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RESEARCH REPORT

Statewide and Sub-area Transportation Model Feasibility Study

Final REPORT
FHWA-ITD-RP130

to

Idaho Transportation Department
Boise, Idaho

by

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13. ABSTRACT *(Maximum 200 words)*
In this research, a feasibility study to develop an Idaho statewide trasportation model is conducted. Review of statewide transportation models from Florida, Wyoming, Michigan, Vermont, Indiana, and Pennsylvania is conducted to summarize the most appropriate procedure for developing a statewide model. On the local level, the transportation planning effort in Idaho is reviewed. This effort includes review of the metropolitan planning organization models as well as Idaho commodity flows, which will be the basis for the statewide model. A review of the transportation planning software packages is conducted to select the most appropriate package for statewide modeling. The research team recommends Transplan as the outweighing package for Idaho statewide modeling. A transportation model requires the input of a transportation network, traffic data and land use data. Therefore, the availability of existing digital databases is assessed. This study has constructed the foundation for developing the Idaho statewide travel demand model. On the basis of this feasibility study, ITD will implement phase two of this project, the development of the Idaho Statewide Transportation Model. The proposal for the model is represented in the final section of this report.

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Executive Summary

The Planning Division of the Idaho Transportation Department is seeking to develop a PC based statewide transportation model. The main objectives of the model are: to facilitate statewide and regional transportation planning, to support decision making on environmental concerns, and to support the data requirements of the Pavement Management System (PMS) and the Highway Performance Monitoring System (HPMS). The statewide travel demand model will provide 5, 10, 15, and 20-year forecasts.

Currently, the Idaho Transportation Department (ITD) uses historically based trend models to forecast 20-year design-hour volumes for the design and analysis of proposed roadway projects. However, ITD planners realize that this trend forecasting method has serious limitations. They would like to develop a procedure that is more theoretically based, similar to the standard four-step travel demand forecasting process that is often used in urban areas. They also want to integrate the statewide model with existing Transportation Planning Models used by the Metropolitan Planning Organizations (MPOs) in Idaho, e.g., Boise metropolitan area, Pocatello urbanized area, and Idaho Falls urban area.

Development of the statewide travel demand model is a two-phase process. Phase 1 is a feasibility study, which identifies existing needs in data requirements and computer hardware and software. Phase 2 is model development, which involves the actual development of the model and training of Idaho Transportation Department personnel as the potential users.

This report summarizes the Phase 1 feasibility study. The report includes the following topics:

1. **Review of statewide transportation models from Florida, Wyoming, Michigan, Vermont, Indiana, and Pennsylvania**. This section details the procedures and steps that each state undertook to develop their own statewide models. A summary of the most appropriate procedure for developing a statewide model concludes the section.

2. **Review of transportation planning efforts in the state of Idaho**. This section reviews technical reports from a Metropolitan Planning Organization and a small urban area in Idaho. Other metropolitan organizations are still in a development stage and only have traffic analysis zone maps.

3. **Commodity flow**. It is important to obtain information on the flow of commodities in and through the state. This information serves two purposes: to estimate the external station truck flow, and to estimate the in-state truck flow.

4. **Review of transportation planning software**. This section reviews transportation planning software packages to determine their suitability for adoption for the Idaho statewide model. The study recommends TranPlan or TransCAD, two leading packages

in the field. The venders of these two packages demonstrated their products on September 10-11, 1997 at the Owyhee Plaza Hotel, Boise, Idaho.

5. **Existing digital databases**. A transportation model requires the input of a transportation network, traffic data, and land-use data. Therefore, one of the first steps in transportation planning is to assess the availability of digital databases. This section reviews the following data sources: the Idaho Transportation Department Milepost And Coded Segment (MACS) database, the National Transportation Atlas Database 1996, the 1990 Census Transportation Planning Package (CTPP), State Summary Commodity Flow Survey (CFS), American Travel Survey (ATS), Federal Highway Administration's Nationwide Personal Transportation Survey (NPTS), the Bureau of Transportation Statistics' Transborder Surface Freight Data Set, and the U.S. Census Bureau for land-use data. To investigate the transportation network data sources and availability, data provided by ITD were compared with data from other sources. The GIS software ARC/INFO was used for this comparison.

6. **Proposal for a statewide model**. The last part of this report includes a proposal for developing the Idaho Statewide Traffic Demand Model. This proposal includes the tasks that will be undertaken over a two-year period.

Appendices to this report include: a detailed software review, the process of converting the ITD Highway Centerline database to an ARC/INFO coverage, an example of an Idaho statewide traffic demand model using TranPlan, and a procedure to develop a trip generation table. These supporting materials are intended to clarify issues related to the development of the statewide demonstration model.

Finally, it should be noted that the software packages used in the feasibility study are simply tools to build a demonstration version of the Idaho statewide model. ITD needs to make a decision on which packages to use for the statewide model. However, the University of Idaho feasibility study software review ranks TranPlan and TransCAD above other packages. These software packages are also used by most states. The University of Idaho research team recommends TranPlan to be used for the Idaho statewide model.

In summary, this phase 1 study demonstrated the feasibility of developing an Idaho Statewide Travel Demand Model. The Idaho Transportation Department has most of the data needed for the model development (see section 5). Furthermore, the University of Idaho research team confirmed the capability of developing the statewide model, as presented in this report (e.g., Appendix D).

Literature Review

Introduction to Statewide Planning

Before 1991, twenty-three of the states in the U.S. had started or completed statewide future year plans. But with the passage of the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991, every state is now required to create and implement a statewide transportation plan that has the ability to be updated annually. Because of this Act, many states are now revising older, more traditional transportation plans.

Historically, statewide planning has been urban orientated and emphasized only one major mode of transportation, the passenger car. ISTEA's purpose is to broaden transportation planning to encompass multimodal planning of the movement of people and goods. ISTEA also heavily emphasizes addressing the environmental concerns of today's transportation systems in planning. Reaching these goals will be possible by utilizing current management systems in decision making, involving the public and local officials in the decision-making process, and expanding the roles of Metropolitan Planning Organizations (MPOs). Through the requirements of ISTEA and the effort of states, statewide planning will provide a more efficient and cohesive transportation system, not only at the state and local level, but also at the national level.

Urban vs. Statewide Transportation Planning

The older traditional models were reliable when used in Urban Transportation Planning (UTP). In order to apply them to Statewide Transportation Planning (STP), many states took similar steps in updating them. The first step was to simplify the models. For the models to be applicable on a statewide level versus an urban one, they had to have the ability to encompass many more variables. The second adaptation was the use of computers in the modeling system. Through the use of programs such as GIS, models became more powerful and flexible. The third most common adaptation was the introduction of multimodal programming. With the use of these models for statewide planning, many more modes of transportation were required to be considered. These new modes include railway, water ports, and airports.

Once a state decided how they would approach the statewide planning process, it created guidelines to follow and objectives to attain. To generate highway improvements that lead to greater benefits, three common guidelines were set:

1. Design for system continuity and balance between state and local levels.
2. Seek low-cost design alternatives.
3. Maximize benefits and minimize costs.

The objectives most commonly set were to provide an early-warning system that would be accessible and accountable for all levels of use.

After this point, states continued the process in various ways and created very diverse models. For most, UTP modeling was the starting point to achieve a STP model. To achieve this changeover, they had to look at issues facing statewide transportation decision-makers.

The following is a compilation of concerns states face when making statewide transportation decisions:

1. Concern for the environment
2. Changing economy
3. Changing urban transit options
4. Increasing difficulty in financing highway maintenance
5. Changing nature of air and rail travel

Taking these concerns into account will result in a STP reflecting an integrated and unified transportation system on all levels.

State-by-State Model Studies

Florida

Florida's original statewide transportation study concluded in 1988. Since that time, it was updated and validated in 1990, 1993, and 1994. The purpose of the study was to develop a useful and straightforward process for forecasting statewide travel on Florida's network system. Statewide forecasts were made for travel outside the urbanized areas, including intercity travel. Florida's model used traditional methods of urban transportation planning (UTP) on a statewide level.

The first step taken in Florida's analysis was the development of Traffic Analysis Zones (TAZs). In creating the TAZs, three systems were utilized. Traffic analysis zones previously defined by the MPO's were analyzed first, then the Census boundaries, Census Tracts and Enumeration Districts, and lastly the System of Public Land Surveys. AutoCad was employed as the mapping software and was found to be flexible and easily revisable in the TAZ formulation process. AutoCad was also used in other areas of the modeling process, as well as MARKNET.

Many features of the Florida statewide transportation model originated from their urban transportation model. This is clearly evident in the development of the Trip Generation Model. The trip purposes indexed were 1) Home-Based Work, 2) Home-Based Shopping, 3) Home-Based Social-Recreational, 4) Home-Based Miscellaneous, 5) Non-Home Based, and 6) Truck/Taxi. The sources of socioeconomic data were 1) urbanized area socioeconomic data, 2) urbanized area productions and attractions, 3) U.S. Census data, 4) Florida Statistical Abstract, and 5) tax assessor's data. By beginning with urban trip generation, a familiar and well-documented procedure, Florida was able to incorporate rural trip generation and finally external trip generation into their model with greater ease.

In the trip distribution phase, as common to most states, the Gravity Model was used. The friction and K factors were developed during the validation phase. In the trip assignment phase, three issues were found to be of concern which were 1) the time of year, 2) the period of the day, and 3) the type of model. The statewide model was developed in a microcomputer environment, where UROAD, an iterative equilibrium model, was used for the process of trip analysis.

Data requirements for transportation supply include:

1. Highway links representing segments of roadways.
2. Cartesian coordinates describing the geographic locations of the nodes and links.
3. Data describing the characteristics of each highway link: distance, travel time and/or speed, tolls, county or other geographic location data, area type, facility type, number of lanes, existing traffic count, capacity, screenline, and roadway name.

Data requirements for travel demand include:

1. Socioeconomic and demographic data: population, dwelling units, auto ownership, school enrollment, place-of-work employment by type, or SIC code.
2. Mapping data: a reference system of Cartesian coordinates, outline of Florida, county boundaries, zone boundaries and centered locations and county names and centroid numbers.

Although the Florida statewide model was operational in 1990, it was not producing accurate traffic estimates. The key issues of validation in the model are the highway networks and model parameters. Recommendations from the report are:

- Zones that cross county lines should always be split to represent different socioeconomic and travel behavior characteristics.

- A rural area travel characteristics study should be conducted to identify any purpose when compared to urban area trip rates.
- Consideration should be given to modifying the facility types and area types used in the statewide model.

Although the state of Florida is far larger than the state of Idaho in population and extent of its transportation system, Idaho's approach in creating a statewide model will be similar.

Wyoming

Wyoming's statewide model began with the investigation of their statewide transportation planning needs. Based on socioeconomic characteristics, the model focuses on the movement of goods and tourists. Traffic counts were used as primary input. A case study was performed in southeast corner of the state, the location of the state capital and the University of Wyoming.

As in the Florida model, Wyoming's approach was to first create TAZs. In doing so, they created several criteria. The TAZs needed to be small enough to be accurate, yet large enough to reduce data collection efforts. Attention should be paid in keeping the TAZs consistent with jurisdictional areas and census blocks. And finally, TAZ sizes must be sufficient enough to conduct intermodal analysis.

Several different computer programs were used in the Wyoming model. The planning network was built with the Window's-based General Network Editor (GNE). To process input data and perform the interactive segmentation procedure, Excel 5.0 with a Macro written in the Microsoft Excel Implementation of Microsoft Visual Basic Programming System was used. After the Origin-Destination (O-D) tables were created using the Entropy Maximization Model, they were entered into the Visual Basic EM model program. Trip assignment proportion matrices were produced with the Quick Response System II (QRSII). For future year O-D table predictions, the Fratar model was used and programmed with the Visual Basic language.

Because Idaho has socioeconomic and geographic conditions similar to those of Wyoming, their modeling procedures may be suitable for our intended use. Three suggestions are made to tailor Wyoming's model to Idaho's needs: 1) incorporating land-use data to make the models more reliable, 2) using GIS in the modeling process, and 3) displaying the results visually to allow a comparison with the land-use data and other transportation data.

Michigan

In 1993, the Michigan Department of Transportation updated their statewide travel demand model and calibrated their existing model. A key focus of the calibration was to review commodity flow modeling with regards to land use. Also examined were the range of approaches to statewide modeling. These approaches included 1) models based on urban transportation theory, 2) models based on analytical procedures, and 3) models based on census type procedures. All three of these approaches, as seen in other statewide models, are commonly used. It was concluded that, although the traditional four-step urban transportation modeling system is somewhat rigid and in some cases simplistic, the Michigan model was the most productive and effective of all the models used by states.

Because it was decided not to change the basic structure of the Michigan model, how to improve the model became the next issue. In order to transform the existing model into one that evaluated a multimodal system, each step of the four-step process had to be reviewed and revised.

In the **trip generation** stage, the following factors would be expected to be included in a multimodal system:

- The generation of Person Trip productions and attractions, including intrazonal trips
- The production model to be based on average trips rates per household cross-classified by household category
- The attraction model to use regression equations based principally on employment categories

For the **trip distribution** stage, the following factors would be expected to be included:

- The model to be conformable with the standard Gravity Model formulation
- The trip distribution to be performed independently for each trip purpose produced by the trip generation model
- The K factors to be capable of handling intrazonal and short/long interzonal trips

For the **mode choice,** these factors would be expected:

- A network that included different carpooling methods
- Trip purposes to be separated according to mode choice

For the **trip assignment** stage, these factors would be expected:

- The capability for all-or-nothing, stochastic equilibrium, and multi-class assignment to be available for highway assignment
- The capability to demand categories in a highly flexible manner and define multiple cost functions for different facility types

Vermont

Vermont's statewide travel demand model was created using the traditional four-step process. Household and roadside surveys were conducted and as a result, trip lengths were obtained. The 1990 Census of Population and Housing data, needed in the trip generation phase, were sorted by TAZs. The Gravity Model was used in trip distribution and the Equilibrium method in trip assignment. Existing GIS centerline data with attributes, roadway segment, number of lanes, functional classification, traffic counts, speed, and capacities were used to develop the transportation network. GIS data files were then exported to TranPlan, a transportation modeling software.

In the area of regional planning, Vermont considered two approaches:

1. **Statewide Based**: A statewide model could be developed at a level of detail that would enable each Regional Planning Center (RPC) to operate as a subarea for a windowing or focusing approach.
2. **Regional Planning Based**: Models could be developed for each RPC and aggregated to a statewide level. Different levels of models could be developed for the RPCs, depending upon potential applications.

Indiana

Indiana also used the four-step travel demand model. Their objectives are: 1) forecasts of passenger and freight travel, 2) highway volume estimates and travel times, 3) capability to analyze individual corridors in Indiana, and 4) providing inputs to Economic Model and cost-benefit analysis. Along with the four-step process, the incremental approach and aggregate models were used. Modeling procedures were processed by TransCad 3.0 for WINDOWS. Trip distribution was modeled with the Gravity Model and trip assignment with the multi-path and equilibrium assignment techniques.

Pennsylvania

Pennsylvania developed a Statewide Transportation Policy Plan that will be used to identify transportation issues and will focus their planning efforts to address them. The Policy Plan became a framework for establishing a new strategic transportation agenda. This agenda included supporting policy decisions, procedures, and investments the Pennsylvania Department of Transportation will need over the next twenty years. Plan development activities included:

1. Incorporate multimodal features into existing and future improvement projects where appropriate.
2. Establish clear responsibility for transportation congestion management, traffic operations, service coordination, and land use.
3. Establish a strategic plan to implement Intelligent Transportation System technology.
4. Foster and promote new formal and informal transportation partnerships.
5. Develop and implement transportation improvements.
6. Consider initiatives that will better insulate the transportation funding base from inflation.
7. Establish the necessary interdepartmental and interagency coordination and responsibility for monitoring Policy Plan implementation.
8. Work with the appropriate resource agencies to improve and streamline the environmental procedures to save time and money.
9. Develop special outreach efforts by public and private transportation stakeholders for persons traditionally underserved by existing transportation systems.
10. Consider amendments to existing transportation legislation and/or new legislation that will expand the resource base and intermodal capabilities of the commonwealth's transportation program.

Summary of the State-by-State Studies

Data Requirements

Every state reviewed underwent major data collection programs in order to provide the necessary information for updating and improving current models and developing new ones. In general, the data collected needed to portray changes in personal household and traveler behavior, precise descriptions of travel patterns, and transportation system performance. The following are specific recommendations on what data are needed:

- **Travel behavior** within households (vehicle ownership and use)
- **Driver characteristics** that affect emissions (time and length of trips, travel variations during and between days, driving characteristics, and trip chaining)

- **Effects of policies** (parking restrictions, commute options, road, bridge, parking and fuel pricing, effects of widened sidewalks, protected cross walks, median removal and insertion, and building setbacks)

- **Management actions** and other transportation control measures

- **Demographic trends** and urban development patterns

- **Use of advanced technologies** (remote sensing, automatic vehicle locating technologies, and global positioning systems)

Concerns

Among the statewide models studied, the following areas need to be addressed for a model to be effective:

- Incorporating the impacts on a **wide range of interests** (e.g., other state facilities)
- Having a broad **range of goals**
- Creating a model that can be matched with **new modes of transportation**
- Having a model that relates to issues stressed by **local officials**
- Creating a model that doesn't require too much maintenance for **easy application**
- Creating base support by maintaining **public involvement**
- Researching **other alternatives** or making the system flexible for other alternatives
- Incorporating **multimodal programming** to some extent
- Correlating **land use** to the system
- Taking trip surveys on **all** highways in the state
- Taking steps towards **implementation** of the model
- Recognizing the inevitable **uncertainties** in the model

Advantages

States that did transform the UTP model towards STP came up with the following advantages to the system:

- **Reduced effort** in forecasting volumes and when to justify a new route
- **Data is easily obtained** to base decisions on relocation of new routes and redirection of travel

- **Classification of roads** became easier
- Aided in **land-use planning problems**
- Helped determine the effects caused by changes in **economic activity**
- Model may be used to **establish priorities** in further studies
- Model may be used to **plan for highway renovations** in poorly developed areas

Metropolitan Transportation Planning in Idaho

The planning of a statewide model must consider transportation planning models that have been developed by the metropolitan planning organizations (MPOs) in the state's urbanized areas and other urban area modeling efforts. Urban areas make up a significant portion of traffic analysis zones (TAZs) in a statewide model. A statewide model, on the other hand, can provide external traffic data to an urban area transportation model. The size and number of the TAZs will most probably coincide with Idaho's six districts and 44 counties since their borders correspond. In areas where more TAZs will be required than provided by the counties or districts, the census tracts will be used. There are 268 census tracts in Idaho. Maps of the counties, districts, census tracts, and major roads in Idaho are provided in Appendix A. Integration of a statewide model and urban area transportation models is therefore important for planning purposes.

Idaho has different levels of planning activities in its urbanized and urban areas. Idaho's three urbanized areas (over 50,000 in population) have Metropolitan Planning Organizations, namely Ada Planning Association, Bannock Planning Organization, and Bonneville Metropolitan Planning Organization. In urban areas (5,000 to 50,000 in population), there are different types of travel forecasting models in place, e.g., Post Falls, Nampa, and Lewiston. For this project, two planning activities (one in an urbanized area and the other in an urban area) have been examined. The following is a summary of urban transportation models for Ada County and Post Falls. Other planning activities in Idaho are in progress of initiating and/or developing travel demand models, e.g., Kootenai County.

Bench/Valley Transportation Study

In 1995, the Ada Planning Association developed its Regional Travel Demand Model and GIS System jointly with Cambridge Systematics, Centennial Engineering, Intermountain Graphics, and Scientech. The system combined the software packages of TranPlan, ARC/INFO, SAS, Foxpro, and other utility programs written in the C programming language. The objectives of the study were as follows:

1. To develop a multimodal transportation network based on the existing highway and transit networks.
2. To develop high-quality base year (1993/1994) trip tables by travel mode, trip purpose, and time of the day.
3. To forecast the changes in land use, socioeconomic variables, and travel characteristics for the future year, 2015.

4. To develop the future year network for different alternatives using the base network and the proposed changes in the transportation system.

5. To develop the future year tables by travel mode, trip purpose, and time of day from the base year trip tables using forecasts of land use, socioeconomic, and travel characteristic data changes, transportation network changes, and incremental demand models.

6. To assign the future year trip tables to future year network.

The highway network included 399 TAZs in Ada County: 285 internal, 16 external and 98 dummy zones. Input data for the base year consisted of socioeconomic data, population, households, retail, non-retail, and employment data from the 1990 Census Transportation Planning Package and the 1990 U.S. Census of Population, as well as data from a household travel survey. Input data for the future year were projected based on three density socioeconomic scenarios.

The Bench/Valley Model did not follow the four-step process commonly used in transportation planning. Instead, it involved the development of a detailed set of origin and destination trip tables by mode, purpose, and time of the day.

City of Post Falls Transportation Study

David Evans and Associates, Inc. completed a transportation study for the city of Post Falls in June of 1997. Using the software package TMODEL 2, the study had three objectives:

1. To create a transportation model to simulate the current (1995) travel conditions and to forecast the future (2015) traffic.

2. To refine the roadway system as defined in the draft Post Falls Comprehensive Plan, May 1994.

3. To make recommendations for sidewalk and bikeway improvements.

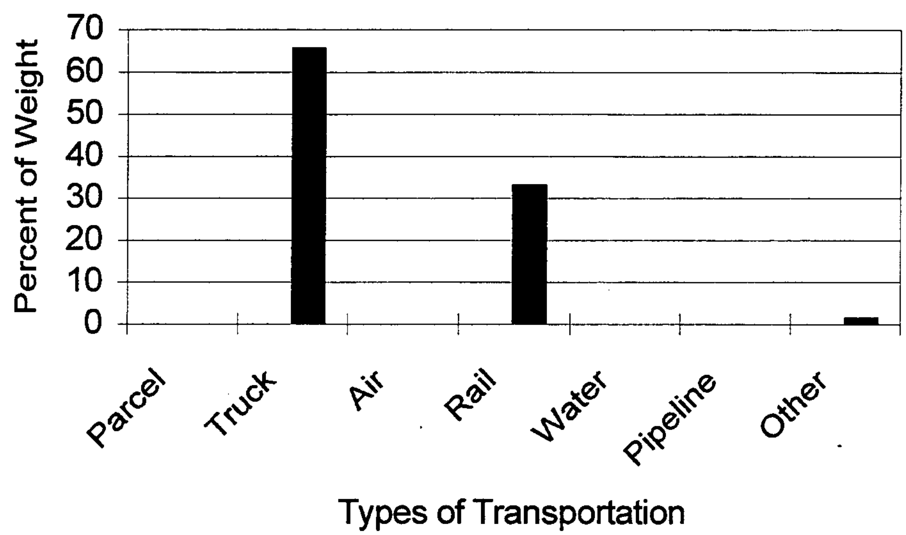
The transportation network included state highways, most county roads, and city streets that were vital to the circulation of traffic. Fifty internal TAZs and eight external zones were defined based on the census blocks, physical barriers, roadway locations, and land-use characteristics. 1990 Census data, including population, households, and employment characteristics provided the basis for the estimated 1995 data and the projected 2015 data used in the model.

The Post Falls study followed a standard procedure of trip generation, trip distribution, trip assignment, model calibration, and future trip assignment.

Commodity Flow in Idaho

Prior to the passage of ISTEA, planning in Idaho primarily focused on the local level, incorporating counties and districts. State legislation has required each city and county to create and continually update comprehensive plans. Because of this, there has been some limited involvement in certain levels of statewide planning. These areas encompassed pavement management, safety management, and traffic monitoring. All have successfully incorporated public involvement in their operating systems. Nonetheless, these comprehensive plans were deficient of intermodal considerations, congestion management, and consideration of public transportation.

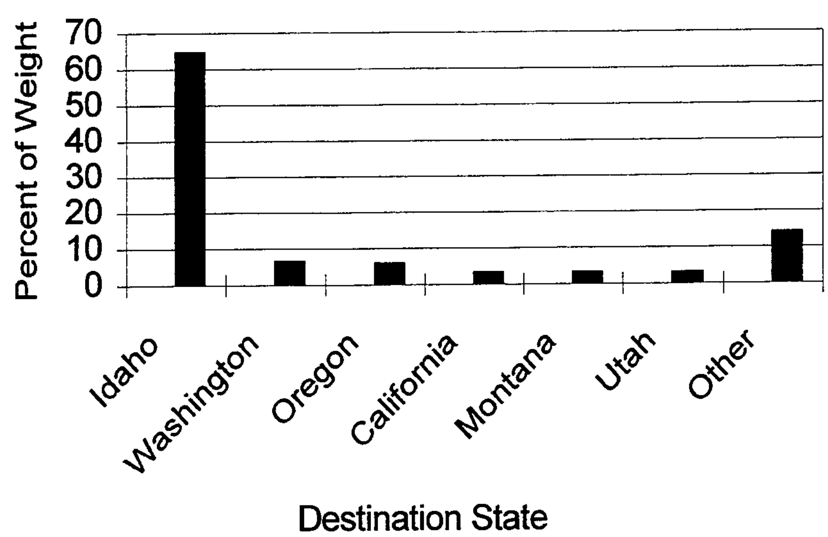
Figure 1: Modes of Transportation for Shipments Originating in Idaho



In an effort to develop an intermodal statewide plan for Idaho, the primary transportation modes used for commodity flows have been researched. In Idaho, approximately 65.5 percent of total weight shipped is done by truck, 33 percent by rail, and 1.5 percent by means of air, water, or pipeline (see figure 1). These shipments originate in Idaho and do not include interstate shipments from other states. (Source: "1993 Commodity Flow Survey State Summaries" published by the U.S. Department of Transportation Bureau of Transportation Statistics in September 1996)

In order to create traffic analysis zones, destinations of shipments originating in Idaho were used. These destinations were viewed in two ways. The first consideration was the state in which the shipment was destined, and the second was the distance that the shipment would travel. According to percent of weight, Washington, Oregon, California, Montana, and Utah are the primary states receiving Idaho commodities (see figure 2). Sixty-four and one-half percent of Idaho's commodities remain within the state. 45.3 percent of Idaho's commodities travels less than 50 miles, 19.4 percent travels only 50 to 99 miles, 8 percent travels 100 to 249 miles, and the remaining percent travel over 250 miles (see figure 3). From this data, an initial trip generation chart was created to simulate commodity origins and destinations (see figure 4).

Figure 2: Domestic Destinations of Shipments Originating in Idaho



Because land-use correlation is vital to the validity of a statewide model for future traffic flow predictions, types of commodities shipped in Idaho were reviewed. Currently in Idaho, lumber or wood products, excluding furniture accounts for 42.8 percent of commodities shipped, by weight. Other primary commodities shipped include nonmetallic minerals 14%, farm products 13.3% (e.g., field crops, fresh fruits or vegetables, poultry, livestock and their products), food (e.g., meat, poultry or small game, fresh, chilled, or frozen; canned or preserved fruits, vegetables, or seafood; dairy, grain mill, and bakery products; beverages) 10.8%, stone products (e.g., clay, concrete, glass) 5.8%, and other commodities account for 13.3% (see figure 5).

Figure 3: Domestic Distance Shipped for Commodities Originating in Idaho

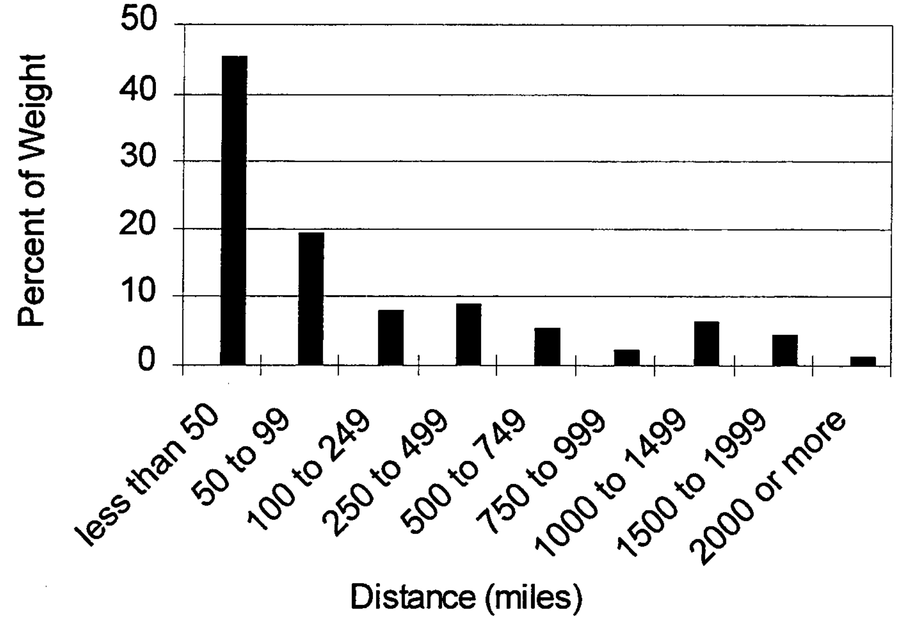
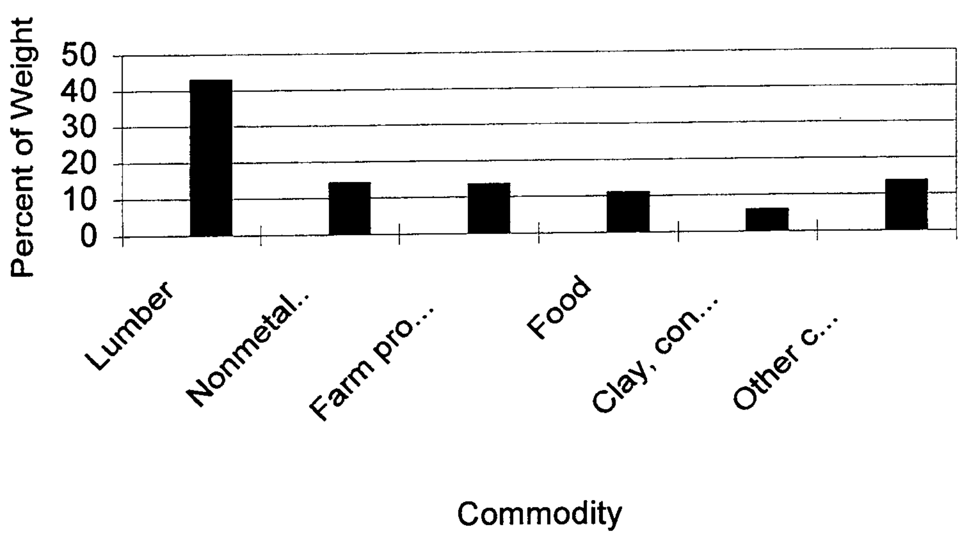


Figure 4: Sample Trip Table

From \ To	ID	CA	WA	OR	UT	MT	Other
ID	64.5	3.2	6.4	5.8	3.0	3.1	14.0
CA	0.0	91.2	0.7	1.3	0.0	0.0	6.8
WA	1.2	4.5	83.8	5.5	0.0	0.0	5.0
OR	0.7	5.7	8.1	80.2	0.0	0.0	5.3
UT	0.9	0.0	0.0	1.1	80.8	0.0	17.2
MT	2.8	0.0	5.9	2.2	0.0	42.2	46.9

Figure 5: Commodity Shipments Originating in Idaho Ranked by Weight



Software Review

From the Internet, twelve traffic modeling software programs were found. Six were selected as candidates for Idaho's statewide traffic demand modeling: TransCAD, TranPlan, TRIPS, EMME/2, MINUTP and TMODEL2. The vendors were contacted by telephone, email, or written a letter to request general information, price lists, or demonstration disks. A summarization of this information for these six software packages can be found in Appendix B. A brief introduction for each of the six software programs is as follows. Additional six software packages are presented briefly.

TransCAD

TransCAD was the first PC-based Urban Transportation Planning (UTP) software program to combine a true geographical information system (GIS) with a fully integrated UTP model. TransCAD was also the first UTP program to offer a fully integrated set of menu screens. The network building facility in TransCAD can be quite challenging to master, even for experts.

TRANPLAN

TranPlan is one of the most commonly used PC-based UTP software programs in the US. TranPlan may not be the fanciest program, in terms of offering multiple versions of advance route assignment procedures, but it does provide all of the options normally associated with the traditional four-step UTP process. TranPlan is often favored for areas in which trip estimation and assignment have legal implications or when state planning agencies require standardized model outputs.

TRIPS

TRIPS is a British product, more widely used in Europe than in the USA. TRIPS's primary distinction is its fairly robust dynamic route assignment algorithm, which explicitly considers intertemporal changes in traffic congestion at specific intersections. This makes TRIPS particularly useful for modeling highly congested or saturated flow networks. TRIPS also includes many additional features, which are available at additional cost, but would not satisfy Idaho's modeling needs.

EMME/2

EMME/2 is a Canadian product that is in many respects the Cadillac of UTP software. EMME/2 provides the best documentation of any UTP package, way beyond the usual perfunctory references to the literature. EMME/2 does not include default settings for any procedure, assures that the user should be able to specify an appropriate model form, and understands what the model represents. EMME/2 is not designed for beginners and is appreciated by more advanced UTP modelers.

MINUTP

MINUTP is based on a variety of UTP utilities developed over the years by COMSIS Corporation in response to client needs. For example, COMSIS recently developed an elasticity-based travel demand management (TDM) evaluation utility for use in conjunction with MINUTP.

TMODEL2

TMODEL2 is one of the older PC-based UTP programs. The program treats networks for different modes separately, assigning mode split prior to trip distribution. The program calculates intersection delays with internal variable formulae, rather than having the delay definitions fixed as constants internally by the modeler.

Quick Response System II (QRS)

QRS II is based on the National Cooperative Highway Research Program Report 187, which outlines the quick response system developed by FHWA for sketch planning and site impact analysis in small urban and rural areas. While QRS II has been greatly expanded since its introduction, it is still mainly a tool for smaller urban transportation planning applications. Because QRS II includes defaults for all model settings based on accepted industry standards, it is perhaps the easiest package to learn and use.

The Highway Emulator (THE)

THE is by far the most basic of programs, providing neither graphics nor training and very little technical support. The program requires relatively little training. Due to the simplicity of the program, it is available for free. Its primary use is for site impact analysis and most often is applied to developments of regional significance in smaller urban areas or in the outlying suburbs of larger cities. This package is one of the few that can be used to develop synthetic origin-destination trip tables based on exiting traffic counts. This approach works best when origin-destination data are in place and vehicle counts are available for all or most of the key route segments in the study area.

TexSIM Traffic Network Simulation Model

TexSIM is an advanced multi-modal microscopic traffic component simulation module. TexSIM is being developed by the Texas Transportation Institute (TTI) to research and implement complex signal systems operation under new types of control strategies. TexSIM Simulation Module Version 3.0 currently runs under the Microsoft Windows and Microsoft Windows NT environments.

SYSTEM II

JHK and Associates developed the commercial version of SYSTEM II quite recently. This is the newest UTP model on the market, and is based largely on utilities JHK has developed over many years. SYSTEM II includes some elements of GIS, as well as a variety of fairly new features designed specifically to accommodate its use of subarea focusing and site analysis.

DYNAVIMTS

DYNAmic Visual Micro-macroscopic Traffic Software (DYNAVIMTS) is a simulation software program Virginia Tech developed to evaluate various aspects of the Automated Highway Systems (AHS). This software addresses both microscopic and macroscopic traffic behaviors in multilayer AHS architecture. This multi-platform software has three modules that operate under UNIX and Windows NT, and call Matlab and Arc/Info for additional processing.

SmartPath Simulation and Animation Package

SmartPath is a simulation package for Automated Highway Systems (AHS). The program may be used to understand how an AHS would perform under various control policies in terms of highway capacity, traffic flow, and other performance measures of interest to transportation system planners and engineers. SmartPath can also be used to simulate, test, and evaluate the performance of the designs of different modules and instrumentations, like engine modes, sensors, and communications.

Existing Digital Databases for a Statewide Model

A transportation model requires the input of a transportation network, traffic data, and land-use data. Therefore, one of the first steps in transportation planning is to assess the availability of digital databases. The following is a summary of digital databases from the Idaho Transportation Department (ITD), the U.S. Bureau of the Census, and other sources.

Milepost and Coded Segment Database

The MACS/ROSE (Milepost And Coded Segment/Roadway Segment) System is an evolving database developed at the Idaho Transportation Department. Within the MACS/ROSE system, roadways, and the various categories of attribute data that describe them, are identified and referenced by the ***key*** attributes in the database—*segment code, mileposts and dates*. Segment codes (arbitrary, six-digit identification numbers) are assigned permanently to the right-of-way (land) upon which the road physically resides. Beginning and Ending Mileposts further identify the length and relative location of the attributes, features and classifications that describe the roadway. Effective and Expiration Dates identify when the road or its descriptive attributes came into existence or ceased to exist.

The MACS/ROSE Database currently resides on the IBM mainframe system, separate from ITD's GIS base map data that is maintained in the Intergraph's MGE environment. ITD plans to use relational database technology and the Intergraph MGE environment to merge the MACS/ROSE database with the GIS base maps. This will create a locationally referenced Integrated Transportation Information System (ITIS). The descriptive attribute data in MACS/ROSE will be related to the base map data via the MACS/ROSE database key.

The 17 active files in the MACS/ROSE database contain many descriptive attributes potentially useful for developing a statewide transportation model. These attributes include: Interchange locations, intersection locations, jurisdictions, boundaries, functional classification, ADT and per cent commercial ADT, federal-aid funding categories, design hour traffic volumes, lane distribution, etc. Attributes specific to the State Highway System—route number, route type, sign type, route direction, business loops and spurs, overlapping routes, national truck routes, etc.—are stored in the State Highway Route Number File.

Transportation Network Data

The highway centerline database maintained by ITD can provide the base network for a statewide model. The database lists the longitude and latitude readings of every 0.1-mile post of all Interstate, U.S., and state highways in Idaho. Table 1 shows an example of the coordinate data. It has a total of 50,766 records. In this study, the ITD highway centerline database is converted to an ARC/INFO coverage and, thereafter, into the input data files required for TranPlan. A detailed description of the conversion procedure is provided in Appendix C. ARC/INFO and TranPlan were used in this feasibility study to demonstrate how assessing data is a vital step in developing a statewide model.

Table 1. The First 11 Records of Coordinate Data File From ITD

```
RERD NO. SEGMENT_CODE MILEHIGHWAY NO.  LATITUDELONGITUDE
601,     001010,        0 ,    84      ,44.0064025257716,116.93984648090
602,     001010,        0.1,   84      ,44.0050360137471,116.93932695686
603,     001010,        0.2,   84      ,44.0036694117377,116.93880732929
604,     001010,        0.3,   84      ,44.0023028930929,116.93828785611
605,     001010,        0.4,   84      ,44.0009363711388,116.93776840834
606,     001010,        0.5,   84      ,43.9995565481996,116.93733909048
607,     001010,        0.6,   84      ,43.9982028404108,116.93681109903
608,     001010,        0.7,   84      ,43.9968877459167,116.93607983847
609,     001010,        0.8,   84      ,43.9955726487808,116.93534848705
610,     001010,        0.9,   84      ,43.9942576324813,116.93461729820
611,     001010,          1,   84      ,43.9929425204591,116.93388613854
```

The TIGER (Topologically Integrated Geographic Encoding and Referencing) database, developed by the U.S. Bureau of the Census and the U.S. Geological Survey (USGS) for the 1990 census, is a comprehensive GIS database at street level. The database was created by combining the Census Bureau's GBF/DIME files for urban areas and the 1:100,000-scale USGS quadrangle maps. It includes political boundaries, statistical area boundaries, and line features such as roads, railroads, and rivers. For this project, the ITD database was used to create the initial network and used the TIGER database to add more links to the network. The TIGER database, because it contains blocks, census tracts, and enumeration districts, is also a good data source for creating traffic analysis zones.

The 1996 National Transportation Atlas Database, produced by the Bureau of Transportation Statistics, U.S. Department of Transportation (USDOT), is a geographic database of transportation facilities. Originally designed to meet the needs of the U.S. Department of Transportation at the national level, the database also has major applications at the regional, state, and local levels. The database includes the geo-spatial information for transportation modal networks, intermodal terminals, and political and statistical areas with related attribute information. Transportation terminals are represented as points (nodes), transportation networks and services as lines (links), and the geographic references as either points or polygons. In this study, the Idaho highway network was extracted from the database and converted to an ARC/INFO coverage. Table 2 shows the ARC attribute table of the coverage. This network was used as a reference.

Table 2. Attribute Data of Highway Network From NTAD96

FNODE#	=	3
TNODE#	=	1
LPOLY#	=	0
RPOLY#	=	0
LENGTH	=	0.233
CDHIGH#	=	1
CDHIGH-ID	=	20227
LINKID	=	20227
LRECTYPE	=	L
LVERSION	=	02
LREVISION	=	02
LMODDATE	=	0
FEATURID	=	16000538
ANODE	=	16000003
BNODE	=	16000002
DESCRIPT	=	
STFIPS1	=	16
STFIPS2	=	
RECTYPE	=	T
VERSION	=	02
REVISION	=	02
MODDATE	=	0
SOURCE	=	U
STFIPS	=	16
CTFIPS	=	21
ORNL_ID	=	16002540
LGURB	=	0
SMURB	=	0
SIGN1	=	U95
SIGN2	=	
SIGN3	=	
MILES	=	15.48
KM	=	24.92
FACTYPE	=	2
TOLL	=	0
LANES	=	2
ACONTROL	=	3
MEDIAN	=	2
SURFACE	=	1
FCLASS	=	2
ACLASS	=	P
RU_CODE	=	1
STATUS	=	1
NHS	=	7
STRAHNET	=	0
TRANSAM	=	0

Traffic Data

Traffic data is available from ITD for traffic demand modeling in Idaho. Every highway in the centerline database is divided into segments, and its beginning and ending mileposts specify every segment. Speed limit, functional class, capacity, and annual average daily traffic were obtained from this file. Using the segment code as the relative item, every highway segment was associated with its traffic data (Table 3). ITD has other traffic data, which can be utilized for model evaluation and calibration in the next phase.

Table 3. The First 11 Records of Attribute Data from ITD

SEGMENT_CODE,	BEGINNING_MP,	ENDING_MP,	FUNC_CLASS,	SPDLMT,	CAPACITY,	AADT
001010,	0.000,	5.968,	1,	065,	4147,	13000
001010,	5.968,	12.610,	1,	065,	4021,	13000
001010,	12.610,	17.640,	1,	065,	4021,	13000
001010,	17.640,	24.839,	1,	065,	4021,	13000
001010,	24.839,	25.991,	1,	065,	4147,	20000
001010,	25.991,	26.343,	1,	065,	4147,	25949
001010,	26.343,	26.700,	1,	065,	4147,	26000
001010,	26.700,	27.621,	11,	065,	6533,	28771
001010,	27.621,	27.893,	11,	065,	4251,	30000
001010,	27.893,	28.466,	11,	065,	4251,	30000
001010,	28.466,	32.640,	11,	065,	4251,	34590

The 1990 Census Transportation Planning Package (CTPP) CD-ROM is a set of special tabulations of 1990 census data tailored to meet the data needs of transportation planners. The 1990 CTPP is a continuation of the program established for the 1970 census and continued for the 1980 census in the same general format. Statewide tabulations provide the following data: characteristics of persons, workers, and housing units; characteristics of workers; and characteristics of workers in journey-to-work flows. The area units for data collection are county (places of 2,500 or more) and county subdivision of residence. These data are useful for intercity trip generation in traffic demand modeling.

The State summary Commodity Flow Survey (CFS) identifies where and how goods are shipped in the United States. It lists the value and weight of commodities shipped by manufacturing, mining, wholesale trade, and selected retail and service industries. The survey was a collaborative project between the U.S. Department of Transportation's Bureau of Transportation Statistics (BTS) and the U.S. Bureau of the Census. The Census Bureau collected quarterly data in 1993, as part of its Economic Census, under the technical guidance of BTS. From a sample of 200,000 establishments, commodity flows were estimated for a universe of approximately 800,000 businesses. Data from the CFS for each state include: mode of transportation; total modal activity, mode of transportation and distance shipped, mode of transportation and shipment size, commodities shipped, commodity and mode of state of destination, state of destination and mode of transportation, state of destination and commodity and shipment, and commodity and distance shipped. Data from the CFS have been used for a variety of freight studies including: national and state freight origin and destination analysis, freight mode split, market-share analysis, and freight planning and management.

The American Travel Survey (ATS) was conducted from January through December 1995. Based on quarterly interviews of approximately 80,000 households in the United States, the survey measured interstate and intermetropolitan passenger travel nationwide by trip and traveler characteristics for all modes and for intermodal combinations. The survey data was released in summer 1997 on CD-ROM, on-line via the Internet, and in printed format.

The Federal Highway Administration's Nationwide Personal Transportation Survey (NPTS) compiles national data on the nature and characteristics of personal travel by all modes of transportation. Information from a national household sample was collected about all trips taken during a designated 24-hour period (travel day). Additional details were collected for trips of 75 miles or farther (one-way) that were taken during the proceeding 14-day period (travel period) including the 24-hour travel day. Available for 1983 and 1990, the NPTS provides the following data: household vehicle availability and use, annual miles per licensed driver, household travel rates, day-of-week and time-of-day travel, vehicle occupancy, and home-to-work trips.

The Bureau of Transportation Statistics' Transborder Surface Freight Data Set (TSFDS), available since April 1993, includes freight flow data by commodity type and by surface mode of transportation (rail, truck, pipeline or mail) for U.S. exports and imports from Canada and Mexico. The data are processed and summarized for BTS by the U.S. Census Bureau on a monthly basis. The Transborder Surface Freight data set provides previously unpublished surface transportation data (other than air or maritime vessel) for U.S. import and export trade with or through Canada and Mexico. The data set includes two sets of tables, one is commodity based, while the other provides geographic detail. The source data for imports and exports are the administrative trade records required by the U.S. Departments of Commerce and Treasury. An increasing amount of import and export statistical information is now available electronically. For imports from Canada and Mexico, approximately 95 percent of the value of those imports are collected electronically. For exports to Mexico, approximately 55 percent are collected through the Automated Export Reporting Program where data are filed directly with the U.S. Census Bureau. The remainder of the Mexican exports is collected from paper documents that are filed with the

U.S. Customs Service and processed by the U.S. Census Bureau. Exports to Canada are obtained through the U.S./Canada Data Exchange, under which the U.S. obtains the data that Canada uses for its imports from the United States.

Land-Use Data

Traffic demand modeling requires the input of population, household, employment, and other socioeconomic data. These various kinds of data are often grouped as land-use data in transportation planning. Most of these data are available from the U.S. Bureau of the Census; however, the most recent complete census data came from the 1990 census. Table 4 shows an example of population data for nine counties in Idaho from the 1990 census. For this project, it was intended that the 1990 census data be supplemented with data compiled by Boise State University for population and employment forecasts; however, the BSU study was out-of-date.

Table 4. Population Data for Nine Counties in Idaho from The 1990 Census

```
"AreaName","L_16p","L_Employ","L_C5F_S","L_16pWkr","L_DrvAlo","L_Carpol","L_Pu
bTra","L_OthTra","L_WlkHom","L_TrvTim",
"ID, Ada County",153481,104423,18874,103285,81.2,10.1,0.8,1.0,5.7,16.9,
"ID, Adams County",2435,1293,263,1249,60.6,12.0,0.0,3.7,23.4,17.0,
"ID, Bannock County",46660,29061,6587,28603,78.1,10.7,2.5,0.5,7.3,16.8,
"ID, Bear Lake County",3998,2081,661,2044,63.1,26.3,0.3,0.2,9.2,21.1,
"ID, Benewah County",5861,3044,671,2961,73.0,12.2,0.4,2.2,11.9,17.0,
"ID, Bingham County",24541,15003,4399,14877,69.8,13.9,5.9,0.9,9.0,18.7,
"ID, Blaine County",10257,7800,1217,7538,70.3,11.6,1.1,1.9,12.9,13.2,
"ID, Boise County",2613,1438,270,1414,61.7,17.3,0.2,3.0,17.3,32.5,
"ID, Bonner County",19925,10445,2277,10152,71.9,13.6,0.2,1.6,12.0,1
```

Idaho Statewide Traffic Demand Model

In this section, details for developing a statewide model for Idaho and a proposed work plan for the next phase will be discussed.

Research Problem Statement

The purpose of this project is to develop a theoretical model based on the standard four-step travel demand forecasting process that is commonly used in transportation planning. The University of Idaho research team determined that the currently used historically based trend model has serious limitations for planning purposes. In addition to the model's use for planning, this project also serves two other purposes: to assist decision-makers in assessing environmental issues related to transportation, and to support the data requirements of the Pavement Management System (PMS) and the Highway Performance Monitoring System (HPMS). The statewide travel demand model will be developed to provide 5, 10, 15, and 20 year forecasts.

One main aspect of this project, which has not been emphasized in other studies, is the integration of geographic information system (GIS) with traffic demand modeling software. GIS is an efficient tool for preparing the necessary data for trip generation and for data display. The University of Idaho research team will also develop the user interface so that the Idaho Transportation Department's transportation planners can easily take advantage of the MGE.

The Development of Idaho Statewide Transportation Model

Basic Model Components

The standard four-step travel demand process includes trip generation, trip distribution, mode split, and trip assignment. The University of Idaho research team will follow this same process in developing the statewide travel demand model; however, they will make the following changes based on our review of models developed in other states.

1. The Idaho transportation planning model will address intercity passenger and freight flows.
2. The model will include trip generation purposes of home-based work, home-based shopping, home-based school, home-based other, non home-based, recreational, vacation, and truck.
3. The model will use 1995 as the base year, and 2020 as the future year.

4. The model will integrate the components of trip generation and mode split. Trip generation will be processed for each trip purpose and each mode. The model will use the cross-classification method to produce home-based trip production, and linear regression models to produce non-home based production and attractions. The study will derive truck trips from traffic counts, and trip rates and regression coefficients from household surveys.

Software

The University of Idaho feasibility study software review ranks TranPlan and TransCAD above other packages. These software packages are also used by most states. The University of Idaho research team recommends TranPlan to be used for the Idaho statewide model.

Data

Existing data sources

1. The highway central-line database maintained by the Idaho Transportation Department provides the base network for the traffic demand modeling process. The traffic counts in the database can be used for model refinement and validation.

2. The 1995 TIGER Line Files can be used to add more links to the base network and to define traffic analysis zones.

3. The Census CD-ROM offers demographic and socioeconomic data for trip generation.

4. The 1995 American Traveler Survey (ATS) will be a useful data source for intercity trip generation. The survey measures intercity passenger flows by all modes, and provides data on trip and traveler characteristics.

5. Intercity passenger trip information is available from the statewide Census Transportation Planning Package (CTPP).

6. The primary source of data for the truck trip will be the 1993 Commodity Flow Survey (CFS).

7. The National Transportation Atlas Database 1996, produced by the Bureau of Transportation Statistics, U.S. Department of Transportation, includes geospatial information for transportation modal networks and intermodal terminals and related attribute information. The database can be used as a reference for the highway network and its attributes.

Data to be collected

1. A household Origin-Destination survey is needed to derive trip production rates, regression equations for trip generation, and other trip characteristics.

2. An external station roadside survey is needed for the external trip generation information. The study team recommends collecting origin-destination data using the handout/mail-back postcard technique.

3. A roadside survey is needed for truck trip data.

4. Land-use forecasting is needed for future trip generations. In traffic demand forecasting, land use is typically represented by demographic and socioeconomic variables such as population, dwelling units, income, and employment. The input of future land-use patterns and related socioeconomic variables are critical to traffic demand forecasting. An earlier study by Boise State University's, Department of Economic on land-use forecast is already out-of-date. A new land-use-forecasting model is needed for statewide transportation planning.

Use of GIS

The use of GIS in the transportation planning process will make a major difference from the traditional planning models. GIS is an efficient tool for linking land use with traffic demand models. The University of Idaho research team plans to use GIS for the following tasks in the transportation planning process:

1. To Geocode and compile trip origins and destinations from surveys.
2. To capture, store, and manipulate socioeconomic data used in transportation planning.
3. To create and edit the highway network and traffic analysis zones.
4. To display the output from the traffic demand modeling.

A user-friendly interface will be developed to facilitate data exchanges between GIS and transportation planning software packages. In order to maintain compatibility with the GIS group within ITD, Intergraph MGE will be the proper software package to be utilized for the data analysis.

Interaction between the Statewide Model and the Metropolitan Area Models

Major urbanized areas in Idaho have developed, or are developing metropolitan area transportation models. The statewide model complements these metropolitan area models. The intercity flows produced by the statewide model can replace the internal-external and external-external trips in a metropolitan area transportation model. The metropolitan models can, in turn, provide measures of impedance through cities, which are important attributes of the activity nodes in the statewide transportation model. In the future, the statewide land-use and socioeconomic models can provide a consistent basis for estimating growth in the inputs to the trip generation model of metropolitan areas. In the long-term, the statewide model and the metropolitan area models should become fully integrated.

Scope of Work

The following 15 tasks are defined to be accomplished within a 24-month period.

Tasks to be undertaken within the first 12 months:

Task 1 - Define Traffic Analysis Zones

a. Create county boundary and census tract/block map.
b. Coordinate TAZ boundaries with county boundary and census tract/block boundary for consistency and facilitating the use of census data.
c. Locate TAZ centroids and identify external centroids.

Task 2 - Develop Roadway Network

a. Process the highway central line digital data from ITD.
b. If necessary, add more links from 1995 Tiger/Line file.
c. Add centroid connectors
d. Build trees.

Task 3 - Process Household Origin-Destination Survey Data

a. Obtain survey data from ITD.
b. Geocode O-D data.
c. Factor survey samples to universe.
d. Create trip records and household characteristics records for trip productions.
e. Create trip records for trip attractions.

Task 4 - Roadside Survey

a. Roadside survey for getting information. about external stations
b. Roadside survey for getting truck trip information.

Task 5 - Establish Trip Generation Model

a. Evaluate data for cross-classification trip generation model (productions).
b. Establish household characteristic variables.
c. Establish trip purpose categories.
d. Create trip tables (by purpose) from expanded survey data.
e. Prepare cross-classification matrix for trip productions.
f. Identify independent land-use activity variables for trip attraction regression analysis.
g. Apply cross-classification and regression to base year data and check against survey data to validate.

Task 6 - Prepare Distribution Model

a. Generate trip length distributions from survey data and network travel times.
b. Develop travel time factors.

Task 7 - Assign Vehicle Trips

a. Assign generated base year trip tables to base year network.
b. Compare assigned model volumes to assigned expanded survey data to validate and adjust as necessary to achieve calibration.
c. Perform screen line/cut line and individual link comparisons.

Task 8 - Integrate the Statewide Model with Existing MPOs' Models

a. Obtain impedance measures from MPOs' models for the statewide model.
b. Compare the intercity traffic flows with the internal-external and external-external trips in a MPOs model.

Tasks to be undertaken in the next 12 months:

Task 9 - Verify and Calibrate Base Year Traffic Demand Model

a. Compare link volumes from assignment to ground counts at strategic locations and on selected screen lines/cut lines.

Task 10 - Develop Land Use Forecasting Model

a. Forecast changes in socioeconomic variables and travel characteristics for the future year.

Task 11 - Forecasting Future Traffic Demand

a. Build future year network.
b. Develop future year trip table.
c. Assign future year trip table to future year network.

Task 12 - Develop Sub-area Models for each Planning Region Based on the Statewide Model

a. Identify the needs and requirements of each planning region for the traffic demand model.
b. Develop sub-area models.

Task 13 - Develop a User-friendly Interface

a. Identify the needs of exchanging data between GIS and transportation software.
b. Develop an easier used interface for end users of the statewide model.

Task 14 - Document Procedures and Results

a. Detail each task and assemble supporting data.
b. Compile base data files.
c. Prepare and develop manuals for model applications.

Task 15 - Conduct Training Sessions

a. Prepare and develop training manuals for model applications.
b. Conduct training sessions for ITD Personnel.

Justification for the Project

The passage of the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 requires every state to create and implement a statewide transportation plan that can be updated annually. The University of Idaho Civil Engineering Department conducted the Statewide and Sub-area Transportation Model Feasibility Study. They have reviewed models developed for the states of Florida, Wyoming, Michigan, Vermont, Indiana, and Pennsylvania, and also, various transportation planning software packages. This project, which is a follow-up of the feasibility study, proposes to develop a PC-based statewide transportation model to be used by the Planning Division of the Idaho Transportation Department.

Project Budget

Duration of the project: twenty-four months

Budget Item/Year	Requested ITD Funds	UI Match	Total Project Funds
Faculty salaries	$ 25,120	$ 10,231	$ 35,351
Other salaries	$ -	$ -	$ -
Student salaries	$ 18,072	$ -	$ 18,072
Total salaries	$ 43,192	$ 10,231	$ 53,423
Fringe benefits	$ 7,880	$ 2,916	$ 10,796
Operating expenses	$ 2,000	$ -	$ 2,000
Travel	$ 3,000	$ -	$ 3,000
Capital costs	$ 3,500	$ -	$ 3,500
Total direct costs	$ 59,572	$ 13,147	$ 72,719
Indirect costs	$ 11,914	$ 5,811	$ 17,725
Waived indirect costs	$ -	$ 14,416	$ 14,416
Project budget (Year 1)	**$ 71,486**	**$ 33,374**	**$ 104,860**

Total project budget (2 Years)	**$ 142,973**	**$ 66,748**	**$ 209,720**

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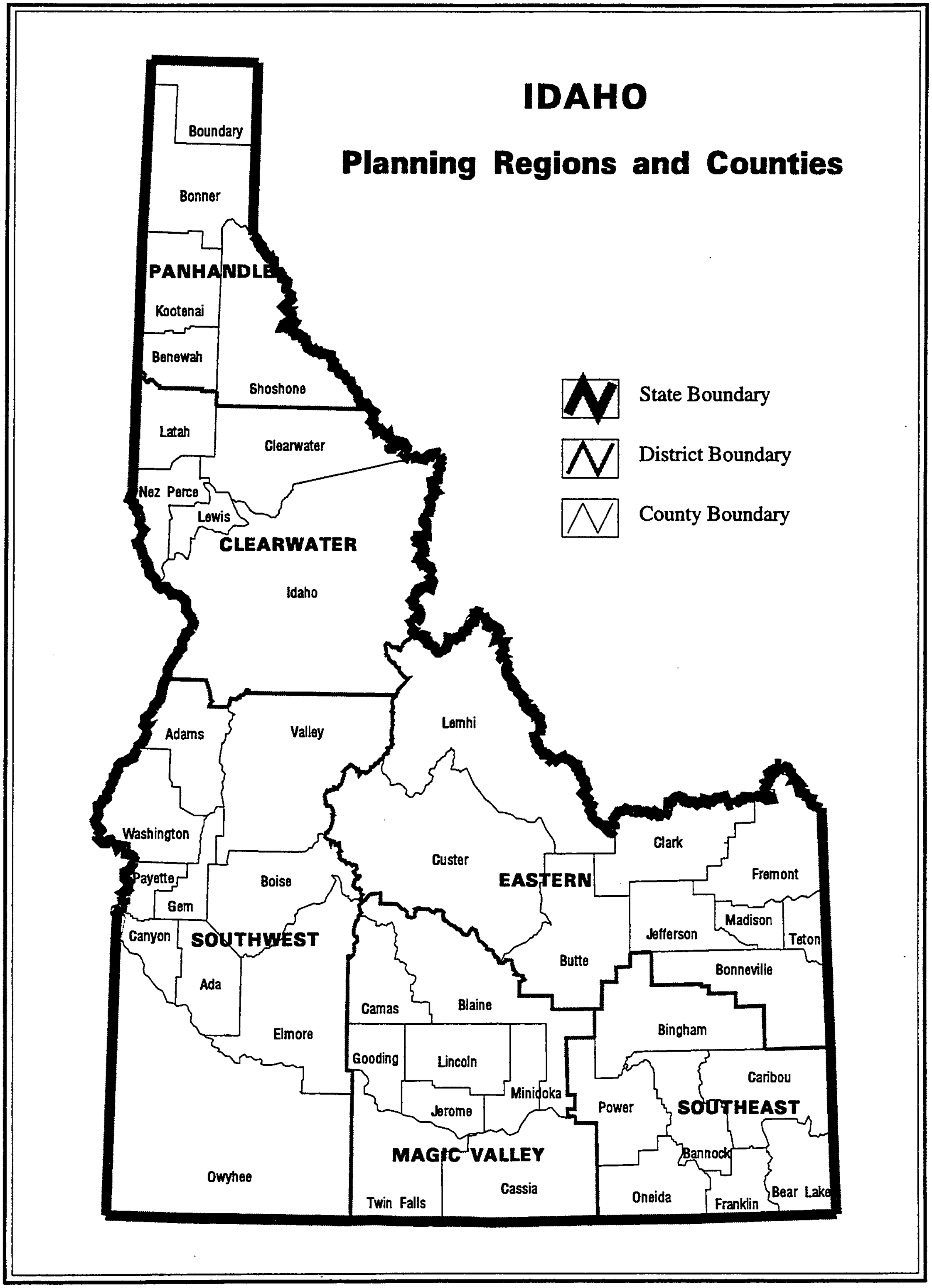
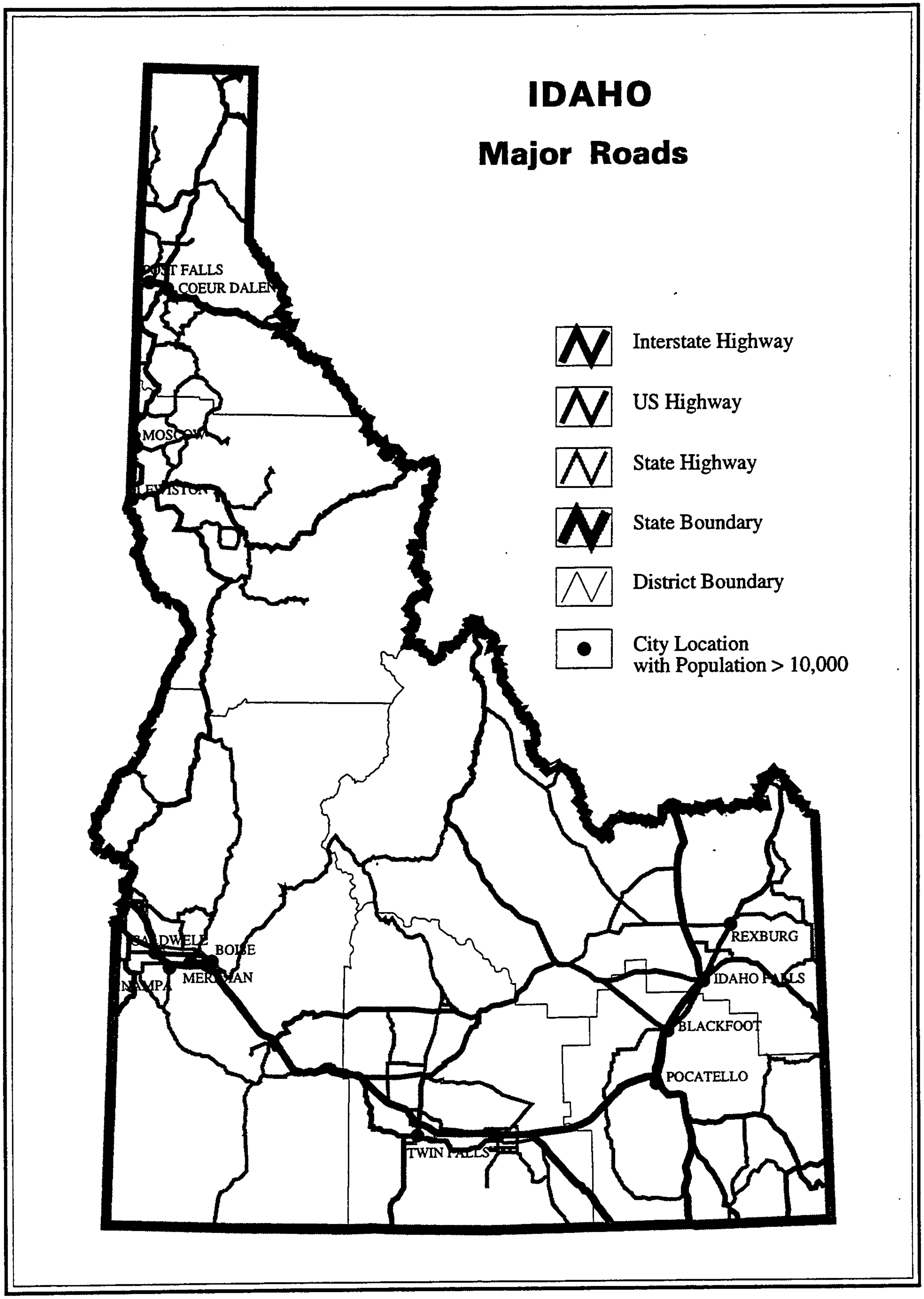
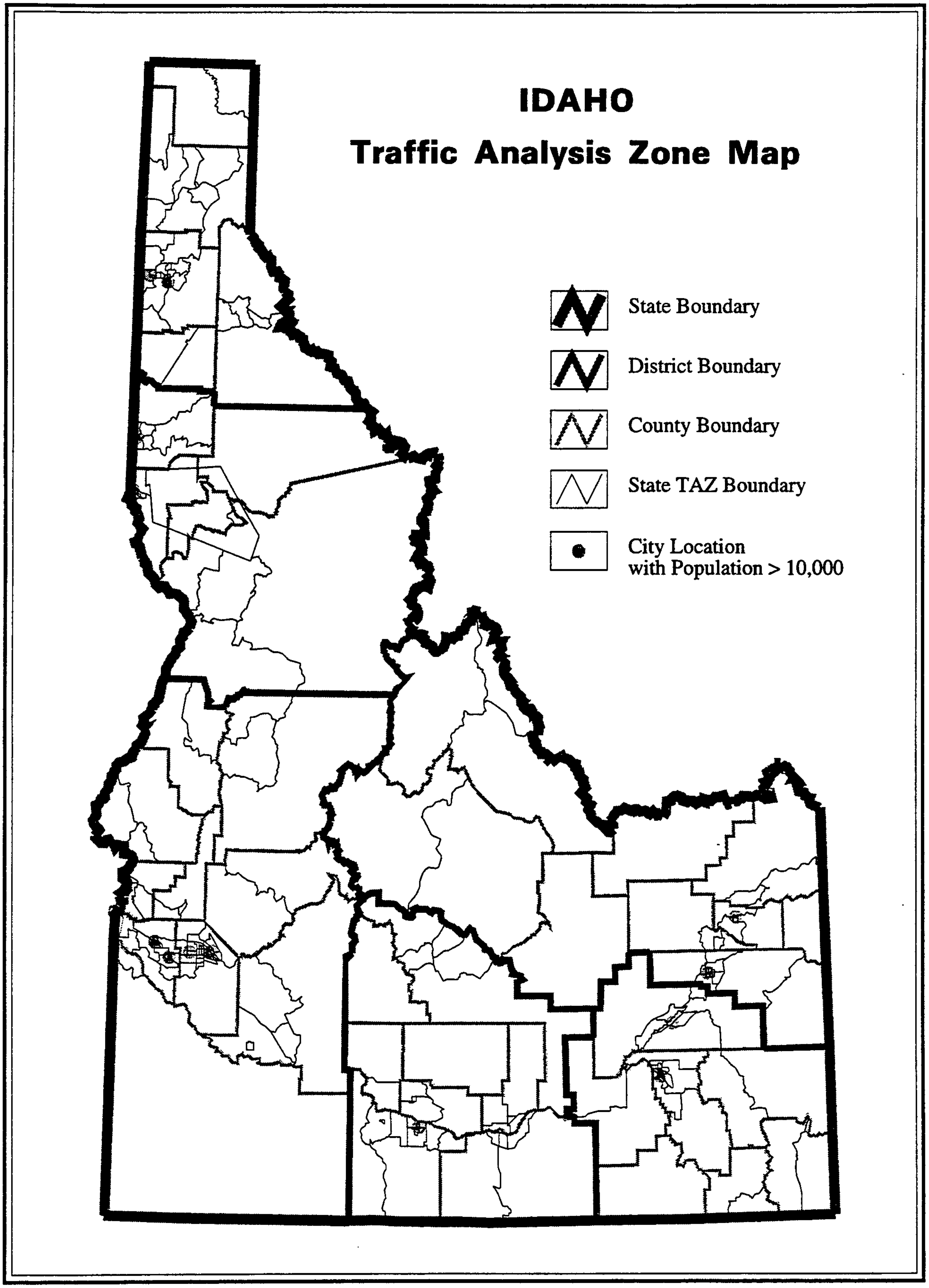
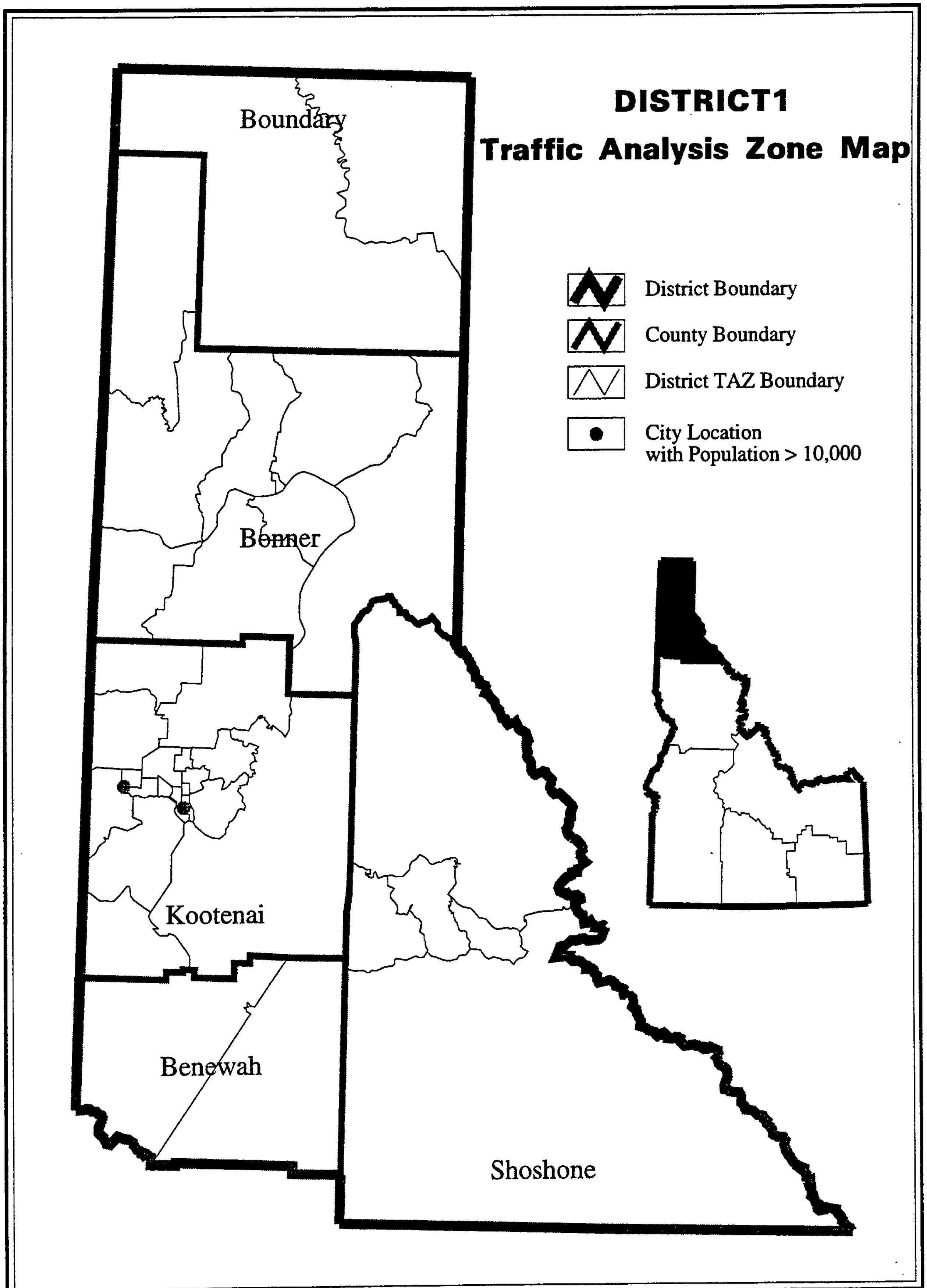
APPENDIX A. Maps

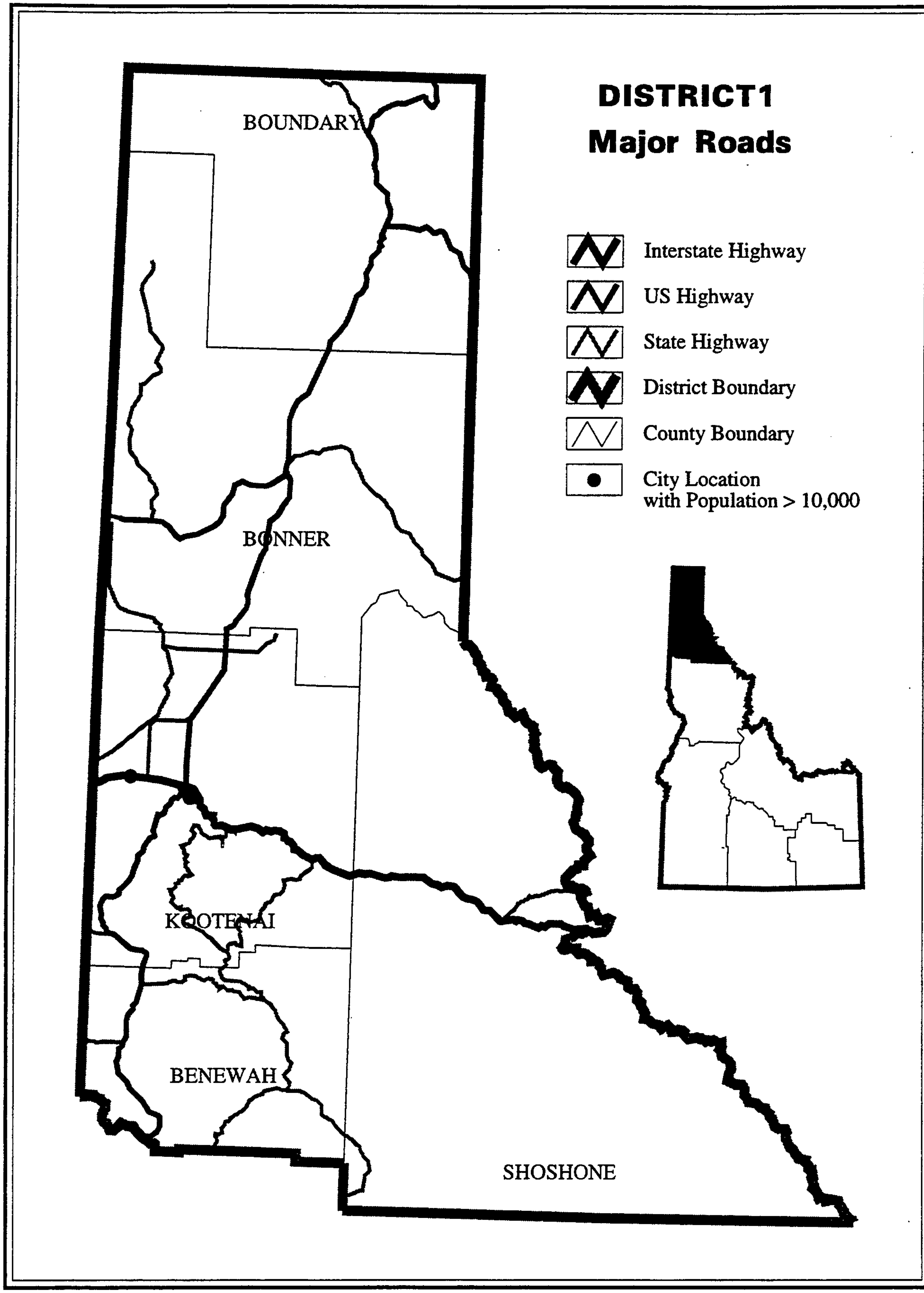
This appendix includes the traffic analysis zone maps and the road maps for Idaho, as a whole and for each district in Idaho.

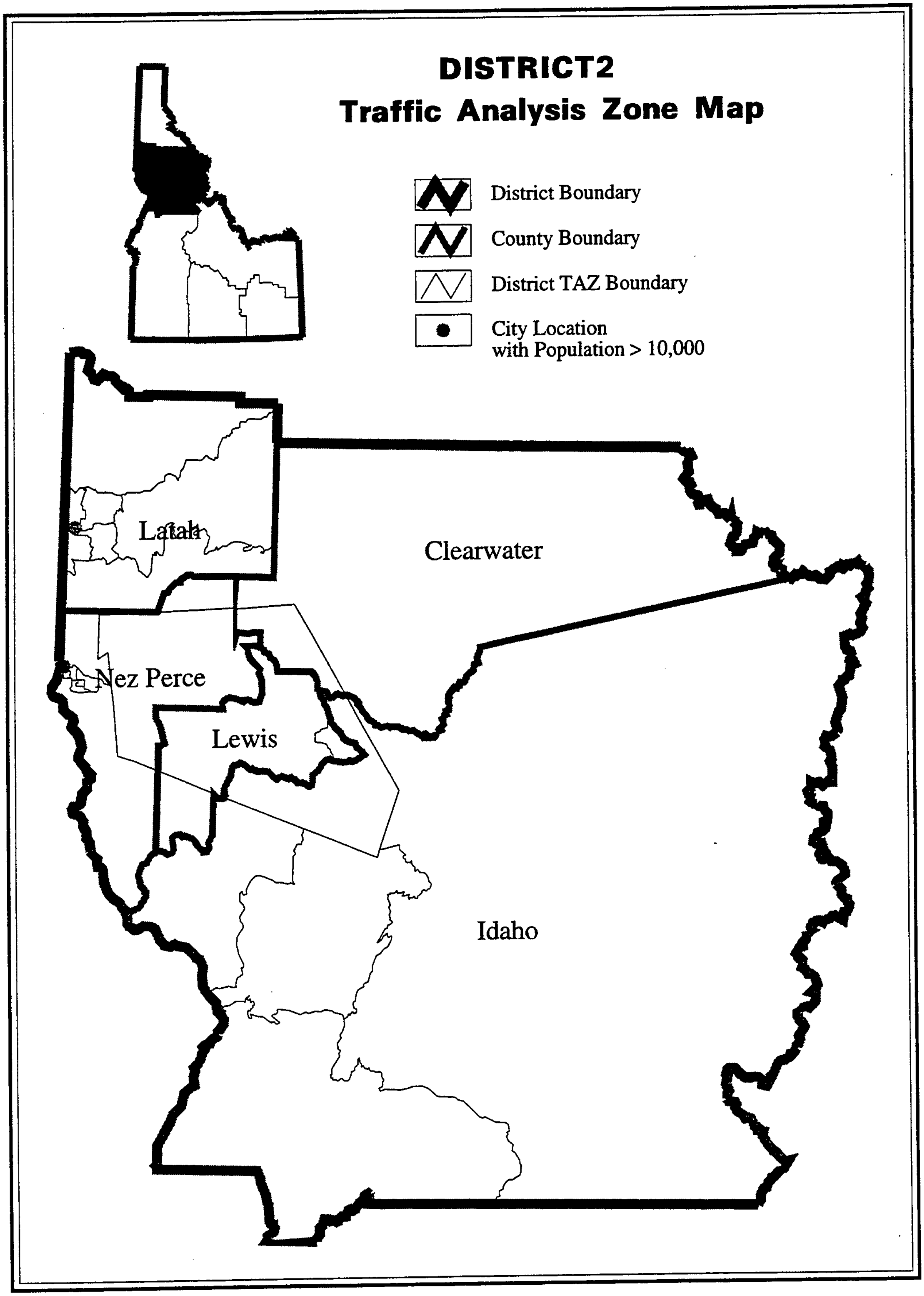

IDAHO
Planning Regions and Counties
State Boundary
District Boundary
County Boundary
PANHANDLE
Boundary
Bonner
Kootenai
Benewah
Shoshone
Latah
CLEARWATER
Clearwater
Nez Perce
Lewis
Idaho
Adams
Valley
Lemhi
Washington
Payette
Gem
Canyon
Boise
Custer
SOUTHWEST
Ada
Elmore
Owyhee
EASTERN
Clark
Fremont
Jefferson
Madison
Teton
Butte
Bonneville
Bingham
Caribou
Camas
Blaine
Gooding
Lincoln
Minidoka
Jerome
Power
SOUTHEAST
Bannock
MAGIC VALLEY
Twin Falls
Cassia
Oneida
Franklin
Bear Lake

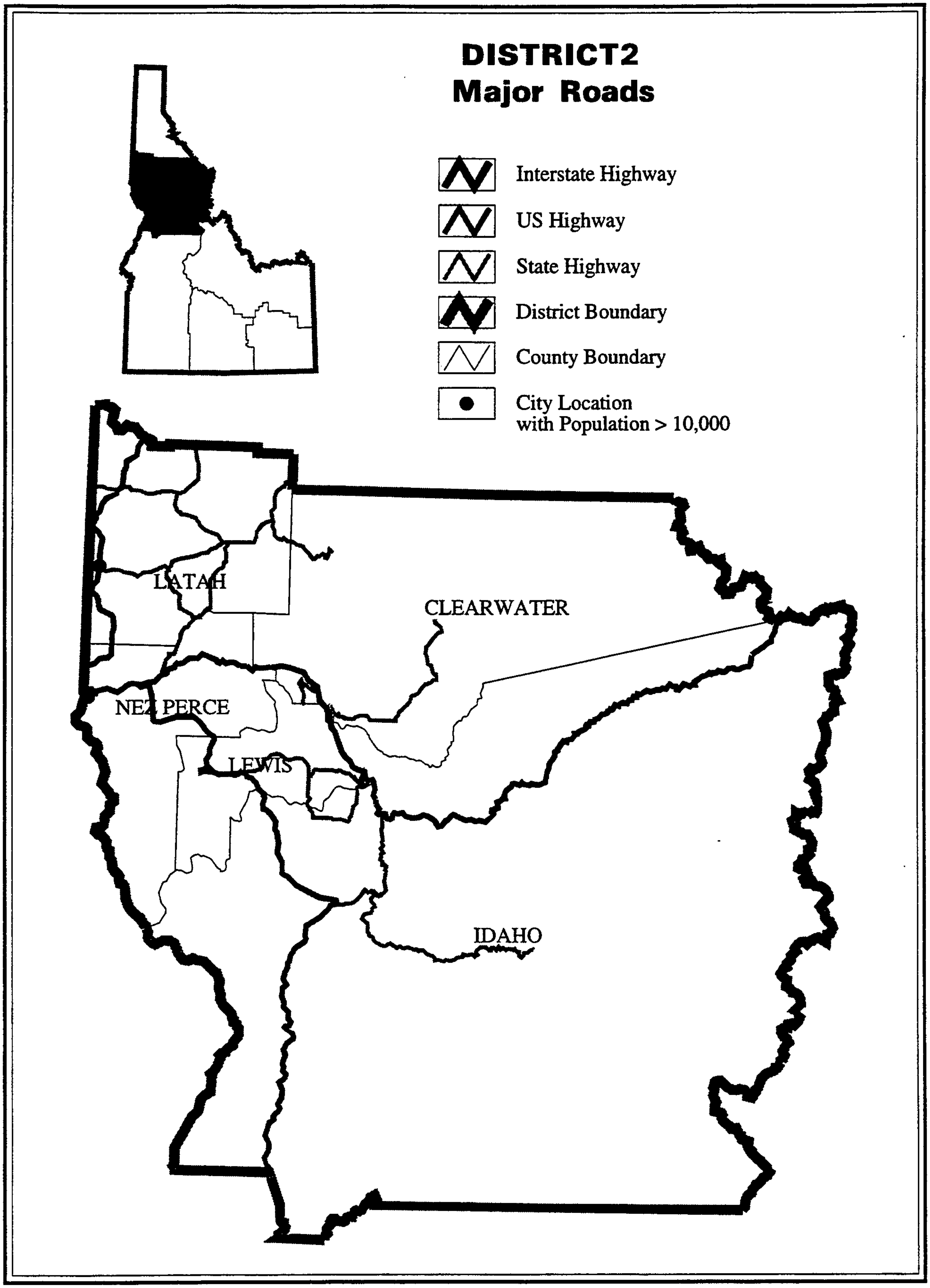

IDAHO
Major Roads
Interstate Highway
US Highway
State Highway
State Boundary
District Boundary
City Location with Population > 10,000
COEUR DALENE
MOSCOW
REXBURG
BOISE
MERIDIAN
IDAHO FALLS
BLACKFOOT
POCATELLO
TWIN FALLS

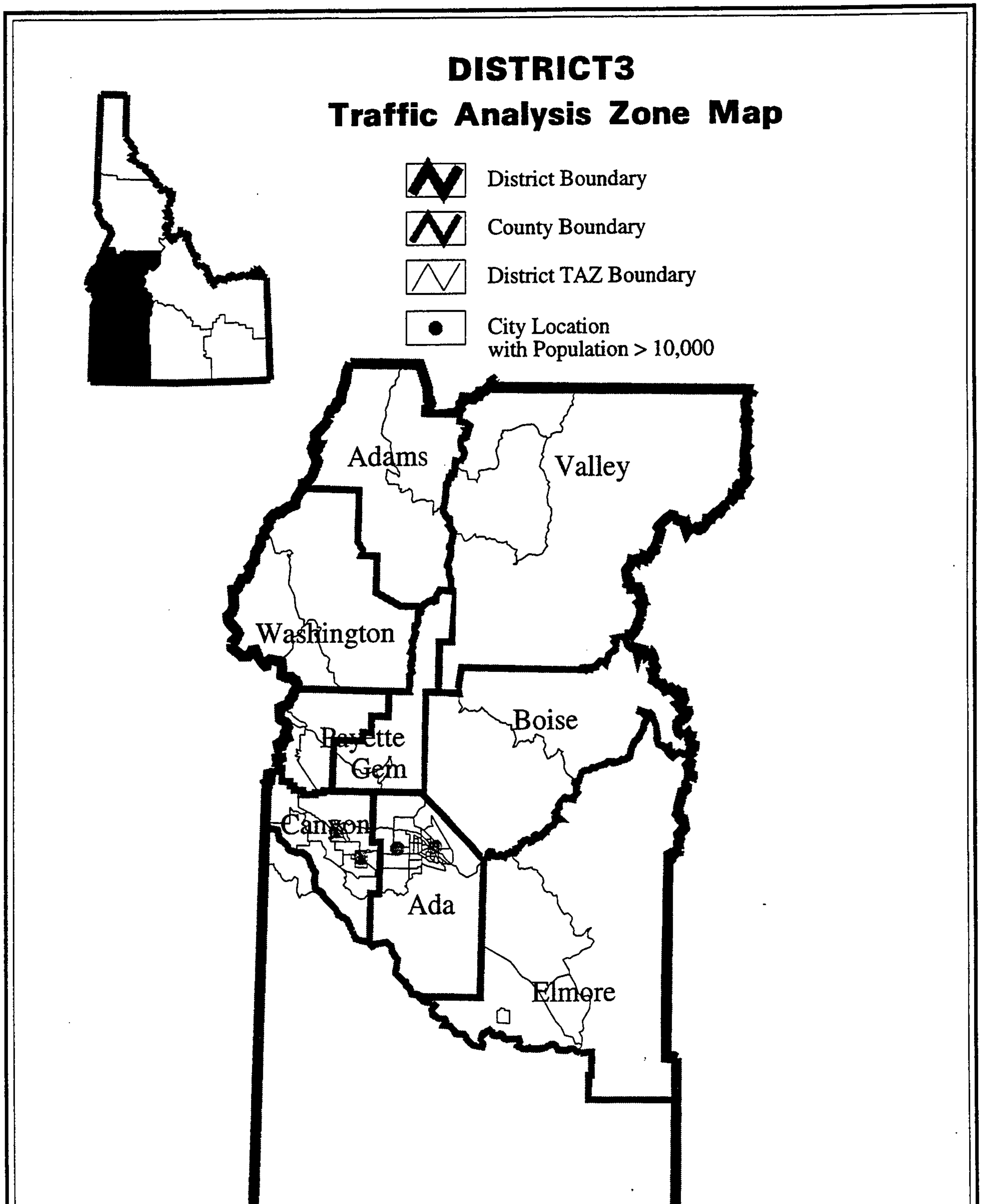

IDAHO
Traffic Analysis Zone Map
State Boundary
District Boundary
County Boundary
State TAZ Boundary
City Location
with Population > 10,000

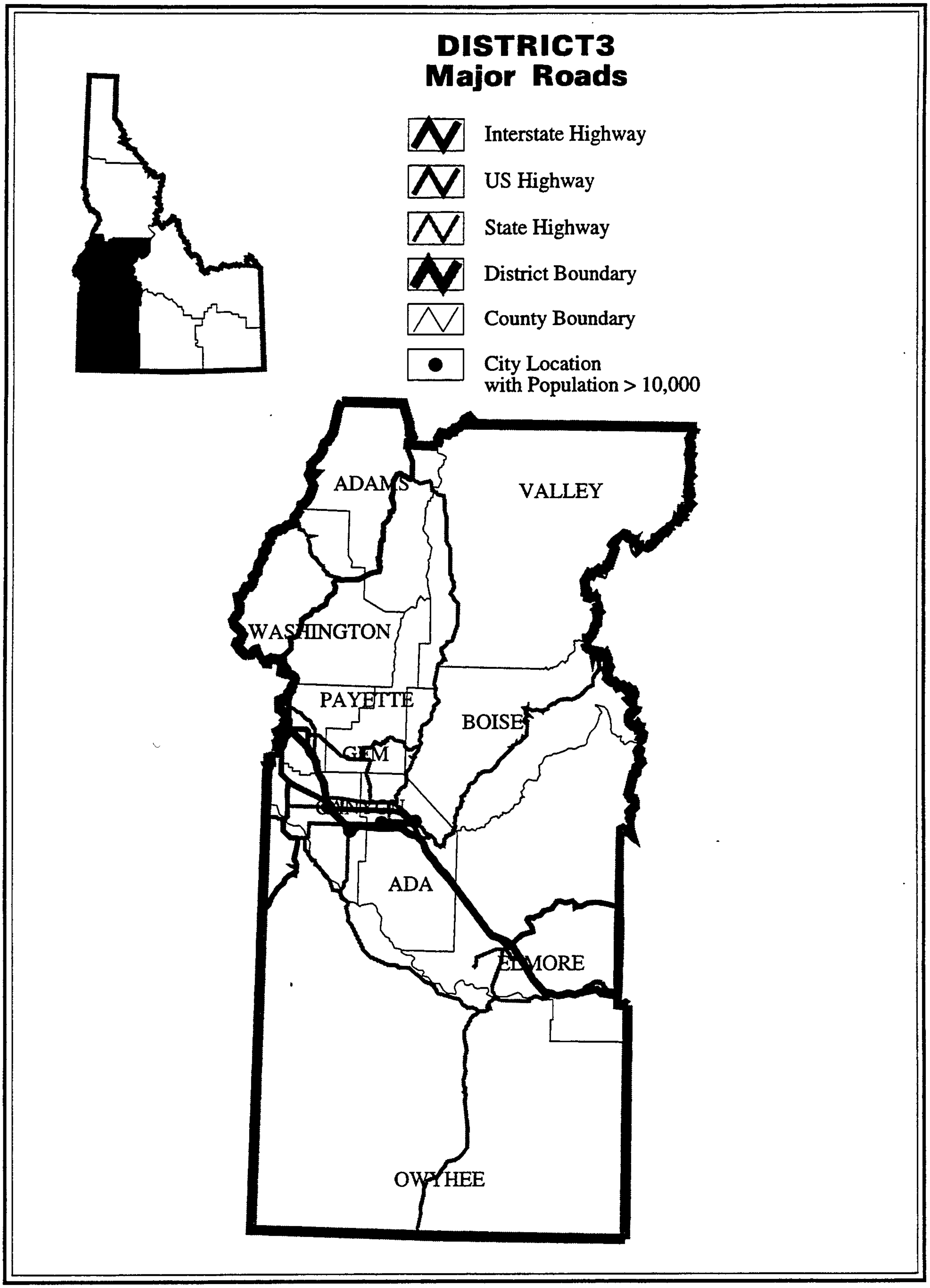

DISTRICT1
Traffic Analysis Zone Map
District Boundary
County Boundary
District TAZ Boundary
City Location
with Population > 10,000
Boundary
Bonner
Kootenai
Benewah
Shoshone

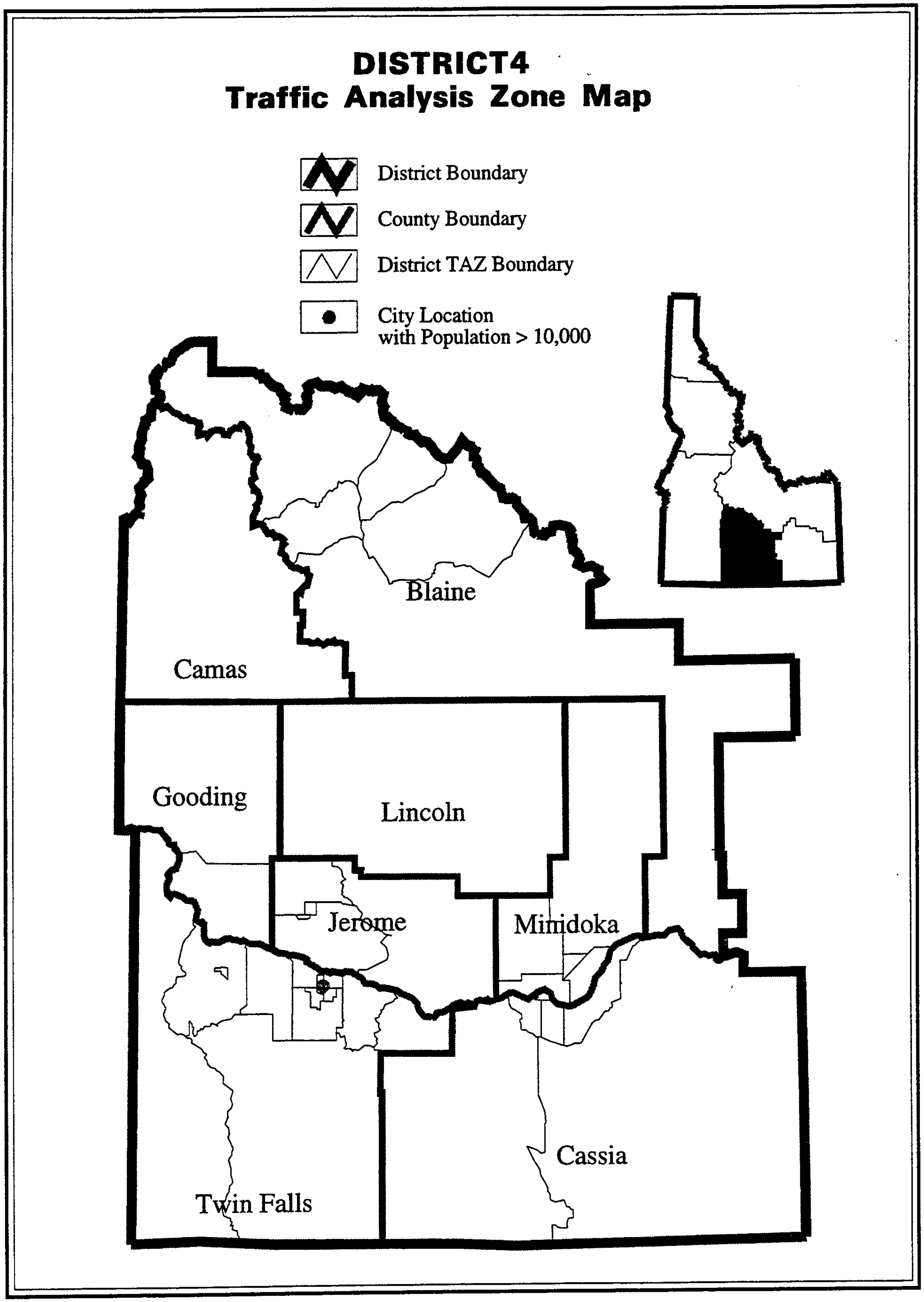

DISTRICT1
Major Roads
Interstate Highway
US Highway
State Highway
District Boundary
County Boundary
City Location
with Population > 10,000
BOUNDARY
BONNER
KOOTENAI
BENEWAH
SHOSHONE

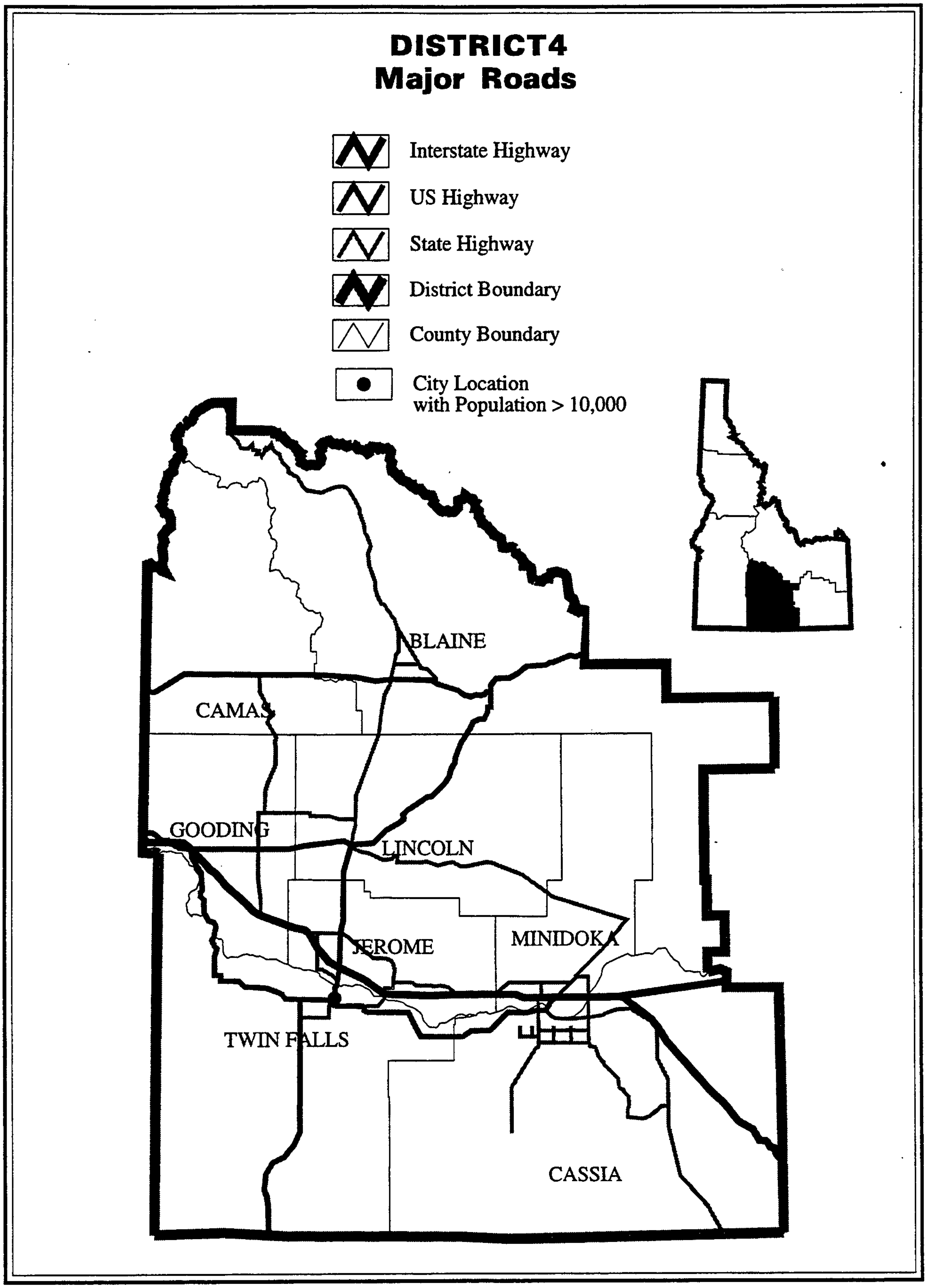

DISTRICT2
Traffic Analysis Zone Map
District Boundary
County Boundary
District TAZ Boundary
City Location
with Population > 10,000
Latah
Clearwater
Nez Perce
Lewis
Idaho

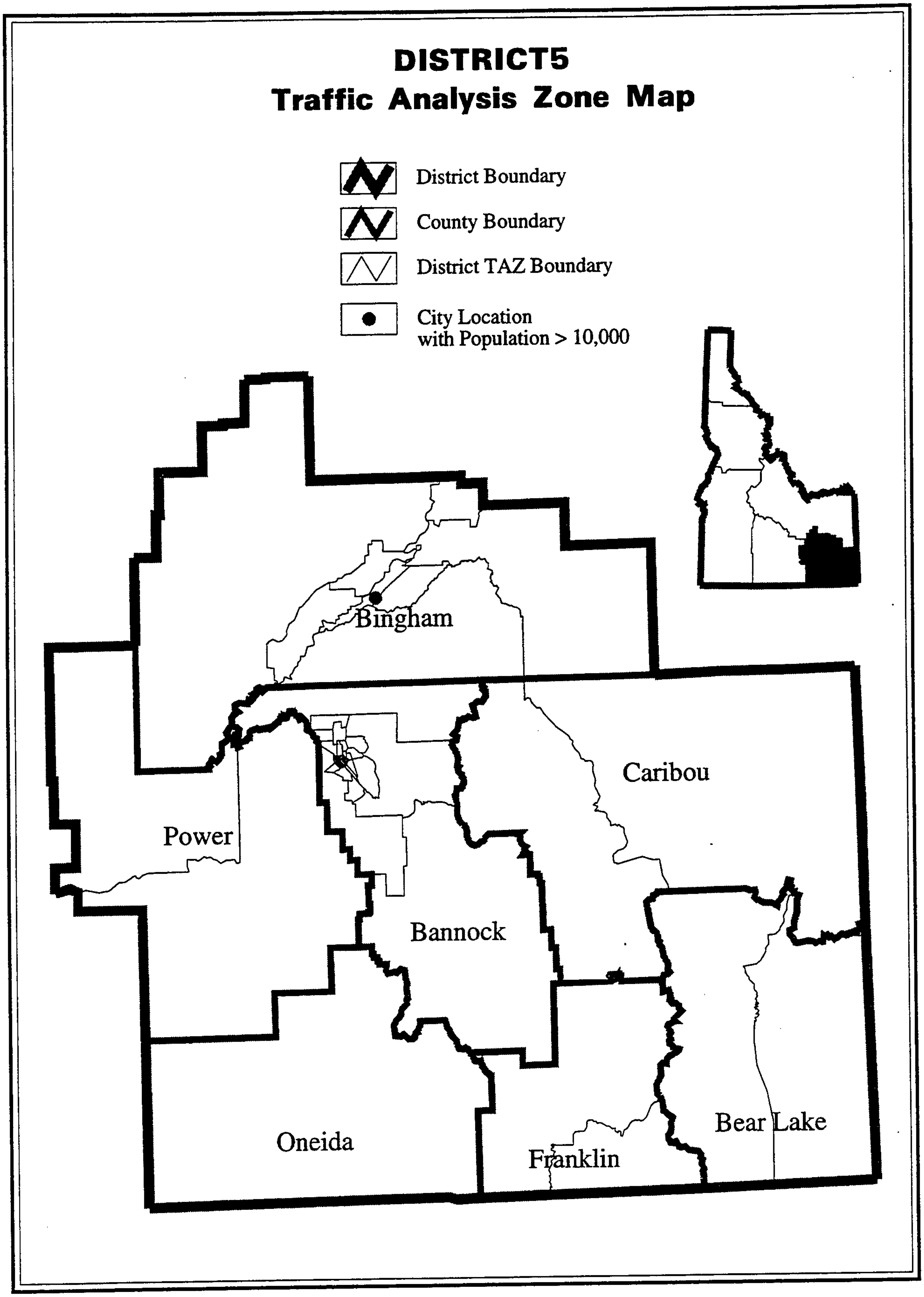

DISTRICT2
Major Roads
Interstate Highway
US Highway
State Highway
District Boundary
County Boundary
City Location
with Population > 10,000
LATAH
CLEARWATER
NEZ PERCE
LEWIS
IDAHO

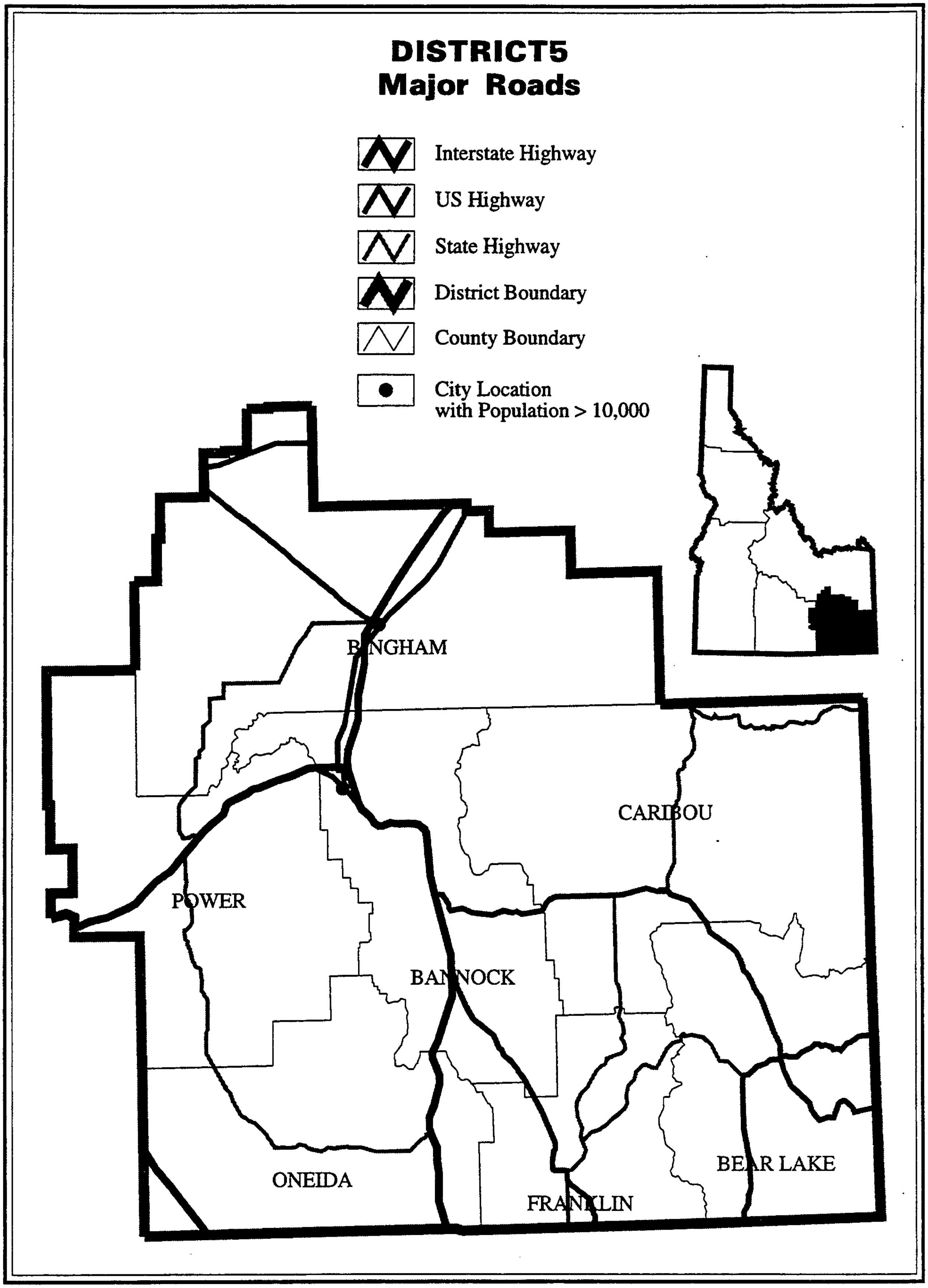

DISTRICT3
Traffic Analysis Zone Map
District Boundary
County Boundary
District TAZ Boundary
City Location
with Population > 10,000
Adams
Valley
Washington
Boise
Payette
Gem
Canyon
Ada
Elmore
Owyhee


DISTRICT3
Major Roads
Interstate Highway
US Highway
State Highway
District Boundary
County Boundary
City Location
with Population > 10,000
ADAMS
VALLEY
WASHINGTON
PAYETTE
BOISE
GEM
ADA
ELMORE
OWYHEE

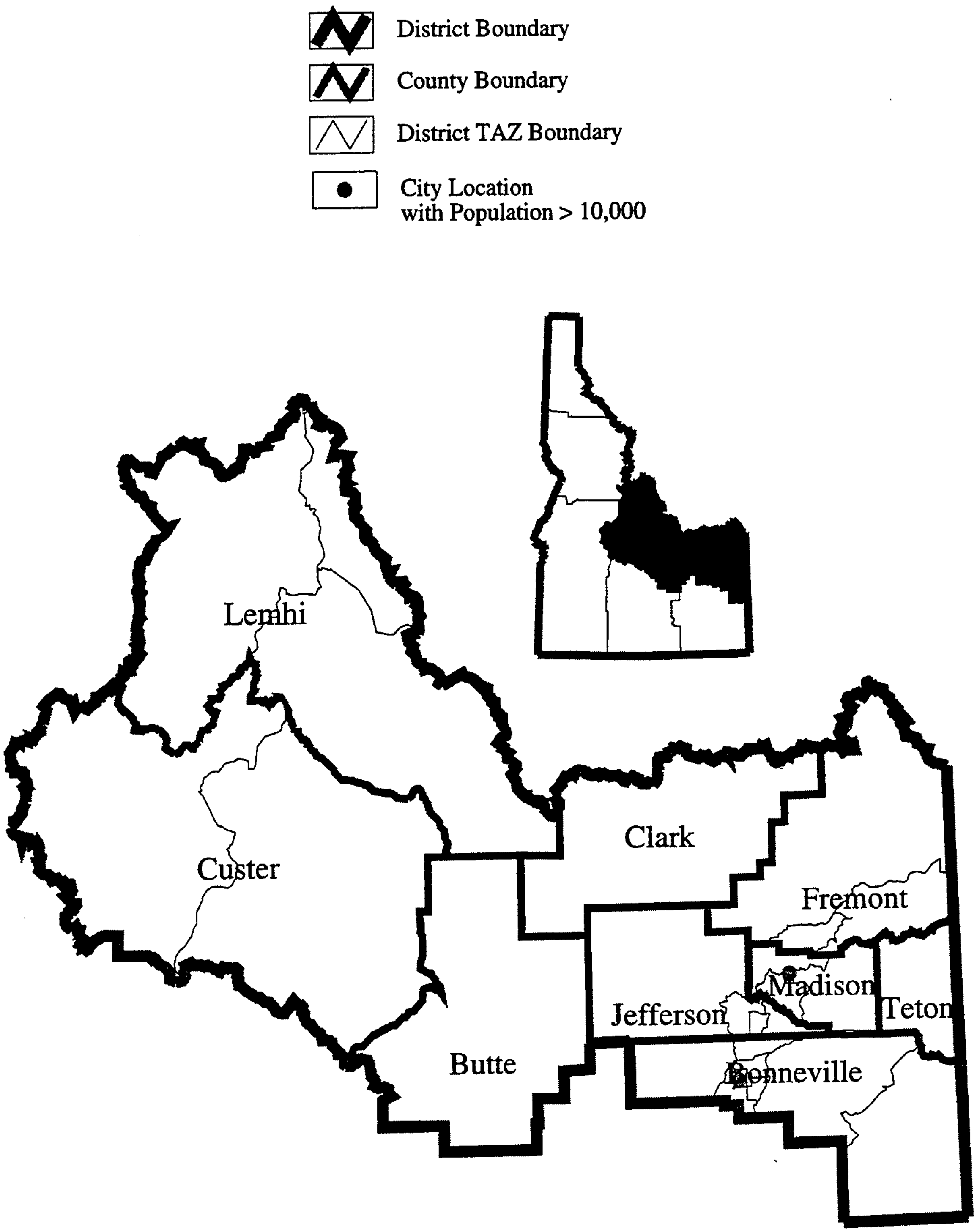

DISTRICT4
Traffic Analysis Zone Map
District Boundary
County Boundary
District TAZ Boundary
City Location
with Population > 10,000
Blaine
Camas
Gooding
Lincoln
Jerome
Minidoka
Cassia
Twin Falls

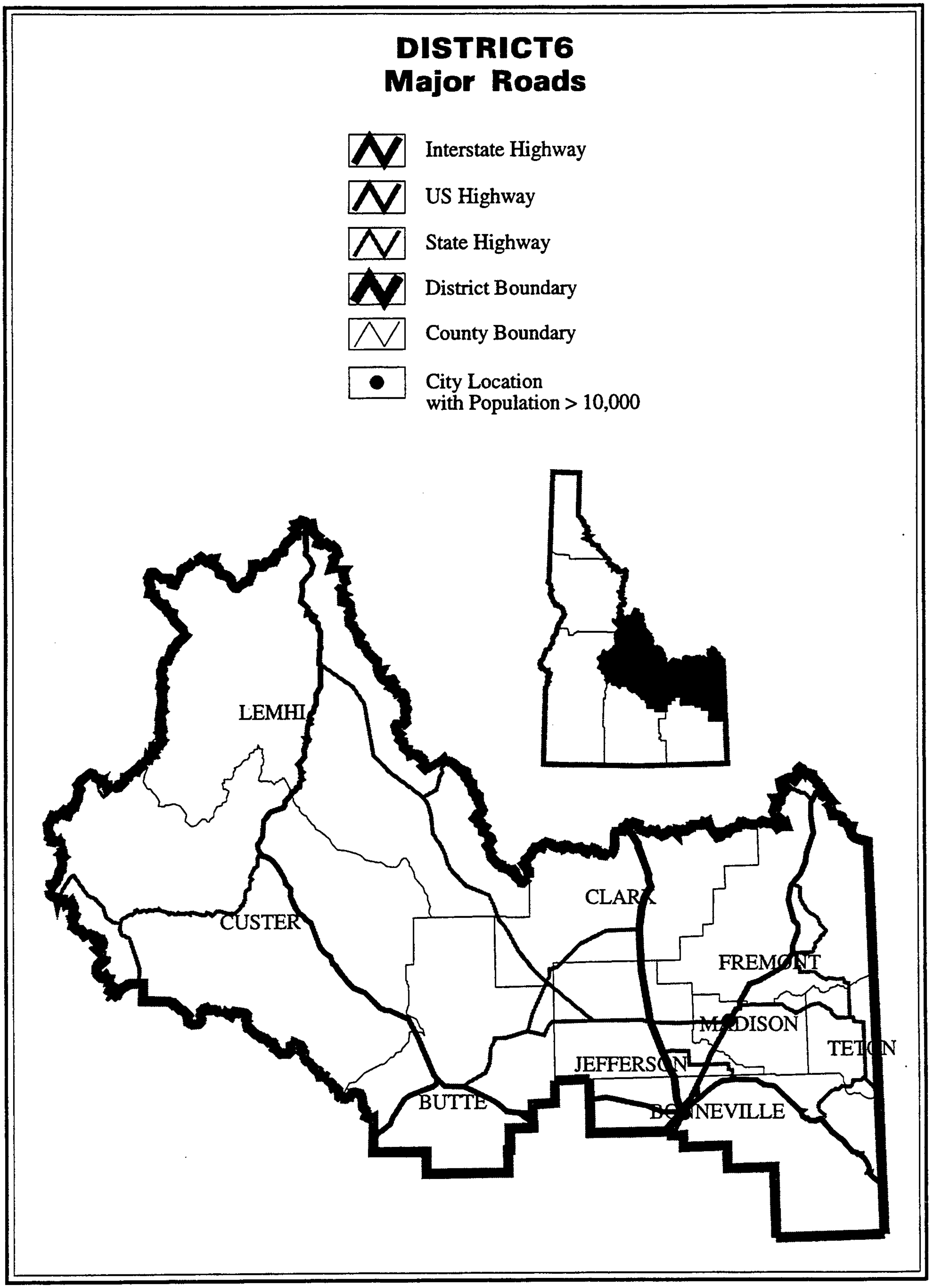

DISTRICT4
Major Roads
Interstate Highway
US Highway
State Highway
District Boundary
County Boundary
City Location
with Population > 10,000
BLAINE
CAMAS
GOODING
LINCOLN
JEROME
MINIDOKA
TWIN FALLS
CASSIA


DISTRICT5
Traffic Analysis Zone Map
District Boundary
County Boundary
District TAZ Boundary
City Location
with Population > 10,000
Bingham
Caribou
Power
Bannock
Oneida
Franklin
Bear Lake


DISTRICT5
Major Roads
Interstate Highway
US Highway
State Highway
District Boundary
County Boundary
City Location
with Population > 10,000
BINGHAM
CARIBOU
POWER
BANNOCK
ONEIDA
FRANKLIN
BEAR LAKE

DISTRICT6
Traffic Analysis Zone Map




DISTRICT6
Major Roads
Interstate Highway
US Highway
State Highway
District Boundary
County Boundary
City Location
with Population > 10,000
LEMHI
CUSTER
CLARK
FREMONT
MADISON
TETON
JEFFERSON
BUTTE
BONNEVILLE

APPENDIX B. TRANSPORTATION SOFTWARE REVIEW

Parameters	TMODEL2	TransCAD	TranPlan	TRIPS	EMME/2	MINUTP
Hardware and Operation Systems	512 + RAM EGA or VGA	PC or UNIX All windows	PC or UNIX OS/2 or windows	PC and UNIX DOS or windows	PC or UNIX DOS	IBM compatible DOS
Size Limits Zone	1,000	No limit	9,000	10,000	2,000	2,000
Links	10,000	No limit	64,000	No limit	40,000	32,700
Nodes	2,500	No limit	No limit	50,000	16,000	16,300
Travel Demand Analysis						
• **Land use:** socio-economic data interface, summaries and display	Partially	Fully	Partially	Partially	Partially	Partially
• **Travel behavior:** household dynamics and trend analysis	Partially	Partially	Partially	Partially	Partially	Partially
• **Trip generation:** I/O from other processing and programming capabilities	Fully	Fully	Fully	Fully	Fully	Fully
• **Trip distribution:** functions, options, special generators and calibration feature	Fully	Fully	Fully	Fully	Fully	Fully
• **Modal data:** commodities, passengers, mode split and calibration features	Partially	Fully	Partially	Partially	Partially	Partially
• **Trip assignment:** customize algorithms, multi-class and speed/flow flexibility	Fully	Fully	Fully	Fully	Fully	Fully
• **Generalized matrix manipulation:** functionality and flexibility	Partially	Fully	Partially	Partially	Fully	Partially
• **Graphical display of matrix data:** OD, select link and impedance	Partially	Fully	Partially	Partially	Fully	Partially
• **Survey:** disaggregate data handling and logit functions	Partially	Fully	Partially	Partially	Partially	Partially

Network Handling						
• **On-screen:** building, editing an display features	Fully	Fully	Fully	Fully	Fully	Fully
• **Diagnostics:** edit and logical network checking	Partially	Partially	Fully	Fully	Partially	Partially
• **Node data:** intersection impedance and display feature	Partially	Partially	Partially	Partially	Partially	Partially
• **Plotting:** bandwidth, attributes and colors	Partially	Partially	Partially	Partially	Partially	Partially
• **Integration with GIS and database**	Partially	Fully	Partially	Partially	Partially	Partially
Others						
• **Multi-user:** can run on many computers per site installation	Yes	No	Yes	Yes	No	Yes
• **Database:** easy exchange input/output	Yes	Yes	Yes	Yes	Yes	Yes
• **EVALS reports:** computer delta difference and statistics	Partially	Partially	Partially	Partially	Partially	Fully
• **Geographic:** summaries by area and site specific features	Partially	Fully	Partially	Partially	Partially	Partially
• **Matrices:** manipulation, display, math and flexibility	Partially	Fully	Fully	Partially	Partially	Partially
• **On-screen & hardcopy plotting:** capability and flexibility	Partially	Fully	Fully	Partially	Partially	Partially
• **Customization:** allows for any model flow	Partially	Fully	Fully	Fully	Fully	Fully
Cost	Standard copy $3,800	Standard first copy $9,995	Standard copy $8,000	Standard copy $20,590	Based on sizes $9,000 – 56,800	Based on sizes $500 – 7,500
Annual support fee		$2,500	$1,625	%15	%12	$500

TransCAD

Caliper Corporation
1172 Beacon Street
Newton, Massachusetts 02161
Tel: (617) 527-4700
Fax: (617) 527-5113

TransCAD is a relatively new travel demand package that integrates GIS capabilities and travel demand analysis. Information on transportation network, freight flows, routes, schedules, transportation analysis zones, passenger demand, and transportation system performance can be stored, displayed, and analyzed at any spatial scale. TransCAD has applications at international, national, regional, and local levels, and can be used for any or all modes of transportation.

TransCAD has five major components:

- The most powerful geographic information system (GIS) available today in the Windows operating system. GIS operations include polygon overlay, buffering, interlayer selection, and aggregation.

- An extend data model, such as networks, paths, tours, nodes, links, flow matrices and dynamic segmentation, that provides essential tools for transportation data display and manipulation.

- The largest collection of transportation analysis procedures ever assembled in one software package. These include:
  - Standard four step UTPS methods
  - Quick response methods
  - Specialized procedures for multimodal models
  - Routing, logistics and optional location models

- Broad and comprehensive sets of transportation, geographic, and demographic data. These include:
  - US DOT National Highway Planning Network
  - US Census TIGER/Line 1994 files
  - Detailed Census demographic and boundary data at all levels

- A powerful development language for creating macros, add-ins, server applications, and custom front-ends.

TransCAD procedures are remarkably fast and can solve mainframe size problems. Procedures include following:

- Trip Generation Procedures - linear, non-linear and logit models.

- Trip Distribution Procedures - Gravity, Fratar, and entropy models.
- Traffic Assignment Procedures - all-or-nothing, incremental, equilibrium, capacity restraint methods.
- Mode Split and Choice Procedures - binary and multinomial logit models.
- Transit Procedures - short path, skim trees.
- Quick Response Procedures - for trip production, attraction and generation.
- Other Related Procedures - OD Matrix estimation, turn penalty editor, Census utilities.
- Statistical Procedures - correlation matrices, one-way and two-way tabulation.
- Routing and Logistics - clustering, regional partitioning, facility location.

Hardware Requirements:
80486 or Pentium - based microcomputer under Windows 3.1, Windows 3.11 (Windows for Workgroups), Windows NT, and Windows 95.

Cost:

Standard TransCAD	(First copy)	$ 9,995
	(Copies 2-5)	8,995
	(Copies 6 - 15)	7,995
	(Copies 16 & up)	6,995
Base TransCAD		2,995
Turnkey TransCAD		19,995
TransCAD Academic Software License		995
TransCAD Lab Pack Software License		2,995

TranPlan

The Urban Analysis Group
50 Oak Court Suite 110
Danville, CA 94526-4048
Phone: 510-838-1363
Fax: 510-838-1372

TranPlan is one of the most commonly used UTP software programs in the U.S. It is a flexible full-functioning travel demand software package that was one of the first to be implemented in DOS based microcomputer. TranPlan may not be the fanciest program, in terms of offering multiple versions of advanced route assignment procedures, but it does provide all of the options normally associated with the traditional four-step UTP process. TranPlan is often favored for areas in which trip estimation and assignment have legal implications or when state planning agencies require standardized model outputs.

Capabilities:

Trip generation -	using user-specified socioeconomic data.
Trip distribution -	Gravity model with extensive statistics and optional K-factors; Fratar model to perform iterative matrix expansion.
Modal choice -	using curvilinear diversions between highway and transit modes.
Trip assignment -	using Equilibrium, all-or-nothing, incremental capacity restraint, iterative capacity restraint and stochastic methods.
Matrix utilities -	update, expand, compress or transpose trip tables; generate zone-to-transit fare matrices; generate trip tables from trip survey data.
Reporting -	detailed reporting and summaries of highway network characteristics, minimum paths and assignment results;

Work is underway on interface modules for the GIS softwares, such as ARC/INFO, MapInfo, AtlasGIS, Maptitude and ArcVIEW.

Size limits:
Zones: 9,000
Links: 64,000
Nodes: 32,000

Hardware requirements:
OS/2 and WINDOWS on PC's, BM RS/6000 AIX (UNIX) , SUN OS (UNIX) systems.

Site License:

TRANPLAN/NIS	$8,000
TPMENU	$1,200
ARC/INFO-Arc/View Interface	$ 600
Academic License	$ 975

TRIPS

MVA House, Victoria Way, Woking, Surrey GU21 1DD, United Kingdom
Telephone +44 (0)1483 728051
Facsimile +44 (0)1483 755207
email: enquiries@mva.co.uk

TRIPS is a British product, more widely used in Europe than in the USA. TRIPS's primary distinction is its fairly robust dynamic route assignment algorithm, which explicitly considers intertemporal changes in traffic congestion at specific intersections. This makes TRIPS particularly useful for modeling highly congested or saturated flow networks. TRIPS also includes many additional features, which are available at additional cost.

TRIPS is a set of inter-related modules, as below. These contain the 'building blocks' of a model, enabling the user to access the features and facilities to build models which meet individual requirements.

- Demand Modeling - Can be used in many innovative ways, also support conventional four-step transportation models.
  - *Trip End Generation and Attraction* - Processing three car ownership and six household groups. Using zonal landuse data and user supplied relationships.
  - *Trip Distribution* - Calibration, Forecasting and Growth Factoring.
  - *Modal Split* - Simple diversion curve functions are used to split trip matrices into modal matrices.
- Highway Assignment - Three levels; shortest single path, Burrell or Dial multi-route building algorithms; equilibrium, volume averaging, iterative and incremental assignment techniques; Full intersection modeling; and Dynamic Modeling.
- Public Transport Assignment - Three levels; multi-routing algorithm; logit sub-models; Crowd model;
- Matrix Estimation - Level 1: accesses commonly available data, such as link counts, trip end; Level 2: allows the use of 'part trip' data; Level 3: provides a hierarchic approach to estimating large matrices.
- Matrix Manipulation - Store zone to zone based data; provide tools to build, manipulate, modify, print, 'dump' and analyze matrix contents. Network Graphics
- TRIPSWIN - provides Windows environment.
- Graphical Project Management Tool - allow data to be input and checked, model results to be understood, networks to be changed and images created for export to work processors, printer and plotters.
- Data Processing - processing of survey data.
- Interfacing to TRIPS - Showman Plus traffic count data program; export to databases, spreadsheets or GIS's.

Hardware requirements:
Personal computers using DOS, Windows 3.1, Windows for workgroups or Windows/95.
Sun Unix workstations using Solaris 2.x or SUNOS 4.1.3
HP Unix Workstations using HP-UX.
DEC Unix Workstations using ULtrix.

Key model building parameters are:
- Zones - up to 10,000
- Nodes - up to 50,000
- Links - No limit
- Intersections - No limit
- Modes (Public Transport) - 20
- Lines (Public Transport) - 9999

Cost:
See attached page.

EMME/2

INRO Consultants Inc
Montreal, Canada
Tel: (514) 369-2023
Fax:(514) 369-2026

EMME/2 is a Canadian product that is in many respects the Cadillac of UTP software. It is a flexible, menu-driven travel demand package that is widely used in North America and Europe. Structured in a database format, the software allows for relatively easy and flexible construct of literally any model design and includes state-of-art highway and transit network handling features. Furthermore, this software also allows users many capabilities to analyze results and to graphically display important evaluation measures. EMME/2 does not include default settings for any procedure, reflecting a philosophy that the user should be able to specify an appropriate model form, understand what the model represents, and be aware of its potential limitations. EMME/2, not designed for beginners, is appreciated by more advanced UTP modelers.

Major features:

Matrix manipulation tools - allow implementation of a wide variety of travel demand forecasting models.

Assignment procedures - based on sound theories.

Interactive calculators - allow implementation of evaluation and impact analysis methods.

Powerful macro language - for automating repetitive procedures.

Comprehensive graphic display capabilities - include network scattergrams, matrix histograms, shortest path builders and scenario comparison.

Interactive/graphic network editors - for entering and updating network data.

Capabilities:

- Provides decision support capabilities, allowing the simultaneous description, analysis and comparison of several proposed scenarios, and providing methods for evaluating various transportation and landuse development alternatives.
- Provides a general framework for implementing a wide variety of travel forecasting models. These can range from the simple implementation of a four step model to more refined demand models and their integration into a variety of road and transit assignment procedures. Impact and evaluation analysis is also possible.
- Offers the planner a wide variety of tools for the direct comparison of future scenarios which may reflect changes in the road and transit network or changes in the socio-economic characteristics of the urban area studied.

Hardware requirements:

Intel 486 or Pentium Pcs , SUN SPARC under UNIX, HP 9000 under HP-UX,
IBM RS/6000 under AIX, DEC Alpha under Digital UNIX (OSF/1),
DEC VAX under VMS

Network size limit: 16 sizes
Zones: 250 - 4,000
Nodes: 2,000 - 32,000
Links: 5,000 - 80,000
Turns: 5,000 - 80,000
Transit lines: 250 - 4,000
Transit line segments: 6,250 - 100,000

Cost:

	Class B	Class C	Class D
Size 1 - 16	$9,000 - $40,000	$12,000 - $48,000	$14,000 - 56,8000

Interfaces such as the 2.11 Toolbox have been developed allowing GIS Systems like ArcInfo to manage and share modeling data with packages like EMME/2.

MINUTP

COMSIS Corporation
8737 Colesville Road #1100
Silver Spring, MD 20910
301-588-0800
FAX 301-588-5922
comsis@cais.com

MINUTP is another flexible, full-functioning travel demand software package that has a long track record in North America and many users. MINUTP offers state-of-the-art forecasting techniques in a form that is easily applied and understood. It provides these techniques in standard formats and includes extensive flexibility for the user to tailor the application to local conditions.

MINUTP's 4-step Demand Forecasting Process:
Trip Generation: simple rates, cross-classification tables, or regression models.
Processing up to 26 data variables and 9 trip purposes.
Trip Distribution: Gravity model formulation or the Fratar growth-factor technique.
Mode Choice: Logit models, Pivot point methods.
Trip Assignment: Equilibrium, stochastic, iterative, and incremental.

New features:

- The *transit forecasting* capabilities have been expanded to handle larger transit systems, permit interactive graphic editing of transit networks, and provide comprehensive options for defining transit lines and controlling transit path building.
- The *highway assignment* procedures have been upgraded to facilitate analysis of High Occupancy Vehicle lanes by permitting the user to assign HOV and not-HOV trips simultaneously.
- *Matrix utilities* that are extremely powerful and fully capable of applying even the most complex mode choice models are provided.

Size limits of highway network:
Zones: 2,000
Links: 32,700
Nodes: 16,300

Size limits of transit network:
500 transit lines
10 transit nodes
6 transit access node.

Hardware requirements:
IBM compatible machines with 256K RAM and 2 Floppy diskettes.

Cost:
The price of the MINUTP software varies depending upon the size of the application network which is determined by the number of zones and nodes. The following is the price schedule as of August 1990:

Plan	A	B	C	D	E	F	DEM
Zones	50	300	400	500	2000	2000	20
Nodes	200	1200	1600	2000	16380	16380	50
Highway with Graphics	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Transit with Graphics	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Training	No	Opt	Opt	Opt	Opt	Incl	No
Update Cost $	50	100	100	100	1 Yr.	2 Yrs	
Total Cost $	500	3000	4000	5000	6000	7500	100

TMODEL 2

TModel Corporation
P.O. Box 1850
Vashon, WA 98070
FAX: (206) 463-5055 or (800) 826-6357
tmodel@tmodel.com or http://www.tmodel.com

TMODEL 2 is one of the older PC-based UTP programs. The program treats networks for different modes separately, assigning mode split prior to trip distribution. The program calculates intersection delays with internal variable formulae, rather than having the delay definitions fixed as constants internally by the modeler.

Capabilities:

Trip Generation Capabilities - Six trip purposes and unlimited user-specified land use or standard land use classifications. Pro-/Post-distribution mode split. Full trip tables manipulation features including fratar, transpose, mask, factor, merge, squeeze/expand.

Traffic Assignment Options - Incremental, Iterative, Adjusted Incremental, with capacity restraint or all-or-nothing assignments; select link and select zone; Multi-Point Assignment (MPA), auto external zone calibration, subarea trip table derivation, HOV/SOV assignment, Emissions. Import files from Transplan, Emme/2, QRS, THE, Motors, GIS.

Intersection Analysis - Dynamic node modeling, dynamic turn penalties and prohibitions, pre-load option, graphic representation, fratering of turns, select zone fratering, merging of files, and NCAP capacity analysis package.

Interactive Graphics - Display and edit network information with color, proportional width, text, street names. Land use, trip table, travel time, and modal impedance graphics from variable angles and azimuths. Import TIGER or .DXF files for graphic layer display. Desire lines. Trip Length Frequency curves. Level-of-Service using SR209.

Model Limits:

Zones: 1,000
Nodes: 2,500
Links: 10,000

Hardware requirements:

512K + RAM, EGA or VGA monitor, mouse.
Math co-processor recommended.
Plotter support includes HPGL, HPGL/2, PCL5 lasers.

Cost:

TMODEL2 w/NCAP - $3,800.00
TMODEL2 Educational - $ 150.00
TMODEL2 Demo - $125.00
TMODEL2 Upgrade - (Call TModel for price)

Appendix C. Conversion of the ITD highway centerline database to an ARC/INFO coverage and the input data files for TranPlan

The ITD highway centerline database includes two kinds of data useful for statewide transportation planning. The first data file has 50,766 records, listing the coordinates at every 0.1-mile post in Latitude and Longitude. The other is an attribute data file for 1,847 highway segments. The attributes are speed limit (SPDLMT), functional class (FUNC_CLASS), capacity, annual average daily traffic (AADT), and milepost.

The following files were created: an ARC/INFO route coverage, a line coverage, and the TranPlan network data files from the above two files. Compared to the National Transportation Atlas Database 1996, the coverage derived from the ITD database had more details. Some differences between the two, however, were difficult to explain. The following describes the general procedure for converting the ITD data files.

The first step was to reformat the ITD data file into the format required by ARC/INFO using C++ programs we wrote. Table 1 shows the first 12 lines of the coordinate data file used to create an ARC/INFO route coverage. Table 2 shows the attribute data used to produce an event Dbase file.

Table 1. Coordinate data file used to create ARC/INFO route coverage

```
1010
0   -116.9398464809   44.0064025257716
0.1 -116.93932695686 44.0050360137471
0.2 -116.93880732929 44.0036694117377
0.3 -116.93828785611 44.0023028930929
0.4 -116.93776840834 44.0009363711388
0.5 -116.93733909048 43.9995565481996
0.6 -116.93681109903 43.9982028404108
0.7 -116.93607983847 43.9968877459167
0.8 -116.93534848705 43.9955726487808
0.9 -116.9346172982   43.9942576324813
1   -116.93388613854 43.9929425204591
```

Table 2. Attribute data file used to produce event Dbase file

```
1010,0,5.968,1,65,4147,13000
1010,5.968,12.61,1,65,4021,13000
1010,12.61,17.64,1,65,4021,13000
1010,17.64,24.839,1,65,4021,13000
1010,24.839,25.991,1,65,4147,20000
1010,25.991,26.343,1,65,4147,25949
1010,26.343,26.7,1,65,4147,26000
1010,26.7,27.621,11,65,6533,28771
1010,27.621,27.893,11,65,4251,30000
1010,27.893,28.466,11,65,4251,30000
1010,28.466,32.64,11,65,4251,34590
```

The completion of an ARC/INFO route coverage and an event table essentially creates a dynamic segmentation data model. Dynamic segmentation allows multiple sets of attributes to be associated with any portion of a highway network. These attributes can be stored, displayed, queried, and analyzed without affecting the underlying highway network's X Y coordinates. A route coverage has three internal data files in ARC/INFO: an arc attribute table, a route attribute table, and a section table. Tables 3-5 show examples of the three data files. These three files were related through the key items of idroute#, highway#, routeline#, and arclink#.

Table 3. A route coverage's arc attribute table

Record	FNODE#	TNODE#	LPOLY#	RPOLY#	LENGTH	ITDROUTE#	ITDROUTE-ID
1	0	0	0	0	0.874	1	1010
2	0	0	0	0	0.856	2	1010
3	0	0	0	0	0.911	3	1010
4	0	0	0	0	0.927	4	1010
5	0	0	0	0	0.914	5	1010
6	0	0	0	0	0.429	6	1010
7	0	0	0	0	0.181	7	1020
8	0	0	0	0	0.007	8	1021
9	0	0	0	0	0.054	9	1030
10	0	0	0	0	0.005	10	1040
11	0	0	0	0	0.024	11	1050

Table 4. A route coverage's route attribute table

Record	HIGHWAY#	HIGHWAY-ID
1	1	1010
2	2	1020
3	3	1021
4	4	1030
5	5	1040
6	6	1050
7	7	1260
8	8	1270
9	9	1270
10	10	1330
11	11	1340

Table 5. A route coverage's section table

ROUTELINK#	=	1
ARCLINK#	=	1
F-MEAS	=	0.000
T-MEAS	=	0.100
F-POS	=	0.000
T-POS	=	0.167
HIGHWAY#	=	1
HIGHWAY-ID	=	1
2		
ROUTELINK#	=	1
ARCLINK#	=	1
F-MEAS	=	0.100
T-MEAS	=	0.200
F-POS	=	0.167
T-POS	=	0.335
HIGHWAY#	=	2
HIGHWAY-ID	=	2

An event table such as the example in Table 6 may be maintained separately from the above route coverage in ARC/INFO or any other database management system. An event table can therefore be updated without affecting the route coverage. On the other hand, the event data can be displayed and queried by relating the event table to the route coverage.

Table 6. An event table

1		
HIGHWAY-ID	=	1010
BEGINNING_MP	=	0.000
ENDING_MP	=	5.968
FUNC_CLASS	=	1
SPDLMT	=	65
CAPACITY	=	4147
AADT	=	13000
2		
HIGHWAY-ID	=	1010
BEGINNING_MP	=	5.968
ENDING_MP	=	12.610
FUNC_CLASS	=	1
SPDLMT	=	65
CAPACITY	=	4021
AADT	=	13000

An event coverage is produced from a route coverage and an event table, i.e., by associating segment attributes with the graphic file. Table 7 shows an arc attribute table and Table 8, a node attribute table from the event coverage created. These two tables were later prepared to produce the input data files for TranPlan.

Table 7. An event coverage's arc attribute table

1		
FNODE#	=	3
TNODE#	=	1
LPOLY#	=	0
RPOLY#	=	0
LENGTH	=	7043.440
EVENTCOVPCC#	=	1
EVENTCOVPCC-ID	=	4203
HIGHWAY-ID	=	1580
BEGINNING_MP	=	6.325
ENDING_MP	=	11.185
FUNC_CLASS	=	6
SPDLMT	=	55
CAPACITY	=	2018
AADT	=	654
2		
FNODE#	=	4
TNODE#	=	2
LPOLY#	=	0
RPOLY#	=	0
LENGTH	=	5701.169
EVENTCOVPCC#	=	2
EVENTCOVPCC-ID	=	4185
HIGHWAY-ID	=	1540
BEGINNING_MP	=	534.720
ENDING_MP	=	538.560
FUNC_CLASS	=	2
SPDLMT	=	55
CAPACITY	=	1634
AADT	=	1297

Table 8. An event coverage's node attribute table

Record	ARC#	EVENTCOVPCC#	EVENTCOVPCC-ID	XCOORD*	YCOORD*
1	1	1	1	***********	***********
2	2	2	2	***********	***********
3	1	3	3	***********	***********
4	2	4	4	***********	***********
5	3	5	5	***********	***********
6	4	6	6	***********	***********
7	6	7	7	***********	***********
8	7	8	8	***********	***********
9	8	9	9	***********	***********
10	9	10	10	***********	***********
11	10	11	11	***********	***********

*The X Y coordinates cannot be shown but are available.

One manipulation required by TranPlan is to add dummy links from the centroids of internal and external traffic analysis zones to the highway network in event coverage. This can be done in ARC/INFO in three steps: create point coverage with the centroids, use the NEAR command to find the nearest nodes in the network to the centroids, and add dummy links by connecting the centroids to their nearest nodes.

After the event coverage was prepared, the coordinates of the start and end points of each arc and attribute data as the ASCII files were downloaded (Tables 9 and 10).

Table 9. An ASCII file unloaded from an event coverage's arc attribute table

FNODE	TNODE	LENGTH	SPDLIMIT	CAPACITY
3	1	7043.440	55	2018
4	2	5701.169	55	1634
5	4	11541.871	55	2018
6	5	5135.527	55	1599
6	3	7575.537	55	2018
7	6	2106.501	55	1599
8	7	6049.569	55	1975
9	8	5590.046	55	2018
10	9	5466.343	55	2018
10	11	3687.956	55	2571
11	12	6196.793	55	2105

Table 10. An ASCII file unloaded from an event coverage's node attribute table

NODE ID	X-COOR	Y-COOR
1	-30326.148	817846.750
2	-7052.831	817227.188
3	-24969.965	814499.688
4	-7034.805	811602.250
5	-17429.434	810861.313
6	-21548.414	807794.125
7	-20437.494	806004.375
8	-18979.611	800278.875
9	-17451.521	795088.813
10	-15767.140	789929.938
11	-12917.243	787589.188

Finally, the ASCII files were re-formatted in C++ programs to meet the requirements of TranPlan. Table 11 shows a portion of the node file with the ID and the X, Y coordinates of each node in the TranPlan format. Table 12 shows 11 records of a link file in the TranPlan format.

Table 11. A node file in the TranPlan format

```
Columns    123456789012345678901234567890123456789012345678901234567890

           N    1      -30326      817846
           N    2       -7052      817227
           N    3      -24969      814499
           N    4       -7034      811602
           N    5      -17429      810861
           N    6      -21548      807794
           N    7      -20437      806004
           N    8      -18979      800278
           N    9      -17451      795088
           N   10      -15767      789929
           N   11      -12917      787589
```

Record Columns	Field Name
1	Record Identifier N
2-6	Node number
7-8	Not used
9-17	X-coordinate
18-19	Not used
20-28	Y-coordinate

Table 12. A link file in the TranPlan format

```
columns    123456789012345678901234567890123456789012345678901234567890

           3    1  440S5500                  2018        2
           4    2  356S5500                  1634        2
           5    4  721S5500                  2018        2
           6    5  320S5500                  1599        2
           6    3  473S5500                  2018        2
           7    6  131S5500                  1599        2
           8    7  378S5500                  1975        2
           9    8  349S5500                  2018        2
          10    9  341S5500                  2018        2
          10   11  230S5500                  2571        2
```

Appendix D. Example of Statewide Traffic Demand Modeling Using TranPlan

TranPlan follows the standard four-step process in traffic demand modeling. It is a PC-based software package, and the user can execute the package through a menu-driven interface or a batch file. TranPlan is not particularly user friendly. This is why it was decided to run TranPlan with preliminary data collected, a task that was not specified in our proposal. The following explains the execution of TranPlan in sequential steps.

Step 1 - Generate a statewide highway network
The TranPlan function, BUILD HIGHWAY NETWORK, allows the user to either generate a new highway network or update an existing network. The function requires two input files: *node.txt,* with the X, Y coordinates of each node; and *link.txt,* with the attributes of each link such as speed limits, capacity, and ground traffic counts. The output file can be displayed and queried in the HNIS (Highway Network Editor) module. The two input files were prepared from the ITD highway centerline database (Appendix C). The output was called *highnet.dat,* which consisted of the highway network description, and nodes, links, and attributes in TRANPLAN format.

Step 2 - Skim the minimum impedance paths to produce interzonal impedance matrix
The TranPlan function, HIGHWAY SELECTED SUMMATION, can skim the minimum impedance paths, either totally or selectively, to produce interzonal impedance matrices. The *highnet.dat* from Step 1 was used as the input, and the output was called *hwyskim.tem,* which contained one merged skim table based on the time factor. Table 1 shows the skim table for zone 1.

Step 3 - Calculate the intrazonal impedance
The TranPlan function, BUILD INTRAZONAL IMPEDANCE, allows the user to generate the intrazonal impedance values for any skim table based on the nearest zones. TranPlan calculates the intrazonal impedance as one-half the average impedance to the adjacent zones. *hwyskim.tem* from Step 2 was used as the input and called *hwycalc.skm* as the output file (Table 2).

Step 4 - Replace interzonal and intrazonal impedance of external stations as 0
The MATRIX UPDATE function was used to replace the interzonal and intrazonal impedance values of external stations as 0. The input file was *hwycalc.skm* from Step 3 and the output file was named *hwyskim.dat.* Table 3 shows the skim table for zone 1 and external station 45. Notice that the interzonal and intrazonal impedance values of external station 45 are set at 0.

Step 5 - Distribute trips
The Gravity Model is the most widely used technique for trip distributions. To draw an analogy to Newton's Law of Gravity, trip productions and attractions equate the masses and the travel time factor function equates the inverse distance function. The GRAVITY MODEL function in TranPlan requires the input of trip productions and attractions stratified by class of trip purposes, travel impedance factors, and zone-to-zone travel indices. The function checks the acceptability of computed attractions, and if necessary, adjusts the calculated attractions to each zone to equal the

input attractions. The following files: *hwyskim.dat* from Step 4, a trip end production and attraction file *tr97.txt*, and a friction factor file *ndff.prn* as were used as the input data. Tables 4 and 5 show parts of *tr97.txt* and *ndff.prn*. Appendix E provides a detailed account of the procedure for deriving *tr97.txt*.

The output from the GRAVITY MODEL function was called *hwygra.dat*, which included tables of zone-to-zone distributed trips for each trip purpose. Table 6 shows trip tables between zone 1 and zone 45 for trip purpose 1.

Step 6 - Balance trip tables
The MATRIX TRANSPOSE function was used to generate an origin-destination matrix from the production-attraction matrix, *hwygra.dat*. The output named *totltabl.dat* was the sum of *hwygra.dat* and its transposed matrix, divided by 2. Table 7 shows a portion of totltabl.dat.

Step 7 - Convert person trips to vehicle trips
The MATRIX UPDATE function was used to convert person trips into vehicle trips. The input was *totltabl.dat* from Step 6. Table 8 shows part of the output named *hwyveh.dat*.

Table 1. Interzonal impedance table for zone 1

ORIGIN ZONE 1 SKIM VALUE TIME 1

TO ZONE	-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-0-
1	**0.00**	90.11	172.87	160.07	183.21	218.54	355.95	260.72	296.94	788.99
11	418.16	472.07	704.24	463.91	860.62	821.09	512.60	624.82	736.78	510.91
21	611.10	797.90	864.15	679.13	826.28	535.81	656.69	557.10	663.12	848.70
31	773.79	641.41	693.66	661.49	736.16	806.88	774.69	682.97	652.63	713.13
41	855.32	826.21	842.05	386.11	40.95	46.11	149.92	48.46	106.90	131.11
51	136.18	179.15	176.70	204.69	410.38	251.35	480.23	827.90	850.71	830.35
61	899.12	896.42	519.82	546.77	574.36	671.20	702.57	740.87	817.86	832.58
71	871.55	862.05	859.73	865.15	907.17	871.29				

Table 2. Intrazonal and Interzonal Impedance Table for Internal Zone 1 and External Zone 45

ORIGIN ZONE 1 SKIM VALUE TIME 1

TO ZONE	-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-0-
1	**21.77**	90.11	172.87	160.07	183.21	218.54	355.95	260.72	296.94	788.99
11	418.16	472.07	704.24	463.91	860.62	821.09	512.60	624.82	736.78	510.91
21	611.10	797.90	864.15	679.13	826.28	535.81	656.69	557.10	663.12	848.70
31	773.79	641.41	693.66	661.49	736.16	806.88	774.69	682.97	652.63	713.13
41	855.32	826.21	842.05	386.11	40.95	46.11	149.92	48.46	106.90	131.
51	136.18	179.15	176.70	204.69	410.38	251.35	480.23	827.90	850.71	830.35
61	899.12	896.42	519.82	546.77	574.36	671.20	702.57	740.87	817.86	832.58
71	871.55	862.05	859.73	865.15	907.17	871.29				

ORIGIN ZONE 45 SKIM VALUE TIME 1

TO ZONE	-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-0-
1	40.95	84.54	167.30	154.50	177.64	212.97	350.38	255.15	291.37	783.42
11	412.59	466.50	698.67	458.34	855.05	815.52	507.03	619.25	731.21	505.34
21	605.53	792.33	858.58	673.56	820.71	530.24	651.12	551.53	657.55	843.13
31	768.22	635.84	688.09	655.92	730.59	801.31	769.12	677.40	647.06	707.56
41	849.75	820.64	836.48	380.54	17.60	29.44	144.35	42.89	101.33	125.54
51	130.61	173.58	171.13	199.12	404.81	245.78	474.66	822.33	845.14	824.78
61	893.55	890.85	514.25	541.20	568.79	665.63	697.00	735.30	812.29	827.01
71	865.98	856.48	854.16	859.58	901.60	865.72				

Table 3. Skim Table for Zone 1 and Zone 45 after Update

ORIGIN ZONE 1 SKIM VALUE TIME 1

TO ZONE	-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-0-
1	21.77	90.11	172.87	160.07	183.21	218.54	355.95	260.72	296.94	788.99
11	418.16	472.07	704.24	463.91	860.62	821.09	512.60	624.82	736.78	510.91
21	611.10	797.90	864.15	679.13	826.28	535.81	656.69	557.10	663.12	848.70
31	773.79	641.41	693.66	661.49	736.16	806.88	774.69	682.97	652.63	713.13
41	855.32	826.21	842.05	386.11	40.95	46.11	149.92	48.46	106.90	131.11
51	136.18	179.15	176.70	204.69	410.38	251.35	480.23	827.90	850.71	830.35
61	899.12	896.42	519.82	546.77	574.36	671.20	702.57	740.87	817.86	832.58
71	871.55	862.05	859.73	865.15	907.17	871.29				

ORIGIN ZONE **45** SKIM VALUE TIME 1

TO ZONE	-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-0
1	40.95	84.54	167.30	154.50	177.64	212.97	350.38	255.15	291.37	783.42
11	412.59	466.50	698.67	458.34	855.05	815.52	507.03	619.25	731.21	505.34
21	605.53	792.33	858.58	673.56	820.71	530.24	651.12	551.53	657.55	843.13
31	768.22	635.84	688.09	655.92	730.59	801.31	769.12	677.40	647.06	707.56
41	849.75	820.64	836.48	380.54	0.00	0.00	0.00	0.00	0.00	0.00
51	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
61	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
71	0.00	0.00	0.00	0.00	0.00	0.00				

Table 4. The First 10 Records of tr97.txt file

GP	1	1	209651	130286	69478	331681	215145
GP	2	1	3400	2112	1195	5436	2751
GP	3	1	64492	39656	21951	102376	60231
GP	4	1	5748	3457	2218	9318	4460
GP	5	1	8155	5037	2878	13071	6561
GP	6	1	34278	20506	12590	54147	31188
GP	7	1	14708	9213	4951	23563	15880
GP	8	1	3800	2330	1400	6103	3076
GP	9	1	27863	17366	9687	44675	22348
GP	10	1	68770	41933	22667	107033	65978

Table 5. The First 10 Records in file ndff.prn

GF	1	1	0	0	0	0	0	0
GF	2	1	13000	1500	9	600	180	123
GF	3	1	12390	2000	12	700	250	138
GF	4	1	10720	3200	15	750	400	156
GF	5	1	8500	4200	18	800	650	178
GF	6	1	7000	6000	22	850	1000	204
GF	7	1	4500	10000	28	1000	1500	237
GF	8	1	2300	11000	35	1200	2300	278
GF	9	1	1730	12000	40	1500	3000	331
GF	10	1	1520	13000	49	1900	4000	400

Table 6. Trip Tables for Zone 1 and Zone 45 in Purpose 1

ORIGIN ZONE 1 PURPOSE 1 209651 TOTAL ORIG/PROD

TO ZONE	-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-0-
1	207598	6	0	0	0	0	0	0	0	0
41	0	0	0	0	289	575	0	487	17	176
51	503	0	0	0	0	0	0	0	0	0

ORIGIN ZONE 45 PURPOSE 1 323 TOTAL ORIG/PROD

TO ZONE	-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-0-
1	323	0	0	0	0	0	0	0	0	0

Table 7. Trip table for zone 1 purpose 1

ORIGIN ZONE 1 PURPOSE 1 212540 TOTAL ORIG/PROD

TO ZONE	-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-0-
1	207598	62	0	0	0	0	0	0	0	0
41	0	0	0	0	306	609	0	516	133	828
51	2488	0	0	0	0	0	0	0	0	0

Table 8. Vehicle trip table for zone 1 purpose 1

ORIGIN ZONE 1 PURPOSE 1 183475 TOTAL ORIG/PROD

TO ZONE	-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-0
1	180610	54	0	0	0	0	0	0	0	0
41	0	0	0	0	176	351	0	297	77	477
51	1433	0	0	0	0	0	0	0	0	0

Step 8 - Combine all purpose trip tables into final total trip table

The MATRIX MANIPULATE function was used to combine five trip tables, each for a different trip purpose, into one total trip table. The input was *hwyveh.dat* from Step 7. Table 9 shows a portion of the output named *finaltt.dat*.

Step 9 - Assign vehicle trips to the network

The TranPlan function, LOAD HIGHWAY NETWORK, assigns vehicle trips to the network. The default method of assignment is all-or-nothing. Using this methodology, all selected intrazonal highway trips are loaded on the minimum paths (based on travel time) of the input highway network. The *highnet.dat* and *finaltt.dat* are used as the input. The output named *loadnet.dat* was the same as the input highway network file, but with the addition of assigned link volume and adjusted impedance data.

The loaded highway network can be displayed and queried using the Highway Network Editor (HNIS) in TranPlan. The functions of REPORT HIGHWAY NETWORK and REPORT HIGHWAY LOAD create detailed text reports about the highway network. Table 10 shows a portion of the report.

TranPlan has a utility program called NETCARD, which can be used to convert a highway network or loaded highway network file from the TranPlan internal format to the "card-image" (Table 11). The card-image has the same format as that of the initial input files, *node.txt* and *link.txt*. Therefore, the output from TranPlan can be processed and converted to an ARC/INFO coverage after being reformated.

Table 9. Final Total Trip Table for Zone 1

ORIGIN ZONE 1 PURPOSE 1 657253 TOTAL ORIG/PROD

TO ZONE	-1-	-2-	-3-	-4-	-5-	-6-	-7-	-8-	-9-	-0-
1	645443	78	0	0	0	0	0	0	0	0
41	0	0	0	0	754	1453	0	1217	422	1446
51	6440	0	0	0	0	0	0	0	0	0

Table 10. A report of the loaded highway network

ANODE	BNODE	Y	DIST	TIME1	SPEED1	TIME2	SPEED2	COST	USER	L1 L2 L3	R	G	PNODE	CAPAC1	CAPAC2
76	918		1.75	3.50	30.00	.00	.00	.00	.00					2000	0
80	45		1.09	2.18	30.00	.00	.00	.00	.00					2000	0
	82		4.40	4.80	55.00	.00	.00	.00	.00					2018	654
81	46		1.03	2.06	30.00	.00	.00	.00	.00					2000	0
83	3.56		3.88	55.05	.00	.00	.00	.00					1634	1297	
82	80		4.40	4.80	55.00	.00	.00	.00	.00					2018	654
	85		4.73	5.16	55.00	.00	.00	.00	.00					2018	823

Table 11. A card-image of the loaded highway network

```
N    1      -37386      797479
 N    2       -31243      725659
 N    3        15200      652406
 N    4       -44924      656936
 N    5       -52523      622047
 N    6       -52163      582871
 N    7        36487      545745
 N    8       -66842      529808
 N    9       -31003      509774
 N   10       147598      383110
 .
 .
 .
 76   9180 175S3000    0 1 0 0 0      0   31981
 80    450 109S3000    0 1 0 0 0      0    7681
 80    820 440S5500    0 1 0 0 0    654    7691
 81    460 103S3000    0 1 0 0 0      0   15021
 81    830 356S5505    0 1 0 0 0   1297   15021
 82    800 440S5500    0 1 0 0 0    654    7681
 82    850 473S5500    0 1 0 0 0    823    7691
 83    810 356S5505    0 1 0 0 0   1297   15021
 83  840 721S5497  0 1 0 0 0  1231  15021
 84  830 721S5497  0 1 0 0 0  1231  15021
 84  850 320S5501  0 1 0 0 0  1519  15021
 85  820 473S5500  0 1 0 0 0  823  7681
 85  840 320S5501  0 1 0 0 0  1519  15021
 85  860 131S5497  0 1 0 0 0  1519  22711
 .
 .
```

Appendix E. Procedure for Trip Generation

In the example, each county in Idaho was chosen as a separate traffic analysis zone (TAZ). First, five trip purposes were defined: home-based work (HBW), home-based shopping (HBSH), home-based school (HBSC), home-based other (HBO), and nonhome-based (NHB). However, no detailed data about truck trips were available for this preliminary model.

The next step was to develop the trip generation method by trip purpose. The two most common methods are cross-classification and multiple regression. The cross-classification approach to trip generation usually stratifies households by size (number of members) and some measure of mobility such as autos available for use by household members. The regression technique is typically based on household survey data, and relates work trips produced by households to one or more independent variables such as member of households, population, autos available, and income.

In this study, the cross-classification method was selected for establishing trip production rates for HBW, HBSH, HBSC, and HBO. For NHB trip productions, the linear regression technique was used that equates travel to employment and household characteristics. The linear regression technique was also used to estimate trip attractions for all purposes.

The trip rates and the linear regression equations were borrowed from the Vermont statewide transportation model. The Vermont study used a household survey to derive the relationships between household characteristics and travel by members of the household. These person-trip relationships were then categorized by trip purpose over a 24-hour period.

Internal zonal trip productions and attractions

1. Home-based productions

The following statistics were downloaded from the 1990 Census CD-ROM by county: total employment, retail employment, school employment, household, household with vehicle 0, 1, 2, 3+, and household with person 1, 2, 3, 4, 5, 6, 7+ . Because the trip rates from the Vermont study were only available for the household with person 1, 2, 3, 4+, the number of households with person 4, 5, 6, 7+ were added together to make a category 4+. Table II.1 shows the household data for Ada county.

Table II.1 Household data by size and autos for Ada County

Person/HH	Autos / HH				
	0	1	2	3+	
1					18218
2					26682
3					12972
4+					19630
	3060	22739	33514	18158	

To use the cross-classification method, the cell values in Table II.1 had to be estimated to produce a matrix. The estimation equation was as follows:

$$\text{Cell}_{ij} = (\text{sum of } i \times \text{sum of } j) \;/\; \text{total}$$

where, total is the average of the row sums and column sums

Table II.2 shows the completed household matrix for Ada County. Table II.3 shows the trip rate matrix borrowed from the Vermont study.

Table II.2. The household matrix for Ada County

	Autos/HH			
Persons/HH	0	1	2	3+
1	719	1053	512	775
2	5346	7830	3806	5760
3	7879	11540	5610	8490
4+	4269	6252	3039	4600

Table II.3. The trip rate matrix based on household data

	Autos/HH			
Persons/HH	0	1	2	3+
1	0.8	1.0	1.0	1.0
2	1.0	1.4	1.8	2.0
3	2.0	2.1	2.5	3.1
4	2.1	2.3	2.8	3.9

Then the home-based work trip production was derived for each TAZ by multiplying the household matrix by the trip rate matrix and summing the products in the matrix. The home-based work trip production for Ada County, for example, was 167,721.

The same procedure was followed to generate trip productions for home-based shopping, home-based school, and home-based other for each county.

2. Nonhome-based productions

The linear regression equation for nonhome-based trip production was:

1.1428 Retail Employment + 1.4846 Non-Retail Employment + 0.2969 HH

3. Trip attractions

The trip attractions were derived from the following linear regression equations:

HBW Attractions	= 1.8361 Total Employment
HBO Attractions	= 1.1788 Total Employment + 2.1432 HH
HB School Attractions	= 7.1350 School Employment
HB Shop Attractions	= 6.1147 Retail Employment
NHB Attractions	= NHB Productions

External trip generation

It is assumed that the trip productions and attractions of external stations had the same characteristics as those of internal trip productions and attractions. First, the proportion of the internal productions and attractions by trip purpose were calculated. The proportions were: HBW 0.23, HBSH 0.14, HBSC 0.08, HBOT 0.36, NHB 0.19. Then, the traffic counts on the links of external entries were multiplied by the above proportions. Finally, the auto trips were multiplied by 1.7356 to convert them to person trips.