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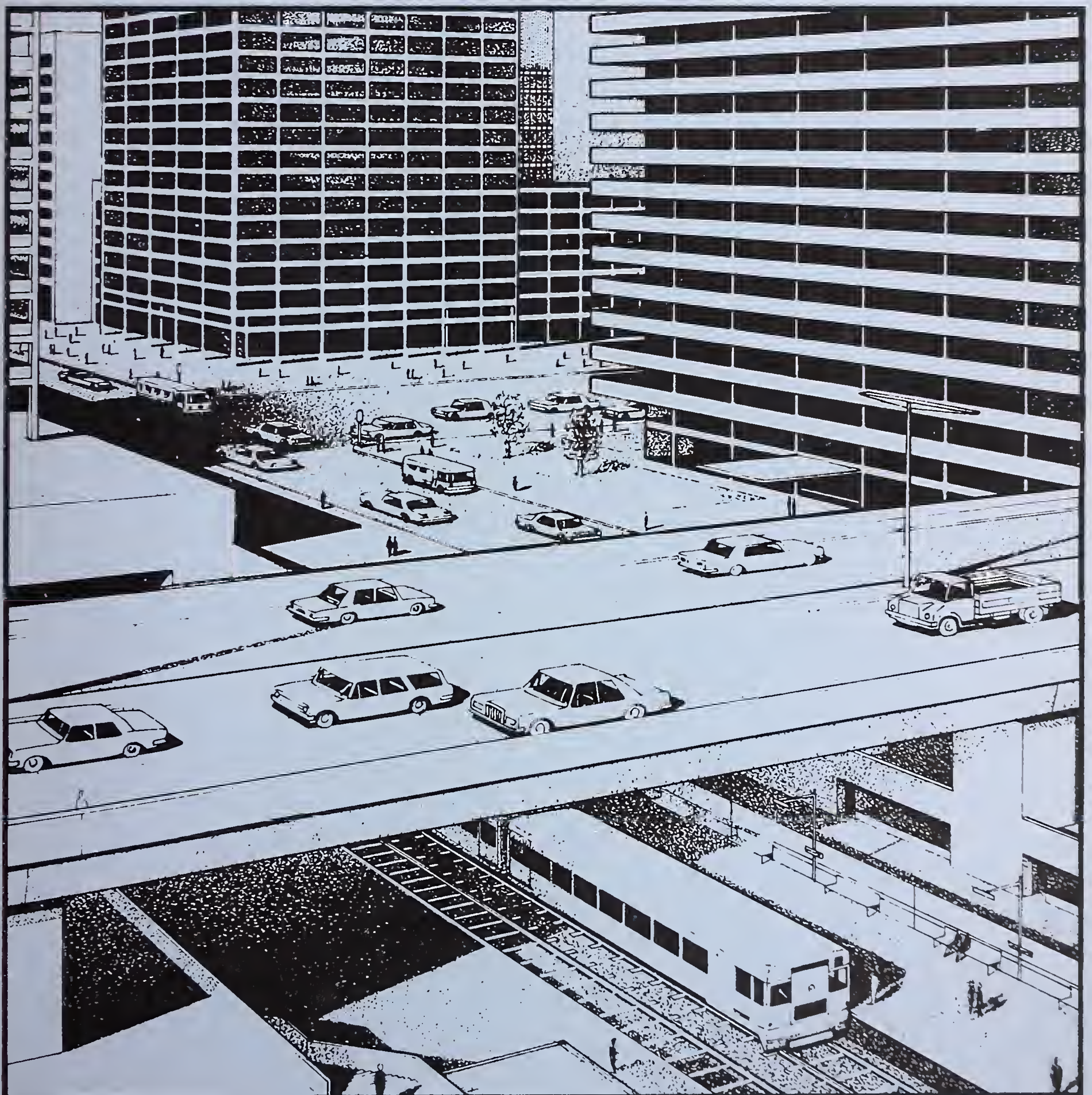
# Systan's Macro-Analytic Regionwide Transportation Model



## User's Guide

March 1983



# Systan's Macro-Analytic Regionwide Transportation Model: User's Guide

Final Report
March 1983



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Office of the Secretary of Transportation
Washington, D.C. 20590

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# PREFACE

SYSTAN's Macro-Analytic Regionwide Transportation (SMART) model is a sketch planning tool for evaluating public transportation alternatives for metropolitan areas. The model and its documentation were developed as part of the Paratransit Integration Program sponsored by the Office of Bus and Paratransit Technology and the Urban Mass Transportation Administration and by the Office of Technology and Planning Assistance of the Office of the Secretary of Transportation. The Paratransit Integration Program is concerned with the development and application of macro-analytic techniques for policy and preliminary planning at the local level.

The SMART model documentation consists of three volumes:

Application Manual: This report describes the use of the model to formulate, evaluate, and compare public transit options for urban regions. It discusses the structure of the model and the purpose of each major component. It also includes detailed application information for four case studies. The document is designed for use by transit planners who must assess the suitability of the model and, if appropriate, use it to investigate urban transportation alternatives.

User's Guide: This document focuses on the preparation and formatting of data for use in the model. Examples are presented, and error messages are explained. The document builds on material in the Applications Manual and is required to run the SMART computer program.

Program Maintenance Manual: This manual describes the internal structure of the computer program, including module structure and linkage and data structures. It includes material on installation and on potential model alterations. Written for the skilled FORTRAN programmer, each installation of the SMART model computer program should have at least one copy of this manual.

The SMART computer program was written by Andrew J. Canfield. Site applications were performed by Carolyn Fratessa and Dr. Wei-Yue Lim. All work was performed under the direction of Dr. Paul S. Jones. SYSTAN gratefully acknowledges the technical and administrative guidance and support of Edward Neigut and Michael Markowski of UMTA. Many other UMTA and DOT staff members have given freely of their time and skill to offer valuable input to the work. However, SYSTAN is solely responsible for the results.

CONTENTS

EXHIBITS

# 1. SUMMARY OF CAPABILITIES

SYSTAN's Macro-Analytic Regionwide Transportation (SMART) model is a deterministic computer program designed to aid planners in (1) the study and evaluation of multi-modal urban transport systems and (2) the evaluation of transport policy actions. Its utility as a planning tool lies in its ability to analyze the implications of major modal shifts between different transport modes using a macro-level methodology that requires minimal data input and little computer time.

The program can handle any urban structure that consists of no more than 50 nodes, 100 zones and 100 links. Zone characteristics such as zone size, zone type, and parking charges, and link characteristics such as link type, number of lanes, presence or absence of preferential lanes and uncongested link speed have all been assigned default values that can be superceded by the program user wherever desired.

SMART has a built-in demand generation procedure. Nevertheless, program users can define their own travel patterns by setting values for the number of origin/destination trips, the volume of flows on links, zonal demand parameters such as population and employment densities, trip lengths for different trip purposes, and even transit loading and unloading rates.

Eight travel mode types are modeled by SMART: automobile, carpool, fixed-route bus, flexible-route service (subscription and dial-a-ride), light rail, heavy rail, private automobile transit (such as park-and-ride), and automated guideway transit (AGT). Each travel mode type has a complete set of default parameters, such as speed and capacity, but these parameters can be modified by the program user.

The travel modes appear in three different kinds of analysis: feeder, line-haul and distribution analysis. Each type of analysis can be applied in isolation to a particular zone or network link, or all three systems can be integrated to perform a door-to-door analysis of particular trips or to perform a regionwide study of an entire urban area.

The output of the SMART program lists the impacts of alternative policy actions in terms of the means and standard derivations of travel times, average travel costs, fuel consumption, and transit performance indicators such as vehicle-miles per hour, service headways, fleet size and pick-ups per hour.

Use of the SMART model begins by formulating a model structure that fits the urban environment of interest. Parameters such as mean trip length, demand rate, and uncongested link speeds can be adjusted to provide a good representation of present travel patterns and practices.

Thereafter, the SMART model can be used to (1) evaluate alternative transit development strategies, (2) estimate the impacts of shifts in demand from private automobiles to public transit, (3) compare the economic and level-of-service tradeoffs between flexible-route demand-responsive and conventional fixed-route public transit systems, (4) evaluate the costs and benefits of alternative strategies designed to reduce the congestion effects of temporal peaks in travel demand, and (5) estimate the impacts of public policies designed to reduce energy consumption.

# 2. OVERVIEW OF THE PROGRAM

## 2.1 MODEL OVERVIEW

The SMART model uses a macroanalytic approach that represents an urban structure in terms of three basic structural components: residential areas or zones with minor activity centers, central business districts (CBD's), and a connecting line-haul transportation route network. No explicit attempt is made to define the surface street network in the residential or CBD zones. Only the freeway/major arterial network that constitutes the line-haul network need be specified in detail. Peak and off-peak travel volumes are generated within the urban structure. The fraction of these trips carried by public transit is varied parametrically.

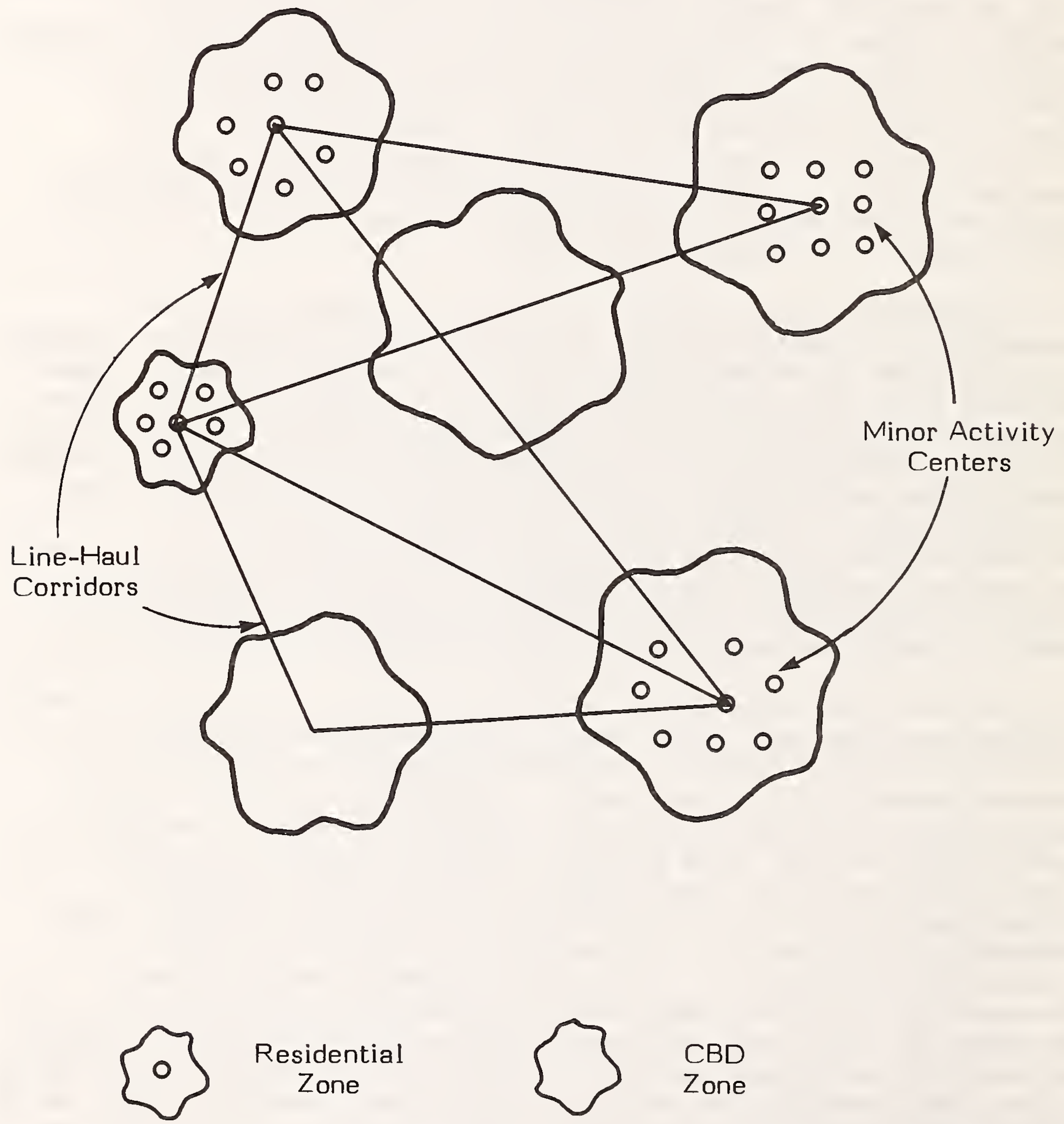
Representations of alternative transport systems have been constructed and tailored to fit the urban structure components. FEEDER transport modes serve residential area trips between individual homes and minor activity centers (see Exhibit 2.1). LINKER transport modes operate on the corridor line-haul system that connects residential and CBD zones. CBD modes serve trip destinations within CBD zones. DUMPER modes collect and distribute trips within the minor activity centers that constitute the retail/commercial/industrial districts of residential zones. Transport modes that serve residential zones, CBDs, and line-haul corridors can be integrated to provide a quantitative picture of door-to-door travel between any pair of origin/destination zones, as well as an aggregated picture of regionwide transportation.

The user has the option of selecting one of two basic structures to describe the urban area under study: a ring/corridor structure or an arbitrary network structure. The ring/corridor structure assigns a circular geometry to the urban area. By default, the center of the circle is the CBD, from which traffic corridors radiate at angles specified by the user or by default. Residential zones are grouped in rings, with exactly two zones adjacent to each radial corridor. Circumferential corridors interconnect the zones of a ring and offer transfer opportunities at intersections with radial corridors. As illustrated in Exhibit 2.2, the circular geometry can be greatly distorted, so that the urban area is accurately portrayed. Thus, all of the zones of a ring need not have uniform radii from the CBD, uniform population or employment density or uniform size. Multiple CBD's can be defined and located at any point in the circular geometry. Zones can be missing; whole sectors of the circle can be missing. Both radial and circumferential corridors can be discontinuous.

The arbitrary network allows the user freedom from the formality of the circular structure, but it requires him/her to completely specify the network, identifying each zone and link. When carefully executed,

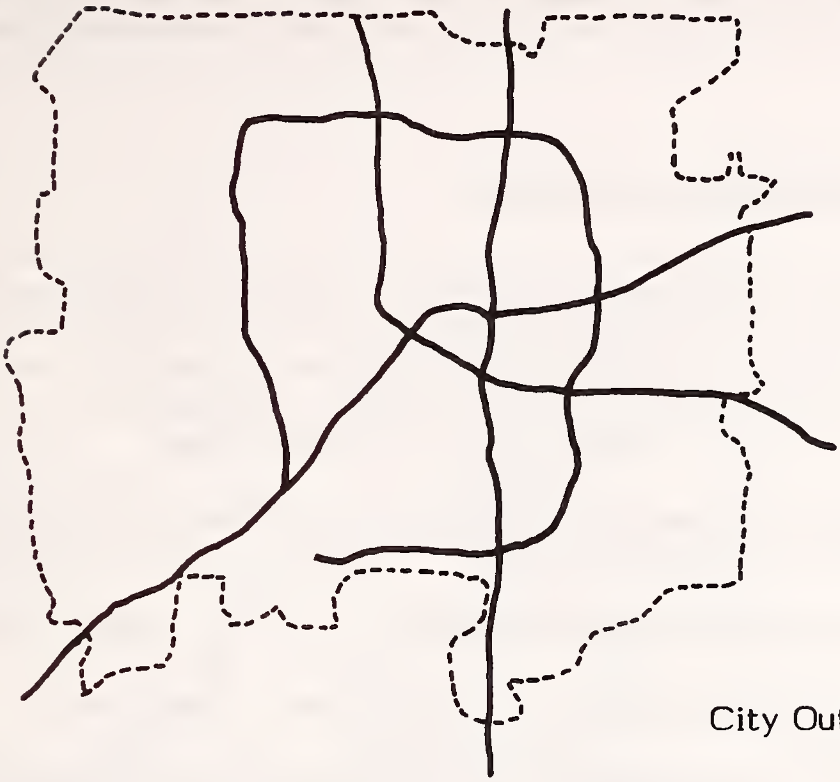
EXHIBIT 2.1

SAMPLE MODULAR REPRESENTATION OF URBAN STRUCTURE

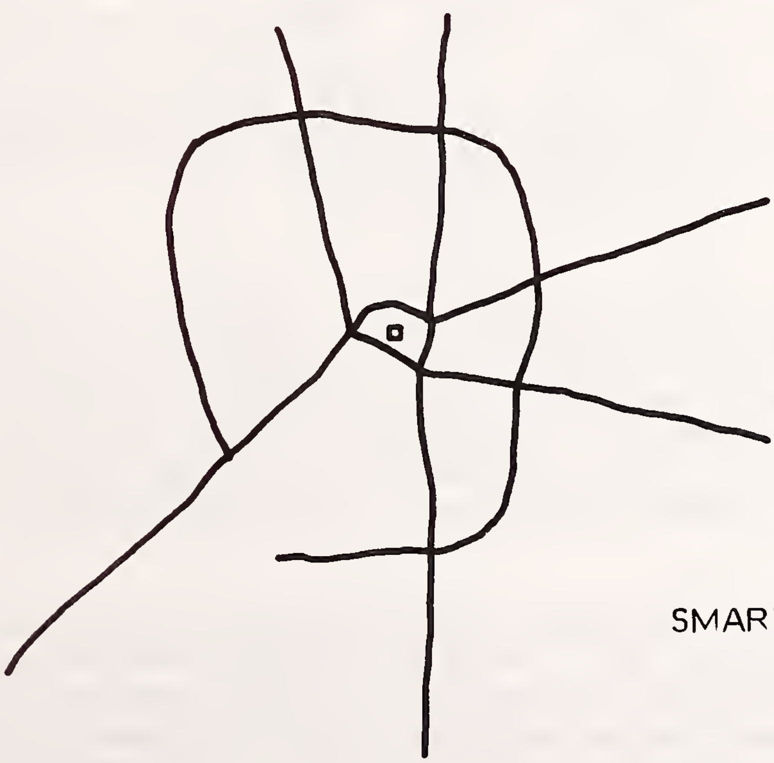


## EXHIBIT 2.2

## SMART CIRCULAR REPRESENTATION



City Outline



SMART Representation

the ring/corridor and arbitrary network structures yield very similar results. Once the structure has been specified, the SMART model does not differentiate between the structured designations. Both the ring/corridor and arbitrary networks are treated as networks that consist of zones, links, and nodes with defined characteristics.

## 2.2 PROGRAM STRUCTURE AND OPERATION

The SMART model performs one or more of the following six types of analysis: feeder service called FEEDER, line-haul service called LINKER, CBD collection/distribution called CBD, non-CBD collection/distribution called DUMPER, regionwide analysis called REGION, and door-to-door analysis called DOOR (see Exhibit 2.3). In addition, the program has several support blocks that:

1. Define the urban structure that is to be analyzed, including zone and link characteristics;

2. Define and modify demand parameters and trip volumes; and

3. Modify modal parameters and perform mode selections.

Default values for the parameters are initialized in subroutine BLOCK DATA, while the scanning of the input data is performed by the MAIN PROGRAM.

Keyword cards, which form the entire input data stream (see Exhibit 2.4), control the operation of SMART. SMART scans the first input data card and performs a set of operations based on the keyword and other information listed on the card. Then SMART reads the second card and performs a second set of operations based on the information stored on the second card. The program continues reading until an END card is reached.

Any combination of the six different types of analysis (FEEDER, LINKER, CBD, DUMPER, DOOR, REGION) can be requested in a single run. For example, the user can request a FEEDER analysis to be followed by a CBD analysis to be followed by a REGION analysis, and finally terminated with another FEEDER analysis. The program can perform any of the analyses without input data, because it is supplied with default parameter values. These defaults are listed with keyword documentation in Appendix A.

SMART will print warning or error messages when it encounters problems with the input data. Data that induce warning messages will not stop the execution of the program, but data that induce error messages will prevent actual analysis. For assistance in interpreting these messages and diagnosing the input deck, the user should refer to Appendix B.

EXHIBIT 2.3

MAJOR FUNCTIONAL COMPONENTS OF SMART

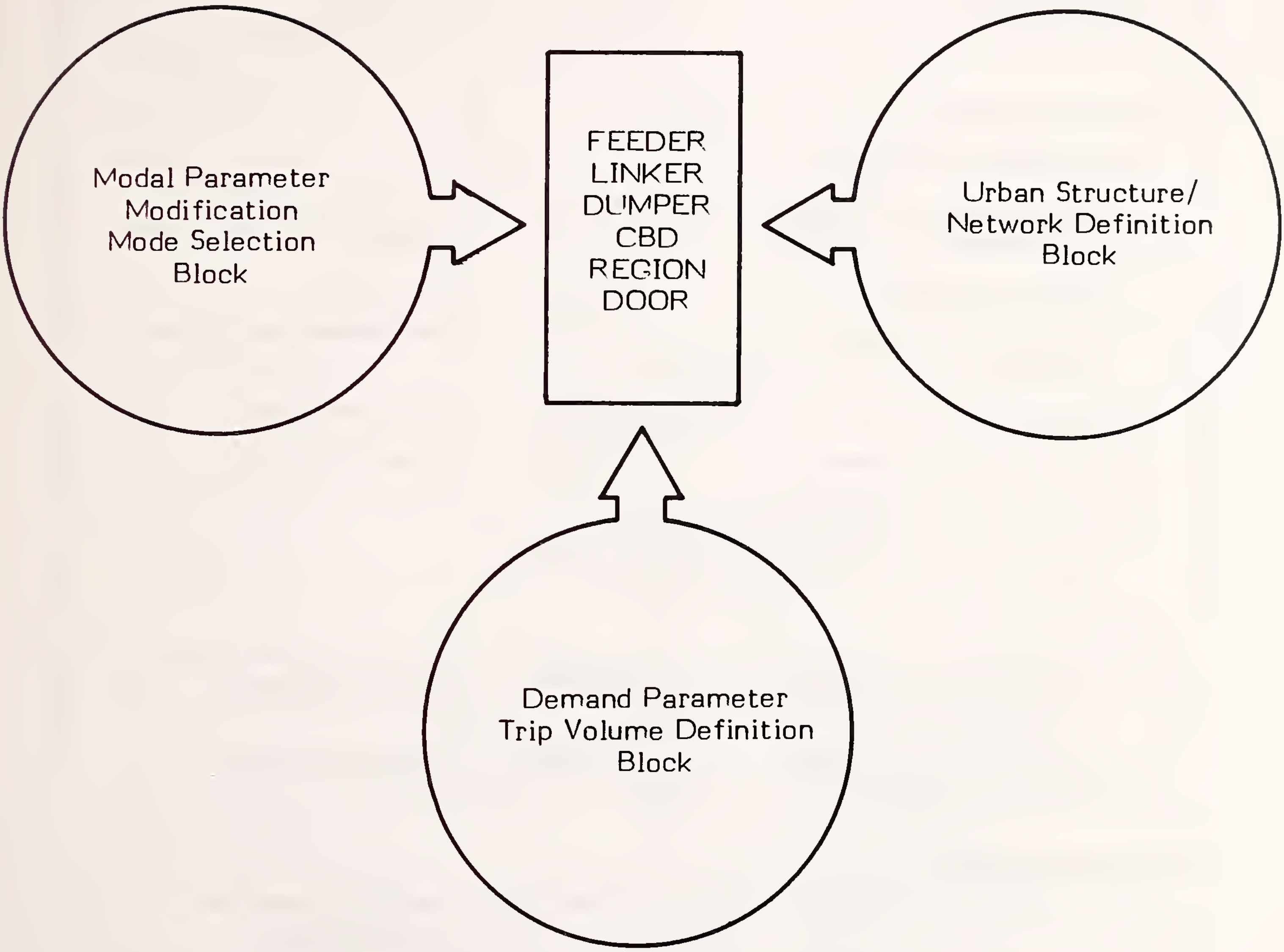


EXHIBIT 2.4

SMART KEYWORDS

| Task | Keyword | Fields |
|---|---|---|
| **Labeling Printout** | | |
| Print comments | Blanks | Embedded comments (SMART will print these) |
| Print run title | TITLE | Run title |
| Print subtitle | SUBTITLE | Task subtitles |
| **Network Definition** | | |
| Ring/corridor system: | | |
| Define number of rings and corridors | URBAN | Number of rings and corridors |
| Define ring radii | RADII | Ring radii |
| Define angles between corridors | ANGLES | Corridor angles |
| Modify existing links | LINKSET | Link definitions |
| Modify existing zones | ZONESET | Zone definitions |
| Arbitrary network system: | | |
| Clear current or default network | NULLNET | |
| Either system: | | |
| Define new link/modify existing link | ONELINK | Link definitions |
| Define new zone/modify existing zone | ONEZONE | Zone definitions |
| **Demand Generation** | | |
| Set demand generation parameter | DEMPARM | Demand generation parameters |
| Set demand parameters for one zone | ONEZDP | Demand parameters for one zone |
| Set demand parameter for one zone in the ring/corridor system | ZDPSET | Demand parameters for one zone |
| Set proportion of daily trips in each time period | TRIPTIME | Temporal distribution of trips |
| Generate and record demand patterns | GENDEM | Demand generation procedure and print unit |

Exhibit 2.4, continued

| Task | Keyword | Fields |
|---|---|---|
| **Demand Specifications** | | |
| Read in user-specified demands | READDEM | Trip type and volume |
| Specify residential demand | VRES | Residential demand |
| Specify activity center demand | VACT | Activity center demand |
| Specify origin/destination trip rate | ODM | Origin/destination trip rate |
| Specify traffic flow on links | TRAFFIC | Specific link traffic rates |
| Specify link transit pickup rates | PICKUPS | Specific link transit pickup rate |
| Define link transit dropoff rates | DROPOFFS | Specific link transit dropoff rate |
| **Archived Network/Demands** | | |
| Create archive file | PUTNET | |
| Read archive file | GETNET | |
| **Special Printing** | | |
| Print network | PRINTNET | |
| Print demands | PRINTDEM | |
| **Other Data Input** | | |
| Modify transit mode share | TMSHARE | Transit mode shares |
| Modify length of time periods | TIMLEN | Time period lengths |
| Modify walking speeds, fractions and distances | WALKING | Walking speeds, fractions and distances |
| Modify carpool fraction | CPFRAC | Fraction of non-transit trips in carpools |
| Modify carpool time parameter | CPTIME | Carpool time parameter |
| Modify highway lane capacity | CAPACITY | Highway lane capacity |

Exhibit 2.4, continued

| Task | Keyword | Fields |
|---|---|---|
| **Travel Mode Selection** | | |
| Prevent default modes from being analyzed | NULLMODE | |
| Select specific modes | MODESEL | Selected mode identifier and characteristics |
| Modify modal parameters | MODEPARM | Travel mode parameters |
| **Analysis Requests** | | |
| Perform FEEDER analysis | FEEDER | Analysis zone identifier and analysis type (whether uniform, subarea or corridor) |
| Perform DUMPER analysis | DUMPER | Analysis zone identifier |
| Perform CBD analysis | CBD | Analysis zone identifier |
| Perform line-haul corridor analysis | LINKER | Nodes at endpoints of network trip to be analyzed |
| Perform regionwide analysis | REGION | |
| Perform door-to-door analysis | DOOR | Characteristics of origin/ destination zones |
| **Termination** | | |
| Terminate run | END | |

The SMART program is coded primarily in standard ANS FORTRAN, X3.9-1966, and has been run on an IBM 3033 system using the FORTRAN H and WATFIV compilers. For a detailed discussion of coding standards and machine independence, refer to the Programmer's Manual.

## Input Order

Because operations are performed sequentially, keyword data cards must be placed in the correct order to ensure proper execution of the program. For example, if the user wishes to run a FEEDER and LINKER analysis of an urban region with a particular spatial structure, the urban structure/network definition keyword cards must precede the analysis specification cards. The input order would be:

Keyword cards describing urban structure and network
Keyword cards calling for the FEEDER analysis
Keyword cards calling for the LINKER analysis

When keyword cards are placed in this order, SMART will first generate the urban structure specified on the urban structure/network cards before performing FEEDER and LINKER analyses.

In another example, suppose that a user desires to first run a FEEDER analysis with default demand values, and then run a new FEEDER analysis with a user-specified set of travel volumes. To do this, the order for the input data must be:

Keyword cards requesting FEEDER analysis
Keyword cards describing travel volume changes
Keyword card requesting FEEDER analysis

Note that if the trip volume keyword card is placed after the second set of FEEDER keyword cards, the second FEEDER analysis will not execute with the correct demand data.

## Pending Actions

There are a number of pending actions in the SMART model. These are tasks that are delayed as long as possible, and are only performed when the model cannot find needed data. For example, if a FEEDER analysis is requested, the program will check to find out if the urban structure has been defined and if travel demand has been generated. If they have not, then the program will wait for the appropriate routines to generate the needed urban structure and demand data before FEEDER analysis is initiated. The pending actions in SMART are:

Initializing the network;
Calculating automobile shortest routes;
Loading demand parameters;
Generating demands; and
Selecting modes for analysis.

## 2.3 GENERAL INPUTS

All SMART model card input has the following field layout:

| Columns | Name | Purpose |
|---|---|---|
| 1-8 | KEYWORD | Defines information contents |
| 9-16 | FIELD 1 | Contain various data, depending on KEYWORD |
| 17-24 | FIELD 2 | |
| 25-32 | FIELD 3 | |
| 33-40 | FIELD 4 | |
| 41-48 | FIELD 5 | |
| 49-56 | FIELD 6 | |
| 57-64 | FIELD 7 | |
| 65-72 | FIELD 8 | |
| 73-80 | SEQUENCE | Ignored |

Any datum read replaces the current value for that datum. SMART supplies initial values for all items, so that all data input is optional. Also, the value of a datum can be changed at any time. It should be kept in mind, however, that changing one value may initiate a series of changes that modify other, dependent, data. For example, setting a new number of corridors cancels any previous corridor descriptive data, and clears all previously generated demand matrices (since the zone numbers are no longer valid).

On virtually all cards, a blank field leaves the current value unchanged (i.e., the field defaults to the current setting). SMART can distinguish between blank and zero, so the entire eight-character field must be blank. One exception to this rule occurs when changing the endpoints of a link. If the user changes one endpoint of a link, both new endpoints must be given, as it is unclear which of the two ends is to be changed.

Units have been chosen for consistency; for example, all distances are measured in miles, and never in blocks. More significantly, almost all times are expressed in minutes. Not only are dwell times and peak period lengths in minutes, but vehicle speed is in miles per minute, and operating cost is in dollars per vehicle-minute. The only exceptions are (1) capital cost, which is expressed in dollars per day or dollars per vehicle-day, since it does not vary with vehicle service time, and (2) trip generation rates, which are expressed in trips per unit of population or employment per day.

Keywords can be grouped into the categories listed in Exhibit 2.4, according to the information they carry and the tasks they require SMART to perform.

Different titles and subtitles may be appropriate for different types of analysis (e.g., FEEDER, LINKER). Hence, the user may wish to precede different analysis keyword cards with different TITLE and SUBTITLE cards. The user should terminate each run with an END card.

# 3. URBAN STRUCTURE

SMART can analyze an urban region that has no more than 50 nodes, 100 zones and 100 links. This region may have either a ring/corridor urban structure or an arbitrary urban network structure. Defaults have been assigned for the ring/corridor structure, and hence input data are necessary only if the user desires to modify the default structure. For an arbitrary network, however, every zone and link in the network must be specified by the user through keyword cards. To make the definition of the urban structure even more flexible, SMART will accept a "composite" network that is formed by adding components to a basic ring/corridor structure.

## 3.1 RING/CORRIDOR STRUCTURE

In this structure, the network is made up of radial and circumferential corridors. The urban region is described in terms of nodes that are formed by the intersections of these corridors, as shown in Exhibit 3.1. A radial corridor is identified by its angular position relative to an arbitrary direction and by the rings through which it passes. For easy reference, radial corridors are numbered counterclockwise around the circle from the arbitrary direction. A circumferential corridor is identified by the radial corridors that limit its length and by the ring within which it lies.

Each corridor is divided into network links. A radial link follows a radial corridor and connects two rings. The general form of a radial link name (or identifier) is RHWYRrCc, where r is an integer from 2 to 8 indicating the outer ring number, and c is an integer from 1 to 6 indicating the corridor number. For example,

RHWYR2C1

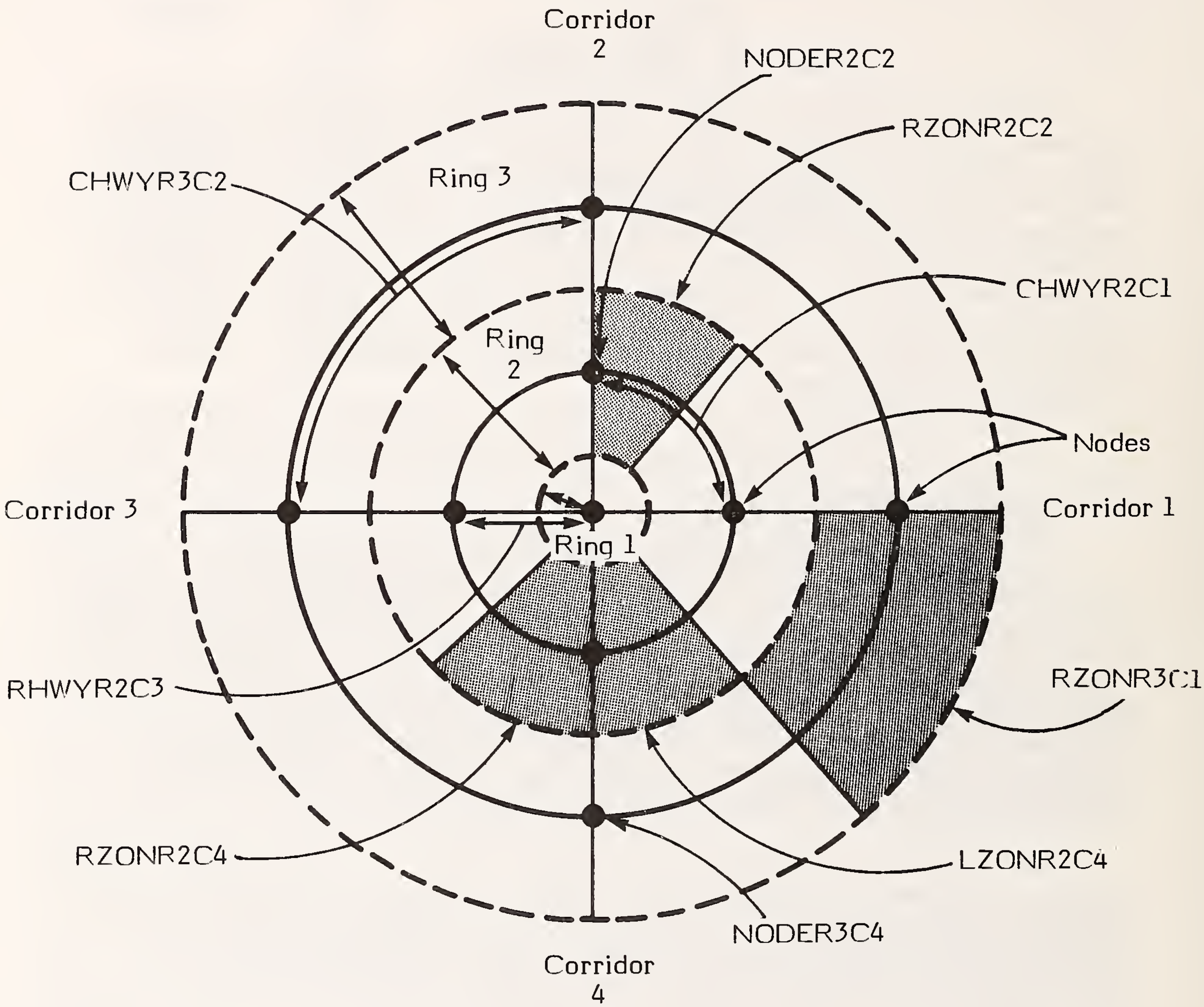
describes a radial highway link in Corridor 1 whose outer terminus is in Ring 2. A circumferential link is in a ring between two adjacent radial corridors. The general form of a circumferential link identifier is CHWYRrNc, where r is an integer from 2 to 8 indicating the ring number and c is an integer from 1 to 6 indicating the (lower) corridor number. For example,

CHWYR5C2

describes a circumferential highway link in Ring 5 that extends from Radial Corridor 2 to Radial Corridor 3. The SMART model can handle a maximum of eight rings and six corridors.

## EXHIBIT 3.1

## SAMPLE 3-RING 4-CORRIDOR URBAN STRUCTURE




| | |
|---|---|
| CHWYR2C1 | Circumferential Highway Ring 2 Corridor 1 |
| CHWYR3C2 | Circumferential Highway Ring 3 Corridor 2 |
| RHWYR2C3 | Radial Highway Ring 2 Corridor 3 |
| RZONR2C2 | Right Zone Ring 2 Corridor 2 |
| LZONR2C4 | Left Zone Ring 2 Corridor 4 |
| RZONR2C4 | Right Zone Ring 2 Corridor 4 |
| LZONR3C1 | Left Zone Ring 3 Corridor 1 |
| NODER3C4 | Node Ring 3 Corridor 4 |
| NODER2C2 | Node Ring 2 Corridor 2 |

For zones, "LEFT" and "RIGHT" are as viewed from the center of the circle.

Each corridor may contain highways or fixed guideway transit, such as heavy rail or light rail. Highways are described by type (e.g., freeway, arterial), number of lanes, length, existence of preferential lanes, free-flow speed and other characteristics. Fixed guideway transit is described in terms of mode type, station spacing, speed, train length, and other characteristics.

Nodes are identified by the corridor to which they are attached and the rings within which they lie. The central node is called NODECNTR. All other nodes have identifiers of the following form: NODERrCc, where r and c are described as before. Thus, NODER3C4 in Exhibit 3.1 is located in Ring 3 attached to Corridor 4.

Zones are identified in much the same way as nodes, except that they have an additional characterizing parameter: whether they lie to the left or right of the nodes (as viewed from the center of the concentric circles). The central zone is called ZONECNTR. "LEFT" zones have identifiers of the form LZONRrCc; "RIGHT" zones have identifiers of the form RZONRrCc, where r and c are defined as before. The geometrical definition of the ring/corridor structure is illustrated in Exhibit 3.1.

The default urban structure has six rings and six corridors. Unless otherwise specified, corridors are spaced equally apart.

All radial corridors default to freeways; circumferential highways default to arterials. Default link lengths are calculated from radii and angle values. The central zone ZONECNTR is automatically initialized to a CBD-type zone; all others are non-CBD's whose zone areas by default are calculated from angle and radii values. There are no default parking charges in the zones, except for those in Ring 2 ($0.50/vehicle trip) and Ring 1 ($2/vehicle trip).

To change the default urban structure, use the URBAN, RADII, ANGLES, LINKSET and ZONESET keyword cards. URBAN changes the number of rings and corridors in the network, RADII the radii, and ANGLES the angular spacing of the radial corridors. Link and zone parameters are changed by the LINKSET and ZONESET cards, which must identify the links and zones of interest and their new parameter values. For a detailed description of these cards, refer to Appendix A. As an example, the data deck:

```
URBAN          2       3
RADII        0.6     2.6
ANGLES         0     120      240
LINKSET CIRCUMFR       2        2LENGTH        6.0FREEWAY NODIAMNDLRAIL
LINKSET RADIAL         2        3MISSING
ZONESET                1              2.0NON-CBD
ZONESET RIGHT          2        2     1.0CBD
END
```

will accomplish the following:

1. Set the number of rings to two, the number of corridors to three.

2. Set the radius of the inner ring (Ring 1) to 0.6 miles, radius of outer ring (Ring 2) to 2.6 miles.

3. Set equal angles between corridor pairs (no change from the defaults).

4. Set characteristics of the circumferential highway in Ring 2 from Corridor 2 to Corridor 3 to the following: The highway is a six-mile long freeway with the default of three lanes in either direction; it has no preferential lanes, but light-rail service is included.

5. Indicate that there is no radial highway from Ring 1 to Ring 2 along Corridor 3.

6. Sets the central zone to be a non-CBD zone with an area of two square miles. The parking charge is unchanged (still $2.00 per trip), and uses the default FEEDER and DUMPER modes.

7. Sets the right zone attached to Ring 2, Corridor 2 to be a CBD zone with a parking charge of $1.00 per trip and with default area and CBD modes.

For a ring/corridor structure with a specific number of rings and corridors, raddii and angles, the URBAN, RADII and ANGLES cards must precede the LINKSET and ZONESET cards. Zone sizes and link lengths will first be calculated using the given number of rings and corridors, radii and angles. Selected zone and link characteristics can subsequently be modified using the LINKSET and ZONESET cards.

Note that links can be deleted using the LINKSET or ONELINK cards with the "MISSING" link type option, and zones can be deleted by setting their population and employment densities to zero (using the ONEZDP or ZDPSET keyword card), thus ensuring that no activities take place in these zones and no trips are attracted to or from these zones. Zones can be added to the ring/corridor structure only through the composite network method. Note also that the "IGNORE" option for zone type can be used to denote which zones are to be ignored when aggregating output measures for regionwide analysis.

Finding Reasonable Ring Radii

The selection of circumferential corridor radii and ring radii is a somewhat arbitrary process that depends on the characteristics of the urban area being modeled. It often occurs that the circumferential corridors can be defined from the pattern of freeways and arterials, but the dimensions of the urbanized rings are not distinct. Because the SMART model places circumferential corridors in the centers of their host rings, a method is needed to estimate ring radii from estimates of circumferential corridor radii. A recursive relationship exists between ring radii and corridor radii:

$$r_n = 2R_n - 2R_{n-1} + 2R_{n-2} - 2R_{n-3} + \ldots \pm r_1$$

where: $r_n$ is the outside radius of the $_n$th ring;
$r_1$ is the outside radius of the central core;
$R_n$ is the radius of the circumferential corridor in the $_n$th ring; and
$R_n \geq 0$ and $r_n \geq 0$ for all n.

There is no value for $R_1$ because the central core or CBD zone does not have a circumferential corridor. Using the above expression, equations for all $r_n$ can be generated using known values of $R_n$ and the unknown value of $r_1$. Then arbitrary values can be selected for $r_1$ until the value of the r seem to fit the urban structure.

The selection process can be illustrated in a simple example. Exhibit 3.2 illustrates a sector of an urbanized area that has been divided into six rings. Five circumferential corridors, lettered A through E, have been identified. The distance from the center of the urban area to each circumferential corridor has been measured at each radial corridor. As expected, the corridor radii are not uniform. Exhibit 3.3 lists the different corridor radii values and the mean value for each corridor. These mean values can be selected for $R_1$, $R_2$, $R_3$, $R_4$, and $R_5$. Other values could be used as well. Using mean values, the second column of Exhibit 3.4 lists the expressions for $r_2$, $r_3$, $r_4$, $r_5$, and $r_6$ in terms of $r_1$. Using four different values for $r_1$ (2.0, 2.5 , 3.5, and 3.4 miles), values of the ring radii have been calculated for each ring. As the value of $r_1$ increases, the radii for rings 3 and 5 increase and those for rings 2, 4, and 6 decrease. As r increases, rings 3 and 5 become wider while rings 2, 4, and 6 become narrower. Thus, changing the value of $r_1$ influences the entire zone structure in rather fundamental ways. It is important that the value selected for $r_1$ give a result that is reasonably representative of the urbanized area that is being modeled.

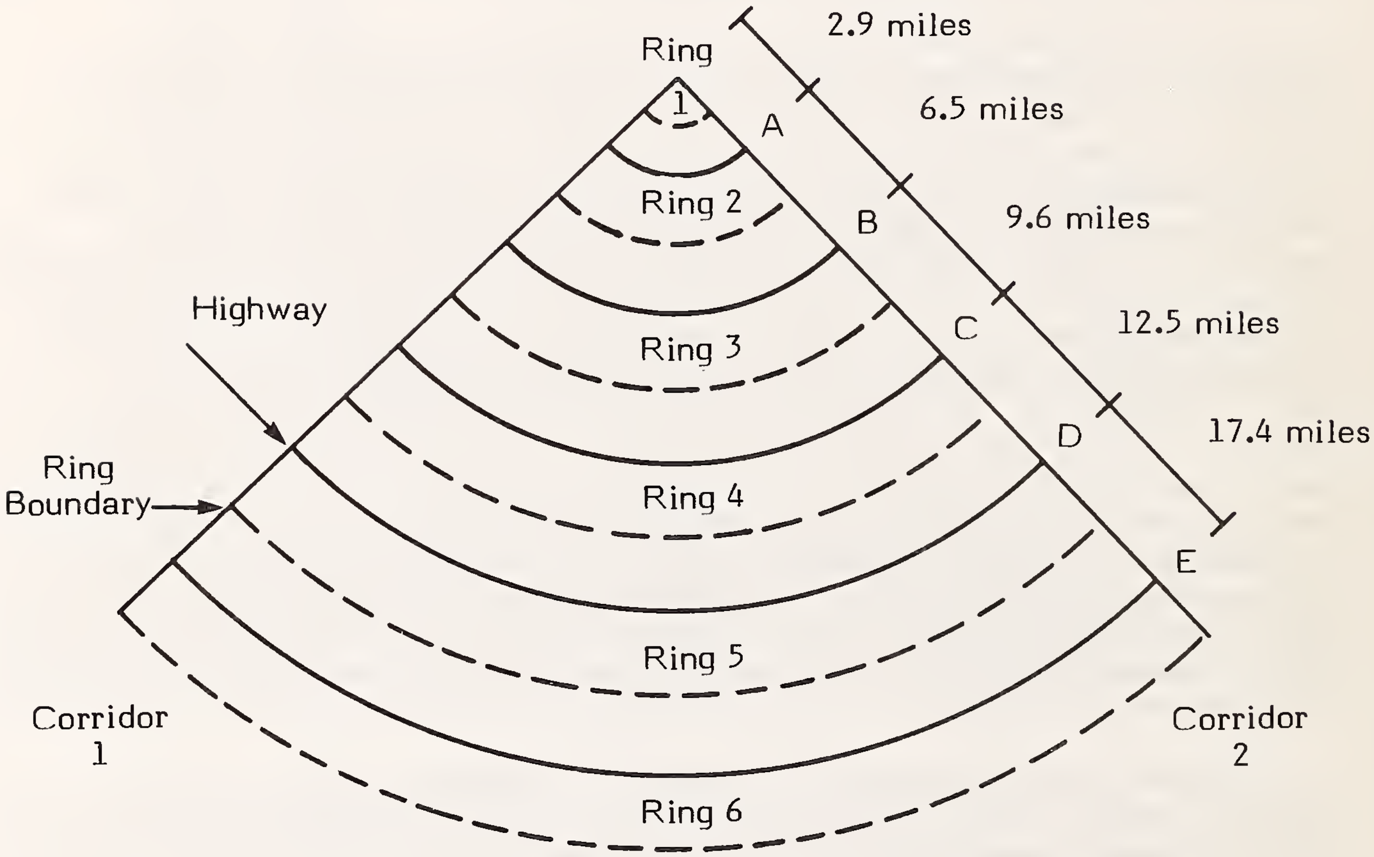
In some instances, natural barriers, railroad tracks, or other physical features may dictate ring radii. In these cases, the values of corridor radii that these ring radii determine should be checked using the following expression:

$$R_n = (r_n + r_{n-1}) / 2$$

If the computed values fit the available circumferential corridors reasonably well, then they can be accepted. If not, other adjustments are needed. It is not necessary that the SMART model represent an exact fit for the entire urban area. Useful results can be secured with only cursory fits; however, good fits yield more believable results. The quality of the fit depends on the user's objectives and wishes. Techniques for modifying individual zones and links are presented in Section 3.3 under the composite network.

EXHIBIT 3.2

URBAN STRUCTURE FOR FINDING RING RADII
(Showing 2 out of 5 corridors)




(Distance measured from center of circle)

EXHIBIT 3.3

HIGHWAY RADII FOR CALCULATING RING RADII

| Circumferential Corridor | Circumferential Highway Radii at Corridor Number | | | | | Average Radius |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | |
| A | 1.8 | - | 3.0 | 2.9 | 4.0 | 2.9 |
| B | - | 6.4 | 6.5 | 6.0 | 6.9 | 6.5 |
| C | - | 10.6 | 8.8 | 9.1 | 9.8 | 9.6 |
| D | 12.0 | - | 13.1 | 12.3 | - | 12.5 |
| E | 16.7 | 15.2 | 16.8 | 18.0 | 20.2 | 17.4 |

EXHIBIT 3.4

INFLUENCE OF CENTRAL RING ON RING SIZE
FOR FIXED HIGHWAY SYSTEM

| Algebraic Expression | | Ring Radii (Miles) | | | |
|---|---|---|---|---|---|
| $r_1$ | -- | 2.0 | 2.5 | 3.0 | 3.5 |
| $r_2$ | $9.4 + r_1$ | 7.4 | 6.9 | 6.4 | 5.9 |
| $r_3$ | $6.7 + r_1$ | 8.7 | 9.2 | 9.7 | 10.2 |
| $r_4$ | $15.4 + r_1$ | 13.4 | 12.9 | 12.4 | 11.9 |
| $r_5$ | $14.5 + r_1$ | 16.5 | 17.0 | 17.5 | 18.0 |

## 3.2 ARBITRARY NETWORK

The arbitrary network is a configuration of zones, nodes and links that are specified by the user. To define an arbitrary network, the current or default network must first be cleared through the use of a NULLNET keyword card. This card will clear all previously generated demands and set the number of links, nodes and zones to zero. Default parameters (such as population, employment densities or trip lengths) of all zones in an arbitrary network are set to the default Ring 3 parameter values. These values can be subsequently changed by the user through the ONEZDP (zonal demand parameters) keyword card. Note that if NULLNET is not specified, the previously generated network will interfere with the arbitrary network and introduce errors. Once the original network has been cleared, the keywords RADII, ANGLES, LINKSET, ZONESET and ZDPSET become invalid until a ring/corridor structure is activated by an URBAN card.

Links and zones in the arbitrary network are defined only by ONEZONE and ONELINK cards; LINKSET and ZONESET cards cannot be used. To create a zone, the user must provide a zone name (zone identifier) and the name of the node it is attached to (node identifier). For a link, a link name (link identifier) and nodes forming the endpoints of the link must be specified. If the nodes specified do not yet exist, they will be created. For new zones, defaults are non-CBD zone type with no parking charge (zone size is required). New links default to a length of 1,000 miles and the default characteristics of ring/corridor radial corridor links. These defaults, of course, can be overridden by the ONEZONE and ONELINK cards.

As an example, an arbitrary two-zone network for LINKER analysis can be generated by the following cards:

```
NULLNET
ONEZONE ZONEONE NODEONE      5.0    1.00NON-CBD FRBUS   FRBUS
ONEZONE ZONETWO NODETWO      4.0    0.50NON-CBD FLEXRTE FRBUS
ONELINK LINKOT  NODEONE NODETWO LANES        2.0FREEWAY NODIAMNDNORAIL
ONELINK LINKOT  NODEONE NODETWO         LENGTH       6.0
LINKER  NODEONE NODETWO
END
```

This accomplishes the following tasks:

1. The previously generated network is cleared.

2. A non-CBD type zone called ZONEONE is defined as attached to a new node called NODEONE; it has an area of five square miles, a parking cost of $1.00 per vehicle trip, and FRBUS (fixed-route bus) feeder and DUMPER service.

3. A second non-CBD type zone called ZONETWO is defined as attached to NODETWO; it has an area of four square miles, a parking cost of $0.50 per trip, and FLEXRTE (flexible route) feeder service and FRBUS (fixed-route bus) DUMPER service.

4. A link called LINKOT is defined as connecting NODEONE and NODETWO; it is a six mile long freeway without a preferential lane. It has two highway lanes in each direction and no rail service.

5. A line-haul analysis is performed on link LINKOT.

Note that the ONEZONE and ONELINK keywords can also be applied to a ring/corridor structure.

## 3.3 COMPOSITE NETWORK

In most cases, an actual urban region will not conform exactly to a ring/corridor structure. Such an urban region can be defined as an arbitrary network. However, this would require a large input data deck to define the characteristics of every zone and link in the region. Another, more efficient way of defining the network is to use a basic ring/corridor structure and then to add zones and links by means of the ONEZONE and ONELINK keyword cards. The end of the zone and link definitions must be indicated by a COMNET (composite network) card. As an example, the job

```
ONEZONE NEWZONE NEWNODE            10.0NON-CBD
ONELINK NEWLINK NEWNODE NODER6C1LENGTH       4.0ARTERIALDIAMOND NORAIL
COMNET
ONEZDP  NEWZONE                    1000      500       1.        2.        3.
ONEZDP  LZONR3C2                    0.0      0.0
END
```

accomplishes the following:

1. A new non-CBD type zone called NEWZONE is added to the ring/corridor network and defined as attached to a new node called NEWNODE; it has an area of ten square miles, no parking charges, and default FEEDER and DUMPER nodes.

2. A new arterial link called NEWLINK is defined as connecting node NODER6C1 and NEWNODE; it is four miles in length with the default of two lanes in each direction, and has a preferential lane but no rail service.

3. Indices that correctly link the new node to the rest of the network are set up when the COMNET card is encountered.

4. The zonal demand parameters of the default six-ring, six-corridor network are generated when the ONEZDP keyword is encountered. The rest of the information on the card specifies NEWZONE as having a population density of 1,000 persons per square mile, an employment density of 500 persons per square mile, and the average trip length for Type 1 (commute) trips starting in this zone is set equal to one minute; Type 2 (non-commute home-based)

trips are set equal to two minutes, and Type 3 (work-work) trips are set equal to three minutes.

5. Zone LZONR3C2 is defined as having zero population and zero employment.

Since the ring/corridor network is active in this example, the demand parameters, such as employment and population densities, and trip lengths, are taken from default values automatically (on encountering the ONEZDP card) only for the original six-ring, six-corridor structure. Hence, all new-zone demand parameters that are added to the original six-ring, six-corridor structure must be completely defined on the ONEZDP card, as shown above.

## 3.4 ARCHIVING

Archiving allows the user to make multiple runs on the same urban structure without regenerating the urban network. During the first run, the network is defined and then saved on a disk or tape file that can be reloaded for subsequent runs. The network is written onto a data file using the PUTNET card, and read from a data file using a GETNET card. By defining several disk or tape data sets, one can save and use many different networks, with each data set corresponding to a single network. However, it is impossible to put more than one network in the same data set. If the PUTNET and GETNET cards are used for the same file in one run, the urban structure in effect should be restored at the time the PUTNET card is read.

The information required on the PUTNET and GETNET card is the FORTRAN unit number in FIELD 1, denoting the network data set to be written or read, and the option "DEMAND" or blank in FIELD 2. If "DEMAND" is specified in PUTNET, the hourly demand matrices will be written to the same file after the network definition. If blank, demand matrices will not be saved. If "DEMAND" is specified for GETNET, the hourly demand matrices will be read from the same file as the network definition. If blank, no demands will be read. FORTRAN unit defaults are 10 and 09, respectively, for PUTNET and GETNET.

The jobs:

```
URBAN   2   3
PUTNET  9   DEMAND
END


GETNET  9  DEMAND
REGION
END
```

generate a two-ring, three-corridor urban structure with accompanying demand matrices which are written onto a data set identified by the data set Reference Number 09. In the next run, these data are read back in for regionwide analysis, so networks and demands do not have to be regenerated. Any other run using the same data can dispense with network and demand generation, and obtain the required information from disk or tape storage.

# 4. TRAVEL DEMAND

Demand modeling in SMART is performed in three steps: first, create zone-to-zone trip rates; second, aggregate zone-to-zone trip rates to produce data for FEEDER, LINKER, DUMPER, CBD, REGION and DOOR analyses; and third, assign these trips to specific links or corridors. Zone-to-zone trip rates can be obtained from one of two sources: (1) by directly reading the data from an external file created by the user, or (2) by generating the information from population and employment data using SMART's own default demand generation routines. Once zone-to-zone trip rate information has been obtained, the same procedure is applied to assign the data to specific routes. The creation of zone-to-zone demand is described in Sections 4.1 and 4.2; Section 4.3 describes the output produced by the demand aggregation procedures and the assignment procedure.

## 4.1 ZONE-TO-ZONE DEMANDS FROM AN EXTERNAL FILE

The keyword READDEM instructs SMART to read in data from an external file. The user must provide the reference number of the dataset on the keyword card. On the external data file, the following information must be supplied:

1. Origin zone identifier;

2. Origin type code (residential area or activity center);

3. Destination zone identifier;

4. Destination type code (residential area or activity center);

5. Time of day; and

6. Number of trips per minute.

The user must prepare a record for each origin/destination zone pair and for each separately identified time of day. Thus, if the study area is divided into 50 zones with entries in one-third of the possible origin/destination combinations for three separate time periods, the origin/destination matrix consists of 2,500 records -- a sizeable dataset.

When SMART encounters a READDEM card, it sets the residential and activity center trip rates, the origin/destination trip rates, and link flows to zero, and then increments these values with the trip rates specified on the user's input cards. Thus, any zonal, origin/destination or link flows that are not specified on the user's input cards will retain zero values.

If only a few items are to be changed, the user should use the VRES, VACT, ODM or TRAFFIC cards (see Section 4.3) instead of the READDEM card to override the current demand values.

## 4.2 DEFAULT GENERATION OF ZONE-TO-ZONE DEMANDS

The default demand generation procedure is invoked if a SMART routine (for example, FEEDER) is called that must use non-existent demand data.

The first step in the default generation process is to obtain zonal demand parameters (i.e., employment and population densities and average trip lengths in minutes) for work, non-work home-based, and non-home-based work trips. These values are introduced by means of ONEZDP or ZDPSET cards. If no values are introduced, the program will use the default values assigned to each of these parameters. Using assigned values for the trip generation rate per unit of population or employment, SMART calculates the total number of trip ends generated in each zone based on its population and employment densities and area. Trip ends are combined into trips using an attraction function that decays exponentially with increasing distance from the originating zone. The zone-to-zone daily trips are then disaggregated by time of day using either user-supplied or SMART default values for the fraction of trips taking place in each time period. At this point, the data are ready to be aggregated into the demand categories required for FEEDER, LINKER, DUMPER, CBD, REGION, and DOOR analyses.

Note that trip generation rates and trip proportions (in each time period) can be modified using the DEMPARM and TRIPTIME cards, as described in Appendix A. These parameters are applied to the entire network, not just to specific zones.

## 4.3 DEMAND AGGREGATION OUTPUT

SMART aggregates zone-to-zone demands into the following categories:

1. One-way trips with one end in the residential districts of the different residential zones (VRES in SMART terminology). These trips are divided into those outbound from the residential district and those inbound to the residential district. Trips are aggregated by time of day (i.e., morning peak, off-peak, or afternoon peak).

2. One-way trips with one end in the minor activity center (or business district) of the different residential zones (VACT in

SMART terminology). These trips are divided into outbound and inbound trips. They are also aggregated by time of day.

3. An origin/destination matrix (ODM) is prepared that lists trip rate by time period, origin node, and destination node.

4. Trip rate (person-trips per minute) are accummulated by links, by time period of trip and by destination node. Trips are assigned specific routes between origin and destination nodes on the basis of shortest uncongested automobile travel time. A conventional shortest-path algorithm is used to make this assignment.

The default for any current residential trip rate can be overridden using the VRES card; the activity center trip rate can be overridden using the VACT card; the origin/destination matrix can be changed using the ODM card; and the link trip volume can be changed using the TRAFFIC card (see Exhibit 4.1).

Trips within CBD zones do not distinguish between activity and residential type; only the time and direction of the trips are important. Therefore, residential trips are aggregated with activity center trips of the same direction to form the CBD trip volume.

A uniform transit mode share is used throughout the study area. The influence of mode share on travel volumes can be investigated by specifying up to six different transit mode share fractions for each SMART run. Using the aggregated data described above and transit mode shares, the SMART model can calculate the following travel demand information:

1. Link and zone trip rates by direction, time period and mode;

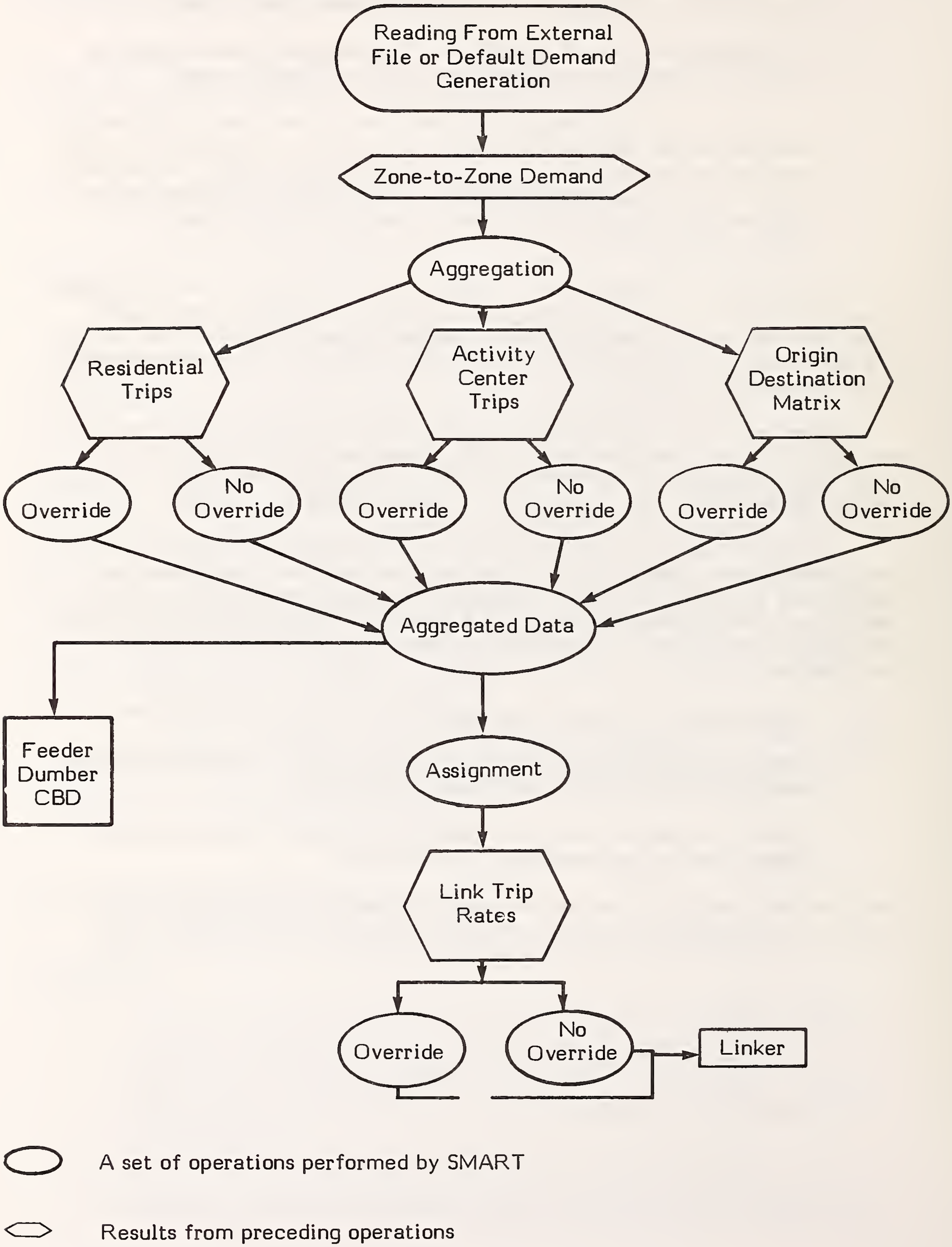
2. Transit boarding rates for each LINKER transit mode category on each link by direction and time period; and

3. Transit unloading rates by direction and time period for each LINKER transit mode category on each link.

The user can override the transit boarding rate by the PICKUPS card, and he/she can override the transit unloading rate by the DROPOFFS card.

EXHIBIT 4.1

DEMAND MODELING IN SMART



# 5. TRAVEL MODES

SMART models eight travel mode types: AUTO, CARPOOL, FRBUS (fixed-route bus), FLEXRTE (flexible-route service), LRAIL (light-rail corridor service), HRAIL (heavy-rail corridor service), PVTAUTO (private automobile transit such as park-and-ride and kiss-and-ride), and AGT (automated guideway transit). Each mode type is described completely by a set of parameters including speed, capacity, and cost. By defining different values for these service descriptors, one can create many different modes for each mode type. For example, one may have several fixed-route bus modes, with modes differing in terms of bus size, route spacing, and maximum headway. From eight mode types, it is possible to create modal variations up to the limit of 25 transportation services that SMART can accommodate.

Note that the term "modes" as used by SMART may, but does not necessarily, imply any difference in service characteristics. It necessarily implies only a difference in the name (or identifier) associated with the mode. For instance, there can be 25 automobile modes, all with identical characteristics but having different names. SMART will still consider them as 25 different modes. Mode names can be defaults, such as AUTO, CARPOOL, FRBUS, FLEXRTE, LRAIL, HRAIL, PVTAUTO or AGT, or they can be user-supplied through the MODESEL card described later in this chapter.

Many mode types not directly modeled by SMART can be indirectly analyzed by making slight adjustments. For example, "subscription" services -- which provide vans or buses to pick up workers in the morning and take them home in the evening -- can be modeled by considering them as large carpools. Electric (trolley) coaches operating on a distribution/collection system can be modeled as fixed-route buses with a change in speed and cost per route-mile. Exhibit 5.1 illustrates the method by which many different transit services can be modeled with SMART. The eight basic modes have been modified to represent 25 different transit services in this example. The user may be able to create more. Changes in vehicle size and service characteristics greatly increase the scope of the services that can be tested. These changes can be made through the MODEPARM (modal parameter) card described later in this manual.

EXHIBIT 5.1

SAMPLE REPRESENTATION OF DIFFERENT TRANSIT SERVICES

| SMART MODE | Transit Service | Modal Parameter Adjustments Required |
|---|---|---|
| Automobile (AUTO) | Automobile | None |
| Carpool (CARPOOL) | Carpool | None |
| | Vanpool | Adjust vehicle capacity, cost |
| | Subscription Bus | Adjust vehicle capacity, cost, add driver cost |
| | Checkpoint Subscription Bus | Adjust vehicle capacity, cost, add driver cost, change mean passengers per stop |
| Fixed-Route Bus (FRBUS) | Fixed-Route Bus | None |
| | Express Bus | Change stops per mile |
| | Preferential Treatment Bus | Change speed on affected links, areas |
| | Checkpoint Deviation Bus | Change route distance, speed |
| | Route-Deviation Bus | Change route distance, speed |
| | Jitney | Change vehicle size, cost, maximum headway |
| Flexible-Route Service (FLEXRTE) | Doorstop Dial-A-Ride | None |
| | Shared-Ride Taxi | Change vehicle size, cost |
| | Checkpoint Dial-A-Ride | Set checkpoints per square mile |
| Light-Rail Service (LRAIL) | Light-Rail Transit | None |
| | Trolley Bus | Change speed, cost |
| | Single Fixed-Route Bus in Residential Area | Change speed, cost |
| | Bus on Exclusive Right-of-Way | Change speed, cost |
| Heavy-Rail Service (HRAIL) | Heavy Rail | None |
| | Commuter Rail | Change speed, cost |
| Automobile Transit (PVTAUTO) | Park-and-Ride | None |
| | Kiss-and-Ride | Double mileage, subtract parking cost, add driver cost |
| Automated Guideway Transit (AGT) | Single Line Transit | None |
| | Ground Rapid Transit | Change wait, travel times, cost |
| | Personal Rapid Transit | Change wait, travel times, cost |

## 5.1 MODE SELECTION

SMART has eight default modes, one corresponding to each mode type shown in Exhibit 5.2. To better conform to reality, certain of these modes are restricted to certain types of analyses. Hence, when requesting FEEDER, LINKER, DUMPER, or CBD analyses, only the modes permitted for that analysis can be selected.

When a travel mode is selected, an entry is made in the selected travel modes list. The parameters for the selected mode are then initialized to the current default values for that mode type. A travel mode can be selected automatically or by request.

When an analysis needs to use a particular type of travel mode (for example, FEEDER requires an AUTO mode), it first checks the selected modes list to find out if that mode type has already been selected. If not, SMART will automatically select such a travel mode using default values to describe it. If the required selection already exists, it will be used, regardless of whether it was chosen by user request or selected automatically during a previous step. Regardless of the selection method, SMART ensures that at least one automobile, one carpool, and one transit mode are included in any analysis.

Mode selection is controlled by the MODESEL and the NULLMODE cards. If both cards are absent from the input deck, SMART will use the automatic selection method, which selects at least one mode from each of the permitted mode types.

When a travel mode is selected, its name (also known as MODE IDENTIFIER) is copied onto the selected modes list. Once selected, a name cannot be removed from the list during the computer run. If, for instance, a FEEDER card requesting a uniform area analysis is placed right at the top of the input deck, SMART will automatically select the default FEEDER modes (AUTO, CARPOOL, FRBUS, FLEXRTE, and PVTAUTO). These default modes will remain on the selected list for the balance of the run and, hence, will be analyzed in any subsequent FEEDER requests.

Since only modes named on the selected modes list are candidates for analysis, the user can suppress the analysis of any default mode by preventing its name from being written on the list. To do this, the user must issue the NULLMODE card before requesting any zonal analysis. Once SMART encounters this card, it will turn off its default mode selection indicator for the analysis specified on the card, and will not add any default modes to the selected list as long as one automobile, one carpool, and one transit mode have been selected for the analysis. If any of these three modes is missing, SMART will automatically select the missing one. Note that the analysis name (FEEDER, DUMPER, CBD, LINKER) must be specified on the NULLMODE card; otherwise, the default selection procedure will remain operative.

After issuing the NULLMODE card, the user can select any desired mode by using the MODESEL card, which must contain the following information:

EXHIBIT 5.2

DEFAULT MODES

| Mode Identifier* | Mode Type | Analysis Permitted |
|---|---|---|
| AUTO | Automobile | FEEDER, DUMPER, CBD, LINKER |
| CARPOOL | Carpool | FEEDER, DUMPER, CBD, LINKER |
| FRBUS | Fixed-Route Bus | FEEDER, DUMPER, CBD, LINKER |
| FLEXRTE | Flexible-Route Service | FEEDER |
| HRAIL | Heavy Rail | LINKER |
| LRAIL | Light Rail | FEEDER, LINKER |
| AGT | Automated Guideway Transit | CBD |
| PVTAUTO | Private Automobile | FEEDER |

*Name used to identifiy mode

1. Mode identifier;

2. Type of analysis permitted for this mode (i.e., FEEDER, LINKER, DUMPER, or CBD);

3. Mode type, which must be one of the eight default mode types; and

4. Whether this mode is to be added to the selected list or is to replace another mode identified on the list.

For further description of this keyword card, refer to Appendix A.

If a new mode is to be added, any name (or identifier) can be assigned to it as long as it is not the identifier of any of the default mode types shown in Exhibit 5.2. The parameters of the new (added) mode are initialized to the current defaults for that mode type. These parameters can be changed by the user only through the MODEPARM card described in Section 5.2.

If a mode is to replace another mode already on the selected list, both must have identical names. Replacement of modes helps to conserve space by re-using positions occupied by unneeded modes. The parameters of the new (replacing) mode are all initialized to the current defaults, and no values are left over from the old (replaced) mode. Except for the continuity of the identifier, there is no restriction on the replacing mode; it can be for a different type of analysis or for a different mode type.

As an example, the input data:

```
NULLMODEFEEDER MODESEL ADD     ALT1
FEEDER  FLEXRTE FEEDER  UNIFORM MODESEL
REPLACE ALT1    DUMPER  FRBUS
```

accomplishes the following:

1. SMART's FEEDER default mode selection indicator is turned off after encountering the NULLMODE card;

2. A flexible-route feeder transit mode called ALT1, with all the default parameters of flexible-route service, is added to the selected modes list;

3. A uniform area feeder analysis is performed, with SMART ensuring that at least one automobile mode (in this case, the default AUTO) and one carpool mode (in this case, the default CARPOOL) are selected in addition to the transit mode ALT1; and finally

4. SMART changes the parameters of ALT1 so that it becomes a fixed-route bus DUMPER mode.

The placement of the NULLMODE card is very important in controlling the mode selection process. If, for example, this card were to follow the FEEDER keyword instead of preceding it, default feeder modes would have been selected upon encountering the keyword "FEEDER" and, once selected, these modes cannot be inactivated by the subsequent NULLMODE card. This means that any additional FEEDER requests within the same job would have these default modes analyzed. Therefore, the NULLMODE card must be placed before any zonal analysis request cards if the default selection process is to be turned off for that analysis.

If the MODESEL card is used without the NULLMODE card, a combination of default and user-selected modes could result. Since the default mode selection indicator is still on, SMART will scan the selected modes list for the appropriate default mode types corresponding to the requested analysis and, if any are missing, SMART will automatically select those.

In the event that multiple modes of the same type are listed in the selected modes table, and the analysis requires that only one mode of that type be active, SMART uses the last mode on the list. This applies to AUTO and CARPOOL modes in CBD, and all LINKER modes.

## 5.2 MODAL PARAMETER DEFINITION

The MODEPARM card controls the definition and modification of modal parameters. Its effect depends on whether it is applied to a default mode (generic update) or to a user-selected mode (selective update). Generic updates change the default values of all modes (corresponding to the updated mode type) selected after the generic update, but do not affect those already selected. In contrast, selective updates apply only to a particular user-selected mode, and do not affect default values. Both generic and selective updates can be made at any point during the run.

The best time to change user-selected mode parameters is immediately after the MODESEL card. It is also possible to change parameter values between analyses. For example, the card sequence:

```
MODESEL ADD     NEWMODE FEEDER  FRBUS
MODEPARMNEWMODE PAS/VEH       20
FEEDER  LZONR2C1UNIFORM
MODEPARMNEWMODE PAS/VEH       60
FEEDER  LZONR2C1UNIFORM
END
```

achieves the following: A new feeder fixed-route bus identified by the name NEWMODE is added to the table of selected modes. Its capacity is set to 20 passengers per vehicle, overriding the default value. A uniform area feeder analysis of zone LZONR2C1 is performed. The capacity of NEWMODE is subsequently changed to 60 passengers per vehicle, and a second uniform area feeder analysis of zone LZONR2C1 is performed, using the new capacity.

If the MODEPARM card is applied to a default mode, the new values on the MODEPARM card will become the default values for any mode of that type selected later in the run, but will not affect those selected before the update. As an example, consider the following card deck:

```
TITLE   CHANGE FRBUS DEFAULT VEHICLE CAPACITY
FEEDER  LZONR2C1UNIFORM
MODESEL ADD     FFRB1   FEEDER  FRBUS
MODEPARMFRBUS   PAS/VEH        20
MODESEL ADD     FFRB2   FEEDER  FRBUS
FEEDER  LZONR2C1UNIFORM
END
```

In this job, a uniform area feeder analysis of zone LZONR2C1 is first made using default or automatically selected travel modes. Then a new feeder fixed-route bus FFRB1 is added to the selected modes list. FFRB1 has all the defaults of a fixed-route bus service. Next, the MODEPARM card changes the default fixed-route bus capacity to 20 passengers per vehicle. Thus, the capacity of the new bus FFRB2 added later has the value of 20 passengers per vehicle, and a second uniform area feeder analysis is performed with FFRB2 described by the new capacity. The previously selected fixed-route bus mode (FFRB1) will still have the original default value.

Changing the defaults for mode type AUTO will also change the defaults for mode types CARPOOL and PVTAUTO to the same values. However, changes made to the defaults of any other mode type, including CARPOOL and PVTAUTO will only affect that type.

## 5.3 SPACE CONSIDERATIONS

REGION selects three dummy travel modes (AUTO TOTAL, CARPOOL TOTAL, and TRANSIT TOTAL). LINKER selects one mode (TRANSIT TOTAL) and DOOR selects four (AUTO TOTAL, CARPOOL TOTAL, TRANSIT TOTAL, and MODE TOTAL). These dummy modes each occupy one position in the selected travel modes table only during the execution of that analysis. When the analysis is terminated, the space reserved for the dummy modes is released and is available for alternate uses.

SMART limits the user to no more than 25 selected travel modes at any time. This number includes automatically selected modes, user-requested modes, and dummy modes. Note that selected modes of the same type but for different analyses count as separate modes. Normally, a REGION analysis will require at least:

1. A FEEDER AUTO mode;

2. A FEEDER CARPOOL mode;

3. At least one FEEDER transit mode;

4. A DUMPER AUTO mode;

5. A DUMPER CARPOOL mode;

6. At least one DUMPER transit mode;

7. A CBD AUTO mode;

8. A CBD CARPOOL mode;

9. One CBD transit mode;

10. A LINKER AUTO mode;

11. A LINKER CARPOOL mode;

12. One or more LINKER transit modes (depending on the network);

13. A dummy AUTO TOTAL mode;

14. A dummy CARPOOL TOTAL mode; and

15. A dummy TRANSIT TOTAL mode.

Thus, REGION has at most ten positions available for alternative FEEDER, DUMPER, or CBD modes.

# 6. FEEDER ANALYSIS

FEEDER transportation caters to trips made between homes in the residential portion of a zone and the minor activity center of that zone. One location within the activity center includes a line-haul station or interchange by which travelers leave the residential zone and enter the regionwide network. FEEDER analyzes local transit service in predominantly residential zones. The standard zone is highly stylized, but comes in three configurations to reflect the diversity of residential neighborhoods.

1. Uniform density: A square zone with uniform population throughout; commercial activity is concentrated at six locations near the line-haul entry located at the center of one side (see Exhibit 6.1).

2. Subarea: A square zone with two different population densities--a high density in a subsquare about the line-haul entry point and low density in the balance of the zone. Commercial activity is the same as for uniform density.

3. Corridor: A square zone with two different population densities--a high-density corridor one-half mile wide extending from the line-haul entry point across the zone, and low density in the balance of the zone. Commercial activity is concentrated along the corridor, which can be served by a light-rail line.[1]

Transportation service in FEEDER is provided by five travel mode types: automobile, carpool, fixed-route bus, flexible-route service (dial-a-ride, shared-ride taxi or subscription service), and private automobile transit. The characteristics of the different mode types are listed below:

1. Automobile: Direct point-to-point service for the automobile driver.

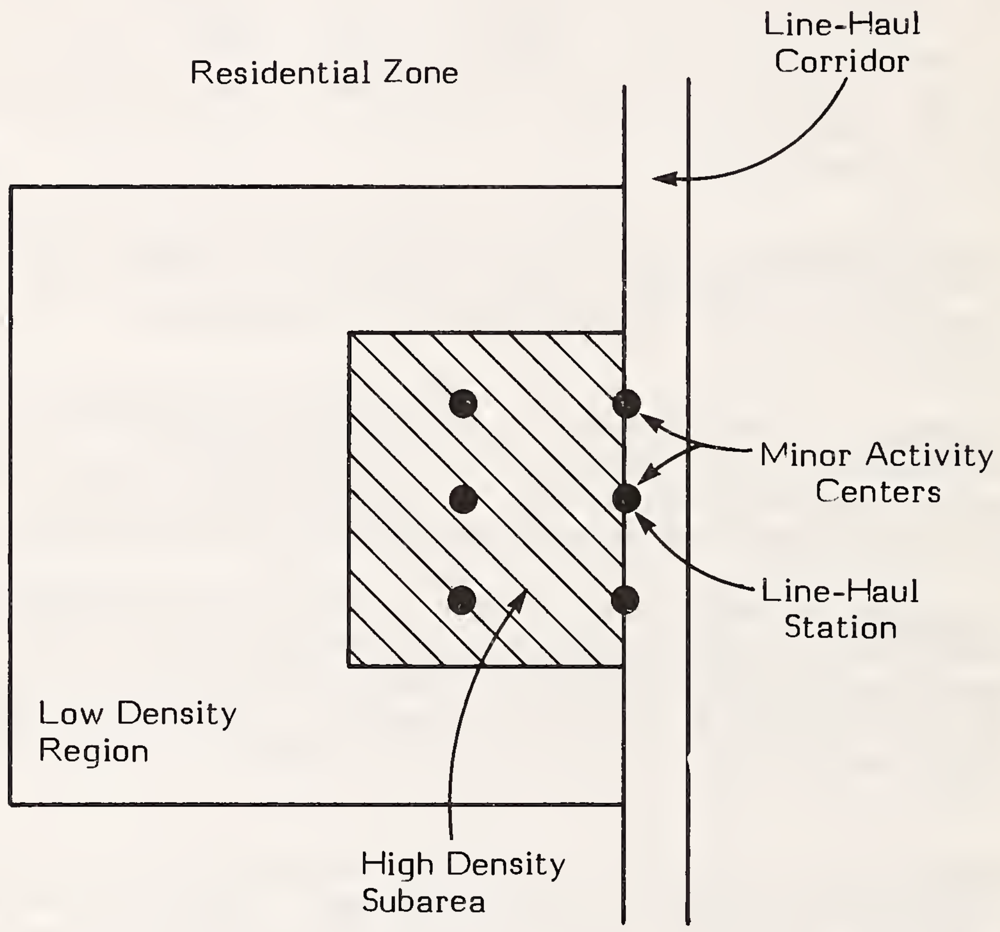
2. Carpool: Doorstop subscription service in which an automobile performs a collection trip to gather riders and then moves non-stop to the line-haul entry point. Carpool trips are not considered to be part of the transit mode share.

---

[1] The corridor configuration permits two different transit services to operate simultaneously. One is restricted to the corridor. The other operates throughout the zone.

EXHIBIT 6.1

SUBAREA GEOMETRY IN FEEDER ANALYSIS



3. Fixed-Route Bus: Routes are distributed uniformly throughout the residential area; service on all routes is identical. Fixed-route service can be modified to reflect point deviation and route deviation services.

4. Flexible-Route Service: Normal peak-period service is doorstop or checkpoint subscription service. Normal off-peak service is many-to-few demand-responsive service provided between residential doorstops or checkpoints and the minor activity center. The user can select service combinations other than the usual (default) combination.

5. Automobile Transit: Automobile feeder to line-haul corridor transit service can be park-and-ride (a parking fee is assessed) or kiss-and-ride (mileage is double origin/destination mileage and the driver does not count in vehicle loading).

6. Light Rail: In a FEEDER analysis with a high-density corridor, transit demand in the corridor is served by a single light-rail line running down the center of the corridor.

FEEDER divides travel between the automobile mode (with a set fraction of carpooling) and a transit mode for each of the four transit modes independently, using the mode shares specified by the user. Even though designed for non-CBD zones, a FEEDER analysis can be performed on any zone. If a CBD-type zone is designated, SMART will print a warning message but will nevertheless proceed with the analysis.

To analyze a single zone without generating the entire network, use the NULLNET card followed by the ONEZONE card describing the analysis zone. For example,

```
NULLNET
ONEZONE ZONE1   NODE1         20NON-CBD
FEEDER
END
```

will generate a single zone network. Since SMART's default demand generation procedure is not appropriate for such a network, override all zonal demand values by the VRES card. Then apply FEEDER analysis to this zone.

A FEEDER analysis may be requested through the FEEDER keyword card, which must identify the zone to be analyzed and the analysis option (whether UNIFORM, SUBAREA or CORRIDOR). When a SUBAREA is desired, the user must specify on the keyword card the ratio of the low-density trip generation rate to the high-density trip generation rate, and the ratio of the size of the subarea to the size of the entire zone. Both these numbers must, of course, be between 0.0 and 1.0. A CORRIDOR option will activate a light-rail transportation mode for the corridor. A higher density of trips is assumed to be concentrated in the half-mile wide corridor centered on the light-rail guideway.

The input deck

```
FEEDER  LZONR2C1UNIFORM
FEEDER  LZONR2C1SUBAREA      0.5    0.25
FEEDER  LZONR2C1CORRIDOR    0.25
END
```

will result in

1. A feeder analysis of zone LZONR2C1, assuming a uniform distribution of trips;

2. A second feeder analysis of zone LZONR2C1, assuming dual densities, with the lower trip generation rate being half that of the higher rate and the size of the high-density subarea being one-quarter that of the entire zone; and

3. A final feeder analysis of zone LZONR2C1 with the light-rail corridor. The density of trips in the light-rail corridor is four times that in the rest of the zone.

Transit mode share (TMSHARE) and carpool demand fraction (CPFRAC) are used to divide demand into three classes:

| Travel Mode | Fraction |
|---|---|
| 1. Automobile | (1-TMSHARE) * (1-CPFRAC) |
| 2. Carpool | (1-TMSHARE) * CPFRAC |
| 3. Transit | TMSHARE |

All travel modes selected within each class are considered to be alternatives, and serve the entire demand for that category. Thus, if there are multiple transit modes (fixed-route bus, flexible-route service), each mode will be analyzed sequentially to determine how well it serves the total transit demand.

If the default travel mode selection procedure is in effect (that is, if the NULLMODE card has not been issued), the program will automatically select one mode from each of the feeder mode types for analysis, with the exception of light rail, which will be included in the selected list only if a CORRIDOR option is specified. To override the default mode selection, use the NULLMODE and MODESEL cards as described in Section 5.1.

SMART is provided with a default number for the average trip length within the residential zone. If the line-haul entry, located in the middle of one side of the square residential area, serves as a destination for local trips and a collection point for interarea trips, and if travel demand is uniformly distributed, then the average trip length would be 0.75S, where $S^2 = A$ is the size of the residential area in square miles. In most real instances, more of the trips would be made in the portion of the zone close to the activity center, and hence the average trip length would generally be less than 0.75S.[2] The default value assigned in the program is 0.67S. Currently, this value cannot be changed by the user; it can only be changed by a programmer working on the source program itself.

No capacity constraints are recognized on the streets of a residential zone.

Travel demand is given by the number of trips per minute that are outbound or inbound to the residential sector of the zone. For SUBAREA analysis, dual densities are involved. A simple way to analyze this is to regard the residential zone as consisting of two separate feeder zones with different uniform densities. The larger of the two zones is equal in size to the original residential zone, and has the lower density. The smaller of the two zones is equal in size to the subarea, and is of a density that equals the difference between the higher and lower densities. The model applies feeder analysis separately to the two zones, and sums or averages the output measures as appropriate. Thus, in the higher density zone, the low density and incremental density transit services are added to produce the high density services. By this device, vehicles serving the low-density area participate in the high-density service as they would in an actual site.

## 6.1 AUTOMOBILE

Because congestion is not considered in FEEDER analysis, the calculation of automobile performance measures is straightforward.

The average time per trip is simply the average trip length divided by the uncongested automobile speed, which can default to 0.33 miles per minute or 20 miles per hour. From observation, the standard deviation of travel time in minutes is assumed to be 0.75 times the square root of the average travel time, in minutes. Fuel consumption is calculated from the average trip length by applying a fuel consumption factor in gallons per mile. The trip frequency is the average automobile occupancy (persons per car trip) divided by the automobile trip rate (persons per minute). The automobile fleet is the average trip time divided by trip frequency. Vehicle miles per minute are calculated from the average trip length, trip time, and vehicle fleet. The cost per trip is calculated from cost per vehicle hour, cost per vehicle mile, cost per vehicle, average number of trips taken by an automobile per day, and average automobile occupancy. Vehicle loading is equal to average automobile occupancy, and pick-ups per minute are simply the automobile demand rate.

---

[2] If one eliminates walking trips, the average trip length would be longer; however, there are very few walking trips in most residential areas.

## 6.2 CARPOOL

The assumptions in SMART's carpool model are:

1. Carpool patrons are uniformly distributed over a square sub-sector of a FEEDER zone, where the sector size, $\theta$, is less than or equal to the size of the feeder zone, and

2. One patron, selected at random, drives.

Carpool circuity is calculated as the additional distance the driver must travel in order to pick up passengers. By considering carpool sizes of 2, 3 and 4 persons per vehicle, a linear equation for carpool distance as a function of carpool size was developed and implemented in the model. This equation fits the tour distance exactly for carpool sizes of 2 and 3. The average trip length is defined as:

$$\frac{\text{Carpool circuity}}{2} + \begin{array}{c}\text{Average trip distance for}\\ \text{single-occupancy auto trip}\\ \text{(0.67S by default)}\end{array}$$

The average trip time is the sum of the non-stop driving time and the time required for stopping and loading/unloading passengers. All other performance measures can be calculated as in the automobile case.

Note that the equation for carpool circuitry depends on the carpool area size $\theta$. The model computes $\theta$ as follows:

1. Calculate $C_r$ = Carpools per square mile per minute
   = Demands per square mile per minute
   * (1-transit mode share)
   * fraction of demand served by carpools
   / carpool size

2. Assuming people leaving for work M minutes apart are candidates for a single carpool, then

   $$C_r * M = \text{Carpools per square mile}$$

3. Carpool collection areas overlap by a factor of K; that is, there are K carpools serving the same area at the same time. Then the carpool area size $\theta$ is

   $$K * \frac{1}{C_r * M} = \frac{K}{C_r * M}$$

The external parameters required for the calculation of $\theta$ are:

1. Fraction of demand served by carpools (carpool fraction), and

2. The carpool time parameter, M/K.

These parameters can be set by the user through the CPFRAC and CPTIME keyword cards or defaults can be used. The M/K parameter gives a measure of each carpool rider's choice. If, for example, persons within a single carpool vary in preferred departure time by no more than 15 minutes (M) and if there are five carpools serving an area at the same time (K) then M/K = 3.0, the default value.

## 6.3 FIXED-ROUTE BUS

Fixed-route service is provided by buses operating on equally-spaced routes that radiate from the line-haul station in the manner shown in Exhibit 6.2.

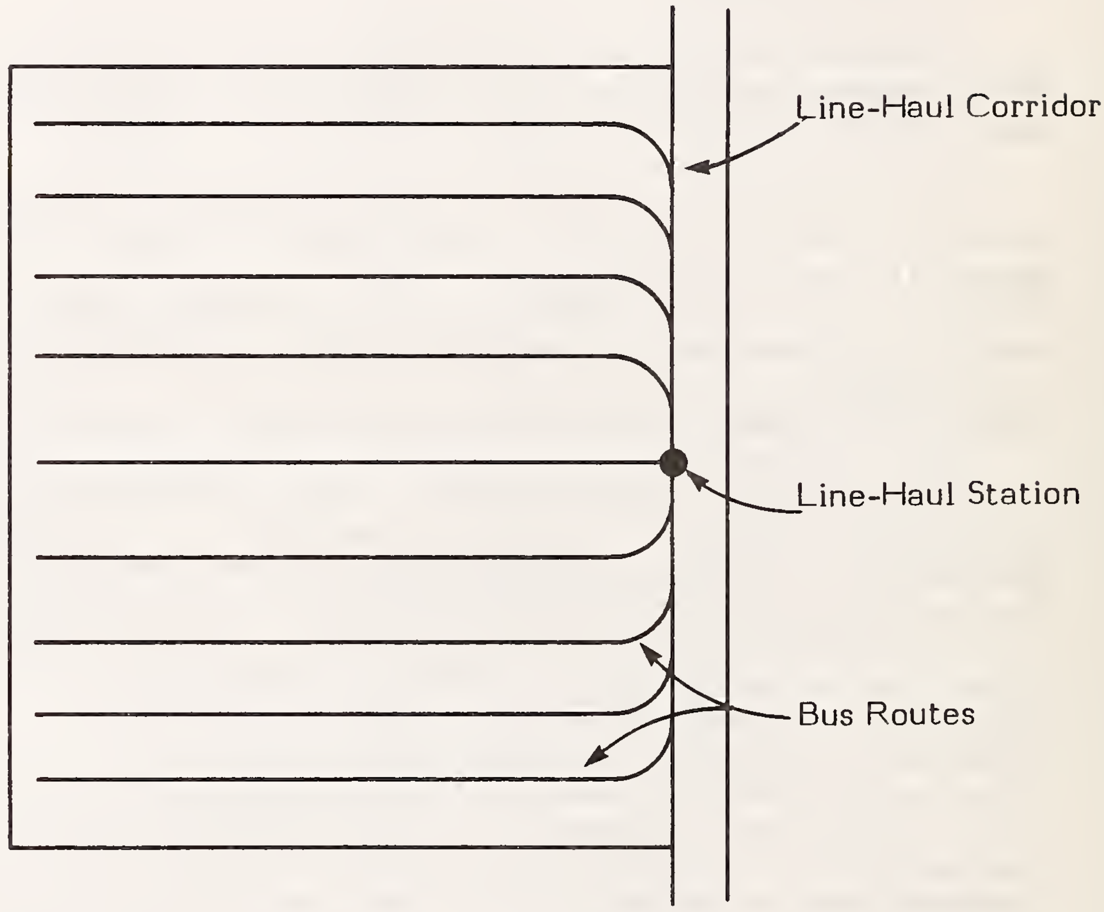
Constraints are placed on the level of service by specifying a maximum average route spacing and a maximum average headway. When demand is low, buses operate at the maximum condition in order to minimize costs. This operation is service-constrained. When demand cannot be accomodated at the minimum level of service, then headways and route spacing are reduced until buses operating at full capacity can handle the demand. This operation is called capacity-constrained.

The capacity-constrained problem is to determine by what amounts one should reduce route spacing and headways to minimize the traveler disutility. Note that the restrictions on maximum route spacing and headway imply a tradeoff between walk and wait time. If, for instance, K is the maximum average walk time and L is the maximum average wait time, then one minute of walk time must contribute L /K times as much disutility to the traveler as one minute of wait time. One can then formulate an objective function consisting of the sum of walk and wait times weighted according to the tradeoff ratio and proceed to minimize it. In the objective function, the average walk distance is equal to one-quarter of the average route spacing and walk time is obtained by dividing average walk distance by the walk speed, which has a default value of three miles per hour. Average wait time depends on the headway and the traveler's knowledge of the schedule. If the traveler has perfect knowledge of the schedule, and if the buses operate exactly on schedule, the traveler can time his departure from home so there will be no wait time. In practice, the traveler does not have perfect knowledge, and buses are not precisely on time. Therefore, the prudent traveler gives himself some margin for error. The amount of margin depends on the size of the penalty the traveler pays for error (e.g., the time he/she must wait if the bus is missed). Turnquist[3] developed the following relationship for waiting time, $t_w$:

[3] Turnquist, M.A., "A Model for Investigating the Effects of Service Frequencies and Reliability on Bus Passenger Waiting Times," Northwestern University, Evanston, Illinois, 1976.

EXHIBIT 6.2

BUS ROUTE PATTERNS IN FEEDER ANALYSIS



$$t_w = \alpha + \beta * h$$

where h is mean headway and
$\alpha$ and $\beta$ are constants.

In the outbound direction, $t_w$ always follows the above relationship; in the inbound direction, it depends on transfer coordination, which is a modal parameter that can be changed at the discretion of the user. For RANDOM transfer,

$$t_w = h/2;$$

for THROUGH (coordinated) transfer,

$$t_w = 0;$$

and for timed transfer,

$$t_w = \alpha + \beta * h.$$

(See MODEPARM card description in Appendix A.)

When service is capacity-constrained, results of the optimization calculations indicate that both headway and route spacing must decrease by the same factor F in order to minimize travel disutility; in other words,

Headway = F * maximum headway, and

Route Spacing = F * maximum route spacing.

where $F^2$ = the actual bus capacity divided by the average number of passengers per bus which would have been assigned had the system used infinitely large buses and been service constrained. Note that F calculated from the above formula must lie between 0.0 and 1.0.

Once headway, route spacing, and bus load are known, transit performance indicators such as the round-trip tour time, bus fleet, vehicle miles per hour, fuel consumption rate, and pick-up rate can be easily calculated. The average time per trip is the average trip length (0.67S) divided by the average speed of the bus. Cost per trip is calculated from cost per vehicle-hour, cost per vehicle-mile, cost per vehicle and cost per route-mile. Default cost per route-mile is zero, but can be made non-zero by the user to model electric coaches, trolleys, etc.

## 6.4 FLEXIBLE-ROUTE SERVICE

Flexible-route service can be demand-responsive or subscription service. Either may be selected to provide service in the off-peak period.

### 6.4.1 Subscription Bus

Outbound subscription service from a traveler's residence to the residential zone's activity center is different from an inbound service. For the outbound direction, the SMART model assumes that each bus leaves the activity center and drives to the extreme end of a pick-up strip, which stretches all the way across the zone and picks up travelers on its return to the activity center. For a uniform trip distribution, the tour distance covered by the bus is indicated in Exhibit 6.3. The bus has to travel a length of S miles, as well as average "up and down" deviations of one-third zone width between adjacent stops to pick up passengers.

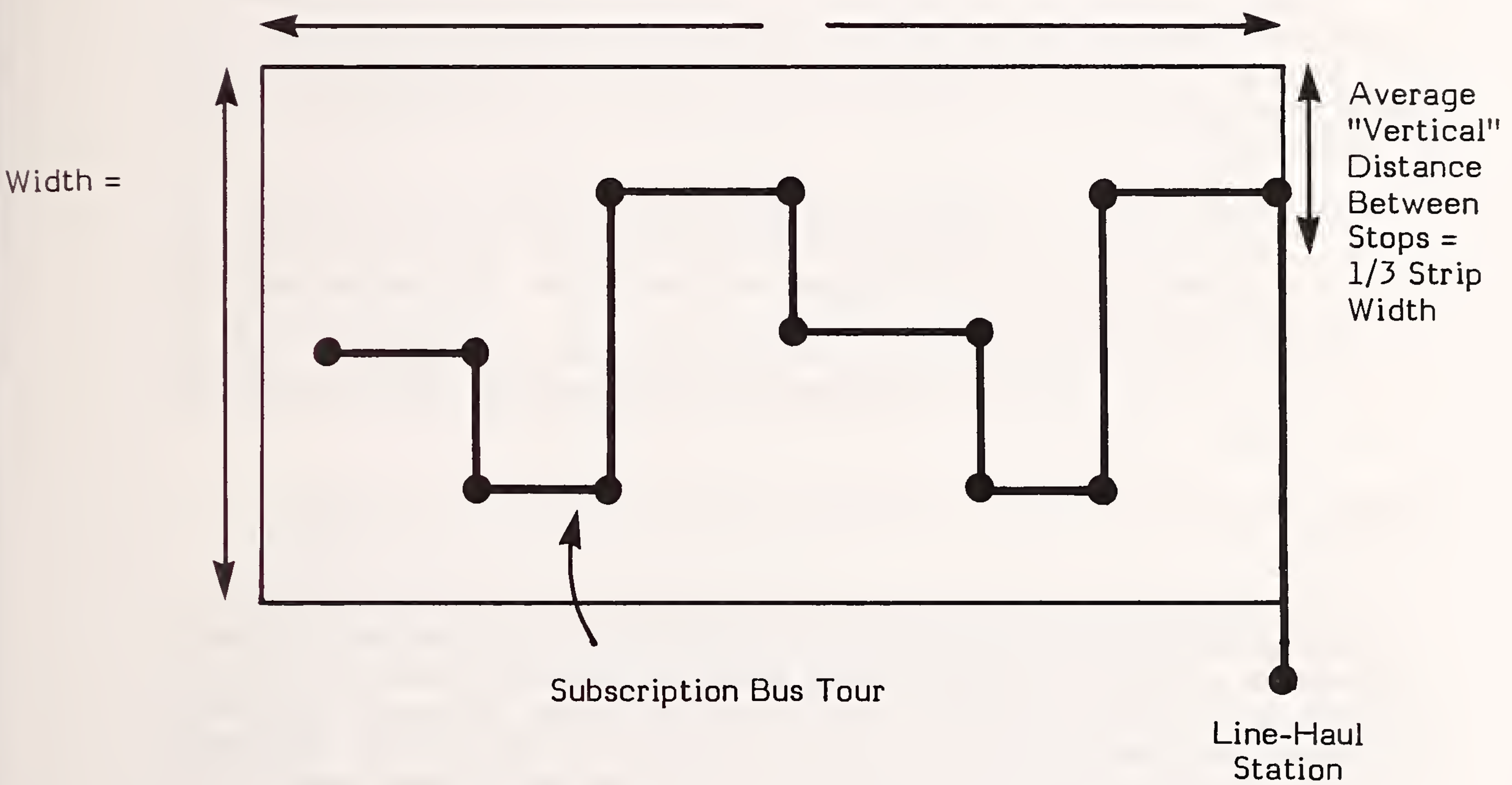
In the inbound direction toward residences, the model assumes that each bus serves a drop-off strip which stretches all the way across the zone. The width of the strip is chosen so that the headway (frequency of buses going to a particular area) is equal to the maximum acceptable headway. Unlike the pick-up strip, the drop-off strip may be served by several vehicles or by one vehicle on alternate tours, depending on the relationship between the maximum headway and the tour time. For instance, if the strip A is served by bus 1 and strip B is served by bus 2, and headway is half the tour time, then A and B will both serve a drop-off strip comprised of both 1 and 2's pick-up strips. The drop-off tour distance can be derived from geometry as before.

For the combined full tour, the model assumes that the drop-off run ends where the pick-up run begins. Although strip misalignment would in general add some distance, vehicles need not go all the way to the end of the strip. With very small error, the full tour distance can be estimated by the sum of the pick-up and drop-off tours.

The total tour time includes the non-stop driving time plus the delays due to stopping, loading and unloading passengers. The non-stop driving time is the tour distance divided by the non-stop vehicle speed. Loading can be calculated from vehicle capacity and demand data, since vehicles will be fully loaded in one or the other direction or perhaps both. The number of stops depends on the type of subscription service. For doorstop service, the number of stops is simply the number of passengers picked up while, for checkpoint service, the number of stops is a fraction of the number of checkpoints in the strip. The number of checkpoints can be calculated from the stop spacing (one of the modal parameters) and from the service area size. The number of travelers per checkpoint is assumed to follow a Poisson distribution, and the fraction of checkpoints requiring service is thus calculated from the probability distribution. Once the number of stops is known, the tour time equation

EXHIBIT 6.3

SUBSCRIPTION BUS OUTBOUND TOUR




N = Number of Buses in Residential Zone

A = Area of Residential Zone

can be solved and average vehicle speed (including stops) can be calculated.

Walk, wait, and ride times are estimated from the subscription tour time, pick-up and drop-off time and checkpoint spacing (for checkpoint service). The standard deviations of walk time is 0.5 times the square root of walk time, the standard deviation of wait time is 1.5 times the square root of wait time, and the standard deviation of ride time is 1.5 times the square root of ride time (all times in minutes). The rest of the performance measures can also be derived once tour time, loading, and number of stops are calculated.

### 6.4.2 Demand-Responsive Service

A many-to-few pattern of demand-responsive service is assumed in the model. The residential zone is divided into several service sectors, each served by a single demand-responsive vehicle that is dispatched from the activity center. A typical demand-responsive tour consists of:

1. A line-haul tour between the station and the service sector;

2. A residential tour within the service sector to pick up and drop off passengers; and

3. An activity center loop serving the commercial district of the zone.

Demand-responsive vehicles may offer either checkpoint or doorstop service.

The equation for the average residential tour distance was approximated from a Ford dial-a-ride simulation study, which used the "traveling salesman" minimum path algorithm.[4] The equation for the activity and line-haul tours was derived by SYSTAN, assuming that the demand-responsive vehicle may enter the activity center loop anywhere along the loop and that trip origin and length can be calculated probabilistically.

One problem in evaluating the equation for tour distance is that it is a function of the number of stops per tour, which is an unknown. For doorstop service, this problem is easily overcome because the number of stops is equal to the number of passengers per bus, which can be calculated. For checkpoint service, however, the number of checkpoints requiring service depends on the probability of passengers arriving at a particular checkpoint, and some assumption regarding the probability

---

[4] Mason, F.J. and J.R. Mumford, "Computer Models for Designing Dial-A-Ride Systems," SAE Automotive Engineering Congress, Detroit, Michigan, 1972.

distribution. In the model, passengers are assumed to arrive independently, which means that passengers per checkpoint follow a Poisson distribution. An equation was developed for number of stops per demand-responsive residential tour, and incorporated into the expression for tour time, which is solved to give tour times and vehicle loading.

Once tour time and vehicle loading are known, the calculation of other performance measures is straightforward. Ride time is half the total tour time. The standard deviations of travel times are derived in the same way as for subscription service.

Note that for doorstop service, the stops per mile modal parameter must be zero, while for checkpoint service, it must be higher than zero. This parameter can be changed through the MODEPARM card.

Walk and wait times differ for doorstop and checkpoint services and for inbound and outbound trips. For outbound (residential origin) doorstop service, there is no walk time. Wait time is calculated from Turnquist's equation on the assumption that, at some point, the traveler will cease productive activity and wait for the transit vehicle. There is no walk time for inbound doorstop service, but the length of time the traveler must wait depends on transfer coordination, as in the fixed-route case. For outbound checkpoint service, the traveler walks from his or her home to the checkpoint (average walk = one-half checkpoint spacing), and waits the length of time calculated from Turnquist's equation. Inbound checkpoint service is similar to inbound doorstop service, with the addition of a walk from the destination checkpoint to the residential destination.

## 6.5 LIGHT RAIL

The light-rail model describes service in a high-density corridor stretching across the residential area from the line-haul access point. Non-rail transit is assumed to serve the low-density trips distributed uniformly across the zone. The light rail mode is restricted to the additional trips found in the high-density corridor (that is, trips that account for the difference between the higher corridor population density and the lower density in the rest of the zone). This option provides a means for exploring mixed transit service in a residential zone.

Headway is either the maximum headway permitted (service constrained) or the largest headway necessary to accommodate travel demand (capacity constrained). Wait time equals $\alpha + \beta *$ headway in the outbound direction, and depends on transfer coordination in the inbound direction (similar to fixed-route bus). The variances of ride, wait and walk times, in minutes, are assumed to equal the respective means.

Costs are calculated from cost per vehicle-hour, cost per vehicle-mile, cost per vehicle and cost per route-mile, which includes the cost of the fixed guideway.

The light-rail procedure can be used to model other fixed-route services that might serve the high-density corridor. Trolley coach would look like light rail, but capital and operating costs for the fixed guideway would be restricted to trolley wires. Fixed-route bus service can be modeled by setting fixed guideway costs to zero.

## 6.6 PRIVATE AUTOMOBILE TRANSIT

Private automobile transit is a transit feeder mode that consists of such operations as park-and-ride and kiss-and-ride. Its differences from the automobile mode are:

1. Stop time for loading and unloading of passengers is included in private automobile transit but excluded from the automobile mode.

2. For kiss-and-ride operations, two-way trips are considered (one to drive the passengers to the line-haul station, the other for the driver to return home), and a charge can also be assessed for driver time.

3. Travel times are weighted according to the fraction of park-and-ride and kiss-and-ride trips. The default assigns all automobile transit trips to park-and-ride.

4. A parking charge is incurred by all park-and-ride trips, since parking is next to the line-haul station and within the commercial district. No parking cost appears in any other FEEDER model.

Automobile equations have been modified in the model to reflect private automobile transit operations.

# 7. DUMPER ANALYSIS

DUMPER models the distribution and collection of travelers within the commercial districts of residential zones. The commercial district is represented as six commercial sites clustered about the zone's connection to a line-haul corridor (see Exhibit 7.1). Travelers originating or terminating at the zone's activity center are assumed to be uniformly distributed among the six sites. Thus, one-sixth of the originations and terminations occur at the line-haul access site and do not enter into the DUMPER analysis.

Three classes of travelers are included in the analysis: (1) interzonal travelers who leave the line-haul station bound for specific commercial sites within the zone; (2) interzonal travelers destined for the line-haul station from origins within a commercial center; and (3) local travelers who originate or terminate in the commercial district of the zone. The traffic movement in and about the commercial center is assumed to be uncongested, because the employment and activity density in commercial centers (shopping centers) that are located in residential zones are not often high enough to create measurable congestion.

A DUMPER analysis can be requested by simply using the DUMPER keyword card, which must identify the zone to be analyzed as follows:

```
DUMPER  LZONR2C1
END
```

Such a card will activate a DUMPER analysis of zone LZONR2C1.

A DUMPER analysis can be performed on any zone. If a CBD-type zone is designated, SMART will print a warning message, but will proceed with the analysis nevertheless.

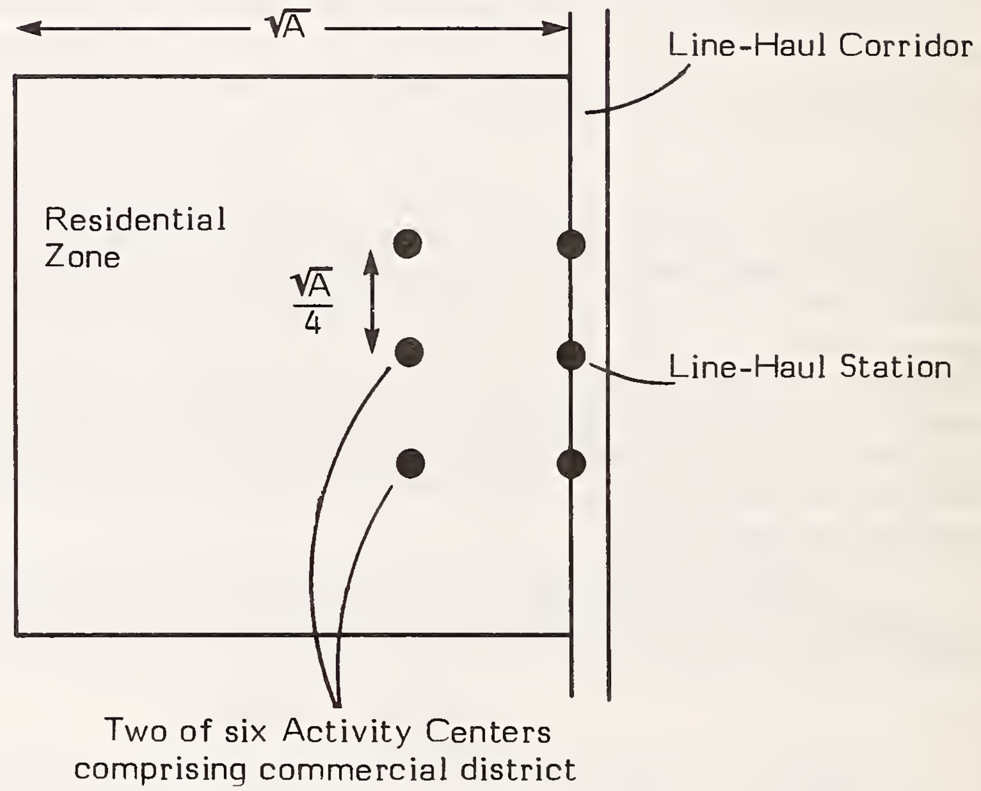
To analyze a single zone without generating the entire network, use the NULLNET card followed by the ONEZONE card describing the zone to be analyzed. For example,

```
NULLNET
ONEZONE ZONE1   NODE1                 20        NON-CBD
```

will generate only a single zone network. Since SMART's default demand generation procedure is not appropriate for such a network, override all default zonal demand values by the VACT card. Then apply DUMPER analysis to this zone.

EXHIBIT 7.1

SPATIAL CONFIGURATION FOR DUMPER ANALYSIS




A = Area of residential zone

Transit mode share (TMSHARE) and carpool demand fraction (CPFRAC) are used to divide total demand into three classes:

| Travel Mode | Fraction of Total Demand |
|---|---|
| Auto Trips | (1-TMSHARE) * (1-CPFRAC) |
| Carpool Trips | (1-TMSHARE) * CPFRAC |
| Transit Trips | TMSHARE |

Only one transit mode type (fixed-route bus) is used in DUMPER analysis. The user can select one or more bus sizes and maximum headways for this type, using the NULLMODE and MODESEL cards. If no selection is made, the default values will be used. All transit modes selected are considered as alternatives, and are assumed to serve the entire demand for that class. For example, if two bus modes are selected, they will be analyzed in sequence, and each is assumed to serve the total transit demand.

For each mode, SMART calculates the average time per trip, average cost per trip, standard deviation of travel time, fuel consumed per trip, average vehicle loading, fleet size, vehicle-miles per minute, and vehicle pick-ups per minute. These performance measures are distinguished by time of day, direction (whether inbound to or outbound from zone) and transit mode share index.

## 7.1 AUTOMOBILE

DUMPER automobile collects and distributes interregional and local trips within the commercial district of a residential zone. Assuming that trips are uniformly distributed across activity centers, the average length of interregional trips (that enter or leave via the line-haul access point) is calculated to be 0.42S. The average trip length for local trips differs slightly; it is actually 0.37S instead of 0.42S, but to simplify the analysis, the same value is used for both trip types in the program.

The average riding time per trip is obtained by dividing the average trip length by the uncongested automobile speed, which can be set to a default value of 0.33 miles per minute or 20 miles per hour. From observation, the standard deviation of ride time is 0.75 times the square root of the average riding time. The average walk time is the average walk distance (0.1 mile default) divided by the average walk speed (3 miles per hour). The standard deviation of walk time is observed to be 0.5 times the average walk time.

Fuel consumption is calculated from the average automobile trip length using mean fuel consumption in gallons per mile. The frequency of trips is the average automobile occupancy (persons per car trip) divided by the automobile trip rate (persons per minute). The automobile fleet size is the average trip time divided by trip frequency. Vehicle-miles per minute are calculated from the average trip length, trip time and vehicle fleet size. The cost per trip is calculated from cost per vehicle-hour, cost per vehicle-mile, cost per vehicle, average number of trips taken by an automobile per day, and average automobile occupancy. Vehicle loading is equal to average automobile occupancy, and pick-ups per minute are simply the automobile demand rate.

## 7.2 CARPOOL

Carpool tour distance is the ingredient in DUMPER carpool analysis. SMART's procedure requires two steps: (1) estimate the expected number of stops as a function of carpool size, and (2) calculate the distance traveled as a function of the number of stops per tour. Combining these two steps, one can calculate the distance traveled as a function of carpool size.

If one assumes that carpool passengers are dropped off randomly, then the number of passengers per stop follows a Poisson distribution, and the number of stops per tour can be calculated from that probability distribution.

$$\text{Number of stops per tour} = \text{Number of commercial centers} \times \left[ 1 - \exp\left\{ - \frac{\text{Carpool size}}{\text{No. of activity centers}} \right\} \right]$$

This equation fits our intuition; it shows that as the number of passengers per carpool or the number of commercial centers increases, the number of stops increases.

In calculating carpool distance as a function of the number of stops per tour, SMART assumes that carpool passengers may need to get off at any one of the commercial center stops, each stop being equally likely, and that the carpool driver/owner may need to backtrack to his own destination after dropping off the last passenger. Given the terminus stop (where the driver gets off) and the number of stops per tour, we must find the permutation of stops that gives the shortest tour and consider that tour length as the distance for that particular case. A program was written to do just that and, from the results, an equation was estimated for the average tour distance:

$$D \approx D_e = 1.67 + 0.74 * N * \frac{S}{4}$$

where D is the actual tour distance in miles per tour;
$D_e$ is an estimate for the tour distance in miles per tour;
N is the number of stops per tour; and
S is the length of a side of the zone.

This equation is used in SMART's DUMPER carpool routines, and gives a close estimate for tour distance as shown in Exhibit 7.2. The program restricts D to values between 0.0 and 1.5*S. The maximum relative error is less than ten percent for two person carpools. For larger carpools, the relative error is substantially smaller. Once tour distance is calculated, SMART computes other carpool performance measures as in the automobile case.

## 7.3 FIXED-ROUTE BUS

The activity center is served by a circular transit route with buses operating in both directions around the loop (Exhibit 7.3). Inbound travelers, whether on intrazone or interzone trips, are picked up at the line-haul point and transported to the commercial center. Outbound travelers are picked up at the commercial centers and delivered to the line-haul point. Local trips that circulate within the activity center are not focused on the line-haul point, and originate and terminate randomly anywhere along the loop.

The largest bus load occurs on the links adjacent to the line-haul point, either Segment A or B in Exhibit 7.3. For the counter-clockwise bus loop, the heaviest passenger outbound loading occurs on Segment A, while the heaviest loading of inbound passengers occurs on Segment B. The exact loading is calculated by taking all possible combinations of origins and destinations for travelers on the link and adding their trip rates.

The maximum loading on Segment A for the counter-clockwise bus is:

Maximum Load = Headway * 0.5 * (TVAIN+TVRA+0.5*TVAA)

Where: TVAIN denotes the inbound interregional trip rate;
TVRA denotes the inbound residential-to-activity center trip rate; and
TVAA denotes the circulating activity center-to-activity center trip rate.

On Segment B, the maximum loading for the bus in the counter-clockwise loop is:

Maximum Load = Headway * 0.5 (TVAOUT+TVAR+0.5*TVAA)

Where: TVAOUT denotes the outbound interregional trip rate,

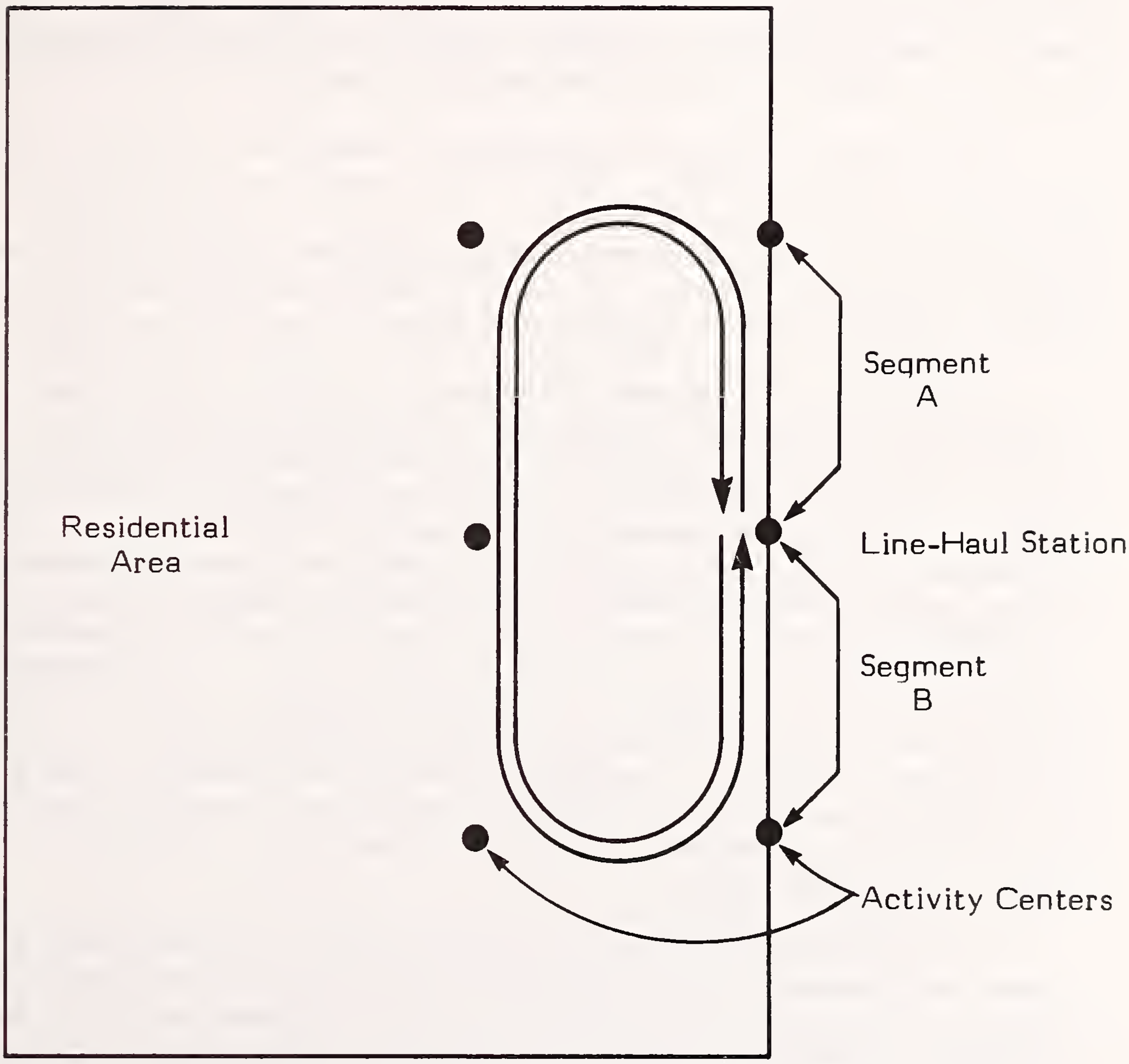
EXHIBIT 7.2

COMPARISON OF CARPOOL DISTANCE CALCULATED FROM LINEAR REGRESSION AND FROM COMPUTER SIMULATION

| Carpool Size<br>N | Distance from Linear Regression<br>$\hat{D}$ | Distance from Computer Simulation<br>D |
|---|---|---|
| 2 | 3.14 | 2.83 |
| 3 | 3.88 | 4.07 |
| 4 | 4.61 | 4.90 |
| 5 | 5.35 | 5.43 |
| 6 | 6.09 | 5.83 |

EXHIBIT 7.3

DUMPER BUS ROUTE



TVAR denotes the outbound activity center-to-residential area trip rate, and
TVAA denotes the circulating activity center-to-activity center trip rate.

Since the different trip rates are known, the loading on the two segments can be calculated and the greater of the two is the maximum load. Due to symmetry, this load will also be the maximum load for the bus in the clockwise direction.

The bus headway is given by the lesser of $HW_{max}$ and MVCAP/MXLODR, where $HW_{max}$ is the user-specified maximum headway, MVCAP is the bus capacity, and MXLODR is the maximum loading rate -- that is, maximum load divided by headway. MXLODR is obtained by leaving out the headway term in the maximum load expression given earlier.

Fleet size is obtained by dividing the round-trip tour time for each direction by headway. Headway is known, but tour time has to be calculated. The tour distance is 1.5S, and the driving time is obtained by dividing tour distance by the vehicle speed. Total tour time is the sum of the driving, stopping, loading and unloading time. Average bus speed (including stops) is tour distance divided by tour time.

The average trip distance for each traveler is calculated for each trip type by taking the probability of choosing any commercial center as a destination or origin, multiplying that probability by the origin-to-destination distance, and then summing over all activity centers. The mean distance is 9/20 * S for all trip types. Ride time is average trip distance divided by average bus speed. Average walk time is average walk distance (0.25 miles) divided by walking speed (three miles per hour). Wait time is equal to $\alpha + \beta$ * headway in the outbound direction, where $\alpha$ and $\beta$ are constants. In the inbound direction, wait time depends on transfer coordination; it is equal to half the headway if transfer is completely random, zero if fully coordinated, and $\alpha + \beta$ * headway if partly coordinated. The standard deviation of ride and wait times are equal to the square root of the means, while the standard deviation of walk time is equal to half the square root of the mean.

Vehicle-miles per minute are calculated from fleet size and vehicle speed; fuel consumption is obtained by multiplying vehicle-miles by fuel consumption/mile; pick-ups per minute equal demand; and cost per trip is calculated from cost per vehicle, cost per vehicle-hour, cost per vehicle-mile and cost per route-mile.

# 8. CBD ANALYSIS

SMART's CBD routine models travel within high-density central business districts. Transportation is provided by automobile, carpool, fixed-route bus and automated guideway transit (AGT). Because travel on CBD streets can be congested, speeds are adjusted to reflect traffic volumes.

To request a CBD analysis, simply use the CBD keyword card which must identify the zone to be analyzed as shown below:

```
CBD     LZONR2C1
END
```

This card will activate a CBD analysis of zone LZONRC1.

A CBD analysis can be performed on any zone. If a non-CBD zone is designated, SMART will print a warning message but will proceed with the analysis nevertheless. For a ring/corridor structure, the default option assigns a CBD to the central zone, while all others are non-CBD type zones. For an arbitrary network structure, all zones default to non-CBD type; thus, if a CBD zone is to be analyzed, it must be designated by the user. For a composite network, the original ring/corridor zones have the ring/corridor default values and the extra non-ring/corridor zones all default to non-CBD zone types. The user has complete freedom to change zone types through the ONEZONE and ZONESET cards (see Appendix A).

CBD zones are represented as square zones with area A. Line-haul corridors can attach anywhere on the periphery of the CBD. In addition, adjacent zones can have a continuous border with the CBD. Inbound travelers are uniformly distributed around the periphery of the CBD. The CBD has a grid street pattern. Its small resident population is uniformly distributed throughout the zone; high-density employment is also uniformly distributed. This structure is idealized and overlooks the concentrations of employment and traffic that one observes in many CBD's. However, the impact of this concentration can easily be modeled by adjusting the area of the CBD or by performing a series of analyses on subdivisions of the CBD.

Only one automobile and one carpool mode are analyzed for a CBD run. If no automobile or carpool modes are selected, SMART will automatically select one of each. If multiple automobile or carpool modes are included on the selection list, SMART will use the last one that appears on the list, and disregard all others. Once dismissed, redundant modes are not available for subsequent CBD analyses. Duplicate automobile and carpool modes are set aside to avoid difficulties when calculating congestion effects.

Because all transit modes are treated independently, multiple transit modes can be selected for sequential analysis. However, CBD can analyze only two transit mode types: fixed-route bus and AGT. If no transit modes are selected, SMART will ensure that at least one fixed-route bus and one AGT mode are analyzed. If the default selection process is "turned off" through the NULLMODE card, SMART will analyze whatever CBD transit modes appear on the mode selection list. If none appear, CBD will run with fixed-route bus as the transit mode.

## 8.1 CONGESTION

Congestion is modeled after the work of Smeed,[1] who studied downtown traffic in Central London and many other cities. Smeed devised an equation that relates traffic volumes to mean vehicle speed. This congestion relation is:

$$\frac{\text{Number of car equivalents using road per hour}}{\text{Width of road (in feet)}} = 68-0.13v^2$$

where v (the average vehicle speed) is in miles per hour. This equation suggests that the average road width occupied by an automobile (or automobile equivalent) is inversely related to the square of the vehicle speed and equals $1/(68-0.13v^2)$.

Converting to SMART units, we find that

$$v = \sqrt{5984 - \frac{LOCDIC * TDEM}{41184 * f * J * S}}$$

Where:

S is the length of one side of the CBD,
LOCDIC is the average distance traveled in the CBD (default is 0.67S),
TDEM is the travel volume in car equivalents per minute,
f is the fraction of CBD ground area that is devoted to streets, and
J is the fraction of the "carriageway" area that is available for automobile and transit travel (this removes the area assigned to street parking, intersections and other purposes not directly related to vehicle travel).

---

[1] Smeed, R.J., "Traffic Studies and Urban Congestion," Journal of Transport Economics and Policy, January 1968.

Of course, v must be real, and therefore non-negative in the model. Smeed's equation yields a maximum speed of 22.87 miles per hour. For a more general case, where maximum speed is Vmax miles per minute,

$$v = \frac{Vmax}{0.38} * \sqrt{5984 - \frac{LOCDIC * TDEM}{f * J * S} / 41184}$$

Data from eight town centers suggest that f, the fraction of total ground area of the town center devoted to streets, lies between 0.10 and 0.2; and that J, the fraction of carriageway area available for automobile and transit travel, lies between 0.22 and 0.46. SMART uses the congestion equation with a value for f of 0.15 and a value for J of 0.34.

TDEM, the total trip rate in the CBD, should include bus trips. Because bus characteristics influence congestion, automobile and carpool vehicle speed can only be computed if bus characteristics are known. Unfortunately, SMART accepts multiple bus modes whose characteristics are not known to the automobile and carpool models. To overcome this problems, SMART considers only auto and carpool trips when calculating congestion. This does not introduce a major error, because with low transit mode shares and high bus capacities, buses do not contribute significantly to congestion.

TDEM, the total trip rate, is the sum of trip rates in the outbound and inbound directions. The trip rate in any direction is the sum of residential and activity center trips (VRES and VACT) in that direction. Smeed's equation recognizes the directionality of center city traffic through the two area coefficients. If one has accurate data on CBD travel, these coefficients can be adjusted to yield a good fit. Otherwise, the default values reflect average circumstances.

## 8.2 AUTOMOBILE AND CARPOOL

Within the CBD, automobiles and carpools behave identically. Carpool circuitry is zero, since SMART assumes that all passengers are driven to a common carpark and walk from there to their individual destinations. In the same fashion, automobile travelers park their automobiles and walk to their destinations.

Total travel time in the CBD is the sum of driving time and walking time. Driving time is calculated by dividing trip distance by mean vehicle speed, as calculated from the Smeed equation. The average trip distance is LOCDIC, which defaults to 0.67S, where $S^2$ is area of the CBD. Walking time is obtained by dividing walk distance by walk speed. Default values are 0.2 miles and 3 miles per hour, respectively. From observation, the standard deviation of driving time is 0.75 times the square root of the average driving time, and the standard deviation of walk time is 0.5 times the average walk time.

Fuel consumption is calculated from the average vehicle trip length by applying a fuel consumption factor in gallons per mile. Trip frequency is calculated from the average trip rate (persons per minute) divided by vehicle occupancy (persons per vehicle trip). The vehicle fleet is the average driving time divided by trip frequency. Vehicle miles per minute are calculated from the average trip length, trip time and vehicle fleet. The cost per trip is calculated from cost per vehicle-hour, cost per vehicle-mile, cost per vehicle, average number of trips taken by the vehicle per day, and average vehicle occupancy. Vehicle loading is average vehicle occupancy, and pick-ups per minute are simply the demand rate (person trips per minute).

## 8.3 FIXED-ROUTE BUS

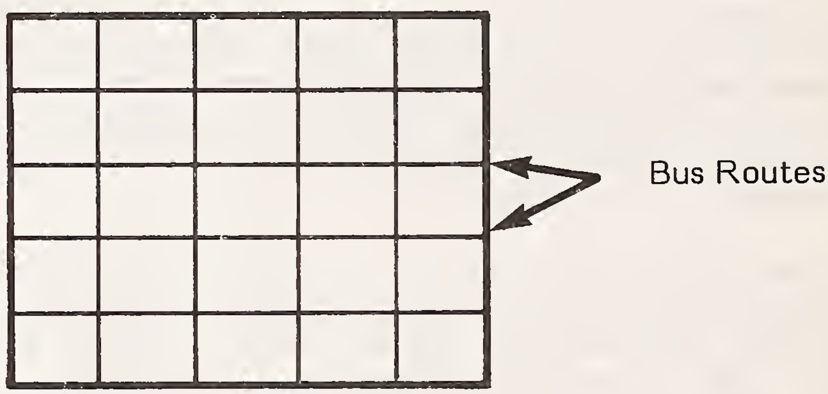



EXHIBIT 8.1

CBD BUS ROUTES

Fixed-route buses follow a grid route pattern in the CBD, as shown in Exhibit 8.1. As many routes run "horizontally" as "vertically." SMART assumes that demand is equidirectional; that is, travelers converge at the CBD and disperse from it in equal numbers in all four directions. Therefore, vehicles running from one end of the route to the other will serve one-quarter of the outbound demand and one-quarter of the inbound demand, as well as local trips circulating within the CBD. All routes serve an equal share of the trips.

Interzonal and local trips have different circulation patterns, and hence exert different influences on vehicle loading. Since SMART cannot distinguish between these trips they must be estimated in some reasonable way. In general, demand in one direction (inbound or outbound) will be higher than in the other. The program assumes all travel opposite to the high volume flow is local, and that a corresponding amount of the high-volume demand is also local. The balance of the high-volume demand is assumed to be interzonal (see Exhibit 8.2). This interzonal demand is either all inbound or all outbound, depending on the time of day. A reasonable assumption is that interzonal trips are all inbound during the A.M. and off-peak periods and outbound during the P.M. peak.

To calculate vehicle loading, SMART assumes that interzonal passengers either board or disembark at a constant rate as the bus moves across the zone. If, for example, interzone passengers are outbound, they will board during the run and disembark at the end of the run. Local passengers will board and disembark uniformly throughout the run. If interzone passengers are inbound, they will board at the beginning of the run and disembark throughout the run.

Suppose the bus has traveled a fraction $\lambda$ of the route it has to cover in a particular direction. Using the above assumptions, the vehicle load at that point can be calculated:

$$LOAD(\lambda) = 2 * \lambda * (1-\lambda) * PPB_l + \lambda * PPB_z$$

Where:

$PPB_l$ is the local passengers per bus, and

$PPB_z$ is the interzonal passengers per bus.

The number of local passengers per bus is given by:

$$PPB_l = \frac{DEM_l * HW}{4 * NR}$$

Where:

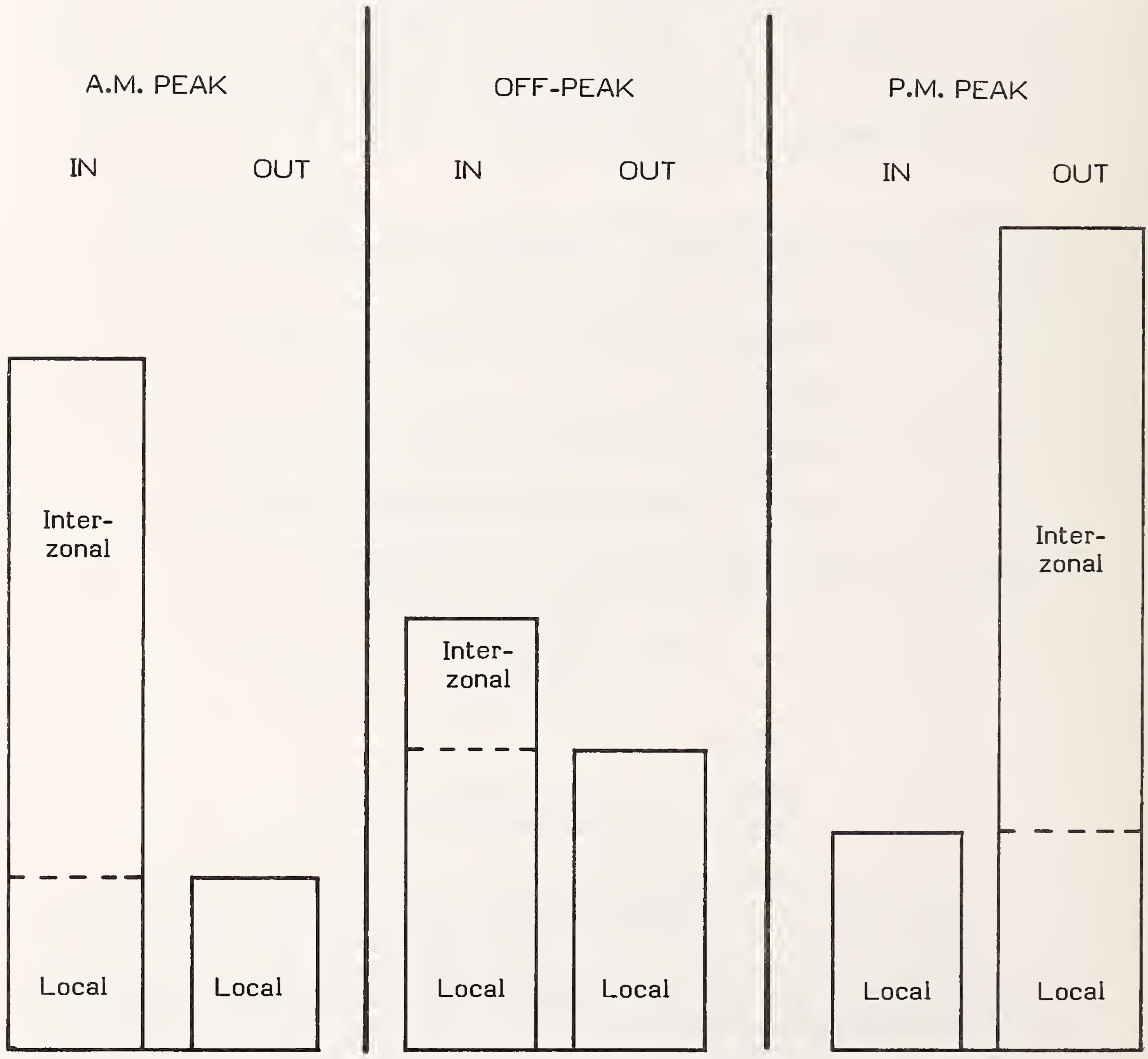
$DEM_l$ is the local demand rate,
HW is the headway of the bus, and
NR is the number of "horizontal" or "vertical" bus routes.

To calculate $PPB_z$, use the same equation as above, but replace $DEM_l$ by DEM , the interzonal trip rate.

The expression for LOAD has an assumed ride distance of 0.5*S for interzonal travelers and an assumed ride distance of 1/3*S for local travelers. Both are considerably less than LOCDIC, which defaults to 0.67*S. The extra passenger-miles caused by the higher value of LOCDIC must be accounted for. SMART assumes that these passenger-miles are

EXHIBIT 8.2

COMPUTATION OF CBD INTERZONAL AND LOCAL TRIPS



included in transfers, which are treated like local trips. With these "missing" passengers due to transfers, the load becomes:

$$LOAD(\lambda) = \lambda * PPB_z + 2 * \lambda * (1-\lambda) * PPB_l$$

$$+ (6 * LOCDIC - 2) * \lambda * (1-\lambda) * PPB_l$$

$$+ (6 * LOCDIC - 3) * \lambda * (1-\lambda) * PPB_z$$

The LOAD equation can be differentiated with respect to $\lambda$ to find the point of maximum load and then the maximum load itself. If the maximum load occurring at the maximum allowable headway is less then vehicle capacity, bus operations are service-constrained, and vehicles will run at the maximum headway. If, however, the maximum load is larger than vehicle capacity, bus operations are capacity-constrained and headway and route spacing must both be less than their maximum permissible values. Following the optimization procedure for FEEDER fixed-route bus,

Headway = F * maximum headway, and

Route spacing = F * maximum route spacing

Where:

$$F = \sqrt{\frac{\text{Vehicle capacity}}{\text{Maximum vehicle load at maximum headway}}}$$

The number of buses running on each route is obtained by dividing the round-trip tour time by headway. Headway is known, and tour time can be calculated from tour distance (2*S), congested vehicle speed, loading/unloading, and stopping times.

The average ride time per person-trip is LOCDIC divided by the average speed of the bus. The wait time per person-trip includes initial wait associated with transfers. Initial wait is normally $\alpha + \beta$ * headway, where $\alpha$ and $\beta$ are constants. However, for short headways (less than five minutes) travelers need not consider schedules and arrivals can be treated as random with mean wait time equal to half the headway. Transfer wait time is zero if transfers are coordinated, and one-half headway if transfers are not coordinated. All transfers are random initially, but can be changed by the user through the MODEPARM card. Walk time is one-quarter route spacing divided by walking speed. The standard deviation of all the travel time components (walk, wait and ride) are equal to their respective means.

Vehicle-miles per minute are calculated from fleet size and vehicle speed; fuel consumption is obtained by multiplying vehicle-miles by fuel consumption per mile, pick-ups per minute equal demand, and cost per trip is calculated from cost per vehicle, cost per vehicle-hour, cost per vehicle-mile and cost per route-mile.

## 8.4 AUTOMATED GUIDEWAY TRANSIT (AGT)

In application, AGT route structures are fixed and can only adapt a few configurations in any particular CBD. For analytical purposes, a more general treatment has been adopted. In this representation, AGT routes will follow a grid pattern with stations located at route intersections. Single-line transport (SLT) service is assumed, in which stations are on line and all vehicles stop at all stations. AGT serves both local and interzonal trips. However, if peak loading exceeds vehicle capacity, SMART does not reduce route spacing and headway as is done with buses. Rather, SMART reduces headway by capacity/maximum load to produce the needed capacity. If the reduced headway is greater than or equal to the minimum headway, no further changes are made to headway or route spacing. If the adjusted headway is less than the minimum headway, SMART sets the actual headway to the minimum value, and reduces route spacing until sufficient capacity has been generated. The high cost of the fixed guideway and terminals is the motivation for using walking times that are appreciably longer than waiting times.

The calculations of route spacing and headway are made separately for each time period throughout the day, and the actual route spacing is set to the minimum calculated route spacing. The actual fleet size is set to the maximum size. All AGT vehicles remain in service throughout the day. Then the selected configuration is used to recompute all service characteristics. With AGT, only one time period will be constrained. The other periods benefit from better service without requiring it. Note that the model keeps fleet size instead of headway constant.

Once headway and route spacing are known, passengers per vehicle can be computed. The probability that a transfer is required to bring any passenger to his/her ultimate destination is derived from the assumption that destinations are randomly located in the CBD, and that passengers will transfer if they have to walk more than a distance of WALKMX, where WALKMX is the user-specified or default maximum walk distance, and equals maximum route spacing. The transfer probability is:

$$\text{Probability of transfer} = 1 - \frac{2 * \text{WALKMX} - \text{RS}/2}{\text{S}}$$

Where: RS denotes route spacing and
S is the length of one side of the CBD.

This probability is restricted to be non-negative. It is used to calculate the number of transferring pick-ups and the pick-up time.

To calculate in-vehicle time, AGT vehicle speed must be known. This speed is a function of station spacing or its equivalent, route spacing. The larger the route spacing, the greater the AGT speed between stations, since the vehicle will have more time to accelerate to maximum velocity and maintain it over a longer period. AGT speed has been calculated using a peak speed of 30 miles per hour, an initial acceleration of 3.2 feet per second squared, deceleration (braking) of 3.2 feet per second squared, a 100 horsepower motor, and a vehicle weight of 40,000 pounds. These parameters are representative of AGT's in service today.

From vehicle speed, in-vehicle time can be calculated. To obtain the total tour time, add in-vehicle time to loading/unloading and stopping time. Fleet size can be calculated from tour time, headway, and route spacing.

# 9. LINKER

LINKER models the line-haul component of the regionwide transportation system. It can be based on either the ring/corridor or the arbitrary network structure. For either structural configuration, the SMART representation of the urban fabric is made up of links, nodes and zones, as illustrated in Exhibit 9.1. Zones are residential areas or CBD's in which trips originate or terminate. Interzonal trips leave the origin zone and enter the network through the node to which the zone is attached. Several zones (up to the network maximum of 100) can be attached to a single node. LINKER analyzes traffic between node pairs (one the origin, the other the destination). All trips originating from zones connected to the same node are collected at that node for distribution to the line-haul system. Similarly, all trips destined for zones connected to the same node converge at that node and are distributed by the zonal FEEDER and DUMPER systems.

To initiate a LINKER run, use the LINKER keyword card which must specify the nodes of interest. The data deck

```
LINKER  NODER2C1NODER4C2
END
```

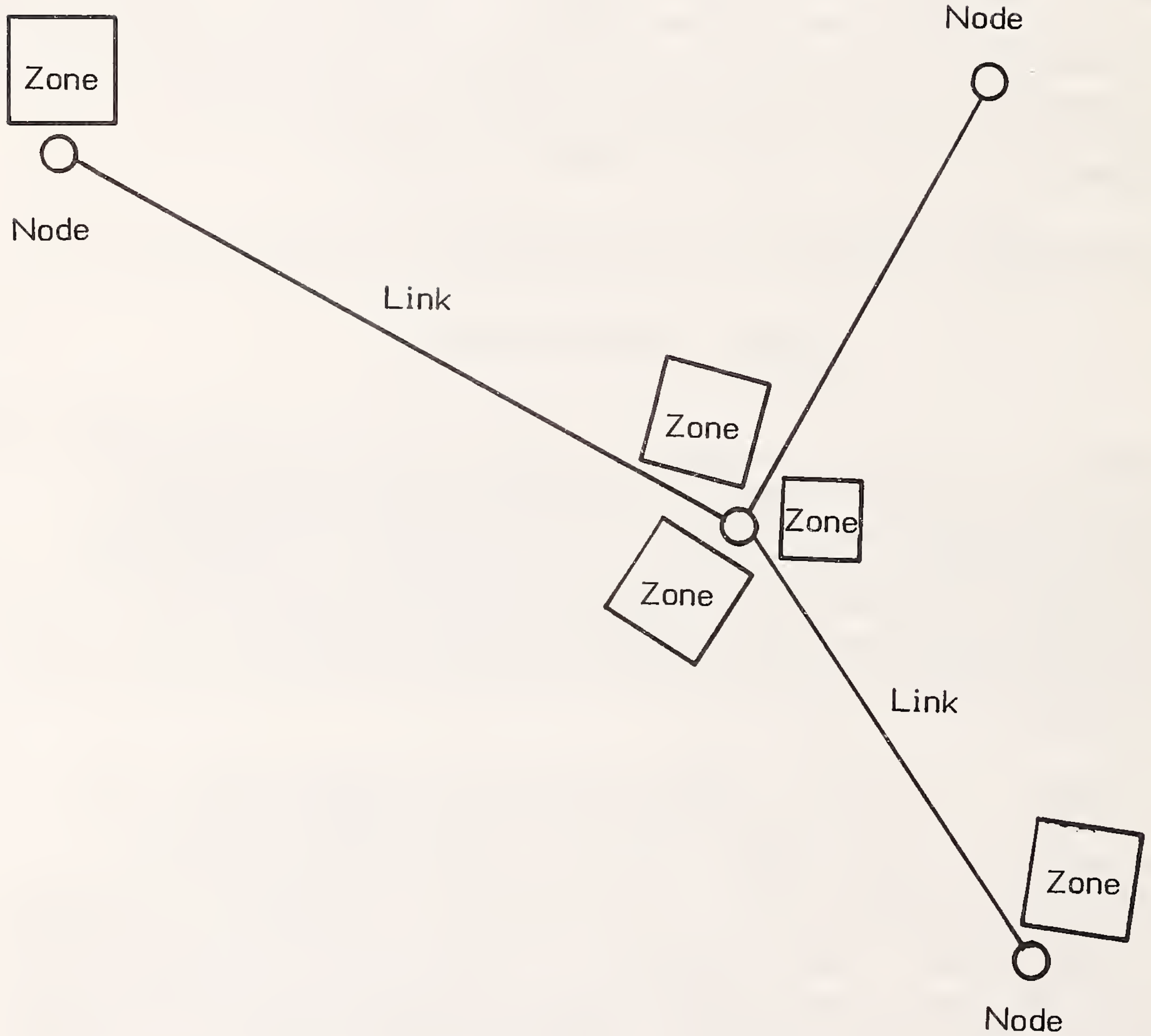
will activate a line-haul analysis of traffic between nodes NODER2C1 and NODER4C2. The two nodes need not be connected by a single link: multi-link paths can be analyzed. The first node on the card is automatically taken to be the origin, the second the destination. LINKER analyzes traffic in both directions on the interconnecting path, hence transportation performance measures for both the origin-to-destination as well as the destination-to-origin directions can be obtained in a single run.

To model link traffic, SMART first finds the path along which traffic will flow. This path is identified by SMART as the shortest-time path that connects origin to destination node for uncongested automobile travel. All automobile, carpool and transit riders traveling between the origin and destination nodes are assigned to this single path. Once assigned, all traffic uses the same path, regardless of time of day, transit mode share and transit service level. SMART also assumes that travelers from the destination to origin node travel the same route in reverse. SMART does not allow probabilistic multi-path routes.

In addition to automobile and carpool, LINKER can model three types of transit modes: fixed-route bus, light rail and heavy rail. SMART must have a transit mode category for each leg (link) in the path. The user may select one using the LINKSET or ONELINK cards (see Section 3.1 for LINKSET and Section 3.2 for ONELINK). LINKER is restricted to

EXHIBIT 9.1

URBAN FABRIC



accept only one alternative for each mode type. If no mode is selected for a link, the transit mode defaults to fixed-route bus.

LINKER only examines one transit mode in each network link per run. If the user has specified more than one mode, LINKER selects a mode using the following priorities:

1. Heavy rail;

2. Light rail; and

3. Fixed-route bus.

In some instances, LINKER is asked to examine a multi-link path in which different transit modes are assigned to different links. In these instances, all travelers transfer from the transit mode of one link to the transit mode of the next link. For example, if transit patrons from A to B take fixed-route bus and then transfer to heavy rail, LINKER models:

1. Exactly one auto mode,

2. Exactly one carpool mode;

3. Exactly one fixed-route bus mode; and

4. Exactly one heavy rail mode.

To compute transit loading on any link, SMART examines that link for its transit mode category. It then goes through each origin/destination node pair in the network and, if the link forms part of their shortest path, all traffic between the two nodes will be assigned to that link. Transit patronage is then the transit mode share portion of this traffic.

For a LINKER analysis between two designated nodes, the program computes output measures only for the group of trips that originate at one node and terminate at the other. Normally, transit ridership includes not only these trips, but also patrons traveling from other origins to other destinations. The cost of providing service on a link is shared equally by all the patrons on a link. Thus,

1. Cost per trip and fuel consumption per trip are the origin/destination travel group's share of total costs and fuel consumption;

2. Fleet size is the group's share of the fleet. If one-half of the passengers on a bus are in the designated group (patrons traveling betwen the two designated nodes), then this counts as one-half of a bus.

3. Average loading is computed in terms of passengers in the travel group per vehicle, and does not reflect other patrons who may be aboard.

4. Vehicle-miles per minute are the travel group's share.

5. Pickups per minute are only the patrons in the group.

6. Headway is the largest headway on any leg of the route. If patrons encounter 15-minute headways on one link, and 30-minute headways on the next link, the headway is 30 minutes.

## 9.1 LINK VEHICLE SPEED

Vehicle speed on highways depends on highway type, traffic volume, number of lanes, lane width, grade and curvature. Within most urban areas, grades and curvatures are reasonably gentle and lanes are sufficiently uniform that variations in width can be overlooked. Vehicle speed therefore depends on highway type (e.g., freeway, arterial), number of lanes and traffic volume. The number of lanes can be modified by removing one lane from general service for the exclusive use of high-occupancy vehicles (diamond lane). The remaining factors are incorporated into the link congestion relation used by SMART:

Congested Link Speed (miles/minute)

$= K_1 * LSPEED + (K \;\; * LSPEED)^{\mu} (1-R)^{\mu}$, if $R \leq 1.0$

$= K_1 * LSPEED$, if $R > 1.0$

Where:

R = CARPLN/CAPPLN
CARPLN denotes the car equivalents per lane,
CAPPLN denotes the capacity of the lane, which depends on highway type, freeway or arterial, and
LSPEED denotes the uncongested link speed.
$K_1$, $K_2$ and $\mu$ are constants.

Default values of the different coefficients for freeway and arterial streets are:

| Coefficient | Freeway | Arterial Street |
|---|---|---|
| LSPEED, mi./min. | 1.0 | 0.583 |
| $K_1$ | 0.4 | 0.4 |
| $K_2$ | 0.25 | 0.1008 |
| $\phi$ | 0.363 | 0.38 |

Traffic is spread uniformly over the available lanes (other than diamond lanes) so that the ratio CARPLAN/CAPPLN is the same for all lanes as is the congested speed.

If the highway has a preferential lane, the traffic will be divided between the preferrential lane and the remaining lanes. All buses and carpools will be assigned to the diamond lane. Automobiles will be divided equally among the remaining lanes. Carpools and buses on diamond lanes always travel at the uncongested link speed. When they are in mixed traffic with automobiles, they travel at the congested speed.

Congested speed calculations are based on car equivalents. Automobiles always represent one car equivalent per vehicle. The default value for carpools is one car equivalent/vehicle and, for buses, it is two car equivalents per vehicle.

## 9.2 AUTOMOBILE AND CARPOOL TRIP CHARACTERISTICS

To get from the origin node to the destination node, automobiles and carpools travel on the series of links that constitute the shortest node to node path. The time spent on the trip is the sum of the times spent on the individual links, which for each link is the link length divided by the appropriate link speed. From observation, the standard deviation of trip time is 0.75 times the square root of the mean.

The rest of the performance measures can be obtained in a straightforward way. Fuel consumption is calculated from the average vehicle trip length by applying a fuel consumption factor in gallons per mile. The frequency of trips is the average vehicle occupancy (persons per vehicle trip) divided by the trip rate (persons per minute). The vehicle fleet is the average driving time divided by trip frequency. Vehicle miles per minute are calculated from the average trip length, trip time and vehicle fleet size. The cost per trip is calculated from cost per vehicle-hour, cost per vehicle-mile, cost per vehicle, average number of trips taken by the vehicle per day, and average vehicle occupancy.

Note that cost per trip is not zero, even if the trip goes from one node to the same node (a "null" LINKER trip), since capital cost will be allocated to the trip regardless of its distance.

## 9.3 TRANSIT TRIP CHARACTERISTICS

The modeling of light rail, heavy rail and fixed-route buses on the link network are similar, except for the calculation of vehicle speed and the selection of express or multi-stop service.

For each direction on the link, SMART calculates the capacity-constrained headway. First, the demand (in travelers/minute) in each direction is obtained by multiplying transit loading by transit mode share. Then the capacity-constrained headway is:

$$\text{Capacity-constrained headway in direction } i = \frac{\text{Vehicle capacity}}{\text{Demand in direction } i}$$

The actual headway is either the capacity-constrained headway in one or the other direction or the maximum allowable (service-constrained) headway, whichever is shorter.

The average number of passengers per vehicle is obtained by multiplying headway and demand. For light rail and fixed-route bus, this also equals vehicle loading, while for heavy rail, it must first be divided by the number of cars per train.

For the two rail systems, the link speed can be user-specified or the default mode speed. Exhibit 9.2 shows the relationship between link speed and station spacing for typical light-rail and heavy-rail systems. The default mode speed is set to 0.833 miles per minute for light rail operating on grade-separated guideways and 0.5 miles per minute for light rail operating in the median strip of an arterial street. No mixed traffic light rail is used in LINKER. For heavy rail, it is one mile per minute. Rail speeds are unaffected by highway congestion. For fixed-route bus, if there is no diamond lane, the buses will move at the congested link speed. Otherwise, they will move on diamond lanes at the uncongested highway speed.

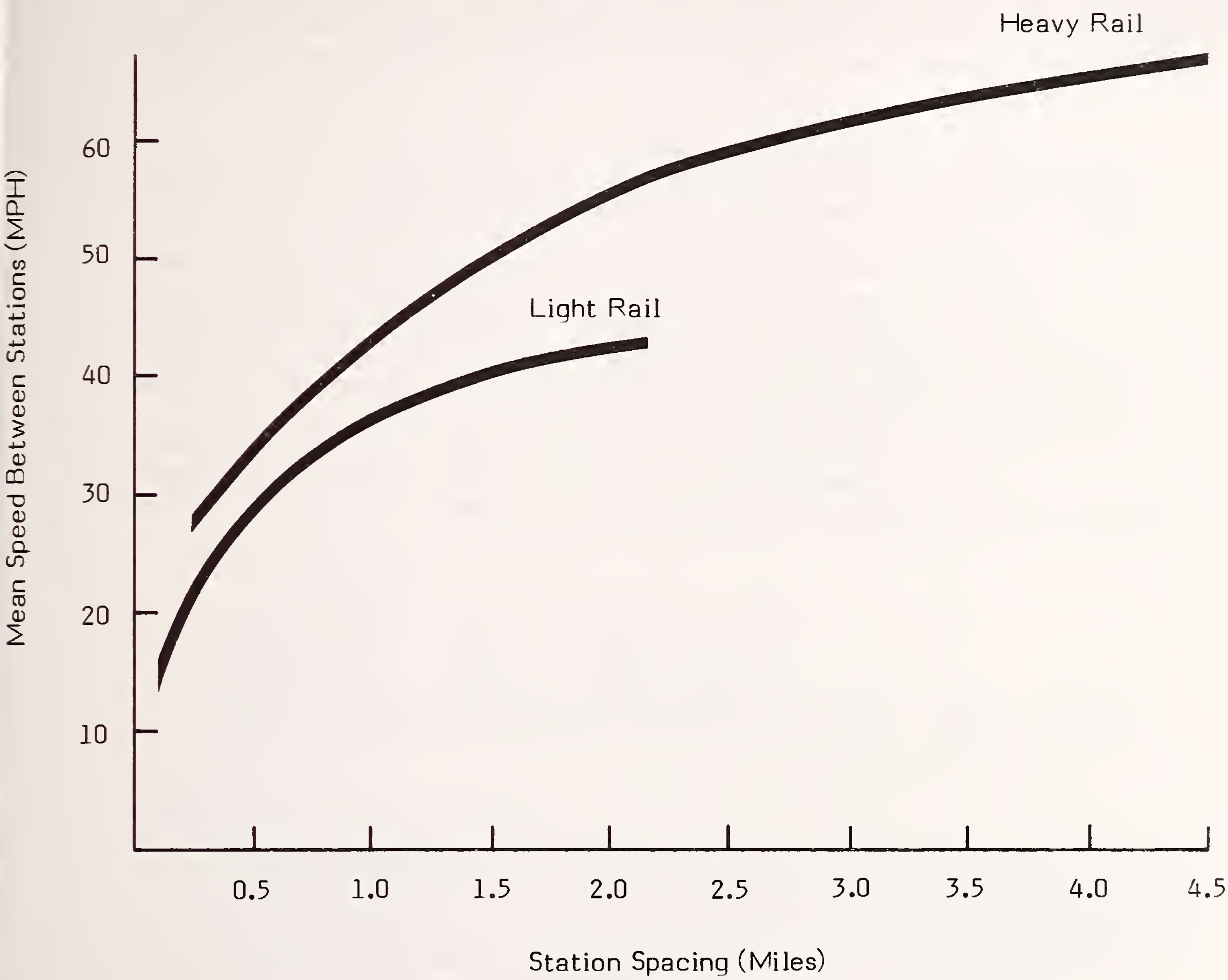
The time to traverse the link depends not only on the non-stop driving time, but also on stopping, loading and unloading times. The number of stops depends on whether express or multi-stop service is provided. For light rail and heavy rail, service is always multi-stop, with the stop spacing a modal parameter determined at the outset of the run. For fixed-route bus, however, there is a choice. The selection of service type is made internally by SMART in the LINKER routine. The rule is that LINKER offers express bus service on the route whenever the demand between the designated nodes at the maximum allowable headway results in capacity constrained operation; that is, buses are full. This rule is based solely on the demand between the two nodes studied, even though patrons may be taking buses for only part of the route (say, buses for the first half and light rail for the second).

The duration of an average passenger trip can be calculated from the in-vehicle, stopping, loading and unloading times. The variance of trip time is half the mean travel time, and the variance for the entire trip is the sum of the individual link travel time variances.

The total fleet required on the route is obtained by adding the fleets required on the individual links making up the route. For heavy rail, fleet size is computed in terms of the number of transit cars in service rather than the number of vehicles (trains).

EXHIBIT 9.2

MEAN SPEED BETWEEN STATIONS VERSUS STATION SPACING FOR LIGHT AND HEAVY RAIL SYSTEMS



Vehicle-miles per minute are calculated from fleet size and vehicle speed; fuel consumption is obtained by multiplying vehicle miles by a fuel consumption per mile factor. Pickups per minute equal demand.

Cost per trip is calculated from cost per vehicle, cost per vehicle-hour, cost per vehicle-mile, and cost per route-mile.

SMART allocates the "impact" of transit service equally among all patrons on the link. It then calculates the measures billable only to travel between the designated origin and destination nodes and prints these.

# 10. DOOR

DOOR's function is to model door-to-door travel between origins and destinations that are located in two different zones, and generally require movement over at least one network link. DOOR calls the FEEDER, DUMPER, CBD and LINKER routines in response to user specifications and sums output measures for door-to-door totals.

To initiate a DOOR analysis, use the DOOR keyword card which specifies (1) the origin zone, (2) trip origin type (activity center or residential), (3) destination zone, (4) trip destination type (activity center or residential), and (5) origin, line-haul and destination transit modes. Of the above information, only the origin and destination zone identities are required. The rest can be left blank for defaults to be assigned. Blank fields for trip origin or destination types will automatically set activity center trip type as defaults; blanks in any of the mode fields will select the default modes that were defined for the zones or links included in the DOOR trip. These defaults must have been previously specified through the ONEZONE, ZONESET, ONELINK or LINKSET CARDS. In the absence of such specifications, the fixed-route bus mode will automatically be selected.

The input deck:

```
MODESEL ADD     FLEX    FEEDER  FLEXRTE
MODESEL ADD     BUSL    LINKER  FRBUS
MODESEL ADD     BUSF    FEEDER  FRBUS
DOOR    LZONR2C1RESIDNTLLZONR2C3RESIDNTLFLEX    BUSL    BUSF
END
```

will accomplish the following:

1. Three new modes are defined and added to the selected modes list. They are FLEX, a flexible-route FEEDER mode, BUSL, a fixed-route bus LINKER mode and BUSF, a fixed-route bus FEEDER mode. All these modes take on the modal parameters that are defaults for their respective mode class.

2. A door-to-door analysis between the residential areas of LZONR2C3 and LZONR2C1 is requested. The origin FEEDER mode is defined to be FLEX, the LINKER mode is BUSL and the destination FEEDER mode is BUSF.

If a trip originates in or is destined to a CBD zone, a CBD run will be initiated. For non-CBD zones, if the trips begin or end in a residential area, FEEDER routines will be called to model those trips; if activity centers are involved, DUMPER analysis is performed. An exception to the FEEDER/DUMPER rule occurs if both origin and destination zones are identical. SMART is sufficiently flexible to accept this. As long as one end of the trip is in the residential zone, FEEDER service is assumed and only if both trip ends are in the activity centers will DUMPER be called.

If the user wishes to designate which modes are to be analyzed on the DOOR run, he/she should be sure that these modes have been selected through a previous analysis or through MODESEL cards, as shown in the above example. Execution will terminate if the designated modes do not appear on the selected list. The user should make sure that the mode selected corresponds to the type of analysis desired. For example, if the trip originates in the residential portion of the origin zone, the origin transit mode should be a FEEDER, not a DUMPER, mode. Thus, care should be taken that no unwanted modifications have been made to the designated modes (in terms of analysis or mode type) through the MODESEL REPLACE option card. Otherwise, strange things may happen.

The user has only limited ability to select the line-haul modes to be used in a DOOR analysis. The SMART model always selects the route to be followed between the origin and destination modes on the basis of least automobile travel time on uncongested links. Therefore, the user does not know the path to be followed and cannot select transit mode by link. Two options are available:

1. The user may accept the current default transit modes on all links of the SMART selected path, or

2. The user may select a single transit mode to supercede the default mode on all links of the SMART selected path.

Additional flexibility is available to the user by allowing him/her to specify the default modes on each link of the network. Thus, if transit options have been specified for the full network, all DOOR trips will use the selected options.

When the origin zone differs from destination zone, each trip is divided into three parts: origin, line-haul and destination. For each part, SMART models exactly one automobile mode, one carpool and one transit mode. Hence, for the complete trip, there may be as many as nine travel modes. This number drops to three if the origin zone is the same as the destination zone. If duplicate modes (for example, multiple FEEDER automobile modes) have been selected, the last chosen will be used.

In addition to the selected modes, SMART allocates space for four "dummy" modes. The first three spaces allow output measures to be summed across zones and links for door-to-door totals, and to be stored by direction, time and mode share index for auto, carpool and transit. The fourth "dummy" mode allows space to store zonal output measures to ensure that no outputs are lost if the same zonal analysis (FEEDER, DUMPER or CBD) is repeated in the DOOR run.

The output lists performance measures for the individual zonal and line-haul portions of transit trips. They are also listed for the auto total, carpool total and transit total modes, but not for FEEDER, LINKER, DUMPER or CBD auto/carpool modes individually.

Depending on zone and trip type, SMART calls FEEDER, DUMPER, or CBD routines. Upon completing a zonal analysis, a DOOR summing routine is called to add the output measures for each zone to the totals for each mode class (that is, auto, carpool or transit). These totals are initialized to zero at the beginning of any DOOR run.

If a line-haul analysis is necessary, as when different origin and destination zones are specified, DOOR will generate transit loading and assign it to the appropriate LINKER mode categories. LINKER will then be called and the output from the routines will be added to the mode totals to form the door-to-door outputs.

Most of the output measures that appear in the printout are obtained by direct summing across zones and link segments in the line-haul portion of the trip. These include trip cost, trip time, variance of trip time, fuel consumption per trip, fleet size and vehicle miles per minute. For headway and vehicle loading, averaging is done. The average is calculated across the fleet as follows:

$$\text{Average Headway} = \frac{\sum_i \text{headway}_i * \text{fleet}_i}{\sum_i \text{fleet}_i}$$

where i is a zonal or line-haul portion of the total trip. A similar equation can be written for vehicle loading. Vehicle pick-ups per minute are known for individual zones, in terms of outbound and inbound trips; but actual zone-to-zone trip rates are not recorded. What SMART prints is therefore vehicle pick-ups for the separate zonal and line-haul portions of the door-to-door trips. This number is higher than the zone-to-zone travel for the two designated zones, since it includes trips destined for other zones as well.

# 11. REGION

REGION collects all zonal and line-haul travel for an entire urban network to produce an aggregate picture of regionwide transportation. REGION can be applied to an entire network or only to a subset of the zones in the network.

To initiate a REGION run, use the REGION keyword card. This card contains only the word "REGION" as the keyword. No further information is allowed on the REGION card.

If the user wishes REGION to ignore certain zones when analyzing the urban configuration, the IGNORE option is used to specify these zones on the ONEZONE or ZONESET cards. In other words, instead of identifying their zone types as CBD or NON-CBD, simply identify the zone as IGNORE. This option is particularly useful when dealing with the outer zones of an urban region. These zones can generate and attract trips, but they are not served by any transit system, and no other internal travel is calculated. Note that even though zonal analysis is not performed on ignored areas, interzonal trips that originate or terminate in these zones and that use the line-haul system are still computed and modeled by LINKER .

For each zone and link, REGION models exactly three modes: auto, carpool and transit. Transit modes can differ from zone to zone, and from link to link; with link transit mode categories restricted to fixed-route bus, light rail and heavy rail. The user can designate a transit mode for any zone by specifying it on the ONEZONE or ZONESET cards and, for any link, by the ONELINK and LINKSET cards (see Sections 3.1 and 3.2 or Appendix A). Designated modes must have been selected in a previous analysis or through the MODESEL card. Make sure that the analysis type for the mode corresponds to the zone type; for example, a CBD mode must correspond to a CBD, and not a non-CBD, zone. Care should also be taken that no unwanted modifications have been made to the designated modes (in terms of analysis or mode type) through the MODESEL REPLACE option card. Otherwise, the results will be affected. If no modes have been designated for any zone, SMART will automatically select fixed-route bus. If multiple fixed-route bus modes have been selected, the last on the list will be chosen.

In addition to the selected modes, SMART allocates space for three "dummy" modes. They are automobile total, carpool total, and transit total modes, which provide space for storing the aggregated output of the regionwide analysis by mode. Automobile total is a matrix that contains the regionwide automobile performance measures, while carpool and transit totals contain regionwide carpool and transit performance measures respectively.

Depending on zone type, REGION calls FEEDER and DUMPER (non-CBD zones) or CBD (CBD zones) to perform the transportation analysis. After performing each zonal analysis, a summing routine is called to aggregate results for each mode that has been modeled.

To initiate line-haul analysis, REGION scans all LINKER mode categories in turn. If any mode is used in any part of the network, the program proceeds to examine each link for the transit loading for that mode. If transit loading is greater than zero, REGION will process that mode on that link. Otherwise, it will simply skip to the next mode. On every link, automobile and carpool modes are modeled.

Note that results from zonal/linker analysis have a directional component; for example, outbound and inbound for zones. Directions do not make sense for regionwide aggregated measures. Therefore, regionwide trip cost, trip time, and fuel consumed per trip is the average of the zonal/linker values in all directions. Furthermore, the average is taken over all travelers, with each having an equal weight. For vehicle loading and headway, the average is taken across the number of vehicles in the fleet, as in DOOR; thus, we have average loading per vehicle and average headway per vehicle. For fleet size, vehicle miles per minute and vehicle pick-ups per minute, direct values are summed across all zones and links. Travel time variance is not computed for regionwide analysis.

Every link defined in a regionwide network is served by a transit mode that is either specified by the user on the ONELINK card or automatically designated by SMART. Thus, every link in a regionwide analysis is served by transit, and it is always possible to travel from one zone to any other zone in the network by line-haul transit. In practice, however, this is not always the case. Certain routes may not be served by transit, and certain areas are not accessible by transit.

Currently, there is no direct facility for specifying non-existent transit service on any network link. To overcome this problem, the user should identify two different networks -- the first being the "complete" network, which contains all road links and zones accessible by automobile, and the second being a "depleted" network consisting only of those links served by transit and those zones reachable by interzonal transit. The first network is used to generate regionwide demand patterns and automobile travel information and write the generated demand data onto an external file using the GENDEM keyword. These data will be used subsequently as input to the second run, which computes transit performance measures. Since zones not served by line-haul transit are missing from the second network, the external demand file must be processed to ensure that all demands corresponding to these missing zones are deleted. Automobile measures can be read from the first run and transit measures from the second. For example, the following decks can be used to model travel in a network consisting of three zones and two links. Only one link (L12, connecting zones Z1 and Z2) is served by transit, with the result that zone Z3 cannot be reached by line-haul transit. Transit mode share is 5% for this region.

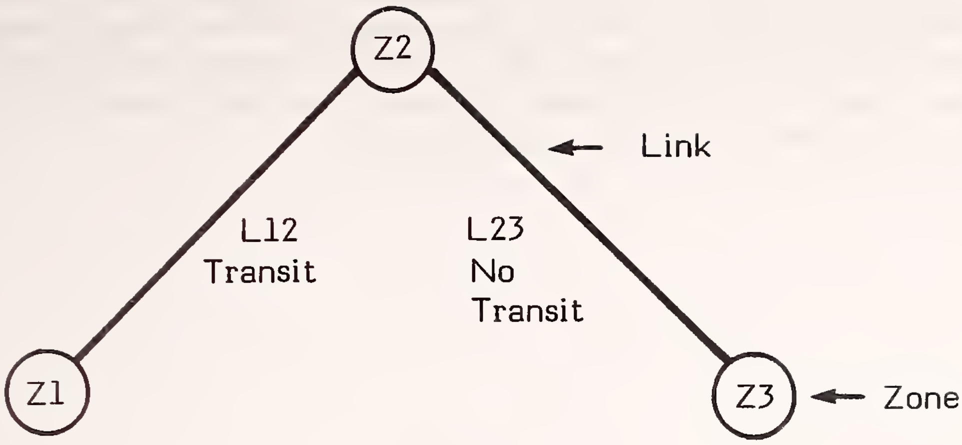



EXHIBIT 11.1

SAMPLE NETWORK FOR REGIONWIDE ANALYSIS

FIRST RUN

```
NULLNET
ONEZONE Z1      N1
ONEZONE Z2      N2
ONEZONE Z3      N3
ONELINK L12     Z1       Z2       LENGTH       4.0
ONELINK L23     Z2       Z3       LENGTH       6.0
TMSHARE        1AM-PEAK     0.05
TMSHARE        1OFF-PEAK    0.05
TMSHARE        1PM-PEAK     0.05
GENDEM          WRITE
REGION
END
```

SECOND RUN

```
NULLNET
ONEZONE Z1      N1
ONEZONE Z2      N2
ONELINK L12     Z1       Z2       LENGTH       4.0
TMSHARE        1AM-PEAK     0.05
TMSHARE        1OFF-PEAK    0.05
TMSHARE        1PM-PEAK     0.05
READDEM
REGION
END
```

In between the first and second runs, the demand data written by GENDEM must be processed to exclude any data pertaining to Zone Z3, which is not served by transit. The first run generates automobile performance measures, and the second generates transit measures.

One disadvantage of this method is that there is a discrepancy between the transit mode share modeled in the first run and that modeled in the second run. The first run assumes 5% transit mode share for all zones in the network; the second assumes 5% mode share for transit-accessible zones only. In general, those zones inaccessible by transit account for only a small percentage of the total demand; hence, this is not likely to be a problem. Travel speeds are a second issue, but are not likely to be of great concern, since congestion is not critically affected by transit mode share.

SMART

SYSTAN's Macro-Analytic

Regionwide Transportation Model

User's Guide

Appendices

## CONTENTS



## LIST OF EXHIBITS

## Appendix A

## KEYWORD DOCUMENTATION AND DEFAULTS

All SMART model card input has the following field layout:

| Column | Name | Purpose |
|---|---|---|
| 1-8 | KEYWORD | Defines information contents |
| 9-16 | FIELD 1 | ) |
| 17-24 | FIELD 2 | ) |
| 25-32 | FIELD 3 | ) |
| 33-40 | FIELD 4 | ) Contains various data, |
| 41-48 | FIELD 4 | ) depending on KEYWORD |
| 49-56 | FIELD 6 | ) |
| 57-64 | FIELD 7 | ) |
| 65-72 | FIELD 8 | ) |
| 73-80 | SEQUENCE | Ignored |

Any datum read in replaces the current value for that datum. SMART supplies initial values for all items, so all data input is optional. Also, the value of a datum can be changed at any time. Be aware, however, that changing one value may clear other, dependent, data. For example, setting a new number of corridors cancels any previous corridor angle data, and clears all previously generated demand matrices (since the zone numbers are no longer valid).

On virtually all cards, a blank field leaves the current value unchanged (i.e., the field defaults to the current setting). SMART can distinguish between blank and zero, so the entire eight-character field must be blank. This rule has several exceptions. For example, when changing the endpoint of a link, it is necessary to give both new endpoints, as it is not clear which of the two ends is to be changed.

Units have been chosen for consistency; for example, all distances are in miles, and never blocks. Most significantly, almost all times are in minutes. Not only are dwell times and peak-period lengths in minutes, but vehicle speed is in miles per minute and operating cost is in dollars per vehicle-minute. Exceptions to this are capital cost, which is expressed in units of dollars per day or dollars per vehicle-day (since it does not vary with the time in service), and trip generation rates, which are expressed in trips per unit of population or employment.

There are a number of pending actions in SMART. These are tasks that must be performed, but are delayed as long as possible; they are only undertaken when necessary data have been created. For example, the program does not start with demand data. If a PRINTDEM card is inserted to request that the demands be printed, the PRINTDEM routine first checks to see if any demands have been generated. If not, the default SMART demand generation procedure is called to generate the necessary data. The pending actions are:

Initializing the network;
Calculating automobile shortest routes;
Loading default demand parameters;
Generating demands; and
Selecting default modes for analysis.

SMART keywords can be grouped into the following categories:

LABELING PRINTOUT

Blanks - Embedded comments
TITLE - Run title
SUBTITLE - Task titles

NETWORK DEFINITION

Ring/corridor system

URBAN - Number of rings and corridors
RADII - Ring radii
ANGLES - Corridor angles
LINKSET - Link definitions
ZONESET - Zone definitions

Arbitrary network system

NULLNET - Clears current or default network

Either system

ONELINK - Link definition
ONEZONE - Zone definition

DEMAND GENERATION

DEMPARM - Demand parameters
ONEZDP - Demand parameters for one zone
ZDPSET - Demand parameters for ring/corridor zones
TRIPTIME - Temporal distribution of trips

DEMAND SPECIFICATION

- READDEM - Read file of demands
- VRES - Specific rates for residential demand
- VACT - Specific rates for activity center demand
- ODM - Specific rates for node-to-node origin/destination matrix
- TRAFFIC - Specific link traffic rates
- PICKUPS - Specific link transit pick-up rates
- DROPOFFS - Specific link transit drop-off rates

ARCHIVED NETWORK/DEMANDS

- PUTNET - Create archive file
- GETNET - Read archive file

SPECIAL PRINTING

- PRINTNET - Print network
- PRINTDEM - Print demands

OTHER DATA INPUT

- TMSHARE - Transit mode share
- TIMLEN - Time period lengths
- WALKING - Walking speeds, fractions, and distances
- CPFRAC - Carpool fraction
- CPTIME - Carpool time parameter

TRAVEL MODE SPECIFICATION

- NULLMODE - Prevent defaults
- MODESEL - Select specific modes
- MODEPARM - Modal parameters

ANALYSIS REQUESTS

- FEEDER - Residential area zonal analysis
- DUMPER - Activity center zonal analysis
- CBD - Central business district analysis
- LINKER - Node to node analysis
- REGION - Regionwide analysis

MISCELLANEOUS

END - Indicates end of input deck

| | |
|---|---|
| KEYWORD: | ANGLES |
| DATA: | Corridor angles |
| CONDITIONS: | Valid only for ring/corridor and composite networks, not for an arbitrary network (when NULLNET is in effect). |

Lists the corridor angles (in degrees). FIELD 1 has the angle for the first corridor, FIELD 2 for the second, and so forth. Angles must be non-negative and less than 360, and are measured from the same datum. For example, three corridors spaced equally apart may have the following angles: 0., 120., 240. A maximum of six angles can be defined.

DEFAULTS: Default values uniformly distribute the number of user-selected corridors, with corridor 1 always at zero degrees. For example:

| Number of Corridors | Default Locations (Degrees) |
|---|---|
| 1 | 0. |
| 2 | 0., 180. |
| 3 | 0., 120., 240. |
| 4 | 0., 90., 180., 270. |

KEYWORD: Blanks

DATA: None

Any card that is blank in Columns 1-8 is treated as comments.

DEFAULTS: None

KEYWORD: CAPACITY

DATA: Lane capacity in car equivalents per minute.

FIELD 1: Capacity of a freeway lane in car equivalents per minute. If blank, default will be assigned.

FIELD 2: Capacity of an arterial lane in car equivalents per minute. If blank, default will be assigned.

The capacity specifications will apply to all lanes of the particular type (freeway or arterial) listed in the field.

DEFAULTS: Freeway capacity is 40 car equivalents per minute. Arterial capacity is 25 car equivalents per minute.

| | |
|---|---|
| KEYWORD: | CBD |
| PURPOSE: | Requests a CBD analysis |
| FIELD 1 | Zone identifier (required) |
| DEFAULTS: | None |

KEYWORD: COMNET

PURPOSE: Advises SMART that a composite network has been defined.

DATA: None

This keyword activates a subroutine which ensures that all link-node indices are correctly computed for a composite network. That is, a network with a basic ring/corridor structure that has additional arbitrarily defined zones and links not belonging to the basic ring/corridor structure.

DEFAULTS: None

| | |
|---|---|
| KEYWORD: | CPFRAC |
| DATA: | Carpool fraction. The new value of carpool fraction will be used in all analyses requested subsequent to this card. |
| FIELD 1 | Fraction of non-transit trips in carpools. Must be more than 0.00 and less than 1.00. |
| DEFAULT: | 0.05 |

KEYWORD: CPTIME

DATA: Carpool time parameter.

SMART calculates a number that is carpools per square mile per minute. This is multiplied by CPTIME and then inverted to give the area, in square miles, of the territory served by a typical carpool. Thus, CPTIME is in units of minutes per carpool. If people are to ride in the same carpool, the range in planned departure time must be fairly small. It is this range in planned departure time (for example, 15 minutes) divided by the number of carpools serving the same area during the same time (for example, 5) that gives CPTIME (for example, 3.0).

DEFAULTS: 3.0 minutes per carpool

KEYWORD: DEMPARM

DATA: Demand generation parameters

SIDE EFFECTS: This card will clear any previously generated demands.

This card provides up to eight parameters for a demand generation procedure. SMART currently uses only FIELDs 1-3; FIELDs 4-8, although currently unused, must be either blank or contain valid floating point numbers.

FIELD 1 Trip origin rate per day per unit of population for trip type 1 (commute trips).

FIELD 2 Trip origin rate per day per unit of population for trip type 2 (shopping trips).

FIELD 3 Trip origin rate per day per unit of employment for trip type 3 (work/work trips).

For each trip type, the same trip rate is applied to all zones.

DEFAULTS: For trip type 1, default is 0.4 trips per day per person.
For trip type 2, default is 0.1 trips per day per person.
For trip type 3, default is 0.05 trips per day per employee.

KEYWORD: DOOR

PURPOSE: Requests a door-to-door analysis between two zones.

DATA: Origin-destination zones, trip end type, and modes

FIELD 1 Origin zone identifier

FIELD 2 Trip origin. Either
ACTIVITY (denoting activity center trip origin),
RESIDNTL (denoting residential area trip origin), or
BLANK.
If BLANK, trip origin is assumed to be activity center.

FIELD 3 Destination zone identifier

FIELD 4 Trip destination. Either
ACTIVITY (denoting activity center trip destination),
RESIDNTL (denoting residential area trip destination), or
BLANK.
If BLANK, trip destination is assumed to be activity center.

FIELD 5 Either origin transit mode or blank.
If blank, default transit mode will be used.

FIELD 6 Either linker transit mode or blank.
If linker transit mode, this mode will be used throughout the line-haul segment of trip.
If blank, defaults will be assigned.

FIELD 7 Either destination transit mode or blank.
If blank, default transit mode will be used.

Note that DOOR analyzes trips from the origin to the destination zones as well as from the destination to the origin zones. Results will be printed for both directions.

DEFAULTS: Default modes correspond to those specified on the ONEZONE or ZONESET cards for that particular zone and type of analysis. If none are specified, fixed-route bus will be the default.

KEYWORD: DROPOFFS

DATA: Passenger dropoff rate for link transit modes

This card overrides the link traffic data calculated by whatever demand generation procedure is used. It only updates single elements of the demand matrices, and therefore does not ensure that the demands balance (e.g., after this card is used, traffic getting off a link may be even greater than the traffic on the link); it is thus inappropriate for a regionwide analysis.

FIELD 1 Link identifier

FIELD 2 Node identifier of one of the endpoints of the link, showing the end at which the passengers are getting off.

FIELD 3 LINKER mode category. Valid options are FRBUS, LRAIL, and HRAIL. Dropoff rates should be entered assuming 100% transit mode share.

FIELD 4 Unused

FIELD 5 Blank, or dropoffs per minute for the AM peak period

FIELD 6 Blank, or dropoffs per minute for the off-peak period

FIELD 7 Blank, or dropoffs per minute for the PM peak period

FIELD 8 Unused

DEFAULT: As calculated by SMART's default demand generation procedure

| | |
|---|---|
| KEYWORD: | DUMPER |
| PURPOSE: | Requests a DUMPER analysis. |
| FIELD 1: | Zone identifier (required). |

KEYWORD: END

PURPOSE: Marks the end of the input deck.

DATA: None

CONDITIONS: This card must be the last card in the input deck.

The SMART input card deck must always terminate with a card with the keyword END. Any input cards after this card will be ignored.

DEFAULTS: None

| | |
|---|---|
| KEYWORD: | FEEDER |
| PURPOSE: | Requests a FEEDER analysis |
| DATA: | FEEDER parameters |
| FIELD 1 | Zone identifier (required) |
| FIELD 2 | One of the options "UNIFORM", "SUBAREA", or "CORRIDOR", or blanks. |
| FIELD 3 | The ratio of the low-density trip generation rate to the high-density trip generation rate. Must be more than 0.00 and not more than 1.00. Used only on Subarea and Corridor analyses. |
| FIELD 4 | The ratio of the size of the subarea to the size of the entire zone. Must be greater than 0.00 and not greater than 1.00. Used only on Subarea analyses. |
| DEFAULTS: | FEEDER analysis type is UNIFORM. If SUBAREA is specified without parameter, the ratio of low-density trip rate to high-density trip rate is 0.2 and the ratio of the size of subarea to size of entire zone is 0.2. |

KEYWORD: GENDEM

PURPOSE: Generates and writes demand onto external file upon card request.

DATA: Demand generation procedure and FORTRAN write unit.

FIELD 1: Name of demand generation procedure. If blank, SYSTAN's default generation algorithm will be used.

FIELD 2: "WRITE" or blank. If "WRITE" is specified, demands will be written onto external file in a format suitable for subsequent reading in of the same data using the READDEM card. If blank, demands will not be written.

FIELD 3: FORTRAN write unit or blank. May not be zero.

DEFAULTS: Default FORTRAN unit number is 11.

KEYWORD: GETNET

PURPOSE: Reload network definition from an archive file.

DATA: Unit number and reload demands option.

SIDE EFFECTS: This card will clear any previously generated demands and zonal demand parameters.

This card tells SMART to read an urban structure definition from a file (one that was written with PUTNET). The effect is as if all URBAN, RADII, ANGLES, NULLNET, ONELINK, LINKSET, ONEZONE, and ZONESET cards preceding the original PUTNET card were substituted for the GETNET card, with one exception. Modes designated on the ONEZONE and ZONESET cards are ignored. The effect is the same as if they have never been designated in the first place.

FIELD 1 Either a FORTRAN unit number or blank. May not be zero.

FIELD 2 If the option "DEMAND" is given, then the hourly demand matrices will be read from the same file. They must have been written in the first place, when the PUTNET was done. If blank, no attempt to read the demands will be made. Notice that reading the network clears all demands anyway.

DEFAULTS: Default unit number is 9.

KEYWORD: LINKER

PURPOSE: Requests a LINKER analysis

DATA: Nodes at endpoints of route to be analyzed

FIELD 1 Node identifier ("origin")

FIELD 2 Node identifier ("destination")

Note that LINKER analyzes both directions, so the analysis is equally good from the second to the first node as from the first node to the second.

DEFAULTS: None.

KEYWORD: LINKSET

DATA: Link definition modifications

CONDITIONS: Invalid for an arbitrary network (NULLNET in effect).

Links cannot be created by the LINKSET card; only links in designated locations in an urban ring/corridor network can be modified.

FIELD 1 Either the option "RADIAL" or "CIRCUMFR" or blanks. If blanks, both radial and circumferential links will be selected.

FIELD 2 Either a ring number or blank. If blank, all rings will be selected.

FIELD 3 Either a corridor number or blank. If blank, all corridors will be selected.

FIELDs 4-8 are identical on both the ONELINK and LINKSET cards. The fields contain options in any order. Some options require that the next field contain a number (such as the length in miles for the LENGTH option). If contrary options are found (e.g., FREEWAY and ARTERIAL), the last one encountered will be used. The options are:

Highway Type Option:
- FREEWAY
- ARTERIAL
- MISSING (used to remove links from a ring/corridor system)

Diamond Lane Options:
- DIAMOND
- NODIAMND

Rail Type Options:
- NORAIL
- LRAIL (light rail) followed by light-rail speed.
- HRAIL (heavy rail)

LENGTH followed by the link length, in miles.

SPEED followed by the uncongested auto speed, in miles per minute.

LANES followed by the number of lanes in each direction (not both directions together).

For example, if the radial corridor in ring 1, corridor 2 is to be modified to an arterial highway six miles in length, FIELD 1 will contain the option "RADIAL", FIELD 2 "1", FIELD 3 "2", FIELD 4 "ARTERIAL", FIELD 5 "LENGTH", and FIELD 6 "6.0".

DEFAULTS: Radial highways default to freeways, circumferential highways default to arterials. In an arbitrary network, all highways default to freeways. Note that changing a highway type does not change (default) parameters.

| | Radial Highways Arbitrary Links | Circumferential Highways |
|---|---|---|
| Type | FREEWAY | ARTERIAL |
| Lanes | 3 | 2 |
| Diamond lane? | No | No |
| Light rail? | No | No |
| Light rail speed | 0.833 | 0.50 |
| Heavy rail? | No | No |
| Auto speed | 1.0 | 0.583 |
| Capacity (cars per lane per minute) | 40.0 | 25.0 |

KEYWORD: MODEPARM

DATA: Travel mode parameters

FIELD 1 This field can contain either an identifier for a particular selected travel mode, in which case the update is said to be selective, or the type code for a type of travel mode, in which case the update is said to be generic. Selective updates apply only to the particular travel mode selected. Generic updates change the default values for all travel modes selected after the generic update, but do not affect any travel mode already selected. Also, generic updates for AUTO are automatically applied to CARPOOL and PRIVATE AUTO TRANSIT as well (but generic CARPOOL and PRIVATE AUTO TRANSIT updates are not applied to AUTO).

FIELDs 2-8 are treated as a series of alternating options (parameter codes) and values. Blank fields will be skipped. The options are:

| | |
|---|---|
| $ | System cost per day. Used in Regionwide analyses only. |
| $/V | Cost per vehicle per day. |
| $/VH | Cost per vehicle-minute. |
| $/VM | Cost per vehicle-mile. |
| $/RM | Cost per route-mile per day. Ignored for AUTO, CARPOOL, DAR, SUBSCR, WALK, and PVTAUTO modes. |
| SPEED | Uncongested local speed (does not apply to LINKER) in miles per minute. |
| STIME | Minimal stop time. |
| STIME/P | Stop time increment per passenger. |
| MPG | Miles per gallon at uncongested local speed. |
| PAS/VEH | Passengers per vehicle (vehicle capacity for transit modes, average loading for AUTO and CARPOOL). |
| MINHDWAY | Minimum headway for AGT service only. |
| MAXHDWAY | Maximum allowable headway (unused by SUBSCR, AUTO, CARPOOL, and WALK). |
| MAXRS | Maximum allowable route spacing (used by FEEDER FRBUS modes only). |

STOPS/M — Stops per mile.

CARS/VEH — Number of car-equivalents per vehicle (used by highway transit modes for congestion calculation).

AMTRAIN — Specifies heavy-rail train size, in number of cars, for the A.M. peak period.

OFFTRAIN — Specifies heavy-rail train size for the off-peak period.

PMTRAIN — Specifies heavy-rail train size for the P.M. peak period.

AMSERVE — Specifies the type of flexible-route service to be offered in the A.M. peak period. Valid values are DAR (dial-a-ride) and SUBSCR (subscription).

OFFSERVE — Specifies the type of flexible-route service for the off-peak period. Valid values are the same as for AMSERVE.

PMSERVE — Specifies the type of flexible-route service for the P.M. peak period. Valid values are the same as for AMSERVE.

TRANSFER — Specifies the type of transfer available from other transit services, and thus the rule for computing wait time. This applies only to passengers coming from another mode/module. For example, in FEEDER it applies only to patrons entering the zone; the transfer time onto the line-haul service is counted in LINKER. Valid values are:

RANDOM - Vehicle arrivals are uncoordinated, and wait time is one-half the headway.

TIMED - Vehicle arrivals are scheduled jointly but, due to random factors and scheduling constraints, wait time is equal to alpha + beta * headway, where alpha = 1.71 and beta = 0.285.

THROUGH - The same vehicle is used in both cases, so the wait time is zero.

## SMART travel modes and parameters

| | | | | <---transit----> | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | AUTO | CARPOOL | PVTAUTO | FRBUS | FLEXRTE | LRAIL | HRAIL | AGT |
| Analyses possible: | | | | | | | | | |
| FEEDER | | X | X | X | X | X | 1 | . | . |
| LINKER | | X | X | . | X | . | X | X | . |
| DUMPER | | X | X | . | X | . | . | . | . |
| CBD | | X | X | . | X | . | . | . | X |
| $ | (REGION analysis only) | X | X | X | X | X | X | X | X |
| $/V | | X | X | X | X | X | X | X | X |
| $/VH | | X | X | X | X | X | X | X | X |
| $/VM | | X | X | X | X | X | X | X | X |
| $/RM | | . | . | . | X | . | X | X | X |
| SPEED | | X | X | X | X | X | X | X | . |
| STIME | minimal stop time | X | X | X | X | X | X | X | X |
| STIME/P | marginal stop time per passenger | X | X | X | X | X | X | X | X |
| MPG | | X | X | X | X | X | X | X | X |
| PAS/VEH | | X | X | X | X | X | X | X | X |
| MINHDWAY | | . | . | . | . | . | . | . | X |
| MAXHDWAY | | . | . | . | X | X | X | X | X |
| MAXRS | maximum route spacing | . | . | . | 2 | . | . | . | . |
| STOPS/M | stops per mile | . | . | . | X | 3 | X | X | X |
| CARS/VEH | car-equivalents per vehicle | X | X | . | X | . | . | . | . |
| aopTRAIN | Heavy-rail train size | . | . | . | . | . | . | X | . |
| aopSERVE | Flex-route service type | . | . | . | . | X | . | . | . |
| TRANSFER | transit coordination level | . | . | . | X | X | X | X | X |

X = allowed and used
. = meaningless
1 = corridor only
2 = FEEDER only
3 = checkpoints per square mile
aop = AM, OFF, or PM

| | |
|---|---|
| KEYWORD: | MODESEL |
| PURPOSE: | Select a travel mode for analysis. |
| DATA: | Mode selection identifier, type, and label |
| FIELD 1 | One of the options "ADD" or "REPLACE" or blanks. Blanks are the same as "ADD". If ADD, this is a new mode that will be added. REPLACE is only used for multiple analyses, when the user might run out of space in the data structure for selected modes. With REPLACE, the mode identifier defines both the previously selected mode to be deleted (replaced) and the new mode to be added. Note that although the new mode is known by the old name, it may have different mode and analysis type, label, and it starts afresh with the appropriate defaults. Users will almost always leave this field blank, for "ADD". |
| FIELD 2 | Mode identifier. A unique alphanumeric identifier for this mode. Valid mode type codes (listed below in FIELD 4) are prohibited. |
| FIELD 3 | Which analysis this mode applies to. Valid names are FEEDER, LINKER, DUMPER, and CBD. |
| FIELD 4 | Mode type (the type of travel mode). Currently valid mode type codes are:<br>AUTO (automobile)<br>CARPOOL (carpool)<br>FRBUS (fixed-route bus)<br>FLEXRTE (flexible-route service)<br>LRAIL (light rail)<br>HRAIL (heavy rail)<br>AGT (automated guideway transit)<br>PVTAUTO (private automobile travel, including both park-and-ride and kiss-and-ride. |
| FIELDs 5-8 | An optional alphanumeric label for printing. If FIELDs 5-8 are blank, a default label depending on the mode type will be used. |
| DEFAULTS: | The only defaults are labels that correspond to the parenthesized mode type descriptions in FIELD 4 above. |

KEYWORD: NULLMODE

PURPOSE: Clear default mode selections

When a FEEDER, LINKER, DUMPER, or CBD analysis is requested, SMART ensures that there is at least one mode of each type selected. To suppress selection of additional default modes, the NULLMODE card is used. SMART will still ensure that AUTO, CARPOOL, and at least one transit mode are selected; but other than these, no defaults will be chosen.

FIELD 1 One of the analysis names "FEEDER", "LINKER", "DUMPER", or "CBD". Any future analysis of this type will not attempt to select all the default modes. Note that if an analysis of this type has already been performed, default modes have already been selected and are still active unless replaced. If FIELD is blank, nothing will be done.

If you use a NULLMODE card, and then forget to select any transit modes at all, SMART will chose FRBUS for you.

DEFAULTS: None

KEYWORD: NULLNET

PURPOSE: Clears the current network.

DATA: None

SIDE EFFECTS: Clears any previously generated demands. Sets zonal demand parameters of all zones in arbitrary network equal to those in Ring 3 of the ring/corridor structure.

Clears the urban structure to zero links, zero nodes, and zero zones. Used to get rid of the default network when an arbitrary network is desired. Once NULLNET has been given, and until the next URBAN card, the keywords RADII, ANGLES, LINKSET, ZONESET, and ZDPSET are invalid.

DEFAULTS: None.

KEYWORD: ODM

DATA: Node-to-node travel volumes

This card overrides the O/D travel volume per minute calculated by whatever demand generation procedure is used. It only updates single elements of the demand matrices, and therefore does not ensure that the demands balance (e.g., after this card is used, volume per minute out from a node may not equal total volume per minute out from attached zones); it is thus inappropriate for a regionwide analysis.

FIELD 1 Origin node identifier

FIELD 2 Destination node identifier

FIELD 3 Unused

FIELD 4 Unused

FIELD 5 Blank, or travel volume per minute for the A.M. peak period.

FIELD 6 Blank, or travel volume per minute for the off-peak period.

FIELD 7 Blank, or travel volume per minute for the P.M. peak period.

FIELD 8 Blank, or travel volume per minute for the off-peak hours.

DEFAULTS: Default volumes are calculated by SMART's default demand generation procedure.

KEYWORD: ONELINK

DATA: Link definition

SIDE EFFECTS: Logically, if a link is added, or an existing link's length is changed, any existing demands should be cleared, because the default generation procedure is dependent on zone-to-zone distances. However, SMART does not do this, to allow for testing alternate network variations on identical demands.

FIELD 1 The unique alphanumeric link identifier. This field must be given.

FIELD 2 The unique alphanumeric identifier for the node at one end of the link, or blanks.

FIELD 3 The unique identifier for the node at the other end of the link.

For new links, both FIELDs 2 and 3 must be given. For existing links, FIELDs 2 and 3 must either both be given or both be blank. To change one endpoint of a link, you must give both new endpoints.

A new link will start out with a length of 1000 miles and will have all the defaults of a freeway.

FIELDs 4-8 are identical on both the ONELINK and LINKSET cards. The fields contain options in any order. Some options require that the next field contain a number (such as the length in miles for the LENGTH option). If contrary options are found (e.g., FREEWAY and ARTERIAL), the last one encountered will be used. The options are:

Highway type option:
FREEWAY
ARTERIAL
MISSING (used to remove links from a ring/corridor system).

Diamond lane options:
DIAMOND
NODIAMND

Rail type options:
NORAIL
LRAIL (light rail) followed by light rail speed.
HRAIL (heavy rail)

LENGTH followed by the link length, in miles.

SPEED followed by the uncongested auto speed, in miles per minute.

LANES followed by the number of lanes in each direction (not both directions together). miles per minute.

For example, if the radial corridor in ring 1 corridor 2 is to be modified to an arterial highway six miles in length, FIELD 1 will contain the option "RADIAL", FIELD 2 "1", FIELD 3 "2", FIELD 4 "ARTERIAL", FIELD 5 "LENGTH", and FIELD 6 "6.0".

DEFAULTS: Radial highways default to freeways, circumferential highways default to arterials. In an arbitrary network, all highways default to freeways. Note that changing a highway type does not change (default) parameters.

| | Radial Highways Arbitrary Links | Circumferential Highways |
|---|---|---|
| Type | FREEWAY | ARTERIAL |
| Lanes | 3 | 2 |
| Diamond lane? | No | No |
| Light rail? | No | No |
| Light-rail speed | 0.833 | 0.50 |
| Heavy rail? | No | No |
| Automobile speed | 1.0 | 0.583 |
| Capacity (cars per lane per minute) | 40.0 | 25.0 |

KEYWORD: ONEZDP

DATA: Zonal demand parameters

SIDE EFFECTS: This card will clear any previously generated demands. However, those zonal demand parameters not changed by the user will retain their default or previously assigned values.

FIELD 1 The unique zone identifier

FIELD 2 Unused

FIELD 3 Unused

FIELDs 4-8 are treated identically for ONEZDP and ZDPSET cards:

FIELD 4 Zonal population density

FIELD 5 Zonal employment density

FIELD 6 Average trip length for type 1 (commute) trips starting in this zone

FIELD 7 Average trip length for type 2 (non-commute home-based) trips starting in this zone.

FIELD 8 Average trip length for type 3 (work-work) trips starting in this zone.

DEFAULTS:

| Ring | Population/ Sq. Mile | Employment/ Sq. Mile | Average Trip Length, All Types (Minutes) |
|---|---|---|---|
| 1 | 3416. | 75590. | 6. |
| 2 | 8443. | 7205. | 8. |
| 3 | 4776. | 2584. | 12. |
| 4 | 3248. | 1407. | 20. |
| 5 | 1624. | 703. | 34. |
| 6 | 812. | 351. | 51. |
| 7 | 406. | 175. | 69. |
| 8 | 203. | 88. | 86. |

Defaults for an arbitrary network are the same as for Ring 3.

| | |
|---|---|
| KEYWORD: | ONEZONE |
| DATA: | Urban structure zone defintion |
| SIDE EFFECTS: | This card cancels any previously generated demands. If a zone is added, all zonal demand parameters in the network are also cleared. |
| FIELD 1 | Unique alphanumeric zone identifier (required) |
| FIELD 2 | Identifier for the node this zone is connected to. Required for new zones. |
| FIELD 3 | Unused |
| | FIELDs 4-7 are identical on both the ONEZONE and ZONESET cards: |
| FIELD 4 | Area size, in square miles. Required for new zones. |
| FIELD 5 | Parking cost per vehicle trip in dollars or blank. For new zones, if blank, parking cost is assumed to be zero. |
| FIELD 6 | Area type. Current options are only "CBD", "NON-CBD", and "IGNORE". Zones designated "IGNORE" will not have their feeder, dumper, or CBD systems modeled in regionwide analysis. If blank for new zones, type defaults to non-CBD. |
| | FIELDs 7 and 8 contain mode identifiers. These must refer to previously selected transit modes for the appropriate analysis type. These transit modes will be used for this zone in any subsequent REGION or DOOR analysis. If no mode is designated, zone will receive fixed-route bus service. |
| FIELD 7 | For a CBD zone, the CBD transit mode to be used in regionwide analysis. For a NON-CBD zone, the FEEDER transit mode to be used in regionwide analysis. |
| FIELD 8 | For a NON-CBD zone, the DUMPER transit mode. |
| DEFAULTS: | Default for FIELDs 7 and 8 is fixed-route bus. If arbitrary network, other defaults are whatever were previously specified by the user. If ring/corridor, area size is calculated by SMART based on radii and angles data. The central zone defaults to CBD type; all others are non-CBD. Parking charges are, for all zones in ring 1, $2.00 per vehicle trip; for ring 2, $0.50 per vehicle trip and zero for all outer rings. |

KEYWORD: PICKUPS

DATA: Passenger pickup rate for link transit modes

This card overrides the link traffic data calculated by whatever demand generation procedure is used. It only updates single elements of the demand matrices, and therefore does not ensure that the demands balance (e.g., after this card is used, traffic picked up on the link may be even greater than the traffic on the link); it is thus inappropriate for a regionwide analysis.

| | |
|---|---|
| FIELD 1 | Link identifier |
| FIELD 2 | Node identifier of one of the endpoints of the link, showing the end at which the passengers are getting on. |
| FIELD 3 | LINKER mode category. Valid options are FRBUS, LRAIL, and HRAIL. Pickup rates should be entered assuming 100% transit mode share. |
| FIELD 4 | Unused |
| FIELD 5 | Blank, or pickups per minute for the A.M. peak period. |
| FIELD 6 | Blank, or pickups per minute for the off-peak period. |
| FIELD 7 | Blank, or pickups per minute for the P.M. peak period. |
| FIELD 8 | Unused |
| DEFAULTS: | Default pickup rates are calculated by SMART's default demand generation procedure. |

KEYWORD: PRINTDEM

PURPOSE: Print demand matrices

This card asks that the demand matrices (giving origins and destinations by period by zone, a node-to-node O/D matrix by period, and link traffic by direction by period) be printed. If no demands have been generated until this time, it will generate them.

KEYWORD: PRINTNET

PURPOSE: Print the network

This card asks that the network definition (links, zones and interconnecting nodes) be printed. It is recommended that a PRINTNET be given before any archiving to maintain a record of the network, through the PUTNET card.

KEYWORD: PUTNET

PURPOSE: Write network definition to an archive file

DATA: Unit number and demand archive selection

FIELD 1 Either a FORTRAN unit number, or blank. May not be zero.

FIELD 2 Either the option "DEMAND" or blank. If the option DEMAND is given, the hourly demand matrices will be written to the same file after the network definition. If blank, the demands will not be written.

PUTNET and GETNET are supplied to allow the user to make one run with a large number of network definition cards defining the city to be modelled, then save this urban structure on disk to be reloaded on subsequent runs. It is also possible to use PUTNET and later GETNET for the same file in one run, thus restoring the urban structure in effect at the time the PUTNET was given. It is not possible to put multiple urban structure definitions out to the same file.

DEFAULT: Default unit number is 10.

KEYWORD: RADII

DATA: Ring outer radii

CONDITIONS: Valid only for a ring/corridor and composite network, not for an arbitrary network (when NULLNET is in effect).

Gives the ring radii. FIELD 1 has the radius for the first ring, FIELD 2 for the second, etc. Only FIELDs for the number of rings specified will be checked; other FIELDs may contain comments.

DEFAULTS: Radii are

| | |
|---|---|
| Ring 1 | 0.6 miles |
| Ring 2 | 2.6 miles |
| Ring 3 | 6.32 miles |
| Ring 4 | 13.07 miles |
| Ring 5 | 31.51 miles |
| Ring 6 | 68.49 miles |
| Ring 7 | 100.0 miles |
| Ring 8 | 140.0 miles |

KEYWORD: READDEM

PURPOSE: Read demands from an external file

DATA: Unit number

FIELD 1 Either a FORTRAN unit number, or blank. May not be zero.

The demands will be read from successive cards as follows:

Columns 1-8: Origin zone identifier

Column 10: Origin type code
1 = Residential area
2 = Activity center

Columns 12-19: Destination zone identifier

Column 21: Destination type code
1 = Residential area
2 = Activity center

Column 23: Time-of-day code
1 = A.M. peak
2 = Off-peak
3 = P.M. peak
4 = Off-peak hours

Columns 25-34: Number of trips per minute

Denote the end of the input demand deck by an END in the first three columns.

The trips on the records are added up, so there is no requirement that they be exhaustive or unique. You may have multiple records for a single origin/destination/time, for example, reflecting different trip types.

DEFAULTS: FORTRAN unit number is 8.

KEYWORD: REGION

PURPOSE: Requests a regionwide analysis

This card contains no data or parameters. The regionwide analysis will be performed for the urban system and demand load currently in effect.

KEYWORD: SUBTITLE

DATA: Run subtitle or task title

The card contains a run subtitle (task title) in columns 9-72. This subtitle will be printed at the top of each page, as long as a TITLE is also defined). If columns 9-16 (FIELD 1) are blank, no subtitle will appear.

| | |
|---|---|
| KEYWORD: | TIMELEN |
| DATA: | Time period lengths |
| SIDE EFFECTS: | This card will clear any previously generated demands, while retaining zonal demand parameters. |
| FIELD 1 | A.M. peak-period length |
| FIELD 2 | Off-peak period length (may include both midday and evening hours) |
| FIELD 3 | P.M. peak-period length |
| | Each period must be longer than 0.0 minutes and shorter than 1440.0 minutes (24 hours), but need not be an integral number of minutes. The sum of the three periods must not exceed 1440.0 minutes. |
| DEFAULTS: | A.M. peak period is 180 minutes or three hours; Off-peak period is 360 minutes or six hours; and P.M. peak period is again 180 minutes or three hours. |

KEYWORD: TITLE

DATA: Run title

The card contains a run title in columns 9-72. This title will be printed at the top of each subsequent page. If columns 9-16 (FIELD 1) are blank, no title or subtitle will be printed. (This may be used to turn off a previously defined title).

| | |
|---|---|
| KEYWORD: | TMSHARE |
| DATA: | Transit mode share data |
| FIELD 1 | The number of transit mode share alternatives to model. The minimum is 1, the maximum is 6, and the initial default is 6. |
| FIELD 2 | One of the options "AM-PEAK", "OFF-PEAK", "PM-PEAK", "RATIOS", or blanks. If blank, FIELDs 3-8 will not be processed, and only FIELD 1 will have any effect.<br><br>"AM-PEAK", "OFF-PEAK", or "PM-PEAK": FIELDs 3-8 contain actual transit mode shares (between 0.00 and 1.00 inclusive) to model. If less than six are to be modelled, the remaining fields are ignored and may contain comments.<br><br>"RATIOS": FIELD 3 contains the ratio of off-peak to am peak transit mode shares. This ratio will be used to recalculate all off-peak shares. FIELD 4 contains the ratio of P.M. peak to A.M. peak transit mode shares, and will be used to recalculate all P.M. peak shares. These ratios may be more or less than 1.00, but an error will occur if a transit mode share is driven above 1.00. |
| DEFAULTS: | For A.M. and P.M. peaks, transit mode shares are: 0.05, 0.10, 0.15, 0.20, 0.25 and 0.30.<br>For off-peak, transit mode shares are: 0.25, 0.05, 0.075, 0.10, 0.125 and 0.15.<br>If less than six transit mode shares are defined in FIELD 1, only as many default values as necessary will be used. For example, if three mode shares are modeled, only the first three defaults in each time period will be used. |

KEYWORD: TRAFFIC

DATA: Link traffic volumes

This card overrides the link traffic volume per minute calculated by whatever demand generation procedure is used. It only updates single elements of the demand matrices, and therefore does not ensure that the demands balance (e.g., after this card is used, traffic on a link may be even less than the O/D matrix volume per minute between the two endpoints); it is thus inappropriate for a regionwide analysis.

FIELD 1 Link identifier

FIELD 2 Node identifier for one of the endpoints of the link, showing the end toward which the traffic is flowing.

FIELD 3 LINKER mode category. Valid options are FRBUS, LRAIL, HRAIL, or AUTO. Auto traffic volumes should be entered assuming 0% transit mode share, others assuming 100% transit mode share.

FIELD 4 Unused

FIELD 5 Blank, or traffic volume per minute for the AM peak period.

FIELD 6 Blank, or traffic volume per minute for the off-peak period.

FIELD 7 Blank, or traffic volume per minute for the PM peak period.

FIELD 8 blank, or traffic volume per minute for the off-hours period. Since SMART assumes no transit service during the off hours, this field must be blank for LRAIL, HRAIL, and FRBUS.

DEFAULTS: Traffic volumes are calculated by SMART's default demand generation procedure.

KEYWORD: TRIPTIME

DATA: Proportion of daily trips in each time period

SIDE EFFECTS: This card will clear any previously generated demands, while retaining any previously generated zonal demand parameters.

For a particular trip type and forward or reverse trips, gives the proportion of daily trips in each of the three time periods. Any excess trips are assumed to be automobile trips in off-peak hours.

FIELD 1 A trip type index, from 1 to 3. The default trip generation procedure assumes type 1 is commute trips, type 2 non-commute home-based trips, and type 3 non-home-based work trips.

FIELD 2 The option "FORWARD" or "REVERSE". Generated trips are assumed to be bidirectional, and an equal number of return trips is generated.

The "FORWARD" direction is

(1) For commute trips: From the residential section of one zone to the activity centers of the same or a different zone.

(2) For non-commute home-based trips: From the residential section of one zone to the activity centers of the same or a different zone.

(3) For non-home-based work trips: From activity centers of one zone to the activity centers of the same or a different zone.

The "REVERSE" direction is

(1) For commute trips: From the activity centers of one zone to the residential area of the same or a different zone.

(2) For non-commute home-based trips: From the activity centers of one zone to the residential area of the same or a different zone.

(3) For non-home-based work trips: From the activity centers of one zone to the activity centers of the same or a different zone.

FIELD 3 The proportion of trips occurring in the AM peak.

FIELD 4 The proportion of trips occurring in the off-peak (not including off-hour trips).

FIELD 5 The proportion occurring in the PM peak.

These fields are proportions, not percents, so they must add up to no more than 1.00.

DEFAULTS:

| | Going: AM-peak | Going: Off-peak | Going: PM-peak | Returning: AM-peak | Returning: Off-peak | Returning: PM-peak |
|---|---|---|---|---|---|---|
| Commute | 1.00 | - | - | - | - | 1.00 |
| Shopping | - | 1.00 | - | - | 0.60 | 0.30 |
| Work-work | 0.10 | 0.80 | 0.10 | 0.10 | 0.80 | 0.10 |

Fraction of trips in each time period

Note: 10% of shopping trips return during off-hours.

KEYWORD: URBAN

DATA: Number of rings and corridors

SIDE
EFFECTS: Clears any previously generated demands and zonal demand parameters.

Changes the number of rings and corridors. Clears all previous link and zone definitions, as well as all previously generated zonal demand parameters and demand.

FIELD 1 Number of rings (minimum 2, maximum 8) Initial default is 6.

FIELD 2 Number of corridors (minimum 1, maximum 6). Initial default is 6.

When a ring/corridor system is being used, SMART uses a set of default identifiers for the links, nodes, and zones. These identifiers must be used in some of the update cards, and have been chosen to make it easy for the analyst to remember. In the explanation below, "r" stands for a ring number from 2 to the number of rings, and "c" stands for a corridor number from 1 to the number of corridors.

RHWYRrCc = Radial highway extending outward to ring r on corridor c. Note that the ring number is the outer ring, not the inner ring.

CHWYRrCc = Circumferential highway in ring r extending from corridor c on the left (as seen from the center of the system) to the next corridor to the right (which is usually c+1 but would be corridor 1 if c is the highest-numbered corridor.

NODECNTR = The node at the center of the system.

NODERrCc = The node at ring r, corridor c.

ZONECNTR = The central zone (CBD) attached to NODECNTR.

LZONRrCc = The zone to the left of NODERrCc (as seen from the center of the system) attached to NODERrCc.

RZONRrCc = The zone to the right of NODERrCc and attached to NODERrCc.

KEYWORD: VACT

DATA: Activity center travel volumes for a zone

This card overrides the activity center traffic volume per minute calculated by whatever demand generation procedure is used. It only updates single elements of the demand matrices, and therefore does not ensure that the demands balance (e.g., after this card is used, daily total inbound volume may not equal daily total outbound volume); it is thus inappropriate for a regionwide analysis.

FIELD 1 Zone identifier

FIELD 2 Travel direction. Valid values are OUT (going out of the zone) and IN (going into the zone).

FIELD 3 Unused

FIELD 4 Unused

FIELD 5 Blank, or activity center travel volume per minute for the A.M. peak period.

FIELD 6 Blank, or activity center travel volume per minute for the off-peak period.

FIELD 7 Blank, or activity center travel volume per minute for the P.M. peak period.

FIELD 8 Blank, or activity center travel volume per minute for the off-hour period.

DEFAULT: Travel volumes are calculated by SMART's default demand generation procedure.

KEYWORD: VRES

DATA: Residential travel volumes for a zone

This card overrides the residential traffic volume per minute calculated by whatever demand generation procedure is used. It only updates single elements of the demand matrices, and therefore does not ensure that the demands balance (e.g., after this card is used, daily total inbound volume may not equal daily total outbound volume); it is thus inappropriate for a regionwide analysis.

FIELD 1 Zone identifier

FIELD 2 Travel direction. Valid values are OUT (going out of the zone) and IN (going into the zone).

FIELD 3 Unused

FIELD 4 Unused

FIELD 5 Blank, or residential travel volume per minute for the A.M. peak period.

FIELD 6 Blank, or residential travel volume per minute for the off-peak period.

FIELD 7 Blank, or residential travel volume per minute for the P.M. peak period.

FIELD 8 Blank, or residential travel volume per minute for the off-hours period.

DEFAULT: Travel volumes are calculated by SMART's default demand generation procedure.

KEYWORD: WALKING

DATA: Walking parameters

The possible options for this card are:

| FIELD 1 | FIELD 2 | FIELD 3 | FIELD 4 |
|---|---|---|---|
| SPEED | value | | |
| FRACTION | DUMPER | value | |
| DISTANCE | CBD | AUTO | value |
| DISTANCE | CBD | CARPOOL | value |
| DISTANCE | DUMPER | AUTO | value |
| DISTANCE | DUMPER | CARPOOL | value |
| DISTANCE | DUMPER | FRBUS | value |

SPEED specifies the speed at which the average person walks. This is used for walking time calculations.

FRACTION specifies the fraction of transit patrons who are travelling to the area near the line-haul station, and who are thus already at their destination. These people will not be served by DUMPER transit service. Walking fraction must be between 0.00 and 1.00 inclusive.

DISTANCE specifies the expected distance that people on different modes will have to walk to get to their final destinations, either from the parking point (for AUTO and CARPOOL) or from the bus stop (for FRBUS).

DEFAULTS: WALK SPEED = 0.05 miles/minute (or three miles/hour).
DUMPER walking fraction = 0%.
CBD automobile riders walk 0.20 miles.
CBD carpool riders walk 0.20 miles.
DUMPER automobile riders walk 0.1 miles.
DUMPER carpool riders walk 0.04 miles.
DUMPER bus riders walk 0.25 miles.

| | |
|---|---|
| KEYWORD: | ZDPSET |
| DATA: | Zonal demand parameters |
| CONDITIONS: | Valid for ring/corridor and composite networks, but not for an arbitrarily defined network (when NULLNET is in effect). |
| SIDE EFFECTS: | This card will clear any previously generated demands. |
| FIELD 1 | One of the options "LEFT" or "RIGHT" or blanks. If blank, both left and right zones are selected. ZONECNTR is the LEFT zone of ring 1, corridor 1. |
| FIELD 2 | Either blanks or a ring number. If blank, all rings will be selected. |
| FIELD 3 | Either blanks or a corridor number. If blank, all corridors will be selected. |
| | FIELDs 4-8 are treated identically for ONEZDP and ZDPSET cards: |
| FIELD 4 | Zonal population density |
| FIELD 5 | Zonal employment density |
| FIELD 6 | Average trip length for type 1 trips (commute trips) starting in this zone. |
| FIELD 7 | Average trip length for type 2 trips (non-commute home-based trips) starting in this zone. |
| FIELD 8 | Average trip length for type 3 trips (non-home-based work trips) starting in this zone. |

DEFAULTS:

| Ring | Population/ Sq. Mile | Employment/ Sq. Mile | Average Trip Length, All Type (Minute) |
|---|---|---|---|
| 1 | 3416. | 75590. | 6. |
| 2 | 8443. | 7205. | 8. |
| 3 | 4776. | 2584. | 12. |
| 4 | 3248. | 1407. | 20. |
| 5 | 1624. | 703. | 34. |
| 6 | 812. | 351. | 51. |
| 7 | 406. | 175. | 69. |
| 8 | 203. | 88. | 86. |

KEYWORD: ZONESET

DATA: Urban structure zone definition modifications

CONDITION: This card is valid for ring/corridor and composite networks, but not for an arbitrary network (when NULLNET is in effect).

New zones cannot be created with the ZONESET card. Only zones in predefined positions in an urban ring/corridor system can be modified with it.

FIELD 1 Either of the options "LEFT" or "RIGHT" or blanks. If blank, both left and right zones (as viewed from the center of the system) will be selected.

FIELD 2 Either a ring number, or blanks. If blank, all rings will be selected.

FIELD 3 Either a corridor number or blanks. If blank, all corridors will be selected.

The central zone is the LEFT zone in ring 1 for corridor 1.

FIELDs 4-8 are identical on both the ONEZONE and ZONESET cards.

FIELD 4 Area size, in square miles.

FIELD 5 Parking cost per vehicle trip in dollars or blank. For new zones, if blank, parking cost is assumed to be zero.

FIELD 6 Area type. Current options are only "CBD", "NON-CBD", and "IGNORE".
Zones designated "IGNORE" will not have their feeder, dumper or CBD systems modeled in regionwide analysis.

FIELDs 7 and 8 contain mode identifiers. These must refer to previously selected transit modes for the appropriate analysis type. These transit modes will be used for this zone in any subsequent REGION or DOOR analysis. If no mode is designated, zone will receive fixed-route bus service.

FIELD 7 For a CBD zone, the CBD transit mode to be used in regionwide analysis. For NON-CBD zone, the the FEEDER transit mode to be used in regionwide analysis.

FIELD 8 For a NON-CBD zone, the DUMPER transit mode to be used in regionwide analysis.

DEFAULTS: Default for FIELDs 7 and 8 is fixed-route bus. Area size is calculated by SMART based on existing radii and angles data. The central zone defaults to CBD type; all others are non-CBD. Parking charges are, for all zones in ring 1, $2.00 per vehicle trip; for ring 2, $.050 per vehicle trip and zero for all outer rings.

## Appendix B

## ERROR MESSAGES

Error messages are printed by the SMART model to help the user diagnose invalid input data. Some of these messages are self-explanatory, while others are more cryptic and require elaboration. In the following description of the latter category, "PARAMETER" denotes parameters such as carpool time fraction and ring structure, while [ ] denotes a user-supplied data value for that parameter.

<u>Messages</u>

DISJOINT NETWORK: At least one node is not linked to the rest of the network. Check for incomplete or incorrect link and node definitions.

DUPLICATE MODE IDENTIFIER FOUND: Mode identifier on MODESEL card corresponds to an already selected mode. Change mode identifier.

EXISTING MODE NOT FOUND TO REPLACE, ADD ASSUMED: MODESEL card specifies a non-existent mode identifier. REPLACE option changed to ADD. Check your mode identifier.

EXPECTING NUMBER, FOUND: [ ] - Expect numeric entry on MODEPARM card, but instead found an unreadable entry. Most likely it is a typographical error, such as typing an "o" rather than a "0" in a numeric field.

INVALID ANALYSIS NAME - On MODESEL card, an invalid analysis (not FEEDER, DUMPER, CBD or LINKER) has been specified for the selected mode.

INVALID CORRIDOR ANGLE: [ ] - Corridor angle values are either unreadable, negative, or not placed in increasing order. If unreadable, it could be a typographical error (for example, data has an "o" instead of "0" in a numeric field.

INVALID DIRECTION: [ ] - On a VRES or VACT card, FIELD(2) is not "OUT" or "IN" as it should be.

INVALID END TYPE: [ ] - On READDEM card, trip end is not "1" or "2" as it should be.

INVALID FLOATING POINT NUMBER: [ ] - Unreadable contents in DEMPARM, ONEZDP or ZDPSET cards. Probably a typographical error.

INVALID MODE CATEGORY: [ ] - On TRAFFIC card, mode specified is not "FRBUS, "LRAIL" or "HRAIL" as it should be.

INVALID MODE TYPE: [ ] - On MODESEL card, FIELD(4) denotes a mode type that is not permitted for the specified analysis.

INVALID OPTION: [ ] - A modal parameter on the MODEPARM card is not known by SMART. Check MODEPARM keyword documentation for acceptable options.

INVALID OR MISSING MODE TYPE: [ ] - On WALKING card, CBD or DUMPER option is specified, but modes are either undefined or not AUTO, CARPOOL, or FRBUS.

INVALID "PARAMETER": [ ] - Value for parameter is undecodeable or does not fall within permissable range. If undecodeable, it could be a typographical error (for example, typing an "o" instead of a "0" in a numeric field.

INVALID RADIAL/CIRCUMFERENTIAL SELECTOR: [ ] - On LINKSET card, FIELD(1) is not "RADIAL," or "CIRCUMFR," or blank as it should be.

INVALID RING RADIUS: [ ] - Ring radii values are either unreadable, less than or equal to zero, or radii are not placed in increasing order. If unreadable, it could be a typographical error (for example, typing an "o" instead of a "0" in a numeric field.

INVALID TRAVEL VOLUME: [ ] - A volume on a VRES or VACT card is negative, or the contents of FIELD(5) to FIELD(8) are unreadable. If unreadable, it could be a typographical error (for example, data has an "o" instead of "0" in a numeric field).

INVALID UPDATE TYPE: [ ] - FIELD(1) on MODESEL card is not "ADD," "REPLACE," or blank as it should be.

INVALID ZONE IDENTIFIER: [ ] - Zone specified on VRES or VACT card has not been defined. Either define this zone or change identifier to an already existing zone.

INVALID ZONE ON DEMAND INPUT: [ ] - Zone for READDEM data has not been previously defined as it should be.

INVALID ZONE SIDE SELECTOR: [ ] - FIELD(1) on a ZONESET or ZDPSET cards is not "LEFT," or "RIGHT" or blank as it should be.

MISSING ANALYSIS NAME: On MODESEL card, no analysis has been specified for the mode selected. Specify it.

MISSING MODE TYPE ON SELECTOR - FIELD(4) on MODESEL card is blank. It should instead denote the mode type for the selected mode.

MISSING VALUE FOR OPTION: [ ] - On MODEPARM card, parameter option and value are not on adjacent fields as they should be.

NEGATIVE OPTION VALUE: [ ] - On MODEPARM card, a non-negative parameter has been assigned a negative value.

NO DESTINATION SPECIFIED: [ ] - Missing destination zone on DOOR card.

NO ORIGIN ZONE SPECIFIED: [ ] - Missing origin zone on DOOR card.

NO SUCH LINK: [ ] - A link not previously defined has been encountered on the TRAFFIC card. Either define this link or check for incorrect typing of link name.

NO SUCH MODE AS: [ ] - A mode not on the selected list is encountered during DOOR analysis. Either select this mode or change mode identifier.

NO SUCH NODE: [ ] - Node not previously defined. Encountered in LINKER analysis or on ODM data card. Either define this node or check for incorrect typing of node name.

NO SUCH TRIP DESTINATION AS: [ ] - On DOOR card, trip destination is not "ACTIVITY" or "RESIDNTL" as it should be.

NO SUCH TRIP ORIGIN AS: [ ] - On DOOR card, trip origin is not "ACTIVITY" or "RESIDNTL" as it should be.

NO SUCH ZONE AS: [ ] - Zone not previously defined. Encountered in CBD, DOOR, DUMPER or FEEDER analysis. Either define zone or check for incorrect typing of zone name.

PROHIBITED MODE IDENTIFIER: [ ] - Mode identifier on MODESEL card corresponds to a default mode. This is not permitted. Change the mode identifier.

UNKNOWN ZONE: Zone specified on ONEZDP card does not exist. Either define the zone or change its name.

UNRECOGNIZED ANALYSIS TYPE: [ ] - The analysis type specified on the NULLMODE card is not known to SMART. It should be either "FEEDER," "LINKER," "DUMPER," or "CBD."

[ ] IS NEITHER A MODE TYPE NOR A SELECTED MODE IDENTIFIER - On MODEPARM card, mode identifier listed is not a default or user-specified name as it should be.

[ ] IS NOT A SELECTED FEEDER/DUMPER/CBD MODE: Such a mode has not been selected for the relevant analysis in DOOR or REGION. Either select it or check for incorrect typing of mode name.

## Appendix C

## SAMPLE PROBLEMS

The following sample jobs cover a wide range of activities. They are intended to illustrate the use of keywords in defining urban structure, selecting demand patterns, and analyzing zonal or line-haul transport systems. Even though each sample job performs a series of tasks, its emphasis as an example is on a particular aspect of the model, such as network definition or modal selection. Jobs can be classified by their area of emphasis:

| | Example |
|---|---|
| Network Definition | 1, 2, 3 |
| Demand Modeling | 4, 5, 6 |
| Mode Selection and Parameter Modification | 7, 8 |
| Miscellaneous | 9, 10 |

The use of each keyword is illustrated at least once in the examples. Outputs are also shown for a selected number of these examples.

EXAMPLE 1

Job Purpose

To illustrate the definition of a ring/corridor network:

1. Define a two-ring, three-corridor network;

2. Set radii of the rings;

3. Set angles between corridors;

4. Modify characteristics of one radial and one circumferential highway;

5. Modify characteristics of two zones;

6. Print the resulting network; and

7. Run a feeder analysis.

Input Data

```
                                         F I E L D
Keyword <--1---><--2---><--3---><--4---><--5---><--6---><--7---><--8--->

TITLE   EXAMPLE 1 -- RING/CORRIDOR DEFINITION
URBAN          2       3
RADII        0.6     3.0
ANGLES       0.0   120.0   240.0
LINKSET CIRCUMFR       2      2LENGTH      6.0LANES        4.0FREEWAY
LINKSET CIRCUMFR       2      2NODIAMNDLRAIL      0.85
LINKSET RADIAL         2      3MISSING
ZONESET LEFT    1       1       2.0            NON-CBD
ZONESET RIGHT   2       2             1.0      CBD
PRINTNET
FEEDER  RZONR2C1UNIFORM
END
```

This job constructs a two-ring, three-corridor network as requested by the URBAN card. The radius of the inner ring (Ring 1) is set to 0.6 miles, and that of the outer ring (Ring 2) is set to 3.0 miles by the RADII card. The three corridors are spaced equally around the ring, separated by angles of 120 degrees as specified by the ANGLES card. Angles are all measured from the same direction, and hence are cumulative. Note that the URBAN card clears all previous networks; To prevent their values from being cleared, all network and demand modification cards must follow (not precede) the URBAN card.

Link modifications can be made on more than one card. For example, circumferential highway Ring 2 Corridor 2 (from corridor 2 to corridor 3 in ring 2) is defined by the LINKSET card as a six-mile long freeway with four lanes in each direction. It is not to have any preferential lanes, but will have a light rail system whose vehicle speed is 0.85 miles per minute. The second link to be modified is radial highway Ring 2 Corridor 3 (from the center to ring 1 in corridor 3) which is defined as missing or non-existent in the network. Note that some link parameters occupy one field, while others occupy two. For example, link type specifications (such as "FREEWAY," "ARTERIAL" or "MISSING") stand alone, while link length specifications need both a "LENGTH" word in one field followed by the length value in the next field. Link parameters not modified by LINKSET cards will retain SMART's default generated values.

Zonal parameters are modified through the ZONESET cards. The central zone (known to SMART as the left zone of Ring 1 Corridor 1) is defined as having an area of two square miles and of non-CBD type, while the right zone of Ring 2 Corridor 2 is defined as a CBD zone of one square mile. Zone parameters not modified by ZONESET cards will retain their default values.

Note that LINKSET and ZONESET cards are applicable to the current network. If none exists, SMART will automatically generate the default structure.

The urban network will be printed when the PRINTNET card is encountered.

FEEDER analysis is performed on zone RZONR2C1 (the right zone of Ring 2 Corridor 1). Finally, the run is terminated by an END card.

The output for this job is listed in Exhibit C.1.

## Exhibit C.1: EXAMPLE 1 OUTPUT -- RING/CORRIDOR DEFINITION

```
SMART MODEL - SYSTAN, INC.                            12/16/81                                   PAGE   1
TITLE   EXAMPLE 1 -- RING/CORRIDOR DEFINITION                                10.
URBAN         2       3                                                      11.
RADII       0.6     3.0                                                      12.
ANGLES      0.0   120.0   240.0                                              13.
LINKSET CIRCUMFR      2       2LENGTH       6.0LANES       4.0FREEWAY        14.
LINKSET CIRCUMFR      2       2NODIAMNDLRAIL      0.85                       15.
LINKSET RADIAL        2       3MISSING                                       16.
ZONESET LEFT    1       1       2.0           NON-CBD                        17.
ZONESET RIGHT   2       2             1.0     CBD                            18.
PRINTNET                                                                     19.
```

SMART MODEL - SYSTAN, INC. 12/16/81 PAGE 2
EXAMPLE 1 -- RING/CORRIDOR DEFINITION

| LINK IDENT | FROM NODE | TO NODE | LENGTH | NO OF LANES | HIGHWAY TYPE | DIAMOND LANE? | LIGHT RAIL? | HEAVY RAIL? | AUTO SPEED | LRAIL SPEED |
|---|---|---|---|---|---|---|---|---|---|---|
| RHWYR2C1 | NODECNTR | NODER2C1 | 1.8 | 3. | FREEWAY | NO | NO | NO | 1.000 | 0.833 |
| RHWYR2C2 | NODECNTR | NODER2C2 | 1.8 | 3. | FREEWAY | NO | NO | NO | 1.000 | 0.833 |
| RHWYR2C3 | NODECNTR | NODER2C3 | 1.8 | 3. | MISSING | NO | NO | NO | 1.000 | 0.833 |
| CHWYR2C1 | NODER2C1 | NODER2C2 | 3.8 | 2. | ARTERIAL | NO | NO | NO | 0.583 | 0.500 |
| CHWYR2C2 | NODER2C2 | NODER2C3 | 6.0 | 4. | FREEWAY | NO | YES | NO | 0.583 | 0.850 |
| CHWYR2C3 | NODER2C3 | NODER2C1 | 3.8 | 2. | ARTERIAL | NO | NO | NO | 0.583 | 0.500 |

EXAMPLE 1 -- RING/CORRIDOR DEFINITION

| ZONE-IDENT | ATTACHED TO | SIZE | TYPE |
|---|---|---|---|
| ZONECNTR | NODECNTR | 2.0 | NON-CBD |
| LZONR2C1 | NODER2C1 | 9.0 | NON-CBD |
| RZONR2C1 | NODER2C1 | 9.0 | NON-CBD |
| LZONR2C2 | NODER2C2 | 9.0 | NON-CBD |
| RZONR2C2 | NODER2C2 | 1.0 | CBD |
| LZONR2C3 | NODER2C3 | 9.0 | NON-CBD |
| RZONR2C3 | NODER2C3 | 9.0 | NON-CBD |

NETWORK CONTAINS 6 LINKS, 4 NODES, AND 7 ZONES

EXAMPLE 1 -- RING/CORRIDOR DEFINITION

```
FEEDER  RZONR2C1UNIFORM                                   20.
```

EXAMPLE 1 -- RING/CORRIDOR DEFINITION

| ZONE | POPULATION | EMPLOYMENT |
|---|---|---|
| ZONECNTR | 6832. | 151180. |
| LZONR2C1 | 76390. | 65189. |
| RZONR2C1 | 76390. | 65189. |
| LZONR2C2 | 76390. | 65189. |
| RZONR2C2 | 8443. | 7205. |
| LZONR2C3 | 76390. | 65189. |
| RZONR2C3 | 76390. | 65189. |
| TOTAL | 397227. | 484331. |

| TRIP TYPE: | 1 | 2 | 3 | OVERALL |
|---|---|---|---|---|
| AVERAGE TRIP LENGTH: | 8.8 | 8.8 | 8.2 | 8.8 MINUTES |

EXAMPLE 1 -- RING/CORRIDOR DEFINITION

FEEDER UNIFORM SERVICE ANALYSIS OF RZONR2C1

ZONE SIZE: 9.0 SQ.MILES

| | | | |
|---|---|---|---|
| TRAVEL TRIP VOLUME DURING AM-PEAK | OUTBOUND: | 169.756 | TRIPS PER MINUTE |
| | INBOUND : | 0.0 | TRIPS PER MINUTE |
| TRAVEL TRIP VOLUME OURING OFF-PEAK | OUTBOUND: | 21.219 | TRIPS PER MINUTE |
| | INBOUND : | 12.732 | TRIPS PER MINUTE |
| TRAVEL TRIP VOLUME DURING PM-PEAK | OUTBOUND: | 0.0 | TRIPS PER MINUTE |
| | INBOUND : | 182.488 | TRIPS PER MINUTE |

LENGTH OF AM-PEAK IS 180.0 MINUTES
LENGTH OF OFF-PEAK IS 360.0 MINUTES
LENGTH OF PM-PEAK IS 180.0 MINUTES

CARPOOL FRACTION: 0.0500
CARPOOL TIME PARAMETER: 3.000

DEFAULT WALK SPEED USED IN THE CALCULATIONS IS 0.050 MILES PER MINUTE

| MODE IDENTIFIER | MODE TYPE | MODE LABEL | FLEXTYPE AM-PEAK | FLEXTYPE OFF-PEAK | FLEXTYPE PM-PEAK | TRANSFER |
|---|---|---|---|---|---|---|
| AUTO | AUTO | AUTO | | | | RANOOM |
| CARPOOL | CARPOOL | CARPOOL | | | | RANDOM |
| FRBUS | FRBUS | FIXED-ROUTE BUS | | | | RANDOM |
| FLEXRTE | FLEXRTE | FLEXIBLE-ROUTE SERVICE | SUBSCR | DAR | SUBSCR | RANDOM |
| PVTAUTO | PVTAUTO | PRIVATE AUTO TRANSIT | | | | RANDOM |

| MODE IDENTIFIER | $ | $/V | $/VH | $/VM | $/RM | SPEED | MIN/STOP | MIN/PASS | MI/GAL | PASS/VEH |
|---|---|---|---|---|---|---|---|---|---|---|
| AUTO | 0.0 | 2.040 | 0.012 | 0.090 | 0.0 | 0.333 | 0.500 | 0.0 | 15.000 | 1.200 |
| CARPOOL | 0.0 | 2.040 | 0.012 | 0.090 | 0.0 | 0.333 | 0.500 | 0.0 | 15.000 | 3.000 |
| FRBUS | 0.0 | 51.780 | 0.160 | 0.480 | 0.0 | 0.333 | 0.200 | 0.020 | 5.200 | 50.000 |
| FLEXRTE | 0.0 | 26.610 | 0.145 | 0.200 | 0.0 | 0.333 | 0.500 | 0.0 | 9.000 | 10.000 |
| PVTAUTO | 0.0 | 1.500 | 0.0 | 0.010 | 0.0 | 0.333 | 0.500 | 0.0 | 15.000 | 1.200 |

| MODE IDENTIFIER | MINHDWAY | MAXHDWAY | MAXRS | STOPS/MI | CARS/VEH | FRACWALK | AMTRAIN | OFFTRAIN | PMTRAIN |
|---|---|---|---|---|---|---|---|---|---|
| AUTO | 0.500 | 0.0 | 0.0 | 0.0 | 1.000 | 0.200 | 1.000 | 1.000 | 1.000 |
| CARPOOL | 0.500 | 0.0 | 0.0 | 0.0 | 1.000 | 0.200 | 1.000 | 1.000 | 1.000 |
| FRBUS | 0.500 | 60.000 | 1.000 | 8.000 | 2.000 | 0.200 | 1.000 | 1.000 | 1.000 |
| FLEXRTE | 0.500 | 60.000 | 1.000 | 4.000 | 1.000 | 0.200 | 1.000 | 1.000 | 1.000 |
| PVTAUTO | 0.500 | 0.0 | 0.0 | 0.0 | 1.000 | 0.200 | 1.000 | 1.000 | 1.000 |

FEEDER UNIFORM SERVICE ANALYSIS OF RZONR2C1 OUTBOUND

TRAVEL TIMES DURING AM-PEAK , (MEAN & STD.DEV.)

| TRANSIT MODE SHARE: | 0.050 | | 0.100 | | 0.150 | | 0.200 | | 0.250 | | 0.300 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AUTO | 6.1 | 1.8 | 6.1 | 1.8 | 6.1 | 1.8 | 6.1 | 1.8 | 6.1 | 1.8 | 6.1 | 1.8 |
| CARPOOL | 7.9 | 2.1 | 7.9 | 2.1 | 7.9 | 2.1 | 8.0 | 2.1 | 8.0 | 2.1 | 8.0 | 2.1 |
| FIXED-ROUTE BUS | 25.7 | 4.9 | 22.2 | 4.6 | 20.6 | 4.4 | 19.7 | 4.3 | 19.0 | 4.3 | 18.6 | 4.2 |
| FLEXIBLE-ROUTE SERVICE | 21.2 | 6.1 | 20.7 | 6.1 | 20.6 | 6.0 | 20.5 | 6.0 | 20.5 | 6.0 | 20.4 | 6.0 |
| PRIVATE AUTO TRANSIT | 6.6 | 1.9 | 6.6 | 1.9 | 6.6 | 1.9 | 6.6 | 1.9 | 6.6 | 1.9 | 6.6 | 1.9 |

TRAVEL TIMES DURING OFF-PEAK, (MEAN & STD.DEV.)

| TRANSIT MODE SHARE: | 0.025 | | 0.050 | | 0.075 | | 0.100 | | 0.125 | | 0.150 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AUTO | 6.1 | 1.8 | 6.1 | 1.8 | 6.1 | 1.8 | 6.1 | 1.8 | 6.1 | 1.8 | 6.1 | 1.8 |
| CARPOOL | 9.8 | 2.3 | 9.8 | 2.4 | 9.9 | 2.4 | 9.9 | 2.4 | 10.0 | 2.4 | 10.0 | 2.4 |
| FIXED-ROUTE BUS | 32.3 | 5.3 | 34.6 | 5.6 | 35.4 | 5.6 | 35.6 | 5.6 | 35.2 | 5.6 | 33.3 | 5.5 |
| FLEXIBLE-ROUTE SERVICE | 43.1 | 9.3 | 37.4 | 8.6 | 34.6 | 8.2 | 32.9 | 8.0 | 31.5 | 7.8 | 30.7 | 7.7 |
| PRIVATE AUTO TRANSIT | 6.6 | 1.9 | 6.6 | 1.9 | 6.6 | 1.9 | 6.6 | 1.9 | 6.6 | 1.9 | 6.6 | 1.9 |

FEEDER UNIFORM SERVICE ANALYSIS OF RZONR2C1 INBOUND

TRAVEL TIMES DURING OFF-PEAK, (MEAN & STD.DEV.)

| TRANSIT MODE SHARE: | 0.025 | | 0.050 | | 0.075 | | 0.100 | | 0.125 | | 0.150 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AUTO | 6.1 | 1.8 | 6.1 | 1.8 | 6.1 | 1.8 | 6.1 | 1.8 | 6.1 | 1.8 | 6.1 | 1.8 |
| CARPOOL | 10.7 | 2.4 | 10.7 | 2.5 | 10.8 | 2.5 | 10.8 | 2.5 | 10.9 | 2.5 | 10.9 | 2.5 |
| FIXED-ROUTE BUS | 42.5 | 6.2 | 43.9 | 6.3 | 45.3 | 6.4 | 46.5 | 6.5 | 45.6 | 6.5 | 42.6 | 6.3 |
| FLEXIBLE-ROUTE SERVICE | 51.4 | 10.3 | 44.1 | 9.4 | 40.6 | 9.0 | 38.4 | 8.7 | 36.6 | 8.5 | 35.6 | 8.4 |
| PRIVATE AUTO TRANSIT | 6.6 | 1.9 | 6.6 | 1.9 | 6.6 | 1.9 | 6.6 | 1.9 | 6.6 | 1.9 | 6.6 | 1.9 |

TRAVEL TIMES DURING PM-PEAK , (MEAN & STD.DEV.)

| TRANSIT MODE SHARE: | 0.050 | | 0.100 | | 0.150 | | 0.200 | | 0.250 | | 0.300 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AUTO | 6.1 | 1.8 | 6.1 | 1.8 | 6.1 | 1.8 | 6.1 | 1.8 | 6.1 | 1.8 | 6.1 | 1.8 |
| CARPOOL | 7.8 | 2.1 | 7.9 | 2.1 | 7.9 | 2.1 | 7.9 | 2.1 | 8.0 | 2.1 | 8.0 | 2.1 |
| FIXED-ROUTE BUS | 30.3 | 5.3 | 24.9 | 4.9 | 22.6 | 4.6 | 21.1 | 4.5 | 20.2 | 4.4 | 19.5 | 4.3 |
| FLEXIBLE-ROUTE SERVICE | 42.2 | 9.2 | 42.1 | 9.2 | 42.1 | 9.2 | 42.1 | 9.2 | 42.1 | 9.2 | 42.1 | 9.2 |
| PRIVATE AUTO TRANSIT | 6.6 | 1.9 | 6.6 | 1.9 | 6.6 | 1.9 | 6.6 | 1.9 | 6.6 | 1.9 | 6.6 | 1.9 |

FEEDER UNIFORM SERVICE ANALYSIS OF RZONR2C1 BI-DIRECTIONAL

| | | | | | | |
|---|---|---|---|---|---|---|
| COST PER TRIP DURING AM-PEAK TRANSIT MODE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| AUTO | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 |
| CARPOOL | 0.21 | 0.21 | 0.21 | 0.21 | 0.22 | 0.22 |
| FIXED-ROUTE BUS | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 | 0.25 |
| FLEXIBLE-ROUTE SERVICE | 0.67 | 0.66 | 0.66 | 0.65 | 0.65 | 0.65 |
| PRIVATE AUTO TRANSIT | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 |
| COST PER TRIP DURING OFF-PEAK TRANSIT MODE SHARE: | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| AUTO | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 |
| CARPOOL | 0.27 | 0.27 | 0.27 | 0.27 | 0.27 | 0.27 |
| FIXED-ROUTE BUS | 0.49 | 0.26 | 0.18 | 0.14 | 0.12 | 0.12 |
| FLEXIBLE-ROUTE SERVICE | 0.60 | 0.50 | 0.46 | 0.43 | 0.41 | 0.40 |
| PRIVATE AUTO TRANSIT | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 |
| COST PER TRIP DURING PM-PEAK TRANSIT MODE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| AUTO | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 | 0.46 |
| CARPOOL | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 | 0.22 |
| FIXED-ROUTE BUS | 0.26 | 0.26 | 0.26 | 0.26 | 0.26 | 0.26 |
| FLEXIBLE-ROUTE SERVICE | 0.67 | 0.67 | 0.67 | 0.67 | 0.67 | 0.67 |
| PRIVATE AUTO TRANSIT | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 | 0.98 |

FEEOER UNIFORM SERVICE ANALYSIS OF RZONR2C1 BI-OIRECTIONAL

| | | | | | | |
|---|---|---|---|---|---|---|
| FUEL CONSUMPTION PER TRIP DURING AM-PEAK | | | | | | |
| TRANSIT MODE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| AUTO | 0.112 | 0.112 | 0.112 | 0.112 | 0.112 | 0.112 |
| CARPOOL | 0.061 | 0.061 | 0.062 | 0.062 | 0.063 | 0.063 |
| FIXED-ROUTE BUS | 0.029 | 0.029 | 0.029 | 0.029 | 0.029 | 0.029 |
| FLEXIBLE-ROUTE SERVICE | 0.085 | 0.084 | 0.084 | 0.084 | 0.084 | 0.084 |
| PRIVATE AUTO TRANSIT | 0.112 | 0.112 | 0.112 | 0.112 | 0.112 | 0.112 |
| FUEL CONSUMPTION PER TRIP DURING OFF-PEAK | | | | | | |
| TRANSIT MOOE SHARE: | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| AUTO | 0.112 | 0.112 | 0.112 | 0.112 | 0.112 | 0.112 |
| CARPOOL | 0.094 | 0.094 | 0.095 | 0.096 | 0.097 | 0.097 |
| FIXED-ROUTE BUS | 0.085 | 0.043 | 0.028 | 0.021 | 0.018 | 0.018 |
| FLEXIBLE-ROUTE SERVICE | 0.089 | 0.075 | 0.068 | 0.064 | 0.062 | 0.060 |
| PRIVATE AUTO TRANSIT | 0.112 | 0.112 | 0.112 | 0.112 | 0.112 | 0.112 |
| FUEL CONSUMPTION PER TRIP DURING PM-PEAK | | | | | | |
| TRANSIT MOOE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| AUTO | 0.112 | 0.112 | 0.112 | 0.112 | 0.112 | 0.112 |
| CARPOOL | 0.060 | 0.060 | 0.061 | 0.061 | 0.062 | 0.063 |
| FIXEO-ROUTE BUS | 0.029 | 0.029 | 0.029 | 0.029 | 0.029 | 0.029 |
| FLEXIBLE-ROUTE SERVICE | 0.084 | 0.084 | 0.084 | 0.084 | 0.084 | 0.084 |
| PRIVATE AUTO TRANSIT | 0.112 | 0.112 | 0.112 | 0.112 | 0.112 | 0.112 |

EXAMPLE 1 -- RING/CORRIDOR DEFINITION

FEEDER UNIFORM SERVICE ANALYSIS OF RZONR2C1 BI-DIRECTIONAL

| | | | | | | |
|---|---|---|---|---|---|---|
| FLEET SIZE NEEDED DURING AM-PEAK TRANSIT MODE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-ROUTE BUS | 5.0 | 10.0 | 15.1 | 20.1 | 25.1 | 30.1 |
| FLEXIBLE-ROUTE SERVICE | 20.6 | 40.1 | 59.6 | 79.2 | 98.8 | 118.4 |
| FLEET SIZE NEEDED DURING OFF-PEAK TRANSIT MODE SHARE: | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| FIXED-ROUTE BUS | 1.3 | 1.5 | 1.7 | 1.8 | 1.9 | 2.3 |
| FLEXIBLE-ROUTE SERVICE | 2.5 | 4.2 | 5.7 | 7.1 | 8.4 | 9.7 |
| FLEET SIZE NEEDED DURING PM-PEAK TRANSIT MODE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-ROUTE BUS | 5.4 | 10.8 | 16.2 | 21.6 | 27.0 | 32.4 |
| FLEXIBLE-ROUTE SERVICE | 21.4 | 42.4 | 63.5 | 84.6 | 105.6 | 126.7 |

FEEDER UNIFORM SERVICE ANALYSIS OF RZONR2C1 INBOUND

| | | | | | | |
|---|---|---|---|---|---|---|
| AVERAGE HEADWAY DURING AM-PEAK TRANSIT MODE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-ROUTE BUS | 32.6 | 23.1 | 18.8 | 16.3 | 14.6 | 13.3 |
| FLEXIBLE-ROUTE SERVICE | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 |
| AVERAGE HEADWAY DURING OFF-PEAK TRANSIT MODE SHARE: | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| FIXED-ROUTE BUS | 60.0 | 60.0 | 60.0 | 60.0 | 58.3 | 53.2 |
| FLEXIBLE-ROUTE SERVICE | 46.4 | 39.1 | 35.6 | 33.4 | 31.6 | 30.6 |
| AVERAGE HEADWAY DURING PM-PEAK TRANSIT MODE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-ROUTE BUS | 31.4 | 22.2 | 18.2 | 15.7 | 14.1 | 12.8 |
| FLEXIBLE-ROUTE SERVICE | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 |

FEEDER UNIFORM SERVICE ANALYSIS OF RZONR2C1 BI-DIRECTIONAL

| | | | | | | |
|---|---|---|---|---|---|---|
| AVERAGE VEHICLE LOADING DURING AM-PEAK | | | | | | |
| TRANSIT MODE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-ROUTE BUS | 20.2 | 20.2 | 20.2 | 20.2 | 20.2 | 20.2 |
| FLEXIBLE-ROUTE SERVICE | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 | 3.1 |
| AVERAGE VEHICLE LOADING DURING OFF-PEAK | | | | | | |
| TRANSIT MODE SHARE: | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| FIXED-ROUTE BUS | 5.1 | 11.1 | 16.9 | 22.5 | 26.5 | 26.5 |
| FLEXIBLE-ROUTE SERVICE | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 | 5.0 |
| AVERAGE VEHICLE LOADING DURING PM-PEAK | | | | | | |
| TRANSIT MODE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-ROUTE BUS | 20.2 | 20.2 | 20.2 | 20.2 | 20.2 | 20.2 |
| FLEXIBLE-ROUTE SERVICE | 3.1 | 3.1 | 3.1 | 3.1 | 3.0 | 3.0 |

FEEDER UNIFORM SERVICE ANALYSIS OF RZONR2C1 BI-DIRECTIONAL

| | | | | | | |
|---|---|---|---|---|---|---|
| VEHICLE-MILES (PER HOUR) DURING AM-PEAK TRANSIT MODE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-ROUTE BUS | 77. | 153. | 230. | 306. | 383. | 460. |
| FLEXIBLE-ROUTE SERVICE | 387. | 768. | 1150. | 1533. | 1916. | 2299. |
| VEHICLE-MILES (PER HOUR) DURING OFF-PEAK TRANSIT MODE SHARE: | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| FIXED-ROUTE BUS | 23. | 23. | 23. | 23. | 24. | 29. |
| FLEXIBLE-ROUTE SERVICE | 41. | 68. | 94. | 118. | 142. | 165. |
| VEHICLE-MILES (PER HOUR) DURING PM-PEAK TRANSIT MODE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-ROUTE BUS | 82. | 165. | 247. | 329. | 412. | 494. |
| FLEXIBLE-ROUTE SERVICE | 412. | 824. | 1235. | 1647. | 2059. | 2470. |

FEEDER UNIFORM SERVICE ANALYSIS OF RZONR2C1    BI-OIRECTIONAL

| | | | | | | |
|---|---|---|---|---|---|---|
| PICKUPS (PER HOUR) OURING AM-PEAK TRANSIT MOOE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| AUTO | 9192. | 8708. | 8225. | 7741. | 7257. | 6773. |
| CARPOOL | 484. | 458. | 433. | 407. | 382. | 356. |
| FIXEO-ROUTE BUS | 509. | 1019. | 1528. | 2037. | 2546. | 3056. |
| FLEXIBLE-ROUTE SERVICE | 509. | 1019. | 1528. | 2037. | 2546. | 3056. |
| PRIVATE AUTO TRANSIT | 509. | 509. | 509. | 509. | 509. | 509. |
| PICKUPS (PER HOUR) OURING OFF-PEAK TRANSIT MOOE SHARE: | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| AUTO | 1887. | 1838. | 1790. | 1742. | 1693. | 1645. |
| CARPOOL | 99. | 97. | 94. | 92. | 89. | 87. |
| FIXEO-ROUTE BUS | 51. | 102. | 153. | 204. | 255. | 306. |
| FLEXIBLE-ROUTE SERVICE | 51. | 102. | 153. | 204. | 255. | 306. |
| PRIVATE AUTO TRANSIT | 70. | 70. | 70. | 70. | 70. | 70. |
| PICKUPS (PER HOUR) DURING PM-PEAK TRANSIT MOOE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| AUTO | 9882. | 9362. | 8842. | 8321. | 7801. | 7281. |
| CARPOOL | 520. | 493. | 465. | 438. | 411. | 383. |
| FIXEO-ROUTE BUS | 547. | 1095. | 1642. | 2190. | 2737. | 3285. |
| FLEXIBLE-ROUTE SERVICE | 547. | 1095. | 1642. | 2190. | 2737. | 3285. |
| PRIVATE AUTO TRANSIT | 1095. | 1095. | 1095. | 1095. | 1095. | 1095. |

```
 .   .   .   .   .   .   .   .   .   .                21.
END

        O ERRORS FOUND
```

EXAMPLE 2

Job Purpose

To illustrate the definition of arbitrary and composite networks:

1. Define an arbitrary two-zone one-link network;

2. Allow one of the arbitrarily defined zones to retain the default zonal demand parameters while changing those of the other;

3. Define an urban two-ring, three-corridor network; Add an extra zone to a selected node so that it has three zones attached instead of the usual two;

4. Specify zonal demand parameter for the extra zone;

5. Create a missing (non-existent) zone by setting its population and employment to zero (no trips produced or attracted by this zone);

6. Print the composite network;

7. Perform a CBD analysis on the extra zone; and

8. Perform a LINKER analysis on the link connecting two selected nodes.

Input Data

```
                                   F I E L D
Keyword <--1---><--2---><--3---><--4---><--5---><--6---><--7---><--8--->

TITLE   EXAMPLE 2 -- ARBITRARY AND COMPOSITE NETWORKS
NULLNET
ONEZONE RZONR2C1NODER2C1            16.0     1.0NON-CBD
ONEZONE ZONECNTRNODECNTR            20.0        NON-CBD
ONELINK RHWYR2C1NODECNTRNODER2C1LENGTH       5.0        NORAIL
PRINTNET
ONEZDP  RZONR2C1                   100.0    50.0    20.0    10.0    20.0
URBAN          2       3
ONEZONE NEWZONE NODER2C1             1.5
COMNET
ONEZDP  NEWZONE                    100.0    50.0    30.0    20.0    20.0
ONEZDP  RZONR2C2                     0.0     0.0
PRINTNET
CBD     NEWZONE
LINKER  NODER2C1NODECNTR
END
```

To indicate that an arbitrary network is to be defined, the NULLNET card must be issued and must precede all urban structure specifications for the arbitrary network. Following the NULLNET card, zone and link characteristics can be specified using the ONEZONE and ONELINK cards.

First, a new zone called RZONR2C1 is defined as attached to a new mode called NODER2C1. This zone is 16 square miles in area, has a parking charge of $1.00 per vehicle trip, and is of non-CBD type. A second new zone called ZONECNTR is defined. It is attached to a new node called NODECNTR, has an area of 20 square miles, has the default parking charge, and is of non-CBD type. If zone type and parking charges are not specified, the new zone will default to a non-CBD zone with no parking charges. Zone size must be specified for a new zone. Connecting NODER2C1 and NODECNTR is a new link, RHWYR2C1; it is five miles in length and has fixed-route bus but no rail service. Zones and links not belonging to the ring/corridor structure can only be defined and modified through the ONEZONE and ONELINK cards. The network is printed when the PRINTNET card is encountered.

The zones in the arbitrary network will, by default, be assigned zonal demand parameters corresponding to the defaults for Ring 3 of the ring/corridor structure. To override this default assignment, use the ONEZDP card. In this example, zone ZONECNTR will have the defaults and RZONR2C1 will have the following user-specified demand parameters: a population density of 100 persons per square mile, an employment density of 50 persons per square mile, and trip lengths of 20 minutes, 10 minutes, and 20 minutes respectively for commute trips, non-commute home-based trips and work-to-work trips.

The URBAN card signifies to SMART that the arbitrary network is no longer in effect; its place is taken by a two-ring, three-corridor structure. In addition, a new zone called NEWZONE is attached to this structure via node NODER2C1 (a default ring/corridor node name). Its area is 1.5 square miles. It defaults to non-CBD type with no parking charge. SMART then connects this with the rest of the network as requested by the COMNET card, to give a composite network. Note that if COMNET is not specified, the extra zone will not get the proper linkage to the ring/corridor structure. Demand parameters must be specified for the new zone, since no defaults are calculated. In this case, population density is set at 100 persons per square mile, employment density is set at 50 persons per square mile, and trips lengths are 30, 20, and 20 minutes respectively for the three different trip types.

For a realistic representation of the particular urban region being modelled, zone RZONR2C2 must be omitted from the network. To do this, the zone's population and employment densities are each set to zero. No trips will originate or terminate in this zone; thus, in effect, the zone is missing from the network. The composite network is printed when SMART encounters the PRINTNET card.

A CBD analysis is performed on NEWZONE and a LINKER analysis between nodes NODER2C1 and NODECNTR. Although NEWZONE is of non-CBD type, SMART will permit a CBD analysis of it after printing a warning message. Finally, the job terminates when it reads an END card.

EXAMPLE 3

Job Purpose

To illustrate archiving of networks and demands:

1. Run a job that

   a) Creates a two-ring, two-corridor urban network,

   b) Generates default demand volumes,

   c) Writes the network and demand data to an archive file for later restoration and use, and

   d) Prints the demand volumes.

2. Run a second job that dispenses with network and demand generation by

   a) Reading in the previously created network and demand data from the archive file, and

   b) Prints the demand volumes.

First Job Input Data

```
                                   F I E L D
Keyword <--1---><--2---><--3---><--4---><--5---><--6---><--7---><--8--->

TITLE   EXAMPLE 3 -- ARCHIVING
SUBTITLEJOB A -- USE OF PUTNET
URBAN          2       2
PUTNET          DEMAND
PRINTDEM
END
```

Second Job Input Data

```
                                   F I E L D
Keyword <--1---><--2---><--3---><--4---><--5---><--6---><--7---><--8--->
TITLE   EXAMPLE 3 -- ARCHIVING
SUBTITLEJOB B -- USE OF GETNET
GETNET          DEMAND
PRINTDEM
PRINTNET
END
```

When the first card (the URBAN card) is encountered, SMART invokes its default urban structure generation routines to create a two-ring, two-corridor network. The PUTNET card requests that the network and demands be archived (saved for a later job). The data will be written to the default FORTRAN unit for archiving, unit 10. SMART invokes the default demand generation routines to compute the required demand data. It then writes the network and demand data onto the archive file. The PRINTDEM card prints the demands, and the job ends with an END card.

The next job is executed with the second deck. The GETNET card instructs SMART to read in both network and demand data from an external file. This file is identified by FORTRAN unit number 9, the default for GETNET. Note that any demand to be read in must have been previously saved. Demands are written when the PRINTDEM card is encountered and the network is printed when the PRINTNET card is reached. The job is terminated by an END card. The output for this example is shown in Exhibits C.2 and C.3

Exhibit C.2. EXAMPLE 3 OUTPUT -- ARCHIVING -- PUTNET

```
SMART MODEL - SYSTAN, INC.                          12/16/81                                   PAGE   1
          .         .         .         .         .         .         .         .         .
TITLE   EXAMPLE 3 -- ARCHIVING                                                   12.
          .         .         .         .         .         .         .         .         .
SUBTITLEJOB A -- USE OF PUTNET                                                   13.
          .         .         .         .         .         .         .         .         .
URBAN             2         2                                                    14.
          .         .         .         .         .         .         .         .         .
PUTNET             DEMAND                                                        15.
```

```
SMART MODEL - SYSTAN, INC.
EXAMPLE 3 -- ARCHIVING
JOB A -- USE OF PUTNET

  ZONE      POPULATION   EMPLOYMENT
ZONECNTR         3863.       85490.
LZONR2C1        84878.       72432.
RZONR2C1        84878.       72432.
LZONR2C2        84878.       72432.
RZONR2C2        84878.       72432.

TOTAL          343376.      375220.

TRIP TYPE:                     1           2           3     OVERALL
AVERAGE TRIP LENGTH:          8.4         8.4         8.0         8.4 MINUTES
         .         .         .         .         .         .         .         .
                                                                              16.
PRINTDEM
```

| ZONE | RESIDENTIAL TRIP ORIGINS PER MINUTE | | | RESIDENTIAL TRIP DESTINATIONS PER MINUTE | | |
|---|---|---|---|---|---|---|
| | AM-PEAK | OFF-PEAK | PM-PEAK | AM-PEAK | OFF-PEAK | PM-PEAK |
| ZONECNTR | 8.585 | 1.073 | 0.0 | 0.0 | 0.644 | 9.229 |
| LZONR2C1 | 188.618 | 23.577 | 0.0 | 0.0 | 14.146 | 202.764 |
| RZONR2C1 | 188.618 | 23.577 | 0.0 | 0.0 | 14.146 | 202.764 |
| LZONR2C2 | 188.618 | 23.577 | 0.0 | 0.0 | 14.146 | 202.764 |
| RZONR2C2 | 188.618 | 23.577 | 0.0 | 0.0 | 14.146 | 202.764 |

EXAMPLE 3 -- ARCHIVING
JOB A -- USE OF PUTNET

| ZONE | ACTIVITY CENTER TRIP ORIGINS PER MINUTE | | | ACTIVITY CENTER TRIP OESTINATIONS PER MINUTE | | |
|---|---|---|---|---|---|---|
| | AM-PEAK | OFF-PEAK | PM-PEAK | AM-PEAK | OFF-PEAK | PM-PEAK |
| ZONECNTR | 4.229 | 29.956 | 191.122 | 178.083 | 38.649 | 4.229 |
| LZONR2C1 | 2.618 | 12.604 | 33.203 | 31.070 | 14.027 | 2.618 |
| RZONR2C1 | 2.618 | 12.604 | 33.203 | 31.070 | 14.027 | 2.618 |
| LZONR2C2 | 2.618 | 12.604 | 33.203 | 31.070 | 14.027 | 2.618 |
| RZONR2C2 | 2.618 | 12.604 | 33.203 | 31.070 | 14.027 | 2.618 |

EXAMPLE 3 -- ARCHIVING
JOB A -- USE OF PUTNET

O/D MATRIX PER MINUTE FOR AM-PEAK

| TO: FROM | NODECNTR | NODER2C1 | NODER2C2 |
|---|---|---|---|
| NODECNTR | 6.279 | 3.827 | 3.827 |
| NODER2C1 | 88.482 | 260.301 | 36.201 |
| NODER2C2 | 88.482 | 36.201 | 260.301 |

O/D MATRIX PER MINUTE FOR OFF-PEAK

| TO: / FROM | NODECNTR | NODER2C1 | NODER2C2 |
|---|---|---|---|
| NODECNTR | 9.754 | 13.026 | 13.026 |
| NODER2C1 | 17.258 | 72.722 | 10.114 |
| NODER2C2 | 17.258 | 10.114 | 72.722 |

O/D MATRIX PER MINUTE FOR PM-PEAK

| TO: / FROM | NODECNTR | NODER2C1 | NODER2C2 |
|---|---|---|---|
| NODECNTR | 6.582 | 95.002 | 95.002 |
| NODER2C1 | 3.997 | 279.415 | 38.860 |
| NODER2C2 | 3.997 | 38.860 | 279.415 |

EXAMPLE 3 -- ARCHIVING
JOB A -- USE OF PUTNET

AUTO TRAVEL VOLUMES PER MINUTE (0% TRANSIT MODE SHARE)

| ON | TOWARDS | AM-PEAK | OFF-PEAK | PM-PEAK | TOWARDS | AM-PEAK | OFF-PEAK | PM-PEAK |
|---|---|---|---|---|---|---|---|---|
| RHWYR2C1 | NODECNTR | 124.684 | 27.372 | 42.857 | NODER2C1 | 40.028 | 23.139 | 133.862 |
| RHWYR2C2 | NODECNTR | 124.684 | 27.372 | 42.857 | NODER2C2 | 40.028 | 23.139 | 133.862 |
| CHWYR2C1 | NODER2C1 | 0.0 | 0.0 | 0.0 | NODER2C2 | 0.0 | 0.0 | 0.0 |
| CHWYR2C2 | NODER2C2 | 0.0 | 0.0 | 0.0 | NODER2C1 | 0.0 | 0.0 | 0.0 |

TOTAL SYSTEM DEMAND RATE: AM-PEAK 783.898 OFF-PEAK 235.993 PM-PEAK 841.124

```
END       .       .       .       .       .       .       .       .       .
                                                                           17.

        O ERRORS FOUND
```

Exhibit C.3. EXAMPLE 3 OUTPUT -- ARCHIVING -- GENET

```
SMART MODEL - SYSTAN, INC.                      12/16/81                                    PAGE    1
TITLE   EXAMPLE 3 -- ARCHIVING                              26.
SUBTITLEJOB B -- USE OF GETNET                              27.
GETNET          DEMAND                                      28.
PRINTDEM                                                    29.
```

EXAMPLE 3 -- ARCHIVING
JOB B -- USE OF GETNET

| ZONE | RESIDENTIAL TRIP ORIGINS PER MINUTE | | | RESIDENTIAL TRIP DESTINATIONS PER MINUTE | | |
|---|---|---|---|---|---|---|
| | AM-PEAK | OFF-PEAK | PM-PEAK | AM-PEAK | OFF-PEAK | PM-PEAK |
| ZONECNTR | 8.585 | 1.073 | 0.0 | 0.0 | 0.644 | 9.229 |
| LZONR2C1 | 188.618 | 23.577 | 0.0 | 0.0 | 14.146 | 202.764 |
| RZONR2C1 | 188.618 | 23.577 | 0.0 | 0.0 | 14.146 | 202.764 |
| LZONR2C2 | 188.618 | 23.577 | 0.0 | 0.0 | 14.146 | 202.764 |
| RZONR2C2 | 188.618 | 23.577 | 0.0 | 0.0 | 14.146 | 202.764 |

EXAMPLE 3 -- ARCHIVING
JOB B -- USE OF GETNET

| ZONE | ACTIVITY CENTER TRIP ORIGINS PER MINUTE | | | ACTIVITY CENTER TRIP DESTINATIONS PER MINUTE | | |
|---|---|---|---|---|---|---|
| | AM-PEAK | OFF-PEAK | PM-PEAK | AM-PEAK | OFF-PEAK | PM-PEAK |
| ZONECNTR | 4.229 | 29.956 | 191.122 | 178.083 | 38.649 | 4.229 |
| LZONR2C1 | 2.618 | 12.604 | 33.203 | 31.070 | 14.027 | 2.618 |
| RZONR2C1 | 2.618 | 12.604 | 33.203 | 31.070 | 14.027 | 2.618 |
| LZONR2C2 | 2.618 | 12.604 | 33.203 | 31.070 | 14.027 | 2.618 |
| RZONR2C2 | 2.618 | 12.604 | 33.203 | 31.070 | 14.027 | 2.618 |

EXAMPLE 3 -- ARCHIVING
JOB B -- USE OF GETNET

O/D MATRIX PER MINUTE FOR AM-PEAK

| FROM \ TO: | NOOECNTR | NOOER2C1 | NOOER2C2 |
|---|---|---|---|
| NOOECNTR | 6.279 | 3.827 | 3.827 |
| NOOER2C1 | 88.482 | 260.301 | 36.201 |
| NODER2C2 | 88.482 | 36.201 | 260.301 |

EXAMPLE 3 -- ARCHIVING
JOB B -- USE OF GETNET

O/D MATRIX PER MINUTE FOR OFF-PEAK

| TO: FROM | NODECNTR | NODER2C1 | NODER2C2 |
|---|---|---|---|
| NODECNTR | 9.754 | 13.026 | 13.026 |
| NODER2C1 | 17.258 | 72.722 | 10.114 |
| NODER2C2 | 17.258 | 10.114 | 72.722 |

EXAMPLE 3 -- ARCHIVING
JOB B -- USE OF GETNET

O/D MATRIX PER MINUTE FOR PM-PEAK

| TO: / FROM | NODECNTR | NODER2C1 | NODER2C2 |
|---|---|---|---|
| NODECNTR | 6.582 | 95.002 | 95.002 |
| NODER2C1 | 3.997 | 279.415 | 38.860 |
| NODER2C2 | 3.997 | 38.860 | 279.415 |

EXAMPLE 3 -- ARCHIVING
JOB B -- USE OF GETNET

AUTO TRAVEL VOLUMES PER MINUTE (0% TRANSIT MODE SHARE)

| ON | TOWARDS | AM-PEAK | OFF-PEAK | PM-PEAK | TOWAROS | AM-PEAK | OFF-PEAK | PM-PEAK |
|---|---|---|---|---|---|---|---|---|
| RHWYR2C1 | NOOECNTR | 124.684 | 27.372 | 42.857 | NOOER2C1 | 40.028 | 23.139 | 133.862 |
| RHWYR2C2 | NOOECNTR | 124.684 | 27.372 | 42.857 | NOOER2C2 | 40.028 | 23.139 | 133.862 |
| CHWYR2C1 | NOOER2C1 | 0.0 | 0.0 | 0.0 | NODER2C2 | 0.0 | 0.0 | 0.0 |
| CHWYR2C2 | NODER2C2 | 0.0 | 0.0 | 0.0 | NOOER2C1 | 0.0 | 0.0 | 0.0 |

TOTAL SYSTEM OEMAND RATE: AM-PEAK 783.898 OFF-PEAK 235.993 PM-PEAK 841.124

PRINTNET . . . . . . . . . 30.

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SMART MODEL - SYSTAN, INC.
EXAMPLE 3 -- ARCHIVING
JOB B -- USE OF GETNET

| LINK IDENT | FROM NODE | TO NODE | LENGTH | NO OF LANES | HIGHWAY TYPE | DIAMOND LANE? | LIGHT RAIL? | HEAVY RAIL? | AUTO SPEED | LRAIL SPEED |
|---|---|---|---|---|---|---|---|---|---|---|
| RHWYR2C1 | NODECNTR | NODER2C1 | 1.6 | 3. | FREEWAY | NO | NO | NO | 1.000 | 0.833 |
| RHWYR2C2 | NODECNTR | NODER2C2 | 1.6 | 3. | FREEWAY | NO | NO | NO | 1.000 | 0.833 |
| CHWYR2C1 | NODER2C1 | NODER2C2 | 5.0 | 2. | ARTERIAL | NO | NO | NO | 0.583 | 0.500 |
| CHWYR2C2 | NODER2C2 | NODER2C1 | 5.0 | 2. | ARTERIAL | NO | NO | NO | 0.583 | 0.500 |

EXAMPLE 3 -- ARCHIVING
JOB B -- USE OF GETNET

| ZONE-IOENT | ATTACHED TO | SIZE | TYPE |
|---|---|---|---|
| ZONECNTR | NOOECNTR | 1.1 | CBO |
| LZONR2C1 | NOOER2C1 | 10.1 | NON-CBO |
| RZONR2C1 | NOOER2C1 | 10.1 | NON-CBO |
| LZONR2C2 | NOOER2C2 | 10.1 | NON-CBO |
| RZONR2C2 | NOOER2C2 | 10.1 | NON-CBO |

NETWORK CONTAINS 4 LINKS, 3 NOOES, AND 5 ZONES

```
      .         .         .         .         .         .         .         .         .         31.
END

        0 ERRORS FOUND
```

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EXAMPLE 4

Job Purpose

To illustrate the modification of zonal demand parameters and traffic flows:

1. Define a two-ring, three-corridor network;

2. Add a zone to this network, thereby constructing a composite network;

3. Define and modify demand parameters for selected zones;

4. Modify origin/destination flows, traffic flows, number of pickups and dropoffs on selected links;

5. Print demand matrices; and

6. Perform a regionwide analysis, ignoring the extra zone added to the ring/corridor network.

Input Data

```
                                   F I E L D
Keyword <--1---><--2---><--3---><--4---><--5---><--6---><--7---><--8--->

TITLE   EXAMPLE 4
SUBTITLEMODIFY ZONAL DEMAND PARAMETERS AND TRAFFIC FLOWS
URBAN          2       3
ONEZONE Z01     NODECNTR             2.0     1.0IGNORE
COMNET
ZDPSET  LEFT                       100.0    50.0    30.0    15.0    15.0
ONEZDP  Z01                        150.0   100.0    20.0    10.0    10.0
ODM     NODECNTRNODER2C2                    50.0    20.0  1000.0    10.0
TRAFFIC RHWYR2C2NODER2C2FRBUS                       20.0
TRAFFIC RHWYR2C2NODER2C2AUTO                       200.0
PICKUPS RHWYR2C2NODER2C2FRBUS                1.0     0.5     1.0
DROPOFFSCHWYR2C2NODER2C2FRBUS                1.0     0.5     1.0
PRINTDEM
REGION
END
```

An urban network consisting of two rings and three corridors is constructed by the URBAN card. A new zone called Z01, attached to NODECNTR (default node name for ring/corridor structure), is defined. It has an area of two square miles, a parking charge of $1.00 per vehicle trip, and is to be omitted (IGNORE option in FIELD 6) in regionwide analysis. The proper node-link indices are set up by the COMNET card to create a composite network.

Zonal demand parameters are defined for the left zones of all rings and corridors. To set parameters for any specific zone, LEFT or RIGHT, the ring number, and the corridor number must be specified in FIELDs 1, 2, and 3 of the ZDPSET card. The population density is defined as 100 persons per square mile, the employment density as 50 persons per square mile, and trip lengths as 30 minutes, 15 minutes and 15 minutes respectively for commute trips, non-commute home-based trips, and work/work trips. The ZDPSET card works only for ring/corridor zones, and thus cannot affect the new zone Z01 that was defined separately. The parameter of this zone can only be set by a ONEZDP card, which must be used since no defaults are assigned to such "extra" zones. The population density of Z01 is set to 150 persons per square mile, the employment density to 100 persons per square mile, and trip lengths are 20 minutes, 10 minutes and 10 minutes respectively.

Origin-destination and link flows are calculated by the default demand generation procedure in SMART, but can be changed by the user through the ODM, TRAFFIC, PICKUPS and DROPOFFS cards. When these cards are used, traffic flows for the specified links and nodes will be changed accordingly, but the rest of the network will not be affected. Hence, flows may not be consistent throughout the network. On the ODM card, the first node indicates the origin, the second the destination. In this example, 50, 20, 50 and 10 trips per minute originate in node NODECNTR and terminate in node NODER2C2 in the morning peak, off-peak, afternoon peak, and off-hours respectively. The first TRAFFIC card identifies the link of interest as RHWYR2C2 (a default link name in the ring/corridor structure) the direction of flow as toward NODER2C2, the mode of interest as fixed-route bus, and the off-peak traffic flow as 20 person-trips per minute. Flows in other time periods would be defined in FIELDs 5, 7, and 8. If any of FIELDs 5 through 8 are blank, the time period corrsponding to that field will retain its current flow rate, here the rate generated by default. Automobile traffic flow is set on the next card. The PICKUPS card specifies that passengers on link RHWYR2C2 are picked up at node NODER2C2 by fixed-route buses at the rate of one person per minute in the morning peak, 0.5 persons per minute in the off-peak, and one person per minute in the afternoon peak. FIELD 8 on this card must be blank, since transit does not operate in the off-peak period; hence, no pickups are made in that time period. The next card specifies the unloading rates for fixed-route buses on link CHWYR2C2 at NODER2C2. on the preceding card. Any blanks in FIELDs 5 through 7 will cause the time period corresponding to that field to retain its current (default) demand value. Note that the nodes listed with the TRAFFIC, ODM, PICKUPS and DROPOFFS keywords must be endpoints of the links specified on the cards.

Demand matrices are printed when the PRINTDEM keyword is encountered. Finally, a regionwide analysis is performed (ignoring zone Z01). Transport systems operating within Z01 are not modeled. Note that, since demands have been modified by the user, demand volumes may not be consistent in regionwide analysis.

The output for this example is shown in Exhibit C.4.

Exhibit C.4. EXAMPLE 4 OUTPUT -- MODIFY DEMAND PARAMETERS AND TRAFFIC FLOWS

```
SMART MODEL - SYSTAN, INC.                            01/12/82                                   PAGE    1
TITLE    EXAMPLE 4                                                            10.
SUBTITLEMODIFY ZONAL DEMANO PARAMETERS AND TRAFFIC FLOWS                      11.
URBAN           2       3                                                     12.
ONEZONE Z01      NODECNTR          2.0      1.0IGNORE                         13.
COMNET                                                                        14.
ZDPSET   LEFT                    100.0    50.0    30.0    15.0    15.0        15.
ONEZDP   Z01                     150.0   100.0    20.0    10.0    10.0        16.
ODM      NODECNTRNODER2C2                 50.0    20.0  1000.0    10.0        17.
```

```
EXAMPLE 4
MODIFY ZONAL DEMAND PARAMETERS AND TRAFFIC FLOWS

  ZONE      POPULATION   EMPLOYMENT
ZONECNTR          113.          57.
LZONR2C1          670.         335.
RZONR2C1        56585.       48288.
LZONR2C2          670.         335.
RZONR2C2        56585.       48288.
LZONR2C3          670.         335.
RZONR2C3        56585.       48288.
ZO1               300.         200.

TOTAL          172180.      146127.

TRIP TYPE:                     1          2          3     OVERALL
AVERAGE TRIP LENGTH:         7.4        7.3        7.3         7.4 MINUTES
         .       .       .       .       .       .       .       .       .
TRAFFIC RHWYR2C2NODER2C2FRBUS                     20.0                 18.
         .       .       .       .       .       .       .       .       .
TRAFFIC RHWYR2C2NODER2C2AUTO                     200.0                 19.
         .       .       .       .       .       .       .       .       .
PICKUPS RHWYR2C2NODER2C2FRBUS              1.0     0.5      1.0        20.
         .       .       .       .       .       .       .       .       .
DROPOFFSCHWYR2C2NODER2C2FRBUS              1.0     0.5      1.0        21.
         .       .       .       .       .       .       .       .       .
PRINTDEM                                                               22.
```

EXAMPLE 4
MODIFY ZONAL DEMAND PARAMETERS AND TRAFFIC FLOWS

| ZONE | RESIDENTIAL TRIP ORIGINS PER MINUTE | | | RESIDENTIAL TRIP DESTINATIONS PER MINUTE | | |
|---|---|---|---|---|---|---|
| | AM-PEAK | OFF-PEAK | PM-PEAK | AM-PEAK | OFF-PEAK | PM-PEAK |
| ZONECNTR | 0.251 | 0.031 | 0.0 | 0.0 | 0.019 | 0.270 |
| LZONR2C1 | 1.489 | 0.186 | 0.0 | 0.0 | 0.112 | 1.601 |
| RZONR2C1 | 125.745 | 15.718 | 0.0 | 0.0 | 9.431 | 135.176 |
| LZONR2C2 | 1.489 | 0.186 | 0.0 | 0.0 | 0.112 | 1.601 |
| RZONR2C2 | 125.745 | 15.718 | 0.0 | 0.0 | 9.431 | 135.176 |
| LZONR2C3 | 1.489 | 0.186 | 0.0 | 0.0 | 0.112 | 1.601 |
| RZONR2C3 | 125.745 | 15.718 | 0.0 | 0.0 | 9.431 | 135.176 |
| ZO1 | 0.667 | 0.083 | 0.0 | 0.0 | 0.050 | 0.717 |

EXAMPLE 4

MODIFY ZONAL DEMAND PARAMETERS AND TRAFFIC FLOWS

| ZONE | ACTIVITY CENTER TRIP ORIGINS PER MINUTE | | | ACTIVITY CENTER TRIP DESTINATIONS PER MINUTE | | |
|---|---|---|---|---|---|---|
| | AM-PEAK | OFF-PEAK | PM-PEAK | AM-PEAK | OFF-PEAK | PM-PEAK |
| ZONECNTR | 0.981 | 10.854 | 100.325 | 93.397 | 15.473 | 0.981 |
| LZONR2C1 | 0.058 | 0.574 | 4.963 | 4.621 | 0.802 | 0.058 |
| RZONR2C1 | 1.496 | 7.082 | 17.341 | 16.242 | 7.815 | 1.496 |
| LZONR2C2 | 0.058 | 0.574 | 4.963 | 4.621 | 0.802 | 0.058 |
| RZONR2C2 | 1.496 | 7.082 | 17.341 | 16.242 | 7.815 | 1.496 |
| LZONR2C3 | 0.058 | 0.574 | 4.963 | 4.621 | 0.802 | 0.058 |
| RZONR2C3 | 1.496 | 7.082 | 17.341 | 16.242 | 7.815 | 1.496 |
| Z01 | 0.091 | 0.969 | 8.756 | 8.151 | 1.373 | 0.091 |

EXAMPLE 4
MODIFY ZONAL OEMANO PARAMETERS AND TRAFFIC FLOWS

O/O MATRIX PER MINUTE FOR AM-PEAK

| FROM \ TO: | NOOECNTR | NOOER2C1 | NODER2C2 | NODER2C3 |
|---|---|---|---|---|
| NOOECNTR | 0.561 | 0.477 | 50.000 | 0.477 |
| NOOER2C1 | 33.761 | 80.912 | 10.000 | 7.455 |
| NOOER2C2 | 33.761 | 7.455 | 80.912 | 7.455 |
| NOOER2C3 | 33.761 | 7.455 | 7.455 | 80.912 |

EXAMPLE 4

MODIFY ZONAL DEMAND PARAMETERS AND TRAFFIC FLOWS

D/D MATRIX PER MINUTE FOR OFF-PEAK

| TO: / FROM | NODECNTR | NODER2C1 | NODER2C2 | NODER2C3 |
|---|---|---|---|---|
| NODECNTR | 0.158 | 3.939 | 20.000 | 3.939 |
| NODER2C1 | 5.603 | 22.598 | 2.070 | 2.070 |
| NODER2C2 | 5.603 | 2.070 | 22.598 | 2.070 |
| NODER2C3 | 5.603 | 2.070 | 2.070 | 22.598 |

EXAMPLE 4
MODIFY ZONAL DEMAND PARAMETERS AND TRAFFIC FLOWS

O/D MATRIX PER MINUTE FOR PM-PEAK

| TO: / FROM | NODECNTR | NODER2C1 | NODER2C2 | NODER2C3 |
|---|---|---|---|---|
| NODECNTR | 0.606 | 36.265 | 1000.000 | 36.265 |
| NODER2C1 | 0.485 | 86.859 | 8.000 | 8.000 |
| NODER2C2 | 0.485 | 8.000 | 86.859 | 8.000 |
| NODER2C3 | 0.485 | 8.000 | 8.000 | 86.859 |

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EXAMPLE 4

MODIFY ZONAL DEMAND PARAMETERS AND TRAFFIC FLOWS

AUTO TRAVEL VOLUMES PER MINUTE (0% TRANSIT MODE SHARE)

| ON | TOWARDS | AM-PEAK | OFF-PEAK | PM-PEAK | TOWARDS | AM-PEAK | OFF-PEAK | PM-PEAK |
|---|---|---|---|---|---|---|---|---|
| RHWYR2C1 | NODECNTR | 48.670 | 9.743 | 16.485 | NODER2C1 | 15.387 | 8.079 | 52.265 |
| RHWYR2C2 | NODECNTR | 48.670 | 9.743 | 16.485 | NODER2C2 | 15.387 | 200.000 | 52.265 |
| RHWYR2C3 | NODECNTR | 48.670 | 9.743 | 16.485 | NODER2C3 | 15.387 | 8.079 | 52.265 |
| CHWYR2C1 | NODER2C1 | 0.0 | 0.0 | 0.0 | NODER2C2 | 0.0 | 0.0 | 0.0 |
| CHWYR2C2 | NODER2C2 | 0.0 | 0.0 | 0.0 | NODER2C3 | 0.0 | 0.0 | 0.0 |
| CHWYR2C3 | NODER2C3 | 0.0 | 0.0 | 0.0 | NODER2C1 | 0.0 | 0.0 | 0.0 |

TOTAL SYSTEM DEMAND RATE: AM-PEAK 390.504 OFF-PEAK 108.927 PM-PEAK 419.175

```
EXAMPLE 4
MODIFY ZONAL DEMAND PARAMETERS AND TRAFFIC FLOWS
      .         .         .         .         .         .         .         .         .
REGION                                                                              23.
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C2 IS  1.3
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C2 IS  1.3
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C2 IS  1.2
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C2 IS  1.2
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C2 IS  1.2
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C2 IS  1.1
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C2 IS  1.3
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C2 IS  1.3
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C2 IS  1.2
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C2 IS  1.2
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C2 IS  1.2
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C2 IS  1.1
```

EXAMPLE 4
MOOIFY ZONAL OEMANO PARAMETERS ANO TRAFFIC FLOWS

REGIONWIOE ANALYSIS

LENGTH OF AM-PEAK IS 180. MINUTES
LENGTH OF OFF-PEAK IS 360. MINUTES
LENGTH OF PM-PEAK IS 180. MINUTES

CARPOOL FRACTION IS 0.050, CARPOOL TIME PARAMETER IS 3.000

WALKING SPEEO IS 0.050 MILES PER MINUTE

CBO AUTO RIDERS WALK 0.200 MILES, CBO CARPOOL RIDERS WALK 0.200 MILES

OUMPER AUTO RIOERS WALK 0.100 MILES, CARPOOL RIOERS 0.040 MILES, BUS RIOERS 0.250 MILES
OUMPER TRANSIT FRACTION IS 1.000

TRANSIT OEMANO RATE PER MINUTE (100% TRANSIT MOOE SHARE)

| | OEMANO LOAOING | | | BOAROING RATE | | | OISEMBARKING RATE | | |
|---|---|---|---|---|---|---|---|---|---|
| | AM-PEAK | OFF-PEAK | PM-PEAK | AM-PEAK | OFF-PEAK | PM-PEAK | AM-PEAK | OFF-PEAK | PM-PEAK |
| ON RHWYR2C1 VIA FRBUS | | | | | | | | | |
| FROM NOOER2C1 TO NOOECNTR | 51.216 | 9.743 | 16.485 | 51.216 | 9.743 | 16.485 | 33.761 | 5.603 | 0.485 |
| FROM NOOECNTR TO NOOER2C1 | 15.387 | 8.079 | 52.265 | 0.477 | 3.939 | 36.265 | 15.387 | 8.079 | 52.265 |
| ON RHWYR2C2 VIA FRBUS | | | | | | | | | |
| FROM NOOER2C2 TO NOOECNTR | 48.670 | 9.743 | 16.485 | 1.000 | 0.500 | 1.000 | 33.761 | 5.603 | 0.485 |
| FROM NOOECNTR TO NOOER2C2 | 67.455 | 20.000 | 1016.000 | 50.000 | 20.000 | 1000.000 | 67.455 | 24.140 | 1016.000 |
| ON RHWYR2C3 VIA FRBUS | | | | | | | | | |
| FROM NOOER2C3 TO NOOECNTR | 48.670 | 9.743 | 16.485 | 48.670 | 9.743 | 16.485 | 33.761 | 5.603 | 0.485 |
| FROM NOOECNTR TO NOOER2C3 | 15.387 | 8.079 | 52.265 | 0.477 | 3.939 | 36.265 | 15.387 | 8.079 | 52.265 |

| MOOE IOENTIFIER | MOOE TYPE | | MOOE LABEL | FLEXTYPE AM-PEAK | FLEXTYPE OFF-PEAK | FLEXTYPE PM-PEAK | TRANSFER |
|---|---|---|---|---|---|---|---|
| FRBUS | FRBUS | (CBO) | FIXEO-ROUTE BUS | | | | RANOOM |
| FRBUS | FRBUS | (FEEOER) | FIXEO-ROUTE BUS | | | | RANOOM |
| FRBUS | FRBUS | (OUMPER) | FIXEO-ROUTE BUS | | | | RANOOM |
| AUTO | AUTO | (FEEOER) | AUTO | | | | RANOOM |
| CARPOOL | CARPOOL | (FEEOER) | CARPOOL | | | | RANOOM |
| AUTO | AUTO | (OUMPER) | AUTO | | | | RANOOM |
| CARPOOL | CARPOOL | (OUMPER) | CARPOOL | | | | RANOOM |
| AUTO | AUTO | (CBO) | AUTO | | | | RANOOM |
| CARPOOL | CARPOOL | (CBO) | CARPOOL | | | | RANOOM |
| FRBUS | FRBUS | (LINKER) | FIXEO-ROUTE BUS | | | | RANOOM |

EXAMPLE 4
MODIFY ZONAL DEMAND PARAMETERS AND TRAFFIC FLOWS

REGIONWIDE ANALYSIS

| MODE IDENTIFIER | $ | $/V | $/VH | $/VM | $/RM | SPEED | MIN/STOP | MIN/PASS | MI/GAL | PASS/VEH |
|---|---|---|---|---|---|---|---|---|---|---|
| FRBUS | 0.0 | 51.780 | 0.160 | 0.480 | 0.0 | 0.333 | 0.200 | 0.020 | 5.200 | 50.000 |
| FRBUS | 0.0 | 51.780 | 0.160 | 0.480 | 0.0 | 0.333 | 0.200 | 0.020 | 5.200 | 50.000 |
| FRBUS | 0.0 | 51.780 | 0.160 | 0.480 | 0.0 | 0.333 | 0.200 | 0.020 | 5.200 | 50.000 |
| AUTO | 0.0 | 2.040 | 0.012 | 0.090 | 0.0 | 0.333 | 0.500 | 0.0 | 15.000 | 1.200 |
| CARPOOL | 0.0 | 2.040 | 0.012 | 0.090 | 0.0 | 0.333 | 0.500 | 0.0 | 15.000 | 3.000 |
| AUTO | 0.0 | 2.040 | 0.012 | 0.090 | 0.0 | 0.333 | 0.500 | 0.0 | 15.000 | 1.200 |
| CARPOOL | 0.0 | 2.040 | 0.012 | 0.090 | 0.0 | 0.333 | 0.500 | 0.0 | 15.000 | 3.000 |
| AUTO | 0.0 | 2.040 | 0.012 | 0.090 | 0.0 | 0.333 | 0.500 | 0.0 | 15.000 | 1.200 |
| CARPOOL | 0.0 | 2.040 | 0.012 | 0.090 | 0.0 | 0.333 | 0.500 | 0.0 | 15.000 | 3.000 |
| FRBUS | 0.0 | 51.780 | 0.160 | 0.480 | 0.0 | 0.333 | 0.200 | 0.020 | 5.200 | 50.000 |
| AUTO | 0.0 | 2.040 | 0.012 | 0.090 | 0.0 | 0.333 | 0.500 | 0.0 | 15.000 | 1.200 |
| CARPOOL | 0.0 | 2.040 | 0.012 | 0.090 | 0.0 | 0.333 | 0.500 | 0.0 | 15.000 | 3.000 |

| MODE IDENTIFIER | MINHDWAY | MAXHDWAY | MAXRS | STOPS/MI | CARS/VEH | FRACWALK | AMTRAIN | OFFTRAIN | PMTRAIN |
|---|---|---|---|---|---|---|---|---|---|
| FRBUS | 0.500 | 60.000 | 1.000 | 8.000 | 2.000 | 0.200 | 1.000 | 1.000 | 1.000 |
| FRBUS | 0.500 | 60.000 | 1.000 | 8.000 | 2.000 | 0.200 | 1.000 | 1.000 | 1.000 |
| FRBUS | 0.500 | 60.000 | 1.000 | 8.000 | 2.000 | 0.200 | 1.000 | 1.000 | 1.000 |
| AUTO | 0.500 | 0.0 | 0.0 | 0.0 | 1.000 | 0.200 | 1.000 | 1.000 | 1.000 |
| CARPOOL | 0.500 | 0.0 | 0.0 | 0.0 | 1.000 | 0.200 | 1.000 | 1.000 | 1.000 |
| AUTO | 0.500 | 0.0 | 0.0 | 0.0 | 1.000 | 0.200 | 1.000 | 1.000 | 1.000 |
| CARPOOL | 0.500 | 0.0 | 0.0 | 0.0 | 1.000 | 0.200 | 1.000 | 1.000 | 1.000 |
| AUTO | 0.500 | 0.0 | 0.0 | 0.0 | 1.000 | 0.200 | 1.000 | 1.000 | 1.000 |
| CARPOOL | 0.500 | 0.0 | 0.0 | 0.0 | 1.000 | 0.200 | 1.000 | 1.000 | 1.000 |
| FRBUS | 0.500 | 60.000 | 1.000 | 8.000 | 2.000 | 0.200 | 1.000 | 1.000 | 1.000 |
| AUTO | 0.500 | 0.0 | 0.0 | 0.0 | 1.000 | 0.200 | 1.000 | 1.000 | 1.000 |
| CARPOOL | 0.500 | 0.0 | 0.0 | 0.0 | 1.000 | 0.200 | 1.000 | 1.000 | 1.000 |

EXAMPLE 4

MODIFY ZONAL DEMAND PARAMETERS AND TRAFFIC FLOWS

REGIONWIDE ANALYSIS

| COST PER TRIP DURING AM-PEAK TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
|---|---|---|---|---|---|---|---|
| FIXED-ROUTE BUS | (CBD) | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| FIXED-ROUTE BUS | (FEEDER) | 0.27 | 0.24 | 0.23 | 0.23 | 0.23 | 0.22 |
| FIXED-ROUTE BUS | (DUMPER) | 0.33 | 0.17 | 0.14 | 0.13 | 0.12 | 0.12 |
| AUTO | (FEEDER) | 0.43 | 0.43 | 0.43 | 0.43 | 0.43 | 0.43 |
| CARPOOL | (FEEDER) | 0.20 | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 |
| AUTO | (DUMPER) | 0.78 | 0.78 | 0.78 | 0.78 | 0.78 | 0.78 |
| CARPOOL | (DUMPER) | 0.36 | 0.36 | 0.36 | 0.36 | 0.36 | 0.36 |
| AUTO | (CBD) | 1.99 | 1.99 | 1.99 | 1.99 | 1.99 | 1.99 |
| CARPOOL | (CBD) | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 |
| FIXED-ROUTE BUS | (LINKER) | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 |
| AUTO | (LINKER) | 0.76 | 0.76 | 0.76 | 0.76 | 0.76 | 0.76 |
| CARPOOL | (LINKER) | 0.53 | 0.53 | 0.53 | 0.53 | 0.53 | 0.53 |
| AUTO TOTAL | (REGION) | 1.41 | 1.41 | 1.41 | 1.41 | 1.41 | 1.41 |
| CARPOOL TOTAL | (REGION) | 0.71 | 0.72 | 0.72 | 0.73 | 0.73 | 0.74 |
| TRANSIT TOTAL | (REGION) | 0.37 | 0.31 | 0.30 | 0.29 | 0.29 | 0.29 |

EXAMPLE 4
MODIFY ZONAL DEMAND PARAMETERS AND TRAFFIC FLOWS

REGIONWIDE ANALYSIS

| COST PER TRIP DURING OFF-PEAK TRANSIT MODE SHARE: | | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
|---|---|---|---|---|---|---|---|
| FIXED-ROUTE BUS | (CBD) | 0.14 | 0.08 | 0.05 | 0.04 | 0.03 | 0.03 |
| FIXED-ROUTE BUS | (FEEDER) | 0.92 | 0.48 | 0.33 | 0.25 | 0.20 | 0.18 |
| FIXED-ROUTE BUS | (DUMPER) | 0.71 | 0.36 | 0.24 | 0.18 | 0.15 | 0.13 |
| AUTO | (FEEDER) | 0.43 | 0.43 | 0.43 | 0.43 | 0.43 | 0.43 |
| CARPOOL | (FEEDER) | 0.27 | 0.27 | 0.27 | 0.27 | 0.27 | 0.27 |
| AUTO | (DUMPER) | 0.78 | 0.78 | 0.78 | 0.78 | 0.78 | 0.78 |
| CARPOOL | (DUMPER) | 0.36 | 0.36 | 0.36 | 0.36 | 0.36 | 0.36 |
| AUTO | (CBD) | 1.99 | 1.99 | 1.99 | 1.99 | 1.99 | 1.99 |
| CARPOOL | (CBD) | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 |
| FIXED-ROUTE BUS | (LINKER) | 0.14 | 0.08 | 0.06 | 0.06 | 0.06 | 0.06 |
| AUTO | (LINKER) | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 | 0.48 |
| CARPOOL | (LINKER) | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 | 0.24 |
| AUTO TOTAL | (REGION) | 2.22 | 2.22 | 2.22 | 2.22 | 2.22 | 2.22 |
| CARPOOL TOTAL | (REGION) | 1.09 | 1.09 | 1.10 | 1.10 | 1.11 | 1.12 |
| TRANSIT TOTAL | (REGION) | 1.06 | 0.55 | 0.38 | 0.30 | 0.24 | 0.22 |

EXAMPLE 4
MODIFY ZONAL DEMAND PARAMETERS AND TRAFFIC FLOWS

REGIONWIDE ANALYSIS

| COST PER TRIP DURING PM-PEAK TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
|---|---|---|---|---|---|---|---|
| FIXED-ROUTE BUS | (CBD) | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| FIXED-ROUTE BUS | (FEEDER) | 0.28 | 0.25 | 0.24 | 0.24 | 0.24 | 0.23 |
| FIXED-ROUTE BUS | (DUMPER) | 0.32 | 0.17 | 0.15 | 0.13 | 0.13 | 0.12 |
| AUTO | (FEEDER) | 0.43 | 0.43 | 0.43 | 0.43 | 0.43 | 0.43 |
| CARPOOL | (FEEDER) | 0.20 | 0.20 | 0.21 | 0.21 | 0.21 | 0.21 |
| AUTO | (DUMPER) | 0.78 | 0.78 | 0.78 | 0.78 | 0.78 | 0.78 |
| CARPOOL | (DUMPER) | 0.36 | 0.36 | 0.36 | 0.36 | 0.36 | 0.36 |
| AUTO | (CBD) | 1.99 | 1.99 | 1.99 | 1.99 | 1.99 | 1.99 |
| CARPOOL | (CBD) | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 |
| FIXED-ROUTE BUS | (LINKER) | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 |
| AUTO | (LINKER) | 0.76 | 0.76 | 0.76 | 0.76 | 0.76 | 0.76 |
| CARPOOL | (LINKER) | 0.53 | 0.53 | 0.53 | 0.53 | 0.53 | 0.53 |
| AUTO TOTAL | (REGION) | 1.41 | 1.41 | 1.41 | 1.41 | 1.41 | 1.41 |
| CARPOOL TOTAL | (REGION) | 0.71 | 0.72 | 0.72 | 0.73 | 0.73 | 0.74 |
| TRANSIT TOTAL | (REGION) | 0.66 | 0.61 | 0.60 | 0.59 | 0.59 | 0.59 |

EXAMPLE 4
MODIFY ZONAL DEMAND PARAMETERS AND TRAFFIC FLOWS

REGIONWIDE ANALYSIS

MEAN TRAVEL TIMES DURING AM-PEAK

| TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
|---|---|---|---|---|---|---|---|
| FIXED-ROUTE BUS | (CBD) | 35.0 | 26.0 | 22.1 | 19.7 | 18.1 | 16.9 |
| FIXED-ROUTE BUS | (FEEDER) | 25.2 | 21.4 | 19.8 | 18.8 | 18.1 | 17.6 |
| FIXED-ROUTE BUS | (DUMPER) | 38.4 | 38.6 | 31.4 | 27.5 | 25.2 | 23.7 |
| AUTO | (FEEDER) | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 |
| CARPOOL | (FEEDER) | 7.2 | 7.3 | 7.3 | 7.3 | 7.4 | 7.4 |
| AUTO | (DUMPER) | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 |
| CARPOOL | (DUMPER) | 7.1 | 7.1 | 7.1 | 7.1 | 7.1 | 7.1 |
| AUTO | (CBD) | 6.4 | 6.4 | 6.3 | 6.3 | 6.3 | 6.3 |
| CARPOOL | (CBD) | 6.4 | 6.4 | 6.3 | 6.3 | 6.3 | 6.3 |
| FIXED-ROUTE BUS | (LINKER) | 18.1 | 13.6 | 12.0 | 11.3 | 10.8 | 10.5 |
| AUTO | (LINKER) | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 |
| CARPOOL | (LINKER) | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 |
| AUTO TOTAL | (REGION) | 8.4 | 8.4 | 8.4 | 8.4 | 8.3 | 8.3 |
| CARPOOL TOTAL | (REGION) | 10.6 | 10.7 | 10.8 | 10.9 | 11.0 | 11.2 |
| TRANSIT TOTAL | (REGION) | 46.7 | 39.2 | 34.8 | 32.2 | 30.6 | 29.4 |

EXAMPLE 4
MODIFY ZONAL OEMANO PARAMETERS ANO TRAFFIC FLOWS

REGIONWIDE ANALYSIS

| MEAN TRAVEL TIMES OURING OFF-PEAK TRANSIT MOOE SHARE: | | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
|---|---|---|---|---|---|---|---|
| FIXEO-ROUTE BUS | (CBD) | 33.5 | 33.8 | 34.0 | 34.3 | 34.5 | 33.6 |
| FIXEO-ROUTE BUS | (FEEDER) | 35.0 | 36.7 | 37.5 | 38.0 | 38.2 | 37.1 |
| FIXEO-ROUTE BUS | (OUMPER) | 33.7 | 33.8 | 34.0 | 34.1 | 34.2 | 34.3 |
| AUTO | (FEEDER) | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 |
| CARPOOL | (FEEDER) | 9.9 | 9.9 | 10.0 | 10.0 | 10.1 | 10.2 |
| AUTO | (OUMPER) | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 |
| CARPOOL | (OUMPER) | 7.1 | 7.1 | 7.1 | 7.1 | 7.1 | 7.1 |
| AUTO | (CBO) | 6.2 | 6.2 | 6.2 | 6.2 | 6.2 | 6.2 |
| CARPOOL | (CBO) | 6.2 | 6.2 | 6.2 | 6.2 | 6.2 | 6.2 |
| FIXED-ROUTE BUS | (LINKER) | 37.6 | 36.2 | 32.9 | 28.8 | 24.8 | 22.1 |
| AUTO | (LINKER) | 3.6 | 3.6 | 3.6 | 3.6 | 3.6 | 3.6 |
| CARPOOL | (LINKER) | 3.6 | 3.6 | 3.6 | 3.6 | 3.6 | 3.6 |
| AUTO TOTAL | (REGION) | 15.5 | 15.5 | 15.5 | 15.5 | 15.5 | 15.5 |
| CARPOOL TOTAL | (REGION) | 19.6 | 19.7 | 19.8 | 19.9 | 20.1 | 20.2 |
| TRANSIT TOTAL | (REGION) | 64.3 | 64.9 | 64.2 | 62.9 | 61.3 | 59.2 |

EXAMPLE 4
MODIFY ZONAL DEMAND PARAMETERS AND TRAFFIC FLOWS

REGIONWIDE ANALYSIS

MEAN TRAVEL TIMES DURING PM-PEAK

| TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
|---|---|---|---|---|---|---|---|
| FIXED-ROUTE BUS | (CBD) | 25.0 | 19.4 | 17.0 | 15.5 | 14.5 | 13.8 |
| FIXED-ROUTE BUS | (FEEDER) | 30.3 | 24.6 | 22.1 | 20.6 | 19.6 | 18.8 |
| FIXED-ROUTE BUS | (DUMPER) | 28.7 | 28.4 | 23.8 | 21.6 | 20.2 | 19.3 |
| AUTO | (FEEDER) | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 |
| CARPOOL | (FEEDER) | 7.2 | 7.2 | 7.3 | 7.3 | 7.3 | 7.4 |
| AUTO | (DUMPER) | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 |
| CARPOOL | (DUMPER) | 7.1 | 7.1 | 7.1 | 7.1 | 7.1 | 7.1 |
| AUTO | (CBD) | 6.4 | 6.4 | 6.4 | 6.3 | 6.3 | 6.3 |
| CARPOOL | (CBD) | 6.4 | 6.4 | 6.4 | 6.3 | 6.3 | 6.3 |
| FIXED-ROUTE BUS | (LINKER) | 7.9 | 7.2 | 7.0 | 6.9 | 6.8 | 6.8 |
| AUTO | (LINKER) | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 |
| CARPOOL | (LINKER) | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 | 1.7 |
| AUTO TOTAL | (REGION) | 8.4 | 8.4 | 8.4 | 8.4 | 8.4 | 8.4 |
| CARPOOL TOTAL | (REGION) | 10.6 | 10.7 | 10.8 | 10.9 | 11.1 | 11.2 |
| TRANSIT TOTAL | (REGION) | 61.5 | 52.7 | 48.3 | 45.7 | 44.1 | 42.9 |

EXAMPLE 4
MODIFY ZONAL DEMAND PARAMETERS AND TRAFFIC FLOWS

REGIONWIDE ANALYSIS

FUEL CONSUMPTION PER TRIP DURING AM-PEAK

| TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
|---|---|---|---|---|---|---|---|
| FIXED-ROUTE BUS | (CBD) | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 |
| FIXED-ROUTE BUS | (FEEDER) | 0.033 | 0.029 | 0.027 | 0.027 | 0.026 | 0.026 |
| FIXED-ROUTE BUS | (DUMPER) | 0.044 | 0.022 | 0.018 | 0.016 | 0.015 | 0.015 |
| AUTO | (FEEDER) | 0.096 | 0.096 | 0.096 | 0.096 | 0.096 | 0.096 |
| CARPOOL | (FEEDER) | 0.057 | 0.058 | 0.058 | 0.059 | 0.060 | 0.060 |
| AUTO | (DUMPER) | 0.050 | 0.050 | 0.050 | 0.050 | 0.050 | 0.050 |
| CARPOOL | (DUMPER) | 0.049 | 0.049 | 0.049 | 0.049 | 0.049 | 0.049 |
| AUTO | (CBD) | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 |
| CARPOOL | (CBD) | 0.016 | 0.016 | 0.016 | 0.016 | 0.016 | 0.016 |
| FIXED-ROUTE BUS | (LINKER) | 0.014 | 0.014 | 0.014 | 0.014 | 0.014 | 0.014 |
| AUTO | (LINKER) | 0.089 | 0.089 | 0.089 | 0.089 | 0.089 | 0.089 |
| CARPOOL | (LINKER) | 0.036 | 0.036 | 0.036 | 0.036 | 0.036 | 0.036 |
| AUTO TOTAL | (REGION) | 0.156 | 0.156 | 0.156 | 0.156 | 0.156 | 0.156 |
| CARPOOL TOTAL | (REGION) | 0.085 | 0.086 | 0.087 | 0.089 | 0.090 | 0.091 |
| TRANSIT TOTAL | (REGION) | 0.046 | 0.038 | 0.036 | 0.035 | 0.035 | 0.034 |

EXAMPLE 4

MOOIFY ZONAL DEMANO PARAMETERS AND TRAFFIC FLOWS

REGIONWIDE ANALYSIS

FUEL CONSUMPTION PER TRIP DURING OFF-PEAK

| TRANSIT MOOE SHARE: | | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
|---|---|---|---|---|---|---|---|
| FIXEO-ROUTE BUS | (CBD) | 0.022 | 0.011 | 0.007 | 0.005 | 0.004 | 0.004 |
| FIXED-ROUTE BUS | (FEEDER) | 0.169 | 0.084 | 0.056 | 0.042 | 0.034 | 0.029 |
| FIXEO-ROUTE BUS | (OUMPER) | 0.122 | 0.061 | 0.041 | 0.031 | 0.024 | 0.020 |
| AUTO | (FEEDER) | 0.096 | 0.096 | 0.096 | 0.096 | 0.096 | 0.096 |
| CARPOOL | (FEEOER) | 0.096 | 0.097 | 0.098 | 0.099 | 0.100 | 0.101 |
| AUTO | (OUMPER) | 0.050 | 0.050 | 0.050 | 0.050 | 0.050 | 0.050 |
| CARPOOL | (OUMPER) | 0.049 | 0.049 | 0.049 | 0.049 | 0.049 | 0.049 |
| AUTO | (CBO) | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 |
| CARPOOL | (CBO) | 0.016 | 0.016 | 0.016 | 0.016 | 0.016 | 0.016 |
| FIXED-ROUTE BUS | (LINKER) | 0.026 | 0.014 | 0.011 | 0.010 | 0.010 | 0.010 |
| AUTO | (LINKER) | 0.089 | 0.089 | 0.089 | 0.089 | 0.089 | 0.089 |
| CARPOOL | (LINKER) | 0.036 | 0.036 | 0.036 | 0.036 | 0.036 | 0.036 |
| AUTO TOTAL | (REGION) | 0.300 | 0.300 | 0.300 | 0.300 | 0.300 | 0.300 |
| CARPOOL TOTAL | (REGION) | 0.173 | 0.174 | 0.176 | 0.177 | 0.178 | 0.179 |
| TRANSIT TOTAL | (REGION) | 0.190 | 0.095 | 0.064 | 0.049 | 0.040 | 0.035 |

EXAMPLE 4
MODIFY ZONAL DEMAND PARAMETERS AND TRAFFIC FLOWS

REGIONWIDE ANALYSIS

FUEL CONSUMPTION PER TRIP DURING PM-PEAK

| TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
|---|---|---|---|---|---|---|---|
| FIXED-ROUTE BUS | (CBD) | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 | 0.004 |
| FIXED-ROUTE BUS | (FEEDER) | 0.032 | 0.029 | 0.027 | 0.027 | 0.026 | 0.026 |
| FIXED-ROUTE BUS | (DUMPER) | 0.042 | 0.021 | 0.018 | 0.016 | 0.015 | 0.014 |
| AUTO | (FEEDER) | 0.096 | 0.096 | 0.096 | 0.096 | 0.096 | 0.096 |
| CARPOOL | (FEEDER) | 0.057 | 0.057 | 0.058 | 0.058 | 0.059 | 0.060 |
| AUTO | (DUMPER) | 0.050 | 0.050 | 0.050 | 0.050 | 0.050 | 0.050 |
| CARPOOL | (DUMPER) | 0.049 | 0.049 | 0.049 | 0.049 | 0.049 | 0.049 |
| AUTO | (CBD) | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 |
| CARPOOL | (CBD) | 0.016 | 0.016 | 0.016 | 0.016 | 0.016 | 0.016 |
| FIXED-ROUTE BUS | (LINKER) | 0.012 | 0.012 | 0.012 | 0.012 | 0.012 | 0.012 |
| AUTO | (LINKER) | 0.089 | 0.089 | 0.089 | 0.089 | 0.089 | 0.089 |
| CARPOOL | (LINKER) | 0.036 | 0.036 | 0.036 | 0.036 | 0.036 | 0.036 |
| AUTO TOTAL | (REGION) | 0.156 | 0.156 | 0.156 | 0.156 | 0.156 | 0.156 |
| CARPOOL TOTAL | (REGION) | 0.085 | 0.086 | 0.087 | 0.088 | 0.090 | 0.091 |
| TRANSIT TOTAL | (REGION) | 0.073 | 0.065 | 0.064 | 0.063 | 0.062 | 0.062 |

EXAMPLE 4
MODIFY ZONAL DEMAND PARAMETERS AND TRAFFIC FLOWS

REGIONWIDE ANALYSIS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| FLEET SIZE NEEDED DURING AM-PEAK TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-ROUTE BUS | (CBD) | 0.6 | 1.2 | 1.8 | 2.4 | 3.0 | 3.6 |
| FIXED-ROUTE BUS | (FEEDER) | 12.3 | 22.1 | 31.9 | 41.7 | 51.4 | 61.2 |
| FIXED-ROUTE BUS | (DUMPER) | 2.7 | 2.8 | 3.6 | 4.3 | 5.1 | 5.9 |
| FIXED-ROUTE BUS | (LINKER) | 1.8 | 3.5 | 5.3 | 7.1 | 8.8 | 10.6 |
| TRANSIT TOTAL | (REGION) | 17.4 | 29.7 | 42.6 | 55.5 | 68.4 | 81.3 |
| FLEET SIZE NEEDED DURING OFF-PEAK TRANSIT MODE SHARE: | | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| FIXED-ROUTE BUS | (CBD) | 0.3 | 0.4 | 0.4 | 0.4 | 0.4 | 0.5 |
| FIXED-ROUTE BUS | (FEEDER) | 5.5 | 6.0 | 6.3 | 6.5 | 6.6 | 7.0 |
| FIXED-ROUTE BUS | (DUMPER) | 2.6 | 2.7 | 2.7 | 2.8 | 2.8 | 2.9 |
| FIXED-ROUTE BUS | (LINKER) | 0.5 | 0.6 | 0.8 | 1.0 | 1.2 | 1.4 |
| TRANSIT TOTAL | (REGION) | 9.0 | 9.6 | 10.1 | 10.6 | 11.0 | 11.8 |
| FLEET SIZE NEEDED DURING PM-PEAK TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-ROUTE BUS | (CBD) | 0.7 | 1.3 | 2.0 | 2.6 | 3.3 | 3.9 |
| FIXED-ROUTE BUS | (FEEDER) | 13.1 | 23.6 | 34.1 | 44.6 | 55.1 | 65.6 |
| FIXED-ROUTE BUS | (DUMPER) | 2.7 | 2.9 | 3.7 | 4.5 | 5.3 | 6.2 |
| FIXED-ROUTE BUS | (LINKER) | 11.7 | 23.5 | 35.2 | 47.0 | 58.7 | 70.4 |
| TRANSIT TOTAL | (REGION) | 28.2 | 51.3 | 75.0 | 98.7 | 122.4 | 146.1 |

EXAMPLE 4
MODIFY ZONAL DEMAND PARAMETERS AND TRAFFIC FLOWS

REGIONWIDE ANALYSIS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| AVERAGE HEADWAY DURING AM-PEAK TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-ROUTE BUS | (CBD) | 52.5 | 37.1 | 30.3 | 26.3 | 23.5 | 21.4 |
| FIXED-ROUTE BUS | (FEEDER) | 40.4 | 29.1 | 23.7 | 20.4 | 18.1 | 16.5 |
| FIXED-ROUTE BUS | (DUMPER) | 60.0 | 60.0 | 48.3 | 40.2 | 34.5 | 30.3 |
| FIXED-ROUTE BUS | (LINKER) | 17.9 | 8.9 | 6.0 | 4.5 | 3.6 | 3.0 |
| TRANSIT TOTAL | (REGION) | 41.6 | 30.0 | 23.8 | 20.2 | 17.7 | 15.9 |
| AVERAGE HEADWAY DURING OFF-PEAK TRANSIT MODE SHARE: | | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| FIXED-ROUTE BUS | (CBD) | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 | 57.9 |
| FIXED-ROUTE BUS | (FEEDER) | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 | 58.4 |
| FIXED-ROUTE BUS | (DUMPER) | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 |
| FIXED-ROUTE BUS | (LINKER) | 60.0 | 55.6 | 46.0 | 36.9 | 29.5 | 24.6 |
| TRANSIT TOTAL | (REGION) | 60.0 | 59.7 | 59.0 | 57.9 | 56.7 | 54.6 |
| AVERAGE HEAOWAY OURING PM-PEAK TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-ROUTE BUS | (CBO) | 50.7 | 35.8 | 29.3 | 25.3 | 22.7 | 20.7 |
| FIXED-ROUTE BUS | (FEEDER) | 39.1 | 28.0 | 22.8 | 19.6 | 17.5 | 15.9 |
| FIXED-ROUTE BUS | (DUMPER) | 60.0 | 58.7 | 46.4 | 38.5 | 33.0 | 28.9 |
| FIXED-ROUTE BUS | (LINKER) | 2.7 | 1.3 | 0.9 | 0.7 | 0.5 | 0.4 |
| TRANSIT TOTAL | (REGION) | 26.2 | 17.8 | 13.8 | 11.6 | 10.2 | 9.1 |

EXAMPLE 4

MODIFY ZONAL DEMAND PARAMETERS AND TRAFFIC FLOWS

REGIONWIDE ANALYSIS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| AVERAGE VEHICLE LOADING DURING AM-PEAK TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-ROUTE BUS | (CBD) | 34.3 | 34.3 | 34.3 | 34.3 | 34.3 | 34.3 |
| FIXED-ROUTE BUS | (FEEDER) | 16.1 | 18.0 | 18.7 | 19.1 | 19.3 | 19.5 |
| FIXED-ROUTE BUS | (DUMPER) | 5.1 | 10.4 | 12.5 | 13.8 | 14.7 | 15.5 |
| FIXED-ROUTE BUS | (LINKER) | 38.7 | 38 6 | 38.6 | 38.6 | 38.6 | 38.6 |
| TRANSIT TOTAL | (REGION) | 17.3 | 20.4 | 21.3 | 21.8 | 22.1 | 22.3 |
| AVERAGE VEHICLE LOADING DURING OFF-PEAK TRANSIT MODE SHARE: | | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| FIXED-ROUTE BUS | (CBD) | 6.2 | 12.5 | 18.7 | 24.9 | 31.2 | 34.8 |
| FIXED-ROUTE BUS | (FEEDER) | 2.4 | 5.5 | 8.7 | 11.8 | 14.8 | 16.8 |
| FIXED-ROUTE BUS | (DUMPER) | 1.9 | 3.8 | 5.7 | 7.7 | 9.7 | 11.8 |
| FIXED-ROUTE BUS | (LINKER) | 17.8 | 33.2 | 40.8 | 43.4 | 43.4 | 43.4 |
| TRANSIT TOTAL | (REGION) | 3.3 | 7.0 | 10.7 | 14.1 | 17.3 | 19.6 |
| AVERAGE VEHICLE LOADING DURING PM-PEAK TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-ROUTE BUS | (CBD) | 34.2 | 34.2 | 34.2 | 34.2 | 34.2 | 34.2 |
| FIXED-ROUTE BUS | (FEEDER) | 16.3 | 18.1 | 18.8 | 19.2 | 19.4 | 19.5 |
| FIXED-ROUTE BUS | (DUMPER) | 5.5 | 10.8 | 12.8 | 14.0 | 15.0 | 15.6 |
| FIXED-ROUTE BUS | (LINKER) | 30.8 | 30.8 | 30.8 | 30.8 | 30.8 | 30.8 |
| TRANSIT TOTAL | (REGION) | 21.7 | 23.9 | 24.5 | 24.9 | 25.1 | 25.2 |

EXAMPLE 4
MODIFY ZONAL DEMAND PARAMETERS AND TRAFFIC FLOWS

REGIONWIDE ANALYSIS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| VEHICLE-MILES (PER HOUR) DURING AM-PEAK TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-ROUTE BUS | (CBD) | 6. | 12. | 18. | 24. | 30. | 35. |
| FIXED-ROUTE BUS | (FEEDER) | 197. | 343. | 490. | 636. | 783. | 929. |
| FIXED-ROUTE BUS | (DUMPER) | 47. | 47. | 57. | 69. | 80. | 91. |
| FIXED-ROUTE BUS | (LINKER) | 32. | 64. | 96. | 129. | 161. | 193. |
| TRANSIT TOTAL | (REGION) | 281. | 466. | 661. | 857. | 1053. | 1249. |
| VEHICLE-MILES (PER HOUR) DURING OFF-PEAK TRANSIT MODE SHARE: | | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| FIXED-ROUTE BUS | (CBD) | 5. | 5. | 5. | 5. | 5. | 5. |
| FIXED-ROUTE BUS | (FEEDER) | 101. | 101. | 101. | 101. | 101. | 105. |
| FIXED-ROUTE BUS | (DUMPER) | 47. | 47. | 47. | 47. | 47. | 47. |
| FIXED-ROUTE BUS | (LINKER) | 10. | 10. | 12. | 15. | 19. | 23. |
| TRANSIT TOTAL | (REGION) | 161. | 162. | 164. | 167. | 171. | 179. |
| VEHICLE-MILES (PER HOUR) DURING PM-PEAK TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-ROUTE BUS | (CBD) | 6. | 13. | 19. | 25. | 32. | 38. |
| FIXED-ROUTE BUS | (FEEDER) | 208. | 365. | 523. | 680. | 838. | 995. |
| FIXED-ROUTE BUS | (DUMPER) | 47. | 48. | 60. | 72. | 84. | 96. |
| FIXED-ROUTE BUS | (LINKER) | 215. | 430. | 645. | 861. | 1076. | 1291. |
| TRANSIT TOTAL | (REGION) | 476. | 856. | 1247. | 1638. | 2029. | 2420. |

EXAMPLE 4
MODIFY ZONAL DEMAND PARAMETERS AND TRAFFIC FLOWS

REGIONWIDE ANALYSIS

PICKUPS (PER HOUR) DURING AM-PEAK

| TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
|---|---|---|---|---|---|---|---|
| FIXED-ROUTE BUS | (CBD) | 284. | 568. | 852. | 1136. | 1419. | 1703. |
| FIXED-ROUTE BUS | (FEEDER) | 1145. | 2290. | 3435. | 4580. | 5726. | 6871. |
| FIXED-ROUTE BUS | (DUMPER) | 202. | 404. | 605. | 807. | 1009. | 1211. |
| AUTO | (FEEDER) | 20669. | 19581. | 18494. | 17406. | 16318. | 15230. |
| CARPOOL | (FEEDER) | 1088. | 1031. | 973. | 916. | 859. | 802. |
| AUTO | (DUMPER) | 3642. | 3450. | 3258. | 3067. | 2875. | 2683. |
| CARPOOL | (DUMPER) | 182. | 182. | 182. | 182. | 182. | 182. |
| AUTO | (CBD) | 5124. | 4854. | 4585. | 4315. | 4045. | 3776. |
| CARPOOL | (CBD) | 270. | 256. | 241. | 227. | 213. | 199. |
| FIXED-ROUTE BUS | (LINKER) | 456. | 911. | 1367. | 1822. | 2278. | 2733. |
| AUTO | (LINKER) | 10406. | 9858. | 9311. | 8763. | 8215. | 7668. |
| CARPOOL | (LINKER) | 548. | 519. | 490. | 461. | 432. | 404. |
| AUTO TOTAL | (REGION) | 21146. | 20033. | 18920. | 17807. | 16694. | 15581. |
| CARPOOL TOTAL | (REGION) | 1113. | 1054. | 996. | 937. | 879. | 820. |
| TRANSIT TOTAL | (REGION) | 1172. | 2343. | 3515. | 4686. | 5858. | 7029. |

EXAMPLE 4
MOOIFY ZONAL DEMANO PARAMETERS ANO TRAFFIC FLOWS

REGIONWIOE ANALYSIS

PICKUPS (PER HOUR) DURING OFF-PEAK

| TRANSIT MOOE SHARE: | | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
|---|---|---|---|---|---|---|---|
| FIXED-ROUTE BUS | (CBD) | 40. | 79. | 119. | 158. | 198. | 237. |
| FIXED-ROUTE BUS | (FEEOER) | 115. | 229. | 344. | 458. | 573. | 687. |
| FIXED-ROUTE BUS | (OUMPER) | 73. | 146. | 220. | 293. | 366. | 439. |
| AUTO | (FEEOER) | 4243. | 4134. | 4025. | 3916. | 3808. | 3699. |
| CARPOOL | (FEEOER) | 223. | 218. | 212. | 206. | 200. | 195. |
| AUTO | (OUMPER) | 2713. | 2644. | 2574. | 2504. | 2435. | 2365. |
| CARPOOL | (OUMPER) | 141. | 141. | 141. | 141. | 141. | 141. |
| AUTO | (CBD) | 1466. | 1428. | 1391. | 1353. | 1316. | 1278. |
| CARPOOL | (CBO) | 77. | 75. | 73. | 71. | 69. | 67. |
| FIXEO-ROUTE BUS | (LINKER) | 72. | 144. | 215. | 287. | 359. | 431. |
| AUTO | (LINKER) | 13637. | 13288. | 12938. | 12588. | 12239. | 11889. |
| CARPOOL | (LINKER) | 718. | 699. | 681. | 663. | 644. | 626. |
| AUTO TOTAL | (REGION) | 6054. | 5898. | 5743. | 5588. | 5433. | 5278. |
| CARPOOL TOTAL | (REGION) | 319. | 310. | 302. | 294. | 286. | 278. |
| TRANSIT TOTAL | (REGION) | 163. | 327. | 490. | 654. | 817. | 980. |

EXAMPLE 4
MODIFY ZONAL DEMAND PARAMETERS ANO TRAFFIC FLOWS

REGIONWIDE ANALYSIS

| PICKUPS (PER HOUR) DURING PM-PEAK TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
|---|---|---|---|---|---|---|---|
| FIXED-ROUTE BUS | (CBO) | 305. | 609. | 914. | 1219. | 1524. | 1828. |
| FIXED-ROUTE BUS | (FEEDER) | 1231. | 2462. | 3693. | 4924. | 6155. | 7386. |
| FIXED-ROUTE BUS | (OUMPER) | 215. | 429. | 644. | 859. | 1074. | 1288. |
| AUTO | (FEEOER) | 22219. | 21050. | 19881. | 18711. | 17542. | 16372. |
| CARPOOL | (FEEDER) | 1169. | 1108. | 1046. | 985. | 923. | 862. |
| AUTO | (OUMPER) | 3876. | 3672. | 3468. | 3264. | 3060. | 2856. |
| CARPOOL | (OUMPER) | 203. | 203. | 203. | 203. | 203. | 203. |
| AUTO | (CBO) | 5500. | 5211. | 4921. | 4632. | 4342. | 4053. |
| CARPOOL | (CBD) | 289. | 274. | 259. | 244. | 229. | 213. |
| FIXED-ROUTE BUS | (LINKER) | 3320. | 6639. | 9959. | 13278. | 16598. | 19917. |
| AUTO | (LINKER) | 11168. | 10581. | 9993. | 9405. | 8817. | 8229. |
| CARPOOL | (LINKER) | 588. | 557. | 526. | 495. | 464. | 433. |
| AUTO TOTAL | (REGION) | 22698. | 21504. | 20309. | 19114. | 17920. | 16725. |
| CARPOOL TOTAL | (REGION) | 1195. | 1132. | 1069. | 1006. | 943. | 880. |
| TRANSIT TOTAL | (REGION) | 1258. | 2515. | 3773. | 5030. | 6288. | 7545. |

```
EXAMPLE 4
MODIFY ZONAL DEMAND PARAMETERS AND TRAFFIC FLOWS
         .         .         .         .         .         .         .         .         .
END                                                                                        24.

        O ERRORS FOUND
```

EXAMPLE 5

Job Purpose

To illustrate the modification of regionwide demand parameters and zonal traffic flow rates:

1. Define an arbitrary two-zone, one-link network.

2. Define trip generation rates for the urban region.

3. Specify the allocation of trips between the various time periods.

4. For one zone, modify the rate of trips inbound to or outbound from the residential area; for the other zone, modify the trip rates inbound to or outbound from the commercial district.

5. Perform uniform FEEDER analysis of the zones.

Input Data

```
                                         F I E L D
Keyword <--1---><--2---><--3---><--4---><--5---><--6---><--7---><--8--->

TITLE   EXAMPLE 5 -- MODIFY REGIONWIDE DEMAND PARAMETERS AND
SUBTITLE             ZONAL TRAFFIC FLOW RATES
NULLNET
ONEZONE ZONE1   NODE1                20.        NON-CBD
ONEZONE ZONE2   NODE2                20.        NON-CBD
ONELINK LINK1   NODE1   NODE2   LENGTH       6.
DEMPARM       2.      1.     0.5
TRIPTIME       1FORWARD      0.4     0.6     0.0
TRIPTIME       1REVERSE      0.0     0.3     0.1
VRES    ZONE1   OUT                          10.      2.      1.
VRES    ZONE1   IN                            1.      2.     10.
VACT    ZONE2   OUT                          20.      5.      2.
VACT    ZONE2   IN                            2.      5.     20.
PRINTDEM
FEEDER  ZONE1   UNIFORM
FEEDER  ZONE2   UNIFORM
END
```

The network type indicator is switched to "arbitrary" with the NULLNET card. A new zone called ZONE1, attached to a new mode called NODE1, is defined. It has an area of 20 square miles and is of non-CBD type. ZONE2 is a second new zone. It is attached to a new node NODE2, with the same characteristics as ZONE1. Connecting NODE1 and NODE2 is LINK1, a new link 6 miles long. Since no other link parameters are specified, LINK1 will have the default characteristics of radial links.

The next eight cards deal with demand modeling and printing. The trip generation rate for all zones in the region is set by DEMPARM to two commute trips per unit population per day, one home-based other trip per unit population per day, and 0.5 work-work trips per unit employment per day. Note that the time unit in this case is day, not minute. The first TRIPTIME card establishes that, for commute trips outbound from the residential area to activity center destinations, 40% of the trips occur in the A.M. peak, 60% in the off-peak, and none in the P.M. peak. The second TRIPTIME card declares that the return (REVERSE) commute (type 1) trips occur: none in the A.M. peak, 30% in the off-peak, and 10% in the P.M. peak. Any blanks in FIELDs 3 to 5 will cause the corresponding time period to retain its default value. These trip proportions will be applied to all zones in the network.

When SMART encounters the first VRES card, it ensures that the urban structure and all demand rates have been generated before making the modification requested by the card. The VRES cards specify that, for ZONE1, outbound residential trip rates as ten trips per minute in the morning peak, two trips per minute in the off-peak, and one trip per minute in the afternoon peak; inbound residential trip rates are one trip per minute in the A.M. peak, two trips per minute in the off-peak, and ten trips per minute in the P.M. peak. Activity center trip rates for ZONE1 remain unchanged from SMART's calculated values. The VACT cards for ZONE 2 specify corresponding outbound and inbound rates for activity centers. The PRINTDEM card causes SMART to print out computed demand matrices.

Finally, a uniform FEEDER analysis is applied separately to the two zones. The input data deck terminates with an END card.

EXAMPLE 6

Job Purpose

To illustrate reading in demand data from an external file:

1. Define an arbitrary two-zone, two-node urban structure;

2. Read in origin-destination trip volume for the two zones, for all time periods;

3. Perform dual density (subarea) FEEDER analysis of one of the zones; and

4. Perform corridor analysis of the link connecting the two zones.

Input Data

```
                                        F I E L D
Keyword <--1---><--2---><--3---><--4---><--5---><--6---><--7---><--8--->

TITLE   EXAMPLE 6 -- EXTERNAL DEMANDS
NULLNET
ONEZONE RZONR2C1NODER2C1                16.     1.0NON-CBD
ONEZONE ZONECNTRNODECNTR                20.        NON-CBD
ONELINK RHWYR2C1NODECNTRNODER2C1LENGTH            5FREEWAY DIAMOND
ONELINK RHWYR2C1NODECNTRNODER2C1LANES             4NORAIL
ONELINK RHWYR2C1NODECNTRNODER2C1SPEED           1.
READDEM
FEEDER  RZONR2C1SUBAREA         0.5     0.3
LINKER  NODECNTRNODER2C1
END
```

The NULLNET card clears the default urban structure, and prepares the program to accept an arbitrarily defined network.

The ONEZONE cards identify the names of the zones, the nodes the zones are attached to, the areas of the zones, the parking costs, and zone types. For new zones, area must be specified; however, if zone type and parking costs are not specified, defaults will be assigned: non-CBD for type, and zero for parking costs. In this example, the first ONEZONE card specifies that zone RZONR2C1 is attached to NODER2C1. It is of a non-CBD type, has an area of 16 square miles, and has an average parking charge of $1.00 per vehicle trip.

The sole link in the network is defined as RHWYR2C1, attached to nodes NODECNTR and NODER2C1. It is a four-lane freeway with a preferential lane, and is five miles long. It does not have rail facilities, and the uncongested link automobile speed is one mile per minute.

All zone and link definition cards must precede the READDEM card. This is becaue the demand subroutines in SMART need the definition of the complete network in order to function. The READEM card tells SMART to read in demand datafrom the FORTRAN unit number specified in FIELD 1. The default FORTRAN unit if field1 is blank is unit 8. However, this default may have been changed during installation, so any doubts should be resolved with the responsible programmer at your own computing facility.

The demand data to be read in is shown in Exhibit C.5. For example, the first line specifies that during the off-peak period, 1000 trips per minute originate from the activity centers of zone RZONR2C1 and terminate in the activity center of zone ZONECNTR. Refer to the READDEM keyword sheet for columns specification. To denote the end of the input demand stream, an END card should be used. Note that before reading in demand data, SMART sets all trip rates to zero; hence, whichever trip rates are not loaded by the READDEM card will retain the value zero.

The FEEDER keyword runs a SUBAREA (non-uniform) FEEDER analysis of the specified zone; in this case, RZONR2C1. The subarea is 30% the size of the entire zone, and the trip generation rate (in trips per minute) in the low-density area is 50% that of the high-density area. The LINKER card performs a corridor line-haul analysis. Finally, the input stream ends with an END card.

The output from this job is shown in Exhibit C.6.

Exhibit C.5. EXAMPLE 4 EXTERNAL DEMAND INPUT

```
columns:
         1    1    2    2    3    3    4
....5....0....5....0....5....0....5....0
RZONR2C1 2 ZONECNTR 2 1        1000
RZONR2C1 2 ZONECNTR 2 2        1000
RZONR2C1 2 ZONECNTR 2 3        1000
RZONR2C1 2 ZONECNTR 2 4        1000
RZONR2C1 1 ZONECNTR 2 1        1000
RZONR2C1 1 ZONECNTR 2 2        1000
RZONR2C1 1 ZONECNTR 2 3        1000
RZONR2C1 1 ZONECNTR 2 4        1000
RZONR2C1 1 ZONECNTR 1 1        1000
RZONR2C1 1 ZONECNTR 1 2        1000
RZONR2C1 1 ZONECNTR 1 3        1000
RZONR2C1 1 ZONECNTR 1 4        1000
RZONR2C1 2 ZONECNTR 1 1        1000
RZONR2C1 2 ZONECNTR 1 2        1000
RZONR2C1 2 ZONECNTR 1 3        1000
RZONR2C1 2 ZONECNTR 1 4        1000
ZONECNTR 2 RZONR2C1 2 1        2000
ZONECNTR 2 RZONR2C1 2 2        2000
ZONECNTR 2 RZONR2C1 2 3        2000
ZONECNTR 2 RZONR2C1 2 4        2000
ZONECNTR 1 RZONR2C1 2 1        2000
ZONECNTR 1 RZONR2C1 2 2        2000
ZONECNTR 1 RZONR2C1 2 3        2000
ZONECNTR 1 RZONR2C1 2 4        2000
ZONECNTR 1 RZONR2C1 1 1        2000
ZONECNTR 1 RZONR2C1 1 2        2000
ZONECNTR 1 RZONR2C1 1 3        2000
ZONECNTR 1 RZONR2C1 1 4        2000
ZONECNTR 2 RZONR2C1 1 1        2000
ZONECNTR 2 RZONR2C1 1 2        2000
ZONECNTR 2 RZONR2C1 1 3        2000
ZONECNTR 2 RZONR2C1 1 4        2000
END
```

Exhibit C.6. EXAMPLE 6 OUTPUT -- EXTERNAL DEMANDS

```
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TITLE   EXAMPLE 6 -- EXTERNAL DEMANDS                                             43.

NULLNET                                                                           44.

ONEZONE RZONR2C1NODER2C1                16.      1.ONON-CBD                      45.

ONEZONE ZONECNTRNODECNTR                20.        NON-CBD                       46.

ONELINK RHWYR2C1NODECNTRNODER2C1LENGTH           5FREEWAY DIAMOND                47.

ONELINK RHWYR2C1NODECNTRNODER2C1LANES            4NORAIL                         48.

ONELINK RHWYR2C1NODECNTRNODER2C1SPEED           1.                               49.

READDEM                                                                           50.

FEEDER  RZONR2C1SUBAREA      0.5      0.3                                         51.
```

FEEDER SUBAREA SERVICE ANALYSIS OF RZONR2C1

ZDNE SIZE: 16.0 SQ.MILES

TRAVEL TRIP VOLUME DURING AM-PEAK DUTBOUND: 2000.000 TRIPS PER MINUTE
INBOUND : 4000.000 TRIPS PER MINUTE
TRAVEL TRIP VOLUME DURING OFF-PEAK OUTBDUND: 2000.000 TRIPS PER MINUTE
INBOUND : 4000.000 TRIPS PER MINUTE
TRAVEL TRIP VOLUME DURING PM-PEAK DUTBDUND: 2000.000 TRIPS PER MINUTE
INBDUND : 4000.000 TRIPS PER MINUTE

LENGTH DF AM-PEAK IS 180.0 MINUTES
LENGTH DF OFF-PEAK IS 360.0 MINUTES
LENGTH DF PM-PEAK IS 180.0 MINUTES

CARPOOL FRACTION: 0.0500
CARPOOL TIME PARAMETER: 3.000

DEFAULT WALK SPEED USED IN THE CALCULATIDNS IS 0.050 MILES PER MINUTE

| MODE IDENTIFIER | MDDE TYPE | MDDE LABEL | FLEXTYPE AM-PEAK | FLEXTYPE OFF-PEAK | FLEXTYPE PM-PEAK | TRANSFER |
|---|---|---|---|---|---|---|
| AUTO | AUTD | AUTO | | | | RANDOM |
| CARPOOL | CARPOOL | CARPODL | | | | RANDDM |
| FRBUS | FRBUS | FIXED-ROUTE BUS | | | | RANDOM |
| FLEXRTE | FLEXRTE | FLEXIBLE-ROUTE SERVICE | SUBSCR | DAR | SUBSCR | RANDOM |
| PVTAUTO | PVTAUTO | PRIVATE AUTO TRANSIT | | | | RANDDM |

| MDDE IDENTIFIER | $ | $/V | $/VH | $/VM | $/RM | SPEED | MIN/STDP | MIN/PASS | MI/GAL | PASS/VEH |
|---|---|---|---|---|---|---|---|---|---|---|
| AUTO | 0.0 | 2.040 | 0.012 | 0.090 | 0.0 | 0.333 | 0.500 | 0.0 | 15.000 | 1.200 |
| CARPDDL | 0.0 | 2.040 | 0.012 | 0.090 | 0.0 | 0.333 | 0.500 | 0.0 | 15.000 | 3.000 |
| FRBUS | 0.0 | 51.780 | 0.160 | 0.480 | 0.0 | 0.333 | 0.200 | 0.020 | 5.200 | 50.000 |
| FLEXRTE | 0.0 | 26.610 | 0.145 | 0.200 | 0.0 | 0.333 | 0.500 | 0.0 | 9.000 | 10.000 |
| PVTAUTD | 0.0 | 1.500 | 0.0 | 0.010 | 0.0 | 0.333 | 0.500 | 0.0 | 15.000 | 1.200 |

| MODE IDENTIFIER | MINHDWAY | MAXHDWAY | MAXRS | STDPS/MI | CARS/VEH | FRACWALK | AMTRAIN | DFFTRAIN | PMTRAIN |
|---|---|---|---|---|---|---|---|---|---|
| AUTO | 0.500 | 0.0 | 0.0 | 0.0 | 1.000 | 0.200 | 1.000 | 1.000 | 1.000 |
| CARPDOL | 0.500 | 0.0 | 0.0 | 0.0 | 1.000 | 0.200 | 1.000 | 1.000 | 1.000 |
| FRBUS | 0.500 | 60.000 | 1.000 | 8.000 | 2.000 | 0.200 | 1.000 | 1.000 | 1.000 |
| FLEXRTE | 0.500 | 60.000 | 1.000 | 4.000 | 1.000 | 0.200 | 1.000 | 1.000 | 1.000 |
| PVTAUTD | 0.500 | 0.0 | 0.0 | 0.0 | 1.000 | 0.200 | 1.000 | 1.000 | 1.000 |

FEEDER SUBAREA SERVICE ANALYSIS OF RZONR2C1 OUTBOUND

TRAVEL TIMES DURING AM-PEAK , (MEAN & STD.DEV.)

| TRANSIT MODE SHARE: | 0.050 | | 0.100 | | 0.150 | | 0.200 | | 0.250 | | 0.300 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AUTO | 7.2 | 2.5 | 7.2 | 2.5 | 7.2 | 2.5 | 7.2 | 2.5 | 7.2 | 2.5 | 7.2 | 2.5 |
| CARPOOL | 8.4 | 2.6 | 8.4 | 2.6 | 8.4 | 2.6 | 8.4 | 2.6 | 8.5 | 2.6 | 8.5 | 2.6 |
| FIXED-ROUTE BUS | 17.7 | 4.5 | 16.7 | 4.4 | 16.2 | 4.4 | 15.9 | 4.4 | 15.7 | 4.4 | 15.6 | 4.4 |
| FLEXIBLE-ROUTE SERVICE | 22.9 | 7.3 | 22.9 | 7.3 | 22.9 | 7.3 | 22.9 | 7.3 | 22.9 | 7.3 | 22.8 | 7.3 |
| PRIVATE AUTO TRANSIT | 7.7 | 2.6 | 7.7 | 2.6 | 7.7 | 2.6 | 7.7 | 2.6 | 7.7 | 2.6 | 7.7 | 2.6 |

TRAVEL TIMES DURING OFF-PEAK, (MEAN & STD.DEV.)

| TRANSIT MODE SHARE: | 0.025 | | 0.050 | | 0.075 | | 0.100 | | 0.125 | | 0.150 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AUTO | 7.2 | 2.5 | 7.2 | 2.5 | 7.2 | 2.5 | 7.2 | 2.5 | 7.2 | 2.5 | 7.2 | 2.5 |
| CARPOOL | 8.4 | 2.6 | 8.4 | 2.6 | 8.4 | 2.6 | 8.4 | 2.6 | 8.4 | 2.6 | 8.4 | 2.6 |
| FIXED-ROUTE BUS | 19.1 | 4.5 | 17.7 | 4.5 | 17.0 | 4.4 | 16.7 | 4.4 | 16.4 | 4.4 | 16.2 | 4.4 |
| FLEXIBLE-ROUTE SERVICE | 28.5 | 8.3 | 28.0 | 8.2 | 27.9 | 8.2 | 27.9 | 8.2 | 27.8 | 8.2 | 27.8 | 8.2 |
| PRIVATE AUTO TRANSIT | 7.7 | 2.6 | 7.7 | 2.6 | 7.7 | 2.6 | 7.7 | 2.6 | 7.7 | 2.6 | 7.7 | 2.6 |

TRAVEL TIMES DURING PM-PEAK , (MEAN & STD.DEV.)

| TRANSIT MODE SHARE: | 0.050 | | 0.100 | | 0.150 | | 0.200 | | 0.250 | | 0.300 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AUTO | 7.2 | 2.5 | 7.2 | 2.5 | 7.2 | 2.5 | 7.2 | 2.5 | 7.2 | 2.5 | 7.2 | 2.5 |
| CARPOOL | 8.4 | 2.6 | 8.4 | 2.6 | 8.4 | 2.6 | 8.4 | 2.6 | 8.5 | 2.6 | 8.5 | 2.6 |
| FIXED-ROUTE BUS | 17.7 | 4.5 | 16.7 | 4.4 | 16.2 | 4.4 | 15.9 | 4.4 | 15.7 | 4.4 | 15.6 | 4.4 |
| FLEXIBLE-ROUTE SERVICE | 22.9 | 7.3 | 22.9 | 7.3 | 22.9 | 7.3 | 22.9 | 7.3 | 22.9 | 7.3 | 22.8 | 7.3 |
| PRIVATE AUTO TRANSIT | 7.7 | 2.6 | 7.7 | 2.6 | 7.7 | 2.6 | 7.7 | 2.6 | 7.7 | 2.6 | 7.7 | 2.6 |

FEEDER SUBAREA SERVICE ANALYSIS OF RZONR2C1 INBOUND

TRAVEL TIMES DURING AM-PEAK , (MEAN & STD.DEV.)

| TRANSIT MODE SHARE: | 0.050 | | 0.100 | | 0.150 | | 0.200 | | 0.250 | | 0.300 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AUTO | 7.2 | 2.5 | 7.2 | 2.5 | 7.2 | 2.5 | 7.2 | 2.5 | 7.2 | 2.5 | 7.2 | 2.5 |
| CARPOOL | 8.3 | 2.6 | 8.3 | 2.6 | 8.3 | 2.6 | 8.3 | 2.6 | 8.3 | 2.6 | 8.3 | 2.6 |
| FIXED-ROUTE BUS | 19.6 | 4.8 | 18.0 | 4.7 | 17.3 | 4.7 | 16.8 | 4.7 | 16.5 | 4.7 | 16.3 | 4.7 |
| FLEXIBLE-ROUTE SERVICE | 43.3 | 9.5 | 43.3 | 9.5 | 43.3 | 9.5 | 43.3 | 9.5 | 43.3 | 9.5 | 43.3 | 9.5 |
| PRIVATE AUTO TRANSIT | 7.7 | 2.6 | 7.7 | 2.6 | 7.7 | 2.6 | 7.7 | 2.6 | 7.7 | 2.6 | 7.7 | 2.6 |

TRAVEL TIMES DURING OFF-PEAK, (MEAN & STD.DEV.)

| TRANSIT MODE SHARE: | 0.025 | | 0.050 | | 0.075 | | 0.100 | | 0.125 | | 0.150 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AUTO | 7.2 | 2.5 | 7.2 | 2.5 | 7.2 | 2.5 | 7.2 | 2.5 | 7.2 | 2.5 | 7.2 | 2.5 |
| CARPOOL | 8.3 | 2.6 | 8.3 | 2.6 | 8.3 | 2.6 | 8.3 | 2.6 | 8.3 | 2.6 | 8.3 | 2.6 |
| FIXED-ROUTE BUS | 21.9 | 4.9 | 19.6 | 4.8 | 18.6 | 4.8 | 18.0 | 4.7 | 17.6 | 4.7 | 17.3 | 4.7 |
| FLEXIBLE-ROUTE SERVICE | 32.7 | 9.3 | 32.1 | 9.3 | 32.0 | 9.3 | 32.0 | 9.3 | 31.9 | 9.3 | 31.9 | 9.3 |
| PRIVATE AUTO TRANSIT | 7.7 | 2.6 | 7.7 | 2.6 | 7.7 | 2.6 | 7.7 | 2.6 | 7.7 | 2.6 | 7.7 | 2.6 |

TRAVEL TIMES DURING PM-PEAK , (MEAN & STD.DEV.)

| TRANSIT MODE SHARE: | 0.050 | | 0.100 | | 0.150 | | 0.200 | | 0.250 | | 0.300 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AUTO | 7.2 | 2.5 | 7.2 | 2.5 | 7.2 | 2.5 | 7.2 | 2.5 | 7.2 | 2.5 | 7.2 | 2.5 |
| CARPOOL | 8.3 | 2.6 | 8.3 | 2.6 | 8.3 | 2.6 | 8.3 | 2.6 | 8.3 | 2.6 | 8.3 | 2.6 |
| FIXED-ROUTE BUS | 19.6 | 4.8 | 18.0 | 4.7 | 17.3 | 4.7 | 16.8 | 4.7 | 16.5 | 4.7 | 16.3 | 4.7 |
| FLEXIBLE-ROUTE SERVICE | 43.3 | 9.5 | 43.3 | 9.5 | 43.3 | 9.5 | 43.3 | 9.5 | 43.3 | 9.5 | 43.3 | 9.5 |
| PRIVATE AUTO TRANSIT | 7.7 | 2.6 | 7.7 | 2.6 | 7.7 | 2.6 | 7.7 | 2.6 | 7.7 | 2.6 | 7.7 | 2.6 |

FEEDER SUBAREA SERVICE ANALYSIS OF RZONR2C1 BI-DIRECTIONAL

| | | | | | | |
|---|---|---|---|---|---|---|
| COST PER TRIP DURING AM-PEAK TRANSIT MODE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| AUTO | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 |
| CARPOOL | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 |
| FIXED-ROUTE BUS | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 |
| FLEXIBLE-ROUTE SERVICE | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 |
| PRIVATE AUTO TRANSIT | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 |
| COST PER TRIP DURING OFF-PEAK TRANSIT MODE SHARE: | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| AUTO | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 |
| CARPOOL | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 |
| FIXED-ROUTE BUS | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 | 0.17 |
| FLEXIBLE-ROUTE SERVICE | 0.42 | 0.41 | 0.41 | 0.41 | 0.41 | 0.41 |
| PRIVATE AUTO TRANSIT | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 |
| COST PER TRIP DURING PM-PEAK TRANSIT MODE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| AUTO | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 |
| CARPOOL | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 |
| FIXED-ROUTE BUS | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 | 0.21 |
| FLEXIBLE-ROUTE SERVICE | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 | 0.50 |
| PRIVATE AUTO TRANSIT | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 | 1.40 |

FEEOER SUBAREA SERVICE ANALYSIS OF RZONR2C1 BI-OIRECTIONAL

| | | | | | | |
|---|---|---|---|---|---|---|
| FUEL CONSUMPTION PER TRIP DURING AM-PEAK TRANSIT MODE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| AUTO | 0.133 | 0.133 | 0.133 | 0.133 | 0.133 | 0.133 |
| CARPOOL | 0.059 | 0.059 | 0.059 | 0.059 | 0.059 | 0.059 |
| FIXED-ROUTE BUS | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 |
| FLEXIBLE-ROUTE SERVICE | 0.066 | 0.066 | 0.066 | 0.066 | 0.066 | 0.066 |
| PRIVATE AUTO TRANSIT | 0.133 | 0.133 | 0.133 | 0.133 | 0.133 | 0.133 |
| FUEL CONSUMPTION PER TRIP DURING OFF-PEAK TRANSIT MODE SHARE: | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| AUTO | 0.133 | 0.133 | 0.133 | 0.133 | 0.133 | 0.133 |
| CARPOOL | 0.059 | 0.059 | 0.059 | 0.059 | 0.059 | 0.059 |
| FIXED-ROUTE BUS | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 |
| FLEXIBLE-ROUTE SERVICE | 0.061 | 0.060 | 0.059 | 0.059 | 0.059 | 0.059 |
| PRIVATE AUTO TRANSIT | 0.133 | 0.133 | 0.133 | 0.133 | 0.133 | 0.133 |
| FUEL CONSUMPTION PER TRIP OURING PM-PEAK TRANSIT MODE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| AUTO | 0.133 | 0.133 | 0.133 | 0.133 | 0.133 | 0.133 |
| CARPOOL | 0.059 | 0.059 | 0.059 | 0.059 | 0.059 | 0.059 |
| FIXEO-ROUTE BUS | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 | 0.023 |
| FLEXIBLE-ROUTE SERVICE | 0.066 | 0.066 | 0.066 | 0.066 | 0.066 | 0.066 |
| PRIVATE AUTO TRANSIT | 0.133 | 0.133 | 0.133 | 0.133 | 0.133 | 0.133 |

FEEDER SUBAREA SERVICE ANALYSIS OF RZONR2C1 BI-DIRECTIONAL

| | | | | | | |
|---|---|---|---|---|---|---|
| FLEET SIZE NEEDED DURING AM-PEAK TRANSIT MODE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-ROUTE BUS | 161.9 | 323.9 | 485.8 | 647.7 | 809.7 | 971.6 |
| FLEXIBLE-ROUTE SERVICE | 550.3 | 1098.2 | 1646.1 | 2194.0 | 2741.9 | 3289.8 |
| FLEET SIZE NEEDED DURING OFF-PEAK TRANSIT MODE SHARE: | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| FIXED-ROUTE BUS | 81.0 | 161.9 | 242.9 | 323.9 | 404.8 | 485.8 |
| FLEXIBLE-ROUTE SERVICE | 277.0 | 542.6 | 810.7 | 1078.6 | 1346.4 | 1614.1 |
| FLEET SIZE NEEDED DURING PM-PEAK TRANSIT MODE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-ROUTE BUS | 161.9 | 323.9 | 485.8 | 647.7 | 809.7 | 971.6 |
| FLEXIBLE-ROUTE SERVICE | 550.3 | 1098.2 | 1646.1 | 2194.0 | 2741.9 | 3289.8 |

FEEDER SUBAREA SERVICE ANALYSIS OF RZONR2C1 INBOUND

| | | | | | | |
|---|---|---|---|---|---|---|
| AVERAGE HEADWAY DURING AM-PEAK TRANSIT MODE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-ROUTE BUS | 5.1 | 3.6 | 2.9 | 2.5 | 2.3 | 2.1 |
| FLEXIBLE-ROUTE SERVICE | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 |
| AVERAGE HEADWAY DURING OFF-PEAK TRANSIT MODE SHARE: | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| FIXED-ROUTE BUS | 7.2 | 5.1 | 4.1 | 3.6 | 3.2 | 2.9 |
| FLEXIBLE-ROUTE SERVICE | 11.6 | 11.3 | 11.2 | 11.2 | 11.2 | 11.1 |
| AVERAGE HEADWAY DURING PM-PEAK TRANSIT MODE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-ROUTE BUS | 5.1 | 3.6 | 2.9 | 2.5 | 2.3 | 2.1 |
| FLEXIBLE-ROUTE SERVICE | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 | 30.0 |

FEEDER SUBAREA SERVICE ANALYSIS OF RZONR2C1 BI-DIRECTIONAL

| | | | | | | |
|---|---|---|---|---|---|---|
| AVERAGE VEHICLE LOADING DURING AM-PEAK TRANSIT MODE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-ROUTE BUS | 25.0 | 25.0 | 25.0 | 25.0 | 25.0 | 25.0 |
| FLEXIBLE-ROUTE SERVICE | 4.5 | 4.6 | 4.6 | 4.6 | 4.6 | 4.6 |
| AVERAGE VEHICLE LOADING DURING OFF-PEAK TRANSIT MODE SHARE: | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| FIXED-ROUTE BUS | 25.0 | 25.0 | 25.0 | 25.0 | 25.0 | 25.0 |
| FLEXIBLE-ROUTE SERVICE | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 |
| AVERAGE VEHICLE LOADING DURING PM-PEAK TRANSIT MODE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-ROUTE BUS | 25.0 | 25.0 | 25.0 | 25.0 | 25.0 | 25.0 |
| FLEXIBLE-ROUTE SERVICE | 4.5 | 4.6 | 4.6 | 4.6 | 4.6 | 4.6 |

FEEDER SUBAREA SERVICE ANALYSIS OF RZONR2C1 BI-DIRECTIONAL

| | | | | | | |
|---|---|---|---|---|---|---|
| VEHICLE-MILES (PER HOUR) DURING AM-PEAK TRANSIT MODE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-ROUTE BUS | 2150. | 4299. | 6449. | 8598. | 10748. | 12897. |
| FLEXIBLE-ROUTE SERVICE | 10749. | 21496. | 32243. | 42990. | 53738. | 64485. |
| VEHICLE-MILES (PER HOUR) DURING OFF-PEAK TRANSIT MODE SHARE: | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| FIXED-ROUTE BUS | 1075. | 2150. | 3224. | 4299. | 5374. | 6449. |
| FLEXIBLE-ROUTE SERVICE | 4901. | 9674. | 14437. | 19197. | 23953. | 28706. |
| VEHICLE-MILES (PER HOUR) DURING PM-PEAK TRANSIT MODE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-ROUTE BUS | 2150. | 4299. | 6449. | 8598. | 10748. | 12897. |
| FLEXIBLE-ROUTE SERVICE | 10749. | 21496. | 32243. | 42990. | 53738. | 64485. |

FEEDER SUBAREA SERVICE ANALYSIS OF RZONR2C1 BI-DIRECTIONAL

| | | | | | | |
|---|---|---|---|---|---|---|
| PICKUPS (PER HOUR) DURING AM-PEAK TRANSIT MODE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| AUTO | 324900. | 307800. | 290700. | 273600. | 256500. | 239400. |
| CARPOOL | 17100. | 16200. | 15300. | 14400. | 13500. | 12600. |
| FIXED-ROUTE BUS | 18000. | 36000. | 54000. | 72000. | 90000. | 108000. |
| FLEXIBLE-ROUTE SERVICE | 18000. | 36000. | 54000. | 72000. | 90000. | 108000. |
| PRIVATE AUTO TRANSIT | 30000. | 30000. | 30000. | 30000. | 30000. | 30000. |
| PICKUPS (PER HOUR) DURING OFF-PEAK TRANSIT MODE SHARE: | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| AUTO | 333450. | 324900. | 316350. | 307800. | 299250. | 290700. |
| CARPOOL | 17550. | 17100. | 16650. | 16200. | 15750. | 15300. |
| FIXED-ROUTE BUS | 9000. | 18000. | 27000. | 36000. | 45000. | 54000. |
| FLEXIBLE-ROUTE SERVICE | 9000. | 18000. | 27000. | 36000. | 45000. | 54000. |
| PRIVATE AUTO TRANSIT | 15000. | 15000. | 15000. | 15000. | 15000. | 15000. |
| PICKUPS (PER HOUR) DURING PM-PEAK TRANSIT MODE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| AUTO | 324900. | 307800. | 290700. | 273600. | 256500. | 239400. |
| CARPOOL | 17100. | 16200. | 15300. | 14400. | 13500. | 12600. |
| FIXED-ROUTE BUS | 18000. | 36000. | 54000. | 72000. | 90000. | 108000. |
| FLEXIBLE-ROUTE SERVICE | 18000. | 36000. | 54000. | 72000. | 90000. | 108000. |
| PRIVATE AUTO TRANSIT | 30000. | 30000. | 30000. | 30000. | 30000. | 30000. |

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LINKER  NOOECNTRNODER2C1                                                          52.
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 25.1
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 50.1
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 25.7
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 51.5
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 25.1
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 50.1
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 23.8
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 47.5
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 25.1
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 50.1
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 23.8
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 47.5
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 22.4
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 44.9
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 24.4
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 48.8
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 22.4
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 44.9
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 21.1
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 42.2
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 23.8
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 47.5
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 21.1
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 42.2
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 19.8
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 39.6
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 23.1
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 46.2
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 19.8
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 39.6
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 18.5
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 36.9
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 22.4
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 44.9
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 18.5
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 36.9
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 25.1
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 50.1
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 25.7
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 51.5
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 25.1
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 50.1
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 23.8
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 47.5
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 25.1
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 50.1
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 23.8
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 47.5
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 22.4
 **WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 44.9
```

```
**WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 24.4
**WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 48.8
**WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 22.4
**WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 44.9
**WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 21.1
**WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 42.2
**WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 23.8
**WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 47.5
**WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 21.1
**WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 42.2
**WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 19.8
**WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 39.6
**WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 23.1
**WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 46.2
**WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 19.8
**WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 39.6
**WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 18.5
**WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 36.9
**WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 22.4
**WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 44.9
**WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 18.5
**WARNING** VOLUME/CAPACITY RATIO ON LINK RHWYR2C1 IS 36.9
```

LINKER ANALYSIS BETWEEN NODECNTR AND NODER2C1

| | PERIOD LENGTH | DEMAND RATE (TRIPS PER MINUTE) FROM NODECNTR TO NODER2C1 | FROM NODER2C1 TO NODECNTR |
|---|---|---|---|
| AM-PEAK | 180. | 8000.000 | 4000.000 |
| OFF-PEAK | 360. | 8000.000 | 4000.000 |
| PM-PEAK | 180. | 8000.000 | 4000.000 |

CARPOOL FRACTION =0.050 FREEWAY CAPACITY = 40.000 ARTERIAL CAPACITY = 25.000
CAPACITY IN CAR-EQUIVALENTS PER LANE PER HOUR

AUTO ROUTE

| ON | TO | MILES | MILES / MIN | HIGHWAY TYPE | NO.OF LANES | DIAMOND LANE? | | TRIPS/MINUTE (0% TMS) AM-PEAK | OFF-PEAK | PM-PEAK |
|---|---|---|---|---|---|---|---|---|---|---|
| RHWYR2C1 | NODER2C1 | 5.0 | 1.000 | FREEWAY | 4. | YES | FOREWARD | 8000.000 | 8000.000 | 8000.000 |
| | | | | | | | REVERSE | 4000.000 | 4000.000 | 4000.000 |

TRANSIT ROUTE

| VIA | ON | TO | MILES | MILES / MIN | | | AM-PEAK | OFF-PEAK | PM-PEAK | HIGHWAY TYPE | NO.OF LANES | DIAMOND LANE? |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FRBUS | RHWYR2C1 | NODER2C1 | 5.0 | 1.000 | DEMAND RATE | FOREWARD | 8000.000 | 8000.000 | 8000.000 | FREEWAY | 4. | YES |
| | | | | | (PER MIN) | REVERSE | 4000.000 | 4000.000 | 4000.000 | | | |
| | | | | | ONBOARDING | FOREWARD | 8000.000 | 8000.000 | 8000.000 | | | |
| | | | | | (PER MIN) | REVERSE | 4000.000 | 4000.000 | 4000.000 | | | |
| | | | | | OFFBOARDING | FOREWARD | 8000.000 | 8000.000 | 8000.000 | | | |
| | | | | | (PER MIN) | REVERSE | 4000.000 | 4000.000 | 4000.000 | | | |

| MODE IDENTIFIER | MODE TYPE | MODE LABEL | FLEXTYPE AM-PEAK | FLEXTYPE OFF-PEAK | FLEXTYPE PM-PEAK | TRANSFER |
|---|---|---|---|---|---|---|
| AUTO | AUTO | AUTO | | | | RANDOM |
| CARPOOL | CARPOOL | CARPOOL | | | | RANDOM |
| FRBUS | FRBUS | FIXED-ROUTE BUS | | | | RANDOM |

| MODE IDENTIFIER | $ | $/V | $/VH | $/VM | $/RM | SPEED | MIN/STOP | MIN/PASS | MI/GAL | PASS/VEH |
|---|---|---|---|---|---|---|---|---|---|---|
| AUTO | 0.0 | 2.040 | 0.012 | 0.090 | 0.0 | 0.333 | 0.500 | 0.0 | 15.000 | 1.200 |
| CARPOOL | 0.0 | 2.040 | 0.012 | 0.090 | 0.0 | 0.333 | 0.500 | 0.0 | 15.000 | 3.000 |
| FRBUS | 0.0 | 51.780 | 0.160 | 0.480 | 0.0 | 0.333 | 0.200 | 0.020 | 5.200 | 50.000 |

LINKER ANALYSIS BETWEEN NODECNTR AND NODER2C1

| MODE IDENTIFIER | MINHDWAY | MAXHDWAY | MAXRS | STOPS/MI | CARS/VEH | FRACWALK | AMTRAIN | OFFTRAIN | PMTRAIN |
|---|---|---|---|---|---|---|---|---|---|
| AUTO | 0.500 | 0.0 | 0.0 | 0.0 | 1.000 | 0.200 | 1.000 | 1.000 | 1.000 |
| CARPOOL | 0.500 | 0.0 | 0.0 | 0.0 | 1.000 | 0.200 | 1.000 | 1.000 | 1.000 |
| FRBUS | 0.500 | 60.000 | 1.000 | 8.000 | 2.000 | 0.200 | 1.000 | 1.000 | 1.000 |

ALL LINKER BUSES ARE EXPRESS

LINKER ANALYSIS FROM NODECNTR TO NODER2C1

TRAVEL TIMES DURING AM-PEAK , (MEAN & STD.DEV.)

| TRANSIT MODE SHARE: | 0.050 | | 0.100 | | 0.150 | | 0.200 | | 0.250 | | 0.300 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AUTO | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 |
| CARPOOL | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 |
| FIXED-ROUTE BUS | 5.1 | 1.6 | 5.0 | 1.6 | 5.0 | 1.6 | 5.0 | 1.6 | 5.0 | 1.6 | 5.0 | 1.6 |
| TRANSIT TOTAL | 5.1 | 1.6 | 5.0 | 1.6 | 5.0 | 1.6 | 5.0 | 1.6 | 5.0 | 1.6 | 5.0 | 1.6 |

TRAVEL TIMES DURING OFF-PEAK, (MEAN & STD.DEV.)

| TRANSIT MODE SHARE: | 0.025 | | 0.050 | | 0.075 | | 0.100 | | 0.125 | | 0.150 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AUTO | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 |
| CARPOOL | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 |
| FIXED-ROUTE BUS | 5.1 | 1.6 | 5.1 | 1.6 | 5.0 | 1.6 | 5.0 | 1.6 | 5.0 | 1.6 | 5.0 | 1.6 |
| TRANSIT TOTAL | 5.1 | 1.6 | 5.1 | 1.6 | 5.0 | 1.6 | 5.0 | 1.6 | 5.0 | 1.6 | 5.0 | 1.6 |

TRAVEL TIMES DURING PM-PEAK , (MEAN & STD.DEV.)

| TRANSIT MODE SHARE: | 0.050 | | 0.100 | | 0.150 | | 0.200 | | 0.250 | | 0.300 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AUTO | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 |
| CARPOOL | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 |
| FIXED-ROUTE BUS | 5.1 | 1.6 | 5.0 | 1.6 | 5.0 | 1.6 | 5.0 | 1.6 | 5.0 | 1.6 | 5.0 | 1.6 |
| TRANSIT TOTAL | 5.1 | 1.6 | 5.0 | 1.6 | 5.0 | 1.6 | 5.0 | 1.6 | 5.0 | 1.6 | 5.0 | 1.6 |

LINKER ANALYSIS FRDM NDDER2C1 TO NDDECNTR

TRAVEL TIMES DURING AM-PEAK , (MEAN & STD.DEV.)

| TRANSIT MDDE SHARE: | 0.050 | | 0.100 | | 0.150 | | 0.200 | | 0.250 | | 0.300 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AUTD | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 |
| CARPDDL | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 |
| FIXED-ROUTE BUS | 5.1 | 1.6 | 5.0 | 1.6 | 5.0 | 1.6 | 5.0 | 1.6 | 5.0 | 1.6 | 5.0 | 1.6 |
| TRANSIT TDTAL | 5.1 | 1.6 | 5.0 | 1.6 | 5.0 | 1.6 | 5.0 | 1.6 | 5.0 | 1.6 | 5.0 | 1.6 |

TRAVEL TIMES DURING OFF-PEAK, (MEAN & STD.DEV.)

| TRANSIT MDDE SHARE: | 0.025 | | 0.050 | | 0.075 | | 0.100 | | 0.125 | | 0.150 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AUTO | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 |
| CARPDDL | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 |
| FIXED-RDUTE BUS | 5.1 | 1.6 | 5.1 | 1.6 | 5.0 | 1.6 | 5.0 | 1.6 | 5.0 | 1.6 | 5.0 | 1.6 |
| TRANSIT TDTAL | 5.1 | 1.6 | 5.1 | 1.6 | 5.0 | 1.6 | 5.0 | 1.6 | 5.0 | 1.6 | 5.0 | 1.6 |

TRAVEL TIMES DURING PM-PEAK , (MEAN & STD.DEV.)

| TRANSIT MDDE SHARE: | 0.050 | | 0.100 | | 0.150 | | 0.200 | | 0.250 | | 0.300 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| AUTD | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 |
| CARPDDL | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 | 12.5 | 2.7 |
| FIXED-RDUTE BUS | 5.1 | 1.6 | 5.0 | 1.6 | 5.0 | 1.6 | 5.0 | 1.6 | 5.0 | 1.6 | 5.0 | 1.6 |
| TRANSIT TDTAL | 5.1 | 1.6 | 5.0 | 1.6 | 5.0 | 1.6 | 5.0 | 1.6 | 5.0 | 1.6 | 5.0 | 1.6 |

LINKER ANALYSIS FROM NODECNTR TO NODER2C1

| PICKUPS (PER HOUR) DURING AM-PEAK TRANSIT MODE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
|---|---|---|---|---|---|---|
| AUTO | 433200. | 410400. | 387600. | 364800. | 342000. | 319200. |
| CARPOOL | 22800. | 21600. | 20400. | 19200. | 18000. | 16800. |
| FIXED-ROUTE BUS | 24000. | 48000. | 72000. | 96000. | 120000. | 144000. |
| TRANSIT TOTAL | 24000. | 48000. | 72000. | 96000. | 120000. | 144000. |

| PICKUPS (PER HOUR) DURING OFF-PEAK TRANSIT MODE SHARE: | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
|---|---|---|---|---|---|---|
| AUTO | 444600. | 433200. | 421800. | 410400. | 399000. | 387600. |
| CARPOOL | 23400. | 22800. | 22200. | 21600. | 21000. | 20400. |
| FIXED-ROUTE BUS | 12000. | 24000. | 36000. | 48000. | 60000. | 72000. |
| TRANSIT TOTAL | 12000. | 24000. | 36000. | 48000. | 60000. | 72000. |

| PICKUPS (PER HOUR) DURING PM-PEAK TRANSIT MODE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
|---|---|---|---|---|---|---|
| AUTO | 433200. | 410400. | 387600. | 364800. | 342000. | 319200. |
| CARPOOL | 22800. | 21600. | 20400. | 19200. | 18000. | 16800. |
| FIXED-ROUTE BUS | 24000. | 48000. | 72000. | 96000. | 120000. | 144000. |
| TRANSIT TOTAL | 24000. | 48000. | 72000. | 96000. | 120000. | 144000. |

LINKER ANALYSIS FROM NODER2C1 TO NOOECNTR

| | | | | | | |
|---|---|---|---|---|---|---|
| PICKUPS (PER HOUR) OURING AM-PEAK TRANSIT MOOE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| AUTO | 216600. | 205200. | 193800. | 182400. | 171000. | 159600. |
| CARPOOL | 11400. | 10800. | 10200. | 9600. | 9000. | 8400. |
| FIXED-ROUTE BUS | 12000. | 24000. | 36000. | 48000. | 60000. | 72000. |
| TRANSIT TOTAL | 12000. | 24000. | 36000. | 48000. | 60000. | 72000. |
| PICKUPS (PER HOUR) OURING OFF-PEAK TRANSIT MOOE SHARE: | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| AUTO | 222300. | 216600. | 210900. | 205200. | 199500. | 193800. |
| CARPOOL | 11700. | 11400. | 11100. | 10800. | 10500. | 10200. |
| FIXEO-ROUTE BUS | 6000. | 12000. | 18000. | 24000. | 30000. | 36000. |
| TRANSIT TOTAL | 6000. | 12000. | 18000. | 24000. | 30000. | 36000. |
| PICKUPS (PER HOUR) DURING PM-PEAK TRANSIT MODE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| AUTO | 216600. | 205200. | 193800. | 182400. | 171000. | 159600. |
| CARPOOL | 11400. | 10800. | 10200. | 9600. | 9000. | 8400. |
| FIXED-ROUTE BUS | 12000. | 24000. | 36000. | 48000. | 60000. | 72000. |
| TRANSIT TOTAL | 12000. | 24000. | 36000. | 48000. | 60000. | 72000. |

LINKER ANALYSIS BETWEEN NOOECNTR ANO NODER2C1 BI-OIRECTIONAL

| | | | | | | |
|---|---|---|---|---|---|---|
| COST PER TRIP DURING AM-PEAK TRANSIT MOOE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| AUTO | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 |
| CARPOOL | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |
| FIXEO-ROUTE BUS | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| TRANSIT TOTAL | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| COST PER TRIP DURING OFF-PEAK TRANSIT MODE SHARE: | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| AUTO | 0.75 | 0./5 | 0.75 | 0.75 | 0.75 | 0.75 |
| CARPOOL | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |
| FIXEO-ROUTE BUS | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 |
| TRANSIT TOTAL | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 |
| COST PER TRIP DURING PM-PEAK TRANSIT MOOE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| AUTO | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 | 0.75 |
| CARPOOL | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 | 0.30 |
| FIXEO-ROUTE BUS | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| TRANSIT TOTAL | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |

LINKER ANALYSIS BETWEEN NODECNTR ANO NODER2C1 BI-DIRECTIONAL

| | | | | | | |
|---|---|---|---|---|---|---|
| FUEL CONSUMPTION PER TRIP OURING AM-PEAK TRANSIT MOOE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| AUTO | 0.278 | 0.278 | 0.278 | 0.278 | 0.278 | 0.278 |
| CARPOOL | 0.111 | 0.111 | 0.111 | 0.111 | 0.111 | 0.111 |
| FIXED-ROUTE BUS | 0.026 | 0.026 | 0.026 | 0.026 | 0.026 | 0.026 |
| TRANSIT TOTAL | 0.026 | 0.026 | 0.026 | 0.026 | 0.026 | 0.026 |
| FUEL CONSUMPTION PER TRIP OURING OFF-PEAK TRANSIT MOOE SHARE: | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| AUTO | 0.278 | 0.278 | 0.278 | 0.278 | 0.278 | 0.278 |
| CARPODL | 0.111 | 0.111 | 0.111 | 0.111 | 0.111 | 0.111 |
| FIXED-ROUTE BUS | 0.026 | 0.026 | 0.026 | 0.026 | 0.026 | 0.026 |
| TRANSIT TOTAL | 0.026 | 0.026 | 0.026 | 0.026 | 0.026 | 0.026 |
| FUEL CONSUMPTION PER TRIP OURING PM-PEAK TRANSIT MODE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| AUTO | 0.278 | 0.278 | 0.278 | 0.278 | 0.278 | 0.278 |
| CARPOOL | 0.111 | 0.111 | 0.111 | 0.111 | 0.111 | 0.111 |
| FIXED-ROUTE BUS | 0.026 | 0.026 | 0.026 | 0.026 | 0.026 | 0.026 |
| TRANSIT TOTAL | 0.026 | 0.026 | 0.026 | 0.026 | 0.026 | 0.026 |

LINKER ANALYSIS BETWEEN NODECNTR AND NODER2C1 BI-DIRECTIONAL

| | | | | | | |
|---|---|---|---|---|---|---|
| FLEET SIZE NEEDED DURING AM-PEAK | | | | | | |
| TRANSIT MODE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-ROUTE BUS | 80.0 | 160.0 | 240.0 | 320.0 | 400.0 | 480.0 |
| TRANSIT TOTAL | 80.0 | 160.0 | 240.0 | 320.0 | 400.0 | 480.0 |
| FLEET SIZE NEEDED DURING OFF-PEAK | | | | | | |
| TRANSIT MODE SHARE: | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| FIXED-ROUTE BUS | 40.0 | 80.0 | 120.0 | 160.0 | 200.0 | 240.0 |
| TRANSIT TOTAL | 40.0 | 80.0 | 120.0 | 160.0 | 200.0 | 240.0 |
| FLEET SIZE NEEDED DURING PM-PEAK | | | | | | |
| TRANSIT MODE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-ROUTE BUS | 80.0 | 160.0 | 240.0 | 320.0 | 400.0 | 480.0 |
| TRANSIT TOTAL | 80.0 | 160.0 | 240.0 | 320.0 | 400.0 | 480.0 |

LINKER ANALYSIS BETWEEN NOOECNTR AND NOOER2C1 BI-OIRECTIONAL

| | | | | | | |
|---|---|---|---|---|---|---|
| AVERAGE HEAOWAY DURING AM-PEAK TRANSIT MOOE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXEO-ROUTE BUS | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| TRANSIT TOTAL | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| AVERAGE HEAOWAY OURING OFF-PEAK TRANSIT MOOE SHARE: | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| FIXEO-ROUTE BUS | 0.2 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 |
| TRANSIT TOTAL | 0.2 | 0.1 | 0.1 | 0.1 | 0.0 | 0.0 |
| AVERAGE HEADWAY OURING PM-PEAK TRANSIT MOOE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXEO-ROUTE BUS | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |
| TRANSIT TOTAL | 0.1 | 0.1 | 0.0 | 0.0 | 0.0 | 0.0 |

LINKER ANALYSIS BETWEEN NODECNTR AND NODER2C1 BI-DIRECTIONAL

| | | | | | | |
|---|---|---|---|---|---|---|
| VEHICLE-MILES (PER HOUR) DURING AM-PEAK TRANSIT MODE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-ROUTE BUS | 4800. | 9600. | 14400. | 19200. | 24000. | 28800. |
| TRANSIT TOTAL | 4800. | 9600. | 14400. | 19200. | 24000. | 28800. |
| VEHICLE-MILES (PER HOUR) DURING OFF-PEAK TRANSIT MODE SHARE: | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| FIXED-ROUTE BUS | 2400. | 4800. | 7200. | 9600. | 12000. | 14400. |
| TRANSIT TOTAL | 2400. | 4800. | 7200. | 9600. | 12000. | 14400. |
| VEHICLE-MILES (PER HOUR) DURING PM-PEAK TRANSIT MODE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-ROUTE BUS | 4800. | 9600. | 14400. | 19200. | 24000. | 28800. |
| TRANSIT TOTAL | 4800. | 9600. | 14400. | 19200. | 24000. | 28800. |



. . . . . . . . . 53.

END

O ERRORS FOUND

EXAMPLE 7

Job Purpose

To illustrate modal selection and parameter modifications:

1. Define a single zone network;
2. Modify the number of outbound and inbound residential trips for the zone in preparation for FEEDER analysis;
3. Change the default generic modal parameters for the flexible-route mode category;
4. Run a FEEDER analysis of the zone;
5. Select a second flexible-route mode for the next FEEDER analysis;
6. Modify the value of vehicle capacity for this new mode; and
7. Perform a second FEEDER analysis on this zone.

Input Data

```
                                     F I E L D
Keyword <--1---><--2---><--3---><--4---><--5---><--6---><--7---><--8--->

TITLE   EXAMPLE 7 -- MODAL SELECTION AND PARAMETER MODIFICATION
NULLNET
ONEZONE LZONR2C1NODER2C1                16.         NON-CBD
VRES    LZONR2C1OUT                             10.      2.       1.
VRES    LZONR2C1IN                              1.0      2.0     10.0
MODEPARMFLEXRTE STOPS/M        2.
FEEDER  LZONR2C1UNIFORM
MODESEL         FLEX1   FEEDER  FLEXRTE USER ADDED FLEX-RTE MODE
MODEPARMFLEX1   PAS/VEH       5.0
FEEDER  LZONR2C1UNIFORM
END
```

The NULLNET card indicates to the program that an arbitrary network is to be set up. This network consists of a single zone called LZONR2C1 attached to node NODER2C1 as listed on the ONEZONE card. It is a non-CBD zone with an area of 16 square miles.

SMART's default demand generation procedure is not appropriate for a one-zone network. Therefore, override all default demand volumes by the VRES card in preparation for FEEDER analysis. Outbound residential trips are set to 10 trips per minute in the A.M. peak, two trips per minute in the off-peak, and one trip per minute in the P.M. peak; inbound residential trips are set in the next card.

Modal parameters are modified by the MODEPARM card. This card must contain the mode identifier (name), the parameters to be changed and the new values of those parameters. The parameter code (for example, cost per vehicle-mile and cost per vehicle-hour) and its value must be in adjacent fields. Blank fields will be skipped. In the above example, the FLEXRTE is the generic name of the flexible-route service; hence, the default value for stops per mile (applicable to checkpoint service) of all flexible-route service is changed to two stops per (square) mile. All other default values remain unaffected. This is an example of a generic modal parameter change. A selective change (changing the parameter for a particular selected mode, not for the entire mode type) is illustrated later in this example.

A uniform FEEDER analysis is then applied to zone LZONR2C1. SMART will automatically select a representative of each FEEDER mode type to model. To suppress default selection, use the NULLMODE card. Note that the default stops per mile for flexible-route service is now two stops per mile, instead of the original default value.

For the second FEEDER run, an additional flexible-route mode of different capacity is to be selected and its impact on the system analyzed. This is achieved through the MODESEL card, which defines the new mode as FLEX1 and as offering flexible-route feeder service. To indicate that this mode is being added to (and not replacing something) on the selected modes list, FIELD 1 should either be blank or contain the word "ADD". Note that new modes added must have a name (identifier) different from any default mode names as listed under the MODESEL keyword. FIELDs 5 through 8 contain one label of 32 characters to label the mode on the reports.

The MODEPARM card specifies FLEX1's capacity as five passengers per vehicle. Since FLEX1 is not a generic mode name, only parameters for FLEX1 are changed (that is, it is a selective change). Default flexible-route parameters are not affected by this card.

The addition of FLEX1 to the selected modes list does not impact the status of modes selected in the previous FEEDER analysis. These modes, together with FLEX1, are all included in the analysis invoked by the final FEEDER card.

Finally, the run terminates with an END card.

EXAMPLE 8

Job Purpose

To illustrate mode selection:

1. Define a two-ring, three-corridor network;

2. Inactivate the default mode selection process;

3. Select three modes (two for FEEDER, one for LINKER);

4. Invoke a door-to-door analysis between two zones in the ring/corridor structure, using the three selected modes for carrying the trips;

5. Replace one of the modes by a CBD automated guideway transit (AGT) service;

6. Select this as the CBD mode for regionwide analysis; and

7. Run a regionwide analysis.

Input Data

```
                                     F I E L D
Keyword <--1---><--2---><--3---><--4---><--5---><--6---><--7---><--8--->

TITLE   EXAMPLE 8 -- MODE SELECTION
URBAN          2       3
NULLMODE
MODESEL ADD     FLEX    FEEDER  FLEXRTE
MODESEL         BUSL    LINKER  FRBUS
MODESEL         BUSF    FEEDER  FRBUS
DOOR    LZONR2C1RESIDNTLLZONR2C3RESIDNTLFLEX    BUSL    BUSF
MODESEL REPLACE BUSF    CBD     AGT
ZONESET LEFT            1       1                       BUSF
REGION
END
```

The first step of the job sets up a two-ring, three-corridor urban structurevia the URBAN card.

the NULLMODE card "switches off" the default mode selection process. From then on, as long as there is at least one automobile, one carpool and one transit mode for each analysis, no modes will be automatically selected. The next three cards explicitly select modes. These are FLEX, a feeder flexible-route service; BUSL, a linker fixed-route bus mode; and BUSF, a feeder fixed-route bus mode. All these are added to the selected modes list. Note that blanks in FIELD 1 of the MODESEL card is equivalent to "ADD".

The DOOR card performs a door-to-door analysis. Information required on this card are origin and destination zone identifiers and trip end types, and transit modes to use. In this example, the analysis is to be made between the residential areas of LZONR2C1 and LZONR2C3 (default names for zones in the ring/corridor structure) This analysis will include one line-haul and two feeder segments. All modes for the trip have been declared in this card: FLEX as the feeder mode in LZONR2C1, BUSL as the linker bus mode for the entire line-haul trip, and BUSF as the feeder mode in LZONR2C3. If FIELDs 5 through 7 are left blank, SMART will be forced to choose one default transit mode for each segment of the journey.

The next task is to make a regionwide run, with automated guideway transit as the CBD mode. We can avoid adding an extra mode (AGT) to the selected list by using the location occupied by a previously selected mode. This is achieved through the MODESEL card, which redefines BUSF as a CBD AGT mode. Since no MODEPARM card is issued for BUSF, it will retain all the default mode characteristics of the AGT class. In this run, it was not really necessary to re-use the slot in the selected modes list occupied by BUSF, since the list was far from full. The re-use of the slot, through the REPLACE option on the MODESEL card, is given for illustration and not out of necessity.

The ZONESET card specifies that BUSF is to be used as the transit mode for the left zone of Ring 1 Corridor 1 in the next regionwide analysis. For this card to be valid, BUSF must have been previously selected, as in this example. SMART then performs a regionwide analysis on the network, with BUSF as the transit mode for the CBD zone and default assignments for all the other zones.

Finally, the run terminates with an END card. The output for this sample job is shown in Exhibit C.7.

Exhibit C.7. EXAMPLE 8 OUTPUT -- MODE SELECTION

```
SMART MODEL - SYSTAN, INC.                              12/16/81                                    PAGE   1
          .         .         .         .         .         .         .         .         .
TITLE    EXAMPLE 8 -- MODE SELECTION                                                        10.
          .         .         .         .         .         .         .         .         .
URBAN            2         3                                                                11.
          .         .         .         .         .         .         .         .         .
NULLMODE                                                                                    12.
          .         .         .         .         .         .         .         .         .
MOOESEL AOO      FLEX      FEEOER    FLEXRTE                                                13.
          .         .         .         .         .         .         .         .         .
MOOESEL          BUSL      LINKER    FRBUS                                                  14.
          .         .         .         .         .         .         .         .         .
MOOESEL          BUSF      FEEOER    FRBUS                                                  15.
          .         .         .         .         .         .         .         .         .
OOOR     LZONR2C1RESIONTLLZONR2C3RESIONTLFLEX      BUSL      BUSF                           16.
```

EXAMPLE 8 -- MODE SELECTION

| ZONE | POPULATION | EMPLOYMENT |
|---|---|---|
| ZONECNTR | 3863. | 85490. |
| LZONR2C1 | 56585. | 48288. |
| RZONR2C1 | 56585. | 48288. |
| LZONR2C2 | 56585. | 48288. |
| RZONR2C2 | 56585. | 48288. |
| LZONR2C3 | 56585. | 48288. |
| RZONR2C3 | 56585. | 48288. |
| TOTAL | 343376. | 375220. |

| TRIP TYPE: | 1 | 2 | 3 | OVERALL |
|---|---|---|---|---|
| AVERAGE TRIP LENGTH: | 7.3 | 7.3 | 7.0 | 7.3 MINUTES |

OOOR-TO-OOOR ANALYSIS BETWEEN LZONR2C1 ANO LZONR2C3

| | ZONE LZONR2C1 TOTAL TRIPS IN | ZONE LZONR2C1 TOTAL TRIPS OUT | ZONE LZONR2C3 TOTAL TRIPS IN | ZONE LZONR2C3 TOTAL TRIPS OUT |
|---|---|---|---|---|
| AM-PEAK ( 180.0 MINUTES) | 0.0 | 125.745 | 0.0 | 125.745 |
| OFF-PEAK( 360.0 MINUTES) | 9.431 | 15.718 | 9.431 | 15.718 |
| PM-PEAK ( 180.0 MINUTES) | 135.176 | 0.0 | 135.176 | 0.0 |

LINK CHARACTERISTICS ANO TRAFFIC VOLUMES ON ROUTE TO LZONR2C1

| TRANSIT LOAOING AM-PEAK | TRANSIT LOAOING OFF-PEAK | TRANSIT LOAOING PM-PEAK | ON LINK | LENGTH | MILES/MIN | TRANSIT MOOE | HIGHWAY TYPE | NO. OF LANES | OIAMONO LANE? |
|---|---|---|---|---|---|---|---|---|---|
| 31.858 | 17.246 | 97.629 | RHWYR2C1 | 1.60 | 1.000 | FRBUS | FREEWAY | 3.0 | NO |
| 31.858 | 17.246 | 97.629 | RHWYR2C3 | 1.60 | 1.000 | FRBUS | FREEWAY | 3.0 | NO |

LINK CHARACTERISTICS ANO TRAFFIC VOLUMES ON ROUTE TO LZONR2C3

| TRANSIT LOAOING AM-PEAK | TRANSIT LOAOING OFF-PEAK | TRANSIT LOAOING PM-PEAK | ON LINK | LENGTH | MILES/MIN | TRANSIT MOOE | HIGHWAY TYPE | NO. OF LANES | OIAMONO LANE? |
|---|---|---|---|---|---|---|---|---|---|
| 90.936 | 20.200 | 34.120 | RHWYR2C1 | 1.60 | 1.000 | FRBUS | FREEWAY | 3.0 | NO |
| 90.936 | 20.200 | 34.120 | RHWYR2C3 | 1.60 | 1.000 | FRBUS | FREEWAY | 3.0 | NO |

| MOOE IOENTIFIER | MOOE TYPE | MOOE LABEL | FLEXTYPE AM-PEAK | FLEXTYPE OFF-PEAK | FLEXTYPE PM-PEAK | TRANSFER |
|---|---|---|---|---|---|---|
| FLEX | FLEXRTE (FEEOER) | FLEXIBLE-ROUTE SERVICE | SUBSCR | DAR | SUBSCR | RANOOM |
| BUSL | FRBUS (LINKER) | FIXEO-ROUTE BUS | | | | RANOOM |
| BUSF | FRBUS (FEEOER) | FIXEO-ROUTE BUS | | | | RANOOM |
| AUTO | AUTO (FEEOER) | AUTO | | | | RANOOM |
| CARPOOL | CARPOOL (FEEOER) | CARPOOL | | | | RANOOM |
| AUTO | AUTO (LINKER) | AUTO | | | | RANOOM |
| CARPOOL | CARPOOL (LINKER) | CARPOOL | | | | RANOOM |

DOOR-TO-DOOR ANALYSIS BETWEEN LZONR2C1 AND LZONR2C3

| MODE IDENTIFIER | $ | $/V | $/VH | $/VM | $/RM | SPEED | MIN/STOP | MIN/PASS | MI/GAL | PASS/VEH |
|---|---|---|---|---|---|---|---|---|---|---|
| FLEX | 0.0 | 26.610 | 0.145 | 0.200 | 0.0 | 0.333 | 0.500 | 0.0 | 9.000 | 10.000 |
| BUSL | 0.0 | 51.780 | 0.160 | 0.480 | 0.0 | 0.333 | 0.200 | 0.020 | 5.200 | 50.000 |
| BUSF | 0.0 | 51.780 | 0.160 | 0.480 | 0.0 | 0.333 | 0.200 | 0.020 | 5.200 | 50.000 |
| AUTO | 0.0 | 2.040 | 0.012 | 0.090 | 0.0 | 0.333 | 0.500 | 0.0 | 15.000 | 1.200 |
| CARPOOL | 0.0 | 2.040 | 0.012 | 0.090 | 0.0 | 0.333 | 0.500 | 0.0 | 15.000 | 3.000 |
| AUTO | 0.0 | 2.040 | 0.012 | 0.090 | 0.0 | 0.333 | 0.500 | 0.0 | 15.000 | 1.200 |
| CARPOOL | 0.0 | 2.040 | 0.012 | 0.090 | 0.0 | 0.333 | 0.500 | 0.0 | 15.000 | 3.000 |

| MODE IDENTIFIER | MINHDWAY | MAXHDWAY | MAXRS | STOPS/MI | CARS/VEH | FRACWALK | AMTRAIN | OFFTRAIN | PMTRAIN |
|---|---|---|---|---|---|---|---|---|---|
| FLEX | 0.500 | 60.000 | 1.000 | 4.000 | 1.000 | 0.200 | 1.000 | 1.000 | 1.000 |
| BUSL | 0.500 | 60.000 | 1.000 | 8.000 | 2.000 | 0.200 | 1.000 | 1.000 | 1.000 |
| BUSF | 0.500 | 60.000 | 1.000 | 8.000 | 2.000 | 0.200 | 1.000 | 1.000 | 1.000 |
| AUTO | 0.500 | 0.0 | 0.0 | 0.0 | 1.000 | 0.200 | 1.000 | 1.000 | 1.000 |
| CARPOOL | 0.500 | 0.0 | 0.0 | 0.0 | 1.000 | 0.200 | 1.000 | 1.000 | 1.000 |
| AUTO | 0.500 | 0.0 | 0.0 | 0.0 | 1.000 | 0.200 | 1.000 | 1.000 | 1.000 |
| CARPOOL | 0.500 | 0.0 | 0.0 | 0.0 | 1.000 | 0.200 | 1.000 | 1.000 | 1.000 |

EXAMPLE 8 -- MODE SELECTION

DOOR-TO-DOOR ANALYSIS FROM LZONR2C1 TO LZONR2C3

TRAVEL TIMES DURING AM-PEAK , (MEAN & STD.DEV.)

| TRANSIT MODE SHARE: | | 0.050 | | 0.100 | | 0.150 | | 0.200 | | 0.250 | | 0.300 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FLEXIBLE-ROUTE SERVICE | (FEEDER) | 19.6 | 5.8 | 19.0 | 5.7 | 18.8 | 5.7 | 18.7 | 5.7 | 18.7 | 5.7 | 18.6 | 5.6 |
| FIXED-ROUTE BUS | (LINKER) | 16.3 | 3.3 | 6.3 | 2.1 | 5.4 | 1.9 | 4.9 | 1.8 | 4.6 | 1.7 | 4.4 | 1.6 |

TRAVEL TIMES DURING OFF-PEAK, (MEAN & STD.DEV.)

| TRANSIT MODE SHARE: | | 0.025 | | 0.050 | | 0.075 | | 0.100 | | 0.125 | | 0.150 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FLEXIBLE-ROUTE SERVICE | (FEEDER) | 41.6 | 9.1 | 35.8 | 8.4 | 33.0 | 8.0 | 31.3 | 7.8 | 30.1 | 7.6 | 29.2 | 7.5 |
| FIXED-ROUTE BUS | (LINKER) | 40.2 | 5.9 | 36.0 | 5.5 | 27.8 | 4.7 | 23.7 | 4.2 | 21.2 | 3.9 | 19.5 | 3.7 |
| FIXED-ROUTE BUS | (FEEDER) | 41.5 | 6.1 | 42.7 | 6.2 | 43.9 | 6.3 | 44.9 | 6.4 | 45.0 | 6.4 | 43.5 | 6.3 |
| AUTO TOTAL | (DOOR) | 13.7 | 2.8 | 13.7 | 2.8 | 13.7 | 2.8 | 13.7 | 2.8 | 13.7 | 2.8 | 13.7 | 2.8 |
| CARPOOL TOTAL | (DOOR) | 22.6 | 3.6 | 22.7 | 3.6 | 22.8 | 3.6 | 22.9 | 3.6 | 23.0 | 3.6 | 23.1 | 3.6 |
| TRANSIT TOTAL | (DOOR) | 123.3 | 12.5 | 114.6 | 11.8 | 104.7 | 11.3 | 99.8 | 10.9 | 96.2 | 10.7 | 92.2 | 10.5 |

TRAVEL TIMES DURING PM-PEAK , (MEAN & STD.DEV.)

| TRANSIT MODE SHARE: | | 0.050 | | 0.100 | | 0.150 | | 0.200 | | 0.250 | | 0.300 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| FIXED-ROUTE BUS | (LINKER) | 15.9 | 3.2 | 6.2 | 2.1 | 5.3 | 1.9 | 4.8 | 1.7 | 4.5 | 1.7 | 4.3 | 1.6 |
| FIXED-ROUTE BUS | (FEEDER) | 30.2 | 5.3 | 24.4 | 4.8 | 21.9 | 4.5 | 20.3 | 4.4 | 19.3 | 4.3 | 18.5 | 4.2 |

DOOR-TO-DOOR ANALYSIS FROM LZONR2C3 TO LZONR2C1

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TRAVEL TIMES DURING AM-PEAK , (MEAN & STO.OEV.) | | | | | | | | | | | | | |
| TRANSIT MOOE SHARE: | | 0.050 | | 0.100 | | 0.150 | | 0.200 | | 0.250 | | 0.300 | |
| FIXEO-ROUTE BUS | (LINKER) | 16.3 | 3.3 | 6.3 | 2.1 | 5.4 | 1.9 | 4.9 | 1.8 | 4.6 | 1.7 | 4.4 | 1.6 |
| FIXED-ROUTE BUS | (FEEDER) | 25.1 | 4.8 | 21.3 | 4.4 | 19.6 | 4.3 | 18.6 | 4.2 | 18.0 | 4.1 | 17.4 | 4.1 |
| TRAVEL TIMES DURING OFF-PEAK, (MEAN & STD.OEV.) | | | | | | | | | | | | | |
| TRANSIT MOOE SHARE: | | 0.025 | | 0.050 | | 0.075 | | 0.100 | | 0.125 | | 0.150 | |
| FLEXIBLE-ROUTE SERVICE | (FEEOER) | 49.4 | 10.1 | 42.1 | 9.2 | 38.5 | 8.8 | 36.3 | 8.5 | 34.7 | 8.3 | 33.6 | 8.1 |
| FIXED-ROUTE BUS | (LINKER) | 40.2 | 5.9 | 36.0 | 5.5 | 27.8 | 4.7 | 23.7 | 4.2 | 21.2 | 3.9 | 19.5 | 3.7 |
| FIXEO-ROUTE BUS | (FEEOER) | 31.1 | 5.2 | 33.1 | 5.4 | 33.8 | 5.5 | 34.0 | 5.5 | 34.2 | 5.5 | 33.3 | 5.5 |
| AUTO TOTAL | (OOOR) | 13.7 | 2.8 | 13.7 | 2.8 | 13.7 | 2.8 | 13.7 | 2.8 | 13.7 | 2.8 | 13.7 | 2.8 |
| CARPOOL TOTAL | (OOOR) | 22.6 | 3.6 | 22.7 | 3.6 | 22.8 | 3.6 | 22.9 | 3.6 | 23.0 | 3.6 | 23.1 | 3.6 |
| TRANSIT TOTAL | (OOOR) | 120.7 | 12.8 | 111.3 | 12.0 | 100.1 | 11.4 | 93.9 | 11.0 | 90.1 | 10.7 | 86.4 | 10.5 |
| TRAVEL TIMES DURING PM-PEAK , (MEAN & STD.DEV.) | | | | | | | | | | | | | |
| TRANSIT MOOE SHARE: | | 0.050 | | 0.100 | | 0.150 | | 0.200 | | 0.250 | | 0.300 | |
| FLEXIBLE-ROUTE SERVICE | (FEEOER) | 41.3 | 9.1 | 41.2 | 9.1 | 41.1 | 9.1 | 41.1 | 9.1 | 41.1 | 9.1 | 41.1 | 9.1 |
| FIXEO-ROUTE BUS | (LINKER) | 15.9 | 3.2 | 6.2 | 2.1 | 5.3 | 1.9 | 4.8 | 1.7 | 4.5 | 1.7 | 4.3 | 1.6 |

DOOR-TO-DOOR ANALYSIS FROM LZONR2C1 TO LZONR2C3

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| COST PER TRIP DURING AM-PEAK TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FLEXIBLE-ROUTE SERVICE | (FEEDER) | 0.59 | 0.57 | 0.57 | 0.57 | 0.56 | 0.56 |
| FIXED-ROUTE BUS | (LINKER) | 0.14 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 |
| COST PER TRIP DURING OFF-PEAK TRANSIT MODE SHARE: | | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| FLEXIBLE-ROUTE SERVICE | (FEEDER) | 0.57 | 0.48 | 0.43 | 0.40 | 0.38 | 0.37 |
| FIXED-ROUTE BUS | (LINKER) | 0.12 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 |
| FIXED-ROUTE BUS | (FEEDER) | 0.49 | 0.26 | 0.18 | 0.14 | 0.12 | 0.11 |
| AUTO TOTAL | (DOOR) | 1.38 | 1.38 | 1.38 | 1.38 | 1.38 | 1.38 |
| CARPOOL TOTAL | (DOOR) | 0.73 | 0.74 | 0.74 | 0.74 | 0.74 | 0.75 |
| TRANSIT TOTAL | (DOOR) | 1.18 | 0.82 | 0.69 | 0.62 | 0.58 | 0.55 |
| COST PER TRIP DURING PM-PEAK TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-ROUTE BUS | (LINKER) | 0.15 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 |
| FIXED-ROUTE BUS | (FEEDER) | 0.22 | 0.23 | 0.23 | 0.23 | 0.23 | 0.23 |

DOOR-TO-DOOR ANALYSIS FROM LZONR2C3 TO LZONR2C1

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| COST PER TRIP DURING AM-PEAK TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-ROUTE BUS | (LINKER) | 0.14 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 |
| FIXED-ROUTE BUS | (FEEDER) | 0.21 | 0.21 | 0.22 | 0.22 | 0.22 | 0.22 |
| COST PER TRIP DURING OFF-PEAK TRANSIT MODE SHARE: | | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| FLEXIBLE-ROUTE SERVICE | (FEEDER) | 0.57 | 0.48 | 0.43 | 0.40 | 0.38 | 0.37 |
| FIXED-ROUTE BUS | (LINKER) | 0.12 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 |
| FIXED-ROUTE BUS | (FEEDER) | 0.49 | 0.26 | 0.18 | 0.14 | 0.12 | 0.11 |
| AUTO TOTAL | (DOOR) | 1.38 | 1.38 | 1.38 | 1.38 | 1.38 | 1.38 |
| CARPOOL TOTAL | (DOOR) | 0.73 | 0.74 | 0.74 | 0.74 | 0.74 | 0.75 |
| TRANSIT TOTAL | (DOOR) | 1.18 | 0.82 | 0.69 | 0.62 | 0.58 | 0.55 |
| COST PER TRIP DURING PM-PEAK TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FLEXIBLE-ROUTE SERVICE | (FEEDER) | 0.58 | 0.58 | 0.58 | 0.58 | 0.58 | 0.58 |
| FIXED-ROUTE BUS | (LINKER) | 0.15 | 0.08 | 0.08 | 0.08 | 0.08 | 0.08 |

DOOR-TO-DOOR ANALYSIS FROM LZONR2C1 TO LZONR2C3

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| FUEL CONSUMPTION PER TRIP DURING AM-PEAK TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FLEXIBLE-ROUTE SERVICE | (FEEDER) | 0.073 | 0.072 | 0.072 | 0.072 | 0.072 | 0.072 |
| FIXED-ROUTE BUS | (LINKER) | 0.018 | 0.018 | 0.018 | 0.018 | 0.018 | 0.018 |
| FUEL CONSUMPTION PER TRIP DURING OFF-PEAK TRANSIT MODE SHARE: | | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| FLEXIBLE-ROUTE SERVICE | (FEEDER) | 0.084 | 0.069 | 0.063 | 0.059 | 0.056 | 0.055 |
| FIXED-ROUTE BUS | (LINKER) | 0.022 | 0.013 | 0.013 | 0.013 | 0.013 | 0.013 |
| FIXED-ROUTE BUS | (FEEDER) | 0.085 | 0.043 | 0.028 | 0.021 | 0.017 | 0.016 |
| AUTO TOTAL | (DOOR) | 0.371 | 0.371 | 0.371 | 0.371 | 0.371 | 0.371 |
| CARPOOL TOTAL | (DOOR) | 0.257 | 0.259 | 0.260 | 0.262 | 0.263 | 0.265 |
| TRANSIT TOTAL | (DOOR) | 0.191 | 0.125 | 0.105 | 0.094 | 0.087 | 0.083 |
| FUEL CONSUMPTION PER TRIP DURING PM-PEAK TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-ROUTE BUS | (LINKER) | 0.018 | 0.018 | 0.018 | 0.018 | 0.018 | 0.018 |
| FIXED-ROUTE BUS | (FEEDER) | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |

DOOR-TO-DOOR ANALYSIS FROM LZONR2C3 TO LZONR2C1

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| FUEL CONSUMPTION PER TRIP DURING AM-PEAK TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-ROUTE BUS | (LINKER) | 0.018 | 0.018 | 0.018 | 0.018 | 0.018 | 0.018 |
| FIXED-ROUTE BUS | (FEEDER) | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| FUEL CONSUMPTION PER TRIP DURING OFF-PEAK TRANSIT MODE SHARE: | | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| FLEXIBLE-ROUTE SERVICE | (FEEDER) | 0.084 | 0.069 | 0.063 | 0.059 | 0.056 | 0.055 |
| FIXED-ROUTE BUS | (LINKER) | 0.022 | 0.013 | 0.013 | 0.013 | 0.013 | 0.013 |
| FIXED-ROUTE BUS | (FEEDER) | 0.085 | 0.043 | 0.028 | 0.021 | 0.017 | 0.016 |
| AUTO TOTAL | (DOOR) | 0.371 | 0.371 | 0.371 | 0.371 | 0.371 | 0.371 |
| CARPOOL TOTAL | (DOOR) | 0.257 | 0.259 | 0.260 | 0.262 | 0.263 | 0.265 |
| TRANSIT TOTAL | (DOOR) | 0.191 | 0.125 | 0.105 | 0.094 | 0.087 | 0.083 |
| FUEL CONSUMPTION PER TRIP DURING PM-PEAK TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FLEXIBLE-ROUTE SERVICE | (FEEDER) | 0.072 | 0.072 | 0.072 | 0.072 | 0.072 | 0.072 |
| FIXED-ROUTE BUS | (LINKER) | 0.018 | 0.018 | 0.018 | 0.018 | 0.018 | 0.018 |

OOOR-TO-OOOR ANALYSIS FROM LZONR2C1 TO LZONR2C3

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| FLEET SIZE NEEOED DURING AM-PEAK TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FLEXIBLE-ROUTE SERVICE | (FEEOER) | 7.1 | 13.3 | 19.6 | 25.8 | 32.1 | 38.3 |
| FIXED-ROUTE BUS | (LINKER) | 0.2 | 0.2 | 0.2 | 0.3 | 0.4 | 0.4 |
| FIXED-ROUTE BUS | (FEEDER) | 1.2 | 2.5 | 3.7 | 4.9 | 6.2 | 7.4 |
| TRANSIT TOTAL | (OOOR) | 8.6 | 15.9 | 23.5 | 31.0 | 38.6 | 46.2 |
| FLEET SIZE NEEOED DURING OFF-PEAK TRANSIT MODE SHARE: | | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| FLEXIBLE-ROUTE SERVICE | (FEEDER) | 0.9 | 1.5 | 2.0 | 2.5 | 2.9 | 3.4 |
| FIXED-ROUTE BUS | (LINKER) | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 |
| FIXEO-ROUTE BUS | (FEEDER) | 0.5 | 0.5 | 0.6 | 0.6 | 0.6 | 0.7 |
| TRANSIT TOTAL | (OOOR) | 1.4 | 2.0 | 2.6 | 3.2 | 3.7 | 4.2 |
| FLEET SIZE NEEOED DURING PM-PEAK TRANSIT MOOE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FLEXIBLE-ROUTE SERVICE | (FEEDER) | 6.7 | 13.5 | 20.2 | 26.9 | 33.7 | 40.4 |
| FIXED-ROUTE BUS | (LINKER) | 0.3 | 0.2 | 0.2 | 0.3 | 0.4 | 0.5 |
| FIXED-ROUTE BUS | (FEEDER) | 2.2 | 4.3 | 6.5 | 8.6 | 10.8 | 12.9 |
| TRANSIT TOTAL | (DOOR) | 9.1 | 18.0 | 26.9 | 35.9 | 44.9 | 53.9 |

DOOR-TO-DOOR ANALYSIS FROM LZONR2C3 TO LZONR2C1

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| FLEET SIZE NEEDED DURING AM-PEAK TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FLEXIBLE-ROUTE SERVICE | (FEEDER) | 6.3 | 12.5 | 18.8 | 25.1 | 31.3 | 37.6 |
| FIXED-ROUTE BUS | (LINKER) | 0.2 | 0.2 | 0.2 | 0.3 | 0.4 | 0.4 |
| FIXED-ROUTE BUS | (FEEDER) | 2.0 | 4.0 | 6.0 | 8.0 | 10.0 | 12.0 |
| TRANSIT TOTAL | (DOOR) | 8.5 | 16.7 | 25.1 | 33.4 | 41.7 | 50.1 |
| FLEET SIZE NEEDED DURING OFF-PEAK TRANSIT MODE SHARE: | | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| FLEXIBLE-ROUTE SERVICE | (FEEDER) | 0.9 | 1.5 | 2.0 | 2.5 | 2.9 | 3.4 |
| FIXED-ROUTE BUS | (LINKER) | 0.0 | 0.0 | 0.1 | 0.1 | 0.1 | 0.1 |
| FIXED-ROUTE BUS | (FEEDER) | 0.5 | 0.6 | 0.6 | 0.7 | 0.7 | 0.8 |
| TRANSIT TOTAL | (DOOR) | 1.4 | 2.1 | 2.7 | 3.2 | 3.7 | 4.3 |
| FLEET SIZE NEEDED DURING PM-PEAK TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FLEXIBLE-ROUTE SERVICE | (FEEDER) | 7.0 | 13.7 | 20.4 | 27.2 | 33.9 | 40.7 |
| FIXED-ROUTE BUS | (LINKER) | 0.3 | 0.2 | 0.2 | 0.3 | 0.4 | 0.5 |
| FIXED-ROUTE BUS | (FEEDER) | 1.3 | 2.7 | 4.0 | 5.3 | 6.6 | 8.0 |
| TRANSIT TOTAL | (DOOR) | 8.6 | 16.5 | 24.7 | 32.8 | 41.0 | 49.1 |

EXAMPLE 8 -- MODE SELECTION

DOOR-TO-DOOR ANALYSIS FROM LZONR2C1 TO LZONR2C3

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| AVERAGE HEADWAY DURING AM-PEAK TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FLEXIBLE-ROUTE SERVICE | (FEEDER) | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 |
| FIXED-ROUTE BUS | (LINKER) | 11.0 | 5.5 | 3.7 | 2.7 | 2.2 | 1.8 |
| FIXED-ROUTE BUS | (FEEDER) | 35.1 | 24.9 | 20.3 | 17.6 | 15.7 | 14.3 |
| TRANSIT TOTAL | (DOOR) | 55.1 | 54.0 | 53.2 | 52.7 | 52.4 | 52.1 |
| AVERAGE HEADWAY DURING OFF-PEAK TRANSIT MODE SHARE: | | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| FLEXIBLE-ROUTE SERVICE | (FEEDER) | 44.4 | 37.1 | 33.5 | 31.3 | 29.7 | 28.6 |
| FIXED-ROUTE BUS | (LINKER) | 60.0 | 49.5 | 33.0 | 24.8 | 19.8 | 16.5 |
| FIXED-ROUTE BUS | (FEEDER) | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 | 57.4 |
| TRANSIT TOTAL | (DOOR) | 50.2 | 43.4 | 39.4 | 36.8 | 34.7 | 33.0 |
| AVERAGE HEADWAY DURING PM-PEAK TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FLEXIBLE-ROUTE SERVICE | (FEEDER) | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 |
| FIXED-ROUTE BUS | (LINKER) | 10.2 | 5.1 | 3.4 | 2.6 | 2.0 | 1.7 |
| FIXED-ROUTE BUS | (FEEDER) | 33.9 | 24.0 | 19.6 | 16.9 | 15.2 | 13.8 |
| TRANSIT TOTAL | (DOOR) | 52.5 | 50.8 | 49.8 | 49.1 | 48.7 | 48.4 |

OOOR-TO-OOOR ANALYSIS FROM LZONR2C3 TO LZONR2C1

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| AVERAGE HEAOWAY OURING AM-PEAK TRANSIT MOOE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FLEXIBLE-ROUTE SERVICE | (FEEOER) | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 |
| FIXEO-ROUTE BUS | (LINKER) | 11.0 | 5.5 | 3.7 | 2.7 | 2.2 | 1.8 |
| FIXEO-ROUTE BUS | (FEEOER) | 35.1 | 24.9 | 20.3 | 17.6 | 15.7 | 14.3 |
| TRANSIT TOTAL | (DOOR) | 52.8 | 51.1 | 49.9 | 49.3 | 48.8 | 48.5 |
| AVERAGE HEAOWAY DURING OFF-PEAK TRANSIT MOOE SHARE: | | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| FLEXIBLE-ROUTE SERVICE | (FEEOER) | 44.4 | 37.1 | 33.5 | 31.3 | 29.7 | 28.6 |
| FIXEO-ROUTE BUS | (LINKER) | 60.0 | 49.5 | 33.0 | 24.8 | 19.8 | 16.5 |
| FIXEO-ROUTE BUS | (FEEOER) | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 | 57.4 |
| TRANSIT TOTAL | (OOOR) | 50.5 | 44.0 | 39.9 | 37.0 | 34.9 | 33.3 |
| AVERAGE HEAOWAY OURING PM-PEAK TRANSIT MOOE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FLEXIBLE-ROUTE SERVICE | (FEEOER) | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 |
| FIXEO-ROUTE BUS | (LINKER) | 10.2 | 5.1 | 3.4 | 2.6 | 2.0 | 1.7 |
| FIXEO-ROUTE BUS | (FEEOER) | 33.9 | 24.0 | 19.6 | 16.9 | 15.2 | 13.8 |
| TRANSIT TOTAL | (OOOR) | 54.5 | 53.7 | 52.9 | 52.5 | 52.2 | 51.9 |

DDOR-TD-DDDR ANALYSIS FROM LZONR2C1 TO LZONR2C3

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| AVERAGE VEHICLE LOADING DURING AM-PEAK TRANSIT MDDE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FLEXIBLE-RDUTE SERVICE | (FEEDER) | 6.0 | 6.0 | 6.1 | 6.1 | 6.1 | 6.1 |
| FIXED-ROUTE BUS | (LINKER) | 8.6 | 8.3 | 8.2 | 8.2 | 8.2 | 8.2 |
| FIXED-RDUTE BUS | (FEEDER) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| TRANSIT TOTAL | (DDOR) | 5.2 | 5.1 | 5.1 | 5.1 | 5.1 | 5.1 |
| AVERAGE VEHICLE LDADING DURING DFF-PEAK TRANSIT MODE SHARE: | | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| FLEXIBLE-RDUTE SERVICE | (FEEDER) | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 | 10.0 |
| FIXED-RDUTE BUS | (LINKER) | 6.1 | 10.1 | 10.1 | 10.1 | 10.1 | 10.1 |
| FIXED-RDUTE BUS | (FEEDER) | 3.2 | 6.8 | 10.6 | 14.6 | 18.1 | 19.9 |
| TRANSIT TOTAL | (DOOR) | 7.5 | 9.2 | 10.1 | 10.9 | 11.4 | 11.7 |
| AVERAGE VEHICLE LOADING DURING PM-PEAK TRANSIT MDDE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FLEXIBLE-ROUTE SERVICE | (FEEDER) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0. |
| FIXED-RDUTE BUS | (LINKER) | 8.6 | 8.3 | 8.3 | 8.2 | 8.2 | 8.2 |
| FIXED-ROUTE BUS | (FEEDER) | 32.7 | 32.7 | 32.7 | 32.7 | 32.7 | 32.7 |
| TRANSIT TOTAL | (DDDR) | 8.0 | 7.9 | 7.9 | 7.9 | 7.9 | 7.9 |

DOOR-TO-DOOR ANALYSIS FROM LZONR2C3 TO LZONR2C1

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| AVERAGE VEHICLE LOADING DURING AM-PEAK TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FLEXIBLE-ROUTE SERVICE | (FEEDER) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| FIXED-ROUTE BUS | (LINKER) | 8.6 | 8.3 | 8.2 | 8.2 | 8.2 | 8.2 |
| FIXED-ROUTE BUS | (FEEDER) | 32.7 | 32.7 | 32.7 | 32.7 | 32.7 | 32.7 |
| TRANSIT TOTAL | (DOOR) | 8.0 | 7.9 | 7.9 | 7.9 | 7.9 | 7.9 |
| AVERAGE VEHICLE LOADING DURING OFF-PEAK TRANSIT MODE SHARE: | | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| FLEXIBLE-ROUTE SERVICE | (FEEDER) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| FIXED-ROUTE BUS | (LINKER) | 6.1 | 10.1 | 10.1 | 10.1 | 10.1 | 10.1 |
| FIXED-ROUTE BUS | (FEEDER) | 5.5 | 12.0 | 18.1 | 24.1 | 29.9 | 32.7 |
| TRANSIT TOTAL | (DOOR) | 2.2 | 3.7 | 4.6 | 5.3 | 5.8 | 6.1 |
| AVERAGE VEHICLE LOADING DURING PM-PEAK TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FLEXIBLE-ROUTE SERVICE | (FEEDER) | 6.1 | 6.1 | 6.1 | 6.1 | 6.1 | 6.1 |
| FIXED-ROUTE BUS | (LINKER) | 8.6 | 8.3 | 8.3 | 8.2 | 8.2 | 8.2 |
| FIXED-ROUTE BUS | (FEEDER) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| TRANSIT TOTAL | (DOOR) | 5.2 | 5.1 | 5.1 | 5.1 | 5.1 | 5.1 |

OOOR-TO-OOOR ANALYSIS FROM LZONR2C1 TO LZONR2C3

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| VEHICLE-MILES (PER HOUR) DURING AM-PEAK TRANSIT MOOE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FLEXIBLE-ROUTE SERVICE | (FEEOER) | 124. | 245. | 367. | 489. | 611. | 733. |
| FIXEO-ROUTE BUS | (LINKER) | 4. | 8. | 12. | 17. | 21. | 25. |
| FIXEO-ROUTE BUS | (FEEOER) | 24. | 49. | 73. | 98. | 122. | 146. |
| TRANSIT TOTAL | (OOOR) | 153. | 303. | 453. | 603. | 754. | 904. |
| VEHICLE-MILES (PER HOUR) DURING OFF-PEAK TRANSIT MOOE SHARE: | | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| FLEXIBLE-ROUTE SERVICE | (FEEDER) | 14. | 24. | 32. | 40. | 48. | 56. |
| FIXEO-ROUTE BUS | (LINKER) | 1. | 1. | 1. | 2. | 2. | 3. |
| FIXEO-ROUTE BUS | (FEEDER) | 8. | 8. | 8. | 8. | 8. | 9. |
| TRANSIT TOTAL | (OOOR) | 23. | 33. | 42. | 50. | 58. | 67. |
| VEHICLE-MILES (PER HOUR) OURING PM-PEAK TRANSIT MOOE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FLEXIBLE-ROUTE SERVICE | (FEEOER) | 132. | 263. | 394. | 525. | 656. | 787. |
| FIXED-ROUTE BUS | (LINKER) | 4. | 9. | 13. | 18. | 22. | 27. |
| FIXED-ROUTE BUS | (FEEOER) | 26. | 52. | 79. | 105. | 131. | 157. |
| TRANSIT TOTAL | (OOOR) | 162. | 324. | 486. | 648. | 810. | 972. |

DOOR-TO-DOOR ANALYSIS FROM LZONR2C3 TO LZONR2C1

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| VEHICLE-MILES (PER HOUR) OURING AM-PEAK TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FLEXIBLE-ROUTE SERVICE | (FEEOER) | 124. | 245. | 367. | 489. | 611. | 733. |
| FIXED-ROUTE BUS | (LINKER) | 4. | 8. | 12. | 17. | 21. | 25. |
| FIXED-ROUTE BUS | (FEEOER) | 24. | 49. | 73. | 98. | 122. | 146. |
| TRANSIT TOTAL | (DOOR) | 153. | 303. | 453. | 603. | 754. | 904. |
| VEHICLE-MILES (PER HOUR) OURING OFF-PEAK TRANSIT MOOE SHARE: | | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| FLEXIBLE-ROUTE SERVICE | (FEEOER) | 14. | 24. | 32. | 40. | 48. | 56. |
| FIXEO-ROUTE BUS | (LINKER) | 1. | 1. | 1. | 2. | 2. | 3. |
| FIXEO-ROUTE BUS | (FEEOER) | 8. | 8. | 8. | 8. | 8. | 9. |
| TRANSIT TOTAL | (OOOR) | 23. | 33. | 42. | 50. | 58. | 67. |
| VEHICLE-MILES (PER HOUR) OURING PM-PEAK TRANSIT MOOE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FLEXIBLE-ROUTE SERVICE | (FEEDER) | 132. | 263. | 394. | 525. | 656. | 787. |
| FIXEO-ROUTE BUS | (LINKER) | 4. | 9. | 13. | 18. | 22. | 27. |
| FIXEO-ROUTE BUS | (FEEOER) | 26. | 52. | 79. | 105. | 131. | 157. |
| TRANSIT TOTAL | (OOOR) | 162. | 324. | 486. | 648. | 810. | 972. |

FEEDER UNIFORM SERVICE ANALYSIS OF LZONR2C1 OUTBOUND

| | | | | | | |
|---|---|---|---|---|---|---|
| PICKUPS (PER HOUR) OURING AM-PEAK TRANSIT MOOE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FLEXIBLE-ROUTE SERVICE | 377. | 754. | 1132. | 1509. | 1886. | 2263. |
| AUTO | 6809. | 6451. | 6092. | 5734. | 5376. | 5017. |
| CARPOOL | 358. | 340. | 321. | 302. | 283. | 264. |
| PICKUPS (PER HOUR) OURING OFF-PEAK TRANSIT MOOE SHARE: | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| FLEXIBLE-ROUTE SERVICE | 24. | 47. | 71. | 94. | 118. | 141. |
| AUTO | 874. | 851. | 829. | 806. | 784. | 762. |
| CARPOOL | 46. | 45. | 44. | 42. | 41. | 40. |
| PICKUPS (PER HOUR) OURING PM-PEAK TRANSIT MOOE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FLEXIBLE-ROUTE SERVICE | 0. | 0. | 0. | 0. | 0. | 0. |
| AUTO | 0. | 0. | 0. | 0. | 0. | 0. |
| CARPOOL | 0. | 0. | 0. | 0. | 0. | 0. |

FEEDER UNIFORM SERVICE ANALYSIS OF LZONR2C1 INBOUND

| | | | | | | |
|---|---|---|---|---|---|---|
| PICKUPS (PER HOUR) DURING AM-PEAK TRANSIT MODE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FLEXIBLE-ROUTE SERVICE | 0. | 0. | 0. | 0. | 0. | 0. |
| AUTO | 0. | 0. | 0. | 0. | 0. | 0. |
| CARPOOL | 0. | 0. | 0. | 0. | 0. | 0. |
| PICKUPS (PER HOUR) DURING OFF-PEAK TRANSIT MODE SHARE: | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| FLEXIBLE-ROUTE SERVICE | 14. | 28. | 42. | 57. | 71. | 85. |
| AUTO | 524. | 511. | 497. | 484. | 470. | 457. |
| CARPOOL | 28. | 27. | 26. | 25. | 25. | 24. |
| PICKUPS (PER HOUR) DURING PM-PEAK TRANSIT MODE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FLEXIBLE-ROUTE SERVICE | 406. | 811. | 1217. | 1622. | 2028. | 2433. |
| AUTO | 7320. | 6935. | 6549. | 6164. | 5779. | 5394. |
| CARPOOL | 385. | 365. | 345. | 324. | 304. | 284. |

FEEDER UNIFORM SERVICE ANALYSIS OF LZONR2C3 OUTBOUNO

| | | | | | | |
|---|---|---|---|---|---|---|
| PICKUPS (PER HOUR) DURING AM-PEAK TRANSIT MODE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-ROUTE BUS | 377. | 754. | 1132. | 1509. | 1886. | 2263. |
| AUTO | 6809. | 6451. | 6092. | 5734. | 5376. | 5017. |
| CARPOOL | 358. | 340. | 321. | 302. | 283. | 264. |
| PICKUPS (PER HOUR) DURING OFF-PEAK TRANSIT MOOE SHARE: | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| FIXEO-ROUTE BUS | 24. | 47. | 71. | 94. | 118. | 141. |
| AUTO | 874. | 851. | 829. | 806. | 784. | 762. |
| CARPOOL | 46. | 45. | 44. | 42. | 41. | 40. |
| PICKUPS (PER HOUR) DURING PM-PEAK TRANSIT MOOE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXEO-ROUTE BUS | 0. | 0. | 0. | 0. | 0. | 0. |
| AUTO | 0. | 0. | 0. | 0. | 0. | 0. |
| CARPOOL | 0. | 0. | 0. | 0. | 0. | 0. |

FEEDER UNIFORM SERVICE ANALYSIS OF LZONR2C3 INBOUND

| | | | | | | |
|---|---|---|---|---|---|---|
| PICKUPS (PER HOUR) DURING AM-PEAK TRANSIT MODE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-ROUTE BUS | 0. | 0. | 0. | 0. | 0. | 0. |
| AUTO | 0. | 0. | 0. | 0. | 0. | 0. |
| CARPOOL | 0. | 0. | 0. | 0. | 0. | 0. |
| PICKUPS (PER HOUR) DURING OFF-PEAK TRANSIT MODE SHARE: | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| FIXED-ROUTE BUS | 14. | 28. | 42. | 57. | 71. | 85. |
| AUTO | 524. | 511. | 497. | 484. | 470. | 457. |
| CARPOOL | 28. | 27. | 26. | 25. | 25. | 24. |
| PICKUPS (PER HOUR) DURING PM-PEAK TRANSIT MODE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-ROUTE BUS | 406. | 811. | 1217. | 1622. | 2028. | 2433. |
| AUTO | 7320. | 6935. | 6549. | 6164. | 5779. | 5394. |
| CARPOOL | 385. | 365. | 345. | 324. | 304. | 284. |

LINKER ANALYSIS FROM NOOER2C1 TO NOOER2C3

| | | | | | | |
|---|---|---|---|---|---|---|
| PICKUPS (PER HOUR) DURING AM-PEAK TRANSIT MOOE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-ROUTE BUS | 44. | 88. | 131. | 175. | 219. | 263. |
| AUTO | 790. | 749. | 707. | 665. | 624. | 582. |
| CARPOOL | 42. | 39. | 37. | 35. | 33. | 31. |
| PICKUPS (PER HOUR) OURING OFF-PEAK TRANSIT MOOE SHARE: | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| FIXED-ROUTE BUS | 6. | 12. | 18. | 24. | 31. | 37. |
| AUTO | 227. | 221. | 215. | 209. | 203. | 198. |
| CARPOOL | 12. | 12. | 11. | 11. | 11. | 10. |
| PICKUPS (PER HOUR) OURING PM-PEAK TRANSIT MOOE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXEO-ROUTE BUS | 47. | 94. | 141. | 188. | 235. | 282. |
| AUTO | 848. | 804. | 759. | 714. | 670. | 625. |
| CARPOOL | 45. | 42. | 40. | 38. | 35. | 33. |

LINKER ANALYSIS FROM NODER2C3 TO NODER2C1

| | | | | | | |
|---|---|---|---|---|---|---|
| PICKUPS (PER HOUR) DURING AM-PEAK TRANSIT MODE SHARE: | 0.050 | 0.100 | 0 150 | 0.200 | 0.250 | 0.300 |
| FIXED-ROUTE BUS | 44. | 88. | 131. | 175. | 219. | 263. |
| AUTO | 790. | 749. | 707. | 665. | 624. | 582. |
| CARPOOL | 42. | 39. | 37. | 35. | 33. | 31. |
| PICKUPS (PER HOUR) DURING OFF-PEAK TRANSIT MODE SHARE: | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| FIXED-ROUTE BUS | 6. | 12. | 18. | 24. | 31. | 37. |
| AUTO | 227. | 221. | 215. | 209. | 203. | 198. |
| CARPOOL | 12. | 12. | 11. | 11. | 11. | 10. |
| PICKUPS (PER HOUR) DURING PM-PEAK TRANSIT MODE SHARE: | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-ROUTE BUS | 47. | 94. | 141. | 188. | 235. | 282. |
| AUTO | 848. | 804. | 759. | 714. | 670. | 625. |
| CARPOOL | 45. | 42. | 40. | 38. | 35. | 33. |

```
MODESEL REPLACE BUSF    CBD     AGT                                    17.
ZONESET LEFT            1       1                     BUSF             18.
REGION                                                                 19.
```

EXAMPLE 8 -- MODE SELECTION

| ZONE | POPULATION | EMPLOYMENT |
|---|---|---|
| ZONECNTR | 3863. | 85490. |
| LZONR2C1 | 56585. | 48288. |
| RZONR2C1 | 56585. | 48288. |
| LZONR2C2 | 56585. | 48288. |
| RZONR2C2 | 56585. | 48288. |
| LZONR2C3 | 56585. | 48288. |
| RZONR2C3 | 56585. | 48288. |
| TOTAL | 343376. | 375220. |

| TRIP TYPE: | 1 | 2 | 3 | OVERALL |
|---|---|---|---|---|
| AVERAGE TRIP LENGTH: | 7.3 | 7.3 | 7.0 | 7.3 MINUTES |

EXAMPLE 8 -- MODE SELECTION

REGIONWIDE ANALYSIS

LENGTH OF AM-PEAK IS 180. MINUTES
LENGTH OF OFF-PEAK IS 360. MINUTES
LENGTH OF PM-PEAK IS 180. MINUTES

CARPOOL FRACTION IS 0.050, CARPOOL TIME PARAMETER IS 3.000

WALKING SPEED IS 0.050 MILES PER MINUTE

CBD AUTO RIDERS WALK 0.200 MILES, CBD CARPOOL RIDERS WALK 0.200 MILES

DUMPER AUTO RIDERS WALK 0.100 MILES, CARPOOL RIDERS 0.040 MILES, BUS RIDERS 0.250 MILES
DUMPER TRANSIT FRACTION IS 1.000

TRANSIT DEMAND RATE PER MINUTE (100% TRANSIT MODE SHARE)

| | DEMAND LOADING | | | BOARDING RATE | | | DISEMBARKING RATE | | |
|---|---|---|---|---|---|---|---|---|---|
| | AM-PEAK | OFF-PEAK | PM-PEAK | AM-PEAK | OFF-PEAK | PM-PEAK | AM-PEAK | OFF-PEAK | PM-PEAK |
| ON RHWYR2C1 VIA FRBUS | | | | | | | | | |
| FROM NODER2C1 TO NODECNTR | 90.936 | 20.200 | 34.120 | 90.936 | 20.200 | 34.120 | 61.751 | 12.046 | 2.791 |
| FROM NODECNTR TO NODER2C1 | 31.858 | 17.246 | 97.629 | 2.672 | 9.092 | 66.301 | 31.858 | 17.246 | 97.629 |
| ON RHWYR2C2 VIA FRBUS | | | | | | | | | |
| FROM NODER2C2 TO NODECNTR | 90.936 | 20.200 | 34.120 | 90.936 | 20.200 | 34.120 | 61.751 | 12.046 | 2.791 |
| FROM NODECNTR TO NODER2C2 | 31.858 | 17.246 | 97.629 | 2.672 | 9.092 | 66.301 | 31.858 | 17.246 | 97.629 |
| ON RHWYR2C3 VIA FRBUS | | | | | | | | | |
| FROM NODER2C3 TO NODECNTR | 90.936 | 20.200 | 34.120 | 90.936 | 20.200 | 34.120 | 61.751 | 12.046 | 2.791 |
| FROM NODECNTR TO NODER2C3 | 31.858 | 17.246 | 97.629 | 2.672 | 9.092 | 66.301 | 31.858 | 17.246 | 97.629 |

| MODE IDENTIFIER | MODE TYPE | | MODE LABEL | FLEXTYPE AM-PEAK | FLEXTYPE OFF-PEAK | FLEXTYPE PM-PEAK | TRANSFER |
|---|---|---|---|---|---|---|---|
| BUSL | FRBUS | (LINKER) | FIXED-ROUTE BUS | | | | RANDOM |
| BUSF | AGT | (CBD) | AUTOMATED GUIDWAY TRANSIT | | | | RANDOM |
| AUTO | AUTO | (FEEDER) | AUTO | | | | RANDOM |
| CARPOOL | CARPOOL | (FEEDER) | CARPOOL | | | | RANDOM |
| AUTO | AUTO | (LINKER) | AUTO | | | | RANDOM |
| CARPOOL | CARPOOL | (LINKER) | CARPOOL | | | | RANDOM |
| FRBUS | FRBUS | (FEEDER) | FIXED-ROUTE BUS | | | | RANDOM |
| FRBUS | FRBUS | (DUMPER) | FIXED-ROUTE BUS | | | | RANDOM |
| AUTO | AUTO | (DUMPER) | AUTO | | | | RANDOM |
| CARPOOL | CARPOOL | (DUMPER) | CARPOOL | | | | RANDOM |
| AUTO | AUTO | (CBD) | AUTO | | | | RANDOM |
| CARPOOL | CARPOOL | (CBD) | CARPOOL | | | | RANDOM |

REGIONWIDE ANALYSIS

| MOOE IOENTIFIER | $ | $/V | $/VH | $/VM | $/RM | SPEED | MIN/STOP | MIN/PASS | MI/GAL | PASS/VEH |
|---|---|---|---|---|---|---|---|---|---|---|
| BUSL | 0.0 | 51.780 | 0.160 | 0.480 | 0.0 | 0.333 | 0.200 | 0.020 | 5.200 | 50.000 |
| BUSF | 0.0 | 50.000 | 0.170 | 0.010 | 8000.000 | 0.333 | 0.170 | 0.050 | 0.0 | 100.000 |
| AUTO | 0.0 | 2.040 | 0.012 | 0.090 | 0.0 | 0.333 | 0.500 | 0.0 | 15.000 | 1.200 |
| CARPOOL | 0.0 | 2.040 | 0.012 | 0.090 | 0.0 | 0.333 | 0.500 | 0.0 | 15.000 | 3.000 |
| AUTO | 0.0 | 2.040 | 0.012 | 0.090 | 0.0 | 0.333 | 0.500 | 0.0 | 15.000 | 1.200 |
| CARPOOL | 0.0 | 2.040 | 0.012 | 0.090 | 0.0 | 0.333 | 0.500 | 0.0 | 15.000 | 3.000 |
| FRBUS | 0.0 | 51.780 | 0.160 | 0.480 | 0.0 | 0.333 | 0.200 | 0.020 | 5.200 | 50.000 |
| FRBUS | 0.0 | 51.780 | 0.160 | 0.480 | 0.0 | 0.333 | 0.200 | 0.020 | 5.200 | 50.000 |
| AUTO | 0.0 | 2.040 | 0.012 | 0.090 | 0.0 | 0.333 | 0.500 | 0.0 | 15.000 | 1.200 |
| CARPOOL | 0.0 | 2.040 | 0.012 | 0.090 | 0.0 | 0.333 | 0.500 | 0.0 | 15.000 | 3.000 |
| AUTO | 0.0 | 2.040 | 0.012 | 0.090 | 0.0 | 0.333 | 0.500 | 0.0 | 15.000 | 1.200 |
| CARPOOL | 0.0 | 2.040 | 0.012 | 0.090 | 0.0 | 0.333 | 0.500 | 0.0 | 15.000 | 3.000 |

| MOOE IOENTIFIER | MINHOWAY | MAXHOWAY | MAXRS | STOPS/MI | CARS/VEH | FRACWALK | AMTRAIN | OFFTRAIN | PMTRAIN |
|---|---|---|---|---|---|---|---|---|---|
| BUSL | 0.500 | 60.000 | 1.000 | 8.000 | 2.000 | 0.200 | 1.000 | 1.000 | 1.000 |
| BUSF | 0.500 | 3.000 | 0.500 | 0.0 | 0.0 | 0.200 | 1.000 | 1.000 | 1.000 |
| AUTO | 0.500 | 0.0 | 0.0 | 0.0 | 1.000 | 0.200 | 1.000 | 1.000 | 1.000 |
| CARPOOL | 0.500 | 0.0 | 0.0 | 0.0 | 1.000 | 0.200 | 1.000 | 1.000 | 1.000 |
| AUTO | 0.500 | 0.0 | 0.0 | 0.0 | 1.000 | 0.200 | 1.000 | 1.000 | 1.000 |
| CARPOOL | 0.500 | 0.0 | 0.0 | 0.0 | 1.000 | 0.200 | 1.000 | 1.000 | 1.000 |
| FRBUS | 0.500 | 60.000 | 1.000 | 8.000 | 2.000 | 0.200 | 1.000 | 1.000 | 1.000 |
| FRBUS | 0.500 | 60.000 | 1.000 | 8.000 | 2.000 | 0.200 | 1.000 | 1.000 | 1.000 |
| AUTO | 0.500 | 0.0 | 0.0 | 0.0 | 1.000 | 0.200 | 1.000 | 1.000 | 1.000 |
| CARPOOL | 0.500 | 0.0 | 0.0 | 0.0 | 1.000 | 0.200 | 1.000 | 1.000 | 1.000 |
| AUTO | 0.500 | 0.0 | 0.0 | 0.0 | 1.000 | 0.200 | 1.000 | 1.000 | 1.000 |
| CARPOOL | 0.500 | 0.0 | 0.0 | 0.0 | 1.000 | 0.200 | 1.000 | 1.000 | 1.000 |

REGIONWIDE ANALYSIS

| COST PER TRIP DURING AM-PEAK TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
|---|---|---|---|---|---|---|---|
| FIXED-ROUTE BUS | (LINKER) | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 | 0.09 |
| AUTOMATED GUIDWAY TRANSIT | (CBD) | 4.56 | 2.30 | 1.55 | 1.17 | 0.94 | 0.79 |
| AUTO | (FEEDER) | 0.43 | 0.43 | 0.43 | 0.43 | 0.43 | 0.43 |
| CARPOOL | (FEEDER) | 0.20 | 0.20 | 0.20 | 0.20 | 0.21 | 0.21 |
| AUTO | (LINKER) | 0.79 | 0.79 | 0.79 | 0.79 | 0.79 | 0.79 |
| CARPOOL | (LINKER) | 0.56 | 0.56 | 0.56 | 0.56 | 0.56 | 0.56 |
| FIXED-ROUTE BUS | (FEEDER) | 0.21 | 0.21 | 0.22 | 0.22 | 0.22 | 0.22 |
| FIXED-ROUTE BUS | (DUMPER) | 0.15 | 0.11 | 0.11 | 0.11 | 0.12 | 0.12 |
| AUTO | (DUMPER) | 0.78 | 0.78 | 0.78 | 0.78 | 0.78 | 0.78 |
| CARPOOL | (DUMPER) | 0.36 | 0.36 | 0.36 | 0.36 | 0.36 | 0.36 |
| AUTO | (CBD) | 1.99 | 1.99 | 1.99 | 1.99 | 1.99 | 1.99 |
| CARPOOL | (CBD) | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 |
| AUTO TOTAL | (REGION) | 1.44 | 1.44 | 1.44 | 1.44 | 1.44 | 1.44 |
| CARPOOL TOTAL | (REGION) | 0.73 | 0.73 | 0.74 | 0.74 | 0.75 | 0.76 |
| TRANSIT TOTAL | (REGION) | 1.43 | 0.85 | 0.65 | 0.56 | 0.50 | 0.46 |

REGIONWIDE ANALYSIS

| COST PER TRIP DURING OFF-PEAK TRANSIT MODE SHARE: | | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
|---|---|---|---|---|---|---|---|
| FIXED-ROUTE BUS | (LINKER) | 0.08 | 0.05 | 0.05 | 0.05 | 0.05 | 0.05 |
| AUTOMATED GUIDWAY TRANSIT | (CBD) | 5.04 | 2.59 | 1.78 | 1.37 | 1.13 | 0.96 |
| AUTO | (FEEDER) | 0.43 | 0.43 | 0.43 | 0.43 | 0.43 | 0.43 |
| CARPOOL | (FEEDER) | 0.26 | 0.26 | 0.26 | 0.26 | 0.26 | 0.27 |
| AUTO | (LINKER) | 0.77 | 0.77 | 0.77 | 0.77 | 0.77 | 0.77 |
| CARPOOL | (LINKER) | 0.54 | 0.54 | 0.54 | 0.54 | 0.54 | 0.54 |
| FIXED-ROUTE BUS | (FEEDER) | 0.49 | 0.26 | 0.18 | 0.14 | 0.12 | 0.11 |
| FIXED-ROUTE BUS | (DUMPER) | 0.32 | 0.16 | 0.11 | 0.09 | 0.07 | 0.06 |
| AUTO | (DUMPER) | 0.78 | 0.78 | 0.78 | 0.78 | 0.78 | 0.78 |
| CARPOOL | (DUMPER) | 0.36 | 0.36 | 0.36 | 0.36 | 0.36 | 0.36 |
| AUTO | (CBD) | 1.99 | 1.99 | 1.99 | 1.99 | 1.99 | 1.99 |
| CARPOOL | (CBD) | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 |
| AUTO TOTAL | (REGION) | 1.63 | 1.63 | 1.63 | 1.63 | 1.63 | 1.63 |
| CARPOOL TOTAL | (REGION) | 0.84 | 0.85 | 0.85 | 0.86 | 0.86 | 0.87 |
| TRANSIT TOTAL | (REGION) | 2.04 | 1.06 | 0.74 | 0.57 | 0.47 | 0.41 |

REGIONWIDE ANALYSIS

| COST PER TRIP DURING PM-PEAK TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
|---|---|---|---|---|---|---|---|
| FIXED-ROUTE BUS | (LINKER) | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 | 0.10 |
| AUTOMATED GUIDWAY TRANSIT | (CBD) | 4.56 | 2.30 | 1.54 | 1.17 | 0.94 | 0.79 |
| AUTO | (FEEDER) | 0.43 | 0.43 | 0.43 | 0.43 | 0.43 | 0.43 |
| CARPOOL | (FEEDER) | 0.20 | 0.20 | 0.20 | 0.20 | 0.20 | 0.21 |
| AUTO | (LINKER) | 0.79 | 0.79 | 0.79 | 0.79 | 0.79 | 0.79 |
| CARPOOL | (LINKER) | 0.56 | 0.56 | 0.56 | 0.56 | 0.56 | 0.56 |
| FIXED-ROUTE BUS | (FEEDER) | 0.22 | 0.23 | 0.23 | 0.23 | 0.23 | 0.23 |
| FIXED-ROUTE BUS | (DUMPER) | 0.14 | 0.12 | 0.12 | 0.12 | 0.12 | 0.12 |
| AUTO | (DUMPER) | 0.78 | 0.78 | 0.78 | 0.78 | 0.78 | 0.78 |
| CARPOOL | (DUMPER) | 0.36 | 0.36 | 0.36 | 0.36 | 0.36 | 0.36 |
| AUTO | (CBD) | 1.99 | 1.99 | 1.99 | 1.99 | 1.99 | 1.99 |
| CARPOOL | (CBD) | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 | 0.80 |
| AUTO TOTAL | (REGION) | 1.44 | 1.44 | 1.44 | 1.44 | 1.44 | 1.44 |
| CARPOOL TOTAL | (REGION) | 0.73 | 0.73 | 0.74 | 0.74 | 0.75 | 0.76 |
| TRANSIT TOTAL | (REGION) | 1.44 | 0.86 | 0.67 | 0.57 | 0.52 | 0.48 |

REGIONWIDE ANALYSIS

MEAN TRAVEL TIMES DURING AM-PEAK

| TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
|---|---|---|---|---|---|---|---|
| FIXED-ROUTE BUS | (LINKER) | 13.0 | 10.3 | 9.3 | 8.8 | 8.5 | 8.3 |
| AUTOMATED GUIDWAY TRANSIT | (CBD) | 9.6 | 10.1 | 10.6 | 11.1 | 11.5 | 12.0 |
| AUTO | (FEEDER) | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 |
| CARPOOL | (FEEDER) | 7.1 | 7.1 | 7.2 | 7.2 | 7.3 | 7.3 |
| AUTO | (LINKER) | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 |
| CARPOOL | (LINKER) | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 | 1.8 |
| FIXED-ROUTE BUS | (FEEDER) | 25.1 | 21.3 | 19.6 | 18.6 | 18.0 | 17.4 |
| FIXED-ROUTE BUS | (DUMPER) | 38.5 | 29.8 | 23.1 | 19.7 | 17.7 | 16.4 |
| AUTO | (DUMPER) | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 |
| CARPOOL | (DUMPER) | 7.1 | 7.1 | 7.1 | 7.1 | 7.1 | 7.1 |
| AUTO | (CBD) | 6.8 | 6.7 | 6.7 | 6.6 | 6.6 | 6.5 |
| CARPOOL | (CBD) | 6.8 | 6.7 | 6.7 | 6.6 | 6.6 | 6.5 |
| AUTO TOTAL | (REGION) | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 | 8.5 |
| CARPOOL TOTAL | (REGION) | 10.8 | 10.8 | 10.9 | 11.0 | 11.2 | 11.3 |
| TRANSIT TOTAL | (REGION) | 38.9 | 32.7 | 29.5 | 27.8 | 26.8 | 26.1 |

REGIONWIDE ANALYSIS

| MEAN TRAVEL TIMES DURING OFF-PEAK TRANSIT MODE SHARE: | | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
|---|---|---|---|---|---|---|---|
| FIXED-ROUTE BUS | (LINKER) | 36.5 | 32.0 | 23.7 | 19.6 | 17.1 | 15.5 |
| AUTOMATED GUIDWAY TRANSIT | (CBD) | 9.2 | 9.1 | 9.0 | 8.9 | 8.8 | 8.8 |
| AUTO | (FEEDER) | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 |
| CARPOOL | (FEEDER) | 9.5 | 9.6 | 9.6 | 9.7 | 9.7 | 9.8 |
| AUTO | (LINKER) | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 |
| CARPOOL | (LINKER) | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 | 1.6 |
| FIXED-ROUTE BUS | (FEEDER) | 35.0 | 36.7 | 37.6 | 38.1 | 38.2 | 37.1 |
| FIXED-ROUTE BUS | (DUMPER) | 33.8 | 33.9 | 34.1 | 34.3 | 34.4 | 34.6 |
| AUTO | (DUMPER) | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 |
| CARPOOL | (DUMPER) | 7.1 | 7.1 | 7.1 | 7.1 | 7.1 | 7.1 |
| AUTO | (CBD) | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 |
| CARPOOL | (CBD) | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 | 6.3 |
| AUTO TOTAL | (REGION) | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 | 8.5 |
| CARPOOL TOTAL | (REGION) | 12.1 | 12.3 | 12.4 | 12.5 | 12.6 | 12.8 |
| TRANSIT TOTAL | (REGION) | 54.9 | 54.4 | 51.9 | 50.7 | 50.0 | 48.7 |

REGIONWIDE ANALYSIS

| MEAN TRAVEL TIMES DURING PM-PEAK TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
|---|---|---|---|---|---|---|---|
| FIXED-ROUTE BUS | (LINKER) | 12.7 | 10.1 | 9.2 | 8.8 | 8.5 | 8.3 |
| AUTOMATED GUIDWAY TRANSIT | (CBD) | 10.6 | 11.3 | 11.9 | 12.5 | 13.1 | 13.7 |
| AUTO | (FEEDER) | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 |
| CARPOOL | (FEEDER) | 7.1 | 7.1 | 7.1 | 7.2 | 7.2 | 7.3 |
| AUTO | (LINKER) | 1.9 | 1.9 | 1.8 | 1.8 | 1.8 | 1.8 |
| CARPOOL | (LINKER) | 1.9 | 1.9 | 1.8 | 1.8 | 1.8 | 1.8 |
| FIXED-ROUTE BUS | (FEEDER) | 30.2 | 24.4 | 21.9 | 20.3 | 19.3 | 18.5 |
| FIXED-ROUTE BUS | (DUMPER) | 28.9 | 22.8 | 18.9 | 16.9 | 15.8 | 15.0 |
| AUTO | (DUMPER) | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 | 5.2 |
| CARPOOL | (DUMPER) | 7.1 | 7.1 | 7.1 | 7.1 | 7.1 | 7.1 |
| AUTO | (CBD) | 6.8 | 6.8 | 6.7 | 6.7 | 6.6 | 6.6 |
| CARPOOL | (CBD) | 6.8 | 6.8 | 6.7 | 6.7 | 6.6 | 6.6 |
| AUTO TOTAL | (REGION) | 8.7 | 8.6 | 8.6 | 8.6 | 8.6 | 8.6 |
| CARPOOL TOTAL | (REGION) | 10.8 | 10.9 | 11.0 | 11.1 | 11.2 | 11.4 |
| TRANSIT TOTAL | (REGION) | 42.1 | 34.5 | 31.1 | 29.2 | 28.1 | 27.3 |

REGIONWIOE ANALYSIS

| FUEL CONSUMPTION PER TRIP OURING AM-PEAK TRANSIT MOOE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
|---|---|---|---|---|---|---|---|
| FIXEO-ROUTE BUS | (LINKER) | 0.012 | 0.012 | 0.012 | 0.012 | 0.012 | 0.012 |
| AUTOMATEO GUIOWAY TRANSIT | (CBO) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| AUTO | (FEEOER) | 0.096 | 0.096 | 0.096 | 0.096 | 0.096 | 0.096 |
| CARPOOL | (FEEDER) | 0.056 | 0.056 | 0.057 | 0.057 | 0.058 | 0.058 |
| AUTO | (LINKER) | 0.089 | 0.089 | 0.089 | 0.089 | 0.089 | 0.089 |
| CARPOOL | (LINKER) | 0.036 | 0.036 | 0.036 | 0.036 | 0.036 | 0.036 |
| FIXED-ROUTE BUS | (FEEDER) | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| FIXED-ROUTE BUS | (OUMPER) | 0.019 | 0.014 | 0.014 | 0.014 | 0.014 | 0.014 |
| AUTO | (OUMPER) | 0.050 | 0.050 | 0.050 | 0.050 | 0.050 | 0.050 |
| CARPOOL | (OUMPER) | 0.049 | 0.049 | 0.049 | 0.049 | 0.049 | 0.049 |
| AUTO | (CBD) | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 |
| CARPOOL | (CBD) | 0.016 | 0.016 | 0.016 | 0.016 | 0.016 | 0.016 |
| AUTO TOTAL | (REGION) | 0.155 | 0.155 | 0.155 | 0.155 | 0.155 | 0.155 |
| CARPOOL TOTAL | (REGION) | 0.084 | 0.084 | 0.086 | 0.087 | 0.088 | 0.090 |
| TRANSIT TOTAL | (REGION) | 0.032 | 0.031 | 0.031 | 0.031 | 0.031 | 0.031 |

REGIONWIDE ANALYSIS

| FUEL CONSUMPTION PER TRIP DURING OFF-PEAK TRANSIT MODE SHARE: | | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
|---|---|---|---|---|---|---|---|
| FIXED-ROUTE BUS | (LINKER) | 0.014 | 0.008 | 0.008 | 0.008 | 0.008 | 0.008 |
| AUTOMATED GUIDWAY TRANSIT | (CBD) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| AUTO | (FEEDER) | 0.096 | 0.096 | 0.096 | 0.096 | 0.096 | 0.096 |
| CARPOOL | (FEEDER) | 0.091 | 0.092 | 0.093 | 0.094 | 0.094 | 0.095 |
| AUTO | (LINKER) | 0.089 | 0.089 | 0.089 | 0.089 | 0.089 | 0.089 |
| CARPOOL | (LINKER) | 0.036 | 0.036 | 0.036 | 0.036 | 0.036 | 0.036 |
| FIXED-ROUTE BUS | (FEEDER) | 0.085 | 0.043 | 0.028 | 0.021 | 0.017 | 0.016 |
| FIXED-ROUTE BUS | (DUMPER) | 0.053 | 0.027 | 0.018 | 0.013 | 0.011 | 0.009 |
| AUTO | (DUMPER) | 0.050 | 0.050 | 0.050 | 0.050 | 0.050 | 0.050 |
| CARPOOL | (DUMPER) | 0.049 | 0.049 | 0.049 | 0.049 | 0.049 | 0.049 |
| AUTO | (CBD) | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 |
| CARPOOL | (CBD) | 0.016 | 0.016 | 0.016 | 0.016 | 0.016 | 0.016 |
| AUTO TOTAL | (REGION) | 0.140 | 0.140 | 0.140 | 0.140 | 0.140 | 0.140 |
| CARPOOL TOTAL | (REGION) | 0.103 | 0.104 | 0.106 | 0.107 | 0.108 | 0.109 |
| TRANSIT TOTAL | (REGION) | 0.085 | 0.043 | 0.030 | 0.023 | 0.019 | 0.017 |

REGIONWIDE ANALYSIS

FUEL CONSUMPTION PER TRIP DURING PM-PEAK

| TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
|---|---|---|---|---|---|---|---|
| FIXED-ROUTE BUS | (LINKER) | 0.012 | 0.012 | 0.012 | 0.012 | 0.012 | 0.012 |
| AUTOMATED GUIDWAY TRANSIT | (CBD) | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| AUTO | (FEEDER) | 0.096 | 0.096 | 0.096 | 0.096 | 0.096 | 0.096 |
| CARPOOL | (FEEDER) | 0.055 | 0.055 | 0.056 | 0.057 | 0.057 | 0.058 |
| AUTO | (LINKER) | 0.089 | 0.089 | 0.089 | 0.089 | 0.089 | 0.089 |
| CARPOOL | (LINKER) | 0.036 | 0.036 | 0.036 | 0.036 | 0.036 | 0.036 |
| FIXED-ROUTE BUS | (FEEDER) | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 | 0.025 |
| FIXED-ROUTE BUS | (DUMPER) | 0.018 | 0.014 | 0.014 | 0.014 | 0.014 | 0.014 |
| AUTO | (DUMPER) | 0.050 | 0.050 | 0.050 | 0.050 | 0.050 | 0.050 |
| CARPOOL | (DUMPER) | 0.049 | 0.049 | 0.049 | 0.049 | 0.049 | 0.049 |
| AUTO | (CBD) | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 | 0.040 |
| CARPOOL | (CBD) | 0.016 | 0.016 | 0.016 | 0.016 | 0.016 | 0.016 |
| AUTO TOTAL | (REGION) | 0.155 | 0.155 | 0.155 | 0.155 | 0.155 | 0.155 |
| CARPOOL TOTAL | (REGION) | 0.083 | 0.084 | 0.085 | 0.087 | 0.088 | 0.089 |
| TRANSIT TOTAL | (REGION) | 0.032 | 0.031 | 0.031 | 0.031 | 0.031 | 0.031 |

REGIONWIDE ANALYSIS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| FLEET SIZE NEEDED DURING AM-PEAK TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-ROUTE BUS | (LINKER) | 2.9 | 5.9 | 8.8 | 11.6 | 14.5 | 17.4 |
| AUTOMATED GUIDWAY TRANSIT | (CBD) | 6.0 | 7.4 | 8.8 | 10.2 | 11.6 | 13.0 |
| FIXED-ROUTE BUS | (FEEDER) | 19.4 | 38.9 | 58.3 | 77.8 | 97.2 | 116.7 |
| FIXED-ROUTE BUS | (DUMPER) | 2.9 | 4.3 | 6.5 | 8.6 | 10.8 | 13.0 |
| TRANSIT TOTAL | (REGION) | 31.3 | 56.5 | 82.4 | 108.3 | 134.2 | 160.0 |
| FLEET SIZE NEEDED DURING OFF-PEAK TRANSIT MODE SHARE: | | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| FIXED-ROUTE BUS | (LINKER) | 0.5 | 0.7 | 1.0 | 1.4 | 1.7 | 2.1 |
| AUTOMATED GUIDWAY TRANSIT | (CBD) | 6.0 | 7.4 | 8.8 | 10.2 | 11.6 | 13.0 |
| FIXED-ROUTE BUS | (FEEDER) | 6.0 | 6.9 | 7.5 | 7.8 | 8.0 | 8.8 |
| FIXED-ROUTE BUS | (DUMPER) | 2.7 | 2.8 | 2.9 | 3.0 | 3.1 | 3.2 |
| TRANSIT TOTAL | (REGION) | 15.2 | 17.8 | 20.2 | 22.4 | 24.4 | 27.1 |
| FLEET SIZE NEEDED DURING PM-PEAK TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-ROUTE BUS | (LINKER) | 3.2 | 6.3 | 9.4 | 12.5 | 15.6 | 18.7 |
| AUTOMATED GUIDWAY TRANSIT | (CBD) | 6.0 | 7.4 | 8.8 | 10.2 | 11.6 | 13.0 |
| FIXED-ROUTE BUS | (FEEDER) | 20.9 | 41.8 | 62.7 | 83.6 | 104.5 | 125.4 |
| FIXED-ROUTE BUS | (DUMPER) | 2.9 | 4.6 | 6.9 | 9.2 | 11.5 | 13.9 |
| TRANSIT TOTAL | (REGION) | 33.0 | 60.2 | 87.9 | 115.6 | 143.3 | 171.0 |

REGIONWIDE ANALYSIS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| AVERAGE HEADWAY DURING AM-PEAK TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-ROUTE BUS | (LINKER) | 11.0 | 5.5 | 3.7 | 2.7 | 2.2 | 1.8 |
| AUTOMATED GUIDWAY TRANSIT | (CBD) | 2.9 | 2.9 | 2.8 | 2.8 | 2.7 | 2.7 |
| FIXED-ROUTE BUS | (FEEDER) | 35.1 | 24.9 | 20.3 | 17.6 | 15.7 | 14.3 |
| FIXED-ROUTE BUS | (DUMPER) | 60.0 | 41.7 | 27.8 | 20.8 | 16.7 | 13.9 |
| TRANSIT TOTAL | (REGION) | 28.9 | 21.2 | 17.2 | 14.8 | 13.2 | 12.0 |
| AVERAGE HEADWAY DURING OFF-PEAK TRANSIT MODE SHARE: | | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| FIXED-ROUTE BUS | (LINKER) | 60.0 | 49.5 | 33.0 | 24.8 | 19.8 | 16.5 |
| AUTOMATED GUIDWAY TRANSIT | (CBD) | 2.4 | 2.0 | 1.7 | 1.5 | 1.3 | 1.2 |
| FIXED-ROUTE BUS | (FEEDER) | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 | 57.4 |
| FIXED-ROUTE BUS | (DUMPER) | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 | 60.0 |
| TRANSIT TOTAL | (REGION) | 37.1 | 35.4 | 33.2 | 31.2 | 29.4 | 27.7 |
| AVERAGE HEADWAY DURING PM-PEAK TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-ROUTE BUS | (LINKER) | 10.2 | 5.1 | 3.4 | 2.6 | 2.0 | 1.7 |
| AUTOMATED GUIDWAY TRANSIT | (CBD) | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 | 3.0 |
| FIXED-ROUTE BUS | (FEEDER) | 33.9 | 24.0 | 19.6 | 16.9 | 15.2 | 13.8 |
| FIXED-ROUTE BUS | (DUMPER) | 60.0 | 39.0 | 26.0 | 19.5 | 15.6 | 13.0 |
| TRANSIT TOTAL | (REGION) | 28.3 | 20.6 | 16.7 | 14.4 | 12.8 | 11.6 |

REGIONWIDE ANALYSIS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| AVERAGE VEHICLE LDADING DURING AM-PEAK TRANSIT MDDE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-RDUTE BUS | (LINKER) | 36.1 | 36.0 | 36.0 | 36.0 | 36.0 | 36.0 |
| AUTDMATED GUIDWAY TRANSIT | (CBD) | 4.4 | 8.5 | 12.6 | 16.5 | 20.2 | 23.8 |
| FIXED-RDUTE BUS | (FEEDER) | 20.3 | 20.3 | 20.3 | 20.3 | 20.3 | 20.3 |
| FIXED-RDUTE BUS | (DUMPER) | 11.6 | 16.1 | 16.1 | 16.1 | 16.1 | 16.1 |
| TRANSIT TDTAL | (REGIDN) | 17.9 | 20.0 | 20.8 | 21.3 | 21.6 | 21.9 |
| AVERAGE VEHICLE LDADING DURING DFF-PEAK TRANSIT MDDE SHARE: | | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| FIXED-RDUTE BUS | (LINKER) | 28.1 | 46.4 | 46.4 | 46.4 | 46.4 | 46.4 |
| AUTDMATED GUIDWAY TRANSIT | (CBD) | 0.7 | 1.1 | 1.4 | 1.6 | 1.8 | 2.0 |
| FIXED-RDUTE BUS | (FEEDER) | 4.4 | 9.5 | 14.6 | 19.4 | 24.2 | 26.5 |
| FIXED-RDUTE BUS | (DUMPER) | 4.2 | 8.4 | 12.7 | 16.9 | 21.1 | 25.3 |
| TRANSIT TDTAL | (REGIDN) | 3.7 | 7.3 | 10.2 | 12.6 | 14.7 | 16.1 |
| AVERAGE VEHICLE LDADING DURING PM-PEAK TRANSIT MDDE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-RDUTE BUS | (LINKER) | 36.1 | 36.1 | 36.0 | 36.0 | 36.0 | 36.0 |
| AUTDMATED GUIDWAY TRANSIT | (CBD) | 4.8 | 9.5 | 14.3 | 19.0 | 23.8 | 28.6 |
| FIXED-RDUTE BUS | (FEEDER) | 20.3 | 20.3 | 20.3 | 20.3 | 20.3 | 20.3 |
| FIXED-RDUTE BUS | (DUMPER) | 12.4 | 16.0 | 16.0 | 16.0 | 16.0 | 16.0 |
| TRANSIT TDTAL | (REGIDN) | 18.3 | 20.3 | 21.0 | 21.5 | 21.9 | 22.3 |

REGIONWIDE ANALYSIS

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| VEHICLE-MILES (PER HOUR) DURING AM-PEAK TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-ROUTE BUS | (LINKER) | 52. | 105. | 157. | 210. | 262. | 314. |
| AUTOMATED GUIDWAY TRANSIT | (CBD) | 98. | 100. | 102. | 103. | 105. | 107. |
| FIXED-ROUTE BUS | (FEEDER) | 293. | 586. | 879. | 1172. | 1465. | 1758. |
| FIXED-ROUTE BUS | (DUMPER) | 47. | 67. | 101. | 134. | 168. | 201. |
| TRANSIT TOTAL | (REGION) | 490. | 857. | 1238. | 1619. | 2000. | 2381. |
| VEHICLE-MILES (PER HOUR) DURING OFF-PEAK TRANSIT MODE SHARE: | | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
| FIXED-ROUTE BUS | (LINKER) | 10. | 12. | 17. | 23. | 29. | 35. |
| AUTOMATED GUIDWAY TRANSIT | (CBD) | 119. | 143. | 167. | 190. | 214. | 237. |
| FIXED-ROUTE BUS | (FEEDER) | 101. | 101. | 101. | 101. | 101. | 110. |
| FIXED-ROUTE BUS | (DUMPER) | 47. | 47. | 47. | 47. | 47. | 47. |
| TRANSIT TOTAL | (REGION) | 276. | 302. | 331. | 361. | 390. | 429. |
| VEHICLE-MILES (PER HOUR) DURING PM-PEAK TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
| FIXED-ROUTE BUS | (LINKER) | 56. | 112. | 169. | 225. | 281. | 337. |
| AUTOMATED GUIDWAY TRANSIT | (CBD) | 96. | 96. | 96. | 96. | 96. | 96. |
| FIXED-ROUTE BUS | (FEEDER) | 315. | 630. | 945. | 1260. | 1575. | 1890. |
| FIXED-ROUTE BUS | (DUMPER) | 47. | 72. | 108. | 143. | 179. | 215. |
| TRANSIT TOTAL | (REGION) | 514. | 910. | 1317. | 1724. | 2131. | 2538. |

REGIDNWIDE ANALYSIS

PICKUPS (PER HDUR) DURING AM-PEAK

| TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
|---|---|---|---|---|---|---|---|
| FIXED-ROUTE BUS | (LINKER) | 842. | 1685. | 2527. | 3370. | 4212. | 5055. |
| AUTOMATED GUIDWAY TRANSIT | (CBD) | 598. | 1195. | 1793. | 2391. | 2988. | 3586. |
| AUTO | (FEEDER) | 40855. | 38704. | 36554. | 34404. | 32254. | 30103. |
| CARPOOL | (FEEDER) | 2150. | 2037. | 1924. | 1811. | 1698. | 1584. |
| AUTO | (LINKER) | 19948. | 18898. | 17848. | 16798. | 15748. | 14698. |
| CARPOOL | (LINKER) | 1050. | 995. | 939. | 884. | 829. | 774. |
| FIXED-ROUTE BUS | (FEEDER) | 2263. | 4527. | 6790. | 9054. | 11317. | 13580. |
| FIXED-ROUTE BUS | (DUMPER) | 464. | 928. | 1392. | 1856. | 2321. | 2785. |
| AUTO | (DUMPER) | 8377. | 7936. | 7495. | 7054. | 6614. | 6173. |
| CARPOOL | (DUMPER) | 419. | 419. | 419. | 419. | 419. | 419. |
| AUTO | (CBD) | 10787. | 10220. | 9652. | 9084. | 8516. | 7949. |
| CARPOOL | (CBD) | 568. | 538. | 508. | 478. | 448. | 418. |
| AUTO TOTAL | (REGION) | 42448. | 40214. | 37980. | 35746. | 33511. | 31277. |
| CARPOOL TOTAL | (REGION) | 2234. | 2117. | 1999. | 1881. | 1764. | 1646. |
| TRANSIT TOTAL | (REGION) | 2352. | 4703. | 7055. | 9407. | 11758. | 14110. |

REGIONWIDE ANALYSIS

| PICKUPS (PER HOUR) DURING OFF-PEAK TRANSIT MODE SHARE: | | 0.025 | 0.050 | 0.075 | 0.100 | 0.125 | 0.150 |
|---|---|---|---|---|---|---|---|
| FIXED-ROUTE BUS | (LINKER) | 132. | 264. | 395. | 527. | 659. | 791. |
| AUTOMATED GUIDWAY TRANSIT | (CBD) | 109. | 218. | 327. | 436. | 545. | 654. |
| AUTO | (FEEDER) | 8386. | 8171. | 7956. | 7741. | 7526. | 7311. |
| CARPOOL | (FEEDER) | 441. | 430. | 419. | 407. | 396. | 385. |
| AUTO | (LINKER) | 6243. | 6083. | 5923. | 5763. | 5603. | 5443. |
| CARPOOL | (LINKER) | 329. | 320. | 312. | 303. | 295. | 286. |
| FIXED-ROUTE BUS | (FEEDER) | 226. | 453. | 679. | 905. | 1132. | 1358. |
| FIXED-ROUTE BUS | (DUMPER) | 169. | 338. | 506. | 675. | 844. | 1013. |
| AUTO | (DUMPER) | 6254. | 6093. | 5933. | 5773. | 5612. | 5452. |
| CARPOOL | (DUMPER) | 325. | 325. | 325. | 325. | 325. | 325. |
| AUTO | (CBD) | 4037. | 3934. | 3830. | 3727. | 3623. | 3520. |
| CARPOOL | (CBD) | 212. | 207. | 202. | 196. | 191. | 185. |
| AUTO TOTAL | (REGION) | 13115. | 12779. | 12443. | 12106. | 11770. | 11434. |
| CARPOOL TOTAL | (REGION) | 690. | 673. | 655. | 637. | 619. | 602. |
| TRANSIT TOTAL | (REGION) | 354. | 708. | 1062. | 1416. | 1770. | 2124. |

REGIONWIDE ANALYSIS

PICKUPS (PER HOUR) DURING PM-PEAK

| TRANSIT MODE SHARE: | | 0.050 | 0.100 | 0.150 | 0.200 | 0.250 | 0.300 |
|---|---|---|---|---|---|---|---|
| FIXED-ROUTE BUS | (LINKER) | 904. | 1808. | 2711. | 3615. | 4519. | 5423. |
| AUTOMATED GUIDWAY TRANSIT | (CBD) | 641. | 1281. | 1922. | 2562. | 3203. | 3843. |
| AUTO | (FEEDER) | 43919. | 41607. | 39296. | 36984. | 34673. | 32361. |
| CARPOOL | (FEEDER) | 2312. | 2190. | 2068. | 1947. | 1825. | 1703. |
| AUTO | (LINKER) | 21403. | 20276. | 19150. | 18023. | 16897. | 15770. |
| CARPOOL | (LINKER) | 1126. | 1067. | 1008. | 949. | 889. | 830. |
| FIXED-ROUTE BUS | (FEEDER) | 2433. | 4866. | 7300. | 9733. | 12166. | 14599. |
| FIXED-ROUTE BUS | (DUMPER) | 494. | 988. | 1482. | 1976. | 2470. | 2965. |
| AUTO | (DUMPER) | 8918. | 8449. | 7979. | 7510. | 7041. | 6571. |
| CARPOOL | (DUMPER) | 468. | 468. | 468. | 468. | 468. | 468. |
| AUTO | (CBD) | 11561. | 10953. | 10344. | 9736. | 9127. | 8519. |
| CARPOOL | (CBD) | 608. | 576. | 544. | 512. | 480. | 448. |
| AUTO TOTAL | (REGION) | 45546. | 43149. | 40752. | 38355. | 35958. | 33561. |
| CARPOOL TOTAL | (REGION) | 2397. | 2271. | 2145. | 2019. | 1893. | 1766. |
| TRANSIT TOTAL | (REGION) | 2523. | 5047. | 7570. | 10093. | 12617. | 15140. |

```
END . . . . . . . . .  20.

        O ERRORS FOUND
```

EXAMPLE 9

Job Purpose

To illustrate changing miscellaneous parameter values:

1. Define a two-ring, three corridor urban structure.

2. Perform a DUMPER analysis on one zone in the network.

3. Change modeling parameters for a second DUMPER run. These parameters are: carpool fraction, carpool time parameter, transit mode share, length of time periods (A.M. peak, P.M. peak and off-peak periods), lane capacity, walking distance for DUMPER bus passengers, and the fraction of transit patrons who are traveling to the vicinity of the line-haul station and need not be served by DUMPER transit.

4. Perform a second DUMPER run on the zone.

Input Data

```
                                    F I E L D
Keyword <--1---><--2---><--3---><--4---><--5---><--6---><--7---><--8--->

TITLE   EXAMPLE 9 -- MISCELLANEOUS PARAMETERS
URBAN          2       3
DUMPER  RZONR2C3
CPFRAC      0.3
CPTIME      3.5
TMSHARE        2AM-PEAK      0.5     0.8
TMSHARE        2PM-PEAK      0.5     0.8
TIMELEN    120.    360.    120.
CAPACITY    30.     20.
WALKING DISTANCEDUMPER  FRBUS        0.2
WALKING FRACTIONDUMPER       0.5
DUMPER  RZONR2C3
END
```

The URBAN card decreases the number of rings and corridors in the network to two and three respectively. A DUMPER analysis is performed on one of the zones, the one that has the default name of RZONR2C3.

Before running the next DUMPER analysis, several parameters are changed. The first is CPFRAC (carpool fraction); that is, fraction of non-transit passengers in carpools. Its value is set to 0.3. Next, carpool time parameter is changed to 3.5. The next two cards affect transit mode share. The first field on both TMSHARE cards decreases the number of mode share indices from a default of 6 to 2: The first mode share is 0.5 for both A.M. and P.M. peak periods (FIELD 3) and the second is 0.8 (FIELD 4). The off-peak mode shares would retain their default values corresponding to the first two mode indices. Any subsequent analysis will consider only two mode shares as specified on the TMSHARE cards.

The lengths of the various time periods are listed on the TIMELEN card. Only three time periods (the A.M., P.M. and off-peak periods) need be specified; the length of the fourth period (off-peak hours) is the difference between 1440 minutes and the length of the other periods. The CAPACITY card changes freeway capacity to 30 car equivalents per lane per minute and the arterial capacity to 20 car equivalents per lane per minute. The WALKING card sets the distance DUMPER fixed-route bus passengers have to walk to their destinations from the bus stop to 0.2 miles. Walking distance for other modes and for CBD analyses can also be set by this card type. Note that since FIELD 3 specifies the mode type, not a selected mode, all modes of that type will have the same walking distance. The fraction of transit passengers arriving at the zonal line-haul station who are within walking distance of their destinations and do not require dumper service is specified on the next WALKING card. This fraction is 0.5.

Finally, a DUMPER run is initiated with the new parameter values. The end of the job is indicated by an END card.

EXAMPLE 10

Job Purpose

To illustrate regionwide and feeder analysis options:

1. Define a two-ring, three-corridor network;
2. Select an AGT mode for the CBD;
3. Define the mode for the central zone as the AGT mode;
4. Perform a regionwide analysis on the network;
5. Turn off the default mode selection indicator; and
6. Run a feeder subarea and a feeder corridor analysis on two different zones.

Input data:

```
                                   F I E L D
Keyword <--1---><--2---><--3---><--4---><--5---><--6---><--7---><--8--->

TITLE   EXAMPLE 10 -- REGIONWIDE AND FEEDER ANALYSIS OPTIONS
URBAN          2       3
MODESEL         CBDAGT  CBD     AGT
ZONESET LEFT           1       1                        CBDAGT
REGION
NULLMODEFEEDER
FEEDER  RZONR2C2SUBAREA      0.5     0.4
FEEDER  RZONR2C3CORRIDOR     0.5
END
```

The URBAN card sets up a two-ring, three-corridor network. Subsequently, a mode called CBDAGT is selected using the MODESEL keyword with the ADD option (indicated by blanks in the first field). The type of analysis applicable to this mode is defined as CBD, and the mode type is AGT. The ZONESET card specifies in FIELD 7 that the CBD mode to be modeled in regionwide analysis is CBDAGT. If no specification had been made, REGION routines would have automatically used the fixed-route bus mode. Note that FIELDs 7 and 8 on the ZONESET cards affect only regionwide analysis invoked by the REGION card, and not other parts of the model. Any mode specified for the zones through the ZONESET or ONEZONE keywords must have been previously selected, either through the MODESEL card or through a former analysis. When initiating the REGION analysis invoked by the next card, SMART searches through the selected list and finds only one CBD mode, no FEEDER or DUMPER modes. Hence, it will automatically select one fixed-route bus transit mode, one automobile mode, and one carpool mode for FEEDER and DUMPER analyses. For CBD analysis it will use CBDAGT as the transit mode and select CBD automobile and carpool.

The NULLMODE card turns off SMART's default mode selection procedure for FEEDER analysis. The model will not make any automatic mode selection, provided that one automobile, one carpool and one transit mode have been selected for FEEDER zonal analysis. For this job, such selections have already been made in REGION. Hence, no additional modes will be selected in FEEDER.

The first FEEDER card specifies that a higher-density subarea exists in the analysis zone. The higher density is twice that of the lower density (low density over high density = 0.5), and the size of the subarea is 40% that of the entire zone. The second FEEDER card specifies a CORRIDOR analysis of RZONR2C3 where the density of the corridor is again twice that of the surrounding low-density area. SMART knows that a light-rail analysis is required, and will automatically select a light-rail mode. The input deck ends with an END card.

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