by minimizing the biases that can occur with improper application.

COORDINATION WITH STATEWIDE MODEL

Output data from the statewide model will available for use with the MPO models. Although it is unlikely that all of the MPOs will use the same data items, a list of the MPO-related output is provided below:

Socioeconomic Data

- Households by household segment (TAZ or areawide control total); and
- Employment by sector (TAZ or areawide control total)

Travel Demand Data

- Person trips (I-X, X-I, X-X) by trip purpose, period of the day, and mode of transport;
- Truck trips (I-X, X-I, X-X) by period of the day;
- Total vehicle trips (I-X, X-I, X-X) by period of the day and mode; and

[4] Items 1 – 4 refer to traffic counts only.

- Network link volumes by vehicle mode

A complete list of all of the statewide model output and its potential uses is provided in Appendix A.

Use of the statewide model output by the MPOs should be closely coordinated with ODOT to ensure that that the data is being properly interpreted, that it is consistent with the scenarios being modeled, and that the latest versions of the data are being used.

One coordination issue that will be particularly important is in maintaining consistency between the socioeconomic data used within the MPO models and the travel demand forecasts from the statewide model. The areawide control totals and distribution of land uses assumed within the MPO models must be reasonably similar to those reflected in the statewide model forecasts of internal-external and external-internal travel for the MPO areas. Otherwise, the statewide model forecasts of these trips may appear high or low or inaccurately distributed in comparison to the internal activity levels assumed with the MPO models.

Another area of coordination will be in maintaining consistency between the MPO model networks and the statewide model networks. The MPOs should provide information to ODOT regarding any significant changes to their model networks so that the same changes may be reflected within the statewide model.

MODEL APPLICATION BY NON-MPO USERS

In certain cases, MPO models may be applied by non-MPO staff. This may occur, for example, if a local jurisdiction is interested in using the model for analysis on a specific project in their area. To help ensure that their model will be properly applied in these cases, an MPO may wish to have protocol in place that defines the allowable range of application for the non-MPO user and the procedure that is to be followed in doing so.

This type of protocol is defined in Section IV., pages 16 – 21 for the application of ODOT urban area models by non-ODOT users. If desired, the MPOs may use this as an example for the development of protocol addressing the use of their models by non-MPO users.

Model Output Protocol

An MPO may also wish to establish model output protocol that addresses the areas of how model output is to be made available and how the output is to be used. Protocol of this type for ODOT urban area models that is found in Section IV., page 23 may be used as an example by the MPOs in defining their own model output protocol.

IV. ODOT Urban Area Model Protocol

ODOT urban area modeling protocol applies to models that:

1) Have been or will be developed by ODOT staff or with ODOT funding; and
2) May be used by non-ODOT staff (local jurisdictions, other public agencies, or consultants).

Model Development Protocol

Model Development Standards

The standards to be followed in the development of ODOT urban area models are embodied within the *Model Development and Application Guidelines* and the *Model Development Procedures Manual*. Separate requirements are presented for models in MPO and non-MPO areas (areas with less than 50,000 population). The requirements for non-MPO areas are to be followed in the development of ODOT urban area models.

Within the non-MPO category, these documents are also structured with the understanding that modeling requirements vary between urban areas, depending upon the size of the area, whether or not it is an air quality attainment area, and the availability of modeling data and professional expertise. Therefore, adherence to the requirements in these documents will encourage standardization, so that models developed for similar urban areas will have similar structures, features, and capabilities.

Model Development Process

The protocol covering the model development process pertains to the general procedural steps necessary to ensure that models are developed that are suited for their intended application and that model development tasks are performed as efficiently as possible. It does not include technical modeling requirements, which are primarily addressed in the *Model Development and Application Guidelines* and *Model Development Procedures Manual*.

The model development process to be used consists of the following steps:

1) Preparation of work program and budget

    a) Definition of model requirements
    b) Preliminary model specification

c) Preparation of preliminary work program and budget
d) Review of products from steps (a) – (c) by OMSC
e) Revision of work program and budget
f) Final approval of work program and budget by OMSC

2) Model development

a) Estimation and calibration of model components
b) Review of model components by OMSC
c) Revision of model components
d) Model validation
e) Review of model by OMSC
f) Development of model documentation
g) Final approval of model by OMSC

PREPARATION OF WORK PROGRAM AND BUDGET

The first step in the preparation of a model development work program and budget is the definition of model requirements. The purpose of the requirements is to identify specific model user needs, as well as any relevant requirements from the *Model Development and Application Guidelines* and *Model Development Procedures Manual*, such as model outputs for air quality non-attainment areas.

Model user needs are defined by:

- the ultimate uses of the model;
- the anticipated availability of model input data; and
- the expertise of the model user.

Once the ultimate uses of the model have been determined (e.g., subarea traffic impact analysis), the specific types of output required to support those applications can be identified. User needs may also be determined by the availability of model input data. For example, the type of a model developed for an area with a limited amount of input data may be significantly different than that for an area with a broader range of data. Similarly, the model application approach should be consistent with expertise of the user, with greater flexibility provided as the level of user knowledge increases.

If the model will likely be used by non-ODOT staff, such as a local jurisdiction, user needs should be identified through interviews with local staff.

An additional requirement for all ODOT urban area models is consistency with the ODOT statewide model. This is primarily related to the definition of TAZ boundaries, so that local model TAZs should either conform to or not straddle statewide model TAZ boundaries.

The product of this first step is a set of written model requirements. These are to prepared in all cases, even when the model is intended solely for internal ODOT use.

In the second step, the model requirements are used as the basis for developing a preliminary model specification, in which each component of the model is identified, together with a detailed description of its data requirements and outputs. A list of the required model development data is prepared, such as travel survey data, land use and socioeconomic data, and transportation network data. Linkages between the components are also identified, with the resolution of any inconsistencies. Refinements may be made to the preliminary specification at the beginning of the actual model development.

With the information from the model specification on what the model will look like, a preliminary work program and budget is to be prepared. The work program should list in detail all of required tasks for the model development process. Relationships between the tasks should be shown, together with timelines, in a Gantt chart-type format. A detailed budget estimate is to be prepared, based on estimates of staff hours by staff person for each task. The budget estimate should be as realistic as possible and not underestimate the number of hours or cost. If information is available on the actual number of hours and cost for a similar, previous model development project, this may serve as a useful guide.

The products from the previous three steps (the model requirements, preliminary model specification, and preliminary work program and budget) are to be submitted to the OMSC for review. At an OMSC meeting, members will provide comments and recommendations to those individuals who will be involved in the model development effort. A written summary of the comments and recommendations will also be provided. The model specification, work program, and budget are to be revised and resubmitted to the OMSC in accordance with the recommendations. The OMSC will then provide written, final approval of the work program and budget. Work on the model development is not to proceed without the final approval of the OMSC.

MODEL DEVELOPMENT

The first general phase of model development involves estimation and calibration of the various model components using observed travel data. This is to be done according to the requirements contained in the *Model Development and Application Guidelines* and the *Model Development Procedures Manual*. It should be organized into logical stages in the

work program, so that all related components are developed in one stage, followed by development of the other related components in subsequent stages. For example, the first stage may consist of estimation and calibration of the household submodels and trip generation models, with development of the destination choice model in the second stage.

Following the completion of each stage, the OMSC will review the model components using information on model performance provided by the model developer. Review points will be established within the work program. The OMSC will then provide a written summary of comments and recommendations, including proposed model revisions. If necessary, the results of the review may also be discussed with the model developer at an OMSC meeting. Revisions to the model components are to be made according to the recommendations prior to commencing work on the next stage of model estimation and calibration.

The second general phase of model development is validation, in which the entire model chain is applied using base year input data, and the output is compared to detailed travel data, such as traffic counts and transit ridership by route. This is the final test of the model's ability to replicate existing travel behavior. The model tests and performance standards contained in the *Model Development and Applications Guidelines* and the *Model Development Procedures Manual* are to be followed in the model validation. As in the model estimation and calibration phase, the model developer will be responsible for providing model validation data to the OMSC for review. The OMSC will prepare a written summary of review comments and recommendations, which are to be used in performing any final model adjustments that may be necessary.

In addition to providing technical recommendations, the OMSC will review the status of the work relative to the budget and schedule in Phases 1 and 2. Information on work progress and budget expenditure will be submitted to the OMSC together with the technical data and an assessment of whether the remaining work can be completed within the existing budget and schedule. Based on this information, the OMSC will propose recommendations for changes to the work scope, budget, and/or schedule, if necessary.

Model documentation is to be prepared in the third general phase of model development. This should include a description of the technical model development process in sufficient detail to allow a basic understanding of how each model component was developed and its main characteristics. The documentation should also contain step-by-step instructions on the operation of each component, so that a user who is unfamiliar with it may apply the model properly. It is to be prepared according to the model documentation guidelines contained in the *Model Development and Application Guidelines*. The documentation will be submitted to the OMSC for review and comment. Following any necessary revisions to the documentation, the OMSC will provide final written approval of the model.

TECHNICAL SUPPORT

A key factor in the efficient development of accurate, reliable models is the availability of adequate technical support. This will be accomplished in two ways:

- Periodic OMSC review, as described above; and
- As-needed support

The as-needed support will be provided through an OMSC "point-of-contact" who will be assigned at the beginning of the study. Requests for assistance are to be made to this OMSC member, who may respond directly, coordinate a response from other OMSC members, or refer the model developer to another member.

ROLES/RESPONSIBILITIES

A summary of the responsibilities of the model developer and OMSC throughout the model development process are shown in the table below.

	Responsibility	Products
Model Developer	1. Preparation of work program and budget	• Model requirements document • Preliminary model specification • Preliminary work scope and budget • Final work scope and budget
	2. Adherence to *Model Development and Application Guidelines*, *Model Development Procedures Manual*, model development protocol, and work program	
	3. Provision of materials for OMSC periodic reviews	• Technical summaries of model development by phase/stage • Information on work, budget, and schedule status
	4. Attendance at OMSC review meetings	
	5. Revisions per OMSC recommendations	
	6. Request for technical assistance from OMSC when needed	

	Responsibility	Products
OMSC	1. Review of work program and budget	• Written comments and recommendations on preliminary work program and budget
	2. Final approval of work program and budget	• Written approval
	3. Review of model development technical summaries and status of work, budget, and schedule by phase/stage	• Written comments and recommendations
	4. Periodic review meetings with model developer	
	5. Review of model documentation	• Written comments and recommendations
	6. Provision of technical support on "as-needed" basis	
	7. Final model approval	• Written approval

Model Use Protocol

For purposes of the protocol, model use is separated into the three categories of modeling data, model application, and model output.

Modeling Data Protocol

MODELING DATA STANDARDS

The discussion of modeling data standards for ODOT urban area models is the same as that provided for MPO models in Section III., page 7.

JOINT COLLECTION OF MODELING DATA

To the maximum extent possible, it will be desirable to have non-ODOT model users participate in the modeling data collection process. Although this participation will be entirely voluntary, it will benefit both ODOT and the user by having more accurate and up-to-date modeling data available than may otherwise be possible.

To facilitate this arrangement, an ODOT staff member will be assigned as a "point-of-contact" for each urban area model. A model database will also be established by ODOT for each model. For data collected by non-ODOT users, the ODOT point-of-contact will have the responsibilities of review, acceptance, and incorporation of the data into the

database. The point-of-contact will also be responsible for providing technical support to the user regarding collection and preparation of the data. All requests for assistance by the user are to be directed to this staff member.

Model Application Protocol

The model application protocol describes the way in which ODOT urban area models are to be applied and the process that is to be followed in doing so.

MODEL APPLICATION STANDARDS

The model application standards are embodied within the *Model Development and Application Guidelines*. For ODOT urban area models, the appropriate standards are contained within the section for non-MPO areas (urban areas with less than 50,000 population). Adherence to these requirements will ensure that the models are applied in a manner that is consistent with their development. This will enhance the accuracy and reliability of the model output by minimizing the biases that can occur with improper application.

COORDINATION WITH STATEWIDE MODEL

The discussion of coordinating the use of statewide model data with ODOT urban area models is the same as that provided for MPO models in Section III., pages 8 - 9.

MODEL APPLICATION BY NON-ODOT USERS

In certain cases, ODOT models may be applied by non-ODOT staff. To help ensure that the models will be properly applied in these cases, the following protocol describes the allowable range of application for non-ODOT model users and the procedure that is to be followed in doing so.

Range of Model Application

The range of model application refers to which model components the user may operate and the model input data or model parameters for each component that the user may alter. A very limited range of application, for example, would be the use of a traffic assignment model to modify network links to reflect the effects of proposed road improvements. A full range of application may include the use of all model components to allow, for example, the development of travel forecasts for a set of areawide land use alternatives.

Non-ODOT model users may use ODOT urban area models for an intermediate range of application that falls between the two examples given above. This consists of two primary areas of application:

- Trip matrix adjustment; and
- Network assignment.

Trip matrix adjustment involves the modification of base trip assignment matrices in order to reflect differences in assumed land uses within a particular subarea or to represent a subarea in greater detail. In the first type of application, the land use differences must be relatively minor, so that the areawide distribution of trips contained in the base trip matrix is not significantly affected. In the second type of application, the TAZ structure within the subarea is disaggregated as a part of a model "focusing" procedure. In both cases, the base trip matrix is rebalanced to reflect the associated changes in zonal trip ends within the subarea.

Network assignment is used to identify changes in travel flows that would result from changes in network structure or network characteristics (link capacity, for example). Typically, this is done to evaluate the effects of system alternatives or the effects of specific network improvements. Special network assignment procedures may also be used to identify the origins and destinations of trips using specific links in the network (select link analysis) or the distribution of trips to and from a particular TAZ (select zone analysis).

With both of these applications, none of the model components preceding the network assignment step would need to be used.

A list of the modifications and modeling procedures that the user may perform within these application areas is presented in the table below.

Application Area	Modification or Model Procedure
Trip Matrix Adjustment	1. Modification of zonal trip ends
	2. Zone system disaggregation
	3. Rebalancing of base trip assignment matrices
Network Assignment	1. Addition, deletion, or modification of network links and centroid connectors
	2. Addition, deletion, or modification of network nodes and centroids
	3. Modification of link capacities
	4. Modification of link speeds

Application Area	Modification or Model Procedure
	5. Modification of link volume-delay function (VDF) codes
	6. Network assignment, including special assignment procedures[5]

Modifications or modeling procedures other than those shown in the table above are to be performed by ODOT staff.

Documentation of Model Use

Model users are to keep a written record of all modifications that are made to the model. This should include a detailed description of the change, as well as an explanation of why the change was made. The purpose of the record is to ensure that the same modifications may be made to the version of the model residing at ODOT, so that consistency may be maintained between user and ODOT versions of the model. An additional purpose is to allow ODOT staff to monitor the use of the model.

Distribution and Residence of Models

Local jurisdictions, public agencies, and consultants performing work under contract to these organizations are eligible to use ODOT urban area models. A copy of the model will be provided by ODOT to the user and, in most cases, reside temporarily with the user until the end of the study. In cases where a local jurisdiction or public agency wishes to have continuous access to the model, an arrangement may be established in which the model resides permanently with the user. Under such an arrangement, provisions must be made for periodic updates to the model databanks residing with ODOT and the user in order to reflect significant changes to the databank made by either party. Generally, this will occur if new or revised base trip matrices have been developed by ODOT or if substantial, permanent changes to any of the base networks have been made by ODOT or the user. For example, new or revised base trip matrices may be developed by ODOT if there have been changes to future land use assumptions within the comprehensive plan. Substantial changes to the base networks may be the result of:

- Major planned or committed transportation improvement projects that previously were not assumed in the network;
- The addition of significant detail to large portions of the network; or
- Changes to individual elements of the network that, taken together, result in significant differences between the current and previous versions of the network.

[5] Select link assignment and select zone assignment.

Similarly, if changes have been made to either the trip assignment model or assignment procedures (implementation of new volume-delay functions, for example), ODOT will provide the user with an updated databank and any other required items, such as revised macros.

Once it has been decided that an update is necessary, the revised databank and/or other model elements will be transmitted from ODOT to the user or vice-versa.

Procedure for Model Application

Following the request for use of an ODOT urban area model, a structured procedure will be followed to guide the model application process. This procedure consists of the following basic steps:

1) Meeting between model user and ODOT staff
2) Execution of letter of agreement
3) Model transmittal
4) Periodic review of model application and result
5) Return of model to ODOT

Model Application Meeting

Initially, a meeting is to be held between the model user and ODOT staff. An ODOT "point-of-contact" will attend the meeting and serve as the key staff person for communication and technical support throughout the model application process. The purposes of the meeting are to:

- Discuss the general nature of the study in which the model is to be applied and the specific needs for the application. Application needs consist not only of the type of model output required, but may also include special considerations such as the interface of the user's GIS with the model;
- Provide the user with a basic understanding of the model components and model operation;
- Identify possible approaches for model application; and
- Provide the user with a brief description of the model protocol, with emphasis on those requirements most closely related to the anticipated application.

Other, less formal purposes of the meeting are to allow ODOT staff to get an understanding of level of expertise of the model user and for the model user to become familiar with the general range of technical modeling services offered by ODOT.

Prior to the meeting, ODOT staff will provide the model user with a standard checklist (see Appendix B) showing the specific items to be discussed at the meeting.

Execution of Letter of Agreement

Before the model can be transmitted to the user, a letter of agreement concerning the application of the model must be signed by ODOT and the user. ODOT staff will be responsible for preparation of the letter. It will be based on the results of the initial meeting between ODOT and the user described in the previous section. A sample letter of agreement is shown in Appendix C. For applications that do not correspond completely to the protocol, the letter will also contain provisions that supplement the protocol as needed. An example of this would be an application not included in the table on pages 17 – 18.

As shown in the sample letter of agreement, a description of the purpose of the model application should be included, together with the type of modifications to be made and modeling procedures to be used. For basic model applications, such as performing network assignments, only a brief explanation is necessary. For more complex applications, however, such as the adjustment of base trip matrices, a detailed work program must be prepared by the model user that identifies each task in the process, the number of staff hours required, and the schedule. The purpose of including staff hours and a schedule is to help avoid underestimation of the time required to perform the model application. The work program should also indicate task responsibilities, including those for ODOT, and review points by ODOT staff. Based on the results of the initial meeting, ODOT will make a determination of whether a work program is needed, and will provide final approval of the work program. It will then be incorporated into the letter of agreement by ODOT. A sample model application work program is included in Appendix D.

If the model is to be applied as part of a Transportation Growth Management (TGM) program study or an ODOT Corridor Planning Program study, ODOT will be responsible for reviewing and providing final approval of all modeling-related elements of the study work scope, budget, and schedule. These will serve as the work program for the letter of agreement and will be incorporated by reference into the letter.

Transmittal of Model

ODOT will transmit the model to the user within one week of execution of the letter of agreement by both parties. This will include the model databank and all external files required to run the model, such as macros, stand-alone computer programs, and model input data files. ODOT will also be responsible for providing model documentation with sufficient information to allow proper model application.

Periodic Review

If specified in the letter of agreement, the results of the model application will be reviewed by ODOT staff at the timepoints identified in the letter. The user will be responsible for providing all information requested by ODOT for the reviews. Upon completion of the review, ODOT will provide the user with written or verbal comments and recommendations. If necessary, a meeting may be held to discuss the results of the review. Once the review items have been addressed by the user and approved by ODOT, work may proceed on the next stage of the work program.

Return of Model

Unless otherwise specified in the letter of agreement, the user will return all of the originally transmitted model components to ODOT within one week of completion of the work program. The user will also be responsible for providing ODOT with documentation of the model use, as previously described, and in accordance with the letter of agreement.

TECHNICAL SUPPORT

In order for ODOT urban area models to be properly applied, it is essential that the model user have adequate technical support. This will be accomplished in two ways:

- Periodic ODOT review, as described above; and
- As-needed support

As mentioned previously, the as-needed support will be provided through an ODOT "point-of-contact" who will be assigned at the beginning of the process.

ROLES/RESPONSIBILITIES

A summary of the responsibilities of the model user and ODOT staff throughout the model application process are shown in the table below.

	Responsibility	Products
Model User	1. Attendance at model application meeting	
	2. Preparation of detailed work program,[6] if required	• Model application work program
	3. Adherence to *Model Development and Application Guidelines*, model application protocol, and letter of agreement	
	4. Provision of materials for ODOT periodic reviews	• Technical summaries of model application work products
	5. Implementation of ODOT staff recommendations	
	6. Return of model to ODOT	• Model use documentation
	7. Request for technical assistance from ODOT staff when needed	
ODOT	1. Model application meeting	
	2. Review of work program, if required	• Written or verbal comments and recommendations
	3. Preparation of letter of agreement	• Letter of agreement
	4. Transmittal of model[7]	
	5. Review of model application work products	• Written or verbal comments and recommendations
	6. Approval of model application work products	• Written or verbal approval
	7. Provision of technical support on "as-needed" basis	

RESOLUTION OF DISAGREEMENTS

Challenges to ODOT decisions regarding the use of ODOT urban area models (where the term "use" refers to model input data, model application, and model output) may be made to the OMSC. The OMSC has final authority regarding use of the models. Challenges will be presented in writing to the chair of the OMSC , or his designee, and will be considered at the next regular meeting of the OMSC. If the model user chooses not to comply with the decision of the OMSC, the model will be immediately returned to ODOT.

[6] Including estimates of staff hours by task and schedule.
[7] Including model documentation.

Model Output Protocol

The model output protocol addresses the areas of how model output is to be made available and how the output is to be used.

STANDARD MODEL OUTPUTS PRODUCED BY ODOT

ODOT will produce standard model outputs for local jurisdictions and other public agencies upon request. A menu of the outputs that may be requested is shown in Appendix E. It will be provided to all interested parties. Special arrangements will be made for the production of model outputs not shown on the menu.

MODEL OUTPUT PRODUCED BY NON-ODOT MODEL USERS

For certain types of model output, it is usually necessary to apply some type of post-processing method before the output can be used for analysis. Specifically with regard to traffic assignments, there are several acceptable methods that may be used to adjust the assigned volumes to more closely reflect actual operating conditions. These methods are described in the *Model Development and Application Guidelines* and are to be followed in the post-processing of auto volumes produced by ODOT urban area models.

The post-processed auto volumes will be provided to ODOT staff together with the assigned volumes for review. The model user will also prepare a brief written description of the post-processing procedure used for ODOT review.

Finally, all output produced by ODOT urban area models is considered to be public record and will be made available to all local jurisdictions and other interested parties in the area.

Technical Support

If the protocol is to be successfully used in promoting the effective and efficient development and use of ODOT urban area models, model developers and users must have an adequate understanding of the appropriate modeling techniques. The *Model Development and Application Guidelines* and the *Model Development Procedures Manual* are intended to serve as the primary sources of information for model developers and users regarding these techniques. In addition to these documents, however, and of equal importance, is the need for adequate technical support.

As described earlier, direct technical support is available in the area model development from the OMSC. This is provided through the review of the model development work program and budget and the review of work products throughout the model development

process. As-needed support is also available at any time during this process through an OMSC "point-of-contact".

Similarly in the area of model use, direct technical support is provided by ODOT to the non-ODOT model user through the model application meeting and review of the model application work program and work products. An ODOT staff "point-of-contact" is also established to provide as-needed support for model data collection and preparation, model application, and model output.

In addition to this direct technical support, assistance is available from several other sources. These are:

- Emme/2 Users Group;
- Additional OMSC assistance;
- Modeling newsletter; and
- Training workshops

The Emme/2 Users Group is comprised of modelers from Oregon and southwest Washington. Informal meetings are held on a quarterly basis in which a variety of current modeling topics are presented and discussed. Staff from ODOT, MPOs, and local jurisdictions are typically in attendance, with all interested parties welcome to attend. The meetings are a valuable source of information on relevant modeling issues and provide an opportunity for the exchange of ideas between members of the local modeling community.

In addition to technical support for model development projects, other OMSC assistance is available for general modeling-related issues. An example of this is in providing recommendations on proper model application when disagreements arise among study participants. In this way, the OMSC functions as an objective source of "on-call" modeling assistance.

A modeling newsletter will be published by ODOT featuring information on current modeling issues, new modeling tools developed by ODOT and others, and upcoming conferences and training opportunities. It will be distributed to local jurisdictions, MPOs, other public agencies, and consultants. The primary purpose of the newsletter will be to develop awareness about modeling resources and solutions to common modeling problems.

ODOT will also sponsor training courses to be held at regular intervals throughout the year. The courses will be oriented to different skill levels, from basic through advanced, in the areas of model development and model application. Special courses will also be held to cover specific modeling topics in greater detail.

V. Non-ODOT Urban Area Model Protocol

Non-ODOT urban area models are models that have been or will be developed without ODOT staff involvement and without ODOT funding. These models fall into two categories:

- Models that are used strictly for local facility planning; i.e., model output is not used in the allocation of state or federal resources; and
- Models that are used in the allocation of state and federal resources.

For models in the first category, there are no requirements for following the ODOT urban area modeling protocol. Users of models in the second category, however, are required to adhere to those elements of the protocol listed below:

Model Development

1) Adherence to the model development standards, as contained in the *Model Development and Application Guidelines* and *Model Development Procedures Manual*;
2) Final approval of a model development work program and budget by the OMSC;
3) Development of model documentation; and
4) Final approval of the model by the OMSC.

Model Application

1) Adherence to the standards for model data collection, preparation, and maintenance, as contained in the *Model Development Procedures Manual*;
2) Adherence to the model application standards, as contained in the *Model Development and Application Guidelines*;
3) If required, final approval of a model application work program by ODOT;
4) Periodic review and approval of the model application and results by ODOT; and
5) Adherence to the requirements for model output produced by model users.

With regard to the model development requirements, although the model developer is not required to follow the same structured process as described in the protocol for preparing the model development work program and budget, the same information as specified in

the protocol is required. Similarly, the model documentation must be prepared according to the *Model Development and Application Guidelines*. For final approval of the model by the OMSC, technical summaries of the model development by phase/stage must be submitted for OMSC review. Final approval by the OMSC is necessary before the model can be applied in studies involving the allocation of state and federal resources.

With regard to the third model application requirement listed above, ODOT staff will determine whether a model application work program is necessary. If so, the work program must be approved by ODOT staff prior to using the model in studies involving the allocation of state and federal resources. For periodic review of the model application, the user will be required to provide all summary information of the model results requested by ODOT.

Appendix A

SUMMARY OF STATEWIDE MODEL OUTPUT

ODOT Statewide Model
Summary of Output Data and Potential Uses

Model Component	Data[8]	Level of Aggregation	Potential Users/Uses
Economic	1. Production ($'s) by industrial sector	Statewide	OEA – State Economic and Revenue Forecast
	2. Employment by sector	Statewide	OEA – State Economic and Revenue Forecast
	3. Exports by sector	Model Region[9] to Other Regions	1. OEA – State Economic and Revenue Forecast 2. Port of Portland
	4. Imports by sector	Other Regions to Model Region	1. OEA – State Economic and Revenue Forecast 2. Port of Portland
	5. Consumption demand: • Motor vehicles • Other durables • Non-durable goods • Services	Statewide	OEA – State Economic and Revenue Forecast
	6. Investment demand: • Residential structures • Non-residential structures • Equipment	Statewide	OEA – State Economic and Revenue Forecast
	7. State and local government demand	Statewide	OEA – State Economic and Revenue Forecast
	8. Income	Statewide	OEA – State Economic and Revenue Forecast
Demographic	1. Size of labor force	Statewide	OEA – Short-term Population Forecast, Long-term Population and Employment Forecast
	2. Number of in- and out-migrating households by household income, age, size, and no. of	Statewide	OEA – Short-term Population Forecast, Long-term Population and Employment Forecast

[8] All data available for each year within the forecasting period.
[9] Oregon plus collar.

ODOT Statewide Model
Summary of Output Data and Potential Uses (cont.)

Model Component	Data[8]	Level of Aggregation	Potential Users/Uses
	workers categories: • Employment-related • Non-employment-related		
	3. Changes in number households by household segment[10]	Statewide	OEA – Short-term Population Forecast, Long-term Population and Employment Forecast
Household Allocation	1. Out-migrating households	TAZ	OEA – Long-term Population and Employment Forecast (county level)
	2. Total households by household segment	TAZ	1. OEA – Long-term Population and Employment Forecast (county level) 2. ODOT – Local urban and statewide corridor travel demand forecasts 3. MPOs, Cities – Travel demand forecasts 4. OHCS – Long-term forecasts of households by income-age strata 5. CDO/CST – Local community development projects
	3. Price of residential space by category	TAZ	1. DLCD, OECDD – Periodic review of local comprehensive plans 2. CDO/CST – Local community development projects
	4. Occupancy densities by residential space category	TAZ	1. DLCD, OECDD – Periodic review of local comprehensive plans 2. CDO/CST – Local community development

[10] Households segmented by household size, income, lifecyle stage, Worker A occupation category, Worker B occupation category, and whether secondary residence is owned. Total households by household segment also available, since changes are applied to totals from previous year.

ODOT Statewide Model
Summary of Output Data and Potential Uses (cont.)

Model Component	Data[8]	Level of Aggregation	Potential Users/Uses
			projects
Production Allocation	1. Total production ($'s) by sector[11]	TAZ	OECDD – Local and regional economic development plans
	2. Price of non-residential space	TAZ	1. DLCD, OECDD – Periodic review of local comprehensive plans 2. CDO/CST – Local community development projects
	3. Occupancy densities by non-residential space category	TAZ	1. DLCD, OECDD – Periodic review of local comprehensive plans 2. CDO/CST – Local community development projects
Developer	1. Quantity of land according to: • whether land is developable and if so, the permitted uses and densities; or • whether land contains developed space and if so, type of space and whether it is occupied	TAZ	1. DLCD, OECDD – Periodic review of local comprehensive plans 2. OECDD – Local and regional economic development plans 3. CDO/CST – Local community development projects
	2. Quantity of space by category	TAZ	1. DLCD, OECDD – Periodic review of local comprehensive plans 2. OECDD – Local and regional economic development plans

[11] Sectors defined by industry and worker type (white collar vs. blue collar).

ODOT Statewide Model
Summary of Output Data and Potential Uses (cont.)

Model Component	Data[8]	Level of Aggregation	Potential Users/Uses
			3. CDO/CST – Local community development projects
	3. Quantity of redeveloped space by category	TAZ	
	4. Quantity of new space (on vacant land) by category	TAZ	
Activity Interactions	1. Value of commodities produced by commodity type[12]	TAZ	1. OECDD – Local and regional economic development plans 2. OEA – State Economic and Revenue Forecast
	2. Value of commodities consumed by commodity type	TAZ	1. OECDD – Local and regional economic development plans 2. OEA – State Economic and Revenue Forecast
	3. Value of commodities exchanged by commodity type	TAZ to TAZ	OEA – State Economic and Revenue Forecast
	4. Prices of commodities exchanged by commodity type	(Exchange) TAZ	OEA – State Economic and Revenue Forecast
Transportation	1. Employment by sector	TAZ	1. OEA – Short-term Population Forecast, Long-term Population and Employment Forecast (county level) 2. OECDD – Local and regional economic development plans 3. ODOT – Local urban and statewide corridor travel demand forecasts 4. MPOs, Cities – Travel demand forecasts 5. CDO/CST – Local community development projects

[12] Also available from Production Allocation Model.

ODOT Statewide Model
Summary of Output Data and Potential Uses (cont.)

Model Component	Data[8]	Level of Aggregation	Potential Users/Uses
	2. Person trips by trip purpose, period of the day, and mode of transport	TAZ to TAZ	1. ODOT – Local urban and statewide corridor travel demand forecasts 2. MPOs, Cities – Travel demand forecasts
	3. Truck trips by period of the day	TAZ to TAZ	1. ODOT – Local urban and statewide corridor travel demand forecasts 2. MPOs, Cities – Travel demand forecasts
	4. Total vehicle trips by period of the day and mode	TAZ to TAZ	1. ODOT – Local urban and statewide corridor travel demand forecasts 2. MPOs, Cities – Travel demand forecasts
	5. Network link volumes by vehicle mode	Link	1. ODOT – Local urban and statewide corridor travel demand forecasts 2. MPOs, Cities – Travel demand forecasts

Appendix B

DISCUSSION ITEM MENU FOR ODOT MODEL APPLICATION MEETING

Discussion Items for ODOT Model Application Meeting

- ☐ 1. General description of study that model is to be used for – *Model User*.
- ☐ 2. Types of analysis model output is to be used for - *Model User*.
- ☐ 3. Specific model outputs needed - *Model User*.
- ☐ 4. Basic description of model components and model operation - *ODOT*.
- ☐ 5. Description of databank contents (scenario descriptions, for example) - *ODOT*.
- ☐ 6. Possible approaches for model application - *ODOT*.
- ☐ 7. Description of protocol, including required steps in model application procedure - *ODOT*.
- ☐ 8. Special user needs for model application (GIS interface, for example) – *Model User*.
- ☐ 9. Other ODOT technical support needed by user for model application - *Model User*.
- ☐ 10. Description of sources of local model input data to be used, if any – *Model User*.
- ☐ 11. Proper preparation methods for model input data - *ODOT*.
- ☐ 12. Proper uses of model output data - *ODOT*.

Appendix C

SAMPLE LETTER OF AGREEMENT

January 28, 2000

John Smith
City of Klamath Falls Community Development Department
1000 Main Street
Klamath Falls, OR 97601

Subject: Letter of Agreement for Use of ODOT Klamath Falls Model

Dear John:

This letter is to establish an agreement between ODOT and the City of Klamath Falls regarding the terms of use of ODOT's Klamath Falls travel demand forecasting model by the city. The terms of use are based on the provisions of the *Oregon Modeling Protocol*, which describe the manner in which ODOT urban area models are to be applied by non-ODOT users. By signing this agreement, the city agrees to adhere to the protocol, as well as any other terms of use identified below.

Based on our previous discussion, it is our understanding that the city wishes to apply the model for analysis purposes in the Southeast Subarea Transportation Study near the US 97 – Highway 66 interchange on the south side of Klamath Falls. The model will be used to produce traffic assignments for several subarea network alternatives and to determine the origin-destination pattern of traffic using several key roadway links. The study will not involve changes to current land use assumptions within the subarea.

In order to apply the model for these purposes, the link structure of the subarea road network must be modified to reflect the network alternatives. This may involve the addition, deletion, or modification of individual links. It may also be necessary to adjust certain attributes of the links, such as capacities or volume-delay function (VDF) codes to better reflect the characteristics of the alternatives. The modeling procedures required to produce the desired outputs are standard traffic assignment for the alternative traffic forecasts and select link assignment for determining origin-destination patterns. These modifications to the model and the modeling procedures to be used are within the allowable range of user application described in the protocol.

All elements of the protocol related to model use are contained on pages 15 - 23 of the protocol document. These elements are to be reviewed and adhered to by the city for this study.

It is also our understanding that in order to more accurately represent some of the network improvements included in the alternatives, it may be necessary to modify the VDF codes as well as the volume-delay functions. Modification of volume-delay functions is not included within the allowable range of user application identified in the protocol. However, for the purposes of this study only, the city will be permitted to perform these revisions as needed. The results of the revisions will be reviewed by ODOT staff together with the other summary information to be provided by the city regarding the model use.

If the model is to be used in any other manner than as described above, the city will notify ODOT beforehand. ODOT will then determine if the additional use is permitted and if any modification of this letter of agreement is necessary.

The signatures below indicate that ODOT and the City of Klamath Falls agree to the terms of the model use described above.

_____ _____

William J. Upton — Date
ODOT Transportation Modeling Program Manager

_____ _____

John Smith — Date
City of Klamath Falls Director of Community Development

Appendix D

SAMPLE MODEL APPLICATION WORK PROGRAM

Note: The sample work program shown on the following page references the model use example contained in the sample letter of agreement in Appendix C. In the sample work program, however, the model use is expanded to include the evaluation of transportation impacts associated with the rezoning of a portion of the study area. This will require a "focused" modeling approach in which the TAZs within the subarea will be disaggregated and greater detail will be added to the network. Because of the added complexity of this application, a model application work program must be included in the letter of agreement.

Southeast Subarea Transportation Study
Work Program for ODOT Klamath Falls Model Adjustment

Purpose

Development and implementation of a focus model for the study area based on the ODOT Klamath Falls travel demand forecasting model and preparation of p.m. peak hour travel forecasts for the Comprehensive Plan and Proposed Land Use Plan scenarios.

Work Scope

Task	Total Hours
A. Focus Model Development and Validation	
1. Disaggregate standard model TAZ system	11
a. Define focus model TAZs within study area	
b. Define focus model TAZs within fringe area	
2. Develop focus model base year network	23
a. Review standard model base year network within focus area	
b. Refine standard model base year network to reflect focus area local road network and disaggregated TAZ system	
c. Verify accuracy of refined network by checking minimum time paths	
3. Prepare technical summary of Subtasks 1. and 2.	8
4. Develop focus model base year trip matrix	30
a. Allocate trips ends for standard model TAZs to focus model TAZs	
1) Estimate trip ends for focus model TAZs based on existing land use estimates and standard model trip generation procedure	
2) Allocate trip ends for standard model TAZs to focus model TAZs using trip end estimates for focus model TAZs	
b. Expand standard model trip matrix	

Task	Total Hours
1) Create one-to-one TAZ ensemble within standard model databank for purpose of "batching out" standard model trip matrix	
2) "Batch-out" standard model trip matrix	
3) Create TAZ ensemble within focus model databank containing standard model – focus model TAZ equivalencies	
4) "Batch–in" standard model trip matrix using focus model TAZ ensemble	
c. Rebalance expanded standard model trip matrix to focus model TAZ trip ends using two-dimensional balancing procedure	
5. Validate focus model	38
a. Assign focus model trip matrix to focus model network	
b. Apply validation tests to assess accuracy of model	
c. Adjust model as necessary	
6. Prepare technical summary of Subtasks 4. and 5.	12
Subtotal	122
B. Preparation of Traffic Forecasts	
1. Develop focus model future year network following steps in Task A.2.	18
2. Develop focus model trip matrices for Comprehensive Plan and Proposed Plan scenarios following steps in Task A.3.	42
3. Perform future year traffic assignments	4
4. Check assignments for reasonableness	12
5. Prepare technical summary of Subtasks 4. and 5.	12
Subtotal	88
Total	210

Responsibilities

1. The city will be responsible for completion of all work tasks shown above.
2. ODOT will be responsible for review and comment on the technical summaries following the completion of Tasks A.2., A.5., and B.4.

Schedule

Task	Activity	Jan-00				Feb-00			
		1	2	3	4	1	2	3	4
A.	**Focus Model Development and Validation**								
1.	Disaggregate standard model TAZ system								
2.	Develop focus model base year network								
3.	Prepare technical summary of Subtasks 1. and 2.								
4.	Develop focus model base year trip matrix								
5.	Validate focus model								
6.	Prepare technical summary of Subtasks 4. And 5.								
B.	**Preparation of Traffic Forecasts**								
1.	Develop focus model future year network								
2.	Develop focus model future year trip matrices								
3.	Perform future year traffic assignments								
4.	Check assignments for reasonableness								
5.	Prepare technical summary of Subtasks 4. and 5.								

Appendix E

ODOT MODEL OUPUT MENU

Menu of Standard ODOT Model Outputs

- ☐ 1. Link Volume Plot – Link Text Only
- ☐ 2. Link Volume Plot – Bandwidths with Link Text
- ☐ 3. Select Link Volume Plot
- ☐ 4. Select Zone Volume Plot
- ☐ 5. Intersection Turning Movement Volume Plots
- ☐ 6. Volume/Capacity (V/C) Ratio Plot
- ☐ 7. Absolute Volume Difference Plot (e.g., Future Year Volume – Base Year Volume)
- ☐ 8. Relative Volume Difference Plot (e.g., Future Year Volume ÷ Base Year Volume)
- ☐ 9. Absolute Volume Difference Plot – Bandwidths with Link Text
- ☐ 10. Relative Volume Difference Plot – Bandwidths with Link Text
- ☐ 11. Zonal Trip End Plot - (Productions-Attractions or Origins-Destinations)
- ☐ 12. Network Plot with Link Attributes (e.g., capacity)