National Travel Demand Forecasting Model Phase I Final Scope

Requested by:

American Association of State Highway and Transportation Officials (AASHTO)

Standing Committee on Planning

Prepared by:

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Executive Summary

The objective of this scope of services is to provide specifications for developing a national travel demand forecasting model (NatMod) that can assist states in estimating external freight and passenger trip flows for statewide models. This project resulted from a Statewide Model Peer Exchange sponsored by the National Academy of Sciences' (NAS) Transportation Research Board (TRB) and held in Long Boat Key, Florida on September 23 and 24, 2004. The resulting Transportation Research Circular[1] from the Peer Exchange describes the general intent of this project. Subsequently, a scoping project for a national model was funded through the National Cooperative Highway Research Program (NCHRP).[2] This scope of services represents the product of this NCHRP task.

Staff from the Transportation Research Board (TRB) organized a panel teleconference to discuss the national model scoping effort and provide guidance. This draft scope of services reflects input from this panel on scope format, data procurement, model structure, travel markets, institutional issues, and other topics.

n Background

Since passage of the Intermodal Surface Transportation Efficiency Act (ISTEA) in 1991, numerous state departments of transportation (DOT) have moved forward with the development and application of statewide models as tools to use in addressing legislative requirements for statewide planning. The reasons for statewide travel forecasting are described in the Guidebook on Statewide Travel Forecasting,[3] which may be referenced for additional background on statewide models. Perhaps the weakest elements of most statewide models are the external trips (i.e., those with origins and/or destinations outside the state), as these trips usually are not generated using available socioeconomic data and are forecasted using growth factor techniques or information from Federal sources and neighboring state DOTs.

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[1] Transportation Research Circular E-C075, Statewide Travel Demand Modeling: A Peer Exchange, Transportation Research Board of the National Academies, August 2005.

[2] Scoping Study for Statewide Travel Forecasting National Model, National Cooperative Highway Research Program 8-36, Task 70, September 2007.

[3] Guidebook on Statewide Forecasting, Federal Highway Administration, Center for Urban Transportation Studies, University of Wisconsin-Milwaukee, March 1999.

A number of statewide models have attempted to enhance the accuracy of external trips by including a "halo" of larger zones immediately outside the state. This technique is most relevant in situations where urbanized areas cross state lines. This approach is more complicated when adjacent states do not share common metropolitan planning organizations (MPO), and resulting data availability and development techniques might differ across the state line. Even with the "halo" approach, external trips still will be needed, albeit at a further distance from the state line.

Freight trips typically are modeled on a national basis using a simplified national network and zone system outside the state for which the statewide model is being developed. A national model potentially could enhance the estimation of base-year and future-year freight and other external trips for statewide models. Trip estimates from the NatMod could be used as input into statewide models, thus eliminating duplicate efforts on the part of each state DOT during statewide model development.

The NatMod could be used for a number of different purposes. A primary function is to provide base-year and forecast-year external trips for statewide models. Estimation of internal-external trips should use information on the state itself while external-external trips might depend completely on the NatMod. Information from the NatMod potentially could be provided by mode and then used for control totals at statewide model external zones for trip generation purposes. Origin-destination (O-D) patterns of freight trips from the NatMod could form the basis of statewide model freight trip tables. Trip tables from the national model also potentially could be extracted to assist in refining trip distribution within states, particularly for external-external trips. Another use of the NatMod would be to estimate travel demand for multistate corridors. The development of statewide models involves some routines and data collection that tend to be duplicated. The NatMod can provide an opportunity for states to draw on standardized datasets and procedures that minimize duplication and effort.

In order to be responsive to the needs of state DOTs, the NatMod must address both passenger and freight modes. Beyond the division of freight and passenger components, subcomponents of these modes also must be addressed – such as tourists and business travelers on the passenger side and heavy duty versus light duty trucks for freight. Different auto occupancy purposes also may be addressed in the model. Inclusion of international trips is related directly to data availability for Canada and Mexico.

n Scope of Services Overview

This scope of services identifies the work specifications in detail. The project would consist of five primary tasks, along with several subtasks.

The first task, Identify Alternative Model Structures, will involve identifying data sources, assessing model components, evaluating institutional issues, and recommending a model structure to move forward with. A national model steering committee (NMSC) will be established with representatives from TRB, FHWA, FTA, and a select group of

state DOT representatives to review and discuss recommendations before proceeding to the next task. The scope of services for all subsequent tasks will be finalized before moving forward with model development and validation.

The second task, Obtain and Prepare Input Data, will move forward with assembling the data necessary to drive the NatMod. Four primary categories of data should be assembled, including network and zone system, demographic and employment data, freight and other economic data, and behavioral data, including the National Household Travel Survey (NHTS). An assessment of data sources will be completed during Task 1 and approved by the NMSC prior to obtaining and preparing input data for Task 2.

During Task 3, Model Development and Validation, the model will be estimated, developed, implemented, validated, calibrated, and tested for sensitivity. It is anticipated that NatMod will be a four-step transportation planning model consisting of trip generation, trip distribution, mode choice, and trip assignment. With a focus on providing travel information for statewide models that are predominantly trip based, it is not expected that activity-based modeling will add sufficient value and accuracy to the model. Accepted model validation standards and best practice guidelines will be employed during this effort.

Once the model has been fully validated and tested, work will proceed to Develop Tools. At a minimum, tools for trip table extraction and network extraction should be developed in order to maximize the usefulness of NatMod to state DOTs and multistate corridor coalitions. Other tools might be added based on feedback from NMSC members.

The study will conclude with an assessment of Future Directions for the NatMod. This task will include a list of limitations for model application based on sensitivity testing. Future enhancements will be discussed using a priority scale for future funding and implementation. Schedules will also be prepared for model maintenance and updates. Discussions with NMSC members and information on available funding will determine the timing of subsequent model development phases such as the expansion to other modes of travel.

Task 1.0 Identify Alternative Model Structures

The focus of Task 1 will be to identify alternative model structures for a National Model through the completion of four subtasks: data sources, model components, institutional issues, and coordination and selection of a model structure. A panel teleconference organized by TRB staff provided guidance on project direction. It was widely recognized that certain elements of the scoping effort needed clarification during this scoping phase while other structural and institutional issues will require further study and analysis during development of the National Model.

A national model steering committee (NMSC) will be established at the onset of this task with representatives from TRB, FHWA, FTA, and a select group of state DOT representatives to review and discuss recommendations before proceeding with obtaining and preparing input data. In cases where a more thorough examination of the data or specific direction from the NMSC is needed, the approach is not defined fully in this scope. Examples include zone size and structure; decisions on trip generation versus matrix estimation; and items identified as "maybe" during Phase I. Such items should be defined during completion of this task and based on input from the NMSC.

n Subtask 1.1: Data Sources

Using information gathered during the national model (NatMod) scoping study, several data sources will be assessed in terms of cost, geographic detail, frequency of updates, consistency with other state and Federal databases, among other considerations as discussed with the NMSC. Information from the scoping study, provided elsewhere in this scope of services, will be updated and amended based on an exhaustive review of data sources. Evaluation of data sources will cover networks and traffic analysis zones (TAZ), demographic and employment data, freight and other economic data, and travel behavior data.

The NatMod TAZ structure is critical to subsequent data collection efforts. As a result, the level of zone detail should be defined early in the process. Table 1 provides a draft overview of different TAZ geographies that could be considered for the NatMod in relation to different model types and applications. Wherever feasible, existing regional and statewide TAZ systems should be evaluated while Census and other geographies (e.g., disaggregated Freight Analysis Framework or FAF zones) should also be considered. The ability of these smaller geographies to nest within county level and larger geographies that are more reliably consistent on a national scale should be carefully evaluated as storage requirements are likely to become burdensome for matrices using smaller geographies.

Table 1. Traffic Analysis Zone Detail for National Model Applications
Identification of Relevant Zone Geographies – Nest Smaller Geographies within Larger Geographies Where Possible

	Existing Traffic Analysis Zones[a]				Census Geography[b]					Other Geographies	
Model Types	MPO TAZs	Regional Model TAZs	Statewide Model TAZs	Multistate Model TAZs	Blocks	Block Groups	Enumeration Districts	Census Tracts	Counties	FAF	TBD
Multistate Highway Corridor Models	Too small	Too small	OK	OK	Too small	OK	OK	OK	OK	Disaggregated	
Multistate Rail Corridor Models	Too small	Too small	OK	OK	Too small	OK	OK	OK	OK	Disaggregated	
Statewide Model Out-of-State Trips and Networks	Too small	Too small	OK	OK	Too small	Too small	Too small	OK	OK	Possibly	
Statewide Freight Models	Special generators[c]	Special generators[c]	OK	OK	Too small	OK	OK	Too large, irregular	Too large	Disaggregated	
Statewide Model Network Development	Too small	Too small	OK	OK	Too small	OK	OK	Too large, irregular	Too large	Too large	
MPO / Regional Model at State Boundary	N / A	N / A	OK	OK	Too small	OK	OK	OK	OK	Too large	
Other MPO / Regional Model Externals	N / A	N / A	OK	OK	Too small	OK	OK	Possibly	Too large	Too large	
Long-Distance / Tourist Trips	Too small	Too small	OK	OK	Too small	Too small	Too small	Possibly	OK	Too large	
Hurricane Evacuation / Climate Change	Too small	Possibly	OK	OK	Too small	OK	OK	OK	Too large	Too large	

[a] Assumes such zone systems and models already exist for the study area.

[b] Assumes new model development effort without pre-existing statewide zone systems.

[c] Special generators include seaports, airports, large distribution centers, etc.

In order for a wide range of model users to be able to access input and output data, non-proprietary data should be given the highest priority and used wherever possible. The ability to disaggregate model data to smaller geographies for subsequent subarea and corridor studies should also be considered in order to minimize storage requirements. For example, GIS network data might be stored in databases and shape files using the most detailed source available; however, the model developer would develop tools for identifying highway segments that should be included in the model network for individual study purposes. Data confidentiality issues must also be addressed.

n Subtask 1.2: Model Components

Different model components and structures will be identified and evaluated to ascertain the pros and cons of each with a goal of keeping the model relatively simple in accordance with comments from the panel teleconference. For example, a model based on origin-destination (O-D) matrix estimation (ODME), with forecasting through Fratar growth factors, would simplify data requirements for covering such a large territory; however, the lack of a trip generation and distribution process would minimize the effects of trip purpose and varying growth rates across the United States on travel demand. Growth factor models are largely predicated on a static trip distribution process whereby the addition of new transportation corridors would not result in a redistribution of trips. This could potentially limit the explanatory power of the model. It should be noted though those elements of ODME are not necessarily mutually exclusive from four-step model approaches.

Potential uses of the NatMod should be reviewed in recommending model components and structure. Table 2 depicts a draft decision matrix that could be considered in assessing model uses for different applications and study types, thus providing consideration for potential model components. The intent is not to use the NatMod for studies of a local or metropolitan nature; however, assumptions used in statewide, regional, and MPO models can be updated based on forecasts from NatMod. For example, in the absence of recent roadside O-D data, select link assignments using NatMod could be used to synthetically estimate internal-external/external-external splits at external zones for these models.

While not specifically addressed in Table 2, policy studies for national and statewide agencies and organizations will benefit greatly from generalized travel demand statistics from the NatMod. The level of geographic detail needed will vary greatly depending on the use and application of the model. For example, to update external trip assumptions in an MPO or regional model, trip estimates are needed at a corridor level while policy studies will only require generalized model statistics (e.g., national, state, groups of states, etc.).

Trip characteristics to be included in the NatMod should be identified by implementation phase. Table 3 provides an assessment of transportation modes, trip purposes, and international trips recommended for eventual inclusion in the NatMod. As indicated, the

Table 2. Draft Decision Matrix for National Model Applications

	MPO/Regional Model Enhancements		Statewide Model Enhancements			Direct Application of National Model		
Study Types	Internal-External Splits	External Forecasts	External Forecasts	Through Trips	Network Building	Freight Trip Tables	Visual Displays	Network Assignment
Multistate Highway Corridor Study	N/A	N/A	N/A	N/A	N/A	N/A	Universally applicable	Universally applicable
Multistate Rail Corridor Study	N/A	N/A	N/A	N/A	Would require rail/multimodal network	N/A	Potential applicability	Potential applicability
Statewide Model External Zones	N/A	N/A	Supplemented by other trend data	Universally applicable	N/A	Through state trips	Limited applicability	N/A
Statewide Model Network Development	N/A	N/A	N/A	N/A	Supplemented by other GIS data	N/A	Potential applicability	N/A
MPO/Regional Model at State Boundary	Supplemented by survey data, where available	Supplemented by other trend data	N/A	N/A	N/A	N/A	Limited applicability	N/A
MPO/Regional Model Elsewhere	Primarily if statewide model is not available	Primarily if statewide model is not available	N/A	N/A	N/A	N/A	Limited applicability	N/A
Long-Distance/ Tourist Trips	N/A	N/A	Supplemented by other trend data	Universally applicable	N/A	N/A	Potential applicability	N/A
Hurricane Evacuation	N/A	N/A	N/A	N/A	N/A	N/A	Potential applicability	Potential applicability
Climate Change	N/A	N/A	N/A	N/A	N/A	N/A	Potential applicability	Potential applicability

Table 3. Trip Characteristics for Consideration in National Model
Assessment of Model Trip Characteristics to Be Included in National Model

		Recommended for Model Inclusion		
Travel Markets	Subcategories	First Phase	Next Phase	Later Phase
Transportation Modes	Highways	Yes	N/A	N/A
	Rail	Maybe	If not already completed	N/A
	Waterways	No	Yes	N/A
	Air	No	Maybe	if not already completed
	Pipeline	No	No	maybe
Trip Types or Purposes	Short-Distance Passenger	Yes	N/A	N/A
	Short-Distance Trucks (Nonfreight)	Yes	N/A	N/A
	Long-Distance Freight	Yes	N/A	N/A
	Long-Distance Tourist	Yes	N/A	N/A
	Long-Distance Business	Yes	N/A	N/A
Seasonality	Summer	Maybe	If not already completed	N/A
	AADT	Yes	N/A	N/A
International Trips	Freight	Yes	N/A	N/A
	Passenger	Yes	Update with survey data	N/A

model must address the highway mode during Phase I, while this phase might also include freight rail based in part on NMSC recommendations and available budget. Highway and rail are commonly included in travel demand forecasting models. Commodities transported by air, water, and pipeline can be included through mode choice; however, assigning such trips to a network is far less common in the travel demand forecasting process.

Passenger and freight trips also must be addressed in NatMod Phase I and it might be desirable to split passenger trips into tourist and nontourist components. Since NatMod is largely focused on long-distance travel, there is no need to differentiate between home-based and nonhome-based trip purposes. Short-distance trip making should only be included to the extent necessary to match traffic counts on key highway segments outside urbanized areas. This will be further fleshed out during validation. International freight trips also should be addressed as part of the freight component, through use of the TransBorder Freight database[4] and other relevant data sources.

n Subtask 1.3: Institutional Issues

The focus of this task is to identify key participants, roles, and responsibilities in the NatMod Phase I process. Table 4 presents a preliminary framework of institutional issues to be considered in finalizing the model structure. Structural considerations should include software options, key participant roles and responsibilities, and other institutional issues such as cost and schedule. Model phases also are outlined in Table 4, including model development, validation, applications, and maintenance as roles and responsibilities might differ among these phases.

The information contained in Table 4 should be reviewed and mulled over via additional discussions with some of the key participants. Discussions among different Federal agencies and transportation organizations should be encouraged to flesh out partners who are willing to serve as champions for model funding and ownership. Some sample questions to be answered at this point in the project might include the following:

- Who will the contracting agency be for this project?
- What will the budget range be for each model phase?
- Should existing proprietary travel demand forecasting software be used? If so, how do we reach a decision on which software to use?

[4] U.S. DOT Research and Innovative Technology Administration, Bureau of Transportation Statistics, TransBorder Freight Data, April 2008.

Table 4. Institutional Issues for National Model

Structural Considerations	Categories	Model Stage			
		Model Development	Model Validation	Model Applications	Model Maintenance
Recommended Key Participant Roles and Responsibilities	FHWA	Contracting Agent	Contracting Agent	Contracting Agent – Multistate Interstate Corridor Studies	Model Owner
	NCHRP / TRB	Review / Advice	N / A	Output Statistics for use in Research	Review / Advice, as Needed
	AASHTO	Review / Advice	N / A	Output Statistics for use in Research	Review / Advice, as Needed
	Public / Private Partnerships	N / A	N / A	Contracting Agent – Multistate Feasibility / Modal Studies	Possible Problem Statements to Address
	State DOTs	N / A	N / A	Contracting Agent – Statewide Model Updates	N / A
	Consultant	Technical Lead	Technical Lead	Technical Lead	General Consultant Support
	Software Vendors	Technical Support	Technical Support	N / A	Software Maintenance Agreements
Institutional Issues	Schedule	6 months	6 months	Dependent on Application Scopes	Update every five years
	Cost	$200k to $800k	$200k to $400k	Dependent on Application Scopes	$200k to $400k
Software Options	–	Flexibility	Consistency with Other Models	Minimize Cost to Model Users	Software Maintenance
	TDF Software Vendors	Somewhat Flexible	Depends on Vendor and State / MPO	Must Own or Purchase Software	Maintenance by Vendor
	New Software Development	Very Flexible	Not Likely	Free to Moderate Cost	Federal Ownership
	TRANSIMS	TBD	Not Likely	Must Own or Purchase Software	Federal Licensing
	AASHTOWare	TBD	Not Likely	Free?	State Support Required

Participants on the panel teleconference expressed a strong desire to develop NatMod in a software independent manner, to the greatest extent possible. NatMod might subsequently be converted into multiple proprietary formats; however, universal file formats should be used for model inputs. The role of software vendors in implementing and enhancing NatMod remains to be determined in the future based on considerations of keeping the model and its data nonproprietary to the greatest extent feasible. At the same time, duplication of programming efforts should be avoided, thus recognizing the importance of including software vendors in the process at the appropriate time. While commercial data will play a role in model development, such data must be applied and converted into a format that is usable across a wide range of software platforms.

As far as agency requirements to use NatMod for different study types, this remains to be determined once the model is developed, validated, and operational. Whether NatMod will replace or merely compliment other tools (e.g., HPMS) likewise cannot be determined until the model is up and running. These issues should be discussed by NMSC members and various Federal agencies involved with model implementation.

n Subtask 1.4: Coordination and Selection of Model Structure

A software selection process might be needed as part of the process of deciding on a model structure. New software will require more programming and GUI development work than if an existing travel demand modeling software system is used. At the same time, there are distinct advantages to platform independence as users would not need to purchase proprietary software for accessing model data. Furthermore, for an existing software platform to be selected, some sort of request for proposals process would likely be needed to afford different software providers an opportunity to compete for selection. Alternately, a design-build contracting approach could be used whereby teams of consulting firms and software vendors are evaluated together for selection, prior to moving forward with this work scope.

Another key decision item on model structure will be to assess the pros and cons of a four-step model compared with an ODME process. Factors to consider in this evaluation would include, but are not limited to: cost of data purchase; ease of model maintenance; model sensitivity and responsiveness to changes in characteristics; storage requirements; and finally, potential uses of the model, some of which were described earlier in Table 2. Due to the large geography covered by the model, it is not practical to incorporate time-of-day stratifications, especially since it would take more than 24 hours from one coast to another.

All NMSC members will be provided with materials prepared during Subtasks 1.1 though 1.3, along with preliminary recommendations on model structure. A meeting will be held with the NMSC during Subtask 1.4, in conjunction with the TRB Annual (or Summer) Meeting, to discuss these findings and recommend a structure for NatMod implementation. Model flow charts, a project schedule by phase, and a detailed work plan for the remaining Phase I tasks also will be prepared.

Task 2.0 Obtain and Prepare Input Data

With any travel demand modeling process, data acquisition, and preparation is critical to the process. The NatMod will of necessity require data compilation on a continental scale, including four main data categories as follows:

- Physical building block data for the model, including the national network and TAZ system;
- Demographic and employment data such as population, households, income, and employment;
- Freight and economic activity data; and
- Travel behavior, especially long-distance trips.

Decision matrices have been developed to provide guidance during the required data collection effort. The following sections describe data considerations, characteristics, and sources to be taken into account for model development.

n Subtask 2.1: National Network and Zone System

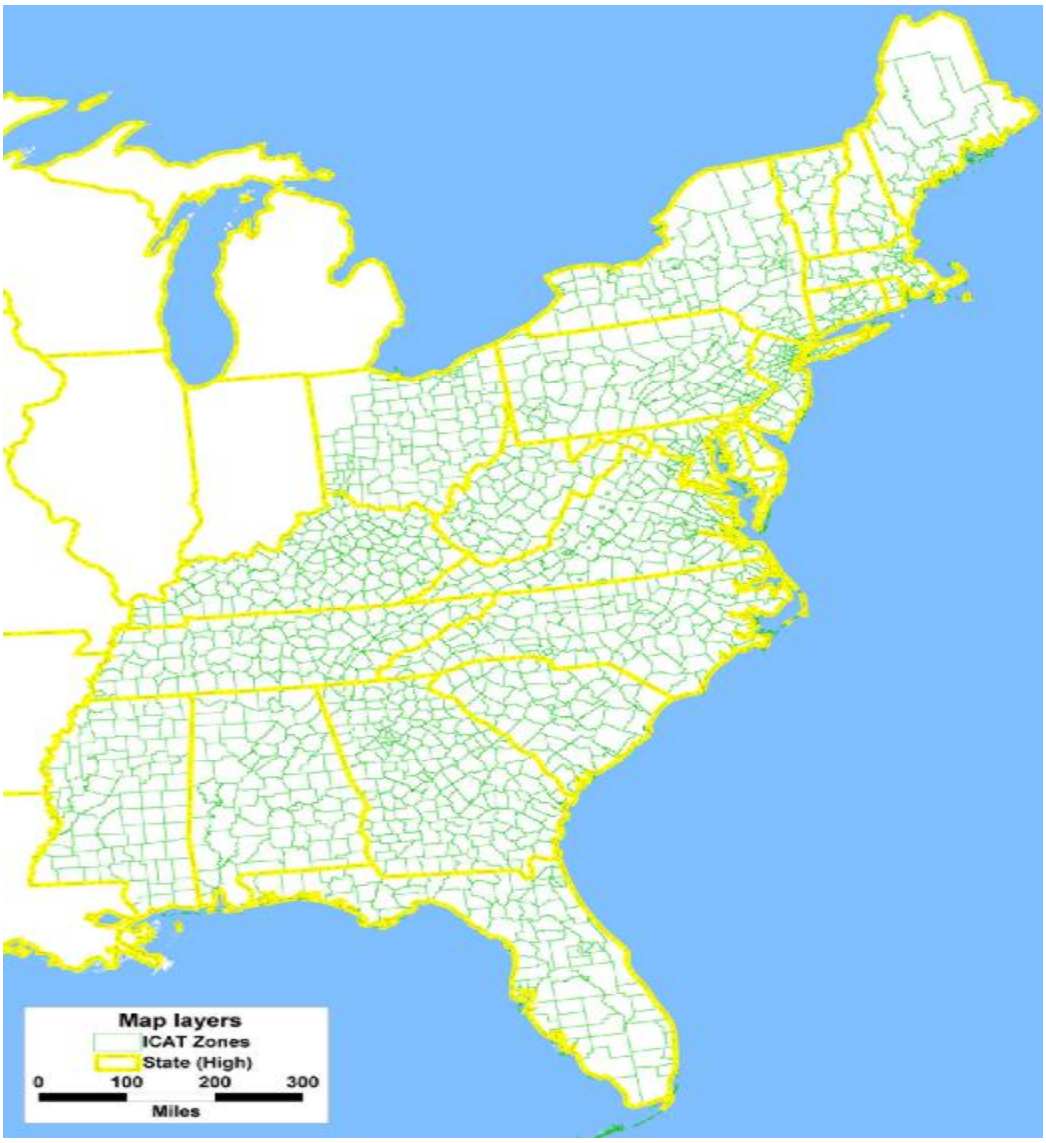
In delineating the TAZ structure, a number of issues must be addressed. The main question regarding the zone system is what size or level of detail to make the zones with respect to the intended uses of the model. As described earlier in Table 1, zone size can be classified by model type or purpose. For example, while county-level TAZs could suffice for multistate models and the areas outside a particular state of interest, county-level TAZs are generally too large for the in-state portions of statewide models. Participants in the panel teleconference favored a flexible zone structure whereby nested geographies were used wherever feasible along with disaggregation tools for more detailed geographies.

A balance must be achieved whereby model geography is appropriate for given study type but file sizes and the number of matrix cells are kept at a manageable level. Disaggregation must be sensitive to the availability of statistically valid data samples. It also is important that the zone system be compatible with network density and geography for proper loading of trips.

Depending on scale and level of detail required, several data sources are available for consideration. The primary source of demographic geography is the U.S. Census Bureau with

geography by block, block group, enumeration district, and census tracts. Other sources of relevant geography include zones created for multistate corridors such as for the I-95 Integrated Corridor Analysis Tool (ICAT).[5] These zones, as depicted in Figure 1, which mostly follow county lines with additional TAZ splits in urban areas, conform to the specific needs of corridor-level analysis in the I-95 transportation study area. For this reason, these zones in the eastern United States could potentially serve as a starting point for the NatMod, which would likely be utilized to perform similar analyses in the future.

Figure 1. Integrated Corridor Analysis Tool (ICAT) Zones



[5] I-95 Corridor Coalition Year 14 Scope of Work Form: Development of General Auto and Truck Trip Tables, Cambridge Systematics, Inc., November 2007.

For freight purposes, consideration should be given to incorporating Freight Analysis Framework (FAF)[6] zones into the model at some level of disaggregation. The FAF zone structure has specifically been set up to accommodate freight data manipulation and would assist with incorporation of freight data into the model structure. The major issue with FAF zones however concerns the likely need for more detail in many areas of the country. For statewide models, distant outlying states from the state of concern can be represented by large aggregations (zones, networks) without concern. For the purposes of targeted studies using NatMod, however, more detail is likely to be required that is geographically consistent in terms of population density and economic output. FHWA has an ongoing work order to develop a tool for FAF disaggregation[7] that should allow for use of these data in a more detailed zone structure.

Regarding the national network, the principal question regards the extent of the network, the required detail, and the modes to be considered. Research has indicated a number of sources of network data. Table 5 summarizes essential and desirable HPMS[8] network attribute characteristics that will need to be assessed during model development. For highway modes, attributes like speeds, functional class and area type are critical in determining network travel patterns. Other attributes such as truck percentages and planned improvements are highly desirable as these aid in comparative analysis. Table 6 illustrates sources of linear data that are applicable to developing networks. The data include alternative sources for highway network data such as the National Highway Planning Network.[9] Network data for other transportation modes also have been identified for potential use.

Eventually, it may be desirable to include the ability to assign rail freight and/or passenger trips. As with the highway network for FAF, this may be copied as is or improved upon with additional data from railroad companies and other relevant entities. Network attributes that are important for railroad network extraction include maximum allowable track speeds and conditions and typical freight commodities transported among others described in Table 5. As part of a study recently conducted for the American Association of Railroads,[10] the Tennessee DOT statewide rail network[11] was used as a starting point for developing an enhanced national rail network, including the addition of track route capacity.

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[6] Freight Analysis Framework, Issues and Plans, Federal Highway Administration, September 2004.

[7] Freight Analysis Framework[2], Origin-Destination Disaggregation Research Plan, prepared by Cambridge Systematics, Inc. for FHWA, September 2007.

[8] Highway Performance Monitoring System Field Manual, Federal Highway Administration Office of Highway Policy Information, May 2005.

[9] National Highway Planning Network Metadata, Federal Highway Administration Office, August 2005.

[10] National Rail Freight and Infrastructure Capacity and Investment Study Final Report, prepared by Cambridge Systematics, Inc. for American Association of Railroads, September 2007.

[11] Tennessee Long-Range Transportation Freight Model Final Report, prepared by PBS&J Consulting Team for Tennessee Department of Transportation, December 2005.

Table 5. HPMS Network Attribute Characteristics

Spatial Attributes
Scale
Projection
Topology
Accuracy
Feature Representation
Coverage
Format
Essential Network Attributes (Roadway)
Posted Speeds
Roadway Functional Classification / Facility Type
Roadway Directionality
Area Type
Number of Lanes
Segment length (GIS / Actual)
Road Name / Route Number
Toll Facility Indicator
Access Control
Terrain Indicator
Traffic Counts / AADT (HPMS Sourced or Otherwise)
Desirable Network Attributes (Roadway)
Truck Counts / Percentages
Planned Improvements by Year
Major Intermodal Connector Indicator (HPMS)
State Identifier
County Identifier
City Identifier
HPMS Data Description Link
http://www.fhwa.dot.gov/ohim/hpmsmanl/chapt4.htm
Rail Network Attributes
Company Name
Number of through mainline tracks
Segment length
Intermodal facilities and coordinates (Yards, Ports, Passenger Stations)
Rated Track Speed / Condition (FRA, Company or Otherwise Sourced)
Trackage Rights Tenants
Passenger Operation Indicator (Amtrak / Commuter Rail)
Should also consider Airports for passengers; Seaports, Riverports, Lakeports for freight.
Waterway Network Attributes
Waterway Name
Channel depth / classification
Waterway Type
Channel length
Freight type / Volumes (If available)
Passenger cruise volumes
Intermodal facilities and coordinates (Ports, Cruise Passenger Stations)

Table 6. Sources of Linear Data

Description	Web Site	Year	Method of Data collection
The National Highway Planning Network (NHPN) is a 1:100,000 scale network database that contains line features representing just over 450,000 miles of current and planned highways in the U.S. The NHPN consists of interstates, principal arterials, and rural minor arterials.	http://www.fhwa.dot.gov/planning/nhpn/ http://www.bts.gov/publications/national_transportation_atlas_database/2007/html/nhpn_lin.html	2005 (2005.08)	Oak Ridge National Laboratory (1991); USGS Digital Line Graph (DLG-3) Series; state-supplied digital and map data (1992, 1993, 2002, 2003); CENSUS TIGER/Line 1994 and 2000; HPMS (2002); Transport Modeling and GIS-T Application Group, Transportation and Space Division, Battelle (2003); FHWA.
The Oak Ridge National Highway Network (NHN) is a database of major highways in the United States. It succeeds the National Highway Planning Network, version 1, with the same basic structure and format. It is designed primarily to address vehicle routing and scheduling problems, but naturally may be used in other studies that require an analytic or geographically based national highway network. The NHN includes both attribute and locational data about roadways acquired from a wide variety of sources. It has been enhanced at Oak Ridge National Laboratories with additional roads and attribute detail and adjusting topology to produce a true analytic network. This documentation is intended primarily to assist users of this database by describing its structure, data elements, and development.	http://www.cta.ornl.gov/transnet/Highways.html	2004	USGS National Atlas Digital Line Graphs; State Maps; Other Maps; HPMS; Defense Movement Coordinators; USGS 1:100,000 Digital Line Graphs; TIGER/Line Files; Digitization of Urban Area Maps; NHPN, version 2; Matchstick networks for Canada and Mexico.

Table 6. Sources of Linear Data (continued)

Description	Web Site	Year	Method of Data collection
The spatial component of the FAF 2.2 network is derived from National Highway Planning Network Version 2005.08 and contains the National Highway System (NHS), National Network (NN),and several intermodal connectors as appropriate for freight network modeling. The network consists of over 447,407 miles of equivalent road mileage. The data set covers the 48 contiguous states, Alaska, Canadian routes that connect Alaska to the contiguous states, and the District of Columbia. The nominal scale of the data set is 1:100,000 with a maximum positional error of ±80 meters.	http://www.ops.fhwa.dot.gov/freight/freight_analysis/faf/index.htm	Published in 2006 – Data available for 2002 and 2035	National Highway Planning Network Version 2005.08.
The HPMS provides data that reflects the extent, condition, performance, use, and operating characteristics of the nation's highways. The HPMS by itself is not geospatial data. It is linked to another FHWA dataset, the National Highway Planning Network (NHPN), through linear referencing. The NHPN provides the geospatial component of this dataset.	http://www.bts.gov/publications/national_transportation_atlas_database/2007/html/hpms.html	2006 (reported in June 2007)	National Highway Planning Network (NHPN), through linear referencing.
Provides comprehensive street, address, Census, and postal data for a variety of U.S.-based geographic applications. Provides millions of miles of addressed streets; offers an extensive list of attributes such as landmarks, POIs, and water features; and can be used for presentation-quality maps.	http://www.teleatlas.com/OurProducts/MapData/Dynamap/index.htm	Varies – typically up-to-date	TANA/GDT relies on relationships with more than 33,000 resource providers, strategic development partnerships, and data enhancement feedback loops for baseline data sources. These ongoing relationships have developed into an effective mechanism to gather local information such as a new subdivision or a change in a street name.

Table 6. Sources of Linear Data (continued)

Description	Web Site	Year	Method of Data collection
NAVTEQ maps provide a highly accurate representation of the detailed road network, including up to 204 attributes like turn restrictions, physical barriers and gates, one-way streets, restricted access, and relative road heights.	http://www.navteq.com	Varies – typically up-to-date	NAVTEQ field researchers drive millions of kilometers of the road network each year. To provide uniformity and maximize precision each team works to a single global specification. And each team has state-of-the-art equipment, including proprietary GPS-based collection technology and GWS software.
The 2005 First Edition TIGER/Line files are an extract of selected geographic and cartographic information from the Census TIGER database. The geographic coverage for a single TIGER/Line file is a county or statistical equivalent entity, with the coverage area based on the latest available governmental unit boundaries. The Census TIGER database represents a seamless national file with no overlaps or gaps between parts. There are 19 record types, including the basic data record, the shape coordinate points, and geographic codes that can be used with appropriate software to prepare maps. Other geographic information contained in the files includes attributes such as feature identifiers/census feature class codes (CFCC) used to differentiate feature types, address ranges and ZIP Codes, codes for legal and statistical entities, latitude/longitude coordinates of linear and point features, landmark point features, area landmarks, and area boundaries.	http://www.census.gov/geo/www/tiger/tiger2005fe/tgr2005fe.html	2005	USGS, including paper maps annotated in the field and subsequently digitized.
The Rail Network is a comprehensive database of the nation's railway system at the 1:100,000 scale. The data set covers all 50 States plus the District of Columbia.	http://gis.fra.dot.gov (link not working); http://www.bts.gov/publications/national_transportation_atlas_database/2007/html/railway_lin.html; http://www.bts.gov/publications/national_transportation_atlas_database/2007/zip/railway_lin.zip		Derived from Federal Railroad Administration (FRA) 100,000 network, although not spatially the same.

Table 6. Sources of Linear Data (continued)

Description	Web Site	Year	Method of Data collection
The CTA Railroad Network is a representation of the North American railroad system that contains every railroad route in the U.S., Canada, and Mexico that has been active since 1993. Corporate structure, a key to the simulation of routing, is explicitly temporal, allowing historical studies and comparisons. Supporting data on interlines and corporate ancestry allows the construction of routable networks for a specific target date. The network is an extension of the Federal Railroad Administration's strategic network. It is important to remember that the fundamental objective in its construction was accurate intercity routing, and effort was spent on the network roughly in order of the benefit/cost relative to that objective.	http://cta.ornl.gov/transnet/RailRoads.html	2005	The base data for the U.S. portion of the network is the Federal Railroad Administration's National Atlas-based strategic rail network. Harry Ladd, U.S. Railroad Traffic Atlas (numerous editions). Mike Walker, Railroad Atlas of North America (all volumes), published by Steam Powered Video. Miscellaneous local urban street maps, county highway maps, topographic maps, and employee timetables.
The National Waterway Network is a comprehensive network database of the nation's navigable waterways. The data set covers the 48 contiguous states plus the District of Columbia, Hawaii, Alaska, Puerto Rico, and water links between. The nominal scale of the data set varies with the source material. The majority of the information is at 1:100,000 with larger scales used in harbor/bay/port areas and smaller scales used in open waters.	http://www.iwr.usace.army.mil/NDC/data/datanwn.htm	2007	USGS Digital Line Graph (DLG) files
U.S. Army Corps of Engineers Navigable Waterway Network (Line).	http://www.bts.gov/publications/national_transportation_atlas_database/2007/zip/waterway_lin.zip	2000?	The hydro polygon/Arc coverages were created using TIGER/LINE 2000 shapefile data gathered from ESRI's Geography Network. The individual county hydrography line shapefiles were processed into Arc/Info coverages and then appended together to create complete state coverages. They were then edited to remove unwanted features, leaving a state-by-state database of both important and navigable water features.

Table 6. Sources of Linear Data (continued)

Description	Web Site	Year	Method of Data collection
It is made up from the ORNL Highway, Rail, and Waterway networks already cited, but this intermodal network also includes the connections between the modal networks, as well as County centroids.	http://cta.ornl.gov/transnet/Intermodal_Network.html	2002? Varies based on individual network updates	Oak Ridge National Highway Network; CTA operational railroad network; National Waterways Network with attached global seaways.

This network, minus proprietary rail information, can be used as a basis for the NatMod railroad network.

As is the case for rail, a water-based network may eventually be developed to allow for better comparative freight analyses. The National Waterway Network is a comprehensive resource indicating ports, marine routings, and commodity flows. As updated information is made available such as new port facilities, changed routes, new commodities, or new technology affecting speeds this resource can be expanded.

Like rail and highway networks, the routes would be represented as links with ports being nodes and each having attributes describing their characteristics. Ports would include attributes like tonnage handled, commodity types, and source (intermodal or not). Link attributes would include speed, length, and capacity. Allowance for seasonality in waterborne freight may be necessary in colder climates.

Given the nature of air travel, it is unlikely that geographic networks with lines drawn across a map would be built for the NatMod. Tabular representation with route origins and destinations, flight lengths, cargo capacity, and passenger capacity may suffice. Such information should be readily available from ticket samples and other data sources. Civil aviation operations and activities are among the most documented in the transportation arena. Airport facilities are found in a variety of network databases.

n Subtask 2.2: Demographic and Employment Data

The principal source of current demographic information is the U.S. Census Bureau and its myriad products.[12] The NatMod project should include some budgeting for the purchase of supplemental proprietary data where necessary for this effort at the appropriate level of geography. However, approvals from the contracting agency must be received prior to purchasing data. Wherever feasible, available Federal and other nonproprietary data will be provided at no cost.

Long-range forecasts are available from private firms that provide county level population and employment characteristics for the forecast year. For employment data, the sources are more diverse as each has certain limitations. Data from private firms, Federal agencies, state employment security agencies, local governments, and chambers of commerce are available. Some employment data sources could potentially serve as useful controls on data garnered from the other available sources. Should proprietary data be necessary for building the model, such data should be modified in a nonproprietary format for subsequent access by model analysts.

[12]U.S. Department of Commerce, U.S. Census Bureau Home Page http://www.census.gov, date unknown.

Table 7 lists some common sources of demographic and employment data available for use in NatMod development. These data sources should be reviewed along with other possible sources and a plan and budget recommended for gathering demographic and employment data for the NatMod.

n Subtask 2.3: Freight and Other Economic Data

Unlike MPO travel models which typically focus on passenger and other short-distance travel, freight and other long-distance travel constitute a significant aspect of a national travel model. Several sources of freight data exist at the national, regional, and local level, including TRANSEARCH,[13] the FAF, the Commodity Flow Survey,[14] the Vehicle Inventory and Use Survey (VIUS),[15] the Carload Waybill Sample,[16] and the U.S. Army Corps of Engineers Waterborne Statistics[17] database among others. Tables 8 and 9 list the sources.

Depending on model application, special attention may need to be paid to freight activities at international points of entry such as border crossings, seaports, and airports. FAF2 does provide detailed flow data at 75 international gateways throughout the country. Other sources provide supplemental information such as value of commodities, mode of transportation, weight, vehicle usage patterns, and O-D data.

Table 10 describes freight modes that could be considered in the NatMod. These should be discussed with the contracting agency and a recommendation made as to preferred modes for inclusion at this time. Discussions with NCHRP panelists for this study indicated that highways should be addressed first with rail as a secondary consideration, and that most other modes are unlikely to be included in the model.

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[13] TRANSEARCH Insight Brochure, Global Insight http://www.globalinsight.com.

[14] 2002 Economic Census/2002 Commodity Flow Survey, Bureau of Transportation Statistics, December 2004.

[15] Vehicle Inventory and Use Survey, Program Documentation, U.S. Census Bureau, April 2006.

[16] Carload Waybill Sample, Federal Railroad Administration, April 2008 Update.

[17] Navigation Data Center, U.S. Army Corps of Engineers, Trends in Commodity Tonnage Flows, June 2008.

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Table 7. Sources of Demographic and Employment Data

Name	Proprietary	Residence or Employment	Description	Web Site	Most Recent Year	Frequency of Updates	Lowest Geographic Unit	Cross Referenced Data Sources
2000 Census PL 94 – 171	No	N (not directly)	Special Information collected by Census to determine redistricting requirements. Total Population; population over 18 years old and race.	http://www.census.gov/support/PLData.htm	2001	Every 10 years	Census Block	
2000 Census Summary File 1	No	Residence	Contains characteristics of persons, workers, households for traffic analysis zones, block groups or tracts depending on local preference.	http://www.census.gov/Press-Release/www/2001/sumfile1.html	2001	Every 10 years	Census Block	
2000 Census Summary File 3	No	Residence	Detailed population and housing 1 in 6 sample data on Income, employment status, education, place of birth etc.	http://www.census.gov/Press-Release/www/2002/sumfile3.html	2002	Every 10 years	Census Tract	
2000 Census Public Use Microdata Sample one and five percent	No	Residence	Individual one and five percent sample records of people and housing units.	http://www.census.gov/Press-Release/www/2003/PUMS.html	2003	Every 10 years	Public Use Microdata Areas(PUMA)	
Census Transportation Planning Package 2000 Part 1	No	Residence	The Census Transportation Planning Package (CTPP) is a set of special tabulations from the decennial census designed for transportation planners. CTPP contains tabulations by place of residence, place of work, and for flows between home and work. Part 1 contains tables related to the residence and individual person.	http://www.trbcensus.com	2003	Every 10 years	Census Block Group/TAZ (whichever is smaller)	
Census Transportation Planning Package 2000 Part 2	No	Residence	CTPP Part 2 contains tables related to the employment, place of work.	http://www.trbcensus.com	2003	Every 10 years	Census Block Group/TAZ (whichever is smaller)	
Census Transportation Planning Package 2000 Part 3	No	Residence	CTPP Part 3 contains tables related to the flow between work and home.	http://www.trbcensus.com; http://www.census.gov/mp/www/spectab/specialtab.html	2004	Every 10 years	Census Block Group/TAZ (whichever is smaller)	
American Community Survey Public Use Microdata Samples	No	Residence	Individual one and five percent sample records of people and housing units from ongoing American Community Survey.	http://www.census.gov/acs/www/	2006		Census Block	
National Household Travel Survey 1990, 1995, 2001	No	Residence – Focus on Behavioral Characteristics	Conducted since 1969 by the Federal Highway Administration (FHWA), the National Household Travel Survey (NHTS) is the nation's inventory of daily and long-distance travel. The NHTS is has been the nation's flagship survey to quantify the travel behavior of the American public. The survey has provided the nation with authoritative data on travel by all modes of transportation, for all travel purposes, and all travel distances. The NHTS series provide vital data on American passenger travel and can be used to examine the relationship among social and demographic change, land development patterns, and transportation. For a national model this data is vital as there are not many sources of long-distance trip information readily accessible to planners.	http://nhts.ornl.gov/index.shtml	2005	No specific frequency of updates. Done as a need is identified and resources made available	Census Block Group	
Longitudinal Employer – Household Dynamics program	No	Employment	LEHD links state Quarterly Census of Employment and Wages (QCEW) with Federal administrative records. The LEHD database enables planners to match workers with past and present employers, together with employer and worker characteristics (Abowd, Lane, and Prevost, 2000). This database consists of quarterly records of the employment and earnings of almost all individuals from the unemployment insurance systems of a number of U.S. states in the 1990s.	http://www.fhwa.dot.gov/planning/Census/lehd.htm; http://lehd.did.census.gov/led/index.html	2006?	Quarterly updates	Census Block	ES202 data, Social security administration UI (unemployment insurance) records, census geography and databases.

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Table 7. Sources of Demographic and Employment Data (continued)

Name	Proprietary	Residence or Employment	Description	Web Site	Most Recent Year	Frequency of Updates	Lowest Geographic Unit	Cross Referenced Data Sources
State Employment Security Departments ES202 Data (QCEW)	No (but has confidentiality restrictions)	Employment	Each state has one or more employment information agencies that supply information upon request on the employment market, employed workers, unemployed workers, statistics etc. This information is usually purchased by the interested user and/or provided with some kind of clause concerning proprietary status. Information available includes workers per establishment, location of establishment, type of establishment business etc.	http://www.subnet.nga.org/workforcecouncilchairs/StateEmpTrainAg.htm	2007?	Generally monthly	Point Lat/Long GIS, database	
U.S. Department of Labor Bureau of Labor Statistics NAICS table data	No	Employment	The data from the Current Employment Statistics survey include series for total employment, number of production or nonsupervisory workers, average hourly earnings, average weekly hours, average weekly earnings, and average weekly overtime hours in manufacturing industries.	http://www.bls.gov/data/home.htm	2006?	Quarterly updates	Metropolitan Statistical Area	
U.S. Department of Labor Bureau of Labor Statistics SIC table data	N	Employment	The data from the Current Employment Statistics survey include series for total employment, number of production or nonsupervisory workers, average hourly earnings, average weekly hours, average weekly earnings, and average weekly overtime hours in manufacturing industries.	http://www.bls.gov/data/home.htm	Pre 2003?	Was on a quarterly basis	Metropolitan Statistical Area	
U.S. Census Bureau Employment Opportunity (EEO) Special Tabulation	No	Employment	The EEO Tabulation is a special tabulation contracted for and paid for by a consortium of four Federal agencies. The tabulation consists of occupation and educational attainment information for 24 data sets made up of residential data, residence to worksite flow data, and worksite data. Particularly noteworthy are data on occupation by age, occupation by industry, and occupation by earnings. The tabulation shows data for 471 census occupations, 268 Office of Personnel Management occupations, and 8 state and local government occupational categories. The tabulation is used in developing affirmative action programs.	http://www.census.gov/eeo2000/index.html	2004	Every 10 years	Metropolitan Statistical Areas or (minor civil divisions of 50,000 or more in CT, MA, ME, NH, and RI)	General Census Summary Files 1-4.
Woods and Poole Metropolitan and County historical and forecast data	Yes	Employment	Complete Database on CD-ROM contains historical data from 1970 and projections to 2030 of population by race, sex, and age, employment by industry, earnings of employees by industry, personal income by source, households by income bracket and retail sales by kind of business. Data for all economic and demographic variables for all years 1969 to 2030 for all geographic areas (U.S., regions, states, counties, DMAs, MSAs, and Micropolitan Areas) are included: 118 million statistics. Technical documentation to read the CD-ROM. $3,500 for Complete Database on CD-ROM.	http://www.woodsandpoole.com/	2007	Annually	County	
InfoUSA	Yes	Employment	Information can be obtained on businesses by type, product, sales volume etc.; household customers as well as specialty compilations generally aimed at the business person seeking to grow markets.	http://www.infousa.com/	2007	Quarterly updates	Point Lat/Long GIS, database	County courthouse filings, SEC, 10K, USPS National Change of Address (NCOA), ZIP+4 and Delivery Sequence File, telephone directories etc.
Dun and Bradstreet business data	Yes	Employment	Source of business information in the U.S. and Canada as well as multi national firms that also operate in the rest of the world. Could be useful for freight generation data.	http://www.selectory.com/Selectory/Login.aspx; http://www.dnb.com/us/	2007	Quarterly updates	Point Lat/Long GIS, database	
Automatic Data Processing National Employment Report	No	Employment	Gives a summary estimate of total nonfarm jobs nationwide. Although not broken out by geography, useful as a control check versus BLS and other statistics.	http://www.adpemploymentreport.com/index.aspx	2008	Monthly	Not broken out by geography (Entire nation)	U.S. Department of Labor Bureau of Labor Statistics NAICS table data used for comparisons.

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Table 8. Freight Data

Existing Data	Proprietary	Level Of Geography	Brief Description Of Source	Web Site(s)	Year(s) Of Availability	Comments
Commodity O-D Tables						
Global Insight TRANSEARCH	Yes	Counties and aggregations of counties	TRANSEARCH is a privately maintained comprehensive market research database for intercity freight traffic flows compiled by Global Insight, formerly Reebie Associates. The database includes information describing commodities (by Standard Transportation Commodity Classification (STCC) code), tonnage, origin and destination markets, and mode of transport. Data are obtained from Federal, state, provincial agencies, trade and industry groups, and a sample of motor carriers. Forecasts of commodity flows for up to 25 years also are available.	http://www.globalinsight.com/ProductsServices/ProductDetail2322.htm	Annually from 1996	Forecasts are available.
FHWA Freight Analysis Framework	Public	FAF Regions	FAF2 is an improvement on FAF1 by providing more geographic regions that cover substate areas (FAF2 includes 114 zones, while FAF1 displayed only interstate flows); providing international freight flows to Canada, Mexico, Latin and South America, Asia, Europe, the Middle East, and the rest of the world through more than 75 international gateways in the country; providing seven mode classifications (truck, rail, water, air, pipeline, intermodal, and others) instead of the traditional four provided by FAF1 (truck, rail, air, water); and providing commodity data using the two-digit Standard Classification of Transported Goods (SCTG) scheme in order to match the 2002 CFS.	http://ops.fhwa.dot.gov/freight/freight_analysis/faf/index.htm	2002, 2006	FAF1 used different modes, a different commodity classification, STCC and was published at the state level only. FAF1 forecasts were for 2010 and 2020. FAF2 includes forecasts to 2035 at five-year intervals.
Census Bureau Commodity Flow Survey	Public	64 largest Metropolitan Areas (MA)[a] and remainder of states not in MAs	The 2002 CFS is undertaken through a partnership between the U.S. Census Bureau, U.S. Department of Commerce, and the BTS, U.S. Department of Transportation. This survey produces data on the movement of goods in the United States. It provides information on commodities shipped, their value, weight, and mode of transportation, as well as the origin and destination of shipments of manufacturing, mining, wholesale, and select retail establishments. The 1993 and 1997 CFS are a continuation of statistics collected in the Commodity Transportation Survey from 1963 through 1997, and includes major improvements in methodology, sample size and scope. For each sampled CFS shipment, zip code of origin and destination, five-digit Standard Classification of Transported Goods (SCTG) code, weight, value, and modes of transport, have been provided.	http://www.bts.gov/programs/commodity_flow_survey/	1993, 1997, 2002	1993 CFS used the STCC commodity classification system.
Mode-Specific Freight Data						
U.S. Census Bureau's Vehicle Inventory and Use Survey (VIUS)	Public	State	The VIUS provides data on the physical and operational characteristics of the nation's private and commercial truck population. Its primary goal is to produce national and state-level estimates of the total number of trucks. This survey was conducted every five years, until 2002, as part of the economic census. A microdata CD-ROM contains unaggregated records for individual trucks by state. The records are masked to avoid possible disclosure of individual vehicles or owners.	http://bhs.econ.census.gov/econhelp/vius/	1963 to 2002 at five year intervals (discontinued)	VIUS has been discontinued after the 2002 Economic Census. The 2002 VIUS used a different data format than earlier datasets.
Surface Transportation Board's Carload Waybill Sample	Public, full confidential data available only to state DOTs	Individual Stations	The STB has statutory authority over the Carload Waybill Sample (49 CFR 1244). Railroads terminating over 4,500 cars per year are required to file a sample of waybills with the STB. The primary purpose of the Carload Waybill Sample is regulatory oversight. This database contains rail shipments data such as origin and destination points; type of commodity; number of cars, tons, revenue; length of haul; participating railroads; interchange locations; and Uniform Rail Costing System shipment variable cost estimates. The Waybill Sample contains confidential information. It is not available for public use. However, there is a public-use version of the Sample that contains aggregated nonconfidential data. Movements are generally aggregated to the Bureau of Economic Analysis (BEA) region to BEA region level at the five-digit Standard Transportation Commodity Code level.	http://www.stb.dot.gov/stb/industry/econ_waybill.html	Annually since 1985	
U.S. Army Corps of Engineers' Waterborne Commerce Statistics Database	Public	Individual Ports	The USACE publishes every year the Waterborne Databanks and Preliminary Waterborne Cargo Summary reports, which contain foreign cargo summaries, including value and weight information by type of service on U.S. waterborne imports and exports. These statistics are based on the U.S. Bureau of the Census trade data matched to the U.S. Customs vessel entrances and clearances.	http://www.iwr.usace.army.mil/ndc/wcsc/wcsc.htm	Annually since 2001	The WBC does not include O-D information. The USACE's WDC waternet includes flows between origin and destinations on water channels.

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Table 8. Freight Data (continued)

Existing Data	Proprietary	Level Of Geography	Brief Description Of Source	Web Site(s)	Year(s) Of Availability	Comments
Mode-Specific Freight Data (continued)						
Federal Highway Administration's Vehicle Travel Information System (VTRIS)	Public	States by individual station	The VTRIS maintains the permanent database of the Station description, Vehicle Classification, and Truck Weight measurements in metric units.	http://www.fhwa.dot.gov/ohim/ohimvtis.htm	Annually since 1990	These truck traffic counts are used by the states to prepare truck volumes in their HPMS submittals.
Employment/Industry Data						
Sources of Employment and Wage Data						
Bureau of Labor Statistics	Public		The Bureau of Labor Statistics (BLS) is the principal fact-finding agency for the Federal government in the broad field of labor economics and statistics. The BLS is an independent national statistical agency within the U.S. Department of Labor that collects, processes, analyzes, and disseminates essential statistical data to the public, the U.S. Congress, other Federal agencies, state, and local governments, business, and labor. The BLS works with state-level employment agencies throughout the country to collect data on employment, unemployment, and wages.	http://www.bls.gov/	annual	This listing is provided as a general source. The LAUS and CES programs listed below are the principal data programs of the BLS.
State Department of Labor	Restricted[b]	Typically counties but may be establishment address.	States Department of Labor tend to be the chief collector of data on industry and regional employment trends in the state. Agencies usually collect data through several distinct programs, in cooperation with the Bureau of Labor Statistics (BLS). Employment, wage, and payroll data also are produced by the Census Bureau of the U.S. Department of Commerce. States collect employment data using the BLS from ES-202.	Information for all state Departments of Labor can be found on the U.S. Department of Labor web site at: http://www.dol.gov/esa/contacts/state_of.htm.	annual, years of historical data varies by state	Publicly available data will vary by state.
Current Employment Statistics (CES)	Public	State and metropolitan areas	CES data are collected through a monthly survey of about 160,000 business and government agencies representing approximately 400,000 individual work sites and provides detailed industry data (industry-level details are available at a four-digit NAICS code for some, generally larger, metropolitan areas) on nonfarm employment, hours, and earning estimates based on payroll records. Current data on employment are available for most industries. CES data is generally not available at the county level.	CES data at the state and metropolitan levels may be obtained at http://www.bls.gov/sae/home.htm while nationwide data is available at http://www.bls.gov/ces/home.htm	Annually, form 1998	
Local Area Unemployment Statistics (LAUS)	Public	Sate and metropolitan areas	These monthly figures provide labor force estimates, the number of persons employed, the number of persons unemployed, and the unemployment rates for areas in the country. Information is available for states, metropolitan statistical areas, counties, and some cities, towns, and villages. One very significant difference between the LAUS data series and the other employment sources (ES 202 and Current Employment Statistics) is that it is based on a household survey rather than an employer survey. Because the LAUS is a household survey, it reflects where employed and unemployed people live, not where they work.	http://www.dol.gov/esa/contacts/state_of.htm	Annually, form 1998	
Occupational Employment Statistics	Public	For the nation as a whole, for individual states, and for metropolitan areas; national occupational estimates for specific industries also are available	Occupational Wage Data are produced by the BLS with cooperation with each state's Department of Labor. The program produces employment and wage estimates for over 800 occupations. These are estimates of the number of people employed in certain occupations, and estimates of the wages paid to them. Self-employed persons are not included in the estimates. These estimates are available for the nation as a whole, for individual states, and for metropolitan areas; national occupational estimates for specific industries also are available.	http://www.bls.gov/oes/	Annually from 1999	
U.S. Census Bureau's County Business Patterns	Public; Suppressed at certain geographies and NAICS industries	U.S., States, Counties, Metro Areas, and Zip Codes	County Business Patterns is an annual series that provides economic data by industry. The series is useful for studying the economic activity of small areas; analyzing economic changes over time; and as a benchmark for statistical series, surveys, and databases between economic censuses. County Business Patterns covers most of the country's economic activity. The series excludes data on self-employed individuals, employees of private households, railroad employees, agricultural production employees, and most government employees. The County Business Patterns program has tabulated data on a North American Industry Classification System (NAICS) basis since 1998.	http://www.census.gov/epcd/cbp/view/cbpview.html	Annually since 1964, but NAICS format since 1998. SIC industries prior to 1998.	Establishments by employment size is always provided. Suppressed employment data by county may be estimated based on the establishment size ranges and numbers of establishments.

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Table 8. Freight Data (continued)

Existing Data	Proprietary	Level Of Geography	Brief Description Of Source	Web Site(s)	Year(s) Of Availability	Comments
Sources of Employment and Wage Data (continued)						
Economic Census Industry Data	Public; Suppressed at certain geographies and NAICS industries	State, metropolitan area, and county	The Census Bureau conducts the Economic Census every five years, in those years ending in "2" and "7," to provide data on the national economy by major industry sector. Industry reports for each state can be downloaded in Adobe Acrobat's PDF format. Each industry report contains data on establishments, sales, and payroll at the state, metropolitan area, county, and community levels. The Economic Census of Manufactures, a subset of the Economic Census, provides data by NAICS code on manufacturing establishments that is unavailable from other public sources. Manufacturing data is included by industry and geographic location for total shipments, annual and first quarter payroll, number of employees, capital expenditures, cost of materials, and value added.	http://www.census.gov/econ/census02/		The data is available in PDF format, not electronically.
Sources of Income Data						
Bureau of Economic Analysis	Public	State, metropolitan area, and county	Income data can be downloaded from the BEA's web site. Historic information on employment and population also is presented on the BEA web site. Basic profiles, explaining the growth of per capita and personal income by county, are available from the BEA's BEA Regional Facts. Personal income and per capita income data currently are available by county, metropolitan area, and state for the 1969 to 2004 period.	http://bea.gov/bea/regional/reis/	Annually since 1969	
Performance Data						
FHWA's Highway Performance Monitoring System (HPMS)	Public Universe and sample records	By road segment	The Highway Performance Monitoring System (HPMS) provides data that show the extent, condition, performance, use, and operating characteristics of the nation's highways. It includes limited data on all public roads, more detailed data for a sample of the arterial and collector functional systems, and certain statewide summary information. It includes pavement condition data, congestion-related data, and traffic data used to determine fatality and injury rates. These data are the source of a large portion of information included in FHWA's annual Highway Statistics and other publications.	http://www.fhwa.dot.gov/policy/ohpi/hpms/index.htm	Annually from 1987	FHWA does not validate sample data fields that are provided for universe records and does not release this data. State submittal files may contain sample data attributes on universe records.
Texas Transportation Institute's Urban Mobility Report	Public	States and Urbanized areas.	The Urban Mobility Report, published on an annual basis, contains over 20 years of data which are used to identify trends and examine issues related to urban congestion. The 2007 study includes information for 85 U.S. urban areas from 1982 to 2005. The measures presented in the report provide a basis for discussion about the significance of the mobility problems and the need for solutions.	in PDF format at: http://mobility.tamu.edu/ums	Annually since 1982	Provides summary and comparative information. It is available in PDF format only.

[a] CFS Metropolitan Area include only the most largest part of the MA in a state. In the case of MAs that are divided by state lines the MA may include only the portion in a single state (e.g., ***Cincinnati-Middletown-Wilmington, OH-KY-IN CSA (OH Part)*** or may separately list MS in two or more states (e.g., ***Chicago-Naperville-Michigan City, IL-IN-WI CSA (IL Part)*** and ***Chicago-Naperville-Michigan City, IL-IN-WI CSA (IN Part).***

[b] Data collected by states Department of Labor through the ES-202 program is confidential. State DOTs mat entered into agreements with their DOLs to provide.

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Table 9. Rail Network and Trip Table Sources

Railroad Network	Source	Connected	TDF Model Platform	Centroids	Track links included	Distance	Signal Control	# Tracks	Usage Rights	Geographic Accuracy
FRA 100K	BTS / NTAD	Unknown	None	None	All including terminal tracks	Yes	No	No	Ownership	
FRA 2M	BTS / NTAD	Unknown	None	None	Major, including sidings and run outs	Yes	No	No	Simple	
ORNL	ORNL / CTA	STCC2-STCC7	Stations, counties, other	None	Major tracks only, no sidings	Yes	yes, not up to AAR standards	Yes	RR families	Same as FRA 100K
TDOT revised	Tons (Cars / TEUS value for fee)	Yes	TransCAD	Counties	For a fee	Yes	No	No	Ownership	Same as FRA 2M
FDOT SIS	FDOT (variation of TDOT)	Yes	TransCAD	Stations (master)	provided	Yes	No	No	Ownership	Same as FRA 2M

Rail Trip Tables	Flow Units	Commodities	Zones	Time Period	Forecasts	Railroads	Train Type
TDF Model Calculated	Tons	6 to 15 As Designated	TAZs	Annual	Modeled	No	No
FAF2 Disaggregated	Tons, Value	SCTG2	Counties	Annual	Provided	No	No
STB Carload Waybill	Tons	STCC2-STCC7	Stations, Counties, Other	Annual	No	Yes	Inferred
TRANSEARCH	Tons (Cars / TEUS Value for Fee)	STCC2-STCC4	TransCAD	Annual	For a Fee	No	No
FAF2 Original	Tons, Value	SCTG2	TransCAD	Annual	Provided	No	No

Note: Issues for STB Waybill unlinking multi-RR trips into single RR tables.

Table 10. Potential Freight Modes for National Model

Mode	Description
Truck	Includes private and for-hire truck. Private trucks are operated by a temporary or permanent employee of an establishment or the buyer/receiver of the shipment. For-hire trucks carry freight for a fee collected from the shipper, recipient of the shipment, or an arranger of the transportation.
Rail	Any common carrier or private railroad.
Water	Includes shallow draft, deep draft, and Great Lakes shipments. FAF2 uses definitions by the U.S. Army Corps of Engineers. Shallow draft includes barges, ships, or ferries operating primarily on rivers and canals; in harbors; the Saint Lawrence Seaway; the Intracoastal Waterway; the Inside Passage to Alaska; major bays and inlets; or in the ocean close to the shoreline. Deep draft includes barges, ships, or ferries operating primarily in the open ocean.
Air (Includes Truck-Air)	Includes shipments by air or a combination of truck and air. Commercial or private aircraft and all air service for shipments that typically weigh more than 100 pounds. Includes air freight and air express.
Truck-Rail Intermodal	Includes shipments by a combination of truck and rail.
Other Multiple Modes	Includes shipments typically weighing less than 100 pounds by Parcel, U.S. Postal Service, or Courier, as well as shipments of all sizes by truck-water, water-rail, and other intermodal combinations.
Pipeline and Unknown	Pipeline is included with unknown because region-to-region flows by pipeline are subject to large uncertainty.

Source: CS Draft Memo New Mexico through Truck Movements to Roy Cornelius from Daniel Tempesta and Cemal Ayvaik, January 2008.

Many freight data sources provide information in raw annual tons. To be useful in a modeling context, it will be necessary to convert the annual tonnage to daily equivalent vehicle units.[18] This is accomplished by obtaining a figure for daily vehicle payload (tons per truck, per railcar, per barge, etc.) and conducting conversions during mode choice. For barges and other nonroad-based modes, this information is needed in mode choice to represent a common frame of reference for comparisons.

Freight forecasts will largely rely on use of county-level employment projections, coupled with available growth trend information at U.S. borders and major ports.

[18]Quick Response Freight Manual II, prepared by Cambridge Systematics, Inc. for Federal Highway Administration, November 2007.

FAF2 trip tables could potentially be disaggregated to smaller geographies to minimize duplication of work both for the national and statewide models. Even as a potential starting point, limitation of FAF trip tables must be understood, as follows:

- No auto trip table;
- No data are available on future planned facilities;
- No data on nonfreight trucks;
- No airport-to-airport travel data; and
- Not sensitive enough to investigate dynamics of congestion impacts and trip diversion.

n Subtask 2.4: NHTS and Other Behavioral Data

The principal source of transportation behavioral data is the National Household Travel Survey (NHTS).[19] The NHTS replaced the American Travel Survey (ATS)[20] and National Personal Transportation Survey (NPTS).[21] These surveys have over the past three decades been the primary inventory of daily and long-distance travel; however, since the ATS was discontinued the sample size of long-distance travelers is not as substantial as it once was. Nonetheless, the NHTS is among the few sources of information on the long-distance trips that will be a focus of interest in a national travel demand model.

Data available in the NHTS includes trip purpose, trip length, travel mode, time-of-day, vehicle type, and mode choice among others. The NHTS and its predecessors have traditionally been updated on average about every seven years though the timing varies from as much as eight years to as little as five years. The latest NHTS is currently underway and due to be completed in 2008.

The Bureau of Transportation Statistics (BTS)[22] also provides limited summary information on the characteristics of long-distance travel. BTS also collects 10 percent samples of airline ticket information for O-D summaries.[23] Amtrak also has station-to-station flow data that should be readily available. Data from intercity bus operators might have proprietary limitations that impede usefulness.

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[19] National Household Travel Survey, Bureau of Transportation Statistics, 2001.

[20] 1995 American Travel Survey Technical Documentation, Bureau of Transportation Statistics, 1995.

[21] National Personal Transportation Survey, Bureau of Transportation Statistics, 1995.

[22] Transportation Statistics Annual Report 1998: Long-Distance Travel and Freight, Bureau of Transportation Statistics, 1998.

[23] Airline Origin and Destination Survey, Bureau of Transportation Statistics, March 2008.

Travel behavior data on work trips have historically been available through Census Journey-to-Work (JTW) and the Census Transportational Planning Package (CTPP). The American Community Survey (ACS) is replacing the previous use of Census long form questionnaires for JTW/CTPP data. ACS data sampling is ongoing and not limited to the years of the decennial Census. Large scale O-D roadside intercept studies such as those recently conducted for the Trans Texas Corridor[24] also could be useful inputs, particularly regarding long-distance travelers.

[24] Statewide Model Application Using the Texas SAM, Presentation by William Smithson/Wilbur Smith & Associates, Inc., TRB Meeting Federal Surface Transportation Requirements in Statewide and Metropolitan Transportation Planning, A Conference, September 2008.

Task 3.0 Model Development and Validation

During Task 3, the National Model will be developed, implemented, validated, and calibrated to an agreed upon base year. The nature of these efforts will depend largely on the model structure agreed upon during Task 1 and the ability to gather the desired data during Task 2. While validation of NatMod will be more akin to validation of a statewide model than that of an urban/regional/MPO model, there will still be some differences related to the density of the highway network and zone system and available data for model development. Sensitivity testing using forecasted trip tables and network assumptions will complete the process of model validation.

n Subtask 3.1: Model Development and Implementation

Passenger Model estimation should be conducted through use of National Household Travel Survey (NHTS) data, including the 2008 Add-On Surveys. Statistical analysis software should be used with NHTS data to develop trip rates, friction factors, auto occupancy rates, and other needed model parameters and stratifications. While it would be possible to borrow parameters from other models and surveys throughout the United States, this could quickly get unwieldy and be potentially biased towards certain regions of the United States or urbanized area size groupings. With the Phase I effort being focused on highway trips, mode choice will be, at most, a simple auto occupancy conversion using factors from NHTS. If origin destination matrix estimation is used, trips already will be in vehicle equivalents. When completed, the ongoing update of NCHRP 365 also should provide guidance in standard benchmarks and settings in the absence of household survey data for a given geography.

Model development and implementation will include efforts to estimate and borrow appropriate model parameters, program scripts and/or executables, and graphical user interfaces (GUIs) to run the model and edit data. This effort will require close coordination with the contracting agency as well as the NMSC. The work approach might vary considerably depending on decisions made during Tasks 1 and 2 regarding model type, available data, and software platform. For example, if NatMod is developed as an O-D matrix estimation process, model development will be largely focused on obtaining accurate traffic counts while trip rates and friction factors will not be needed. Growth factors would be needed from a variety of sources to develop future year trip tables.

Given the data requirements of a model on the scale of the entire Continental United States, it is advisable to keep the model structure as simple as possible. Larger geographies, such as counties, are preferable given that such data are more likely to be consistent on a continental scale. Observed relationships between attributes like area, population density, industrial density, type, and trip production rates (passenger and freight) may be used to get data for geographies at finer scales like tracts, block groups, or traditional MPO TAZs.

n Subtask 3.2: Trip Generation

Statistical analysis should be conducted on NHTS data to estimate passenger person trip generation rates and household stratifications for the NatMod. The number of trip purposes could be consistent with the NHTS; however, for the purposes of the NatMod, a more simplified trip purpose structure of home-based work, home-based other, and non-home-based trips could be considered. Alternately, passenger trips could be split into local and long-distance or urban and rural groupings using other information available from the NHTS and other sources, assuming sufficient sample sizes. It should be noted however that modeling local trips is best left to MPO urban and regional models owing to the inevitable coarseness of the NatMod.

Freight trips are clearly integral to the NatMod and freight trip production and attraction rates would likely be based on a regression analysis using a combination of proprietary and nonproprietary data on freight movements. It would be preferable to use nonproprietary inputs whenever possible. Outputs from the NatMod should always be in a nonproprietary format for general distribution. Most statewide freight models generate tons by commodity group as surrogates for trips by purpose, with tons converted to trucks during mode choice. Recommendations should be made on a set of commodity groupings based on differences in subsequent trip distribution and mode choice patterns.

The passenger component of trip generation would likely take the form of cross-classification; however, regression rates could alternately be used to simplify data requirements, particularly if trip purposes are defined by urban versus rural or long- versus short-distance. It also would be anticipated that passenger trips might be generated in person trip equivalents; however, the pros and cons of person versus vehicle trip generation should be evaluated in recommending a rate structure. It is thought to be preferable to do the modeling on a person trip basis, particularly if mode choice considerations become important. If cross classification is selected, identification of appropriate household (HH) stratifications that could be supported by NHTS or similar data (e.g., HHs by auto availability) will be required.

Validation of passenger trip generation will likely focus on comparisons between model estimated and observed (e.g., NHTS) trip purpose percentages and aggregate trip rates (e.g., trips per HH, trips per person, etc.). Trip purpose stratifications and aggregate trip rates from statewide models and travel surveys can be used as benchmarks for assessing model validity. Table 11 depicts 2001 NHTS percent trips by purpose and Table 12 depicts aggregate trip rates based on 2001 NHTS data.

Table 11. 2001 NHTS Percent Trips by Purpose

	Travel Day (TD) Person Trips (Sample Size) Household in Urban/ Rural Area					
	Urban	Rural	All	Urban	Rural	All
Trip Purpose	528	131	659			
Not Ascertained						
Home-Based Work	53,857	18,014	71,871	11.15%	11.36%	11.20%
Home-Based Shopping	110,822	32,333	143,155	22.94%	20.40%	22.31%
Home-Based Social / Recreational	66,573	20,407	86,980	13.78%	12.87%	13.56%
Other Home-Based	103,959	34,442	138,401	21.52%	21.73%	21.57%
Not Home-Based	147,913	53,313	201,226	30.62%	33.63%	31.36%
All	483,652	158,640	642,292			
Excluding "Not Ascertained"	483,124	158,509	641,633	100.00%	100.00%	100.00%

Table 12. 2001 NHTS Aggregate Trip Rates

	Sample Size Person Trips	Sample Size Persons	Sample Size Households	Aggregate Rates	
Trips per Person	642,292	160,758		4.00	
Trips per Dwelling Unit	642,292		69,817	9.20	
Average Household Size				2.59	Census 2000

These statistics are unweighted and were derived from the national sample for a Florida DOT sponsored study.[25] The ongoing update to NCHRP 365[26,27] also should result in new benchmarks for similar statistics in addition to benchmarks from the NHTS and other statewide models.

[25] FSUTMS-Cube Framework Phase I: Default Model Parameters, prepared by Cambridge Systematics, Inc. for Florida DOT, May 2006.

[26] Report 365-Travel Estimation Techniques for Urban Planning, prepared by Barton-Aschman and Associates and Transportation Research Board for NCHRP, 1998.

[27] NCHRP 8-61 Travel Demand Forecasting: Parameters and Techniques Research Plan, prepared by Cambridge Systematics, Inc. in Association with Vanasse Hangen Brustlin, Inc., Dr. Chandra Bhat, Gallop Corporation, and Martin / Alexiou / Bryson, PLLC, September 2007.

n Subtask 3.3: Trip Distribution

Should the ODME process be used, trip distribution already is determined based on adjustment of the seed matrix. Otherwise, a Gravity Model or Destination Choice procedure will most likely be used. While the Gravity Model has the advantage of simplicity and more widespread use, obtaining reliable friction factors for very long trips might be a challenge. If a Gravity Model method of distribution is selected, friction factors could potentially be calculated from the NHTS or a gamma function could be derived from NHTS.

Validation of passenger trip distribution will largely focus on average trip length statistics from the NHTS, such as those depicted in Table 13 and other available statewide survey data. However, it is possible to get the averages right but have the wrong shape of the frequency distribution. This can be solved by using measures of goodness of fit such as the coincidence ratio. O-D patterns need to be validated too and it is not clear what level of O-D aggregation would be needed for the NHTS data to be sufficient. Allowance might have to be considered for larger error terms in the NatMod in comparison to MPO or statewide surveys given the limitations on sampling within select regions of the United States. Traffic counts crossing state lines and screenlines also might be needed for this area of validation.

Table 13. 2001 NHTS Average Trip Lengths by Purpose

	TD Person Trip Duration (Mean) Household in Urban/Rural Area		
	Urban	Rural	All
Trip Purpose Not Ascertained	16.51	8.59	15.30
Home-Based Work	24.42	24.64	24.46
Home-Based Shopping	15.27	19.71	16.12
Home-Based Social/Recreational	23.94	25.32	24.22
Other Home-Based	17.87	20.13	18.35
Not Home-Based	19.84	19.94	19.86
All	19.43	21.12	19.78

Zones also can be aggregated to states or groups of states to summarize model-derived trip distribution patterns. Logic might have to play a significant role in assessing validity of a district-level matrix as CTPP data are more focused on intraurban travel. A district-level table from NHTS records also could be developed for comparative purposes.

Freight trip distribution validation could use FAF2 data as a base for comparison. The comparison would be based on average commodity group travel distances. It may be necessary to validate freight trip distribution with an eye towards mode choice as similar commodity groupings might have different trip length characteristics depending on freight mode of travel.

n Subtask 3.4: Mode Choice

Mode choice for passenger trips in a national model should simply be limited to inputting a set of auto occupancy factors and applying these to previously calculated person trips. Table 14 is a summary of auto occupancy rates from the NHTS national sample. It is recommended that additional analysis be completed on NHTS auto occupancy rates to identify rates by urbanized area population size and geographic region, as the model should apply different auto occupancy factors for home-based work trips in higher density regions versus lower density regions. Such auto occupancies should already account for siphoning off any transit trips.

Table 14. 2001 NHTS Auto Occupancy Rates by Purpose

	TD Vehicle Occupancy (Mean) Household in Urban/Rural Area		
	Urban	Rural	All
Trip Purpose Not Ascertained	1.17	1.23	1.18
Home-Based Work	1.09	1.10	1.10
Home-Based Shopping	1.80	1.80	1.80
Home-Based Social/Recreational	1.95	1.89	1.94
Other Home-Based	1.67	1.76	1.70
Not Home-Based	1.73	1.66	1.71
All	1.63	1.62	1.63

A more sophisticated approach to passenger mode choice could be considered as an optional service once the highway model is operational. This would likely be limited to intercity rail services such as Amtrak. Modeling of air passenger travel would be considerably more complex and is not expected until later development phases. Intercity bus services could be added dependent on available patronage data.

Freight mode choice should be handled in a different manner. First, freight tonnage tables from trip distribution are split into different transportation modes (truck, rail, air, water,

and pipeline) based on TRANSEARCH and other possible sources. Next, the freight truck tonnages would be converted to truck trips also based on data from TRANSEARCH and other sources. Should rail be incorporated into the model, conversion factors also would be needed to adjust rail tonnage to car loads. Air, water, and pipeline modes are not expected for assignment at this time.

n Subtask 3.5: Highway Assignment

Highway assignment for the NatMod should at a minimum include the highway auto and truck trips. Statewide models generally use the Strategic Highway Network (STRAHNET) in areas distant from their vicinity and gradually increase the network detail (NHPN and state DOT GIS Road files) as proximity increases. Since the NatMod needs to provide a consistent level of detail throughout the United States, STRAHNET is not detailed enough for model network development. The NHPN, on the other hand, sometimes provides more network detail than might be needed, and it is possible there might be a few key highway segments that should be added to the NHPN based on highway assignment validation results. Therefore, the NHPN should be used as a starting point for network development, with links added and some NHPN links deactivated for modeling purposes based on assignment results. Figures 2 and 3 depict the STRAHNET and NHPN coverages, respectively.

Figure 2. Strategic Highway Network (STRAHNET)

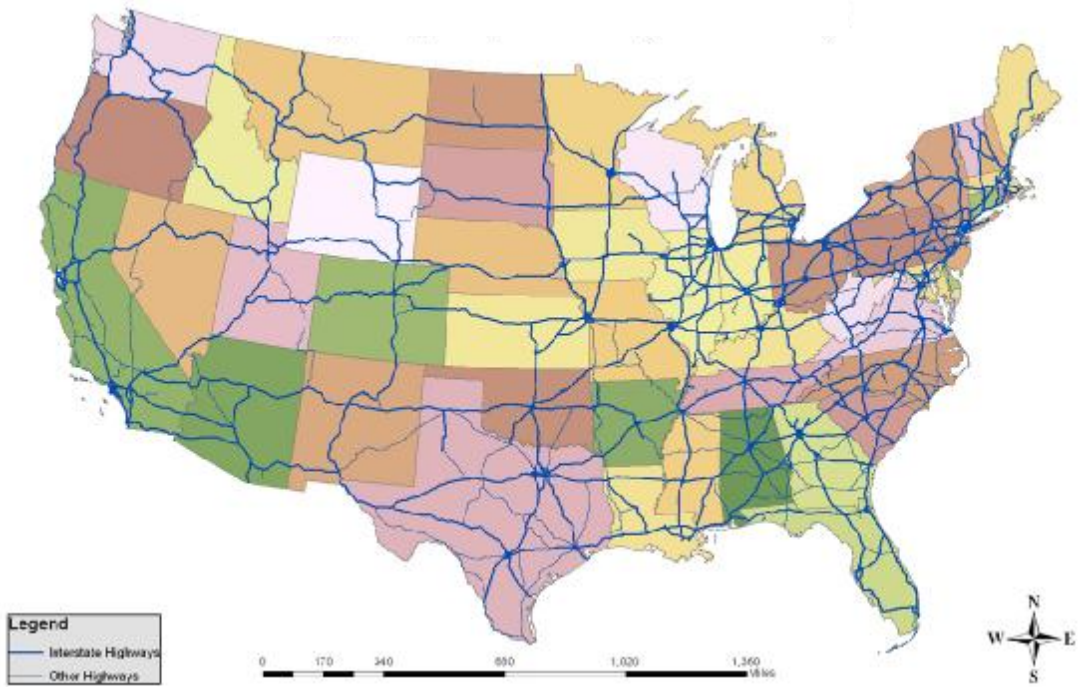
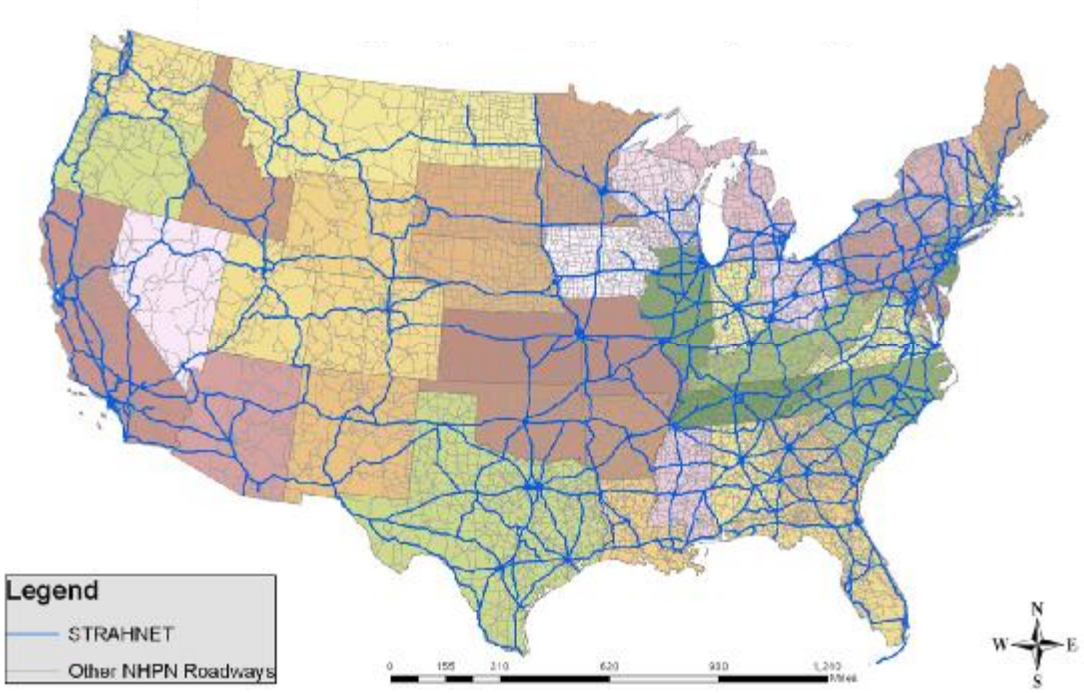


Figure 3. National Highway Planning Network (NHPN)



The aggregated scale of the NatMod opens up the possibility of using an All or Nothing assignment routine without penalty. Several statewide travel models implement the freight assignment in this fashion. Assignment equilibrium might be difficult to achieve with a rather sparse network combined with a potentially large number of trips. It would be best to try alternate algorithms and identify the best fit.

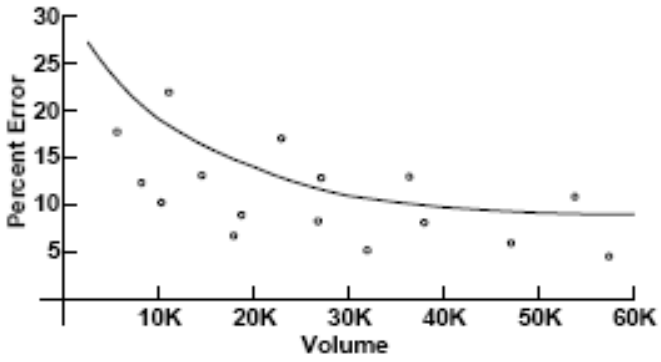
Owing to the large geographic scale of the model, using time-of-day modeling is unnecessary. The long-distance trips that will be the focus of the NatMod will take several hours to cross even midsize states and will thus be comparatively insensitive to departure time / arrival time analysis.

As with modeling at smaller geographic scales, validation will involve comparing observed counts to model assignments. At the level of network detail likely in the NatMod, count data from HPMS and other databases should be readily available. Commonly accepted validation guidelines as published in documents such as the Model Validation and Reasonableness Checking Manual[28] will inevitably have to be relaxed. Higher RMSE error terms and higher volume / count ratios will likely be tolerated for the NatMod. Aggregate VMT comparisons should be made as a control to ensure assignments are within reason along with screenlines representing major rivers, mountain ranges, and groups of states. Cordon lines can be used to represent regions, such as New

[28]Model Validation and Reasonableness Checking Manual, prepared by Barton Aschman and Associates and Cambridge Systematics, Inc. for FHWA, February 1997.

England, and cutlines can represent parallel corridors, such as I-65 and I-75, representing major travel movements. Validation guidance provided in the previously referenced Guidebook on Statewide Travel Forecasting should generally suffice for a national model as well. Figure 4, copied from this document, indicates an accuracy curve whereby 68 percent of errors should be falling below the curve (32 percent above the curve) is considered satisfactory.

Figure 4. Statewide Model Validation Accuracy Curve



n Subtask 3.6: Sensitivity Testing

Model validation also consists of reasonableness and sensitivity checks beyond matching base year travel conditions. In fact, model validation should not be considered complete until forecast year sensitivity tests are completed. Tests of the sensitivity to changes must be done through model application. Future year sensitivity testing of hypothetical or planned alternative corridor strategies also should be accomplished to determine if additional validation adjustments might be necessary. The reasonability of future year model forecasts is usually assessed by conducting a series of sensitivity tests and measuring the change in demand based on a change in supply. For example, as lanes are added to a congested roadway network, it is expected that traffic would increase on the facilities receiving the additional capacity.

In addition to the process of assessing a model's ability to respond to change in supply, sensitivity testing of other measures such as tolls, auto operating costs, and vehicle mix should ensure a reasonable response to changing conditions. With a rather limited national network of existing special purpose lanes, base year model validation will not be an option along every corridor, but rather will require sensitivity testing and assessment of vehicle mix in general purpose and special use lanes based on available statistics from elsewhere in the U.S.[29]

[29] FSUTMS-Cube Framework Phase II: Model Validation Guidelines and Standards, prepared by Cambridge Systematics, Inc. for Florida DOT, June 2008.

Task 4.0 Develop Tools and Documentation

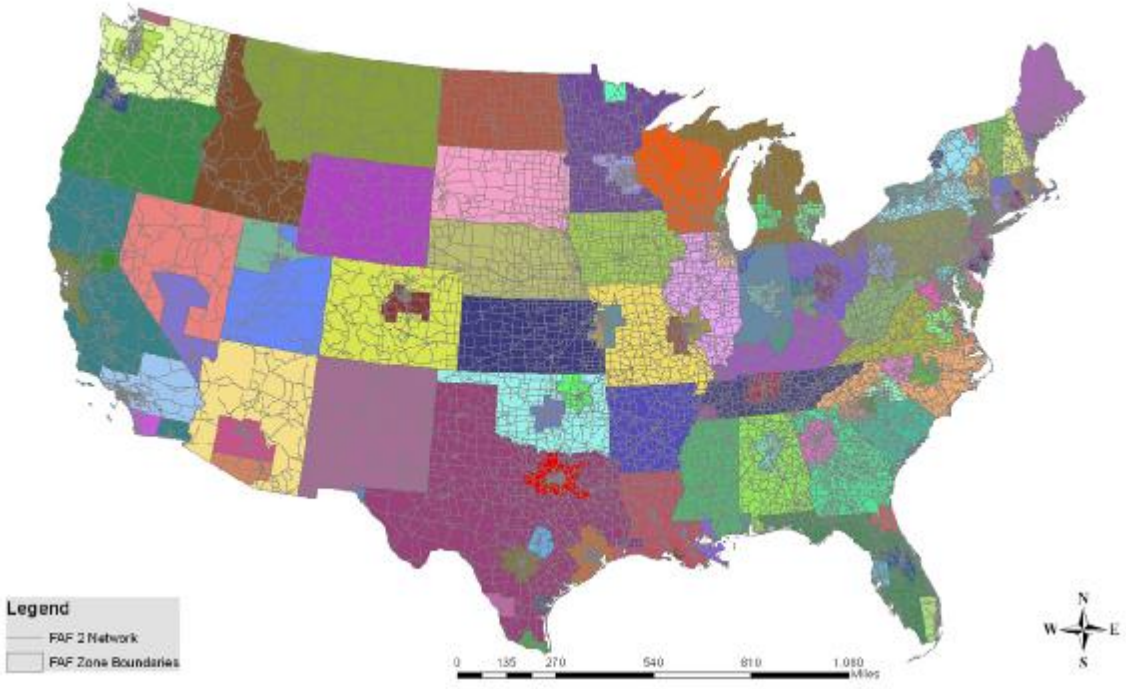
Task 4 will consist of developing tools to enhance the consistency, usefulness, and speed of updates to NatMod. Tools also should include a flexible interface for different data formats. These tools should streamline the process for generating equivalencies among different geographies based on appropriate available data sources. Additionally, documentation of the work undertaken in the model development process will be performed as part of this task, including a NatMod User Manual.

n Subtask 4.1: Disaggregation Tools

One key characteristic of NatMod should be the ability to store data in a geography native to its source yet include tools to disaggregate data at a finer zone and network system where appropriate. A good example of this is the previously referenced FAF disaggregation tool currently under development. This tool would enable FAF2 data to be disaggregated from FAF zones to model TAZs and other geographies. Figure 5 depicts the FAF2 highway network and FAF regions or zones. Currently, these regional zones are disaggregated to county zones based on a set of assumptions; however, the new disaggregation tool will include greater flexibility and a more robust set of assumptions and data for disaggregation.

Disaggregation tools will rely on already established relationships among different data sources at an aggregated geography for disaggregation to smaller geographies. It is not the intent of the scoping study to determine which data should reside at specific geographies. This should be addressed in greater detail during subsequent model development efforts. From a highway network standpoint, the focus would be to enable network links to be used in a model run that was previously stored as background information.

Figure 5. Freight Analysis Framework 2 (FAF2) Network



n Subtask 4.2: Trip Table Extraction and Aggregation

The purpose of trip table extraction would be to use NatMod trip tables to update statewide models. Trip table extraction would be used to take a trip table in the NatMod zone system and convert the file(s) to a different zone numbering sequence compatible with a statewide model. An equivalency table in a database format would be used to process these adjustments. This equivalency process also could be used to aggregate NatMod zones into states or metropolitan areas for subsequent analyses in different regions of the United States.

Should a commercial modeling software platform become a base for NatMod, such tools would already be available although conversion routines to other software packages used for statewide models might need to be developed. Likewise, commercially available GIS software packages already have such capabilities. However, if tools are to be "platform independent," new extraction and aggregation tools will need to be developed.

n Subtask 4.3: Network Extraction and Aggregation

The concept of network extraction and aggregation is similar to that of trip tables. Portions of the national network could be extracted for use in statewide models, especially since freight is typically distributed through use of a skeletonized United States network. Aggregation tools could also be used in constructing statewide model networks as the level of detail required differs in adjoining states versus more distant states.

Tools for link / node extraction should be able to merge geographies from readily available datasets. Common commercial GIS applications could be modified with scripting routines to allow easier data entry and reasonableness checking. Line GIS files from data sources described earlier in Table 6 that are necessary for travel demand modeling should allow for missing elements to be readily added.

It also may be possible to develop completely new software tools from scratch that perform and aid the extraction tasks. Developing a new tool from scratch will allow flexibility and allows the specific requirements of network or trip table extraction to be met perfectly. Platform independent tools also provide maximum flexibility for potential model users and applications. Conversely however, it may prove costly in terms of development time and effort compared to modifying existing GIS or travel demand modeling software packages.

n Subtask 4.4: Project Documentation and User Manual

NatMod technical documentation should be set up for easy reference by potential model users. Tables listing common network data sources, freight data sources, zone geography data sources, and Census-related data sources that are potentially sharable between the NatMod and smaller geographic-level modeling should be included. Other necessary items for technical documentation include an overview of the model development and validation process with agreed upon recommendations for future reference and consultation.

A user manual will be required to describe all model components. This manual should specify required input data files and sources, data dictionaries, operating instructions, and descriptions of the output files and formats. For automated processes using scripts, descriptions via flowcharts, algorithms, and / or actual code also should be included.

Technical reports and user manuals should be available in PDF format and available for free downloading from the TMIP web site.

Task 5.0 Future Directions

Task 5 discusses potential future directions for the NatMod. Initially, given the geographic scale of the United States, it is likely that the NatMod will be constructed using a set of simple specifications. In the future, it may be desirable to upgrade some of these specifications. This discussion is divided into a section on anticipated limitations and one on future enhancements.

n Subtask 5.1: Limitations of Model Application

The major concern at the outset with development of the NatMod surrounds the issue of consistent and reliable data availability nationwide. Owing to this, it is likely that the NatMod will use a zone and network system that is rather coarse, with the use of counties and Census Tracts being the minimum geographic units. At these scales, data consistency and reliability are more easily achieved than with smaller TAZs. The coarseness of the NatMod may constrain the scope of analysis possible. It is not likely for instance that detailed project-level congestion estimates can be accomplished as would be the case with more sophisticated MPO models.

Owing to geographic scale, it is not likely that time-of-day modeling, microsimulation, activity-based, or discrete choice approaches can work at this scale given the data requirements for modeling at that fidelity. Applications which likely fall within the limits of the NatMod were described earlier in Table 2. A few of these are described below.

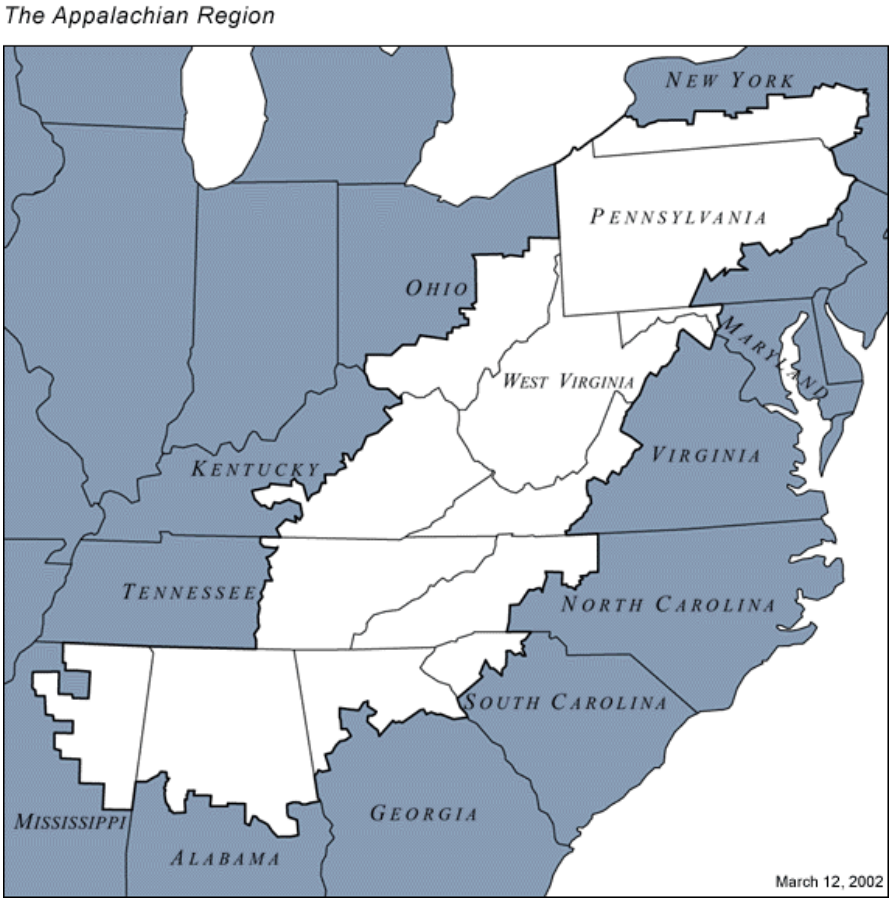
Common Framework for Statewide Modeling

Availability of the NatMod will offer to statewide modeling practitioners a common framework for estimating external travel demand patterns (i.e., from other states). Many aspects of individual statewide models involve duplication in the acquisition of national network and freight data from various sources. With the NatMod in place, many aspects of this duplicative work can be eliminated. The states can use the base data from the NatMod process and add detail as needed for their requirements. In particular, forecasting growth in external trips, estimating the distribution of through trips, adjusting freight through trip tables, and preparing highway networks are seen as excellent applications of a national model to statewide models.

Direct Application of National Model

In terms of conducting network assignments, a national model would be most useful in multistate highway and rail corridor studies (assuming a rail network is developed through the NatMod study). The I-95 ICAT and Appalachian Development Highway System (ADHS)[30] resulted in development of multistate models that would have benefited from a national model. These two multistate models include considerable overlap in terms of the network and zone system especially with the inclusion of major metropolitan regions along the periphery of these study areas. As depicted in Figure 6, modeling the Appalachian Region required inclusion of nearby metropolitan areas such as Washington, D.C.; Atlanta, Georgia; and Charlotte, North Carolina.

Figure 6. The Appalachian Region



Source: Appalachian Regional Commission.

[30] Appalachian Development Highway System: ADHS Travel Model, prepared by Cambridge Systematics, Inc. for Appalachian Regional Commission, October 2007.

Additionally, it is envisioned that climate change and hurricane evacuation could both potentially benefit from NatMod as such phenomena do not adhere to jurisdictional boundaries. Evacuation networks and zones are typically less detailed than what is required for MPO models, hence being somewhat compatible with NatMod geographies. Aggregation and disaggregation tools could resolve any areas of incompatibility.

MPO and Regional Model Enhancements

Application of a national model for enhancing MPO and regional models is considerably more limited than uses in statewide and multistate modeling. For MPO and regional models at state boundaries, however, a national model could provide useful input on external trip forecasts and defining external splits should a recent O-D survey not be readily available. NatMod also could be used on other regional model external trips if a statewide model is not available.

n Subtask 5.2: Future Phased Enhancements

As stated earlier, it is likely that the initial NatMod effort will be relatively simple, likely only having auto and truck highway modes. The trip categories or purposes also will be limited to short-distance passenger, short-distance nonfreight trucks, long-distance freight, long-distance tourist/VFR (visiting friends and relatives), and possibly long-distance personal business. While the NatMod will not likely have the detail and complexity of the MPO or Statewide models, there are certain enhancements that may eventually be incorporated into our later model development phases.

Among future NatMod enhancements could be the incorporation of additional modes to the assignment process. These may include freight rail, passenger rail (longer-distance commuter and intercity), intercity bus, and waterborne transport, including passenger ferry and freight. The primary constraints will be funding and data availability. Perhaps as this national modeling process proceeds, greater effort may be devoted to collecting unavailable or difficult to obtain data.

In the phase following initial development, it is likely that the rail mode would be among the next to be included. Incorporation of freight rail will allow for testing of the aggregate traffic effects of freight diversion for compatible commodities. Longer term, with more robust mode choice models, it also may be possible to implement a model based on cost in terms of energy use or other parameters of significant impact. Concurrent with development of a passenger rail mode, intercity bus travel also could be modeled. This would ensure that the comparison between the land operating modes is complete and fair as intercity buses can increase the capacity of highway facilities.

Following inclusion of rail and intercity bus, subsequent phases could include air and waterborne transportation. The waterborne mode will most likely be weighted heavily

towards freight traveling either down navigable inland waterways or along intracoastal waterways. In a few instances such as crossings of the Great Lakes, long-distance passenger ferry service modeling could be accomplished. Increased use of such services could have an impact on competing circumferential surface highway and/or rail routes.

In addition to mode diversification, future versions of NatMod could include the following:

- Additional zone splits and network detail;
- Adding trip generation and distribution processes where O-D matrix estimation may be used initially;
- Further disaggregation of passenger trip purposes;
- Consideration of seasonality within certain regions of the United States; and
- Inclusion of international passenger trips from Canada and Mexico.

Table 3, provided earlier in this scope, includes possible concepts for a phased model development.