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GENERAL PLANNING CONSULTANT:

TECHNICAL MEMORANDUM 86.1.4

PATRONAGE FORECASTING PROCEDURES

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Prepared for:

Southern California Rapid Transit District

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TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

PAGE

TABLE OF CONTENTS (CONTINUED)

LIST OF TABLES

LIST OF TABLES (CONTINUED)

LIST OF FIGURES

1. INTRODUCTION

1.1 BACKGROUND

Because reliable and detailed patronage forecasts are essential to transit system planning and evaluation, SCRTD has undertaken an extensive program of development and refinement related to improved forecasting procedures. Although the SCRTD patronage forecasting is carried out within the framework of the overall regional travel forecasting process, SCRTD and its consultants have extended the process to meet the specialized needs of SCRTD. The major thrust of this development and refinement work was initiated under the Transportation Planning and Modeling Services contract conducted during FY1982 and FY1983. Additional refinement work has continued over FY1984 and FY1985.

The primary purpose of the Transportation Planning and Modeling Services contract was to implement new mode choice models developed for the Southern California Association of Governments (SCAG) and to develop related transit networks for the simulation of future transit system alternatives. More recent efforts have focused on details of transit system supply representation and system access coding in the simulation networks, as well as automation of network coding procedures to increase efficiency and improve reliability. Together these efforts have included:

- Development of a finer-grained analysis zone system in the vicinity of potential rail lines;
- Development of a new base network to represent 1982 transit service;
- Analysis of person-trip tables provided by SCAG, and recommendations for any modifications that should be made;
- Updating the mode choice models to reflect new path-building criteria and network-coding practices;
- Critical review of the mode choice model performance and its exogenous trip-end variable inputs;
- Construction of new networks for rail alternative background bus systems and the null bus network;
- Construction of new networks for the Wilshire Starter Line and related Operable Segments;
- Implementation of a mode-of-arrival model for rail planning to provide necessary station boarding data;
- Implementation of an improved fare matrix calculation program;

- Implementation and refinement of a transit route analysis program to assist in the design of future bus systems;

- Development of an automated evaluation program to produce desired effectiveness measures directly from model output files.

1.1.1 General Description

Patronage forecasts produced by SCRTD are prepared within the context of the overall regional forecasting process conducted by SCAG with the cooperation of CALTRANS. This process is depicted in Figure 1-1. (17)* The shaded area shown in Figure 1-1 is the part of the process which SCRTD conducts for its needs as an extension of the SCAG process. Even though the starting point for the SCRTD forecasts is the person-trip forecasts produced by SCAG, the preceeding steps in the process have not been accepted as a "black box." With full cooperation and support from SCAG, SCRTD and its consultants have been instrumental in the review, evaluation, and improvement of all stages of the regional travel-forecasting process. The part of the model chain employed by SCRTD for transit patronage forecasting has at its center a set of mode choice models which deal explicitly with multimodal choices through a nested logit structure of conditional probability relationships. The models predict the shares related to the primary Auto and Transit modes and, simultaneously, the shares for important Auto and Transit submodes based on detailed level-of-service and cost characteristics of each submode. This structure ensures that the primary mode split directly reflects the properties of the available submodes and that trips by each submode are an integral output of the model. The SCRTD process embodies a high degree of automation in the building and checking of transit system simulation networks, as well as graphical checks through computerized network plotting. The process ensures consistency and objectivity in the coded networks and minimizes coding errors.

The SCRTD process goes well beyond network coding and mode choice model application as indicated in Figure 1-2. While the process maintains compatibility with standard UTPS programs, it encompasses several custom-built programs. Transit network development is based on the UTPS program UNET, but is augmented by the custom programs UCHEK, UMATCH, and BLDCON, as described in Chapter 4. Networks are developed for the AM Peak and Midday periods. Using the standard UTPS program UPATH, paths are built for the following mode-time period combinations:

- AM Walk

- AM Park-n-Ride (PNR)

* For this and subsequent references, see LIST OF REFERENCES at the conclusion of this report.

SCRTD FORECASTING CONTEXT

REGIONAL TRANSPORTATION MODELING PROCESS-PLANNING CONTEXT

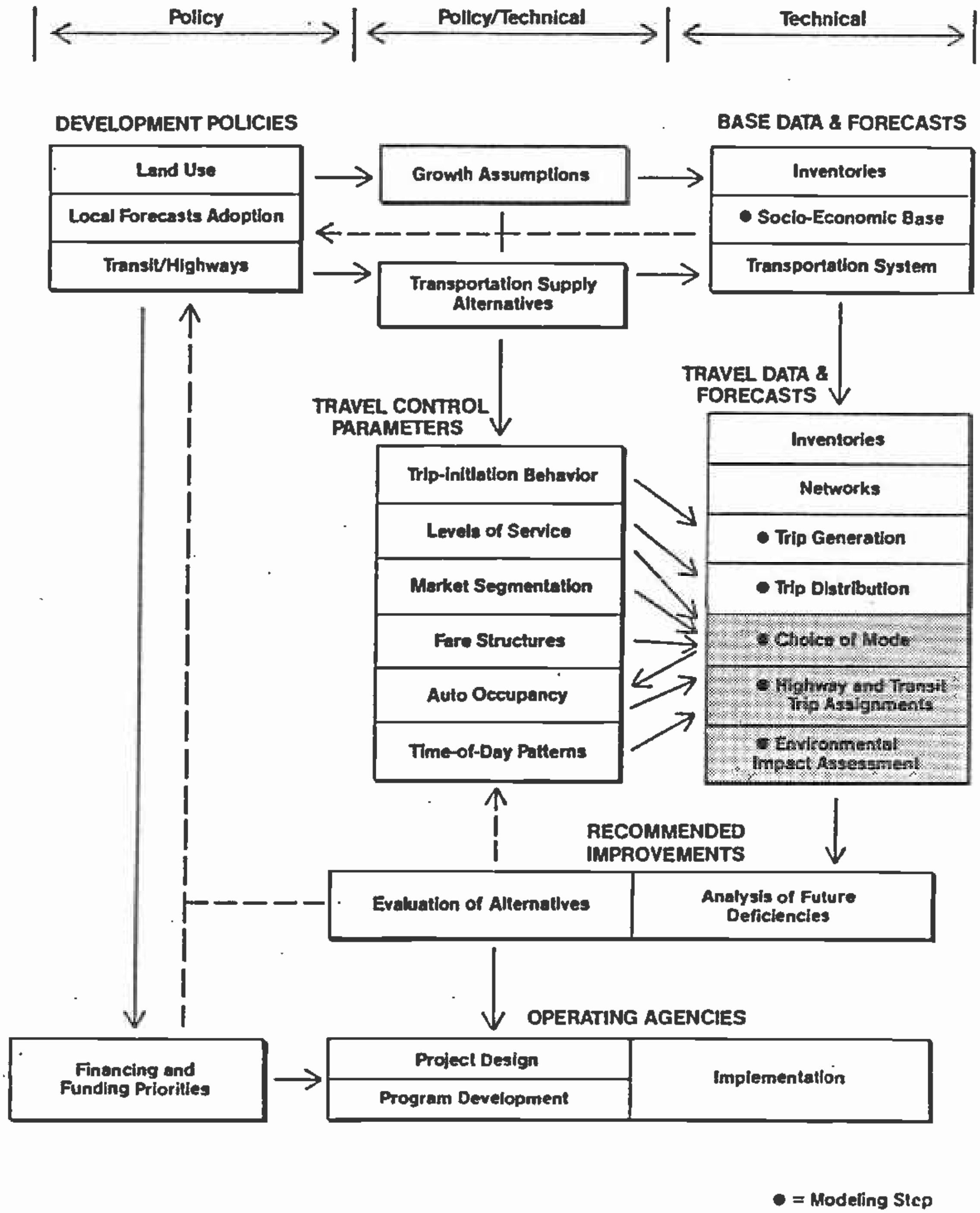


Figure 1-1

SCRTD PATRONAGE FORECASTING PROCESS

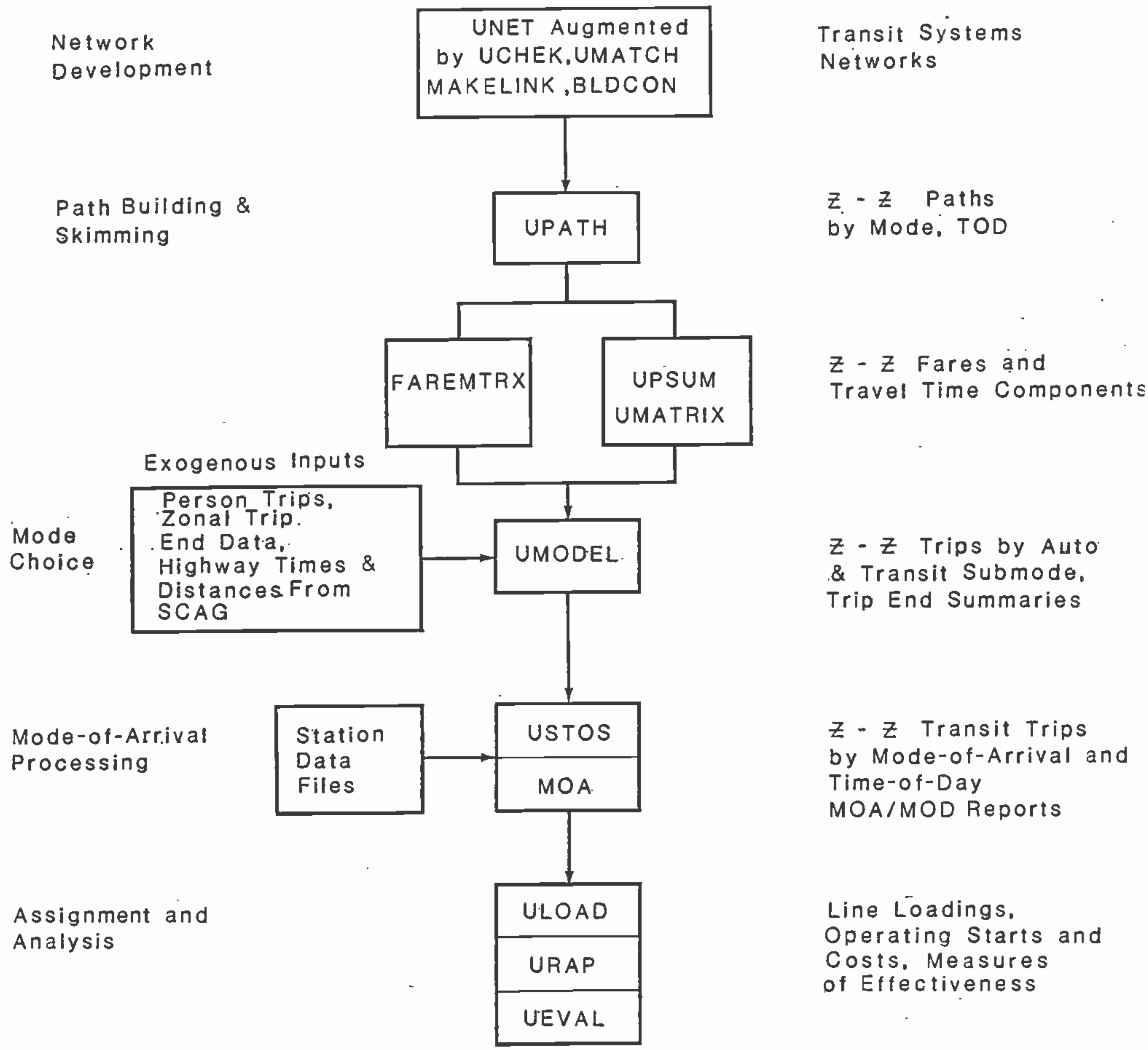


Figure 1-2

- AM Kiss-n-Ride (KNR)
- Midday Walk

The fare matrix related to each set of paths is created by the custom program FAREMTRX, while matrices of z-z transit travel time components related to each set of paths are created using the standard UTPS programs UPSUM and UMATRIX. Mode-choice models for work and nonwork trip purposes are implemented within the framework provided by the UTPS program UMODEL. It is at this stage that the SCRTD process interfaces with the SCAG process. Mode-of-arrival processing is accomplished through a combination of the standard UTPS program USTOS and a custom MOA program. This is a highly complex process, and great care must be taken in the preparation of MOA inputs. Assignment and analysis encompasses three programs -- the standard UTPS program ULOAD (actually ULOAD, SORT, & UPRAS)) and two custom programs: URAP and UEVAL.

1.1.2 Model Chain Improvements

Major improvements have been made to four areas of the modeling process:

- Person Trip Forecasts
- Transit Network Construction
- Mode Choice Model Calibration/Validation
- Analysis and Evaluation

1.1.2.1 Person-Trip Forecasts

Improvement of the person-trip forecasts took the form of a change in methodology from an unconstrained to a constrained trip distribution process for home-based work trips. This change resulted in substantially better estimates of CBD-oriented work trips in comparison to observed CBD cordon-crossing volumes. Initially this improvement was adopted only for the SCRTD forecasts. Also, for a time, several errors and inconsistencies crept into the process. These related to the formation of zone-to-zone travel time matrices (skim trees) and the order in which trip ends by purpose were input to the model relative to their corresponding deterrence factors (F-factors). The SCRTD staff has since corrected these problems and clearly documented the correct process to ensure that such problems do not recur. (3) (7)

The travel demand forecasting process is very often subject to problems of this nature -- across all urban areas and regions. Such problems may be attributable to changes in personnel, differences in individual philosophy, lack of documentation, or simply human error and oversight. The potential for such problems increases with the size and complexity of the urban area being modeled. Much of the effort directed towards model review and improvement by SCRTD staff and its consultants has been related to improving consistency and accuracy as opposed to fundamental changes in methodology -- not because errors were known to exist but because the potential for error is so great. Transit network construction is a prime example of this.

1.1.2.2 Transit Network Construction

A tremendous amount of effort has gone into improved network development procedures. These have been directed to improved consistency, accuracy, and efficiency with no change in network design concepts. The design concepts being pursued are those established by CSI in their Model Improvement Study for SCAG in 1981/82. (1) (13) Transit networks of the nature required for an area such as the SCAG region are extremely complex. With over 1,600 zones, 500 transit lines, 7,000 nodes, and 14,000 links, the SCRTD networks are among the most complex ever developed for travel forecasting purposes. Manual procedures for networks of this scale are highly inefficient, unobjective, and error-prone. Thus, a high priority was given to automating the process to the maximum extent practical. Subsequently, efforts focused on achieving greater consistency with the network-coding practices used for mode choice model derivation, essential to correct model application. While seemingly straightforward, this entailed considerable analysis and experimentation, since the translation of network design concepts into detailed network coding practices involves significant latitude. (15) (13) Network coding procedures and practices are discussed at length later in this document.

1.1.2.3 Mode Choice Model Calibration/Validation

Mode choice model calibration/validation efforts have been a direct consequence of modifications elsewhere in the model chain. If a significant change is made in one part of the model, its impact on other parts of the process must be carefully reviewed. For example, when the methodology for person-trip distribution was modified, it was necessary to analyze its impact on the performance of the mode choice model. The new person-trip distribution resulted in substantially different estimates of transit trips by the mode choice model. It was found that the new person-trip distribution eliminated the need for a CBD/Non-CBD bias coefficient introduced in the original model validation to correct for an underestimate of transit trips to the CBD. (5) Elimination of bias or correction factors such as this results in a more robust predictive model. Recalibration/validation of the mode choice models to account for this and other modifications is covered in detail later in this document.

1.1.2.4 Analysis and Evaluation

Analysis and evaluation have been enhanced considerably in the SCRTD process through the MDA program which produces detailed rail station data; by the Transit Route Analysis program (URAP) which produces a detailed analysis for each bus route; and by the program UEVAL which produces effectiveness measures, specified by UMTA, directly from output files created in preceding model steps. Each of these programs is described in detail later in this document.

In addition to the improvements outlined above, this document includes a description of important analyses made in relation to the model chain and its various inputs. These analyses did not always lead to modifications in the process. However, such analyses broaden our knowledge of the model chain performance, help document implicit assumptions and the translation of model concepts into actual practice, and provide a framework for the continuing critical review of model forecasts.

1.2 PURPOSE AND ORGANIZATION

This document describes the current status of the SCRTD patronage forecasting process and presents related analyses. It follows very closely in format, and updates, the final report produced by the Transportation Planning and Modeling Services contract. Following this introductory chapter, there are six chapters as outlined below.

Chapter 2 of the report outlines the purposes of the modification to the zone system, the procedures used to subdivide zones, and the networks defined and built for the project. In describing the networks developed, information is provided on the sources of the network descriptions developed.

Chapter 3 describes the exogenous inputs to the travel simulation. These inputs include the trip tables for 1980 and 2000, trip-end data for both mode choice and mode of arrival, the highway network data, and other input data. An extensive analysis of the trip-end data was undertaken. Results of this analysis are provided in this chapter.

In chapter 4, the procedures for building and cleaning the networks are described in some detail. The primary purposes of this chapter are to show what has been checked and corrected in building the networks, and also to provide a tutorial for subsequent efforts to replicate the same standards of transit network construction. The types of errors detected are described, and the effects of these errors on the results of the simulation are demonstrated in certain relevant cases.

Chapter 5 describes the mode choice models that were applied. These consisted of the models developed for SCAG during 1981 and 1982, together with a model for non-home-based trips provided by this consultant team. The models required updating, and the reasons for this updating, the procedures used, and the results of the updating are described. The method of applying the mode choice models is described, together with a description of the procedures used for building transit paths through the networks. The basis for the selected path-building parameters is also discussed.

Chapter 6 describes the mode-of-arrival model, which estimates the proportions of people arriving by station by the alternative access modes of walk, bus, Kiss-n-Ride, and Park-n-Ride. The model also permits changes to be made in modes of arrival because of the limiting capacity of parking at a station. The modifications made to the model consequent upon the adoption of the new mode choice models are described, and some new facilities added to the model are also noted. The procedure for applying the model is detailed, and the outputs are discussed.

Finally, chapter 7 describes the procedures for assigning transit trips to the transit networks and for analyzing the implications of these loadings. A procedure called URAP is used to provide more detailed reports about the functioning of the transit system, and this procedure is described in detail. Results from alternative model runs are summarized in this chapter, and analysis of the patronage results is included.

2. NETWORK AND ZONING SYSTEMS

2.1 ZONING

The existing Los Angeles Regional Transportation Study (LARTS) zone system consists of 1,325 zones covering all of Los Angeles County and the contiguous metropolitan areas in Ventura, San Bernardino, Riverside, and Orange Counties. In the 1,325-zone system, zones 1-30 represent external-cordon stations, 31-40 are unused, and 41-1,325 represent the 1,285 internal zones. In 1980 this area contained a population of approximately 11.2 million people, and is scheduled to grow by the year 2000 to approximately 14.9 million. A number of the zones are empty of population, or almost empty, because of the various areas of mountains and other undeveloped land that penetrate the metropolitan area or define islands within it. Without excluding any of these, the existing zone system averages to approximately 8,715 people per zone.

In 1980 it was estimated that approximately 38 million person trips were made each day by residents of the area, and these trips average to 26,460 trips per day per zone. Current transportation planning practice recommends restricting zones to a maximum of 20,000 trip ends. Clearly, the 1,325-zone system is likely to violate this guideline in at least half of the zones. Unfortunately, the enormous computing time and associated costs do not allow this guideline to be met reasonably in the Los Angeles region.

The 1,325-zone system already generates trip matrices that contain approximately 1.76 million cells, which represent an enormous consumption of computer core, computer time, and final space for processing and storage. Larger zone systems can be accommodated in modern computers, but the costs of doing so escalate rapidly. By increasing the number of zones to 1,500, for example, the trip matrices grow to 2.25 million cells, while an increase to 1,800 zones would generate enormous matrices of 3.24 million cells. Given these size implications, it is not surprising that every effort has been made in the region to live with the existing zone system or to expand it only very slowly, and principally in the peripheral areas, as they become more intensively developed.

A result of this system of comparatively large zones is that insufficient accuracy exists for planning rail alternatives. In several cases, previous work with the zone system found two stations located in one zone. When this happens, no sensible information can be obtained on the comparative size and location of the two stations, and no effect can be detected from deleting one of the stations. Apart from this rather extreme effect, the lack of detail surrounding the stations may lead to substantial errors affecting estimates of access to the stations, provision of bus services, and competition between bus and rail.

It was determined that rail planning in the region necessitated subdividing zones in the vicinity of rail lines. Consequently, alternatives were investigated for such subdivision, while maintaining consistency with the overall 1,325-zone system in the region. In other words, it was decided that creation of new zones that had boundaries crossing the boundaries of existing zones in the 1,325-zone system would not be acceptable.

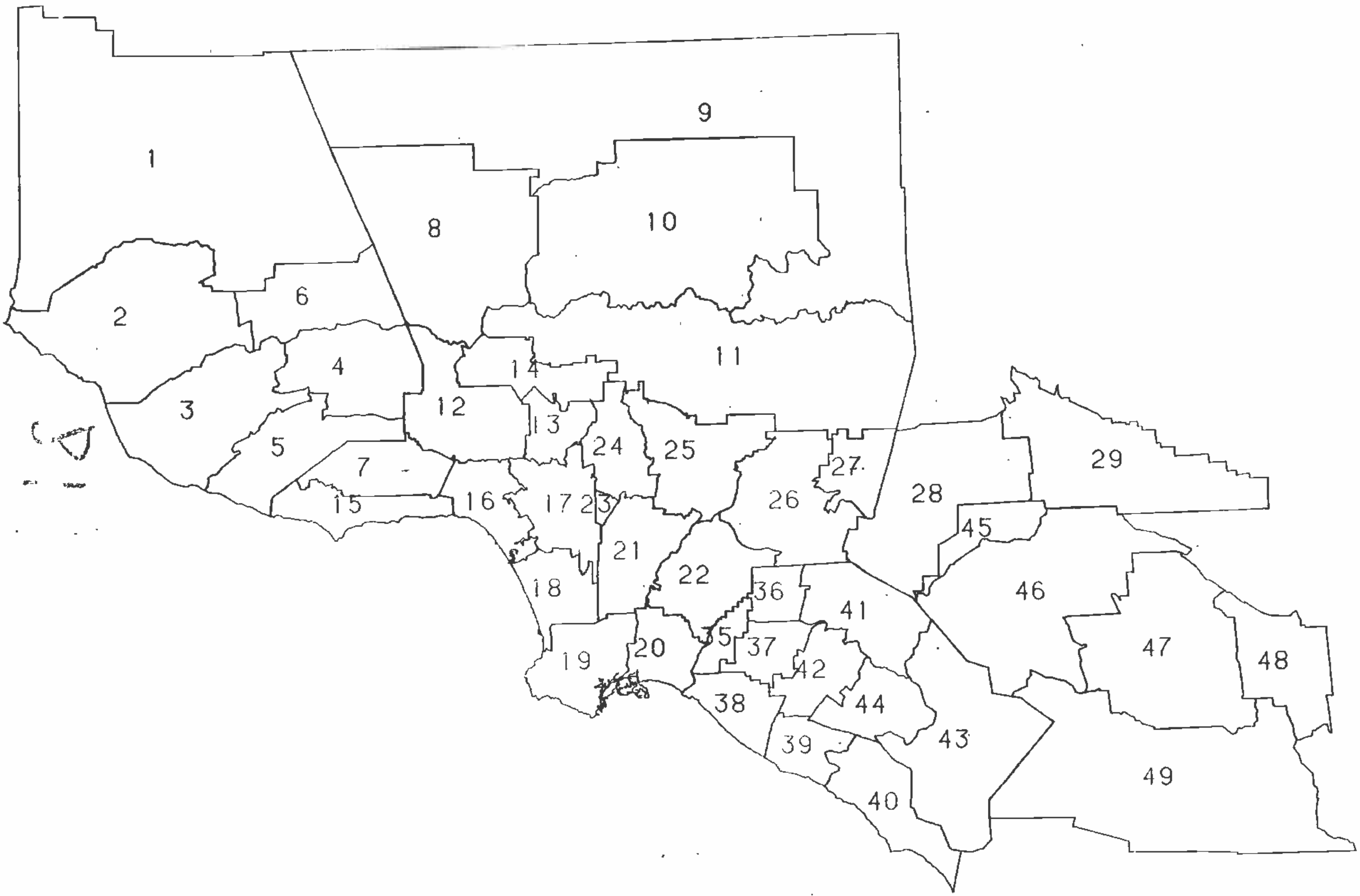
As a preliminary step, all of the potential rail corridors in the region were identified. Within each of these the current zone system was scrutinized. It was suggested initially that all of the zones within a band of one existing zone width from the potential rail line should be subdivided into their constituent census tracts. (With the exception of the Los Angeles Central Business District, almost all zones in the region consist of from one to four census tracts. Within the Los Angeles CBD all zones consist of one census tract, while a few zones in the region are partial census tracts.) For the Los Angeles CBD, various other documents were considered, including recent parking studies that had used a 100-zone system for the CBD, and a study of the proposed DPM which used about 50 zones.

Based on these procedures, a candidate set of zones was developed for initial scrutiny. It was determined that the use of as detailed a CBD zone structure as 100 zones and subdivision of all rail corridor zones into their constituent census tracts would generate too many zones for reginal planning, with the total number of zones increasing to approximately 1,850 zones. Selective recombining of zones was undertaken to reduce this number. Within the rail corridors, census tracts that would not assist in improved accuracy--either by separating stations along the rail line or by defining distinct market segments for rail (by access characteristics or by location)--were recombined to multitract zones. In the CBD, a compromise zoning was set up that retained the existing zone boundaries in the CBD but subdivided the zones from 17 CBD zones to 30. The final result of the zoning activity was to add 303 new zones, increasing the number of regional zones from 1,325 to 1,628, resulting in an increase in the number of cells in a trip matrix from 1.76 million to 2.65 million. This is a 50-percent increase in the size of the trip tables and other matrices required for running the forecasting models.

As noted, except in the CBD, the procedure for defining the new zone boundaries was to use within-zone census tracts. Because regional data are developed at the level of the Regional Statistical Area (RSA), which is a highly aggregate level, it is necessary to develop a procedure to split the data into a finer disaggregation in those zones that are subdivided. Figure 2-1 shows the RSAs for most of Los Angeles county and provides an example of the size of RSAs. The procedures for disaggregating are outlined below.

Population is available at the level of the census tract. Therefore, population can be obtained for the new zones. At the time of development of the subzoning, census employment data were not available for the 1980 census, at the tract level. A 1976 census of employment was used as a mechanism to proportion employment among the subzones. The data from this survey were not used in any absolute manner, but rather only as a relative proportioning procedure.

SCAG REGIONAL STATISTICAL AREAS



PLANNING DEPARTMENT

KILOMETERS
0. 10.0 20.0

MILES
0. 10.0 20.0

NORTH

RTD

Figure 2-1

Given the proportional splits of population and employment for each of the subdivided zones, these fractions were used in the UTPS procedure USQEX to split the trip productions for all purposes among the subzones, using the trip tables for the original 1,328-zone system. Similarly, fractions were derived from the employment data to split trip attractions. It could be argued that some trip purposes might be split among the zones more correctly by using some combination of employment and population, but it was felt not to be appropriate to attempt to generate a greater sophistication of the splitting procedure, given the relatively inaccurate information on which it is based. Subsequently, it should be simple to undertake trip generation and distribution at the level of the new zones.

To subdivide highway travel times, which were provided to SCRTD as a set of highway skims, it was not feasible to alter the highway network to add new centroid connectors, so that the procedure used was based on the skims themselves. The intrazonal times were extracted for each subdivided zone. These were then divided by 2 (n-1) to produce new intrazonal times for the subdivided zones, where n is the number of subdivided zones from the original zone. Travel times from one subdivided zone to another, within an original single zone, were set equal to the original intrazonal time divided by (n-1). Thus, if an original zone had an intrazonal time of eight minutes and was subdivided into three new zones, the intrazonal times for each of the three new zones were set equal to two minutes (8/2(3-1)), and the times between each of the three new zones were set to four minutes (8/(3-1)). For travel times to all other zones, it was assumed that these would be the same for the new subdivided zones as for the original parent zones.

Zone numbers were assigned to the new zones starting from the first available zone number of 1,326. The new numbers, from 1,326 through 1,628, were assigned in numerical order based on the original numbering of the parent zones. The number of the parent zone was retained as the number of the first subdivided zone within each parent zone. Thus, if zone 710 was subdivided into three zones, the first subdivision retained the number 710 and the remaining two were allocated the next available numbers from the range between 1,326 and 1,628.

For the CBD zones, data were used from a Downtown People Mover study completed in 1980. These data provided a basis for making identical splits on the production and attractions to those used for the non-CBD zones. The same procedure for splitting travel times for the highway network and for allocating zone numbers was used for CBD and non-CBD zones.

New zone centroids were geocoded from USGS maps for use in the transit network. The zone centroids were given metric coordintes based on the USGS 7-1/2 minute Quad series of maps in conformance with the existing CALTRANS transit network for 1980. The zone centroids were generally located, as for the parent zones, at the geographical center of the new zones. This was appropriate because most of the zones are fully developed and have relatively homogenous development patterns.

Figure 2-2 shows the locations of the subdivided zones on a corridor basis. Appendix 2-1 contains equivalencies between old and new zones and between new zones and RSAs.

2.2 NETWORKS

2.2.1 Purpose and Context

The primary purpose of the network-building phases of the project was to provide transit networks for the base year and for several alternatives for the year 2000. These transit networks were intended to be as accurate representations as possible of future year scenarios, and would also represent the development for the year 2000 of a background bus system for the alternative rail networks. Details of the procedures used in building, checking, and correcting the networks are provided later in this report.

2.2.2 Common Changes to Network Coding

A number of changes was developed to apply to all of the networks as part of the overall network-building procedures. These changes are described in the next paragraphs.

2.2.2.1 Coordinates

The coordinate system used was the same as was present in the base networks (FAR00.MRLTR and FY85A.BASE), and apparently stemmed originally from the system developed for CALTRANS 1980 SIP network. At one point in the past both the consultant staff and the District agreed to use a single, common (master) coordinates file. This is no longer the case. Given the importance the coordinates file now assumes, this would be a useful device to which to return.

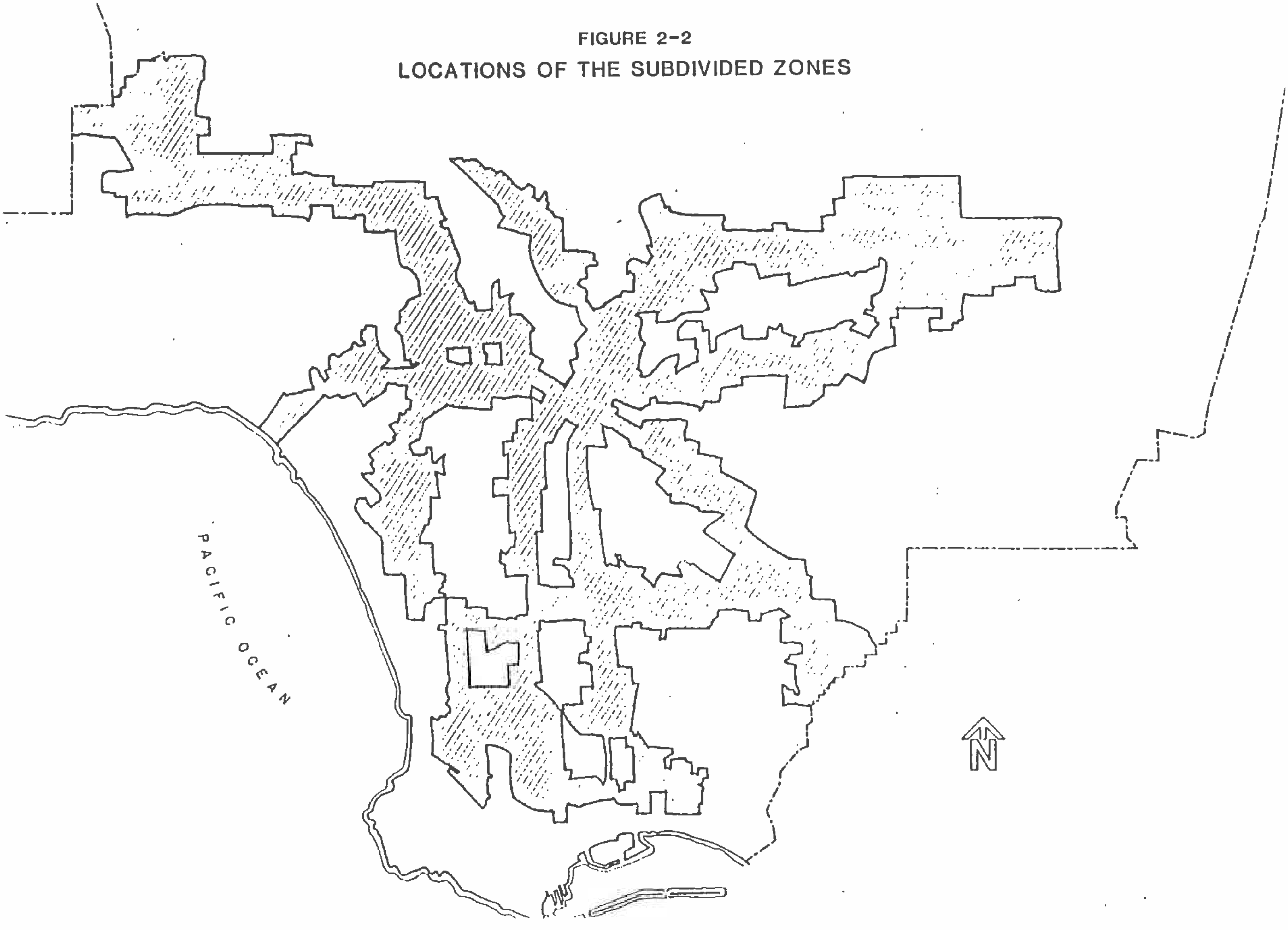
2.2.2.2 Node Numbering

In the early phases of the project, a new node-numbering system was designed and implemented. This scheme consisted of two importaant components--reservation of certain ranges of numbers to represent special nodes and a renumbering of all nodes to provide geographic content to the node numbers. On the first of these nodes 1 through 2000 are reserved for zone centroids, cordon stations, and other future special purposes. In the present numbering system nodes 1 through 30 are cordon stations, 41 through 1,628 are zone centroids, and 31 through 40 and 1,629 through 2,000 are unused and available for future network expansion.

Node numbers from 8,000 through the maximum permitted node number of 8,191 are reserved for rail stations. Rail station numbers are intended to follow the expected order of construction of stations on the Wilshire Starter Line, and thereafter have been assigned on a line-by-line basis in approximately the same order as done in earlier rail networks. The node numbers 7,900-7,949 have been reserved for highway dummy nodes, a practice detailed later. There was some discussion early in the project of reserving the node numbers 7,800

FIGURE 2-2

LOCATIONS OF THE SUBDIVIDED ZONES



through 7,991 as rail dummy (local) nodes (i.e., the bus stop location from which it is possible to enter the rail station). It is unlikely that these node numbers are even available today. Some, as noted above, have already been diverted to other purposes. Additionally, it is judged to be poor coding practice to move or change transit node numbers which would, of course, be necessary as rail alignments changed. Thus, the idea has been largely abandoned.

When the networks were originally renumbered, the region was divided into a series of east-west bands, starting in the south and working towards the north. Within the bands, north-south subdivisions were defined to form "plates" within which consecutive node numbers were assigned. Figure 2-3 shows the plates used for renumbering. Node numbers were assigned by starting in the southwest corner of the plate, working across to the east in a shallow band, then returning to the western side and working across in another band. In this way, node numbers increase generally in a southwest-to-northeast direction and, except at the edges of the "plates," are grouped by similar values. The renumbering was performed on all nodes in the transit network from node 1,001 up. The node numbers ending in a "1" were not used at this stage, in order to provide spare node numbers for use when new nodes must be added. Leaving one node number in ten as a spare provides some capability to retain geographic information in the node numbers, even with subsequent expansion of the node numbers.

2.2.2.3 Mode, Company, and Line Numbers

The networks were built using the UNET procedure in UTPS. Within the constraints relating to this program, various conventions have been set up. For the access/egress modes, in conformance with the needs of the modal-split models, the following definitions have been standardized into the networks:

- o <u>Mode 1</u> - Walk links both for centroid connectors, walk networks, and dummy connectors
- o <u>Mode 2</u> - Auto links to an official park 'n' ride location, permitting both park 'n' ride and kiss 'n' ride access
- o <u>Mode 3</u> - Auto links to a kiss 'n' ride location, permitting kiss 'n' ride access only

The following definition of transit modes has been used:

- o <u>Mode 4</u> - SCRTD local bus routes
- o <u>Mode 5</u> - Express bus routes (all operators)
- o <u>Mode 6</u> - Heavy rail rapid transit (all operators)
- o <u>Mode 7</u> - Light rail rapid transit (all operators)
- o <u>Mode 8</u> - Local bus service of all operators except SCRTD (municipal operators or "munis")

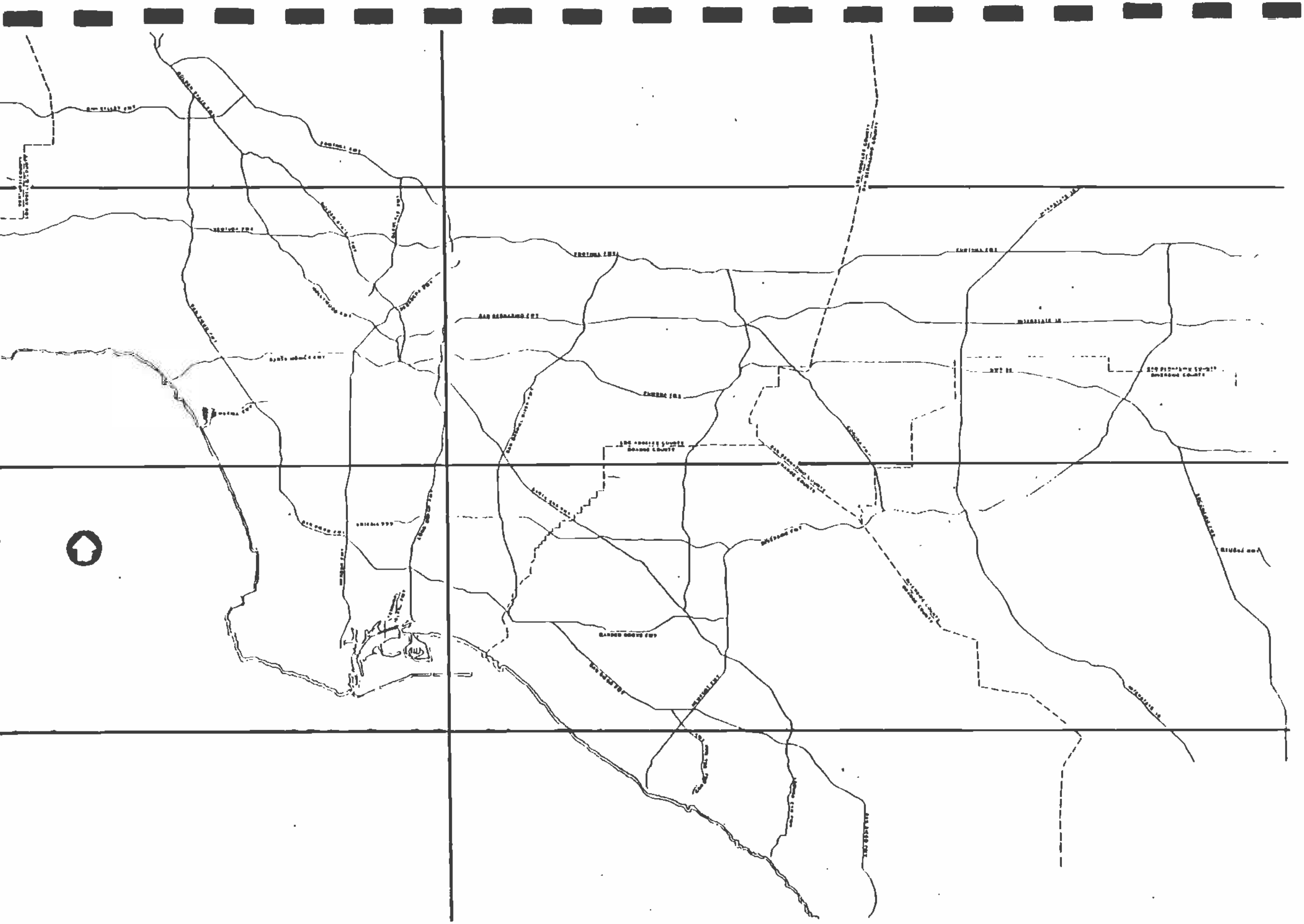


FIGURE 2-3

MAP SHOWING DIVISION OF LOS ANGELES REGION INTO "PLATES" FOR NODE NUMBERING

Standard company numbers have been established and are shown in Table 2-1. These company numbers apply to all transit modes.

The only rule applied consistently to the UNET line numbers assigned to various companies is that the new fare program assumes that, just as it is now, there must be a break between RTD and municipal operators in Mode 5. Coding for all RTD express and limited bus routes must precede that for any municipal operator. For example, in DPFN5 network UNET, line numbers for RTD Mode 5 (express and limited routes) range from 1 to 65. Line numbers for municipal operators begin at 150. The gap need not be so wide, but some crossover point must be maintained, and RTD lines must precede those of any other operator.

2.2.2.4 Link Lengths and Speeds

As much as possible, transit link lengths are coded to equal actual distance on the ground to the nearest tenth of a mile. When a link involves a geometry that is more complex than a straight line from one node to the next, the distance coded is always the true on-ground distance.

Speeds on the links are based on an area-type and facility-type classification, as used in standard highway network practice. The average bus-running speeds for each area type and facility type were determined from the average actual performance of buses on those facility types and within the area types. Different speeds were allocated for each of express and local bus service, and for each of the peak and the midday periods. Table 2-2 shows the speeds in current use on the networks.

Facility type and area type were defined in close consultation with RTD staff and boundaries defined for the area types of CBD, CBD fringe, residential, outlying CBD, and rural. Similarly, the facility types over which the buses operate were defined according to the highway scheme of freeway, expressway, two-way arterial with parking, one-way arterial without parking, other/centroid connector, and two-way arterial without parking. The majority of links in the transit network are in residential areas and are two-way arterials with parking. No transit links are coded in the existing networks on "centroid connectors or other" facilities and some combinations of area types and facility types do not occur, even though speeds may have been defined for them.

However, in the course of path-tracing on the FAR85.BASE network, it was discovered that the use of the link-speed table distorted actual bus travel times on specific high-speed facilities. This is partially the result of congestion on certain freeways which in the real world makes bus travel slower on those facilities. However, use of a facility-type/area-type speed table simplifies network link-speed coding by assuming that the same speed can be attained by buses on similar facilities, in similar areas, at the same time of day. With UNET networks this is generally considered to be a necessary simplification in order to estimate acceptable speeds for so many

TABLE 2-1

MODE AND COMPANY NUMBERING FOR THE LOS ANGELES REGIONAL TRANSIT NETWORKS

Operator	Service Type	Mode Number	Company Number
SCRTD	Local Bus	4	1
SCRTD	Express Bus	5	1
OCTD	Express Bus	5	2
OMNITRANS	Express Bus	5	5
Gardena	Express Bus	5	8
Long Beach	Express Bus	5	9
Norwalk	Express Bus	5	11
Santa Monica	Express Bus	5	12
Torrance	Express Bus	5	14
SCRTD	Heavy Rail	6	1
SCRTD	Light Rail	7	1
OCTD	Light Rail	7	2
OCTD	Local Bus	8	2
RTA	Local Bus	8	3
SCAT	Local Bus	8	4
OMNITRANS	Local Bus	8	5
Commerce	Local Bus	8	6
Culver City	Local Bus	8	7
Gardena	Local Bus	8	8
Long Beach	Local Bus	8	9
Montebello	Local Bus	8	10
Norwalk	Local Bus	8	11
Santa Monica	Local Bus	8	12
Simi Valley	Local Bus	8	13
Torrance	Local Bus	8	14
Miscellaneous	Local Bus	8	20

Source: Schimpeler Corradino Associates

TABLE 2-2

TRANSIT SPEEDS BY MODE, TIME OF DAY, FACILITY TYPE, AND AREA TYPE FOR LOS ANGELES TRANSIT NETWORKS

Facility Type	Area Type 1 CBD		2 CBD Fringe		3 Residen-tial		4 OBD		5 Rural	
Freeway 1	-	-	18a	21b	32	34	-	-	32	34
	-	-	18c	20d	32	38	-	-	35	38
Expressway 2	-	-	17	21	34	38	-	-	36	38
	-	-	18	20	34	42	-	-	38	46
2-Way Arterial w/Pkg 3	8	9	13	13	15	15	10	14	24	25
	8	9	13	15	25	28	15	16	25	28
1-Way Arterial w/o Pkg. 4	9	9	14	13	15	16	10	15	26	27
	9	9	14	16	28	29	15	16	25	30
Other/Centroid Conn. 5	10	10	14	14	18	15	11	15	26	28
	10	10	14	16	28	29	15	16	26	30
2-Way Arterial w/o Pkg. 6	11	12	15	15	20	18	12	18	26	26
	11	12	15	16	30	30	35	18	26	32

a - Local Bus, Peak
b - Local Bus, midday
c - Express Bus, peak
d - Express Bus, midday

All entries are speeds in miles per hour, rounded to the nearest integer value as required by UNET.

Source: Schimpeler Corradino Associates.

links. Bus speeds on freeways are clearly not the only example of distortion resulting from the use of this technique, but the magnitude of the discrepancy is probably greatest in the case of these links. The team briefly considered reviewing coded versus actual bus speeds on all freeway facilities, but decided against it for three reasons. One was simply the time required to complete such a study. A second reason hinged on the fact that the networks were intended to replicate future year conditions. While some freeways are clearly more congested than others today, no one knows how congested these facilities will be in the future. Finally, the intention in the future is to move to INET networks which can represent bus speed on the basis of a congested highway network. The team did, however, alter speeds on the San Bernardino busway to reflect more accurately the existing conditions. In addition, projected speeds on the future Harbor Busway were assumed to be similar to current speeds on the El Monte Busway.

Table 2-2 reflects the fact that the team made changes to the existing coding of express bus links in the CBD. This change reflected a decision to alter the standard speed table by ceasing to distinguish between express and local bus speeds in the Los Angeles CBD. The rationale behind this move is the realization that, in the downtown, buses must operate in platoons with little, if any, opportunity to pass one another. This fact, coupled with the reality that, for a given route, express buses generally operate on the same stop patterns as local buses in the downtown, argues against differentiating between their speeds in these areas. The team also conducted a comprehensive analysis of facility-type/area-type codes vis-a-vis link speeds for five networks (including the validation network) which provides the basis for the most recent coding efforts.

Overall, link speeds were found to be fairly consistent with what the facility-type/area-type coding would dictate. Moreover, in the limited instances where this was not the case, cursory analysis did not reveal whether this was the fault of incorrect link speed coding or incorrect facility-type/area-type coding.

Table 2-2 has been updated to reflect both the new CBD coding for express buses and to correct a discrepancy between the old link speed table and what was present in the networks for facility-type 3 and area-type 3 for routes 4 and 8. Apparently, the old link speed table was not updated when this change was made.

The only other problem encountered in the examination of link speeds is some apparent vagueness or misinterpretation of what links do indeed lie in the CBD. While not of critical importance, some clean-up effort could stand to be made in this area.

In terms of link-coding conventions, a rule that has been adopted in the networks is to define all transit links as two-way links. In Los Angeles, one-way streets occur almost entirely within the CBD. Very few occurrences exist outside this area. To simplify route coding and to avoid the need to specify lines that are partially on one-way and partially on two-way streets as two separate one-way lines, all links are treated as two-way. In the downtown area, lines that serve one-way pairs of streets are divided roughly equally between the two members of the one-way pair to provide approximately the same service levels as are actually provided. This leads to an equally useful convention that links be coded with the a-node always smaller than the b-node. This is particularly helpful with zonal connectors and dummy walk links to rail stations.

2.2.3 Definitions and Development of the Networks

2.2.3.1 Definitions

The original 30-year financial plan networks were (see Figure 2-4):

- Fiscal Year 1985 (OPFN1) - containing only Phase V Sector Improvements to the existing all-bus network,

- Fiscal Year 1990 (OPFN2) = NW002 - embodying the MOS-1 alignment of Metro Rail (from Union Station to Wilshire Blvd. and Alvarado St.) and Long Beach Light Rail,

- Fiscal Year 1991 (OPFN3) - containing the MOS-3 alignment of Metro Rail (from Union Station to Beverly Blvd. and Fairfax Ave.) and Long Beach Light Rail,

- Fiscal Year 1993 (OPFN4) - including the full MOS-5 or LPA alignment of Metro Rail (from Union Station to North Hollywood), Long Beach Light Rail, Century Light Rail (only from Studebaker Road to Douglas and El Segundo Blvds.), and San Fernando Valley Light Rail, and

- Fiscal Year 1995 (OPFNS) - embodying the full LPA alignment of Metro Rail, Long Beach Light Rail, all of Century Light Rail, San Fernando Valley Light Rail, Coastal Light Rail, and Harbor Freeway Busway.

Since the time that these were built, other networks have been developed:

- MOS-5 Only (MOS5) - containing only the full LPA alignment of Metro Rail and the background bus changes related to it.

The MOS-5 Only network became the basis for all of the CORE networks including:

- A series of "CORE1" networks, with a "CORE1" level prefix, so-called because they were generated for the first-level screening process of CORE. They are of only passing interest here, as they were networks developed with a common generic background bus network, a condensed 771-zone system, but with alternate rail alignments overlaid. The level designators are presented here for identification: LPA, VERPICA1, VERPICA2, VERPICA3, VERSMOB, WESTSVC1 or WSTSVC1C (the "C" suffix in these networks stands for the corrected version), WESTSVC2 or WSTSVC2C, WESTSVC3 or

METRO RAIL NETWORK ANCESTRY

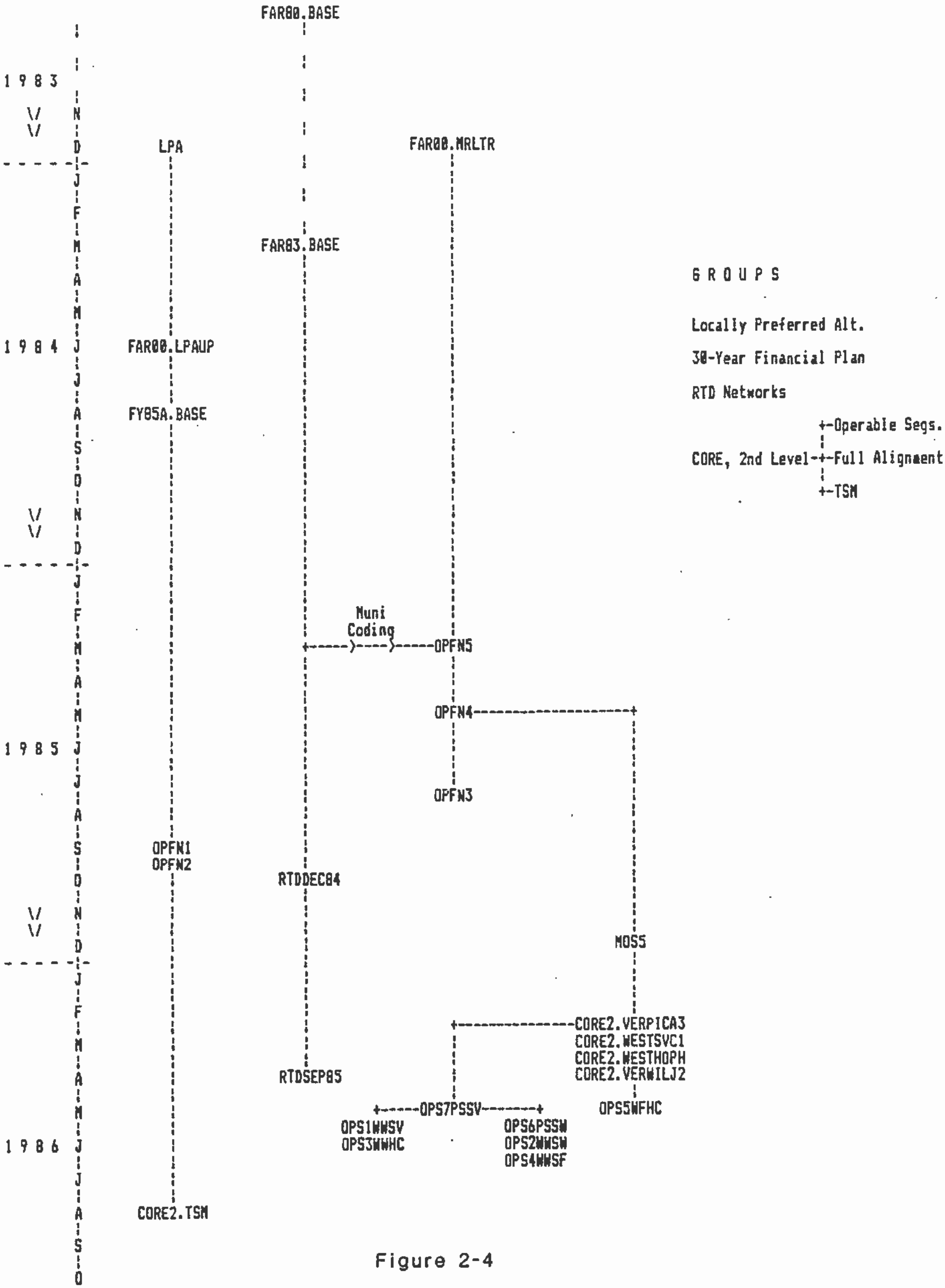


Figure 2-4

WSTSVC3C, LBREASVD, VERSUNDE, WESTOLYF or WSTOLYFC, WESTWILG or WSTWILGC, WESTHOPH or WSTHOPHC, and WESMSVH2 (an unofficial variation on the WESTHOPH network).

- The "CORE2" full alignment networks comprising:

  A3 - (VERPICA3) - Rail with a trunk line downtown from Union Station to Wilshire & Vermont, a west branch to Pico & Rimpau, and a north branch along Vermont and along Sunset to the Valley;

  CI - (WESTSVC1) - Rail with a trunk line downtown from Union Station to Wilshire & Normandie, a west branch to Pico & Rimpau, and a north branch along Western and along Hollywood to the Valley;

  H - (WESTHOPH) - Rail with a trunk line downtown from Union Station to Wilshire & Western, a west branch to Pico & Rimpau, and a north branch along Western and along Sunset to the Valley; and

  J2 - (VERWILJ2) - Rail with a trunk line downtown from Union Station to Wilshire & Vermont, a west branch to Pico & Rimpau, and a north branch along Vermont and along Hollywood to the Valley.

- The VERPICA3 and the VERWILJ2 networks in turn become the basis for all of the operable segment networks. Operable segment network 5 (OPS5WFHC) stemmed from VERWILJ2, while all of the others built on VERPICA3 as a base. A description of the individual operable segment networks follows:

  OPS1WWSV - A3/J to Wilshire & Western and Santa Monica & Vermont;

  OPS2WWSW - C1/H to Wilshire & Western and Santa Monica & Western;

  OPS3WWHC - A3 to Wilshire & Western and Hollywood & Cahuenga;

  OPS4WWSF - H to Wilshire & Western and Sunset & Fairfax;

  OPS5WFHC - J to Wilshire & Fairfax and Hollywood & Cahuenga;

  OPS6PSSW - C1 to Pico & San Vicente (Rimpau) and Santa Monica & Western; and

  OPS7PSSV - A3 to Pico & San Vicente (Rimpau) and Santa Monica & Vermont.

Finally, the "generic" TSM network developed for the CORE second-level analysis came from OPFN2 and includes TSM measures proposed for the MOS-1 network plus all measures west of Alvarado as developed and described in Technical memorandum 6.1.3: Description of

Transportation System (TSM) Alternative Network for the MOS-1, MOS, and LPA in September of 1984.

2.2.3.2 Development

Background bus changes were arrived at in all cases only after discussions with District planning staff. The operating philosophies used in this effort were as follows:

- o Short-ending competing express bus service at an outlying station
- o Deleting some express service on competing alignments
- o Pulling bus lines into stations as their termination points instead of terminating lines at other nearby locations
- o Adding some new feeder services from residential areas to rail stations
- o Changing frequencies to reduce competition between bus and rail and to improve service into stations
- o In some cases deleting or reducing the frequency of parallel through-local service -- changing it instead to serve only a feeder function.

In each rail corridor any express bus service that would parallel the rail was deleted and services were provided to feed the ends of the rail lines instead. If existing express bus service started away from or beyond the end of a rail line and then continued parallel to the rail line, this service was terminated at the farthest suburban station. Where bus lines currently terminated a few links short of a station, they were continued to the next rail station. Similarly, if service ran past a station but the transit node serving the station was not included as a bus stop, then the transit node was added to the line description.

2.3 TRANSIT NETWORK ACCESS

2.3.1 General Description

Access to transit service is reflected in three distinct stages in the modeling process. The most important and most obvious stage is in the coding of transit networks which have a fundamental influence on all stages of the patronage forecasting process carried out by SCRTD. Access to transit service is also reflected in general terms in the market segmentation process carried out by SCAG as part of the preparation of trip-end data for input to the mode-choice models. Transit service availability and auto availability are the two variables which determine the market segments as described in Chapter 3. Transit service availability is expressed as the proportion of each zone which is within one-half mile of at least one transit route. Access to rail stations, specifically, is an input to the mode-of-arrival model. Here access is reflected by the identification of the rail station to which each analysis zone centroid is nearest.

Within the transit system simulation networks, access for three transit submodes is reflected -- walk access, park-and-ride access, and kiss-and-ride access. Of these, walk access is most critical since about 85% of all transit trips are by walk access; only 15% are by auto access. Mode choice is quite sensitive to walk access times; thus great care must be taken to reflect accurately walk access time for each zone -- to determine first which zones are appropriately connected by walk access and, for these zones, to determine the appropriate average walk time. The importance of walk access coding to the outcome of patronage forecasts has led to a critical review of this element.

2.3.2 Analysis of Walk-Access Coding Methodology

A fundamental aspect of the current approach to modeling urban travel demand is the representation of geographic analysis areas (traffic analysis zones) as if they were a single point in the travel simulation networks. This is a necessary expedient to reduce the real world to manageable dimensions. The extent of abstraction and potential error borne of this practice is, broadly, a function of zone size. A fine-grained system of zones will be subject to less error than a more aggregate system. In the coding of highway networks this abstraction is only of modest concern since intrazonal times, at driving speeds, are generally small. By contrast, such abstraction is of serious concern in the coding of transit networks. Since the principal transit submode is walk-access-transit for which access times are measured in terms of walking speeds, access distance becomes critical. The representation of walk access to transit is further complicated by the fact that transit service is much less universal than is the roadway system. Concern for minimizing the potential error related to walk access coding has resulted in the development of more finely disaggregated zoning systems and the introduction of additional measures such as the percent of each zone within walking distance of transit. Both of these devices are employed in the SCRTD modeling procedures.

Historically, the coding of walk access in transit networks has been done manually. The analyst would examine each zone individually and link it to available transit routes "in the most appropriate fashion." Potentially, the manual process is able to bring more complete information to bear on the access coding problem; however, it is a tedious, subjective, personalized, inefficient, and error-prone process. For these reasons the access coding process has been automated for SCRTD transit networks. This process utilizes the rectangular coordinates of transit route nodes (stops) and zone centroids to determine acceptable and efficient walk linkages.

Automation of the walk-access coding process raises two key concerns:

- o Does the automated process accurately reproduce the walk-access linkages and times used in model derivation?

- o Does the automated process introduce biases in transit-trip estimates, especially estimates of rail-transit volumes, since the rail mode did not exist in the data used for model development?

CSI, developers of the mode choice models currently in use, under contract to SCAG, established three basic criteria for walk-access coding as follows:

1. There is at least one connecting link to each line on any route within 0.5 mile of a centroid.

2. The fewest numbers of links possible are used to connect any centroid to all accessible lines. (This is for economy and clarity in network construction and accounting, and for economy in later stages of modeling.)

3. Uniform time and distance on all links from a given centroid. (This is to represent access conditions typical of spacing distance between transit routes in the geographical neighborhood.)

Beginning with the LARTS 1978 Base Transit Network, CSI made extensive checks on the walk-access coding in comparison to these criteria. As a result, many walk links were deleted and some added. Strict adherence to the first criteria left many more zones unconnected by walk access than in the LARTS network. Subsequently, zones previously connected were reconnected unless the elimination of transit service between 1978 and 1980 could be identified to explain the lack of connection. Thus, while the stated criteria were used as guidelines, they were not rigidly followed.

Similar effects were observed when BLDCON2 was first implemented to create walk links automatically "from scratch" in strict adherence to the basic criteria above. Comparison of the initial results of BLDCON2 with walk access coding in pre-BLDCON2 networks indicated many more zones unconnected by walk-access in the BLDCON2 network. This led to an examination of unconnected zones by means of:

- o Comparison to the independently derived zonal variable Percent Walk -- indicating the percent of the zone within walking distance of transit.

- o Reference to the transit trips produced by zone based on the 1983 on-board survey.

- o Visual inspection of the unconnected zones in relation to coded transit routes and the proximity of transit nodes relative to zone centroid location.

The analysis was based on comparison of the MOS-5 ONLY network, created by using BLDCON2, and the MRLTR network, created by using a pre-BLDCON2 file of walk-access links. This analysis also examined the mode choice model application programs to determine the precise manner in which the zonal variable Percent Walk was employed relative to access-coding in the transit networks. Findings are summarized below.

The zonal variable labeled Percent Walk directly determines the fraction of person-trip productions assumed to have transit available by walk access (Segments 1 and 2). It also acts as a switch in the mode choice model to bypass the calculation of walk transit trips if it is equal to zero. Changes in the zonal values of Percent Walk will have no impact on mode choice unless:

- o MSEG is rerun to produce new market segmentation.
- o Values change from zero to nonzero or vice versa.

The mode choice model contains similar switches related to network-derived values. If auto access time for PNR or KNR is zero, or if TIVTT for walk transit is zero, the calculation of transit trips for the respective transit submode is bypassed. Network coding can result in more restrictive calculation of transit trips, but cannot override the Percent Walk/Market Segmentation restrictions.

Based on the Percent Walk value for each unconnected zone and the number of HB WORK WALK TRN trips from the on-board survey, simple frequency distributions of the unconnected zones were prepared as shown in Figure 2-5. These frequency distributions indicate:

- o There is a high degree of consistency between network structure and the zonal variable Percent Walk for zones that are unconnected in both networks or only in the MRLTR('84) network -- i.e., most of these zones have a Percent Walk of zero.
- o Conversely, there is a high degree of inconsistency between network structure and Percent Walk for zones which are unconnected only in the MOS-5 ONLY network.
- o Similar observations flow from the frequency distributions with respect to the number of trips recorded in the on-board survey. For zones unconnected in both networks, only six out of 207 zones have trips; whereas for zones only unconnected in MOS-5 ONLY, 82 out of 202 have recorded trips. Note that, because the on-board survey is a small sample survey, there are many zones which in reality produce transit trips, but for which no trips were recorded or sampled. Nevertheless, the difference in the distributions for "old" and "new" zones strongly suggests reexamination of the newly unconnected zones.

Geographic plots of the unconnected zones overlayed with existing bus routes and with the Percent Walk variable have been produced as illustrated in Figures 2-6 through 2-8. These plots reveal many examples where the unconnection of zones in the MOS-5 ONLY network is inconsistent with available transit service coverage. Detailed examination of such zones, in terms of the real world versus the network representation of the real world, yields a variety of explanations for why BLDCON2 was unable to find a walk connection within 0.5 miles. Factors contributing to the unconnection of zones include the following.

ANALYSIS OF ZONES UNCONNECTED BY WALK ACCESS

CATEGORY OF UNCONNECTED ZONES	NUMBER OF ZONES BY PERCENT WALK 0.0	0 < % <.5	.5< % < 1.	1.0	TOTAL
(1) IN BOTH NETS	180	3	11	9	203
(2) ONLY IN MOS-5	5	26	73	107	211
(3) ONLY IN MRLTR	11	1	1	3	16
(4) (1)+(3)	191	4	12	12	

	NUMBER ZONES BY TRIPS FROM ON-BOARD SURVEY 0	1-499	500-999	1000+	TOTAL
(1) IN BOTH NETS	201	4	1	1	207
(2) ONLY IN MOS-5	120	69	9	4	202
(3) ONLY IN MRLTR	15	1	0	0	16

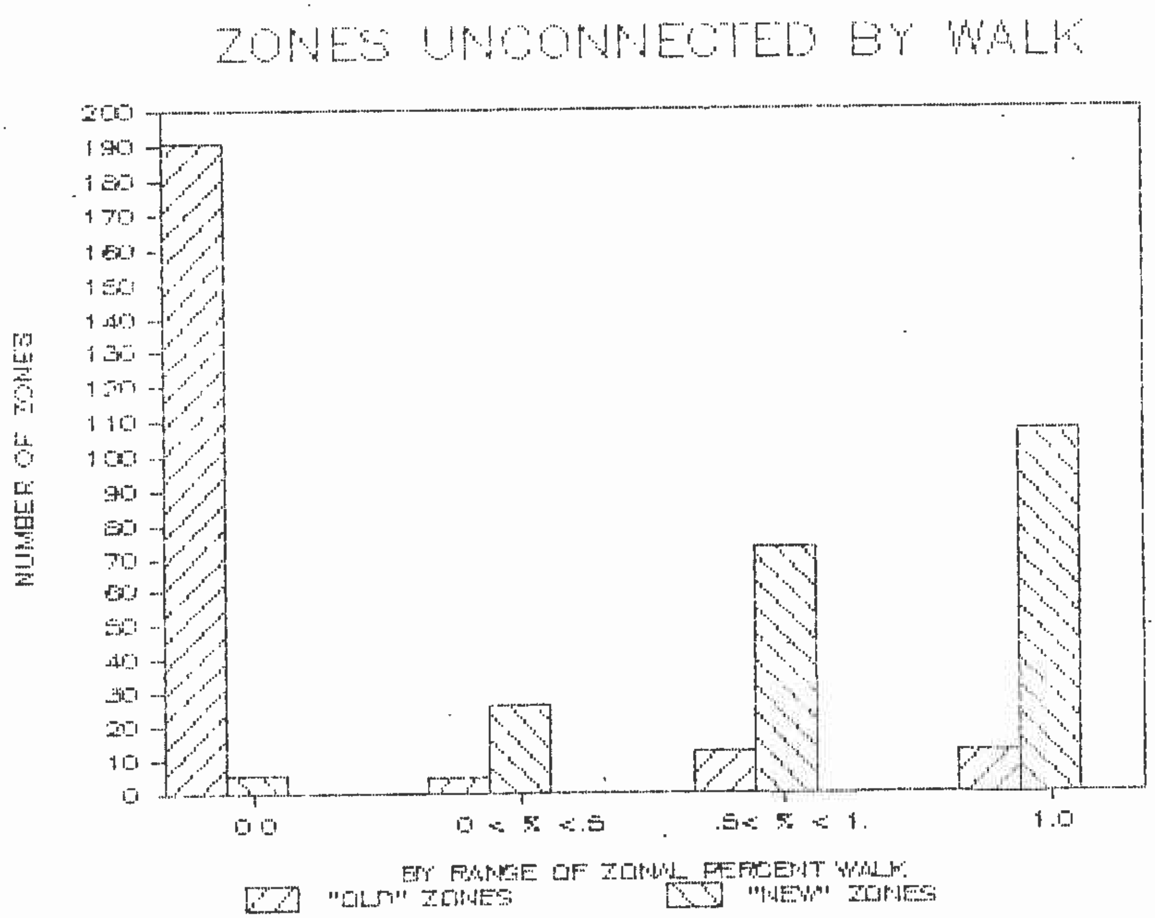


Figure 2-5

PERCENT OF ZONE WITHIN WALKING DISTANCE OF TRANSIT

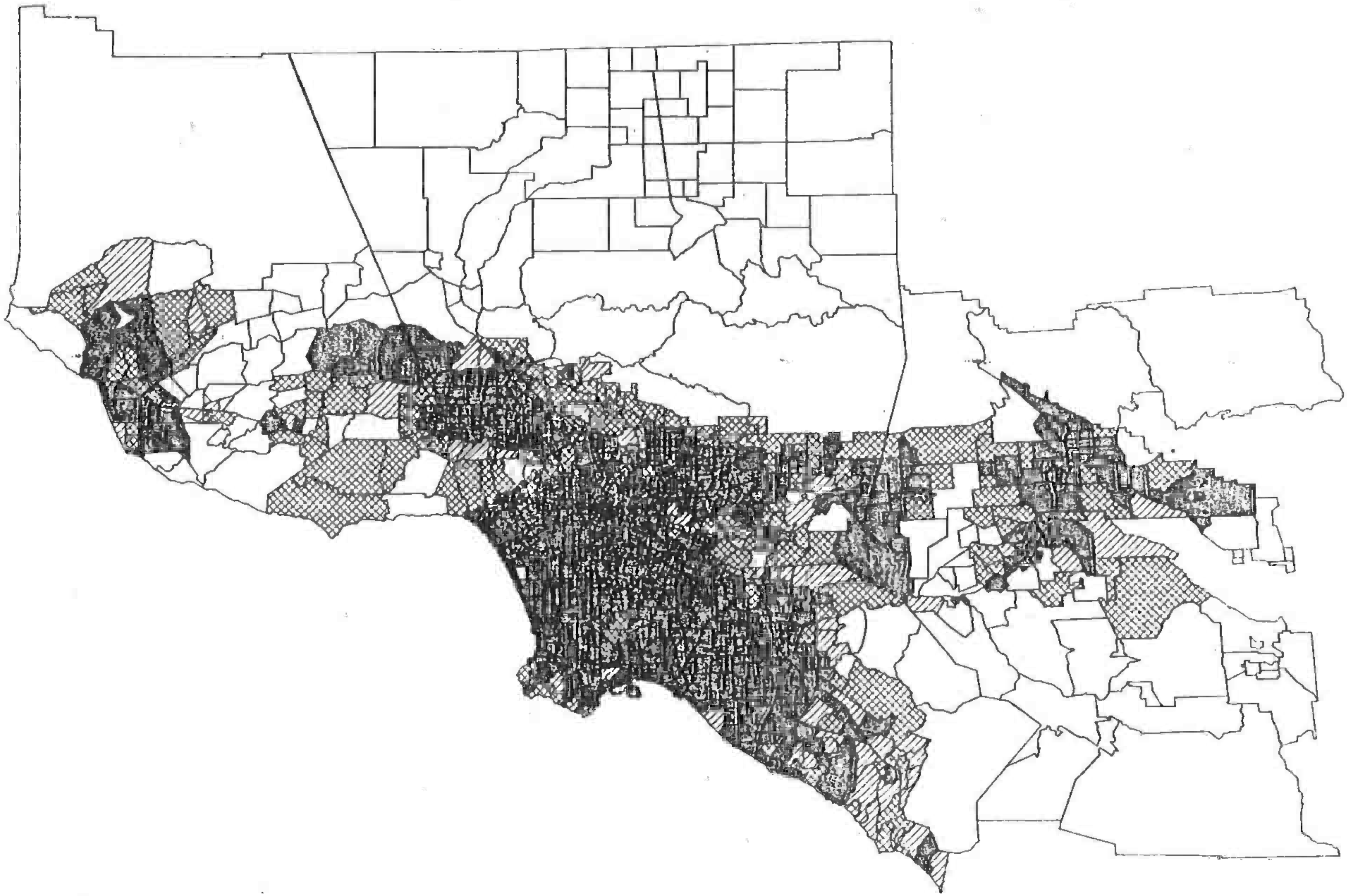
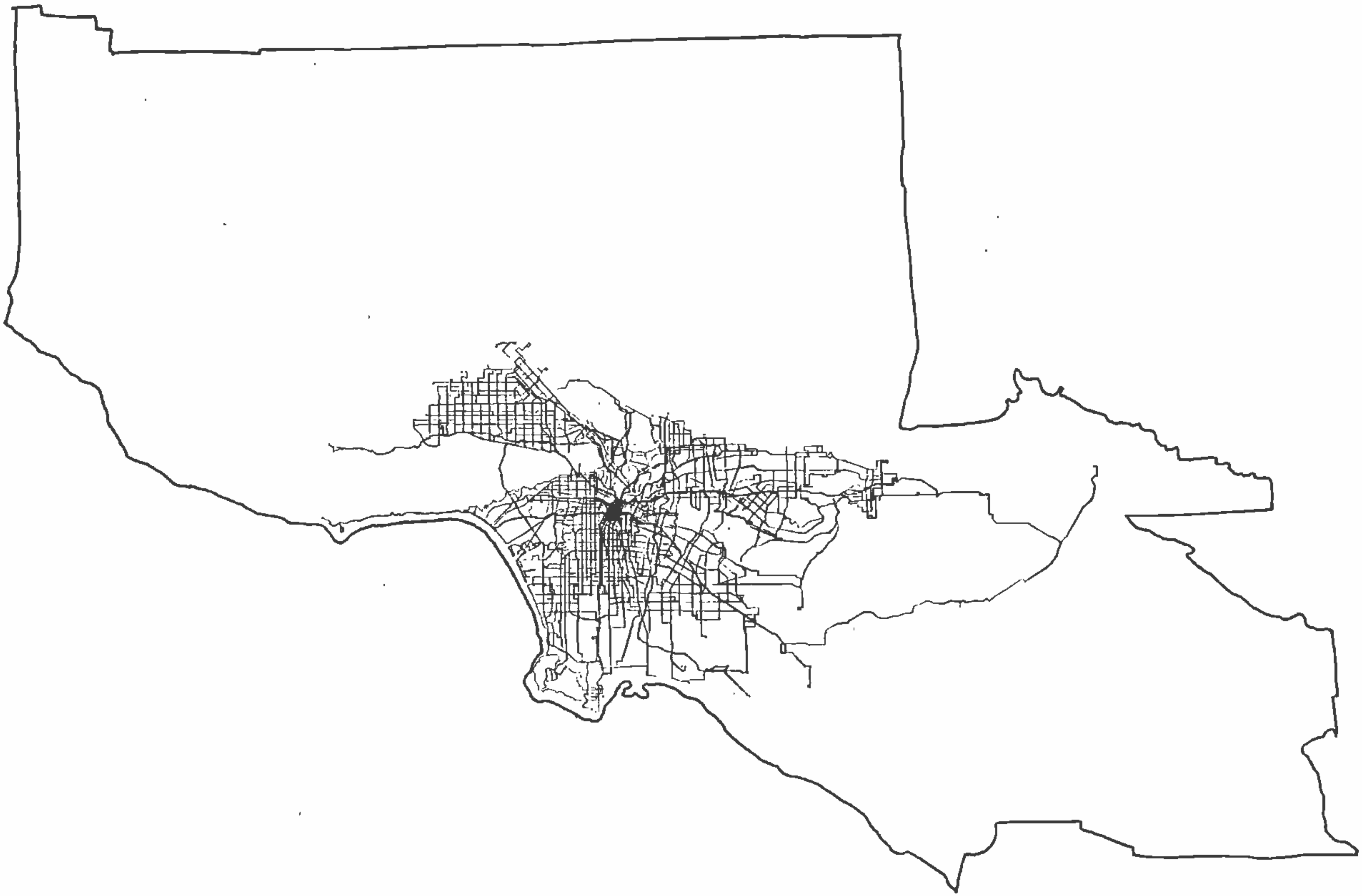


Figure 2-6

SCRTD CURRENT TRANSIT SERVICE



PLANNING DEPARTMENT

KILOMETERS
0. 10.0 20.0

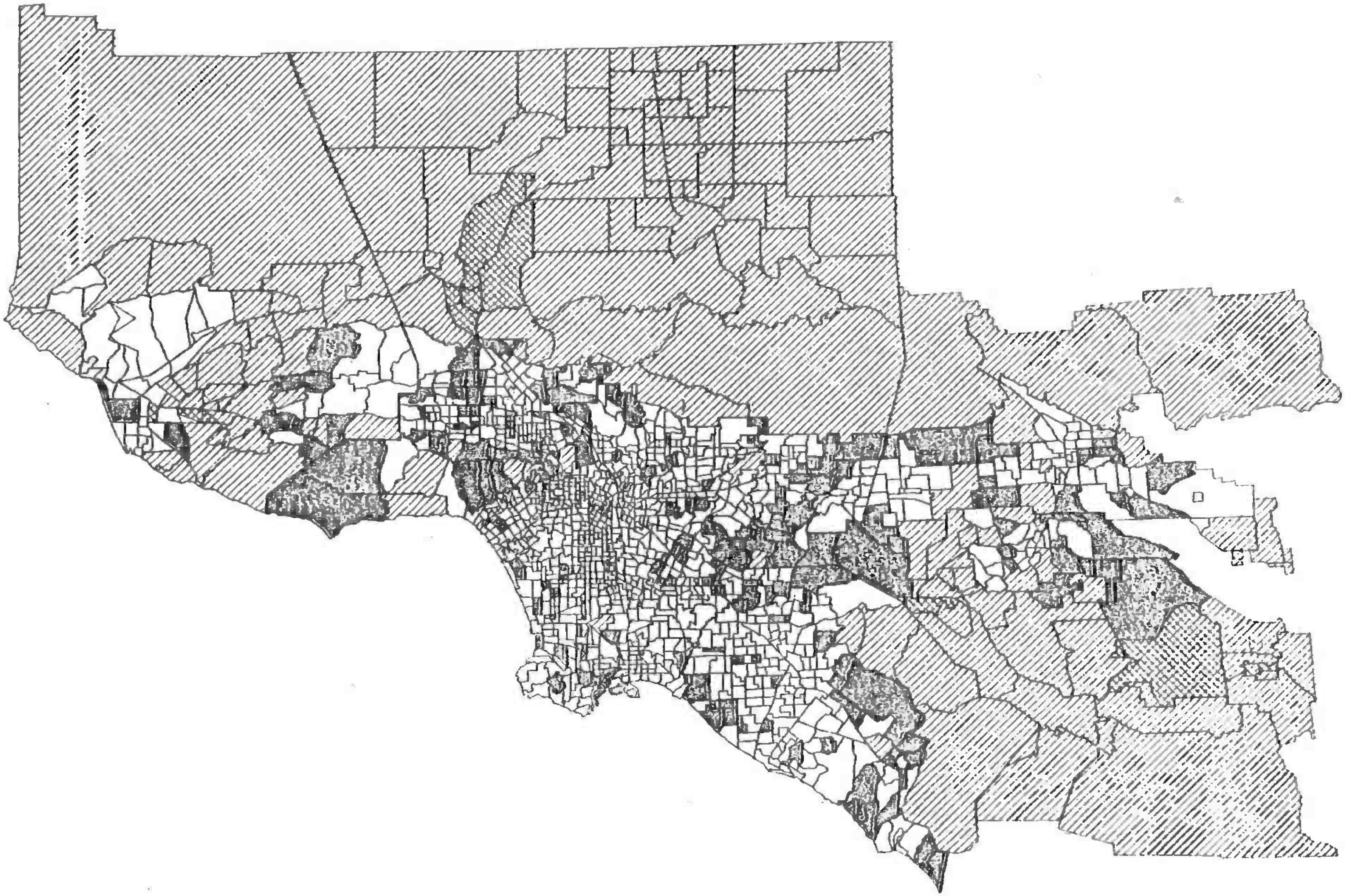
MILES
0. 10.0 20.0

NORTH

RTD

Figure 2-7

ZONES UNCONNECTED BY WALK ACCESS IN RECENTLY BUILT NETWORKS



PLANNING DEPARTMENT

KILOMETERS
0. 10.0 20.0

MILES
0. 10.0 20.0

RTD

NORTH

ZONES UNCONNECTED IN...

MRLTR AND MOS-5

MRLTR ONLY

MOS-5 ONLY

NEITHER NETWORK

Figure 2-8

- Abstraction of route structure in the coded network
- Sparsity of stops in the coded network
- BLDCON2's assumption of service independence

The coded transit network is an abstraction of the real world. Transit routes are not represented in all their detail but are consolidated on common streets and terminated at common points and minor deviations in routing omitted. This practice, which is typical and essential in coding large networks, has not been employed to a great extent, but enough to increase walk times marginally to impacted zones. This impact does not have to be very great to place some zones outside the 0.5 mile distance imposed by BLDCON2 in its initial version.

Similarly, transit stops are not all included in the coded network, in part because of the limit of 50 nodes per line in UNET and in part because of the overall limit in the number of nodes and links. In general, nodes are placed only at the intersection of streets included in the network. Because zones consist of one or more census tracts and since census tract boundaries generally follow streets, zones often have nodes/stops only at their corner points. This means that in the majority of cases BLDCON2 can only build walk links from the zone centroid diagonally to the corners of the zone. Thus, a rectangular zone 0.8 miles by 0.6 miles, with nodes/stops at its corners and its centroid in the geographic center, would just make the 0.5 limit. If either dimension of the zone were a fraction longer, BLDCON2 would not connect it -- even though the perpendicular distances from the centroid to the sides are well within the 0.5 limit. In reality there is likely to be a stop at some point other than the corner points which, if included in the network, would reduce the walk distance as viewed by BLDCON2. If the zone centroid is at any point other than the geographic center, this reduces the walk distance to two of the corners and increases the distance to the other two. This can increase or decrease the likelihood that the zone will be connected, depending on the orientation of the zone with respect to available service.

BLDCON2's implicit assumption that all routes serving a zone provide completely independent service makes the sparsity of stops all the more critical. This assumption is often, but not always, correct. It is often the case that different parts of a zone are served by different routes, each providing service to the same general destinations such that residents can walk to the nearest service and in which case the average time is reduced compared to that calculated by BLDCON2.

The combination of these factors has resulted in many zones being unconnected when in fact they should be connected, not because riders are walking further than 0.5 miles but because the simplifying assumptions embodied in the coded networks and the BLDCON2 algorithm result in an overestimate of the true average walk distance. In most cases BLDCON2 results in logical and consistent walk connections. It is not surprising that a simple, automated procedure does not recognize all the intricacies of such a complex system as that being modeled. It is important in this case, however, that we do not ignore the aberrations cause by simplification, since this seriously underrepresents the potential market area for transit and will cause incorrect model constants to be developed.

There was also a concern that modifications made to connect zones did not at the same time:

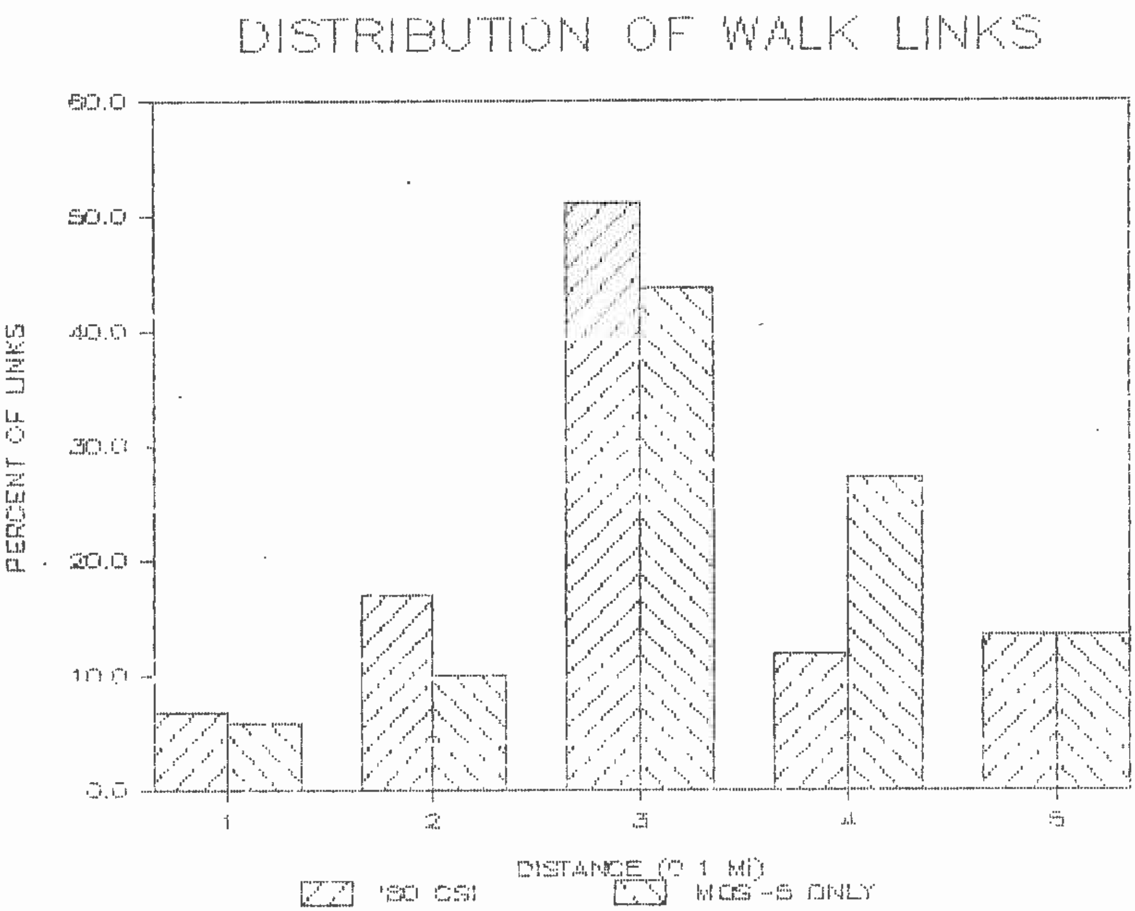
- o Overcorrect -- i.e., connect zones that are not served by transit, or

- o Make the process overly complex, inconsistent, subject to additional steps that may be forgotten or subject to lengthy manual procedures.

Fortunately, the potential for overcorrection is very small. The great majority of zones unconnected only in the initial MOS-5 ONLY network should be connected. Almost all the zones unconnected in previous networks have a Percent Walk of 0.0, in which case the calculation of walk-access transit trips is completely bypassed in the mode choice models. Thus, the main concern in modifying the procedure was to maintain efficiency and consistency. This was accomplished by modifying BLDCON2 to incorporate reference to the Percent Walk files as an additional control.

A check on Percent Walk was incorporated in BLDCON2 as an initial step. This allowed any zone with a Percent Walk of zero to be bypassed immediately in conformity with the check made in the mode choice models. The initial search procedure was modified to identify all nodes within 1.0 miles, but those over 0.5 miles are kept separate. If there are connections within 0.5 miles, only these are included, and the result is identical to the earlier version. If there are no connections within 1.0 miles, the zone will remain unconnected as in the earlier version. If neither of the preceding conditions is true, then BLDCON2, as modified, selects the subset of links in the 0.5-to- 1.0 range having the minimum distance based on increments of 0.1 mile. A uniform distance of 0.5 miles is used for any zone connected by this secondary process. There is evidence to suggest that a maximum walk distance of 0.5 miles was used previously, even for zones that BLDCON2 left unconnected. Further, this modification was to correct an overestimate in walk times as viewed by BLDCON2, not a relaxation of the 0.5-mile maximum walk distance. Thus, walk times are capped at 0.5 miles.

As a further check on walk links in comparisons to those used in the original model development, a comparative distribution of walk links was prepared as illustrative in Figure 2-9. As shown, the distributions are quite similar. The current set of walk links produced by BLDCON2 contains approximately 200 fewer links -- 2,800 versus 3,000. The overall average walk distance is now 3.3 miles, versus 3.1 miles for the model development set.



DISTRIBUTION OF WALK LINKS
60.0
50.0
40.0
30.0
20.0
10.0
0.0
PERCENT OF LINKS
1
2
3
4
5
DISTANCE (0.1 MI)
'80 CSI
MGS-5 ONLY

Figure 2-9

2.4 ANALYSIS OF POTENTIAL WALK-ACCESS BIAS

Because of the concern that automated coding of walk access might result in biased estimates of transit patronage, especially rail transit patronage, an extensive analysis was made of the potential for such bias. Ideally the analysis would have been based on actual distribution of trip ends within zones; however, such data are not available for today, much less for the future. Nevertheless, it is possible to assess adequately this potential problem without such data. This was accomplished through two separate analyses:

1. An analysis of actual walk-access trips to show the distribution of walk-trip volumes by access distance, and

2. A theoretical analysis of the effects of alternative trip-end distributions on the estimation of walk-access trips.

2.4.1 Actual Model Results

First, it is appropriate to consider the order of magnitude of walk-access trips to rail produced in actual modeling efforts. As reported in the FEIS (Page 2-60, Table 2-3), the total number of walk-access trips to the rail for the full 18.6-mile Locally-Preferred Alternative is 131,353 out of the total 364,137 rail trips forecast. This total represents 36.1 percent of rail trips. Of these, 46,285 or 35 percent of all walk-access trips board at one of the four CBD stations. A further 35,492 board at the Alvarado and Vermont stations. The remaining 12 stations account for the balance of 49,576 walk-access trips.

A detailed analysis of several stations reveals the data shown in Table 2-3, which follows. Several important conclusions can be drawn from this. First, only one of the stations -- Universal City -- has a walk connector as long as 0.5 miles. Most stations are typically of the nature shown by Crenshaw and Cahuenga with four or five walk-access connectors ranging between 0.1 and 0.4 miles in length. Second, the largest trip volumes generally occur on the shorter walk-access links. In the case of Universal City station, the decline in volume for the longest links is quite dramatic. In the case of the Cahuenga station there is a fairly large volume of trips from the two zones at 0.4 miles, but this is the only case in which a large volume is found beyond 0.3 miles.

Because of the small size of most zones in the rail corridor (these zones having been split into multiple zones prior to any simulations of rail patronage for the FEIS and subsequent analyses), it is unlikely that there will be any long walk connectors except in the vicinity of stations between Hollywood/Cahuenga and North Hollywood, for which walk-access volumes are low anyway.

TABLE 2-3

WALK ACCESS RESULTS FOR THE LPA SIMULATIONS -- SELECTED STATIONS

HOME-BASED WORK TRIPS

Station	WALK ACCESS DISTANCE									
	0.1		0.2		0.3		0.4		0.5	
	No.	Trips	No.	Trips	No.	Trips	No.	Trips	No.	Trips
7th & Flower	6	1204* 8337*	0	- -	0	- -	0	- -	0	- -
Vermont	1	1382 706	2	1383 1966	1	869 32	0	- -	0	- -
Crenshaw	2	501 660	2	1028 1067	0	- -	0	- -	0	- -
Cahuenga	0	- -	3	1399 1870	1	110 118	2	1353 1477	0	- -
Universal City	0	-	2	337 1912	0	- -	1	109 87	1	108 88

* The first line is productions (home-based work) and the second is attractions (home-based work)

2.4.2 A Theoretical Analysis of Walk Sensitivity to Trip-End Distribution

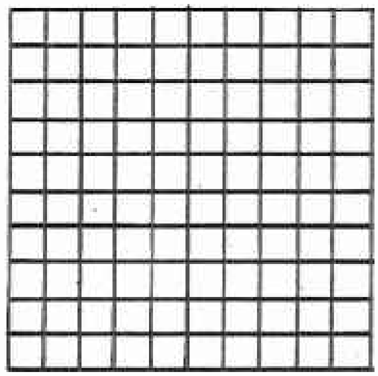
The purpose of this theoretical analysis was to determine the sensitivity of the walk-access modal split to alternative distributions of trip ends in a zone that is connected to a train station by an access link of 0.5 miles or less. The procedure used to investigate this was to apply an incremental logit model to increments of zonal trip-ends from close to the station to the furthest point in the zone. For this purpose two theoretical zones were constructed, one of which is square, while the other one is rectangular with the long side twice as long as the short side. Each of these zones is divided into squares, with the square zone consisting of 100 equal-size squares and the rectangular zone of 50 equal-size squares, as shown in Figure 2-10.

For these two zones it was assumed that the station is either at one corner of the zone (the most common location, given that zone boundaries are usually on arterial streets and stations are at the intersection of arterial streets) or midway along one side of the zone (assumed to be the short side of the rectangular zone). An examination of the zones adjacent to stations along the entire rail line from Union Station to North Hollywood indicates that these two geometric shapes and station locations are by far the most common that actual zones approximate. In the CBD all but two adjacent zones are rectangular, with the station at the corner, and the other two zones are approximately square, also with the station at the corner. A similar pattern appers along the rest of the line, with the only irregular zone shapes appearing for the Hollywood Bowl Station, Universal City, and Crenshaw. For the remaining stations most zones are rectangular with the station at the corner, but with some square zones and a location that is closer to a midpoint of the side of a zone for Wilshire/Alvarado, Fairfax/Santa Monica, Sunset/La Brea, and North Hollywood.

In each case the walk-access distance was assumed to be the true length of the centroid connector to the station. This will tend to be an overestimate for the case of a station midway along the side of the zone, because the average distance will usually have been determined to the corner of the zone. Otherwise, the assumption was a good approximation to the actual coding in the network. Starting from the station, the 50 or 100 squares in the zone are grouped, by increasing distance from the station, into 10 categories. For the two alternative zone shapes and the two alternative station locations, this categorization is shown in Figure 2-11. The access distance for each category is assumed to be the midpoint distance along the connector from the station to the farthest edge of each distance increment. Thus, in Figure 2-10(a), if the centroid distance is 0.5 miles, the first square is assumed to have an access distance of 0.05 miles, the three squares in the next increment are assumed to be 0.15 miles from the station, the five in the next increment are assumed to be 0.25 miles from the station, and so forth until the tenth category, containing 19 squares, which is assumed to be 0.95 miles from the station.

SUBDIVISION OF ZONES

(A) SQUARE



(B) RECTANGULAR

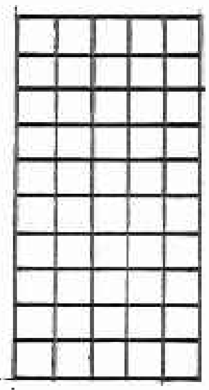


Figure 2-10

ZONE SHAPES AND STATION LOCATIONS

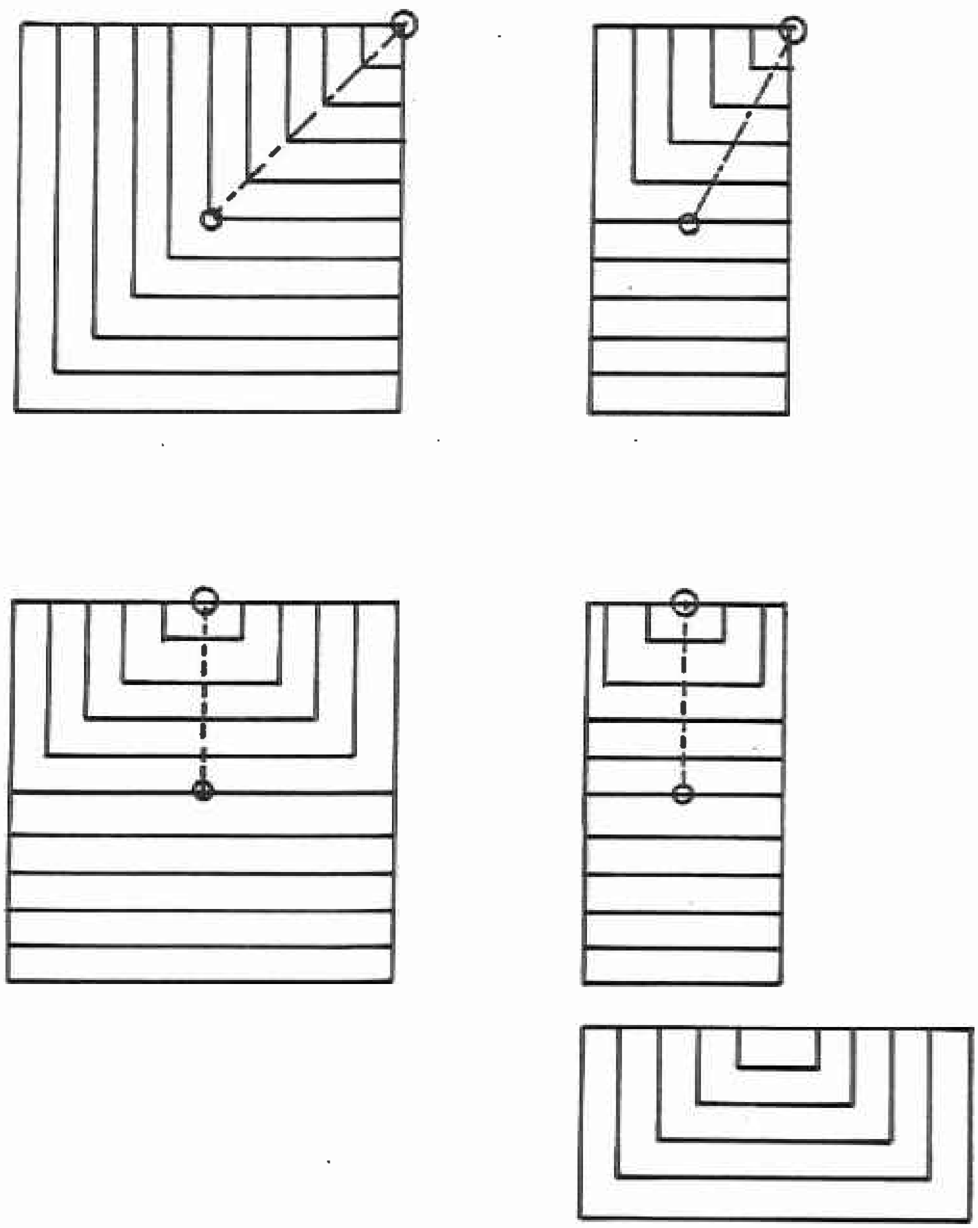


Figure 2-11

To use the incremental logit model, three alternative probabilities were assumed for the walk-access mode to rail, based on the range found in the actual data from the LPA simulation. Varying with zone and station, the range of market shares for walk-to-rail was found to be from 0.01 to 0.08, with a majority of zones in the range of 0.05 to 0.075 where walk connectors exist. The three probabilities used were, therefore, 0.01, 0.05, and 0.08. Centroid connector distances were assumed to range from 0.1 miles through 0.5 miles.

Finally, to complete the theoretical problem, five alternative distributions were assumed for trip ends in a zone. The first assumption is of a uniform trip-end density over the entire zone. The second and third are of approximately normal distributions centered on the zone centroid with significantly different standard deviations assumed relative to the zone dimensions. The fourth distribution is skewed to a side of the zone that includes the station. The fifth distribution is the same degree of skewness, but to a side of the zone as far away from the station as possible. These distributions are shown in Figures 2-12(a) through 2-12(h).

2.4.3 Summary of Results

Tables 2-4 and 2-5 summarize the results of applying the incremental logit model to varying zone shapes, station locations, centroid distances, mode shares, and trip-end distributions. Table 2-4 presents the results for a station located at the corner of a zone. The following conclusions can be drawn from this Table:

1. For a square zone and a symmetrical distribution of trip ends (i.e., uniform, normal1 or normal2), the error of using the mean probability for all trips concetrated at the centroid increases with zone size, from a minimum of about 2 percent of the transit share to a maximum of 13 percent of the transit share.

2. For a square zone and a skewed distribution, the error increases again with zone size and is much larger when the distribution is skewed to the zone side furthest from the station. In this case the error varies between six and 25 percent. When the trip-end distribution is skewed to the side closest to the station, the error ranges between one and three percent.

3. For a square zone, the errors are always overestimates.

4. For a rectangular zone with a symmetrical distribution, the error is invariant with zone size and ranges between zero and one percent for all cases. It is always an overestimate.

5. For a rectangular zone with a skewed distribution towards the station, the transit share is always underestimated by an amount that increases with zone size from three to 18 percent.

6. For a rectangular zone with a skewed distribution away from the station, the transit share is always overestimated by an amount that increases with zone size from five to 20 percent.

TRIP END DISTRIBUTIONS

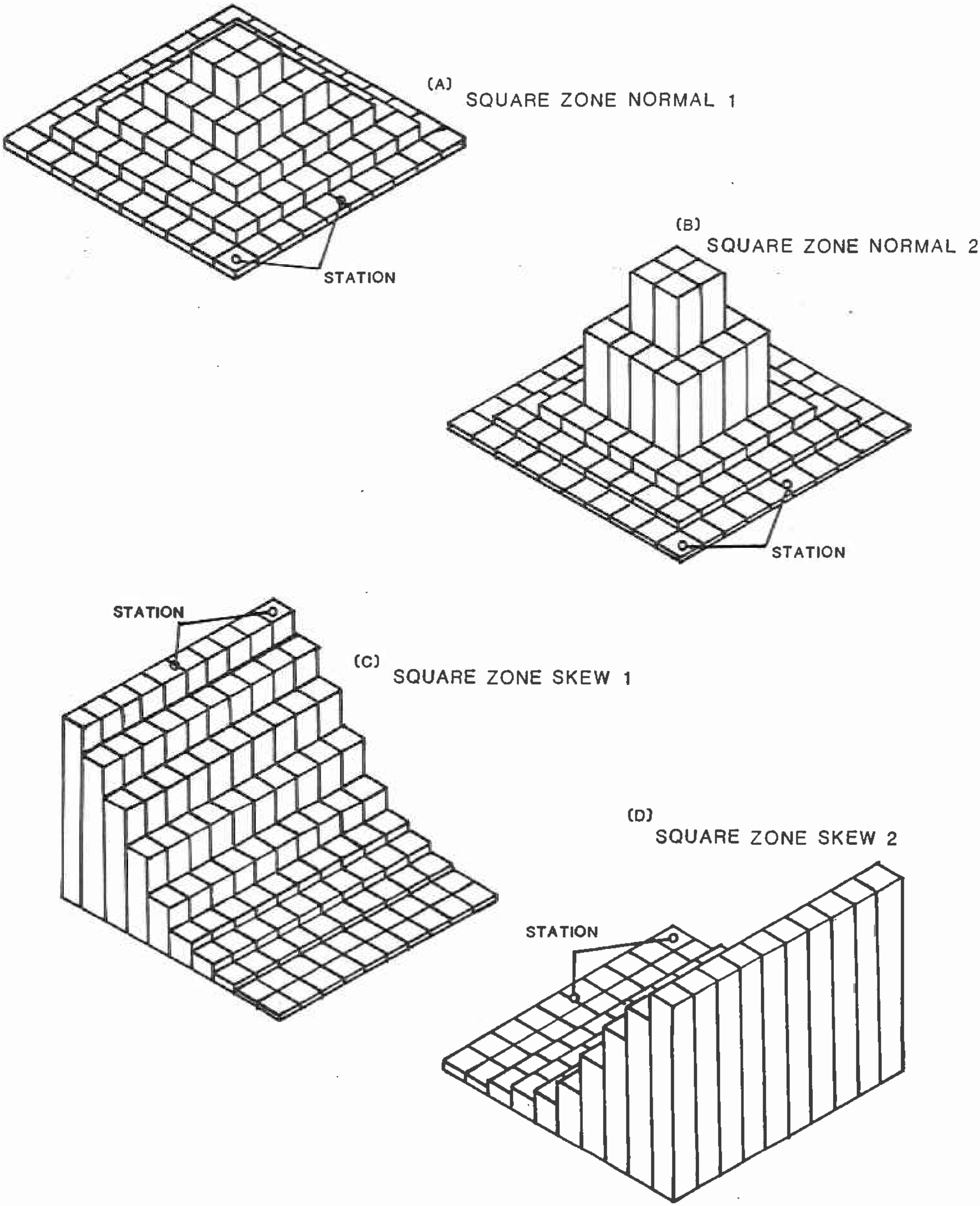
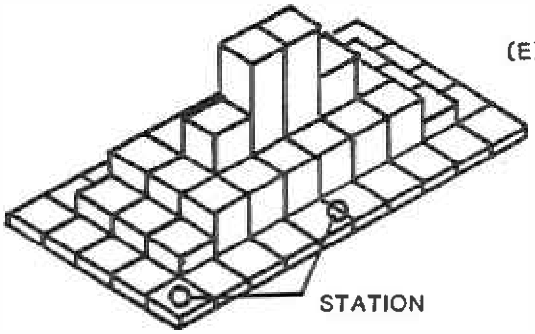
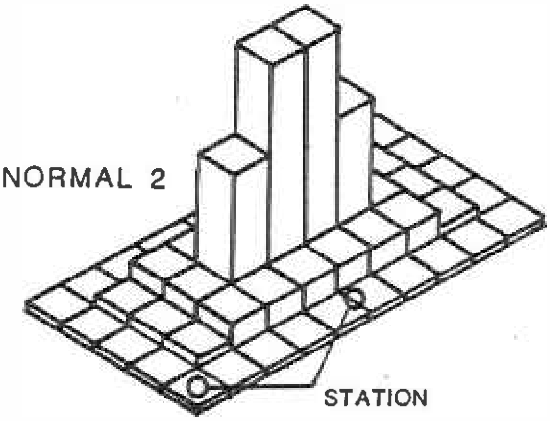


Figure 2-12

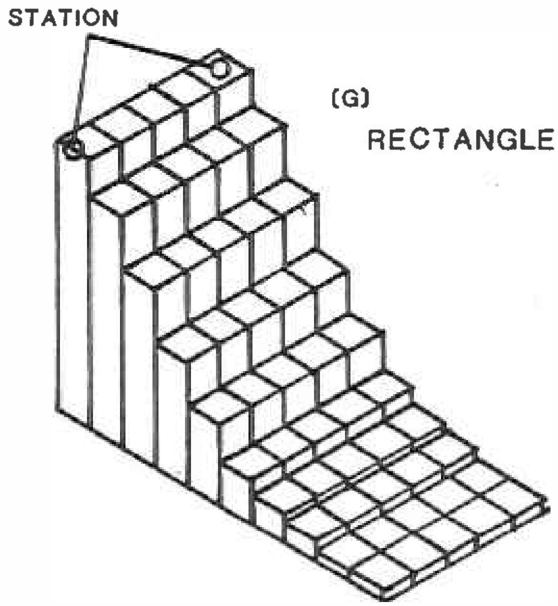
TRIP END DISTRIBUTIONS



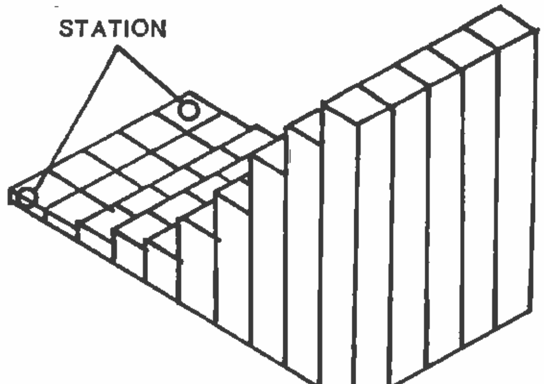
(E)
RECTANGLE ZONE NORMAL 1



(F)
RECTANGLE NORMAL 2



(G)
RECTANGLE SKEW 1



(H)
RECTANGLE SKEW 2

Figure 2-12 (Cont.)

TABLE 2-4

SENSITIVITY OF WALK ACCESS TO TRIP-END DISTRIBUTION

STATION LOCATED AT ZONE CORNER

Zone Geometry	Centroid Distance	Ave. Prob.	Distribution: Uniform	Normal1	Normal2	Skew1	Skew2
Square	0.1	0.01	.0097(3%)	.0098(2%)	.0098(2%)	.0099(1%)	.0094(6%)
Square	0.1	0.05	.0483(3%)	.0488(2%)	.0491(2%)	.0494(1%)	.0471(6%)
Square	0.1	0.08	.0774(3%)	.0782(2%)	.0785(2%)	.0791(1%)	.0755(6%)
Rectangular	0.1	0.01	.0099(1%)	.0100(0%)	.0100(0%)	.0103(3%)	.0095(5%)
Rectangular	0.1	0.05	.0496(1%)	.0499(0%)	.0499(0%)	.0515(3%)	.0477(5%)
Rectangular	0.1	0.08	.0794(1%)	.0798(0%)	.0799(0%)	.0823(3%)	.0764(5%)
Square	0.2	-	(6%)	(5%)	(4%)	(2%)	(11%)
Rectangular	0.2	-	(1%)	(0%)	(0%)	(7%)	(9%)
Square	0.3	-	(9%)	(7%)	(5%)	(3%)	(16%)
Rectangular	0.3	-	(1%)	(0%)	(0%)	(13%)	(17%)
Square	0.4	-	(11%)	(8%)	(7%)	(3%)	(21%)
Rectangular	0.4	-	(1%)	(0%)	(0%)	(13%)	(17%)
Square	0.5	0.01	.0086(14%)	.0090(10%)	.0092(8%)	.0097(3%)	.0075(25%)
Square	0.5	0.05	.0433(13%)	.0450(10%)	.0459(8%)	.0486(3%)	.0376(25%)
Square	0.5	0.08	.0694(13%)	.0721(10%)	.0736(8%)	.0776(3%)	.0606(24%)
Rectangular	0.5	0.01	.0099(1%)	.0100(0%)	.0101(1%)	.0118(18%)	.0080(20%)
Rectangular	0.5	0.05	.0495(1%)	.0501(0%)	.0502(0%)	.0587(17%)	.0400(20%)
Rectangular	0.5	0.08	.0790(1%)	.0800(0%)	.0800(0%)	.0933(17%)	.0644(20%)

TABLE 2-5

SENSITIVITY OF WALK ACCESS TO TRIP-END DISTRIBUTION

STATION LOCATED AT MIDWAY ALONG ZONE SIDE

Zone Geometry	Centroid Distance	Ave. Prob.	Distribution				
			Uniform	Normal1	Normal2	Skew1	Skew2
Square	0.1	0.01	.0099(1%)	.0100(0%)	.0098(2%)	.0103(3%)	.0095(5%)
Square	0.1	0.05	.0496(1%)	.0499(0%)	.0491(2%)	.0515(3%)	.0477(5%)
Square	0.1	0.08	.0794(1%)	.0798(0%)	.0786(2%)	.0823(3%)	.0764(5%)
Rectangular	0.1	0.01	.0100(0%)	.0100(0%)	.0100(0%)	.0105(5%)	.0095(5%)
Rectangular	0.1	0.05	.0500(0%)	.0500(0%)	.0522(4%)	.0522(4%)	.0477(5%)
Rectangular	0.1	0.08	.0800(0%)	.0800(0%)	.0800(0%)	.0834(4%)	.0765(5%)
Square	0.2	-	(1%)	(0%)	(4%)	(6%)	(9%)
Rectangular	0.2	-	(0%)	(0%)	(0%)	(9%)	(9%)
Square	0.3	-	(1%)	(0%)	(5%)	(10%)	(13%)
Rectangular	0.3	-	(1%)	(1%)	(0%)	(14%)	(12%)
Square	0.4	-	(1%)	(0%)	(7%)	(13%)	(16%)
Rectangular	0.4	-	(2%)	(1%)	(0%)	(20%)	(16%)
Square	0.5	0.01	.0099(1%)	.0101(1%)	.0092(8%)	.0118(18%)	.0080(20%)
Square	0.5	0.05	.0495(1%)	.0503(1%)	.0460(8%)	.0587(17%)	.0400(20%)
Square	0.5	0.08	.0790(1%)	.0803(1%)	.0737(8%)	.0933(17%)	.0644(20%)
Rectangular	0.5	0.01	.0103(3%)	.0102(2%)	.0101(1%)	.0127(27%)	.0080(20%)
Rectangular	0.5	0.05	.0515(3%)	.0511(2%)	.0504(1%)	.0628(26%)	.0404(19%)
Rectangular	0.5	0.08	.0820(3%)	.0815(2%)	.0805(1%)	.0996(25%)	.0649(19%)

Table 2-5 presents the results for a station located on the side of a zone. The following conclusions can be drawn from this Table:

1. For a square zone and a symmetrical distribution of trip-ends (i.e., uniform, normal1 or normal2), the error of using the mean probability for all trips concentrated at the centroid is invariant with zone size (except for the normal2 distribution) and is around one percent. In the case of the steeper normal distribution, the error varies from two percent in a small zone to eight percent in a large zone. These distributions give rise to the mean probability being an overestimate in all cases.

2. For a square zone and a skewed distribution, the error increases with zone size and is much larger when the distribution is skewed to the zone side farthest from the station. In this case the error varies between five and 20 percent and shows that the mean is an overestimate. When the trip-end distribution is skewed to the side closest to the station, the error ranges between three and 18 percent and is an underestimate.

3. For a rectangular zone with a symmetrical distribution, the error increases with zone size and ranges between zero and three percent with an overestimate in the smallest zones to an underestimate for zones larger than 0.2 miles for the centroid connector.

4. For a rectangular zone with a skewed distribution towards the station, the transit share is always underestimated by an amount that increases with zone size from five to 27 percent.

5. For a rectangular zone with a skewed distribution away from the station, the transit share is always overestimated by an amount that increases with zone size from five to 20 percent.

In general, the Tables indicate that only the extreme distributions (skewed) for the larger zone sizes produce errors in excess of ten percent of the transit market share. Further, if the trip ends in a zone are skewed to the side of the zone nearest to the station, then use of the average walk distance will underestimate the transit share of trips in all cases.

2.4.4 Extension of the Theoretical Results to Actual Zones

The implications of the theoretical work in the preceding section are seen most clearly by applying them to the selected stations described in section 2.4.1. Accordingly, the zones around those stations have been classified to approximate the theoretical shapes and distributions and the approximate errors in trips computed. The results of this are shown in Table 2-6.

In all cases in Table 2-6, the worst case has been assumed whenever there is any question of the appropriate case to apply to a zone. Thus, when a zone is an irregular shape, a square zone is assumed because the errors for a square zone are generally larger than for a

TABLE 2-6

APPLICATION OF THE THEORETICAL RESULTS TO SAMPLED STATION ZONES

Station	Zone	Dist.	Approx. Shape	Station Location	Distribution	%Error	Error in Trips Ps	As
7th/Flower	715	0.1	Rect.	Corner	Uniform	-1	-6	-12
	716	0.1	Square	Corner	Uniform	-3	-1	-96
	1563	0.1	Square	Corner	Uniform	-3	-12	-43
	1567	0.1	Rect.	Corner+	Uniform	-1	*	-12
	1568	0.1	Rect.	Corner	Uniform	-1	-1	-13
Station Total							-20	-176
Vermont	394	0.1	Square	Corner	Skewl	-1	-14	-7
	1409	0.3	Rect.	Corner*	Uniform	-1	*	-9
	1410	0.2	Rect.	Corner	Skewl	+7	+34	+63
	1427	0.2	Square	Corner	Skewl	-2	-18	-21
Station Total							+2	+26
Crenshaw	391	0.2	Rect.	Corner	Skewl	+7	+49	+34
	392	0.2	Rect.	Corner	Skewl	+7	+23	+40
	1403	0.1	Rect.	Corner+	Skewl	+3	+7	+10
	1424	0.1	Square	Corner	Skewl	-1	-3	-3
Station Total							+76	+81
Hollywood/ Cahuenga	343	0.3	Irreg.	Corner+	Normall	-2	-2	-2
	352	0.2	Irreg.	Corner+	Uniform	-6	-7	-7
	353	0.2	Square	Corner+	Uniform	-6	-51	-62
	1383	0.4	Irreg.	Corner	Uniform	-9	-91	-50
	1384	0.4	Rect.	Corner	Uniform	-1	-3	-9
	1386	0.2	Rect.	Corner	Uniform	-1	-4	-7
Station Total							-158	-137
Universal City	276	0.5	Irreg.	Corner	Skewl	-3	-3	-3
	1364	0.2	Rect.	Side	Skewl	+9	+30	+18
	1365	0.2	Irreg.	Corner	Skewl	-2	0	-34
	1366	0.4	Irreg.	Corner+	Uniform	-14	-14	-12
Station Total							+13	-21

* Less than 1 trip

\+ No station on zone boundary -- corner assumed for error calculation rectangular zone. When the station is not on the boundary of a connected zone it is assumed that the most appropriate locational pattern is represented by the corner station, which has larger errors than the side station. Distributions of trip ends are assumed on the basis of the development patterns of the zones. Generally, CBD zones are approximately uniform, while zones along a major arterial, such as Wilshire Boulevard, have a trip-end distribution that is skewed to the arterial. In only one or two cases are zones assumed to have some other distribution than this.

The five stations analyzed here have 28,103 home-based work, walk-access trips reported in Table 2-3. This represents 21.14 percent of the total walk-access transit trips projected for the Locally-Preferred Alternative. Table 2-6 shows a total error of -314 walk access trips, indicating that the method of using the zone centroid with no distributional information on trip ends and access to the station has resulted in an overestimate of approximately 314 trips, or 1.117 percent of the projected walk-access trips. Applying that error to the total of walk-access trips indicates a potential error of 1,468 walk-access trips, which in turn suggests a maximum overestimate of rail patronage by this figure. In fact, the overestimate is probably less than this because, under a different access treatment, some of the trips estimated to be walk-access from the current coding convention would have occurred as bus access, while the balance probably would not be rail trips. It should also be noted that the method used by SCRTD for walk-access coding underestimated walk-access trips in two cases (Vermont and Crenshaw), overestimated in two cases (7th & Flower and Hollywood/Cahuenga, and gave a mixed result in one case (Universal City). Therefore, the simple expansion of the results of these five stations is somewhat questionable and the reality may be of a smaller overestimate of walk-access trips.

It may be concluded from these analyses that the automated coding of walk-access does not introduce any significant bias in patronage forecasts as long as consistency is maintained between the coding procedures used in the forecast network compared to those used for model development.

3. EXOGENOUS INPUTS

3.1 OVERALL PURPOSE

Given the different agency responsibilities in the Los Angeles area, the SCRTD does not develop all of the travel forecasts for the region, nor many of the specific forecasts of other data used in the travel-forecasting process. Instead, it is the responsibility of other agencies in the region to provide various elements of input information to SCRTD from which transit patronage forecasts can be made. These inputs include trip tables by purpose, trip-end data for modal-split modeling, trip-end data for mode-of-arrival modeling, and characteristics of the highway system.

As part of this project, an evaluation was undertaken of these various items of input, with a view to providing a more complete understanding of the patronage-estimation results as well as to ensure that there is explicity agreement on the basis from which the forecasts have been drawn.

3.2 TRIP GENERATION AND DISTRIBUTION

The trip-generation and trip-distribution models establish the base person-trip movements to be used in estimating transit demand. The ability of existing trip-generation and trip-distribution models to replicate data from the base year (1980) indicates that the models can be used with confidence as the basis for transit alternatives analysis and the development of Environmental Impact Statements for transit improvements. SCAG provided 1980 trip tables, and these were analyzed during the fall of 1982. Subsequently, in March 1983 a new set of 1980 trip tables was provided, based on the latest available census data, and these were then subjected to the same analyses. The trip tables represent, of course, the output of the trip-generation and trip-distribution models.

To validate the models, a series of seven screenlines was established across which both model-produced trips and data obtained from highway ground counts and transit passenger counts were accumulated. The counts are the standard against which the model results are compared. A comparison of the initial trip tables for 1980 with the ground count indicated that the model results were 13.0 percent high across all screenlines in total. Individual screenline differences varied from -3.8 percent to +33.4 percent. The major differences were across the two easternmost screenlines (#16 and #12 in Figure 3-1). Similar results were found for the second set of 1980 trip tables, with the average difference being -27.3 percent and the range being from -5.8 percent to -50.5 percent. The major differences were found on screenlines 16, 15, and 12 in this case.

The results from the screenline tests cannot be considered exact, given the methods for developing count data. Both highway and transit counts were used, with the highway counts being converted to highway person trips using both truck volume percentages and average auto

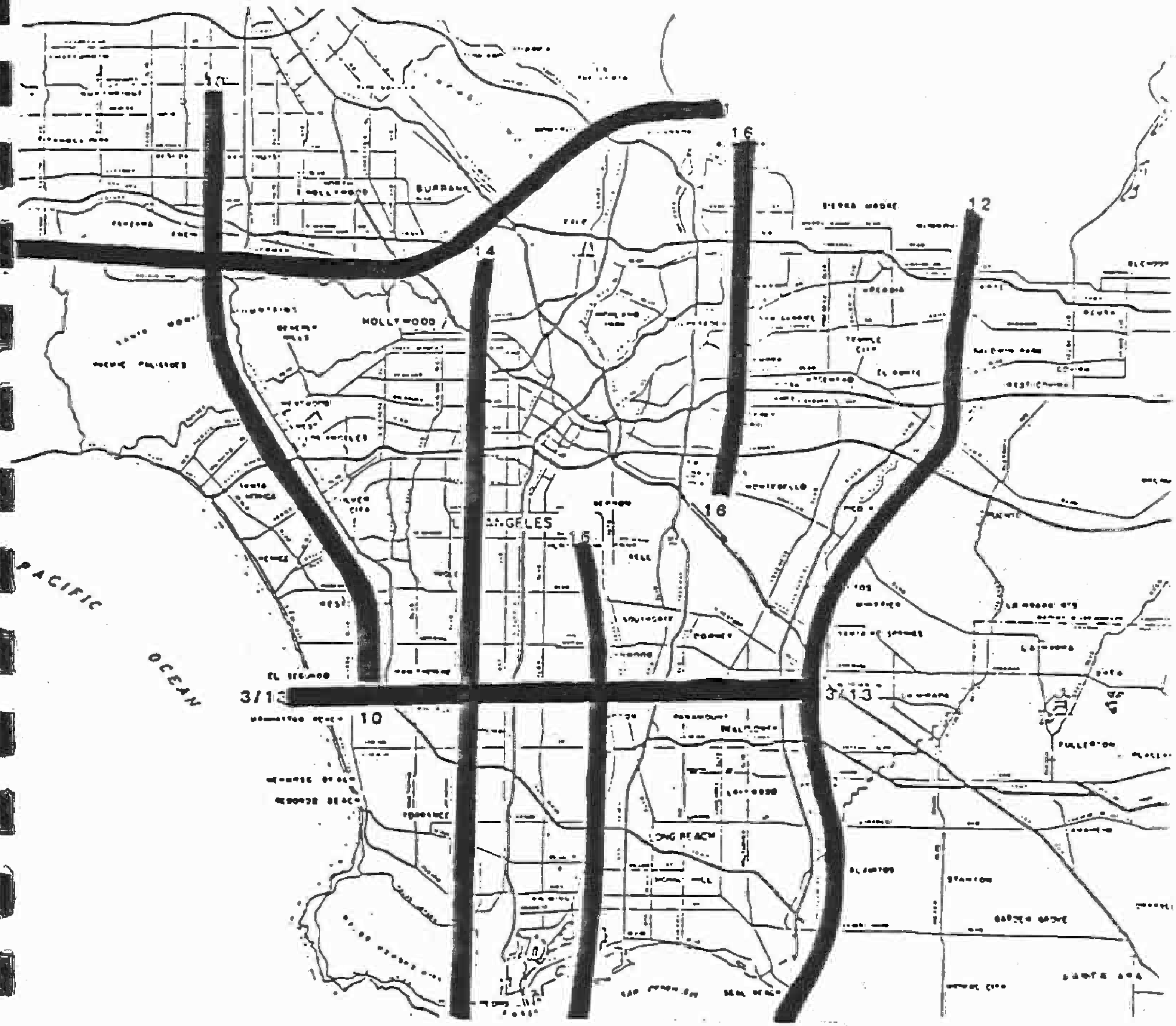


FIGURE 3-1
SCREENLINE LOCATIONS WITHIN LOS ANGELES COUNTY

occupancies. Three primary sources were used for highway counts on all arterials and freeways crossing the screenlines: the 1980 traffic volume publications of the City of Los Angeles, the County of Los Angeles, and CALTRANS. The first two books contain average weekday volumes, while the CALTRANS counts were seven-day counts for which a factor provided by CALTRANS was used to convert to average weekday volumes.

Truck volume percentages were provided by CALTRANS for freeways, and an average value of 3.0 percent, recommended by CALTRANS staff, was used for arterials because no percentages were available on a facility-by-facility basis. An auto occupancy of 1.4 was assumed on all screenlines based on a number of studies within Los Angeles County and for the Metropolitan area.

Some sensitivity tests were run to validate the counts. Truck percentages were varied between one-half and twice the values given by CALTRANS, and auto occupancy was varied between 1.2 and 1.6. These altered values changed the performance of the screenlines, but in no case provided any evidence that a significant departure from the assumed values would lead to closer approximation to screenline volumes, nor that subsequent findings could be affected to any great extent by these assumptions.

Several methods were considered for improving the trip-table results:

- Use of special generators in the trip-generation phase
- Balancing of attractions in the gravity-model application (subsequently adopted by SCAG)
- Use of gravity-model "f"-factor curves that vary by location within the region
- Collection of new data to permit recalibration of the gravity model and possible development of K-factors
- Review of the policy speeds in the table used to develop link speeds

A basic requirement in selection of a method was that compatibility be maintained among the forecasting procedures used by the planning agencies in the region. Also, the regional control total on the number of trips was to be preserved. It was deemed unacceptable for SCRTD to use models or control totals for trip generation and distribution that differed from those being used by SCAG and CALTRANS. One method that was rejected was the use of zonal K-factors in the Gravity Model of trip distribution. Theoretically and conceptually, such factors are undesirable because they simply represent a factor that alters individual trip interchanges from what the model estimates to what was observed. Nevertheless, in a region as large and complex as Los Angeles, K-factors can be justified. They were not used in this case because the calibration data for the gravity model were not available to SCRTD, and recent data for 1980 or 1982 against which up-to-date K-factors could be estimated have not been collected.

The only immediate change implemented by SCAG was to employ attraction-balancing in the trip-distribution process. This change resulted in substantially different trip-distribution patterns, especially to the Los Angeles CBD. In fact, this change in person-trip distribution necessitated recalibration of the mode choice models -- eliminating the need for a special CBD bias factor -- as described in chapter 5.

Results of the revised trip distribution are summarized in Tables 3-1 through 3-5. The process for creating the new, recommended person-trip tables is documented in the form of a data-processing flow chart in Appendix 3-1. This appendix includes the steps required for conversion of 1,325-zone matrices to 1,628-zone matrices. Both 1980 and year 2000 trip-distribution runs are documented in Appendix 3-1, as is the creation of highway skims for mode choice model input.

3.3 TRIP-END DATA

Trip-end data of various types are used in both the mode choice and the mode-of-arrival models. The effects of these data items can be quite significant, depending on the form of the models in current use. For example, the zonal parking costs for each of work and nonwork trips are an input to the mode choice models. Although the work mode choice model is not very sensitive to the auto parking costs, the nonwork mode choice model is highly sensitive. In some initial model runs it was found that halving the forecast increase in parking costs for the nonwork trips decreased rail trips by about 30 percent. As a result of this sensitivity, the trip-end data, both for 1980 and for the year 2000, were scrutinized carefully to determine their reasonableness and to provide a basis for assessing the results of the model applications.

Following is a summary of a statistical analysis for key exogenous variables. Four basic statistical tools were used to evaluate the relationship between 1980 values and the year 2000 values.

1. Frequency counts and percentages;
2. Pearson correlation coefficients;
3. t-test; and
4. SPSS-generated scatterplot diagrams for 1980 versus year 2000.

Details of this analysis are presented in Technical Memorandum 3.1.3, Analysis of and Recommendations for Exogenous Variable Forecasting Techniques, April 1986.

A summary of the results of the Pearson correlation and t-test is found in Table 3-6. These indicators, in concert with the scatterplots of key exogenous variables, reveal trends in current forecasting techniques. Each key variable is discussed below in detail.

TABLE 3-1

AVERAGE TRIP LENGTHS (IN MINUTES) - YR 1980

Trip Purpose	SCRTD Revised Trip Tables (FAR80VAL flwchrt)	SCRTD Old Trip Tables (FAR82VAL flwchrt)	SCAG
Home Based Work	22.49	24.15	22.17
Other to Work	18.16	22.46	18.56
Home Based Other	12.66	11.09	12.99
Other to Other	10.94	14.70	11.56
Home Based Shop	10.23	14.87	10.96

TABLE 3-2

PERSON TRIP SCREENLINE CROSSING CHECK - YR 1980

Screen Line#	SCRTD Revised Trip Tables (FAR80VAL flwchrt)	SCRTD Old Trip Tables (FAR82VAL flwchrt)
1	+9.4%	+0.7%
3/13	+9.5%	+0.6%
10	+1.52%	-6.6%
12	+25.80%	+11.9%
14	+15.34%	+4.6%
15	+19.08%	+28.6%
16	+28.64%	+30.7%
TOTAL	+15.41%	+11.0%

TABLE 3-3

AVERAGE TRIP LENGTHS (IN MINUTES) - YR 2000

Trip Purpose	SCRTD Revised Trip Tables (FAR20LPW flwchrt)	SCRTD Old Trip Tables (FAR00VAL flwchrt)	SCAG
Home Based Work	22.86	24.60	23.02
Other to Work	18.30	19.63	18.89
Home Based Other	13.10	7.95	13.58
Other to Other	10.72	9.62	11.41
Home Based Shop	10.91	11.15	12.06

TABLE 3-4

PERSON TRIP TABLE CHARACTERISTICS - YR 1980

	SCRTD Revised Trip Tables (FAR80VAL flwchrt)	SCRTD Old Trip Tables (FAR82VAL flwchrt)	SCAG
REGIONAL TRIP MAKING			
Total HBW Trips	7041435	7041433	7041422
Intrazonal	469544	448838	468341
Intrazonal (%)	(6.67)	(6.37)	(6.65)
Total HBO Trips	20190139	20190125	20190170
Intrazonal	4073809	4412868	4066519
Intrazonal (%)	(20.18)	(21.86)	(20.14)
Total OO Trips	8396533	8396479	8396507
Intrazonal	2003669	1315610	1979657
Intrazonal (%)	(23.86)	(15.67)	(23.58)
Total OW Trips	3306501	3306500	3306501
Intrazonal	391460	266467	390851
Intrazonal (%)	(11.84)	(08.06)	(11.82)
All Purposes Comb.	38934608	38934537	38934600
Intrazonal	6938482	6443783	6905368
Intrazonal (%)	(17.82)	(16.55)	(17.74)
TRIPS PRODUCED FROM OUTSIDE THE LA CBD AND ATTRACTED TO THE LA CBD			
Total HBW Trips	274253	271726	276122
Total HBO Trips	422679	410977	428606
Total OO Trips	103261	186214	104202
Total OW Trips	79676	119370	80136
All Purposes Comb.	879869	988287	889066

(CONTINUED)

TABLE 3-4 (CONTINUED)

PERSON TRIP TABLE CHARACTERISTICS - YR 1980

	SCRTD Revised Trip Tables (FAR80VAL flwchrt)	SCRTD Old Trip Tables (FAR82VAL flwchrt)	SCAG
TRIPS PRODUCED FROM THE LA CBD AND ATTRACTED TO OUTSIDE THE LA CBD			
Total HBW Trips	10589	10037	10581
Total HBO Trips	23363	18870	23648
Total OO Trips	100321	10241	99992
Total OW Trips	67521	4531	67377
All Purposes Comb.	201794	43679	201598
TRIPS PRODUCED FROM AND ATTRACTED WITHIN THE LA CBD (INTRA CBD TRIPS)			
Total HBW Trips	7096	7648	7103
Intrazonal	1053	820	1074
Intrazonal (%)	(14.84)	(10.72)	(15.12)
Total HBO Trips	24320	28812	24034
Intrazonal	5626	4252	5829
Intrazonal (%)	(23.13)	(14.76)	(24.25)
Total OO Trips	90325	11304	90651
Intrazonal	42279	1443	42969
Intrazonal (%)	(46.81)	(12.77)	(47.40)
Total OW Trips	43613	4134	43754
Intrazonal	10498	456	10707
Intrazonal (%)	(24.07)	(11.03)	(24.47)
All Purposes Comb.	165354	51898	165542
Intrazonal	59456	6971	59505
Intrazonal (%)	(35.96)	(13.43)	(35.95)

TABLE 3-5

PERSON TRIP TABLE CHARACTERISTICS - YR 2000

	SCRTD Revised Trip Tables (FAR201pw flwchrt)	SCRTD Old Trip Tables (FAR001pw flwchrt)	SCAG
REGIONAL TRIP MAKING			
Total HBW Trips	9236240	9236240	9236202
Intrazonal	696054	668764	692321
Intrazonal (%)	(7.54)	(7.24)	(7.50)
Total HBO Trips	26238848	26239159	26239153
Intrazonal	5816189	4660258	5838404
Intrazonal (%)	(22.17)	(17.76)	(22.25)
Total OO Trips	10994119	10994129	10994001
Intrazonal	3034274	1785336	3018804
Intrazonal (%)	(27.60)	(16.24)	(27.46)
Total OW Trips	4341640	4341642	4341630
Intrazonal	601589	598038	589906
Intrazonal (%)	(13.86)	(13.77)	(13.59)
All Purposes Comb.	50810190	50804048	50810986
Intrazonal	10148106	7712396	10139435
Intrazonal (%)	(19.97)	(15.18)	(19.96)
TRIPS PRODUCED FROM OUTSIDE THE LA CBD AND ATTRACTED TO THE LAC CBD			
Total HBW Trips	337001	333217	342468
Total HBO Trips	464622	442451	470769
Total OO Trips	110589	121979	114288
Total OW Trips	93429	88475	100011
All Purposes Comb.	1005641	986122	1027536

(CONTINUED)

TABLE 3-5 (CONTINUED)

PERSON TRIP TABLE CHARACTERISTICS - YR 2000

	SCRTD Revised Trip Tables (FAR201pw flwchrt)	SCRTD Old Trip Tables (FAR001pw flwchrt)	SCAG
TRIPS PRODUCED FROM THE LA CBD AND ATTRACTED TO OUTSIDE THE LA CBD			
Total HBW Trips	12227	11451	12881
Total HBO Trips	29429	24778	29683
Total OO Trips	108801	118790	107895
Total OW Trips	71832	67959	74717
All Purposes Comb.	222289	222978	225176
TRIPS PRODUCED FROM AND ATTRACTED WITHIN THE LA CBD (INTRA CBD TRIPS)			
Total HBW Trips	10240	11016	9586
Intrazonal	1474	1146	1425
Intrazonal (%)	(14.39)	(10.40)	(14.87)
Total HBO Trips	30349	35001	30095
Intrazonal	7451	4162	7697
Intrazonal (%)	(24.55)	(11.89)	(25.58)
Total OO Trips	92516	82531	93423
Intrazonal	40133	16091	41047
Intrazonal (%)	(43.40)	(19.50)	(43.94)
Total OW Trips	56125	60000	53238
Intrazonal	11873	9764	11538
Intrazonal (%)	(21.15)	(16.27)	(21.67)
All Purposes Comb.	189230	188548	186342
Intrazonal	60931	31163	61707
Intrazonal (%)	(32.20)	(16.53)	(33.11)

TABLE 3-6

COMPARISON OF EXOGENOUS VARIABLES: YEAR 1980 TO YEAR 2000

Variable	Value Type	Pearson Correlation Value	Pearson Correlation Effect	T-Test Student's "T" Value	T-Test Student's "T" Effect	Conclusion
HHTOTAL	Value	0.83	Large Difference	-21.3	Increase	Distribution changed, shift in values
EMPL	Value	0.90	Change	-17.4	Increase	Slight change in distribution, shift in values
POP	Value	0.82	Change	-17.4	Increase	Distribution changed, shift in values
HHSIZE	Rate	0.96	Change	24.5	Drop	Distribution same values decreased shift in values
AUTPER	Rate	0.89	Change	-14.3	Drop	Distribution changed slightly, increase in values
AUTOTOT	Rate	0.98	Same	- 0.7	Same	Base Values = Future values
LDRVTOT	Rate	0.94	Same	1.98	Drop	Distribution of rates changed slightly, values same
WORKERT	Rate	0.99	Same	-95.10	Big Increase	Distribution same, large increase of values
INCMTOT	Rate	0.99	Same	-30.92	Increase	Distribution same, rates increased
HWYTERT	Value	1.00	Same	0	Same	Base Values = Future Values
PRKSCTW	Value	0.96	Slight Change	-10.7	Increase	Distribution same, shift in values
PRKSCTN	Value	0.98	Same	- 6.6	Increase	Distribution same, shift in values

Note: All Pearson correlations are significant beyond 99.9%.

3.3.1 Total Households, Employment, Population

The following provides some background information related to the changing demographics in the region for the purpose of subsequent discussions on highway terminal time, parking costs, and market segment variables.

3.3.1.1 Households (HHTOTALB (1980) and HHTOTALF (2000))

The number of households within the SCAG region has increased from 1980 to the year 2000. The mean number of households per zone increased from 3,185 in 1980 to 4,181 in the year 2000. A Pearson correlation of 0.83 reveals that a uniform factor was probably applied to most zones to project year 2000 values from 1980 households, while a minority of zones were projected with a variety of other factors. The t-statistic of -21.3 indicates that this factor increased 1980 values considerably overall.

The scatterplot diagram of households for 1980 versus year 2000 illustrates that households either increased or stayed generally the same. The cluster of points below the equivalency line indicates that a uniform factor was applied to increase 1980 values.

3.3.1.2 Employment (EMPLB (1980) and EMPLF (2000))

Employment throughout the SCAG region has also increased in the year 2000. The mean number of employees per zone increased from 4,117 in 1980 to 5,568 in the year 2000. A Pearson correlation of 0.90 reveals that a generally uniform factor was applied to 1980 values to project year 2000 employment. A t-statistic of -17.4 indicates that this factor considerably increased employment for the year 2000.

The scattergram of 1980 versus the year 2000 employment illustrates that employment in most zones stayed approximately the same, as shown by the tight cluster of points adjacent to the equivalency line. The sprinkling of points below the equivalency line are the few zones which experienced a dramatic increase in employment. Hence, existing employment centers are projected to be growing while some new employment centers are forecast to appear throughout the region.

3.3.1.3 Population (POPB (1980) and POPF (2000))

Population within zones throughout the SCAG region increases considerably. The mean population per zone in 1980 is 8,432 whereas the mean population in the year 2000 is 10,590. A Pearson coefficient of 0.82 indicates that a uniform factor was applied to most zones throughout the region, and the t-statistic of -17.4 indicates that many of these changes represent considerable increases.

3.3.2 Household Size and Autos Per Person (HHSIZEB (1980) and HHSIZEF (2000))

3.3.2.1 Household Size

Household size is defined by the number of persons per household. The mean household size decreased from 2.60 in 1980 to 2.46 in the year 2000. The Pearson correlation coefficient of 0.96 reveals that 1980 and year 2000 values are related in a linear fashion. A t-statistic of 24.5 further indicates that household size has decreased considerably.

3.3.2.2 Autos Per Person (AUTOPERB (1980) and AUTPERF (2000))

The number of autos per person per zone increased considerably from 1980 to the year 2000, as the mean number of autos per person increased from 0.74 in 1980 to 0.79 in the year 2000. A Pearson coefficient of 0.89 indicates that 1980 values are unrelated to year 2000 projected values. The t-statistic of -14.3 defines a considerable increase in the number of autos per person over the region.

3.3.3 Market Segment Variables

Four market segment variables are used in the CSI models which describe the socioeconomic nature of an average household in each zone, segmented by auto ownership and walk accessibility to available transit. These variables include number of autos owned per household, number of licensed drivers per household, workers per household, and income per household.

3.3.3.1 Number of Autos Owned Per Household (AUTOTOTB (1980) and AUTOTOF (2000))

The number of autos owned per household for each zone for all market segments stayed virtually the same from 1980 to the year 2000. The mean number of autos owned for 1980 is 1.959 and for the year 2000 it is 1.961. In addition, the Pearson coefficient of 0.98 and the t-statistic of -0.7 indicate that the number of autos owned remained essentially constant among all zones.

The scatterplot of 1980 versus 2000 values clearly illustrates these unchanged values, since almost all points on the plot are tightly grouped around the equivalency line.

3.3.3.2 Number of Licensed Drivers Per Household (LDRVTOTB (1980) and LDRVTOTF (2000))

The number of licensed drivers per household for all market segments also remained constant from 1980 to 2000. The mean number of licensed drivers dropped only slightly from 1.91 in 1980 to 1.90 in 2000. Likewise, the Pearson coefficient of 0.94 and the t-statistic of 1.98 indicate little if any change between the two years.

The scatterplot for this variable also illustrates the consistency from 1980 to 2000, since almost all points fit tightly around the equivalency line.

3.3.3.3 Workers per Household (WORKERTB (1980) and WORKERTF (2000))

The number of workers per household for all market segments increased dramatically from 1980 to the year 2000 as the mean increased from 1.36 in 1980 to 1.48 in 2000. This considerable increase is further substantiated by the t-statistic of -95.10. However, since the Pearson coefficient is 0.99, all zones experience the same increase. Hence, the number of workers per household increased by the same rate for all zones within the region.

The scatterplot clearly illustrates the consistency of increases for all zones since almost all points are tightly grouped. In addition, the actual increase is illustrated by the grouping of points which are noticeably shifted toward the higher year 2000 values or below the equivalency line.

3.3.3.4 Income Per Household (INCMTOTB (1980) and INCMTOTF (2000))

The income per household for all market segments also increased from 1980 to 2000, as expected. The mean income increased from 17,162 in 1980 to 18,228 in 2000. This increase is also substantiated by a high t-statistic of -30.92. Almost all zones experienced an increase and at the same rate, as indicated by a Pearson coefficient of 0.99. Therefore, it appears that almost all zones experienced a straight-line increase from 1980 to 2000.

The scattergram also substantiates these findings. An overall increase in income among all zones is illustrated by the location of points shifted below the equivalency line toward the higher year 2000 values. Since all zones experience generally the same increase, the points on the diagram are tightly grouped in a linear fashion.

The interrelationship of these four market segment variables is perhaps as important as the analysis of each variable. As discussed above, each household is expected to contain approximately the same number of autos and persons, but is expected to support a greater number of workers. Therefore, additional work trips must be accommodated by carpooling or transit. Further, this observation is also supported by the noted decrease in autos per person for each zone.

3.3.3.5 Autos per Licensed Driver

The variable autos-per-licensed-driver is explicitly included in both the auto submode and transit submode models of the CSI work mode choice model structure; and it is explicitly included in the auto/transit model of the work model structure together with utility values computed in the submode models. The autos-per-licensed-driver variable is also included as one of the independent variables in the nonwork mode choice model formulation.

No sensitivity analysis of this socioeconomic variable is reported by CSI. However, a sensitivity test provided by the SCRTD model-application shakedown process indicates a high sensitivity of mode choice to autos per licensed driver within the CSI nonwork model. Examination of the model coefficients suggests that the same must be the case for the work model.

The forecast of a decrease in mean autos per licensed driver when weighted by trip productions is equivalent to forecasting a decrease in autos per licensed driver for the region as a whole. Such a forecast is not necessarily wrong, but is sufficiently unusual to warrant careful attention to the question of whether or not it is valid. It needs to be supportable by some evidence that such trends are beginning to occur, such as data showing that auto ownership per licensed driver is decreasing today in areas of Greater Los Angeles that are experiencing increased housing density without decreasing income. Metro Rail itself may cause some decrease in auto ownership, but one would expect that any such decrease would be less in percentage terms than the relative increase in transit ridership at most, and such is not the case with the SCAG forecasts.

A careful resolution of this data validity question is particularly important in view of the dependence of the CSI mode choice models on the autos-per-licensed-driver variable. A future year underestimate of this variable could inflate transit ridership estimates.

Mean values of this variable show a slight increase from 1980 to 2000, changing from 1.24 to 1.25 based on a simple zonal average. However, when the mean is weighted by the trip productions in the zone, the mean drops from 1.21 in 1980 to 1.06 in 2000. In the "82A" trip-end data, errors were found in zonal values provided by SCAG, resulting from miscalculation under certain circumstances. These values appear to have been corrected in the SCAG 82 data, but no other changes are apparent. The illogical values found in this analysis have been corrected where possible. However, their presence may indicate that there are additional, more subtle errors. SCAG should undertake a detailed analysis of this variable and its forecasting to determine if such errors do exist.

3.3.4 Highway Terminal Time (HWYTERTB (1980) and HWYTERTF (2000))

Auto highway terminal time, a variable associated with the attraction end of a trip, is the only out-of-vehicle component of auto travel time, and includes auto parking, unparking, and walk time to the final destination. It is not uncommon for mode choice models to be quite sensitive to auto terminal time.

As employment densities increase, convenient parking facilities become less available and are therefore located farther from the employment location. As a result, the time to park, unpark, and walk to the final employment destination increases. Thus, it is expected that, as employment densities increase over time, terminal times should increase as well. However, the year 2000 estimates of highway terminal are identical, zone by zone, to the 1980 estimates. The terminal times range from 0 to 5 minutes and, out of the 1,325 zones, 91 percent are assigned a terminal time of one minute. The mean highway terminal time was calculated to be 1.038 minutes for both 1980 and 2000. A Pearson coefficient of 1.00 indicates a perfect linear relationship between 1980 and year 2000 highway terminal times, and a t-statistic of 0.0 indicates absolutely no change in values.

Auto terminal times are difficult to measure. Given a mode choice model quite sensitive to auto terminal times, the safest course is to continue to use the same forecast times in the future year as for the base year. The primary objection to this is that it makes it impossible to reflect the changing auto terminal times for new high-density development, and there is no indication of the expansion of the CBD or outlying business districts. The year 2000 forecasts take the course of using the 1980 terminal time forecasts unchanged. This is an adequate and conservative approach.

3.3.5 Parking Costs

Auto parking costs and auto fuel cost are the two components of auto travel cost used in the CSI mode choice models. CSI does not present any parking-cost sensitivity analysis results, but fuel-cost sensitivities of the models parallel their sensitivities to fuel cost.

The work mode choice model exhibits a relatively low sensitivity to fuel cost within the expected range, but the nonwork mode choice model is extremely sensitive to this variable. The CSI report indicates that a 100 percent increase in the fuel-cost component of auto cost results in a 97 percent increase in nonwork transit ridership. It follows that parking costs can also have a marked effect on the transit-ridership forecasts and must be estimated with great care.

The estimation procedure used by LARTS in developing these costs is based upon a "hierarchical" relationship -- or a ranking of parking costs -- as they relate to employment densities, according to historical data and judgment.

Parking costs are reflective of several factors -- employment density, congestion, supply, etc. It is assumed that these factors will increase over time, and thus it is expected that existing parking costs will at least remain the same, if not increase considerably over time.

3.3.5.1 Parking Costs -- Work, Daily (PRKSCTWB (1980) and PRKSCTWF (2000))

Parking cost estimates for 1980 ranged from $0.00 to $4.40 per day, with approximately 96 percent of the zones having daily parking costs less than $1.00. By the year 2000 parking costs increased, ranging from $0.00 to $8.50 with approximately 90 percent of the zones having a daily parking less than $1.00. The mean parking cost was 11 cents in 1980 and 35 cents in the year 2000, per day.

As illustrated by a Pearson coefficient of 0.96 and a t-statistic of -10.7, parking costs in 1980 were increased by generally the same factor. In addition, mean parking costs from 1980 to year 2000 increased considerably; therefore, forecasts of parking cost increases were consistent among zones throughout the SCAG region.

3.3.5.2 Parking Costs -- Nonwork, Hourly (PRKSCTNB (1980) and PRKSCTNF (2000))

Nonwork parking cost estimates for 1980 ranged from $0.00 to $2.63 with 98 percent of the zones having a parking cost of less than $1.00. In the Year 2000 nonwork parking costs increase significantly, ranging from $0.00 to $5.10 with approximately 96 percent of the zones having parking costs less than $1.00. The mean nonwork parking cost was approximately four cents in 1980 and 11 cents in 2000.

The Pearson coefficient of 0.98 and t-statistic of -6.6 also indicate a consistent increase among zones, and the scattergram confirms that costs increased consistently, in that all points lie below the equivalency line toward higher year 2000 values.

Broad areas of the CBD, Hollywood, the Wilshire corridor, the San Fernando Valley, Long Beach, and Pasadena-South Pasadena are estimated to have measurable average all-day parking costs in both 1980 and 2000. A very few zones (including three in Los Angeles County plus zone subdivisions) are indicated to have no parking cost in 1980, but measurable cost in 2000. Several zones that have no parking costs for either year bear further investigation, as does the broad extent of certain suburban areas that have parking costs.

The most critical finding, however, relates to the magnitude of the parking-cost change from 1980 to 2000 in constant dollars. Table 3-7 shows both 1976 constant dollars and 1982 constant dollars for the forecasts of various areas. (1976 dollars are used in the data sets provided to SCRTD while the 1982 values are more useful for comparison to present conditions.) It should be kept in mind that the parking costs are average parking costs for the entire zone and should reflect an average of all paid-for and free parking as incurred by individual travelers. Also, the work cost should represent an average eight- or nine-hour parking cost while the nonwork parking cost should be an average for two or three hours. Although documentation has been provided to SCRTD on the derivation of the parking costs, it is not apparent from this documentation to what extent these averages have taken both time of parking and existence of free parking into account. The degree of increase projected is worthy of thorough review.

It would be useful to have constant dollar historical-trend data available for pay parking rates and free parking percentages in Los Angeles, preferably stratified by a variable such as trip-attraction density. This should be the subject of a regional project together with a detailed study of likely future changes in cost and supply of parking.

TABLE 3-7

COMPARISON OF CURRENT AND FORECAST PARKING COSTS
(IN 1982 DOLLARS)

Location	Work Cost		Nonwork Cost	
	1980	2000	1980	2000
Mean for All Zones	$0.28 (0.17)	$0.85 (0.51)	$0.13 (0.08)	$0.34 (0.20)
Mean for Zones with Parking Costs	$2.65 (1.57)	$6.96 (4.12)	$2.17 (1.29)	$5.72 (3.39)
Mean for CBD Zones	$6.47 (3.83)	$13.90 (8.23)	$3.86 (2.29)	$8.34 (4.94)
Attraction-Weighted: All Zones	$0.55 (0.32)	$1.52 (0.90)	$0.17 (0.10)	$0.38 (0.22)
Attraction-Weighted: CBD Zones	$6.39 (3.78)	$13.84 (8.20)	$3.85 (2.28)	$8.35 (4.95)

1976 Dollars are shown in parentheses

Source: Schimpeler Corradino Associates

Sensitivity tests for Metro Rail ridership have been conducted for parking costs in the region and are reported in chapter 8 of this report. The sensitivity of the CSI nonwork mode choice model to auto-parking costs makes careful estimation and judicious application of parking costs imperative.

3.4 MINIMUM DISTANCES

In addition to the conventional zone-to-zone highway skims referenced above, for input to trip distribution and mode choice, two special files are required for input to the mode-of-arrival model as follows:

- o Zone-to-closest-station distances -- this file identifies the rail station to which each zone is closest and the minimum path distance to that station. The file contains one record for each zone in EBCDIC format. For this file, stations are always rail stations.
- o Zone-to-station highway time and distance matrices -- this file is a UTPS binary matrix file in which the rows represent zones and the columns represent rail stations or bus Park-n-Ride locations.

3.4.1 Zone-to-Closest-Station Distances

Chapter 6, covering the mode-of-arrival model, describes the use of distances from zones to the nearest station as a means to determine the percent of trips treated as walk (in mode choice) that are, in fact, feeder bus trips. This computation is undertaken within the mode-of-arrival model. These minimum distances are required as an input data file to the mode-of-arrival model, and this section is concerned with the means to develop this input data file. The minimum distances have been computed by a program called UMINDIST which determined the minimum distance from each zone to a designated station. As shown in Table 3-8, the percent of walk trips is then determined as a function of both the type of station and the minimum distance. If the distance is over one mile, the percent of walk trips is zero for all station types. The UMINDIST program is structured to determine the minimum distances from the highway network for two reasons. First, in previous applications of this procedure, no digitized transit network existed, and coordinates are needed to locate the stations vis-a-vis the zone centroids and the potential links to the stations. Second, in the transit network, links to a station that may be used to compute the distance to the nearest station may not always exist. For example, if a station is a type 1 station (with no Park-n-Ride and no Kiss-n-Ride permitted), the station will have only walk links to it. In the primary versions of the transit networks built for this project, walk links (centroid connectors) are only included in the network if they are less than 0.5 miles in length. Therefore, a zone may be 0.8 miles from a type 1 station and 1.4 miles from a type 4 station, and the transit network will define the type 4 station as being the nearest, because no link will exist from the zone to the type 1 station.

TABLE 3-8

PERCENTAGE OF WALK TRIPS AS A FUNCTION OF DISTANCE TO NEAREST STATION

Station Type	Percentage of Walk Trips for Zone-to-Station Distance (Miles)									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
1	100	100	100	100	73	30	1	0	0	0
2	100	100	95	86	75	57	36	8	5	0
3	100	100	95	86	75	57	36	8	5	0
4	95	85	69	56	42	31	22	13	7	4

Station Type Definitions:

1. A station where no highway access of any type is anticipated, such as a station in the CBD.
2. A station where the only highway access anticipated is Kiss-n-Ride.
3. A station where the access is walk or bus, but potential Kiss-n-Ride trips would go to another type 2 station.
4. A station where all types of highway access are anticipated and which has some parking facilities.

Source: Schimpeler Corradino Associates

The minimum distances were examined for the LPA network and were compared to the link distances in the links file of that network. Significant differences were found in many cases. Some differences could be expected to be found, including:

- o Distances along walk centroid connectors in the transit network are averages for all walk centroid connectors for a zone. Therefore, actual walking distances should vary from the coded links.

- o Auto distances are coded in the transit network from the 1,628-zone network, while the highway network is for 1,325 zones, and manual corrections were applied for the expanded zone system.

- o The coordinate system for the transit network is based on meters, while that for the highway network is based on feet. This is likely to results in some differences in value.

Notwithstanding these expected differences, it was found that the UMINDIST values differed substantially in most cases from the values that would have been obtained from the transit network. The UMINDIST values also did not agree with the measured distances from the network plots. As a result, the latest network runs have used new distances, based on the transit network coordinates and the links file. Actual walk link distances are used rather than the average for the zone, by recomputing the distance from the coordinates of the zone centroid and the station. The coordinate-based version of the program to calculate minimum zone-to-station distances is sometimes referred to as MNMDIST rather than UMINDIST.

3.4.2 Zone-to-Station Matrices

The process involved in driving zone-to-station matrices is a lengthy one. The basic steps are shown in Figure 3-2. The process involves creation of a special highway network containing dummy zones to represent rail stations and formal bus Park-n-Ride lots. Station zones are numbered 1,629-2,028, allowing up to 400 stations/lots to be identified at one time. Because of the complexity of this process, an attempt has been made to maintain strict consistency, in fact, constancy in the highway node numbers assigned to each dummy station zone. Once a station is assigned a node number, that node number is never used for any other station. Appendix 3-2 is a recent tabulation of this node number assignment.

Once all stations have been identified by dummy station nodes in the highway network, the network is built and paths built and skimmed to create a 2,028-by-2,028 zone highway skim. A special program, USTATION, is then employed to create a zone-to-station matrix -- a non-square matrix having 1,628 rows representing zones and 400 columns representing stations. This matrix was formerly used as an input to the program UMINDIST to create the zone-to-closest-station distance file but, as indicated above, this file is now created using the

ZONE-TO-STATION HIGHWAY SKIMS PROCESSING

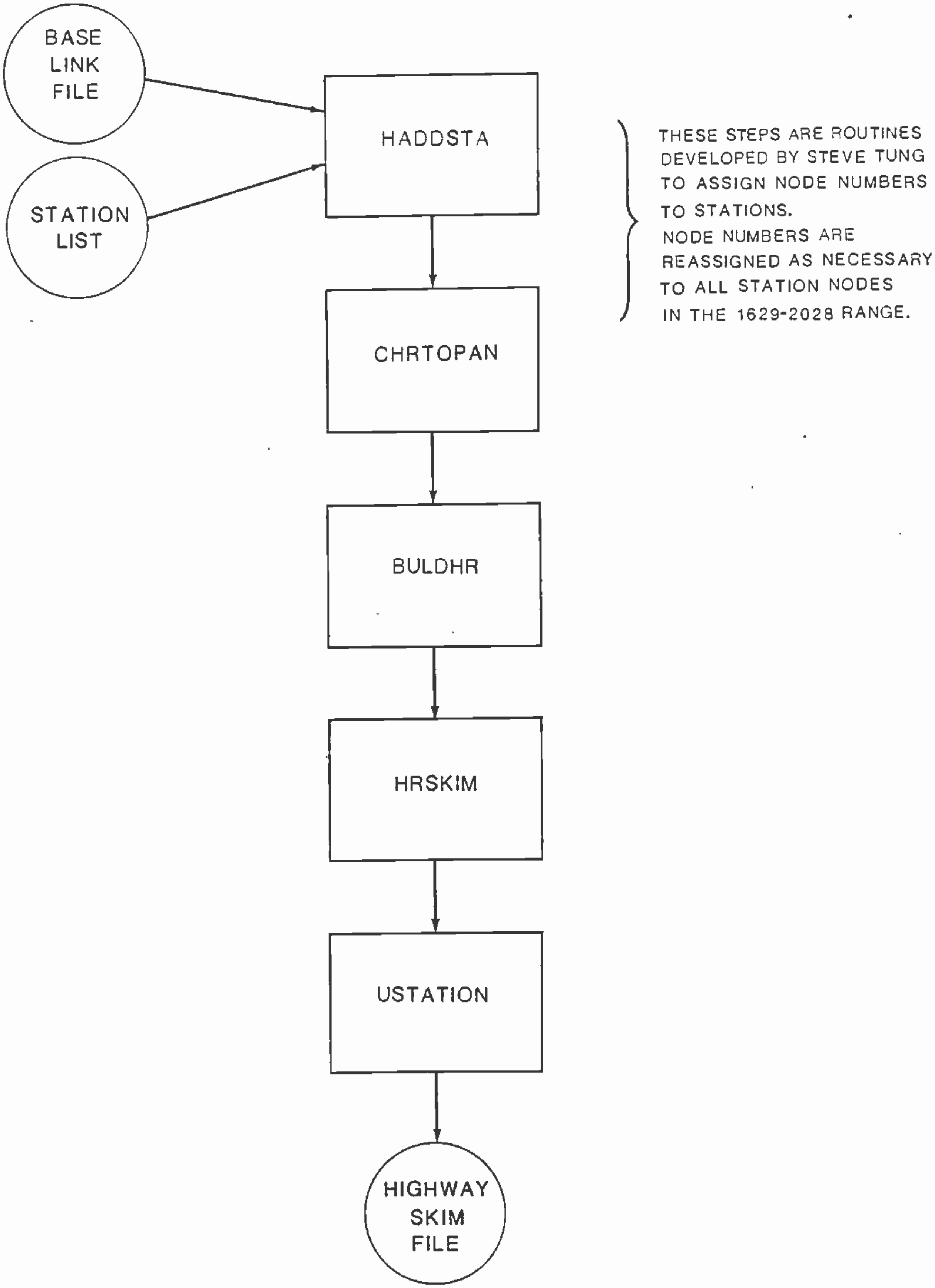


Figure 3-2

transit network coordinate file instead. <u>However, the USTATION output file is still a required input to the mode-of-arrival model.</u> The preparation and application of these files is covered further in chapter 6.

4.0 TRANSIT NETWORK INPUTS

4.1 PURPOSE

The primary purpose of the procedures described in this chapter is to produce networks that are as clean and accurate a representation as possible of actual transit operations, within the limitations imposed by the network-building procedures of UTPS. There are three components to this activity. The first is the method used to build the networks themselves. The second is the types of checks that can be run to determine whether or not the network is a complete and accurate representation of the actual operations of transit in the region. The third is the procedures for isolating and correcting errors found in the networks. One of the most difficult aspects of network building is to detect errors, and this becomes much more difficult as the complexity of the network increases. The transit networks for the Los Angeles region represent highly complex networks that stretch standard network-building procedures, such as UNET, to their limits. As a result, many of the problems encountered relate as much to the limitations in the network program as to the building of a network itself.

A goal of this project was to produce a set of transit networks that are sufficiently accurate and free of errors that they can stand intensive scrutiny, and can be relied on to produce as accurate estimates of transit patronage as is possible, using state-of-the-art techniques in travel forecasting. Various aspects of forecasting are highly sensitive to specific components of the network structure. Furthermore, it is not widely recognized that the accuracy and correctness of the networks affect every aspect of the travel forecasting, so that a network with significant errors in it will propagate those errors through the entire forecasting process.

One of the purposes to be served by this chapter is to provide sufficient detail on the checks and corrections made in the network so that the same procedures can be used again in future network building in the Los Angeles region. This chapter also covers minimum path selection for transit networks and transit system fare matrix construction.

4.2 NETWORK-BUILDING PROCEDURES

4.2.1 Structure of Network Files

The network is defined by three computer files -- a coordinate file, a links file, and a lines file. The coordinate file provides a list of all nodes used, including all zone centroids, rail and bus stations, etc., and provides X and Y coordinates for each node. The coordinates are taken from the U.S. Geological Service maps in the 7-1/2' series for the Los Angeles region, and are metric coordinates, measured from a base point well outside California.

In theory, there should be only one master coordinate file, since the practice of changing node locations or having nodes represent different locations in different networks is to be strongly discouraged. Nonetheless, many coordinate files, though ultimately stemming from a common base, are now network-dependent.

The links file provides information on every one-way and two-way link defined in the network. Each link is defined by the two nodes that represent the ends of the link, referred to as the A-node and the B-node. In the format required by UNET, each link is described by the mode or modes that operate on it, the length of the link, and either the speeds or travel times for the four periods of the AM peak, the PM peak, the midday, and the evening. Nonetheless, only one time or speed is actually required on each link. The link must also be defined as being either two-way or one-way. As with all input data sets to UTPS programs, the links file is defined as an eighty-column record, although only the first 65 columns of the record are read by the UNET program. In this project, an additional description of the network was provided in the form of the area type and facility type, recorded in columns 69 and 70 of the record. This information was processed by a program developed by the consultant staff to determine the speeds to be coded on the link. The speeds for each combination of facility type and area type are described in chapter 3 and displayed in Table 3-2. By using this capability, a future network can have different speeds encoded on the links card, simply by changing the values in the look-up table of speeds and rerunning the computer program that determines the speeds.

The lines file consists of descriptions of each line and subline of all transit operators in the region. The description of one line may occupy up to six card images. The description consists of the mode number, the company number, and a line number that must be unique within the mode. The line description also includes a designator to show if the line is a one-way or a two-way line, and there is a sequence number for the cards making up a line description. The remainder of the description includes headways for up to four periods (AM, PM, midday, and evening), and the sequence of nodes that describes the route of the line. Each pair of consecutive nodes must describe a link to be found in the links file, and UNET permits a maximum of 50 nodes to describe a line. The last card of each line description must contain a "T" in card column 72. The UNET program reads nothing beyond column 72, and the remaining columns (73 through 80) have been used to provide an abbreviated reference to individual operators' actual bus line designations. UNET requires that line numbers are assigned consecutively (although gaps are permissible), and allows a maximum of 255 lines in a mode. Once sublines are included in the consecutive scheme, it becomes impossible to have UNET line numbers correspond to an operator's line numbers, even if these are within the required range from 1 through 255. However, this would be impossible, in any case, for municipal operators.

The consultant staff has recently revived the concept of the headway file, a file within the network library which, while not a part of the model chain, provides a description of what is contained in the lines file. In the past, headway files have fallen into disuse because they took a long time to create and were quickly outdated through changes in the network which, in haste, were never reflected in the headways file. The consultant staff, however, has created a program which will read a headways file and, assisted by a permanent file of node number-street name equivalents, will quickly produce the skeleton of a headways file. To date, 433 nodes are in the permanent file, and while this does not eliminate all of the tedium of creating a headways file, it does speed up the process. The headway file thereby created includes mode, UNET line number, and AM, PM, and midday headways. It states whether the line is one-way or not, includes the company description, and the first and last coded nodes and a description of those as well, if they are included in the node description file. Table 4-1 is a sample output from a simple test network of lines running through Union Station.

4.2.2 Conventions

Several conventions have been adopted in the coding of the transit lines for SCRTD. The form and reason for these conventions are important, and should be maintained in future networks.

4.2.2.1 Periods of the Day

All Los Angeles region networks are currently coded for three periods of the day only -- the AM peak, the PM peak, and the midday period. These periods are defined as:

- AM Peak - From 6:00 a.m. through 8:59 a.m.
- PM Peak - From 3:00 p.m. through 5:59 p.m.
- Midday - From 9:00 a.m. through 2:59 p.m.

The two peak periods are each considered to be three hours in length, while the midday period is 6 hours. These periods are defined because the peak loads on the SCRTD system occur during these defined peak periods.

4.2.2.2 Direction of Coding

At one time, the direction in which the coding of two-way bus lines was undertaken was thought to be important. A great deal of time and attention was devoted to insuring that coding always proceeded in the direction of maximum AM peak-period flow. This practice has largely been abandoned. The intended benefits seemed to be disproportionately outweighed by the time, effort, and susceptibility to errors that the procedure of reversing the direction of coding causes. When comparing two networks, the most important element is certainly consistency of coding. While the practice of adopting a uniform direction of coding would seem to engender standard practice, in practice it did not. In numerous instances, supposed differences were pointed up between networks only to find, on closer inspection, that the coding was identical, but reversed. Given the numerous networks in existence and

TABLE 4-1

SAMPLE HEADWAY FILE

PAGE 0001

10:10:53 09/30/86 MRPGP1 MRP.MININET.UNIONSTA.BUS.DATA(HDWY)

----+----1----+----2----+----3----+----4----+----5----+----6----+----7----+----

4	25	8.0	10.0	15.0		S 27	4971-UNION STATION	TO 4680-CENTURY CITY
4	26	22.0	10.0	15.0		S 28	4971-UNION STATION	TO 4680-CENTURY CITY
4	31	10.0	18.0	15.0		S 33	4333-2ND/S MONICA	TO 4971-UNION STATION
4	32	90.0	0.0	0.0		S 33A	4402-VENICE/OVERLND	TO 4971-UNION STATION
4	33	12.0	12.0	25.0		S 38	4433-W LA TRNST CTR	TO 4971-UNION STATION
4	34	6.0	6.0	6.0		S 40	2516-HWTHRNE/ARTSIA	TO 4971-UNION STATION
4	36	22.0	20.0	30.0		S 42	4971-UNION STATION	TO 2367-CATALINA/AVE I
4	46	15.0	15.0	20.0		S 55	2308-AVALON/D	TO 4971-UNION STATION
4	47	18.0	22.0	30.0		S 55A	2636-LONG BCH/GRNLF	TO 4971-UNION STATION
4	48	15.0	15.0	20.0		S 56	2468-DEL AMO/AVALON	TO 4971-UNION STATION
4	242	35.0	0.0	0.0		S 28B	4710-FAIRFX/SN VNCT	TO 4971-UNION STATION
4	244	30.0	15.0	25.0		S 38A	4463-JFFRSN/ARLNGTON	TO 4971-UNION STATION
4	246	15.0	0.0	99.9		S 38C	4971-UNION STATION	TO 4439-LA BREA/JFFRSN
5	21	15.0	30.0	50.0		S446	2200-KOREAN BELL S	TO 4971-UNION STATION
5	22	99.9	35.0	60.0		S446A	2216-PACIFIC/24TH ST	TO 4971-UNION STATION
5	45	35.0	60.0	0.0		S443	2368-PLS VRDE/CHICO	TO 4971-UNION STATION
5	46	20.0	25.0	35.0		S444	2230-MARINELAND	TO 4971-UNION STATION
5	47	18.0	15.0	30.0		S483	7246-F OAKS/LOMA AL	TO 4971-UNION STATION
5	48	18.0	22.0	30.0		S485	7252-FONTANET/LAKE	TO 4971-UNION STATION
5	49	15.0	25.0	35.0		S487	7188-SRRA MORE/BLDN	TO 4971-UNION STATION
5	50	25.0	25.0	99.9		S489	7182-HSTNGS/ALEGRIA	TO 4971-UNION STATION
5	54	2.0	2.0	12.0	OW	S400	6563-EL MONTE STN	TO 6561-EL MONTE STN
6	1	4.0	4.0	8.0		M R	8000	TO 8021

the lack of consistency with this intended standard, it is suggested that such a standard not be imposed for the present. When a completely new base network is developed -- as part of a conversion to INET, for example -- this standard might be revived.

4.2.2.3 Counts of the Numbers of Trips

The count of the number of trips for frequency and headway calculation is made by designating a control point on each bus line. The control point is established as being a stop listed in the printed schedule that is somewhere near the midpoint of the line. If a line has a number of sublines operating, then the control point will usually be one of the first listed timing points at which all sublines are in operation. No attempt was ever made to identify this control point as the maximum load point, although it appears that it is close to that point on most lines. On Express lines, the control point is usually designated as the last timing point before the bus begins operation on the major freeway segment, or on the busway.

Trips are counted for each period -- AM Peak, PM Peak, and midday -- using the periods defined in section 4.2.2.1, and defining this period at the control point. Thus, the time that trips start or end is irrelevant for the trip counting. What is relevant is the time when the trip passes the control point. For existing services, trip counts are made from the appropriate published schedules at the time for which the network is being built.

Because the PM networks are never run, counts of PM trips are far less critical. Nonetheless, they are calculated if only because the PM rush is more important to the District's operations and there is a hope that someday some method may be developed for incorporating PM networks into the modeling stream. Generally, the PM peak trips are counted in the opposite direction to the AM peak. When service is equal in both directions in the PM peak, then the direction opposite to the AM peak is always used. If service levels are not equal, then the PM peak count is again made in the direction in which the maximum number of trips occur, which is generally, but not always, the opposite of the AM peak.

When District staff were creating both the FAR80.BASE and FAR83.BASE networks, they created a separate on-line documentation file for each, which included UNET line number, mode, company number, route description (including operator), terminal points, control point, trip counts, and computed headway. Such a file should serve as a model for future effort, since it provides such a useful reference as to what was done.

4.2.2.4 Subline Definition

In original practice, all sublines of a line are defined in the same direction, unless two or more sublines are defined as one-way operations in the opposite direction. As a result, a short turnback that is operated only in the direction opposite to the peak on a two-way line will not appear as a coded subline in the transit network.

All lines and sublines are defined as two-way, if service is provided in both directions in all periods in which the line or subline offers service. In the event that there is a major imbalance in service levels in the two directions, two one-way sublines are defined, with the appropriate headways on each.

Generally, there must be a significant imbalance between the number of trips in the peak versus off-peak direction in order to warrant a separately coded line. The general guideline has been that the number of trips in the peak direction must be at least 1.5 times greater than those in the off-peak direction.

4.2.2.5 UNET Line Numbering

UNET line numbers have been assigned in numeric order with the line (route) numbers of the operator in the Base-Year network. In other words, the lines of each operator were organized in both the headway and the lines files in ascending order within each company and mode. Ordered UNET line numbers are then assigned to the lines and sublines. If an existing line is changed in terms of service or minor routing alterations, the UNET line number remains assigned to that line or subline, which is desirable from the standpoint of consistency. Ideally, actual operator route numbers could remain in numerical order, and UNET line numbers could be permanently reserved for certain routes, with new routes being added only at the end of the existing range of used line numbers. While this would be desirable from the point of view of finding a real-world route number, these twin objectives of consistency and an ordered sort are both impossible and undesirable to fulfill, for a number of reasons. The first reason is that there are currently about 220 mode 4 lines coded in most of the Los Angeles transit networks, 100 mode 5 lines, and 210 mode 8 lines. This leaves only minimal flexibility in assigning line numbers and no possibility whatsoever of permanently reserving certain line numbers for certain routes, despite the fact that those routes may be unused in any given network. Unfortunately, additional lines are often added or substituted, and given the overall UNET limit of 255 lines per mode, the luxury of reserving UNET line numbers cannot be guaranteed. It should be noted that current network checking programs (mentioned later) put a high priority on the consistency of retaining the same UNET line numbers for the same line description across different networks. If an existing route is simply given a new route number and any other changes are minor, the UNET line number will remain unchanged. For this reason, actual operator route numbers cannot always be kept in a numerically ordered sort, or, in the case of municipal routes, cannot even always be kept together by operator.

4.2.2.6 Headway Calculation

Headways are not determined by dividing the period by the number of trips, because this procedure generates a wide range of fractional headways that are not good approximations of true headways. This arises usually because of the setting of the boundaries of the periods, such that a period may contain some trips made at one headway and some at another, and because of the effects of trippers during the peak periods. In the Los Angeles networks, the number of trips in a period is used to define the entry point in a look-up table that provides an easy conversion between the number of trips and a headway. The conversion is shown in Table 4-2.

By using the look-up table, all bus lines are assigned headways that are integer numbers of minutes (except for the 7.5-minute headway -- 8 buses per hour), and the headways assigned are all drawn from those used by the scheduling department of the SCRTD. This has the additional advantage of simplifying the assignment of policy minimum and maximum headways for the URAP program, described in chapter 7.

4.2.2.7 Walk Connectors

Walk Connectors can be separated into four basic forms:

- o Zone centroid walk connectors
- o "Dummy" walk links
- o "Mini-walk" links or "Mini-walk network" links
- o CBD sidewalk walk links

All walk connectors in the networks are two-way. Zone centroid connectors are simply connections from the individual zones to the transit network, and represent an individual's walk from his home, place of work, shopping, etc. to the local bus stop.

"Dummy" walk connectors join the local (or "dummy") transit node at the actual street location of a rail station to the rail station node, and are coded as a zero-time, zero-distance walk link.

"Mini-walk" links and CBD sidewalk links are similar in concept, since both replicate the sidewalks available for walking into or out of zones or transferring to nearby transit lines. The difference between them is that the "Mini-walk" network is confined to a one-mile square area centroid on the station, while CBD sidewalk network replicates the sidewalks which run throughout downtown - a much larger area. Both allow walking transfers.

In the course of checking paths for the 1995 network, it was apparent that several walk connectors in the older networks, particularly in the Wilshire Corridor, appeared on the plots as being longer than one-half mile (airline distance), but were coded as 0.5 miles or less. Documentation for coding guidelines for the calibration network had inferred that a ten-minute walk was the maximum length permissible for any walk connector. At three miles per hour (standard walk speed), this represents one-half mile. In evaluating this problem, reference was made to documentation for the program BLDCON, which had initially built all of the walk connectors in the networks. At that point it was discovered through the documentation that, in building the walk connectors for each zone, the program calculated the zone to transit-node distance for each walk link built and chose the minimum distance

TABLE 4-2

CONVERSION OF NUMBER OF TRIPS TO HEADWAY

No. of Trips Peak	Midday	Headway
200	200	0
72-198	144-198	2.0
51- 71	103-143	3.0
40- 50	80-102	4.0
33- 39	66- 79	5.0
28- 32	56- 65	6.0
25- 27	50- 55	7.0
24	47- 49	7.5
21- 23	41- 46	8.0
17- 20	33- 40	10.0
14- 16	27- 32	12.0
11- 13	22- 26	15.0
10	19- 21	18.0
9	18	20.0
8	16- 17	22.0
7	14- 15	25.0
6	12- 13	30.0
5	10- 11	35.0
-	9	40.0
4	8	45.0
-	7	50.0
3	5- 6	60.0
2	3- 4	90.0
1	1- 2	99.9
0	0	0

Source: Schimpeler Corradino Associates

to apply to all of the walk links for that zone. This, too, was contrary to calibration network coding guidelines, which dictated that an average distance for all walk connectors built from a given zone be applied to each of the connectors. There seemed to be no explanation for the overlength connectors; these appeared to have been added manually.

It was decided to correct the problem of overlength connectors by means of a new BLDCON run which would rebuild all of the walk connectors in the network. Because the team was already aware of several bugs with the existing program, it decided to conduct a thorough review of BLDCON to determine the extent of the problems with simply running the program and to verify that the program was, in fact, building walk connectors based on minimum distances. Having discovered that this was indeed the case, the decision was made to write a new BLDCON program.

The team undertook this task and decided to create a program which would optimize walk connectors by building the shortest link possible to every transit line within one-half mile of a zone. Freeway dummy nodes (through their 7900-7949 numbering) were specifically exempted. Likewise, rail nodes, by virtue of their special 8000 numbering convention, could be converted by means of an equivalence table so that walk connectors would be built into the local (dummy) node and not the rail node. Mini-walk connectors were left intact as was walk coding in the CBD (accomplished through user specification of the appropriate zones). The new BLDCON program, BLDCON2, was run on all of the new networks. The distances coded on the links built in this manner were an average of the distance for all walk links built from a given zone. Thus, if three walk links were built by the program from zone 200, for example, and their actual lengths were .3 mi., .4 mi., and .5 mi., the average of these distances, or .4 mi., would be coded on all three links. This technique compensates for the fact that a singl point, the centroid, is being used to represent a much larger area (the entire zone).

The first simulation run using a network with walk connectors built by BLDCON2 uncovered the fact that the new BLDCON nearly doubled the number of unconnected zones by the strict imposition of the half-mile (airline distance) rule. Analysis revealed that many of these zones were supposed to be 100 percent accessible by transit, according to the modal choice input data sets. Two questions were raised by this discovery. One was whether the location of zone centroids appeared to be acceptable or not, and the other was whether figures for the percentage of zones within walking distance of transit were reasonable. Further investigations revealed specific, isolated problems, but pointed to the overall integrity of both zone centroid location and the percent-walk-to-transit file, at least in the aggregate. It was decided, then, to alter BLDCON2 by relaxing its half-mile maximum walk connector rule in the case of zones left unconnected by its rigid imposition, allowing the program to build walk connectors of up to one mile long to connect zones with greater than zero percent walk accessibility. For zones having zero percent of the zone accessible to transit service, no connectors of any length were built. In order to present transit as a viable choice for those zones with walk connectors which were calculated, in fact, to be longer than one-half mile, it was necessary to represent these connectors as only .5 mile long.

4.2.2.8 Auto Centroid Connectors

Auto centroid connectors are built from zone centroids to selected Park-n-Ride and Kiss-n-Ride locations in the transit network. Park-n-Ride connectors are built to nodes where official Park-n-Ride facilities are, or will be, provided. Park-n-Ride connectors are built for distances of up to 7.0 miles (airline distance) from the parking location. Kiss-n-Ride-only connectors have been constructed as well to places where a significant amount of auto drop-off activity is known to take place and where some amount of space is available for cars to wait. A further criteria for a Kiss-n-Ride location is that some amount of express bus or rail service must be available. Kiss-n-Ride connectors are limited in length to 4.5 miles. A list of all of the bus-only Park-n-Ride and Kiss-n-Ride locations included in the recent networks can be found as part of Tables 4-3 and 4-4.

The staff recently undertook a comprehensive reanalysis of Park-n-Ride and Kiss-n-Ride connectors under the following guidelines.

1. Park-n-Ride links should be built first since these connectors can also be used for Kiss-n-Ride trips. Park-n-Ride connectors should be equal to or less than 7.0 miles in length.

2. Kiss-n-Ride links should be built with reference to pre-existing Park-n-Ride connectors. Kiss-n-Ride connectors should be equal to or less than 4.5 miles in length.

3. In general, all possible connections should be made to a given Park-n-Ride or Kiss-n-Ride location, subject to the maximum connector-length rules and the following:

4. If a zone is within 7 miles of a Park-n-Ride location or 4.5 miles of a Kiss-n-Ride location and no other auto connect location is within such a circle drawn from the zone, a connector should be built from that zone to the auto-connect location unless the only direction of travel possible from that lot or location is illogical. Such an occurrence would be possible if, for example, a zone lay some distance to the east of a Park-n-Ride lot where the only buses serving that lot traveled east. In reality, no one would drive west to the lot to go east.

5. Where two Park-n-Ride or Kiss-n-Ride locations lie within 7 miles or 4.5 miles, respectively, of a zone, coding should be to the closest auto-connect location unless additional or more logical directions of travel can be attained by also (or instead) connecting to a more distant location. In any such decision, all possible major directions of travel should be considered, including reverse commuting.

TABLE 4-3

PARK-N-RIDE LOCATIONS

STATION LOCATION
Battery and Gaffey
Hamilton and Torrance
4665 Lampson
Long Beach Airport Lakewood Boulevard and Wardlow Road
Orangethorpe and Magnolia
Freeway and Alondra
La Mirada and Ocasso
* Ventura and Riverton
Fallbrook and Criswell
Victory and Topanga
Albatross and Castleton
Diamond Bar and Pomona
Santa Anita and Ramona
Barranca and Workman
McKinley and White (Los Angeles County Fairgrounds)
McKinley and Garey
Monte Vista and San Jose
Citrus and Foothill
Colorado and St. Johns
Shirley and Plummer
Roscoe and Noble
Harbor Freeway and Martin Luther King
Harbor Freeway and Slauson Avenue
Harbor Freeway and Manchester Avenue
Harbor Freeway and Rosecrans Avenue
Artesia Boulevard and Vermont Avenue (Southbay Transit Center)
Harbor Freeway and Carson Street
Harbor Freeway and Pacific Coast Highway

Eliminated in networks with Harbor Freeway Busway OPFN5, present in all others.

* This Park-n-Ride lot was deleted in any network with the full LPA (OPFN4 and OPFN5). It remains present in all others.

TABLE 4-4

KISS-N-RIDE LOCATIONS

Peninsula Shopping Center
(Hawthorne Boulevard and Silver Spur Road)
Long Beach Boulevard and Willow Street
Artesia and Hawthorne Boulevard
* Rosecrans Avenue and Avalon Boulevard
San Antonio and Firestone Bouelvard
#$ Harbor Freeway and Manchester
#$ Harbor Freeway and Slauson Avenue
Santa Monica Freeway and Fairfax (West Los Angeles Transit Center)
Los Angeles/University of Southern California Medical Center
Cal State, Los Angeles San Bernardino Busway
Hollywood Freeway and Hollywood Boulevard
Mulholland Drive/Valley Circle Boulevard and Calabasas Road/Avenue San Luis
Ventura and Sepulveda Boulevard
Riverside Drive (west) and Coldwater Canyon Avenue
Vineland Avenue and Riverside Drive (east)
Ventura Freeway and Golden State Freeway
Garfield Avenue and Whittier Boulevard
Puente Avenue and San Bernardino Freeway
West Covina Fashion Park
Asuza Avenue and San Bernardino
Mariposa Street and Lake Avenue

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* Not part of 1995 network.

Only the five stations noted are constituted bus-only KNR stations for the purposes of mode-of-arrival.

$ Park-n-Ride in 1995 network. Kiss-n-Ride in networks without Harbor Busway.

6. Connectors should not cross significant physical obstacles such as mountains or major bodies of water.

7. No CBD zones should be connected by auto access because these links are particularly susceptible to being used for nonhome-based trips which, in reality, would not have a car available for that purpose. Auto connect links in other areas could also be used for nonhome-based trips, but because greater numbers of these trips occur in the CBD, this danger looms larger there.

8. No auto-connect links should cross the CBD, because that possibility is so difficult in a practical sense that no one, in reality, would attempt it.

9. In areas where the "influence" of Park-n-Ride and Kiss-n-Ride locations overlags, the "influence" area of the Park-n-Ride lot should be considered to be 4.5 miles even if longer connectors for this lot are already present.

Though perhaps not quite as complex as the above discussion would suggest, considerable thought should go into the construction of sensible auto-connect links. It is not enough to suggest that later phases of the modeling process will take care of whatever deficiencies are present when the networks are completed. Carefully building auto-connects is a tiresome and lengthy process and one which is extremely subjective in the way it is carried out.

The team has developed a fool-proof method of manually building auto connectors. A program created earlier in the project, BLDCON, is used to create the universe of legal Park-n-Ride or Kiss-n-Ride connectors. Unfortunately, the program has no logic built into it, and simply builds all possible Park-n-Ride and Kiss-n-Ride connectors at 7 miles or 4.5 miles, respectively, from the auto-connect location. The program is run for all auto-connect locations in the network, creating massive numbers of links which are then emptied into two master files, one for Park-n-Ride, the other for Kiss-n-Ride. When manual selection of appropriate Park-n-Ride and Kiss-n-Ride links is completed, the a-node/b-node combination is placed into a separate file. The team developed a program for taking this computer-based "shopping list," going to the master list and picking out the needed links and placing them in a separate file. Since only legal auto-connect links exist in the master files, using this process, it is impossible to build over-length connectors. For small numbers of additional links it may be quicker to go manually to the master files to determine correct link length.

In view of how difficult, complex, and time-consuming building auto connectors can be, some thought has been given to creating a thinking auto- connector program. Such a program would eliminate much of the difficulty in the process and introduce a good measure of consistency and standardization in building auto connectors as BLDCON2 has done for walk-connector building. A program of this type was never actually built, but it seems appropriate here to speak to some of the logic such a program would have to employ.

1. The program would read mode 2 (Park-n-Ride) and mode 3 (Kiss-n-Ride) links and compile a list of Park-n-Ride and Kiss-n-Ride stations.

2. Since it might be appropriate to build all access connectors (including walk) at the same time, the program could read the list of routes passing through each auto-connect node. This list (or more accurately, array) is generated as part of BLDCON2 when it builds walk connectors. If auto connectors alone were being built, then the same kind of list would have to be generated from reading the lines file.

3. Route characteristics would then be generated for the routes passing through each auto-connect location. At a minimum, they would indicate the directions of travel possible on each bus route passing through each auto-connect location. Four compass rose divisions (North, South, East, and West) would probably suffice. Another important attribute would be the auto-connect spot's location as coded in the coordinate file. These characteristics would then be retained as nodal characteristics. Other possible items of interest would be service frequency, the presence of a local or express route passing through a node, speed differentials on nearby links or entire routes, etc. These could even be ranked.

4. The program would then search out from each zone to see what auto -connect locations were within 4.5 miles and 7 miles, the distance in which general compass rose direction the auto-connect location lies.

5. There would be a general bias towards building connectors to the closest auto-connect location, subject to the following.

6. No connector (or only very short connectors) would be built to a Park-n-Ride or Kiss-n-Ride location from which the only direction of travel would be the opposite of that needed to travel to that location. Thus, if a Park-n-Ride lot lay a considerable distance to the east of a zone and the only buses passing through that node travel west, no connection from that zone would be built to that Park-n-Ride lot. The general direction of the connector from the zone to the auto-connect location would weigh heavily in program logic, so that it might be worthwhile to build a connector to an auto-connect location to the north if it was possible to travel further north from that location, even if a connector had already been built to a closer Park-n-Ride or Kiss-n-Ride location to, for example, the east, at which it was also possible to travel north.

7. Physical barriers (mountains, bodies of water) or even the CBD could be user-specified, using the four nodes (or coordinates) defining its dimensions and not allowing auto-connect links to originate within or cross those boundaries.

All of this is much easier to explain philosophically than to program. But though it would take considerable effort, such a program would save a great deal of time in building auto connectors, as well as inject a degree of standardization not presently known.

4.2.2.9 Speeds and Travel Times

In UNET, it is possible to code either travel times or speeds onto the link cards. The convention that has been adopted in the networks built in this project is as follows:

- o For modes 1 (Walk), 2 (Park-n-Ride), 3 (Kiss-n-Ride), 4 (Local Bus), 5 (Express Bus), and 8 (Local Bus), speeds are coded on the link cards.

- o For modes 6 (Heavy Rail) and 7 (Light Rail), travel times are coded on the link cards.

In general, speeds offer the greatest flexibility for changes in the network, particularly for forecasting, and are therefore preferred. However, speeds for rail are not appropriate, because the average speed on a link is dependent on the length of the link and the dwell times in the stations at either end. Therefore, travel time is preferable to use for rail, where the travel times will reflect dwell time, acceleration and deceleration, and the length of time (if any) when the rail vehicle will travel at maximum speed.

Travel times for the Wilshire Starter Line and for the Minimum Operable Segment were taken from the Preliminary Operating Plan (Prepared for SCRTD by Booz, Allen, and Hamilton, Inc., May 1982), with adjustments to allow for the Crenshaw/Wilshire station. For heavy rail, the times were originally calculated by assuming acceleration/deceleration of 2.93 ft/sec/sec, and a cruising speed of 55 mph for heavy rail. The derivation of the formulas follows:

It is assumed that:

$a = d$,

where a is the acceleration rate [ft./sec.^{2}],

and d is the deceleration rate [ft./sec.^{2}].

The time required to reach maximum speed, S_m [ft./sec.], is therefore:

$$t_a = t_d = \frac{S_m}{a}$$

remembering that $a = d$,

that t_a is the time to accelerate to maximum speed [sec.],

and that t_d is the time to decelerate from maximum speed [sec.].

Therefore:

$$t_{a+d} = 2t_a = 2\left(\frac{S_m}{a}\right)$$

where t_{a+d} is the time required to accelerate to maximum speed and immediately decelerate to stop. The distance required to do this can be calculated as follows:

$$D_a = D_d = 1/2\ at_a^2$$

where D_a is the distance needed to accelerate to maximum speed [ft.],

and D_d is the distance needed to decelerate from maximum speed [ft].

Therefore:

$$D_{a+d} = at_a^2$$

where D_{a+d} is the distance traveled during acceleration to full speed and immediate deceleration [ft]. One can move to a calculation of full travel time between stations by remembering the simple formula:

$$\text{Time} = \frac{\text{Distance}}{\text{Speed}}$$

But since one is accounting for acceleration and deceleration (nonconstant speeds), the formula will be a bit more complex:

$$T_t = t_c + t_{a+d} + t_s$$

where: T_t is total time between stations,
t_c is the time spent at maximum speed,
and t_s is the time spent in the station taking on passengers (dwell time).

To continue, t_c is simply:

$$t_c = \frac{D_c}{S_m}$$

where D_c is the distance at maximum speed [ft], or

$$D_c = D_t - D_{a+d}$$

where D_t is the total distance between a station pair.

Now one can recombine to arrive at total time.

$$T_t = \frac{(D_t - D_a + d)}{S} + 2t_a + t_s$$

$$= \frac{(D_t - (at_a^2))}{S_m} + 2\left(\frac{S_m}{a}\right) + t_s$$

Times thus calculated should be rounded to the nearest tenth of a minute.

While this produces considerably more accurate results than using average speeds to generate link times, the assumption of constant acceleration speed is, in itself, an abberation, however useful it may be in speeding up the calculations. Therefore, for the CORE study, engineering times were used as supplied by the District's Transit Systems Development (TSD) staff.

Using the same formulas, the team also developed a method for calculating travel times between stations on both new and realigned light rail lines. For the purposes of estimating rail link times, maximum acceleration and deceleration rates of 3.9 feet/second/second were assumed. Maximum speeds on rail lines are a factor of the degree to which rail vehicles are separated from other traffic, the type of safety control (both on rail and nonrail vehicles), the congestion on the line as a result of other rail traffic, and the number and severity of grades and curves on the alignment.

Metro Rail, of course, is completely separated from other traffic throughout its alignment. The same is true of the Century Light Rail line where it runs in the freeway median. The Long Beach, Coastal, and Century Light Rail lines (outside the freeway portion of Century's route) will not be fully separated from automobile traffic, but will probably operate in exclusive rights-of-way for a large portion of their routes, with crossing gates located at major intersections. San Fernando Valley Light Rail, while enjoying an exclusive right-of-way, will probably not have crossing-gate protection along its route.

For light rail routes, two and sometimes three different typical "speed regimes" were used: one for straight sections, another for curves, and a third for downtown running. Furthermore, because each rail line differs slightly in the degree of separation it enjoys from other traffic and the land use it passes through, the speeds assumed in these "regimes" are dependent on the line in question, as indicated in Table 4-5. In the case of Century Light Rail, within the freeway median, a maximum speed of 55 mph was assumed in straight sections and 35 mph in curves. Calculation of rail travel times outside of the freeway median used 35 mph in straight sections and 25 mph in the curves. Since much of Coastal Light Rail parallels the Century Light Rail line outside the freeway median, it was assumed to share this last set of speeds. For the Long Beach Light Rail line, the team used the travel times already in the base network. Where these were not applicable, additional work was performed to estimate rail travel time, assuming maximum speeds of 45 mph and 35 mph mid-corridor and 30

TABLE 4-5

ASSUMED LIGHT RAIL "SPEED REGIMES"
FOR TRAVEL TIME CALCULATIONS

FACILITY	TYPICAL TOP SPEED	SPEED IN CURVES	DOWNTOWN SPEEDS Straight Sections	Curves
Century Light Rail (in freeway median)	55 mph	35 mph	--	--
Coastal Light Rail & Century Light Rail (outside freeway median)	35 mph	25 mph	--	--
Long Beach Light Rail	45 mph	35 mph	30 mph (1)	25 mph (1)
San Fernando Valley Light Rail	35 mph (2)	25 mph (2)	--	--

Acceleration and deceleration rates assumed to be uniform at 3.9 ft./sec./sec.

(1) - In tunnel
(2) - Additional penalty of 20 seconds/mile imposed.

mph/25 mph downtown. The San Fernando Valley Light Rail line, operating without crossing gates, was assumed to operate at typical top speeds of 35 mph in straight sections and 25 mph in curves. In the case of San Fernando Valley Light Rail, an additional penalty was imposed on link travel times due to the absence of crossing gates. This delay was assumed to be approximately equal to 20 seconds/mile. Finally, some distinction needed to be made for all rail links between peak and off-peak dwell times, as the results of greater passenger loads in the off-peak periods. This was accomplished by assuming a dwell time of 20 seconds off-peak and a full minute in peak periods.

In running alternatives with networks similar to those developed for the 30-year financial plan, the team discovered rail patronage to be unexpectedly sensitive to relatively small variations in travel time. With this in mind, it would probably be prudent sometime in the future to conduct a more thorough investigation of all coded rail travel times. Ultimately, it would be helpful to arrive at an acceptable and universally agreed-upon methodology for estimating rail travel times of all descriptions.

4.2.3 Building and Checking the Base-Year Network

The original Base-Year network was constructed somewhat differently from the future networks. To build the 1982 network, the CALTRANS SIP network was used, and a set of 1:2000 scale plots were produced from it. The lines described in the lines file were then traced onto the plots. This procedure permitted a check to be made of the completeness and correctness of the links file provided by CALTRANS, and allowed a structured checking of the individual lines. As the lines were traced, they were examined by SCRTD Planning staff, and notations were made of all route deviations between the coded SIP lines and the actual early-1982 lines. Lines that were found in the line description that were not operating at all in 1982 were traced and marked for eventual deletion. The tracing was completed to allow a complete check to be made on the plotted links.

After completion of this step, a complete set of bus schedules was assembled for all operators for the first half of 1982. Each line in the schedules was then traced on the plots, using the route map provided on the printed schedule, and with the assistance of District Planning staff for the SCRTD bus lines. For those lines in the SIP network for which changes had already been identified, this procedure acted as a check on the noted changes. For other lines, it provided the means to add lines not included in the SIP network. A complete listing of all lines, by company and by type of operation (Express or Local), was generated in this process and was checked by SCRTD staff. This listing also provided the original basis for recording the counts of trips. Subsequent checks on the network led to regeneration of the counts and some reclassification of lines.

Once these checks and lists were completed, the changes were edited into copies of the computer files to form the new files for the 1982 Base-Year network. Because the plots were used intensively at this stage, all work on the initial building of the new network was done on the original node numbers of the CALTRANS network. After all changes had been edited into the files, the renumbering of the nodes was undertaken, and this was followed by appending area types and facility types on the link records, as described in the following paragraphs.

Initially, in consultation with District Planning staff, the various outlying business districts, the boundaries of the CBD and the CBD fringe, and rural areas in the Los Angeles region were identified, and their boundaries drawn on a 1:6000 scale map. Over these areas, rectangular areas were plotted so as to include completely the true area for the special area type, and the coordinates of their corners were identified. A computer program was written and used that determined the coordinates at the midpoint of each link in the links file, and then checked to see if this lay inside any of the above area types, i.e., the CBD, the CBD fringe, the outlying business districts, or the rural areas. If not, area type 3 -- residential -- was noted on the link record. If the midpoint did lie inside one of these designated areas, then the appropriate area type was recorded. After running the program, traces of the rectangular boundaries and the true boundaries were laid over 1:2000 scale plots of the network, and links in the "edge" areas that had been included in the rectangular coordinates were identified and listed for manual correction to the true area type.

The same computer program recorded each link as a facility-type 3 link -- a 2-way arterial with parking. This facility type is by far the most common one for transit links in the region. Again, with the assistance of District Planning staff, links were identified on the plots that were other than 2-way arterials. Primarily, this consisted of all freeway links (which are usually easy to identify because of their extreme length), sections of expressway, and a few 2-way arterials without parking. As noted in chapter 2, no links are coded as 1-way arterials, even though such links do occur in the Los Angeles CBD and in a few scattered locations elsewhere. Manual editing was then performed on the facility types to change all those that were identified as being other than a facility type 3 to their correct facility type. The program was then run to look up speeds as a function of the mode, area type, and facility type of each link. In the CALTRANS network, no distinction was made in the speeds of express and local bus service. Therefore, many links were indicated as being used by both modes 4 and 5, or 5 and 8, or 4, 5, and 8. In such cases, a new link record was created by the "speeds" program for each mode 5 link, and the separate speeds for that link recorded on it. The new link record represented a duplicate of the original one, except for speed and mode. The mode 5 reference on the original link was then deleted.

At this point, the 1982 Base-Year network had been built, and was ready for checking.

4.3 BUILDING AND CHECKING FUTURE YEAR NETWORKS

Once the network has been defined, the first step in the network-building process is the determination of which network would most appropriately be suited to act as a base network. The most important factor to be considered in this process is the extent of the fixed facilities (usually rail) in the possible alternate base networks and the similarity of these to what is to be included in the new network. This will probably (but not necessarily) also influence the amount of background bus service changes which need to be implemented, but the extent of these should be considered as well in the selection of a base network. Once this new network has been named and allocated space on a disk pack, the base network lines, links, and coordinates are copied in. The first step is to make a hard-copy printout of the lines file in preparation for lines editing. There is no way to get around the laboriousness of actual route coding and network changes which must be undertaken node-by-node manually, with the aid of a network plot and a good street map. Ideally, coding should be accomplished by taking care of links and lines at the same time. In practice, this almost never works perfectly, and link omissions have to be resolved after the lines coding is finished.

It is important to keep a record of the changes that are made on separate coding sheets, recording periodically a description of the node locations in the line being edited (see Figure 4-1). This allows for later reconstruction of the coding philosophy in the changes that were made. At the same time, changes should be noted on the hard-copy printout of the lines file, since this will be the document from which computer keypunching will actually be done. In the case of links, coding sheets are used mainly as an aid during coding, allowing one to return to full link construction after the line coding is complete. With these forms (see Figure 4-2), it is important to make a note of the line a new link combination is needed for and what similar links are in the area. A progress check-off sheet (see Figure 4-3) is also useful in insuring that no step in the network-building process is overlooked.

Once the line (including rail line) changes have been made, the integrity of the links can be checked through a program developed by District staff called CHEKLINK. The program reads a lines file and determines whether the necessary links are present in the network. In a slightly different configuration, the program can, after reading the lines file, pull only the needed transit links from an existing links file or concatenation of links files. What makes the program particularly useful is not just that it checks the completeness of the links file, but that it reports out any missing links in a separate file in standard UNET link card format. This allows the user simply to input distance and speeds and insert the new links into the existing larger file. It is, however, important to note that the program does nothing for nontransit links and, indeed, in the mode where it builds a new links file, it does not even copy over the nontransit links.

Project ____________ Job No. ______

Subject ____________ Sheet ______ of ____

Made by ______ Date ______ Checked by ______ Date ______

BACKGROUND BUS CHANGE FOR:

RT: MODE: ( )

HEADWAY: PEAK
OFF-PEAK

NODE	LOCATION

Figure 4-1

LINK CHANGES

1st NODE	2nd NODE	MODE	LENGTH	AM SPEED	MID-DAY SPEED	COMMENTS

Figure 4-2

ETNET					
MDA DATA					
BLDCON NBCNLINK -> LINKS					
UCHEK REPORTS CHECKED					
UCHEK RUN					
KNR CONNECTORS					
PNR CONNECTORS					
MINI-WALKS					
UMATCH CHECKED					
UMATCH RUN					
RAIL-LOCAL DUMMY LINKS					
RAIL LINKS CHECKED					
RAIL LINE CODING HEADWAYS!					
BUS LINK CARD INTEGRITY (CHEKLINK)					
BUS LINE CARD CHANGES					
NETWORK NAME					

Figure 4-3

When rail is in place, some additional care obviously must be taken, since the existence of rail complicates the network. Certain network components relate only to rail. Most important of these are the rail lines (including headways) and links themselves, the dummy walk links into the stations, and the "miniwalk" networks. Calculation of rail link travel times is thoroughly discussed in section 4.2.2.9. Dummy links are walk links with zero time and zero distance coded in the appropriate columns and which simply allow someone to walk from the local (bus) transit node into the station. Miniwalk networks are sets of walk links which replicate sidewalks along transit links in the vicinity of stations and which allow transit patrons to walk from nearby cross streets into the stations. General practice in network building has been to double-check manually rail line coding, including headways, and to sort and print out rail links, dummy links, and miniwalk network links for subsequent checking.

It is possible at this point to run the program UMATCH. UMATCH is a relatively simple program designed to insure that bus lines actually meet the rail, Park-n-Ride, and Kiss-n-Ride locations they are supposed to. UMATCH is also useful in uncovering general line-coding errors. The results of UMATCH are considerably easier to use in instances where UNET line number guidelines, mentioned earlier, have been consistently adhered to.

The next step is to build Park-n-Ride and Kiss-n-Ride access connectors to the new stations and to check the integrity of pre-existing auto connectors. Usually, rail lines are concentrated in a rather limited and centralized geographic area. Since a comprehensive analysis of Park-n-Ride and Kiss-n-Ride connectors has already been conducted by the team, there is little reason to adjust auto connectors in outlying areas, distant from the new station-related Park-n-Ride or Kiss-n-Ride locations. Thus, complete sets of plots of auto connect links are rarely needed, and analysis can be concentrated in the small area around the rail line.

Once this process is completed, the network is essentially complete with the exception of centroid walk connectors which are now computer-generated with the program BLDCON2 after the network undergoes one last check for accuracy. The program UCHEK is this final check. This program identifies all Park-n-Ride and Kiss-n-Ride locations and rail stations, the number and length of auto connect links into these locations, and any auto links which violate the auto link length rules. In addition, in the case of rail stations, the program also states the number of miniwalk links around the station and the local (dummy) node number. In a second report, the program performs an analysis of walk connectors. In this report, the program highlights any zones with walk connectors which are either coded to be over length, or which have nonuniform distances. UCHEK also identifies zones with walk connectors which have nonuniform walk speeds or walk speeds not equal to three miles per hour. The final report compares, line-by-line, the coding of "new" and base network line files, including headways, and determines whether routes are coded as one-way or two-way routes. This last report is particularly helpful in insuring that only the intended lines have been edited and that the specific changes made are correct.

The last network-building procedure and the last step before actually beginning the model chain is to run the program BLDCON2, more thoroughly described elsewhere. The great advantage to BLDCON2 is that it consistently optimizes walk connectors and adjusts to whatever transit network is in place. The user's responsibility is simply to check that the output appears reasonable.

4.3.1 UNET-Related Debugging

The last step in the checking and correcting process is to run the program UNET. This produces a list of errors of several types affecting both the lines and links files. Considerable care is needed in dealing with the errors that are noted by UNET, because the errors are not always a result of the most obvious cause, nor is the error message, in itself, always an accurate identifier of the reason for the error. The errors that may be detected include:

- Omission of the terminating "T" at the end of a line description. This usually leads to an error message indicating that cards in a line description are out of sequence -- a fatal error.

- Any part of the lines file that is "out of sort." The lines file is required to be sorted by mode and line number, and by sequence number within the line. Any violation of this will produce a fatal error.

- Lack of a link in the links file that corresponds to a consecutive pair of nodes in a line description. Processing will continue past this error, and statistics will be compiled on all lines that are error-free. There are numerous reasons for this error to arise, demanding great care in investigation and correction. Return codes will be further discussed later.

- A line description that is too long will produce a fatal error in UNET processing.

- Too many links in the links file. UNET counts one link for each direction and each mode of a bidirectional link, and for each mode of a one-way link. The limit in UNET is 32,767. More than this cannot be processed, and will produce a fatal error. More frightening is the fact that UNET produces no error messages for this mistake, though its occurrence is relatively rare.

- Inclusion of a link that will take more than 25.5 minutes to travel. UNET sets this as the maximum travel time for a link and will replace any travel time that exceeds 25.5 minutes with 25.5 minutes.

- Omission of any of the required data items for a line description, e.g., a line number, a company number, a mode number, etc.

- o Use of a node number greater than the highest number -- 8191 -- allowed by the UNET program.

Often, the best course of action with errors of this type is to fix the first error that can be easily identified and rerun the proram. For instance, a missing 'T' in column 72 of the last card of a line description will cause the program to generate an error message of improper line and sequence numbers (because it fails to recognize the new line as anything but an extension of the old). The next card record read produces the same error, and the program continues to generate error messages for every line card read past that point, generating sometimes as much as twice the normal output. Correcting the first error will often make many of the other alleged errors disappear.

There is no substitute, however, for return code-checking both at the beginning and end of the UNET output. Unfortunately, UNET often happily generates VBS transit network files (TNETS) and statistics on lines, simply skipping over lines with mistakes. Nonetheless, a check of the return codes will in most cases quickly reveal these errors. Anything but a return code "0" on a UNET run should be considered unsatisfactory.

Missing links ought to send one back to the lines description, the plots, the schedules, and the maps to determine if there is a coding error or simply a link that is present with the wrong mode for a line that needs it. Often, the latter case can be checked fairly quickly in the existing links file.

If a line description has been included that is too long, this error will be reported and will usually be fairly obvious. Correction of this error requires that the line description is shortened to no more than fifty nodes. This can be cone by finding locations on the line where a node can be omitted, possibly by creating a new link that is made up of two or more original links. Candidate nodes for those are those where no interchanges to other lines occur, or where centroid connectors terminate but can be moved to an adjacent node, without loss of accuracy.

The problem of too many <u>links</u> is a thorny one, but occurs less frequently today because of the way in which access connectors are built. Use of the BLDCON2 program has sliced link requirements by as much as 6000 links. Moreover, the careful, manual process of building auto connect links has saved on the number of links needed there as well. There remains one last armament in reserve, a program called MAKELINK, developed by District staff, which will read a lines file and a links file together (or even a concatenation of links files) and pull out only those transit links needed to run the network. A desirable by-product of this program is that it will help produce cleaner network plots, although generating new networks from a links file built in this way will be more difficult.

If a link has been included that is longer than 25.5 miles or takes more than the maximum 25.5 minutes to traverse, three possible corrections may be made. First, the link length must be checked to make sure this is not in error, for example by keying the length into the file one place to the left of where it should be, thereby effectively multiplying the link length by 10. Second, if the link length is found to be correct, then the speeds on the link should be checked. In a bus network, the only links that can legitimately generate this problem are long links on a freeway, with very long hauls in areas of low population density, with no intermediate stops. In some cases, it may be found that the speed allocated is not correct. Third, if the link genuinely takes more than 25.5 minutes to traverse, then an intermediate node is desirable, to shorten the length of each of the two resulting links, so that neither one takes more than 25.5 minutes. This is referred to as a freeway dummy node because it does not represent an actual stop, and steps should be taken to insure that it is not possible to access this node either directly through walk or auto or through transfer with other bus lines. The system the team has adopted has been to reserve the range 7900-7949 for freeway dummy nodes. A list is kept of those already used to keep them unique. This limited range of numbers identifies them to both the experienced code and to network programs like BLDCON2.

Omission of required elements of a line description are indicated clearly by the UNET error message, and correction is an obvious procedure. Similarly, use of a node number that exceeds the maximum allowable node number requires renumbering of any appropriate nodes to allow the offending node to be renumbered as 8191 or less.

4.3.1.1 Use of UNET Reports and Outputs

This completes the discussion of errors which can be uncovered through running UNET, except to speak about UNET reports. In general, these reports are not very useful, but report 4 can be a good check on network errors even after the network would otherwise appear to be "clean and green" through a successful run of UNET. Report 4 is a listing of route and vehicle miles, and even a cursory analysis of the output and comparison with previous runs can help to uncover network coding problems either in headway or line descriptions.

A final word should be said about line-coding descriptions and their effect on later stages of the modeling process. In many cases, several bus lines will traverse a common section of street, which may be anything from a block or two to several miles. For very short segments of common street, there is no need to be concerned with consistency of coding, partly because inconsistencies are unlikely to occur, and partly because the effects of such inconsistencies will be minimal. This is not the case for long sections of common routing. Inconsistent coding affects the way UPATH calculates combined headways and, therefore, minimal paths, and tends to produce lumpy loadings out of ULOAD.

An example of this situation and the effects of it illustrates the problem more easily. Suppose that two lines operate in common from node 5131 through node 5216, but that the line descriptions have been coded to include some variations in nodes included or excluded, resulting from the presence of links that permit some nodes to be bypassed. Suppose that the line descriptions are as shown below for the common section:

Line 12	5130	5131	5132	5134	5138	5140	5144	5187	5189
	5198	5199	5207	5216	5222				
Line 27	5127	5131	5132	5138	5139	5140	5144	5166	5187
	5189	5198	5199	5216	5219				

The underlined nodes are those that do not correspond between the two descriptions. Based on these, the models will assume that there is a common section comprising nodes 5131 and 5132, another one for 5140 and 5144, and a third one for 5187-5189-5198-5199. In effect, only the last set of three links will be treated as truly a common street segment. Line 12 will be assigned all trips that transfer onto or off this street at nodes 5134 and 5207, while line 27 will be assigned all those that enter or leave at nodes 5139 or 5166. It is not completely clear how ULOAD will assign the trips that enter at 5131 and leave at 5216, or one of the other common nodes, nor those that enter at 5216 and exit at 5131 or a common node. However, the loading will not be in proportion to service levels on the common street segment.

Given the complexity of the networks and the difficulty of insuring that the networks are reasonably correct, these types of problems pale in comparison. However, it is important to remember that the way lines are coded does make a difference and to make every effort to be consistent with what is already in place. Another reason to put these types of issues into perspective is that although UPATH will not generate a combined headway in the above situation, it is not really in conflict with the real world in which headways might be quite asymmetric, for instance, running on 15 minutes and 30 minutes but only 7 minutes apart.

4.3.2 Error-Checking from Plots

Until UNET runs without error messages, it is not possible to obtain plots of the current network. All work from plots up to this stage must be done on plots of a previous network. As a result, various problems are likely not to have been detected. Therefore, as soon as an error-free run of UNET is obtained, a set of plots should be run, to allow some basic checking to be undertaken.

The plots should be examined from edge to edge to check for several potential problems. Some of the checks that should be made at this stage represent cleanup of the network that produces a more obviously clean and correct model. The checks that should be made on the network are:

- o Check of all long links, to make sure that these are genuine freeway links that are long, and are not the representation of a "tunnel" caused by one misplaced or mistyped node.

- o Check of unexpected gaps in the network, where a street obviously should continue from one node to another, but does not. This may represent a "hole" in the network caused by the omission of a link, and may have been overcome in the line descriptions by an incorrect bus routing.

- o A cursory check for problems with auto connectors. Specifically, checks should be made that auto connectors are not built to an illogical Park- n-Ride location, and that generally two, but not more than three, connectors are built from any one zone.

If a link is found that is excessively long, then the node numbers should be checked on each end of this. Because the nodes in the current networks have been numbered on the basis of geographic location, a node that is far out of sequence would indicate that it has either been mistyped or has an incorrect coordinate. In this case, the original records from which the link in question was constructed should be checked, and the coordinates should be checked with nearby nodes, to determine if there is an indication of an error in these. A similar procedure of checking back to original records is indicated if "holes" are found in the network. In this case, however, it should be recognized that some genuine gaps will occur in a transit network, because buses are not routed over the entire lengths of streets, and a routing deviation may generate an apparent gap that is correct.

It should be noted that, in UNET, a zone without centroid connectors or only centroid connectors of a mode which is not being plotted will not itself show up on a plot. For example, a zone may be connected to the network by walk and Park-n-Ride but not by Kiss-n-Ride. On a plot of Kiss-n-Ride plus transit links, not only will no connectors from that zone be displayed, but the centroid itself will not appear.

Auto connectors that pass right by, or even over, a nearer Park-n-Ride or Kiss-n-Ride lot should be deleted. It is highly improbable that a potential transit user will drive right by one such facility to go to the next. (The only reason for such a movement, generally, would be that the nearer lot is full, a fact that travel-forecasting procedures are not equipped to handle.)

Despite all of the checks, there is clearly no substitute for careful coding in the first place under adequate supervision. All of the checking programs and procedures used after the coding is complete is only a mediocre second line of defense.

4.4 PATH SELECTION AND PATH CHARACTERISTICS

An important component in the calibration and application of the mode choice models is the input of transit service characteristics for each of the transit submodes represented in the second level of the hierarchical model. Significant changes can be produced in modal shares simply by changing the path-selection procedure, thus generating different paths and therefore different transit service characteristics.

To build and run the mode choice models, four sets of paths and skims are required: AM peak walk to transit; AM peak Park-n-Ride; AM peak Kiss-n-Ride; and midday walk to transit. The work mode choice model, which is assumed to be applied to peak-period trips only, specifies the three transit alternatives of walk access, Park-n-Ride, and Kiss-n-Ride, while the nonwork and non-home-based models each assume that the trips take place on the midday network with walk access only permitted to transit.

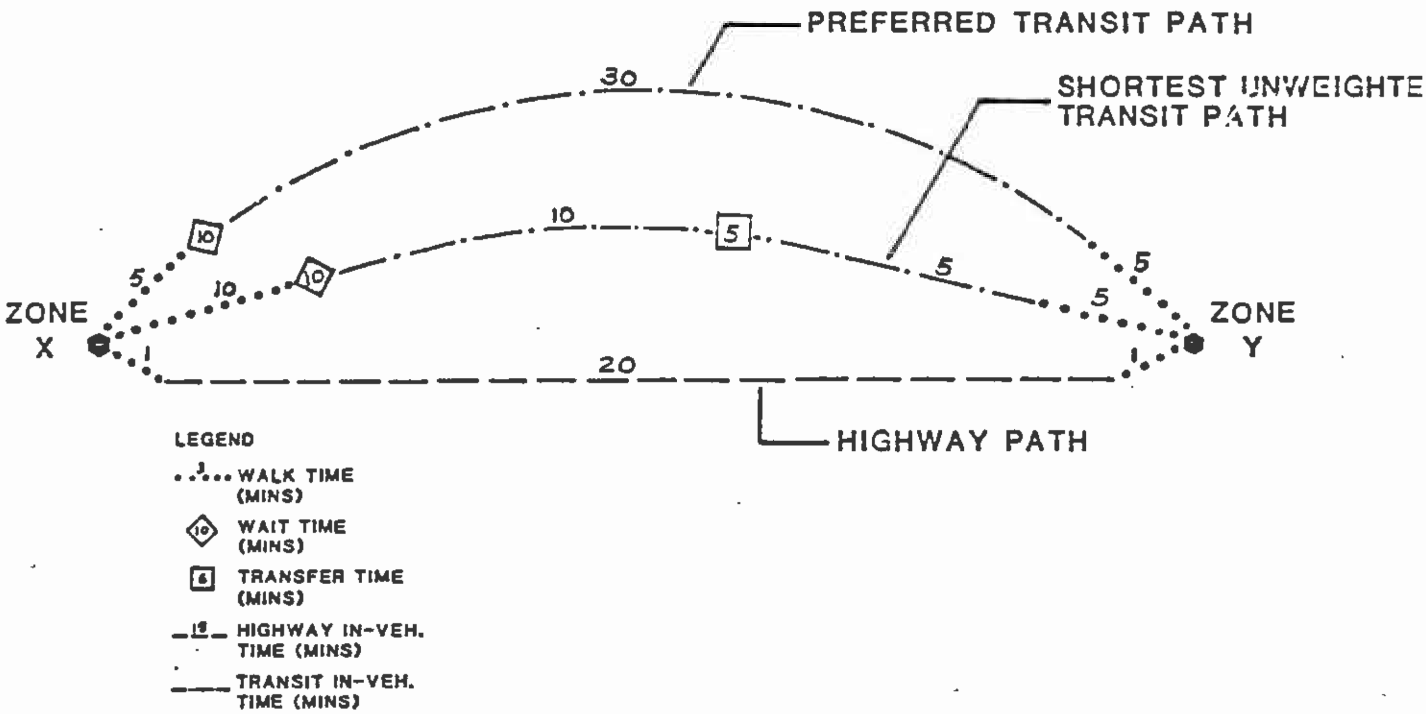
The path-building parameters were developed through a series of tests of values, with the values based on theoretical and conceptual reasoning for the initial values.

4.4.1 Consistency Between Paths and Mode Choice Models

It is extremely important that the parameters used in path-building are consistent with the coefficients used for travel characteristics in modal split. This fact is not widely recognized in current practice, and the justification is therefore provided in some detail in this report. In logit models of mode choice, the out-of-vehicle travel times are generally found to have coefficients that are in the range of two to five times the size of the coefficient of in-vehicle time. Generally, it is also found that walking time has a coefficient that is somewhat smaller than waiting time, ranging from about 1.5 to four times the coefficient of in-vehicle time, if the two variables are included as separate variables in a mode choice model. Observation of use of the transit system also indicates that people do not like to transfer, and will often avoid a transfer by traveling a longer, direct alternative route or path.

The reason that it is important that there be consistency between these values and the path-building parameters is that the path-building parameters provide an effective route and transit submode selection. If this is produced inconsistently with the mode choice model, the resulting paths will not represent the paths most likely to be selected by travelers, and an underestimate of important parameters, such as walk time and wait time, may result. In turn, this will have the effect of biasing the calibration of the coefficients of components of time, and will require that the modal constants are used to provide a correction for these inappropriate transit times. This leads to incorrect forecasts when changes are made to the network that impact different trip interchanges disproportionately, as happens with the introduction of rail in a specific corridor, for example. Further, once a mode choice model has been calibrated based on a particular set of path-selection criteria, these same criteria must be used in building a pattern for application of the model.

An example may help to illustrate the importance of this consistency. Suppose that there are two zones, between which workers currently choose auto over transit by a margin of 3 to 1, i.e., the modal split is 75 percent auto and 25 percent transit. The example is shown in Figure 4-4. Suppose, further, that the transit paths are built without using any weights different from 1.0 for the components of



TIME	AUTO	UNWEIGHTED TRANSIT	PREFERED TRANSIT
WALK	1	10	5
WAIT	–	10	10
IN-VEH	20	10	30
TRANSFER	–	5	–
IN-VEH	–	5	–
WALK	1	5	5
TOTAL	22	45	50

Figure 4-4

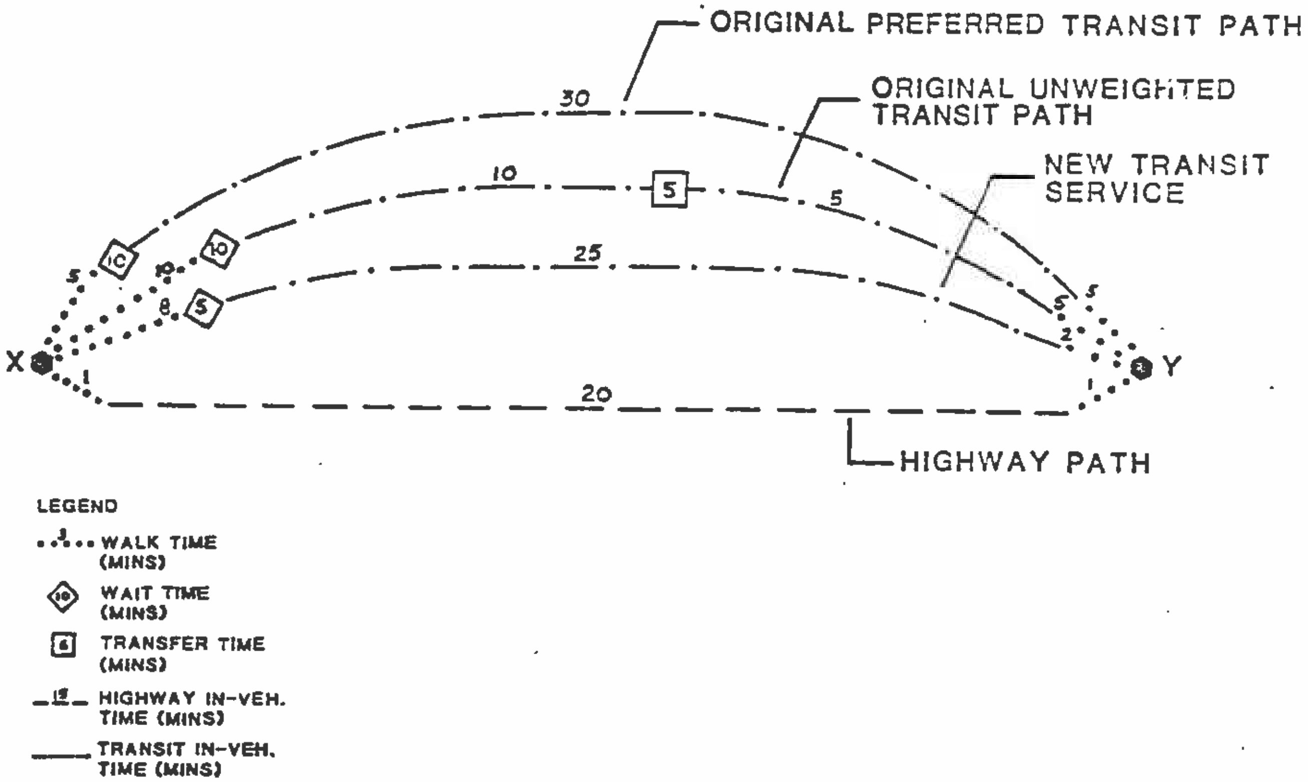
PATH-SELECTION EXAMPLE

transit time, while the mode choice model has a coefficient of out-of-vehicle time that is 3.5 times the in-vehicle-time coefficient. Suppose further that the auto path provides an in-vehicle time of 20 minutes and an out-of-vehicle time of 2 minutes. With the coefficients just noted, the travel time component of the auto utility will be 27 in-vehicle minutes (20 + 3.5*2). Using the unweighted transit travel times, suppose that the shortest-time path, based on total time, involves a 10-minute walk to transit, a 10-minute wait for transit, a 10-minute ride on the transit vehicle, a transfer that incurs an additional 5-minute wait, a second ride of 5 minutes on a transit vehicle, and a 5-minute walk to the final destination. This totals 45 minutes of clock time.

In calibration, the model is provided with data that state that, when the auto time is 27 minutes of equivalent in-vehicle time and the transit time is 120 (3.5*10 + 3.5*10 + 10 + 3.5*5 + 5 + 3.5*5) equivalent in-vehicle minutes, the modal split is 25% transit and 75% auto.

Now, suppose that the majority of the transit users do not use the path found from the unweighted values, because of the amount of out-of-vehicle time involved. Instead, consistent with the modal-split model, they prefer to use a path that involves a 5-minute walk to transit, a 10-minute wait, a 30-minute in-vehicle travel time with no transfer, and a 5-minute walk to the final destination. This path has a total elapsed time of 50 minutes, making it longer than the previous path, but the mode choice model assesses this path as having 100 equivalent in-vehicle minutes (3.5*5 + 3.5*10 + 30 + 3.5*5). Thus, in reality, it requires that there be a difference between auto and transit of 73 equivalent in-vehicle minutes to generate a transit share of 25 percent, while the unweighted path indicates that this share can be achieved when the difference is 93 equivalent in-vehicle minutes. To compensate for this, the model will have to provide an anti-auto constant that effectively makes transit appear more attractive than the unweighted path would suggest. The constants will, of course, produce correct market shares for the calibration.

In forecasting, suppose now that a new transit service is provided that involves an 8-minute walk to transit, a 5-minute wait, and a 25-minute ride in the transit vehicle to a point that requires a 2-minute walk to the final destination, as shown in Figure 4-5. With a total of 40 unweighted minutes, this becomes the selected path. However, the modal-split model receives information that the equivalent in-vehicle minutes for this new alternative are 77.5. Against the calibration of unweighted times, this represents an improvement of 42.5 in-vehicle minutes. In reality, the improvement over the path used by most travelers is only 22.5 in-vehicle minutes. As a fraction of the difference between transit and auto, the unweighted path generates an improvement of 46 percent in the difference, while the weighted paths would have given an improvement of 31 percent. The constant plays no part in the change in transit share, apart from fixing the original position of the logit curve. Hence, the unweighted paths would lead to a substantial overestimate of the increased use of transit, in this case.



TIME	AUTO	UNWEIGHTED TRANSIT	PREFERED TRANSIT	NEW SERVICE
WALK	1	10	5	8
WAIT	-	10	10	5
IN-VEH	20	10	30	25
TRANSFER	-	5	-	-
IN-VEH	-	5	-	-
WALK	1	5	5	2
TOTAL	22	45	50	40

Figure 4-5

EXAMPLE OF ADDITION OF NEW SERVICE FOR PATH-SELECTION

In some situations, the unweighted paths would lead, incorrectly, to no change in patronage, if the unweighted path did not change, even though the new service was clearly more likely to be used. Thus, while replication of base data can always be assured by adjusting the constants, forecasting will necessarily be incorrect, unless forecasts involve a constant relative change to all transit and/or auto paths.

In the above example, if path selection uses a weighting factor of 3.0, for example, for walking and waiting time, then the highway path will have a weighted value of 26 minutes. The transit path with the shortest total elapsed time will have a weighted time of 105 minutes, while the preferred transit path will have a weighted time of 90 minutes. Thus, the preferred path will be found to be the shortest path. The new transit service will have a weighted time of 70 minutes, so that it will still become the shortest path, as it should. In all cases, unweighted values are used in the skims and passed to the mode choice model.

The paths that will result from a range of weights on walking, waiting, and transfer time will all be consistent with the mode choice model, provided only that the weights are within a range of about 1 or 2 of the mode choice weights.

4.4.2 Choosing Parameters for Path-Building

The UPATH program in UTPS allows a number of alternative parameters to be set to obtain paths. As established in the preceding section, it is important that weights be used on time components to obtain paths that are consistent with the mode choice model. (It should be noted that cost is not used as a path-building determinant in the current application of the models; this is consistent with calibration of the models.) Beyond the use of weights, there are also minimum and maximum values that can be used for initial waiting time and transfer waiting time, a limit on the number of transfers, penalties that can be added to waiting times, and a complete set of available transfer prohibitors. One category of parameters, penalties on waiting times, is not used in the path-building from this project; and transfer prohibitors are used as sparingly as possible. Both of these parameters are considered to be conceptually and realistically false, and are provided to permit reasonable paths to be built when a network is not constructed in the optimal manner. In some instances, the network construction is compromised by the limitations in the computer software, and may require that these parameters are used. In the case of the networks built in this project, conventions and procedures have been used that remove the need for almost all of these parameters. For example, a penalty of 8 minutes on each transfer, if applied in the unweighted example in section 4.4.1, would have caused the preferred path to be selected as the shortest path. (The addition of the penalty would have changed the time on the unweighted shortest path to 53 minutes, compared to the unchanged 50 minutes of the preferred path.) Choice of the appropriate penalty is difficult and unlikely to be satisfactory in all cases. For example, choice of a penalty of 5 minutes or less would not change the path selection in the example in section 4.4.1, while a choice of more than 5 minutes might still be insufficient in other cases. Use of a constant penalty has also been found to have peculiar effects on modes that are frequently accessed by another mode, such as rail transit or express bus, often diverting paths away from such modes to an unrealistic extent.

The use of transfer prohibitors can have the effect of causing some zones to become disconnected, and may also prevent use of some parts of the network. Under certain circumstances, they have also been shown to generate serious problems in using Moore's algorithm for path-building. Therefore, these parameters are also not recommended for use. However, in constructing auto access paths for the Los Angeles transit networks, it was necessary to use two transfer prohibitors to prevent paths from being built from a zone along an auto connector to a transit node, and thence to a walk connector into the destination zone. One additional parameter is considered best if set to a value that makes it ineffective: the maximum number of transfers. This parameter can be used to prohibit paths with more than a certain number of transfers. It is a dangerous parameter, however, because it will disconnect a zone where there is no path with less than the number of transfers specified.

The choice of the values for the remaining path-building parameters is based on an examination of the paths that are built and on conceptual and theoretical reasoning. The starting point is to set weights that will be consistent with the travel-time weights in the mode choice model. Variations of these values may be proposed, based on the concepts of path-building. Maximum and minimum values are proposed on the basis of theoretical and conceptual arguments. Checking the paths is done best by examining paths that correspond to the work trips of a number of people who can be asked to provide details of their usual way of using transit to work. In this project, several members of the District's Planning staff who use transit to work were asked to assist in checking the path selection. For each person who cooperated, location of their home was determined, and paths obtained from the zone containing their home to the SCRTD offices. From the computer paths, a description was developed for each individual, listing the bus route number(s) used, the time to walk or wait, and the locations of any transfers. Paths were generated for walk to bus, Park-n-Ride, and Kiss-n-Ride, and each was checked for reasonableness. If a number of paths did not match, the parameters were changed selectively until most paths matched or were judged to be reasonable alternatives to the path used by each staff member.

4.4.3 Values of the Path Parameters

The initial set of path parameters selected are shown in Table 4-6. For these paths, walk time was given a coefficient of 2.5, initial waiting time was given a coefficient of 1.5 on all modes, transfer waiting time was weighted at 3.0, no minimum waiting times were set, but maximum initial waiting times of 15 minutes were set. The UTPS default of 60.0 minutes was left in force on the maximum transfer waiting time. The reasons for these initial values are as follows:

TABLE 4-6

INITIAL PATH PARAMETERS USED

Parameter & Mode		Function	Value
CTTIME	1	Coefficient of walk time	2.5
	2	Coefficient of auto (PNR/KNR) time	0.1
	3	Coefficient of auto (KNR only) time	0.1
	4-8	Coefficient of transit in-vehicle times	1.0
CWTIME	4-8	Coefficient of transit wait time	1.5
CXTIME	4-8	Coefficient of transit transfer time	3.0
WMAX	4-8	Maximum waiting time	15.0
XFERS		Maximum permitted number of transfers	8.0
NOX (2,1)		Transfer prohibitor from mode 2 to mode 1	T
NOX (3,1)		Transfer prohibitor from mode 3 to mode 1	T

Source: Schimpeler Corradino Associates

- Walking time is weighted between 2 and 3 times the in-vehicle time in most logit mode choice models;

- Waiting time is weighted at 2.5 to 3.5 times in-vehicle time in most logit mode choice models, but all transit users must incur an initial wait. Therefore, a smaller coefficient was applied to the initial wait than to the transfer wait;

- A maximum initial waiting time of 15 minutes is used on the assumption that people arrive at bus stops randomly for service with less than a 30-minute headway, incurring a wait of half the headway, but will learn the schedule for a less frequent service and will arrive close to the expected time of arrival of the bus in this situation; and

- There was no strong argument for setting any other values.

The maximum number of transfers was set to 8, which should not normally be encountered, particularly with the weight of 3.0 on transfer time. To build the midday walk paths, modes 2 and 3 are deleted. To build the morning peak walk paths, the same deletion is used. For the morning peak Park-n-Ride paths, the weight for Park-n-Ride is set to 0.1, while only mode 3 is deleted. A transfer prohibition was used between modes 2 and 1, to prevent paths being built along a Park-n-Ride connector to a walk connector. The morning peak Kiss-n-Ride paths were built by permitting all access modes to be used (1, 2, and 3), setting both coefficients for in-vehicle time on modes 2 and 3 to 0.1, and prohibiting transfers between modes 2 and 1, and between modes 3 and 1.

The use of a weight of 0.1 for the auto access times when Park-n-Ride and Kiss-n-Ride paths are being built is necessary to make these paths very attractive, compared to walking to transit. In past research by the Consultant team, a value of 0.1 has been found to be necessary and appropriate to build such paths for all possible situations. Again, the function of these paths in the modal-split model needs to be understood. The modal-split model will provide the actual choices between alternative paths, based on actual travel times. If it is physically possible to access the network by auto, a link is needed so that a path can be defined. If this path is obviously illogical, the modal-split model will reject it effectively by assigning a very low probability to its use. If a unit weight is used, then a walk-only access path will be found in many instances when auto access is possible. This will bias the results of the modal-split model.

As noted in chapter 4, auto links (modes 2 and 3) are coded as one-way links out of a zone, so that zones cannot be accessed by auto. There are no dummy links connecting auto to transit nodes, including rail stations, but walk and bus nodes are connected into stations only through dummy walk links. There is no distinction between walk connectors and the downtown walk network.

The effects of the selected path parameters should be as follows:

- o The coefficient on walking time should generate paths that keep walking time to a minimum. Thus, path selection will favor longer in-vehicle time rather than a long walk to a shorter transit ride.

- o The coefficient on initial waiting time should favor a transit line with a shorter headway, even if the in-vehicle time is somewhat longer than that of a line with a longer headway.

- o The coefficient on transfer time should discourage the use of transfers in paths, and should effectively make the maximum transfers parameter redundant.

- o The maximum initial waiting time will prevent waiting times from being calculated as half the headway for headways from 31 minutes through 99.9 minutes. It is not expected that real paths in the system would incur waiting times of, for example, 30 to 45 minutes.

- o Weighting the in-vehicle times for Park-n-Ride and Kiss-n-Ride modes by 0.1, when paths are being built for these access modes, will encourage all possible paths to be built using these modes. In other words, paths will generally not be built with walk access when these weights are used. Walk access must be permitted, however, because a number of zones will not have auto connectors.

When these initial values were used, it was found that there were several problems in the resulting paths.

- o Too many transfers were still being used in the selected paths. This was particularly a problem in the CBD, where combined headways on some streets generated transfer waiting times of 0 minutes.

- o Too few paths used express bus, even when it was available.

- o Too few paths for Park-n-Ride and Kiss-n-Ride used the auto mode.

To deal with these problems, several changes were tested on the path parameters. First, the coefficient of transfer time was set to 5.0, to reduce the use of transfers. This was found to generate much more reasonable paths, in terms of transfers, with about one-third of the paths having no transfer, one-third having one transfer, and the remainder having between 2 and 4 transfers. One problem that this generated, however, was that a number of zone pairs now exceeded the limit of 255 minutes for the path length (this being computed in terms of the weighted values), thereby disconnecting the zones. Therefore, a lower value of 4.0 was tried. This was accompanied by setting the minimum transfer time to 2.0 minutes, so that transfers in the CBD would be less likely to occur for short travel distances in the CBD. This was found to generate an almost identical set of paths, except that more zone pairs remained connected.

To deal with the problem of the express bus use, the values of the maximum waiting and transfer times were reset for mode 5 (express bus) only to 8.0 minutes for initial wait and 15.0 minutes for transfer wait. This was done on the assumption that the lack of express bus paths was caused by the fact that most express buses have long headways, because headways are computed as an average for the entire peak period. If an express bus runs once only in each peak, its headway is set as 99.9 minutes (the maximum that UNET permits), and if it runs twice or three times, the headway for the peak would be 90 minutes and 60 minutes respectively. These headways were found to be very common for the express buses. They result in the express buses being assigned the maximum waiting time of 15.0 minutes if the path accesses the express bus directly from the nontransit mode, and a 60-minute maximum (which effectively leaves the half-headway waiting time unchanged) if local bus is used as the access mode. The new values would cut the waiting time to 8.0 minutes for express bus when it is accessed directly, and to a maximum of 15.0 minutes when it is accessed by another bus. This was considered to be reasonable on the grounds that an express-bus user would know the schedule for an infrequently running express bus and would time his or her arrival at the bus stop close to the express bus schedule, and that use of a local bus to access the express bus would also be likely to be timed closely to the schedule. The result was, as desired and expected, that substantially more paths were built using express bus, with a concomitant reduction in transit travel times for the peak period.

Finally, the problem of the lack of Park-n-Ride and Kiss-n-Ride paths was attributed to the rather small number of auto connectors (1100) in the initial networks. This small number was caused by the somewhat restrictive rules used initially to generate auto connectors. Therefore, auto connectors were rebuilt, using more liberal rules, these being the rules described in chapter 4, and 2,802 connectors resulted in the 1982 network. This resolved the problem.

After implementing each of these changes, two remaining problems were identified. First, it was found that paths originating in the CBD were still using too many transfers, and were not using the walk network. Therefore, the minimum initial waiting time was also set to 2.0 minutes, in conformance with the minimum transfer time. This solved this problem. Second, early tests of the mode choice models were found to be generating too high a transit share of the market for the nonwork trips. Indeed, some initial runs produced estimates of nonwork transit shares that were approximately double the observed values. The path values were therefore compared between the calibration data used by the SCAG contractual work on the mode choice models and the data from this project. Good agreement was found except in two cases. The waiting and transfer times for both peak and midday were found to be uncapped in the SCAG data. In the mode choice model code, the peak waiting time was reduced for times in excess of 13.0 minutes in the CSI code by resetting the value to 8.5+0.4 (initial waiting time). This has the effect of reducing a path waiting time of 15 minutes to 14.5 minutes, a path waiting time of 20 minutes to 16.5 minutes, and a path waiting time of 30 minutes to 20.5 minutes. This was determined to have an effect similar to the use of a maximum waiting time of 15 minutes. However, no such reduction was used in the nonwork models. Therefore, it was decided that the maximum values should be changed for the midday paths, to provide closer conformance to the calibration of the mode choice model. The waiting-time maxima were doubled to 30 minutes for all modes except express bus, which was set at 15.0 minutes, and the express bus maximum transfer time was set to 30.0 minutes. This change brought the calibration and SCRTD waiting and transfer times into reasonable agreement on a regional basis, yielding one set of values of the path parameters shown in Table 4-7.

4.4.4 Modification of Path-Selection Parameters

The path-selection parameters in Table 4-7 were used for a time until, as part of a review of the network coding for the FY85 transit network, a set of walk paths was traced from a downtown Los Angeles zone to zones in outlying areas. Two general types of problems were found with the paths. The first problem was that, for several interchanges, program UPATH did not find the path with the minimum weighted impedance. The second problem was that, for a significant proportion of the interchanges checked, the paths selected by program UPATH, while having the minimum weighted impedance, were not the paths that realistically would be selected by a transit rider.

After tracing the paths for 20 to 25 interchanges, a pattern emerged in which it appeared that too little walking was occurring in the downtown prior to the initial boarding. Rather than walking, transit riders took buses for short distances to access the line that would be taken to the final destination. In most of these cases, the line taken to the final destination was the same as the one that would have been accessed by walking. Walking, however, was the most realistic access mode, and, for several interchanges, would have actually resulted in a lower weighted impedance.

The effect of this problem on the level of transit patronage for these interchanges was probably minor: riding rather than walking results in an additional transfer which increases total wait time and causes transit to appear slightly less attractive. The effect of this problem on another interchange that was examined was much more severe, however, because it caused an illogical sequence of lines to be taken to the destination zone. Had the walk mode been used, a much more logical line would have been selected, significantly reducing both weighted impedance and unweighted travel time.

Two causes were identified for this problem of path selection. The first cause was the combination of path-building coefficients that were used which heavily favored riding over walking, particularly in areas having a high density of transit service such as the downtown. As can be seen below, walk time was considered 2.5 times more onerous than transit in-vehicle time. Combined with this, the application of an initial wait time coefficient of only 1.5 applied to wait times that were already low due to the high frequency of service had the effect of minimizing the disadvantage of riding transit.

TABLE 4-7

INTERMEDIATE PATH-BUILDING PARAMETERS

Parameter & Mode		Definition	Value
CTTIME	1	Coefficient of walk time	2.5
	2-3	Coefficient of auto access time	0.1
	4-8	Coefficient of transit in-vehicle time	1.0
CWTIME	4-8	Coefficient of waiting time	1.5
CXTIME	4-8	Coefficient of transit transfer time	4.0
WMAX	4,6-8	Maximum waiting time for transit	15.0 peak 30.0 midday
WMAX	5	Maximum waiting time for express bus	8.0 peak 15.0 midday
WMIN	4-8	Minimum waiting time for transit	2.0
XMAX	4,6-8	Maximum transfer time for transit	30.0 peak 60.0 midday
XMAX	5	Maximum transfer time for express bus	15.0 peak 30.0 midday
XMIN	4-8	Minimum transfer time for transit	2.0
XFERS		Maximum permitted number of transfers	5.0
NOX (2,1)		Transfer prohibitor from mode 2 to mode 1	T
NOX (3,1)		Transfer prohibitor from mode 3 to mode 1	T

Source: Schimpeler Corradino Associates

The second cause was related to the way in which program UPATH functions. In finding the minimum impedance path, program UPATH does not "look ahead" all the way to the destination zone, but to all leq nodes from the node at which it is currently located. Thus, the initial path segment built by program UPATH for the interchange described above was the minimum impedance path for as far ahead as the program could look. Had the program been able to look further ahead, however, it would have realized that the selection of this initial segment would result in a path being built to the destination zone with a total weighted impedance higher than the minimum. By the time the initial segment had been built, it was "too late," i.e., the program could not go back to the origin zone and start again, but could only attempt to minimize total impedance from the node at which it was located.

The solution to the problem was to change the path-building coefficients to prevent the program from starting out on an illogical path. The effect of this change was to shift the pattern of little or no walking in the downtown to one in which, for most interchanges, walks of two to four blocks occurred prior to the initial boarding. A revised walk time coefficient of 1.5 makes walking appear less onerous, while a higher initial wait time coefficient of 3.0 discourages excessive boardings. These revisions corrected both types of problems discussed above.

One additional change was the decrease of the transfer time coefficient from 4.0 to 3.0. This was done to eliminate the problem of too little transferring occurring outside of the downtown. The most dramatic example of this problem was found for an interchange whose destination zone was located one to two miles south of the El Monte station on the San Bernardino Busway. Along the path built by program UPATH, a local line operating on arterials was taken from the downtown directly to the destination zone. In-vehicle time along this path was 59 minutes. An alternate path having less initial wait time and walk time was identified, however, which allowed 22 minutes of in-vehicle time to be saved by taking an express line operating on the San Bernardino Busway. Although this required a nine-minute wait at the El Monte station to transfer to a local line that would be taken to the destination zone, this path would, realistically, have a much higher likelihood of being selected by a transit rider. In this case and others, application of the lower transfer time coefficient resulted in the selection of more realistic paths by program UPATH.

To maintain consistency with the revised coefficients for building walk paths, the same changes were made to the coefficients used for building Park-n-Ride and Kiss-n-Ride paths. Using the same downtown origin zone that was used to trace walk paths, numerous Park-n-Ride paths built with the revised coefficients were traced, and all appeared to be reasonable. The complete, final set of parameters used for building walk and auto access paths is shown in Table 4-8.

TABLE 4-8

FINAL PATH SELECTION PARAMETERS

	PEAK			OFF-PEAK		
	Walk	PNR	KNR	Walk	PNR	KNR
XFERS	8	8	8	8	--	--
CTTIME (mode 1)	1.5	1.5	1.5	1.5	--	--
CTTIME (mode 2)	1.0	.1	.1	1.0	--	--
CTTIME (mode 3)	1.0	1.0	.1	1.0	--	--
CTTIME (modes 4-8)	1.0	1.0	1.0	1.0	--	--
CWTIME	3.0	3.0	3.0	3.0	--	--
CXTIME	3.0	3.0	3.0	3.0	--	--
WMIN	2.0	2.0	2.0	2.0	--	--
WMAX (modes 4, 6-8)	15.0	15.0	15.0	30.0	--	--
WMAX (mode 5)	8.0	8.0	8.0	15.0	--	--
XMIN	2.0	2.0	2.0	2.0	--	--
XMAX (modes 4, 6-8)	60.0	60.0	60.0	60.0	--	--
XMAX (mode 5)	15.0	15.0	15.0	30.0	--	--

Note: Additional parameter DELETE=2,3 used to build WALK paths.
Additional parameters NOX(2,1)=T and DELETE=3 used to build PNR paths.
Additional parameters NOX(2,1)=T and NOX(3,1)=T used to build KNR paths.

4.5 FARE MATRIX CONSTRUCTION

4.5.1 Fare Matrix Basis

As part of the mode choice model package, the fare programs developed for SCAG were provided to the District. The LARTS fare model was not compatible with the mode definitions used for the SCRTD transit networks, and required modifications to the structure. Also, no fare program existed for the year 2000. There was also a somewhat less-than-straightforward logic to the LARTS program, which made it desirable to recreate the program with greater clarity and better documentation.

In the program, the fare is set equal to the sum of a base fare, a linehaul fare rate times the distance, any transfer charges, and a parking lot charge for Park-n-Ride. The user may set the base fare for each of modes 4 through 8, the rate per fare zone for modes 5, 6, and 7, the length of a fare zone, and the amount of a transfer among any combination of modes 4 through 8, including transfers from one line in a mode to another line in the same mode. Because the fare program works from the skim tables from UPSUM, it is also necessary to provide an average speed for each of modes 5, 6, and 7, to permit conversion of the travel time on these modes to a distance. Finally, the user specifies the distance that a passenger can travel into the next fare zone before being charged the next fare increment.

It is important to note that the fares to be used in this program are the average fares that are expected to be paid, not the base cash fares. These averages should take into account the proportion of reduced fares used, pass use, etc., so that the resulting fares computed will represent average fares for the entire region. In current use, the values used for the user parameters in the fare program are shown in Table 4-9.

All of these values are user parameters that may be changed to reflect alternative fare policies. However, the forecasts reported later in this report are based on the above values. In subsequent work by SCRTD staff, two additional facilities were added to the fare model: the capability to place an upper limit on the rail fare, and the use of a variable discount for off-peak fares. The upper limit (cap) is set by entering a parameter that indicates the maximum fare that can be charged, while the discount is computed as a percentage, also entered as a parameter.

4.5.2 Updated Fare Matrix Program

As part of the FY85 work program, an updated fare matrix calculation program, FAREMTRX, was developed. This program embodies more rigorous algorithms for fare calculation and also provides the necessary basis for revenue calculation. FAREMTRX is a UTPS-compatible FORTRAN program which calculates and writes out a file of interzonal transit fares to be used by the modal split program. The program also writes out the distributions of these transit fares by mode, to be used in revenue calculation. For the transit alternative of interest,

TABLE 4-9

VALUES FOR USER PARAMETERS

Parameter	82 Val	Forecast
Parking charge	$0.35	$1.00
Fare zone distance	4.75 miles	3.0 miles
Fare zone rounding	0.1 miles	0.1 miles
Mode 4 base fare	43.0 cents	50.0 cents
Mode 5 fare/zone	7.12 cents	18.75 cents
Mode 6 fare/zone	125.0 cents*	25.0 cents
Mode 7 fare/zone	75.0 cents	25.0 cents
Mode 8 base fare	35.0 cents	35.0 cents
Transfer mode 4-4	10.0	10.0
Transfer mode 4-5	10.0	10.0
Transfer mode 4-6	10.0	10.0
Transfer mode 4-7	10.0	10.0
Transfer mode 4-8	10.0	10.0
Transfer mode 5-5	0.0	0.0
Transfer mode 5-6	10.0	10.0
Transfer mode 5-7	10.0	10.0
Transfer mode 5-8	10.0	10.0
Transfer mode 6-6	0.0	0.0
Transfer mode 6-7	10.0	10.0
Transfer mode 6-8	10.0	10.0
Transfer mode 7-7	0.0	0.0
Transfer mode 7-8	10.0	10.0
Transfer mode 8-8	0.0	0.0
Mode 5 average speed	24.75 mph	24.75 miles per hour
Mode 6 average speed	-	36.0 miles per hour
Mode 7 average speed	-	36.0 miles per hour

FAREMTRX reads as input both the output file from UPATH and the output line file from UNET, enabling the calculation of transit fares based on the actual paths from origin zones to destination zones, and the calculation of fares for express transit services based on the actual distances traveled in express mode. The program also permits the use of different parking costs at different Park-n-Ride lot locations (for both bus and rail), computes costs of multiple transfers, distinguishes between RTD and non-RTD express routes and assigns the fares appropriately, and permits the optional use of combined Metro Rail and light rail fares.

For a complete description of FAREMTRX, see Technical Memorandum 87.3.1: Documentation of the Fare Matrix Calculation Program - FAREMTRX, September 1986.

5. MODE CHOICE MODELS

5.1 SOURCES AND PROCEDURES

At the time the Transportation Planning and Modeling Services project commenced, a project for SCAG was nearing completion, in which new modal-split models were being built and tested for the region. (13, Vol. I) One of the original goals of the TPMS project was to implement the models resulting from the SCAG project and use these as the basis of travel forecasting for the region. The models used for the results reported in this document are the SCAG models for Home-Based Work (HBW) and Home-Based Other (HBO) trips, together with an alternative model used for Non-Home-Based (NHB) trips. The SCAG project produced a model for NHB trips that factored the modal split from the HBW model. This procedure is not as desirable as one in which a model of similar structure to the other two models is used for forecasting modal split for NHB trips. However, because NHB trips represent 25 percent or fewer of regional trips, and less than 10 percent of regional transit trips, changes in this methodology are not expected to give rise to significant differences in the decisions that would be reached on the basis of patronage figures. The NHB model is an adaptation of one developed by Barton-Aschman Associates for Houston and resembles the other models, in that it is also a multinomial logit model.

The modal-split models are all multinomial logit models that predict the proportion of transit trips for a trip interchange as a function of the relative travel times and costs of the modes for that interchange and of the characteristics of households in the production zone for the trip-interchange movement. The primary travel characteristics used by each of the models are:

- The total in-vehicle travel time by an alternative mode or mode combination;
- The total out-of-vehicle travel time for each alternative mode or combination of modes; and
- The total costs for each alternative mode, including transit fares, parking costs, and auto-running costs. The costs are divided by income in all cases.

Each of the models also uses characteristics of the trip makers, as determined by the production end of the trip. These characteristics are grouped into four market segments, defined as follows:

1. Households within walking distance of transit which own no automobiles.
2. Households within walking distance of transit which own one or more automobiles.

3. Households not within walking distance of transit which own no automobiles.

4. Households not within walking distance of transit which own one or more automobiles.

The models also use additional traveler characteristics. The Work mode choice model uses the following additional variables:

- o Average number of autos per licensed driver; and

- o Average number of workers per household.

The Nonwork model uses:

- o Average number of autos per licensed driver; and

- o Average household income.

The Non-Home-Based model uses none of these variables, but includes the number of transfers for a transit trip. Each of the Work and Nonwork models also contains a CBD dummy variable, and bias constants for each of the counties in the region.

As part of the FY85 work program, a detailed evaluation of the regional mode choice models was conducted. See Technical Memorandum 2.1.1: Evaluation of the Regional Mode Choice Models, December 1985, Revised September 1986.

5.2 MODEL CALIBRATION

Model calibration is the process of applying a model, with inputs related to a known set of output values, and adjusting model parameters until the model replicates the known values. The HBW and HBO models were calibrated by CSZ to 1980 conditions based on actual transit share of the market by county and CBD-cordon crossings. Subsequently, it has been necessary to perform several recalibrations because of changes in exogenous input variables and changes in transit network coding procedures.

5.2.1 Model Input Revisions

At various points in time, the mode-split models have been recalibrated to reflect the following:

- o Zone system change -- The transit network and the model estimation in this project are based on a zone system containing 1,628 zones, while the original work was done with the region divided into 1,325 zones. Wherever a different transit path would be built through the network, or a transit path would be provided with different values for the times or costs used by the model, the modal split would change and would cause the calibrated model to perform differently from the calibration case.

- Revised trip distribution -- The original validation had been performed using a distribution of person trips which was developed using a single iteration gravity model. This methodology tended to underestimate the number of person trips to the central business district by as much as 48 percent for home-based work trips and 78 percent for home-based nonwork trips. This problem in distribution was overcome by using a five-iteration gravity model, but most certainly the difference in person-trip distribution would affect the transit trip estimation considerably, and therefore it was essential to repeat the calibration effort for the home-based work and nonwork purposes.

- Revised path-building criteria -- As discussed in chapter 4, detailed analysis of the paths resulting from the original path-building criteria indicated deficiencies which led to development of improved criteria. This resulted in inconsistencies compared with the paths for which the models had previously been calibrated.

- Revised network-coding procedures -- Many improvements have been made in transit network-coding procedures as discussed in chapter 4 and also in chapter 2, under Transit Network Access (2.3). Some of these changes, such as those related to walk access described in Section 2.3, clearly necessitated recalibration. Others, such as automating manual procedures or refinement of bus route coding in the base year network, are more subtle, but nevertheless result in shifts in input values for which the models should be recalibrated.

In addition to adjusting the models developed by SCAG, it was also necessary to adjust the transferred non-home-based model to insure that this model was adequate for the Los Angeles region. This transferred model used parameters derived from the models calibrated for New orleans, Houston, and Seattle, giving the model the proper sensitivity to system characteristics, such as in-vehicle time and waiting time. It is necessary, however, to modify the bias coefficients of the model in order to meet the regional modal characteristics.

5.2.2 Calibration Methodology

The changes to the input information for the mode choice models required that an update be performed on the models. The nature of the recalibration in such a case is to adjust the constants in the model that relate to the average transit share for each county and also to adjust the individual mode shares, mode-by-mode. No change is required to the coefficients of the variables in the models, because these were derived from data on a sample of households, and the information for these households is basically unaffected by the changes to trip tables, path-building, and path characteristics. The mode constants and county biases are, however, generated from regional data after the initial calibration. These are the inputs that have been changed since the original calibration and generate a need to recompute the values.

Updating involves changing the constants until the observed market shares are obtained both regionally and county by county. The models are hierarchical models, which means that the updating of the constants is not a simple procedure of a recalculation of each constant, but involves an iterative fitting of the values. The hierarchical structure is such that the models predict, at the highest level of the hierarchy, the split between transit and auto. At the second, the split is between three categories of auto occupancy for the auto mode, and between the alternative access modes to transit for the transit mode. At the second level, the models are simple multinomial models of mode choice. At the first level, however, there is a need to use some type of "average" characteristic values for a generic mode called "auto" and for a generic mode called "transit." The average values are obtained by using the natural logarithm of the sum of the exponentiated utilities from the individual, second-level submodes. The procedure is shown structurally and mathematically in Figure 5-1. Because of these "logsum" terms, which include the individual constants for the submodes of both transit and auto, there is no unique mathematical correction that can be made to the constants. Any change in the individual mode constants generates a change in overall auto-transit split, which requires readjustment to meet the observed shares. A cyclical process arises from this, which usually converges in about three to five iterations. It can be shown, using the logit formulation, that the change in logit coefficient to produce the correct modal probability can be approximated as follows:

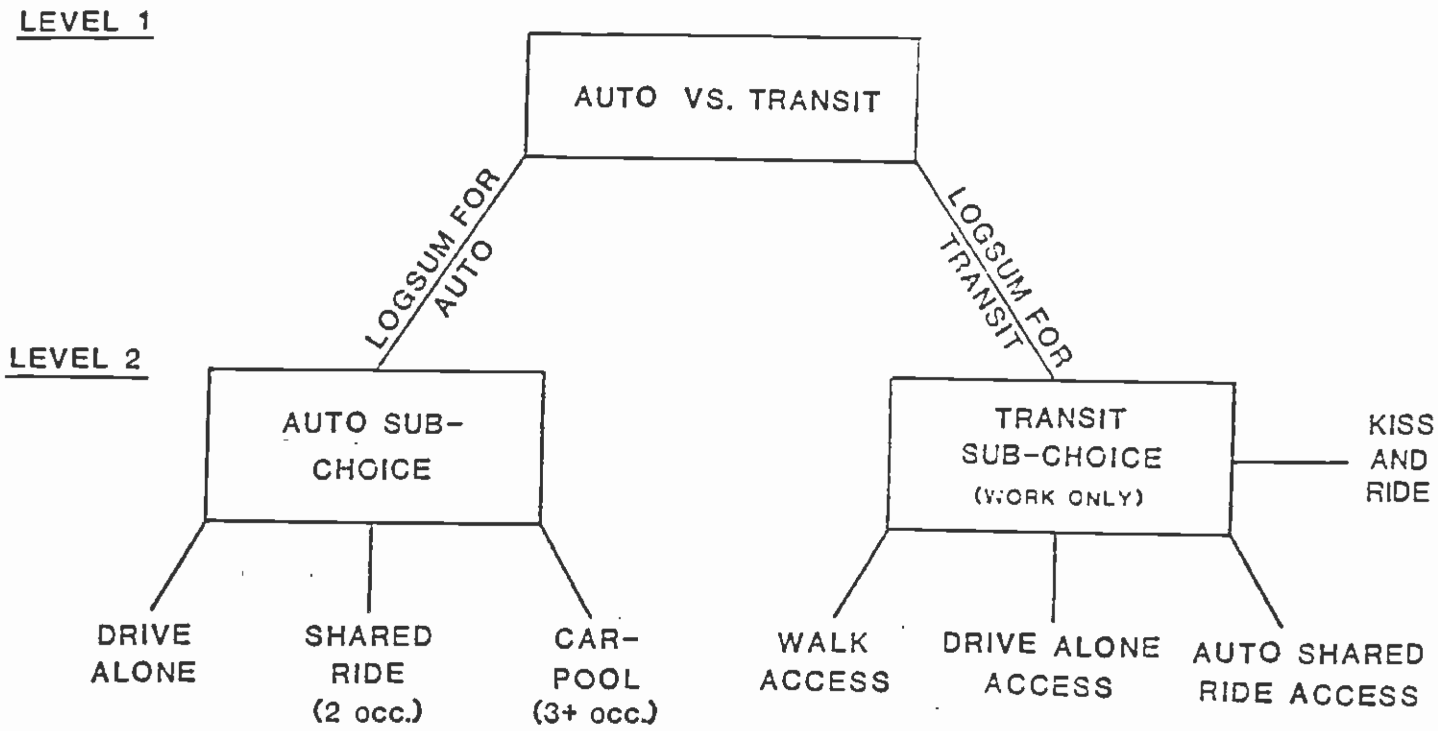
$$C(1) = C + Ln((P*P(1)-P(1))/(P*P(1)-P))$$

where:

C(1)	is the new coefficient to estimate the correct probability
C	is the coefficient from the original calibration or from the previous application
P	is the estimated probability associated with the coefficient C and with the variable associated with the coefficient
P(1)	is the observed probability associated with the variable
Ln	is the natural logarithm

This formulation will give an exactly correct answer if each interchange has the same modal probability, i.e., the observed probability is the same for all movements. When the individual interchanges have probabilities which differ from the mean probability, the formulation is only an approximation, but the revised coefficient will be changed in the "correct" direction, and two or three iterations will normally be sufficient to obtain a model which produces a modal probability which is very close to the observed probability.

Because of the structure of the home-based work and nonwork model, this adjustment to the model had to be performed in two stages. Typically, in stage one, the modal bias coefficients were adjusted to obtain the correct modal probabilities. These bias coefficients were: 1) the walk access constant; 2) the park/ride drive alone constant; 3) the park/ride shared ride constant; and 4) the kiss/ride constant.



LEVEL 1 MODEL:

$$P_k = \frac{\exp[\,U_k\,]}{\exp[U_{auto}] + \exp[U_{transit}]}$$

k = auto or transit

U_{auto} = f(logsum Auto subchoices)

$U_{transit}$ = f(logsum Transit subchoices)

LEVEL 2 MODEL:

$$P_t = \frac{\exp[\,U_t\,]}{\sum_{m=1}^{m}(\exp[\,U_m\,])}$$

t = one of the auto subchoices or one of the transit subchoices

$\sum_{m=1}^{m}$ = sum over all auto subchoices or sum over all transit subchoices

FIGURE 5-1

STRUCTURE OF THE HIERARCHICAL MODE CHOICE MODELS

Once these bias coefficients were adjusted, the next stage dealt with the subarea constants. These constants were: 1) the Los Angeles constant; 2) the Orange County constant; 3) the Riverside constant; 4) the San Bernardino constant; and 5) the Ventura constant.

The original model also had a bias constant for the Los Angeles Central Business District, but it was determined that this bias coefficient was required to compensate for the distribution problem previously described. In the process of updating the models, the CBD bias constant was reset to zero. It appears that the CBD constant played the role of compensating for overestimating the percentage transit modal split to the CBD and for underestimating CBD transit-passenger cordon crossings. The 1980 estimated CBD work-trip modal split was 15.5 percent over the actual value of 31.0 percent, while the estimated cordon crossings were 16.1 percent under the observed counts. With the new person-trip distribution and the CBD bias constant set to zero, the model yields a CBD mode split value of 32.2 percent.

The nonhome-based model was much simpler with respect to bias coefficients, with only modal bias constants included. For the auto occupancy model it was necessary to investigate the bias coefficients for three persons per vehicle, four persons per vehicle, and five-plus persons per vehicle. For the primary mode choice model, bias coefficients were investigated for the drive-along mode and the group highway mode.

5.2.3 Updated Models

Following is a presentation of the recalibrated mode choice models. Table 5-1 compares the most recent calibration constants with the original values produced by CSI and with the interim values produced under the Transportation Planning and Modeling Services contract.

Figures 5-2, 5-3, and 5-4 present the actual model equations for the home-based work, home-based nonwork, and nonhome-based models, respectively.

The ability of the models to reproduce observed mode shares is illustrated in Table 5-2. As indicated, the models have been calibrated to produce estimated mode shares which are virtually identical with the observed shares. The largest error in estimated transit trips is indicated for Orange County work trips, and here the error is only 1.38 percent. Most categories are well within one percent error.

The recalibrated models presented here represent the culmination of efforts to produce more rigorous and efficient procedures and to ensure that the models are being applied in accordance with the concepts and practices underlying their development. Special attention has been devoted to network-coding procedures because of the complexity of the networks and because of uncertainties related to the precise procedures used in the networks used for model development. The breadth and depth of analyses conducted into network-coding

TABLE 5-1

COMPARISON OF MODE CHOICE MODEL CALIBRATION CONSTANTS

MODEL CONSTANTS	UPARMS NUMBER	CSI Calibrated Value	CSI Adjusted Value	Planning Modeling Services (LPAUP)	CALIB 3 NOV85
HB WORK MODE CHOICE					
Primary Auto-Trn Split					
AUTO	51	0.31705	-0.7403	-0.7403	-0.7403
TRANSIT: (By Production Co.)					
Los Angeles	61	0.00000	0.1689	0.2797	0.5140
Orange	62	0.00000	-0.2895	-0.4770	-0.1940
Riverside	63	0.00000	0.4961	0.2141	0.4100
San Bernardino	64	0.00000	0.4522	0.1702	0.3660
Ventura	65	0.00000	0.2936	0.0116	0.1074
Transit CBD Attraction	55	0.00000	0.1670	0.0000	0.0000
Transit Submode Split					
PARK-RIDE ALONE	21	-2.82380	-1.4492	-0.8037	-0.8101
PARK-RIDE SHARED	22	-3.67500	-1.6320	-1.0253	-1.0350
KISS-RIDE	23	-1.63680	0.2342	0.3889	0.3837
WALK ACCESS	32	3.67600	3.1600	3.0135	3.3248
Auto Submode Split					
DRIVE ALONE	41	0.12778	-0.3791	-0.3273	-0.2484
3+ PERSON CARPOOL	42	-1.98380	-1.4057	-1.4377	-1.4377
NONWORK MODE CHOICE					
Home-Based Nonwork					
TRANSIT	21	3.26000	3.6274	3.6274	3.6274
TRANSIT: (By Production County)					
Los Angeles	41	0.00000	-0.0058	-0.5748	-0.3475
Orange	42	0.00000	0.2716	-0.4554	-0.1407
Riverside	43	0.00000	0.3949	-0.1402	0.3819
San Bernardino	44	0.00000	0.5429	0.0078	0.2495
Ventura	45	0.00000	0.6557	0.1206	0.3623
Nonhome-Based					
DRIVE ALONE	87		-2.6904	3.2191	-2.8850
SHARED RIDE	88		-2.5040	-3.0327	-2.8130

WORK MODE CHOICE STRUCTURE

AUTO SUB-MODE MODEL

MODES: DRIVE ALONE, 2 PERSONS/CAR, 3+ PERSONS/CAR

GENERAL FORMULATION

PROB MODE (M,IH) = EXP [U(M,IH)]/SUM OF EXP[U(M,IH)]; M = 1,3

WHERE:

MODE(M,IH) IS THE 3 AUTO-SUB-MODES FOR MARKET SEGMENTATION IH

U(M,IH) IS THE UTILE EQUATION FOR MODE M AND MARKET SEGMENT IH[1]

UTILE EQUATIONS:

```
U(DRIVE ALONG) = -0.2484 - 0.0099303 * IVTT
                 -0.019855 * COST/INCOME (IH)
                 -0.055835 * OVTT
U(2 PER/CAR)   = -2.4734*ALD(IH) + 0.28022 * WRK (IH)
                 -0.0099303 * IVTT - 0.019855 * COST/INCOME(IH)
                 -0.055835 * OVTT
U(3+ PER/CAR)  = -1.4377 - 2.4734 - * ALD(IH) + 0.69721 * WRK(IH)
                 -0.0099303 * IVTT - 0.019855 * COST/INCOME(IH)
                 -0.055835 * OVTT
```

WHERE:

IVTT:	IS IN-VEHICLE TRAVEL TIME
OVTT:	IS OUT-OF-VEHICLE TRAVEL TIME
COST:	IS OUT-OF-POCKET COST
INCOME(IH):	IS ANNUAL INCOME (DOLLARS) FOR MARKET SEGMENT IH (DIVIDED BY 1000)
ALD(IH):	AUTOS PER LICENSED DRIVER FOR MARKET SEGMENT IH (ZONE SPECIFIC)[2]
WRK(IH):	WORKERS PER HOUSEHOLD (?) FOR MARKET SEGMENT IH (ZONE SPECIFIC)

1 SEE TEXT FOR A DESCRIPTION OF THE MARKET SEGMENTS

2 ALD HAS MAXIMUM VALUE OF 1.0

Figure 5-2

WORK MODE CHOICE STRUCTURE (CONTINUED:2)

TRANSIT SUB-MODE MODEL

MODES: WALK, PARK AND RIDE (DRIVE ALONE), PARK AND RIDE (SHARED RIDE), KISS AND RIDE

GENERAL FORMULATION

PROB MODE (ST,IH) = EXP [U(ST,IH)]/SUM OF EXP[U(ST,IH)]; (ST = 1,4)

WHERE:

MODE(ST,IH) IS THE 4 TRN SUB-MODE FOR MARKET SEGMENT IH

U(ST,IH) IS THE UTILE EQUATION FOR SUB-MODE ST AND MARKET SEGMENT IH

UTILE EQUATIONS:

```
U(WALK)        = -0.0099303 * IVTT -0.019855 * COST/INCOME(IH)
                 -0.055835 * OVTT + 3.3248
U(P/R:D.A.)    = -0.8101 + 3.0808 * ALD(IH) - 0.0099303 * IVTT
                 -0.019855 * COST/INCOME(IH) - 0.055835 * OVTT
U(P/R:S.R.)    = -1.0305 + 0.88302 * ALD(IH) + 0.37216 * WRK(IH)
                 -0.0099303 * IVTT - 0.019855 * COST/INCOME(IH)
                 -0.055835 * OVTT
U(K/R)         =  0.3837 0.89754 * ALD(IH) + 0.34352 * WRK(IH)
                 -0.0099303 * IVTT - 0.019855 * COST/INCOME(IH)
                 -0.055835 * OVTT
```

WHERE:

IVTT:	IS IN-VEHICLE TIME
OVTT:	IS OUT-OF-VEHICLE TIME
COST:	IS OUT-OF-POCKET COST
INCOME(IH):	IS ANNUAL INCOME FOR MARKET SEGMENT IH (DIVIDED BY 1000) (ZONE SPECIFIC)
ALD(IH):	IS AUTOS/LICENSED DRIVERS FOR MARKET SEGMENT IH (ZONE SPECIFIC)
WRK(IH):	IS WORKERS/HOUSEHOLD FOR MARKET SEGMENT IH (ZONE SPECIFIC)

Figure 5-2

WORK MODE CHOICE STRUCTURE (CONTINUED:3)

TRANSIT MODEL

MODES: TRANSIT PERSON/AUTOMOBILE PERSON

GENERAL FORMULATION

PROB MODE (AT,IH) = EXP [U(AT,IH)]/SUM OF EXP[U(AT,IH)]; AT = 1,2

WHERE:

MODE(AT,IH) IS THE 2 MODES FOR MARKET SEGMENT IH

U(AT,IH) IS THE UTILE EQUATION FOR MODE AT AND SEGMENT IH

UTILE EQUATIONS:

U(AUTO) = -0.7403 + 4.7726 * ALD(IH) - 0.31411 * AD(IH)
+1.0 * LOGA

U(TRANSIT) = UCO(I) + 1.0 * LOGT

WHERE:

ALD(IH): AUTOS/LICENSED DRIVERS FOR MARKET SEGMENT IH

AD(IH): DUMMY VARIABLE, 1 IF AUTOS OWNED, 0 IF NO AUTOS OWNED

LOGA: NATURAL LOG OF SUM OF EXP [U(M,IH)], M = 1,3 (SEE AUTO SUB-MODE MODEL)

LOGT: NATURAL LOG OF SUM OF EXP [U(ST,IH)], ST = 1,4 (SEE TRANSIT SUB-MODE MODEL)

UCO(I): BIAS COEFFICIENT BY COUNTY:

I	COUNTY	COEFF.
1	LOS ANGELES	0.5140
2	ORANGE	-0.1940
3	RIVERSIDE	0.4100
4	SAN BERNARDINO	0.3660
5	VENTURA	0.1074

Figure 5-2

NONWORK MODE CHOICE STRUCTURE

PRIMARY MODEL (HOME-BASED NONWORK TRIPS)

MODES: AUTOMOBILE PERSON, TRANSIT

GENERAL FORMULATION

PROB MODE (M,IH) = EXP [U(M,IH)]/SUM OF EXP[U(M,IH)]; M = 1,2

WHERE:

MODE(M,IH) IS THE M MODE (AUTO/TRANSIT) FOR THE IH MARKET SEGMENT[1]

U(M,IH) IS THE UTILE EQUATION FOR THE M MODE AND THE IH MARKET SEGMENT

[1] NOTE: WHEN IH IS 3 OR 4 (HOUSEHOLDS NOT WITHIN WALKING DISTANCE OF TRANSIT) THEN AUTOMOBILE PROBABILITY = 1.0 AND TRANSIT PROBABILITY IS 0.0.

UTILE EQUATIONS:

```
U(AUTO) = -3.76 * FWODL(IH) + 0.0738 * (INCOME(IH)/1000.)
          +5.15 * ALD(IH) - 0.0292 * IVTT - 0.0905 * OVTT
          -0.287 * (COST/LOG(INCOME(IH)) + 7.87 * (1/DIST)

U(TRN)  = UCO(I) + 3.6274 - 0.0292 * IVTT - 0.0905 * OVTT
          -0.287 * (COST/LOG(INCOME(IH)) + 5.15 * (1/DIST)
```

WHERE:

FWODL (IH) IS 1.0 MINUS LICENSED DRIVERS PER PERSON FOR MARKET SEGMENT IH, IF TOTAL AUTOMOBILE OWNERSHIP, FOR MARKET SEGMENT IH, IS GREATER THAN ZERO; OTHERWISE THE VARIABLE IS EQUAL TO 0.0.

INCOME(IH) IS ANNUAL AVERAGE SALARY FOR MARKET SEGMENT IH

ALD(IH) IS AUTOMOBILES PER LICENSED DRIVERS FOR MARKET SEGMENT IH

Figure 5-3

NONWORK MODE CHOICE STRUCTURE (CONTINUED:2)

IVTT IS IN-VEHICLE TRAVEL TIME
OVTT IS OUT-OF-VEHICLE TRAVEL TIME
COST IS OUT-OF-POCKET COST
DIST IS THE HIGHWAY DISTANCE (MILES)
UCO (I) ARE COUNTY BIAS COEFFICIENTS

I	COUNTY	COEFF.
1	LOS ANGELES	-0.3475
2	ORANGE	-0.1407
3	RIVERSIDE	0.3819
4	SAN BERNARDINO	0.2495
5	VENTURA	0.3623

TRIP ESTIMATION MODEL (HOME-BASED NONWORK TRIPS)

TRIPS(M,IH) = PROB MODE(M,IH) * PTRP * FTRIP(IH)

AND

TRIPS(M) = TRIPS(M,IH)
IH= 1

AUTO DRIVER TRIPS = TRIPS (1)/1.55

WHERE:

TRIPS(M,IH) IS PRIME MODE TRIPS (1 = HIGHWAY PERSON, 2 = TRANSIT) FOR MODE M AND MARKET SEGMENT IH
PTRP IS HOME-BASED NON-WORK PERSON TRIPS
FTRIP(IH) IS PROPORTION OF PERSON TRIPS FOR MARKET SEGMENT IH
AUTO-DRIVER TRIPS IS HOME-BASED NONWORK AUTOMOBILE TRIPS

Figure 5-3

Primary Mode Choice Model

TRN = 0.025 (WALK + WAIT1 + WAIT2) + 0.01 (TRNRUN) + 0.014 (FARE) + 0.075 (XFERS) + 0.170(HWYACC) + 1.55 (AUTOCONN)

ONE = 0.2423 (HWYEXC) + 0.01 ($HWYRUN_1$) + 0.014 ($HWYCST_1$) + 0.0384 ($PRKCST_1$) - 2.8850

GROUP = 0.3048 (HWYEXC) + 0.01 ($HWYRUN_G$) + 0.014 ($HWYCST_G$) + 0.0384 ($PRKCST_G$) - 2.8130

Auto Occupancy Modeling

TWO = 0.3048 (HWYEXC) + 0.01 ($HWYRUN_2$) + 0.014 ($HWYCST_2$) + 0.0384 ($PRKCST_2$)

THREE = 0.3048 (HWYEXC) + 0.01 ($HWYRUN_3$) + 0.014 ($HWYCST_3$) + 0.0384 ($PRKCST_3$) + 0.99

FOUR = 0.3048 (HWYEXC) + 0.01 ($HWYRUN_4$) + 0.014 ($HWYCST_4$) + 0.0384 ($PRKCST_4$) + 1.16

FIVE+ = 0.3048 (HWYEXC) + 0.01 ($HWYRUN_5$) + 0.014 ($HWYCST_5$) + 0.0384 ($PRKCST_5$) + 1.6

Where:

TRN = disutility of transit mode for a given trip.
ONE = disutility of drive-alone mode for a given trip.
GROUP = disutility of group mode for a given trip.
TWO = disutility of two-occupant submode for a given trip.
THREE = disutility of three-occupant submode for a given trip.
FOUR = disutility of four-occupant submode for a given trip.
FIVE+ = disutility of five-or-more occupant submode for a given trip.
WALK = Walk-access time to/from transit in minutes.
WAIT1 = Waiting time for first transit vehicle in minutes.

WAIT2 = Waiting time for second and subsequent transit vehicles, if any, in minutes.

TRNRUN = Transit in-vehicle time (not including auto-access time) in minutes.

FARE = Transit fare in 1980 cents.

XFERS = Number of transfers between transit vehicles.

HWYACC = Auto-access time to transit in minutes.

AUTOCONN = Auto connect dummy variable signifying whether an automobile is required to access transit, 1 if an auto is required, 0 otherwise.

HWYEXC = Highway-excess time (sum of terminal times at origin and destination) in minutes.

HWYRUN (X) = Highway in-vehicle time, in minutes, for submode X.
HWYCST (X) = Highway operating cost, in 1980 cents, for submode X.
PRKCST (X) = One-half of the parking cost, in 1980 cents, for submode X.

Figure 5-4

TABLE 5-2

OBSERVED VERSUS ESTIMATED MODE SHARES

TRIP CATEGORY	Observed Mode Share	Estimated Mode Share	Estimated Person Trips	Estimated Transit Trips	%Error Transit Trips
HOME-BASED WORK TRIPS					
TRN SHARE BY CO. OF PROD.					
Los Angeles	0.0959	0.0968	4601415	445504	0.93
Orange	0.0215	0.0218	1563274	34107	1.38
Riverside) San Bernardino > Ventura)	0.0147	0.0147	876745	12865	0.00
TRN SHARE FOR REGION	0.0692	0.0699	7041434	492476	1.00
TRANSIT SUBMODE SHARE					
Walk	0.8499	0.8491		418118	-0.08
Park-Ride Alone	0.0975	0.0983		48427	0.08
Park-Ride Shared	0.0173	0.0178		8776	0.05
Kiss-Ride	0.0353	0.0348		17152	-0.05
AUTO SUBMODE SHARE					
Drive Alone	0.7785	0.7801		5108617	0.16
2 Person	0.1578	0.1539		1007788	-0.39
3+ Person	0.0637	0.0660		432562	0.23
HOME-BASED NONWORK TRIPS					
TRN SHARE BY CO. OF PROD.					
Los Angeles	0.0356	0.0357	13452860	480112	0.01
Orange	0.0095	0.0095	3857162	36679	0.00
Riverside) San Bernardino > Ventura)	0.0049	0.0049	2880117	14183	0.00
TRN SHARE FOR REGION	0.0261	0.0263	20190139	530974	0.02
NONHOME-BASED TRIPS TRN SHARE FOR REGION	0.0135	0.0137	11703054	160111	0.02

procedures and their impacts, as discussed earlier, has demonstrated conclusively the consistency and objectivity of the recently established procedures. From this standpoint, the latest models can be relied upon to produce more reliable forecasts than previously.

5.3 MODE CHOICE MODEL APPLICATION

5.3.1 Application Program Development

The purpose of this report is to document the (SCRTD) procedures for applying the regional set of mode choice models developed recently for the Los Angeles five-county region by Cambridge Systematics, Inc. (CSI), under contract to the Southern California Association of Governments. A description of the model development process is contained in Volume I of the final project report. (13) Volume II of that report provides user documentation for the CSI program software used to apply the models in an aggregate forecasting context. (13) This report documents the programs used to apply the models in the SCRTD demand forecasting environment and, as such, supersedes chapters 3 and 4 of the original Volume II report.

Modifications to the CSI model application software were primarily a function of:

1. Revisions to individual model bias constants stemming from rational adjustments in level-of-service and cost input data preparation methodology. A detailed description of these adjustments and their underlying rationale is contained in Technical Memorandum No. 4.2, Final Modal Choice Model Specifications.

2. Minor source code modifications to the CSI Home-Based Work Model application program. In particular, to implement a generalized specification of the "county-of-origin" indicator.

3. A complete substitution of the CSI Non-Work/Non-Home Based application program with entirely new program software. New software was required to provide essential flexibility in individual model application. In particular, this new software allows for use of a transferred Non-Home Based program in place of the default factoring procedure.

All of the above represent appropriate adjustments and/or enhancements to model formulation and application while still retaining the basic CSI model structure and coefficients.

Application of the mode choice models requires the assembly of all of the inputs that have been discussed in the preceding sections. Figure 5-5 shows the flow diagram for the application of the mode choice models.

Two separate subroutines comprise the Modal Choice application package: the work mode choice model and the nonwork mode choice model. The use of these programs is described in terms of their input data

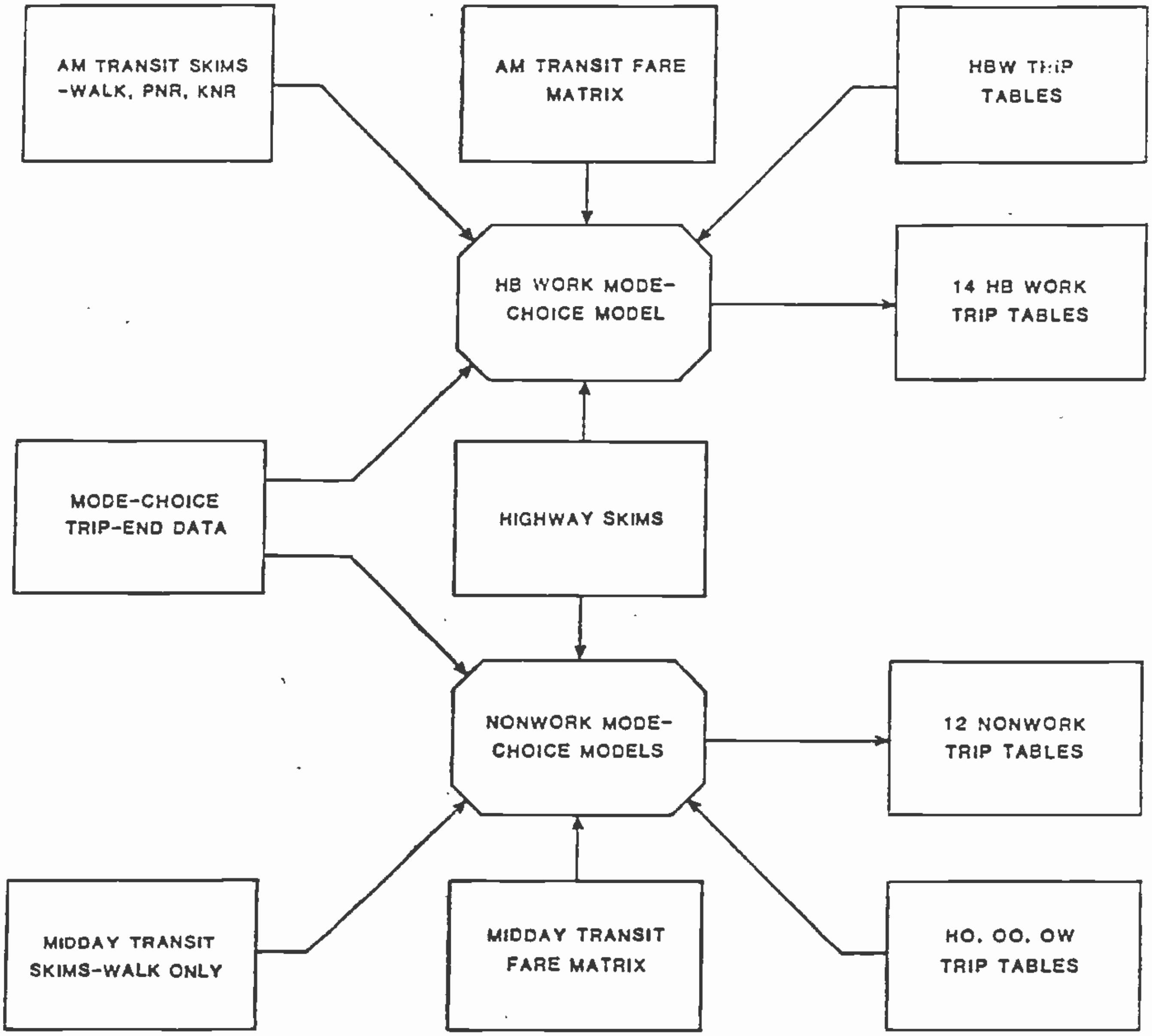


Figure 5-5

FLOW DIAGRAM FOR THE APPLICATION OF THE MODE CHOICE MODEL requirements, special options and parameters, standard output files and reports, and typical job control language statements used to operate the programs. Three of the input files to the application programs are generated by the CSI Market Segmentation Program (MSEG). These files contain various zonal attributes (i.e., parking costs, terminal times, etc.) and socioeconomic variables. This report assumes that this data is provided by SCAG for the current forecast year, and it is therefore not described here. A description of the MSEG program is included in Volume II of the CSI final report referenced above.

The mode choice models were designed and implemented to operate in the Urban Mass Transportation Administration's UTPS planning software environment. The application programs consist of user-coded subroutines which are used in conjunction with the UMTA program UMODEL.

5.3.2 Work Mode Choice Program

The Home-Based Work Mode Choice Program uses highway and transit travel times and costs to "split" a person-trip table into several modal trip tables. The input person-trip table represents 24-hour trips in a production-attraction format. The mode choice model program utilizes the proportion of person-trips in each of four basic market segments to apply the primary and nested logit models. The four market segments used by the model are defined as follows:

1. Households within walking distance of transit which own no automobiles.

2. Households within walking distance of transit which own one or more automobiles.

3. Households not within walking distance of transit which own no automobiles.

4. Households not within walking distance of transit which own one or more automobiles.

Obviously, in each of these segments, not all transit submodes are assumed available.

The Work Mode Choice Program allows the user to modify the coefficients of the model and various exogenous factors of the model, if necessary. The default values of these coefficients and factors are generally the values determined in the calibration/adjustment phase.

5.3.2.1 Input Data

The Mode Choice Program requires a considerable amount of data on the characteristics of the transit and highway systems and the urban area. Some of the information (zonal data) is coded as "card image" files and input directly to the mode choice program. The rest of the data files are zone-to-zone arrays constructed through use of standard UTPS programs such as UPSUM and USTOS. Fifty-two pieces of data, listed in Table 5-3 and discussed further in Table 5-4, are required by the program. Their location and type are defined to UMODEL through the "Variable Identification Card." The first twenty-eight data items are zonal or vector variables (i.e., one record per zone); the last twenty-four items are interchange (zone-to-zone) data. The derivation of these data elements is described below:

1. Zone Number. The first data item on each and all of trip-end ("A") files input to the program.

2. to 4. Highway Access and Terminal Time. The access time and distance is developed by network analysts to reflect the in-vehicle non-network portion of a highway trip. Historically, CALTRANS highway network centroids have been placed directly on the nearest available arterial link, thereby excluding local circulation time from the interchange value. These values are applied as either an origin or destination variable, depending upon the interchange. Terminal time, however, reflects the "out-of-vehicle" (walk) time to reach the motorists final destination from the parking location.

5. Parking Cost. The cost developed by local planners to represent the average nine-hour parking cost in each zone. The value should reflect employee-provided as well as publicly purchased parking. This zonal cost is applied to all auto submodes, although it is discounted by the applicable auto submode occupancy. However, no provision exists at present to evaluate carpool/noncarpool parking-cost incentives. Historically, no documented or quantitative method has been used to derive these values.

6. CBD Indicator. This zonal variable identifies only those zones defined as comprising the Los Angeles Central Business District. As such, it is a surrogate for employment densities exceeding a particular level and, therefore, should not be modified unless a new zonal structure is implemented.

7. Transit Availability. This is expressed as the percent or fraction of households within walking distance of transit. Although no definition of a maximum walking distance has been provided (13, Vol. I), a typical assumption would be one-half mile. The determination of this value is currently based upon subjective judgement.

TABLE 5-3

DEFINITION OF INPUT DATA REQUIREMENTS FOR THE MODE CHOICE APPLICATION PROGRAM FOR HOME-BASED WORK TRIPS

Data Item Number	Data Type	Description
1	A	Zone Number[4]
2	A	Highway Time to Access Network IIVT)[1]
3	A	Highway Distance to Access Network[1]
4	A	Highway Terminal Time[1]
5	A	Parking Cost (Cents)
6	A	CBD Indicator (0,1)
7	A	Percent of Zone Within Walking Distance of Transit
8	P	County of Origin Code (1-5)
9	A	Proportion of Person-Trips: Market Segment 1
10	A	Autos Owned: Market Segment 1[2]
11	A	Licensed Drivers: Market Segment 1[2]
12	A	Number of Workers: Market Segment 1[2]
13	A	Income (Annual-Dollars): Market Segment 1
14	A	Proportion of Person-Trips: Market Segment 2
15	A	Autos Owned: Market Segment 2[2]
16	A	Licensed Drivers: Market Segment 2[2]
17	A	Number of Workers: Market Segment 2[2]
18	A	Annual Income (Dollars): Market Segment 2
19	A	Proportion of Person-Trips: Market Segment 3
20	A	Autos Owned: Market Segment 3[2]
21	A	Licensed Drivers: Market Segment 3[2]
22	A	Number of Workers: Market Segment 3[2]
23	A	Annual Income (Dollars): Market Segment 3
24	A	Proportion of Person-Trips: Market Segment 4
25	A	Autos Owned: Market Segment 4[2]
26	A	Licensed Drivers: Market Segment 4[2]
27	A	Workers: Market Segment 4[2]
28	A	Annual Income (Dollars): Market Segment 4

(CONTINUED)

NOTE: The Market Segmentation Strata are: 1 = Households within walking distance of transit and own no automobiles, 2 = Households within walking distance of transit and own one or more automobiles, 3 = Households not within walking distance of transit and own no automobiles, and 4 = Households not within walking distance of transit and own one or more automobiles.

TABLE 5-3 (CONTINUED)

DEFINITION OF INPUT DATA REQUIREMENTS FOR THE MODE CHOICE APPLICATION PROGRAM FOR HOME-BASED WORK TRIPS (continued)

Data Item Number	Data Type	Description
29	X	Highway Time: Drive Alone (Hundredths of Minutes)1
30	X	Highway Time: Two-Person Carpool (Hundredths of Minutes)1
31	X	Highway Time: Three Plus Person Carpool (Hundredths of Minutes)1
32	X	Highway Distance: Drive Alone (Hundredths of Miles)1
33	X	Highway Distance: Two-Person Carpool (Hundredths of Miles)1
34	X	Highway Distance: Three Plus Person Carpool (Hundredths of Miles)1
35	X	Transit in Vehicle Time (Walk Access)3
36	X	Transit in Vehicle Time (Park/Ride Access)3
37	X	Transit in Vehicle Time (Kiss/Ride Access)3
38	X	Initial Waiting Time (Walk Access)
39	X	Initial Wait Time (Park/Ride Access)
40	X	Initial Wait Time (Kiss/Ride Access)
41	X	Wait Two (Transfer) Time (Walk Access)
42	X	Wait Two (Transfer) Time (Park/Ride Access)
43	X	Wait Two (Transfer) Time (Kiss/Ride Access)
44	X	Auto Access (TRN) Time (Park/Ride Access)
45	X	Auto Access (TRN) Time (Kiss/Ride Access)
46	X	Walk Time (Walk Access)
47	X	Walk Time (Park/Ride Access)
48	X	Walk Time (Kiss/Ride Access)
49	X	Transit Fare (Walk Access) (Cents)
50	X	Transit Fare (Park/Ride Access) (Cents)
51	X	Transit Fare (Kiss/Ride Access) (Cents)
52	T	Person-Trips

NOTE: The Market Segmentation Strata are: 1 = Households within walking distance of transit and own no automobiles, 2 = Households within walking distance of transit and own one or more automobiles, 3 = Households not within walking distance of transit and own no automobiles, and 4 = Households not within walking distance of transit and own one or more automobiles.

TABLE 5-4

REFERENCES TO DATA TYPE DESCRIPTIONS (TABLE 5-3)

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1. The model is structured for travel time in minutes and distance in miles. In the case of Items 2-4, these values must be expressed in hundredths and are normally integerized for ease of input. Within the program they are converted to the proper units. No UPARMS exist to "scale" the inputs, so they must be input in hundredths.

2. Each of these market segment variables are FORTRAN "real" variables and are expressed on a per-household basis.

3. In-vehicle time is Transit run time only; that is, the addition of Mode 4-8.

4. There must be a zone number on each card of the zonal data. As required by UMODEL, it must be placed in the same column fields of all input "A" files.

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8. **County of Origin.** This code defines the county-of-origin bias constant to be applied for an interchange. The county codes have been defined as follows:

Code	County
1	Los Angeles
2	Orange
3	Riverside
4	San Bernardino
5	Ventura

9. to 28. **Market Segment Variables.** For each of the four market segments defined above, the following data is provided to the program:

- o Proportion of Person-Trips
- o Autos Owned Per Household
- o Licensed Drivers Per Household
- o Workers Per Household
- o Annual Income

This information is provided directly as output from the CSI Market Segmentation Program (MSEG).

29. to 34. **Highway Time and Distance.** These skim matrices are generated using the CALTRANS FWY program package and normally are expressed in hundredths of minutes and miles, respectively. The difference between the drive-alone and two-person matrices typically has been the influence of freeway ramp-metering bypass for two (plus)-person vehicles. The difference between the two-person and three (plus)-person matrices has typically been the presence of physically separated freeway lanes for three (plus)-person carpoolers, such as the San Bernardino High-Occupancy Vehicle Lane.

35. to 48. **Transit Time Components.** Execution of the UNET, UPATH, UPSUM program sequence summarizes the transit travel time components for each minimum path. The standard components used in the program are:

- o In-Vehicle Time
- o Initial Wait Time
- o Transfer Wait Time
- o Walk Time

Each of these components is input for all three of the primary transit submodes: Park-n-Ride, Kiss-n-Ride, Walk. The Park-n-Ride components are used for both Park-n-Ride, Drive-Alone, and Park-n-Ride Shared-Ride model calculations. In addition to the four standard components, auto access time is also required for the Park-n-Ride and Kiss-n-Ride submodes.

49. to 51. Transit Fare Matrices. These fare matrices are input, like the travel time components, for each of the three primary transit submodes. They are constructed through use of a specialized UMODEL application program (FAREMTRX). A description of the methodology and algorithms incorporated in FAREMTRX is found in chapter 4.

52. Person-Trip Table. This is synthesized via the regional trip generation and distribution process recently modified to iteratively balance attractions as discussed in chapter 3.

5.3.2.2 Parameters and Options

The work mode choice program is structured to allow a degree of flexibility in specifying the application of the program using differing types of policy inputs. To invoke this feature, UMODEL provides for the input of numerous user-coded parameters, called "UPARMS." Each parameter has a default value which is used if no alternative value is coded. In most cases, the default values were determined in the calibration/adjustment phase, and normally do not need to be altered.

Table 5-5 describes the various UPARMS and their default values. This table is fairly self-explanatory, and so this section will therefore discuss only some of the particularly unique or potentially confusing parameters:

1. Consumer Price Index Option. All input costs are factored by the 1976 consumer price index (170.5) to the appropriate forecast year consumer price index for the particular variable. Since all input costs are divided by income in all utile equations, it is important that each category of cost (fare, fuel price, parking cost) and zonal income be assigned the correct CPI value. This is accomplished in UPARMS 1-4. This mechanism allows the user to input inflated dollar values and still maintain the integrity of the original model formulation.

2. Scaling of Highway Times and Distances. Time and distance in the mode choice model are specified in terms of minutes and miles. It is likely that the highway skim tree inputs will not be in these units. UPARMS 59 and 60 allow the user to communicate the proper units to the program. It should be noted that these scale factors

TABLE 5-5

USER CODED PARAMETERS WORK PROGRAM

UPARMS No.	Description	Acronym	Default Value
1	CPI for Transit Fares	CPIF	233.3
2	CPI for Fuel Prices	CPIAC	233.3
3	CPI for Income	CPINC	170.5
4	CPI for Parking Costs	CPIPC	170.5
5	Circuity for Park-Ride Shared-Ride Access	IVTPRS	1.25
6	Circuity for Two-Person Carpool (Additive Minutes)	IVT2CP	2.50
7	Circuity for Three-Person Carpool (Additive Minutes)	IVT3CP	5.90
8	Factor A for Adjusting WAIT1	WAITA	8.5
9	Factor B for Adjusting WAIT1	WAITB	0.4
10	Factor C for Adjusting WAIT1	WAITC	13.0
11	OVTT Penalty for Park-Ride	OVTPRD	4.0
12	OVTT Penalty for Kiss-Ride	OVTKR	1.0
13	Average Speed for Carpool Circuity	CPCSPD	20.0
14	Average Speed for Auto Access to Transit	TACSPD	22.0
15	Adjustment Factor for Transit Availability	PADJ	1.0
16	Gasoline Price (Cents/Gallon)	FPRICE	120.0
17	Average Fuel Economy (Miles/Gallon)	FECON	17.5
18	First Zone to be Processed by UMODEL	FZONE	41.0
19	Average Vehicle Occupancy for Three+ Carpools	AOCC3	3.2
20	Debug Option 0=No, 1=Yes	-	0.0
21	Park and Ride (QA) Constant	C1 (1)	-0.8037
22	Park and Ride (SR) Constant	C1 (2)	-1.0253
23	Kiss-Ride Constant	C1 (3)	0.3889
24	In-Vehicle Travel Time Coefficient	C1 (4)	-0.0099303
25	Cost/Income Coefficient	C1 (5)	-0.019855
26	Out-of-Vehicle Travel Time Coefficient	C1 (6)	-0.055835
27	Autos/Licensed Drivers (P/R DA) Coefficients	C1 (7)	3.0808
28	Autos/Licensed Drivers (P/R SR) Coefficients	C1 (8)	0.88302
29	Autos/Licensed Drivers (K/R) Coefficient	C1 (9)	-0.89754
30	Number of Workers (P/R SR) Coefficient	C1 (10)	0.37216
31	Number of Workers (K/R)	C1 (11)	0.34352
32	Walk Access Constant	C1 (12)	3.0135
33	CBD Dummy (P/R DA) Coefficient	C1 (13)	0.0
34	CBD Dummy (P/R SR) Coefficient	C1 (14)	0.0
35	CBD Dummy (K/R)	C1 (15)	0.0
36	Not Used	-	-
37	Not Used	-	-
38	Not Used	-	-
39	Not Used	-	-
40	Not Used	-	-

(CONTINUED)

TABLE 5-5 (CONTINUED)

USER CODED PARAMETERS WORK PROGRAM

UPARMS No.	Description	Acronym	Default Value
41	Drive Alone Constant	C2 (1)	-0.3273
42	Three+ Person CP Constant	C2 (2)	-1.4377
43	In Vehicle Travel Time (Auto) COEF	C2 (3)	-0.0099303
44	Cost/Income (Auto) COEF	C2 (4)	-0.019855
45	Out-of-Vehicle Time (Auto) COEF	C2 (5)	-0.055835
46	Autos/Licensed Driver (Two, Three+ CP) COEF	C2 (6)	-2.4734
47	Number of Workers (Two CP) COEFF	C2 (7)	0.28022
48	Number of Workers (Three+ CP) COEFF	C2 (8)	0.69721
49	CBD Dummy (Two CP) COEF	C2 (9)	0.0
50	CBD Dummy (Three+ CP) COEF	C2 (10)	0.0
51	Auto Constant	C3 (1)	-0.7403
52	Autos/Licensed Driver (Auto) COEF	C3 (2)	4.7726
53	Zero Auto Dummy (Auto) COEF	C3 (3)	-0.31411
54	LOGSUM COEF	C3 (4)	1.0
55	CBD Dummy (Transit) COEF	C3 (5)	0.0
56	Not Used	-	-
57	Not Used	-	-
58	Not Used	-	-
59	Highway Time Scaling Factor	TIMUN	0.01
60	Highway Distance Scaling Factor	DISUN	0.01
61	County Bias COEF (Los Angeles)	UCO (1)	0.2797
62	County Bias COEF (Orange)	UCO (2)	-0.4770
63	County Bias COEF (Riverside)	UCO (3)	0.2141
64	County Bias COEF (San Bernardino)	UCO (4)	0.1702
65	County Bias COEF	UCO (5)	-0.0116

NOTE: UPARMS (21) to (35) Are for Transit Submode Model.
UPARMS (41) to (50) Are for Auto Submode Model.
UPARMS (51) to (65) Are for Auto/Transit Model.

apply to the drive-alone, two-person, and three (plus)-person matrices equally.

3. Model Coefficients. The program contains a user-coded parameter for each coefficient and constant contained in the submode and primary models. These parameters (21-35, 41-55, 61-65) default to values determined during the calibration/adjustment process and, therefore, under normal circumstances can be ignored. The user may wish to change these coefficients in a sensitivity analysis or because additional information has been obtained. The user may note that there are several coefficients for variables which were not ultimately utilized in the CSI calibration (i.e., the default values are zero). These variables are still included in the logit utile equations so that the coefficients can be used, if desired, for sensitivity analysis.

5.3.2.3 Standard Output Files and Reports

The basic output of the work mode choice program is a set of modal trip tables. Fourteen trip matrices are produced by the program. These are described in Table 5-6. The trip tables are output directly to a mass storage device (tape or disk) and are not printed by the mode choice program. The UTPS program UFMTR can be used to obtain printed summaries of these tables in various formats.

The mode choice program does, however, print four trip-end summaries displaying trips produced by, and attracted to, each zone. The format of each of these summaries is described in Table 5-7.

5.3.3 Nonwork Mode Choice Program

The Nonwork Mode Choice Program combines mode choice calculations for the Home-Based Nonwork and Nonhome-Based trip purposes. Four logit mode split model formulations have been incorporated into the application program:

1. The CSI Home-Based Nonwork Mode Choice Model.
2. The CSI Nonhome-Based Transit Trip Factoring Procedure.
3. A transferred Home-Based Nonwork Mode Choice Model.
4. A transferred Nonhome-Based Mode Choice Model.

The use of one or more of these models in actual execution is controlled directly by user option (see UPARMS definitions). The CSI home-based nonwork model (1.) is calibrated for the L.A. area, whereas the transferred nonwork model (3.) is not. Conversely, the transferred nonhome-based model (4.) embodies the latest recalibration efforts, whereas the CSI nonhome-based model (2.) does not. The transferred nonhome-based structure is preferred to the CSI structure, as discussed earlier, which is why the transferred model has been kept up to date in the various recalibration efforts. Currently, therefore, formulations 1. and 4. are the ones that should be applied.

TABLE 5-6

OUTPUT TRIP TABLES

Table Number	Definition
1	Total Automobile Person-Trips
2	Drive Alone Auto Person-Trips
3	Two Person/Car Person-Trips
4	Three Plus Person/Car Person-Trips
5	Total Transit Trips
6	Transit Walk Trips
7	Transit Park/Ride (Drive Along) Trips
8	Transit Park/Ride (Shared Ride) Trips
9	Transit Kiss/Ride Trips
10	Total Auto Driver Trips
11	Drive Along and Two Persons/Car Auto-Driver Trips
12	Two Persons/Car Auto-Driver Trips
13	Three Plus Persons/Car Auto-Driver Trips
14	Total Auto-Passenger Trips

TABLE 5-7

TRIP-END SUMMARIES

Report Number	Table Number	Definition
1	1	Total Automobile Person-Trips
1	2	Total Transit Trips
1	4 (Person)	Total Person-Trips
2	1	Drive Alone Auto Person-Trips
2	2	Two Person/Car Person-Trips
2	3	Three Plus Person/Car Person-Trips
2	4 (Person)	Total Automobile Person-Trips
3	1	Transit Park/Ride Plus Kiss/Ride Trips
3	2	Transit Walk Trips
3	4 (Person)	Total Transit Trips
4	1	Transit Park/Ride (Drive Alone) Trips
4	2	Transit Park/Ride (Shared Ride) Trips
4	3	Transit Kiss/Ride Trips
4	4 (Person)	Total Transit Trips

The Nonwork Mode Choice Program uses highway and transit travel times and costs to split (purpose-specific) person-trip tables into a set (by purpose) of modal trip tables. The person-trip tables represent 24-hour trips in production-attraction format, except for the two Nonhome-Based trip tables (other-other, other-work) which are in origin-destination format. For the CSI Home-Based Nonwork model, the market segmentation delineation is identical to that used in the Home-Based Work model. If the transferred Home-Based Nonwork model is selected, a four-income level market segmentation is used. The proportioning of person-trips for each interchange into the four income level market segmentation is used. The proportioning of person-trips for each interchange into the four income levels is discussed in Technical Memorandum 4.2. The CSI Home-Based Nonwork model forumlation is considerably less complicated than the work model, and therefore requires significantly fewer level-of-service matrices as input. This is both a result of the more simplistic binary form of the model and the implicit assumption that only households within walking distance of transit can utilize transit for nonwork travel. Both of the transferred models are multimodal (not binary) in form, and are applied internally as such. However, the program's trip-table outputs and trip-end summaries are consistent with CSI's original output conventions. As indicated previously, this application program represents a new and original programming effort. To the extent possible, however, input and output data file conventions were maintained.

5.3.3.1 Input Data

There are forty-seven pieces of data listed in Table 5-8 which are required by the program. The notes contained in Table 2 also apply. Their location and type are defined to UMODEL through the "Variable Identification Cards." The first twenty-six data items are zonal or vector variables (i.e., one record per zone); the next eleven items are interchange (zone-to-zone) data; the next nine items are temporary or "generated" variables; and the last item is also a zonal variable. The derivation of these data elements is briefly described below:

1. <u>Zone Number</u>. The first data item on each and all of the trip-end ("A") files input to the program.

2. to 4. <u>Highway Access and Terminal Time</u>. Identical to the values supplied to the work model program. Refer to work section for definition of content.

5. <u>Parking Cost</u>. Developed by local planners to represent an average off-peak parking cost in each zone. Documentation of the basis or typical duration for these costs are not yet available from CALTRANS.

6. <u>CBD Indicator</u>. Refer to the work program section for a description of this variable.

TABLE 5-8

DEFINITION OF INPUT DATA REQUIREMENTS FOR THE MODE CHOICE APPLICATION PROGRAM FOR NON-WORK TRIPS

Data Item Number	Data Type	Description
1	P	Zone Number
2	P	Highway Time to Access Network (IVT) (Minutes*100)
3	P	Highway Distance to Access Network (Miles * 100.0)
4	A	Highway Terminal Time (Minutes * 100)
5	A	Park Cost (Cents)
6	A	CBD Indicator (0,1)
7	P	Proportion of Person-Trips: Market Segment 1
8	P	Autos Owned: Market Segment 1
9	P	Licensed Drivers: Market Segment 1
10	P	Annual Income: Market Segment 1
11	P	Number of Persons: Market Segment 1
12	P	Proportion of Person-Trips: Market Segment 2
13	P	Autos Owned: Market Segment 2
14	P	Licensed Drivers: Market Segment 2
15	P	Annual Income: Market Segment 2
16	P	Number of Persons: Market Segment 2
17	P	Proportion of Person-Trips: Market Segment 3
18	P	Autos Owned: Market Segment 3
19	P	Licensed Drivers: Market Segment 3
20	P	Annual Income: Market Segment 3

(CONTINUED)

TABLE 5-8 (CONTINUED:2)

DEFINITION OF INPUT DATA REQUIREMENTS FOR THE MODE CHOICE APPLICATION PROGRAM FOR NON-WORK TRIPS

Data Item Number	Data Type	Description
21	P	Number of Persons: Market Segment 3
22	P	Proportion of Person-Trips Market Segment 4
23	P	Autos Owned: Market Segment 4
24	P	Licensed Drivers: Market Segment 4
25	P	Annual Income: Market Segment 4
26	P	Number of Persons: Market Segment 4
27	X	Highway Travel Time
28	X	Highway Distance
29	X	Transit In-Vehicle Time
30	X	Initial Transit Wait Time
31	X	Transfer Time
32	X	Transit Walk Time
33	X	Transit Fare
34	T	Home-Based Non-Work Person-Trips
35	T	Non-Home Based (Other-to-Other) Person-Trips
36	T	Non-Home Based (Other-Work) Person-Trips
37	X	Number of Transit Transfer
38	P*	Percent of Trips-Income Quartile 1
39	P*	Percent of Trips-Income Quartile 2
40	P*	Percent of Trips-Income Quartile 3

(CONTINUED)

TABLE 5-8 (CONTINUED:3)

DEFINITION OF INPUT DATA REQUIREMENTS FOR THE MODE CHOICE APPLICATION PROGRAM FOR NON-WORK TRIPS

Data Item Number	Data Type	Description
41	P*	Percent of Trips-Income Quartile 4
42	P*	Percent of Trips Within Walking Distance
43	P*	Inverse of the Log of Income-CSI Market Segment 1
44	P*	Inverse of the Log of Income-CSI Market Segment 2
45	P*	Inverse of the Log of Income-CSI Market Segment 3
46	P*	Inverse of the Log of Income-CSI Market Segment 4
47	P*	County of Origin Code

7\. to 26. Market Segment Variables. For each of the four market segments defined above, the following data is provided to the program:

- Proportion of Person-Trips
- Autos Owned Per Household
- Licensed Drivers Per Household
- Annual Income
- Persons Per Household

This data is similar to the work model market segment data, but includes persons per household rather than workers per household. This information is provided directly as output from the CSI Market Segmentation Program (MSEG).

27\. & 28. Highway Time and Distance. These off-peak skim matrices are generated using the CALTRANS FWY program package and are normally expressed in hundredths of minutes and miles, respectively.

29\. to 32. Transit Time Components. Execution of the UNET, UPATH, UPSUM program sequence summarizes the transit travel time components for each minimum path. The components used in the program are:

- In-Vehicle Time
- Initial Wait Time
- Transfer Wait Time
- Walk Time
- Number of Transfers

These interchange values are built only for paths which can access transit via the walk mode.

33\. Transit Fare. As in the work model, these values are generated by UFARE. The fare levels input also represent average daily fares.

34\. to 36. Person-Trip Tables. Synthesized via the standard regional trip-generation and distribution process.

37\. Transit Time Components. Execution of the UNET, UPATH, UPSUM program sequence summarizes the transit travel time components for each minimum path. The components used in the program are:

- o In-Vehicle Time
- o Initial Wait Time
- o Transfer Wait Time
- o Walk Time
- o Number of Transfers

These interchange values are built only for paths which can access transit via the walk mode.

38. to 46. Generated Variables. These variables are generated internally within the program and are temporarily "stored" in these locations.

47. County-of-Origin Code. Refer to the work program section section for a description of this variable.

5.3.3.2 Parameters and Options

The nonwork program includes nearly 100 user-coded parameters (UPARMS) to control program operation. Table 5-9 describes these UPARMS and their default values. While use of most of the parameters is generally straightforward, those which are unique or of particular importance are described below:

1. Consumer Price Index Option. All input costs are adjusted to an equivalent dollar basis in the same manner as the work model program. UPARMS 1-3 and 17 are used for this purpose.

2. Initial Wait Time Adjustment Factors. The procedure used to adjust initial wait time for the work model is described in Volume II of CSI's final report documentation. While these factors are also included in the nonwork model program as UPARMS 6-8, they are not used in the utility calculations. This is consistent with the original CSI nonwork program code.

3. Model Coefficients. The program contains a user-coded parameter for each coefficient and constant in each of the individual modal split models. The correspondence between parameters and model are as follows:

UPARMS	MODEL
5, 9-10, 14-16	CSI HNB
21-35, 41-45	CSI HBNW
50-77	BAA HBNW
80-92	BAA NHB

TABLE 5-9

USER CODED PARAMETERS NONWORK PROGRAM

UPARMS No.	Description	Acronym	Default Value
1	CPI for Transit Fares	CPIF	233.2
2	CPI for Fuel Prices	CPIAC	233.2
3	CPI for Income	CPINC	170.5
4	Auto Occupancy for HBNW Trips	AOCCHB	1.55
5	Auto OCC for NHB 0 - 0 Trips	AOCCOO	1.46
6	Factor A for Adjusting WAIT1	WAITA	8.5
7	Factor B for Adjusting WAIT2	WAITB	0.4
8	Factor C for Adjusting WAIT3	WAITC	13.0
9	Factor Relating 0-0 NHB TRN Share to HBNW TRN Share	TFR1	0.3431
10	0-0 NHB Mode Share (TRN) When HBNW Trips = 0	TPR2	0.0156
11	Gasoline Price (Cents/Gallon)	FPRICE	120.0
12	Average Fuel Economy (Miles/Gallon)	FECON	17.5
13	First Zone to be Processed by Model	FZONE	41.0
14	Auto OCC for NHB 0-W Trips	AOCCOW	1.14
15	Factor Relating NHB 0-W Transit Mode Share to HBNW Transit Share	TFR3	0.2608
16	NHB 0-W Transit Share When HRNW Trips = 0	TFR4	0.0182
17	CPI For Parking Costs	CPIPR	170.5
18	Not Used	-	0.0
19	Not Used	-	0.0
20	Not Used	-	0.0
21	Transit Constant	C (1)	3.6274
22	Dummy COEFF (1 If Autos GT 0 and No Drivers Licensed)	C (2)	-3.76
23	Income Coefficient	C (3)	0.0738
24	Autos/Licensed Drivers Coefficient	C (4)	5.15
25	In-Vehicle Travel Time Coefficient	C (5)	-0.0292
26	Out-of-Vehicle Travel Time Coefficient	C (6)	-0.0905
27	Cost/Log (Income) Coefficient	C (7)	-0.287
28	1/Distance Coefficient (Auto EQ)	C (8)	7.87
29	1/Distance Coefficient (Transit EQ)	C (9)	5.15
30	Log (Population/Retail EMP) Coefficient	C (10)	0.293
31	Log (Retail EMP) Coefficient	C (11)	1.0
32	CBD Dummy (Transit) Coefficient	C (12)	0.0
33	CBD Dummy (Auto) Coefficient	C (13)	0.0
34	Auto Constant (Mode Choice Model)	C (14)	0.0
35	CBD Dummy (Auto) Mode Choice Coefficient	C (15)	0.0
36	Not Used	-	-
37	Not Used	-	-
38	Not Used	-	-

(CONTINUED)

TABLE 5-9 (CONTINUED:2)

USER CODED PARAMETERS NONWORK PROGRAM

UPARMS No.	Description	Acronym	Default Value
39	Not Used	-	-
40	Not Used	-	-
41	County Bias COEF (Los Angeles)	UCO (1)	-0.5748
42	County Bias COEF (Orange)	UCO (2)	-0.4554
43	County Bias COEF (Riverside)	UCO (3)	-0.1402
44	County Bias COEF (San Bernardino)	UCO (4)	-0.0078
45	County Bias COEF	UCO (5)	0.1206
46	Not Used	-	-
47	Not Used	-	-
48	Not Used	-	-
49	Not Used	-	-
50	HBNW Coefficient--Out-of-Vehicle Time	COOVI	0.200
51	HBNW Coefficient--In-Vehicle Time	COIVT	0.008
52	HBNW Coefficient--Cost	COCSI	0.012
53	HBNW Coefficient--Transfers	COXFR	0.135
54	HBNW Coefficient--Drive Alone Term. Time	COHWTO	0.340
55	HBNW Coefficient--Shared Ride Term. Time	COHWTG	0.283
56	HBNW Coefficient--Parking Cost	COPRK	0.032
57	HBNW Bias Coefficient--Transit	COBIAS	0.000
58	HBNW Bias Coefficient--Drive Alone, INC 1	PBIAS (1,1)	0.093
59	HBNW Bias Coefficient--Drive Alone, INC 2	PBIAS (1,2)	-1.180
60	HBNW Bias Coefficient--Drive Alone, INC 3	PBIAS (1,3)	-2.140
61	HBNW Bias Coefficient--Drive Alone, INC 4	PBIAS (1,4)	-2.929
62	HBNW Bias Coefficient--Shared Ride, INC 1	PBIAS (2,1)	-1.528
63	HBNW Bias Coefficient--Shared Ride, INC 2	PBIAS (2,2)	-2.217
64	HBNW Bias Coefficient--Shared Ride, INC 3	PBIAS (2,3)	-2.742
65	HBNW Bias Coefficient--Shared Ride, INC 4	PBIAS (2,4)	-3.111
66	HBNW Auto OCC. Bias COEFF-Three per Car, INC 1	PBIAS (3,1)	0.898
67	HBNW Auto OCC. Bias COEFF-Three per Car, INC 2	PBIAS (3,2)	0.954
68	HBNW Auto OCC. Bias COEFF-Three Per Car, INC 3	PBIAS (3,3)	1.025
69	HBNW Auto OCC. Bias COEFF-Three Per Car, INC 4	PBIAS (3,4)	1.126
70	HBNW Auto OCC. Bias COEFF--Four Per Car, INC 1	PBIAS (4,1)	1.124
71	HBNW Auto OCC. Bias COEFF--Four Per Car, INC 2	PBIAS (4,2)	1.171
72	HBNW Auto OCC. Bias COEFF--Four Per Car, INC 3	PBIAS (4,3)	1.229
73	HBNW Auto OCC. Bias COEFF--Four Per Car, INC 4	PBIAS (4,4)	1.309
74	HBNW Auto OCC. Bias COEFF-Five+ Per Car, INC 1	PBIAS (5,1)	1.505
75	HBNW Auto OCC. Bias COEFF-Five+ Per Car, INC 2	PBIAS (5,2)	1.554
76	HBNW Auto OCC. Bias COEFF-Five+ Per Car, INC 3	PBIAS (5,3)	1.614
77	HBNW Auto OCC. Bias COEFF-Five+ Per Car, INC 4	PBIAS (5,4)	1.696
78	Not Used	-	-
79	Not Used	-	-

(CONTINUED)

TABLE 5-9 (CONTINUED:3)

USER CODED PARAMETERS NONWORK PROGRAM

UPARMS No.	Description	Acronym	Default Value
80	NHB Coefficient--Out-of-Vehicle Time	CNOVT	0.025
81	NHB Coefficient--In-Vehicle Time	CNIVT	0.010
82	NHB Coefficient--Cost	CNCST	0.013
83	NHB Coefficient--Number of Transfers	CNXFR	0.075
84	NHB Coefficient--Drive Alone Term. Time	CNHWTO	0.2423
85	NHB Coefficient--Shared Ride Term. Time	CNHWTG	0.3048
86	NHB Coefficient--Parking Cost	CNPRK	0.0360
87	NHB Bias Coefficient--Drive Alone	CNBIAO	-3.2191
88	NHB Bias Coefficient--Shared Ride	CNBIAG	-3.0327
89	NHB Auto OCC. Bias Coefficient--Three Per Car	CNBIAT	0.9930
90	NHB Auto OCC. Bias Coefficient--Four Per Car	CNBIAF	1.1610
91	NHB Auto OCC. Bias Coefficient--Five Per Car	CNBIAV	1.6280
92	Average Occupancy For Five Person/Car	AOCFIV	5.100
93	System Variable for Distribution--RPT #1	IVDR(1)	1.0
94	System Variable for Distribution--RPT #2	IVDR(2)	2.0
95	System Variable for Distribution--RPT #3	IVDR(3)	3.0
96	Highway Time Scaling Factor	HTINFA	0.01
97	Highway Distance Scaling Factor	HDINFA	0.01
98	Auto Occupancy for Intra Trips	AOCIIX	2.5
99	Not Used	-	-
100	Model Specification	IMODEL	2.0

1 = Both CSI Models
2 = CSI No=-Work/BAA NHB
3 = BAA Non-Work/CSI NHB
4 = Both BAA Models

These parameters default to values determined during the calibration/adjustment process, and therefore, under normal circumstances, can be ignored. An exception is the transferred Home-Based Nonwork model (UPARMS 50-77) which has not been adjusted to local observed data and should not be used.

4. System Variable Distribution Reports. These parameters (UPARMS 93-95) specify the system variable for the three distribution reports (see section on Standard Output Files and Reports for a description of these reports). The user has a choice of system variables as follows:

Parameter Code	System Variable	Units or Units Range
1	Highway In-Vehicle Time	2 Minutes
2	Highway Distance	Miles
3	Transit In-Vehicle Time	5 Minutes
4	Transit Walk Time	Minutes
5	Transit Initial Wait Time	Minutes
6	Transit Transfer Time	Minutes
7	Transit Out-of-Vehicle Time	Minutes
8	Transit Transfers	Number
9	Transit Fares	10 Cents
10	Highway Out-of-Vehicle Time	Minutes
11	Highway Running Cost	10 Cents
12	Highway Parking Cost/2	10 Cents
13	Total Highway Cost	20 Cents

5. Scaling of Highway Times and Distances. UPARMS 96 and 97 allow the user to communicate the proper units to the program.

6. Model Specification. Substantial flexibility in the application of individual models (by purpose) is provided by UPARMS 100. However, because the Barton-Aschman Nonwork model has not been calibrated, codes 3 and 4 should not be used.

5.3.3.3 Standard Output Files and Reports

The basic output of the nonwork mode choice program is a set of twelve modal trip tables. In addition, four trip-end summaries, a system variable distribution report, an average variable report, and a district trip summary report are produced.

The output trip tables are stratified by both trip purpose (Home-Based Nonwork, Other-to-Other, Other-to-Work) and mode (auto and transit). A definition of the individual output tables is contained in Table 5-10. These trip tables are output directly to a storage device (Tape or disk) and are not printed by the mode choice program. The UFMTR program can be used to obtain printed copies of these tables in various formats. The program does, however, print four trip-end

TABLE 5-10

OUTPUT TRIP TABLES

Table Number	Definition
1	Total Automobile Person-Trips (HBNWK)
2	Total Transit Trips (HBNWK)
3	Auto Driver Trips (HBNWK)
4	Total Automobile Person-Trips (NHB 0-0)
5	Total Transit Trips (NHB 0-0)
6	Auto Driver Trips (NHB 0-0)
7	Total Automobile Person-Trips (NHB W-0)
8	Total Transit Trips (NHB W-0)
9	Auto Driver Trips (NHB W-0)
10	Total Automobile Person-Trips (HBNWK + NHB 0-0) + NHB W-0)
11	Total Transit Trips (HBNWK + NHB 0-0) + NHB W-0)
12	Total Auto-Driver Trips (HBNWK + NHB 0-0 + NHB W-0)

summary reports for each purpose and total, showing trips produced by, and attracted to, each zone. The formats of these summaries are provided in Table 5-11. Note that the parameter "REPORT = 4" must be coded on the "&SELECT" card in order to produce this report.

Three additional reports are also produced by the program:

1. System Variable Distribution Summary Report. Three of these reports are always printed for the three system variables identified by UPARMS 93, 94, and 95. This report takes the modal trips for each interchange and puts them in the row identified by the system variable value for that interchange. For example, if an interchange has a highway run time of 3.5 minutes, all trips for that interchange are included in the fourth row (3.001-4.000 minutes) of the highway run time system variable distribution summary report. This process is performed for all trips except intrazonal trips or trips to or from an external zone.

2. Subarea Trip Summary. This report is a district-to-district modal trip table, including a trip-end summary of productions and attractions. Intrazonal trips and external station trips are included, with external stations as District 7. The zonal equivalences to districts are obtained from the county code and CBD indicator values input in the variable ID cards.

3. Average Variable Value Report. This report specifies the average value of each of eleven system variables and variable combinations, weighted by the modal trip values and by person-trips. These average values can be used with the system variable distribution reports to perform sensitivity analyses on the model results. Highway costs and times are for the one-person-per-car mode only.

TABLE 5-11

TRIP-END SUMMARIES

Report Number	Table Number	Definition
1	1	Total Automobile Person-Trips (HBNWK)
1	2	Total Transit Trips (HBNWK)
1	3	Auto Driver Trips (HBNWK)
1	4 (Person)	Total Person-Trips (HBNWK)
2	1	Total Automobile Person-Trips (NHB 0-0)
2	2	Total Transit Trips (NHB 0-0)
2	3	Auto Driver Trips (NHB 0-0)
2	4 (Person)	Total Person-Trips (NHB 0-0)
3	1	Total Automobile Trips (NHB W-0)
3	2	Total Transit Trips (NHB W-0)
3	3	Auto Driver Trips (NHB W-0)
3	4 (Person)	Total Person-Trips (NHB W-0)
4	1	Total Automobile Person-Trips (HBNWK, NHB 0-0), NHB W-0)
4	2	Total Transit Trips (HBNWK, NHB 0-0, NHB W-0)
4	3	Auto Driver Trips (HBNWK, NHB 0-0, NHB W-0)
4	4 (Person)	Total Person-Trips (HBNWK, NHB 0-0, NHB W-0)

6. MODE-OF-ACCESS-AND-EGRESS MODEL

6.1 INTRODUCTION

This chapter provides a description of the mode-of-access-and-egress model developed for the Los Angeles region. This model and computer application program were developed in order to allow planners and designers to obtain a more accurate and detailed estimate of the characteristics of transit trips accessing and leaving the planned Metro Rail transit stations. This more detailed estimate should contribute to the design of a more efficient and cost-effective system.

The following section (6.2) describes objectives for development of a mode-of-access-and-egress model. Section 6.3 describes the model and analytical procedures implemented for the SCRTD application. It also describes the model as it was developed initially and then the modifications designed to improve its accuracy and usefulness specifically for the Los Angeles case. The remaining section (6.4) covers the actual application programs and their interrelationships.

6.2 MODEL OBJECTIVES

When the design of a rail system in an urban area is begun, the characteristics of travel to and from the planned rail stations can be crucial. In many cases, the successful implementation of a rail system depends upon the provision of adequate feeder bus service, automobile drop-off space, and parking spaces. Detailed investigation to detemine the requirements of provisions for feeder buses and automobiles is necessary, since these requirements are essential parameters in the physical design of stations and, therefore, can substantially affect the capital cost of the system. It is important not only to estimate these characteristics of travel for the entire day, but also by various time periods, especially peak-period travel. The number and types of trips accessing a station in the peak hour, for example, are essential parameters for determining the size of the station in terms of bus bays, entrances, fare gates, and automobile access locations.

Therefore, the primary objective of a mode-of-access-and-egress model is to provide a reliable tool to estimate the number of trips entering and leaving each rail station, by mode and time period. If this estimate is made using the standard UTPS process, the analyst is faced with a significant amount of manual calculation and use of approximations which can modify the estimate to a considerable degree. Unlike rail systems in the older eastern cities such as New York, modern rail system design places a great deal of emphasis on multimodal access to stations (i.e., feeder bus, Park-n-Ride, and Kiss-n-Ride). Many new systems are seriously considering satellite parking facilities; that is, parking areas serviced by feeder or express buses which, in turn, serve a rapid rail station. This emphasis on multimodal access and satellite parking facilities simply increases the complexity of estimating the mode of access and makes the effort to produce these estimates using normal procedures impossible. The standard UTPS process does, however, contain the information required to make these estimates in a logical and reasonable manner. Meeting the need to develop a process (i.e., computer program) which can use this information to produce the reports and computer files which will provide the required information is the primary purpose of this model.

The objective for developing the Los Angeles mode-of-access-and-egress model was to construct a methodology which could estimate statin access and egress by mode and time of day and to implement this methodology through the use of a UTPS-compatible computer program. This objective was met by utilizing information and models (i.e., modal choice) previously developed for the Los Angeles region, UTPS files, and ancillary processes already in place, and by modifying a computer program originally developed for the Houston region.

In addition to using the mode-of-access-and-egress information for designing the rail system, the model is able to provide information on traffic volume in the vicinity of the station and its impact on air quality. In the normal UTPS process, the allocation of Park-n-Ride and Kiss-n-Ride vehicle trips to specific highway segments is a tedious and typically manual task. The mode-of-access-and-egress model was designed to allow this allocation (i.e., assignment) to be performed in the same manner as "normal" highway vehicle trips are allocated to highway segments. Highway access to the rail stations probably will contribute only a small proportion of the regional air pollutants, but the normal UTPS process requires this calculation to be performed manually. The mode-of-access-and-egress model produces a computer file, or files, which allows this task to be performed using computer techniques.

6.3 MODEL SYSTEM OVERVIEW

This section describes the Los Angeles mode-of-access-and-egress model in general terms. It contains a brief description of the model's derivation and information (used in the model) obtained from other sources. The basic model was taken from that developed for the Houston Alternatives Analysis Study. The model uses travel data from the mode choice models, travel times and costs from the transit networks, information on the physical characteristics of the stations, travel times and costs from the highway network, and socioeconomic data, to estimate the mode of access and egress by time period for each station in the system (bus and rail). The basic model structure was significantly modified in this project, since the Los Angeles region had considerably more base information available prior to applying the mode-of-access-and-egress model than did the Houston region. This additional information was obtained from the mode choice models which directly estimate home-based work transit travel by submode (i.e., feeder bus, Park-n-Ride, and Kiss-n-Ride) for each interchange.

6.3.1 Model Features

The mode-of-arrival model consists of a set of algorithms linked to two travel-demand models which together produce a set of reports and computer files that describe the modes of access and egress to each station by time of day. The model contains several unique features not generally found in other mode-of-arrival models, including:

1. A capacity-restraint technique that allows the user the option of restricting park'n'ride access to the number of spaces available at the station. If the model determines that there is more demand than supply, then surplus trips are either shifted to feeder bus or Kiss-n-Ride, or are removed from the transit trip file.

2. A procedure to identify and follow transit trips that use satellite parking lots, showing the mode of arrival for the initial lot and bus arrivals at the proper rail station. Thus, if a traveler uses auto to a bus station and then uses bus to a rail station, this is tracked and reported by the mode-of-arrival model.

3. The model determines if any trips pass through the network node at a rail station without ever boarding rail, and does not include such trips as part of the rail volume nor of the station arrivals and departures. (As explained below, this is never invoked in this network.)

4. The model produces reports that show the mode of arrival and departure by station for daily trips, A.M. and P.M. peak hours, and morning, midday, afternoon, and evening periods.

5. The model produces tables of peak-hour trips that can be assigned to the transit networks. These assignments can be used to analyze all transit routes, not just rapid rail routes.

6. The model produces a set of park'n'ride and kiss'n'ride vehicle trip tables. These trips can be assigned to the highway network to allow the analyst to estimate the highway impacts near station locations and regional air pollutants, although this feature has not been utilized in current applications in Los Angeles.

The networks for Los Angeles have been constructed so as to use special node numbers for all rail stations. If a path uses the link that enters a rail station, the only way out of the station node is on rail. Therefore, all paths that pass through a station node are paths using rail. This is not so for special bus stations, where paths may use the node of the bus station, but not use the express bus service at that station. Thus, only for special bus stations will this feature be used in the current Los Angeles networks. The facility to check this exists in the mode-of-arrival program.

6.3.2 Defining the Modes of Access and Egress

In following the paths of transit trips, the mode-of-arrival model determines whether or not transit trips use rail at any point in the path. Possible transit paths include:

- Walk to a rail station, ride rail, walk to final destination = walk access and egress.
- Walk to a rail station, ride rail, ride bus to closer-to-final destination, and walk to final destination = walk access and bus egress.
- Walk to bus, ride bus to rail station, ride rail, and walk to final destination = feeder bus access and walk egress.
- Walk to bus, ride bus to rail station, ride rail, ride bus to near-final destination, walk to final destination = feeder bus access and egress.
- Auto to rail parking lot, ride rail, and walk to final destination = Park-n- Ride access, walk egress.
- Auto to rail parking lot, ride rail, transfer to bus to near -final destination, and walk to final destination = park 'n' ride access and feeder bus egress.
- Auto to bus parking lot, bus to rail, ride rail, and walk to final destination = feeder bus access and walk egress.
- As above, but with bus to near-final destination = feeder bus access and egress.
- Replacement in the last four alternatives of dropoff from car for parking = replacement of Kiss-n-Ride for Park-n-Ride.

All of the above paths that are asymmetrical and can also be defined in the reverse direction. Because paths are built in the production-attraction sense, park 'n' ride and kiss 'n' ride are permitted only at the production or home end of the trip.

6.3.3 Parking Capacity Constraints

The mode-of-arrival model provides two sets of several of the output tables, one of these sets being for the case of unconstrained parking, and the second for constrained parking. The unconstrained parking reports provide both parking-accumulation reports and station arrival and departure reports for conditions in which the parking capacity at stations is ignored, although parking is permitted only at those stations so designated. The constrained reports for both these cases accumulate parking on an hourly basis, noting whether the parker is a short- or long-term and the hour of arrival. Once the parking lot is full, no further trips are allowed to arrive by park 'n' ride, until some of the earlier parkers begin to leave the lot. Preference is given to long-term parkers, and then the exclusion of long-term parkers begins, until only the maximum parking accumlation is possible.

The "surplus" Park-n-Ride trips are investigated to determine which trips should be reallocated to Kiss-n-Ride and feeder bus, and which should be removed from the transit trip table. This investigation consists of ascertaining the submode split from the original model formulation and shifting the "surplus" Park-n-Ride trips to the submodes, using the market shares of feeder bus and Kiss-n-Ride from the original model. The remaining market share proportion is assumed to be lost from transit. This is a logical allocation, because movements which have significant feeder bus and Kiss-n-Ride ridership, such as areas near a station, will have most of the surplus trips reallocated to these modes; and movements with few feeder bus and Kiss-n-Ride trips, such as areas far from a station, will have most of the surplus trips removed from the transit market.

6.3.4 Model Structure

In general, the model system is a series of nested models which first split transit trips into walk and non-walk trips, then into transit and highway arrivals, and finally into Park-n-Ride and Kiss-n-Ride trips. This nested structure is shown in Figure 6-1. The walk/non-walk model is a simple table look-up procedure based on zone-to-station distance as shown in Table 6-1. The transit/highway model is a binary logit choice model described in Table 6-2.

The Park-n-Ride/Kiss-n-Ride access model also is a logit model, and the calculation steps and coefficients are illustrated in Table 6-3. For access stations where no parking is available but drop-off trips are probable, the program uses a simple distance-related model to estimate the proportion of Kiss-n-Ride trips. These relationships are as follows:

1. For distances greater than 3.8 miles: Kiss-n-Ride proportion = 0.0.

2. For distances greater than 2.0 miles but less than 3.8 miles: Kiss-n-Ride proportion = 0.218 - 0.0559 * highway distance (miles).

3. For distances greater than 1.0 miles but less than 2.0 miles: Kiss-n-Ride proportion = 0.464 - 0.170 * highway distance (miles).

4. For distances less than 1.0 mile: Kiss-n-Ride proportion = 0.30.

6.3.5 Modifications for the Los Angeles Region

The-mode-of-access-and-egress model (program) was modified significantly for use in the SCRTD context. These modifications are a result of the mode choice models for the region which provide considerably more information than did the Houston models. The new mode choice model for work trips produces transit trips stratified by

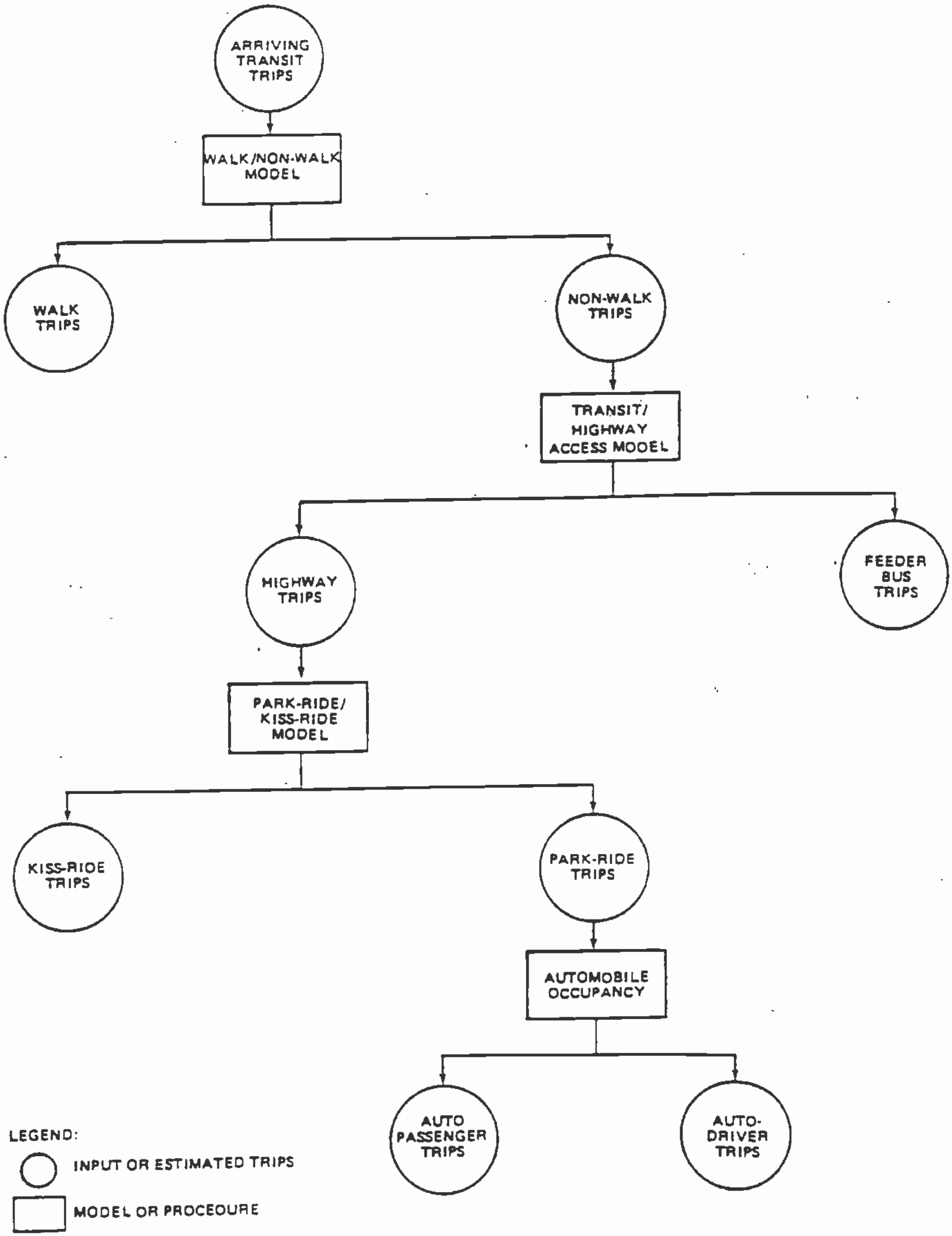


Figure 6-1

HIERARCHICAL STRUCTURE FOR MODE-OF-ARRIVAL MODEL

TABLE 6-1

WALK/NON-WALK MODEL DIVERSION

Type of Station(1)	Proportion of Walk Trips for Each: Zone-to-Station Distance (Miles)									
	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9	1.0
1	1.0	1.0	1.0	1.0	0.73	0.30	0.01	0.0	0.0	0.0
2	1.0	1.0	0.95	0.86	0.75	0.57	0.36	0.08	0.05	0.0
3	1.0	1.0	0.95	0.86	0.75	0.57	0.36	0.08	0.05	0.0
4	0.95	0.85	0.69	0.56	0.42	0.31	0.22	0.13	0.07	0.04

(1) Type of Station definitions:

1. A station where no highway access of any type is anticipated, such as a station in the central business district.

2. A station where the only highway access anticipated is the drop-off mode (i.e., Kiss-n-Ride).

3. A station where the access is walk or bus, but potential Kiss-n-ride trips would go to another type 2 station.

4. A station where all types of highway access are anticipated and which has some parking facilities.

Note: Model is applied to both choice and non-choice trips, since calibration of this model used entire transit market.

Source: Mode of Access User's Guide, prepared by Peat, Marwick, Mitchell & Co. for the Metropolitan Washington Council of Governments.

TABLE 6-2

TRANSIT/HIGHWAY ACCESS MODEL

Probability of choosing transit access = EXP (feeder)/(1 + EXP (feeder))

Probability of choosing highway access = 1.0 - transit access probability

The term "feeder" is a linear utility equation described below.

Feeder = -0.0417 * (IVTFBM-IVTHWM) - 0.10425 * (WAITFBM-WAITHWM)
-0.7249 * (XFERFBM-XFERHWM) - 0.084 * HWYDST
-0.024611 * (CSTFBM-CSTHWM) - 0.164073 * ACTHWM + INC (I)

Where:

IVTFBM: is the in-vehicle transit time for the transit access mode(1)
IVTHWM: is the in-vehicle transit time for the highway access mode
WAITFBM: is the total waiting time for the transit access mode
WAITHWM: is the total waiting time for the highway access mode(2)
XFERFBM: is the number of transfers for the transit access mode
XFERHWM: is the number of transfers for the highway access mode
HWYDST: is the total highway distance of the trip, measured over the the highway network (miles)
CSTFBM: is the cost associated with the transit access mode
CSTHWM: is the cost associated with the highway mode
ACTHWM: is the highway access time (in-vehicle time) from the origin zone to the station
INC (1): are bias coefficients associated with each income level The values of these coefficients are as follows:

INCOME QUARTILE	BIAS COEFFICIENT
Low	2.94297
Low-Medium	2.58120
High-Medium	2.58120
High	1.12427

Notes: All travel times are in minutes, costs are in cents. Highway mode values are for Park-n-Ride mode.

(1) Unless otherwise specified, the value of the independent variables is for the entire interchange, i.e., from the origin zone to the destination zone.

(2) Includes the parking terminal time, i.e., the time to park a vehicle and walk to the station entrance.

TABLE 6-3

PARK-N-RIDE/KISS-N-RIDE ACCESS MODEL CALCULATION STEPS

For each income level (4)

Calculate Kiss-n-Ride Utile (KRUT)
KRUT = 5.0 * (origin zone terminal + station terminal time) + 2.0 * zone-to-station highway time + 2.0 * zone-to-station highway distance * highway cost/mile * income factor

Calculate Park-n-Ride Utile (PRUT)
PRUT = 2.5 * (origin zone terminal time + station terminal time) + zone-to-station highway time + ((highway distance * highway cost/mile) + (0.5 * station parking cost)) * income factor/car occupancy

Calculate difference in Utility (DELU)
DELU = KRUT - PRUT

Calculate Park-n-Ride market share for single-car households (SCPAR) SCPAR = 1.0/(1.0 + EXP (-0.05001 * (10.03 + DELU)))

Calculate Park-n-Ride market share for multi-car households (MCPAR) MCPAR = 1.0/(1.0 + EXP (-0.032929 * (35.01 + DELU)))

Calculate total Park-n-Ride market share for income level (PRMS)
PRMS = SCPAR * proportion of single-car households + MCPZR * proportion of multi-car households

Calculate total Kiss-n-Ride market share for income level (KRMS)
KRMS = 1.0-PRMS

Constants and Factors Used in Model

	Income Quartile			
	Low	Low-Medium	High-Medium	High
Income Factor	0.55866	0.330579	0.330579	0.18939
Proportion of Single-Car Households	0.947	0.800	0.800	0.626

four major submodes: feeder bus, Kiss-n-Ride passengers, Park-n-Ride drivers (vehicles), and Park-n-Ride passengers. Therefore, for transit work trips, it was not necessary to apply the Washington/Seattle models to obtain these submodes. The input submode defined as feeder-bus actually contains transit trips which may involve walking to stations or taking a feeder bus to the station. Therefore, the revised model still applies the walk/non-walk diversion curves to these input trips. For the egress modes, the program uses the walk/non-walk diversion curves to "split" these movements into walk-from-station and feeder-bus-from-station.

The Los Angeles mode choice models which generate nonwork transit trip tables do not "split" trips into the four submodes, but the mode-of-access models described in the previous section are applied for these trip purposes. Due to the inherent structure of the non-work mode choice model, there are no transit trips estimated which can use a highway mode to access the transit system. For this reason, all non-work transit trips are considered "choice" trips in the mode-of-access-and-egress model, i.e., trips which potentially can use any mode to access the transit system. This modification should produce more accurate estimates, since it is not unreasonable to expect that a proportion of nonwork trips will arrive at rail stations by other modes than walk or feeder bus.

The second major modification was implementation of a procedure to address "surplus" Park-n-Ride trips. The original model formulation compared the number of Park-n-Ride trips for each station with the number of parking spaces and classified excess trips as "potential" trips lost to the transit trip market. For the Los Angeles model version, these potential lost trips were investigated to ascertain which trips should be reallocated to Kiss-n-Ride and feeder bus and which trips should be removed from the transit trip table. This investigation consisted of ascertaining the submode split from the original model formulation and shifting the potential lost trips to the submodes using these market shares, with the feeder bus and Kiss-n-Ride market share proportion allocated to their respective submode and the other market share proportions being removed from the transit travel market. The mathematical algorithm used to implement this procedure is shown in Table 6-4.

The mode-of-access-and-egress procedure developed for the SCRTD uses the best attributes of existing Los Angeles data and models and the generic mode-of-arrival model developed for the Houston region to construct a procedure which meets the primary objectives of a mode-of-access-and-egress model. This procedure contains unique features, such as capacity constraint, and the detailed estimation procedures provided by the regional mode choice model. The procedure will produce several printed reports, the most important being the mode of arrival and departure by station by time period and a parking accumulation report for each station where parking is provided. The program will also produce a series of transit and automobile trip tables which can be assigned to their respective networks in order to perform detailed analysis on the transit and highway system. Care was taken to utilize all the available regional data in order to increase

TABLE 6-4

POTENTIAL LOST TRIP REALLOCATION PROCEDURE

Definitions:

POTLST: Potential lost trips, i.e., Park-n-Ride trips in excess of parking spaces.

SUMTRN: Sum of all transit trips accessing station, including the potential lost trips.

SUMLPT: Sum of walk, Park-n-Ride auto-driver, and Park-n-Ride auto-passenger transit trips.

FBTRP: Feeder bus transit trips, from original model formulation.

KRTRP: Kiss-n-Ride transit trips, from original model formulation.

PROPLST: Proportion of potential lost trips which are excluded from the final transit travel market.

LSTRP: Number of potential lost trips which are excluded from the final transit travel market.

SHFTRP: Number of potential lost trips which are reallocated to the Kiss-n-Ride and feeder bus submodes.

NFBTRP: Feeder bus trips including the trips reallocated from the potential lost trips.

NKRTRP: Kiss-n-Ride trips including the trips reallocated from the potential lost trips.

SUMFBKR: Sum of feeder bus and Kiss-n-Ride trips from the original model formulation.

Algorithm to Reallocate Potential Lost Trips:

```
PROPLST= SUMLPT/SUMTRN
LSTRP=   PROPLST*POTLST
SHFTRP=  POTLST-LSTRP
SUMFBKR= FBTRP+KRTRP
NFBTRP=  FBTRP+(SHFTRP*FBTRP/SUMFBKR)
NKRTRP=  KRTRP+(SHFTRP*KRTRP/SUMFBKR)
```

---

the accuracy of the estimates, including using the submode split data available from the region's new mode choice model.

6.3.6 Diurnal Factors

A further input required by the mode-of-arrival model is diurnal factors, describing the proportion of each of work and nonwork trips that are assumed to occur in each of the AM peak, the PM peak, the midday, and the evening, and the proportions of the AM and PM peak period trips that occur in the peak one hour of each period. For rail trips specifically, it is difficult to arrive at diurnal factors for a region that currently has no rail, and the best estimate is obtained by using a transit diurnal distribution and relying on the modal-split model to generate the different rail distribution as a result of the purpose split to rail versus bus.

Table 6-5 shows the diurnal factors that are built into the mode-of-arrival model as default values, the values obtained from recent RTD on-board surveys (for all purposes combined), the values used for the mode-of-arrival model application in the Los Angeles region, and the results of these factors on the total trips on transit and on rail alone. In the case of the "All" purposes figures for the defaults and the application figures, an assumed modal split was used between work and nonwork trips. The diurnal factors shown for these trips are the percentages of trips by purpose. In the last two sets of figures, the percentages are those of all trips, and figures are provided only for one peak hour, the AM peak, because this is the only one that is simulated in current model runs. From these figures, it can be seen that the selected diurnal factors approximate the observed distributions quite well.

6.4 APPLICATION OF THE MODEL

The mode-of-arrival model is implemented using five UTPS-compatible computer programs and using as inputs a set of data from other parts of the estimation procedure. Figure 6-2 shows the flow diagram for application of the model. Two alternative versions of the mode-of-arrival model have been set up for use on the SCRTD computer. The first is for the average morning peak hour, determined by allocating one third of the peak-period trips to the peak hour. This produces trip tables for assignment that are also based on both 24 hours and the average AM peak hour. The second is for the peak AM peak hour, and is currently defined by taking 49 percent of the transit work trips from the peak period, and 25 percent of the nonwork transit trips form the peak period, for the morning peak; and taking 45 percent of the transit peak period work trips and 30 percent of the transit peak period nonwork trips for the evening peak hour. Similarly, trip tables for 24 hours and the peak AM peak period are output by this setup for assignment to the transit network. Trip tables for the PM peak are not produced, because the production-attraction sense of the peak transit paths permits only AM peak trips to be assigned.

TABLE 6-5

DIURNAL FACTORS IN THE MODE-OF-ARRIVAL MODEL

Source	Purpose	AM	Midday	Period PM	Evening	AM Hour	PM Hour
MOA Defaults (Percent by Purpose)	Work	38.9	16.7	33.1	11.3	19.2	17.5
	Nonwork	11.0	46.0	36.0	7.0	3.0	14.0
	All	25.0	31.8	34.6	9.2	11.1	15.8
RTD Surveys	All	25.4	33.8	28.6	12.0	12.4	10.9
Los Angles Application* (% by Purpose)	Work	40.0	16.7	32.0	11.3	21.2	14.4
	Nonwork	15.0	50.0	25.0	10.0	4.4	7.5
	All	27.5	33.4	28.5	10.6	12.8	11.0
Transit System Simulation	Work	16.9	7.1	13.5	4.8	8.8	
	Nonwork	8.7	28.9	14.4	5.8	2.6	
	All	25.6	35.9	28.0	10.6	12.4	
Rail Only	Work	22.3	9.3	17.9	6.3	11.6	
	Nonwork	6.6	22.1	11.1	4.4	1.9	
	All	28.9	31.4	29.0	10.7	13.5	

All entries are in percentages of trips.

Source: Schimpeler Corradino Associates

* NOTE: These values are split between arriving and leaving trips in the MOA model. For example, UPARMS (1) plus UPARMS (5) in Table 6-11 add to .400 or 40.0% as shown above for AM Period Work Trips.

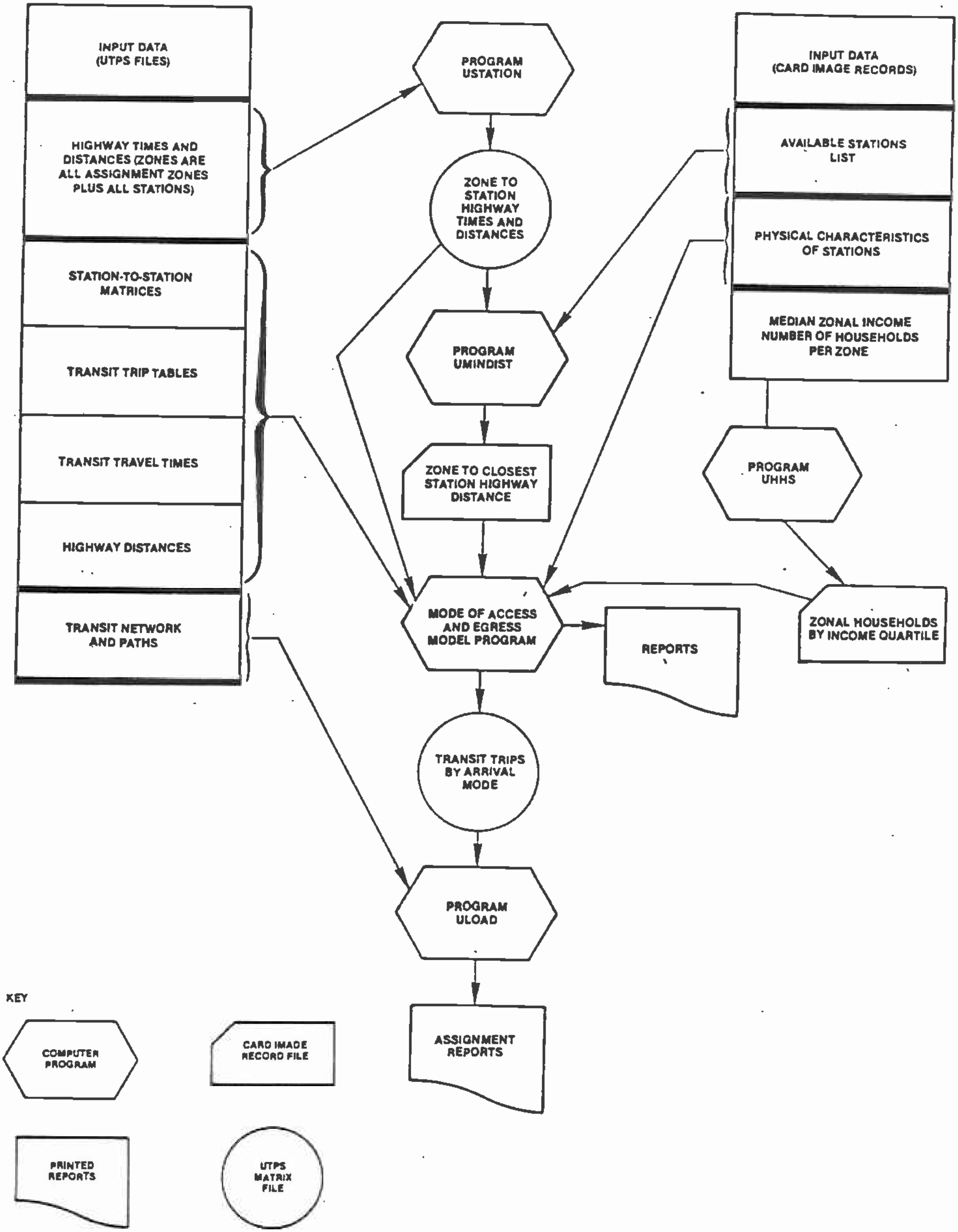


Figure 6-2

GENERAL FLOW DIAGRAM FOR MODE OF ACCESS AND EGRESS PROCEDURES

The five modules used to implement the mode-of-arrival model are described in the next sections of this chapter.

6.5 ZONE/STATION HIGHWAY IMPEDANCE PROGRAM (USTATION)

This UTPS-compatible program USTATION reads specially prepared highway time and distance matrices dimensioned (row and column) by the number of regional analysis zones plus the maximum number of possible formal (Park-n-Ride) stations/lots. These matrices are prepared by modifying the standard regional highway network to include a "dummy" centroid connection for each individual Park-n-Ride lot or transitway station. The numbering sequence of these additional centroids must range from the number of regional zones plus one to the number of regional zones plus the highest station number. Care should be taken to insure that the station-numbering sequence used in this special highway network is consistent with the numbering convention used in the construction of access/egress "station" matrices (USTOS). The representation of all possible lot/station locations in the highway network should reflect the maximum number of sites to be considered in the subsequent analysis in order to minimize the frequency with which the highway network develeopment and USTATION process must be run.

The function of this program (USTATION) is to reconfigure the above input matrices, outputting a rectangular set (time and distance) of matrices dimensioned by the number of regional model zones (row) and the number of Park-n-Ride or transitway stations (column). However, the matrices written to the output file are zero-filled beyond the highest station number to match the row dimension, thus producing a standard "square" matrix. A graphic representation of this reconfiguration is shown in Figure 6-3.

The program allows the user to scale the output matrices. The output data set from the program is used in both the main mode-of-arrival program as interchange variables 31 and 32, respectively, and in the MNMDIST program as FT11F001.

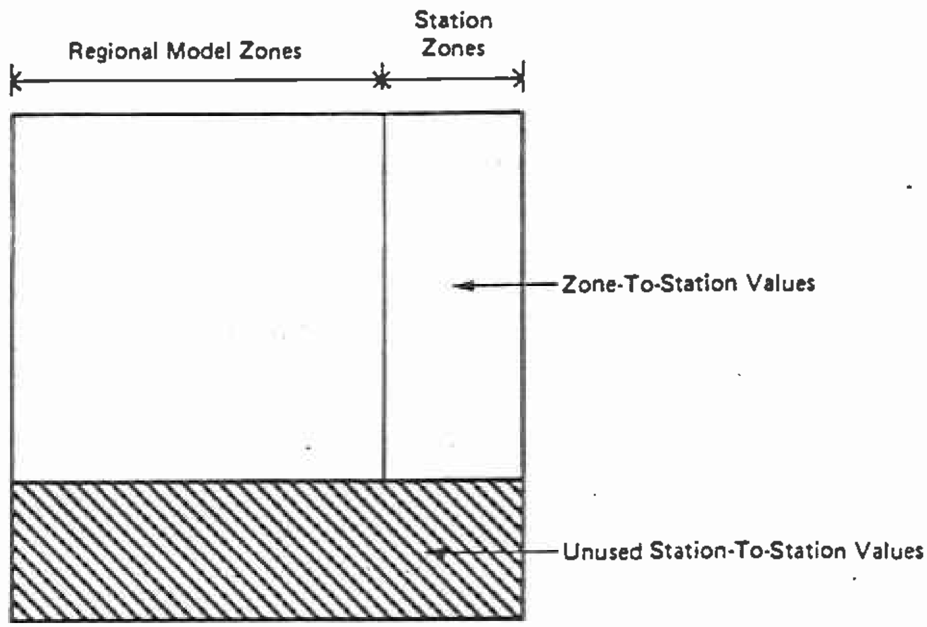
6.5.1 Input Data

The USTATION program uses both highway time and distance impedance matrices constructed as described above. As in normal UTPS-compatible programs, the user is afforded the flexibility of inputting these two matrices using any of the FT11F001 through FT18F001 units. The parameter card keyword "TABLES" is used to identify the location of these input tables. A normal application of the program would input both tables on FT11F001.

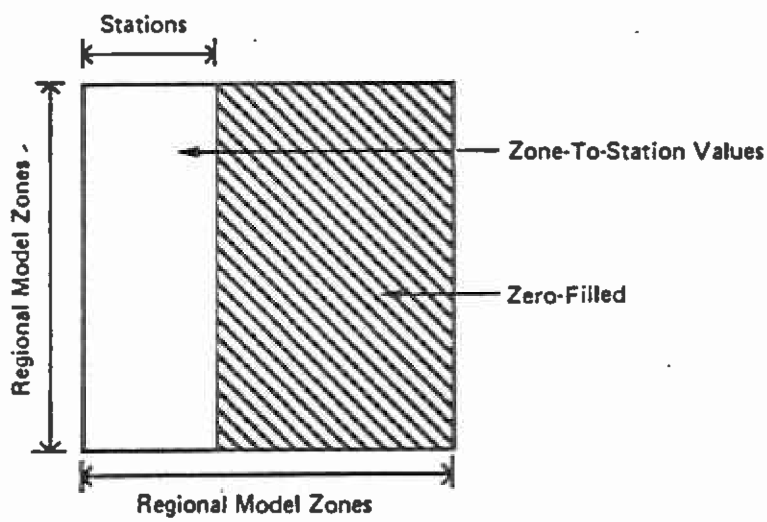
6.5.2 Parameters and Options

Program control is transmitted through the use of a single PARAM name list card which follows the title card in the SYSIN (or FT05F001) data set. It is composed of six keywords:

1. ZONES -- the number of standard regional model zones as used in the transit network and modal split model.



INPUT IMPEDANCE MATRIX
(HIGHWAY TIME OR DISTANCE)



OUTPUT IMPEDANCE MATRIX
(HIGHWAY TIME OR DISTANCE)

Figure 6-3

ZONE/ STATION HIGHWAY IMPEDANCE

2. HZONES -- the number of zones in the "modified" highway network. This value is specified as ZONES plus the maximum number of transit stations.

3. NSTA -- the zone number of the first transit stations. This value would normally be ZONES + 1.

4. TABLES -- a two-dimensional array that specifies the location of the time and distance matrices respectively. TABLES defaults to 1001 and 1002.

5. TSCALE -- used to scale the output highway time matrix.

6. DSCALE -- used to scale the output highway distance matrix.

6.5.3 Standard Output Files and Reports

The single output of USTATION (on FT19F001) is a two-table, four-byte, impedance file constructed as follows:

Table	Description
1	Zone-to-Station Highway Time
2	Zone-to-Station Highway Distance

As indicated above, the units of these two output tables are controlled by the TSCALE and DSCALE parameter keywords.

6.6 CLOSEST STATION PROGRAM

The closest station/minimum distance file required by UTPS-compatible program MNMDIST reads the zone-to-station highway times and distances created by the USTATION program and determines the closest station for each regional zone as a function of highway distance. Through the specification of &EQUIV cards, only a subset of the maximum potential Park-n-Ride/transitway stations will be considered in the determination of the closest station. This selection of lots/stations should be consistent with the coding of the transit network and its corresponding use of lots/stations.

A "card image" data file (one record per zone) is written on FT09F001 summarizing these calculations and is used subsequently as input to the main Mode-of-Arrival model program.

The program allows the user to scale properly the input time and distance matrices to output zonal values in decimal miles and minutes, although the Mode-of-Arrival program uses only the distance values.

6.6.1 Input Data

The MNMDIST program reads the zone-to-station highway time and distance matrices output from USTATION. These matrices are dimensioned by regional model zones (row) and station number (column).

As in normal UTPS-compatible programs, the user is afforded the flexibility of inputting these two matrices using any of the FT11F001 through FT18F001 units. The parameter card keyword "TABLES" is used to identify the location of these input tables.

A normal application of the program would input both tables on FT11F001.

6.6.2 Parameters and Options

Program control is transmitted through the use of two types of namelist cards which follow the title card in the SYSIN (or FT05F001) data set. The &PARAM card is composed of five keywords:

1. ZONES -- the number of standard regional model zones as used in the transit network and modal split model.

2. NSTA -- the maximum number of Park-n-Ride lot/transitway stations.

3. TABLES -- a two-dimensional array that specifies the location of the time and distance matrices, respectively. TABLES defaults to 1001 and 1002.

4. TSCALE -- used to scale the input highway time matrix.

5. DSCALE -- used to scale the input highway distance matrix.

The &EQUIV card, which follows the &PARAM card, specifies to the program the selection of stations (column dimension) to be included in the closest station determination. District 1 is used to specify the stations to be included in the program execution. District 2 contains all remaining station numbers and the sequence of zone numbers up to the ZONES values.

The &PARAM keywords are summarized in Table 6-6.

6.6.3 Standard Output Files and Reports

The primary output of MNMDIST (on FT09F001) is a "card image" data file (1 record per zone) constructed as follows:

Description	Type	Column(s)
Regional Zone Number	I*4	1- 5
Closest Station Number	I*4	6-10
Highway Distance	R*4	11-15
Highway Time	R*4	16-20

TABLE 6-6

PARAM CONTROL CARD KEYWORDS

Keyword	Definition	Default Value
ZONES	Number of Regional Model Zones	0
NSTA	Maximum Number of Park-n-Ride Lot/ Transitway Stations	0
TABLES	Input Table Numbers of Time and Distance Matrices	1001, 1002
TSCALE	Output Highway Time Matrix Scale Factor	1.0
DSCALE	Output Highway Distance Matrix Scale Factor	1.0

As indicated above, the units of the output time and distance values are controlled by the TSCALE and DSCALE parameter keywords.

In addition, MNMDIST produces Report 2, which simply displays the value(s) of each PARAM keyword as used by the program. Report 2 produces a summary of the data written to the FT09F001 data set.

6.7 HOUSEHOLDS AND INCOME DISTRIBUTION PROGRAM (UHHS)

Program UHHS is designed to estimate the number of households in each income quartile for each zone, given the total number of households and the average household income for each zone. An income quartile is defined as the income boundaries within which 25 percent of the region's households would be placed. Four quartiles are used, as follows:

1. LOW -- The 25 percent of households regionally which have the lowest income.
2. LOW-MEDIUM -- The 25 percent of households regionally which have an income greater than 25 percent of households but less than 50 percent of households.
3. HIGH-MEDIUM -- The 25 percent of households regionally which have an income greater than 50 percent of households but less than 25 percent of households.
4. HIGH -- The 25 percent of households regionally which have the highest income.

The procedure is first to compare each zone's median household income with the median household income for the region. The ratio of the zonal median household income and the regional median household income implies a certain distribution of households for each income quartile. The distribution is expressed as a set of four curves, shown in Figure 6-4. These curves were developed empirically from the 1970 New Orleans SMSA census data. The appropriate distribution, once found, is applied to the total number of households to obtain an estimate of the number of households in each income quartile for each zone. It should be noted that there is no guarantee that the model will allocate 25 percent of all households to each income quartile on a regionwide basis. Therefore, an adjustment process is carried out after the initial distribution to ensure that each quartile contains 25 percent of the households regionally.

6.7.1 Input Data Requirements

Program UHHS requires one input file (EBCDIC), which it reads from unit FT01F001. This file should contain the zone number, the median income of the zone, and the number of households in the zone. These three data items should be coded in columns 8-14, 15-22, and 64-70, respectively, and may be taken from the trip-end data file that is used as input to the CSI Market Segmentation Program (MSEG).

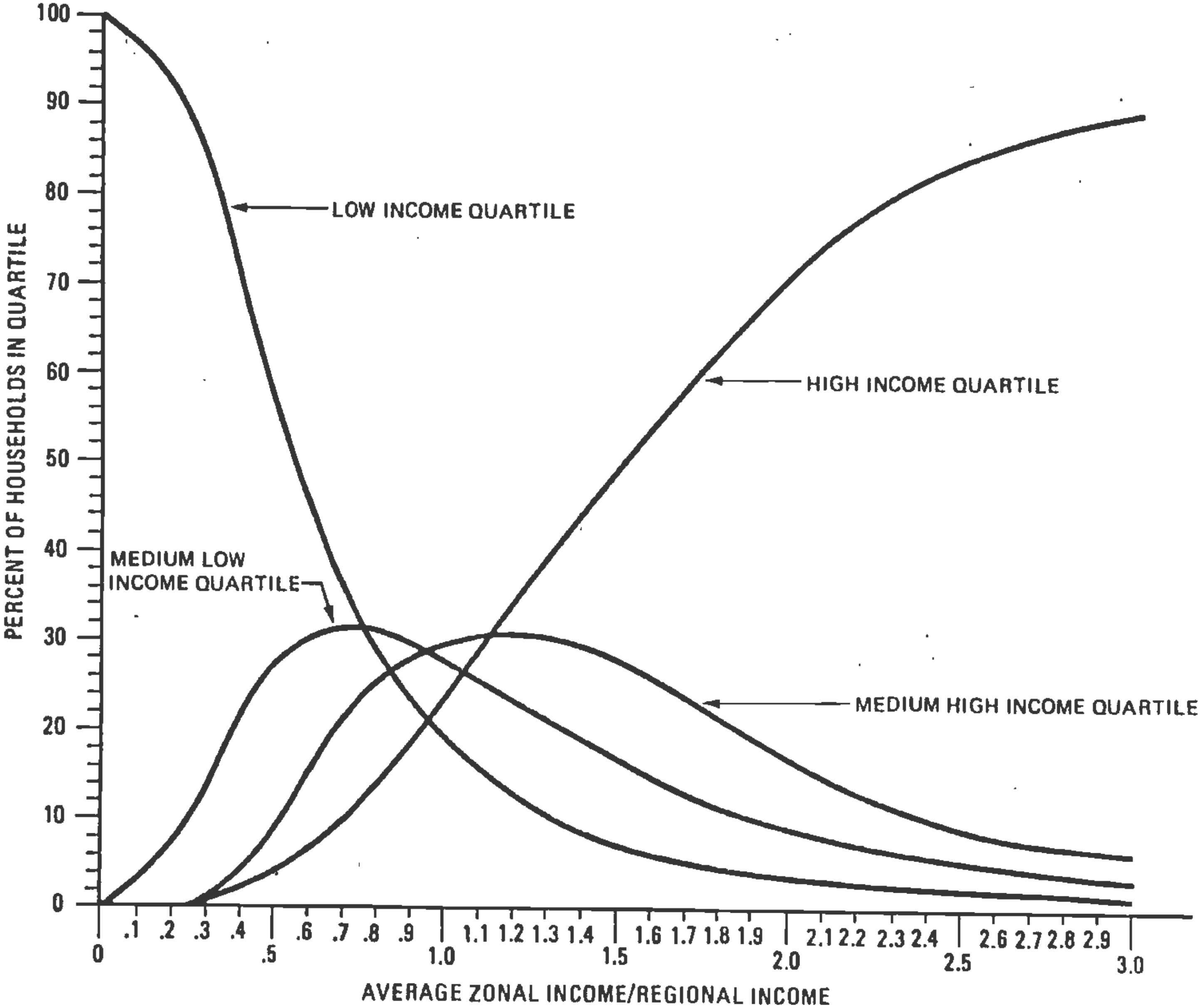


Figure 6-4

RELATIONSHIP OF INCOME QUARTILES TO AVERAGE INCOME

6.7.2 Parameters and Options

Program control is transmitted through the use of a PARAM name list card which follows the title card in the SYSIN (or FT05F001) data set. It is composed of three keywords:

1. ZONES -- the number of zones in the region under study.

2. RMHI -- The regional median income in 1967 dollars. If an RMHI value is not specified, the program will calculate the regional median income from the input data. In this case, the third keyword, INCAL, must be specified as defined below.

3. INCAL -- indicates, when set equal to T (true), that RMHI is to be calculated within the program. In this case, the RMHI keyword should not be specified.

If INCAL is not specified, it defaults to F (false), and a value for RMHI must be given in the PARAM card.

A summary of these keywords and their default values is given in Table 6-7.

6.7.3 Standard Output Files and Reports

Program UHHS produces one output file (unit FT02F001). The program writes one line for each zone, which contains the zone number followed by the number of households in each of the four income quartiles in that zone (from low to high). The format of this file is as follows:

Description	Type	Column(s)
Regional Zone Number	I*4	1-5
Households by Quartile	R*4	6-12, 13-19, 20-26, 27-33

One report is printed, giving the zone number, number of households in the low, low-medium, high-medium and high income quartiles, and the total number of households for each zone. An example of the output is shown below.

Households by Income Quartile

Zone	(1)	(2)	(3)	(4)	Total
1	28.	24.	16.	7.	75.
2	24.	37.	38.	31.	130.
3	17.	32.	43.	48.	140.
4	22.	29.	26.	18.	95.

TABLE 6-7

UHHS PARAM CONTROL CARD KEYWORDS

Keyword	Definition	Default Value
ZONES	Number of Regional Zones	0
RMHI	Regional Median Income (1967 dollars)	-
INCAL	Set equal to T if program is to Oalculate RMHI. Set to F if RMHI is provided in the PARAM card.	F

6.8 MODE-OF-ARRIVAL PROGRAM

6.8.1 Introduction

The mode-of-arrival program accepts data from the Zone/Station Highway Impedance program, the closest station program, Household Income Distribution Program (HIDP), the mode choice model program, the transit skim tree program, and the USTOS program, and estimates the mode of arrival for all stations (nodes) specified by the user. These estimates are used to produce a set of printed reports and trip tables, including a vehicle accumulation report for each Park-n-Ride station, a mode-of-arrival report for four time periods of the day, and a peak-hour trip table for the morning peak. The mode-of-arrival program is written as a subroutine in the UTPS program UMODEL, and the normal UMODEL conventions should be followed in applying the program.

6.8.2 Input Data

The mode-of-access-and-egress program requires thrity-four matrix-type data files and seventeen zone- or station-related items of information. The matrix-type files are normal UTPS trip tables or skim trees and in general consist of:

1. Transit trip tables
2. Transit travel items and fares
3. Highway travel times and distances
4. Matrices identifying access and egress stations

Six transit trip tables are to be input to the program. These trip tables are the transit trip tables produced by the mode choice models. There are four transit work trip tables, each table being a submode set of trips from the mode choice model. (13, Vol. I) That is, there is a separate trip table for a) walk and feeder bus access trips; b) Park-n-Ride, drive alone, trips; c) Park-n-Ride, shared ride trips; and d) Kiss-n-Ride trips. Because of this stratification of transit work trips into submodes by the mode choice model, the program does not apply a mode-of-arrival model to the transit work trips.

Thirteen matrices are required by the program in the specification of transit travel times and fares. These matrices can be stratified into two major groups: (a) those travel times and fares applicable to a transit trip if the trip was made using a feeder bus access and (b) those travel times and fares applicable to a transit trip if the trip was made using a highway access mode. The mode choice model requires two highway access mode transit travel time matrices to be built, Park-n-Ride and Kiss-n-Ride, and it is suggested that the user input the matrix with the greatest number of highway access connections, normally the Kiss-n-Ride matrix. The transit travel time stratifications are as follows:

1. Walk time.
2. Initial (boarding) wait time.
3. Transfer time.
4. In-vehicle transit time.

5. In-vehicle highway access time (highway access submode only).
6. Number of transfers.

The units for these matrices must be whole minutes for transit travel times and whole cents for transit fare matrices.

Three highway travel times and distance matrices are required in the program. Two of these matrices are prepared by the ZONE/STATION HIGHWAY IMPEDANCE PROGRAM (USTATION) previously described. These matrices represent the zone-to-station highway travel time and highway distances. The third matrix is the zone-to-zone highway distance matrix, a data set required by the mode-of-arrival model to estimate submode trips for the nonwork purposes. The user may input these matrices into any units desired (e.g., miles, tenths of miles, etc.), since scaling factors are provided in the user-coded parameters. However, it is recommended that the precision of the station-to-zone distance matrix be at least tenths of miles.

The final set of input matrices are the station access and egress matrices. Under normal circumstances, the user will develop these matrices using the UTPS program USTOS. Twelve access/egress matrices are required by the program. Six of these matrices contain the access and egress stations for only the rail stations in the study area. The reason for this "split" into total stations and rail stations is to allow the program to "follow" a trip if the first access was at a nonrail station and a subsequent access was at a rail station, i.e., if the driver used a satellite parking lot to access the rail station by bus. The user should check the data in these matrices closely, since the program will only apply the mode-of-arrival model and report data on interchanges which have an access and egress station. The user also should be aware that program USTOS will only "find" access and egress stations when a "transfer" occurs; this transfer can be a transit-mode-to-transit-mode transfer, a nontransit-mode-to-transit-mode transfer, or a nontransit-link-to-nontransit-link movement. In the development of several alternative transit systems, the user may wish to skip a station for one of the alternatives. Early versions of the program USTOS would not allow the "skipping" of station numbers, and if there were missing station numbers, the user had to use dummy nodes (i.e., nodes lower than the highest node number, but not actually in the network) to fill in the missing station numbers in the USTOS run. In the current version of USTOS, skipping station numbers is not a problem; the user does not have to worry about using dummy nodes to fill in gaps. A summary of all matrix input data is shown in Table 6-8.

Of the seventeen possible zone- or station-related data items, seven possible items are zone-related and nine items are station-related. The seventeenth item is the zone number, which is a requirement of UMODEL. Two of the zone-related data items are the closest station number and the distance to the closest station, which are generated by the Closest Station program (MNMDIST) and normally will require no intervention from the user. (This program outputs the zone number in columns 1-5, and the user should follow this zone number format for other zone/station input or change the zone number format on this

Table 6-8

DESCRIPTION OF MATRIX INPUT DATA (MOS)

Variable Number (1)	Description of Matrix Input
1	Transit Walk/Feeder Bus Work Trips
2	Transit Park-n-Ride (drive alone) Work Trips
3	Transit Park-n-Ride (shared ride) Work Trips
4	Transit Kiss-n-Ride Work Trips
5	Transit Home-Based Non-Work Trips
6	Transit Non-Home Based Trips
13	Transit Walk Time: By Feeder Bus Access
14	Transit Boarding Time: Bus Feeder Bus Access
15	Transit Transfer Time: By Feeder Bus Access
16	Transit In-Vehicle Time: By Feeder Bus Access
17	Number of Transfers: By Feeder Bus Access
19	Transit Fare: By Feeder Bus Access
20	Transit Walk Time: By Highway Access (2)
21	Transit Boarding Time: By Highway Access
22	Transit Transfer Time: By Highway Access
23	Transit In-Vehicle Time: By Highway Access
24	Number of Transfers: By Highway Access
25	In-Vehicle Highway Access Time: By Highway Access (3)
26	Transit Fare: By Highway Access
27	Access Station for Feeder Bus Access (all stations)
28	Egress Station for Feeder Bus Access (all stations)
29	Access Station for Highway Access (all stations)
30	Egress Station for Highway Access (all stations)
31	Highway Travel Time (zone-to-station)
32	Highway Travel Time (zone-to-station)
48	Access Station for Feeder Bus Access (rail station only)
49	Egress Station for Feeder Bus Access (rail station only)
50	Access Station for Highway Access (rail station only)
51	Egress Station for Highway Access (rail station only)
52	Highway Distance (zone-to-zone)
53	Access Station for Midday Feeder Bus Access (all stations)
54	Egress Station for Midday Feeder Bus Access (all stations)
55	Access Station for Midday Feeder Bus Access (rail station)
56	Egress station for Midday Feeder Bus Access (rail station only)

(1) Variable number refers to the Data Item Number on the UMODEL Data Identification Cards.

(2) Suggested highway access travel times are from the Kiss-n-Ride Transit Network, in order to obtain all possible highway access movements.

(3) Used only as a check that the movement is connected via a highway access link.

file. See the UMODEL Users Guide for a discussion on zone-level data input.) The origin zone highway terminal time is the out-of-vehicle time required at the non-station end of the trip. This time should be coded in minutes, and it is suggested that the highway terminal time from the mode choice model is an acceptable value. (Decimal points are allowable in zonal data. For example, a terminal time of two and one-half minutes could be coded 2.5.)

The last four zonal data items are the number of households by income quartile. This data is generated by program UHHS and should not require any intervention by the user. The program will use these households by income quartile to "split" the input home-based nonwork trips into the four income levels required by the mode-of-arrival models. The technique used to perform this split is as follows:

TRIPS (I,O.D) = TRIPS (O,D)* (HH(O,I)/SUM OF HH (O,I))

Where:

TRIPS (I,O,D) are transit trips for income level I from zone O to zone D

TRIPS (O,D) are input transit trips from zone O to zone D

HH (O,I) are the households for income level I for zone O
If for some reason the user does not input this household data for a zone, the program will "split" the transit trips equally among the four income quartiles. A summary of the zone-related data items is shown in Table 6-9.

There are nine station-related data items. Because of the structure of the UTPS program UMODEL, these data items can be input as "zonal" data by coding the station number in place of the zone number. In coding the Data Identification cards for application of the program,the zone/station number must still be identified with the phrase "ZONE NUMBER" (beginning in column 37) in order for the program to function correctly. In general, the station data consists of:

1. Parking Capacity
2. Parking Cost
3. Station Terminal Time
4. Type of Station

The station type data element consists of four codes (1, 2, 3, and 4) which specify how a station may be accessed. The definition of these codes follows Table 6-9.

TABLE 6-9

DESCRIPTION OF ZONE-RELATED DATA (MOA)

Variable Number	Z Array Number	Description
7	16	Number of Households in Lowest-Income Quartile (1)
8	17	Number of Households in Low-Medium Income Quartile (1)
9	18	Number of Households in High-Medium Income Quartile (1)
10	19	Number of Households in High-Income Quartile (1)
33	1	Zone Number (2)
34	2	Highway Terminal Time, at the Origin Zone
35	3	Closest Station Number (3)
36	4	Distance to Closest Station (3)

(1) Data produced by program UHHS.

(2) The user must inform UMODEL where the zone number is on one file of the A files. The location must be used for the zone number on all A files, in order for the program to properly store the data. See the "UMODEL Users Guide" for a detailed discussion on zone-level input data.

(3) Data produced by program MNMDIST.

Station Type Code	Definition
1	A station where no highway access of any type is anticipated, such as a station in the Central Business District.
2	A station where the only highway access anticipated is the drop-off mode (i.e., Kiss-n-Ride).
3	A station where the access is walk or bus, but potential Kiss-n-Ride trips would go to another Type 2 station.
4	A station where all types of highway access are anticipated and which has some parking facilities.

The definitions for Station Types 1 and 2 are fairly straightforward. Station Type 4 is the typical station with parking at or near the station. It is anticipated that the Type 3 station specification will seldom be used, and is included for Kiss-n-Ride areas where the normal walk and bus transfer would occur at one station, with no parking (the Type 3 station), while the Kiss-n-Ride movement would occur at another station (the Type 2 station). This mechanism will allow the walk and bus access trips to be assigned to the Type 3 station, while the highway access is assigned to the Type 2 station.

Two types of parking capacity may be input -- a long-term parking capacity and a short-term parking capacity. The long-term capacity is the parking available to all users and should include any long-term parking facilities near the station in addition to the long-term spaces planned for the station complex. Some rail stations (such as the Silver Spring station in Washington, D.C.) have no spaces in the station complex, but substantial parking within one or two blocks of the station. The short-term spaces are defined as those spaces reserved for short time periods (i.e., two to three hours). In addition, the program assumes that these spaces will be used for the drop-off (Kiss-n-Ride) vehicles in the peak periods, and, therefore, during these periods the short-term parkers will be "shunted" to the long-term spaces. The coding of parking capacities is very important, since the program will ascertain when the spaces are filled and divert Park-n-Ride trips to feeder bus, Kiss-n-Ride mode, or remove them from the transit mode. When short-term parkers (i.e., non-work and non-home based trips) are estimated, the program will attempt to let them use the short-term spaces; if these spaces are filled, the program will divert the automobiles to the long-term spaces until these too are filled. Therefore, it is possible to specify no short-term spaces without losing any transit trips unless there are not enough long-term spaces. Parking capacity need only be coded for Type 4 stations.

As with parking capacity, the program will accept two parking costs -- one for long-term parkers (i.e., work trips) and one for short-term parkers (i.e., nonwork trips). The parking costs specified should be in cents (i.e., a dollar charge should be coded 100.0) and should be the average or normal cost for long- and short-term parking. The use of these costs is predicated on trip purpose (i.e., work is long-term and nonwork is short-term) and not the type of parking capacity space the program allocates to the trip. Therefore, it is possible to have only long-term parking capacity and a short-term parking cost (e.g., a lot with an attendant and hourly parking charges).

The final station information required is four data items specifying the station terminal time required for the two highway modes (Park-n-Ride and Kiss-n-Ride) for short and long term. As with the parking costs, the allocation of the long-term and short-term data is predicated on trip purpose. The definition of station terminal time is the time it would take once the automobile leaves the normal highway system. For Park-n-Ride trips, this would include (1) the time from the highway system to the parking lot, (2) the time spent in the lot looking for a space and parking the vehicle, and (3) the time spent walking from the vehicle to the station entrance. It is anticipated that this time probably will be a function of the size of the parking facility, but the location and design of the facility might also influence this time. For Kiss-n-Ride trips, the station terminal time would include the time from the highway system to the drop-off facility and the walking time from the drop-off facility to the station entrance. It is anticipated that this time will be primarily a function of the station design. The anticipated difference between long-term and short-term time is the degree of congestion with long-term time being attributed to peak period congestion and short-term to off-peak period. Since the program does <u>not</u> "split" work trips into the various submodes, but instead accepts the trips from the modal choice model, the only purpose of the long-term parking costs and terminal times is to provide a complete reporting of physical station characteristics.

A station type <u>must</u> be coded for all stations in the analysis. Stations not given a type will be assumed to be a Type 1 station by the program. The other station data need only be coded for Type 2 and 4 stations. A summary of station-related data items is contained in Table 6-10.

This completes the description of the input data required by the mode-of-arrival program. The matrix data must be UTPS matrices, while the zone/station data may be input in any card image format, subject to the normal UMODEL constraints.

Specifications of data location and format are performed by providing the program with the normal Data Identification Cards for program UMODEL. Examples of these cards can be found in the Example Setup section of this chapter.

6.8.3 Parameters and Options

The user has the option of specifying up to 62 parameters which control the program. All of these parameters have default values coded in the program, and under normal conditions the user will probably only have to code three or four of these parameters. However, this section will describe each of the parameters. The

TABLE 6-10

DESCRIPTION OF STATION-RELATED DATA (MOA)

Variable Number	Z Array Number	Description
37	5	Long Term Parking Capacity (spaces)
38	6	Long Term Parking Costs (cents)
39	7	Long Term Parking Terminal Time for Park-n-Ride Trips (minutes)
40	8	Long Term Parking Terminal Time for Kiss-n-Ride Trips (minutes)
41	9	Short Term Parking Capacity (spaces)
42	10	Short Term Parking Costs (cents)
43	11	Short Term Parking Terminal Time for Park-n-Ride Trips (minutes)
44	12	Short Term Parking Terminal Time for Kiss-n-Ride Trips (minutes)
45	13	Type of Station (1 = CBD, 2 = Kiss-n-Ride, 3 = Potential Kiss-n-Ride Station, 4 = Park-n-Ride Station)

program parameters are specified using the UMODEL name list variable "UPARMS(x)," where x is the parameter number; and the user may change the default value by coding on the &PARAM card the value of UPARMS(x). For example, if the user wished to make the value for parameter 24 (average car occupancy for non-work trips) equal to 1.50, the user would code:

&PARAM UPARMS (24) = 1.5 &END

A summary of the user-coded parameters is shown in Table 6-11.

The first eighteen parameters specify the diurnal distribution of transit trips. These specifications are necessary in order to produce the mode-of-arrival reports and trip tables. The standard set of trip estimates in matrix form (i.e., trip tables) is usually ordered in production-attraction format. That is, no matter what the actual direction of the trip, the estimated trip is always shown as beginning at the home end of the trip (the production) and ending at the non-home end of the trip (the attraction). In order to work with the normal transportation planning trip estimates, it was necessary to define the diurnal distribution in a unique manner. In this definition, trips were defined as "arriving" in a certain period and "leaving" in a certain period, with "arriving" signifying that the trip direction was from the traveler's home to the station while "leaving" signifies that the trip direction is from the station to the traveler's home. For example, the default values used by the program for morning peak-period transit work trips are that 39.1 percent of all transit work trips arrive in the A.M. peak hour (home to station), while only 0.9 percent of the transit work trips leave in the same time (station to home). In the P.M. peak period the reverse is true, with 30.4 percent leaving and 1.6 percent arriving. If the user wishes to change the diurnal distribution, he should be very careful to insure that the sum of the arriving proportions and leaving proportions each add to 0.50, by purpose. If this is not done, the program may "lose" trips or have unbalanced trip movements, i.e., more trips leaving the traveler's home than arriving or vice versa. The program does not check the sum of the arriving and leaving proportion. The default values for the diurnal distributions were developed using survey data from Los Angeles and should represent a fairly standard travel pattern. Adjustments to these default values are <u>not</u> recommended unless the user has sufficient origin-destination survey data and has analyzed this data in detail. The diurnal definitions used in developing the proportions are as follows:

A.M. Peak Period:	from 6 AM to 9 AM
Mid-day period:	from 9 AM to 3 PM
PM Peak Period	from 3 PM to 6 PM
Evening Period:	After 6 PM

Parameters 17 and 18 specify the proportion of the A.M. peak-period travel which occurs in <u>the</u> peak hour. The value in current use is 0.530 for work trips, and for nonwork trips the proportion is 0.293. Parameters 31 and 32 specify the proportion of the PM peak-period travel which occurs in <u>the</u> peak hour. For work trips the default

TABLE 6-11

DEFINITION OF USER-SPECIFIED PARAMETERS FOR THE MODE-OF-ARRIVAL PROGRAM

UPARMS Number	Definition	Defalt Value
1	Proportion of Transit Work Trips Arriving in the AM Peak Period	0.391
2	Proportion of Transit Work Trips Arriving in the Mid-Day Period	0.068
3	Proportion of Transit Work Trips Arriving in the PM Peak Period	0.016
4	Proportion of Transit Work Trips Arriving in the Evening Period	0.025
5	Proportion of Transit Work Trips Leaving in the AM Peak Period	0.009
6	Proportion of Transit Work Trips Leaving in the Mid-Day Period	0.099
7	Proportion of Transit Work Trips Leaving in the PM Peak Period	0.304
8	Proportion of Transit Work Trips Leaving in the Evening Period	0.088
9	Proportion of Transit Non-Work Trips Arriving in the AM Peak Period	0.125
10	Proportion of Transit Non-Work Trips Arriving in the Mid-Day Period	0.243
11	Proportion of Transit Non-Work Trips Arriving in the PM Peak Period	0.087
12	Proportion of Transit Non-Work Trips Arriving in the Evening Period	0.045
13	Proportion of Transit Non-Work Trips Leaving in the AM Peak Period	0.025
14	Proportion of Transit Non-Work Trips Leaving in the Mid-Day Period	0.257

(CONTINUED)

TABLE 6-11 (CONTINUED:2)

DEFINITION OF USER-SPECIFIED PARAMETERS FOR THE MODE-OF-ARRIVAL PROGRAM

UPARMS Number	Definition	Default Value (3)
15	Proportion of Transit Non-Work Trips Leaving in the PM Peak Period	0.163
16	Proportion of Transit Non-Work Trips Leaving in the Evening Peak Period	0.055
17	Proportion of AM Peak-Period Transit Work Trips Which Occur in the Peak Hour	0.490 (0.530)
18	Proportion of AM Peak-Period Transit Non-Work Trips Which Occur in the Peak Hour	0.250 (0.293)
19	Average Parking Duration of Transit Work Trips (1)	9.0
20	Average Parking Duration for Transit Non-Work Trips (1)	3.0
21	Report Hourly Accumulation by Station (0.0=NO, 1.0=YES)	1.0
22	Maximum Station Number for Run	200.0
23	Maximum Number of Zonal Interchange with an Access Station and No Egress Station or Vice Versa	100,000.0
24	Average Car Occupancy for Park-n-Ride Non-Work Trips	1.1
25	Scale Factor for Highway Distances from Program USTATION (2)	0.01 (0.1)

(1) Program will be rounded to nearest whole hour.
(2) The scaling factors will be multiplied by the input data. The results should be miles (or minutes). For example, if program USTATION is producing distances in tenths of miles, the scaling factor should be 0.1 (i.e., UPARMS(25)=0.1).
(3) Value in current use shown in ( ) where different than default value.

(CONTINUED)

TABLE 6-11 (CONTINUED:3)

DEFINITION OF USER-SPECIFIED PARAMETERS FOR
THE MODE-OF-ARRIVAL PROGRAM

UPARMS Number	Definition	Default Value
26	Scale Factor for Highway Travel Times from Program USTATION (2)	1.0
27	The Cost of Operating an Automobile Per Mile (cents)	10.5
28	Scale Factor for Zone-to-Zone Highway Distances	0.01
29	Report AM Peak-Hour Trip-End Summaries (0=NO, 1=YES)	1.0
31	Proportion of PM Peak-Period Transit Work Trips Which Occur in the Peak Hour	0.450
32	Proportion of PM Peak-Period Transit Non-Work Trips Which Occur in the Peak Hour	0.300
33	Build Peak-Hour Vehicle Tables (0.0=NO; 1.0=AM Peak Hour; 2.0=PM Peak Hour	0.0 (1.0)
34	Percent of Average Peak-Hour Work Trips in Peak Period	0.333
35	Percent of Average Peak-Hour Non-Work Trips in Peak Period	0.333
36	To Output Average Peak-Hour Transit Trips in Output Table 1 Through 6, Rather Than Peak-Hour Trips (0.0 = NO; 1.0 = YES)	0.0 (1.0)
37	Highest Rail Station Number	50.0
Parameters 38 Through 39 Are Not Used; Parameters 40 Through 51 are Coefficients for the Park-n-Ride/Kiss-n-Ride Model; Parameters 52 Through 61 are Coefficients for the Highway/Transit Model. These Coefficients Are Used Only for Non-Work Trips.		
40	First Quartile Income Coefficient (PNR/KNR Model)	0.55866
41	Second Quartile Income Coefficient (PNR/KNR Model)	0.330579

(CONTINUED)

TABLE 6-11 (CONTINUED:4)

DEFINITION OF USER-SPECIFIED PARAMETERS FOR
THE MODE-OF-ARRIVAL PROGRAM

UPARMS Number	Definition	Default Value
42	Third Quartile Income Coefficient (PNR/KNR Model)	0.330579
43	Fourth Quartile Income Coefficient (PNR/KNR Model)	0.18939
44	The Percent of Single-Automobile Households for First Quartile Income Households	0.947
45	The Percent of Single-Automobile Households for Second Quartile Income Households	0.800
46	The Percent of Single-Automobile Households for Third Quartile Income Households	0.800
47	The Percent of Single-Automobile Households for Fourth Quartile Income Households	0.626
48	Single-Car Bias Coefficient (PNR/KNR Model)	-0.05001
49	Single-Car Off-Set Coefficient (PNR/KNR Model)	10.03
50	Multiple-Car Bias Coefficient (PNR/KNR Model)	-0.032929
51	Multiple-Car Off-Set Coefficient (PNR/KNR Model)	35.01
52	Coefficient on In-Vehicle Transit Time Difference (HWY/TRN Model)	-0.0417
53	Coefficient on Out-of-Vehicle Time Difference (HWY/TRN Model)	-0.10425
54	Coefficient on Number of Transfers Difference (HWY/TRN Model)	-0.7249
55	Coefficient of Zone-to-Zone Highway Difference (HWY/TRN Model)	-0.084
56	Coefficient on Travel Cost Difference (HWY/TRN Model)	-0.024611
57	Coefficient on In-Vehicle Highway Access Time (HWY/TRN Model)	-0.164073

(CONTINUED)

TABLE 6-11 (CONTINUED:5)

DEFINITION OF USER-SPECIFIED PARAMETERS FOR
THE MODE-OF-ARRIVAL PROGRAM

UPARMS Number	Definition	Default Value
58	Bias Coefficient for First Income Quartile (HWY/TRN Model)	2.94297
59	Bias Coefficient for Second Income Quartile (HWY/TRN Model)	2.58120
60	Bias Coefficient for Third Income Quartile (HWY/TRN Model)	2.58120
61	Bias Coefficient for Fourth Income Quartile (HWY/TRN Model)	1.12427
62	Car Occupancy for Work Trip Park-n-Ride, Shared Ride Submode	2.0

proportion is 0.450 and for nonwork trips the default proportion is 0.300.

Parameters 19, 20, and 21 specify information for the parking accumulation reports (REPORT 10 and 11). The user can request the report using the twenty-first parameter. The average parking duration for work and nonwork trips is specified by parameters 19 and 20. This average duration only affects the results of Report 11. For this reason, the vehicles shown on REPORT 10 and 11 may disagree with the mode-of-arrival summary reports, although if the default values are used, this disagreement is very minor.

Parameters 22 through 29 specify various constraints, options, and scaling factors associated with the input data or output reports and the definitions on Table 6-11 are fairly straightforward. The program will stop if the number of interchanges with an access but not egress station exceeds the specified number, and the user may wish to make this a fairly large number if the input data is felt to be "clean." Parameter 33 allows the user to request peak-hour "vehicle" trip tables. These trip tables are developed from the Park-n-Ride and Kiss-n-Ride estimates, and may prove useful for highway assignments, given some additional computer processing of the trip tables and highway network.

Parameters 34, 35, and 36 allow the user to modify the peak-hour output transit trip tables. Normally, these trip tables are developed by applying the peak-period and peak-hour (A.M.) factors to the daily estimates, thereby producing the A.M. peak-hour trip table. The user may be assigning these trips to a non-peak hour transit network; for example, the network might have average two- or three-hour peak period headways. In this case, a more appropriate trip table would be one with a two- or three-hour average, rather than the one-hour peak. Parameters 34 and 35 allow the user to make this adjustment, the default values being for an average peak-period hour; while parameter 36 specifies if parameters 34 and 35 are to be used, the default is to use the parameters. These parameters (34, 35, and 36) affect only the output trip tables, not the printed reports.

Parameter 37 specifies the highest rail station number. This value should correspond to the highest station number on the rail station access-and-egress matrices. The program does not make a logical comparison check between this parameter and the rail station numbers on the input matrices.

Parameters 40 through 61 contain the coefficients for the mode-of-arrival models used to "split" non-work transit trips to the various submodes.

Parameter 62 is the average automobile occupancy for the transit work Park-n-Ride shared ride submode.

Only one other parameter, besides the user-coded parameters, is required for the program. This is the ZONES parameter needed for most UTPS programs. The program will set all other necessary UMODEL parameters.

6.8.4 Standard Output Files and Reports

The mode-of-access-and-egress program will generate up to thirteen trip tables. These trip tables will all be contained on one UTPS file (the J9 file), and the definition and order of these tables is shown on Table 6-12. The program will always produce nine transit trip tables. Five of these trip tables are for the A.M. peak hour (or the average peak hour). In order to use these A.M. peak-hour trip tables for assignment purposes, it is necessary for the user to combine the home to non-home and the non-home to home trip tables. Because of computer storage limitations, it was necessary to output the non-home to home trips (Tables 4 and 5) with the trips specified in the wrong direction. Therefore, in order to obtain a trip-table assignment, it is necessary to use the UTPS program UMATRIX to transpose Tables 4 and 5 and then add them to Table 1. The walk-to-transit trips are included with the feeder bus trips, since the feeder bus network has the most normal connections for typical walk trips. The daily trip tables have the same format as the trip tables from the mode choice model and can be used to make daily assignments.

In addition to the nine trip tables which are always produced, the program can generate four additional optional trip tables. These trip tables represent vehicle trips for an A.M. or P.M. peak hour and may be useful if the user wishes to assign these trips to a highway network. In order to build these trip tables, the user must set a Table 8 parameter equal to 1.0 (for A.M. trips) or 2.0 (for P.M. trips). When calculating the Kiss-n-Ride vehicle trip tables, the assumption is made that a trip from home to non-home will have a corresponding trip from non-home to home and vice versa. This is not always true, though, since the Kiss-n-Ride vehicle obviously does not stop at the station, and the only logical place to return the vehicle (given the programming constraints) is to the home area. Based on the above assumption, however, Tables 12 and 13 will always be exactly the same. Park-n-Ride vehicles were separated from Kiss-n-Ride vehicles, since it is possible to have station designs with different exit and entrance points for these vehicles. Since the vehicle trip tables show the ultimate origin and destination zones, these tables are not extremely useful unless they are used in conjunction with program VASSIGN (described in section 6.9 which follows) to produce trip tables which are configured in zone-to-station format.

The program can produce nine printed reports, of which three are optional. The first optional set of reports are the station accumulation reports (Report 10 and 11). If requested, the program will produce a report for each Park-n-Ride station, showing the parking accumulation for each hour of the day, the number of vehicles entering and leaving the parking lot, and the stratification of accumulation between long- and-short-term parking. When short-term parking is not available, the program will allocate these vehicles to the long-term spaces, if any are available. The program will not allow the short-term spaces to be used in the peak periods, since the assumption is that these spaces will be available for Kiss-n-Ride vehicles. Report 10 is the unconstrained accumulation report, and Report 11 is the constrained accumulation report. By comparing these

TABLE 6-12

TRIP TABLES PRODUCED BY MODE-OF-ARRIVAL PROGRAM

Output Table Number	Definition
1	AM Peak Hour (1) Walk and Feeder Bus Trips from Home to Non-Home
2	AM Peak Hour Park-n-Ride Trips From Home to Non-Home
3	AM Peak Hour Kiss-n-Ride Trips From Home to Non-Home
4	AM Peak Hour Feeder Bus Trips from Non-Home to Home (2)
5	AM Peak Hour Walk Trips From Non-Home to Home
6	Daily Home-Based Non-Work Walk and Feeder Bus Trips in Production/Attraction Format (Home to Non-Home)
7	Daily Home-Based Work Walk and Feeder Bus Trips in Production/Attraction Format (Home to Non-Home)
8	Daily Park-n-Ride Transit Trips in Production/Attraction Format (Home to Non-Home)
9	Daily Kiss-n-Ride trips in Production/Attraction Format (Home to Non-Home)
OPTIONAL TABLE TRIPS (3)	
10	Peak Hour (AM or PM) Park-n-Ride Vehicle Trips From Home to Non-Home
11	Peak Hour (AM or PM) Park-n-Ride Vehicle Trips From Non-Home to Home (2)
12	Peak Hour (AM or PM) Kiss-n-Ride Vehicle Trips From Home to Non-Home
13	Peak Hour (AM or PM) Kiss-n-Ride Vehicle Trips From Non-Home to Home (2)

(1) Average peak period hour if parameter 36 is set to 1.0.
(2) Because of limitation on the UTPS program, UMODEL, and computer storage limitations, these trips are produced moving in the wrong direction. The necessary past-processing is discussed in the text of this chapter.
(3) These tables will be built if parameter 33 is set of 1.0 (AM Peak Hour) or 2.0 (PM Peak Hour).

two reports, the analyst can ascertain the proportion of the Park-n-Ride demand which is shifted to other submodes or lost to transit; it is also possible to ascertain the time periods for which the demand exceeds the supply. This comparison information may prove to be valuable to the station designers. An example of the two accumulation reports is shown in Tables 6-13 and 6-14.

The other set of optional reports is a series of trip-end summaries showing the peak-hour transit trips which access and egress the stations. These summaries are in standard production/attraction format, showing the home to nonhome trips, and it is anticipated that these reports will be used primarily to assist the user in investigating any illogical results of the specific run. The first set of trip-end summaries contains four classes of trips, which are:

Column Number	UMODEL Heading *	Definition
1	Table (1)	Walk trips
2	Table (2)	Feeder bus trips
3	Table (3)	Highway-related trips
4	Person Trips	Total transit trips

The second set of trip-ends also summarizes four classes of trips, which are:

Column Number	UMODEL Heading	Definition
1	Table (1)	Kiss-n-Ride trips
2	Table (2)	Park-n-Ride vehicle trips
3	Table (3)	Park-n-Ride Passenger trips (not including the driver)
4	Person Trips	All highway-related trips

The first nonoptional report is the summary of Station Parking Attributes report (Report 12). This report repeats the data input by the user for each station. The number of lost trips for each station also is shown. The definition of lost trips is the number of Park-n-Ride trips in excess of the station capacity and which the program did not allocate to feeder buses or to the Kiss-n-Ride mode. Table 6-15 shows an example of the Station Parking Attributes report.

The mode-of-arrival-and-egress reports represent the second nonoptional reports, Reports 14, 15, 16, and 17. These show the mode of arrival and departure for each station, for each period of the day, and for constrained and unconstrained demand. The constrained reports (Reports 15 and 17) also show the number of lost trips by station. The program identifies the lost trips for both the access and egress station, and, therefore, lost trips can appear at non Park-n-Ride

* The UTPS program UMODEL has fixed headings for these columns which cannot be modified.

TABLE 6-13

UNCONSTRAINED STATION ACCUMULATION REPORT

MODE OF ARRIVAL -- ALT. FAROOLP5 -- USING MAR. 1983 VERSION

4MAR83 16.58.41 UMODEL REPORT 10 PAGE 7

UNCONSTRAINED STATION ACCUMULATION

STATION NUMBER: 1

TIME PERIOD		LONG-TERM PARKING			SHORT-TERM PARKING			TOTAL PARKING		
FROM	TO	IN	OUT	ACCUM	IN	OUT	ACCUM	IN	OUT	ACCUM
6	7	2047.	0.	2047.	0.	0.	0.	2047.	0.	2047.
7	8	2047.	0.	4093.	0.	0.	0.	2047.	0.	4093.
8	9	2047.	0.	6140.	0.	0.	0.	2047.	0.	6140.
9	10	305.	201.	6244.	0.	0.	0.	305.	201.	6244.
10	11	305.	201.	6348.	0.	0.	0.	305.	201.	6348.
11	12	305.	201.	6452.	0.	0.	0.	305.	201.	6452.
12	13	305.	167.	6589.	0.	0.	0.	305.	167.	6589.
13	14	305.	167.	6727.	0.	0.	0.	305.	167.	6727.
14	15	305.	167.	6864.	0.	0.	0.	305.	167.	6864.
15	16	305.	2013.	5156.	0.	0.	0.	305.	2013.	5156.
16	17	215.	2013.	3358.	0.	0.	0.	215.	2013.	3358.
17	18	215.	2013.	1561.	0.	0.	0.	215.	2013.	1561.
18	19	215.	305.	1471.	0.	0.	0.	215.	305.	1471.
19	20	143.	277.	1337.	0.	0.	0.	143.	277.	1337.
20	21	143.	277.	1202.	0.	0.	0.	143.	277.	1202.
21	22	143.	277.	1067.	0.	0.	0.	143.	277.	1067.
22	23	143.	192.	1018.	0.	0.	0.	143.	192.	1018.
23	24	0.	192.	827.	0.	0.	0.	0.	192.	827.
24	1	0.	192.	635.	0.	0.	0.	0.	192.	635.
1	2	0.	130.	505.	0.	0.	0.	0.	130.	505.
2	3	0.	76.	429.	0.	0.	0.	0.	76.	429.
3	4	0.	76.	354.	0.	0.	0.	0.	76.	354.
4	5	0.	88.	265.	0.	0.	0.	0.	88.	265.
5	6	0.	88.	177.	0.	0.	0.	0.	88.	177.
6	7	0.	88.	88.	0.	0.	0.	0.	88.	88.

TABLE 6-14

CONSTRAINED STATION ACCUMULATION REPORT

MODE OF ARRIVAL -- ALT. FAROOLP5 -- USING MAR. 1983 VERSION

4MAR83 16.58.41 UMODEL REPORT 11 PAGE 8

CONSTRAINED STATION ACCUMULATION

STATION NUMBER: 1

TIME PERIOD		LONG-TERM PARKING			SHORT-TERM PARKING			TOTAL PARKING		
FROM	TO	IN	OUT	ACCUM	IN	OUT	ACCUM	IN	OUT	ACCUM
6	7	2047.	0.	2047.	0.	0.	0.	2047.	0.	2047.
7	8	453.	0.	2500.	0.	0.	0.	453.	0.	2500.
8	9	0.	0.	2500.	0.	0.	0.	0.	0	2500.
9	10	201.	201.	2500.	0.	0.	0.	201.	201.	2500.
10	11	0.	0.	2500.	0.	0.	0.	0.	0.	2500.
11	12	0.	0.	2500.	0.	0.	0.	0.	0.	2500.
12	13	110.	110.	2500.	0.	0.	0.	110.	110.	2500.
13	14	0.	0.	2500.	0.	0.	0.	0.	0.	2500.
14	15	0	0.	2500.	0.	0.	0.	0.	0.	2500.
15	16	305.	1906.	899.	0.	0.	0.	305.	1906.	899.
16	17	215.	453.	661.	0.	0.	0.	215.	453.	661.
17	18	215	0.	876.	0.	0.	0.	215.	0.	876.
18	19	215	258.	833.	0.	0.	0.	215.	258.	833.
19	20	143.	140.	836.	0.	0.	0.	143.	140.	836.
20	21	143.	140.	839.	0.	0.	0.	143.	140.	839.
21	22	143.	190.	792.	0.	0.	0.	143.	190.	792.
22	23	143.	54.	881.	0.	0.	0.	143.	54.	881.
23	24	0.	54.	827.	0.	0.	0.	0.	54.	827.
24	1	0.	192.	635.	0.	0.	0.	0.	192.	635.
1	2	0.	130.	505.	0.	0.	0.	0.	130.	505.
2	3	0.	76.	429.	0.	0.	0.	0.	76.	429.
3	4	0.	76.	354.	0.	0.	0.	0.	76.	354.
4	5	0.	88.	265.	0.	0.	0.	0.	88.	265.
5	6	0.	88.	177.	0.	0.	0.	0.	88.	177.
6	7	0.	88.	88.	0.	0.	0.	0.	88.	88.

TABLE 6-15

SUMMARY OF STATION PARKING ATTRIBUTES

MODE OF ARRIVAL -- ALT. FAROOLP5 -- USING MAR. 1983 VERSION

4MAR83 16.58.41 UMODEL REPORT 12 PAGE 47

SUMMARY OF STATION PARKING ATTRIBUTES

		LONG-TERM DATA				SHORT-TERM DATA				
STATION	TYPE	PARK	TERM TIME		CAPACITY	PARK	TERM TIME		CAPACITY	LOST
NUMBER		COST	K/R	P/R		COST	K/R	P/R		TRIPS
1	4	0.	1.0	1.0	2500.	0.	0.0	0.0	0.	4196.
2	1	0.	1.0	1.0	0.	0.	0.0	0.0	0.	1147.
3	1	0.	1.0	1.0	0.	0.	0.0	0.0	0.	2453.
4	1	0.	1.0	1.0	0.	0.	0.0	0.0	0.	957.
5	2	0.	1.0	1.0	0.	0.	0.0	0.0	0	266.
6	2	0.	1.0	1.0	0.	0.	0.0	0.0	0.	374.
7	2	0.	1.0	1.0	0.	0.	0.0	0.0	0.	183.
8	2	0.	1.0	1.0	0.	0.	0.0	0.0	0.	279.
9	2	0.	1.0	1.0	0.	0.	0.0	0.0	0.	193.
10	2	0.	1.0	1.0	0.	0.	0.0	0.0	0.	213.
11	4	0.	1.0	1.0	1000.	0.	0.0	0.0	0	2138.
12	4	0.	2.0	4.0	1000.	0.	0.0	0.0	0.	618.
13	2	0.	1.0	1.0	0.	0.	0.0	0.0	0.	607.
14	2	0.	1.0	1.0	0.	0.	0.0	0.0	0.	387.
15	1	0.	1.0	1.0	0.	0.	0.0	0.0	0.	0.
16	4	0.	2.0	4.0	2450.	0.	0.0	0.0	0.	2778.
17	4	0.	2.0	4.0	2200.	0.	0.0	0.0	0.	806.
18	1	0.	0.0	0.0	0.	0.	0.0	0.0	0.	0.
19	2	0.	1.0	1.0	0.	0.	0.0	0.0	0.	230.
20	1	0.	0.0	0.0	0.	0.	0.0	0.0	0.	0.
21	1	0.	0.0	0.0	0.	0.	0.0	0.0	0.	0.
22	1	0.	0.0	0.0	0.	0.	0.0	0.0	0.	0.
23	1	0.	0.0	0.0	0.	0.	0.0	0.0	0.	0.
24	1	0.	0.0	0.0	0.	0.	0.0	0.0	0.	0.
25	1	0.	0.0	0.0	0.	0.	0.0	0.0	0.	0.
26	1	0.	0.0	0.0	0.	0.	0.0	0.0	0.	0.
27	1	0.	0.0	0.0	0.	0.	0.0	0.0	0.	0.
28	1	0.	0.0	0.0	0.	0.	0.0	0.0	0.	0.
29	1	0	0.0	0.0	0.	0.	0.0	0.0	0.	0.
30	1	0.	0.0	0.0	0.	0.	0.0	0.0	0.	0.

stations. The program does conserve trips on a daily basis; that is, unconstrained demand does equal constrained demand plus lost trips. For the separate periods during the day, this conservation may be slightly incorrect, since the Park-n-Ride trips shifted to feeder bus and Kiss-n-Ride trips are not calculated or stored by time period. Examples of the Mode of Arrival report are shown in Table 6-16 to 6-19. The report distinguishes between trips which access a rail station and use the rail mode and trips which access a rail station and do not use the rail mode. For the former trips, the arrivals are shown with the normal station number (i.e., between 1 and 200), while for the latter the arrival trips are shown with the station number, which is 200 higher than the rail station number (i.e., 201 to 400).

The final report is a list of peak-hour trips which transfer at a station but which do not appear on the mode-of-arrival station reports. The primary reason for these trips not appearing on the mode of arrival report is that they had an access station but no egress station, or vice versa; for example, a transit trip which transferred at a rail station from a feeder bus to a feeder bus. The primary reason for this report is to allow the analyst to ascertain which of the trips from a peak hour assignment are really not station related. An example of the report is shown in Table 6-20.

6.9 BUILD VEHICLE ASSIGNMENT TRIP TABLE PROGRAM

The UTPS-compatible program (VASSIGN) reads uncompressed UTPS trip tables dimensioned (row and column) by the number of regional analysis zones.

The function of program (VASSIGN) is to reconfigure the above input tables, outputting a set of trip tables dimensioned (row and column) by the number of regional model zones plus the number of Park-n-Ride or transitway stations. VASSIGN redistributes the input trips to one or more of the Park-n-Ride or transitway stations, based upon an input access station matrix from UTPS program USTOS. Care should be taken that the user-supplied dimensional parameters for the output tables are consistent with the numbering convention of the input (USTOS) matrix.

VASSIGN was designed to reconfigure output trip Tables 10, 11, and 12 from the Mode of Arrival Program (see previous section). The output tables are zero-filled except for the station-trip assignments. The user is given the option of inputting one additional trip table (i.e., regional trip table) to be output exactly as input but dimensioned the same as the other output tables. The user exercises this option by specifying the table input/output option (TBLOPT) on the PARAM card. See Figure 6-5 for the graphic representation of the table manipulation done by VASSIGN.

6.9.1 Input Data

Program VASSIGN uses as input three or four trip tables (depending on user option) and one USTOS access station matrix. As in normal UTPS-compatible programs, the user is afforded the flexibility of inputting

TABLE 6-16

UNCONSTRAINED DEMAND FOR A.M. PERIOD

MODE OF ARRIVAL -- ALT. FAROOLP5 -- USING MAR. 1983 VERSION

4MAR83 16.58.41 UMODEL REPORT 14 PAGE 49

UNCONSTRAINED DEMAND FOR A.M. PERIOD

STAT NO	MODE OF ARRIVAL WALK TRPS	BUS TRPS	K/R TRPS	P/R VEH	TRPS PASS	TOTAL TRPS	MODE OF DEPARTURE WALK TRPS	BUS TRPS	K/R TRPS	P/R VEH	TRPS PASS	TOTAL TRPS
1	498	5667	1360	6142	573	14240	676	3165	49	248	23	4161
2	1029	4679	0	0	0	5708	5209	6183	0	0	0	11392
3	501	4838	0	0	0	5339	5160	14427	0	0	0	19587
4	1184	2053	0	0	0	3237	8961	3720	0	0	0	12681
5	3993	1550	2556	0	0	8099	3332	1244	372	0	0	4948
6	1629	4188	1024	0	0	6841	3121	3256	142	0	0	6519
7	305	2358	720	0	0	3383	433	3719	91	0	0	4243
8	158	5535	575	0	0	6268	681	3743	75	0	0	4499
9	898	3374	1034	0	0	5306	1318	1481	65	0	0	2864
10	210	1736	453	0	0	2399	423	1206	32	0	0	1661
11	237	5416	878	3113	315	9959	368	6230	35	142	14	6789
12	120	1695	305	1351	124	3595	504	1929	10	40	4	2487
13	21	3136	164	0	0	3321	255	4136	9	0	0	4400
14	2	2328	1171	0	0	3501	107	3791	89	0	0	3987
16	34	2264	1000	4882	445	8625	78	2676	25	133	12	2924
17	3	4291	362	2000	172	6828	126	2985	10	63	5	3191
19	3	1916	196	0	0	2115	105	2291	16	0	0	2412
TOTAL	10825	57024	11798	17488	1629	98764	30859	66182	1020	626	58	98745
51	0	0	0	0	0	0	0	0	0	0	0	0
52	0	84	0	0	0	84	0	57	0	0	0	57
53	1	59	4	17	2	83	30	43	0	0	0	73
56	0	24	5	24	2	55	0	57	0	1	0	58
57	4	14	54	282	26	380	2	12	2	10	1	27
58	0	1	5	28	2	36	0	0	0	1	0	1
59	0	0	0	1	0	1	0	0	0	0	0	0
60	0	0	6	47	4	57	0	0	0	2	0	2
61	4	183	21	141	13	362	1	54	2	10	1	68
62	0	6	1	7	1	15	2	6	0	0	0	8
63	2	215	18	89	8	332	0	53	1	4	0	58
64	0	1	1	10	1	13	0	0	0	0	0	0

(CONTINUED)

TABLE 6-16 (CONTINUED)

UNCONSTRAINED DEMAND FOR A.M. PERIOD

MODE OF ARRIVAL -- ALT. FAR00LP5 -- USING MAR. 1983 VERSION

4MAR83 16.58.41 UMODEL REPORT 14 PAGE 49

UNCONSTRAINED DEMAND FOR A.M. PERIOD

STAT NO	MODE OF ARRIVAL						MODE OF DEPARTURE					
	WALK TRPS	BUS TRPS	K/R TRPS	P/R VEH	TRPS PASS	TOTAL TRPS	WALK TRPS	BUS TRPS	K/R TRPS	P/R VEH	TRPS PASS	TOTAL TRPS
65	0	89	13	84	7	193	0	71	0	3	0	74
66	0	0	4	31	3	38	0	0	0	1	0	1
68	0	7	20	123	10	160	0	25	1	7	1	34
69	0	1006	175	1072	88	2341	3	623	7	42	3	678
70	0	0	2	17	2	21	0	0	0	2	0	2
71	0	0	26	145	11	182	0	2	1	4	0	7
TOTAL	10836	58713	12153	19606	1089	103117	30897	67185	1034	713	64	99893

TABLE 6-17

CONSTRAINED DEMAND FOR A.M. PERIOD

MODE OF ARRIVAL -- ALT. FAROOLP5 -- USING MAR. 1983 VERSION

4MAR83 16.58.41 UMODEL REPORT 15 PAGE 54

CONSTRAINED DEMAND FOR A.M. PERIOD

	MODE OF ARRIVAL							MODE OF DEPARTURE						
STAT NO	WALK TRPS	BUS TRPS	K/R TRPS	P/R VEH	TRPS PASS	TOTAL TRPS	LOST TRPS	WALK TRPS	BUS TRPS	K/R TRPS	P/R VEH	TRPS PASS	TOTAL TRPS	LOST TRPS
1	498	5638	1399	2502	233	10270	3164	666	3156	56	93	9	3980	106
2	1026	4701	0	0	0	5727	836	5114	6152	0	0	0	11266	29
3	496	4875	0	0	0	5371	1800	4993	14336	0	0	0	19329	62
4	1178	2055	0	0	0	3233	678	8788	3677	0	0	0	12469	25
5	3992	1550	2556	0	0	8098	199	3291	1231	372	0	0	4894	6
6	1628	4187	1024	0	0	6839	281	3066	3224	142	0	0	6432	8
7	305	2356	720	0	0	3381	135	417	3669	91	0	0	4177	4
8	158	5535	575	0	0	6268	215	669	3710	75	0	0	4454	6
9	897	3397	1034	0	0	5328	148	1292	1480	65	0	0	2837	4
10	210	1755	453	0	0	2418	163	419	1204	32	0	0	1655	5
11	237	5570	905	998	101	7811	1636	361	6204	41	23	2	6631	47
12	119	1697	306	1000	92	3214	418	496	1093	10	29	3	2441	11
13	21	3156	164	0	0	3341	447	240	4059	9	0	0	4308	12
14	2	2327	1171	0	0	3500	228	104	3729	89	0	0	3922	8
16	34	2284	1003	2449	223	5993	2100	77	2660	26	63	6	2832	54
17	3	4316	362	2000	172	6853	582	126	2971	10	63	5	3175	14
19	3	1920	196	0	0	2119	172	104	2262	16	0	0	2382	4
TTL	10807	57319	11868	8949	821	89764	13272	30223	65627	1034	271	25	97180	405
51	0	0	0	0	0	0	172	0	0	0	0	0	0	4
52	0	85	0	0	0	85	0	0	57	0	0	0	57	0
53	1	59	4	17	2	83	0	30	43	0	0	0	73	0
56	0	24	5	24	2	55	1	0	57	0	1	0	58	0
57	4	14	54	282	26	380	0	2	12	2	10	1	27	0
58	0	1	5	28	2	36	0	0	0	0	1	0	1	0
59	0	0	0	1	0	1	0	0	0	0	0	0	0	0
60	0	0	6	47	4	57	0	0	0	0	2	0	2	0
61	4	183	21	141	13	362	3	1	54	2	10	1	68	0
62	0	6	1	7	1	15	0	2	6	0	0	0	8	0
63	2	215	18	89	8	332	0	0	53	1	4	0	58	0
64	0	1	1	10	1	13	0	0	0	0	0	0	0	0

(CONTINUED)

TABLE 6-17 (CONTINUED)

CONSTRAINED DEMAND FOR A.M. PERIOD

MODE OF ARRIVAL -- ALT. FAROOLP5 -- USING MAR. 1983 VERSION

4MAR83 16.58.41 UMODEL REPORT 15 PAGE 54

CONSTRAINED DEMAND FOR A.M. PERIOD

	MODE OF ARRIVAL							MODE OF DEPARTURE						
STAT NO	WALK TRPS	BUS TRPS	K/R TRPS	P/R VEH	TRPS PASS	TOTAL TRPS	LOST TRPS	WALK TRPS	BUS TRPS	K/R TRPS	P/R VEH	TRPS PASS	TOTAL TRPS	LOST TRPS
65	0	89	13	84	7	193	1	0	71	0	3	0	74	0
66	0	0	4	31	3	38	0	0	0	0	1	0	1	0
68	0	7	20	123	10	160	0	0	25	1	7	1	34	0
69	0	1029	178	1000	82	2289	59	3	627	8	35	3	676	3
70	0	0	2	17	2	21	0	0	0	0	2	0	2	0
71	0	0	26	145	11	182	0	0	2	1	4	0	7	0
TTL	10818	59032	12226	10995	995	94066	13336	30261	66634	1049	351	31	98326	408

TABLE 6-18

UNCONSTRAINED DEMAND FOR A.M. PEAK HOUR

MODE OF ARRIVAL -- ALT. FAROOLP5 -- USING MAR. 1983 VERSION

4MAR83 16.58.41 UMODEL REPORT 16 PAGE 59

UNCONSTRAINED DEMAND FOR A.M. PEAK HOUR

STAT	MODE OF ARRIVAL						MODE OF DEPARTURE					
STAT NO	WALK TRPS	BUS TRPS	K/R TRPS	P/R VEH	TRPS PASS	TOTAL TRPS	WALK TRPS	BUS TRPS	K/R TRPS	P/R VEH	TRPS PASS	TOTAL TRPS
1	167	2274	643	2864	267	6215	312	1384	19	93	9	1817
2	332	1788	0	0	0	2120	1846	2484	0	0	0	4330
3	159	1664	0	0	0	1823	2215	5728	0	0	0	7943
4	330	859	0	0	0	1189	3338	1631	0	0	0	4969
5	1485	589	828	0	0	2902	1266	515	97	0	0	1878
6	593	1584	341	0	0	2518	1244	1312	37	0	0	2593
7	119	933	252	0	0	1304	206	1449	24	0	0	1679
8	63	2160	198	0	0	2421	289	1501	20	0	0	1810
9	357	1272	451	0	0	2080	567	608	21	0	0	1196
10	79	686	193	0	0	958	177	522	10	0	0	709
11	96	2271	410	1430	145	4352	160	2737	13	50	5	2965
12	45	713	146	650	60	1614	213	845	4	17	2	1081
13	9	1353	73	0	0	1435	124	1867	3	0	0	1994
14	1	1004	490	0	0	1495	52	1670	27	0	0	1749
16	16	1045	487	2364	216	4128	38	1248	12	60	5	1363
17	1	2004	175	958	82	3220	63	1421	5	26	2	1517
19	1	818	81	0	0	900	51	1012	5	0	0	1068
52	0	40	0	0	0	40	0	27	0	0	0	27
53	0	28	2	8	1	39	14	20	0	0	0	34
56	0	10	3	11	1	25	0	27	0	0	0	27
57	1	6	26	133	12	178	1	6	1	4	0	12
58	0	0	2	13	1	16	0	0	0	0	0	0
60	0	0	3	22	2	27	0	0	0	1	0	1
61	2	60	9	59	5	135	1	19	0	3	0	23
62	0	3	1	3	0	7	1	3	0	0	0	4
63	1	94	8	40	4	147	0	23	0	2	0	25
64	0	0	1	5	0	6	0	0	0	0	0	0
65	0	39	6	40	3	88	0	33	0	1	0	34
66	0	0	2	14	1	17	0	0	0	1	0	1
68	0	3	9	54	4	70	0	12	0	2	0	14
69	0	397	82	502	41	1022	1	274	3	16	1	295
70	0	0	1	7	1	9	0	0	0	0	0	0
71	0	0	12	69	5	86	0	1	0	2	0	3
TOTAL	3857	23697	4935	9246	851	42586	12179	28379	301	278	24	41161

TABLE 6-19

CONSTRAINED DEMAND FOR A.M. PEAK HOUR

MODE OF ARRIVAL -- ALT. FAR00LP5 -- USING MAR. 1983 VERSION

4MAR83 16.58.41 UMODEL REPORT 17 PAGE 61

CONSTRAINED DEMAND FOR A.M. PEAK HOUR

	MODE OF ARRIVAL							MODE OF DEPARTURE						
STAT NO	WALK TRPS	BUS TRPS	K/R TRPS	P/R VEH	TRPS PASS	TOTAL TRPS	LOST TRPS	WALK TRPS	BUS TRPS	K/R TRPS	P/R VEH	TRPS PASS	TOTAL TRPS	LOST TRPS
1	167	2241	652	1177	110	4347	1505	307	1375	21	36	3	1742	43
2	330	1794	0	0	0	2124	397	1801	2468	0	0	0	4269	11
3	157	1673	0	0	0	1830	854	2135	5684	0	0	0	7819	25
4	328	860	0	0	0	1188	320	3257	1611	0	0	0	4868	10
5	1484	589	828	0	0	2901	96	1247	509	97	0	0	1853	3
6	592	1584	341	0	0	2517	135	1218	1297	37	0	0	2552	4
7	119	933	252	0	0	1304	65	198	1425	24	0	0	1647	2
8	63	2159	198	0	0	2420	104	283	1485	20	0	0	1788	3
9	357	1278	451	0	0	2086	72	555	606	21	0	0	1182	2
10	79	691	193	0	0	963	79	175	520	10	0	0	705	2
11	96	2309	417	490	50	3362	789	157	2718	15	11	1	2902	20
12	45	713	146	482	44	1430	202	209	833	4	13	1	1060	5
13	9	1357	73	0	0	1439	217	117	1830	3	0	0	1950	5
14	1	1003	490	0	0	1494	140	51	1640	27	0	0	1718	3
16	16	1049	487	1191	109	2852	1027	37	1239	12	29	3	1320	25
17	1	2010	175	958	82	3226	285	62	1413	5	26	2	1508	7
19	1	819	81	0	0	901	84	50	998	5	0	0	1053	2
52	0	40	0	0	0	40	0	0	27	0	0	0	27	0
53	0	28	2	8	1	39	0	14	20	0	0	0	34	0
56	0	10	3	11	1	25	0	0	27	0	0	0	27	0
57	1	6	26	133	12	178	0	1	6	1	4	0	12	0
58	0	0	2	13	1	16	0	0	0	0	0	0	0	0
60	0	0	3	22	2	27	0	0	0	0	1	0	1	0
61	2	60	9	59	5	135	2	1	19	0	3	0	23	0
62	0	3	1	3	0	7	0	1	3	0	0	0	4	0
63	1	94	8	40	4	147	0	0	23	0	2	0	25	0
64	0	0	1	5	0	6	0	0	0	0	0	0	0	0
65	0	39	6	40	3	88	0	0	33	0	1	0	34	0
66	0	0	2	14	1	17	0	0	0	0	1	0	1	0
68	0	3	9	54	4	70	0	0	12	0	2	0	14	0
69	0	403	82	474	39	998	27	1	275	3	14	1	294	1
70	0	0	1	7	1	9	0	0	0	0	0	0	0	0
71	0	0	12	69	5	86	0	0	1	0	2	0	3	0
TTL	3849	23748	4951	5250	474	38272	6400	11877	28097	305	145	11	40435	173

TABLE 6-20

PEAK-HOUR TRIPS WHICH TRANSFER AT STATION NODES,
BUT DO NOT APPEAR ON MODE-OF-ARRIVAL STATION REPORTS

MODE OF ARRIVAL -- ALT. FAROOLP5 -- USING MAR. 1983 VERSION

4MAR83 16.58.41 UMODEL REPORT 18 PAGE 64

PEAK-HOUR TRIPS WHICH TRANSFER AT STATION NODES,
BUT DO NOT APPEAR ON MODE-OF-ARRIVAL STATION REPORTS

STATION	FEEDER BUS TRIPS	HIGHWAY RELATED TRIPS
47	0	0
48	0	0
49	0	0
50	0	0
51	0	0
52	32	241
53	50	535
54	0	0
55	0	1824
56	20	104
57	15	894
58	12	1629
59	4	173
60	0	513
61	280	1430
62	5	177
63	64	541
64	15	68
65	62	157
66	11	938
67	0	0
68	45	494
69	654	1989
70	0	252
71	8	2152
72	0	0
73	0	0
74	0	0
75	0	0
76	0	0
77	0	0
78	0	0
79	0	0
80	0	0

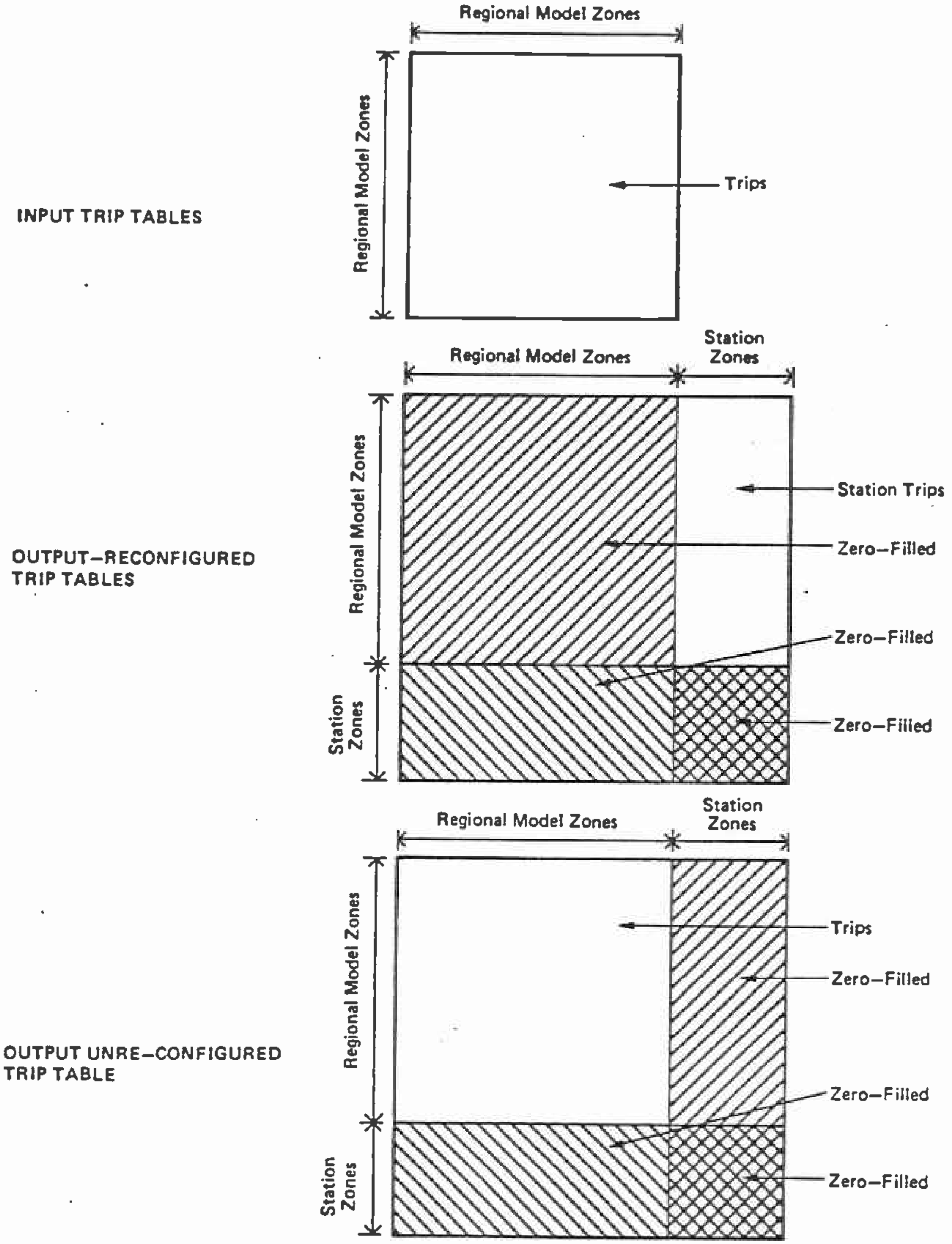


Figure 6-5
TRIP TABLE MANIPULATION

the tables and matrix using any of the FT11F001 through FT18F001 files. The user can identify the input table files by specifying them with the keyword TABLES on the parameter card (PARAM). Default values have been assigned for the input tables and reflect the high probability that the trip tables from the mode-of-access program, the USTOS matrix, and the optional regional trip table will be input from different datasets. If the user desires to override the default table parameters, the user table numbers must be in the following order on the PARAM card.

1. 3 Mode-of-Arrival Output Tables
2. USTOS Station Matrix
3. Optional Regional Trip Table

The user should also note that 1. and 2. from above must always be input. In addition, the user must include table numbers for all input tables if the keyword TABLES is used.

The parameter keyword OTBLES can be used to override the output table files. Again, the user must include table numbers for all output files if the keyword OTBLES is used.

6.9.2 Parameters and Options

Program control is transmitted through the use of a single PARAM card which follows the title card in the SYSIN (or FT05F001) data set. It is composed of six keywords:

1. ZONES -- the number of standard regional model zones as used in the mode-of-arrival program.

2. HZONES -- the number of zones in the "modified" highway network. This value is specified as ZONES plus the maximum number of transit stations.

3. NSTA -- the zone number of the first transit station. This value would normally be ZONES +1.

4. TABLES -- an array that specifies the location of the three Mode-of-Arrival Trip Tables, the USTOS access station matrix, and the optional trip table, respectively.

5. OTBLES -- an array that specifies the location of the three reconfigured Mode-of-Arrival Trip Tables and the optional trip-table, respectively.

6. TBLOPT -- logical value specified as "T" if the user wishes to input and output the optional trip table.

A summary of those keywords and default values is shown in Table 6-21.

TABLE 6-21

VASSIGN PARAM CONTROL CARD KEYWORDS

Keyword	Definition	Default Value
ZONES	Number of Regional Model Zones	0
HZONES	Number of "Modified" Highway Network Zones	0
NSTA	Zone Number of the First Park-N-Ride Lot/Transitway Station	0
TABLES	Input Table Numbers; i) Mode of Arrival Output Tables ii) USTOS Access Station Matrix iii) Optional Input Regional Table	 2001, 2002, 2003 3001 1001
OTBLES	Output Table Numbers i) Reconfigured Tables ii) Expanded Regional Table	 9001, 9002, 9003 9004
TBLOPT	Optional Input/Output Table "T" for optional table	F

6.9.3 Standard Output Files and Reports

The single output of USTATION is a three- or four-table, four-byte file, constructed as follows:

Table	Definition
1	Reconfigured Mode-of-Arrival trip table 7
2	Reconfigured Mode-of-Arrival trip table 8
3	Reconfigured Mode-of-Arrival trip table 9
4 (Optional)	Expanded regional trip table

VASSIGN also produces report 1, which displays the value(s) of each PARAM keyword as used by the program.

6.10 APPLICATION NOTES

The mode-of-arrival program is the most complex element in the SCRTD forecasting process. There are many inputs as discussed in the preceding sections, and many opportunities for errors and inconsistencies to creep in. This section highlights potential problem areas and checks to help avoid common errors.

The mode-of-arrival program (MOA) makes extensive use of station identification numbers. A given station is referred to by several different numbers at various points in the MOA process as follows:

- In the transit network representation (UNET), each station is assigned a station node number, beginning with node number 8,000, and also a local node number, numbered less than 8,000.
- For USTATION purposes, each station, Park-n-Ride (PNR), or Kiss-n-Ride (KNR) location is assigned a node number in the highway network which becomes a "station zone" in the range 1629 to 1628 plus the highest station number. The station-numbering system used here must be consistent with the STOP numbering used in USTOS. The station-zone number used in the special USTATION-related highway network must be equal to the station-STOP number minus 1628. Thus, the implied station number in the zone-to-station matrix output by USTATION will correspond to the USTOS STOP number.
- The building of access and egress matrices using USTOS requires that each station and each PNR/KNR location be equivalenced to a STOP number. Rail stations are assigned STOPS numbers starting with 1. PNR/KNR locations are numbered starting with 300. By SCRTD convention, the STOP number assignment to stations and PNR/KNR locations is fixed; i.e., once a STOP number is assigned to a location, that number is not used again for another location. The STOP numbering must be consistent with that used in the USTATION processing as indicated above.

It is essential that accuracy and consistency be carefully maintained throughout this process. In particular, the following guidelines must be adhered to:

- The geographic location of all stations and PNR/KNR locations must be accurately reflected in the highway network used for USTATION processing so that zone-to-station highway times and distances are accurate. The transit network should not include any PNR/KNR locations, unless they are also included in the USTATION highway network. The practice of including some marginal KNR locations in the transit network, but not in the highway network, should be avoided.

- The closest station distance program input file should include only those stations in a specific alternative; i.e., the file is specific to each alternative, whereas the zone-to-station file created by USTATION encompasses many alternatives. Station reference numbers must be consistent with those used in the transit network, as well as those used in the USTATION/USTOS processing.

- The USTOS keyword STOPS must equal the number of stops specified (not the highest STOP number). The value of UPARMS (22) in the MOA program must equal the maximum rail station or PNR/KNR location number in the alternative network being modeled. UPARMS (37) must equal the maximum rail station number.

7. ASSIGNMENT AND ANALYSIS

7.1 INTRODUCTION

This chapter covers the transit network assignment process for both the A.M. peak hour and daily assignments. An updated version of URAP is described as part of the standard assignment process.

Section 7.3 covers a recently developed program (UEVAL) for calculating measures of effectiveness. UEVAL is a UTPS-compatible program which takes as input standard files created or used in other parts of the modeling process.

Section 7.4 outlines procedures developed to check the accuracy, consistency, and reasonableness of model output at each stage in the process. The final section of the chapter presents results from the current model set compared to earlier results for the same rail system alternative.

7.2 NETWORK ASSIGNMENT

7.2.1 Assignment Process

The network assignment for the transit trips is the process of loading the trips from the transit trip tables produced by the mode-of-arrival model to the transit network. Basically, two types of assignments are performed: assignment of peak-hour trips to a one-hour peak network, and assignment of 24-hour trips to the network. The 24-hour assignment is undertaken by loading the work trips to the AM paths, the nonwork trips to the midday paths, and combining the results into a single loaded network. The 24-hour assignment is a production-attraction (P-A) assignment, and produces highly directional "flows" in the loading. The true loads by direction for each link of each line must be determined by adding together the "up" and "down" directions for each link of each transit line and dividing by two. This P-A loading is necessitated by the use of the one-way auto connectors which generate asymmetrical paths that permit network loading only in the P-A sense. The AM peak loading provides a directional sense, because it can be assumed that the P-A work trip tables are a close approximation to the origin-destination (O-D) movement in the morning (with most trips originating at the production end of the trip -- home). Thus, by taking the appropriate fraction of the work-trip table, an AM O-D table results.

The assignment is performed by the UTPS program ULOAD, and this is followed, in the Los Angeles model stream, by a custom-software program called URAP, which is a UTPS-compatible program summarizing various pieces of information from the loaded networks.

As noted in the previous chapter, the peak trip tables consist of two alternatives: an average AM peak hour, and a peak AM peak hour. The average AM peak hour provides the best information about the sizing of the peak transit-vehicle fleet, because this shows the average need for transit capacity over a three-hour peak. Given that peaks occur at disparate points in the peak period for each line in the system and that one cannot generally afford to design a transit system to provide the level of service needed at the highest peak, this is the design peak. The peak AM peak hour provides useful statistics such as the highest peak hourly load on each line, and the peak link volume in the peak direction. These are useful information inputs, particularly for the design of a rail transit system, but should not provide the basis for normal peak-period service design. Rather, highest peak loads indicate the maximum strain that will be placed on the system, including elevators, escalators, and stairs to rail-station platforms, etc.

For the ULOAD program, the only user-specified parameters to be provided are the trip tables to be used (predefined by the selection of peak, 24-hour, or AM assignments), the zones to be used (41 through 1,628), and the vehicle capacities. The vehicle capacities specified are 65 for local bus of both SCRTD and other operators (140 percent of seating capacity of the average bus), 46 for express bus (100 percent of seating capacity), and 650 for rail in the peak; and 52, 46, and 488 respectively for the 24-hour assignment (an average of 6 hours of peak capacity and 12 hours of off-peak capacity, where the latter is seating capacity only on local bus and rail).

The URAP program is run immediately following the assignment, as a further step of the same job run. URAP provides reports that assist the analysis of the bus system and provides enhanced estimates of certain statistics of the transit network, compared to those produced by the standard ULOAD and UNET programs of UTPS.

7.2.2 Application of the Assignment Program

The assignment is set up to operate with the transit trip tables that are output by mode of arrival, and uses the paths and skims generated from the network for use in the mode choice model and the mode-of-arrival model. Under operation as a peak one-hour assignment, whether peak AM peak hour or average AM peak hour, the assignment uses the AM skims and paths from the transit network. Under operation as a 24-hour assignment, the AM peak paths and skims are used for the work trips and the midday paths and skims are used for the nonwork trips. The option is used in the assignment to load trips on lines that use the same street in proportion to the frequencies of service on each line. The ULOAD program generates computer-readable files of the loaded network in the form of loaded "legs," where a leg is a sequence of one or more links over which there is no volume change for the period of the assignment. The loaded legs files are stored on disk initially (subsequently on tape, to save disk space) and are thereby available for subsequent analysis, without rerunning the entire ULOAD program.

7.3 DESCRIPTION OF PROGRAM URAP2

7.3.1 Summary

URAP2 is a bus operations analysis program that combines capabilities of the existing UTPS software with a comprehensive set of additional features designed to translate the outputs of a travel demand model forecast into a detailed set of operating statistics. These route-specific operating statistics can then be used as input to subsequent operating cost procedures and analyses. URAP 2 provides statistics for the transit network under four conditions:

- Coded: This is the representation of the transit system as provided in the input network description.
- Loaded: This is the service levels required to satisfy the passenger demand assigned to the network in the ULOAD run.
- Nominal: This is the service levels required to satisfy the passenger demand, but incorporating user-specified maximum and minimum systemwide policy-service levels.
- Modified: This is the service levels as estimated for the nominal case, modified by route-specific, user-specified (override) parameters.

URAP2 provides an analytical capability that is more extensive than is available in the transit-usage summary produced by ULOAD in Report 5. URAP2 considers parameters such as vehicle capacities, overall deadheading characteristics, layover times, hours of operation, and conversion from average weekday to annual operating statistics. The program also provides the mechanism to modify initial line codings or vary control parameters on a line-specific basis or in the creation of new lines (e.g., turnbacks, or other subline operations), as well as estimating statistics under the four conditions listed above.

URAP2 differs from earlier URAP versions in that it explicitly considers base-period demand in calculating base-period system requirements. URAP2 also allows the user to plot histograms of A.M. peak-hour route volumes, and includes an automated cutback capability whereby the user needs only to specify the endpoints of the new cutback route and the portion of the volume of the coded route to be allocated to the new route.

7.3.2 Program Operation

Vehicle capacities are set in URAP2 consistent with the values defined for ULOAD. Layover time can be entered into URAP2 in two alternative ways: as an integer value, in which case it is assumed to be a constant number of minutes to be added to each one-way trip; or as a decimal fraction, in which case it is assumed to be the fraction of running time to be added to each one-way trip for layover. Because the mode-of-arrival model is used to set up peak one-hour trip tables (either for the average peak hour or for the peak AM peak hour), the peak-hour factor in URAP2 is set to 1.0 when performing a peak analysis. This indicates simply that the input trip tables are trips for one hour. The primary user-specified input that is important to URAP beyond these values is a table of policy headways. Three values can be assigned as policy headways: the maximum allowable peak headway, the maximum allowable off-peak headway, and the minimum allowable off-peak headway. Each of these values is defined for a coded peak headway. Thus, if the coded peak headway is specified as two minutes, a corresponding maximum peak, maximum off-peak, and minimum off-peak headway can be specified. These values will override the demand-based calculations whenever these would violate the policy values. An example may be helpful to demonstrate the operation of these policy headways. Suppose, first, that the three policy headways for a coded peak headway of two minutes have been set as five minutes, two minutes, and ten minutes, respectively, for the maximum peak, minimum off-peak, and maximum off-peak policy headways. Second, suppose that a specific line with a coded peak headway of two minutes and coded off-peak headway of five minutes is found to require a peak headway of six minutes, based on demand. The demand headway will be set to six minutes, but the nominal peak headway will be reset to five minutes, because this is the maximum peak headway allowed. Table 7-1 shows the values currently used for all policy headways.

7.3.3 Reports

Several reports are provided by URAP. In addition to the "playback" of user-specified parameters, the primary reports requested in the current set-up are report numbers 5, 6, 7, 8, 9, and 10. Report 5 details the distance, peak time, and off-peak time of each line, and then lists out the four highest volume links on the line. These links are listed by indicating the volume of trips and the A node and B node, this latter providing the direction of the volume. Report 6 provides the same initial values for each line, and then provides details under each of the four conditions of the headways and vehicle requirements for peak and off-peak, and the vehicle hours and vehicle miles for the line. The maximum load is also listed, and an asterisk beside this indicates that the maximum load exceeds the coded capacity, necessitating a reduction in headways for the loaded case. Report 7 is a compressed version of Report 6, in which the coded and loaded vehicle hours and vehicle miles, the off-peak times, off-peak headways, and off-peak vehicle requirements are omitted.

Report 8 provides a summary by mode of the vehicle requirements, vehicle hours and vehicle miles under each of the four conditions, with vehicle requirements provided for both peak and off-peak. Report 9 provides annual operating statistics of vehicle hours and vehicle miles for each mode; and Report 10 provides a list of headways encountered by URAP2 for which no policy values were provided. Under current operation, there should be no values in this report, in which case the report is not printed. Further details of the program are to be found in the User's Manual of Computer Procedures (Schimpeler Corradino Associates, prepared for SCRTD, November 1983).

TABLE 7-1

POLICY HEADWAY VALUES USED IN URAP

Coded Headway	Maximum Peak Headway	Maximum Off-Peak Headway	Minimum Off-Peak Headway
2.0	4.0	10.0	2.0
3.0	5.0	12.0	3.0
4.0	8.0	15.0	4.0
5.0	10.0	15.0	5.0
6.0	12.0	15.0	6.0
7.0	15.0	20.0	7.0
7.5	15.0	20.0	7.5
8.0	15.0	20.0	8.0
10.0	20.0	30.0	10.0
12.0	20.0	30.0	12.0
15.0	30.0	30.0	15.0
18.0	30.0	40.0	18.0
20.0	30.0	40.0	20.0
22.0	30.0	60.0	22.0
25.0	30.0	60.0	25.0
30.0	30.0	60.0	30.0
35.0	60.0	70.0	35.0
40.0	60.0	75.0	40.0
45.0	60.0	90.0	45.0
50.0	60.0	90.0	50.0
60.0	60.0	90.0	60.0
90.0	90.0	99.9	90.0
99.9	99.9	99.9	99.9

Source: Schimpeler Corradino Associates

Report 4 is an optional report which summarizes the operating characteristics of each line as coded for input to the UTPS network program UNET. The route distances and times and the headway data are all expressed in tenths.

The user may request the printing of A.M. peak hour histograms, presenting the cumulative volume of a route. Separate plots are produced for each direction. Histograms are produced using the UTPS subroutine FREQ. If Report 4 is selected, histograms will be printed for a selected route following the line record information for that route.

For further information on URAP2, see Technical Memorandum 87.3.2: Bus Statistics/Route Analysis Program documentation -- URAP2.

7.4 DESCRIPTION OF PROGRAM UEVAL

7.4.1 <u>Summary</u>

UEVAL is a series of six UTPS-compatible FORTRAN programs which report major effectiveness measures for a given transit alternative. These measures include bus and rail patronage, amounts of service provided, service utilization and efficiency, automobile utilization, capital and operating costs, and cost-effectiveness.

The programs are designed to complement the normal UTPS demand modeling chain. Numerous data sets which are created during the modeling chain are input data sets to one or more of the evaluation programs.

The six programs operate independently; most likely the user will choose to operate them in pairs. The function of each program is summarized below.

EVAL1 - This program computes and presents general information related to a specific alternative including travel and service characteristics, costs, revenues, and service efficiency.

EVAL3 - This program computes and presents automobile utilization measures related to a specific alternative. If requested by the user, this program will compare auto utilization to that for a TSM alternative.

EVAL2W, EVAL2N - These programs (W for work trips, N for non-work trips) calculate the travel time savings associated with a guideway alternative when compared to a TSM alternative. The results are used in the calculation of the old UMTA cost-effectiveness index.

EVAL4W, EVAL4N -- These programs (W for work trips, N for non-work trips) calculate the user benefits associated with a guideway or TSM alternative when compared to a Do-Nothing alternative. The results are used in the calculation of the new UMTA cost-effectiveness index.

Program EVAL1 produces eight reports listing various effectiveness measures, including a summary report.

Titles of these reports are:

- o Daily Regionwide Transit Patronage
- o RTD Rail Patronage
- o Bus Patronage
- o Total RTD Patronage
- o RTD Service
- o RTD Utilization and Efficiency
- o Capital Costs

Program EVAL3 produces a single report listing automobile utilization measures. The other four programs do not produce formal reports. The function and operation of each UEVAL module is described below.

7.4.2 EVAL1

This program obtains, calculates, and presents major effectiveness measures for a given transit alternative. The user must first identify and assemble all of the necessary input data sets and enter the names in the appropriate locations in the EVAL1 JCL. Then the user should decide which RSAs he wishes to include in the subregional trip summaries listed in the table labeled 'Daily Regionwide Transit Patronage.' The numbers corresponding to these RSAs must be included in the array R. The user should then define an 'alternative name' of up to six characters, and an 'alternative description' of up to 20 characters. EVAL1 is then executed as a stand-alone program.

Input Data Sets: Since the program obtains and reports a wide variety of information, many input data sets are required:

FT01F001 - Alternative-Specific Input Data Set. This data set must contain total and annualized capital costs and annual local capital funding for the alternative being evaluated. This data set must be assembled by the user.

FT02F001 - URAP Output File. This data set contains bus and rail service and utilization data for the alternative being evaluated. It is the output of the URAP program.

FT03F001 - BUSCOST Output File. This data set contains operating and maintenance costs for the alternative being evaluated. It must be assembled by the user.

FT04F001 - Revenue Calculator Program Output File. This data set contains operating revenues for the alternative being evaluated. It must be assembled by the user.

FT09F001 - User-Specified File With Rail Data (Optional). This data set contains information on the rail peak load point and rail station activity. It is assembled by the user with the printout from Mode of Arrival and UPRAS.

FT11F001 - Work Transit Trip Tables for the alternative being evaluated (UTPS).

FT12F001 - Work Person Trip Table (UTPS).

FT13F001 - Nonwork Transit Trip Tables for the alternative being evaluated (UTPS).

FT15F001 - Work Transit Skims for the alternative being evaluated (UTPS).

FT16F001 - Nonwork Transit Skims for the alternative being evaluated (UTPS).

FT22F001 - Names of Regional Statistical Areas (RSAs). Data set MRP.RSA.NAMES can be used.

FT23F001 - Names of Rail Stations. Data set MRP.RAIL.STATION.NAMES can be used.

FT24F001 - Zone to RSA Equivalence File. Data set MRP.ZONE.TO.RSA.EQUIVS can be used.

User Parameters: A few input parameters must be specified by the user. These are included in an &INPUT card at the end of the program:

Key Word	Explanation
R	This array of up to 10 values, representing the RSA numbers requested for subregional trip-end summaries.
ALTNM	Alternative Name.
DESCR	Alternative Description.
FILE9	Has FT09 been specified? 1=Yes, 0=No (Default=0).

7.4.3 EVAL2W

This program calculates the travel time savings associated with a guideway alternative when comparted to a TSM alternative. The change in ridership is also calculated. EVAL2W calculates these values for work trips only. The results are used in the calculation of the old UMTA cost-effectiveness index.

The user must first identify the necessary input data sets and enter the names in the appropriate locations in the JCL. The user should then define guideway and TSM 'alternative names' of up to six characters, and 'alternative descriptions' of up to 20 characters. EVAL2W is then executed as a stand-alone program.

Input Data Sets: The following input data sets are used by the program:

FT11F001 - Work Transit Skims for the alternative being evaluated (UTPS).

FT12F001 - Work Transit Skims for the TSM alternative (UTPS).

FT13F001 - Work Transit Trip Tables for the alternative being evaluated (UTPS).

FT14F001 - Work Transit Trip Tables for the TSM alternative (UTPS).

User Parameters: A few input parameters must be specified by the user. These are included in an &INPUT card at the end of the program.

Key Word	Explanation
ALTNM	Alternative Name
ALTDES	Alternative Description
TSMNM	TSM Alternative Name
TSMDES	TSM Alternative Description

7.4.4 EVAL2N

This program calculates the travel-time savings associated with a guideway alternative when compared to a TSM alterantive. The change in ridership is also calculated. EVAL2N calculates these values for non-work trips only. The results are used in the calculation of the old UMTA cost-effectiveness index.

The user must first identify the necessary input data sets and enter the names in the appropriate locations in the JCL. The user should then define guideway and TSM 'alternative names' of up to six characters, and 'alternative descriptions' of up to 20 characters. EVAL2N is then executed as a stand-alone program.

Input Data Sets: The following input data sets are used by the program:

FT11F001 - Nonwork Transit Skims for the alternative being evaluated (UTPS).

FT12F001 - Nonwork Transit Skims for the TSM alternative (UTPS).

FT13F001 - Nonwork Transit Trip Tables for the alternative being evaluated (UTPS).

FT14F001 - Nonwork Transit Trip Tables for the TSM alternative (UTPS).

User Parameters: A few input parameters must be specified by the user. These are included in an &INPUT card at the end of the program.

Key Word	Explanation
ALTNM	Alternative Name
ALTDES	Alternative Description
TSMNM	TSM Alternative Name
TSMDES	TSM Alternative Description.

7.4.5 EVAL3

This program calculates and presents automobile utilization measures for a given transit alternative. It will also compute diverted automobile travel in comparison with a TSM alternative if requested by the user.

Program Execution: The user must first determine if a comparison to a TSM alternative is to be made. If a comparison is to be made, the user must then determine if the two alternatives have the same or different highway skims. Then the user must identify tthe necessary input data sets and enter the names in the appropriate locations in the EVAL3 JCL. Finally, the user should then define the guideway and TSM 'alternative names' of up to six characters, and 'alternative descriptions' of up to 20 characters, and enter the necessary user parameters. EVAL3 is then executed as a stand-alone program.

Input Data Sets: The following input data sets are used by the program:

FT01F001 - 'A' deck for the alternative being evaluated. This data set contains the highway network access times and distances.

FT02F001 - 'A' deck for the TSM alternative. If no comparison is being made, this data set should not be defined.

FT11F001 - Work Transit Trip Tables for the alternative being evaluated (UTPS).

FT12F001 - Non-Work Transit Trip Tables for the alternative being evaluated (UTPS).

FT13F001 - Highway Skims for the alternative being evaluated (UTPS).

FT14F001 - Work Transit Trip Tables for the TSM alternative. If no comparison is being made, this data set should not be defined (UTPS).

FT15F001 - Non-Work Transit Trip Tables for the TSM alternative. If no comparison is being made, this data set should not be defined (UTPS).

FT16F001 - Highway Skims for the TSM alternative. If no comparison is being made, or if these skims are the same as those for the alternative being evaluated, this data set should not be defined (UTPS).

FT24F001 - Zone to RSA Equivalence File. Data set MRP.ZONE.TO.RSA.EQUIVS can be used.

User Parameters: A few input parameters must be specified by the user. These are included in an &INPUT card at the end of the program:

Key Word	Explanation
COMPAR	This is the comparison switch. 'Y' indicates that there is an alternative to be compared to.
GWYNM	Alternative Name.
GWYDES	Alternative Description.
TSMNM	TSM Alternative Name.
TSMDES	TSM Alternative Description
NSKIMS	Number of highway skim data sets specified by user (1 or 2)

7.4.6 EVAL4W

This program calculates user benefits associated with a given guideway of TSM alterantive when compared with a Do-Nothing alternative. EVAL4W calculates benefits for work trips only. The result is used in the calculation of the new UMTA cost-effectiveness index.

The user must first identify the necessary input data sets and enter the names in the appropriate locations in the JCL. The user should then define the appropriate 'alternative names' of up to six characters, and 'alternative descriptions' of up to 20 characters. EVAL4W is then executed as a stand-alone program.

Input Data Sets: The following input data sets are used by the program:

FT11F001 - Work Transit Skims for the Alternative being evaluated (UTPS).

FT12F001 - Work Transit Skims for the Do-Nothing Alternative (UTPS).

FT13F001 - Work Transit Trip Tables for the Alternative being evaluated (UTPS).

FT14F001 - Work Transit Trip Tables for the Do-Nothing Alternative (UTPS).

FT15F001 - Work Transit Fares for the Alternative being evaluated (UTPS).

FT16F001 - Work Transit Fares for the Do-Nothing Alternative (UTPS).

User Parameters: A few input parameters must be specified by the user. These are included in an &INPUT card at the end of the program.

Key Word	Explanation
ALTNM	Alternative Name.
ALTDES	Alternative Description.
DNNM	Do-Nothing Alternative Name.
DNDES	Do-Nothing Alternative Description.
AINFL	Inflation factor for converting input fares to 1984 dollars for Alternative being evaluated.
DINFL	Inflation factor for converting input fares to 1984 dollars for Do-Nothing Alternative.

7.4.7 EVAL4N

This program calculates user benefits associated with a given guideway or TSM Alternative when compared with a Do-Nothing Alternative. EVAL4N calculates benefits for nonwork trips only. The result is used in the calculation of the new UMTA cost-effectiveness index.

The user must first identify the necessary input data sets and enter the names in the appropriate locations in the JCL. The user should then define the appropriate 'alternative names' of up to six characters, and 'alternative descriptions' of up to 20 characters. EVAL4N is then executed as a stand-alone program.

Input Data Sets: The following input data sets are used by the program:

FT11F001 - Non-Work Transit Skims for the alternative being evaluated (UTPS).

FT12F001 - Non-Work Transit Skims for the Do-Nothing alternative (UTPS).

FT13F001 - Non-Work Transit Trip Tables for the alternative being evaluated (UTPS).

FT14F001 - Non-Work Transit Trip Tables for the Do-Nothing alternative (UTPS).

FT15F001 - Non-Work Transit Fares for the alternative being evaluated (UTPS).

FT16F001 - Non-Work Transit Fares for the Do-Nothing alternative (UTPS).

User Parameters: A few input parameters must be specified by the user. These are included in an &INPUT card at the end of the program.

Key Word	Explanation
ALTNM	Alternative Name. Dimensioned A4, A2.
ALTDES	Alternative Description. Dimensioned 5A4.
DNNM	Do-Nothing Alternative Name. Dimensioned A4, A2.
DNDES	Do-Nothing Alternative Description. Dimensioned 5A4.
AINFL	Inflation factor for converting input fares to 1984 dollars for alternative being evaluated.
DINFL	Inflation factor for converting input fares to 1984 dollars for Do-Nothing alternative.

7.4.8 Using EVAL1 and EVAL3 to Create a Project Description

By combining the output of programs EVAL1 and EVAL3 for a given transit alternative, the user creates a nine-page description of an alternative's merits. Descriptions for various alternatives can then be reviewed by decision-makers for use in their evaluations.

For a more complete description of UEVAL, see: Technical Memorandum 86.3.1: Documentation of the Measures of Effectiveness Evaluation Programs - UEVAL, June 1986.

7.5 FORECAST RESULTS

This section presents results of the forecasting process -- from both recent forecasts and forecasts made in earlier years. A series of forecasts have been made for the MOS-5 ONLY System, based on variations in the model inputs and parameters. These forecasts are compared to those produced earlier for the LPA System (LPAUP, FEIS '84) and the MRLTR System (CEA '84). Differences between the forecasts are related to:

- new person-trip forecasts
- the change from minimum to average walk times
- automation of walk-access coding
- revisions to path selection parameters

- o recalibration of the mode choice models

- o correction of miscellaneous errors in fare matrix construction and other parameters.

While all these factors are reflected in the latest runs for MOS-5 ONLY, there were several intermediate runs that reflect the impacts of the individual factors.

7.5.1 MOS-5 ONLY Forecasts

Following is a brief chronology and summary of major impacts related to the various forecasts for MOS-5 ONLY. This series of forecasts was initiated to determine the impact of changes in the path selection parameters and the mode choice model recalibration necessitated by revision of the path parameters. As indicated, several other problems were uncovered leading to further revisions, analysis, and recalibration. Table 7-2 outlines the various forecast runs made for MOS5-ONLY in terms of the variations in model parameters and input data. Table 7-3 summarizes patronage forecast results.

The initial forecast for MOS-5 ONLY produced substantially lower mode shares than earlier forecasts, much lower rail ridership, and large differences in the distribution of ridership among stations. A somewhat lower mode split and the shift from walk-MOA to bus-MOA is explainable by the change from minimum to average walk times. However, analysis indicated that BLDCON2 was much too restrictive in the generation of walk connectors, resulting in many more zones being unconnected. This also distorted the model recalibration, which revealed itself most prominently on the transit auto access submodes. To correct this, BLDCON2 was modified and the mode choice models recalibrated again.

The first revised forecast for MOS-5 ONLY (REV1) corrected the biases introduced in the previous calibration and produced more logical results; but, the lower mode split compared to 1980 was questioned, and there were large unexplained differences in individual station volumes. This led to several further runs designed to isolate the impacts of specific model inputs and parameters.

The run made with no change other than the person trip forecast input produced somewhat higher mode splits, but a slightly lower rail ridership. This run had a moderate impact on individual station volumes, but did nothing to help explain the large differences in comparison to LPAUP. It was also noted that PA4 had approximately 236,000 more person trips than PA5.

Revision 2 (REV2), using the same sta-sta rail times as LPAUP, restored rail ridership to approximately 350,000 with about half of the additional riders coming from additional transit trips (mode split) and half from the rerouting of transit paths. This forecast had a roughly uniform effect on station volumes and thus did not help explain the large deviations for individual stations.

TABLE 7-2

ALTERNATIVE TRAVEL FORECAST MODEL INPUTS/PARAMETERS

FORECAST	WALK/AUTO ACCESS LINKS	PATH PARAMETERS	FARE FIX (?)	PERSON TRIPS	MCH MODEL CALIB.	RAIL TIME	ZN-STA DIST'S	I.D. #
LPAUP (FEIS'84)	Pre-BLDCON2	2.5/1.5/4.0 (OLD)	NO/NO (*)	PA4	SCRTD1	LPA	XY	1
MRLTR (CEA'84)	"	"	"	PA5	SCRTD2	MRLTR	HWY	2
GPC YBO CALIB 2	BLDCON2	1.5/3.0/3.0	NA/NO	"	SCRTD3	NA	NA	
MOS5 ONLY (Init.)	"	"	YES/NO	"	"	MRLTR	HWY	
GPC YBO CALIB 3	BLDCON2 (Rev)	"	NA/NO	"	SCRTD4	NA	NA	
MOS5 ONLY Rev.1	"	"	YES/NO	"	"	MRLTR	HWY	3
MOS5 ONLY Rev.1	"	"	"	PA4	"	"	"	4
MOS5 ONLY Rev.2	"	"	"	PA5	"	LPA	"	5
MOS5 ONLY Rev.2 (**)	"	OLD	"	"	"	"	"	6
MOS5 ONLY Rev.2 (**)	"	NEW	"	"	"	"	XY	7
MOS5 ONLY RevFARE	"	"	YES/YES	"	"	"	"	8
MOS5 ONLY Rev.3	Elim. Extr.	"	YES/NO	"	"	"	"	9

(*) VARIABLE NAME ERROR/FARES FOR LIMITEDS
(**) MODE CHOICE NOT RERUN, JUST MOA FORECAST NUMBERS (#1-#9) ARE USED TO IDENTIFY THE VARIOUS FORECASTS IN SOME EXHIBITS

TABLE 7-3

IMPACTS OF ALTERNATIVE TRAVEL FORECAST MODEL INPUTS/PARAMETERS

FORECAST	Trn Mode Share: HBWORK	Trn Mode Share: TOTAL	HBWORK Trn Submode Shares: WALK	HBWORK Trn Submode Shares: PNR DA	HBWORK Trn Submode Shares: PNR SR	HBWORK Trn Submode Shares: KNR	TOTAL TRANSIT TRIPS	TOTAL PERSON TRIPS	DAILY RAIL RIDERS	RAIL MODE-OF-ARRIVAL (No./Pct.): WALK	RAIL MODE-OF-ARRIVAL (No./Pct.): BUS	RAIL MODE-OF-ARRIVAL (No./Pct.): KNR	RAIL MODE-OF-ARRIVAL (No./Pct.): PNR	FORECAST REF. #
LPAUP (FEIS '84)	7.2	3.8	78.3	14.5	2.9	4.4	1924215	50243472	360859	131200 36.4	187931 52.1	28174 7.8	13544 3.7	1
MRLTR (CEA '84)	7.0	3.7	76.4	15.6	3.3	4.6	1855007	49765629	354995	104829 29.5	199969 56.3	39616 11.2	10581 3.0	2
GPC YBO CALIB 2 (BLDCON2, PATHS)	7.3	3.1	84.7	10.1	1.8	3.4	1146651	37360282	NA	NA	NA	NA	NA	
MOSS ONLY (Init.)	6.2	3.3	84.8	9.8	2.1	3.3	1641285	50007709	310691	77507 24.9	195382 62.9	27047 8.7	10755 3.5	
GPC YBO CALIB 3 (Rev. BLDCON2)	7.0	3.0	84.9	9.8	1.8	3.5	1183561	38934627	NA	N/A	N/A	N/A	N/A	
MOSS ONLY REV.1 (Rev. BLDCON2)	6.5	3.4	80.8	12.4	2.6	4.4	1697794	50007265	327323	79747 24.4	205687 62.8	29807 9.1	12082 3.7	3
MOSS ONLY REV.1 (PA4 vs PA5)	6.7	3.5	81.4	12.0	2.5	4.2	1783279	50243433	326141	84289 25.8	196591 60.3	33489 10.3	11772 3.6	4
MOSS ONLY REV.2 (LPA Rail Times)	6.5	3.4	80.5	12.7	2.6	4.3	1707599	50007207	349502	84439 24.2	221932 63.5	30592 8.7	12539 3.6	5
MOSS ONLY REV.2 (Old Paths)	6.5 (**)	3.4 (**)	80.5	12.7	2.6	4.3	1707599	50007207	335751	85679 25.5	207293 61.7	30712 9.2	12067 3.6	6
MOSS ONLY REV.2 (XY ZN-STA Times)	6.5 (**)	3.4 (**)	80.5	12.7	2.6	4.3	1707599	50007207	348108	111368 32.0	194490 55.9	29721 8.5	12529 3.6	7
MOSS ONLY RevFARE (LIMITED's FARE)	6.6	3.4	80.5	12.6	2.6	4.3	1709625	50007263	348159	111379 32.0	194712 55.9	29637 8.5	12431 3.6	8
MOSS ONLY REV.3 (Ex. KNR Links)	6.6	3.4	80.5	12.6	2.6	4.3	1707199	50007171	347291	112835 32.5	192921 55.5	29018 8.4	12517 3.6	9

(*) VARIABLE NAME ERROR/FARES FOR LIMITEDS
(**) MODE CHOICE NOT RERUN, JUST MOA
NA Not Applicable

A further run was made using the same trips as produced for REV2, but with paths rebuilt using the old path parameters. This produced moderately lower rail ridership with a more or less uniform effect over all stations. This result indicates the model is quite robust with respect to path parameters but, again, did not help explain the station-level variations.

At this point it was discovered that all the runs made for MOS-5 ONLY used a different procedure for calculating walk distances to the nearest rail station than that used for LPAUP. A coordinate-based (XY) procedure was used in the LPAUP forecast as opposed to the highway-network based procedure used for MRLTR and MOS-5 ONLY. Use of the coordinate-based procedure helped explain some of the station-level variations, but only marginally, and boosted rail ridership.

The final two runs related to adjustment of transit fares for limited routes, and elimination of unreasonable KNR access links had very marginal impact on rail ridership.

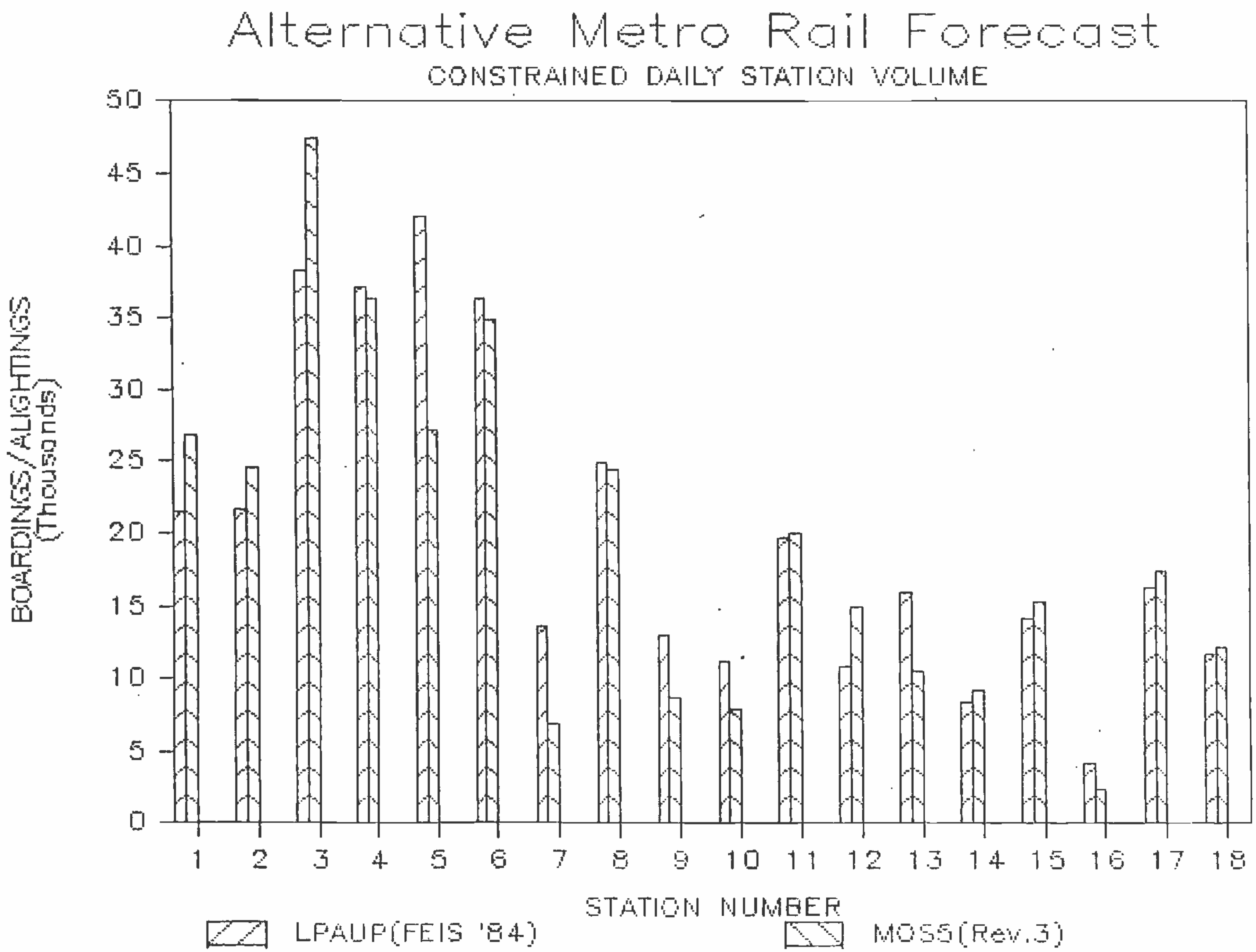
Final Metro Rail station volumes are shown in Figure 7-1, in comparison to the earlier LPA volumes. Figure 7-2 shows the Metro Rail alignment and station locations assumed in both forecasts.

Subsequent analysis of network-coding differences led to the finding that station-level variations were attributable to background bus network-coding. Seemingly minor changes in background bus-coding can have major impacts on total rail volumes, and especially on the distribution among stations because of the "all-or-nothing" transit assignment process.

Nothing in the analysis suggests any error related to the forecast of lower transit mode shares for Year 2000 work trips compared to Year 1980. Analysis of 1980 and 2000 person trips and transit trips on a geographic subarea basis indicates that the growth rate of person trips is much higher outside the transit service area than inside, which tends to reduce the regional average transit share. Within the area served by Metro Rail, the percent of work trips by transit rises from less than 14% in 1980 to over 16% in 2000. Transit work trips increase by 32% within the Metro Rail area compared to a 22% increase in the overall RTD service area (including the Metro Rail area). Outside the Metro Rail area, transit work trips increase by only 7.2%, further indicating the substantial impact of Metro Rail. These findings are illustrated in Figures 7-3 and 7-4.

7.5.2 Detailed Comparisons

In order to check the results of system forecasts at each stage in the modeling process, detailed tabulations of comparative statistics are prepared. These tabulations compare the current system results with those obtained previously for a similar system configuration. Tables 7-4 through 7-9 exhibit such comparisons for the MOS5-ONLY forecasts.



Alternative Metro Rail Forecast
CONSTRAINED DAILY STATION VOLUME
BOARDINGS/ALIGHTINGS (Thousands)
0
5
10
15
20
25
30
35
40
45
50
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
STATION NUMBER
LPAUP(FEIS '84)
MOSS(Rev.3)

Figure 7-1

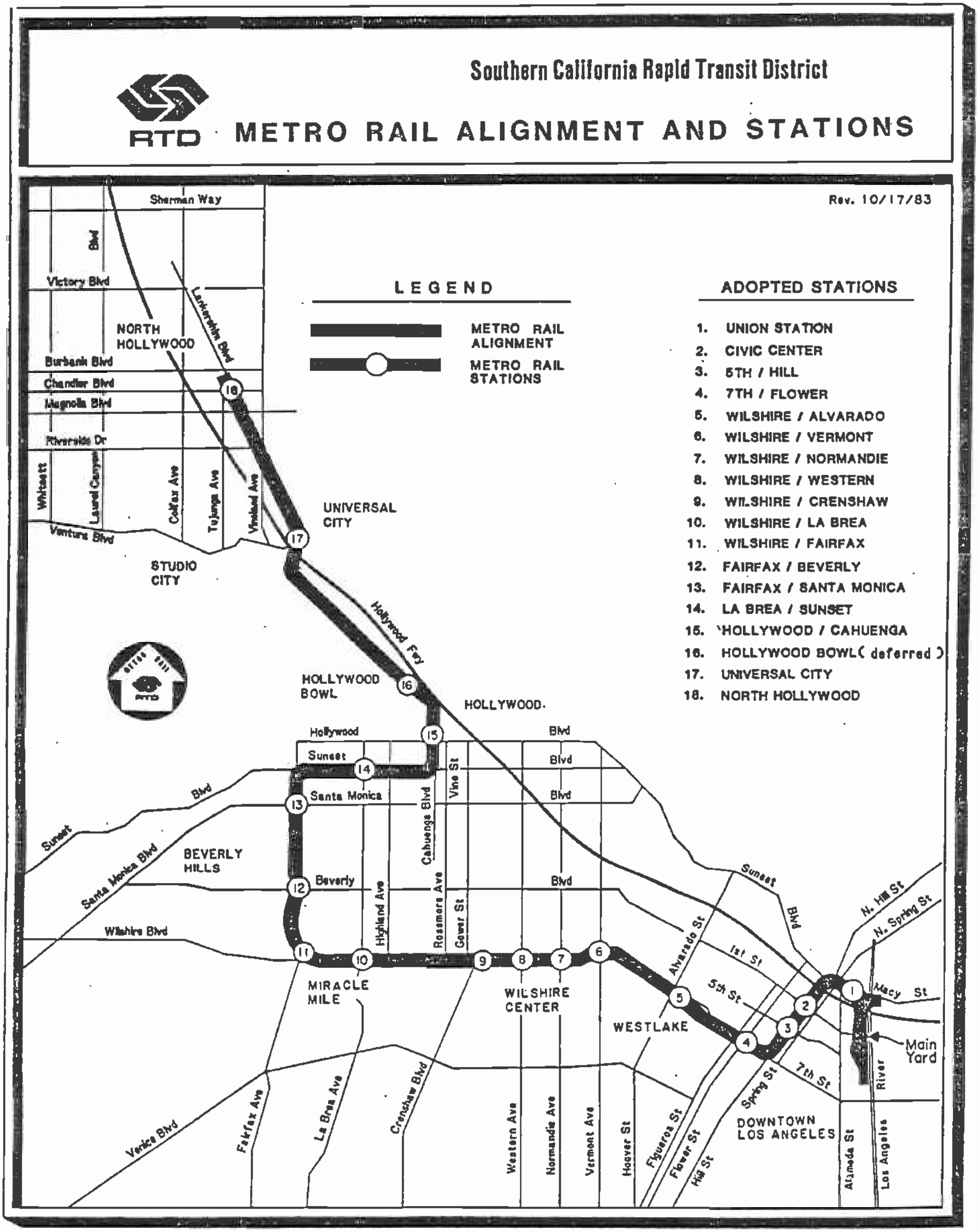

Southern California Rapid Transit District
RTD
METRO RAIL ALIGNMENT AND STATIONS
Rev. 10/17/83
LEGEND
METRO RAIL ALIGNMENT
METRO RAIL STATIONS
ADOPTED STATIONS
1. UNION STATION
2. CIVIC CENTER
3. 5TH / HILL
4. 7TH / FLOWER
5. WILSHIRE / ALVARADO
6. WILSHIRE / VERMONT
7. WILSHIRE / NORMANDIE
8. WILSHIRE / WESTERN
9. WILSHIRE / CRENSHAW
10. WILSHIRE / LA BREA
11. WILSHIRE / FAIRFAX
12. FAIRFAX / BEVERLY
13. FAIRFAX / SANTA MONICA
14. LA BREA / SUNSET
15. HOLLYWOOD / CAHUENGA
16. HOLLYWOOD BOWL(deferred)
17. UNIVERSAL CITY
18. NORTH HOLLYWOOD
Sherman Way
Victory Blvd
NORTH HOLLYWOOD
Lankershim Blvd
Burbank Blvd
Chandler Blvd
Magnolia Blvd
Riverside Dr
Whitsett
Laurel Canyon
Colfax Ave
Tujunga Ave
Vineland Ave
Ventura Blvd
UNIVERSAL CITY
STUDIO CITY
Hollywood Fwy
HOLLYWOOD BOWL
HOLLYWOOD
Hollywood Blvd
Sunset Blvd
Santa Monica Blvd
Sunset Blvd
Santa Monica Blvd
BEVERLY HILLS
Beverly Blvd
Wilshire Blvd
Highland Ave
Cahuenga Blvd
Vine St
Rosemore Ave
Gower St
MIRACLE MILE
WILSHIRE CENTER
WESTLAKE
Alvarado St
Sunset Blvd
1st St
5th St
7th St
N. Hill St
N. Spring St
Macy St
Main Yard
River
Spring St
DOWNTOWN LOS ANGELES
Venice Blvd
Fairfax Ave
La Brea Ave
Crenshaw Blvd
Western Ave
Normandie Ave
Vermont Ave
Hoover St
Figueroa St
Flower St
Hill St
Alameda St
Los Angeles

Figure 7-2

Growth in Total Person Work Travel

Ratio of Year
2000 to 1980 Trips

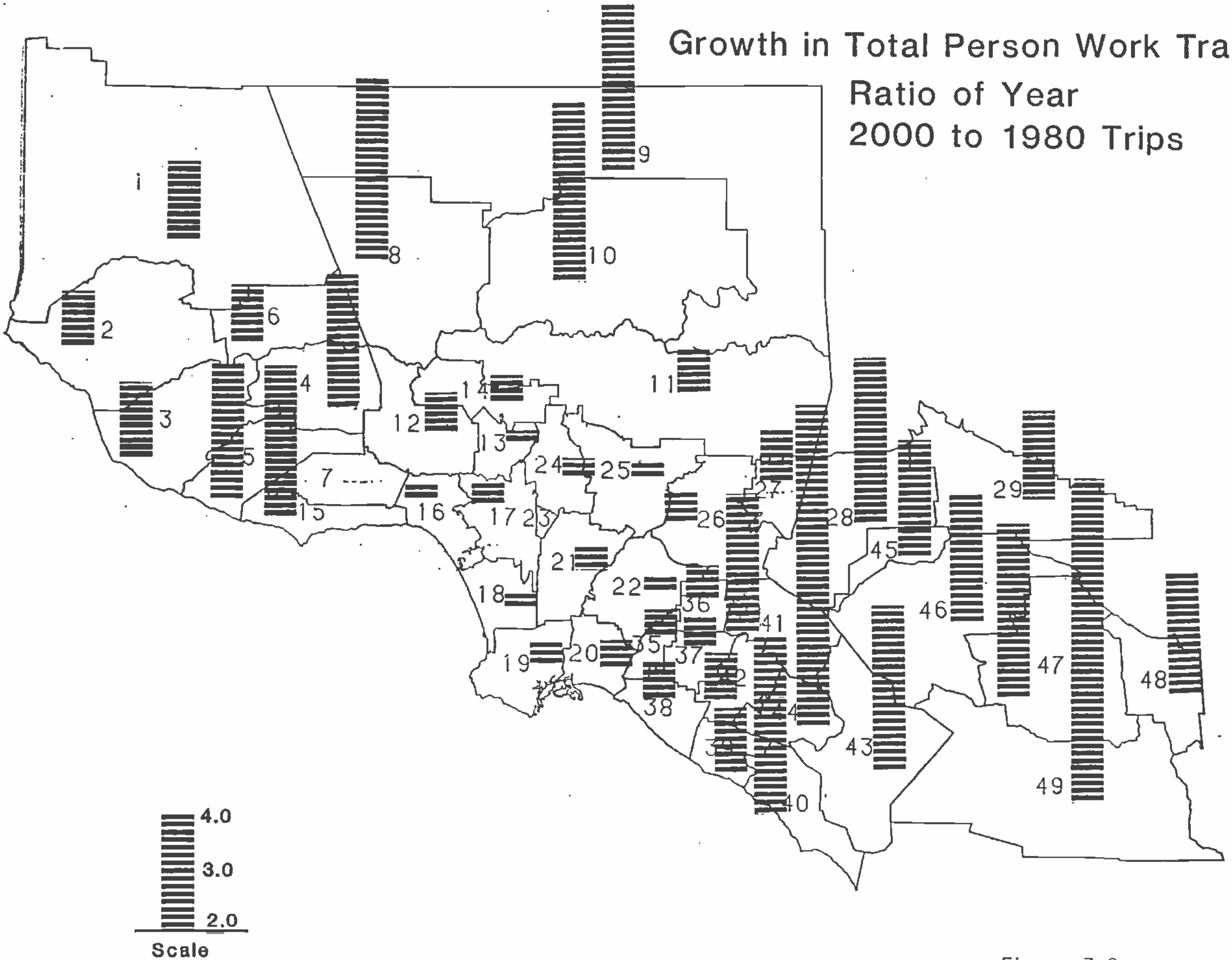


Figure 7-3

Growth in Total Daily Transit Trips 1980 to 2000

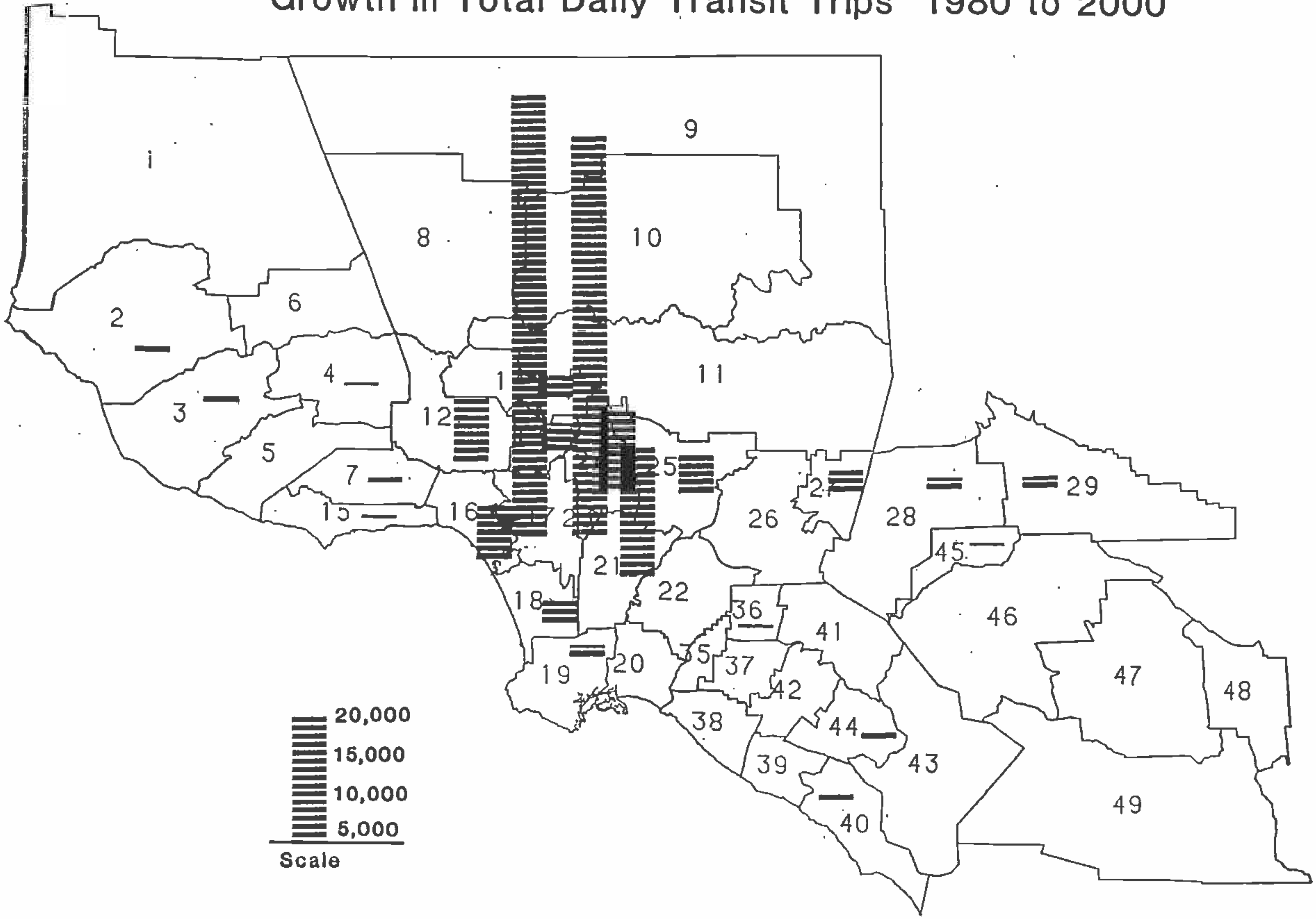


Figure 7-4

TABLE 7-4

ALTERNATIVE SYSTEM NETWORK STATISTICS

ITEM		LPAUP('84) Number	%	MOS5 ONLY Initial Number	%	MOS5 ONLY Rev.1 Number	%	MOS5 ONLY Rev.2/3 Number	%
LINES BY MODE:	M4	239	46.6	233	44.5	233	44.5	233	44.5
	M5	68	13.3	78	14.9	78	14.9	78	14.9
	M6	1	0.2	1	0.2	1	0.2	1	0.2
	M7	0	0.0	0	0.0	0	0.0	0	0.0
	M8	205	40.0	212	40.5	212	40.5	212	40.5
	TOT	513	00.0	524	100.0	524	100.0	524	100.0
LINKS BY MODE:	M1	8560	31.1	5680	22.2	6136	23.6	6136	23.6
	M2	1499	5.5	1092	4.3	1092	4.2	1065	4.1
	M3	1342	4.9	1143	4.5	1143	4.4	1094	4.2
	M4	7440	27.1	7838	30.6	7838	30.1	7838	30.2
	M5	2666	9.7	3200	12.5	3200	12.3	3200	12.3
	M6	36	0.1	36	0.1	36	0.1	36	0.1
	M7	0	0.0	0	0.0	0	0.0	0	0.0
	M8	5940	26.1	6610	25.8	6610	25.4	6610	25.4
	TOT	27483	100.0	25599	100.0	26055	100.0	25979	100.0
ROUTE MILES:	M4	7250.0	49.5	6945.6	45.7	6945.6	45.7	6945.6	5.8
	M5	2428.8	16.6	2826.9	18.6	2826.9	18.6	2826.9	18.6
	M6	37.2	0.3	39.2	0.3	39.2	0.3	37.2	0.2
	M7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	M8	4945.0	33.7	5370.5	35.4	5370.5	35.4	5370.5	35.4
	TOT	14661.0	100.0	15182.2	100.0	15182.2	100.0	15180.2	100.0
TOT VEHS REQ'D:	AM	2824		2859		2859		2855	
	PM	2678		2683		2683		2679	
	MID	1929		1945		1945		1943	
	NIT	0		0		0		0	
VEHICLE MILES:	M4	190549	56.9	186214	55.5	186214	55.5	186214	55.6
	M5	40118	12.0	47406	14.1	47406	14.1	47406	14.2
	M6	5022	1.5	5292	1.6	5292	1.6	5022	1.5
	M7	0	0.0	0	0.0	0	0.0	0	0.0
	M8	99187	29.6	96309	28.7	96309	28.7	96309	28.8
	TOT	334876	100.0	335221	100.0	335221	100.0	334951	100.0

(CONTINUED)

TABLE 7-4 (CONTINUED)

ALTERNATIVE SYSTEM NETWORK STATISTICS

ITEM		LPAUP('84) Number	%	MOS5 ONLY Initial Number	%	MOS5 ONLY Rev.1 Number	%	MOS5 ONLY Rev.2/3 Number	%
VEHICLE HOURS:	M4	16590	59.1	16338	57.7	16338	57.7	16338	57.8
(By	M5	2277	8.1	2670	9.4	2670	9.4	2670	9.4
Mode)	M6	144	0.5	180	0.6	180	0.6	144	0.5
	M7	0	0.0	0	0.0	0	0.0	0	0.0
	M8	9069	32.3	9108	32.2	9108	32.2	9108	32.2
	TOT	28080	100.0	28296	100.0	28296	100.0	28260	100.0
VEHICLE HOURS:	AM	8472	30.2	8577	30.3	8577	30.3	8565	30.3
(By	PM	8034	28.6	8049	28.4	8049	28.4	8037	28.4
Period)	MID	11574	41.2	11670	41.2	11670	41.2	11658	41.3
	NIT	0	0.0	0	0.0	0	0.0	0	0.0
	TOT	28080	100.0	28296	100.0	28296	100.0	28260	100.0

TABLE 7-5

ALTERNATIVE SYSTEM UNWEIGHTED SKIM STATISTICS

ITEM	LPAUP ('84) Mean	Std Dev	MOS5 ONLY Mean	Initial Std Dev	MOS5 ONLY Mean	Rev.1 Std Dev	MOS5 ONLY Mean	Rev.2/3 Std Dev
AM WALK PATHS:								
WAIT1	8.280	4.417	7.837	4.417	8.137	4.483	8.139	4.483
WAIT2	13.677	8.586	16.264	10.572	17.019	10.771	17.040	10.774
AUTO	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WALK	11.901	3.562	13.380	2.824	14.254	3.094	14.253	3.093
M4 RUN	42.704	29.905	35.104	25.158	36.205	25.832	36.025	25.655
M5 RUN	49.244	28.727	54.926	33.891	55.618	33.604	55.615	33.642
M6 RUN	17.553	8.950	18.882	10.494	19.503	10.508	17.177	8.870
M7 RUN	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
M8 RUN	29.403	25.759	26.370	24.310	27.518	25.015	27.537	25.012
XFERS	2.074	0.930	2.321	1.136	2.356	1.133	2.371	1.139
AM PNR PATHS:								
WAIT1	6.341	4.393	6.066	4.232	6.316	4.364	6.325	4.366
WAIT2	12.826	8.773	15.057	10.612	15.952	10.899	15.974	10.910
AUTO	12.749	7.129	8.227	3.960	8.250	3.961	8.337	3.928
WALK	7.819	3.916	9.419	3.977	10.306	4.350	10.314	4.351
M4 RUN	38.690	28.456	32.937	24.043	33.727	24.451	33.558	24.265
M5 RUN	50.577	28.131	55.809	33.999	57.029	34.057	57.083	34.138
M6 RUN	16.122	9.541	17.204	11.135	17.408	11.118	15.517	9.367
M7 RUN	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
M8 RUN	29.592	27.387	28.017	24.962	29.352	25.675	29.364	25.665
XFERS	1.808	0.804	2.071	1.058	2.107	1.063	2.118	1.068
AM KNR PATHS:								
WAIT1	6.401	4.307	5.962	4.055	6.205	4.195	6.203	4.199
WAIT2	12.769	8.809	14.964	10.645	15.883	10.940	15.912	10.949
AUTO	11.096	6.922	7.356	3.826	7.355	3.831	7.408	3.854
WALK	7.093	3.581	8.221	3.522	9.042	3.922	9.088	4.001
M4 RUN	37.758	28.006	30.470	22.545	31.350	23.033	31.204	22.844
M5 RUN	47.937	28.245	53.613	34.848	55.163	35.008	55.268	35.042
M6 RUN	16.192	9.434	17.047	11.212	17.275	11.216	15.431	9.447
M7 RUN	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
M8 RUN	29.809	27.611	27.913	24.995	29.291	25.705	29.301	25.699
XFERS	1.782	0.805	2.052	1.064	2.091	1.074	2.102	1.079

(CONTINUED)

TABLE 7-5 (CONTINUED)

ALTERNATIVE SYSTEM UNWEIGHTED SKIM STATISTICS

ITEM	LPAUP ('84) Mean	Std Dev	MOS5 ONLY Mean	Initial Std Dev	MOS5 ONLY Mean	Rev.1 Std Dev	MOS5 ONLY Mean	Rev.2/3 Std Dev
MIDDAY PATHS:								
WAIT1	12.224	7.174	11.193	6.672	11.550	6.800	11.557	6.805
WAIT2	17.794	9.649	20.282	11.685	21.003	11.724	21.059	11.750
AUTO	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
WALK	11.760	3.534	13.551	2.851	14.347	9.684	14.353	3.119
M4 RUN	47.855	31.266	43.071	29.387	44.450	30.104	44.107	29.851
M5 RUN	42.874	22.286	46.850	25.126	46.840	25.091	46.880	25.090
M6 RUN	19.212	8.296	19.084	8.896	19.807	8.823	16.911	7.431
M7 RUN	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
M8 RUN	29.245	27.030	28.242	26.049	29.563	26.737	29.569	26.725
XFERS	1.929	0.856	2.042	0.929	2.081	0.937	2.097	0.948

TABLE 7-6

ALTERNATIVE SYSTEM FARE MATRIX STATISTICS

ITEM	LPAUP('84) Number	%	MOS5 ONLY Initial Number	%	MOS5 ONLY Rev.1 Number	%	MOS5 ONLY Rev.2/3 Number	%
FARE MATRIX RUN STATS								
AM WALK								
TOT ZZI'S W/SERVICE	1422347		1131603		1477839		1480213	
NONXFER ZZI'S:M4	55783	3.9	37777	3.3	43205	2.9	42836	2.9
M5	14097	1.0	12105	1.1	14285	1.0	14241	1.0
M6	3757	0.3	3407	0.3	3539	0.2	3586	0.2
M7	0	0.0	0	0.0	0	0.0	0	0.0
M8	11901	0.8	6946	0.6	8907	0.6	8907	0.6
SUBTOT	85538	6.0	60235	5.3	69936	4.7	69570	4.7
XFER ZZI'S:								
1 MODE	252460	17.7	181667	16.1	230923	15.6	226144	15.3
2 MODES	633186	44.5	479827	42.4	632180	42.8	628009	42.4
3 MODES	379933	26.7	346305	30.6	457153	30.9	463147	31.3
4+MODES	71230	5.0	63569	5.6	87647	5.9	93343	6.3
SUBTOT	1336809	94.0	1071369	94.7	1407903	95.3	1410643	95.3
TOTAL	1422347	100.0	1131603	100.0	1477839	100.0	1480213	100.0
AM PNR								
TOT ZZI'S W/SERVICE	1484129		1269267		1531548		1533833	
NONXFER ZZI'S:M4	65739	4.4	39531	3.1	45419	3.0	46230	3.0
M5	20049	1.4	19518	1.5	22358	1.5	22358	1.5
M6	27091	1.8	21370	1.7	21687	1.4	21111	1.4
M7	0	0.0	0	0.0	0	0.0	0	0.0
M8	16012	1.1	8183	0.6	10094	0.7	10094	0.7
TOT	128891	8.7	88602	0.7	99558	6.5	99793	6.5
XFER ZZI'S:								
1 MODE	188291	12.7	144744	11.4	177930	11.6	176498	11.5
2 MODES	744643	50.2	635285	50.1	756352	49.4	750955	49.0
3 MODES	396678	26.7	361710	28.5	446250	29.1	452276	29.5
4+MODES	25626	1.7	38926	3.1	51458	3.4	54311	3.5
SUBTOT	1355238	91.3	1180665	93.0	1431990	93.5	1434040	93.5
TOTAL		0.0	1269267	100.0	1531548	100.0	1533833	100.0

(CONTINUED)

TABLE 7-6 (CONTINUED)

ALTERNATIVE SYSTEM FARE MATRIX STATISTICS

ITEM	LPAUP('84) Number	%	MOS5 ONLY Initial Number	%	MOS5 ONLY Rev.1 Number	%	MOS5 ONLY Rev.2/3 Number	%
AM KNR								
TOT ZZI'S								
W/SERVICE	1491904		1289960		1539433		1541423	
NONXFER								
ZZI'S:M4	75206	5.0	42332	3.3	48414	3.1	49861	3.2
M5	34387	2.3	33553	2.6	37586	2.4	37601	2.4
M6	28213	1.9	22382	1.7	22721	1.5	22141	1.4
M7	0	0.0	0	0.0	0	0.0	0	0.0
M8	15971	1.1	8264	0.6	10213	0.7	10213	0.7
SUBTOT	153777	10.3	106531	8.3	118934	7.7	119816	7.8
XFER ZZI'S:								
1 MODE	171490	11.5	123805	9.6	153234	10.0	151482	9.8
2 MODES	745356	50.0	662592	51.4	778312	50.6	771236	50.0
3 MODES	396298	26.6	363054	28.1	443762	28.8	451273	29.3
4+MODES	24983	1.7	33978	2 6	45191	2.9	47616	3.0
SUBTOT	1338127	89.7	1183429	91.7	1420499	92.3	47616	3.1
TOTAL	1491904	100.0	1289960	100.0	1539433	100.0	1541423	100.0
MIDDAY								
TOT ZZI'S								
W/SERVICE	1290126		1023991		1312510		1316185	
NONXFER								
ZZI'S:M4	62210	4.8	46480	4.5	52652	4.0	52316	4.0
M5	7648	0.6	7424	0.7	8720	0.7	8704	0.7
M6	3792	0.3	3323	0.3	3583	0.3	3596	0.3
M7	0	0.0	0	0.0	0	0.0	0	0.0
M8	12259	1.0	7225	0.7	9117	0.7	9117	0.7
TOT	85909	6.7	64452	6.3	74072	5.6	73733	5.6
XFER ZZI'S:								
1 MODE	364914	28.3	263005	25.7	333631	25.4	325198	24.7
2 MODES	536689	41.6	419674	41.0	543486	41.4	542789	41.2
3 MODES	254916	19.8	233407	22.8	303615	23.1	312119	23.7
4+MODES	47698	3.7	43453	4.2	57706	4.4	62346	4.7
SUBTOT	1204217	93.3	959539	93.7	1238438	94.4	1242452	94.4
TOTAL	1290126	100.0	1023991	100.0	1312510	100.0	1316185	100.0

TABLE 7-7

ALTERNATIVE SYSTEM MODE SPLIT STATISTICS (MOSSMS2.WKS)

ITEM	Y80 PAS Number	CALIB2 #6 %	Y80 PAS Number	CALIB3 %	LPAUP('84) Number	%	MRLTR('84) Number	%	MOSS ONLY Number	Initial %	MOSS ONLY Number	Rev.1 %	MOSS ONLY Number	Rev1/PA4 %	MOSS ONLY Number	Rev.2 %	MOSS ONLY Number	RevFARE %	MOSS ONLY Number	Rev.3 %
HOME BASED WORK																				
TOT AUTO PERSON	6079460	92.7	6548958	93.0	8569660	92.8	8561551	93.0	8665365	93.8	8633603	93.5	8614189	93.3	8630939	93.5	8629553	93.4	8631203	93.5
TOT TRN PERSON	475495	7.3	492476	7.0	666811	7.2	640914	7.0	570025	6.2	601789	6.5	621283	6.7	604617	6.5	605841	6.6	60421	6.5
TOTAL PERSON	6554955	100.0	7041434	100.0	9235471	100.0	9202465	100.0	9235390	100.0	9235392	100.0	9235472	100.0	9235456	100.0	9234953	100.0	9235420	100.0
OA AUTO PERSON	4915726	77.4	5108617	78.0	6451380	75.4	6451953	75.3	6638201	76.6	6620786	76.7	6618949	.76.8	6618899	76.7	6618239	76.7	6619069	75.7
2/CAR AUTO PRSN	991247	15.9	1007788	15.4	1443585	16.8	1448786	16.9	1391613	16.1	1380888	16.0	1369557	15.9	1380233	16.0	1379859	16.0	1380403	16.0
3+/CAR AUTO PRSN	416123	6.7	432552	6.6	663704	7.7	663754	7.8	635715	7.3	632083	7.3	625887	7.3	631772	7.3	631618	7.3	631868	7.3
TOTAL AUTO PRSN	6223096	100.0	6548967	100.0	8563769	100.0	8564393	100.0	8665529	100.0	8633757	100.0	8614293	100.0	8630904	100.0	8629716	100.0	8631340	100.0
TRANSIT WALK	403073	84.7	418118	84.9	521889	78.3	489902	76.4	483289	84.8	486011	80.8	505553	81.4	485431	80.5	487603	80.5	486891	80.6
TRANSIT OA PNR	47851	10.1	48427	9.8	96496	14.5	100195	15.6	56048	9.8	74639	12.4	74338	12.0	76493	12.7	76447	12.6	76118	12.6
TRANSIT SR PNR	8675	1.8	8776	1.8	19235	2.9	21457	3.3	11689	2.1	15441	2.6	15404	2.5	15827	2.6	15810	2.6	15652	2.6
TRANSIT KNR	16417	3.4	17152	3.5	29190	4.4	29294	4.6	18960	3.3	25684	4.3	25994	4.2	25873	4.3	25954	4.3	25523	4.2
TOTAL TRANSIT	476016	100.0	492473	100.0	666810	100.0	640848	100.0	569986	100.0	601774	100.0	621289	100.0	604624	100.0	605814	100.0	604184	100.0
HOME BASED NONWORK																				
AUTO PERSON	19147362	97.4	19659165	97.4	24932997	96.2	24651060	96.3	24948756	96.8	24923501	96.7	25028210	96.6	24917146	96.7	24916589	96.7	24917146	96.7
TRANSIT PERSON	516205	2.6	530974	2.6	973572	3.8	940731	3.7	814625	3.2	839558	3.3	878306	3.4	845797	3.3	846474	3.3	845797	3.3
AUTO DRIVER	12204721	62.1	12683332	62.8	16085611	62.1	15978980	62.4	16095479	62.5	16079352	62.4	16147070	62.3	16075414	62.4	16074894	62.4	16075414	62.4
TOTAL PERSON	19663567	100.0	20190139	100.0	25906569	100.0	25591791	100.0	25763381	100.0	25763069	100.0	25906516	100.0	25762943	100.0	25763063	100.0	25762943	100.0
NON-HOME-BASED O-O																				
AUTO PERSON	7929939	98.7	8288753	254.7	10597806	98.2	10498017	98.4	10531186	98.5	10530715	98.5	10596129	98.2	10530314	98.5	10530229	98.5	10530314	98.5
TRANSIT PERSON	103632	1.3	107800	3.3	189063	1.8	174960	1.6	164474	1.5	164847	1.5	190755	1.8	165255	1.5	165341	1.5	165255	1.5
AUTO DRIVER	4697743	58.5	4953319	152.2	6643889	61.6	6129089	57.4	6151573	57.5	6149706	57.5	6494491	60.2	6149577	57.5	6149547	57.5	6149577	57.5
TOTAL PERSON	8033571	100.0	8396553	100.0	10786869	100.0	10672977	100.0	10695660	100.0	10695562	100.0	10786884	100.0	10695569	100.0	10695570	100.0	10695569	100.0
NON-HOME-BASED O-W																				
AUTO PERSON	3056870	98.3	3254190	98.4	4219794	97.8	4199994	97.7	4221117	97.9	4221652	97.9	4221626	97.8	4221309	97.9	4221240	97.9	4221309	97.9
TRANSIT PERSON	51319	1.7	52311	1.6	94769	2.2	98402	2.3	92161	2.1	91590	2.1	92935	2.2	91930	2.1	91996	2.1	91930	2.1
AUTO DRIVER	1901125	61.2	2057434	62.2	2590639	60.0	2502933	58.2	2513886	58.3	2513330	58.3	2533720	58.7	2513207	58.3	2513180	58.3	2513207	58.3
TOTAL PERSON	3108189	100.0	3306501	100.0	4314563	100.0	4298396	100.0	4313278	100.0	4313242	100.0	4314561	100.0	4313239	100.0	4313236	100.0	4313392	100.0
TOTAL WORK-RELATED																				
AUTO PERSON	9136330	94.5	9803148	94.7	12788454	94.4	12761545	94.5	12886482	95.1	12855255	94.9	12835815	94.7	12852148	94.9	12850793	94.8	12852512	94.9
TRANSIT PERSON	526814	5.5	544787	5.3	761580	5.6	739316	5.5	662186	4.9	693379	5.1	714218	5.3	696547	5.1	697837	5.2	696147	5.1
AUTO DRIVER	6716851	69.5	7166051	69.3	9052019	66.8	8954786	66.3	9152087	67.5	9134116	67.4	9152569	67.5	9132106	67.4	9131419	67.4	9132276	67.4
TOTAL PERSON	9663144	100.0	10347935	100.0	13550034	100.0	13500861	100.0	13548668	100.0	13548634	100.0	13550033	100.0	13548695	100.0	13548630	100.0	13548659	100.0
TOTAL ALL PURPOSES																				
AUTO PERSON	36213631	96.9	37751066	97.0	48319257	96.2	47910622	96.3	48366424	96.7	48309471	96.6	48460154	96.5	48299608	96.6	48297611	96.6	48299972	96.6
TRANSIT PERSON	1146651	3.1	1183561	3.0	1924215	3.8	1855007	3.7	1641285	3.3	1697794	3.4	1783279	3.5	1707599	3.4	1709652	3.4	1707199	3.4
AUTO DRIVER	23619315	63.2	24802702	63.7	31781519	63.3	31062855	62.4	31399139	62.8	31363174	62.7	31794130	63.3	31357097	62.7	31355860	62.7	31357267	62.7
TOTAL PERSON	37360282	100.0	38934627	100.0	50243472	100.0	49765629	100.0	50007709	100.0	50007265	100.0	50243433	100.0	50007207	100.0	50007263	100.0	50007171	100.0

TABLE 7-8

ALTERNATIVE SYSTEM DAILY MODE OF ARRIVAL/DEPARTURE STATISTICS

ITEM	LPAUP (FEIS '84) Number	%	MRLTR (CEA '84) Number	%	(Rev'd BLOCON2) MOS5 ONLY Rev.1 Number	%	(PA4 VS PA5) MOS5 ONLY Rev.1 Number	%	(LPA Rail Times) MOS5 ONLY Rev.2 Number	%	(Old Paths) MOS5 ONLY Rev.2 Number	%	(XY Sta Dists) MOS5 ONLY Rev.2 Number	%	(LIMITED's Fare) MOS5 ONLY Rev.2 Number	%	MOS5 ONLY Rev.3 Number	%
UNCONSTRAINED																		
Metro Rail:																		
WALK	132565	35.2	105520	29.6	80308	23.9	84828	25.3	85048	23.7	86248	25.0	112177	31.3	112177	31.3		
BUS	188275	49.9	190558	53.5	207018	61.5	197644	59.0	223335	62.2	208490	60.5	195755	54.7	195950	54.8		
KNR	27842	7.4	39220	11.0	29483	8.8	33211	9.9	30275	8.4	30402	8.8	29404	8.2	29358	8.2		
PNR	28353	7.5	21132	5.9	19850	5.9	19377	5.8	20594	5.7	19353	5.6	20586	5.8	20340	5.7		
TOTAL	377035	100.0	356430	100.0	336659	100.0	335060	100.0	359252	100.0	344493	100.0	357922	100.0	357825	100.0		
Total:																		
WALK	132664	34.5	113080	27.5	80766	23.1	85184	24.7	85550	23.0	86750	24.3	112314	30.3	112311	30.3		
BUS	190897	49.7	227267	55.2	210889	60.4	200444	58.2	227327	61.0	212016	59.5	200173	53.9	200382	54.0		
KNR	28428	7.4	43230	10.5	30601	8.8	34040	9.9	31430	8.4	31477	8.8	30574	8.2	30514	8.2		
PNR	32225	8.4	28344	6.9	27009	7.7	24732	7.2	28166	7.6	26385	7.4	28192	7.6	27816	7.5		
TOTAL	384214	100.0	411921	100.0	349265	100.0	344400	100.0	372473	100.0	356628	100.0	371253	100.0	371023	100.0		
CONSTRAINED																		
Metro Rail:																		
WALK	131200	36.4	104829	29.5	79747	24.4	84289	25.8	84439	24.2	85679	25.5	111368	32.0	111379	32.0	112835	32.5
BUS	187931	52.1	199969	56.3	205687	62.8	196591	60.3	221932	63.5	207293	61.7	194490	55.9	194712	55.9	192921	55.6
KNR	28174	7.8	39616	11.2	29807	9.1	33489	10.3	30592	8.8	30712	9.1	29721	8.5	29637	8.5	29018	8.4
PNR	13554	3.8	10581	3.0	12082	3.7	11772	3.6	12539	3.6	12067	3.6	12529	3.6	12431	3.6	12517	3.6
TOTAL	360859	100.0	354995	100.0	327323	100.0	326141	100.0	349502	100.0	335751	100.0	348108	100.0	348159	100.0	347291	100.0
Total:																		
WALK	131299	35.7	112337	28.2	80204	23.7	84645	25.3	84941	23.5	86181	24.9	111504	31.0	111512	31.0	113403	31.6
BUS	190557	51.8	227076	56.9	209630	61.9	199431	59.6	226007	62.6	210880	60.8	198993	55.3	199226	55.4	196794	54.8
KNR	28760	7.8	43659	10.9	31062	9.2	34374	10.3	31893	8.8	31906	9.2	31039	8.6	30923	8.6	30330	8.5
PNR	17416	4.7	15708	3.9	17625	5.2	16023	4.8	18375	5.1	17638	5.1	18387	5.1	18224	5.1	18361	5.1
TOTAL	368032	100.0	398780	100.0	338521	100.0	334473	100.0	361216	100.0	346605	100.0	359923	100.0	359885	100.0	358888	100.0

TABLE 7-9

METRO RAIL ARRIVALS/DEPARTURES BY MODE - DAILY, CONSTRAINED

STATION/MODE	LPAUP('84) Number	%Tot	MRLTR('84) Number	%Tot	MRLTR-LPA	MOS5 ONLY Rev.3 Number	%Tot	MOS5-LPA
1 Union								
WALK	2280	10.7	3985	20.0	1705.0	3093	11.5	813.0
BUS	12925	60.4	9671	48.6	-3254.0	18398	68.6	5473.0
KNR	2171	10.1	2236	11.2	65.0	1637	6.1	-534.0
PNR	4032	18.8	4012	20.2	-20.0	3704	13.8	-328.0
TOTAL	21408	100.0	19904	100.0	-1504.0	26832	100.0	5424.0
2 1st/Hill								
WALK	11380	52.4	10440	41.2	-940.0	12124	49.3	744.0
BUS	10318	47.6	14882	58.8	4564.0	12479	50.7	2161.0
KNR	0	0.0	0	0.0	0.0	0	0.0	0.0
PNR	0	0.0	0	0.0	0.0	0	0.0	0.0
TOTAL	21698	100.0	25322	100.0	3624.0	24603	100.0	2905.0
3 5th/Hill								
WALK	21625	56.5	19615	47.6	-2010.0	28015	59.1	6390.0
BUS	16659	43.5	21606	52.4	4947.0	19384	40.9	2725.0
KNR	0	0.0	0	0.0	0.0	0	0.0	0.0
PNR	0	0.0	0	0.0	0.0	0	0.0	0.0
TOTAL	38284	100.0	41221	100.0	2937.0	47399	100.0	9115.0
4 7th/Flower								
WALK	10217	27.5	8184	21.9	-2033.0	9694	26.6	-523.0
BUS	26983	72.5	29236	78.1	2253.0	26717	73.4	-266.0
KNR	0	0.0	0	0.0	0.0	0	0.0	0.0
PNR	0	0.0	0	0.0	0.0	0	0.0	0.0
TOTAL	37200	100.0	37420	100.0	220.0	36411	100.0	-789.0
5 Alvarado								
WALK	20632	49.1	17527	55.2	-3105.0	15808	58.0	-4824.0
BUS	13933	33.2	4140	13.0	-9793.0	3755	13.8	-10178.0
KNR	7444	17.7	10092	31.8	2648.0	7704	28.3	260.0
PNR	0	0.0	0	0.0	0.0	0	0.0	0.0
TOTAL	42009	100.0	31759	100.0	-10250.0	27267	100.0	-14742.0
6 Vermont								
WALK	15879	43.6	11002	30.2	-4877.0	12670	36.3	-3209.0
BUS	17078	46.9	17198	47.2	120.0	17458	50.0	380.0
KNR	3479	9.5	8218	22.6	4739.0	4769	13.7	1290.0
PNR	0	0.0	0	0.0	0.0	0	0.0	0.0
TOTAL	36436	100.0	36418	100.0	-18.0	34897	100.0	-1539.0

(CONTINUED)

TABLE 7-9 (CONTINUED:2)

METRO RAIL ARRIVALS/DEPARTURES BY MODE - DAILY, CONSTRAINED

STATION/MODE	LPAUP('84) Number	LPAUP('84) %Tot	MRLTR('84) Number	MRLTR('84) %Tot	MRLTR-LPA	MOS5 ONLY Rev.3 Number	MOS5 ONLY Rev.3 %Tot	MOS5-LPA
7 Normandie								
WALK	4956	36.1	5477	23.3	521.0	3366	48.7	-1590.0
BUS	6179	45.1	14942	63.5	8763.0	1258	18.2	-4921.0
KNR	2580	18.8	3111	13.2	531.0	2290	33.1	-290.0
PNR	0	0.0	0	0.0	0.0	0	0.0	0.0
TOTAL	13715	100.0	23530	100.0	9815.0	6914	100.0	-6801.0
8 Western								
WALK	9091	36.4	1859	12.0	-7232.0	4469	18.3	-4622.0
BUS	13169	52.8	9528	61.3	-3641.0	17024	69.8	3855.0
KNR	2687	10.8	4144	26.7	1457.0	2900	11.9	213.0
PNR	0	0.0	0	0.0	0.0	0	0.0	0.0
TOTAL	24947	100.0	15531	100.0	-9416.0	24393	100.0	-554.0
9 Crenshaw								
WALK	3503	26.9	2813	23.1	-690.0	2211	25.5	-1292.0
BUS	6900	52.9	5115	42.0	-1785.0	3752	43.3	-3148.0
KNR	2633	20.2	4248	34.9	1615.0	2694	31.1	61.0
PNR	0	0.0	0	0.0	0.0	0	0.0	0.0
TOTAL	13036	100.0	12176	100.0	-860.0	8657	100.0	-4379.0
10 La Brea								
WALK	3745	33.7	4113	30.6	368.0	1772	22.4	-1973.0
BUS	6268	56.4	7046	52.5	778.0	4513	57.0	-1755.0
KNR	1098	9.9	2274	16.9	1176.0	1626	20.6	528.0
PNR	0	0.0	0	0.0	0.0	0	0.0	0.0
TOTAL	11111	100.0	13433	100.0	2322.0	7911	100.0	-3200.0
11 Fairfax								
WALK	4277	21.8	2695	13.6	-1582.0	1881	9.4	-2396.0
BUS	12408	63.2	13612	68.7	1204.0	14549	72.8	2141.0
KNR	1141	5.8	1470	7.4	329.0	1501	7.5	360.0
PNR	1818	9.3	2044	10.3	226.0	2057	10.3	239.0
TOTAL	19644	100.0	19821	100.0	177.0	19988	100.0	344.0
12 Beverly								
WALK	3820	35.2	1626	15.7	-2194.0	2537	16.9	-1283.0
BUS	5319	49.1	7908	76.5	2589.0	10765	71.7	5446.0
KNR	363	3.3	91	0.9	-272.0	370	2.5	7.0
PNR	1342	12.4	711	6.9	-631.0	1334	8.9	-8.0
TOTAL	10844	100.0	10336	100.0	-508.0	15006	100.0	4162.0

(CONTINUED)

TABLE 7-9 (CONTINUED:3)

METRO RAIL ARRIVALS/DEPARTURES BY MODE - DAILY, CONSTRAINED

STATION/MODE	LPAUP('84) Number	LPAUP('84) %Tot	MRLTR('84) Number	MRLTR('84) %Tot	MRLTR-LPA	MOS5 ONLY Rev.3 Number	MOS5 ONLY Rev.3 %Tot	MOS5-LPA
13 Santa Monica								
WALK	3031	19.0	2278	14.3	-753.0	1899	18.0	-1132.0
BUS	12190	76.5	12358	77.4	168.0	8143	77.2	-4047.0
KNR	714	4.5	1337	8.4	623.0	500	4.7	-214.0
PNR	0	0.0	0	0.0	0.0	0	0.0	0.0
TOTAL	15935	100.0	15973	100.0	38.0	10542	100.0	-5393.0
14 Sunset (19 in LPA)								
WALK	4588	54.7	4247	48.8	-341.0	4188	45.1	-400.0
BUS	3366	40.1	4041	46.4	675.0	4461	48.1	1095.0
KNR	439	5.2	414	4.8	-25.0	634	6.8	195.0
PNR	0	0.0	0	0.0	0.0	0	0.0	0.0
TOTAL	8393	100.0	8702	100.0	309.0	9283	100.0	890.0
15 Cahuenga (14 in LPA)								
WALK	8001	56.9	6779	50.4	-1222.0	6857	45.1	-1144.0
BUS	4992	35.5	5682	42.2	690.0	6975	45.9	1983.0
KNR	1064	7.6	988	7.3	-76.0	1360	9.0	296.0
PNR	0	0.0	0	0.0	0.0	0	0.0	0.0
TOTAL	14057	100.0	13449	100.0	-608.0	15192	100.0	1135.0
16 Hollywood Bowl (15 in LPA)								
WALK	1449	34.3	81	2.9	-1368.0	526	22.1	-923.0
BUS	2015	47.7	2352	84.4	337.0	1735	72.9	-280.0
KNR	762	18.0	354	12.7	-408.0	119	5.0	-643.0
PNR	0	0.0	0	0.0	0.0	0	0.0	0.0
TOTAL	4226	100.0	2787	100.0	-1439.0	2380	100.0	-1846.0
17 Universal (16 in LPA)								
WALK	2154	13.3	1731	11.8	-423.0	1437	8.3	-717.0
BUS	9433	58.1	11547	78.7	2114.0	12552	72.1	3119.0
KNR	1095	6.7	226	1.5	-869.0	503	2.9	-592.0
PNR	3564	21.9	1175	8.0	-2389.0	2912	16.7	-652.0
TOTAL	16246	100.0	14679	100.0	-1567.0	17404	100.0	1158.0

(CONTINUED)

TABLE 7-9 (CONTINUED:4)

METRO RAIL ARRIVALS/DEPARTURES BY MODE - DAILY, CONSTRAINED

STATION/MODE	LPAUP('84) Number	LPAUP('84) %Tot	MRLTR('84) Number	MRLTR('84) %Tot	MRLTR-LPA	MOS5 ONLY Rev.3 Number	MOS5 ONLY Rev.3 %Tot	MOS5-LPA
18 North Hollywood (17 in LPA)								
WALK	572	4.9	377	3.0	-195.0	288	2.4	-284.0
BUS	7796	66.8	9105	72.6	1309.0	9003	73.7	1207.0
KNR	504	4.3	413	3.3	-91.0	411	3.4	-93.0
PNR	2798	24.0	2639	21.1	-159.0	2510	20.6	-288.0
TOTAL	11670	100.0	12534	100.0	864.0	12212	100.0	542.0
TOTAL METRO RAIL								
WALK	131200	36.4	104829	29.5	-26371.0	112835	32.5	-18365.0
BUS	187931	52.1	199969	56.3	12038.0	192921	55.6	4990.0
KNR	28174	7.8	39616	11.2	11442.0	29018	8.4	844.0
PNR	13554	3.8	10581	3.0	-2973.0	12517	3.6	-1037.0
TOTAL	360859	100.0	354995	100.0	-5864.0	347291	100.0	-13568.0

Tables 7-4, 7-5 and 7-6 are produced as checks on the preparation of the alternative system network and related processing. These exhibits indicate the expected differences among the network statistics. As shown in Table 7-4, the only difference between the two MOS-5 ONLY networks is in the number of walk (M1) links. Both MOS5 ONLY networks have fewer walk and auto-access (M2 & M3) links than does the LPAUP network. This is due in part to the more rigorous application of the coding standards established by CSI and in part to the greater efficiency of the automated coding process which eliminates duplicative links.

Table 7-5 reflects the change in convention for coding walk links -- from the use of minimum times to the use of average times. This results in a two- to three-minute increase in walk times on the average. This exhibit also reflects the change in path selection parameters, which results in a higher level of transfers and tends to produce greater use of rail. Table 7-6 shows a similar pattern, with the MOS-5 ONLY network having fewer nontransfer interchanges and more total interchanges provided with transit service compared to the LPAUP network.

Table 7-7 compared mode choice model results for the two MOS-5 ONLY runs -- the LPAUP forecast and 1980 model calibration output. The MOS-5 ONLY forecasts are more conservative than the earlier LPAUP forecast. The LPAUP forecast shows an increase in the proportion of work trips made by transit, whereas the MOS5 forecast shows a decline relative to 1980. Each of the forecasts indicates an increase in the proportion of nonwork trips by transit, but the increase is more modest for MOS5. The two forecasts for MOS5 clearly indicate the impact of the "unconnected zones problem" on the transit submode shares. The recalibration of the model, based on the transit network with many incorrectly unconnected zones, distorts the balance between walk and auto access in the first MOS5 forecast. Even after the proper recalibration, MOS5 is forecast to have somewhat lower levels of auto access relative to LPAUP -- in terms of both absolute number and submodal proportions. Overall, the revised MOS-5 ONLY forecast of transit ridership is 1.7 million daily riders compared to the 1.9 million figure forecast for LPAUP.

Table 7-8 and 7-9 summarize Mode-of-Arrival results. The most striking result is the reduction in walk arrivals. This reflects a combination of lower ridership overall, and a shift from walk to bus caused by the change in walk-link coding from minimum to average times. Table 7-9 also indicates substantial differences at the station level. The greatest differences are for stations where both walk and bus access are substantially lower for MOS-5 ONLY, relative to LPAUP. These stations include: Alvarado, Normandie, Crenshaw, La Brea and Santa Monica. In addition, a substantially lower park-ride estimate is evident for the Universal station. These differences are directly related to the more stringent adherence to network-coding standards. In earlier networks, it was common to have walk and auto access links longer than the standard maxima connected directly to station nodes. In the case of walk links longer than 0.5 miles, the nonwork trips estimated in the mode choice model to use transit would be assigned a bus mode of arrival in the mode-of-arrival model. To the extent that this occurred in the LPAUP forecast but not in the MOS5 forecast, it will show up as lower bus arrivals in the MOS5 forecast -- even if there was no real change in bus services.

APPENDICES

APPENDIX 1

ZONE DISTRICT EQUIVALENTS

```
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 &EQUIV  DIST= 617,ZCNE= 617 &END                                         0617000
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 &EQUIV  DIST= 619,ZCNE= 619,1526  &END                                   0619000
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 &EQUIV  DIST= 623,ZCNE= 623,1528  &END                                   0623000
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 &EQUIV  DIST= 667,ZCNE= 667,1549  &END                                   06670008
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 &EQUIV   DIST= 845,ZONE= 845,1627  &END                                  08450008
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   QUIV   DIST= 893,ZONE= 893 &END                                        08930006
 &EQUIV   DIST= 894,ZONE= 894 &END                                        08940006
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 &EQUIV  DIST= 951,ZCNE= 951 &END                                       09510006
 &EQUIV  DIST= 952,ZCNE= 952 &END                                       09520006
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 &EQUIV  DIST=1015,ZONE=1015 &END                                       10150006
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 &EQUIV  DIST=1017,ZONE=1017 &END                                       10170006
 &EQUIV  DIST=1018,ZONE=1018 &END                                       10180006
 &EQUIV  DIST=1019,ZONE=1019 &END                                       10190006
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 &EQUIV   DIST=1180,ZCNE=1180 &END                                       11800006
```

```
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   10:42:02    09/30/86    MRPGP1       MRPSTT.TSC.CNTL(EQVLST2)
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 &EQUIV   DIST=1304,ZONE=1304  &END                                      1304000
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 &EQUIV   DIST=1306,ZONE=1306  &END                                      1306000
 &EQUIV   DIST=1307,ZONE=1307  &END                                      1307000
 &EQUIV   DIST=1308,ZONE=1308  &END                                      1308000
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APPENDIX 2

PREPARATION OF PERSON-TRIP TABLES AND HIGHWAY SKIMS FOR MODE CHOICE MODEL INPUT, 1980 AND 2000

This appendix describes the steps undertaken to develop the revised 1980 and 2000 person-trip tables and highway skims for mode choice model input. The content is based on a memo prepared by A. Kumar, dated Febrary 24, 1984. Following are important notes regarding the development process.

- Consistent with the SCAG/CALTRANS procedure, the highway skims used for trip distribution include access times and terminal times at both the production and attraction end of each trip interchange, except for interzonal cells to which no access or terminal times are added.

- No 1.15 factor is applied to the interzonal times.

- Work trips are distributed on peak travel times, and nonwork trips on off-peak times.

- Care must be taken to insure the correct sequencing of trip ends and friction factors for nonwork distribution. The usual sequence is: home-to-other, other-to-other, and home-to-shop (HOOOHS).

- Consistent with the CSI mode choice model derivation, the 1,628-zone highway skims do not contain access and terminal times. These are input to the mode choice models as trip-end variables and added during the calculation of modal utilities.

- Figures 1 and 2 depict creation of the 1980 1,325-zone person-trip tables. Expansion of the 1,325-zone person-trip tables and highway skims to the 1,628-zone system is charted in Figures 3 through 7, for 1980. Figures 8 through 14 document the same process for the year 2000.

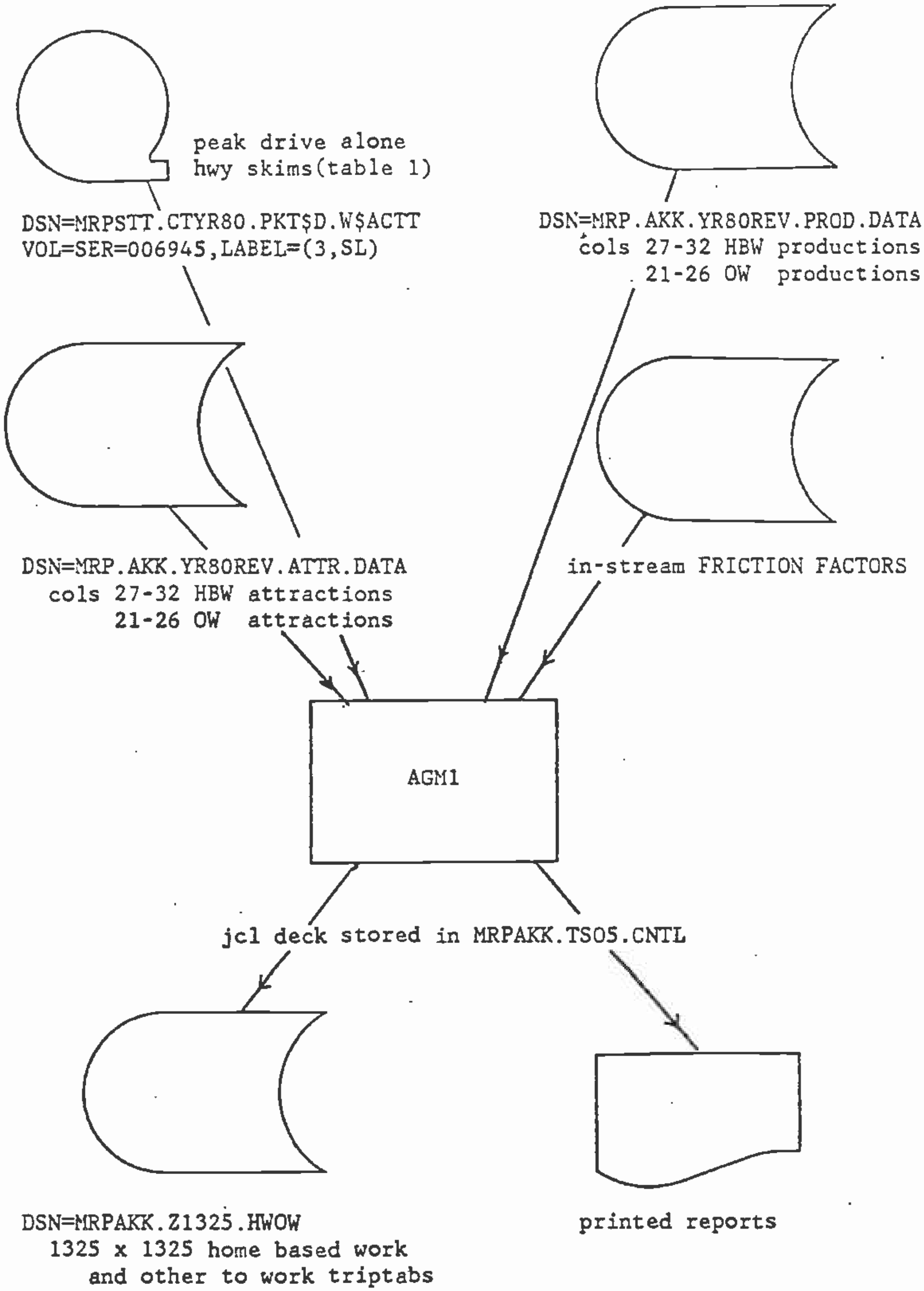


Figure 1. Creation of 1325 x 1325 Home Based Work and Other to Work Tables-1980

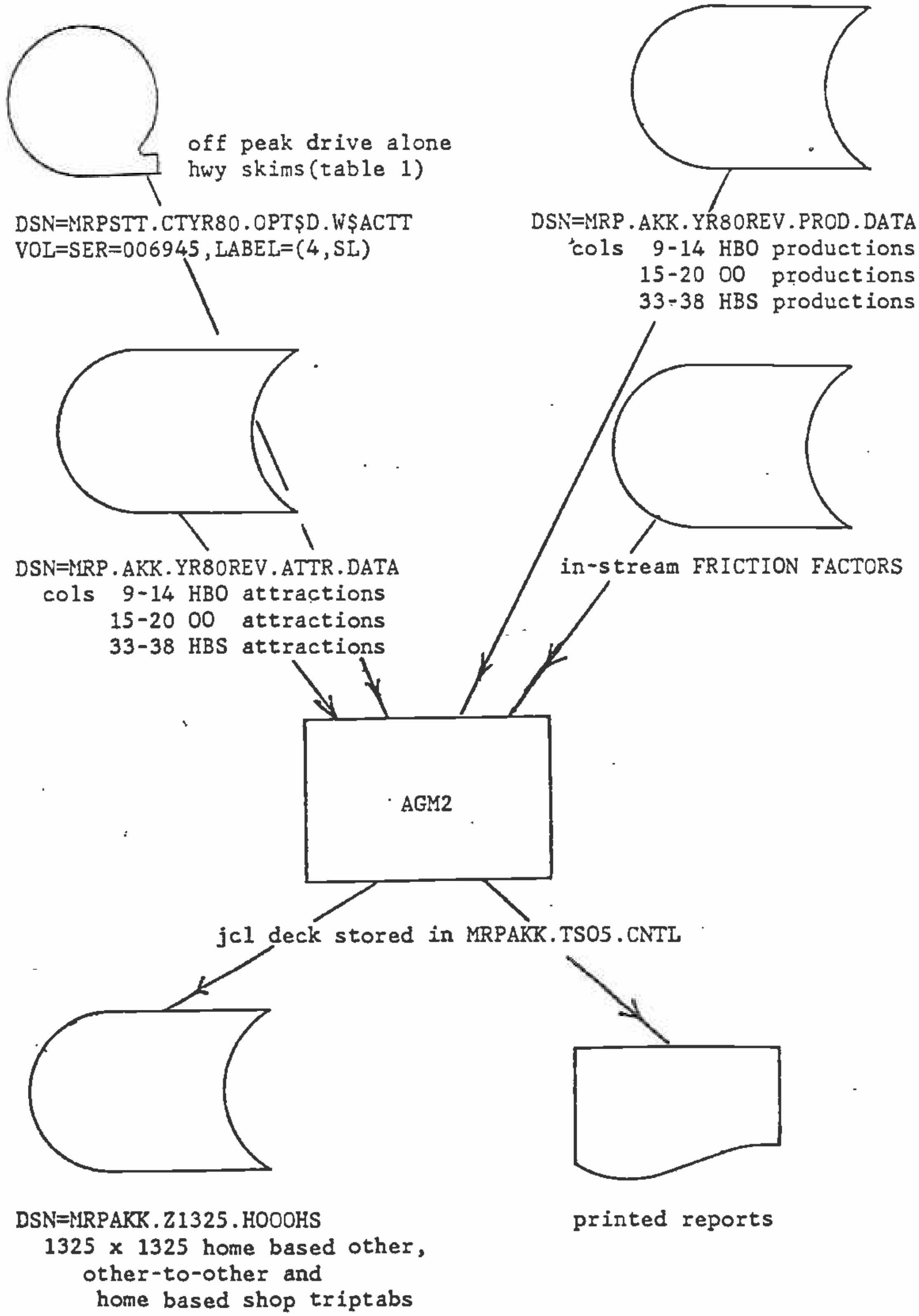


Figure 2.Creation of Home to Oth.,Oth.to Oth. and Home to shop tables - 1980

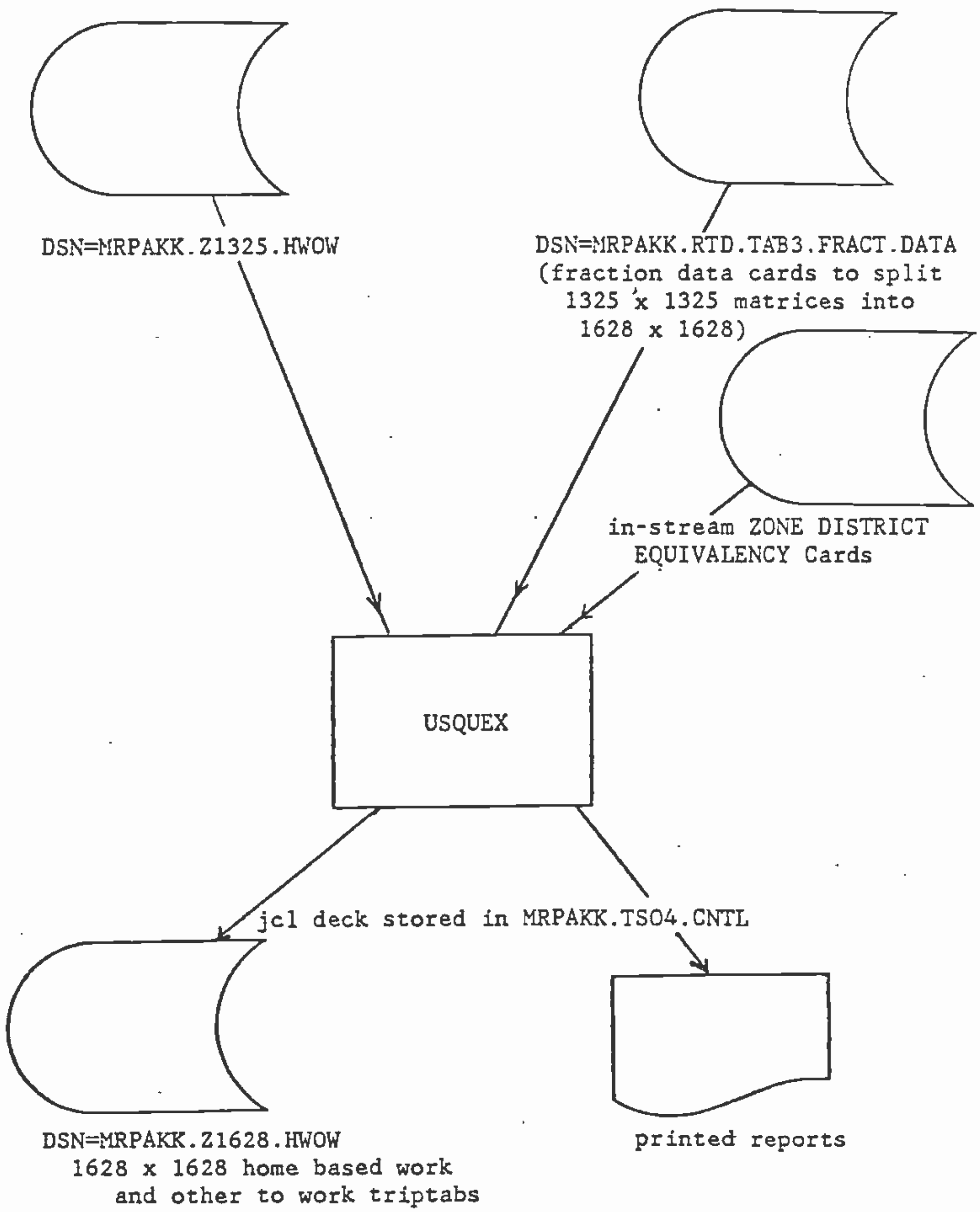


Figure 3.Expansion of 1325 x 1325 HBW and OW Trip Tables into 1628 x 1628-1980

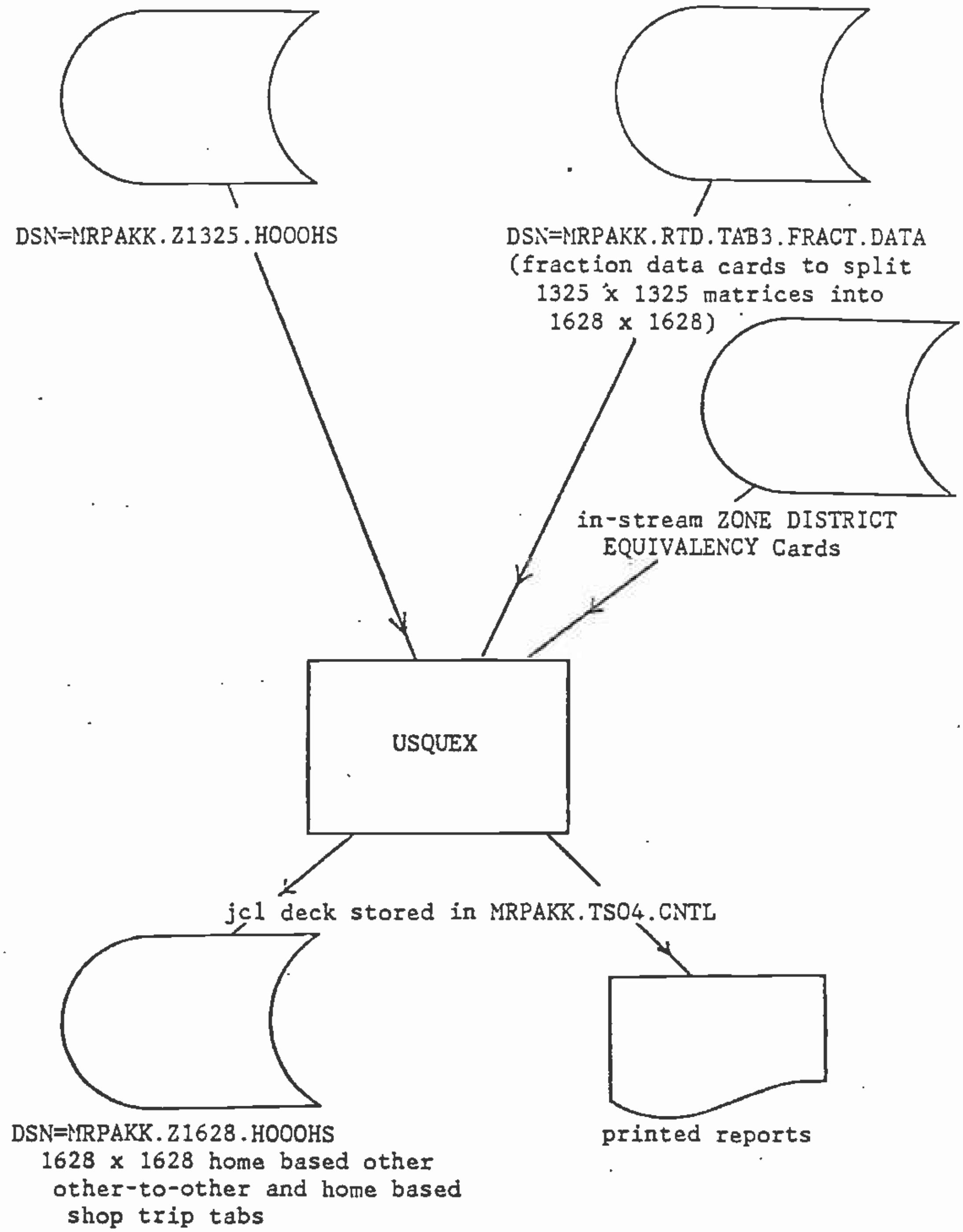


Figure 4.Expansion of 1325 x 1325 HBW, OO, HBS Tables into 1628 x 1628 -1980

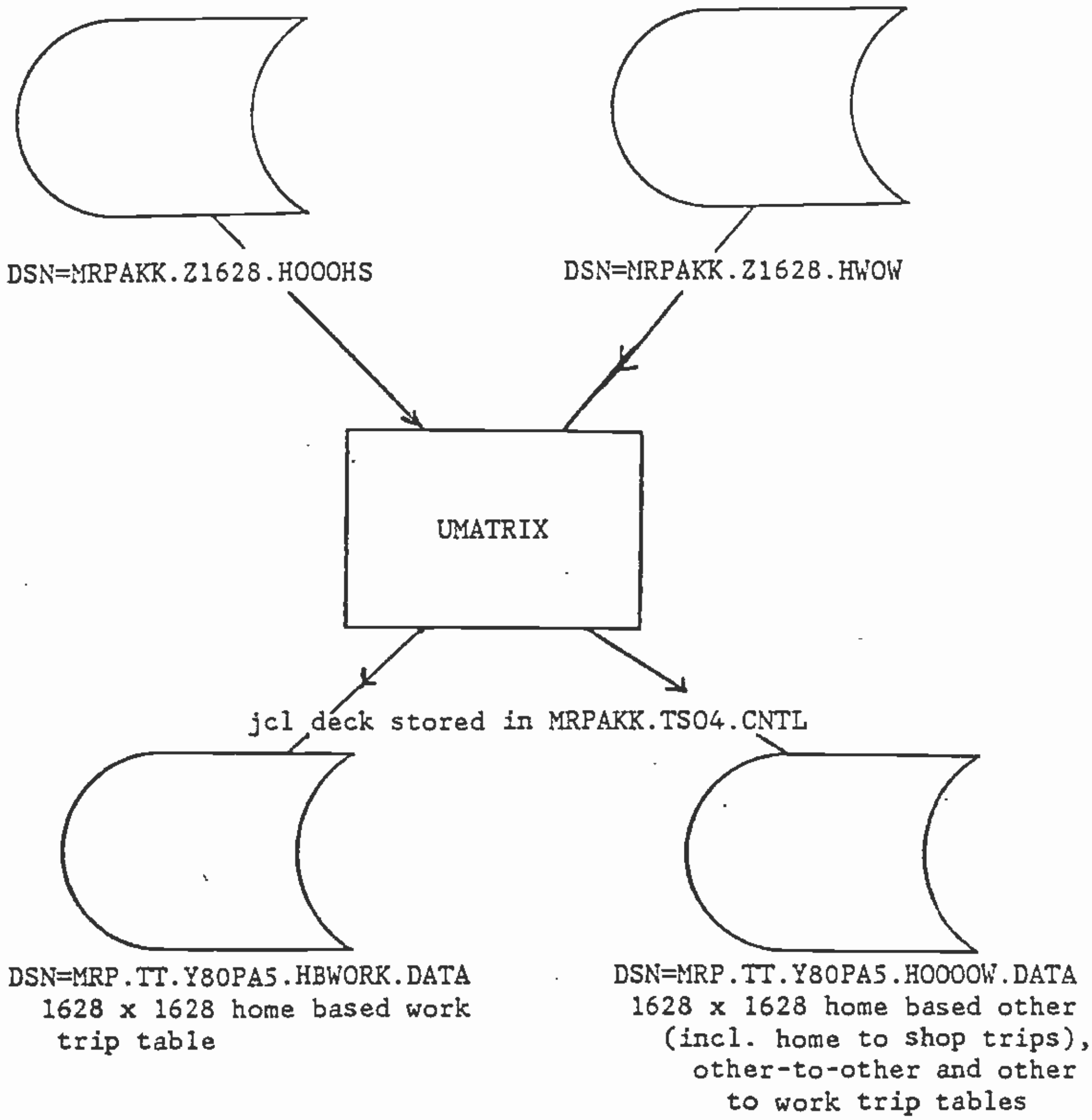
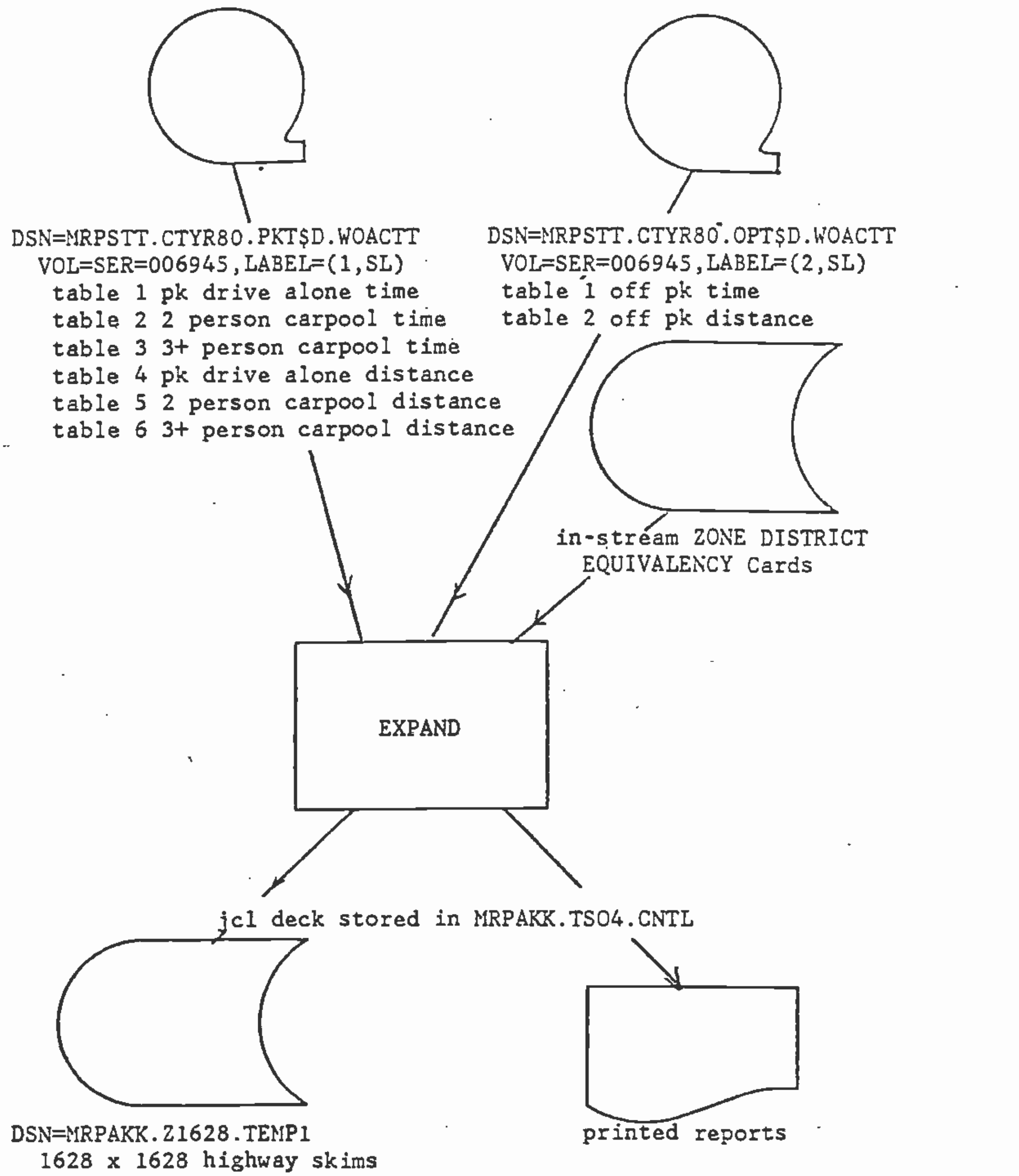
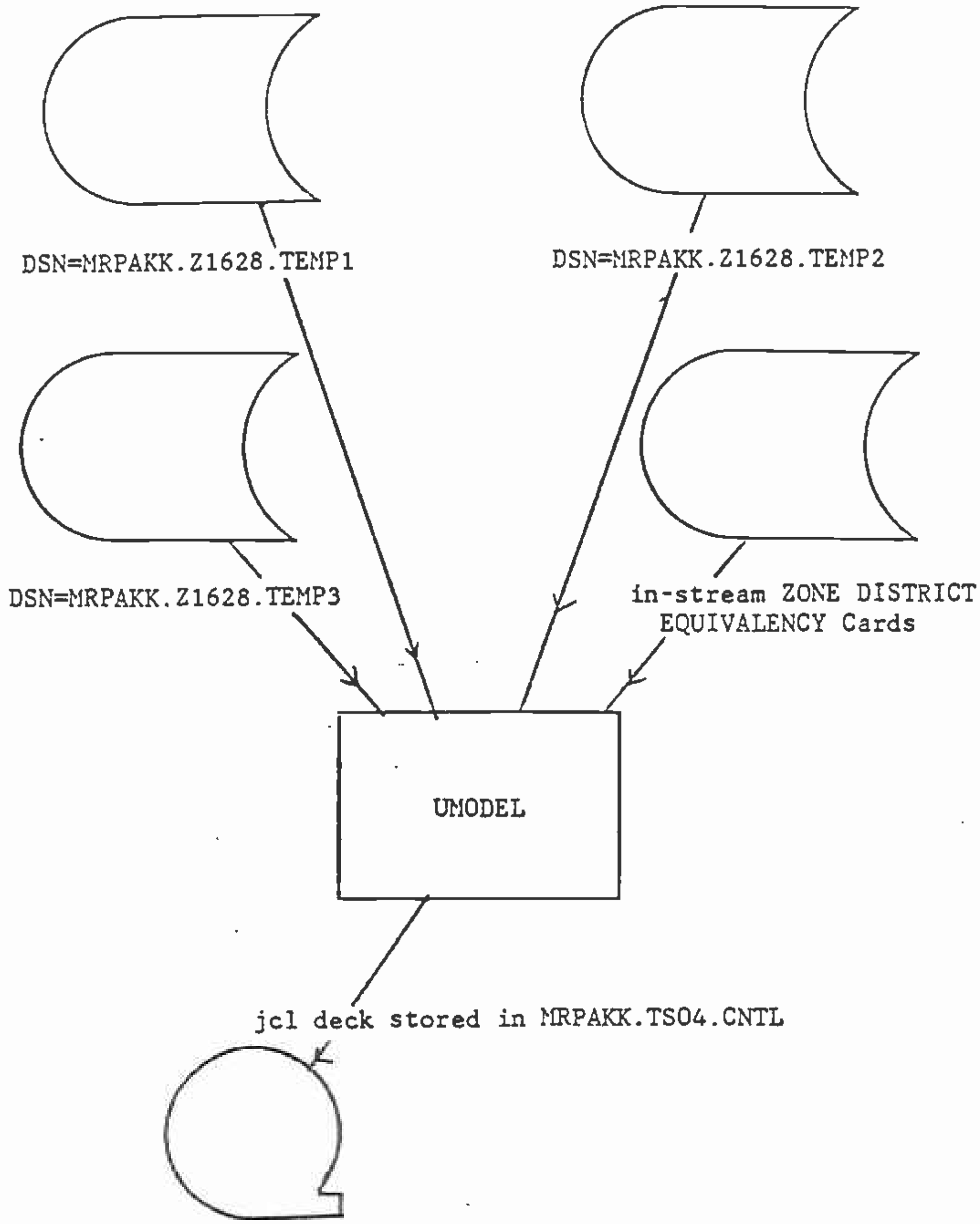


Figure 5.Creation of 1628 x 1628 HBW,HO,OO,OW Tables for Mode Choice Analysis



Note: The Processing is done 3 times as USQUEX can handle only 3 matrices at a time properly. Temporary data sets TEMP1, TEMP2, P3 and TEMP3 are created.

Figure 6.Expansion of 1325 x 1325 Hwy time and dist. skim into 1628 x 1628



DSN=MRP.Y82Z1628.H8,VOL=SER=005552,LABEL=(1,SL)
1628 x 1628 highway skims

table 1 pk drive alone time	table 5 pk 3 person carpool time
table 2 pk drive alone dist	table 6 pk 3 person carpool dist
table 3 pk 2 person carpool time	table 7 off peak time
table 4 pk 2 person carpool dist	table 8 off peak distance

Figure 7.Adjustments to 1628 x 1628 time and distance highway skims-1980

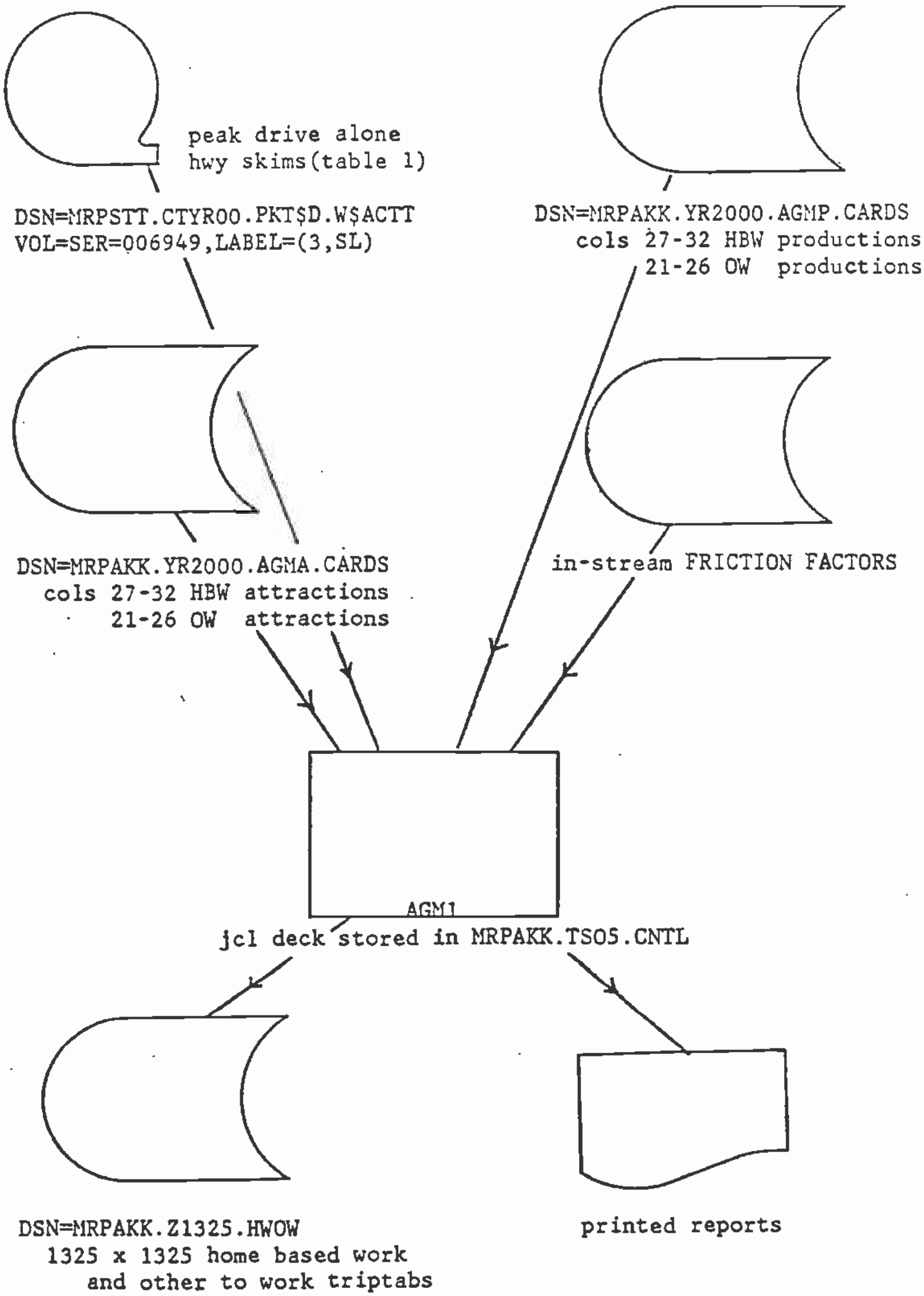


Figure 8.Creation of 1325 x 1325 HW,OW Person Trip Tables- Year 2000

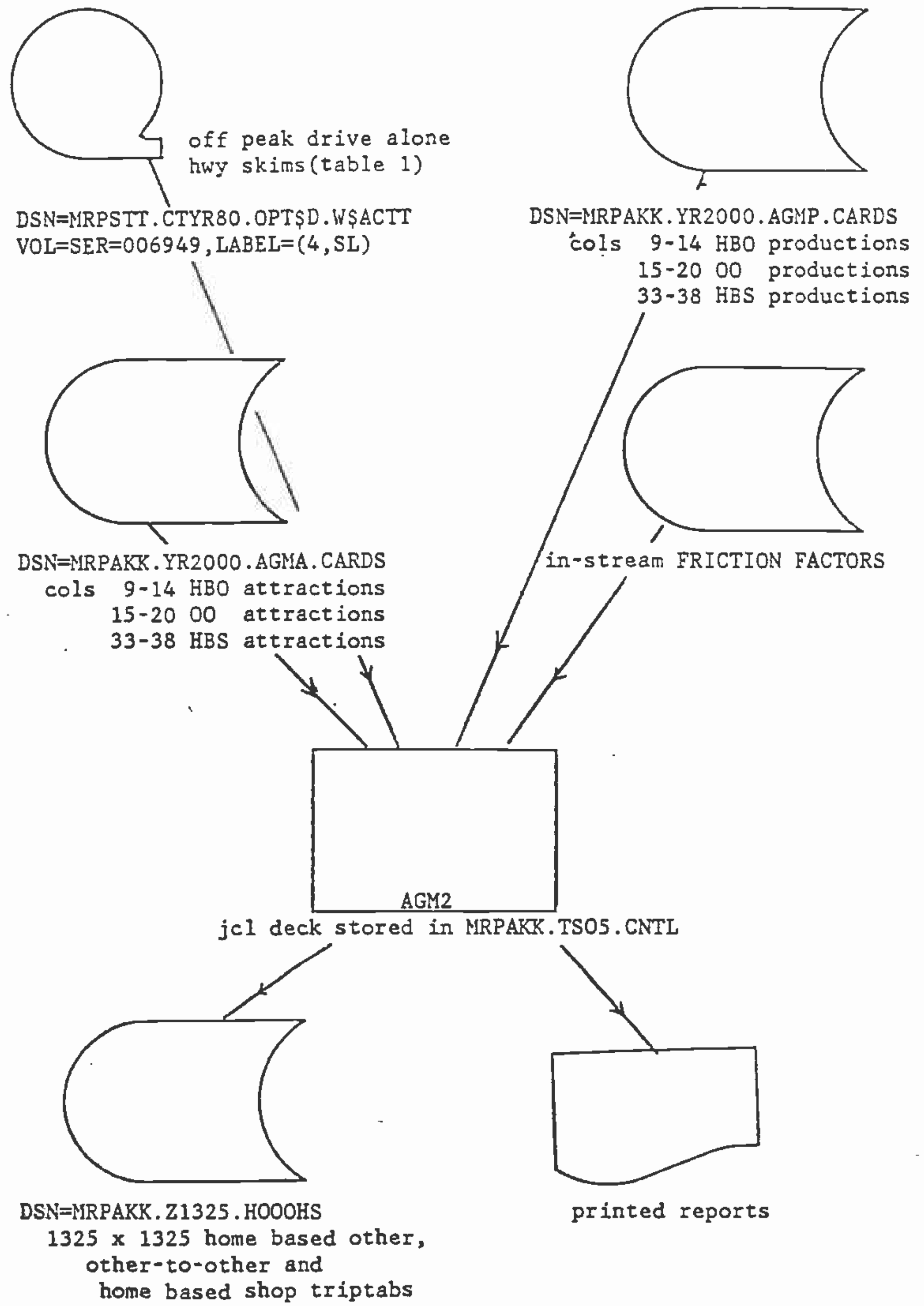


Figure 9.Creation of 1325 x 1325 HO,OO,HS person trip tables-Year 2000

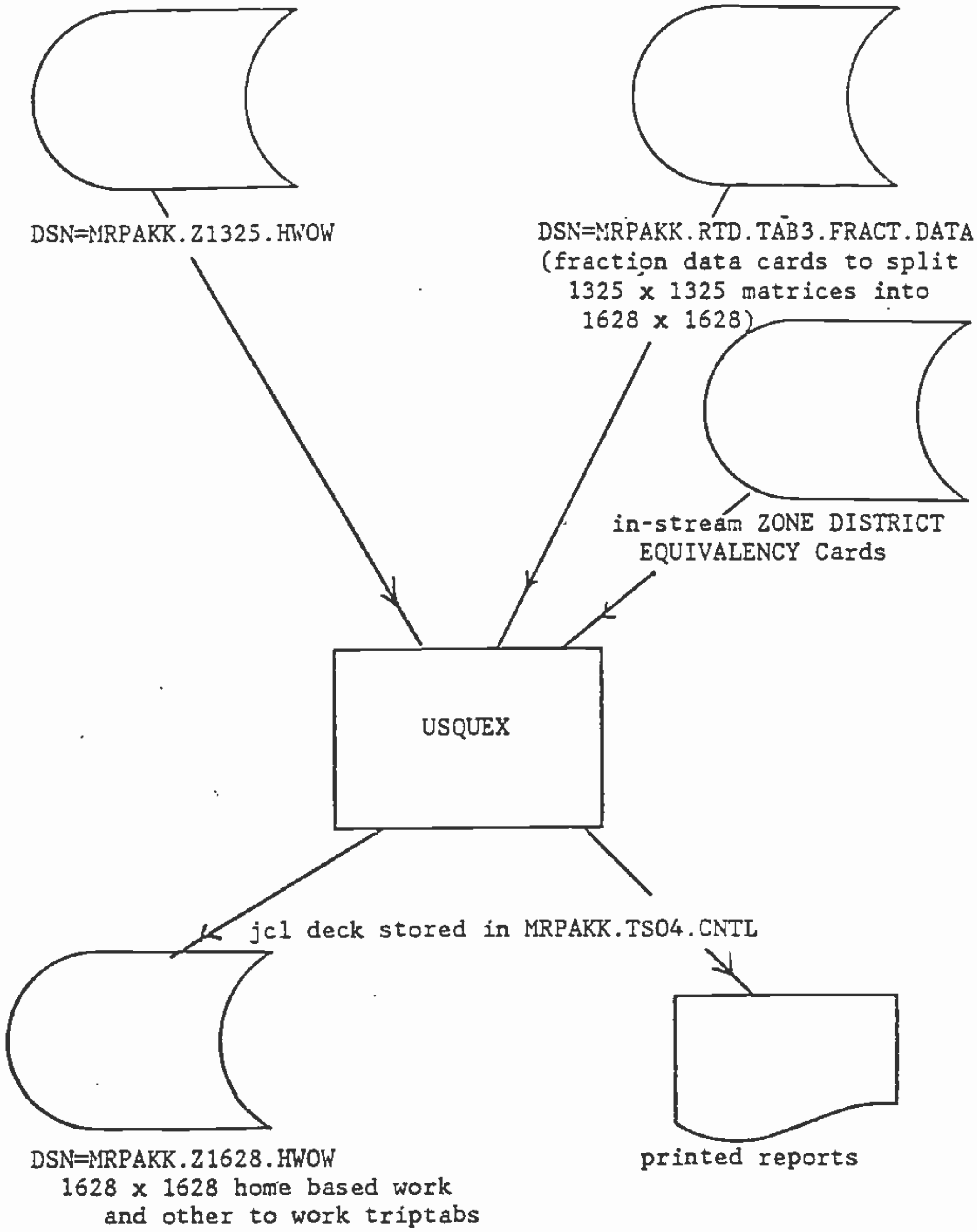


Figure 10.Expansion of 1325 x 1325 HBW and OW Trip Tables into 1628 x 1628-2000

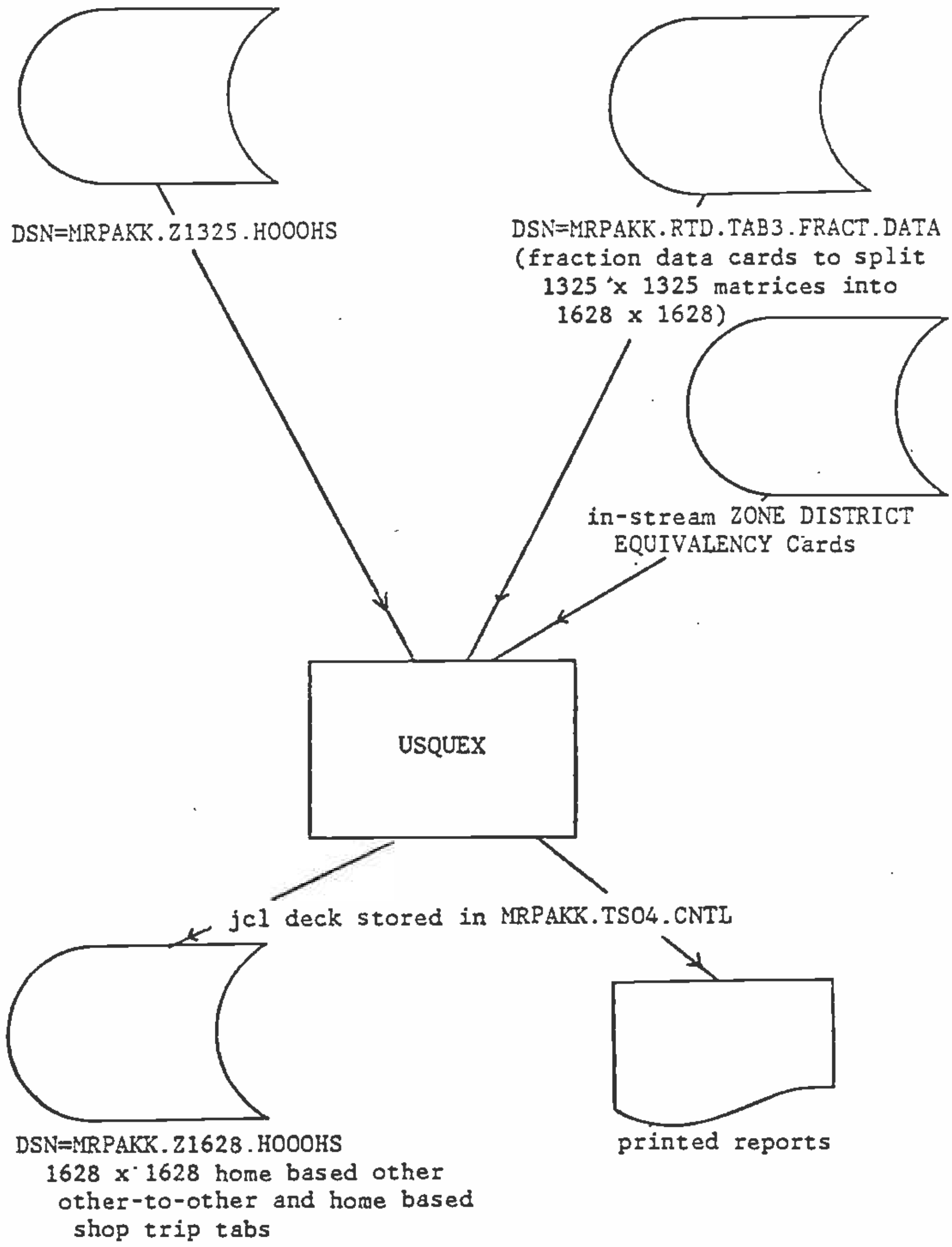


Figure 11. Expansion of 1325 x 1325 HBW, OO, HBS Tables into 1628 x 1628 - 2000

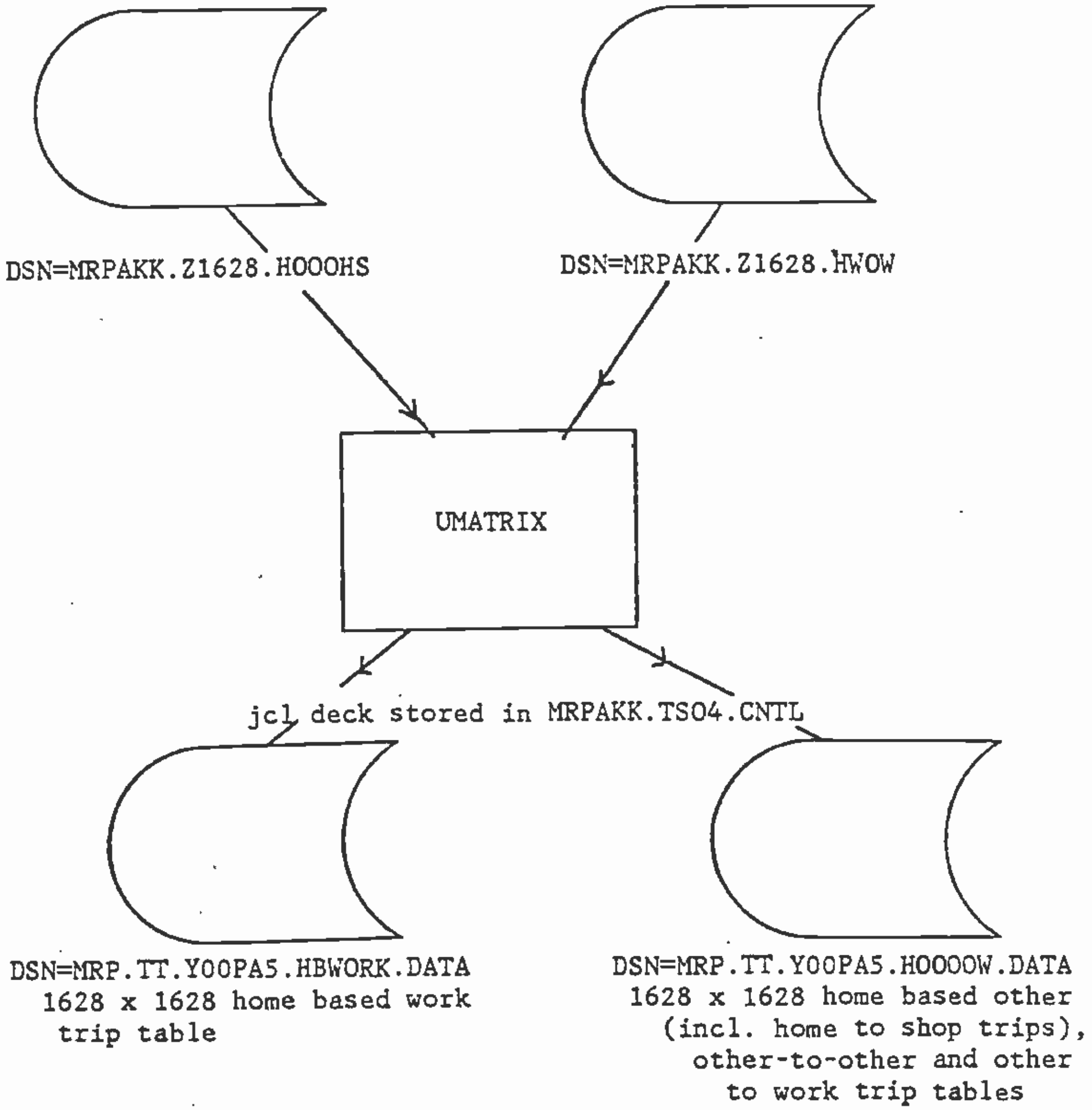
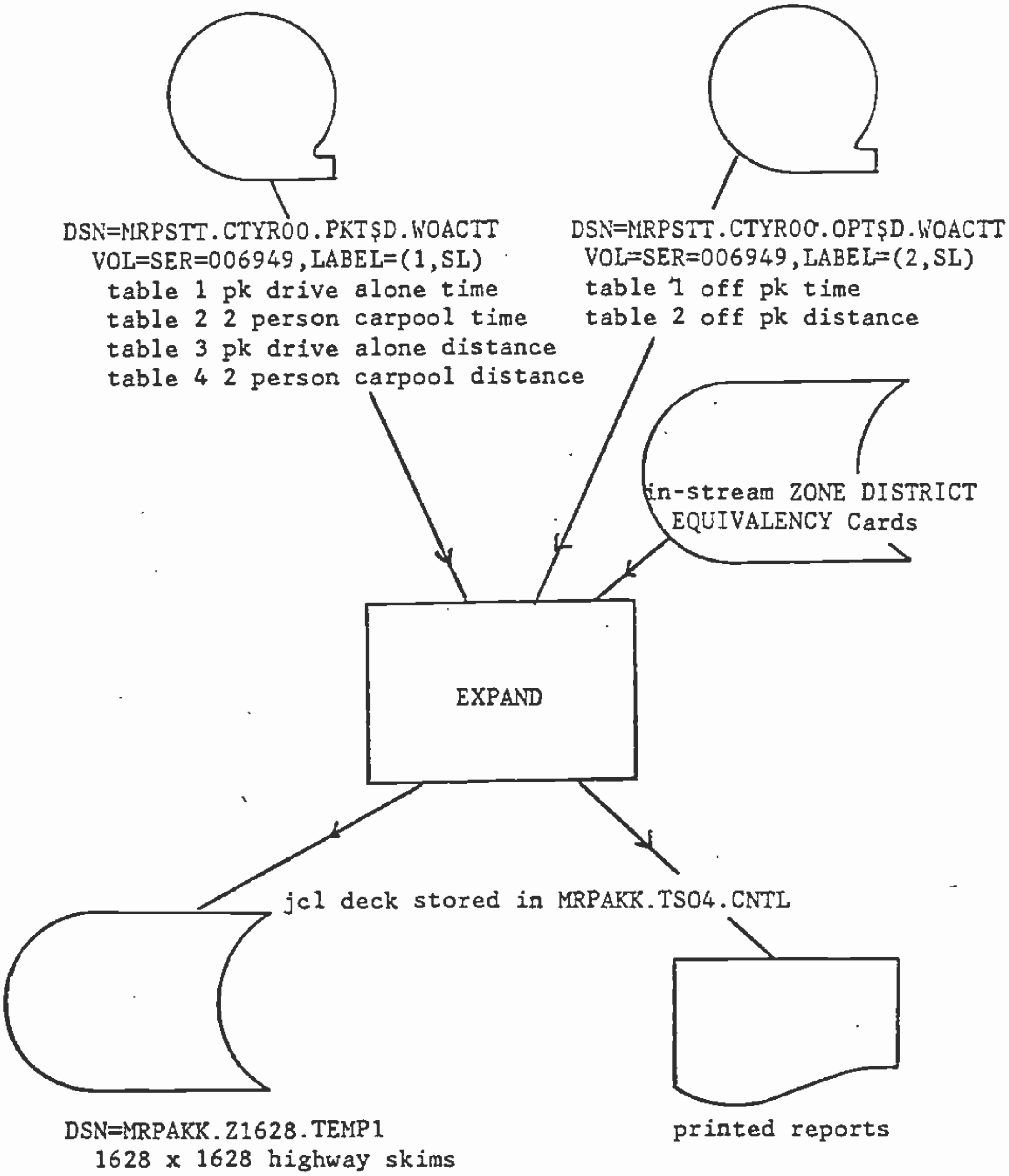
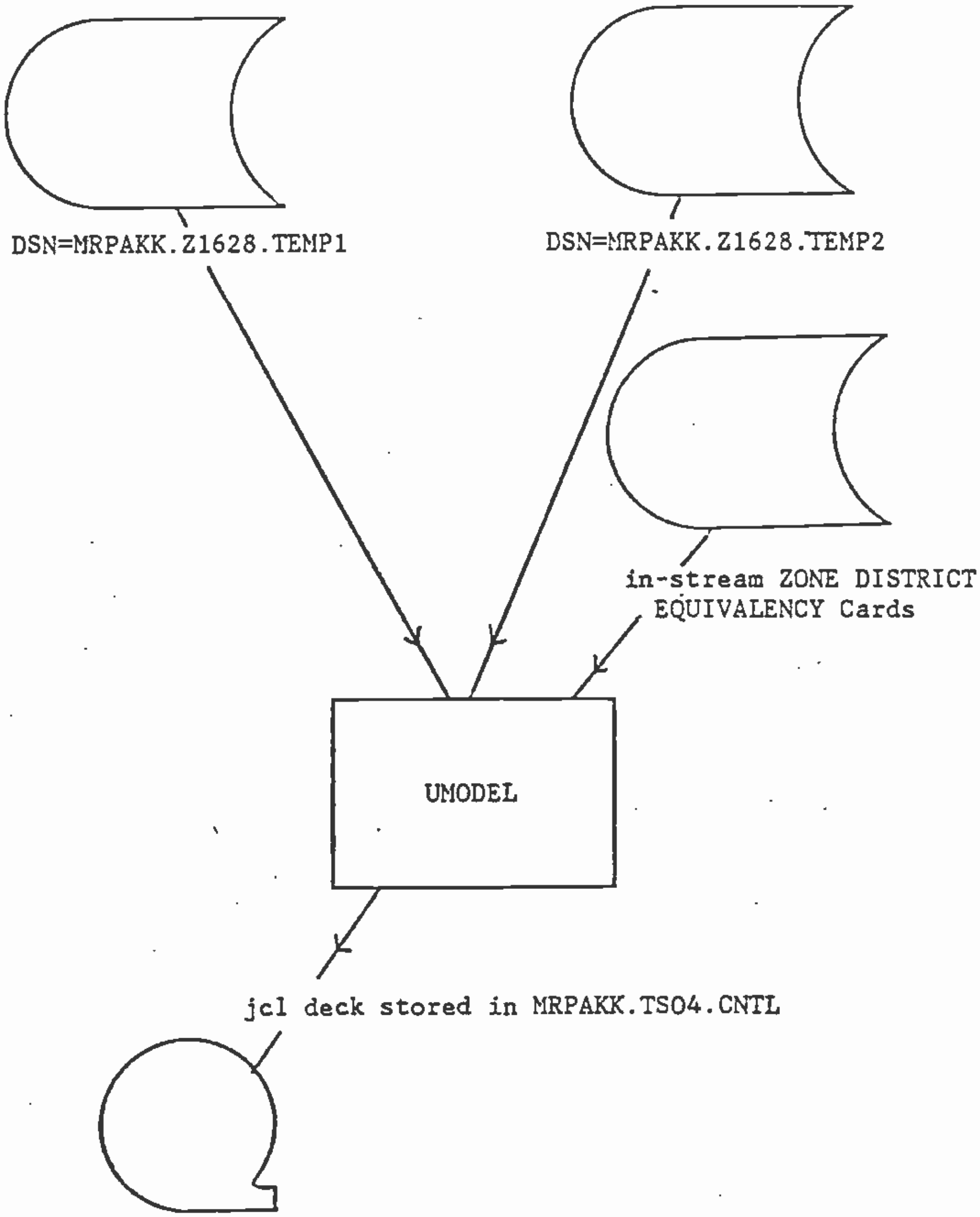


Figure 12.Creation of 1628 x 1628 HBW,HO,OO,OW Tables for Mode Choice Analysis



Note: The Processing is done 2 times as USQUEX can handle only 3 matrices at a time properly. Temporary data sets TEMP1, TEMP2 P3 are created.Three(3+)person carpool time and distance skims are identical to those of 2 person carpool.

Figure 13.Expansion of 1325 x 1325 Hwy time and dist. skim into 1628 x 1628



DSN=MRP.Y20Z1628.H8,VOL=SER=005567,LABEL=(1,SL)
1628 x 1628 highway skims

table 1 pk drive alone time	table 5 pk 3 person carpool time
table 2 pk drive alone dist	table 6 pk 3 person carpool dist
table 3 pk 2 person carpool time	table 7 off peak time
table 4 pk 2 person carpool dist	table 8 off peak distance

Figure 14. Adjustments to 1628 x 1628 time and distance highway skims-2000

APPENDIX 3

USTATION INPUT

K.L.K.

MAY 17 1984

MEMORANDUM

TO : Distribution Date: 5/11/84

FROM : Stephen Tung

SUBJECT : Various Highway Link and Skim Data Files

This Memorandum describes various data sets created to carry out HR/UROAD/USTATION/UMINDIST modeling steps, prior to running the Mode-of-Arrival program. The 1325 x 1325 highway time and distance skims received from CALTRANS are also described.

A. The following data sets were created by using CALTRANS' highway network (YEAR 1995) as a base to modify and add access links to reflect 1628 zone structures :

(1) DSN=MRPSTT.YR2000.HWYLINK.NOV1683,UNIT=3380 (cataloged)
UTPS highway link card format with 1628 zones

(2) DSN=MRPSTT.YR2000.HWYLINK.BA1BASE,UNIT=3380 (cataloged)
This was an output file from a FORTRAN program <MRPSTT.TSO3.CNTL(HWYBASE)> which re-numbered node numbers from 1629 to 2028 to make rooms for adding rail stations and park'n'ride lots. Node numbers exceeding 8191 were re-numbered also. This file is in UTPS highway link card format.

(3) DSN=MRPSTT.BA1BASE.STA400,UNIT=3380 (cataloged)
UTPS highway link card format with 1628 zones , 192 rail stations and 21 park'n'ride lots. (Attachment 1 provides a list of station numbers and description of stop locations.)

(4) DSN=MRPSTT.BA1BASE.HR,UNIT=3380 (cataloged)
UTPS HR format with 1628 zones , 192 rail stations and 21 park'n'ride lots.

B. The following highway skim files (1325 zone system) were provided by CALTRANS on tape :

(1) VOL=SER=008637

a. LABEL=1,DSN=MRPSTT.CTYR00.PKT$D.WOACTT
LARTS YAER 2000 Highway Time And Distance File (without access and terminal times added)
TABLE 1 : Peak Standard (drive alone) Highway Time
TABLE 2 : Peak Carpool (3+) Highway Time
TABLE 3 : Peak Standard (drive alone) Highway Distance
TABLE 4 : Peak Carpool (3+) Highway Distance

b. LABEL=2,DSN=MRPSTT.CTYR00.OPT$D.WOACTT
LARTS YAER 2000 Highway Time And Distance File (without access and terminal times added)
TABLE 1 : Off-peak Standard (drive alone) Highway Time
TABLE 2 : Off-peak Carpool (3+) Highway Time

TABLE 3 : Off-peak Standard (drive alone) Highway Distance
TABLE 4 : Off-peak Carpool (3+) Highway Distance

a. LABEL=3,DSN=MRPSTT.CTYR00.PKT$D.W$ACTT
LARTS YAER 2000 Highway Time And Distance File (with access and terminal times added)
TABLE 1 : Peak Standard (drive alone) Highway Time
TABLE 2 : Peak Carpool (3+) Highway Time
TABLE 3 : Peak Standard (drive alone) Highway Distance
TABLE 4 : Peak Carpool (3+) Highway Distance

b. LABEL=2,DSN=MRPSTT.CTYR00.OPT$D.WOACTT
LARTS YAER 2000 Highway Time And Distance File (with access and terminal times added)
TABLE 1 : Off-peak Standard (drive alone) Highway Time
TABLE 2 : Off-peak Carpool (3+) Highway Time
TABLE 3 : Off-peak Standard (drive alone) Highway Distance
TABLE 4 : Off-peak Carpool (3+) Highway Distance

(2) TAPE, VOL=SER=006945

a. LABEL=1,DSN=MRPSTT.CTYR80.PKT$D.WOACTT
LARTS YAER 1980 Highway Time And Distance File (without access and terminal times added)
TABLE 1 : Peak Standard (drive alone) Highway Time
TABLE 2 : Peak Share Rider Highway Time
TABLE 3 : Peak Carpool (3+) Highway Time
TABLE 4 : Peak Standard (drive alone) Highway Distance
TABLE 5 : Peak Share rider Highway Distance
TABLE 6 : Peak Carpool (3+) Highway Distance

b. LABEL=2,DSN=MRPSTT.CTYR80.OPT$D.WOACTT
LARTS YAER 1980 Highway Time And Distance File (without access and terminal times added)
TABLE 1 : Off-peak Standard (drive alone) Highway Time
TABLE 2 : Off-peak Standard (drive alone) Highway Distance

a. LABEL=3,DSN=MRPSTT.CTYR00.PKT$D.W$ACTT
LARTS YAER 2000 Highway Time And Distance File (with access and terminal times added)
TABLE 1 : Peak Standard (drive alone) Highway Time
TABLE 2 : Peak Share Rider Highway Time
TABLE 3 : Peak Carpool (3+) Highway Time
TABLE 4 : Peak Standard (drive alone) Highway Distance
TABLE 5 : Peak Share rider Highway Distance
TABLE 6 : Peak Carpool (3+) Highway Distance

b. LABEL=2,DSN=MRPSTT.CTYR00.OPT$D.WOACTT
LARTS YAER 2000 Highway Time And Distance File (with access and terminal times added)
TABLE 1 : Off-peak Standard (drive alone) Highway Time
TABLE 2 : Off-peak Standard (drive alone) Highway Distance

Distribution:

Keith Killough
Peter Stopher
Ashok Kumar
Laiky Tamny
Rodger Maxwell

TRAN-SIT NODE #		HIGH-WAY NODE #	STAT-ION #	LOCATION
8000	3533	3504	0001	UNION STATION -METRO RAIL
8001	3335	7806	0002	CIVIC CENTER -METRO RAIL
8003	3341	3506	0003	5TH & HILL -METRO RAIL
8004	3481	2853	0004	7TH & FLOWER -METRO RAIL
8006	3302	2849	0005	ALVARADO -METRO RAIL
8007	3172	7807	0006	VERMONT -METRO RAIL
8008	3005	7808	0007	NORMANDIE -METRO RAIL
8009	3059	7809	0008	WESTERN -METRO RAIL
8010	3058	2845	0009	CRENSHAW -METRO RAIL
8011	2997	7810	0010	LA BREA -METRO RAIL
8012	3035	7811	0011	FAIRFAX -METRO RAIL
8014	2987	7812	0012	BEVERLY -METRO RAIL
8015	2364	7813	0013	SANTA MONICA -METRO RAIL
8016	2365	2926	0014	SUNSET -METRO RAIL
8017	2367	2980	0015	CAHUENGA -METRO RAIL
8018		2971	0016	HOLLYWOOD BOWL -METRO RAIL
8020	2343	4293	0017	UNIVERSAL CITY -METRO RAIL
8021	2329	7814	0018	N. HOLLYWOOD -METRO RAIL
8030		2827	0061	WILSHIRE & LINCOLN -SANTA MONICA/LA/EL MONTE
8029		2829	0062	WILSHIRE & 26TH -SANTA MONICA/LA/EL MONTE
8028		2830	0063	WILSHIRE & BUNDY -SANTA MONICA/LA/EL MONTE
8027		2831	0064	WILSHIRE & SAN VICENTE -SANTA MONICA/LA/EL MONTE
8025		2835	0066	WILSHIRE & WESTHOLME -SANTA MONICA/LA/EL MONTE
8023		2837	0068	WILSHIRE & BEVERLY -SANTA MONICA/LA/EL MONTE
8022		2840	0069	WILSHIRE & LA CIENEGA -SANTA MONICA/LA/EL MONTE
8050		8014	0070	I-10 & I-5 -SANTA MONICA/LA/EL MONTE
8051		3556	0071	I-10 & S-7 -SANTA MONICA/LA/EL MONTE
8052		5922	0072	I-10 & ATLANTIC -SANTA MONICA/LA/EL MONTE
8053		6488	0073	I-10 & DELMAR -SANTA MONICA/LA/EL MONTE
8054		5933	0074	I-10 & ROSEMEAD -SANTA MONICA/LA/EL MONTE
8055		5930	0075	I-10 & SANTA ANITA -SANTA MONICA/LA/EL MONTE
8040		4392	0131	CANOGA & PLUMMER -CANOGA PARK/H'WOOD/LA/NORWALK
8039		4371	0132	CANOGA & ROSCOE -CANOGA PARK/H'WOOD/LA/NORWALK
8038		6260	0133	CANOGA & SHERMAN WAY -CANOGA PARK/H'WOOD/LA/NORWALK
8037		4909	0134	VICTORY & WINNETKA -CANOGA PARK/H'WOOD/LA/NORWALK
8036		4911	0135	OXNARD & RESEDA -CANOGA PARK/H'WOOD/LA/NORWALK
8035		4328	0136	VICTORY & BALBOA -CANOGA PARK/H'WOOD/LA/NORWALK
8033		4340	0138	OXNARD & VAN NUYS -CANOGA PARK/H'WOOD/LA/NORWALK
8032		4319	0139	BURBANK & FULTON -CANOGA PARK/H'WOOD/LA/NORWALK
8031		4321	0140	CHANDLER & LAUREL CYN-CANOGA PARK/H'WOOD/LA/NORWALK
8170		3635	0141	MISSION & ALHAMBRA -PASADENA BRANCH

TRAN-SIT NODE #	HIGH-WAY NODE #	STAT-ION #	LOCATION	
8171	3595	0142	MAIN & HUNTINGTON	-PASADENA BRANCH
8172	3596	0143	FAIROAKS & HUNTINGTON	-PASADENA BRANCH
8173	4539	0144	FAIROAKS & COLORADO	-PASADENA BRANCH
8002	3505	0081	4TH & FLOWER	-BURBANK/LA/NORWALK
8048	6761	0101	SAN FERNANDO & ALAMEDA	-BURBANK/LA/NORWALK
8047	6426	0102	SAN FERNANDO & OMAR	-BURBANK/LA/NORWALK
8046	4510	0103	SAN FERNANDO & COLORADO	-BURBANK/LA/NORWALK
8045	4508	0104	SAN FERNANDO & LOS FELIZ	-BURBANK/LA/NORWALK
8044	3558	0105	SAN FERNANDO & EAGLE ROCK	-BURBANK/LA/NORWALK
8043	3563	0106	SAN FERNANDO & AVE 26	-BURBANK/LA/NORWALK
8042	7170	0107	DODGER STADIUM	-BURBANK/LA/NORWALK
8189	6264	0108	11TH & MAIN	-BURBANK/LA/NORWALK
8188	3484	0109	9TH & SAN PEDRO	-BURBANK/LA/NORWALK
8190	3489	0110	SOTO & OLYMPIC	-BURBANK/LA/NORWALK
8191	3491	0111	8TH & OLYMPIC	-BURBANK/LA/NORWALK
8185	6744	0112	DOWNEY & OLYMPIC	-BURBANK/LA/NORWALK
8112	6742	0113	SANTA ANA & ATLANTIC	-BURBANK/LA/NORWALK
8113	6737	0114	SANTA ANA & PARAMOUNT	-BURBANK/LA/NORWALK
8114	6731	0115	SANTA ANA & NORWALK	-BURBANK/LA/NORWALK
8120	6778	0171	I-5 & ROXFORD	-SYLMR/SNTA MNCA/LAX/LNG BCH
8121	6929	0172	I-405 & RENALDI	-SYLMR/SNTA MNCA/LAX/LNG BCH
8122	6927	0173	I-405 & DEVONSHIRE	-SYLMR/SNTA MNCA/LAX/LNG BCH
8123	6926	0174	I-405 & NORDHOFF	-SYLMR/SNTA MNCA/LAX/LNG BCH
8124	6924	0175	I-405 & ROSCOE	-SYLMR/SNTA MNCA/LAX/LNG BCH
8125	6923	0176	I-405 & SHERMAN WAY	-SYLMR/SNTA MNCA/LAX/LNG BCH
8034	6922	0137	I-405 & VICTORY	-SYLMR/SNTA MNCA/LAX/LNG BCH
8126	8082	0177	I-405 & VENTURA FWY	-SYLMR/SNTA MNCA/LAX/LNG BCH
8127	6916	0178	I-405 & SUNSET	-SYLMR/SNTA MNCA/LAX/LNG BCH
8026	2833	0065	I-405 & WILSH/WSTWOOD	-SYLMR/SNTA MNCA/LAX/LNG BCH
8128	6910	0179	I-405 & VENICE	-SYLMR/SNTA MNCA/LAX/LNG BCH
8129	6053	0180	I-405 & JEFFERSON	-SYLMR/SNTA MNCA/LAX/LNG BCH
8086	3353	0182	SEPULVEDA & EL SEGUNDO	-SYLMR/SNTA MNCA/LAX/LNG BCH
8087	3381	0183	ROSECRANS & AVIATION	-SYLMR/SNTA MNCA/LAX/LNG BCH
8088	3373	0184	MANHATTAN BCH& AVIATION	-SYLMR/SNTA MNCA/LAX/LNG BCH
8089	3778	0185	HAWTHORNE & ARTESIA	-SYLMR/SNTA MNCA/LAX/LNG BCH
8090	3817	0186	HAWTHORNE & 190TH	-SYLMR/SNTA MNCA/LAX/LNG BCH
8131	3830	0187	TORRANCE & CRENSHAW	-SYLMR/SNTA MNCA/LAX/LNG BCH
8132	3868	0188	SEPULVEDA & WESTERN	-SYLMR/SNTA MNCA/LAX/LNG BCH
8134	3875	0190	RIGHT OF WAY & ATLANTIC	-SYLMR/SNTA MNCA/LAX/LNG BCH
8135	3877	0191	RIGHT OF WAY & REDONDO	-SYLMR/SNTA MNCA/LAX/LNG BCH
8136	3880	0192	R-O-WAY & BELLFLOWER	-SYLMR/SNTA MNCA/LAX/LNG BCH
8060	6257	0082	OLYMPIC & BROADWAY	-LA/SO. LA/I-110/SAN PEDRO
8061	2822	0083	FIGUEROA & PICO	-LA/SO. LA/I-110/SAN PEDRO

TRAN-SIT NODE #		HIGH-WAY NODE #	STAT-ION #			LOCATION	
8163	5072	3920	0051			RIGHTOFWAY & PAC. CST. HWY	-LA/LB (LRT)
8164		3943	0052			RIGHTOFWAY & ANAHEIM	-LA/LB (LRT)
8165	5075	6964	0053			RIGHTOFWAY & 10TH ST	-LA/LB (LRT)
8167	5159	4079	0054			RIGHTOFWAY & 6TH ST	-LA/LB (LRT)
8168	5158	6251	0055			RIGHTOFWAY & 3RD ST	-LA/LB (LRT)
8166		4089	0056			LONG BEACH TRANSIT MALL	-LA/LB (LRT)
8130	3881	3282	0181			CENTURY & SEPULVEDA	
8100		3308	0121			I-105 & SEPULVEDA	-CENTURY (LRT)
8101		3311	0122			I-105 & HAWTHORNE	-CENTURY (LRT)
8102		9669	0123			I-105 & CRENSHAW	-CENTURY (LRT)
8067	4055	3292	0089			CENTURY & VERMONT	
8103		3316	0124			I-105 & VERMONT	-CENTURY (LRT)
8104		3363	0125			I-105 & AVALON	-CENTURY (LRT)
8105		9678	0126			I-105 & LONG BEACH BLVD	-CENTURY (LRT)
8106		9680	0127			I-105 & LONG BEACH FREEWAY	-CENTURY (LRT)
8107		9683	0128			I-105 & LAKEWOOD	-CENTURY (LRT)
8108		9686	0129			I-105 & I605(SG FWY)	-CENTURY (LRT)
8119		6915	0151			WILSHIRE & I-405	-SANTA MONICA (LRT)
8137		6914	0152			SANTA MONICA & I-405	-SANTA MONICA (LRT)
8138		2895	0153			SANTA MONICA & WESTWOOD	-SANTA MONICA (LRT)
8139		2896	0154			SANTA MONICA & BEVERLY GLEN	-SANTA MONICA (LRT)
8024		2897	0067			SANTA MONICA & AVE O/T STARS	-SANTA MONICA (LRT)
8169		2836	0155			SANTA MONICA & WILSHIRE	-SANTA MONICA (LRT)
8174		2898	0156			SANTA MONICA & CANON	-SANTA MONICA (LRT)
8175		6755	0157			SANTA MONICA & REXFORD	-SANTA MONICA (LRT)
8176		2899	0158			SANTA MONICA & BEVERLY	-SANTA MONICA (LRT)
8177		6250	0159			SANTA MONICA & MELROSE	-SANTA MONICA (LRT)
8178		2900	0160			SANTA MONICA & ROBERTSON	-SANTA MONICA (LRT)
8179		6261	0161			SANTA MONICA & LA CIENEGA	-SANTA MONICA (LRT)
5620		7801	0302			FALLBROOK&CRISWELL	(CANOGA PARK)
5626		7802	0303			VICTORY&TOPANGA	(TOPANGA PLAZA)
7439		7803	0304			SHIRLEY&PLUMMER	(NORTHRIDGE)
2245	4990	3963	0306	7	3	BATTERY&GAFFEY	(CALTRANS SAN PEDRO)
2464	4559	2677	0307	7	3	HAMILTON&TORRANCE	(ALPINE VILLAGE)
3186		7300	0308			XIMENO&PCH-CIRCLE	(LONG BEACH)
3703		3454	0309			LA MIRADA&OCASSO	(LA MIRADA MALL)
3698		6727	0310			FREEWAY&ALONDRA	(LA MIRADA DRIVE-IN)
3586	5937	7804	0311	7	15	ORANGETHORPE&MAGNOLIA	(FULLERTON TRN CTR)
7049		4605	0312			CITRUS&FOOTHILL	(CITRUS COLLEGE)
6610		7805	0313			BARRANCA&WORKMAN	(EASTLAND SHPG CTR)
6135		2416	0314			DIAMOND BAR&POMONA	(CALTRANS)
5984		3716	0315			ALBATROSS&CASTLETON	(PUENTE HILLS MALL)
6652		4945	0316			MONTE VISTA&SAN JOSE	(MONTCLAIR PLAZA)
6629		4946	0317			MCKINLEY&WHITE	(POMONA FAIRGROUNDS)
6636		4947	0318			MCKINLEY&GAREY	(CALTRANS POMONA)
3215		7815	0320			4665 LAMPSON	(CALTRANS LOS ALAMITOS)

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3. "Availability of Revised 1980 and 2000 Period and Modal Trip Tables and Highway Skims," memo to Gary Spivack, et al., from Keith Killough, February 23, 1984 (see also related memos (2) of August 27, 1984 from A. Kumar to Keith Killough).

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5. "Elimination of CSI Work Mode Split Model's CBD/Non-CBD Variable in Connection with Multi-Iteration Trip Distribution," memo to File 929, LA Models, from Dick Pratt, February 3, 1983.

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7. "Flow Charts, Data Sets and Pertinent Travel Characteristics - 1980 and 2000 Person and Modal Trip Tables," memo to Gary Spivack, et al., from A. Kumar, February 24, 1984.

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