Folder Title:	Water Supply and Urban Development Research Material - Demand Analysis and Evaluation Methodology for Urban Transport components for the transportation and land sectors of the Colon Urban Development Project - Robert H. Sarly - April 1980
Folder ID:	1156145
Series:	Urban development reference subject files
Dates:	11/01/1979 - 04/30/1980
Fonds:	Records of the Urban Development Sector
ISAD Reference Code:	WB IBRD/IDA URB-563S
Digitized:	04/11/2023

lysis & Evaluation m
ansport components.
& land sectors of the Colon Urban Devel.
Robert M. Sarly April, 1980

ANNEX

DEMAND ANALYSIS AND EVALUATION METHODOLOGY

FOR URBAN TRANSPORT COMPONENTS

for the Transportation and Land Sectors

of the Colon Urban Development Project

Draft prepared by Robert M. Sarly, Consultant, for the World Bank, Urban Operations Review & Support Unit.

April 1980

RMSarly:dm/bb/al
2/29/80

COLON URBAN DEVELOPMENT PROJECT

Demand Analysis and Evaluation Method
for Transport and Land Sectors

Context

1. Summary of Approach

In multi-sectoral urban projects, significant changes in the level and location of linked economic activities will result from direct project interventions as well as induced program impacts. In given circumstances, projections of future locational demands for residential and employment land cannot be readily made by extrapolating past trends. Structural changes, such as relative accessibilities, aggregate demand, supply of serviced land on the market, and overall location cost borne by the activity, will affect returns to investment throughout the urban economy and particularly in the Land and Transport sectors where locational preferences are most directly exercised.

Within the framework of an urban development project, analytic method is needed to identify future levels and locations of economic activity with sufficient confidence to serve as the basis of rudimentary cost-benefit evaluation. Any given method, especially one with an operational focus, will be a highly simplified application of basic non principles. The particular approach described herein is adapted from an operational tradition of Strategic Land Use-Transportation Analyses in which some quantitative detail is sacrificed for quickly determined strategic indicators of overall project impact in the urban area.

The method is based upon a conurbation of manual calibration, and manual and programal estimation. The program is written for use on a Texas Instrument TI59 hand-held programmable calculator, with use of attached paper tape printer. Discounted time and operating cost savings are automatically calculated for each link, year, mode, income group and (if

required) origin of trip. A complete run of a given configuration of transport inputs takes about four hours.

The entire study takes about two calendar months (3 mm) including Data assembly, input generation, manual calculation, programmable estimation, manual estimation, interpretation of results and reporting.

COLON URBAN PROJECT

JUSTIFICATION OF HIGHWAY COMPONENT: II

Summary of Results

1. The highway improvement is economically justified. From the perspective of intercity transport alone, the investment is already overdue, in that past "territorial" constraints on the expansion of the highway to meet growing demand in the region and between Cristobal Port and Panama City has resulted in near, or above, capacity levels of service on the highway. (See IRR, FURR, and increase in C/B ratio from 1973 to present below section E: Justification).

2. The integrated urban development project to revitalize the Colon sub-region proposes to increase and disperse economic activity and housing in the corridor between Manzanillo Island and the Cativa/ Sabanitas suburbs. The resulting additional metropolitan travel demand in effect transforms the highway, which is the only transport spine in the sub-region, from an inter-city to a metropolitan transport artery. As such it is an indispensible component of the integrated urban development program (see below section C: Impact).

3. Demand for the road improvements to the Boyd-Roosevelt Highway between Cativa/Randolph Road junction and Manzanillo Island is a direct result of the implementation of the integrated urban project, and in particular of the employment and housing components in the Expanded Free Zone, Porto Escondido and industrial zones (5, 6, and 7 in the attached map). Indirectly additional travel demands will also be generated in Manzanillo Island and Cativa-Sabanitas (Zones 1 and 8), as a result of the urban project (see below section B: Context).

4. Reductions in the overall size, or delays in the implementation rate of the urban project would reduce overall demand for transport on the road, providing that both employment and housing were reduced in equal proportions. However, if employment in the new Free Zone sites is to develop in any event, as is currently planned, while the housing in Porto Escondido (Zone 6) is eliminated or reduced, then travel demand on the road would increase further, due to the increase in average consequent commuting distance (along the Boyd-Roosevelt corridor) between jobs and homes.

5. In the absence of both the proposed highway improvements and new housing, residential preferences, especially for low-income households would generate strong demands for locations in the proximity of employment resulting in illegal squatting conditions if affordable legal options were unavailable. The areas most likely to be affected would be the Expanded Free Zone industrial zone and Rainbow City (zones 5, 7, and 4), where land would be available, and to a lesser extent, Manzanillo Island (Zone 1) where services would be available.

6. At the other extreme, implementation of the integrated urban project, but without these road improvements, would undermine the effectiveness of the urban project as a whole. The growth of travel demand on the road would quickly create congestion and loss of efficiency to all road users. The disbenefits to the urban project directly attributable to the absence of the proposed road improvements, as shown in the attached memo, would represent a significant share of overall project benefits. Disbenefits to goods movement, which generate 10% of the trip volumes, represent 60% of the total operating cost savings achievable on the road by 1984. Bus travelers which amount to 50% of the trip volumes, would bear about 10% of the operating cost savings, while car travelers (40% of the total trips) would derive 40% of the total operating cost savings. The low- and middle-income travelers generate 25% and 35% of the trips respectively and would incur 6% and 10% of the respective total disbenefits.

7. In view of the above, implementation of the urban project in its current form including the proposed road improvements would appear to generate the minimum negative externalities for the transport sector in the provision of essential access to linked economic activities in Gran Colon.

COLON URBAN PROJECT

JUSTIFICATION OF HIGHWAY COMPONENT: II

A. Objectives

1. Implementation of the urban project is not required to justify going ahead with construction of the road: as shown below, the road is justified on the basis of regional demand. However, the road is required to ensure the urban project realizes its objectives, particularly:

(i) the objective of stimulating improvements in key sectors such as transport, and in the level of transport services in Colon, to reduce travel costs and improve standards of access;

(ii) the objective of avoiding the disbenefits of \$18,027 million (present value) in additional travel expenditures on the unimproved road (1980-1999), that would be incurred by the Colon population were the urban project to go ahead without the road component; and

(iii) ensure that the imminent rise in the volumes of trips along the road caused directly by the housing and employment components of the project are satisfactorily served, so that bottlenecks do not arise that delay overall project implementation causing cost overruns and development imbalance.

B. Context

2. The existing two lane Boyd-Roosevelt Highway is the only access corridor between Colon (i.e., Manzanillo Island), the main housing and employment development areas of the urban project, the suburbs of Cativa and Sabanitas, and Panama City (and the rest of the Metropolitan Region). Upgrading of the highway as proposed in the urban project will be along its existing alignment. No alternative alignment is likely to develop in the foreseeable future.

3. The roadway widening part of the project comprises a doubling of the existing two lane highway which extends from 800 meters east of the refinery junction in Cativa to the Randolph Road junction for a distance of 6.8 kilometers. The one-way loop part of the project extends from Randolph Road junction to Manzanillo Island for a distance of 2.5 kilometers inbound and a return route through Rainbow City for a distance of about 2.8 kilometers outbound. There are about nine junctions all of which will be at grade. Lane width will be 3.65 meters and the existing one-way loop roads will be brought up to comparable service levels as the main highway by means of resurfacing and geometric design of junctions, storage lanes and slipways.

4. On the basis of the regional demand projections made in the 1973 technical and feasibility study of Boyd-Roosevelt, the expansion of the road from its current two lane capacity to four lanes was determined to be economically justified from regional demand alone. On the basis of 1973 cost estimates this produced a benefit-cost ratio in the range of 1.8. Regional travel volumes then were estimated to be over 6,000 average daily trips (ADT) in 1973, with projections of over 10,000 ADT by 1980.

5. Current travel volume estimates based upon survey data collected by the Ministry of Public Works (MOP) in 1979 show current volumes along the road to be about 10,000-12,000 ADT, growing at an average rate of about 5% p.a. Current peak hour volumes are 1,200 passenger car units (PCU), which prevail an average of 28 hours per week. This peak hour demand exceeds the assumed effective capacity of the road during 25% of the travel week.

C. Impact

6. Without an urban project previous trends of traffic growth within Colon, and between Colon and Panama City, suggest that demand would continue to grow at about 5% p.a. producing 1984 ADT of 12,000 and 1990 ADT of 16,000.

7. However, in view of the dual impact of the urban project on Colon the expected growth in traffic demand will be about 20% greater due to:

(a) the accelerated development of economic activities in Colon resulting from the urban project; and

(b) the increased dispersion of project activities within the Colon sub-region, whose inter-relationships will rely on effective sub-regional transport access.

8. The economic analysis of demand for travel on the Boyd-Roosevelt Road done for this project component has taken the above impacts into account. It has been constructed upon conservative assumptions of trip generation, trip distribution and modal split, trip assignment and travel cost. The method distinguishes nine origin and destination zones in the city, three income classes and three travel modes. It also distinguishes operating costs and time costs.

9. The results of this demand analysis show a rapid increase in the number of peak hour PCU's from about 1,350 in 1980 to 1,650 in 1981, 2,000 in 1982, 2,300 in 1983, 2,600 in 1984 and 3,900 in 1989.

D. Cost

10. The capital cost of the road component, based upon preliminary estimates prepared by MOP, is $5,772 million (base) plus physical and price contingencies for a gross of $8,700 million.

E. Justification

11. Assuming (conservatively) an actual capital cost of about $8.0 million (not including price contingencies), economic evaluation of the road project shows a benefit-cost ratio in excess of 2.25 and a net present value of $10.03 million, not including time cost savings.

12. When time cost savings are taken into account the benefit-cost ratio rises to 12.94, and the net present value increases to $95.50 million.

13. The first year rate of return is 110%, showing that the optimum time for initiating investment in the road is already past, and that further delay is not justified.

14. The internal rate of return (IRR) for the road is 39.75% not including time cost savings. When these are included the IRR is in excess of 100%.

15. Sensitivity tests on costs show that a 20% rise in costs reduces IRR to 34.65%, and that a 20% fall in expected benefits reduces IRR to 32.15%.

RMSarly:bb

COLON URBAN PROJECT

ROADWAY IMPROVEMENT: ORIGIN/DESTINATION TRIP VOLUMES

1979 - 1984

1	1979	1984
POP	75000	65000
EMP	8000	9500
MP OR	8100	7760
MP DE	6470	8940

2	1979	1984
POP	-	-
EMP	5000	5000
MP OR	500	500
MP DE	3840	4700

3	1979	1984
POP	-	-
EMP	3000	3500
MP OR	300	350
MP DE	2300	3210

4	1979	1984
POP	5000	5000
EMP	250	500
MP OR	855	1050
MP DE	215	617

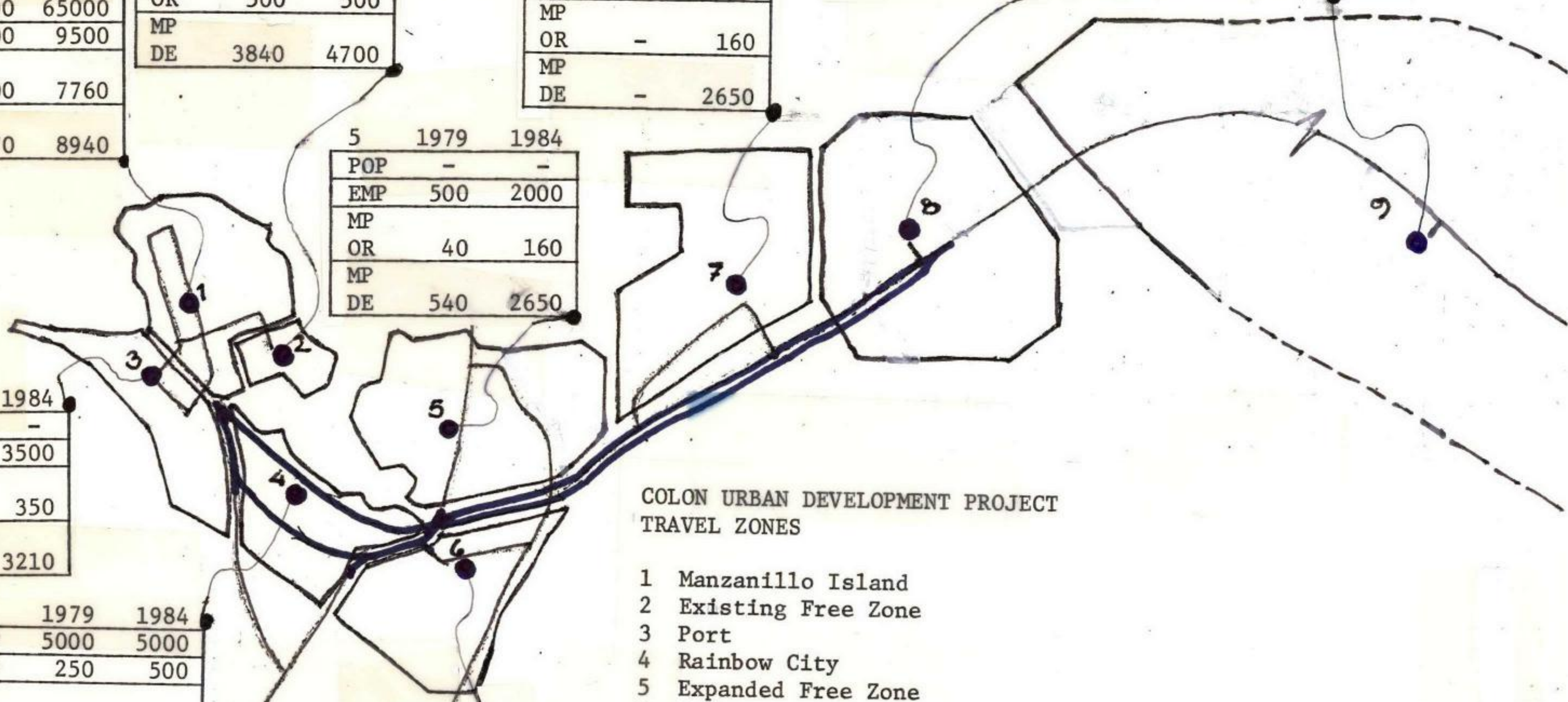
5	1979	1984
POP	-	-
EMP	500	2000
MP OR	40	160
MP DE	540	2650

6	1979	1984
POP	-	25000
EMP	-	250
MP OR	-	3015
MP DE	-	319

7	1979	1984
POP	-	-
EMP	-	2000
MP OR	-	160
MP DE	-	2650

8	1979	1984
POP	20000	25000
EMP	1500	2500
MP OR	2610	3400
MP DE	1290	2680

9	1979	1984
POP	-	-
EMP	-	-
MP OR	3025	9214
MP DE	745	1514



COLON URBAN DEVELOPMENT PROJECT
TRAVEL ZONES

1 Manzanillo Island
2 Existing Free Zone
3 Port
4 Rainbow City
5 Expanded Free Zone
8 Cativa-Sabanita-Puerto Pilon
9 Panama City Metropolitan Region

MPPE = Morning Peak Period Destinations
MPOR = Morning Peak Period Origins
include only vehicle trips (2 hours)

2. Introduction to the Demand Analysis

Amongst the objectives of transport sector intervention in the Colon Urban Development project is the provision of an efficient transport system to make linked economic activities in metropolitan Colon more accessible to the urban population. Since the impact of the overall project is multi-sectoral and complex it will not be possible to represent its derived benefit in a single measure such as a cost-benefit ratio, or internal rate of return. The estimate of the transport components' net worth, its benefits and costs (associated with road widening, traffic improvements, bus and train service provision, bus fleet expansion and vehicle maintenance) are therefore defined by the following evaluation measures:

1. time savings to bus travellers
2. operating cost savings to bus travellers
3. time savings to car travellers
4. operating cost savings to car travellers
5. time and operating cost savings to trucks
6. time savings to train travellers
7. levels of service for the public bus system and primary road network
8. travel expenditure share of household income
9. generalized travel share of location costs for households.

Each of the above terms is measured for nine separate geographic areas in the metropolitan region, and with respect to its incidence in three income classes. The areas are:

1. Manzanillo Island (excluding the Colon Free Zone)
2. Colon Free Zone
3. Cristobal Port
4. Rainbow City
5. New Commercial Zone (Coco Solito)
6. Puerto Escondido
7. New Industrial Area (Export Processing Zone)
8. Cativa - Sabantas - Puerto Pilon Suburbs
9. Rest of the Metropolitan Region and Panama City

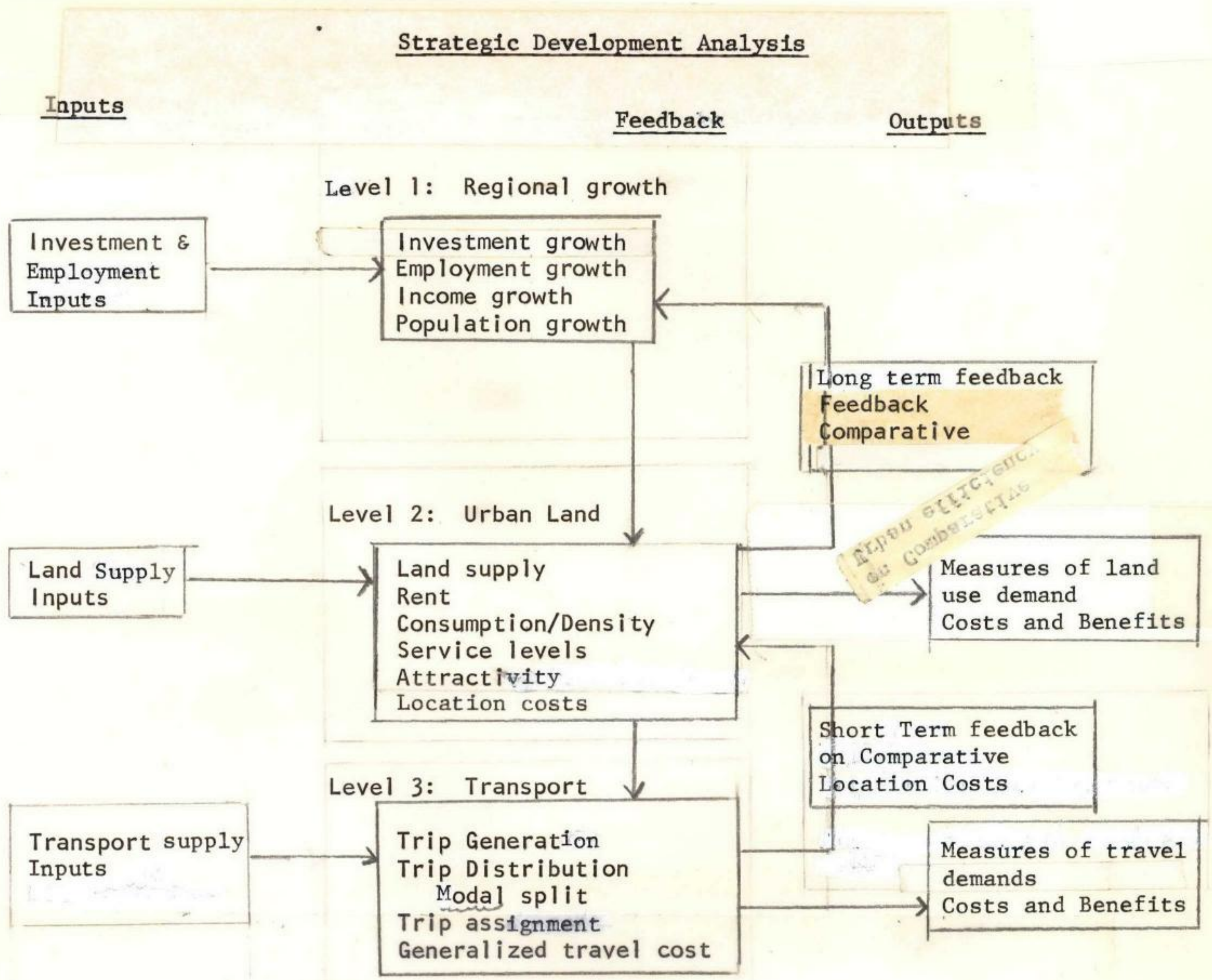
The three income classes are:

	Average HH income per month
1. Upper income (top 2 deciles)	$1800/m
2. Middle income (from 4th to 8th decile)	$425/m
3. Lower income (bottom 3 deciles)	$125/m

3. Method in General

The method for estimating the above evaluation measures relies on an aggregate strategic analysis of transport and land use changes over the project period, and on their interaction. On the basis of these estimates are made of the generation, distribution, assignment and cost of household and business trips, for each income class and for every zone in the region. Travel cost forecasts serve as the basis for estimating locational demand in general, and in particular the values of land in different parts of the region. From these estimates, long-term implications for changes in the land use structure of the Metropolitan Region are determined.

Future levels of demand for transport facilities and services are taken as a function of the future urban spatial structure and the rate of growth of economic activity in the Colon Region. These are expressed logically in three levels of a strategic development analysis, as shown in the following diagram:



Each level of analysis starting with Regional growth provides the operating assumptions upon which the next level projections are made. The analysis is validated on the basis of existing conditions by calibrating the governing relationships linking the supply and demand of transport and land, from survey and field observation. These relationships then derive the projection of future demand levels in terms of changes in supply and the behavior of the urban economy under conditions of growth.

4. Method in Detail

The method is made operational in three phases:

1. Manual calibration of functional relationships governing the changing values of transport and land demands by mode, link, zone and service class.
2. Programmable estimation of travel benefits by mode, link, zone of origin, and income class
3. Manual estimation of location cost changes and imputed affect on the demand for land by income class, zones density and rent values.

4.1 Manual Calibration of Transport Demands

The governing relationships for the transport analysis are shown below:

Trip Generation and Distribution

(Equation 1) $T_i^{z^\circ} = P_\cdot^z \;\; z$

(Equation 2) $T_j^{z^\circ} = P_\cdot^z \;\; z$

T_i^{zo} = number of trips generated by an activity (residential/ employment) z for purpose o from origin zone.

T_j^{zo} = number of trips generated by an activity (employment) of type z for purpose o to destination zone j.

P^z = Population (or number of employees) associated with that activity

α^z = Propensity for each unit of activity to generate a morning peak hour trip.

This function is used to discriminate trips by origin zone, i, destination zone j, car users and non-car users. It is used to generate estimates of existing conditions reflecting known overall flows of public and private traffic.

link, zone and income class.

(Equation 3) $$T_{ij}^{mzo} = \frac{O_i^{mzo} D_j^{mzo} \circ B}{C_{ij}^{mb}}$$

T_{ij}^{mzo} = Total trips per mode m between zones i and j for activity type z and figure o.

O_i^{mzo} = Number of trip origins in Zone j, for mode m activity z, purpose o^1.

D_j^{zo} = Number of trip destinations in zone j for activity z, purpose o.

C_{ij}^{b} = Cost of travel between zone i and j.

b = Elasticity of demand for travel with respect to cost.

B = Normalizing factor = $1/ \sum^{m} O_i D_i / C_{ij}$

Trip Assignment & Costs

Given the simplified structure of the transport network in metropolitan Colon, inter-zonal traffic is assigned directly to links. These links acquire traffic loads which generate congestion as a function of free flow link speeds and design capacities.

Travel costs are estimated in two parts:

1. Operating costs, measured in terms of average use, speed and distance, characteristic vehicle cost per kilometer at link speed.
2. The cost assumed in terms of real (i.e., congested) travel time elapsed per journey plus the (pedestrian) access time at either end of the (vehicular) journey.

(Equation 4) $$G_c = \sum^{j} C_i^{op} + \sum^{j} C_i^{t}$$

The cost of travel is aggregated for each income class and each mode for all trips made by households in a single origin zone to all other zones, This measure is taken to be the generalized cost of travel for the typical household in each origin zone. Truck trips are similarly aggregated by employment-origin zones for all trips.

The results of the transport analysis are fed back into the land analysis in terms of generalized travel costs per household. These values are then used to reestimate locational demand for land in different zones in terms of residential densities, land rent and numbers of households to be located in each zone.

The governing relationships for the land analysis are as follows:

4.2 Manual Calibration of Land Demands

Demand for Land

The first function determines the quantity of land consumed by each activity l^z given the unit rent of land, r_l and the income of the activity w_i^z. The relationships amongst these factors (land consumption, rent and income) are governed by three parameters:

(a) constant coefficient, k^z

(b) price elasticity of demand, p^e, which is negative to reflect the reduction of land consumption that occurs with an increase in rents.

(c) income elasticity of demand i^e, which is positive to reflect the increase in land consumption that occurs with an increase in incomes.

The demand for land function is specified in the following form:

(Equation 5) $l_i^z = k^z r_i^{-pe} \cdot w^{z^{ie}}$ where:

l_i^z = land consumed by household group z in zone i.

r_i = rent of land per m^2 in zone i

w^z = income of activity z

p^e = price elasticity of demand for land

i^e = income elasticity of demand for land

k^z = constant scalar.

Cost of Location

The second function, determines the total cost for an activity, z, resulting from the selection of a location in zone i, C_i^z, as the sum of the cost of land rent $l_i^z \cdot r_i$ plus the cost of building rent $S_i^z \cdot b_i^z$ plus the transport cost associated with locating in the zone $A_i^z\ g_i^z$ plus the cost of providing the zone with infrastructure services $F_i^z \cdot O_i^z$. The transport cost is calculated as the weighted average of the cost of all trips made by that activity in that zone. This cost connects the land use sub-model with the transport sub-model. The function is specified in the following form:

(Equation 6) $$C_i^z = l_i^z \cdot r_i + S_i^z \cdot b_i^z + A_i^z \cdot g_i^z + \sum^{Q} F_i^z \cdot c_i^z$$

Where:

C_i^z = Cost of location for household group z at zone i.

$l_i^z \cdot r_i$ = Cost of ground rent for land consumed.

$S_i^z \cdot b_i^z$ = Cost of building rent.

Where: S = amount of built space per household.

b = unit cost of space.

$A_i^z \cdot g_i^z$ = Transport cost.= G_c

Where: A = accessibility index for HH

g = unit cost of transport

$\sum^{Q} F_i^z \cdot c_i^z$ = Cost of infrastructure for all services, Q

Where: F = standard of service.

c = unit cost of standard service.

Distribution of Activities

The third function, determines the distribution among all the zones of each activity in terms of the total number of the activity G^z, the amount of land available for development in zone i, L_i, the location cost of the activity C_i^z, and residual attraction W_i^z. The function is specified in the following form:

(Equation 7) $G_i^z = G^z . L_i . W_i^z . C_i^{z\ -1_z} B^z$

Where:

G_i^z = total number of households

G^z = total number of household group z

L_i = total land available in zone i.

W_i^z = residual attraction index for household group z in zone i.

C_i^z = location cost for household group z in zone i.

1_z = elasticity of demand for location with respect to cost.

B^z = normalizing factor

Budget Constraint

The following constraint must be respected to ensure land supply and located demand are in balance.

(Equation 8) $G_i^z . 1_i^z = L_i$

Cost Recovery

The cost of location function is the basis for estimating means for cost recovery in terms of a recovery rate by cost component for each activity, and for each location for all public capital investment projects, as follows:

(Equation 9)

$$RC_i^{*z} = T_i l_i^z r_r + T_2 S_i^z \cdot b_i^z + T_3 A_i^z \cdot g_i^z + T_4 F_i^z \cdot c_i^z$$

where: R = cost recovery rate (aggregate),

T_i= land tax rate

T_2= building tax rate

T_3= public transit fares and road user charges

T_4= utilities user charges

In terms of this formulation, C^* may be thought of as the social cost of location since not all of C_i^{z*} may necessarily be charged to the locator. Nonetheless, all of C_i^{*z} is recovered as a result of the locators' choice of the i^{th} location on aggregate, though certain areas (target groups, project sited, etc.) may be cross-subsidized in order to ensure affordability.

The inclusion of C_i^{*z} in the function ensures that the social values created by project investments are reflected in land prices throughout the urban market area in proportion to their impacts for each activity group at each location, and are recovered without detriment to the benefit share of the targetted poverty groups.

Income Generation

The demand for land function for household activities is the basis for incorporating real income, w^* and not just wage income w. Income gains and social subsidies that may have been created in different locations in each of the cost categories as follows:

(Equation 10)

$$l_i^{*r} = \frac{K^z . {w^{*z}}^{ie}}{r_i^{pe}}$$

where: $w^{*z^{ie}} = \sum B^{p} - R \cdot C_{i}^{*z} + \sum^{p} b_{i} + w_{i}^{z}$

where: $\sum B^{p}$ = the sum of project capital costs per household

$R \cdot C_{i}^{*z}$ = total costs recovered per household

$\sum^{p} b_{i}^{z}$ = sum of income gains resulting from operating cost savings in each project.

w_{i}^{z} = wage income per household.

Difference between project costs and costs recovered measures the proportion of conferred benefit not directly recovered by tax, user charge (etc.,) or other methods. The function shows the effect of income gains changes in location and service levels. Also, the use of b_{i}^{z} ensures that locational preferences reflect the aggregate effect of income gains from constraints on the structure of demand, and in particular on land prices and location priorities for development.

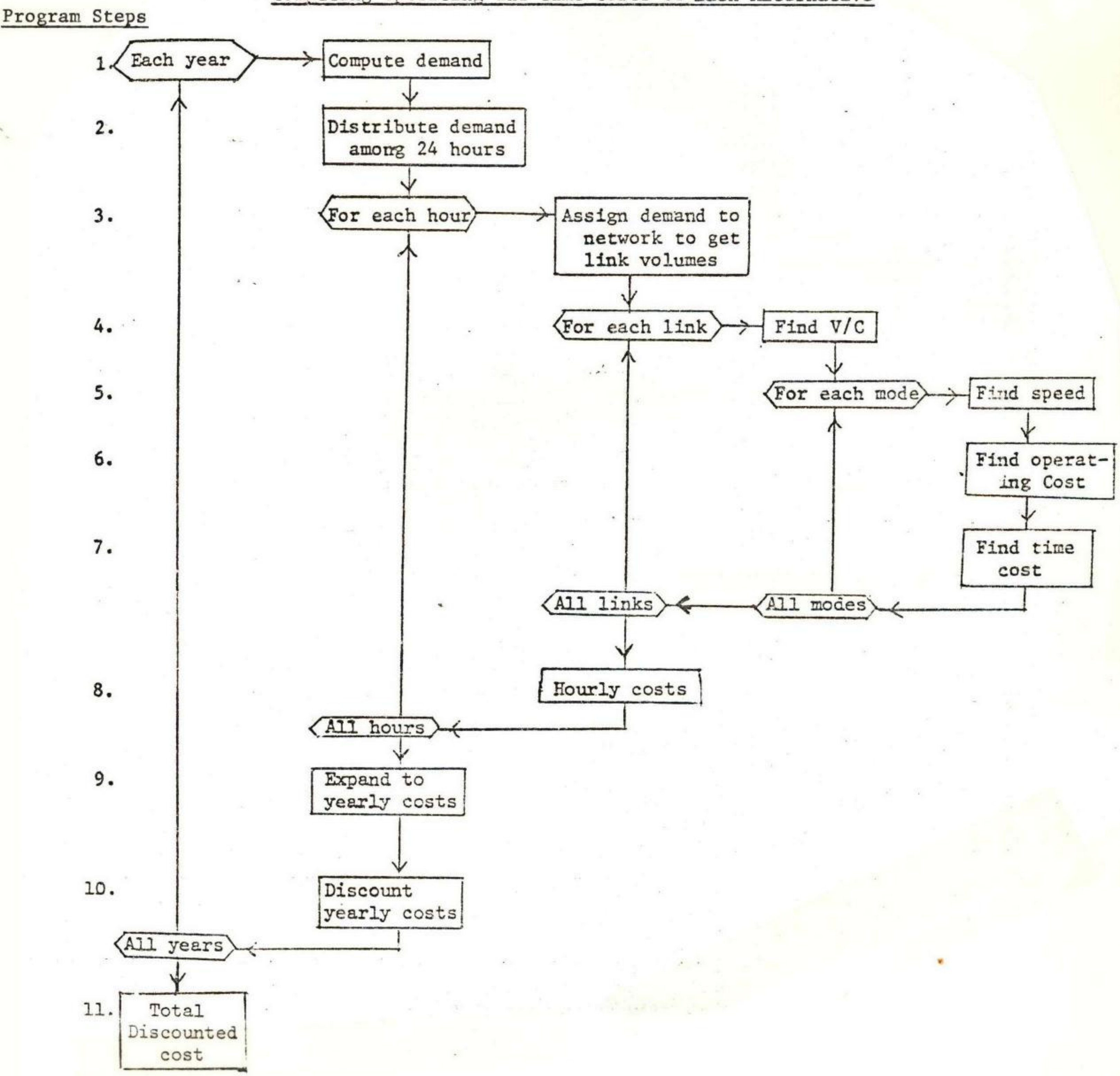
The income effects identified in the analysis are used to indicate aggregate changes in the levels of household demand by income group and location in the urban area. These indicators are viewed from the broad employment market perspective through disaggregated demand and income elasticities as the basis for examining consequent employment impact. This examination requires a separate formulation of a specific income-employment relationship that applies for a given urban system. This is not included in the above.

4.3 Programmable Estimation

A general sketch of the method for estimating transport benefits by means of a hand-held computer program is shown in the diagram below. Discussion follows this diagram, step-by-step.

Figure 1

Computing Operating and Time Costs of Each Alternative



Step 1: For Each Year, Compute Demand

Demand is used for an average weekday as representative of the whole year. Demand has two dimensions: O-D pair, and mode. Because of population and activity growth in different locations, demand between different O-D pairs varys in magnitude and growth. There is also a different demand for each mode of freight and passenger transport. All modes are aggregated into: truck (freight), auto, and bus (transit). Demand values are taken from the results of the manual algorithm.

Step 2: Distribute Demand Throughout the Day

Demand also has a temporal and a directional dimension. Usually demand is not predicted directly for an hour, however; it is predicted for the entire day and later distributed. For each direction there is a peaking profile, which gives the relative demand in each hour of the day. For convenience we may say there is a peaking profile of 48 hours, where the first 24 hours correspond to one direction (positive) and the last 24 to the other (negative) direction.

The most common assumption is that the daily peaking profile will be the same in every year for every O-D pair. This assumption can cause significant error when the network includes major radial and crosstown roads, each of which exhibit different peaking patterns. (The crosstown road has 2 peaks per rush hour while the radial has only

However, in the corridor problem with which we are dealing it is probably safe to assume each link of the same road will have the same peaking pattern. Different modes may have different peaking profiles, however. Thus the demand at an hour h is

where $$D^{t,h}_{m,p} = D^{t}_{m,p} f^{h}_{m} \qquad (2)$$

f^h_m is the peaking factor for hour h and mode m, and the vector $\left\{f^h_m\right\}$, h = 1,..., H is called the peaking profile for mode m. Thus a peaking profile is assumed given for each mode. It is common to not analyze all 48 hours separately but rather to select a few representative hours, the results of which are expanded hours in the day which have similar flows. A peaking profile for peak direction travel in San Jose, Costa Rica is found in Attachment A.

<u>Step 3: For Each Hour, Assign Demand to the Network to Get Link Volumes</u>

This can be the most complex step of the urban transportation analysis procedure. However, our restricted problem definition makes this problem trivial. Each O-D pair has a unique path, covering a known set of links. To get link volumes one must aggregate over O-D pairs and modes. Links, like hourly flows, are assumed unidirectional and furthermore we assume a link is symmetric in its capacity. Thus the flow on link j in hour 10 is the flow in the positive direction on link j at 10 a.m., while the flow in hour 34 is the flow in the negative direction at 10 a.m.

To aggregate over modes (since they all share the same roadway), each mode is given a passenger car unit (PCU) equivalency. This PCU equivalency depends not only on vehicle size, but on vehicle performance as well; and since vehicle performance is differentially affected by link characteristics, particularly grade, there must be a PCU equivalency factor for each mode and link.

Link volumes must be measured in vehicles. For auto and truck this presents no problem, since demand is usually measured in vehicles, or if measured in passengers, a single

---

[illegible] should be modeled as a separate road.

occupancy factor can convert demand into vehicles. However, when bus demand is measured in passengers, it is not so readily converted into vehicles since load factors can vary widely throughout the day. Since bus operations are usually centrally planned, bus volumes may be exogenously specified. In more complex networks rerouting is also a possibility. In the simple corridor analysis with which we are dealing, it is probably sufficient to assume that load factors on each route at each hour will be the same year-to-year, so that demand can be measured in vehicles in the base year and treated in the same way as cars and trucks.

Aggregating over O-D pairs is simple summation, so that the link volumes are:

$$V_a^{t,h} = \sum^{p} \sum^{m} D_{m,p}^{t,h} \; e_{m,a} \; \delta_{a,p} \qquad (3)$$

where

$V_a^{t,h}$ = volume (in PCU's) on link a in hour h and year t

$D_{m,p}^{t,h}$ = demand for mode m between O-D pair p in hour h and year t (measured in vehicles

$e_{m,a}$ = PCU equivalency factor for mode m on link a

$\delta_{a,p} = \begin{cases} 1 \text{ if link a is on the path between O-D pair p} \\ 0 \text{ otherwise} \end{cases}$

In addition we will later need modal link volumes, which are:

$$V_{m,a}^{t,h} = \sum^{p} D_{m,p}^{t,h} \; \delta_{a,p} \quad (3.1)$$

Step 4: For Each Link, Calculate the Volume/Capacity Ratio (V/C)

Since the volume has been determined in Step 3, all that is needed is the link capacities. These are given for both alternatives (no-build and build), and are the same at every hour in every year (barring the use of reversible lanes, peak hour exclusive lanes, etc.). Therefore, for any link, hour and year, for an alternative b (no-build or build,

$$(V/C)_a^{t,h,b} = V_a^{t,h} \div C_a^b \qquad (4)$$

where

C_a^b = capacity of link a in alternative b

$(V/C)_a^{t,h,b}$ = volume/capacity ratio in alternative b on link a at time h in year t

Since each alternative is analyzed identically, we shall remove the superscript b and continue with the notation $(V/C)_a^{t,h}$, realizing that its value pertains to a particular alternative.

Step 5: For Each Mode, Find the Speed

The speed at which traffic flows on a link depends on the volume on the link and its capacity. All existing models (to my knowledge) give speed as a function of the volume/capacity ratio. Recognizing that volume and capacity affect speed not only by their ratio, often there is a family of speed-flow (speed vs. V/C) curves for roads of different capacities, e.g., 2-lane and 4-lane arterials.

Because of different vehicle and operating characteristics, the speeds of each mode will be affected differently by congestion. Therefore each mode will have its own speed-flow relations.

Therefore the speed of mode m on link a which is of type s will be

$$x_{m,a}^{t,h} = g_{m,s}\left[(V/C)_a^{t,h} \right] \qquad (5)$$

where

$g_{m,s}[\ *\ ]$ is a particular speed-flow relation for mode m and road type s. Different functional forms exist for the functions $g_{m,s}$. In order to identify the appropriate curve to be used for a particular link (given that mode is known), there must be a pointer specific to each link indicating the correct curve. If all of the curves have the same functional form with a different parameter (e.g., minimum speed), the pointer may be simply the parameter and thus the functional form of the speed-flow curve needs to be stored only once. This pointer or parameter is called s_m. (It seems obvious that the speed of the bus and truck modes might be affected by grade. However most analyses consider the peak direction only, which is one direction half the day and the other direction the other half, so that average grade on every link is zero, and average speed is almost unaffected by grade. The same is true for operating cost, though it is known that it costs more to travel a distance on a hilly road with

an "average" grade of zero than on a flat road. Since we will usually be using models for speed and cost that ignore grade, the remainder of this paper shall ignore it, too. Furthermore, ignoring grade allows both directions of a link to be identical. This is a significant simplification, making flows to be direction abstract, and hence allowing analysis of flows in one hour to be expanded to hours with similar flows without regard to direction when less than 48 hours are analyzed.) Some examples of speed-flow functions are found in Attachment A.

Step 6: For Each Mode, Determine Operating Cost

Vehicle operating cost on a link is difficult to measure, and therefore difficult to model. It is affected by road characteristics (grade, curvature, pavement), vehicle characteristics (weight, engine type), and operating characteristics (speed, number of stops). Most models give operating cost in terms of one of the operating characteristics only (speed) aggregating different vehicle types (within the same mode) and averaging over road characteristics. If pavement is uniform over the road, there is no more than normal curvature for an urban road, and grades are not great, such approximations are acceptable. Under normal urban operating conditions a study found that 95% of the variation in fuel consumption among British cars could be explained by speed alone. Since other auto related costs are roughly proportional to fuel consumption, the simple speed-operating cost relation may be sufficient for autos.

Operating cost is usually computed by a function of this form:

$$OC^{t,h}_{m,a} = \beta_m + \frac{\alpha_m}{X^{t,h}_{m,a}} \cdot d_a \cdot V^{t,h}_{m,a} \qquad (6)$$

where

$OC^{t,h}_{m,a}$ = operating cost for mode m on link at time h in year t

α_m, β_m = parameters (per hour and per Km operating cost for mode m)

$X^{t,h}_{m,a}$ = speed of mode m on link a at time h in year t

d_a = length of link a

$V^{t,h}_{m,a}$ = volume of mode m on link a at time h in year t.

Since operating cost should include the labor cost of paid drivers such a function including a term in which distance is divided by speed (which yields time) is especially appropriate for bus and truck. Operating cost models estimated in a few cities are documented in Attachment A.

Step 7: For Each Mode, Determine Time Cost

The time each vehicle spends on a link is the link's distance divided by the vehicle's speed. The total passenger time is the vehicle time multiplied by vehicle occupancy (not including paid drivers). The total time cost is this total passenger time multiplied by the value of time.

Vehicle occupancy can vary not only by mode but also by link and by time of day, particularly on buses where loads may be 80 in the peak and 20 off-peak, and may increase steadily toward the city center. Value of time is generally taken to be fixed for all modes and all times, and invariant over the year.

Thus the passenger wait time cost is

$$TC^{t,h}_{m,a} = \frac{d_a}{X^{t,h}_{m,a}} \cdot W^{h}_{m,a} \cdot v \cdot V^{t,h}_{m,a} \qquad (8)$$

where

$TC^{t,h}_{m,a}$ = time cost for mode m on link a at time h in year t

d_a = length of link a

$X^{t,h}_{m,a}$ = speed of mode m on link a at time h in year t

$W^{h}_{m,a}$ = vehicle occupancy of mode m on link a at time h

v = value of time

$V^{t,h}_{m,a}$ = volume (of vehicles) of mode m on link a at time h in year t

Step 8: Aggregate Costs Over Modes and Links

Steps 4-7 must be repeated for every link and every mode as the flowchart in Figure 1 indicates, aggregating costs to yield hourly costs. Thus the operating and time costs for an hour h in year t are:

$$OC^{t,h} = \sum^{a} \sum^{m} OC^{t,h}_{m,a}$$
$$TC^{t,h} = \sum^{a} \sum^{m} TC^{t,h}_{m,a} \qquad (9)$$

Other meaningful aggregations should be taken as well, such as total costs for modes, for links, etc.

Step 9: Aggregate Costs Over Hours, Expanding to Yearly Costs

Steps 3-8 are repeated for each hour. To expand the predicted hourly costs to yearly costs one needs to know the number of hours in a year that hour represents. These annualization factors should insure that the daily demand (in Step 1) is properly expanded to annual demand. Different hours may have different annualization factors because they represent different numbers of weekday and weekend hours. Also some analyses may want to consider peak hours only in computing benefit.

The annual costs are then:

$$OC^{t} = \sum^{h} OC^{t,h} \; N_h$$
$$TC^{t} = \sum^{h} TC^{t,h} \; N_h \qquad (10)$$

where

N_h = number of hours in a year represented by hour h.

Step 10: Discount Yearly Costs

Either annual or continuous compounding may be used to discount the yearly costs to present values. For operating costs, these formulas are:

$$\overline{OC}^{t} = OC^{t} (1 + D)^{-t} \quad \text{(yearly compounding)}$$
$$\overline{OC}_{t} = OC^{t} e^{-Dt} \quad \text{(continuous compounding)} \quad (11)$$

where

OC_t = discounted operating cost from year t

D = shadow discount rate

time costs are similarly discounted

Step 11: Aggregate Discounted Costs

This yields the present costs of the alternative being studied. The difference between the present cost of the no-build alternative and that of the build alternative is the present value of the build alternative. (When other discounted costs, such as construction, maintenance, etc., are subtracted this becomes net present value.) So the final equation for present operating costs (and similarly for time cost) is

$$OC = {}^{t} \; \overline{OC}^{t} \qquad (12)$$

The predicted costs thus obtained may be disaggregated and manipulated in any way to afford the analyst a closer look to see the benefits accruing to each link, or to each mode, or to find link specific benefit/cost ratios, internal rates of return, etc.

5. Solution Procedure

Within the above Analytic framework, the solution procedure provides a logical, yet simple sequence of analytic tasks. These tasks are listed below and elaborated in detail in the following sections.

5.1 Summary of Tasks

A. Strategic Forecasts of Travel Demands

1. Review land use conditions and developmental assumptions
2. Review test road network and bus system conditions and changes
3. Review traffic assignments and diversions

B. Future Demand Volumes

1. Estimate future auto/truck traffic volumes
2. Estimate future bus and bus passenger traffic volumes
3. Estimate future train passenger traffic volumes
4. Develop peak hour and peak direction factors
5. Estimate future peak hour, peak direction volumes for auto/truck, bus and bus passenger, train passengers.

C. Design Capacities

1. Develop lane capacity of auto/truck
2. Determine PCU equivalencies and passenger capacities for bus and mini-bus

D. Volume/Capacity Ratios

1. Compute V/C ratio for auto/trucks and for busses

E. Level of Service and Travel Speed

1. For auto/trucks and for busses, establish a LOS - V/C Speed table.
2. Determine LOS and travel speed, knowing V/C.

F. Travel Time, Stops, and Idling Time

1. Develop a "model" to relate LOS, travel time per km., stops per km., and idling time per km. for auto/trucks and busses.

2. Determine on a "per kilometre" basis, travel time, stops, idling time, and excess travel time (actual time minus 1.0 minute as derived from 60 kph base)

G. Time Costs and Vehicle Operating Costs

1. Determine value of driver's time and passengers' time per hour.

2. Determine for auto/truck and for bus, vehicle operating cost per km. for 60 kph base, and for additional costs due to stops and idling time.

H. Time Savings

1. For auto/truck drivers and for bus passengers, compute time savings during six peak hour, peak directions for each year (1979-1999). "Savings" are based on difference between "No Build" (Alternative 1) and "Build" (Alternative 2).

2. Compute present value of time savings.

I. Vehicle Operating Cost Savings

1. For auto/truck volumes and for bus volumes, compute operating cost savings by link during six peak hour, peak directions for each year (1979-1999). "Savings" are based on "No Build" (Alternative 1) and "Build" (Alternative 2).

2. Compute present value of vehicle operating cost savings.

J. Project Costs

1. Determine present value of project costs.

K. Economic Evaluation

1. Determine benefit-cost (B/C) ratio, "Benefits" refer to the sum of present values for time savings and vehicle operating cost savings.

2. Determine net present value (NPV).

3. Determine internal rate of return.

5.2 Input Requirements

A description of input requirements and assumptions used to calibrate the analysis to conditions in Colon in 1979 is given in the pages that follow.

Input Requirements

For a project with A links, M modes, a benefit horizon of T years, each of which has H hours, considering 2 alternatives.

Number of Items	Variable	
A x M	$V^{o,*}_{m,a}$	base year vehicular demand for mode m on link a
M or 1	r_m or r	demand growth rate (for mode m)
H x M or H	f^h_m or f^h	peaking factor (for mode m) in hour h
M	e_m	PCU equivalency factor for mode m
2A	C^b_a	capacity of link a under alternative b (no build or build)
2M	α_m, β_m	operating cost model parameters for mode m
A	d_a	length of link a
H x M or M	W^h_m or W_m	vehicle occupancy of mode m(in hour h)
1	v	value of time

H	N_h	yearly number of travel hours of type h
1	D	shadow discount rate
M	s_m	speed-flow curve parameter for mode m

plus a speed-flow function

c_B	bus fares
t_c	terminal times
C_{nr}	non-transport location costs
W	disaggregate attractivity indices
L	land availability
P	aggregate popular growth
E	aggregate employment growth

BENEFITS ON A SINGLE LINK: SINGLE HOUR EXPANDED

(Input Data Format)

Site: ______________________________ Date: ______________

Analyst: ______________________ Page: _____ of ______

Costs: __________________________

Enter		Press
(Initialize)		A
(Initialize)		B
Auto mode:		
growth factor (1.xx)	= 1. ______	R/S
PCU equivalency factor (1)	= 1 ______	R/S
speed-flow function parameter	= ______	R/S
per hour operating cost ($/hr)	= ______	R/S
per km operating cost ($/hr)	= ______	R/S
auto occupancy ______ x value of time ______ ($/hr)	= ______	R/S
Truck mode:		
growth factor (1.xx)	= 1. ______	R/S
PCU equivalency factor	= ______	R/S
speed-flow function parameter	= ______	R/S
per hour operating cost	= ______	R/S
per km operating cost	= ______	R/S
occupancy x value of time	= 0.0 ______	R/S

Enter		Press
Bus Mode		
growth factor (vehicular) (1.xx)	= 1. ______	R/S
PCU equivalency factor	= ______	R/S
speed-flow function parameter	= ______	R/S
per hour operating cost	= ______	R/S
per km operating cost	= ______	R/S
bus occupancy ______ x value of time ______	= ______	R/S
(Initialize)		C
Base year vehicular volumes (peak hour, peak direction)		
auto volume (veh/hr)	= ______	R/S
truck volume	= ______	R/S
bus volume	= ______	R/S
Link capacities (one direction)		
no build capacity (veh/hr)	= ______	R/S
build capacity	= ______	R/S
Link length (km)	= ______	R/S
Peak hour, peak direction yearly expansion factor (number of peak hours per year)	= ______	STO 11
First year discount factor (1.xx)	= ______	STO 13
Discount rate (1.xx)	= ______	STO 14
Number of years	= ______	STO 00
First Year in Benefit Horizon	= ______	STO 06

5.3 Regional Growth, Land and Transport Inputs for Colon Urban Development Project

Level 1: Regional Growth Inputs

The key regional growth assumptions underlying the projection of travel demands are described in the Project Appraisal Report and summarized in the tables below:

Employment Growth and Change 1979-1989

Based on "basic" employment-generating project investment and "non-basic" job-generation (assuming a multiplier of 1.8) distributed to spatial structure of the market and available land.

Urban Project Build

Year	Employment					
	1979		1984		1989	
Zone	Basic	Non-basic	Basic	Non-basic	Basic	Non-basic
1	500	7,500	500	9,000	500	11,000
2	5,000	-	5,000	-	5,000	-
3	3,000	-	3,500	-	4,000	-
4	-	250	-	500	-	1,300
5	500	-	2,000	-	3,000	-
6	-	-	-	250	-	500
7	-	-	2,000	-	5,000	-
8	1,000	500	1,000	1,500	1,000	2,000
9	-	-	-	-	-	-
Total	10,000	8,250	14,000	11,250	18,500	14,800

Urban Project No-Build

Year	Employment					
	1979		1984		1989	
Zone	Basic	Non-basic	Basic	Non-basic	Basic	Non-basic
1	500	7,500	500			
2	5,000	-	5,000			
3	3,000	-	3,000			
4	-	250	-			
5	500	-	1,000			
6	-	-	-			
7	-	-	-			
8	1,000	500	1,000			
9	-	-	-			
Total	10,000	8,250				

Population Growth and Change 1979-1989

Based upon a full labor participation rate of .33 and an unemployment rate (in formal sector activities) of 40% effective 1979 and reducing ___ to 7%-10% by 1989, distributed on the basis of observed existing densities and inputed changes on future locational cost/demand for housing. Income classes are defined in terms of average income levels which are taken to neither increase nor decline in real terms over the analysis period. Population growth arising from natural increase and net in-migration are not distinguished in the h household totals shown below; average household size is taken as 4.6 (existing 1979 average) throughout the period. (Households.)

Income	1979				1980				198			
Class / Zone	High	Medium	Low	Total	High	Medium	Low	Total	High	Medium	Low	Total
1	2,600	8,300	4,100	15,000	2,500	8,000	2,500	13,000	2,500	8,000	2,500	13,000
4	800	200	-	1,000	800	200	-	1,000	800	200	-	1,000
6	-	-	-	-		3,000	2,000	5,000	-	3,000	2,000	5,000
8	800	2,000	1,200	4,000	1,000	2,500	1,500	5,000	1,500	3,500	2,000	7,000
Total	4,200	10,500	5,300	20,000	4,300	13,700	6,000	24,000	4,800	14,700	6,500	26,000

Level 2: Urban Land Inputs

The key land assumptions underlying the projection of land demands are summarized in the tables below:

Land Available for Residential Use

Based on surveyed land use patterns and observed net residential densities existing for 1979, with income classes separately estimated by zone.

INCOME CLASS

Year	1979							1984				1989			
Zone	High		Middle		Low		Total	High	Middle	Low	Total	High	Middle	Low	Total
1	78.0	300	83.0	100	12.3	30	173.3	75.0	80.0	77.5	162.5				
4	48.0	600	4.0	200	0.0		52.0	48.0	4.0		52.0				
6	-	-	-	-	-	-	-	-	75.0	15.0	90.0				
8	72.0	900	60.0	300	10.8	90	142.8	90.0	75.0	13.5	178.5				
Total	198.0		147.0		23.1		368.1	213.0	234.0	36.0	483.0				

Disaggretated Attractivity Indices.

Based upon existing and future demand by income class in proportion to class size in each residential zone, and a calibrated coefficient of attraction.

Income Class	1979						1984						1989					
Zone	High	αH	Middle	αM	Low	αL	High	αH	Middle	αM	Low	αL	High	αH	Middle	αM	Low	αL
1	26		83		41		25		80		25		25		80		25	
4	8		2		0		8		2		0		8		2		0	
6	-		-		-		0		30		20		-		30		20	
8	8		20		12		10		25		15		15		35		20	

Non-transport Location Expenditure

Based upon an estimated proportion of average household income budgeted for land, housing and utilities costs, measured in terms of monthly household expenditures per square meter of residential land.

	1979			1984			1989		
Income Class	High	Middle	Low	High	Middle	Low	High	Middle	Low
Zone									
1	1.80	1.10	0.83						
4	0.90	0.53	-						
6	-	-	-						
8	0.60	0.35	0.28						

Level 3: Transport Inputs

The key transport assumptions underlying the projection of travel demands are summarized in the tables below:

Values of Travel Time

Income Class

	High	Middle	Low
Average HH income/month	$1800	$425	$125
Average hourly income/traveler	$8.72	$225	$0.73
Value of travel time rate	25%	25%	25%
VOT/minute of travel	0.036	0.009	0.003

Trip Rate by Mode (Morning Peak Period Only)
1979

Income class	High			Middle			Low		
Mode	Car	Bus	Walk	Car	Bus	Walk	Car	Bus	Walk
Zone									
1	0.6	0.2	0.2	0.2	0.3	0.3	0.1	0.3	0.3
4	0.7	0.2	0.1	0.2	0.4	0.2	-	-	-
6	-	-	-	0.2	0.4	0.2	0.1	0.3	0.3
8	0.7	0.2	0.1	0.2	0.4	0.2	0.0	0.5	0.2
9	.8	.2	-	0.2	.6	-	-	1.0	-

Year 1984/1989

Income class	High			Middle			Low		
Mode	Car	Bus	Walk	Car	Bus	Walk	Car	Bus	Walk
1	0.7	0.2	0.2	0.3	0.3	0.3	0.1	0.3	0.3
4	0.8	0.2	0.1	0.3	0.4	0.2	-	-	-
6	-	-	-	0.3	0.4	0.2	0.1	0.4	0.2
8	0.8	0.2	0.1	0.2	0.4	0.2	0.1	0.4	0.2
9	0.9	0.1	-	0.5	0.5	0.2	0.1	0.9	-

TRUCK TRIP RATE PER UNIT OF EMPLOYMENT

Zone	Truck Trips
1	0.08
2	0.10
3	0.10
4	0.06
5	0.08
6	0.06
7	0.08
8	0.06
9	-

INTERZONAL LINK DISTANCES

(Based upon shortest route distances between zone centroids along existing roads in kilometers).

	1	2	3	4	5	6	7	8
1	0.67	1.40	1.00	2.40	4.80	4.40	8.20	9.60
2	1.40	0.36	1.60	3.00	5.40	5.00	8.80	10.20
3	1.00	1.60	0.54	2.20	4.60	4.20	8.00	9.40
4	2.40	3.00	2.20	0.74	2.40	2.00	5.80	7.20
5	4.80	5.40	4.60	2.40	0.66	1.60	5.40	6.80
6	4.40	5.00	4.20	2.00	1.60	1.00	4.60	6.00
7	8.20	8.80	8.00	5.80	5.40	4.60	1.20	3.00
8	9.60	10.20	9.40	7.20	6.80	6.00	3.00	1.20

PCU EQUIVALENCY AND OCCUPANCY RATE

	PCU Equivalent	Occupancy
cars	1.0	1.6
busses	3.0	45.0
trucks	3.0	1.0

PEAK PERIOD EXPANSION FACTOR TO MONTHLY TOTALS

trucks	115.0
busses	92.0
cars	107.4

Expansion factors are based on the following considerations for the purpose of estimating benefits:

Auto: Peak (2 hour) volume is 1/7 of total daily

3 peak periods @ full benefit	=	3.00
2 " " " 2/3 "	=	1.33
1 " " " 1/3 "	=	0.33
1 " " " no "	=	0.00
		4.67
4.67 (daily) X 23 (days per month)	=	115.0

Bus: Peak (2 hour) volume is 1/5 of total daily

3 peak periods @ full benefit	=	3.00
2 " " 1/2 "	=	1.00
		4.00
4.00 (daily) X 23 (days per month)	=	92.0

Truck: peak (2 hour) volume is 1/8 of total daily

3 peak periods @ full benefit	=	3.00
2 " " 2/3 "	=	1.33
2 " " 1/2 "	=	0.67
1 " " 0 "	=	0.00
		5.00
5.00 (daily) X 23 (days per month)	=	115.0

AUTOMOBILE OPERATING COST PER 1,600 KMS. (1979)

MPH	KPH	Gas	Oil	Tires	Maintenance	Depreciation	Interest	Total
10	16	49.11	2.39	1.02	7.00	45.00	36.00	140.52
15	24	51.01	2.23	1.22	8.00	41.00	28.50	131.96
20	32	45.82	1.92	1.63	8.50	36.00	22.50	116.37
25	40	43.47	1.82	2.14	8.85	34.50	19.00	109.78
30	48	41.24	1.77	2.65	9.50	32.50	16.50	104.16
35	56	43.22	1.71	3.26	9.85	30.50	15.00	103.54
40	64	43.45	1.71	3.82	10.60	29.00	13.50	102.08
45	72	46.70	1.66	4.54	11.00	27.50	13.00	104.40
50	80	48.67	1.61	5.30	11.50	26.50	12.00	105.58
55	88	53.04	1.50	6.17	12.25	26.00	11.50	110.46
60	96	57.14	1.58	7.19	13.00	25.00	11.00	114.89
65	104	62.96	1.77	8.36	13.75	24.50	10.50	121.84

Using linear regression a curve is determined to fit these data points, whose equation is:

$$C = 0.1046-0.001256x + 0.000009512x^2$$

where C = \$ cost per km for cars
x = speed in km/hour

For busses, based upon 1977 data, the ratio of bus to auto operating costs is given as 4.3. For trucks, based upon the same data source, the truck to auto operating cost ratio is given as 5.6. These values are taken as given.

ASSUMED LEVELS OF BUS FARES

Destination Zone / Origin Zone	1	2	3	4	5	6	7	8	9	Total
1.	.10	.10	.10	.10	.25	.20	.40	.50	1.25	
2	.10	.10	.10	.15	.25	.25	.45	.50	1.25	
3	.10	.10	.10	.10	.20	.20	.40	.50	1.25	
4	.10	.15	.10	.10	.10	.10	.30	.35	1.15	
5	.25	.25	.20	.10	.10	.10	.25	.35	1.00	
6	.20	.25	.20	.10	.10	.10	.25	.30	1.05	
7	.40	.45	.40	.30	.25	.25	.10	.15	.85	
8	.50	.50	.50	.35	.35	.30	.15	.10	.75	
9	1.25	1.25	1.25	1.15	1.00	1.05	.85	.75		

ASSUMED LEVELS OF TRIP TERMINAL TIME IN MINUTES

Origin Zone	Destination Zone	1	2	3	4	5	6	7	8	Note
	Cars	4	4	4	4	4	5	4	4	5 Min.
	Busses	9	9	9	9	9	15	9	9	Service Level
	Cars	4	4	4	3	4	6	4	4	10. Min.
	Busses	14	14	14	14	14	18	14	14	Service Level
	Cars	6	6	6	6	6	8	6	6	10 Min.
	Busses	18	18	18	18	18	22	18	18	Service Level
	Cars	4	4	4	4	4	6	4	4	10 Min.
	Busses	14	14	14	14	14	18	14	14	Service Level

LINK CAPACITY TABLE

	1	2	3	4	5	6	7	8
1		240	1,600	1,600	-	-	-	-
2	240		-	-	-	-	-	-
3	1,600	-		800	-	-	-	-
4	1,600	-	800		1,200	1,200	800	800
5	-	-	-	1,200		1,200	800	800
6	-	-	-	1,200	1,200		800	800
7	-	-	-	800	800	800		800
8	-	-	-	800	800	800	800	

REVISED OPERATING COST FOR TRUCK

At 40 km/h, car operating cost of \$ 0.07.

Truck operating cost is 5.6 times higher, or \$ 0.39

$$\$0.39 \frac{1}{km} \times \frac{40km}{hr} = \$15.59/hrs$$

The labor cost component is \$1/hr, so the reduced OC is 14.5%. This corresponds to \$0.36/km, which is 5.2 times higher than auto.

So truck cost is [5.2 (auto cost/km) X distance + \$1 time]

6. OPERATING THE PROGRAM

6.1 BASIC USER INSTRUCTIONS FOR A T159 & PRINTER

1. To turn on the calculator, first plug in the printer and calculator. DO NOT turn on calculator and printer before plugging in the printer. To turn off the calculator, turn off both calculator and printer before unplugging the printer.

2. Algebraic operations -- The TI59 uses logic known as Algebraic Operating System. Algebraic operations are punched into the calculator going from left to right as they would be written out. For example, to perform the following calculation:

$$8 \div 3 = 2.67$$

you would push the following buttons:

1) $\boxed{8}$
2) $\boxed{\div}$
3) $\boxed{3}$
4) $\boxed{=}$

Where there are a complex series of calculations, the calculator follows certain rules about which ones are performed first. Alternatively, you can use parentheses to make the calculator perform operations in a particular order.

The order of operations performed by the T159 is:

1) Special single function keys (such as trig and log functions)
2) Powers and roots (Y^X and $\sqrt[x]{Y}$)
3) Multiplications and divisions
4) Additions and subtractions

Example

$$3 + 10 - 2 \times 14 \div 7 = 9$$

This is the same as

$$3 + 10 -(2 * 14 \div 7) = 9$$

If you do not wish the above interpretation to be followed you must use parentheses, for example:

$$(3 + 10 - 2) * 14 \div 7 = 22$$

2. <u>Special function and operation keys</u>

A) Every key can be used in 2 ways as indicated by 1) labels on the key and 2) gold labels above the key. To get the use of the gold label function, push the gold key marked $\boxed{\text{2nd}}$ before pushing the desired key.

B) The INV key will give you the use of inverse functions or operations for many of the keys. For example to compute e ^{2} push the following:

$\boxed{2}$

$\boxed{\text{INV}}$

$\boxed{\text{ln}}$

4. <u>User Labels</u> -- User labels are names given by the programmer to different parts (or subroutines) of a pocket calculator program. By pushing a user label key, you are able to have the calculator perform a specific subroutine. The user labels are contained in the top row of the TI59 and consist of A,B,C,D,E, and A', B', C', D', E'.

5. <u>Memory Structure</u> -- The TI59 memory is divided into a section to hold a program and a section to hold data. When the TI59 is turned on, it contains 480 spaces for program instruction and 60 spaces for data.

You may re-partition memory if you need more data storage, or more program storage. Following are two commands useful in memory partitioning:

A. 2nd OP 1 6 will cause the calculator to display the current memory partition. Ordinarily the display will read 479.59 (program positions go from 000 to 479 and data registers go from 00 to 59).

B. X 2nd OP 1 7 will cause the calculator to repartition memory so that there are 10X data registers. For example:

4 2nd OP 1 7 would give a partition of 639.39 (or 640 program positions and 40 data registers).

6. Reading a Card -- In order to read a card the calculator must be properly partitional in the same manner as when the card was created. The calculator must also be told the proper place to store the data on the card. Each magnetic card has two sides (or banks). The calculator memory can hold 4 banks (or 2 cards) worth of information.

To read a card, first push the number of the memory bank into which this card will be read. The number will be 1, 2, 3 or 4. Usually the proper memory bank is indicated upon the card or in programmer user instructions. As an alternative, push 0 before reading the card. Then the card will be automatically read into the proper bank.

The second step in reading a card is to hold the yellow side up and insert the proper end (designated by the bank number on the card) into the card reader. Let the calculator process the card through (do not push the card once the calculator has hold of it) and then gently remove the card. The calculator will display the number of the memory bank into which the card read. If there is a misread or if you have pushed an improper bank number, the calculator display will flash. In this case you must start over.

7. Listing Memory

There are two commands which allow you to list memory. There are:

A. [2nd] [List]

This command will print out the program memory. It is especially useful for checking that the current program has been properly read in. To stop the listing push [R/S]

B. [INV] [2nd] [List]

This command will print out the contents of the data registers. To stop the listing push [R/S] .

Notes: Occasionally the listing does not start at the proper place (i.e. does not start at program location 000 or data register 00). To correct for this you press [GTO] and the proper memory address. For a program, the address would be 000, and for the data registers (under normal partitioning) the address would be 480. The calculator may flash when given the data register address, but this procedure works nontheless. Follow with the desired list command.

8. Run Stop and Reset

These are two useful commands. Reset [RST] will place the program counter at the beginning of a program which is at address 000. Thus reset may be used when you wish to start a program from the beginning.

Run/Stop [R/S] may be used to stop program execution, and it may be used to start program execution at the current location in the program. For example, a program may halt execution to wait for data. The user enters the data into the display and starts execution by pressing [R/S].

9. Clears -- There are four clear commands with the T159 as follows:

CE -- clears the current display only

CLR -- clears the current math operation

2nd CP -- clears the program

2nd CMs -- clears the data registers

10. Store and Recall

Press STO and a two digit data register number to place the display in memory. For example, 1 STO 0 2 would place a 1 in register 2.

Press RCL and a two digit data register number to recall the contents of the data register onto the display. In the above example, RCL 0 2 would display a 1.

11. Printer commands -- The printer attached to the T 59 has a number of different operating modes. If none of its three buttons have been pushed, then the printer takes all its instructions from the calculator.

If the PRINT button is pushed, the printer will print out the current display on the calculator.

If the TRACE button is pushed, the printer will print out each step in the execution of a program. Trace is very useful for debugging.

The ADV or advance button merely advances the paper in the printer.

6.2 INSTRUCTIONS FOR COMPUTING BENEFITS TO ORIGIN ZONES [FIRST PROGRAM]

1. Fill in, for each mode, a matrix giving volume on each link, by income class within each origin zone, for each mode. (See Tables 1-3)

   Differentiate between volume inbound (+) and outbound (-).

2. Compute, for each link, the total volume in PCU's. This is given by

$$V^e = \sum_{\substack{\text{MODES} \\ m}} \Big(\sum^{\substack{\text{INCOME} \\ \text{CLASS } i}} V_{mi} \Big) \cdot PCU_m \div OCCUPANCY_m$$

   Note than inbound volume must be computed separately from outbound.

3. Table 4 summarizes the necessary link data. Fill in such a table, including length, V/C in each direction, and free-flow speed. If V/C or free-flow speed changes in the build alternative, mark that down.

4. Fill in, for each mode (bus and car) for each zone, a table headed "ORIGIN ZONE:" (See Tables 5-10) which contains all the data needed.

5. Fill in, for truck, a table for each origin zone (see Tables 11-16).

6. You are now ready to run the programs.

7. After turning on the printer and calculator, set the partition; Press 9 2nd Op 17 23.908

8. Enter side 2A of program UTB -2.2(A) after entering zero (0).

9. Enter the data on one of the bus or car tables. To enter the data, enter each number and then press the key indicated (A, B, or C). Where no key is indicated, press R/S. Enter data corresponding to the no-build alternative. If you make an error in entering data, see Step 19 below. Fill in the data for one origin zone and one mode completely.

10. Enter zero (0), and load card 1B of UTB-2.2(A).

11. If desired fix the output format by pressing 2nd Fix n where (n) is the number of digits desired after the decimal.

12. Press A and wait until costs are printed. These are the operating and time costs for each income class, and their sum over the income classes.

13. If there is a build alternative, enter data for it. You may re-enter all the data (beginning with number of links, as the values of time and model parameters don't change), or enter only those items that change. To do the latter, see 19 below. To do the former, do Steps 8-11. Before entering data you may want to change the format (as in Step 12).

    * Whatever you do, <u>be sure to enter the number of links</u>, even if it hasn't changed, by entering it and pressing <u>STO</u> <u>00</u>, or pressing C if card 1A is in memory.

14. Press B and wait. The same items as listed in Step 12 will be printed for the build alternative; so will the differences between no build and build.

15. Now select another mode-zone pair. It is best to do all the zones of a single mode together.

16. For each mode-zone pair, repeat Steps 8-15. Note: If values of time and modal parameters do not change, they need not be repeated.

    Also, you may want to undo the fixed display format by pressing INV 2nd Fix.

17. You are now ready to do the trucks. For each origin zone, perform Steps 8-15 again, with these changes:

    Use Program UTB-2.2(B), sides 1A and 1B instead of Program UTB-2.2(A),
    Because these are the income classes, the run time and output in Steps 12 and 14 will be shorter
    Output is operating cost not including labor, labor cost and their sum.

18. FINISHED!

19. <u>Error Recovery</u>

    1. You may list the contents of the data registers, beginning with register (m) by pressing (<u>m</u>) <u>INV</u> <u>2nd</u> list. Press R/S when you want it to stop listing.
    2. You may enter any number directly by entering it and pressing <u>STO</u> <u>ab</u>, where <u>ab</u> is the register it goes in. This also applies

to changes for the build alternative.

3. The contents of the data registers is given in the Table so marked for each program.

Figure 2

Detailed Output Table

Link \ Year	1	2	. . .	T	Total (discounted)
1	□	□	. . .	□	□
2	□	.	.	.	.
.	.		.	.	.
A	□			□	□
Total	□	□	. . .	□	□

□ = Alternative 1 (no build)

1. Peak hour V/C
2. Peak hour auto speed

Alternative 2 (build)

3. Peak hour V/C
4. Peak hour auto speed

not included in row and column totals

Mode 1 (auto)

Alternative 1 (no build)

5. Operating cost
6. Time cost

Alternative 2 (build)

7. Operating cost
8. Time cost

Difference (benefit of build alternative)

9. Operating cost
10. Time cost

Mode 2 (truck)

Alternative 1

11. Operating Cost
12. Time cost

Alternative 2

13. Operating cost

Figure 2 (continued)

14. Time cost

Difference

15. Operating cost

16. Time cost

Mode 3 (bus)

Alternative 1

17. Operating cost

18. Time cost

Alternative 2

19. Operating cost

20. Time cost

Difference

21. Operating cost

22. Time cost

Total (all modes)

Alternative 1

23. Operating cost

24. Time cost

Alternative 2

25. Operating cost

26. Time cost

Difference

27. Operating cost

28. Time cost

6.3 ESTIMATED 1979 TRAVEL BENEFITS BY ORIGIN ZONE

By mode, income class and zone of origin for conditions existing with no highway component as compared to those with the proposed highway component.

Summary:

Table 1:

SUMMARY GENERALIZED TRAVEL COST - YEAR: 1979

Zone:		High Income HH	Middle Income HH	Low Income HH	Employment	Total
1.	Car					
	Bus					
	Truck					
	Walk					
2.	Car					
	Bus					
	Truck					
	Walk					
3.	Car					
	Bus					
	Truck					
	Walk					
4.	Car					
	Bus					
	Truck					
	Walk					
5.	Car					
	Bus					
	Truck					
	Walk					
6.	Car					
	Bus					
	Truck					
	Walk					
7.	Car					
	Bus					
	Truck					
	Walk					
8.	Car					
	Bus					
	Truck					
	Walk					
9.	Car					
	Bus					
	Truck					
	Walk					
Total	Car					
	Bus					
	Truck					
	Walk					
Total						

Table 2: TRIP-ORIGIN - MORNING PEAK

Year 1979

Zone:		High Income HH	Middle Income HH	Low Income HH	Employment Places	Total
1.	Car	1,560	1,660	-		3,220
	Bus	520	2,490	1,230		4,240
	Truck	-	-	-	640	640
	Walk	520	2,490	1,230		4,240
2.	Car					
	Bus					
	Truck				500	500
	Walk					
3.	Car					
	Bus					
	Truck				300	300
	Walk					
4.	Car	560	40	-		600
	Bus	160	80	-		240
	Truck	-	-	-	15	15
	Walk	80	40	-		120
5.	Car					
	Bus					
	Truck				40	40
	Walk					
6.	Car	0	0	0		0
	Bus	0	0	0		0
	Truck	0	0	0	-	0
	Walk	0	0	0		0
7.	Car					
	Bus					
	Truck					
	Walk					
8.	Car	560	400	-		960
	Bus	160	800	600		1,560
	Truck	-	-	-	90	90
	Walk	80	400	240		720
9.	Car	+580	320	-		900
	Bus	+145	+480	+1,300		1,925
	Truck				200	200
	Walk	-	-	-		-
Total	Car	3,260	2,420	-		5,680
	Bus	985	3,850	3,130		7,965
	Truck	-	-	-	1,785	1,785
	Walk	680	2,930	1,470		5,080
Total		4,925	9,200	4,600	1,785	20,510

Table 3: TRIP DESTINATIONS - MORNING PEAK

Year: 1979

		High Income HH	Middle Income HH	Low Income HH	Employment Places	Total
Zone:						
1.	Car	485	1,465	-		1,950
	Bus	105	2,355	1,420		3,880
	Truck				640	640
	Walk	30	1,780	420		2,230
2.	Car	1,250	420	-		1,670
	Bus	420	625	625		1,670
	Truck				500	500
	Walk	330	635	535		1,500
3.	Car	750	250	-		1,000
	Bus	250	375	375		1,000
	Truck				300	300
	Walk	250	375	375		1,000
4.	Car	70	20	-		90
	Bus	20	40	50		110
	Truck				15	15
	Walk	10	20	20		50
5.	Car	130	70	-		200
	Bus	35	100	165		300
	Truck				40	40
	Walk	-	-	-	-	-
6.	Car					
	Bus					
	Truck					0
	Walk					
7.	Car					
	Bus					
	Truck					0
	Walk					
8.	Car	420	120	-		540
	Bus	120	240	300		660
	Truck				90	90
	Walk	60	120	120		300
9.	Car	155	75	-		230
	Bus	35	115	195		345
	Truck				200	200
	Walk	-	-	-		-
Total	Car	3,260	2,420	-		5,680
	Bus	985	3,850	3,130		7,965
	Truck	-	-	-	1,785	1,785
	Walk	680	2,930	1,470		5,080
Total		4,925	9,200	4,600	1,785	20,510

Table 4: O-D DISTRIBUTION OF CAR TRIPS

Year: 1979

Destination Zones

Origin Zone	1	2	3	4	5	6	7	8	9	TOTAL
1. H	283	649	400	23	39	0	0	82	74	1,560
M	1,043	288	169	14	51	0	0	40	52	1,660
L	0	0	0	0	0	0	0	0	0	0
TOTAL	1,326	937	569	37	90	0	0	112	126	3,220
2. H										
M										
L										
TOTAL										
3. H										
M										
L										
TOTAL										
4. H	43	198	134	25	39	0	0	64	27	560
M	22	9	8	0	0	0	0	0	1	40
L	0	0	0	0	0	0	0	0	0	0
TOTAL	95	207	142	25	39	0	0	64	28	600
5. H										
M										
L										
TOTAL										
6. H										
M										
L										
TOTAL										
7. H										
M										
L										
TOTAL										
8. H	43	171	82	9	29	0	0	199	27	560
M	205	69	40	0	10	0	0	65	11	400
L	0	0	0	0	0	0	0	0	0	0
TOTAL	248	240	122	9	39	0	0	264	38	960
9. H	86	222	134	13	23	0	0	75	27	580
M	195	54	33	3	9	0	0	15	11	320
L	0	0	0	0	0	0	0	0	0	0
TOTAL	281	276	167	16	32	0	0	90	38	900
H	485	1,250	750	40	130	0	0	420	155	3,260
M	1,465	420	250	20	70	0	0	120	75	2,420
L	0	0	0	0	0	0	0	0	0	0
GRAND TOTAL	1,950	1,670	1,000	90	200	0	0	540	230	5,680

Table 5: O-D DISTRIBUTION OF BUS TRIPS
Year: 1979

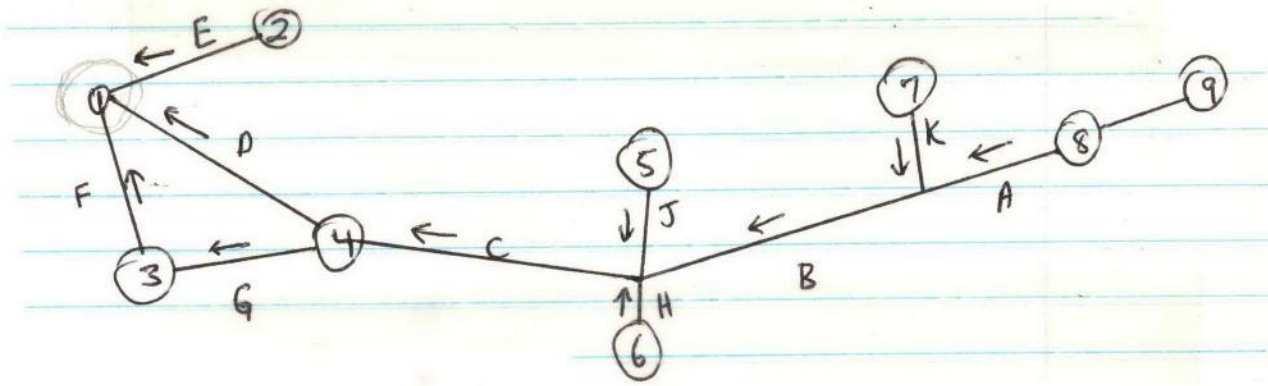
Origin Zone	Destination Zone 1	2	3	4	5	6	7	8	9	TOTAL
1. H	72	241	139	2	20	0	0	28	18	520
M	1,624	388	250	24	62	0	0	64	78	2,490
L	628	270	149	15	52	0	0	40	76	1,230
TOTAL	2,324	899	538	41	134	0	0	132	172	4,240
2. H										
M										
L										
TOTAL										
3. H										
M										
L										
TOTAL										
4. H	11	61	37	8	5	0	0	31	6	160
M	44	16	8	0	0	0	0	10	2	80
L	0	0	0	0	0	0	0	0	0	0
TOTAL	55	77	45	8	5	0	0	41	8	240
5. H										
M										
L										
TOTAL										
6. H										
M										
L										
TOTAL										
7. H										
M										
L										
TOTAL										
8. H	7	52	37	0	7	0	0	44	7	160
M	393	143	70	11	26	0	0	136	21	800
L	202	95	71	15	45	0	0	136	36	600
TOTAL	602	290	178	26	78	0	0	316	64	1,560
9. H	15	66	37	3	3	0	0	17	4	145
M	294	78	47	5	12	0	0	30	14	480
L	590	260	155	20	68	0	0	124	83	1,300
TOTAL	899	404	239	28	83	0	0	171	101	1,925
TOTAL										
H	105	420	250	20	35	0	0	120	35	985
M	2,355	625	375	40	100	0	0	242	115	3,850
L	1,420	625	375	50	165	0	0	300	195	3,130
GRAND TOTAL	3,880	1,675	1,000	110	300	0	0	660	345	7,965

Table 6: O-D DISTRIBUTION OF TRUCK TRIPS

Year: 1979

Origin Zone	Destination 1	2	3	4	5	6	7	8	9	TOTAL
1. TOTAL	276	141	109	6	10	0	0	26	72	640
2. TOTAL	147	203	66	5	5	0	0	18	56	500
3. TOTAL	102	69	72	1	10	0	0	12	34	300
4. TOTAL	2	1	3	0	0	0	0	7	2	15
5. TOTAL	17	7	7	0	4	0	0	0	5	40
6. TOTAL	0	0	0	0	0	0	0	0	0	0
7. TOTAL	0	0	0	0	0	0	0	0	0	0
8. TOTAL	24	23	9	0	7	0	0	17	10	90
9. TOTAL	72	56	34	2	4	0	0	10	22	200
GRAND TOTAL	640	300	300	15	40	0	0	90	200	1,785

Table 7: NETWORK



Arrow points in inbound (+) direction.

Link	PCU's in (2 hrs)	PCU's out (2 hrs)	Capacity (No Build/Build)	V/C in (NB/B)	V/C out (NB/B)	Length	Car Free-flow speed (NB/B)
A						3.4	
B						3.4	80/100
AB	1777	924	800/2400	1.11/.37	.58/.19	6.8	80/100
C	1784	1064	1600	.56	.33	1.5	60
D	1603	864	1600	.50	.27	2.4	60
E	891	2036	1000	.45	1.02	1.4	60
F	519	912	1600	.16	.29	1.1	60
G	463	165	800	.29	.10	2.2	60
J	108	250	1200	.05	.10	0.9	60
H			1200			0.5	60
K			1200				60

Table 8:
Year: 1979

Mode: Car

Link Assignments

Origin / Link	A	B	C	D	E	F	G	H	J	K
1. H M L	(Same as B)	164^{-} 85 (0)	221^{-} 120	251^{-} 130	621^{-} 328	408^{-} 163	- -		57^{-} 35	
2. H M L										
3. H M L										
4. H M L		90^{-} 41	128^{-} 1	271^{+} 31	199^{-} 8	- -	132^{+} 8		38^{-} 0	
5. H M L										
6. H M L		+809/-254								
8. H M L		331^{+} 331	302^{+} 322	211^{+} 282	169^{-} 76	- -	82^{+} 40		29^{-} 9	
9. H M L		478^{+} 294	455^{+} 287	308^{+} 249	222^{-} 54	- -	134^{+} 33		23^{-} 9	
TOTAL H M L		+809/-254 +625/-86 +1434/ -340	+757/ -349 +609/-121 +1366/ -470	+790/-251 +362/-130 +1352/ -381	+0/ -1211 +0/-466 +0/-1677	+0/-408 +0/-163 +0/-671	+348/-0 +81/-0 +429/-0		+0/-147 +0/-53 +0/-260	
GRAND TOTAL°										

Table 9:
Year: 1979
Mode: Bus
Link Assignments

Origin Zone / Link	A	B	C	D	E	F	G	H	J	K
1. H M L	(Same as B)	43 122 114	55 152 147	61 168 158	223 283 214	155 237 154	- - -		12 30 33	
2. H M L										
3. H M L										
4. H M L		35^{-} 10 0	42^{-} 10	74^{+} 62 0	58^{-} 16 0	- - -	37^{+} 8 0		7^{-} 0	
5. H M L										
6. H M L										
8. H M L		140^{+} 650 429	111^{+} 631 393	68^{+} 552 321	51^{-} 118 98	- - -	34^{+} 69 63		29^{-} 20 36	
9. H M L		122^{+} 433 1093	117^{+} 421 1025	77^{+} 369 850	62^{-} 78 260		37^{+} 47 155		5^{-} 12 68	
TOTAL H M L		262 1083 1522 +2867	228 1052 1418 +2698	219 983 1171 2373	0 0 0 0	0 0 0 0	108 124 218 +440		0 0 0 0	
GRAND TOTAL°		- 78 132 114	- 97 162 147	- 61 168 158	- 394 493 512	- 155 261 134	0 0 0		53 68 137	

Table 10:
Year: 1979
Mode: Truck
Link Assignments

Origin \ Link	A	B	C	D	E	F	G	H	J	K
1. H M L	(Same as B)	98^{-}	108^{-}	114^{-}	141^{-}	109^{-}	-		10^{-}	
2. H M L		74^{-}	79^{-}	84^{-}	297^{+}	66^{-}	-		5^{-}	
3. H M L		46^{-}	56^{-}	-	69^{-}	171^{+}	57^{-}		10^{-}	
4. H M L		6^{-}	6^{-}	3^{+}	1^{-}	-	3^{+}		0^{-}	
5. H M L		5^{-}	28^{+}	24^{+}	7^{-}		4^{+}		33^{+}	
6. H M L										
8. H M L		63^{+}	56^{+}	47^{+}	23^{-}	-	9^{+}		7	
9. H M L		168^{+}	166^{+}	128^{+}	56^{-}	-	34^{+}		2^{-}	
TOTAL H M L		230	250	200	297	173	55		36	
GRAND TOTAL°		230	250	200	297	173	55		36	

Table 11: YEAR: 1979

ORIGIN ZONE: 1 Input Data

MODE: Car

Values of Time ($/hr)

9	Class 1	2.18	(A)
10	Class 2	.56	
11	Class 3	.18	

Mode:

5	O.C. parameter	1	(B)
6	occupancy	1.6	
7	expansion factor	107.4	

0 Number of Links: 6 (C)

Link: A-B outbound

20	length (km)	5.5
21	V/C	0.58/.19
22	free-flow speed (km/h)	80/100
23	class 1 vol	164
24	class 2 vol	85
25	class 3 vol	0

Link: C out

26	length	1.5
27	V/C	.33
28	free-flow spd	60
29	class 1 vol	221
30	class 2 vol	120
31	class 3 vol	0

Link: D out

32	length	2.4
33	V/C	0.27
34	free-flow spd	60
35	class 1 vol	251
36	class 2 vol	130
37	class 3 vol	0

Link: E out

38	length	1.4
39	V/C	1.02
40	free-flow spd	60
41	class 1 vol	621
42	class 2 vol	328
43	class 3 vol	0

Link: F out

44	length	1.0
45	V/C	0.29
46	free-flow spd	60
47	class 1 vol	408
48	class 2 vol	163
49	class 3 vol	0

Link: J out

50	length	0.9
51	V/C	.10
52	free-flow spd	60
53	class 1 vol	57
54	class 2 vol	35
55	class 3 vol	0

Link:

56	length	
57	V/C	
58	free-flow spd	
59	class 1 vol	
60	class 2 vol	
61	class 3 vol	

Link:

62	length	
63	V/C	
64	free-flow spd	
65	class 1 vol	
66	class 2 vol	
67	class 3 vol	

Link:

68	length	
69	V/C	
70	free-flow spd	
71	class 1 vol	
72	class 2 vol	
73	class 3 vol	

YEAR: 1979

ORIGIN ZONE: 1

Input Data

MODE: Bus

	Values of Time ($/hr)		
9	Class 1	2.18	(A)
10	Class 2	.56	
11	Class 3	.18	

	Mode:		
5	O.C. parameter	4.3	(B)
6	occupancy	45	
7	expansion factor	92	

0 Number of Links: 6 (C)

	Link: A-B out	
20	length (km)	5.5
21	V/C	.58/.19
22	free-flow speed (km/h)	64/80
23	class 1 vol	43
24	class 2 vol	122
25	class 3 vol	114

	Link: C out	
26	length	1.5
27	V/C	.33
28	free-flow spd	42
29	class 1 vol	55
30	class 2 vol	152
31	class 3 vol	147

	Link: D out	
32	length	2.4
33	V/C	.27
34	free-flow spd	42
35	class 1 vol	61
36	class 2 vol	168
37	class 3 vol	158

	Link: E out	
38	length	1.4
39	V/C	1.02
40	free-flow spd	42
41	class 1 vol	223
42	class 2 vol	283
43	class 3 vol	214

	Link: F out	
44	length	1.0
45	V/C	.29
46	free-flow spd	42
47	class 1 vol	155
48	class 2 vol	237
49	class 3 vol	154

	Link: J oút	
50	length	0.9
51	V/C	.10
52	free-flow spd	42
53	class 1 vol	12
54	class 2 vol	30
55	class 3 vol	33

	Link:	
56	length	
57	V/C	
58	free-flow spd	
59	class 1 vol	
60	class 2 vol	
61	class 3 vol	

	Link:	
62	length	
63	V/C	
64	free-flow spd	
65	class 1 vol	
66	class 2 vol	
67	class 3 vol	

	Link:	
68	length	
69	V/C	
70	free-flow spd	
71	class 1 vol	
72	class 2 vol	
73	class 3 vol	

Year: 1979

Table 13:

BENEFITS TO RESIDENTS OF ORIGIN ZONE 1 Output Costs

	AUTO	BUS	$/Month
NO BUILD			
Income class 1			
OC	15304.	652.	
TC	24177.	9269.	
Income class 2			
OC	7826.	1312.	
TC	3209.	4137.	
Income class 3			
OC	0.	1136.	
TC	0.	1111.	
Total			
OC	23131.	3100.	
TC	27386.	14517.	
BUILD			
Income class 1			
OC	15449.	635.	
TC	21628.	8553.	
Income class 2			
OC	7901.	1263.	
TC	2870.	3615.	
Income class 3			
OC	0.	1089.	
TC	0.	955.	
Total			
OC	23350.	2987.	
TC	24498.	13123.	
DIFFERENCE			
Income class 1			
OC	-145.	17.	
TC	2549.	716.	
Income class 2			
OC	-75.	50.	
TC	339.	522.	
Income class 3			
OC	0.	46.	
TC	0.	157.	
Total			
OC	-220.	113.	
TC	2888.	1394.	

YEAR: 1979

Table 14: ORIGIN ZONE: 4 Input Data

MODE: Car

	Values of Time ($/hr)		
9	Class 1	2.18	(A)
10	Class 2	.56	
11	Class 3	.18	

	Mode:		
5	O.C. parameter	1	(B)
6	occupancy	1.6	
7	expansion factor	107.4	

0	Number of Links:	6	(C)

	Link: A-B out	
20	length (km)	5.5
21	V/C	0.58/.19
22	free-flow speed (km/h)	80/100
23	class 1 vol	90
24	class 2 vol	1
25	class 3 vol	0

	Link: C out	
26	length	1.5
27	V/C	0.33
28	free-flow spd	60
29	class 1 vol	128
30	class 2 vol	1
31	class 3 vol	0

	Link: D in	
32	length	2.4
33	V/C	.50
34	free-flow spd	60
35	class 1 vol	271
36	class 2 vol	31
37	class 3 vol	0

	Link: E out	
38	length	1.4
39	V/C	1.02
40	free-flow spd	60
41	class 1 vol	199
42	class 2 vol	8
43	class 3 vol	0

	Link: G in	
44	length	2.2
45	V/C	.29
46	free-flow spd	60
47	class 1 vol	133
48	class 2 vol	8
49	class 3 vol	0

	Link: I out	
50	length	0.9
51	V/C	.10
52	free-flow spd	60
53	class 1 vol	38
54	class 2 vol	0
55	class 3 vol	0

	Link:	
56	length	
57	V/C	
58	free-flow spd	
59	class 1 vol	
60	class 2 vol	
61	class 3 vol	

	Link:	
62	length	
63	V/C	
64	free-flow spd	
65	class 1 vol	
66	class 2 vol	
67	class 3 vol	

	Link:	
68	length	
69	V/C	
70	free-flow spd	
71	class 1 vol	
72	class 2 vol	
73	class 3 vol	

YEAR: 1979

Table 15: ORIGIN ZONE: 4

Input Data

MODE: Bus

	Values of Time ($/hr)		
9	Class 1		(A)
10	Class 2		
11	Class 3		

	Mode:		
5	O.C. parameter	4.3	(B)
6	occupancy	45	
7	expansion factor	92	

0	Number of Links:	6	(C)

	Link: A-B	
20	length (km)	5.5
21	V/C	.58/.19
22	free-flow speed (km/h)	64/80
23	class 1 vol	35
24	class 2 vol	10
25	class 3 vol	0

	Link: C out	
26	length	1.5
27	V/C	.33
28	free-flow spd	42
29	class 1 vol	42
30	class 2 vol	10
31	class 3 vol	0

	Link: D in	
32	length	2.4
33	V/C	.50
34	free-flow spd	42
35	class 1 vol	74
36	class 2 vol	62
37	class 3 vol	0

	Link: E out	
38	length	1.4
39	V/C	1.02
40	free-flow spd	42
41	class 1 vol	58
42	class 2 vol	16
43	class 3 vol	0

	Link: G in	
44	length	2.2
45	V/C	.29
46	free-flow spd	42
47	class 1 vol	37
48	class 2 vol	8
49	class 3 vol	0

	Link: J out	
50	length	0.9
51	V/C	.10
52	free-flow spd	42
53	class 1 vol	7
54	class 2 vol	0
55	class 3 vol	0

	Link:	
56	length	
57	V/C	
58	free-flow spd	
59	class 1 vol	
60	class 2 vol	
61	class 3 vol	

	Link:	
62	length	
63	V/C	
64	free-flow spd	
65	class 1 vol	
66	class 2 vol	
67	class 3 vol	

	Link:	
68	length	
69	V/C	
70	free-flow spd	
71	class 1 vol	
72	class 2 vol	
73	class 3 vol	

Year: 1979

Table 16: BENEFITS TO RESIDENTS OF ORIGIN ZONE 4 Output Costs

		AUTO	BUS
			$/Month
NO BUILD			
Income class 1	OC	9248.	407.
	TC	13248.	4852.
Income class 2	OC	528.	176.
	TC	192.	529.
Income class 3	OC	0.	0.
	TC	0.	0.
Total	OC	9776.	584.
	TC	13441.	5381.
BUILD			
Income class 1	OC	9327.	391.
	TC	11849.	4215.
Income class 2	OC	529.	172.
	TC	188.	483.
Income class 3	OC	0.	0.
	TC	0.	0.
Total	OC	9856.	563.
	TC	12038.	4698.
DIFFERENCE			
Income class 1	OC	-79.	16.
	TC	1399.	637.
Income class 2	OC	-1.	5.
	TC	4.	47.
Income class 3	OC	0.	0.
	TC	0.	0.
Total	OC	-80.	20.
	TC	1403.	683.

YEAR: 1979

Table 17: ORIGIN ZONE: 8

Input Data

MODE: Car

	Values of Time ($/hr)		
9	Class 1	2.18	(A)
10	Class 2	.56	
11	Class 3	.18	
	Mode:		
5	O.C. parameter	1	(B)
6	occupancy	1.6	
7	expansion factor	107.4	
0	Number of Links:	6	(C)

	Link: AB in	
20	length (km)	5.5
21	V/C	1.11/.37
22	free-flow speed (km/h)	80/100
23	class 1 vol	331
24	class 2 vol	331
25	class 3 vol	0

	Link: C in	
26	length	1.5
27	V/C	.56
28	free-flow spd	60
29	class 1 vol	302
30	class 2 vol	322
31	class 3 vol	0

	Link: D in	
32	length	2.4
33	V/C	.50
34	free-flow spd	60
35	class 1 vol	211
36	class 2 vol	282
37	class 3 vol	0

	Link: E out	
38	length	1.4
39	V/C	1.02
40	free-flow spd	60
41	class 1 vol	169
42	class 2 vol	76
43	class 3 vol	0

	Link: G in	
44	length	2.2
45	V/C	.29
46	free-flow spd	60
47	class 1 vol	82
48	class 2 vol	40
49	class 3 vol	0

	Link: J out	
50	length	.9
51	V/C	.10
52	free-flow spd	60
53	class 1 vol	29
54	class 2 vol	9
55	class 3 vol	0

	Link:	
56	length	
57	V/C	
58	free-flow spd	
59	class 1 vol	
60	class 2 vol	
61	class 3 vol	

	Link:	
62	length	
63	V/C	
64	free-flow spd	
65	class 1 vol	
66	class 2 vol	
67	class 3 vol	

	Link:	
68	length	
69	V/C	
70	free-flow spd	
71	class 1 vol	
72	class 2 vol	
73	class 3 vol	

YEAR: 1979

Table 18: ORIGIN ZONE: 8 Input Data

MODE: BUS

	Values of Time ($/hr)		
9	Class 1		(A)
10	Class 2		
11	Class 3		
	Mode:		
5	O.C. parameter	4.3	(B)
6	occupancy	45	
7	expansion factor	92	
0	Number of Links:	6	(C)
	Link: AB+		
20	length (km)	5.5	
21	V/C	1.11/.37	
22	free-flow speed (km/h)	64/80	
23	class 1 vol	140	
24	class 2 vol	650	
25	class 3 vol	429	
	Link: C+		
26	length	1.5	
27	V/C	.56	
28	free-flow spd	40	
29	class 1 vol	111	
30	class 2 vol	631	
31	class 3 vol	393	
	Link: D+		
32	length	2.4	
33	V/C	.50	
34	free-flow spd	42	
35	class 1 vol	68	
36	class 2 vol	552	
37	class 3 vol	321	
	Link: F-		
38	length	1.4	
39	V/C	1.02	
40	free-flow spd	42	
41	class 1 vol	51	
42	class 2 vol	118	
43	class 3 vol	98	

	Link: G+	
44	length	2.2
45	V/C	.29
46	free-flow spd	42
47	class 1 vol	34
48	class 2 vol	69
49	class 3 vol	63
	Link: J-	
50	length	0.9
51	V/C	.10
52	free-flow spd	42
53	class 1 vol	21
54	class 2 vol	20
55	class 3 vol	36
	Link:	
56	length	
57	V/C	
58	free-flow spd	
59	class 1 vol	
60	class 2 vol	
61	class 3 vol	
	Link:	
62	length	
63	V/C	
64	free-flow spd	
65	class 1 vol	
66	class 2 vol	
67	class 3 vol	
	Link:	
68	length	
69	V/C	
70	free-flow spd	
71	class 1 vol	
72	class 2 vol	
73	class 3 vol	

Year: 1979

Table 19: BENEFITS TO RESIDENTS OF ORIGIN ZONE 8 Output Costs

	AUTO	BUS	$/Month
NO BUILD			
Income class 1			
OC	17282.	948.	
TC	34120.	15089.	
Income class 2			
OC	16995.	4592.	
TC	8464.	18290.	
Income class 3			
OC	0.	2994.	
TC	0.	3859.	
Total			
OC	34277.	8534.	
TC	42584.	37237.	
BUILD			
Income class 1			
OC	14752.	779.	
TC	16311.	7023.	
Income class 2			
OC	14464.	3808.	
TC	3889.	8670.	
Income class 3			
OC	0.	2477.	
TC	0.	1818.	
Total			
OC	29216.	7064.	
TC	20200.	17512.	
DIFFERENCE			
Income class 1			
OC	2531.	169.	
TC	17809.	8065.	
Income class 2			
OC	2531.	784.	
TC	4575.	9619.	
Income class 3			
OC	0.	517.	
TC	0.	2041.	
Total			
OC	5061.	1470.	
TC	22383.	19725.	

Year: 1979

Table 20: BENEFITS TO RESIDENTS OF ORIGIN ZONE 9 OUTPUT COSTS

	AUTO	BUS	$/Month
NO BUILD			
Income class 1			
OC			
TC			
Income class 2			
OC			
TC			
Income class 3			
OC			
TC			
Total			
OC			
TC			
BUILD			
Income class 1			
OC			
TC			
Income class 2			
OC			
TC			
Income class 3			
OC			
TC			
Total			
OC			
TC			
DIFFERENCE			
Income class 1			
OC			
TC			
Income class 2			
OC			
TC			
Income class 3			
OC			
TC			
Total			
OC			
TC			

Year: 1979

Table 21: BENEFITS TO RESIDENTS OF ORIGIN ZONE 9

		AUTO	BUS	
NO BUILD				
Income class 1	OC	21829.57	846.01	bottom
	TC	43073.42	36065.39	
Income class 2	OC	14158.55	2935.36	
	TC	7053.11	11225.28	
Income class 3	OC	0.00	7365.38	No-Build
	TC	0.00	9154.68	
		Build		
Total	OC	35988.13	11146.74	
	TC	50126.53	56445.36	
BUILD				
Income class 1	OC	18175.10	698.87	
	TC	17355.66	16721.07	
Income class 2	OC	11910.82	2413.16	
	TC	2989.76	4817.35	
Income class 3	OC	0.00	6047.22	Build w/loop
	TC	0.00	3955.50	
Total	OC	30085.92	9159.25	
	TC	20345.42	25493.92	
		Difference		
DIFFERENCE				
Income class 1	OC	3654.47	147.13	Difference w/loop
	TC	25717.76	19344.32	
Income class 2	OC	2247.73	522.20	
	TC	4063.35	6407.94	
Income class 3	OC	0.00	1318.16	
	TC	0.00	5199.18	
Total	OC	5902.20	1987.49	
	TC	29781.11	30951.44	
		OK		

1759.52
6418.56

2660.47
37907.89

YEAR: 1979

Input Data

Table 22: ORIGIN ZONE: 1
MODE: Truck

Modal Parameters		
Labor cost ($/hr)		(B)
O.C parameter		
expansion factor		
Number of Links:	6	(C)

Link: AB-	
Length (km)	5.5
V/C	.58/.19
Free-flow speed (km/h)	80/100
Volume	98

Link: C-	
Length	1.5
V/C	.33
Free-flow speed	.60
Volume	108

Link: D-	
Length	2.4
V/C	.27
Free-flow speed	60
Volume	114

Link: E-	
Length	1.4
V/C	1.02
Free-flow speed	60
Volume	141

Link: F-	
Length	1.0
V/C	.29
Free-flow speed	60
Volume	109

Link: J	
Length	0.9
V/C	.1
Free-flow speed	60
Volume	10

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Link:	
Length	
V/C	
Free-flow speed	
Volume	

YEAR: 1979

Input Data

Table 23: ORIGIN ZONE: 2
MODE: Truck

Modal Parameters		
Labor cost ($/hr)	1	(B)
O.C parameter	5.2	
expansion factor	115	

Number of Links: 6 (C)

Link: AB	
Length (km)	5.5
V/C	58/.19
Free-flow speed (km/h)	80/100
Volume	74

Link: C-	
Length	1.5
V/C	.33
Free-flow speed	60
Volume	79

Link: D-	
Length	2.4
V/C	.27
Free-flow speed	60
Volume	84

Link: E+	
Length	1.4
V/C	.45
Free-flow speed	60
Volume	297

Link: F-	
Length	1.0
V/C	.29
Free-flow speed	60
Volume	66

Link: J-	
Length	0.9
V/C	.10
Free-flow speed	60
Volume	5

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Link:	
Length	
V/C	
Free-flow speed	
Volume	

YEAR: 1979

Input Data

Table 24: ORIGIN ZONE: 3
MODE: Truck

Modal Parameters	
Labor cost ($/hr)	(B)
O.C parameter	
expansion factor	

Number of Links: (C)

Link: AB-	
Length (km)	5.5
V/C	.58/.19
Free-flow speed (km/h)	80/100
Volume	46

Link: C-	
Length	1.5
V/C	.33
Free-flow speed	60
Volume	56

Link: E-	
Length	1.4
V/C	1.02
Free-flow speed	60
Volume	69

Link: F+	
Length	1.0
V/C	.16
Free-flow speed	60
Volume	171

Link: G-	
Length	2.2
V/C	.10
Free-flow speed	60
Volume	57

Link: J-	
Length	0.9
V/C	.1
Free-flow speed	60
Volume	10

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Link:	
Length	
V/C	
Free-flow speed	
Volume	

YEAR: 1979

Table 25: ORIGIN ZONE: 4 Input Data
MODE: Truck

Modal Parameters

Labor cost ($/hr)	________	(B)
O.C parameter	________	
expansion factor	________	

Number of Links: 5 (C)

Link: C-	
Length (km)	1.5
V/C	.33
Free-flow speed (km/h)	60
Volume	6

Link: D+	
Length	2.4
V/C	.5
Free-flow speed	60
Volume	3

Link: E-	
Length	6.4
V/C	1.02
Free-flow speed	60
Volume	1

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Link: G+	
Length	2.2
V/C	.29
Free-flow speed	60
Volume	3

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Link:	
Length	
V/C	
Free-flow speed	
Volume	

YEAR: 1979

Input Data

Table 26: ORIGIN ZONE: 5
MODE:

Modal Parameters

Labor cost ($/hr)	(B)
O.C parameter	
expansion factor	

Number of Links: 6 (C)

Link: AB-	
Length (km)	5.5
V/C	.58/.19
Free-flow speed (km/h)	80/100
Volume	5

Link: C+	
Length	1.5
V/C	.56
Free-flow speed	60
Volume	28

Link: D+	
Length	2.4
V/C	.5
Free-flow speed	60
Volume	24

Link: E-	
Length	1.4
V/C	1.02
Free-flow speed	60
Volume	7

Link: G+	
Length	2.2
V/C	.29
Free-flow speed	60
Volume	4

Link: J+	
Length	.9
V/C	.05
Free-flow speed	60
Volume	33

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Link:	
Length	
V/C	
Free-flow speed	
Volume	

YEAR: 1979

Input Data

Table 27: ORIGIN ZONE: 8
MODE: Truck

Modal Parameters		
Labor cost ($/hr)		(B)
O.C parameter		
expansion factor		

Number of Links: 6 (C)

Link: AB+	
Length (km)	5.5
V/C	1.1/.37
Free-flow speed (km/h)	80/100
Volume	63

Link: C+	
Length	1.5
V/C	.56
Free-flow speed	60
Volume	56

Link: D+	
Length	2.4
V/C	.5
Free-flow speed	60
Volume	47

Link: E-	
Length	1.4
V/C	.1.02
Free-flow speed	60
Volume	23

Link: G+	
Length	2.2
V/C	.29
Free-flow speed	60
Volume	9

Link: J-	
Length	.9
V/C	.1
Free-flow speed	60
Volume	7

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Year 1979

Output Costs

TRUCK COSTS FROM EACH ORIGIN ZONE

ZONE:	1	2	3
No-Build			
OC *	53,796	8,991	30,263
labor	4,113	3,128	2,176
Build			
OC *	54,566	9,573	30,624
labor	3,365	2,563	1,825
Difference			
OC *	-770	-582	-362
labor	748	565	351
total OC	-22	-17	-10

ZONE:	4	5	8
No-Build			
OC *	2,330	7,368	30,225
labor	155	539	21,541
Build			
OC *	2,377	7,407	25,987
labor	109	501	19,909
Difference			
OC *	-47	-39	4,239
labor	46	38	1,632
total OC	-1	-1	5,870

* Operating cost minus $1/hr labor cost.

Projected 1984 travel benefits by mode, income class, zone of origin for conditions assumed to prevail with no highway component as compared to those with the proposed highway component. Summary:

Year 1984

Table 29: SUMMARY GENERALIZED TRAVEL COST

ZONE:	High Income HH	Middle Income HH	Low Income HH	Employment	Total
1. Car					
bus					
truck					
walk					
2. Car					
bus					
truck					
walk					
3. Car					
bus					
truck					
walk					
4. Car					
bus					
truck					
walk					
5. Car					
bus					
truck					
walk					
6. Car					
bus					
truck					
walk					
7. Car					
bus					
truck					
walk					
8. Car					
bus					
truck					
walk					
9. Car					
bus					
truck					
walk					
Total: Car					
bus					
truck					
walk					
Total:					

Year 1984

Table 30: TRIP ORIGINS - MORNING PEAK HOUR

ZONE		HIGH INCOME HH	MIDDLE INCOME HH	LOW INCOME HH	EMPLOYMENT	TOTAL
1.	Car	1.500	1,600	250		3,350
	Bus	500	2,400	750		3,650
	Truck				760	760
	Walk	500	1,200	375		2,075
2.	Car				500	
	Bus					
	Truck					
	Walk					
3.	Car					
	Bus				350	350
	Truck					
	Walk					
4.	Car	560	40	80		680
	Bus	160	80	100		340
	Truck				30	30
	Walk	180	20			200
5.	Car				160	160
	Bus					
	Truck					
	Walk					
6.	Car		600	200		800
	Bus		1,200	1,000	15	2,200
	Truck		300	200		500
	Walk					
7.	Car				160	160
	Bus					
	Truck					
	Walk					
8.	Car	700	500	100		1,300
	Bus	200	1,000	750		1,950
	Truck				150	150
	Walk	100	250	150		500
9.	Car	4,112	424	380		4,916
	Bus	1,303	180	2,815		4,298
	Truck				0	
	Walk	175	120	675		970
TOTAL	Car	6,872	3,164	1,010		11,046
	Bus	2,163	4,860	5,415		12,438
	Truck				2,125	2,125
	Bus	955	1,890	1,400		2,245

Table 31: TRIP DESTINATIONS - MORNING PEAK HOUR

ZONE	HIGH INCOME HH	MIDDLE INCOME HH	LOW INCOME HH	EMPLOYMENT	TOTAL
1. Car	2280	1140	500		3920
Bus	760	1710	1710		4180
Truck				460	460
Walk	380	570	570		1520
2. Car	1200	600	200		2000
Bus	400	900	900		2200
Truck				500	500
Walk	200	420	310		930
3. Car	840	340	140		1320
Bus	280	630	630		1540
Truck				350	350
Walk	200	420	310		930
4. Car	195	82	20		297
Bus	55	120	150		325
Truck				30	30
Walk	30	50	50		130
5. Car	780	330	80		1190
Bus	220	480	600		1300
Truck				160	160
Walk	40	80	80		200
6. Car	94	42	10		146
Bus	28	60	75		163
Truck				15	15
Walk	15	10	10		35
7. Car	780	330	80		1190
Bus	220	480	600		1300
Truck				160	160
Walk	40	80	80		200
8. Car	700	300	100		1100
Bus	200	480	750		1430
Truck				150	150
Walk	50	80	100		230
9. Car					
Bus					
Truck					
Walk					
TOTAL Car	6872	3164	1010		11046
Bus	2163	4860	5415		12438
Truck				2125	2125
Walk	955	1890	1400		4245
TOTAL	9990	9914	7825	2125	29854

Table 32: O-D DISTRIBUTION OF TRUCK TRIPS Year 1985

ORIGIN ZONES	1	2	3	4.	5	6	7	8	9	TOTAL
1. H	584	318	200	24	118	19	183	54	0	1500
M	673	336	200	19	148	16	92	116	0	1600
L	121	40	37	2	8	21	8	32	0	250
TOTAL	1378	694	437	45	274	37	283	202	0	3350
2. H										
M										
L										
TOTAL										
3. H										
M										
L										
TOTAL										
4. H	155	89	80	36	102	18	44	36	0	560
M	9	7	4	4	4	1	4	7	0	40
L	27	19	2	7	7	1	10	7	0	80
TOTAL	191	115	86	47	113	20	56	50	0	680
5. H										
M										
L										
TOTAL										
6. H	190	103	66	28	14	9	93	30	0	
M	170	103	66	28	94	9	93	38	0	600
L	65	41	35	4	27	1	18	9	0	200
TOTAL										
7. H										
M										
L										
TOTAL										
8. H	175	94	67	15	67	15	100	167	0	700
M	132	76	23	18	42	8	56	101	0	456
L	26	22	8	3	8	2	14	17	0	100
TOTAL	333	192	98	36	117	25	170	285	0	1,256
9. H	1356	699	493	120	493	45	453	453		4,112
M	156	81	47	13	42	5	42	38	0	424
L	141	78	53	9	30	4	30	35	0	380
TOTAL	1653	858	593	142	565	54	525	526	0	4,916
TOTAL H	2280	1200	840	195	780	67	780	700	0	6842
M	1140	600	340	82	330	42	330	300	0	3164
L	380	200	140	20	80	10	80	100	0	1010
TOTAL	3800	2000	1320	297	1190	119	1190	1100	0	11,016

Table 33: O-D DISTRIBUTION OF CAR TRIPS Year 1984

ORIGIN TOWNS	1	2	3	4	5	6	7	8	9	TOTAL
1. H	193	110	67	6	49	4	54	17	0	500
M	981	467	477	57	187	16	88	127	0	2400
L	354	134	114	20	47	7	4	40	0	750
TOTAL	1528	711	658	83	283	27	176	184	0	3650
2. H										
M										
L										
TOTAL										
3. H										
M										
L										
TOTAL										
4. H	59	27	25	8	17	8	8	8	0	160
M	24	16	8	4	8	4	8	8	0	80
L	31	15	15	8	8	7	8	8	0	100
TOTAL	114	58	48	20	33	19	24	24	0	340
5. H										
M										
L										
TOTAL										
6. H										
M	390	230	133	37	177	28	112	93	0	1200
L	282	159	96	21	168	23	138	103	0	990
TOTAL	672	389	229	58	345	51	250	196	0	2190
7. H										
M										
L										
TOTAL										
8. H	56	28	19	2	24	3	23	45	0	200
M	252	153	99	18	90	10	44	234	0	1000
L	160	114	67	17	67	10	110	205	0	750
TOTAL	468	295	185	37	181	23	277	484	0	1950
9. H	457	235	169	39	130	13	130	130	0	1303
M	63	34	23	4	18	2	18	18	0	180
L	873	478	338	84	310	28	310	394	0	2815
TOTAL	1393	747	530	127	458	43	458	542	0	4298
TOTAL H	760	400	380	55	220	28	220	200	0	2263
M	110	150	630	120	480	30	480	480	0	2480
L	110	700	630	150	100	75	750	750	0	3265
TOTAL	980	1250	1640	325	800	133	1450	1430	0	8008

Table 34: O-D DISTRIBUTION OF TRUCK TRIPS Year 1984

ORIGIN TOWNS	1	2	3	4	5	6	7	8	9	TOTAL
1. H M L										
TOTAL	354	154	140	12	43	0	28	29	0	760
2. H M L										
TOTAL	167	177	71	6	26	0	33	20	0	500
3. H M L										
TOTAL	115	68	73	6	26	6	36	20	0	350
4. H M L										
TOTAL	10	10	10	0	0	0	0	0	0	30
5. H M L										
TOTAL	31	28	23	0	38	9	14	17	0	160
6. H M L										
TOTAL	8	7	0	0	0	0	0	0	0	15
7. H M L										
TOTAL	36	30	14	6	16	0	30	28	0	160
8. H M L										
TOTAL	39	26	19	0	11	0	19	36	0	150
9. H M L										
TOTAL										
TOTAL H M L										
TOTAL	760	500	350	30	160	15	160	150		2125

Table 35: LINK ASSIGNMENTS

MODE: Car

YEAR: 1984

Link Origin Zone		A	B	C	D	E	F	G	H	I	J	K	TOTAL
1	H M L	79- 80	168- 223										
	H M L	35 5	113 11										
	H M L	0 6- 3	10 18- 7										
	H M L	538+ 387+	397+ 318										
	H M L	3687+ 21 470	3210+ 19 470										
6	H M L												
7	H M L												
In	H M L Total	4225+ 408 470 5103+	3607+ 337+ 470+ 4414										
OUT	H M L Total	114- 91- 3- 208-	381- 252- 7- 640-										

Table 36: LINK ASSIGNMENTS

YEAR: 1984

MODE: Bus

Link Origin Zone		A	B	C	D	E	F	G	H	I	J	K	TOTAL
1	H	22	72										
	M	132	387										
	L	0	0										
2	H	9	18										
	M	10	20										
	L	0	0										
3	H	0	0										
	M	8-	32-										
	L	12	18										
4	H	237+	210+										
	M	1020	960										
	L	940	820										
5	H	2085	1885										
	M	125	110										
	L	1470	1390										
6	H												
	M												
	L												
7	H												
	M												
	L												
In	H	2322+	2095+										
	M	1145	1070										
TOTAL	L	2410	2210										
		4375	4375										
In	H	31-	90-										
	M	150	439-										
	L	12	18-										
TOTAL		193	647										

Table 37: LINK ASSIGNMENTS

YEAR: 1984

MODE: Truck

Link Origin Zone		A	B	C	D	E	F	G	H	I	J	K	TOTAL
1	H M L	29-	57-										
2	H M L	20-	53-										
3	H M L	20-	56-										
4	H M L	0	0										
5	H M L	17-	3										
6	H M L	15-	30-										
7	H M L	28-	102+										
8 9	H M L	103+ 228+	84+ 190+										
TOTAL	H M L	129 331+	227 376+										

TABLE 38

YEAR 1984

LINK ASSIGNMENTS BY MODE CAR DCUS

ORIGIN/ZONE LINK	1	2	3	4	5	6	7	8	9	Total Passengers	Total PCU
1-1	3,350			113						3,350	
1-2	694					144		162	858	1,973	
1-3	437									437	
1-4	842									842	
2-1											
2-2											
*(2-5)											
3-1											
3-3											
3-4											
4-1				306		379		495	2,571	3,691	
4-3				86		101		98	593	878	
4-4				680						680	
4-5	274			113						387	
4-6	37			20						57	
4-7	283			58						341	
4-8	203			50						253	
*(5-2)											
5-4											
5-5											
5-6											
5-7											
5-8											
6-4						572				572	
6-5						121				121	
6-6						800				800	
6-7						110				110	
6-8						47				47	
7-4											
7-5											
7-6											
7-7											
7-8											
8-4								629	3,246	3,875	
8-5								117	565	682	
8-6								25	54	79	
8-7								170	525	695	
8-8								1,300		1,300	
8-9											
9-8									5,916	5,916	
9-9									5,916	5,916	

TABLE 39

YEAR 1984

LINK ASSIGNMENTS BY MODE BUS DCUS

ORIGIN/ZONE LINK	1	2	3	4	5	6	7	8	9	Total Passengers	Total PCU
1-1	3,650									3,650	
1-2	711			58		389		295	747	2,200	
1-3	658									658	
1-4	763									763	
2-1											
2-2											
*(2-5)											
3-1											
3-3											
3-4											
4-1				172		1,061		763	2,140	4,136	
4-3				48		229		185	520	982	
4-4				340						340	
4-5	283			23						316	
4-6	27			19						46	
4-7	176			24						200	
4-8	184			24						208	
*(5-2)											
5-4											
5-5											
5-6											
5-7											
5-8											
6-4						1,348				1,348	
6-5						345				345	
6-6						2,200				2,200	
6-7						250				250	
6-8						196				196	
7-4											
7-5											
7-6											
7-7											
7-8											
8-4								985	1,587	2,572	
8-5								181	458	639	
8-6								23	43	66	
8-7								274	458	732	
8-8								1,950		1,950	
8-9											
9-8									4,298	4,298	
9-9									4,298	4,298	

TABLE 40

YEAR 1984

LINK ASSIGNMENTS BY MODE TRUCK DCUS

ORIGIN/ZONE LINK	1	2	3	4	5	6	7	8	9	Total passengers	Total PCU
1-1	760									760	
1-2	154		68	10	28	7	30	26		323	
1-3	140	71								211	
1-4	112	85								197	
2-1		333								333	
2-2		500								500	
*(2-5)											
3-1			183							183	
3-3			350							350	
3-4			161							161	
4-1				20	59	15	66	65		225	
4-3				10	23		14	23		66	
4-4				30						30	
4-5	43	26	6							75	
4-6			26							26	
4-7	28	33	36							97	
4-8	29	20	20							69	
*(5-2)											
5-4					72					72	
5-5					160					160	
5-6					9					9	
5-7					14					14	
5-8					17					17	
6-4						15				15	
6-5											
6-6						15				15	
6-7											
6-8											
7-4							86			86	
7-5							16			16	
7-6											
7-7							160			160	
7-8							28			28	
8-4								84		84	
8-5								11		11	
8-6											
8-7								19		19	
8-8								150		150	
8-9											
9-8											
9-9											

REGISTER CONTENTS: UTB-2.1(A)

FOR CAR & BUS

YEAR: 1984

ORIGIN ZONE: 1

MODE: Bus

Values of Time ($/hr)

9	Class 1	2.18	(A)
10	Class 2	.56	
11	Class 3	.18	

Mode:

5	O.C. parameter	4.3	(B)
6	occupancy	45	
7	expansion factor	92	

0 Number of Links: 10 (C)

Link: A outbound

20	length (km)	2.1
21	V/C	1135/1600=0.17/0.24
22	free-flow speed (km/h)	64/80
23	class 1 vol	22
24	class 2 vol	132
25	class 3 vol	0

Link: B outbound

26	length	3.4
27	V/C	
28	free-flow spd	68/80
29	class 1 vol	72
30	class 2 vol	387
31	class 3 vol	0

Link:

32	length	
33	V/C	
34	free-flow spd	
35	class 1 vol	
36	class 2 vol	
37	class 3 vol	

Link:

38	length	
39	V/C	
40	free-flow spd	
41	class 1 vol	
42	class 2 vol	
43	class 3 vol	

Link:

44	length	
45	V/C	
46	free-flow spd	
47	class 1 vol	
48	class 2 vol	
49	class 3 vol	

Link:

50	length	
51	V/C	
52	free-flow spd	
53	class 1 vol	
54	class 2 vol	
55	class 3 vol	

Link:

56	length	
57	V/C	
58	free-flow spd	
59	class 1 vol	
60	class 2 vol	
61	class 3 vol	

Link:

62	length	
63	V/C	
64	free-flow spd	
65	class 1 vol	
66	class 2 vol	
67	class 3 vol	

Link:

68	length	
69	V/C	
70	free-flow spd	
71	class 1 vol	
72	class 2 vol	
73	class 3 vol	

TRIP-ORIGINS - MORNING PEAK HOUR

ZONE	HIGH INCOME HH	MIDDLE INCOME HH	LOW INCOME HH	EMPLOYMENT	TOTAL
1. Car	2250	2100	350		4725
Bus	1000	3600	1500		6100
Truck				920	920
Walk	250	800	375		1425
2. Car					
Bus					
Truck				500	500
Walk					
3. Car					
Bus					
Truck				400	400
Walk					
4. Car	840	60			900
Bus	280	120			400
Truck				150	150
Walk	120	20			140
5. Car					
Bus					
Truck				240	240
Walk					
6. Car		750	300		1050
Bus		1800	1600		3400
Truck				30	30
Walk		225	300		525
7. Car					
Bus					
Truck				400	400
Walk					
8. Car	735	650	300		1685
Bus	375	1400	900		2675
Truck				180	180
Walk	75	260	100		435
9. Car	5175	350	410		5935
Bus	2325	225	2420		4970
Truck					
Walk	135	145	550		830
TOTAL Car	9000	3915	1385		14300
Bus	3980	7145	6420	2820	17545
Truck				2820	2820
Walk	580	1450	1325		3355
TOTAL	13560	12510	9130	2820	38020

Year 1989

TRIP DESTINATIONS - MORNING PEAK HOUR

ZONE	HIGH INCOME HH	MIDDLE INCOME HH	LOW INCOME HH	EMPLOYMENT	TOTAL
1. Car	2990	1035	460		4485
Bus	1380	2070	2070		5520
Truck				920	920
Walk	230	500	460		1190
2. Car	1300	600	200		2100
Bus	600	1000	900		2500
Truck				500	500
Walk	100	250	200		550
3. Car	1040	360	160		1560
Bus	480	900	630		2010
Truck				400	400
Walk	80	200	160		440
4. Car	725	400	100		1225
Bus	250	575	475		1300
Truck				150	150
Walk	50	100	75		225
5. Car	870	500	120		1490
Bus	300	600	540		1440
Truck				240	240
Walk	60	90	90		240
6. Car	115	80	15		210
Bus	50	150	115		315
Truck				30	30
Walk	5	40	20		65
7. Car	1150	700	150		2000
Bus	500	1250	1150		2900
Truck				400	400
Walk	25	150	200		375
8. Car	810	240	180		1230
Bus	420	600	540		1560
Truck				180	180
Walk	30	120	120		270
9. Car					
Bus					
Truck					
Walk					
TOTAL Car	9000	3915	1385		14300
Bus	3980	7145	1420		17545
Truck				2820	2820
Walk	1580	1450	1325		3355
TOTAL	13560	12510	9180	2820	38020

Year 1989

O-D DISTRIBUTION OF CAR TRIPS

ORIGIN	ZONE	1	2	3	4.	5	6	7	8	9	TOTAL
1. H		873	343	280	136	201	20	281	116	0	2250
M		688	366	236	193	175	31	355	56	0	2100
L		168	73	48	24	21	4	18	19	0	375
	TOTAL	1729	782	564	353	397	55	654	191	0	4725
2. H											
M											
L											
	TOTAL										
3. H											
M											
L											
	TOTAL										
4. H		248	146	131	129	86	9	69	23	0	840
M		11	7	7	7	7	7	7	7	0	60
L		0	0	0	0	0	0	0	0	0	0
	TOTAL	259	153	138	136	93	16	76	30	0	900
5. H											
M											
L											
	TOTAL										
6. H											
M		140	96	42	105	159	26	113	69	0	750
L		82	38	39	28	38	2	44	27	0	300
	TOTAL	222	134	881	133	197	28	157	96	0	1050
7. H											
M											
L											
	TOTAL										
8. H		163	86	448	46	68	34	128	165	0	735
M		95	78	43	61	113	9	164	87	0	650
L		74	32	24	19	24	3	43	81	0	300
	TOTAL	332	196	115	126	205	46	335	333	0	1685
9. H		1707	125	621	444	508	5 52	672	466	0	5175
M		91	53	32	39	46	77	61	21	0	350
L		136	57	49	29	37	4	45	53	0	5135
	TOTAL	1934	835	702	482	601	63	778	540		5935
TOTAL H		2990	1300	1040	725	870	115	1150	810	0	9000
M		1035	600	360	400	500	80	700	240		3915
L		460	300	160	100	120	75	150	180	0	1545
TOTAL		4485	2200	1560	1225	1490	270	2000	1230	0	14,460

O-D DISTRIBUTION OF BUS TRIPS Year 1989

ORIGIN ZONE	1	2	3	4.	5	6	7	8	9	TOTAL
1. H	401	169	135	60	63	11	94	67	0	1,000
M	1342	570	509	247	217	59	541	115	0	3,600
L	633	230	190	81	95	20	180	66	0	1,500
TOTAL	2376	969	834	393	375	90	815	248	0	6,100
2. H										
M										
L										
TOTAL										
3. H										
M										
L										
TOTAL										
4. H	93	42	34	34	27	8	25	17	0	280
M	32	16	16	16	8	8	16	8	0	120
L	0	0	0	0	0	0	0	0	0	0
TOTAL	125	58	50	50	35	16	41	25		4 0
5. H										
M										
L										
TOTAL										
6. H	0	0	0	0	0	0	0	0	0	0
M	372	229	210	201	210	73	292	239	0	1800
L	443	238	136	158	197	30	279	93	0	1600
TOTAL	815	467	346	359	407	103	571	332		3400
7. H										
M										
L										
TOTAL										
8. H	96	40	32	16	24	8	79	80	0	375
M	264	153	136	93	147	25	340	246	0	1400
L	220	93	62	51	65	17	231	161	0	900
TOTAL	580	286	230	160	236	50	650	487	0	2675
9. H	790	349	279	140	186	23	302	256	0	2325
M	64	32	29	18	18	5	41	18	0	225
L	774	339	242	169	194	48	460	194	0	2420
TOTAL	1528	720	550	32	398	76	803	468	0	4970
TOTAL H										
M										
L										
TOTAL										

O-D DISTRIBUTION OF TRUCK TRIPS

Year 1989

ORIGIN ZONE	1	2	3	4.	5	6	7	8	9	TOTAL
1. H M L										
TOTAL	381	149	120	40	86	6	75	63	0	920
2. H M L										
TOTAL	133	142	74	35	20	7	74	14	0	500
3. H M L										
TOTAL	149	60	97	14	21	0	44	15	0	400
4. H M L										
TOTAL	46	24	24	16	16	0	16	8	0	150
5. H M L										
TOTAL	71	35	27	18	48	0	27	14	0	240
6. H M L										
TOTAL	10	10	5	0	0	0	5	0	0	30
7. H M L										
TOTAL	92	51	34	17	30	17	121	38	0	400
8. H M L										
TOTAL	38	28	19	10	19	0	38	28	0	180
9. H M L										
TOTAL	120	100	60	5	8	2	10	20	0	325
TOTAL H M L										
TOTAL	920	500	400	150	240	30	400	180	0	3,145

Year 1989

LINK ASSIGNMENTS BY MODE CAR

ORIGIN ZONE	1	2	3	4	5	6	7	8	9	Total Passengers	Total FCU
LINK 1-1	4725									4725	
1-2	782			153		134		196	835	2100	
1-3	564									564	
1-4	1650									1650	
2-1											
2-2											
*(2-5)											
3-1											
3-3											
3-4											
4-1				312		356		528	2769	3965	
4-3				138		81		115	702	1036	
4-4				900						900	
4-5	397			93						490	
4-6	55			16						71	
4-7	654			76						730	
4-8	191			30						221	
*(5-2)											
5-4											
5-5											
5-6											
5-7											
5-8											
6-4						570				570	
6-5						197				197	
6-6						1050				1050	
6-7						151				151	
6-8						96				96	
7-4											
7-5											
7-6											
7-7											
7-8											
8-4								769	3973	4742	
8-5								205	601	806	
8-6								46	63	109	
8-7								335	778	1113	
8-8								1685		1685	
8-9											
9-8									5135	5135	
9-9									5135	5135	

Year 1989

LINK ASSIGNMENTS BY MODE

ORIGIN ZONE	1	2	3	4	5	6	7	8	9	Total Passengers	Total FCU
LINK 1-1	6100									6100	
1-2	969			58		467		286		1780	
1-3	834									834	
1-4	1927									1927	
2-1											
2-2											
*(2-5)											
3-1											
3-3											
3-4											
4-1				183		1282		866	2248	4579	
4-3				50		346		230	540	1166	
4-4				400						400	
4-5	375			35						410	
4-6	90			16						106	
4-7	815			41						856	
4-8	248			25						273	
*(5-2)											
5-4											
5-5											
5-6											
5-7											
5-8											
6-4						1987				1987	
6-5						407				407	
6-6						3400				3400	
6-7						571				571	
6-8						332				332	
7-4											
7-5											
7-6											
7-7											
7-8											
8-4								1256	3115	4371	
8-5								236	398	634	
8-6								50	76	126	
8-7								650	803	1453	
8-8								2675		2675	
8-9											
9-8									4970	4970	
9-9									4970	4970	

Year 1989

LINK ASSIGNMENTS BY MODE: TRUCK

ORIGIN ZONE	1	2	3	4	5	6	7	8	9	Total Passengers	Total FCU
LINK 1-1	920									920	
1-2	149		60	24	35	10	51			329	
1-3	120	74								194	
1-4	270	150								420	
2-1		357								357	
2-2		500								500	
2-5											
3-1			209							209	
3-3			400							400	
3-4			94							94	
4-1				70	106	20	143	66		405	
4-3				24	27	5	34	19		109	
4-4				150						150	
4-5	86	20	21	16						143	
4-6	6	7								13	
4-7	75	74	44	16						209	
4-8	63	14	15	8						100	
5-2											
5-4					157					157	
5-5					240					240	
5-6					0					0	
5-7					27					27	
5-8					14					14	
6-4						25				25	
6-5											
6-6						30				30	
6-7						5				5	
6-8											
7-4							194			194	
7-5							30			30	
7-6							17			17	
7-7							400			400	
7-8							38			38	
8-4								95		95	
8-5								19		19	
8-6								38		38	
8-7											
8-8								180		180	
8-9											
9-8											
9-9											

PROGRAMMING LAND DEMAND

A1) With <u>No</u> highway component

A2) With highway component

B1) With weak public transport component
B1A) Context A1
B1B) Context A2

B2) With strong public transport component
B2A) Context A1
B2B) Context A2

					$\frac{LW}{\sqrt{C}}$	$\frac{GLW}{\sqrt{C}}$	B		
1	83	83	6889	898 30	229.6	.75	7875	8300	79
4	4 8	2	8	4.7	1.702	.01	105	200	.02
8	60 48	20	1200	16.1	59.6	.24	2520	2000	.19
					305.8		10500	10500	

Low mode

	L_i	W_i	$\frac{LW}{\sqrt{C}}$		$\frac{LW}{\sqrt{C}}$	$\frac{GLWB}{\sqrt{C}}$	Mode	4.4
1	12.13	41	501	10	60	.70	3710	4100
4	/	0	/	/				—
8	10.8	12	130	6	22	.30	1590	1200
					72			5300

- 98 -

$$G_1^z \; 2 \; \frac{G^2 L_1 W_1^z}{C_1^z} B$$

Total loan cost/mm

	H	M	L
1 2	394 9.9 50 1404 1494	11.3 CAR 5.4 BUS 16 882 898	2.2 BUS 2 103 105
3 4 5 6	22.5 CAR 5.3 BUS 28 432 460	.72 .71 1 21 22	0
7 8 9	51.3 CAR 16.1 BUS 67 432 499	25.4 CAR 22.3 BUS 48 210 258	6.8 BUS 7 30 37

1989

1984 - 1989 Volume Increments
Links A & B

			LINK A			LINK B				
			1984	1989	Increment	1979	1984	1989	1984-89 Increment	1979-84 Increment
High	Auto	In	4223	5279	211.2	809	3603	4479	174.8	559.2
		Out	114	139	5	254	281	489	41.6	5.4
	Bus	In	2322	2364	8.4	262	2095	1983	22.4	366.6
		Out	31	84	10.6	78	90	203	22.6	2.4
Med.	Auto	In	418	892	94.5	625	357	667	62	53.6
		Out	91	132	8.2	86	252	607	71	33.2
	Bus	In	1245	1361	23.2	1083	1060	977	16.6	4.6
		Out	142	462	64	132	439	1211	154.4	61.4
Low	Auto	In	470	576	21.2	0	470	488	3.6	94
		Out	3	46	8.6	0	7	108	20.2	1.4
	Bus	In	2410	3965	311	1522	2210	3274	212.8	137.6
		Out	6	159	30.6	114	18	618	120	19.2
	Truck	In	342	417	15	230	387	576	37.8	31.4
		Out	342	417	15	230	387	576	37.8	31.4

Origin Zone: 1

Mode: Car

Values of Time ($/hr) (A)

class 1	2.18
class 2	.56
class 3	.18

Mode: (B)

O.C. parameter	1
occupancy	1.6
expansion factor	107.4

Number of Links: 9 (C)

Link: A Out

length (km)	2.1
V/C	.73/.24
free-flow speed (km/h)	80/100
class 1 vol	79
class 2 vol	86
class 3 vol	0

Link: B Out

length	3.4
V/C	.96/.32
free-flow spd	80/100
class 1 vol	168
class 2 vol	223
class 3 vol	0

Link: C Out

length	1.5
V/C	.62
free-flow spd	60
class 1 vol	363
class 2 vol	408
class 3 vol	0

Link: D Out

length	2.4
V/C	.49
free-flow spd	60
class 1 vol	402
class 2 vol	453
class 3 vol	0

Link: E Out

length	1.4
V/C	1.15
free-flow spd	60
class 1 vol	284
class 2 vol	231
class 3 vol	50

Link: F Out

length	1.0
V/C	.27
free-flow spd	60
class 1 vol	198
class 2 vol	231
class 3 vol	50

Link: H Out

length	0.5
V/C	.05
free-flow spd	60
class 1 vol	18
class 2 vol	16
class 3 vol	0

Link: J Out

length	o.9
V/C	.52
free-flow spd	60
class 1 vol	177
class 2 vol	169
class 3 vol	0

Link: K Out

length	0.5
V/C	.54
free-flow spd	60
class 1 vol	89
class 2 vol	73
class 3 vol	0

Year: 1984

Origin Zone: 4

Mode: Car

Values of Time ($/hr) (A)

class 1	
class 2	
class 3	

Mode: (B)

O.C. parameter	
occupancy	
expansion factor	

Number of Links: 9 (C)

Link: A Out

length (km)	2.1
V/C	.73/.24
free-flow speed (km/h)	80/100
class 1 vol	35
class 2 vol	5
class 3 vol	0

Link: B Out

length	3.4
V/C	.96/.32
free-flow spd	80/100
class 1 vol	113
class 2 vol	11
class 3 vol	0

Link: C Out

length	1.5
V/C	.62
free-flow spd	60
class 1 vol	200
class 2 vol	17
class 3 vol	0

Link: D In

length	2.4
V/C	1.02
free-flow spd	60
class 1 vol	246
class 2 vol	17
class 3 vol	0

Link: F Out

length	1.4
V/C	1.15
free-flow spd	60
class 1 vol	88
class 2 vol	6
class 3 vol	0

Link: G In

length	2.2
V/C	.59
free-flow spd	60
class 1 vol	79
class 2 vol	6
class 3 vol	0

Link: H Out

length	.5
V/C	.05
free-flow spd	60
class 1 vol	26
class 2 vol	0
class 3 vol	0

Link: J Out

length	.9
V/C	.52
free-flow spd	60
class 1 vol	61
class 2 vol	6
class 3 vol	0

Link: K Out

length	.5
V/C	.54
free-flow spd	60
class 1 vol	78
class 2 vol	6
class 3 vol	0

Origin Zone: 6

Mode: Car

Values of Time ($/hr)

class 1		(A)
class 2		
class 3		

Mode:

O.C. parameter		(B)
occupancy		
expansion factor		

Number of Links: 9 (C)

Link: A Out

length (km)	2.1
V/C	.73/.24
free-flow speed (km/h)	80/100
class 1 vol	0
class 2 vol	6
class 3 vol	3

Link: B Out

length	3.4
V/C	.96/.32
free-flow spd	80/100
class 1 vol	0
class 2 vol	18
class 3 vol	7

Link: C In

length	1.5
V/C	1.25
free-flow spd	60
class 1 vol	0
class 2 vol	20
class 3 vol	8

Link: D In

length	2.4
V/C	1.02
free-flow spd	60
class 1 vol	0
class 2 vol	12
class 3 vol	4

Link: E Out

length	1.4
V/C	1.15
free-flow spd	60
class 1 vol	0
class 2 vol	3
class 3 vol	1

Link: G In

length	2.2
V/C	.59
free-flow spd	60
class 1 vol	0
class 2 vol	6
class 3 vol	3

Link: H In

length	.5
V/C	.04
free-flow spd	60
class 1 vol	0
class 2 vol	56
class 3 vol	19

Link: J Out

length	.9
V/C	.52
free-flow spd	60
class 1 vol	0
class 2 vol	16
class 3 vol	5

Link: K Out

length	.5
V/C	.54
free-flow spd	60
class 1 vol	0
class 2 vol	12
class 3 vol	4

Year: 1984

Origin Zone: 8

Mode: Car

Values of Time ($/hr) (A)

class 1	
class 2	
class 3	

Mode: (B)

O.C. parameter	
occupancy	
expansion factor	

Number of Links: 9 (C)

Link: A In

length (km)	2.1
V/C	1.5/.96
free-flow speed (km/h)	80/100
class 1 vol	536
class 2 vol	387
class 3 vol	0

Link: B In

length	3.4
V/C	1.5/.89
free-flow spd	395
class 1 vol	318
class 2 vol	0
class 3 vol	

Link: C In

length	1.5
V/C	1.25
free-flow spd	60
class 1 vol	317
class 2 vol	264
class 3 vol	0

Link: D In

length	2.4
V/C	1.02
free-flow spd	60
class 1 vol	235
class 2 vol	215
class 3 vol	0

Link: E Out

length	1.4
V/C	1.15
free-flow spd	60
class 1 vol	96
class 2 vol	77
class 3 vol	0

Link: G In

length	2.2
V/C	.59
free-flow spd	60
class 1 vol	69
class 2 vol	40
class 3 vol	0

Link: H Out

length	.5
V/C	.05
free-flow spd	60
class 1 vol	9
class 2 vol	11
class 3 vol	0

Link: J Out

length	.1
V/C	.52
free-flow spd	60
class 1 vol	69
class 2 vol	43
class 3 vol	0

Link: K Out

length	.5
V/C	.54
free-flow spd	60
class 1 vol	141
class 2 vol	69
class 3 vol	0

Origin Zone: 1

Mode: Bus

Values of Time ($/hr)		
class 1		(A)
class 2		
class 3		
Mode:		
O.C. parameter	4.3	(B)
occupancy	45	
expansion factor	92	
Number of Links:	9	(C)

Link: A Out

length (km)	2.1
V/C	.73/.24
free-flow speed (km/h)	64/80
class 1 vol	72
class 2 vol	387
class 3 vol	0

Link: B Out

length	1.5
V/C	.96/.32
free-flow spd	64/80
class 1 vol	72
class 2 vol	387
class 3 vol	0

Link: C Out

length	1.5
V/C	.62
free-flow spd	42
class 1 vol	116
class 2 vol	738
class 3 vol	0

Link: D Out

length	2.4
V/C	.49
free-flow spd	42
class 1 vol	125
class 2 vol	819
class 3 vol	0

Link: E Out

length	1.4
V/C	1.15
free-flow spd	47
class 1 vol	109
class 2 vol	443
class 3 vol	194

Link: F Out

length	1.0
V/C	.29
free-flow spd	42
class 1 vol	67
class 2 vol	312
class 3 vol	133

Link: H Out

length	.5
V/C	.05
free-flow spd	02
class 1 vol	0
class 2 vol	36
class 3 vol	0

Link: J Out

length	.9
V/C	.52
free-flow spd	42
class 1 vol	44
class 2 vol	315
class 3 vol	0

Link: K Out

length	.5
V/C	.54
free-flow spd	42
class 1 vol	50
class 2 vol	255
class 3 vol	0

Year: 1984

Origin Zone: 41

Mode: Bus

Values of Time ($/hr) (A)

class 1	
class 2	
class 3	

Mode: (B)

O.C. parameter	
occupancy	
expansion factor	

Number of Links: 9 (C)

Link: A Out

length (km)	2.1
V/C	.73/.24
free-flow speed (km/h)	64/80
class 1 vol	9
class 2 vol	10
class 3 vol	0

Link: B Out

length	3.4
V/C	.96/.32
free-flow spd	64/80
class 1 vol	18
class 2 vol	20
class 3 vol	0

Link: C Out

length	1.5
V/C	.62
free-flow spd	42
class 1 vol	49
class 2 vol	30
class 3 vol	0

Link: D In

length	2.4
V/C	1.02
free-flow spd	42
class 1 vol	75
class 2 vol	40
class 3 vol	0

Link: E Out

length	1.4
V/C	1.15
free-flow spd	42
class 1 vol	27
class 2 vol	10
class 3 vol	0

Link: G In

length	2.2
V/C	.59
free-flow spd	47
class 1 vol	27
class 2 vol	10
class 3 vol	0

Link: H Out

length	.5
V/C	.05
free-flow spd	42
class 1 vol	9
class 2 vol	0
class 3 vol	0

Link: J Out

length	.9
V/C	.52
free-flow spd	42
class 1 vol	22
class 2 vol	10
class 3 vol	0

Link: K Out

length	.5
V/C	.54
free-flow spd	42
class 1 vol	9
class 2 vol	10
class 3 vol	0

Origin Zone: 6

Mode: Bus

Values of Time ($/hr) (A)
class 1
class 2
class 3

Mode: (B)
O.C. parameter
occupancy
expansion factor

Number of Links: 9 (C)

Link: A Out

length (km)	2.1
V/C	.73/.24
free-flow speed (km/h)	64/80
class 1 vol	0
class 2 vol	8
class 3 vol	6

Link: B Out

length	3.4
V/C	.96/.32
free-flow spd	64/80
class 1 vol	0
class 2 vol	32
class 3 vol	18

Link: C In

length	1.5
V/C	1.25
free-flow spd	42
class 1 vol	0
class 2 vol	56
class 3 vol	20

Link: D In

length	2.4
V/C	1.02
free-flow spd	42
class 1 vol	0
class 2 vol	36
class 3 vol	12

Link: E Out

length	1.4
V/C	1.15
free-flow spd	42
class 1 vol	0
class 2 vol	8
class 3 vol	3

Link: G In

length	2.2
V/C	.59
free-flow spd	42
class 1 vol	0
class 2 vol	16
class 3 vol	6

Link: H In

length	.5
V/C	.04
free-flow spd	42
class 1 vol	0
class 2 vol	112
class 3 vol	54

Link: J Out

length	.9
V/C	52
free-flow spd	42
class 1 vol	0
class 2 vol	26
class 3 vol	16

Link: K Out

length	.5
V/C	.54
free-flow spd	42
class 1 vol	0
class 2 vol	24
class 3 vol	12

Origin Zone: 8

Mode: Bus

Values of Time ($/hr)

class 1		(A)
class 2		
class 3		

Mode:

O.C. parameter		(B)
occupancy		
expansion factor		

Number of Links: 9 (C)

Link: A In

length (km)	2.1
V/C	1.5/.96
free-flow speed (km/h)	64/80
class 1 vol	231
class 2 vol	1120
class 3 vol	940

Link: B In

length	3.4
V/C	1.5/.89
free-flow spd	64/80
class 1 vol	210
class 2 vol	160
class 3 vol	820

Link: C In

length	1.5
V/C	1.25
free-flow spd	42
class 1 vol	180
class 2 vol	800
class 3 vol	720

Link: D In

length	2.4
V/C	1.25
free-flow spd	42
class 1 vol	140
class 2 vol	630
class 3 vol	600

Link: E Out

length	1.4
V/C	1.15
free-flow spd	42
class 1 vol	50
class 2 vol	210
class 3 vol	200

Link: G In

length	2.2
V/C	.54
free-flow spd	42
class 1 vol	30
class 2 vol	140
class 3 vol	100

Link: H Out

length	.5
V/C	.05
free-flow spd	42
class 1 vol	0
class 2 vol	20
class 3 vol	0

Link: J Out

length	.9
V/C	.52
free-flow spd	43
class 1 vol	30
class 2 vol	140
class 3 vol	100

Link: K Out

length	.5
V/C	.54
free-flow spd	42
class 1 vol	27
class 2 vol	160
class 3 vol	120

ORIGIN ZONE: 1
Mode: Truck

Modal Parameters

labor cost ($/hr)	1	(B)
O.C. parameter	5.2	
expansion factor	115	

Number of Links: 8 (C)

Link: A Out

	length (km)	2.1
21	V/C	.73/.24
22	free-flow speed (km/h)	80/100
	volume	135

Link: B Out

	length	3.4
25	V/C	.96/.32
26	free-flow speed	80/100
	volume	135

Link: C Out

length	1.5
V/C	.62
free-flow speed	60
volume	178

Link: D Out

length	2.4
V/C	.49
free-flow speed	60
volume	190

Link: E Out

length	1.4
V/C	1.15
free-flow speed	60
volume	158

Link: F Out

length	1.0
V/C	29
free-flow speed	60
volume	140

Link: H Out

length	15
V/C	.05
free-flow speed	60
volume	0

Link: J Out

length	.9
V/C	.52
free-flow speed	60
volume	43

Link: K Out

length	.5
V/C	.54
free-flow speed	60
volume	28

Year: 1984

ORIGIN ZONE: 2

Mode: Truck

Modal Parameters

Labor cost ($/hr) ______ (B)

O.C. parameter ______

expansion factor ______

Number of Links: ______ (C)

Link:

length (km) ______

V/C .73/.24

free-flow speed (km/h) 85/100

23 volume 72

Link:

length ______

V/C .96/.32

free-flow speed 80/100

27 volume 105

Link:

length ______

V/C ______

free-flow speed ______

31 volume 131

Link:

length ______

V/C ______

free-flow speed ______

35 volume 137

Link:

length ______

37 V/C .56

free-flow speed ______

31 volume 375

Link:

length ______

V/C ______

free-flow speed ______

43 volume 71

Link:

length ______

V/C ______

free-flow speed ______

volume ______

Link:

length ______

V/C ______

free-flow speed ______

47 volume 26

Link:

length ______

V/C ______

free-flow speed ______

51 volume 33

Year: 1984

ORIGIN ZONE: 3
Mode: Truck

Modal Parameters

Labor cost ($/hr)		(B)
O.C. parameter		
expansion factor		
Number of Links:	9	(C)

Link:	A Out
length (km)	2.1
V/C	.73/.24
free-flow speed (km/h)	80/100
volume	58

Link:	B Out
length	3.4
V/C	.96/.32
free-flow speed	80/100
volume	94

Link:	C Out
length	1.5
V/C	.62
free-flow speed	60
volume	126

Link:	E Out
length	1.4
V/C	1.15
free-flow speed	60
volume	68

Link:	Fin
length	1.0
V/C	.18
free-flow speed	60
volume	183

Link:	G Out
length	2.2
V/C	.25
free-flow speed	60
volume	132

Link:	H Out
length	.5
V/C	.05
free-flow speed	60
volume	6

Link:	J Out
length	.9
V/C	.52
free-flow speed	60
volume	26

Link:	K Out
length	.5
V/C	.54
free-flow speed	60
volume	36

Year: 1984

ORIGIN ZONE: 4
Mode: Truck

Modal Parameters		
Labor cost ($/hr)		(B)
O.C. parameter		
expansion factor		
Number of Links:	3	(C)

Link: D In	
length (km)	2.4
V/C	1.02
free-flow speed (km/h)	60
volume	20

Link: E Out	
length	1.4
V/C	1.15
free-flow speed	60
volume	10

Link: G In	
length	2.2
V/C	59
free-flow speed	60
volume	10

Link:	
length	
V/C	
free-flow speed	
volume	

Link:	
length	
V/C	
free-flow speed	
volume	

Link:	
length	
V/C	
free-flow speed	
volume	

Link:	
length	
V/C	
free-flow speed	
volume	

Link:	
length	
V/C	
free-flow speed	
volume	

Link:	
length	
V/C	
free-flow speed	
volume	

Year: 1984

ORIGIN ZONE: 5
Mode: Truck

Modal Parameters		
Labor cost ($/hr)		(B)
O.C. parameter		
expansion factor		
Number of Links:	9	(C)

Link: A Out	
length (km)	2.1
V/C	.73/.24
free-flow speed (km/h)	80/100
volume	39

Link: B Out	
length	3.4
V/C	.96/.32
free-flow speed	80/100
volume	53

Link: C In	
length	1.5
V/C	1.25
free-flow speed	60
volume	82

Link: D In	
length	2.4
V/C	1.02
free-flow speed	60
volume	59

Link: E Out	
length	1.4
V/C	1.15
free-flow speed	60
volume	28

Link: G In	
length	2.2
V/C	.59
free-flow speed	60
volume	23

Link: H Out	
length	.5
V/C	.05
free-flow speed	60
volume	9

Link: J In	
length	.9
V/C	.23
free-flow speed	60
volume	182

Link: K Out	
length	.5
V/C	.54
free-flow speed	60
volume	14

Year: 1984

ORIGIN ZONE: 6
Mode: Truck

Changes from Zone 5

Modal Parameters

Labor cost ($/hr)		(B)
O.C. parameter		
expansion factor		

Number of Links: 7 (C)

Link:

length (km)	
V/C	
free-flow speed (km/h)	
volume	0

Link:

length	
V/C	
free-flow speed	
volume	0

Link:

length	
V/C	
free-flow speed	
volume	15

Link:

length	
V/C	
free-flow speed	
volume	15

Link:

length	
V/C	
free-flow speed	
volume	7

Link:

length	
V/C	
free-flow speed	
volume	0

Link: H In

length	
V/C	.04
free-flow speed	
volume	15

Link:

length	
V/C	
free-flow speed	
volume	

Link:

length	
V/C	
free-flow speed	
volume	

Year: 1984

ORIGIN ZONE: 7
Mode: Truck

Changes from Zone 5

Monal Parameters
Labor cost ($/hr) ______ (B)
O.C. parameter ______
expansion factor ______

Number of Links: 9 (C)

Link:
length (km) ______
V/C .73/.24
free-flow speed (km/h) 80/100
volume 66

Link: B In
length ______
V/C 1.5/.89
free-flow speed 80/100
volume 102

Link:
length ______
V/C ______
free-flow speed ______
volume 86

Link:
length ______
V/C ______
free-flow speed ______
volume 66

Link:
length ______
V/C ______
free-flow speed ______
volume 30

Link:
length ______
V/C ______
free-flow speed ______
volume 14

Link:
length ______
V/C ______
free-flow speed ______
volume 0

Link:
length ______
V/C .52
free-flow speed ______
volume 16

Link:
length ______
V/C .25
free-flow speed ______
volume 198

Year: 1984

ORIGIN ZONE: 8
Mode: Truck

Changes from Zone 7

Modal Parameters		
Labor cost ($/hr)		(B)
O.C. parameter		
expansion factor		

Number of Links: 9 (C)

Link: A In	
length (km)	
V/C	1.5/.96
free-flow speed (km/h)	80/100
volume	114

Link: B In	
length	
V/C	1.5/.89
free-flow speed	80/100
volume	95

Link:	
length	
V/C	
free-flow speed	
volume	84

Link:	
length	
V/C	
free-flow speed	
volume	65

Link:	
length	
V/C	
free-flow speed	
volume	.26

Link:	
length	
V/C	
free-flow speed	
volume	19

Link:	
length	
V/C	
free-flow speed	
volume	0

Link:	
length	
V/C	
free-flow speed	
volume	11

Link:	
length	
V/C	.54
free-flow speed	
volume	19

Year: 1984

BENEFITS TO RESIDENTS OF ORIGIN ZONE 1

		AUTO	BUS
NO BUILD			
Income class 1	OC	15501.79	757.77
	TC	26508.26	11165.60
Income class 2	OC	17232.42	4317.18
	TC	7351.37	15500.10
Income class 3	OC	642.27	308.73
	TC	124.18	561.18
Total	OC	33376.47	5383.69
	TC	33983.81	27226.89
BUILD			
Income class 1	OC	14865.12	705.71
	TC	21635.33	9043.61
Income class 2	OC	16403.70	4033.77
	TC	5747.25	12536.17
Income class 3	OC	642.27	308.73
	TC	124.18	561.18
Total	OC	31911.08	5048.21
	TC	27506.75	22140.97
DIFFERENCE			
Income class 1	OC	636.67	52.06
	TC	4872.93	2122.00
Income class 2	OC	828.72	283.42
	TC	1604.12	2963.93
Income class 3	OC	0.00	0.00
	TC	0.00	0.00
Total	OC	1465.39	335.48
	TC	6477.06	5085.92

Year 1984

BENEFITS TO RESIDENTS OF ORIGIN ZONE 4

		AUTO	BUS
NO BUILD			
Income class 1	OC	9522.10	350.04
	TC	19656.22	6354.84
Income class 2	OC	777.92	211.92
	TC	400.14	946.12
Income class 3	OC	0.00	0.00
	TC	0.00	0.00
Total	OC	10300.02	561.96
	TC	20056.36	7300.96
BUILD			
Income class 1	OC	9105.81	336.11
	TC	16541.71	5790.64
Income class 2	OC	736.34	196.45
	TC	318.58	785.08
Income class 3	OC	0.00	0.00
	TC	0.00	0.00
Total	OC	9842.16	532.56
	TC	16860.29	6575.72
DIFFERENCE			
Income class 1	OC	416.29	13.93
	TC	3114.51	564.20
Income class 2	OC	41.57	15.48
	TC	81.56	161.04
Income class 3	OC	0.00	0.00
	TC	0.00	0.00
Total	OC	457.86	29.40
	TC	3196.07	725.24

Year 1984

BENEFITS TO RESIDENTS OF ORIGIN ZONE 6

		AUTO	BUS
NO BUILD			
Income class 1			
	OC	0.00	0.00
	TC	0.00	0.00
Income class 2			
	OC	1055.08	325.44
	TC	560.76	1581.57
Income class 3			
	OC	402.91	145.92
	TC	68.81	211.23
Total			
	OC	1457.99	471.36
	TC	629.57	1792.80
BUILD			
Income class 1			
	OC	0.00	0.00
	TC	0.00	0.00
Income class 2			
	OC	988.49	302.77
	TC	432.34	1343.70
Income class 3			
	OC	376.57	132.77
	TC	52.27	167.03
Total			
	OC	1365.06	435.54
	TC	484.60	1510.73
DIFFERENCE			
Income class 1			
	OC	0.00	0.00
	TC	0.00	0.00
Income class 2			
	OC	66.59	22.68
	TC	128.42	237.87
Income class 3			
	OC	26.34	13.15
	TC	16.55	44.20
Total			
	OC	92.93	35.82
	TC	144.97	282.07

Year 1984

BENEFITS TO RESIDENTS OF ORIGIN ZONE 8

		AUTO	BUS
NO BUILD			
Income class 1	OC	23756.66	1637.97
	TC	77277.15	44108.70
Income class 2	OC	18663.96	7507.09
	TC	15639.94	51844.24
Income class 3	OC	0.00	6519.95
	TC	0.00	14509.99
Total	OC	42420.63	15665.01
	TC	92917.09	110462.93
BUILD			
Income class 1	OC	20887.15	1475.81
	TC	41713.83	25365.74
Income class 2	OC	16454.43	6756.39
	TC	8619.70	29539.95
Income class 3	OC	0.00	5883.00
	TC	0.00	8429.37
Total	OC	37341.58	14115.20
	TC	50333.53	63335.06
DIFFERENCE			
Income class 1	OC	2869.51	162.16
	TC	35563.32	18742.96
Income class 2	OC	2209.54	750.70
	TC	7020.24	22304.29
Income class 3	OC	0.00	636.94
	TC	0.00	6080.63
Total	OC	5079.05	1549.81
	TC	42583.56	47127.88

Year 1984

TRUCK COSTS FROM EACH ORIGIN ZONE

Origin Zone:	1	2	3	4
No-Build				
OC *	82483.03	73860.69	54476.85	4229.52
labor	7834.72	6080.97	4706.83	554.65
Build				
OC *	77669.78	70182.93	51222.28	4229.52
labor	5719.15	4485.11	3306.68	554.65
Difference				
OC *	4813.25	3677.76	3254.57	0.00
labor	2115.56	1595.86	1400.15	0.00
Total OC	6928.81	5273.63	4654.72	0.00

Origin Zone:	5	6	7	8
No-Build				
OC	37543.85	3925.04	48609.66	54610.80
labor	4394.30	598.01	7464.02	9364.21
Build				
OC	35671.86	3925.04	44407.69	48762.77
labor	3577.03	598.01	4650.16	5377.30
Difference				
OC *	1871.99	0.00	4201.97	5848.03
labor	817.27	0.00	2813.86	3986.91
Total OC	2689.26	0.00	7015.83	9834.94

6.4 Instructions for computing benefits to a single link (Second Program)

BSL-2.3(A)

USER INSTRUCTIONS

		Enter	Press
1.	Set partition.	7	2nd Op. 17
2.	Enter data on Input Data Sheet into appropriate registers. This includes data this will probably not change during the analysis: modal characteristics, values of time, discount rate. It also includes data-specific to one link: modal volumes, volume increments (or growth rate), length, and capacity. To check that all the data is properly stored, press 0 INV 2nd list.		
3.	Load program BSL-2.3(A) for liniar growth, or program BSL-2.3(B) for exponential growth. Load sides 1 and 2.	0 0	(load sides) (load side 2)
4.	Initialize the accumulators of discounted costs.	0	STO 68 STO 69
5.	Enter number of years for which costs should be computed with volume and growth data as given.	n_1	STO 00
6.	Fix the display format to have 2 decimal places		2nd Fix 2
7.	Computer costs for n_1 years	B	
8.	To change the incremental volumes		

SINGLE LINK COST STREAM PROGRAM

BSL 2.3(A) INPUT DATA

Register		Link A 1979 NB	Link A 1981 NB	Link A 1981 Build	Link B 1979 NB	Link B 1981 NB	Link B 1981 Build	Link C 1979 NB	Link C 1984 NB
8	Auto free-flow speed	80		100					
9	expansion factor	107.4							
10	OC parameter	1							
11	occupancy	1.6							
12	Bus free-flow speed	64		80					
	expansion factor	92							
	OC parameter	4.3							
	occupancy	45							
16	Truck free-flow speed	80		100					
	expansion factor	115							
	OC parameter	5.2							
	occupancy	1							
20	Class 1 auto volume in	809	2175.4					757	
21	" out	254	198					349	
22	bus volume in	262	1086					228	
23	" out	78	59.2					97	
24	Class 2 auto volume in	625	538.2					609	
25	" out	86	88					121	
26	bus " in	1083	1107.8					1052	
27	" out	132	139.2					162	
28	Class 3 auto volume in	0	188					0	
29	" out	0	1.2					0	
30	bus " in	1522	1877.2					1418	
31	" out	114	73.2					147	
32	Truck volume in	230	270.4					250	503
	" out	230	270.4					250	503
34	Class 1 value of time	2.18							
35	Class 2 VOT	.56							
36	Class 3 VOT	.18							
37	Auto PCU equivalency	1							
38	Bus PCU "	3							
39	Truck PCU "	3							

<u>Yearly incremental volumes</u>

Register		Link A 1979 NB	Link B 1979 NB	Link C 1979 NB
40	Class 1 Auto yiv in	683.2	559.2	489
	" out	-28	5.4	10
	Bus " in	412	366.6	169
	" out	- 9.4	2.4	16
44	Class 2 Auto yiv in	-43.4	-53.6	57
45	" out	1	33.2	58
46	Bus " in	12.4	-4.6	69
47	" out	3.6	61.4	62
48	Class 3 Auto yiv in	94	94	103
49	Auto " out	0.6	1.4	10
50	Bus " in	177.6	137.6	219
51	Bus " out	-20.4	-19.2	0
52	Truck " in	20.2	31.4	50.6
53	" out	20.2	31.4	50.6

54 1 + discount rate	1.11				
55* first year discount factor	1	1.2321		1.2321	
56 link length (km)	3.4			3.4	
57 link capacity (PCV)	1600	4800	4800		4800
68 cumulative discounted total OC					
69 cumulative discounted total TC					

Supplementary Yearly incremental volumes for 1984					Link A 1984 NB	Link B 1984 NB	Link C 1984 NB
40	Class 1	Auto	yiv	in	211.2	174.8	135
41			"	out	45.6	41.6	70
42		Bus	"	in	-28.4	-22.4	138
43			"	out	10.6	22.6	23
44	Class 2	Auto	yiv	in	94.5	62	-39
45			"	out	8.2	71	80
46		Bus	"	in	23.2	-16.6	32
47			"	out	64	154.4	142
48	Class 3	Auto	yiv	in	21.2	3.6	3
49			"	out	8.6	20.2	17
50		Bus	"	in	311	212.8	10
51		Bus	"	out	30.6	120	60
52	Truck		"	in	15	37.8	58
53			"	out	15	37.8	58

COMPUTING COSTS ON LINK A, 1981-2000

Link A No-Build

1. Load liniar growth program, BSL-2.3(A)

2. Enter data for Link A, 1981, No-Build. Store it on a magnetic card (press 3 2nd write and load side 3; 4 2nd write & load side)

3. a. Enter 0 STO 68 STO 69
   b. Enter 3 STO 00. Press 2nd Fix 2.
   c. Press B
      (costs for 1981, 1982, 1983 will be printed)
      (volumes will be updated to 1984)

4. a. Enter incremental volumes for the 1984-1989 interval, in registers 40-53.
   b. Enter 5 STO 00
   c. Press B
      (costs for 1984, 85, 86, 87, 88 will be printed)
      (volumes will be updated to 1989)

5. Load exponential growth program, BSL-2.3(B), sides 1 & 2.

6. a. Enter cumulative operating costs into register 68
      Enter cumulative time costs into register 69.
      (these costs were the first 2 of the last 3 numbers just printed)
   b. Enter growth factor: 1.05 STO 41
   c. Enter 12 STO 00
   d. Press B
      (Costs for 1989-2000 will be printed - takes 30 minutes)

Link A Build

7. If you have the Link A 1981 No-Build data on a card, load in (press 0, enter side 3; press 0, enter side 4.
   If not, the 1981 data may be entered manually.

8. Change the free-flow speeds (registers 8, 12, 16) and capacity (register 57) for build.

9. Proceed with Stpes 3-6.

DISCOUNTED COSTS ON SINGLE LINK INPUTS

BSL-2.3(A) CARD B

Register Content (Input Data)

Register	Content				Group
*00	number of years				
01	counter				
02	counter				
03	pointer				
04	pointer				
05	pointer				
06	pointer				
07	pointer				
08	car	free-flow speed			modal char. file
09		expansion factor			
10		operating cost parameter			
11		occupancy			
12	bus				
13					
14					
15					
16	truck				
17					
18					
19					
20	Class 1	car	volume	in	car, bus vols.
21				out	
22		bus		in	
23				out	
24	Class 2	car			
25					
26		bus			
27					
28	Class 3	car			
29					
30		bus			
31					
32	truck	volume	in		truck vols.
33			out		
34	Class 1	VOT			VOT
35	2				
36	3				
37	car	PCV equivalency			PCU
38	bus	" "			
39	truck	" "			
40	incremental volumes	class 1	car	in	
41				out	
42			bus	in	
43				out	
44		class 2	car		
45					
46			bus		
47					
48		class 3	car		
49					
50			bus		
51					
52	truck incremental volume in				
53	truck incremental volume out				
54	1+ discount rate				
55	discount factor for first year				
56	length				
57	capacity (for 2 hours)				

LINK A
No-Build 1979-84

# of years →	~~6~~ 6 ← (6)	00	
	0.	01	
	0.	02	
	0.	03	
	0.	04	
	0.	05	
	0.	06	
Modal Char's	0.	07	
	80.	08	Free-flow spd
expansion factor	107.4	09	
	1.	10	~~etc~~ Operating cost param
occupancy	1.6	11	
	64.	12	
	92.	13	
bus	4.3	14	
	45.	15	
	80.	16	
	115.	17	
truck	5.2	18	
	1.	19	
class 1 car in	809.	20	
out	254.	21	
bus in	262.	22	
out	78.	23	
class 2 car in	625.	24	
out	86.	25	
bus in	1083.	26	Volumes
out	132.	27	(2 hour,
class 3 car in	0.	28	pax)
out	0.	29	
bus in	1522.	30	79
out	114.	31	values
truck in	230.	32	for
out	230.	33	the
	2.18	34	LINK
Values of time	0.56	35	
	0.18	36	
PCU equiv.	1.	37	
	3.	38	
	3.	39	
Class 1 car in	683.2	40	
out	-28.	41	
bus in	412.	42	Yearly
out	-9.4	43	volume
class 2	-43.4	44	increments
	1.	45	unique
	12.4	46	to
	3.6	47	each
class 3	94.	48	LINK
	0.6	49	
	177.6	50	
	-20.4	51	
truck in	20.2	52	
out	20.2	53	1 +
	1.11	54	discount rate ~~factor~~
1st year discount factor	1.	55	
	2.1	56	length
	1600.	57	capacity
	0.	58	(2 hour)

LINK A
Build 1979-84

0.	00
0.	01
0.	02
0.	03
54.	04
34.	05
23.	06
40.	07
100.	08
107.4	09
1.	10
1.6	11
80.	12
92.	13
4.3	14
45.	15
100.	16
115.	17
5.2	18
1.	19
4908.2	20
86.	21
2734.	22
21.6	23
364.6	24
92.	25
1157.4	26
153.6	27
564.	28
3.6	29
2587.6	30
-8.4	31
351.2	32
351.2	33
2.18	34
0.56	35
0.18	36
1.	37
3.	38
3.	39
683.2	40
-28.	41
412.	42
-9.4	43
-43.4	44
1.	45
12.4	46
3.6	47
94.	48
0.6	49
177.6	50
-20.4	51
20.2	52
20.2	53
1.11	54
1.870414552	55
2.1	56
4800.	57

LINK A: NO-BUILD 1980-1999

1980	1981	1992
1777.38	2336.74	2896.10
924.10	966.45	1008.81
19599.96	34787.47	48982.30
39973.71	110664.40	167022.34
859.92	2046.37	3202.31
13779.42	52844.60	88441.27
20459.88	36833.85	52184.61
53753.13	163509.00	255463.61
13438.26	13541.77	12736.82
7421.34	11074.65	10813.01
3143.92	3378.48	3440.96
13685.11	22187.36	23603.70
16582.18	16920.25	16177.78
21106.45	33262.01	34416.71
0.00	1977.99	3980.86
0.00	554.32	1165.83
4264.12	4986.85	5470.89
6067.62	10870.13	12571.74
4264.12	6964.84	9451.75
6067.62	11424.46	13737.57
71370.39	81565.14	88951.56
6982.43	11085.09	12585.13
112676.57	142284.08	166765.70
87909.63	219280.56	316203.02
112676.57	240860.42	376211.20
87909.63	285459.69	542097.15
200586.20	526320.11	918308.36

1983	1984	1985
3455.46	4014.82	4846.33
1051.16	1093.51	1201.50
62971.22	76949.12	95488.31
217849.80	268632.01	335511.23
4348.10	5493.35	6687.93
121367.97	154278.06	188175.87
67319.32	82442.47	102176.25
339217.77	422910.06	523687.10
11856.55	10977.07	12257.97
10003.27	9195.05	10298.52
3488.02	3535.26	3804.32
23915.23	24230.39	25524.69
15344.57	14512.33	16062.29
33918.50	33425.44	35823.21
5971.67	7962.73	10546.47
1748.88	2332.03	3064.23
5929.51	6386.99	7794.93
13717.66	14860.38	18128.85
11901.18	14349.72	18341.40
15466.54	17192.41	21193.08
96133.97	103402.73	116802.29
13656.89	14753.80	16878.63
190699.05	214707.25	253382.23
402259.70	488281.72	597582.02
515648.70	657083.02	792551.51
836225.98	1157872.27	1477364.02
1351874.68	1814955.29	2269915.53
	1157872.27	

1986	1987	1988
5118.48	5390.63	5662.78
1267.14	1332.78	1398.42
100064.23	104642.68	109223.18
351687.53	367895.89	384138.15
6738.62	6790.09	6842.27
189225.39	190322.56	191471.27
106802.85	111432.77	116065.46
540912.91	558218.45	575609.42
14422.92	16592.60	18766.51
12218.69	14149.62	16092.06
4031.03	4262.49	4498.32
26566.89	27681.87	28875.63
18453.95	20855.09	23264.83
38785.58	41831.49	44967.68
11144.57	11748.19	12357.07
3215.71	3369.97	3527.24
8749.05	9705.53	10664.19
20267.73	22417.20	24578.19
19893.62	21453.71	23021.26
23483.44	25787.17	28105.43
122931.18	129128.28	135381.29
17924.05	19016.13	20157.53
268081.61	282869.85	297732.83
621105.97	644853.24	668840.06
921675.27	1044419.99	1160811.13
1776524.94	2056343.85	2317809.99
2698200.21	3100763.83	3478621.12

1989	1990	1991
5934.94	6207.09	6517.44
1464.06	1529.70	1606.18
113805.33	118388.75	124357.28
400416.12	416731.64	437981.57
6895.11	6948.53	7299.68
192675.43	193939.01	203926.72
120700.44	125337.28	131656.96
593091.55	610670.65	641908.29
20944.16	23125.09	24329.15
18046.74	20014.42	21118.52
4738.15	4981.60	5251.71
30154.23	31523.82	33521.63
25682.31	28106.70	29580.86
48200.97	51538.24	54640.15
12970.88	13589.27	14287.35
3687.78	3851.82	4057.35
11624.88	12587.41	13224.49
26751.62	28938.42	30434.98
24595.76	26176.69	27511.84
30439.39	32790.24	34492.34
141679.23	148012.50	156691.80
21350.94	22599.06	24322.58
312657.75	327633.17	345441.46
693082.86	717598.20	755363.36
1270924.33	1374876.87	1473618.14
2561903.02	2789584.95	3005498.64
3832827.35	4164461.82	4479116.78

1992	1993	1994
6843.32	7185.48	7544.76
1686.49	1770.82	1859.36
130626.10	137209.89	144124.08
460363.36	483945.27	508800.89
7668.49	8055.82	8462.58
214462.62	225582.30	237324.52
138294.59	145265.71	152586.65
674825.98	709527.57	746125.41
25595.21	26926.07	28324.65
22295.18	23550.93	24893.13
5535.90	5834.74	6148.86
35690.09	38049.61	40623.62
31131.11	32760.82	34473.51
57985.26	61600.54	65516.74
15021.04	15791.99	16601.95
4275.34	4506.75	4752.70
13893.62	14596.38	15334.40
32014.70	33683.14	35446.36
28914.66	30388.37	31936.35
36290.04	38189.89	40199.06
165853.46	175513.19	185687.23
26231.90	28353.03	30716.08
364193.82	383928.09	404683.74
795333.18	837671.02	882557.29
1567403.24	1656472.57	1741053.23
3210308.27	3404643.61	3589101.92
4777711.51	5061116.18	5330155.15

1995	1996	1997
7921.99	8318.09	8734.00
1952.32	2049.94	2152.44
151384.84	159009.19	167014.98
535009.78	562658.16	591839.65
8889.70	9338.20	9809.12
249731.58	262849.76	276729.86
160274.54	168347.39	176824.10
784741.36	825507.92	868569.52
29794.00	31337.35	32958.10
26330.08	27871.14	29526.95
6478.87	6825.47	7189.36
43439.03	46526.84	49922.75
36272.87	38162.82	40147.45
69769.10	74397.98	79449.70
17452.73	18346.27	19284.56
5014.41	5293.24	5590.73
16109.38	16923.15	17777.59
37311.01	39284.39	41374.54
33562.12	35269.42	37062.15
42325.41	44577.63	46965.26
196392.65	207647.53	219471.20
33355.96	36313.13	39634.57
426502.19	449427.15	473504.91
930191.84	980796.66	1034619.05
1821360.26	1897597.77	1969959.82
3764249.79	3930624.90	4088737.63
5585610.06	5828222.67	6058697.45

1998	1999
1998	
9170.698911	9629.233856
2260.058668	2373.061601
175421.008	184247.0007
622656.2156	655219.1345
10303.55567	10822.67238
291427.7652	307005.1374
185724.5637	195069.6731
914083.9808	962224.2719
34659.8183	36446.30163
31309.57107	33232.72244
7571.299412	7972.098942
53667.9646	57810.08548
42231.11771	44418.40057
84977.53567	91042.80792
20269.74758	21304.06724
5908.601147	6248.804085
18674.70343	19616.58294
43590.3263	45941.58789
38944.45101	40920.65018
49498.92745	52190.39198
231884.4556	244909.6901
43374.80135	47597.18721
498784.5881	525318.4139
1091935.245	1153054.659
3	0
20[illegible]9517.974	21[illegible]4675.269
4239072.677	4382090.551
6~~2~~28590.651	6~~5~~36765.821
288	1984

1999

LINK B: NO-BUILD 1980-1989

1980	1981	1982
1777.38	2279.64	2781.90
924.10	1046.27	1168.45
19599.96	32641.85	45026.58
39973.71	98486.18	150731.79
859.92	1940.07	3006.44
13779.42	47594.91	81980.38
20459.88	34581.92	48033.02
53753.13	146081.09	232712.17
13438.26	13806.44	13449.59
7421.34	10623.17	10892.58
3143.92	3452.41	3627.37
13685.11	21288.99	23791.51
16582.18	17258.86	17076.96
21106.45	31912.15	34684.09
0.00	1979.28	4008.47
0.00	530.77	1169.30
4264.12	4859.26	5257.90
6067.62	10161.54	12070.43
4264.12	6838.54	9266.37
6067.62	10692.31	13239.73
71370.39	85821.00	98404.96
6982.43	11384.82	14161.31
112676.57	144500.31	172781.31
87909.63	200070.38	294797.30
112676.57	242857.03	383090.22
87909.63	268153.22	507417.32
200586.20	511010.25	890507.54

1983	1984	1985
3284.15	3786.41	4288.67
1290.62	1412.79	1534.97
57067.41	69108.20	81144.52
193671.70	236753.84	279986.28
4055.32	5104.08	6152.62
111771.57	141615.96	171517.16
61122.72	74212.28	87297.14
305443.26	378369.80	451503.44
12987.26	12560.55	12163.41
10216.85	9618.82	9108.82
3780.88	3941.74	4108.59
24378.45	25116.38	26025.69
16768.14	16502.30	16271.99
34595.31	34735.20	35134.51
6015.29	8023.70	10033.50
1755.09	2341.81	2929.61
5606.87	5952.70	6295.68
12959.03	13837.78	14704.71
11622.16	13976.39	16329.17
14714.12	16179.59	17634.32
110738.07	123339.20	136138.15
16201.95	18411.40	20808.81
200251.09	228030.18	256036.46
370954.64	447695.99	525081.08
529512.09	679722.63	831667.80
778656.15	1073567.37	1385177.43
1308168.24	1753290.00	2216845.24

1986	1987	1988
4563.90	4839.14	5114.38
1751.17	1967.37	2183.57
85873.61	90621.77	95377.19
297162.07	315484.41	335124.38
6157.62	6164.61	6172.80
171538.26	172140.30	173420.95
92031.23	96786.38	101550.00
468700.33	487624.71	508545.33
15057.08	18016.42	21017.73
11609.74	14538.36	17968.11
4511.15	4930.55	5360.90
28481.34	31894.47	36435.21
19568.23	22946.97	26378.62
40091.08	46432.83	54403.32
10504.87	11004.33	11524.14
3027.77	3158.20	3327.45
7214.81	8152.99	9104.69
16580.94	18659.73	20982.79
17719.68	19157.33	20628.83
19608.72	21817.92	24310.24
152713.34	169272.27	185737.73
24545.44	28876.71	33880.75
282032.46	308162.95	334295.18
552945.56	584752.18	621139.64
982453.88	1130883.15	1275942.69
1680804.71	1962455.52	2231984.46
2663258.59	3093338.67	3507927.15

1989	1990	1991
5389.61	5664.85	5948.09
2399.77	2615.97	2746.77
100133.22	104693.77	109928.46
356256.52	372487.80	391112.19
6181.68	6182.26	6491.37
175480.09	175498.81	184273.75
106314.91	110876.02	116419.82
531736.61	547986.61	575385.94
24044.75	26847.80	28190.19
21974.05	24537.56	25764.44
5798.14	6187.91	6497.31
42277.63	45123.51	47379.69
29842.90	33035.71	34687.50
64251.68	69661.07	73144.13
12058.29	12559.88	13187.87
3542.27	3689.71	3874.20
10065.80	11007.02	11557.37
23592.90	25799.59	27089.57
22124.08	23566.90	24745.24
27135.17	29489.31	30963.77
202080.76	216276.14	227089.94
39637.05	42424.82	44546.06
360362.65	383754.77	402942.51
662760.51	689561.81	724039.90
1416817.38	1551969.85	1679816.79
2491073.96	2733926.93	2963652.70
3907891.34	4285896.78	4643469.49

1992	1993	1994
6245.50	6557.77	6885.66
2884.10	3028.31	3179.72
115424.88	121196.12	127255.93
410667.80	431201.18	452761.24
6815.94	7156.73	7514.57
193487.44	203161.81	213319.90
122240.82	128352.86	134770.50
604155.23	634363.00	666081.15
29599.70	31079.68	32633.67
27052.66	28405.30	29825.56
6822.17	7163.28	7521.45
49748.67	52236.10	54847.91
36421.87	38242.96	40155.11
76801.33	80641.40	84673.47
13847.27	14539.63	15266.61
4067.91	4271.31	4484.87
12135.24	12742.00	13379.10
28444.05	29866.25	31359.57
25982.51	27281.63	28645.71
32511.96	34137.56	35844.44
238444.44	250366.66	262885.00
46773.36	49112.03	51567.63
423089.63	444244.12	466456.32
760241.89	798253.99	838166.69
1800753.08	1915152.27	2023367.72
3180960.87	3386522.65	3580972.99
4981713.95	5301674.92	5604340.71

1995	1996	1997
7229.94	7591.44	7971.01
3338.71	3505.65	3680.93
133618.72	140299.66	147314.64
475399.31	499169.27	524127.74
7890.30	8284.81	8699.06
223985.90	235185.19	246944.45
141509.02	148584.48	156013.70
699385.20	734354.46	771072.19
34265.35	35978.62	37777.55
31316.84	32882.68	34526.81
7897.52	8292.39	8707.01
57590.30	60469.82	63493.31
42162.87	44271.01	46484.56
88907.14	93352.50	98020.12
16029.94	16831.44	17673.01
4709.11	4944.57	5191.80
14048.05	14750.46	15487.98
32927.55	34573.92	36302.62
30078.00	31581.90	33160.99
37636.66	39518.49	41494.42
276029.25	289830.71	304322.24
54146.02	56853.32	59695.98
489779.14	514268.09	539981.50
880075.02	924078.77	970282.71
2125733.69	2222566.36	2314164.84
3764912.49	3938909.32	4103500.91
5890646.18	6161475.68	6417665.75

1998	1999
8369.56	8788.04
3864.97	4058.22
154680.38	162414.40
550334.12	577850.83
9134.01	9590.71
259291.67	272256.26
163814.38	172005.10
809625.80	850107.09
39666.43	41649.75
36253.16	38065.81
9142.37	9599.48
66667.97	70001.37
48808.79	51249.23
102921.13	108067.19
18556.66	19484.50
5451.39	5723.96
16262.38	17075.50
38117.75	40023.64
34819.04	36559.99
43569.14	45747.60
319538.36	335515.27
62680.78	65814.82
566980.57	595329.60
1018796.85	1069736.69
2400812.04	2482775.62
4259195.67	4406474.49
6660007.71	6889250.10

LINK C: NO-BUILD 1979-1999

		1980	1981	1982
		1783.62	2371.51	2959.40
		1070.82	1276.57	1482.32
Class 1				
Car	OC	14942.79	23793.61	31817.04
	TC	29915.68	74122.91	104522.38
Bus	OC	603.77	1021.94	1414.42
	TC	9512.77	25259.49	36732.65
Total	OC	15546.57	24815.55	33231.46
	TC	39428.44	99382.40	141255.03
Class 2				
Car	OC	10123.21	12554.95	14371.25
	TC	5544.22	10113.27	11702.71
Bus	OC	2312.61	2718.84	3000.99
	TC	10053.84	17814.83	19936.49
Total	OC	12435.83	15273.79	17372.24
	TC	15598.05	27928.10	31639.20
Class 3				
Car	OC	0.00	1718.07	3459.39
	TC	0.00	474.42	977.42
Bus	OC	2998.94	3654.39	4130.10
	TC	4257.79	8053.20	9358.92
Total	OC	2998.94	5372.46	7589.49
	TC	4257.79	8527.63	10336.34
Truck	OC	58224.87	75245.46	90305.16
	TC	5881.66	10821.49	13657.12
Total	OC	89206.20	120707.26	148498.34
	TC	65165.96	146659.62	196887.69
Discounted Totals				
	OC	89206.20	197951.48	318476.06
	TC	65165.96	197291.74	357090.20
Grand Total		154372.15	395243.22	675566.27

1983	1984	1985
3547.29	4135.18	4723.07
1688.07	1893.82	2099.57
39768.12	47693.71	55593.77
133797.88	163512.94	193700.12
1805.90	2197.67	2589.42
47971.45	59544.20	71497.89
41574.02	49891.38	58183.19
181769.33	223057.15	265198.00
16216.76	18101.17	20010.37
13283.28	15104.01	17204.71
3284.02	3570.89	3860.05
21917.19	24180.40	26771.85
19500.78	21672.06	23870.42
35200.46	39284.42	43976.56
5208.09	6965.55	8729.18
1479.71	1993.84	2521.99
4596.25	5060.53	5523.19
10497.56	11647.23	12808.15
9804.35	12026.08	14252.38
11977.27	13641.07	15330.14
105584.66	121040.14	136571.52
16705.98	20215.66	24253.80
176463.80	204629.66	232877.50
245653.03	296198.29	348758.51
447504.87	582300.77	720502.23
536709.58	731824.57	938795.77
984214.46	1314125.34	1659298.00

1986	1987	1988
4970.95	5218.82	5466.70
2386.69	2673.82	2960.94
58965.87	62151.70	65328.24
209556.31	221128.24	232429.99
2933.74	3268.97	3603.77
83170.32	92797.79	102301.89
61899.60	65420.66	68932.00
292726.63	313926.04	334731.88
20846.96	21492.00	22127.31
18989.32	19642.63	20223.27
4247.09	4610.24	4972.07
30882.96	33618.81	36257.36
25094.05	26102.24	27099.38
49872.28	53261.44	56480.63
8908.68	9064.76	9219.71
2614.72	2662.95	2708.47
5676.58	5822.59	5968.15
13295.95	13647.69	13988.88
14585.25	14887.34	15187.86
15910.68	16310.64	16697.36
154786.24	170898.35	186911.44
30223.61	33523.49	36664.63
256365.14	277308.59	298130.68
388733.20	417021.61	444574.49
857565.51	991133.52	1120500.33
1146628.41	1347490.38	1540403.03
2004193.92	2338623.90	2660903.36

1989	1990	1991
5714.57	5962.45	6260.57
3248.07	3535.19	3711.95
68504.78	71681.31	75265.38
243731.73	255033.47	267785.14
3938.56	4273.36	4487.03
111805.99	121310.09	127375.60
72443.34	75954.68	79752.41
355537.72	376343.56	395160.74
22762.61	23397.92	24567.82
20803.91	21384.55	22453.77
5333.91	5695.74	5980.52
38895.92	41534.47	43611.19
28096.52	29093.66	30548.34
59699.82	62919.02	66064.97
9374.66	9529.62	10006.10
2753.99	2799.51	2939.49
6113.72	6259.28	6572.24
14330.07	14671.27	15404.83
15488.38	15788.90	16578.34
17084.07	17470.78	18344.32
202924.53	218937.62	229884.50
39805.76	42946.90	45094.24
318952.77	339774.86	356763.60
472127.38	499680.26	524664.27
1245186.86	1364850.29	1478045.43
1724969.32	1900948.95	2067416.17
2970156.18	3265799.24	3545461.60

1992	1993	1994
6573.60	6902.28	7247.40
3897.55	4092.43	4297.05
79028.65	82980.08	87129.09
281174.40	295233.12	309994.78
4711.38	4946.95	5194.30
133744.38	140431.60	147453.18
83740.03	87927.03	92323.38
414918.78	435664.72	457447.95
25796.21	27086.02	28440.32
23576.46	24755.29	25993.05
6279.55	6593.53	6923.20
45791.75	48081.34	50485.41
32075.76	33679.55	35363.52
69368.22	72836.63	76478.46
10506.40	11031.72	11583.31
3086.46	3240.79	3402.83
6900.86	7245.90	7608.19
16175.07	16983.83	17833.02
17407.26	18277.62	19191.50
19261.54	20224.61	21235.84
241378.73	253447.67	266120.05
47348.96	49716.40	52202.22
374601.78	393331.87	412998.46
550897.49	578442.36	607364.48
1585121.91	1686410.47	1782223.98
2224885.16	2373842.32	2514747.73
3810007.07	4060252.79	4296971.71

1995	1996	1997
7609.77	7990.25	8389.77
4511.90	4737.49	4974.37
91485.54	96059.82	100862.81
325494.52	341769.24	358857.70
5454.01	5726.71	6013.05
154825.84	162567.13	170695.48
96939.55	101786.53	106875.86
480320.35	504336.37	529553.19
29862.34	31355.45	32923.23
27292.70	28657.34	30090.20
7269.36	7632.83	8014.47
53009.68	55660.16	58443.17
37131.70	38988.29	40937.70
80302.38	84317.50	88533.37
12162.47	12770.60	13409.13
3572.97	3751.62	3939.20
7988.60	8388.03	8807.44
18724.67	19660.90	20643.95
20151.08	21158.63	22216.56
22297.64	23412.52	24583.14
279426.05	293397.36	308067.22
54812.33	57552.95	60430.60
433648.39	455330.81	478097.35
637732.70	669619.34	703100.31
1872858.38	1958593.62	2039694.52
2648036.64	2774120.74	2893389.49
4520895.02	4732714.36	4933084.01

1998	1999
8809.25	9249.72
5223.09	5484.24
105905.95	111201.25
376800.59	395640.62
6313.70	6629.39
179230.26	188191.77
112219.65	117830.63
556030.85	583832.39
34569.39	36297.86
31594.71	33174.45
8415.20	8835.96
61365.33	64433.60
42984.59	45133.81
92960.04	97608.05
14079.58	14783.56
4136.16	4342.97
9247.81	9710.20
21676.14	22759.95
23327.39	24493.76
25812.30	27102.92
323470.58	339644.11
63452.13	66624.73
502002.21	527102.32
738255.32	775168.09
2116411.59	2188981.80
3006211.27	3112934.58
5122622.86	5301916.38

LINK A: BUILD - 1980-1999

1980	1981	1982
1777.38	2336.74	2896.10
924.10	966.45	1008.81
15908.83	25113.71	35322.14
10606.16	20502.50	34576.78
645.04	1444.67	2337.90
3638.93	9607.14	18114.48
16553.87	26558.39	37660.04
14245.09	30109.65	52691.27
10526.98	9771.03	9356.99
1862.67	2050.35	2284.42
2303.10	2393.85	2534.78
3416.00	4067.99	4934.78
12830.08	12164.88	11891.77
5278.67	6118.34	7219.20
0.00	1364.89	2800.45
0.00	96.94	235.33
3100.28	3491.75	3985.75
1489.01	1939.85	2563.02
3100.28	4856.64	6786.20
1489.01	2036.80	2798.35
62782.56	67628.97	73809.99
2143.91	2586.72	3158.60
95266.79	111208.88	130148.00
23156.68	40851.50	65867.42
95266.79	195454.97	301086.01
23156.68	59959.83	113419.30
118423.47	255414.80	414505.31

19 1982

1983	1984	1985
3455.46	4014.82	4846.3275
1051.16	1093.51	1201.505
47125.71	60499.41	49857.92072
54254.34	81018.09	82612.00555
3344.84	4454.86	3583.738172
30075.08	46441.18	46343.61117
50470.55	64954.28	53441.65889
84329.42	127459.27	128955.6167
9096.42	8838.73	6467.769952
2546.19	2815.29	2526.348756
2701.86	2874.09	2022.353557
6031.17	7371.10	6263.366172
11798.28	11712.82	8490.123509
8577.35	10186.39	8789.714928
4412.89	6223.80	5505.454674
431.11	700.94	754.5529598
4558.63	5178.70	4177.426537
3394.29	4470.31	4464.966641
8971.52	11402.49	9682.881211
3825.40	5171.25	5219.519601
81072.27	88996.65	63346.62333
3882.98	4783.77	4085.17992
152312.61	177066.24	134961.2869
100615.15	147600.68	147050.0312
412455.67	529094.69	601250.5034
186988.23	284217.37	362836.3252
599443.91	813312.06	964086.8286

1 19 1985

1986	1987	1988
5118.48	5390.6325	5662.785
1267.143333	1332.781667	1398.42
53358.32061	56891.24731	60444.96746
94520.24709	107693.7998	122208.3852
3676.593058	3764.96024	3848.940867
50871.58797	55711.66757	60869.64642
57034.91366	60656.20755	64293.90833
145391.8351	163405.4674	183078.0317
7722.968247	9013.577819	10335.1902
3251.672759	4080.459455	5021.039731
2166.518822	2309.38308	2450.949987
7047.233781	7893.366	8804.513666
9889.487069	11322.9609	12786.14018
10298.90654	11973.82546	13825.5534
5945.025838	6386.048958	6827.386908
863.5210288	983.5102303	1115.16227
4772.760275	5378.997575	5994.419249
5448.129276	6558.888796	7806.783329
10717.78611	11765.04653	12821.80616
6311.650305	7542.399026	8921.945599
66649.70369	69956.99144	73263.88678
4580.461556	5123.622091	5717.435882
144291.8905	153701.2064	163165.7414
166582.8535	188045.314	211542.9665
670749.9061	737444.9321	801230.4623
443072.3577	524670.202	607367.5878
1113822.264	1262115.134	1408598.05

19 1588

1989	1990	1991
5934.9375	6207.09	6517.4445
1464.058333	1529.696667	1606.1815
64010.34143	67580.36016	72077.90214
138140.3815	155566.7989	178411.0861
3928.727391	4004.567039	4259.387088
66351.25334	72162.15678	82743.12666
67939.06882	71584.92719	76337.28923
204491.6349	227728.9557	261154.2128
11683.72025	13055.48465	13898.92845
6081.836299	7271.359467	8325.782247
2591.283247	2730.488892	2896.862423
9783.442524	10832.93302	12361.34078
14275.0035	15785.97355	16795.79087
15865.27882	18104.29248	20687.12303
7268.208278	7707.929649	8212.267768
1259.124254	1416.048493	1622.531871
6617.532412	7247.059507	7707.823737
9201.451133	10752.62613	12328.2564
13885.74069	14954.98916	15920.09151
10460.57539	12168.67462	13950.78827
76567.73905	79867.44624	84373.09422
6364.700516	7068.235975	8014.930691
172667.5521	182193.3361	193426.2658
237182.1896	265070.1588	303807.0548
862041.2941	919847.9055	975137.0286
690899.4736	775001.3385	861841.7972
1552940.768	1694849.244	1836978.826

19 1991

1992	1993	1994
6843.316725	7185.482561	7544.756689
1686.490575	1770.815104	1859.355859
76806.05992	81770.23281	85897.86053
204926.2005	235720.0766	248477.4635
4526.911225	4807.533096	5050.541829
95023.44442	109284.4962	115205.1551
81332.97114	86577.76591	90948.40236
299949.6449	345004.5727	363682.6186
14785.62493	15716.87577	16502.68619
9548.876682	10968.53706	11567.32689
3071.92489	3256.089936	3422.135104
14131.78327	16184.15832	17084.18609
17857.54982	18972.96571	19924.8213
23680.65995	27152.69538	28651.51299
8742.467769	9299.233322	9766.078082
1862.111607	2140.26452	2256.661294
8191.579927	8699.048006	9138.838832
14156.88208	16280.39238	17162.79618
16934.0477	17998.28133	18904.91691
16018.99369	18420.6569	19419.45748
89109.91051	94092.51496	98601.55612
9108.534553	10373.10522	10969.80839
205234.4792	217641.5279	228379.6967
348757.8331	400951.0302	422723.3974
1027987.833	1078479.541	1126211.89
951651.911	1044670.475	1133021.502
1979639.744	2123150.016	2259233.393

19 10 1994

1995	1996	1997
7921.994524	8318.09425	8733.998962
1952.323652	2049.939834	2152.436826
90185.11724	94688.34693	99418.89304
260935.9742	274023.2239	287771.6252
5303.575931	5569.444417	5848.823351
120989.778	127067.7214	133454.3377
95488.69317	100257.7913	105267.7164
381925.7522	401090.9453	421225.9629
17320.3857	18180.53783	19085.79564
12154.35615	12772.19083	13422.61522
3596.103843	3779.802209	3973.910551
17973.72599	18913.67263	19907.54159
20916.48954	21960.34004	23059.70619
30128.08214	31685.86346	33330.1568
10251.48655	10761.77595	11298.3969
2370.578768	2490.374119	2616.371787
9596.829096	10078.09659	10583.87619
18025.0957	18931.20834	19883.44195
19848.31564	20839.87254	21882.27309
20395.67447	21421.58246	22499.81373
103332.7404	108342.4214	113658.7132
11568.03857	12204.5284	12882.59197
239586.2388	251400.4254	263868.4089
444017.5474	466402.9196	489938.5254
1171324.111	1213969.823	1254294.768
1216626.545	1295743.693	1370617.165
2387950.656	2509713.516	2624911.932

10 199 1997

1998	1999
9170.698911	9629.233856
2260.058668	2373.061601
104388.7222	109610.4442
302215.3752	317390.572
6142.424903	6450.998379
140165.862	147219.4759
110531.1471	116061.4426
442381.2372	464610.0479
20038.99934	21043.17491
14107.54378	14829.03455
4179.156243	4396.311636
20959.19124	22072.86796
24218.15558	25439.48655
35066.73502	36901.90251
11862.89378	12456.90522
2748.917562	2888.380511
11115.46927	11674.24544
20884.23939	21936.18869
22978.36305	24131.15066
23633.15696	24824.5692
119312.5942	125337.7627
13605.94426	14378.76061
277040.2599	290969.8425
514687.0735	540715.2802
1292437.016	1328527.142
1441478.065	1508545.094
2733915.081	2837072.236

1989

LINK B BUILD 1979-1999

1980	1981	1982
1777.38	2279.64	2781.90
924.10	1046.27	1168.45
15908.83	23809.63	32410.80
10606.16	18958.76	30325.92
645.04	1373.25	2173.41
3638.93	8963.94	16249.94
16553.87	25182.87	34584.21
14245.09	27922.70	46575.86
10526.98	10115.04	9971.02
1862.67	2058.30	2279.62
2303.10	2461.31	2658.57
3416.00	4083.65	4911.22
12830.08	12576.34	12629.59
5278.67	6141.95	7190.84
0.00	1376.72	2803.22
0.00	95.70	227.23
3100.28	3402.32	3784.83
1489.01	1863.35	2364.52
3100.28	4779.04	6588.05
1489.01	1959.05	2591.74
62782.56	70299.43	78858.03
2143.91	2688.18	3372.90
95266.79	112837.69	132659.87
23156.68	38711.89	59731.35
95266.79	196922.36	304592.09
23156.68	58032.26	106511.56
118423.47	254954.62	411103.65

1983	1984	1985
3284.15	3786.41	4288.67
1290.62	1412.79	1534.97
42168.33	53133.68	65133.19
45644.12	65885.02	92050.44
3064.16	4041.91	5091.65
26148.59	39337.01	56514.07
45232.49	57175.59	70224.84
71792.71	105222.03	148564.51
9944.44	9910.62	9799.07
2507.82	2722.74	2903.14
2877.04	3100.54	3318.80
5903.82	7065.73	8400.58
12821.48	13011.16	13117.87
8411.65	9788.48	11303.71
4376.77	6129.34	8048.98
407.35	649.38	967.05
4231.25	4718.32	5225.93
3015.01	3837.75	4856.12
8608.01	10847.66	13274.91
3422.36	4487.13	5823.17
88452.69	98849.68	109782.23
4226.99	5280.12	6562.63
155114.67	179884.09	206399.85
87853.71	124777.76	172254.03
418010.60	536505.82	658994.09
170749.44	252944.41	355168.80
588760.04	789450.24	1014162.89

1986	1987	1988
4563.90	4839.14	5114.38
1751.17	1967.37	2183.57
70293.47	75550.40	80891.65
106208.10	122015.40	139587.17
5195.02	5290.47	5378.49
61646.54	67099.71	72871.89
75488.49	80840.87	86270.14
167854.64	189115.11	212459.06
12005.57	14256.71	16570.11
3787.79	4803.67	5965.01
3631.23	3946.44	4268.24
9499.57	10696.98	12003.28
15636.80	18203.16	20838.35
13287.35	15500.64	17968.28
8613.67	9166.66	9711.82
1087.50	1218.85	1361.82
6084.87	6961.63	7856.63
5955.97	7204.44	8615.24
14698.54	16128.29	17568.46
7043.47	8423.29	9977.06
121153.90	132952.59	145267.77
7837.41	9287.16	10928.09
226977.73	248124.91	269944.71
196022.87	222326.21	251332.49
780345.65	899857.10	1016993.26
459970.63	567055.91	676115.74
1240316.28	1466913.01	1693109.01

1989	1990	1991
5389.61	5664.85	5948.09
2399.77	2615.97	2746.77
86307.34	91788.59	98021.22
159039.47	180489.48	206122.01
5459.72	5534.86	5896.81
78961.18	85365.47	97497.25
91767.05	97323.44	103918.02
238000.65	265854.95	303619.26
18960.38	21437.68	22812.39
7286.26	8782.11	9949.08
4599.82	4943.48	5261.04
13429.17	14985.55	16936.14
23560.19	26381.16	28073.42
20715.43	23767.66	26885.22
10253.68	10796.48	11521.29
1517.14	1685.53	1922.26
8770.25	9702.53	10335.57
10202.25	11979.53	13667.36
19023.93	20499.00	21856.85
11719.38	13665.06	15589.62
158156.10	171640.04	182601.98
12776.61	14849.35	16810.84
292507.27	315843.64	336450.28
283212.07	318137.03	362904.94
1131341.60	1242576.83	1349326.89
786830.35	898873.28	1014016.96
1918171.96	2141450.11	2363343.85

1992	1993	1994
6245.50	6557.77	6885.66
2884.10	3028.31	3179.72
104612.31	111571.21	118908.01
235823.61	270265.55	310231.21
6278.39	6680.20	7102.87
111555.40	127857.74	146775.18
110890.70	118251.41	126010.88
347379.00	398123.29	457006.38
24284.14	25858.55	27541.24
11296.56	12854.08	14656.09
5600.10	5961.85	6347.48
19185.87	21783.56	24786.11
29884.24	31820.40	33888.72
30482.44	34637.64	39442.20
12289.62	13102.94	13962.76
2196.42	2514.16	2882.69
11004.03	11709.13	12452.13
15622.32	17888.45	20517.13
23293.66	24812.07	26414.89
17818.74	20402.61	23399.82
194348.26	206925.69	220381.13
19075.00	21691.30	24717.45
358416.86	381809.56	406695.61
414755.18	474854.85	544565.86
1451777.06	1550098.46	1644449.74
1132570.92	1254852.81	1381189.27
2584347.98	2804951.28	3025639.02

1995	1996	1997
7229.94	7591.44	7971.01
3338.71	3505.65	3680.93
126497.63	132988.91	139830.21
353932.09	372345.06	391798.90
7540.46	7927.55	8335.02
167459.29	176150.69	185330.10
134038.09	140916.46	148165.22
521391.38	548495.74	577129.00
29317.56	30989.98	32777.63
16639.38	17699.77	18851.53
6754.90	7152.69	7576.49
28097.76	29990.62	32060.03
36072.46	38142.67	40354.11
44737.14	47690.40	50911.55
14855.86	15635.40	16459.54
3286.09	3463.46	3651.89
13223.45	13915.26	14644.79
23393.65	24643.37	25969.02
28079.30	29550.66	31104.33
26679.74	28106.83	29620.90
234605.15	248081.54	262498.83
28050.06	29867.03	31844.40
432795.00	456691.32	482122.50
620858.32	654160.00	689505.86
1734905.78	1820897.20	1902680.90
1510951.36	1634124.59	1751087.27
3245857.14	3455021.79	3653768.17

1998	1999
8369.56	8788.04
3864.97	4058.22
147038.94	154632.94
412365.86	434125.13
8763.86	9215.11
195030.89	205289.61
155802.81	163848.06
607396.75	639414.75
34686.15	36720.92
20105.64	21474.74
8027.46	8506.74
34328.54	36822.18
42713.62	45227.66
54434.18	58296.93
17330.49	18250.48
3852.30	4065.72
15413.85	16224.29
27376.63	28872.95
32744.34	34474.77
31228.93	32938.67
277903.29	294338.50
34001.88	36362.11
509164.05	537888.99
727061.74	767012.45
1980492.45	2054547.74
1862198.43	1967798.89
3842690.89	4022346.63

LINK C - BUILD 1979-99

1980	1981	1982
1783.62	2371.51	2959.40
1070.82	1276.57	1482.32
12183.41	17270.96	23039.54
8065.55	13944.52	22319.40
453.06	727.68	1037.19
2545.08	4747.42	7861.69
12636.47	17998.64	24076.73
10610.64	18691.94	30181.09
7953.37	9085.95	10519.99
1401.95	1892.36	2540.43
1691.64	1922.57	2201.17
2509.66	3267.43	4274.74
9645.01	11008.52	12721.16
3911.61	5159.79	6815.17
0.00	1205.50	2472.59
0.00	84.24	204.90
2180.51	2557.14	3018.10
1046.61	1426.45	1955.99
2180.51	3762.64	5490.69
1046.61	1510.68	2160.90
49730.29	58647.79	68748.32
1735.44	2360.18	3179.72
74192.27	91417.60	111,036.90
17304.30	27722.59	42336.88
74192.27	156550.47	246670.51
17304.30	42279.61	76641.17
91496.57	198830.08	323311.68

1983	1984	1985
3547.29	4135.18	4723.07
1688.07	1893.82	2099.57
29766.63	37375.64	45655.80
34028.86	49945.39	70970.23
1385.16	1765.62	2169.88
12199.86	18086.60	25857.39
31151.79	39141.26	47825.67
46228.71	68031.99	96827.62
12196.19	14021.87	15926.31
3376.89	4433.11	5741.08
2511.15	2836.25	3166.02
5572.92	7203.86	9209.96
14707.34	16858.12	19092.33
8949.81	11636.96	14951.04
3890.19	5471.99	7192.73
376.40	613.77	932.59
3545.81	4114.82	4704.31
2670.48	3606.16	4800.19
7436.00	9586.81	11897.04
3046.88	4219.93	5732.78
80090.79	92434.70	105519.73
4243.13	5601.03	7305.40
133385.92	158020.89	184334.77
62468.54	89489.91	124816.84
344201.15	448294.40	557688.12
122317.62	181267.40	255340.12
466518.77	629561.80	813028.24

1986	1987	1988
4970.95	5218.82	5466.70
2386.69	2673.82	2960.94
49058.42	52549.17	56129.64
80812.02	91705.24	103726.11
2494.23	2827.87	3169.92
31698.72	38301.51	45725.84
51552.65	55377.04	59299.56
112510.73	130006.75	149451.95
16504.38	17115.63	17773.79
6204.65	6708.37	7257.49
3487.15	3821.39	4169.94
10575.44	12108.72	13828.76
19991.53	20937.02	21943.73
16780.09	18817.08	21086.25
7447.63	7704.35	7963.13
1023.64	1121.92	1227.80
4894.77	5086.09	5278.97
5280.56	5800.48	6362.58
12342.40	12790.44	13242.10
6304.20	6922.41	7590.38
119050.76	133424.68	148655.63
8875.15	10667.46	12703.83
202937.34	222529.17	243141.03
144470.17	166413.70	190832.40
666186.71	773369.76	878875.09
332579.77	412734.33	495541.57
998766.48	1186104.09	1374416.66

1989	1990	1991
5714.57	5962.45	6260.57
3248.07	3535.19	3711.95
59794.93	63535.79	67854.74
116951.78	131460.33	150333.45
3519.43	3875.35	4128.05
54032.46	63282.82	72386.27
63314.36	67411.14	71982.79
170984.24	194743.15	222719.73
18483.89	19244.53	20560.27
7857.41	8513.64	9675.00
4532.76	4908.86	5234.26
15754.90	17906.80	20392.58
23016.65	24153.39	25794.53
23612.31	26420.44	30067.58
8223.62	8485.17	9061.77
1341.64	1463.80	1674.45
5473.66	5670.07	6039.92
6969.52	7624.01	8720.05
13697.29	14155.23	15101.69
8311.16	9087.81	10394.50
164695.01	181456.14	193854.72
15006.05	17596.22	20012.21
264723.30	287175.91	306733.73
217913.76	247847.62	283194.01
982361.98	1083500.88	1180822.37
580729.46	668017.55	757870.28
1563091.44	1751518.42	1938692.65

1992	1993	1994
6573.60	6902.28	7247.40
3897.55	4092.43	4297.05
72420.63	77239.32	82186.85
172214.63	197600.76	224474.90
4394.28	4674.41	4962.36
82941.74	95189.11	108143.96
76814.90	81913.73	87149.21
255156.37	292789.86	332618.86
21966.43	23465.89	25037.86
11017.90	12572.14	14252.22
5579.18	5944.24	6324.30
23269.58	26602.16	30178.58
27545.61	29410.13	31362.16
34287.48	39174.30	44430.80
9670.94	10313.45	10972.30
1918.71	2202.12	2501.86
6429.62	6839.74	7261.41
9990.86	11465.32	13025.36
16100.57	17153.19	18233.71
11909.57	13667.45	15527.23
207090.25	221188.78	235937.71
22806.81	26042.24	29530.19
327551.33	349665.83	372682.79
324160.22	371673.86	422107.08
1274449.92	1364493.85	1450954.33
850528.50	946239.82	1044166.48
2124978.42	2310733.67	2495120.81

1995	1996	1997
7609.77	7990.25	8389.77
4511.90	4737.49	4974.37
86539.52	91126.73	95958.42
237030.60	250437.62	264776.07
5222.16	5495.53	5783.07
114107.16	120461.85	127243.25
91761.68	96622.26	101741.49
351137.76	370899.47	392019.32
26553.22	28162.65	29868.93
15335.31	16534.73	17866.73
6687.83	7071.86	7477.11
32265.67	34554.15	37070.37
33241.05	35234.51	37346.04
47600.98	51088.87	54937.11
11548.53	12155.49	12794.51
2639.44	2785.99	2942.31
7642.37	8043.26	8464.96
13746.91	14516.33	15337.99
19190.90	20198.75	21259.47
16386.35	17302.31	18280.30
250029.68	264985.67	280832.12
31699.36	34093.23	36742.56
394223.31	417041.19	441179.12
446824.44	473383.89	501979.29
1533348.71	1611874.32	1686712.69
1137554.73	1226689.22	1311841.28
2670903.44	2838563.54	2998553.97

1998	1999
8809.25	9249.72
5223.09	5484.24
101044.86	106396.70
280136.33	296620.66
6085.40	6403.18
134491.00	142249.76
107130.26	112799.88
414627.33	438870.42
31674.78	33582.92
19350.14	21006.75
7904.31	8354.23
39844.75	42912.41
39579.09	41937.14
59194.89	63919.16
13466.98	14174.33
3109.30	3287.98
8908.38	9374.49
16216.83	17158.39
22375.36	23548.81
19326.13	20446.37
297595.06	315300.67
39682.91	42955.43
466679.77	493586.51
532831.26	566191.39
1758031.71	1825987.53
1393269.72	1471221.61
3151301.42	3297209.14

ANNEX

DEMAND ANALYSIS AND EVALUATION METHODOLOGY

FOR URBAN TRANSPORT COMPONENTS

for the Transportation and Land Sectors

of the Colon Urban Development Project

Draft prepared by Robert M. Sarly, Consultant, for the World Bank, Urban Operations Review & Support Unit.

April 1980

RMSarly:dm/bb/al
2/29/80

COLON URBAN DEVELOPMENT PROJECT

Demand Analysis and Evaluation Method
for Transport and Land Sectors

Context

1. Summary of Approach

In multi-sectoral urban projects, significant changes in the level and location of linked economic activities will result from direct project interventions as well as induced program impacts. In given circumstances, projections of future locational demands for residential and employment land cannot be readily made by extrapolating past trends. Structural changes, such as relative accessibilities, aggregate demand, supply of serviced land on the market, and overall location cost borne by the activity, will affect returns to investment throughout the urban economy and particularly in the Land and Transport sectors where locational preferences are most directly exercised.

Within the framework of an urban development project, analytic method is needed to identify future levels and locations of economic activity with sufficient confidence to serve as the basis of rudimentary cost-benefit evaluation. Any given method, especially one with an operational focus, will be a highly simplified application of basic non principles. The particular approach described herein is adapted from an operational tradition of Strategic Land Use-Transportation Analyses in which some quantitative detail is sacrificed for quickly determined strategic indicators of overall project impact in the urban area.

The method is based upon a conurbation of manual calibration, and manual and programal estimation. The program is written for use on a Texas Instrument TI59 hand-held programmable calculator, with use of attached paper tape printer. Discounted time and operating cost savings are automatically calculated for each link, year, mode, income group and (if

required) origin of trip. A complete run of a given configuration of transport inputs takes about four hours.

The entire study takes about two calendar months (3 mm) including Data assembly, input generation, manual calculation, programmable estimation, manual estimation, interpretation of results and reporting.

COLON URBAN PROJECT

JUSTIFICATION OF HIGHWAY COMPONENT: II

Summary of Results

1. The highway improvement is economically justified. From the perspective of intercity transport alone, the investment is already overdue, in that past "territorial" constraints on the expansion of the highway to meet growing demand in the region and between Cristobal Port and Panama City has resulted in near, or above, capacity levels of service on the highway. (See IRR, FURR, and increase in C/B ratio from 1973 to present below section E: Justification).

2. The integrated urban development project to revitalize the Colon sub-region proposes to increase and disperse economic activity and housing in the corridor between Manzanillo Island and the Cativa/ Sabanitas suburbs. The resulting additional metropolitan travel demand in effect transforms the highway, which is the only transport spine in the sub-region, from an inter-city to a metropolitan transport artery. As such it is an indispensible component of the integrated urban development program (see below section C: Impact).

3. Demand for the road improvements to the Boyd-Roosevelt Highway between Cativa/Randolph Road junction and Manzanillo Island is a direct result of the implementation of the integrated urban project, and in particular of the employment and housing components in the Expanded Free Zone, Porto Escondido and industrial zones (5, 6, and 7 in the attached map). Indirectly additional travel demands will also be generated in Manzanillo Island and Cativa-Sabanitas (Zones 1 and 8), as a result of the urban project (see below section B: Context).

4. Reductions in the overall size, or delays in the implementation rate of the urban project would reduce overall demand for transport on the road, providing that both employment and housing were reduced in equal proportions. However, if employment in the new Free Zone sites is to develop in any event, as is currently planned, while the housing in Porto Escondido (Zone 6) is eliminated or reduced, then travel demand on the road would increase further, due to the increase in average consequent commuting distance (along the Boyd-Roosevelt corridor) between jobs and homes.

5. In the absence of both the proposed highway improvements and new housing, residential preferences, especially for low-income households would generate strong demands for locations in the proximity of employment resulting in illegal squatting conditions if affordable legal options were unavailable. The areas most likely to be affected would be the Expanded Free Zone industrial zone and Rainbow City (zones 5, 7, and 4), where land would be available, and to a lesser extent, Manzanillo Island (Zone 1) where services would be available.

6. At the other extreme, implementation of the integrated urban project, but without these road improvements, would undermine the effectiveness of the urban project as a whole. The growth of travel demand on the road would quickly create congestion and loss of efficiency to all road users. The disbenefits to the urban project directly attributable to the absence of the proposed road improvements, as shown in the attached memo, would represent a significant share of overall project benefits. Disbenefits to goods movement, which generate 10% of the trip volumes, represent 60% of the total operating cost savings achievable on the road by 1984. Bus travelers which amount to 50% of the trip volumes, would bear about 10% of the operating cost savings, while car travelers (40% of the total trips) would derive 40% of the total operating cost savings. The low- and middle-income travelers generate 25% and 35% of the trips respectively and would incur 6% and 10% of the respective total disbenefits.

7. In view of the above, implementation of the urban project in its current form including the proposed road improvements would appear to generate the minimum negative externalities for the transport sector in the provision of essential access to linked economic activities in Gran Colon.

COLON URBAN PROJECT

JUSTIFICATION OF HIGHWAY COMPONENT: II

A. Objectives

1. Implementation of the urban project is not required to justify going ahead with construction of the road: as shown below, the road is justified on the basis of regional demand. However, the road is required to ensure the urban project realizes its objectives, particularly:

(i) the objective of stimulating improvements in key sectors such as transport, and in the level of transport services in Colon, to reduce travel costs and improve standards of access;

(ii) the objective of avoiding the disbenefits of $18,027 million (present value) in additional travel expenditures on the unimproved road (1980-1999), that would be incurred by the Colon population were the urban project to go ahead without the road component; and

(iii) ensure that the imminent rise in the volumes of trips along the road caused directly by the housing and employment components of the project are satisfactorily served, so that bottlenecks do not arise that delay overall project implementation causing cost overruns and development imbalance.

B. Context

2. The existing two lane Boyd-Roosevelt Highway is the only access corridor between Colon (i.e., Manzanillo Island), the main housing and employment development areas of the urban project, the suburbs of Cativa and Sabanitas, and Panama City (and the rest of the Metropolitan Region). Upgrading of the highway as proposed in the urban project will be along its existing alignment. No alternative alignment is likely to develop in the foreseeable future.

3. The roadway widening part of the project comprises a doubling of the existing two lane highway which extends from 800 meters east of the refinery junction in Cativa to the Randolph Road junction for a distance of 6.8 kilometers. The one-way loop part of the project extends from Randolph Road junction to Manzanillo Island for a distance of 2.5 kilometers inbound and a return route through Rainbow City for a distance of about 2.8 kilometers outbound. There are about nine junctions all of which will be at grade. Lane width will be 3.65 meters and the existing one-way loop roads will be brought up to comparable service levels as the main highway by means of resurfacing and geometric design of junctions, storage lanes and slipways.

4. On the basis of the regional demand projections made in the 1973 technical and feasibility study of Boyd-Roosevelt, the expansion of the road from its current two lane capacity to four lanes was determined to be economically justified from regional demand alone. On the basis of 1973 cost estimates this produced a benefit-cost ratio in the range of 1.8. Regional travel volumes then were estimated to be over 6,000 average daily trips (ADT) in 1973, with projections of over 10,000 ADT by 1980.

5. Current travel volume estimates based upon survey data collected by the Ministry of Public Works (MOP) in 1979 show current volumes along the road to be about 10,000-12,000 ADT, growing at an average rate of about 5% p.a. Current peak hour volumes are 1,200 passenger car units (PCU), which prevail an average of 28 hours per week. This peak hour demand exceeds the assumed effective capacity of the road during 25% of the travel week.

C. Impact

6. Without an urban project previous trends of traffic growth within Colon, and between Colon and Panama City, suggest that demand would continue to grow at about 5% p.a. producing 1984 ADT of 12,000 and 1990 ADT of 16,000.

7. However, in view of the dual impact of the urban project on Colon the expected growth in traffic demand will be about 20% greater due to:

(a) the accelerated development of economic activities in Colon resulting from the urban project; and

(b) the increased dispersion of project activities within the Colon sub-region, whose inter-relationships will rely on effective sub-regional transport access.

8. The economic analysis of demand for travel on the Boyd-Roosevelt Road done for this project component has taken the above impacts into account. It has been constructed upon conservative assumptions of trip generation, trip distribution and modal split, trip assignment and travel cost. The method distinguishes nine origin and destination zones in the city, three income classes and three travel modes. It also distinguishes operating costs and time costs.

9. The results of this demand analysis show a rapid increase in the number of peak hour PCU's from about 1,350 in 1980 to 1,650 in 1981, 2,000 in 1982, 2,300 in 1983, 2,600 in 1984 and 3,900 in 1989.

D. Cost

10. The capital cost of the road component, based upon preliminary estimates prepared by MOP, is $5,772 million (base) plus physical and price contingencies for a gross of $8,700 million.

E. Justification

11. Assuming (conservatively) an actual capital cost of about $8.0 million (not including price contingencies), economic evaluation of the road project shows a benefit-cost ratio in excess of 2.25 and a net present value of $10.03 million, not including time cost savings.

12. When time cost savings are taken into account the benefit-cost ratio rises to 12.94, and the net present value increases to $95.50 million.

13. The first year rate of return is 110%, showing that the optimum time for initiating investment in the road is already past, and that further delay is not justified.

14. The internal rate of return (IRR) for the road is 39.75% not including time cost savings. When these are included the IRR is in excess of 100%.

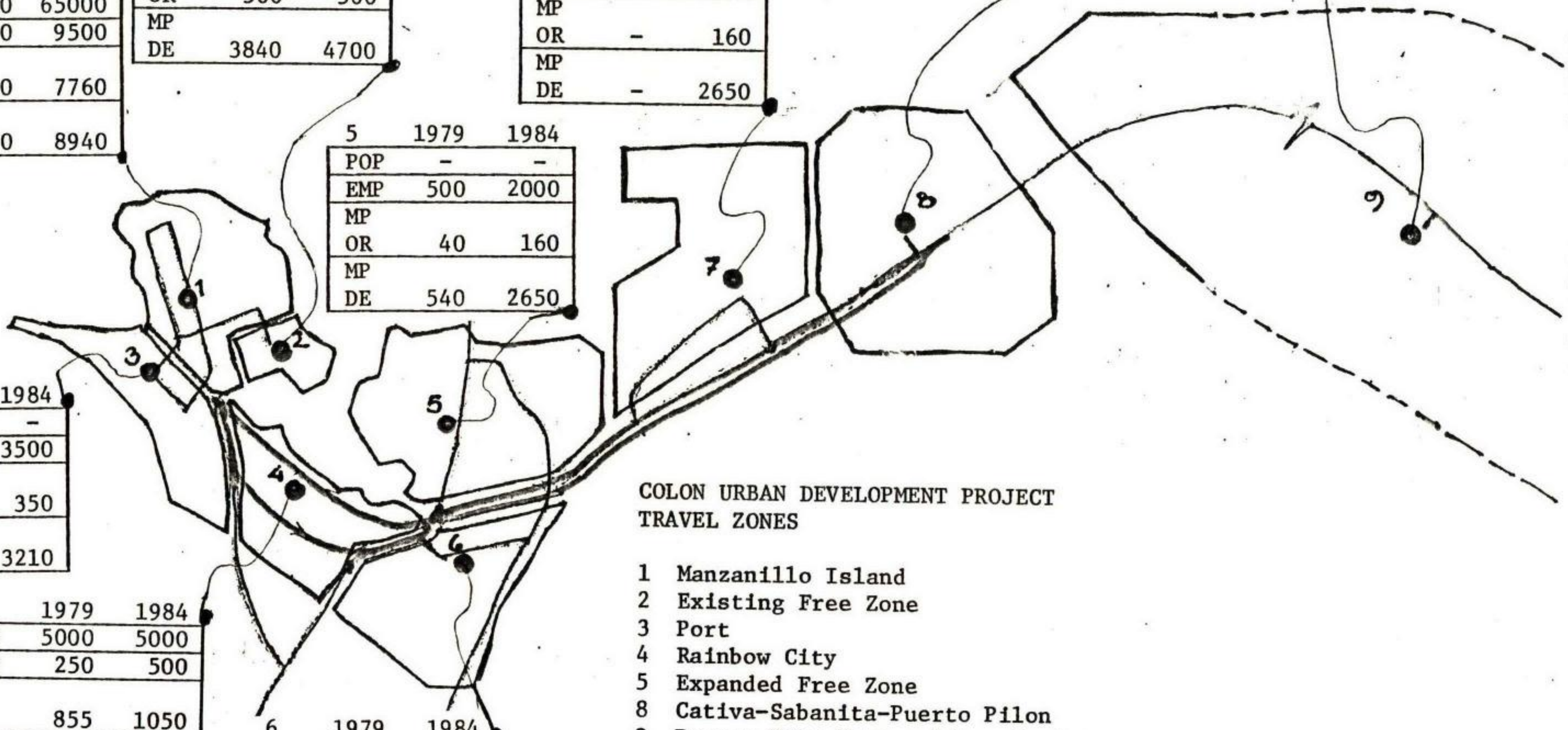
15. Sensitivity tests on costs show that a 20% rise in costs reduces IRR to 34.65%, and that a 20% fall in expected benefits reduces IRR to 32.15%.

RMSarly:bb

COLON URBAN PROJECT

ROADWAY IMPROVEMENT: ORIGIN/DESTINATION TRIP VOLUMES

1979 - 1984



1	1979	1984
POP	75000	65000
EMP	8000	9500
MP OR	8100	7760
MP DE	6470	8940

2	1979	1984
POP	-	-
EMP	5000	5000
MP OR	500	500
MP DE	3840	4700

3	1979	1984
POP	-	-
EMP	3000	3500
MP OR	300	350
MP DE	2300	3210

4	1979	1984
POP	5000	5000
EMP	250	500
MP OR	855	1050
MP DE	215	617

5	1979	1984
POP	-	-
EMP	500	2000
MP OR	40	160
MP DE	540	2650

6	1979	1984
POP	-	25000
EMP	-	250
MP OR	-	3015
MP DE	-	319

7	1979	1984
POP	-	-
EMP	-	2000
MP OR	-	160
MP DE	-	2650

8	1979	1984
POP	20000	25000
EMP	1500	2500
MP OR	2610	3400
MP DE	1290	2680

9	1979	1984
POP	-	-
EMP	-	-
MP OR	3025	9214
MP DE	745	1514

COLON URBAN DEVELOPMENT PROJECT
TRAVEL ZONES

1 Manzanillo Island
2 Existing Free Zone
3 Port
4 Rainbow City
5 Expanded Free Zone
8 Cativa-Sabanita-Puerto Pilon
9 Panama City Metropolitan Region

MPPE = Morning Peak Period Destinations
MPOR = Morning Peak Period Origins
include only vehicle trips (2 hours)

2. Introduction to the Demand Analysis

Amongst the objectives of transport sector intervention in the Colon Urban Development project is the provision of an efficient transport system to make linked economic activities in metropolitan Colon more accessible to the urban population. Since the impact of the overall project is multi-sectoral and complex it will not be possible to represent its derived benefit in a single measure such as a cost-benefit ratio, or internal rate of return. The estimate of the transport components' net worth, its benefits and costs (associated with road widening, traffic improvements, bus and train service provision, bus fleet expansion and vehicle maintenance) are therefore defined by the following evaluation measures:

1. time savings to bus travellers
2. operating cost savings to bus travellers
3. time savings to car travellers
4. operating cost savings to car travellers
5. time and operating cost savings to trucks
6. time savings to train travellers
7. levels of service for the public bus system and primary road network
8. travel expenditure share of household income
9. generalized travel share of location costs for households.

Each of the above terms is measured for nine separate geographic areas in the metropolitan region, and with respect to its incidence in three income classes. The areas are:

1. Manzanillo Island (excluding the Colon Free Zone)
2. Colon Free Zone
3. Cristobal Port
4. Rainbow City
5. New Commercial Zone (Coco Solito)
6. Puerto Escondido
7. New Industrial Area (Export Processing Zone)
8. Cativa - Sabantas - Puerto Pilon Suburbs
9. Rest of the Metropolitan Region and Panama City

The three income classes are:

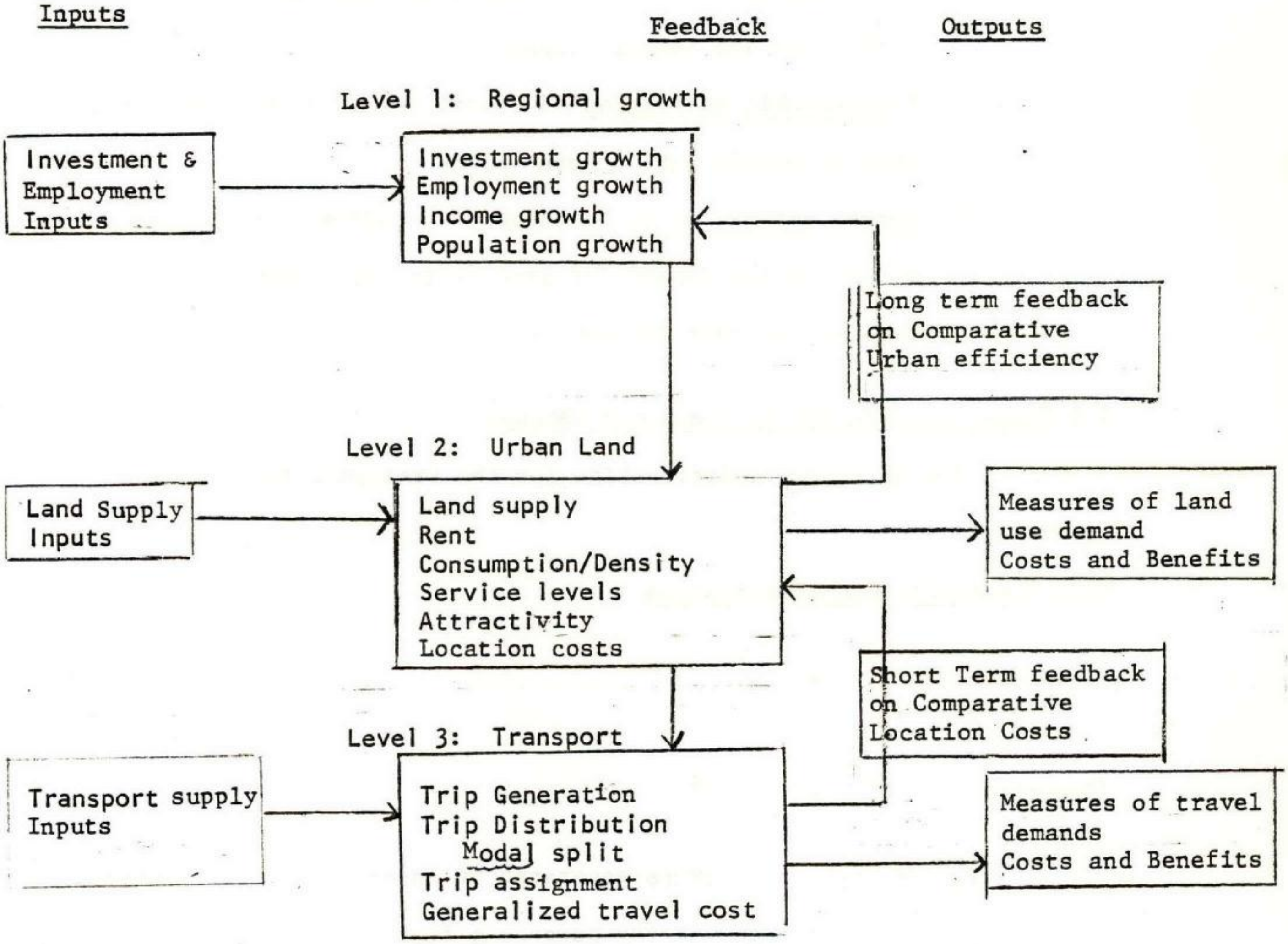
	Average HH income per month
1. Upper income (top 2 deciles)	\$1800/m
2. Middle income (from 4th to 8th decile)	\$425/m
3. Lower income (bottom 3 deciles)	\$125/m

3. Method in General

The method for estimating the above evaluation measures relies on an aggregate strategic analysis of transport and land use changes over the project period, and on their interaction. On the basis of these estimates are made of the generation, distribution, assignment and cost of household and business trips, for each income class and for every zone in the region. Travel cost forecasts serve as the basis for estimating locational demand in general, and in particular the values of land in different parts of the region. From these estimates, long-term implications for changes in the land use structure of the Metropolitan Region are determined.

Future levels of demand for transport facilities and services are taken as a function of the future urban spatial structure and the rate of growth of economic activity in the Colon Region. These are expressed logically in three levels of a strategic development analysis, as shown in the following diagram:

Strategic Development Analysis



Each level of analysis starting with Regional growth provides the operating assumptions upon which the next level projections are made. The analysis is validated on the basis of existing conditions by calibrating the governing relationships linking the supply and demand of transport and land, from survey and field observation. These relationships then derive the projection of future demand levels in terms of changes in supply and the behavior of the urban economy under conditions of growth.

4. Method in Detail

The method is made operational in three phases:

1. Manual calibration of functional relationships governing the changing values of transport and land demands by mode, link, zone and income class.
2. Programmable estimation of travel benefits by mode, link, zone of origin, and income class
3. Manual estimation of location cost changes and imputed affect on the demand for land by income class, zones density and rent values.

4.1 Manual Calibration of Transport Demands

The governing relationships for the transport analysis are shown below:

Trip Generation and Distribution

(Equation 1) $T_i^{z\circ} = P^z_{\cdot} \quad z$

(Equation 2) $T_j^{z\circ} = P^z_{\cdot} \quad z$

T_i^{zo} = number of trips generated by an activity (residential/ employment) z for purpose o from origin zone.

T_j^{zo} = number of trips generated by an activity (employment) of type z for purpose o to destination zone j.

P^z = Population (or number of employees) associated with that activity

α^z = Propensity for each unit of activity to generate a morning peak hour trip.

This function is used to discriminate trips by origin zone, i, destination zone j, car users and non-car users. It is used to generate estimates of existing conditions reflecting known overall flows of public and private traffic.

(Equation 3) $$T_{ij}^{mzo} = \frac{O_i^{mzo} D_j^{mzo}}{C_{ij}^{mb}} \circ B$$

T_{ij}^{mzo} = Total trips per mode m between zones i and j for activity type z and figure o.

O_i^{mzo} = Number of trip origins in Zone j, for mode m activity z, purpose o.

D_j^{zo} = Number of trip destinations in zone j for activity z, purpose o.

C_{ij}^{b} = Cost of travel between zone i and j.

b = Elasticity of demand for travel with respect to cost.

B = Normalizing factor = $1/ \sum^{m} O_i D_i / C_{ij}$

Trip Assignment & Costs

Given the simplified structure of the transport network in metropolitan Colon, inter-zonal traffic is assigned directly to links. These links acquire traffic loads which generate congestion as a function of free flow link speeds and design capacities.

Travel costs are estimated in two parts:

1. Operating costs, measured in terms of average use, speed and distance, characteristic vehicle cost per kilometer at link speed.
2. The cost assumed in terms of real (i.e., congested) travel time elapsed per journey plus the (pedestrian) access time at either end of the (vehicular) journey.

(Equation 4) $$G_c = \sum^{j} C_i^{op} + \sum^{j} C_i^{t}$$

The cost of travel is aggregated for each income class and each mode for all trips made by households in a single origin zone to all other zones, This measure is taken to be the generalized cost of travel for the typical household in each origin zone. Truck trips are similarly aggregated by employment-origin zones for all trips.

The results of the transport analysis are fed back into the land analysis in terms of generalized travel costs per household. These values are then used to reestimate locational demand for land in different zones in terms of residential densities, land rent and numbers of households to be located in each zone.

The governing relationships for the land analysis are as follows:

4.2 Manual Calibration of Land Demands

Demand for Land

The first function determines the quantity of land consumed by each activity l^z given the unit rent of land, r_1 and the income of the activity w_i^z. The relationships amongst these factors (land consumption, rent and income) are governed by three parameters:

(a) constant coefficient, k^z

(b) price elasticity of demand, p^e, which is negative to reflect the reduction of land consumption that occurs with an increase in rents.

(c) income elasticity of demand i^e, which is positive to reflect the increase in land consumption that occurs with an increase in incomes.

The demand for land function is specified in the following form:

(Equation 5) $l_i^z = k^z r_i^{-pe} \cdot w^{z^{ie}}$ where:

l_i^z = land consumed by household group z in zone i.

r_i = rent of land per m^2 in zone i

w^z = income of activity z

p^e = price elasticity of demand for land

i^e = income elasticity of demand for land

k^z = constant scalar.

Cost of Location

The second function, determines the total cost for an activity, z, resulting from the selection of a location in zone i, C_i^z, as the sum of the cost of land rent $l_i^z \cdot r_i$ plus the cost of building rent $S_i^z \cdot b_i^z$ plus the transport cost associated with locating in the zone $A_i^z\ g_i^z$ plus the cost of providing the zone with infrastructure services $F_i^z \cdot O_i^z$. The transport cost is calculated as the weighted average of the cost of all trips made by that activity in that zone. This cost connects the land use sub-model with the transport sub-model. The function is specified in the following form:

(Equation 6) $$C_i^z = l_i^z \cdot r_i + S_i^z \cdot b_i^z + A_i^z \cdot g_i^z + \sum^{Q} F_i^z \cdot c_i^z$$

Where:

C_i^z = Cost of location for household group z at zone i.

$l_i^z \cdot r_i$ = Cost of ground rent for land consumed.

$S_i^z \cdot b_i^z$ = Cost of building rent.

Where: S = amount of built space per household.

b = unit cost of space.

$A_i^z \cdot g_i^z$ = Transport cost.= G_c

Where: A = accessibility index for HH

g = unit cost of transport

$\sum^{Q} F_i^z \cdot c_i^z$ = Cost of infrastructure for all services, Q

Where: F = standard of service.

c = unit cost of standard service.

Distribution of Activities

The third function, determines the distribution among all the zones of each activity in terms of the total number of the activity G^z, the amount of land available for development in zone i, L_i, the location cost of the activity C_i^z, and residual attraction W_i^z. The function is specified in the following form:

(Equation 7) $G_i^z = G^z . L_i . W_i^z . C_i^{z^{-1_z}} B^z$

Where:

G_i^z = total number of households

G^z = total number of household group z

L_i = total land available in zone i.

W_i^z = residual attraction index for household group z in zone i.

C_i^z = location cost for household group z in zone i.

1_z = elasticity of demand for location with respect to cost.

B^z = normalizing factor

Budget Constraint

The following constraint must be respected to ensure land supply and located demand are in balance.

(Equation 8) $G_i^z . 1_i^z = L_i$

Cost Recovery

The cost of location function is the basis for estimating means for cost recovery in terms of a recovery rate by cost component for each activity, and for each location for all public capital investment projects, as follows:

(Equation 9)

$$RC_i^{*z} = T_i l_i^z r_r + T_2 S_i^z \cdot b_i^z + T_3 A_i^z \cdot g_i^z + T_4 F_i^z \cdot c_i^z$$

where: R = cost recovery rate (aggregate),

T_i= land tax rate

T_2= building tax rate

T_3= public transit fares and road user charges

T_4= utilities user charges

In terms of this formulation, C^* may be thought of as the social cost of location since not all of C_i^{z*} may necessarily be charged to the locator. Nonetheless, all of C_i^{*z} is recovered as a result of the locators' choice of the i^{th} location on aggregate, though certain areas (target groups, project sited, etc.) may be cross-subsidized in order to ensure affordability.

The inclusion of C_i^{*z} in the function ensures that the social values created by project investments are reflected in land prices throughout the urban market area in proportion to their impacts for each activity group at each location, and are recovered without detriment to the benefit share of the targetted poverty groups.

Income Generation

The demand for land function for household activities is the basis for incorporating real income, w^* and not just wage income w. Income gains and social subsidies that may have been created in different locations in each of the cost categories as follows:

(Equation 10)

$$l_i^{*r} = \frac{K^z . w^{*z^{ie}}}{r_i^{pe}}$$

where: $w^{*z^{ie}} = \sum B^p - R\cdot C_i^{*z} + \sum^p b_i + w_i{}^z$

where: $\sum B^p$ = the sum of project capital costs per household

$R\cdot C_i^{*z}$ = total costs recovered per household

$\sum^p b_i^z$ = sum of income gains resulting from operating cost savings in each project.

w_i^z = wage income per household.

Difference between project costs and costs recovered measures the proportion of conferred benefit not directly recovered by tax, user charge (etc.,) or other methods. The function shows the effect of income gains changes in location and service levels. Also, the use of b_i^z ensures that locational preferences reflect the aggregate effect of income gains from constraints on the structure of demand, and in particular on land prices and location priorities for development.

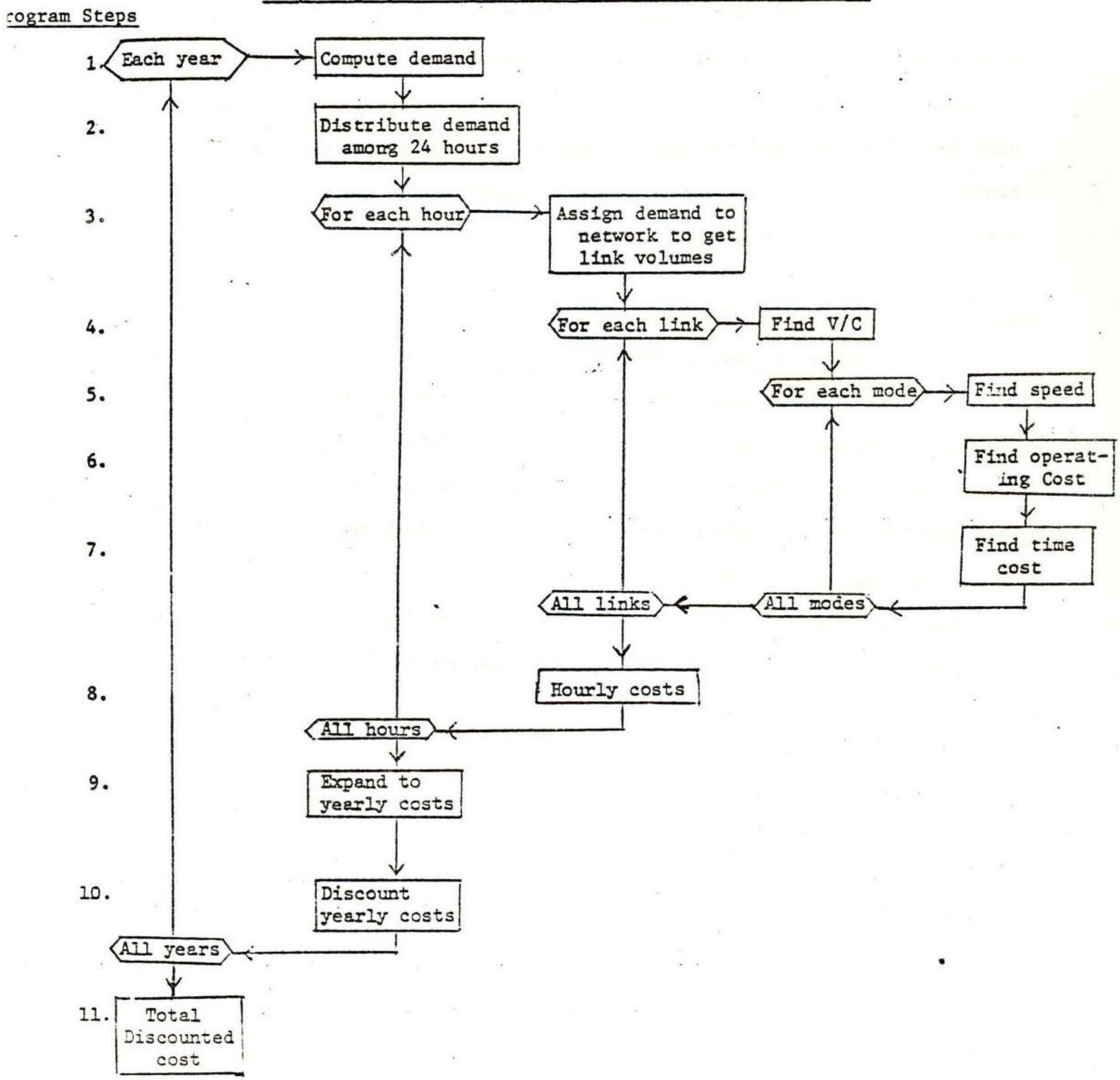
The income effects identified in the analysis are used to indicate aggregate changes in the levels of household demand by income group and location in the urban area. These indicators are viewed from the broad employment market perspective through disaggregated demand and income elasticities as the basis for examining consequent employment impact. This examination requires a separate formulation of a specific income-employment relationship that applies for a given urban system. This is not included in the above.

4.3 Programmable Estimation

A general sketch of the method for estimating transport benefits by means of a hand-held computer program is shown in the diagram below. Discussion follows this diagram, step-by-step.

Figure 1

Computing Operating and Time Costs of Each Alternative



Step 1: For Each Year, Compute Demand

Demand is used for an average weekday as representative of the whole year. Demand has two dimensions: O-D pair, and mode. Because of population and activity growth in different locations, demand between different O-D pairs varys in magnitude and growth. There is also a different demand for each mode of freight and passenger transport. All modes are aggregated into: truck (freight), auto, and bus (transit). Demand values are taken from the results of the manual algorithm.

Step 2: Distribute Demand Throughout the Day

Demand also has a temporal and a directional dimension. Usually demand is not predicted directly for an hour, however; it is predicted for the entire day and later distributed. For each direction there is a peaking profile, which gives the relative demand in each hour of the day. For convenience we may say there is a peaking profile of 48 hours, where the first 24 hours correspond to one direction (positive) and the last 24 to the other (negative) direction.

The most common assumption is that the daily peaking profile will be the same in every year for every O-D pair. This assumption can cause significant error when the network includes major radial and crosstown roads, each of which exhibit different peaking patterns. (The crosstown road has 2 peaks per rush hour while the radial has only

However, in the corridor problem with which we are dealing it is probably safe to assume each link of the same road will have the same peaking pattern. Different modes may have different peaking profiles, however. Thus the demand at an hour h is

where $$D^{t,h}_{m,p} = D^{t}_{m,p} f^{h}_{m} \qquad (2)$$

f^h_m is the peaking factor for hour h and mode m, and the vector $\left\{f^h_m\right\}, h = 1, \ldots,$ H is called the peaking profile for mode m. Thus a peaking profile is assumed given for each mode. It is common to not analyze all 48 hours separately but rather to select a few representative hours, the results of which are expanded hours in the day which have similar flows. A peaking profile for peak direction travel in San Jose, Costa Rica is found in Attachment A.

Step 3: For Each Hour, Assign Demand to the Network to Get Link Volumes

This can be the most complex step of the urban transportation analysis procedure. However, our restricted problem definition makes this problem trivial. Each O-D pair has a unique path, covering a known set of links. To get link volumes one must aggregate over O-D pairs and modes. Links, like hourly flows, are assumed unidirectional and furthermore we assume a link is symmetric in its capacity. Thus the flow on link j in hour 10 is the flow in the positive direction on link j at 10 a.m., while the flow in hour 34 is the flow in the negative direction at 10 a.m.

To aggregate over modes (since they all share the same roadway), each mode is given a passenger car unit (PCU) equivalency. This PCU equivalency depends not only on vehicle size, but on vehicle performance as well; and since vehicle performance is differentially affected by link characteristics, particularly grade, there must be a PCU equivalency factor for each mode and link.

Link volumes must be measured in vehicles. For auto and truck this presents no problem, since demand is usually measured in vehicles, or if measured in passengers, a single

---

occupancy factor can convert demand into vehicles. However, when bus demand is measured in passengers, it is not so readily converted into vehicles since load factors can vary widely throughout the day. Since bus operations are usually centrally planned, bus volumes may be exogenously specified. In more complex networks rerouting is also a possibility. In the simple corridor analysis with which we are dealing, it is probably sufficient to assume that load factors on each route at each hour will be the same year-to-year, so that demand can be measured in vehicles in the base year and treated in the same way as cars and trucks.

Aggregating over O-D pairs is simple summation, so that the link volumes are:

$$V_a^{t,h} = \sum^{p} \sum^{m} D_{m,p}^{t,h} \; e_{m,a} \; \delta_{a,p} \qquad (3)$$

where

$V_a^{t,h}$ = volume (in PCU's) on link a in hour h and year t

$D_{m,p}^{t,h}$ = demand for mode m between O-D pair p in hour h and year t (measured in vehicles

$e_{m,a}$ = PCU equivalency factor for mode m on link a

$\delta_{a,p} = \begin{cases} 1 \text{ if link a is on the path between O-D pair p} \\ 0 \text{ otherwise} \end{cases}$

In addition we will later need modal link volumes, which are:

$$V_{m,a}^{t,h} = \sum^{p} D_{m,p}^{t,h} \; \delta_{a,p} \qquad (3.1)$$

Step 4: For Each Link, Calculate the Volume/Capacity Ratio (V/C)

Since the volume has been determined in Step 3, all that is needed is the link capacities. These are given for both alternatives (no-build and build), and are the same at every hour in every year (barring the use of reversible lanes, peak hour exclusive lanes, etc.). Therefore, for any link, hour and year, for an alternative b (no-build or build,

$$(V/C)_a^{t,h,b} = V_a^{t,h} \div C_a^b \qquad (4)$$

where

C_a^b = capacity of link a in alternative b

$(V/C)_a^{t,h,b}$ = volume/capacity ratio in alternative b on link a at time h in year t

Since each alternative is analyzed identically, we shall remove the superscript b and continue with the notation $(V/C)_a^{t,h}$, realizing that its value pertains to a particular alternative.

Step 5: For Each Mode, Find the Speed

The speed at which traffic flows on a link depends on the volume on the link and its capacity. All existing models (to my knowledge) give speed as a function of the volume/capacity ratio. Recognizing that volume and capacity affect speed not only by their ratio, often there is a family of speed-flow (speed vs. V/C) curves for roads of different capacities, e.g., 2-lane and 4-lane arterials.

Because of different vehicle and operating characteristics, the speeds of each mode will be affected differently by congestion. Therefore each mode will have its own speed-flow relations.

Therefore the speed of mode m on link a which is of type s will be

$$x_{m,a}^{t,h} = g_{m,s}\left[(V/C)_a^{t,h}\right] \qquad (5)$$

where

$g_{m,s}[\,*\,]$ is a particular speed-flow relation for mode m and road type s. Different functional forms exist for the functions $g_{m,s}$. In order to identify the appropriate curve to be used for a particular link (given that mode is known), there must be a pointer specific to each link indicating the correct curve. If all of the curves have the same functional form with a different parameter (e.g., minimum speed), the pointer may be simply the parameter and thus the functional form of the speed-flow curve needs to be stored only once. This pointer or parameter is called s_m. (It seems obvious that the speed of the bus and truck modes might be affected by grade. However most analyses consider the peak direction only, which is one direction half the day and the other direction the other half, so that average grade on every link is zero, and average speed is almost unaffected by grade. The same is true for operating cost, though it is known that it costs more to travel a distance on a hilly road with

an "average" grade of zero than on a flat road. Since we will usually be using models for speed and cost that ignore grade, the remainder of this paper shall ignore it, too. Furthermore, ignoring grade allows both directions of a link to be identical. This is a significant simplification, making flows to be direction abstract, and hence allowing analysis of flows in one hour to be expanded to hours with similar flows without regard to direction when less than 48 hours are analyzed.) Some examples of speed-flow functions are found in Attachment A.

Step 6: For Each Mode, Determine Operating Cost

Vehicle operating cost on a link is difficult to measure, and therefore difficult to model. It is affected by road characteristics (grade, curvature, pavement), vehicle characteristics (weight, engine type), and operating characteristics (speed, number of stops). Most models give operating cost in terms of one of the operating characteristics only (speed) aggregating different vehicle types (within the same mode) and averaging over road characteristics. If pavement is uniform over the road, there is no more than normal curvature for an urban road, and grades are not great, such approximations are acceptable. Under normal urban operating conditions a study found that 95% of the variation in fuel consumption among British cars could be explained by speed alone. Since other auto related costs are roughly proportional to fuel consumption, the simple speed-operating cost relation may be sufficient for autos.

Operating cost is usually computed by a function of this form:

$$OC^{t,h}_{m,a} = \beta_m + \frac{\alpha_m}{X^{t,h}_{m,a}} \cdot d_a \cdot V^{t,h}_{m,a} \qquad (6)$$

where

$OC^{t,h}_{m,a}$ = operating cost for mode m on link at time h in year t

α_m, β_m = parameters (per hour and per Km operating cost for mode m)

$X^{t,h}_{m,a}$ = speed of mode m on link a at time h in year t

d_a = length of link a

$V^{t,h}_{m,a}$ = volume of mode m on link a at time h in year t.

Since operating cost should include the labor cost of paid drivers such a function including a term in which distance is divided by speed (which yields time) is especially appropriate for bus and truck. Operating cost models estimated in a few cities are documented in Attachment A.

Step 7: For Each Mode, Determine Time Cost

The time each vehicle spends on a link is the link's distance divided by the vehicle's speed. The total passenger time is the vehicle time multiplied by vehicle occupancy (not including paid drivers). The total time cost is this total passenger time multiplied by the value of time.

Vehicle occupancy can vary not only by mode but also by link and by time of day, particularly on buses where loads may be 80 in the peak and 20 off-peak, and may increase steadily toward the city center. Value of time is generally taken to be fixed for all modes and all times, and invariant over the year.

Thus the passenger wait time cost is

$$TC^{t,h}_{m,a} = \frac{d_a}{X^{t,h}_{m,a}} \cdot W^{h}_{m,a} \cdot v \cdot V^{t,h}_{m,a} \qquad (8)$$

where

$TC^{t,h}_{m,a}$ = time cost for mode m on link a at time h in year t

d_a = length of link a

$X^{t,h}_{m,a}$ = speed of mode m on link a at time h in year t

$W^{h}_{m,a}$ = vehicle occupancy of mode m on link a at time h

v = value of time

$V^{t,h}_{m,a}$ = volume (of vehicles) of mode m on link a at time h in year t

Step 8: Aggregate Costs Over Modes and Links

Steps 4-7 must be repeated for every link and every mode as the flowchart in Figure 1 indicates, aggregating costs to yield hourly costs. Thus the operating and time costs for an hour h in year t are:

$$OC^{t,h} = \sum^{a} \sum^{m} OC^{t,h}_{m,a}$$
$$TC^{t,h} = \sum^{a} \sum^{m} TC^{t,h}_{m,a} \qquad (9)$$

Other meaningful aggregations should be taken as well, such as total costs for modes, for links, etc.

Step 9: Aggregate Costs Over Hours, Expanding to Yearly Costs

Steps 3-8 are repeated for each hour. To expand the predicted hourly costs to yearly costs one needs to know the number of hours in a year that hour represents. These annualization factors should insure that the daily demand (in Step 1) is properly expanded to annual demand. Different hours may have different annualization factors because they represent different numbers of weekday and weekend hours. Also some analyses may want to consider peak hours only in computing benefit.

The annual costs are then:

$$OC^{t} = \sum^{h} OC^{t,h} \;\; N_h$$
$$TC^{t} = \sum^{h} TC^{t,h} \;\; N_h \qquad (10)$$

where

N_h = number of hours in a year represented by hour h.

Step 10: Discount Yearly Costs

Either annual or continuous compounding may be used to discount the yearly costs to present values. For operating costs, these formulas are:

$$\overline{OC}^{t} = OC^{t} \; (1 + D)^{-t} \quad \text{(yearly compounding)}$$
$$\overline{OC}_{t} = OC^{t} \; e^{-Dt} \quad \text{(continuous compounding)} \qquad (11)$$

where

OC_t = discounted operating cost from year t

D = shadow discount rate

time costs are similarly discounted

Step 11: Aggregate Discounted Costs

This yields the present costs of the alternative being studied. The difference between the present cost of the no-build alternative and that of the build alternative is the present value of the build alternative. (When other discounted costs, such as construction, maintenance, etc., are subtracted this becomes net present value.) So the final equation for present operating costs (and similarly for time cost) is

$$OC = \overset{t}{\ } \; \overline{OC}^{t} \qquad (12)$$

The predicted costs thus obtained may be disaggregated and manipulated in any way to afford the analyst a closer look to see the benefits accruing to each link, or to each mode, or to find link specific benefit/cost ratios, internal rates of return, etc.

5. Solution Procedure

Within the above Analytic framework, the solution procedure provides a logical, yet simple sequence of analytic tasks. These tasks are listed below and elaborated in detail in the following sections.

5.1 Summary of Tasks

A. Strategic Forecasts of Travel Demands

1. Review land use conditions and developmental assumptions
2. Review test road network and bus system conditions and changes
3. Review traffic assignments and diversions

B. Future Demand Volumes

1. Estimate future auto/truck traffic volumes
2. Estimate future bus and bus passenger traffic volumes
3. Estimate future train passenger traffic volumes
4. Develop peak hour and peak direction factors
5. Estimate future peak hour, peak direction volumes for auto/truck, bus and bus passenger, train passengers.

C. Design Capacities

1. Develop lane capacity of auto/truck
2. Determine PCU equivalencies and passenger capacities for bus and mini-bus

D. Volume/Capacity Ratios

1. Compute V/C ratio for auto/trucks and for busses

E. Level of Service and Travel Speed

1. For auto/trucks and for busses, establish a LOS - V/C Speed table.
2. Determine LOS and travel speed, knowing V/C.

F. Travel Time, Stops, and Idling Time

1. Develop a "model" to relate LOS, travel time per km., stops per km., and idling time per km. for auto/trucks and busses.

2. Determine on a "per kilometre" basis, travel time, stops, idling time, and excess travel time (actual time minus 1.0 minute as derived from 60 kph base)

G. Time Costs and Vehicle Operating Costs

1. Determine value of driver's time and passengers' time per hour.

2. Determine for auto/truck and for bus, vehicle operating cost per km. for 60 kph base, and for additional costs due to stops and idling time.

H. Time Savings

1. For auto/truck drivers and for bus passengers, compute time savings during six peak hour, peak directions for each year (1979-1999). "Savings" are based on difference between "No Build" (Alternative 1) and "Build" (Alternative 2).

2. Compute present value of time savings.

I. Vehicle Operating Cost Savings

1. For auto/truck volumes and for bus volumes, compute operating cost savings by link during six peak hour, peak directions for each year (1979-1999). "Savings" are based on "No Build" (Alternative 1) and "Build" (Alternative 2).

2. Compute present value of vehicle operating cost savings.

J. Project Costs

1. Determine present value of project costs.

K. Economic Evaluation

1. Determine benefit-cost (B/C) ratio, "Benefits" refer to the sum of present values for time savings and vehicle operating cost savings.

2. Determine net present value (NPV).

3. Determine internal rate of return.

5.2 Input Requirements

A description of input requirements and assumptions used to calibrate the analysis to conditions in Colon in 1979 is given in the pages that follow.

Input Requirements

For a project with A links, M modes, a benefit horizon of T years, each of which has H hours, considering 2 alternatives.

Number of Items	Variable	
A x M	$V^{o,*}_{m,a}$	base year vehicular demand for mode m on link a
M or 1	r_m or r	demand growth rate (for mode m)
H x M or H	f^h_m or f^h	peaking factor (for mode m) in hour h
M	e_m	PCU equivalency factor for mode m
2A	C^b_a	capacity of link a under alternative b (no build or build)
2M	α_m, β_m	operating cost model parameters for mode m
A	d_a	length of link a
H x M or M	W^h_m or W_m	vehicle occupancy of mode m(in hour h)
1	v	value of time

H	N_h	yearly number of travel hours of type h
1	D	shadow discount rate
M	s_m	speed-flow curve parameter for mode m

plus a speed-flow function

c_B	bus fares
t_c	terminal times
C_{nr}	non-transport location costs
W	disaggregate attractivity indices
L	land availability
P	aggregate popular growth
E	aggregate employment growth

BENEFITS ON A SINGLE LINK: SINGLE HOUR EXPANDED

(Input Data Format)

Site: ______________________ Date: __________

Analyst: ______________________ Page: ______ of ______

Costs: ______________________

Enter		Press
(Initialize)		A
(Initialize)		B
Auto mode:		
growth factor (1.xx)	= 1.______	R/S
PCU equivalency factor (1)	= 1	R/S
speed-flow function parameter	= ______	R/S
per hour operating cost ($/hr)	= ______	R/S
per km operating cost ($/hr)	= ______	R/S
auto occupancy ______ x value of time ______ ($/hr)	= ______	R/S
Truck mode:		
growth factor (1.xx)	= 1.______	R/S
PCU equivalency factor	= ______	R/S
speed-flow function parameter	= ______	R/S
per hour operating cost	= ______	R/S
per km operating cost	= ______	R/S
occupancy x value of time	= 0.0	R/S

Enter		Press
Bus Mode		
growth factor (vehicular) (1.xx)	= 1. ______	R/S
PCU equivalency factor	= ______	R/S
speed-flow function parameter	= ______	R/S
per hour operating cost	= ______	R/S
per km operating cost	= ______	R/S
bus occupancy ______ x value of time ______	= ______	R/S
(Initialize)		C
Base year vehicular volumes (peak hour, peak direction)		
auto volume (veh/hr)	= ______	R/S
truck volume	= ______	R/S
bus volume	= ______	R/S
Link capacities (one direction)		
no build capacity (veh/hr)	= ______	R/S
build capacity	= ______	R/S
Link length (km)	= ______	R/S
Peak hour, peak direction yearly expansion factor (number of peak hours per year)	= ______	STO 11
First year discount factor (1.xx)	= ______	STO 13
Discount rate (1.xx)	= ______	STO 14
Number of years	= ______	STO 00
First Year in Benefit Horizon	= ______	STO 06

5.3 Regional Growth, Land and Transport Inputs for Colon Urban Development Project

Level 1: Regional Growth Inputs

The key regional growth assumptions underlying the projection of travel demands are described in the Project Appraisal Report and summarized in the tables below:

Employment Growth and Change 1979-1989

Based on "basic" employment-generating project investment and "non-basic" job-generation (assuming a multiplier of 1.8) distributed to spatial structure of the market and available land.

Urban Project Build

Year	Employment					
	1979		1984		1989	
Zone	Basic	Non-basic	Basic	Non-basic	Basic	Non-basic
1	500	7,500	500	9,000	500	11,000
2	5,000	-	5,000	-	5,000	-
3	3,000	-	3,500	-	4,000	-
4	-	250	-	500	-	1,300
5	500	-	2,000	-	3,000	-
6	-	-	-	250	-	500
7	-	-	2,000	-	5,000	-
8	1,000	500	1,000	1,500	1,000	2,000
9	-	-	-	-	-	-
Total	10,000	8,250	14,000	11,250	18,500	14,800

Urban Project No-Build

Year	Employment					
	1979		1984		1989	
Zone	Basic	Non-basic	Basic	Non-basic	Basic	Non-basic
1	500	7,500	500			
2	5,000	-	5,000			
3	3,000	-	3,000			
4	-	250	-			
5	500	-	1,000			
6	-	-	-			
7	-	-	-			
8	1,000	500	1,000			
9	-	-	-			
Total	10,000	8,250				

Population Growth and Change 1979-1989

Based upon a full labor participation rate of .33 and an unemployment rate (in formal sector activities) of 40% effective 1979 and reducing ___ to 7%-10% by 1989, distributed on the basis of observed existing densities and inputed changes on future locational cost/demand for housing. Income classes are defined in terms of average income levels which are taken to neither increase nor decline in real terms over the analysis period. Population growth arising from natural increase and net in-migration are not distinguished in the h household totals shown below; average household size is taken as 4.6 (existing 1979 average) throughout the period. (Households.)

Income	1979				1980				198			
Class	High	Medium	Low	Total	High	Medium	Low	Total	High	Medium	Low	Total
Zone												
1	2,600	8,300	4,100	15,000	2,500	8,000	2,500	13,000	2,500	8,000	2,500	13,000
4	800	200	-	1,000	800	200	-	1,000	800	200	-	1,000
6	-	-	-	-		3,000	2,000	5,000	-	3,000	2,000	5,000
8	800	2,000	1,200	4,000	1,000	2,500	1,500	5,000	1,500	3,500	2,000	7,000
Total	4,200	10,500	5,300	20,000	4,300	13,700	6,000	24,000	4,800	14,700	6,500	26,000

Level 2: Urban Land Inputs

The key land assumptions underlying the projection of land demands are summarized in the tables below:

Land Available for Residential Use

Based on surveyed land use patterns and observed net residential densities existing for 1979, with income classes separately estimated by zone.

INCOME CLASS

Year	1979							1984				1989			
Zone	High		Middle		Low		Total	High	Middle	Low	Total	High	Middle	Low	Total
1	78.0	300	83.0	100	12.3	30	173.3	75.0	80.0	77.5	162.5				
4	48.0	600	4.0	200	0.0		52.0	48.0	4.0		52.0				
6	-	-	-	-	-	-	-	-	75.0	15.0	90.0				
8	72.0	900	60.0	300	10.8	90	142.8	90.0	75.0	13.5	178.5				
Total	198.0		147.0		23.1		368.1	213.0	234.0	36.0	483.0				

Disaggretated Attractivity Indices.

Based upon existing and future demand by income class in proportion to class size in each residential zone, and a calibrated coefficient of attraction.

Income	1979						1984						1989					
Class	High	αH	Middle	αM	Low	αL	High	αH	Middle	αM	Low	αL	High	αH	Middle	αM	Low	αL
Zone																		
1	26		83		41		25		80		25		25		80		25	
4	8		2		0		8		2		0		8		2		0	
6	-		-		-		0		30		20		-		30		20	
8	8		20		12		10		25		15		15		35		20	

Non-transport Location Expenditure

Based upon an estimated proportion of average household income budgeted for land, housing and utilities costs, measured in terms of monthly household expenditures per square meter of residential land.

Income Class	1979 High	1979 Middle	1979 Low	1984 High	1984 Middle	1984 Low	1989 High	1989 Middle	1989 Low
Zone									
1	1.80	1.10	0.83						
4	0.90	0.53	-						
6	-	-	-						
8	0.60	0.35	0.28						

Level 3: Transport Inputs

The key transport assumptions underlying the projection of travel demands are summarized in the tables below:

Values of Travel Time

Income Class

	High	Middle	Low
Average HH income/month	\$1800	\$425	\$125
Average hourly income/traveler	\$8.72	\$225	\$0.73
Value of travel time rate	25%	25%	25%
VOT/minute of travel	0.036	0.009	0.003

Trip Rate by Mode (Morning Peak Period Only)
1979

Income class	High			Middle			Low		
Mode	Car	Bus	Walk	Car	Bus	Walk	Car	Bus	Walk
Zone									
1	0.6	0.2	0.2	0.2	0.3	0.3	0.1	0.3	0.3
4	0.7	0.2	0.1	0.2	0.4	0.2	-	-	-
6	-	-	-	0.2	0.4	0.2	0.1	0.3	0.3
8	0.7	0.2	0.1	0.2	0.4	0.2	0.0	0.5	0.2
9	.8	.2	-	0.2	.6	-	-	1.0	-

Year 1984/1989

Income class	High			Middle			Low		
Mode	Car	Bus	Walk	Car	Bus	Walk	Car	Bus	Walk
1	0.7	0.2	0.2	0.3	0.3	0.3	0.1	0.3	0.3
4	0.8	0.2	0.1	0.3	0.4	0.2	-	-	-
6	-	-	-	0.3	0.4	0.2	0.1	0.4	0.2
8	0.8	0.2	0.1	0.2	0.4	0.2	0.1	0.4	0.2
9	0.9	0.1	-	0.5	0.5	0.2	0.1	0.9	-

TRUCK TRIP RATE PER UNIT OF EMPLOYMENT

Zone	Truck Trips
1	0.08
2	0.10
3	0.10
4	0.06
5	0.08
6	0.06
7	0.08
8	0.06
9	-

INTERZONAL LINK DISTANCES

(Based upon shortest route distances between zone centroids along existing roads in kilometers).

	1	2	3	4	5	6	7	8
1	0.67	1.40	1.00	2.40	4.80	4.40	8.20	9.60
2	1.40	0.36	1.60	3.00	5.40	5.00	8.80	10.20
3	1.00	1.60	0.54	2.20	4.60	4.20	8.00	9.40
4	2.40	3.00	2.20	0.74	2.40	2.00	5.80	7.20
5	4.80	5.40	4.60	2.40	0.66	1.60	5.40	6.80
6	4.40	5.00	4.20	2.00	1.60	1.00	4.60	6.00
7	8.20	8.80	8.00	5.80	5.40	4.60	1.20	3.00
8	9.60	10.20	9.40	7.20	6.80	6.00	3.00	1.20

PCU EQUIVALENCY AND OCCUPANCY RATE

	PCU Equivalent	Occupancy
cars	1.0	1.6
busses	3.0	45.0
trucks	3.0	1.0

PEAK PERIOD EXPANSION FACTOR TO MONTHLY TOTALS

trucks	115.0
busses	92.0
cars	107.4

Expansion factors are based on the following considerations for the purpose of estimating benefits:

Auto: Peak (2 hour) volume is 1/7 of total daily

3 peak periods @ full benefit		=	3.00
2 " " " 2/3 "		=	1.33
1 " " " 1/3 "		=	0.33
1 " " " no "		=	0.00
			4.67
4.67 (daily) X 23 (days per month)		=	115.0

Bus: Peak (2 hour) volume is 1/5 of total daily

3 peak periods @ full benefit		=	3.00
2 " " 1/2 "		=	1.00
			4.00
4.00 (daily) X 23 (days per month)		=	92.0

Truck: peak (2 hour) volume is 1/8 of total daily

3 peak periods @ full benefit		=	3.00
2 " " 2/3 "		=	1.33
2 " " 1/2 "		=	0.67
1 " " 0 "		=	0.00
			5.00
5.00 (daily) X 23 (days per month)		=	115.0

AUTOMOBILE OPERATING COST PER 1,600 KMS. (1979)

MPH	KPH	Gas	Oil	Tires	Maintenance	Depreciation	Interest	Total
10	16	49.11	2.39	1.02	7.00	45.00	36.00	140.52
15	24	51.01	2.23	1.22	8.00	41.00	28.50	131.96
20	32	45.82	1.92	1.63	8.50	36.00	22.50	116.37
25	40	43.47	1.82	2.14	8.85	34.50	19.00	109.78
30	48	41.24	1.77	2.65	9.50	32.50	16.50	104.16
35	56	43.22	1.71	3.26	9.85	30.50	15.00	103.54
40	64	43.45	1.71	3.82	10.60	29.00	13.50	102.08
45	72	46.70	1.66	4.54	11.00	27.50	13.00	104.40
50	80	48.67	1.61	5.30	11.50	26.50	12.00	105.58
55	88	53.04	1.50	6.17	12.25	26.00	11.50	110.46
60	96	57.14	1.58	7.19	13.00	25.00	11.00	114.89
65	104	62.96	1.77	8.36	13.75	24.50	10.50	121.84

Using linear regression a curve is determined to fit these data points, whose equation is:

$$C = 0.1046 - 0.001256x + 0.000009512x^2$$

where C = \$ cost per km for cars
x = speed in km/hour

For busses, based upon 1977 data, the ratio of bus to auto operating costs is given as 4.3. For trucks, based upon the same data source, the truck to auto operating cost ratio is given as 5.6. These values are taken as given.

ASSUMED LEVELS OF BUS FARES

Destination Zone / Origin Zone	1	2	3	4	5	6	7	8	9	Total
1.	.10	.10	.10	.10	.25	.20	.40	.50	1.25	
2	.10	.10	.10	.15	.25	.25	.45	.50	1.25	
3	.10	.10	.10	.10	.20	.20	.40	.50	1.25	
4	.10	.15	.10	.10	.10	.10	.30	.35	1.15	
5	.25	.25	.20	.10	.10	.10	.25	.35	1.00	
6	.20	.25	.20	.10	.10	.10	.25	.30	1.05	
7	.40	.45	.40	.30	.25	.25	.10	.15	.85	
8	.50	.50	.50	.35	.35	.30	.15	.10	.75	
9	1.25	1.25	1.25	1.15	1.00	1.05	.85	.75		

ASSUMED LEVELS OF TRIP TERMINAL TIME IN MINUTES

Origin Zone	Destination Zone	1	2	3	4	5	6	7	8	Note
	Cars	4	4	4	4	4	5	4	4	5 Min.
	Busses	9	9	9	9	9	15	9	9	Service Level
	Cars	4	4	4	3	4	6	4	4	10. Min.
	Busses	14	14	14	14	14	18	14	14	Service Level
	Cars	6	6	6	6	6	8	6	6	10 Min.
	Busses	18	18	18	18	18	22	18	18	Service Level
	Cars	4	4	4	4	4	6	4	4	10 Min.
	Busses	14	14	14	14	14	18	14	14	Service Level

LINK CAPACITY TABLE

	1	2	3	4	5	6	7	8
1		240	1,600	1,600	-	-	-	-
2	240		-	-	-	-	-	-
3	1,600	-		800	-	-	-	-
4	1,600	-	800		1,200	1,200	800	800
5	-	-	-	1,200		1,200	800	800
6	-	-	-	1,200	1,200		800	800
7	-	-	-	800	800	800		800
8	-	-	-	800	800	800	800	

REVISED OPERATING COST FOR TRUCK

At 40 km/h, car operating cost of \$ 0.07.

Truck operating cost is 5.6 times higher, or \$ 0.39

$$\$0.39 \frac{1}{km} \text{ X } \frac{40km}{hr} = \$15.59/hrs$$

The labor cost component is \$1/hr, so the reduced OC is 14.5%. This corresponds to \$0.36/km, which is 5.2 times higher than auto.

So truck cost is [5.2 (auto cost/km) X distance + \$1 time]

6. OPERATING THE PROGRAM

6.1 BASIC USER INSTRUCTIONS FOR A T159 & PRINTER

1. To turn on the calculator, first plug in the printer and calculator. DO NOT turn on calculator and printer before plugging in the printer. To turn off the calculator, turn off both calculator and printer before unplugging the printer.

2. Algebraic operations -- The TI59 uses logic known as Algebraic Operating System. Algebraic operations are punched into the calculator going from left to right as they would be written out. For example, to perform the following calculation:

$$8 \div 3 = 2.67$$

you would push the following buttons:

1) $\boxed{8}$
2) $\boxed{\div}$
3) $\boxed{3}$
4) $\boxed{=}$

Where there are a complex series of calculations, the calculator follows certain rules about which ones are performed first. Alternatively, you can use parentheses to make the calculator perform operations in a particular order.

The order of operations performed by the T159 is:

1) Special single function keys (such as trig and log functions)
2) Powers and roots (Y^X and $\sqrt[x]{Y}$)
3) Multiplications and divisions
4) Additions and subtractions

Example

$$3 + 10 - 2 \times 14 \div 7 = 9$$

This is the same as

$$3 + 10 - (2 * 14 \div 7) = 9$$

If you do not wish the above interpretation to be followed you must use parentheses, for example:

$$(3 + 10 - 2) * 14 \div 7 = 22$$

2. Special function and operation keys

A) Every key can be used in 2 ways as indicated by 1) labels on the key and 2) gold labels above the key. To get the use of the gold label function, push the gold key marked $\boxed{\text{2nd}}$ before pushing the desired key.

B) The INV key will give you the use of inverse functions or operations for many of the keys. For example to compute e ^{2} push the following:

$\boxed{2}$

$\boxed{\text{INV}}$

$\boxed{\text{ln}}$

4. User Labels -- User labels are names given by the programmer to different parts (or subroutines) of a pocket calculator program. By pushing a user label key, you are able to have the calculator perform a specific subroutine. The user labels are contained in the top row of the TI59 and consist of A,B,C,D,E, and A', B', C', D', E'.

5. Memory Structure -- The TI59 memory is divided into a section to hold a program and a section to hold data. When the TI59 is turned on, it contains 480 spaces for program instruction and 60 spaces for data.

You may re-partition memory if you need more data storage, or more program storage. Following are two commands useful in memory partitioning:

A. $\boxed{2nd}$ $\boxed{OP}$ $\boxed{1}$ $\boxed{6}$ will cause the calculator to display the current memory partition. Ordinarily the display will read 479.59 (program positions go from 000 to 479 and data registers go from 00 to 59).

B. $\boxed{X}$ $\boxed{2nd}$ $\boxed{OP}$ $\boxed{1}$ $\boxed{7}$ will cause the calculator to repartition memory so that there are 10X data registers. For example:

$\boxed{4}$ $\boxed{2nd}$ $\boxed{OP}$ $\boxed{1}$ $\boxed{7}$ would give a partition of 639.39 (or 640 program positions and 40 data registers).

6. Reading a Card -- In order to read a card the calculator must be properly partitional in the same manner as when the card was created. The calculator must also be told the proper place to store the data on the card. Each magnetic card has two sides (or banks). The calculator memory can hold 4 banks (or 2 cards) worth of information.

To read a card, first push the number of the memory bank into which this card will be read. The number will be 1, 2, 3 or 4. Usually the proper memory bank is indicated upon the card or in programmer user instructions. As an alternative, push 0 before reading the card. Then the card will be automatically read into the proper bank.

The second step in reading a card is to hold the yellow side up and insert the proper end (designated by the bank number on the card) into the card reader. Let the calculator process the card through (do not push the card once the calculator has hold of it) and then gently remove the card. The calculator will display the number of the memory bank into which the card read. If there is a misread or if you have pushed an improper bank number, the calculator display will flash. In this case you must start over.

7. Listing Memory

There are two commands which allow you to list memory. There are:

A. 2nd List

This command will print out the program memory. It is especially useful for checking that the current program has been properly read in. To stop the listing push R/S

B. INV 2nd List

This command will print out the contents of the data registers. To stop the listing push R/S .

Notes: Occasionally the listing does not start at the proper place (i.e. does not start at program location 000 or data register 00). To correct for this you press GTO and the proper memory address. For a program, the address would be 000, and for the data registers (under normal partitioning) the address would be 480. The calculator may flash when given the data register address, but this procedure works nontheless. Follow with the desired list command.

8. Run Stop and Reset

These are two useful commands. Reset RST will place the program counter at the beginning of a program which is at address 000. Thus reset may be used when you wish to start a program from the beginning.

Run/Stop R/S may be used to stop program execution, and it may be used to start program execution at the current location in the program. For example, a program may halt execution to wait for data. The user enters the data into the display and starts execution by pressing R/S.

9. Clears -- There are four clear commands with the T159 as follows:

CE -- clears the current display only

CLR -- clears the current math operation

2nd CP -- clears the program

2nd CMs -- clears the data registers

10. Store and Recall

Press STO and a two digit data register number to place the display in memory. For example, 1 STO 0 2 would place a 1 in register 2.

Press RCL and a two digit data register number to recall the contents of the data register onto the display. In the above example, RCL 0 2 would display a 1.

11. Printer commands -- The printer attached to the T 59 has a number of different operating modes. If none of its three buttons have been pushed, then the printer takes all its instructions from the calculator.

If the PRINT button is pushed, the printer will print out the current display on the calculator.

If the TRACE button is pushed, the printer will print out each step in the execution of a program. Trace is very useful for debugging.

The ADV or advance button merely advances the paper in the printer.

6.2 INSTRUCTIONS FOR COMPUTING BENEFITS TO ORIGIN ZONES [FIRST PROGRAM]

1. Fill in, for each mode, a matrix giving volume on each link, by income class within each origin zone, for each mode. (See Tables 1-3)
   Differentiate between volume inbound (+) and outbound (-).
2. Compute, for each link, the total volume in PCU's. This is given by
   $$V^e = \sum_{\substack{\text{MODES}\\ m}} \Big(\sum^{\substack{\text{INCOME}\\ \text{CLASSES } i}} V_{mi} \Big) \cdot PCU_m \div OCCUPANCY_m$$
   Note than inbound volume must be computed separately from outbound.
3. Table 4 summarizes the necessary link data. Fill in such a table, including length, V/C in each direction, and free-flow speed. If V/C or free-flow speed changes in the build alternative, mark that down.
4. Fill in, for each mode (bus and car) for each zone, a table headed "ORIGIN ZONE:" (See Tables 5-10) which contains all the data needed.
5. Fill in, for truck, a table for each origin zone (see Tables 11-16).
6. You are now ready to run the programs.
7. After turning on the printer and calculator, set the partition; Press 9 2nd Op 17 23. [illegible]
8. Enter side 2A of program UTB -2.2(A) after entering zero (0).
9. Enter the data on one of the bus or car tables. To enter the data, enter each number and then press the key indicated (A, B, or C). Where no key is indicated, press R/S. Enter data corresponding to the no-build alternative. If you make an error in entering data, see Step 19 below. Fill in the data for one origin zone and one mode completely.
10. Enter zero (0), and load card 1B of UTB-2.2(A).
11. If desired fix the output format by pressing 2nd Fix n where (n) is the number of digits desired after the decimal.

12. Press A and wait until costs are printed. These are the operating and time costs for each income class, and their sum over the income classes.

13. If there is a build alternative, enter data for it. You may re-enter all the data (beginning with number of links, as the values of time and model parameters don't change), or enter only those items that change. To do the latter, see 19 below. To do the former, do Steps 8-11. Before entering data you may want to change the format (as in Step 12).

 ✳ Whatever you do, <u>be sure to enter the number of links</u>, even if it hasn't changed, by entering it and pressing <u>STO</u> <u>00</u>, or pressing C if card 1A is in memory.

14. Press B and wait. The same items as listed in Step 12 will be printed for the build alternative; so will the differences between no build and build.

15. Now select another mode-zone pair. It is best to do all the zones of a single mode together.

16. For each mode-zone pair, repeat Steps 8-15. Note: If values of time and modal parameters do not change, they need not be repeated.

    Also, you may want to undo the fixed display format by pressing INV 2nd Fix.

17. You are now ready to do the trucks. For each origin zone, perform Steps 8-15 again, with these changes:

    Use Program UTB-2.2(B), sides 1A and 1B instead of Program UTB-2.2(A),

    Because these are the income classes, the run time and output in Steps 12 and 14 will be shorter

    Output is operating cost not including labor, labor cost and their sum.

18. FINISHED!

19. <u>Error Recovery</u>

    1. You may list the contents of the data registers, beginning with register (m) by pressing (<u>m</u>) <u>INV</u> <u>2nd</u> list. Press R/S when you want it to stop listing.

    2. You may enter any number directly by entering it and pressing <u>STO</u> <u>ab</u>, where <u>ab</u> is the register it goes in. This also applies

to changes for the build alternative.

3. The contents of the data registers is given in the Table so marked for each program.

Figure 2

Detailed Output Table

Link \ Year	1	2		T	Total (discounted)
1	□	□	. . .	□	□
2	□	.	.	.	.
.	.		.	.	.
A	□			□	□
Total	□	□	. . .	□	□

□ =

Alternative 1 (no build)

1. Peak hour V/C
2. Peak hour auto speed

Alternative 2 (build)

3. Peak hour V/C
4. Peak hour auto speed

not included in row and column totals

Mode 1 (auto)

Alternative 1 (no build)

5. Operating cost
6. Time cost

Alternative 2 (build)

7. Operating cost
8. Time cost

Difference (benefit of build alternative)

9. Operating cost
10. Time cost

Mode 2 (truck)

Alternative 1

11. Operating Cost
12. Time cost

Alternative 2

13. Operating cost

Figure 2 (continued)

14. Time cost

Difference

15. Operating cost

16. Time cost

Mode 3 (bus)

Alternative 1

17. Operating cost

18. Time cost

Alternative 2

19. Operating cost

20. Time cost

Difference

21. Operating cost

22. Time cost

Total (all modes)

Alternative 1

23. Operating cost

24. Time cost

Alternative 2

25. Operating cost

26. Time cost

Difference

27. Operating cost

28. Time cost

6.3 ESTIMATED 1979 TRAVEL BENEFITS BY ORIGIN ZONE

By mode, income class and zone of origin for conditions existing with no highway component as compared to those with the proposed highway component.

Summary:

Table 1:

SUMMARY GENERALIZED TRAVEL COST - YEAR: 1979

Zone:		High Income HH	Middle Income HH	Low Income HH	Employment	Total
1.	Car					
	Bus					
	Truck					
	Walk					
2.	Car					
	Bus					
	Truck					
	Walk					
3.	Car					
	Bus					
	Truck					
	Walk					
4.	Car					
	Bus					
	Truck					
	Walk					
5.	Car					
	Bus					
	Truck					
	Walk					
6.	Car					
	Bus					
	Truck					
	Walk					
7.	Car					
	Bus					
	Truck					
	Walk					
8.	Car					
	Bus					
	Truck					
	Walk					
9.	Car					
	Bus					
	Truck					
	Walk					
Total	Car					
	Bus					
	Truck					
	Walk					
Total						

Table 2: TRIP-ORIGIN - MORNING PEAK

Year 1979

Zone:		High Income HH	Middle Income HH	Low Income HH	Employment Places	Total
1.	Car	1,560	1,660	–		3,220
	Bus	520	2,490	1,230		4,240
	Truck	–	–	–	640	640
	Walk	520	2,490	1,230		4,240
2.	Car					
	Bus					
	Truck				500	500
	Walk					
3.	Car					
	Bus					
	Truck				300	300
	Walk					
4.	Car	560	40	–		600
	Bus	160	80	–		240
	Truck	–	–	–	15	15
	Walk	80	40	–		120
5.	Car					
	Bus					
	Truck				40	40
	Walk					
6.	Car	0	0	0		0
	Bus	0	0	0		0
	Truck	0	0	0	–	0
	Walk	0	0	0		0
7.	Car					
	Bus					
	Truck					
	Walk					
8.	Car	560	400	–		960
	Bus	160	800	600		1,560
	Truck	–	–	–	90	90
	Walk	80	400	240		720
9.	Car	+580	320	–		900
	Bus	+145	+480	+1,300		1,925
	Truck				200	200
	Walk	–	–	–		–
Total	Car	3,260	2,420	–		5,680
	Bus	985	3,850	3,130		7,965
	Truck	–	–	–	1,785	1,785
	Walk	680	2,930	1,470		5,080
Total		4,925	9,200	4,600	1,785	20,510

Table 3: TRIP DESTINATIONS - MORNING PEAK

Year: 1979

Zone:		High Income HH	Middle Income HH	Low Income HH	Employment Places	Total
1.	Car	485	1,465	-		1,950
	Bus	105	2,355	1,420		3,880
	Truck				640	640
	Walk	30	1,780	420		2,230
2.	Car	1,250	420	-		1,670
	Bus	420	625	625		1,670
	Truck				500	500
	Walk	330	635	535		1,500
3.	Car	750	250	-		1,000
	Bus	250	375	375		1,000
	Truck				300	300
	Walk	250	375	375		1,000
4.	Car	70	20	-		90
	Bus	20	40	50		110
	Truck				15	15
	Walk	10	20	20		50
5.	Car	130	70	-		200
	Bus	35	100	165		300
	Truck				40	40
	Walk	-	-	-	-	-
6.	Car					
	Bus					
	Truck					0
	Walk					
7.	Car					
	Bus					
	Truck					0
	Walk					
8.	Car	420	120	-		540
	Bus	120	240	300		660
	Truck				90	90
	Walk	60	120	120		300
9.	Car	155	75	-		230
	Bus	35	115	195		345
	Truck				200	200
	Walk	-	-	-		-
Total	Car	3,260	2,420	-		5,680
	Bus	985	3,850	3,130		7,965
	Truck	-	-	-	1,785	1,785
	Walk	680	2,930	1,470		5,080
Total		4,925	9,200	4,600	1,785	20,510

Table 4: O-D DISTRIBUTION OF CAR TRIPS

Year: 1979

Origin Zone	Destination Zones 1	2	3	4	5	6	7	8	9	TOTAL
1. H	283	649	400	23	39	0	0	82	74	1,560
M	1,043	288	169	14	51	0	0	40	52	1,660
L	0	0	0	0	0	0	0	0	0	0
TOTAL	1,326	937	569	37	90	0	0	112	126	3,220
2. H										
M										
L										
TOTAL										
3. H										
M										
L										
TOTAL										
4. H	43	198	134	25	39	0	0	64	27	560
M	22	9	8	0	0	0	0	0	1	40
L	0	0	0	0	0	0	0	0	0	0
TOTAL	95	207	142	25	39	0	0	64	28	600
5. H										
M										
L										
TOTAL										
6. H										
M										
L										
TOTAL										
7. H										
M										
L										
TOTAL										
8. H	43	171	82	9	29	0	0	199	27	560
M	205	69	40	0	10	0	0	65	11	400
L	0	0	0	0	0	0	0	0	0	0
TOTAL	248	240	122	9	39	0	0	264	38	960
9. H	86	222	134	13	23	0	0	75	27	580
M	195	54	33	3	9	0	0	15	11	320
L	0	0	0	0	0	0	0	0	0	0
TOTAL	281	276	167	16	32	0	0	90	38	900
H	485	1,250	750	40	130	0	0	420	155	3,260
M	1,465	420	250	20	70	0	0	120	75	2,420
L	0	0	0	0	0	0	0	0	0	0
GRAND TOTAL	1,950	1,670	1,000	90	200	0	0	540	230	5,680

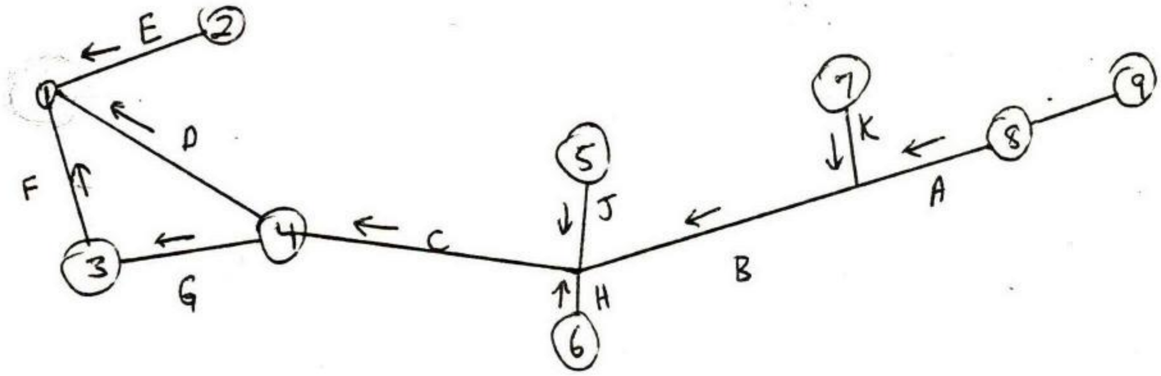
Table 5: O-D DISTRIBUTION OF BUS TRIPS
Year: 1979

Origin Zone	Destination Zone 1	2	3	4	5	6	7	8	9	TOTAL
1. H	72	241	139	2	20	0	0	28	18	520
M	1,624	388	250	24	62	0	0	64	78	2,490
L	628	270	149	15	52	0	0	40	76	1,230
TOTAL	2,324	899	538	41	134	0	0	132	172	4,240
2. H										
M										
L										
TOTAL										
3. H										
M										
L										
TOTAL										
4. H	11	61	37	8	5	0	0	31	6	160
M	44	16	8	0	0	0	0	10	2	80
L	0	0	0	0	0	0	0	0	0	0
TOTAL	55	77	45	8	5	0	0	41	8	240
5. H										
M										
L										
TOTAL										
6. H										
M										
L										
TOTAL										
7. H										
M										
L										
TOTAL										
8. H	7	52	37	0	7	0	0	44	7	160
M	393	143	70	11	26	0	0	136	21	800
L	202	95	71	15	45	0	0	136	36	600
TOTAL	602	290	178	26	78	0	0	316	64	1,560
9. H	15	66	37	3	3	0	0	17	4	145
M	294	78	47	5	12	0	0	30	14	480
L	590	260	155	20	68	0	0	124	83	1,300
TOTAL	899	404	239	28	83	0	0	171	101	1,925
TOTAL										
H	105	420	250	20	35	0	0	120	35	985
M	2,355	625	375	40	100	0	0	242	115	3,850
L	1,420	625	375	50	165	0	0	300	195	3,130
GRAND TOTAL	3,880	1,675	1,000	110	300	0	0	660	345	7,965

Table 6: O-D DISTRIBUTION OF TRUCK TRIPS
Year: 1979

Origin Zone	Destination 1	2	3	4	5	6	7	8	9	TOTAL
1. TOTAL	276	141	109	6	10	0	0	26	72	640
2. TOTAL	147	203	66	5	5	0	0	18	56	500
3. TOTAL	102	69	72	1	10	0	0	12	34	300
4. TOTAL	2	1	3	0	0	0	0	7	2	15
5. TOTAL	17	7	7	0	4	0	0	0	5	40
6. TOTAL	0	0	0	0	0	0	0	0	0	0
7. TOTAL	0	0	0	0	0	0	0	0	0	0
8. TOTAL	24	23	9	0	7	0	0	17	10	90
9. TOTAL	72	56	34	2	4	0	0	10	22	200
GRAND TOTAL	640	300	300	15	40	0	0	90	200	1,785

Table 7: NETWORK



Arrow points in inbound (+) direction.

Link	PCU's in (2 hrs)	PCU's out (2 hrs)	Capacity (No Build/Build)	V/C in (NB/B)	V/C out (NB/B)	Length	Car Free-flow speed (NB/B)
A						3.4	
B						3.4	80/100
AB	1777	924	800/2400	1.11/.37	.58/.19	6.8	80/100
C	1784	1064	1600	.56	.33	1.5	60
D	1603	864	1600	.50	.27	2.4	60
E	891	2036	1000	.45	1.02	1.4	60
F	519	912	1600	.16	.29	1.1	60
G	463	165	800	.29	.10	2.2	60
J	108	250	1200	.05	.10	0.9	60
H			1200			0.5	60
K			1200				60

Table 8:
Year: 1979
Mode: Car
Link Assignments

Origin Zone / Link	A	B	C	D	E	F	G	H	J	K
1. H M L	(Same as B)	164^- 85 (0)	221^- 120	251^- 130	621^- 328	408^- 163	- -		57^- 35	
2. H M L										
3. H M L										
4. H M L		90^- 41	128^- 1	271^+ 31	199^- 8	- -	132^+ 8		38^- 0	
5. H M L										
6. H M L		+809/-254								
8. H M L		331^+ 331	302^+ 322	211^+ 282	169^- 76	- -	82^+ 40		29^- 9	
9. H M L		478^+ 294	455^+ 287	308^+ 249	222^- 54	- -	134^+ 33		23^- 9	
TOTAL H M L		+809/-254 +625/-86 +1434/-340	+757/-349 +609/-121 +1366/-470	+790/-251 +362/-130 +1352/-381	+0/-1211 +0/-466 +0/-1677	+0/-408 +0/-163 +0/-671	+348/-0 +81/-0 +429/-0		+0/-147 +0/-53 +0/-260	
GRAND TOTAL°										

Origin Zone / Link		A	B	C	D	E	F	G	H	J	K
1.	H M L	(Same as B)	43 122 114	55 152 147	61 168 158	223 283 214	155 237 154	– – –		12 30 33	
2.	H M L										
3.	H M L										
4.	H M L		35^- 10 0	$42^{\div}$ 10	74^+ 62 0	58^- 16 0	– – –	37^+ 8 0		7^- 0	
5.	H M L										
[illegible]	H M L										
8.	H M L		140^+ 650 429	111^+ 631 393	68^+ 552 321	51^- 118 98	– – –	34^+ 69 63		29^- 20 36	
9.	H M L		122^+ 433 1093	117^+ 421 1025	77^+ 369 850	62^- 78 260		37^+ 47 155		5^- 12 68	
TOTAL	H M L		262 1083 1522 +2867	228 1052 1418 +2698	219 983 1171 2373	0 0 0 0	0 0 0 0	108 124 218 +440		0 0 0 0	
GRAND TOTAL°			– 78 132 114	– 97 162 147	– 61 168 158	– 394 493 512	– 155 261 134	0 0 0		53 68 137	

Table 9:
Year: 1979
Mode: Bus
Link Assignments

Table 10:
Year: 1979
Mode: Truck
Link Assignments

Origin Zone / Link	A	B	C	D	E	F	G	H	J	K
1. H M L	(Same as B)	98^-	108^-	114^-	141^-	109^-	-		10^-	
2. H M L		74^-	79^-	84^-	297^+	66^-	-		5^-	
3. H M L		46^-	56^-	-	69^-	171^+	57^-		10^-	
4. H M L		6^-	6^-	3^+	1^-	-	3^+		0^-	
5. H M L		5^-	28^+	24^+	7^-		4^+		33^+	
6. H M L										
8. H M L		63^+	56^+	47^+	23^-	-	9^+		7	
9. H M L		168^+	166^+	128^+	56^-	-	34^+		2^-	
TOTAL H M L		230	250	200	297	173	55		36	
GRAND TOTAL°		230	250	200	297	173	55		36	

Table 11: YEAR: 1979

ORIGIN ZONE: 1 Input Data

MODE: Car

	Values of Time ($/hr)		
9	Class 1	2.18	(A)
10	Class 2	.56	
11	Class 3	.18	

	Mode:		
5	O.C. parameter	1	(B)
6	occupancy	1.6	
7	expansion factor	107.4	

0	Number of Links:	6	(C)

	Link: A-B outbound	
20	length (km)	5.5
21	V/C	0.587/.19
22	free-flow speed (km/h)	80/100
23	class 1 vol	164
24	class 2 vol	85
25	class 3 vol	0

	Link: C out	
26	length	1.5
27	V/C	.33
28	free-flow spd	60
29	class 1 vol	221
30	class 2 vol	120
31	class 3 vol	0

	Link: D out	
32	length	2.4
33	V/C	0.27
34	free-flow spd	60
35	class 1 vol	251
36	class 2 vol	130
37	class 3 vol	0

	Link: E out	
38	length	1.4
39	V/C	1.02
40	free-flow spd	60
41	class 1 vol	621
42	class 2 vol	328
43	class 3 vol	0

	Link: F out	
44	length	1.0
45	V/C	0.29
46	free-flow spd	60
47	class 1 vol	408
48	class 2 vol	163
49	class 3 vol	0

	Link: J out	
50	length	0.9
51	V/C	.10
52	free-flow spd	60
53	class 1 vol	57
54	class 2 vol	35
55	class 3 vol	0

	Link:	
56	length	
57	V/C	
58	free-flow spd	
59	class 1 vol	
60	class 2 vol	
61	class 3 vol	

	Link:	
62	length	
63	V/C	
64	free-flow spd	
65	class 1 vol	
66	class 2 vol	
67	class 3 vol	

	Link:	
68	length	
69	V/C	
70	free-flow spd	
71	class 1 vol	
72	class 2 vol	
73	class 3 vol	

YEAR: 1979

ORIGIN ZONE: 1

Input Data

MODE: Bus

	Values of Time ($/hr)		
9	Class 1	2.18	(A)
10	Class 2	.56	
11	Class 3	.18	

	Mode:		
5	O.C. parameter	4.3	(B)
6	occupancy	45	
7	expansion factor	92	

0 Number of Links: 6 (C)

	Link: A-B out	
20	length (km)	5.5
21	V/C	.58/.19
22	free-flow speed (km/h)	64/80
23	class 1 vol	43
24	class 2 vol	122
25	class 3 vol	114

	Link: C out	
26	length	1.5
27	V/C	.33
28	free-flow spd	42
29	class 1 vol	55
30	class 2 vol	152
31	class 3 vol	147

	Link: D out	
32	length	2.4
33	V/C	.27
34	free-flow spd	42
35	class 1 vol	61
36	class 2 vol	168
37	class 3 vol	158

	Link: E out	
38	length	1.4
39	V/C	1.02
40	free-flow spd	42
41	class 1 vol	223
42	class 2 vol	283
43	class 3 vol	214

	Link: F out	
44	length	1.0
45	V/C	.29
46	free-flow spd	42
47	class 1 vol	155
48	class 2 vol	237
49	class 3 vol	154

	Link: J oút	
50	length	0.9
51	V/C	.10
52	free-flow spd	42
53	class 1 vol	12
54	class 2 vol	30
55	class 3 vol	33

	Link:	
56	length	
57	V/C	
58	free-flow spd	
59	class 1 vol	
60	class 2 vol	
61	class 3 vol	

	Link:	
62	length	
63	V/C	
64	free-flow spd	
65	class 1 vol	
66	class 2 vol	
67	class 3 vol	

	Link:	
68	length	
69	V/C	
70	free-flow spd	
71	class 1 vol	
72	class 2 vol	
73	class 3 vol	

Year: 1979

Table 13:

BENEFITS TO RESIDENTS OF ORIGIN ZONE 1 Output Costs

		AUTO	BUS	$/Month
NO BUILD				
Income class 1	OC	15304.	652.	
	TC	24177.	9269.	
Income class 2	OC	7826.	1312.	
	TC	3209.	4137.	
Income class 3	OC	0.	1136.	
	TC	0.	1111.	
Total	OC	23131.	3100.	
	TC	27386.	14517.	
BUILD				
Income class 1	OC	15449.	635.	
	TC	21628.	8553.	
Income class 2	OC	7901.	1263.	
	TC	2870.	3615.	
Income class 3	OC	0.	1089.	
	TC	0.	955.	
Total	OC	23350.	2987.	
	TC	24498.	13123.	
DIFFERENCE				
Income class 1	OC	-145.	17.	
	TC	2549.	716.	
Income class 2	OC	-75.	50.	
	TC	339.	522.	
Income class 3	OC	0.	46.	
	TC	0.	157.	
Total	OC	-220.	113.	
	TC	2888.	1394.	

YEAR: **1979**

Table 14: ORIGIN ZONE: **4** Input Data

MODE: **Car**

	Values of Time ($/hr)		
9	Class 1	2.18	(A)
10	Class 2	.56	
11	Class 3	.18	

	Mode:		
5	O.C. parameter	1	(B)
6	occupancy	1.6	
7	expansion factor	107.4	

0	Number of Links:	6	(C)

	Link: **A-B out**	
20	length (km)	5.5
21	V/C	0.58/.19
22	free-flow speed (km/h)	80/100
23	class 1 vol	90
24	class 2 vol	1
25	class 3 vol	0

	Link: **C out**	
26	length	1.5
27	V/C	0.33
28	free-flow spd	60
29	class 1 vol	128
30	class 2 vol	1
31	class 3 vol	0

	Link: **D in**	
32	length	2.4
33	V/C	.50
34	free-flow spd	60
35	class 1 vol	271
36	class 2 vol	31
37	class 3 vol	0

	Link: **E out**	
38	length	1.4
39	V/C	1.02
40	free-flow spd	60
41	class 1 vol	199
42	class 2 vol	8
43	class 3 vol	0

	Link: **G in**	
44	length	2.2
45	V/C	.29
46	free-flow spd	60
47	class 1 vol	133
48	class 2 vol	8
49	class 3 vol	0

	Link: **I out**	
50	length	0.9
51	V/C	.10
52	free-flow spd	60
53	class 1 vol	38
54	class 2 vol	0
55	class 3 vol	0

	Link:	
56	length	
57	V/C	
58	free-flow spd	
59	class 1 vol	
60	class 2 vol	
61	class 3 vol	

	Link:	
62	length	
63	V/C	
64	free-flow spd	
65	class 1 vol	
66	class 2 vol	
67	class 3 vol	

	Link:	
68	length	
69	V/C	
70	free-flow spd	
71	class 1 vol	
72	class 2 vol	
73	class 3 vol	

YEAR: 1979

Table 15: ORIGIN ZONE: 4

Input Data

MODE: Bus

	Values of Time ($/hr)		
9	Class 1		(A)
10	Class 2		
11	Class 3		
	Mode:		
5	O.C. parameter	4.3	(B)
6	occupancy	45	
7	expansion factor	92	
0	Number of Links:	6	(C)
	Link: A-B		
20	length (km)	5.5	
21	V/C	.58/.19	
22	free-flow speed (km/h)	64/80	
23	class 1 vol	35	
24	class 2 vol	10	
25	class 3 vol	0	
	Link: C out		
26	length	1.5	
27	V/C	.33	
28	free-flow spd	42	
29	class 1 vol	42	
30	class 2 vol	10	
31	class 3 vol	0	
	Link: D in		
32	length	2.4	
33	V/C	.50	
34	free-flow spd	42	
35	class 1 vol	74	
36	class 2 vol	62	
37	class 3 vol	0	
	Link: E out		
38	length	1.4	
39	V/C	1.02	
40	free-flow spd	42	
41	class 1 vol	58	
42	class 2 vol	16	
43	class 3 vol	0	

	Link: G in	
44	length	2.2
45	V/C	.29
46	free-flow spd	42
47	class 1 vol	37
48	class 2 vol	8
49	class 3 vol	0
	Link: J out	
50	length	0.9
51	V/C	.10
52	free-flow spd	42
53	class 1 vol	7
54	class 2 vol	0
55	class 3 vol	0
	Link:	
56	length	
57	V/C	
58	free-flow spd	
59	class 1 vol	
60	class 2 vol	
61	class 3 vol	
	Link:	
62	length	
63	V/C	
64	free-flow spd	
65	class 1 vol	
66	class 2 vol	
67	class 3 vol	
	Link:	
68	length	
69	V/C	
70	free-flow spd	
71	class 1 vol	
72	class 2 vol	
73	class 3 vol	

Year: 1979

Table 16: BENEFITS TO RESIDENTS OF ORIGIN ZONE 4 Output Costs

		AUTO	BUS	$/Month
NO BUILD				
Income class 1	OC	9248.	407.	
	TC	13248.	4852.	
Income class 2	OC	528.	176.	
	TC	192.	529.	
Income class 3	OC	0.	0.	
	TC	0.	0.	
Total	OC	9776.	584.	
	TC	13441.	5381.	
BUILD				
Income class 1	OC	9327.	391.	
	TC	11849.	4215.	
Income class 2	OC	529.	172.	
	TC	188.	483.	
Income class 3	OC	0.	0.	
	TC	0.	0.	
Total	OC	9856.	563.	
	TC	12038.	4698.	
DIFFERENCE				
Income class 1	OC	-79.	16.	
	TC	1399.	637.	
Income class 2	OC	-1.	5.	
	TC	4.	47.	
Income class 3	OC	0.	0.	
	TC	0.	0.	
Total	OC	-80.	20.	
	TC	1403.	683.	

YEAR: 1979

Table 17: ORIGIN ZONE: 8

Input Data

MODE: Car

Values of Time ($/hr)

9	Class 1	2.18	(A)
10	Class 2	.56	
11	Class 3	.18	

Mode:

5	O.C. parameter	1	(B)
6	occupancy	1.6	
7	expansion factor	107.4	

0 Number of Links: 6 (C)

Link: AB in

20	length (km)	5.5
21	V/C	1.11/.37
22	free-flow speed (km/h)	80/100
23	class 1 vol	331
24	class 2 vol	331
25	class 3 vol	0

Link: C in

26	length	1.5
27	V/C	.56
28	free-flow spd	60
29	class 1 vol	302
30	class 2 vol	322
31	class 3 vol	0

Link: D in

32	length	2.4
33	V/C	.50
34	free-flow spd	60
35	class 1 vol	211
36	class 2 vol	282
37	class 3 vol	0

Link: E out

38	length	1.4
39	V/C	1.02
40	free-flow spd	60
41	class 1 vol	169
42	class 2 vol	76
43	class 3 vol	0

Link: G in

44	length	2.2
45	V/C	.29
46	free-flow spd	60
47	class 1 vol	82
48	class 2 vol	40
49	class 3 vol	0

Link: J out

50	length	.9
51	V/C	.10
52	free-flow spd	60
53	class 1 vol	29
54	class 2 vol	9
55	class 3 vol	0

Link:

56	length	
57	V/C	
58	free-flow spd	
59	class 1 vol	
60	class 2 vol	
61	class 3 vol	

Link:

62	length	
63	V/C	
64	free-flow spd	
65	class 1 vol	
66	class 2 vol	
67	class 3 vol	

Link:

68	length	
69	V/C	
70	free-flow spd	
71	class 1 vol	
72	class 2 vol	
73	class 3 vol	

YEAR: 1979

Table 18: ORIGIN ZONE: 8 Input Data

MODE: BUS

	Values of Time ($/hr)		
9	Class 1		(A)
10	Class 2		
11	Class 3		
	Mode:		
5	O.C. parameter	4.3	(B)
6	occupancy	45	
7	expansion factor	92	
0	Number of Links:	6	(C)
	Link: AB+		
20	length (km)	5.5	
21	V/C	1.11/.37	
22	free-flow speed (km/h)	64/80	
23	class 1 vol	140	
24	class 2 vol	650	
25	class 3 vol	429	
	Link: C+		
26	length	1.5	
27	V/C	.56	
28	free-flow spd	40	
29	class 1 vol	111	
30	class 2 vol	631	
31	class 3 vol	393	
	Link: D+		
32	length	2.4	
33	V/C	.50	
34	free-flow spd	42	
35	class 1 vol	68	
36	class 2 vol	552	
37	class 3 vol	321	
	Link: F-		
38	length	1.4	
39	V/C	1.02	
40	free-flow spd	42	
41	class 1 vol	51	
42	class 2 vol	118	
43	class 3 vol	98	

	Link: G+	
44	length	2.2
45	V/C	.29
46	free-flow spd	42
47	class 1 vol	34
48	class 2 vol	69
49	class 3 vol	63
	Link: J-	
50	length	0.9
51	V/C	.10
52	free-flow spd	42
53	class 1 vol	21
54	class 2 vol	20
55	class 3 vol	36
	Link:	
56	length	
57	V/C	
58	free-flow spd	
59	class 1 vol	
60	class 2 vol	
61	class 3 vol	
	Link:	
62	length	
63	V/C	
64	free-flow spd	
65	class 1 vol	
66	class 2 vol	
67	class 3 vol	
	Link:	
68	length	
69	V/C	
70	free-flow spd	
71	class 1 vol	
72	class 2 vol	
73	class 3 vol	

Year: 1979

Table 19: BENEFITS TO RESIDENTS OF ORIGIN ZONE 8 Output Costs

		AUTO	BUS	$/Month
NO BUILD				
Income class 1	OC	17282.	948.	
	TC	34120.	15089.	
Income class 2	OC	16995.	4592.	
	TC	8464.	18290.	
Income class 3	OC	0.	2994.	
	TC	0.	3859.	
Total	OC	34277.	8534.	
	TC	42584.	37237.	
BUILD				
Income class 1	OC	14752.	779.	
	TC	16311.	7023.	
Income class 2	OC	14464.	3808.	
	TC	3889.	8670.	
Income class 3	OC	0.	2477.	
	TC	0.	1818.	
Total	OC	29216.	7064.	
	TC	20200.	17512.	
DIFFERENCE				
Income class 1	OC	2531.	169.	
	TC	17809.	8065.	
Income class 2	OC	2531.	784.	
	TC	4575.	9619.	
Income class 3	OC	0.	517.	
	TC	0.	2041.	
Total	OC	5061.	1470.	
	TC	22383.	19725.	

Year: 1979

Table 20: BENEFITS TO RESIDENTS OF ORIGIN ZONE 9 OUTPUT COSTS

	AUTO	BUS	$/Month
NO BUILD			
Income class 1			
OC			
TC			
Income class 2			
OC			
TC			
Income class 3			
OC			
TC			
Total			
OC			
TC			
BUILD			
Income class 1			
OC			
TC			
Income class 2			
OC			
TC			
Income class 3			
OC			
TC			
Total			
OC			
TC			
DIFFERENCE			
Income class 1			
OC			
TC			
Income class 2			
OC			
TC			
Income class 3			
OC			
TC			
Total			
OC			
TC			

Year: 1979

Table 21: BENEFITS TO RESIDENTS OF ORIGIN ZONE 9

		AUTO	BUS
NO BUILD			
Income class 1	OC	21829.57	846.01
	TC	43073.42	36065.39
Income class 2	OC	14158.55	2935.36
	TC	7053.11	11225.28
Income class 3	OC	0.00	7365.38
	TC	0.00	9154.68
Total	OC	35988.13	11146.74
	TC	50126.53	56445.36
BUILD			
Income class 1	OC	18175.10	698.87
	TC	17355.66	16721.07
Income class 2	OC	11910.82	2413.16
	TC	2989.76	4817.35
Income class 3	OC	0.00	6047.22
	TC	0.00	3955.50
Total	OC	30085.92	9159.25
	TC	20345.42	25493.92
DIFFERENCE			
Income class 1	OC	3654.47	147.13
	TC	25717.76	19344.32
Income class 2	OC	2247.78	522.20
	TC	4063.35	6407.94
Income class 3	OC	0.00	1318.16
	TC	0.00	5199.18
Total	OC	5902.20	1987.49
	TC	29781.11	30951.44

_______ Build

_______ Difference

_______ OK

No-Build

Build w/loop

Difference w/loop

1759.52
6418.56

2660.47
37907.89

YEAR: 1979

Input Data

Table 22: ORIGIN ZONE: 1
MODE: Truck

Modal Parameters

Labor cost ($/hr)		(B)
O.C parameter		
expansion factor		

Number of Links: 6 (C)

Link: AB-	
Length (km)	5.5
V/C	.58/.19
Free-flow speed (km/h)	80/100
Volume	98

Link: C-	
Length	1.5
V/C	.33
Free-flow speed	.60
Volume	108

Link: D-	
Length	2.4
V/C	.27
Free-flow speed	60
Volume	114

Link: E-	
Length	1.4
V/C	.1.02
Free-flow speed	60
Volume	141

Link: F-	
Length	1.0
V/C	.29
Free-flow speed	60
Volume	109

Link: J	
Length	0.9
V/C	.1
Free-flow speed	60
Volume	10

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Link:	
Length	
V/C	
Free-flow speed	
Volume	

YEAR: 1979

Input Data

Table 23: ORIGIN ZONE: 2
MODE: Truck

Modal Parameters

Labor cost ($/hr)	1	(B)
O.C parameter	5.2	
expansion factor	115	

Number of Links: 6 (C)

Link: AB

Length (km)	5.5
V/C	58/.19
Free-flow speed (km/h)	80/100
Volume	74

Link: C-

Length	1.5
V/C	.33
Free-flow speed	60
Volume	79

Link: D-

Length	2.4
V/C	.27
Free-flow speed	60
Volume	84

Link: E+

Length	1.4
V/C	.45
Free-flow speed	60
Volume	297

Link: F-

Length	1.0
V/C	.29
Free-flow speed	60
Volume	66

Link: J-

Length	0.9
V/C	.10
Free-flow speed	60
Volume	5

Link:

Length	
V/C	
Free-flow speed	
Volume	

Link:

Length	
V/C	
Free-flow speed	
Volume	

Link:

Length	
V/C	
Free-flow speed	
Volume	

YEAR: 1979

Input Data

Table 24: ORIGIN ZONE: 3
MODE: Truck

Modal Parameters

Labor cost ($/hr)		(B)
O.C parameter		
expansion factor		

Number of Links: (C)

Link: AB-

Length (km)	5.5
V/C	.58/.19
Free-flow speed (km/h)	80/100
Volume	46

Link: C-

Length	1.5
V/C	.33
Free-flow speed	60
Volume	56

Link: E-

Length	1.4
V/C	1.02
Free-flow speed	60
Volume	69

Link: F+

Length	1.0
V/C	..16
Free-flow speed	60
Volume	171

Link: G-

Length	2.2
V/C	.10
Free-flow speed	60
Volume	57

Link: J-

Length	0.9
V/C	.1
Free-flow speed	60
Volume	10

Link:

Length	
V/C	
Free-flow speed	
Volume	

Link:

Length	
V/C	
Free-flow speed	
Volume	

Link:

Length	
V/C	
Free-flow speed	
Volume	

YEAR: 1979

Table 25: ORIGIN ZONE: 4
MODE: Truck

Input Data

Modal Parameters

Labor cost ($/hr)	(B)
O.C parameter	
expansion factor	

Number of Links: 5 (C)

Link: C-

Length (km)	1.5
V/C	.33
Free-flow speed (km/h)	60
Volume	6

Link: D+

Length	2.4
V/C	.5
Free-flow speed	60
Volume	3

Link: E-

Length	6.4
V/C	1.02
Free-flow speed	60
Volume	1

Link:

Length	
V/C	
Free-flow speed	
Volume	

Link: G+

Length	2.2
V/C	.29
Free-flow speed	60
Volume	3

Link:

Length	
V/C	
Free-flow speed	
Volume	

Link:

Length	
V/C	
Free-flow speed	
Volume	

Link:

Length	
V/C	
Free-flow speed	
Volume	

Link:

Length	
V/C	
Free-flow speed	
Volume	

YEAR: 1979

Input Data

Table 26: ORIGIN ZONE: 5
MODE:

Modal Parameters

Labor cost ($/hr)		(B)
O.C parameter		
expansion factor		

Number of Links: 6 (C)

Link:	AB-
Length (km)	5.5
V/C	.58/.19
Free-flow speed (km/h)	80/100
Volume	5

Link:	C+
Length	1.5
V/C	.56
Free-flow speed	60
Volume	28

Link:	D+
Length	2.4
V/C	.5
Free-flow speed	60
Volume	24

Link:	E-
Length	1.4
V/C	1.02
Free-flow speed	60
Volume	7

Link:	G+
Length	2.2
V/C	.29
Free-flow speed	60
Volume	4

Link:	J+
Length	.9
V/C	.05
Free-flow speed	60
Volume	33

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Link:	
Length	
V/C	
Free-flow speed	
Volume	

YEAR: 1979

Input Data

Table 27: ORIGIN ZONE: 8
MODE: Truck

Modal Parameters

Labor cost ($/hr)		(B)
O.C parameter		
expansion factor		

Number of Links: 6 (C)

Link: AB+	
Length (km)	5.5
V/C	1.1/.37
Free-flow speed (km/h)	80/100
Volume	63

Link: C+	
Length	1.5
V/C	.56
Free-flow speed	60
Volume	56

Link: D+	
Length	2.4
V/C	.5
Free-flow speed	60
Volume	47

Link: E-	
Length	1.4
V/C	1.02
Free-flow speed	60
Volume	23

Link: G+	
Length	2.2
V/C	.29
Free-flow speed	60
Volume	9

Link: J-	
Length	.9
V/C	.1
Free-flow speed	60
Volume	7

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Link:	
Length	
V/C	
Free-flow speed	
Volume	

TRUCK COSTS FROM EACH ORIGIN ZONE

ZONE:	1	2	3
No-Build			
OC *	53,796	8,991	30,263
labor	4,113	3,128	2,176
Build			
OC *	54,566	9,573	30,624
labor	3,365	2,563	1,825
Difference			
OC *	-770	-582	-362
labor	748	565	351
total OC	-22	-17	-10

ZONE:	4	5	8
No-Build			
OC *	2,330	7,368	30,225
labor	155	539	21,541
Build			
OC *	2,377	7,407	25,987
labor	109	501	19,909
Difference			
OC *	-47	-39	4,239
labor	46	38	1,632
total OC	-1	-1	5,870

* Operating cost minus $1/hr labor cost.

Projected 1984 travel benefits by mode, income class, zone of origin for conditions assumed to prevail with no highway component as compared to those with the proposed highway component. Summary:

Year 1984

Table 29: SUMMARY GENERALIZED TRAVEL COST

ZONE:		High Income HH	Middle Income HH	Low Income HH	Employment	Total
1.	Car					
	bus					
	truck					
	walk					
2.	Car					
	bus					
	truck					
	walk					
3.	Car					
	bus					
	truck					
	walk					
4.	Car					
	bus					
	truck					
	walk					
5.	Car					
	bus					
	truck					
	walk					
6.	Car					
	bus					
	truck					
	walk					
7.	Car					
	bus					
	truck					
	walk					
8.	Car					
	bus					
	truck					
	walk					
9.	Car					
	bus					
	truck					
	walk					
Total:	Car					
	bus					
	truck					
	walk					
Total:						

Year 1984

Table 30: TRIP ORIGINS - MORNING PEAK HOUR

ZONE	HIGH INCOME HH	MIDDLE INCOME HH	LOW INCOME HH	EMPLOYMENT	TOTAL
1. Car	1.500	1,600	250		3,350
Bus	500	2,400	750		3,650
Truck				760	760
Walk	500	1,200	375		2,075
2. Car				500	
Bus					
Truck					
Walk					
3. Car					
Bus				350	350
Truck					
Walk					
4. Car	560	40	80		680
Bus	160	80	100		340
Truck				30	30
Walk	180	20			200
5. Car				160	160
Bus					
Truck					
Walk					
6. Car		600	200		800
Bus		1,200	1,000	15	2,200
Truck		300	200		500
Walk					
7. Car				160	160
Bus					
Truck					
Walk					
8. Car	700	500	100		1,300
Bus	200	1,000	750		1,950
Truck				150	150
Walk	100	250	150		500
9. Car	4,112	424	380		4,916
Bus	1,303	180	2,815		4,298
TrucK				0	
Walk	175	120	675		970
TOTAL Car	6,872	3,164	1,010		11,046
Bus	2,163	4,860	5,415		12,438
Truck				2,125	2,125
Bus	955	1,890	1,400		2,245

Table 31: TRIP DESTINATIONS - MORNING PEAK HOUR

ZONE	HIGH INCOME HH	MIDDLE INCOME HH	LOW INCOME HH	EMPLOYMENT	TOTAL
1. Car	2280	1140	500		3920
Bus	760	1710	1710		4180
Truck				460	460
Walk	380	570	570		1520
2. Car	1200	600	200		2000
Bus	400	900	900		2200
Truck				500	500
Walk	200	420	310		930
3. Car	840	340	140		1320
Bus	280	630	630		1540
Truck				350	350
Walk	200	420	310		930
4. Car	195	82	20		297
Bus	55	120	150		325
Truck				30	30
Walk	30	50	50		130
5. Car	780	330	80		1190
Bus	220	480	600		1300
Truck				160	160
Walk	40	80	80		200
6. Car	94	42	10		146
Bus	28	60	75		163
Truck				15	15
Walk	15	10	10		35
7. Car	780	330	80		1190
Bus	220	480	600		1300
Truck				160	160
Walk	40	80	80		200
8. Car	700	300	100		1100
Bus	200	480	750		1430
Truck				150	150
Walk	50	80	100		230
9. Car					
Bus					
Truck					
Walk					
TOTAL Car	6872	3164	1010		11046
Bus	2163	4860	5415		12438
Truck				2125	2125
Walk	955	1890	1400		4245
TOTAL	9990	9914	7825	2125	29854

Table 32: O-D DISTRIBUTION OF TRUCK TRIPS Year 1985

ORIGIN ZONES	1	2	3	4.	5	6	7	8	9	TOTAL
1. H	584	318	200	24	118	19	183	54	0	1500
M	673	336	200	19	148	16	92	116	0	1600
L	121	40	37	2	8	21	8	32	0	250
TOTAL	1378	694	437	45	274	37	283	202	0	3350
2. H										
M										
L										
TOTAL										
3. H										
M										
L										
TOTAL										
4. H	155	89	80	36	102	18	44	36	0	560
M	9	7	4	4	4	1	4	7	0	40
L	27	19	2	7	7	1	10	7	0	80
TOTAL	191	115	86	47	113	20	5	50	0	680
5. H										
M										
L										
TOTAL										
6. H										
M	170	103	66	28	94	9	93	38	0	600
L	65	41	35	4	27	1	18	9	0	200
TOTAL										
7. H										
M										
L										
TOTAL										
8. H	175	94	67	15	67	15	100	167	0	700
M	132	76	23	18	42	8	56	101	0	456
L	26	22	8	3	8	2	14	17	0	100
TOTAL	333	192	98	36	117	25	170	285	0	1,256
9. H	1356	699	493	120	493	45	453	453		4,112
M	156	81	47	13	42	5	42	38	0	424
L	141	78	53	9	30	4	30	35	0	380
TOTAL	1653	858	593	142	565	54	525	526	0	4,916
TOTAL H	2280	1200	840	195	780	67	780	700	0	6842
M	1140	600	340	82	330	42	330	300	0	3164
L	380	200	140	20	80	10	80	100	0	1010
TOTAL	3800	2000	1320	297	1190	119	1190	1100	0	11,016

Table 33: O-D DISTRIBUTION OF CAR TRIPS   Year 1984

ORIGIN TOWNS	1	2	3	4	5	6	7	8	9	TOTAL
1. H	193	110	67	6	49	4	54	17	0	500
M	981	467	477	57	187	16	88	127	0	2400
L	354	134	114	20	47	7	4	40	0	750
TOTAL	1528	711	658	83	283	27	176	184	0	3650
2. H										
M										
L										
TOTAL										
3. H										
M										
L										
TOTAL										
4. H	59	27	25	8	17	8	8	8	0	160
M	24	16	8	4	8	4	8	8	0	80
L	31	15	15	8	8	7	8	8	0	100
TOTAL	114	58	48	20	33	19	24	24	0	340
5. H										
M										
L										
TOTAL										
6. H										
M	390	230	133	37	177	28	112	93	0	1200
L	282	159	96	21	168	23	138	103	0	990
TOTAL	672	389	229	58	345	51	250	196	0	2190
7. H										
M										
L										
TOTAL										
8. H	56	28	19	2	24	3	23	45	0	200
M	252	153	99	18	90	10	44	234	0	1000
L	160	114	67	17	67	10	110	205	0	750
TOTAL	468	295	185	37	181	23	277	484	0	1950
9. H	457	235	169	39	130	13	130	130	0	1303
M	63	34	23	4	18	2	18	18	0	180
L	873	478	338	84	310	28	310	394	0	2815
TOTAL	1393	747	530	127	458	43	458	542	0	4298
TOTAL H	760	400	380	55	220	28	220	200	0	2263
M	110	150	630	120	480	30	480	480	0	2480
L	110	700	630	150	100	75	750	750	0	3265
TOTAL	980	1250	1640	325	800	133	1450	1430	0	8008

Table 34: O-D DISTRIBUTION OF TRUCK TRIPS Year 1984

ORIGIN TOWNS	1	2	3	4	5	6	7	8	9	TOTAL
1. H										
M										
L										
TOTAL	354	154	140	12	43	0	28	29	0	760
2. H										
M										
L										
TOTAL	167	177	71	6	26	0	33	20	0	500
3. H										
M										
L										
TOTAL	115	68	73	6	26	6	36	20	0	350
4. H										
M										
L										
TOTAL	10	10	10	0	0	0	0	0	0	30
5. H										
M										
L										
TOTAL	31	28	23	0	38	9	14	17	0	160
6. H										
M										
L										
TOTAL	8	7	0	0	0	0	0	0	0	15
7. H										
M										
L										
TOTAL	36	30	14	6	16	0	30	28	0	160
8. H										
M										
L										
TOTAL	39	26	19	0	11	0	19	36	0	150
9. H										
M										
L										
TOTAL										
TOTAL H										
M										
L										
TOTAL	760	500	350	30	160	15	160	150		2125

Table 35: LINK ASSIGNMENTS

MODE: Car

YEAR: 1984

Link Origin Zone		A	B	C	D	E	F	G	H	I	J	K	TOTAL
1	H M L	79- 80	168- 223										
	H M L	35 5	113 11										
	H M L	0 6- 3	10 18- 7										
	H M L	538+ 387+	397+ 318										
	H M L	3687+ 21 470	3210+ 19 470										
6	H M L												
7	H M L												
In	H M L Total	4225+ 408 470 5103+	3607+ 337+ 470+ 4414										
OUT	H M L Total	114- 91- 3- 208-	381- 252- 7- 640-										

YEAR: 1984

MODE: Bus

Table 36: LINK ASSIGNMENTS

Link Origin Zone		A	B	C	D	E	F	G	H	I	J	K	TOTAL
1	H	22	72										
	M	132	387										
	L	0	0										
2	H	9	18										
	M	10	20										
	L	0	0										
3	H	0	0										
	M	8-	32-										
	L	12	18										
4	H	237+	210+										
	M	1020	960										
	L	940	820										
5	H	2085	1885										
	M	125	110										
	L	1470	1390										
6	H												
	M												
	L												
7	H												
	M												
	L												
In	H	2322+	2095+										
	M	1145	1070										
TOTAL	L	2410	2210										
		4875	4375										
In	H	31-	90-										
	M	150	439-										
	L	12	18-										
TOTAL		193	647										

Table 37: LINK ASSIGNMENTS

MODE: Truck

YEAR: 1984

Link Origin Zone		A	B	C	D	E	F	G	H	I	J	K	TOTAL
1	H M L	29-	57-										
2	H M L	20-	53-										
3	H M L	20-	56-										
4	H M L	0	0										
5	H M L	17-	3										
6	H M L	15-	30-										
7	H M L	28-	102+										
8	H M L	103+	84+										
9		228+	190+										
TOTAL	H M L	129 331+	227 376+										

TABLE 38

YEAR 1984

LINK ASSIGNMENTS BY MODE CAR DCUS

ORIGIN/ZONE LINK	1	2	3	4	5	6	7	8	9	Total Passengers	Total PCU
1-1	3,350			113						3,350	
1-2	694					144		162	858	1,973	
1-3	437									437	
1-4	842									842	
2-1											
2-2											
*(2-5)											
3-1											
3-3											
3-4											
4-1				306		379		495	2,571	3,691	
4-3				86		101		98	593	878	
4-4				680						680	
4-5	274			113						387	
4-6	37			20						57	
4-7	283			58						341	
4-8	203			50						253	
*(5-2)											
5-4											
5-5											
5-6											
5-7											
5-8											
6-4						572				572	
6-5						121				121	
6-6						800				800	
6-7						110				110	
6-8						47				47	
7-4											
7-5											
7-6											
7-7											
7-8											
8-4								629	3,246	3,875	
8-5								117	565	682	
8-6								25	54	79	
8-7								170	525	695	
8-8								1,300		1,300	
8-9											
9-8									5,916	5,916	
9-9									5,916	5,916	

TABLE 39

YEAR 1984

LINK ASSIGNMENTS BY MODE BUS DCUS

ORIGIN/ZONE LINK	1	2	3	4	5	6	7	8	9	Total Passengers	Total PCU
1-1	3,650									3,650	
1-2	711			58		389		295	747	2,200	
1-3	658									658	
1-4	763									763	
2-1											
2-2											
*(2-5)											
3-1											
3-3											
3-4											
4-1				172		1,061		763	2,140	4,136	
4-3				48		229		185	520	982	
4-4				340						340	
4-5	283			23						316	
4-6	27			19						46	
4-7	176			24						200	
4-8	184			24						208	
*(5-2)											
5-4											
5-5											
5-6											
5-7											
5-8											
6-4						1,348				1,348	
6-5						345				345	
6-6						2,200				2,200	
6-7						250				250	
6-8						196				196	
7-4											
7-5											
7-6											
7-7											
7-8											
8-4								985	1,587	2,572	
8-5								181	458	639	
8-6								23	43	66	
8-7								274	458	732	
8-8								1,950		1,950	
8-9											
9-8									4,298	4,298	
9-9									4,298	4,298	

TABLE 40

YEAR 1984

LINK ASSIGNMENTS BY MODE TRUCK DCUS

ORIGIN/ZONE LINK	1	2	3	4	5	6	7	8	9	Total passengers	Total PCU
1-1	760									760	
1-2	154		68	10	28	7	30	26		323	
1-3	140	71								211	
1-4	112	85								197	
2-1		333								333	
2-2		500								500	
*(2-5)											
3-1			183							183	
3-3			350							350	
3-4			161							161	
4-1				20	59	15	66	65		225	
4-3				10	23		14	23		66	
4-4				30						30	
4-5	43	26	6							75	
4-6			26							26	
4-7	28	33	36							97	
4-8	29	20	20							69	
*(5-2)											
5-4					72					72	
5-5					160					160	
5-6					9					9	
5-7					14					14	
5-8					17					17	
6-4						15				15	
6-5											
6-6						15				15	
6-7											
6-8											
7-4							86			86	
7-5							16			16	
7-6											
7-7							160			160	
7-8							28			28	
8-4								84		84	
8-5								11		11	
8-6											
8-7								19		19	
8-8								150		150	
8-9											
9-8											
9-9											

REGISTER CONTENTS: UTB-2.1(A)

YEAR: 1984

FOR CAR & BUS

ORIGIN ZONE: 1

MODE: Bus

	Values of Time ($/hr)		
9	Class 1	2.18	(A)
10	Class 2	.56	
11	Class 3	.18	
	Mode:		
5	O.C. parameter	4.3	(B)
6	occupancy	45	
7	expansion factor	92	
0	Number of Links:	10	(C)
	Link: A outbound		
20	length (km)	2.1	
21	V/C	1135/1600=0.17/0.24	
22	free-flow speed (km/h)	64/80	
23	class 1 vol	22	
24	class 2 vol	132	
25	class 3 vol	0	
	Link: B outbound		
26	length	3.4	
27	V/C		
28	free-flow spd	68/80	
29	class 1 vol	72	
30	class 2 vol	387	
31	class 3 vol	0	
	Link:		
32	length		
33	V/C		
34	free-flow spd		
35	class 1 vol		
36	class 2 vol		
37	class 3 vol		
	Link:		
38	length		
39	V/C		
40	free-flow spd		
41	class 1 vol		
42	class 2 vol		
43	class 3 vol		
	Link:		
44	length		
45	V/C		
46	free-flow spd		
47	class 1 vol		
48	class 2 vol		
49	class 3 vol		
	Link:		
50	length		
51	V/C		
52	free-flow spd		
53	class 1 vol		
54	class 2 vol		
55	class 3 vol		
	Link:		
56	length		
57	V/C		
58	free-flow spd		
59	class 1 vol		
60	class 2 vol		
61	class 3 vol		
	Link:		
62	length		
63	V/C		
64	free-flow spd		
65	class 1 vol		
66	class 2 vol		
67	class 3 vol		
	Link:		
68	length		
69	V/C		
70	free-flow spd		
71	class 1 vol		
72	class 2 vol		
73	class 3 vol		

TRIP-ORIGINS - MORNING PEAK HOUR

ZONE	HIGH INCOME HH	MIDDLE INCOME HH	LOW INCOME HH	EMPLOYMENT	TOTAL
1. Car	2250	2100	350		4725
Bus	1000	3600	1500		6100
Truck				920	920
Walk	250	800	375		1425
2. Car					
Bus					
Truck				500	500
Walk					
3. Car					
Bus					
Truck				400	400
Walk					
4. Car	840	60			900
Bus	280	120			400
Truck				150	150
Walk	120	20			140
5. Car					
Bus					
Truck				240	240
Walk					
6. Car		750	300		1050
Bus		1800	1600		3400
Truck				30	30
Walk		225	300		525
7. Car					
Bus					
Truck				400	400
Walk					
8. Car	735	650	300		1685
Bus	375	1400	900		2675
Truck				180	180
Walk	75	260	100		435
9. Car	5175	350	410		5935
Bus	2325	225	2420		4970
Truck					
Walk	135	145	550		830
TOTAL Car	9000	3915	1385		14300
Bus	3980	7145	6420	2820	17545
Truck				2820	2820
Walk	580	1450	1325		3355
TOTAL	13560	12510	9130	2820	38020

 Year 1989

TRIP DESTINATIONS - MORNING PEAK HOUR

ZONE	HIGH INCOME HH	MIDDLE INCOME HH	LOW INCOME HH	EMPLOYMENT	TOTAL
1. Car	2990	1035	460		4485
Bus	1380	2070	2070		5520
Truck				920	920
Walk	230	500	460		1190
2. Car	1300	600	200		2100
Bus	600	1000	900		2500
Truck				500	500
Walk	100	250	200		550
3. Car	1040	360	160		1560
Bus	480	900	630		2010
Truck				400	400
Walk	80	200	160		440
4. Car	725	400	100		1225
Bus	250	575	475		1300
Truck				150	150
Walk	50	100	75		225
5. Car	870	500	120		1490
Bus	300	600	540		1440
Truck				240	240
Walk	60	90	90		240
6. Car	115	80	15		210
Bus	50	150	115		315
Truck				30	30
Walk	5	40	20		65
7. Car	1150	700	150		2000
Bus	500	1250	1150		2900
Truck				400	400
Walk	25	150	200		375
8. Car	810	240	180		1230
Bus	420	600	540		1560
Truck				180	180
Walk	30	120	120		270
9. Car					
Bus					
Truck					
Walk					
TOTAL Car	9000	3915	1385		14300
Bus	3980	7145	1420		17545
Truck				2820	2820
Walk	1580	1450	1325		3355
TOTAL	13560	12510	9180	2820	38020

O-D DISTRIBUTION OF CAR TRIPS

ORIGIN	ZONE	1	2	3	4.	5	6	7	8	9	TOTAL
1.	H	873	343	280	136	201	20	281	116	0	2250
	M	688	366	236	193	175	31	355	56	0	2100
	L	168	73	48	24	21	4	18	19	0	375
	TOTAL	1729	782	564	353	397	55	654	191	0	4725
2.	H										
	M										
	L										
	TOTAL										
3.	H										
	M										
	L										
	TOTAL										
4.	H	248	146	131	129	86	9	69	23	0	840
	M	11	7	7	7	7	7	7	7	0	60
	L	0	0	0	0	0	0	0	0	0	0
	TOTAL	259	153	138	136	93	16	76	30	0	900
5.	H										
	M										
	L										
	TOTAL										
6.	H										
	M	140	96	42	105	159	26	113	69	0	750
	L	82	38	39	28	38	2	44	27	0	300
	TOTAL	222	134	81	133	197	28	157	96	0	1050
7.	H										
	M										
	L										
	TOTAL										
8.	H	163	86	48	46	68	34	128	165	0	735
	M	95	78	43	61	113	9	164	87	0	650
	L	74	32	24	19	24	3	43	81	0	300
	TOTAL	332	196	115	126	205	46	335	333	0	1685
9.	H	1707	125	621	444	508	52	672	466	0	5175
	M	91	53	32	39	46	77	61	21	0	350
	L	136	57	49	29	37	4	45	53	0	5135
	TOTAL	1934	835	702	482	601	63	778	540		5935
TOTAL	H	2990	1300	1040	725	870	115	1150	810	0	9000
	M	1035	600	360	400	500	80	700	240		3915
	L	460	300	160	100	120	75	150	180	0	1545
TOTAL		4485	2200	1560	1225	1490	270	2000	1230	0	14,460

O-D DISTRIBUTION OF BUS TRIPS

Year 1989

ORIGIN ZONE	1	2	3	4.	5	6	7	8	9	TOTAL
1. H	401	169	135	60	63	11	94	67	0	1,000
M	1342	570	509	247	217	59	541	115	0	3,600
L	633	230	190	81	95	20	180	66	0	1,500
TOTAL	2376	969	834	393	375	90	815	248	0	6,100
2. H										
M										
L										
TOTAL										
3. H										
M										
L										
TOTAL										
4. H	93	42	34	34	27	8	25	17	0	280
M	32	16	16	16	8	8	16	8	0	120
L	0	0	0	0	0	0	0	0	0	0
TOTAL	125	58	50	50	35	16	41	25		4 0
5. H										
M										
L										
TOTAL										
6. H	0	0	0	0	0	0	0	0	0	0
M	372	229	210	201	210	73	292	239	0	1800
L	443	238	136	158	197	30	279	93	0	1600
TOTAL	815	467	346	359	407	103	571	332		3400
7. H										
M										
L										
TOTAL										
8. H	96	40	32	16	24	8	79	80	0	375
M	264	153	136	93	147	25	340	246	0	1400
L	220	93	62	51	65	17	231	161	0	900
TOTAL	580	286	230	160	236	50	650	487	0	2675
9. H	790	349	279	140	186	23	302	256	0	2325
M	64	32	29	18	18	5	41	18	0	225
L	774	339	242	169	194	48	460	194	0	2420
TOTAL	1528	720	550	32	398	76	803	468	0	4970
TOTAL H										
M										
L										
TOTAL										

O-D DISTRIBUTION OF TRUCK TRIPS Year 1989

ORIGIN ZONE	1	2	3	4.	5	6	7	8	9	TOTAL
1. H M L										
TOTAL	381	149	120	40	86	6	75	63	0	920
2. H M L										
TOTAL	133	14	74	35	20	7	74	14	0	500
3. H M L										
TOTAL	149	60	97	14	21	0	44	15	0	400
4. H M L										
TOTAL	46	24	24	16	16	0	16	8	0	150
5. H M L										
TOTAL	71	35	27	18	48	0	27	14	0	240
6. H M L										
TOTAL	10	10	5	0	0	0	5	0	0	30
7. H M L										
TOTAL	92	51	34	17	30	17	121	38	0	400
8. H M L										
TOTAL	38	28	19	10	19	0	38	28	0	180
9. H M L										
TOTAL	120	100	60	5	8	2	10	20	0	325
TOTAL H M L										
TOTAL	920	500	400	150	240	30	400	180	0	3,145

LINK ASSIGNMENTS BY MODE CAR

ORIGIN ZONE	1	2	3	4	5	6	7	8	9	Total Passengers	Total FCU
LINK 1-1	4725									4725	
1-2	782			153		134		196	835	2100	
1-3	564									564	
1-4	1650									1650	
2-1											
2-2											
*(2-5)											
3-1											
3-3											
3-4											
4-1				312		356		528	2769	3965	
4-3				138		81		115	702	1036	
4-4				900						900	
4-5	397			93						490	
4-6	55			16						71	
4-7	654			76						730	
4-8	191			30						221	
*(5-2)											
5-4											
5-5											
5-6											
5-7											
5-8											
6-4						570				570	
6-5						197				197	
6-6						1050				1050	
6-7						151				151	
6-8						96				96	
7-4											
7-5											
7-6											
7-7											
7-8											
8-4								769	3973	4742	
8-5								205	601	806	
8-6								46	63	109	
8-7								335	778	1113	
8-8								1685		1685	
8-9											
9-8									5135	5135	
9-9									5135	5135	

Year 1989

LINK ASSIGNMENTS BY MODE

ORIGIN ZONE	1	2	3	4	5	6	7	8	9	Total Passengers	Total FCU
LINK 1-1	6100									6100	
1-2	969			58		467		286		1780	
1-3	834									834	
1-4	1927									1927	
2-1											
2-2											
*(2-5)											
3-1											
3-3											
3-4											
4-1				183		1282		866	2248	4579	
4-3				50		346		230	540	1166	
4-4				400						400	
4-5	375			35						410	
4-6	90			16						106	
4-7	815			41						856	
4-8	248			25						273	
*(5-2)											
5-4											
5-5											
5-6											
5-7											
5-8											
6-4						1987				1987	
6-5						407				407	
6-6						3400				3400	
6-7						571				571	
6-8						332				332	
7-4											
7-5											
7-6											
7-7											
7-8											
8-4								1256	3115	4371	
8-5								236	398	634	
8-6								50	76	126	
8-7								650	803	1453	
8-8								2675		2675	
8-9											
9-8									4970	4970	
9-9									4970	4970	

Year 1989

LINK ASSIGNMENTS BY MODE: TRUCK

ORIGIN ZONE	1	2	3	4	5	6	7	8	9	Total Passengers	Total FCU
LINK 1-1	920									920	
1-2	149		60	24	35	10	51			329	
1-3	120	74								194	
1-4	270	150								420	
2-1		357								357	
2-2		500								500	
2-5											
3-1			209							209	
3-3			400							400	
3-4			94							94	
4-1				70	106	20	143	66		405	
4-3				24	27	5	34	19		109	
4-4				150						150	
4-5	86	20	21	16						143	
4-6	6	7								13	
4-7	75	74	44	16						209	
4-8	63	14	15	8						100	
5-2											
5-4					157					157	
5-5					240					240	
5-6					0					0	
5-7					27					27	
5-8					14					14	
6-4						25				25	
6-5											
6-6						30				30	
6-7						5				5	
6-8											
7-4							194			194	
7-5							30			30	
7-6							17			17	
7-7							400			400	
7-8							38			38	
8-4								95		95	
8-5								19		19	
8-6								38		38	
8-7											
8-8								180		180	
8-9											
9-8											
9-9											

PROGRAMMING LAND DEMAND

A1) With <u>No</u> highway component

A2) With highway component

B1) With weak public transport component
B1A) Context A1
B1B) Context A2

B2) With strong public transport component
B2A) Context A1
B2B) Context A2

					$\frac{LW}{\sqrt{C}}$	$\frac{GLW}{\sqrt{C}}$	B		
1	83	83	6889	898 30	229.6	.75	7875	8300	79
4	4 8	2	8	4.7	1.702	.01	105	200	.02
8	60 48	20	1200	16.1	59.6	.24	2520	2000	.19
					305.8		10500	10500	

LOW MODE

	L_i	W_i	LW	$\sqrt{C}$	$\frac{LW}{\sqrt{C}}$	$\frac{GLWD}{\sqrt{C}}$	Mode	4.11
1	12.13	41	541	4 10	60	.70	3710	4100
4	—	0	/	/				—
8	10.8	12	130	6	22	.30	1590	1200
					72			5300

- 98 -

11

$$G_1^z \, 2 \quad \frac{G^2 \; L_1 \; W_1^z}{C_1^z} \; B$$

Total loan cost/mm

	H	M	L
1 2	39.4 9.9 50 1404 / 1494	11.3 CAR 5.4 BUS 16 882 / 898	2.2 BUS 2 103 / 105
3 4 5 6	22.5 CAR 5.3 BUS 28 432 / 460	.72 .71 1 21 / 22	/ 0
7 8 9	51.3 CAR 16.1 BUS 67 432 / 499	25.4 CAR 22.3 BUS 48 210 / 258	6.8 BUS 7 30 / 37

1984 - 1989 Volume Increments
Links A & B

			LINK A 1984	LINK A 1989	LINK A Increment	LINK B 1979	LINK B 1984	LINK B 1989	LINK B 1984-89 Increment	LINK B 1979-84 Increment
High	Auto	In	4223	5279	211.2	809	3603	4479	174.8	559.2
		Out	114	139	5	254	281	489	41.6	5.4
	Bus	In	2322	2364	8.4	262	2095	1983	22.4	366.6
		Out	31	84	10.6	78	90	203	22.6	2.4
Med.	Auto	In	418	892	94.5	625	357	667	62	53.6
		Out	91	132	8.2	86	252	607	71	33.2
	Bus	In	1245	1361	23.2	1083	1060	977	16.6	4.6
		Out	142	462	64	132	439	1211	154.4	61.4
Low	Auto	In	470	576	21.2	0	470	488	3.6	94
		Out	3	46	8.6	0	7	108	20.2	1.4
	Bus	In	2410	3965	311	1522	2210	3274	212.8	137.6
		Out	6	159	30.6	114	18	618	120	19.2
	Truck	In	342	417	15	230	387	576	37.8	31.4
		Out	342	417	15	230	387	576	37.8	31.4

Origin Zone: 4

Mode: Car

Values of Time ($/hr)

class 1	2.18	(A)
class 2	.56	
class 3	.18	

Mode:

O.C. parameter	1	(B)
occupancy	~~1.6~~	
expansion factor	107.4	

Number of Links: 9 (C)

Link: A Out

length (km)	2.1
V/C	.73/.24
free-flow speed (km/h)	80/100
class 1 vol	79
class 2 vol	86
class 3 vol	0

Link: B Out

length	3.4
V/C	.96/.32
free-flow spd	80/100
class 1 vol	168
class 2 vol	223
class 3 vol	0

Link: C Out

length	1.5
V/C	.62
free-flow spd	60
class 1 vol	363
class 2 vol	408
class 3 vol	0

Link: D Out

length	2.4
V/C	.49
free-flow spd	60
class 1 vol	402
class 2 vol	453
class 3 vol	0

Link: E Out

length	1.4
V/C	1.15
free-flow spd	60
class 1 vol	284
class 2 vol	231
class 3 vol	50

Link: F Out

length	1.0
V/C	.27
free-flow spd	60
class 1 vol	198
class 2 vol	231
class 3 vol	50

Link: H Out

length	0.5
V/C	.05
free-flow spd	60
class 1 vol	18
class 2 vol	16
class 3 vol	0

Link: J Out

length	o.9
V/C	.52
free-flow spd	60
class 1 vol	177
class 2 vol	169
class 3 vol	0

Link: K Out

length	0.5
V/C	.54
free-flow spd	60
class 1 vol	89
class 2 vol	73
class 3 vol	0

Year: 1984

Origin Zone: 4

Mode: Car

Values of Time ($/hr)

class 1	______	(A)
class 2	______	
class 3	______	

Mode:

O.C. parameter	______	(B)
occupancy	______	
expansion factor	______	

Number of Links: 9 (C)

Link: A Out

length (km)	2.1
V/C	.73/.24
free-flow speed (km/h)	80/100
class 1 vol	35
class 2 vol	5
class 3 vol	0

Link: B Out

length	3.4
V/C	.96/.32
free-flow spd	80/100
class 1 vol	113
class 2 vol	11
class 3 vol	0

Link: C Out

length	1.5
V/C	.62
free-flow spd	60
class 1 vol	200
class 2 vol	17
class 3 vol	0

Link: D In

length	2.4
V/C	1.02
free-flow spd	60
class 1 vol	246
class 2 vol	17
class 3 vol	0

Link: F Out

length	1.4
V/C	1.15
free-flow spd	60
class 1 vol	88
class 2 vol	6
class 3 vol	0

Link: G In

length	2.2
V/C	.59
free-flow spd	60
class 1 vol	79
class 2 vol	6
class 3 vol	0

Link: H Out

length	.5
V/C	.05
free-flow spd	60
class 1 vol	26
class 2 vol	0
class 3 vol	0

Link: J Out

length	.9
V/C	.52
free-flow spd	60
class 1 vol	61
class 2 vol	6
class 3 vol	0

Link: K Out

length	.5
V/C	.54
free-flow spd	60
class 1 vol	78
class 2 vol	6
class 3 vol	0

Origin Zone: 6

Mode: Car

Values of Time ($/hr) (A)

class 1	
class 2	
class 3	

Mode: (B)

O.C. parameter	
occupancy	
expansion factor	

Number of Links: 9 (C)

Link: A Out

length (km)	2.1
V/C	.73/.24
free-flow speed (km/h)	80/100
class 1 vol	0
class 2 vol	6
class 3 vol	3

Link: B Out

length	3.4
V/C	.96/.32
free-flow spd	80/100
class 1 vol	0
class 2 vol	18
class 3 vol	7

Link: C In

length	1.5
V/C	1.25
free-flow spd	60
class 1 vol	0
class 2 vol	20
class 3 vol	8

Link: D In

length	2.4
V/C	1.02
free-flow spd	60
class 1 vol	0
class 2 vol	12
class 3 vol	4

Link: E Out

length	1.4
V/C	1.15
free-flow spd	60
class 1 vol	0
class 2 vol	3
class 3 vol	1

Link: G In

length	2.2
V/C	.59
free-flow spd	60
class 1 vol	0
class 2 vol	6
class 3 vol	3

Link: H In

length	.5
V/C	.04
free-flow spd	60
class 1 vol	0
class 2 vol	56
class 3 vol	19

Link: J Out

length	.9
V/C	.52
free-flow spd	60
class 1 vol	0
class 2 vol	16
class 3 vol	5

Link: K Out

length	.5
V/C	.54
free-flow spd	60
class 1 vol	0
class 2 vol	12
class 3 vol	4

Origin Zone: 8

Mode: Car

Values of Time ($/hr)

class 1		(A)
class 2		
class 3		

Mode:

O.C. parameter		(B)
occupancy		
expansion factor		

Number of Links: 9 (C)

Link: A In

length (km)	2.1
V/C	1.5/.96
free-flow speed (km/h)	80/100
class 1 vol	536
class 2 vol	387
class 3 vol	0

Link: B In

length	3.4
V/C	1.5/.89
free-flow spd	395
class 1 vol	318
class 2 vol	0
class 3 vol	

Link: C In

length	1.5
V/C	1.25
free-flow spd	60
class 1 vol	317
class 2 vol	264
class 3 vol	0

Link: D In

length	2.4
V/C	1.02
free-flow spd	60
class 1 vol	235
class 2 vol	215
class 3 vol	0

Link: E Out

length	1.4
V/C	1.15
free-flow spd	60
class 1 vol	96
class 2 vol	77
class 3 vol	0

Link: G In

length	2.2
V/C	.59
free-flow spd	60
class 1 vol	69
class 2 vol	40
class 3 vol	0

Link: H Out

length	.5
V/C	.05
free-flow spd	60
class 1 vol	9
class 2 vol	11
class 3 vol	0

Link: J Out

length	1
V/C	.52
free-flow spd	60
class 1 vol	69
class 2 vol	43
class 3 vol	0

Link: K Out

length	.5
V/C	.54
free-flow spd	60
class 1 vol	141
class 2 vol	69
class 3 vol	0

Origin Zone: 1

Mode: Bus

Values of Time ($/hr) (A)

class 1	
class 2	
class 3	

Mode: (B)

O.C. parameter	4.3
occupancy	45
expansion factor	92

Number of Links: 9 (C)

Link: A Out

length (km)	2.1
V/C	.73/.24
free-flow speed (km/h)	64/80
class 1 vol	72
class 2 vol	387
class 3 vol	0

Link: B Out

length	1.5
V/C	.96/.32
free-flow spd	64/80
class 1 vol	72
class 2 vol	387
class 3 vol	0

Link: C Out

length	1.5
V/C	.62
free-flow spd	42
class 1 vol	116
class 2 vol	738
class 3 vol	0

Link: D Out

length	2.4
V/C	.49
free-flow spd	42
class 1 vol	125
class 2 vol	819
class 3 vol	0

Link: E Out

length	1.4
V/C	1.15
free-flow spd	47
class 1 vol	109
class 2 vol	443
class 3 vol	194

Link: F Out

length	1.0
V/C	.29
free-flow spd	42
class 1 vol	67
class 2 vol	312
class 3 vol	133

Link: H Out

length	.5
V/C	.05
free-flow spd	02
class 1 vol	0
class 2 vol	36
class 3 vol	0

Link: J Out

length	.9
V/C	.52
free-flow spd	42
class 1 vol	44
class 2 vol	315
class 3 vol	0

Link: K Out

length	.5
V/C	.54
free-flow spd	42
class 1 vol	50
class 2 vol	255
class 3 vol	0

Origin Zone: 41

Mode: Bus

Values of Time ($/hr)
- class 1 ______ (A)
- class 2 ______
- class 3 ______

Mode: ______
- O.C. parameter ______ (B)
- occupancy ______
- expansion factor ______

Number of Links: 9 (C)

Link: A Out	
length (km)	2.1
V/C	.73/.24
free-flow speed (km/h)	64/80
class 1 vol	9
class 2 vol	10
class 3 vol	0

Link: B Out	
length	3.4
V/C	.96/.32
free-flow spd	64/80
class 1 vol	18
class 2 vol	20
class 3 vol	0

Link: C Out	
length	1.5
V/C	.62
free-flow spd	42
class 1 vol	49
class 2 vol	30
class 3 vol	0

Link: D In	
length	2.4
V/C	1.02
free-flow spd	42
class 1 vol	75
class 2 vol	40
class 3 vol	0

Link: E Out	
length	1.4
V/C	1.15
free-flow spd	42
class 1 vol	27
class 2 vol	10
class 3 vol	0

Link: G In	
length	2.2
V/C	.59
free-flow spd	47
class 1 vol	27
class 2 vol	10
class 3 vol	0

Link: H Out	
length	.5
V/C	.05
free-flow spd	42
class 1 vol	9
class 2 vol	0
class 3 vol	0

Link: J Out	
length	.9
V/C	.52
free-flow spd	42
class 1 vol	22
class 2 vol	10
class 3 vol	0

Link: K Out	
length	.5
V/C	.54
free-flow spd	42
class 1 vol	9
class 2 vol	10
class 3 vol	0

Origin Zone: 6

Mode: Bus

Values of Time ($/hr) (A)

class 1	
class 2	
class 3	

Mode: (B)

O.C. parameter	
occupancy	
expansion factor	

Number of Links: 9 (C)

Link: A Out

length (km)	2.1
V/C	.73/.24
free-flow speed (km/h)	64/80
class 1 vol	0
class 2 vol	8
class 3 vol	6

Link: B Out

length	3.4
V/C	.96/.32
free-flow spd	64/80
class 1 vol	0
class 2 vol	32
class 3 vol	18

Link: C In

length	1.5
V/C	1.25
free-flow spd	42
class 1 vol	0
class 2 vol	56
class 3 vol	20

Link: D In

length	2.4
V/C	1.02
free-flow spd	42
class 1 vol	0
class 2 vol	36
class 3 vol	12

Link: E Out

length	1.4
V/C	1.15
free-flow spd	42
class 1 vol	0
class 2 vol	8
class 3 vol	3

Link: G In

length	2.2
V/C	.59
free-flow spd	42
class 1 vol	0
class 2 vol	16
class 3 vol	6

Link: H In

length	.5
V/C	.04
free-flow spd	42
class 1 vol	0
class 2 vol	112
class 3 vol	54

Link: J Out

length	.9
V/C	.52
free-flow spd	42
class 1 vol	0
class 2 vol	26
class 3 vol	16

Link: K Out

length	.5
V/C	.54
free-flow spd	42
class 1 vol	0
class 2 vol	24
class 3 vol	12

Year: 1984

Origin Zone: 8

Mode: Bus

Values of Time ($/hr)

class 1		(A)
class 2		
class 3		

Mode:

O.C. parameter		(B)
occupancy		
expansion factor		

Number of Links: 9 (C)

Link: A In

length (km)	2.1
V/C	1.5/.96
free-flow speed (km/h)	64/80
class 1 vol	231
class 2 vol	1120
class 3 vol	940

Link: B In

length	3.4
V/C	1.5/.89
free-flow spd	64/80
class 1 vol	210
class 2 vol	160
class 3 vol	820

Link: C In

length	1.5
V/C	1.25
free-flow spd	42
class 1 vol	180
class 2 vol	800
class 3 vol	720

Link: D In

length	2.4
V/C	1.25
free-flow spd	42
class 1 vol	140
class 2 vol	630
class 3 vol	600

Link: E Out

length	1.4
V/C	1.15
free-flow spd	42
class 1 vol	50
class 2 vol	210
class 3 vol	200

Link: G In

length	2.2
V/C	.54
free-flow spd	42
class 1 vol	30
class 2 vol	140
class 3 vol	100

Link: H Out

length	.5
V/C	.05
free-flow spd	42
class 1 vol	0
class 2 vol	20
class 3 vol	0

Link: J Out

length	.9
V/C	.52
free-flow spd	43
class 1 vol	30
class 2 vol	140
class 3 vol	100

Link: K Out

length	.5
V/C	.54
free-flow spd	42
class 1 vol	27
class 2 vol	160
class 3 vol	120

Year: 1984

ORIGIN ZONE: 1
Mode: Truck

Model Parameters

Labor cost ($/hr)	1	(B)
O.C. parameter	5.2	
expansion factor	115	
Number of Links:	8	(C)

Link: A Out

	length (km)	2.1
21	V/C	.73/.24
22	free-flow speed (km/h)	80/100
	volume	135

Link: B Out

	length	3.4
25	V/C	.96/.32
26	free-flow speed	80/100
	volume	135

Link: C Out

length	1.5
V/C	.62
free-flow speed	60
volume	178

Link: D Out

length	2.4
V/C	.49
free-flow speed	60
volume	190

Link: E Out

length	1.4
V/C	1.15
free-flow speed	60
volume	158

Link: F Out

length	1.0
V/C	29
free-flow speed	60
volume	140

Link: H Out

length	15
V/C	.05
free-flow speed	60
volume	0

Link: J Out

length	.9
V/C	.52
free-flow speed	60
volume	43

Link: K Out

length	.5
V/C	.54
free-flow speed	60
volume	28

Year: 1984

ORIGIN ZONE: 2
Mode: Truck

Modal Parameters
Labor cost ($/hr) ______ (B)
O.C. parameter ______
expansion factor ______

Number of Links: ______ (C)

Link: ______
length (km) ______
V/C .73/.24
free-flow speed (km/h) 85/100
23 volume 72

Link: ______
length ______
V/C .96/.32
free-flow speed 80/100
27 volume 105

Link: ______
length ______
V/C ______
free-flow speed ______
31 volume 131

Link: ______
length ______
V/C ______
free-flow speed ______
35 volume 137

Link: ______
length ______
37 V/C .56
free-flow speed ______
31 volume 375

Link: ______
length ______
V/C ______
free-flow speed ______
43 volume 71

Link: ______
length ______
V/C ______
free-flow speed ______
volume ______

Link: ______
length ______
V/C ______
free-flow speed ______
47 volume 26

Link: ______
length ______
V/C ______
free-flow speed ______
51 volume 33

Year: 1984

ORIGIN ZONE: 3
Mode: Truck

Modal Parameters

Labor cost ($/hr)		(B)
O.C. parameter		
expansion factor		
Number of Links:	9	(C)

Link:	A Out
length (km)	2.1
V/C	.73/.24
free-flow speed (km/h)	80/100
volume	58

Link:	B Out
length	3.4
V/C	.96/.32
free-flow speed	80/100
volume	94

Link:	C Out
length	1.5
V/C	.62
free-flow speed	60
volume	126

Link:	E Out
length	1.4
V/C	1.15
free-flow speed	60
volume	68

Link:	Fin
length	1.0
V/C	.18
free-flow speed	60
volume	183

Link:	G Out
length	2.2
V/C	.25
free-flow speed	60
volume	132

Link:	H Out
length	.5
V/C	.05
free-flow speed	60
volume	6

Link:	J Out
length	.9
V/C	.52
free-flow speed	60
volume	26

Link:	K Out
length	.5
V/C	.54
free-flow speed	60
volume	36

Year: 1984

ORIGIN ZONE: 4
Mode: Truck

Modal Parameters		
Labor cost ($/hr)		(B)
O.C. parameter		
expansion factor		
Number of Links:	3	(C)

Link: D In	
length (km)	2.4
V/C	1.02
free-flow speed (km/h)	60
volume	20

Link: E Out	
length	1.4
V/C	1.15
free-flow speed	60
volume	10

Link: G In	
length	2.2
V/C	59
free-flow speed	60
volume	10

Link:	
length	
V/C	
free-flow speed	
volume	

Link:	
length	
V/C	
free-flow speed	
volume	

Link:	
length	
V/C	
free-flow speed	
volume	

Link:	
length	
V/C	
free-flow speed	
volume	

Link:	
length	
V/C	
free-flow speed	
volume	

Link:	
length	
V/C	
free-flow speed	
volume	

Year: 1984

ORIGIN ZONE: 5
Mode: Truck

Modal Parameters

Labor cost ($/hr)		(B)
O.C. parameter		
expansion factor		
Number of Links:	9	(C)

Link: A Out

length (km)	2.1
V/C	.73/.24
free-flow speed (km/h)	80/100
volume	39

Link: B Out

length	3.4
V/C	.96/.32
free-flow speed	80/100
volume	53

Link: C In

length	1.5
V/C	1.25
free-flow speed	60
volume	82

Link: D In

length	2.4
V/C	1.02
free-flow speed	60
volume	59

Link: E Out

length	1.4
V/C	1.15
free-flow speed	60
volume	28

Link: G In

length	2.2
V/C	.59
free-flow speed	60
volume	23

Link: H Out

length	.5
V/C	.05
free-flow speed	60
volume	9

Link: J In

length	.9
V/C	.23
free-flow speed	60
volume	182

Link: K Out

length	.5
V/C	.54
free-flow speed	60
volume	14

Year: 1984

ORIGIN ZONE: 6
Mode: Truck

Changes from Zone 5

Modal Parameters
- Labor cost ($/hr) ______ (B)
- O.C. parameter ______
- expansion factor ______

Number of Links: 7 (C)

Link: ______
- length (km) ______
- V/C ______
- free-flow speed (km/h) ______
- volume 0

Link: ______
- length ______
- V/C ______
- free-flow speed ______
- volume 0

Link: ______
- length ______
- V/C ______
- free-flow speed ______
- volume 15

Link: ______
- length ______
- V/C ______
- free-flow speed ______
- volume 15

Link: ______
- length ______
- V/C ______
- free-flow speed ______
- volume 7

Link: ______
- length ______
- V/C ______
- free-flow speed ______
- volume 0

Link: H In
- length ______
- V/C .04
- free-flow speed ______
- volume 15

Link: ______
- length ______
- V/C ______
- free-flow speed ______
- volume ______

Link: ______
- length ______
- V/C ______
- free-flow speed ______
- volume ______

Year: 1984

ORIGIN ZONE: 7
Mode: Truck

Changes from Zone 5

Modal Parameters		
Labor cost ($/hr)		(B)
O.C. parameter		
expansion factor		
Number of Links:	9	(C)

Link:	
length (km)	
V/C	.73/.24
free-flow speed (km/h)	80/100
volume	66

Link: B In	
length	
V/C	1.5/.89
free-flow speed	80/100
volume	102

Link:	
length	
V/C	
free-flow speed	
volume	86

Link:	
length	
V/C	
free-flow speed	
volume	66

Link:	
length	
V/C	
free-flow speed	
volume	30

Link:	
length	
V/C	
free-flow speed	
volume	14

Link:	
length	
V/C	
free-flow speed	
volume	0

Link:	
length	
V/C	.52
free-flow speed	
volume	16

Link:	
length	
V/C	.25
free-flow speed	
volume	198

Year: 1984

ORIGIN ZONE: 8
Mode: Truck

Changes from Zone 7

Modal Parameters
Labor cost ($/hr) ______ (B)
O.C. parameter ______
expansion factor ______

Number of Links: 9 (C)

Link: A In
length (km)
V/C 1.5/.96
free-flow speed (km/h) 80/100
volume 114

Link: B In
length
V/C 1.5/.89
free-flow speed 80/100
volume 95

Link:
length
V/C
free-flow speed
volume 84

Link:
length
V/C
free-flow speed
volume 65

Link:
length
V/C
free-flow speed
volume .26

Link:
length
V/C
free-flow speed
volume 19

Link:
length
V/C
free-flow speed
volume 0

Link:
length
V/C
free-flow speed
volume 11

Link:
length
V/C .54
free-flow speed
volume 19

Year: 1984

BENEFITS TO RESIDENTS OF ORIGIN ZONE 1

		AUTO	BUS
NO BUILD			
Income class 1	OC	15501.79	757.77
	TC	26508.26	11165.60
Income class 2	OC	17232.42	4317.18
	TC	7351.37	15500.10
Income class 3	OC	642.27	308.73
	TC	124.18	561.18
Total	OC	33376.47	5383.69
	TC	33983.81	27226.89
BUILD			
Income class 1	OC	14865.12	705.71
	TC	21635.33	9043.61
Income class 2	OC	16403.70	4033.77
	TC	5747.25	12536.17
Income class 3	OC	642.27	308.73
	TC	124.18	561.18
Total	OC	31911.08	5048.21
	TC	27506.75	22140.97
DIFFERENCE			
Income class 1	OC	636.67	52.06
	TC	4872.93	2122.00
Income class 2	OC	828.72	283.42
	TC	1604.12	2963.93
Income class 3	OC	0.00	0.00
	TC	0.00	0.00
Total	OC	1465.39	335.48
	TC	6477.06	5085.92

Year 1984

BENEFITS TO RESIDENTS OF ORIGIN ZONE 4

		AUTO	BUS
NO BUILD			
Income class 1	CC	9522.10	350.04
	TC	19656.22	6354.84
Income class 2	CC	777.92	211.92
	TC	400.14	946.12
Income class 3	CC	0.00	0.00
	TC	0.00	0.00
Total	CC	10300.02	561.96
	TC	20056.36	7300.96
BUILD			
Income class 1	CC	9105.81	336.11
	TC	16541.71	5790.64
Income class 2	CC	736.34	196.45
	TC	318.58	785.08
Income class 3	CC	0.00	0.00
	TC	0.00	0.00
Total	CC	9842.16	532.56
	TC	16860.29	6575.72
DIFFERENCE			
Income class 1	CC	416.29	13.93
	TC	3114.51	564.20
Income class 2	CC	41.57	15.48
	TC	81.56	161.04
Income class 3	CC	0.00	0.00
	TC	0.00	0.00
Total	CC	457.86	29.40
	TC	3196.07	725.24

Year 1984

BENEFITS TO RESIDENTS OF ORIGIN ZONE 6

		AUTO	BUS
NO BUILD			
Income class 1	OC	0.00	0.00
	TC	0.00	0.00
Income class 2	OC	1055.08	325.44
	TC	560.76	1581.57
Income class 3	OC	402.91	145.92
	TC	68.81	211.23
Total	OC	1457.99	471.36
	TC	629.57	1792.80
BUILD			
Income class 1	OC	0.00	0.00
	TC	0.00	0.00
Income class 2	OC	988.49	302.77
	TC	432.34	1343.70
Income class 3	OC	376.57	132.77
	TC	52.27	167.03
Total	OC	1365.06	435.54
	TC	484.60	1510.73
DIFFERENCE			
Income class 1	OC	0.00	0.00
	TC	0.00	0.00
Income class 2	OC	66.59	22.68
	TC	128.42	237.87
Income class 3	OC	26.34	13.15
	TC	16.55	44.20
Total	OC	92.93	35.82
	TC	144.97	282.07

Year 1984

BENEFITS TO RESIDENTS OF ORIGIN ZONE 8

		AUTO	BUS
NO BUILD			
Income class 1	OC	23756.66	1637.97
	TC	77277.15	44108.70
Income class 2	OC	18663.96	7507.09
	TC	15639.94	51844.24
Income class 3	OC	0.00	6519.95
	TC	0.00	14509.99
Total	OC	42420.63	15665.01
	TC	92917.09	110462.93
BUILD			
Income class 1	OC	20887.15	1475.81
	TC	41713.83	25365.74
Income class 2	OC	16454.43	6756.39
	TC	8619.70	29539.95
Income class 3	OC	0.00	5883.00
	TC	0.00	8429.37
Total	OC	37341.58	14115.20
	TC	50333.53	63335.06
DIFFERENCE			
Income class 1	OC	2869.51	162.16
	TC	35563.32	18742.96
Income class 2	OC	2209.54	750.70
	TC	7020.24	22304.29
Income class 3	OC	0.00	636.94
	TC	0.00	6080.63
Total	OC	5079.05	1549.81
	TC	42583.56	47127.88

Year 1984

TRUCK COSTS FROM EACH ORIGIN ZONE

Origin Zone:	1	2	3	4
No-Build				
OC *	82483.03	73860.69	54476.85	4229.52
labor	7834.72	6080.97	4706.83	554.65
Build				
OC *	77669.78	70182.93	51222.28	4229.52
labor	5719.15	4485.11	3306.68	554.65
Difference				
OC *	4813.25	3677.76	3254.57	0.00
labor	2115.56	1595.86	1400.15	0.00
Total OC	6928.81	5273.63	4654.72	0.00

Origin Zone:	5	6	7	8
No-Build				
OC	37543.85	3925.04	48609.66	54610.80
labor	4394.30	598.01	7464.02	9364.21
Build				
OC	35671.86	3925.04	44407.69	48762.77
labor	3577.03	598.01	4650.16	5377.30
Difference				
OC *	1871.99	0.00	4201.97	5848.03
labor	817.27	0.00	2813.86	3986.91
Total OC	2689.26	0.00	7015.83	9834.94

6.4 Instructions for computing benefits to a single link (Second Program)

BSL-2.3(A)

USER INSTRUCTIONS

		Enter	Press
1.	Set partition.	7	2nd Op. 17
2.	Enter data on Input Data Sheet into appropriate registers. This includes data this will probably not change during the analysis: modal characteristics, values of time, discount rate. It also includes data-specific to one link: modal volumes, volume increments (or growth rate), length, and capacity. To check that all the data is properly stored, press 0 INV 2nd list.		
3.	Load program BSL-2.3(A) for liniar growth, or program BSL-2.3(B) for exponential growth. Load sides 1 and 2.	0 0	(load sides) (load side 2)
4.	Initialize the accumulators of discounted costs.	0	STO 68 STO 69
5.	Enter number of years for which costs should be computed with volume and growth data as given.	n_1	STO 00
6.	Fix the display format to have 2 decimal places		2nd Fix 2
7.	Computer costs for n_1 years	B	
8.	To change the incremental volumes		

SINGLE LINK COST STREAM PROGRAM

BSL 2.3(A) INPUT DATA

Register			Link A 1979 NB	Link A 1981 NB	Link A 1981 Build	Link B 1979 NB	Link B 1981 NB	Link B 1981 Build	Link C 1979 NB	Link C 1984 NB
8	Auto	free-flow speed	80		100					
9		expansion factor	107.4							
10		OC parameter	1							
11		occupancy	1.6							
12	Bus	free-flow speed	64		80					
		expansion factor	92							
		OC parameter	4.3							
		occupancy	45							
16	Truck	free-flow speed	80		100					
		expansion factor	115							
		OC parameter	5.2							
		occupancy	1							
20	Class 1	auto volume in	809	2175.4					757	
21		" out	254	198					349	
22		bus volume in	262	1086					228	
23		" out	78	59.2					97	
24	Class 2	auto volume in	625	538.2					609	
25		" out	86	88					121	
26		bus " in	1083	1107.8					1052	
27		" out	132	139.2					162	
28	Class 3	auto volume in	0	188					0	
29		" out	0	1.2					0	
30		bus " in	1522	1877.2					1418	
31		" out	114	73.2					147	
32	Truck	volume in	230	270.4					250	503
		" out	230	270.4					250	503
34	Class 1	value of time	2.18							
35	Class 2	VOT	.56							
36	Class 3	VOT	.18							
37	Auto	PCU equivalency	1							
38	Bus	PCU "	3							
39	Truck	PCU "	3							

<u>Yearly incremental volumes</u>

Register			Link A	Link B	Link C
40	Class 1	Auto yiv in	683.2	559.2	489
		" out	-28	5.4	10
		Bus " in	412	366.6	169
		" out	- 9.4	2.4	16
44	Class 2	Auto yiv in	-43.4	-53.6	57
45		" out	1	33.2	58
46		Bus " in	12.4	-4.6	69
47		" out	3.6	61.4	62
48	Class 3	Auto yiv in	94	94	103
49		Auto " out	0.6	1.4	10
50		Bus " in	177.6	137.6	219
51		Bus " out	-20.4	-19.2	0
52	Truck	" in	20.2	31.4	50.6
53		" out	20.2	31.4	50.6

54 1 + discount rate	1.11				
55* first year discount factor	1	1.2321		1.2321	
56 link length (km)	3.4			3.4	
57 link capacity (PCV)	1600	4800	4800		4800
68 cumulative discounted total OC					
69 cumulative discounted total TC					

Supplementary Yearly incremental volumes for 1984				Link A 1984 NB	Link B 1984 NB	Link C 1984 NB
40	Class 1	Auto	yiv in	211.2	174.8	135
41			" out	5	41.6	70
42		Bus	" in	8.4	−22.4	138
43			" out	10.6	22.6	23
44	Class 2	Auto	yiv in	94.5	62	−39
45			" out	8.2	71	80
46		Bus	" in	23.2	−16.6	32
47			" out	64	154.4	142
48	Class 3	Auto	yiv in	21.2	3.6	3
49			" out	8.6	20.2	17
50		Bus	" in	311	212.8	10
51		Bus	" out	30.6	120	60
52	Truck		" in	15	37.8	58
53			" out	15	37.8	58

COMPUTING COSTS ON LINK A, 1981-2000

Link A No-Build

1. Load liniar growth program, BSL-2.3(A)

2. Enter data for Link A, 1981, No-Build. Store it on a magnetic card (press 3 2nd write and load side 3; 4 2nd write & load side)

3. a. Enter 0 STO 68 STO 69
   b. Enter 3 STO 00. Press 2nd Fix 2.
   c. Press B
   (costs for 1981, 1982, 1983 will be printed)
   (volumes will be updated to 1984)

4. a. Enter incremental volumes for the 1984-1989 interval, in registers 40-53.
   b. Enter 5 STO 00
   c. Press B
   (costs for 1984, 85, 86, 87, 88 will be printed)
   (volumes will be updated to 1989)

5. Load exponential growth program, BSL-2.3(B), sides 1 & 2.

6. a. Enter cumulative operating costs into register 68
   Enter cumulative time costs into register 69.
   (these costs were the first 2 of the last 3 numbers just printed)
   b. Enter growth factor: 1.05 STO 41
   c. Enter 12 STO 00
   d. Press B
   (Costs for 1989-2000 will be printed - takes 30 minutes)

Link A Build

7. If you have the Link A 1981 No-Build data on a card, load in (press 0, enter side 3; press 0, enter side 4.
   If not, the 1981 data may be entered manually.

8. Change the free-flow speeds (registers 8, 12, 16) and capacity (register 57) for build.

9. Proceed with Stpes 3-6.

DISCOUNTED COSTS ON SINGLE LINK INPUTS

BSL-2.3(A) CARD B

Register Content (Input Data)

*00	number of years	
01	counter	
02	counter	
03	pointer	
04	pointer	
05	pointer	
06	pointer	
07	pointer	
08	car free-flow speed	modal char. file
09	expansion factor	modal char. file
10	operating cost parameter	modal char. file
11	occupancy	modal char. file
12	bus	modal char. file
13		modal char. file
14		modal char. file
15		modal char. file
16	truck	modal char. file
17		modal char. file
18		modal char. file
19		modal char. file
20	Class 1 car volume in	car, bus vols.
21	out	car, bus vols.
22	bus in	car, bus vols.
23	out	car, bus vols.
24	Class 2 car	car, bus vols.
25		car, bus vols.
26	bus	car, bus vols.
27		car, bus vols.
28	Class 3 car	car, bus vols.
29		car, bus vols.
30	bus	car, bus vols.
31		car, bus vols.
32	truck volume in	truck vols.
33	out	truck vols.
34	Class 1 VOT	VOT
35	2	VOT
36	3	VOT
37	car PCV equivalency	PCU
38	bus " "	PCU
39	truck " "	PCU

40	incremental volumes class 1 car in
41	out
42	bus in
43	out
44	class 2 car
45	
46	bus
47	
48	class 3 car
49	
50	bus
51	
52	truck incremental volume in
53	truck incremental volume out
54	1+ discount rate
55	discount factor for first year
56	length
57	capacity (for 2 hours)

LINK A
No-Build 1979-84

# of years → 6 ← (6)		00
	0.	01
	0.	02
	0.	03
	0.	04
	0.	05
	0.	06
Modal Char's	0.	07
Free-flow spd	80.	08
expansion factor	107.4	09
operating cost param	1.	10
occupancy	1.6	11
	64.	12
	92.	13
	4.3	14
bus	45.	15
	80.	16
	115.	17
truck	5.2	18
	1.	19
class 1 car in	809.	20
out	254.	21
bus in	262.	22
out	78.	23
class 2 car in	625.	24
out	86.	25
bus in; Volumes	1083.	26
out; (2 hour,	132.	27
class 3 car in; pax)	0.	28
out	0.	29
bus in; 79 values	1522.	30
out; for	114.	31
truck in; the	230.	32
out; link	230.	33
	2.18	34
Values of	0.56	35
time	0.18	36
PCU	1.	37
equiv.	3.	38
	3.	39
Class 1 car in	683.2	40
out	-28.	41
bus in	412.	42
out; yearly	-9.4	43
class 2; volume	-43.4	44
increments	1.	45
unique	12.4	46
to each	3.6	47
class 3; link	94.	48
	0.6	49
	177.6	50
	-20.4	51
truck in	20.2	52
out; 1 + discount rate	20.2	53
	1.11	54
1st year discount factor	1.	55
length	2.1	56
capacity (2 hour)	1600.	57
	0.	58

LINK A
Build 1979-84

0.	00
0.	01
0.	02
0.	03
54.	04
34.	05
23.	06
40.	07
100.	08
107.4	09
1.	10
1.6	11
80.	12
92.	13
4.3	14
45.	15
100.	16
115.	17
5.2	18
1.	19
4908.2	20
86.	21
2734.	22
21.6	23
364.6	24
92.	25
1157.4	26
153.6	27
564.	28
3.6	29
2587.6	30
-8.4	31
351.2	32
351.2	33
2.18	34
0.56	35
0.18	36
1.	37
3.	38
3.	39
683.2	40
-28.	41
412.	42
-9.4	43
-43.4	44
1.	45
12.4	46
3.6	47
94.	48
0.6	49
177.6	50
-20.4	51
20.2	52
20.2	53
1.11	54
1.870414552	55
2.1	56
4800.	57

LINK A: NO-BUILD 1980-1999

1980	1981	1992
1777.38	2336.74	2896.10
924.10	966.45	1008.81
19599.96	34787.47	48982.30
39973.71	110664.40	167022.34
859.92	2046.37	3202.31
13779.42	52844.60	88441.27
20459.88	36833.85	52184.61
53753.13	163509.00	255463.61
13438.26	13541.77	12736.82
7421.34	11074.65	10813.01
3143.92	3378.48	3440.96
13685.11	22187.36	23603.70
16582.18	16920.25	16177.78
21106.45	33262.01	34416.71
0.00	1977.99	3980.86
0.00	554.32	1165.83
4264.12	4986.85	5470.89
6067.62	10870.13	12571.74
4264.12	6964.84	9451.75
6067.62	11424.46	13737.57
71370.39	81565.14	88951.56
6982.43	11085.09	12585.13
112676.57	142284.08	166765.70
87909.63	219280.56	316203.02
112676.57	240860.42	376211.20
87909.63	285459.69	542097.15
200586.20	526320.11	918308.36

1983	1984	1985
3455.46	4014.82	4846.33
1051.16	1093.51	1201.50
62971.22	76949.12	95488.31
217849.80	268632.01	335511.23
4348.10	5493.35	6687.93
121367.97	154278.06	188175.87
67319.32	82442.47	102176.25
339217.77	422910.06	523687.10
11856.55	10977.07	12257.97
10003.27	9195.05	10298.52
3488.02	3535.26	3804.32
23915.23	24230.39	25524.69
15344.57	14512.33	16062.29
33918.50	33425.44	35823.21
5971.67	7962.73	10546.47
1748.88	2332.03	3064.23
5929.51	6386.99	7794.93
13717.66	14860.38	18128.85
11901.18	14349.72	18341.40
15466.54	17192.41	21193.08
96133.97	103402.73	116802.29
13656.89	14753.80	16878.63
190699.05	214707.25	253382.23
402259.70	488281.72	597582.02
515648.70	657083.02	792551.51
836225.98	1157872.27	1477364.02
1351874.68	1814955.29	2269915.53
	1157872.27	

1986	1987	1988
5118.48	5390.63	5662.78
1267.14	1332.78	1398.42
100064.23	104642.68	109223.18
351687.53	367895.89	384138.15
6738.62	6790.09	6842.27
189225.39	190322.56	191471.27
106802.85	111432.77	116065.46
540912.91	558218.45	575609.42
14422.92	16592.60	18766.51
12218.69	14149.62	16092.06
4031.03	4262.49	4498.32
26566.89	27681.87	28875.63
18453.95	20855.09	23264.83
38785.58	41831.49	44967.68
11144.57	11748.19	12357.07
3215.71	3369.97	3527.24
8749.05	9705.53	10664.19
20267.73	22417.20	24578.19
19893.62	21453.71	23021.26
23483.44	25787.17	28105.43
122931.18	129128.28	135381.29
17924.05	19016.13	20157.53
268081.61	282869.85	297732.83
621105.97	644853.24	668840.06
921675.27	1044419.99	1160811.13
1776524.94	2056343.85	2317809.99
2698200.21	3100763.83	3478621.12

1989	1990	1991
5934.94	6207.09	6517.44
1464.06	1529.70	1606.18
113805.33	118388.75	124357.28
400416.12	416731.64	437981.57
6895.11	6948.53	7299.68
192675.43	193939.01	203926.72
120700.44	125337.28	131656.96
593091.55	610670.65	641908.29
20944.16	23125.09	24329.15
18046.74	20014.42	21118.52
4738.15	4981.60	5251.71
30154.23	31523.82	33521.63
25682.31	28106.70	29580.86
48200.97	51538.24	54640.15
12970.88	13589.27	14287.35
3687.78	3851.82	4057.35
11624.88	12587.41	13224.49
26751.62	28938.42	30434.98
24595.76	26176.69	27511.84
30439.39	32790.24	34492.34
141679.23	148012.50	156691.80
21350.94	22599.06	24322.58
312657.75	327633.17	345441.46
693082.86	717598.20	755363.36
1270924.33	1374876.87	1473618.14
2561903.02	2789584.95	3005498.64
3832827.35	4164461.82	4479116.78

1992	1993	1994
6843.32	7185.48	7544.76
1686.49	1770.82	1859.36
130626.10	137209.89	144124.08
460363.36	483945.27	508800.89
7668.49	8055.82	8462.58
214462.62	225582.30	237324.52
138294.59	145265.71	152586.65
674825.98	709527.57	746125.41
25595.21	26926.07	28324.65
22295.18	23550.93	24893.13
5535.90	5834.74	6148.86
35690.09	38049.61	40623.62
31131.11	32760.82	34473.51
57985.26	61600.54	65516.74
15021.04	15791.99	16601.95
4275.34	4506.75	4752.70
13893.62	14596.38	15334.40
32014.70	33683.14	35446.36
28914.66	30388.37	31936.35
36290.04	38189.89	40199.06
165853.46	175513.19	185687.23
26231.90	28353.03	30716.08
364193.82	383928.09	404683.74
795333.18	837671.02	882557.29
1567403.24	1656472.57	1741053.23
3210308.27	3404643.61	3589101.92
4777711.51	5061116.18	5330155.15

1995	1996	1997
7921.99	8318.09	8734.00
1952.32	2049.94	2152.44
151384.84	159009.19	167014.98
535009.78	562658.16	591839.65
8889.70	9338.20	9809.12
249731.58	262849.76	276729.86
160274.54	168347.39	176824.10
784741.36	825507.92	868569.52
29794.00	31337.35	32958.10
26330.08	27871.14	29526.95
6478.87	6825.47	7189.36
43439.03	46526.84	49922.75
36272.87	38162.82	40147.45
69769.10	74397.98	79449.70
17452.73	18346.27	19284.56
5014.41	5293.24	5590.73
16109.38	16923.15	17777.59
37311.01	39284.39	41374.54
33562.12	35269.42	37062.15
42325.41	44577.63	46965.26
196392.65	207647.53	219471.20
33355.96	36313.13	39634.57
426502.19	449427.15	473504.91
930191.84	980796.66	1034619.05
1821360.26	1897597.77	1969959.82
3764249.79	3930624.90	4088737.63
5585610.06	5828222.67	6058697.45

1998	1999
9170.698911	9629.233856
2260.058668	2373.061601
175421.008	184247.0007
622656.2156	655219.1345
10303.55567	10822.67238
291427.7652	307005.1374
185724.5637	195069.6731
914083.9808	962224.2719
34659.8183	36446.30163
31309.57107	33232.72244
7571.299412	7972.098942
53667.9646	57810.08548
42231.11771	44418.40057
84977.53567	91042.80792
20269.74758	21304.06724
5908.601147	6248.804085
18674.70343	19616.58294
43590.3263	45941.58789
38944.45101	40920.65018
49498.92745	52190.39198
231884.4556	244909.6901
43374.80135	47597.18721
498784.5881	525318.4139
1091935.245	1153054.659
3	0
20~~8~~9517.974	21~~7~~4675.269
4239072.677 √	4382090.551
6~~2~~28590.651	6~~5~~36765.821 1999
288	1484

LINK B: NO-BUILD 1980-1989

1980	1981	1982
1777.38	2279.64	2781.90
924.10	1046.27	1168.45
19599.96	32641.85	45026.58
39973.71	98486.18	150731.79
859.92	1940.07	3006.44
13779.42	47594.91	81980.38
20459.88	34581.92	48033.02
53753.13	146081.09	232712.17
13438.26	13806.44	13449.59
7421.34	10623.17	10892.58
3143.92	3452.41	3627.37
13685.11	21288.99	23791.51
16582.18	17258.86	17076.96
21106.45	31912.15	34684.09
0.00	1979.28	4008.47
0.00	530.77	1169.30
4264.12	4859.26	5257.90
6067.62	10161.54	12070.43
4264.12	6838.54	9266.37
6067.62	10692.31	13239.73
71370.39	85821.00	98404.96
6982.43	11384.82	14161.31
112676.57	144500.31	172781.31
87909.63	200070.38	294797.30
112676.57	242857.03	383090.22
87909.63	268153.22	507417.32
200586.20	511010.25	890507.54

1983	1984	1985
3284.15	3786.41	4288.67
1290.62	1412.79	1534.97
57067.41	69108.20	81144.52
193671.70	236753.84	279986.28
4055.32	5104.08	6152.62
111771.57	141615.96	171517.16
61122.72	74212.28	87297.14
305443.26	378369.80	451503.44
12987.26	12560.55	12163.41
10216.85	9618.82	9108.82
3780.88	3941.74	4108.59
24378.45	25116.38	26025.69
16768.14	16502.30	16271.99
34595.31	34735.20	35134.51
6015.29	8023.70	10033.50
1755.09	2341.81	2929.61
5606.87	5952.70	6295.68
12959.03	13837.78	14704.71
11622.16	13976.39	16329.17
14714.12	16179.59	17634.32
110738.07	123339.20	136138.15
16201.95	18411.40	20808.81
200251.09	228030.18	256036.46
370954.64	447695.99	525081.08
529512.09	679722.63	831667.80
778656.15	1073567.37	1385177.43
1308168.24	1753290.00	2216845.24

1986	1987	1988
4563.90	4839.14	5114.38
1751.17	1967.37	2183.57
85873.61	90621.77	95377.19
297162.07	315484.41	335124.38
6157.62	6164.61	6172.80
171538.26	172140.30	173420.95
92031.23	96786.38	101550.00
468700.33	487624.71	508545.33
15057.08	18016.42	21017.73
11609.74	14538.36	17968.11
4511.15	4930.55	5360.90
28481.34	31894.47	36435.21
19568.23	22946.97	26378.62
40091.08	46432.83	54403.32
10504.87	11004.33	11524.14
3027.77	3158.20	3327.45
7214.81	8152.99	9104.69
16580.94	18659.73	20982.79
17719.68	19157.33	20628.83
19608.72	21817.92	24310.24
152713.34	169272.27	185737.73
24545.44	28876.71	33880.75
282032.46	308162.95	334295.18
552945.56	584752.18	621139.64
982453.88	1130883.15	1275942.69
1680804.71	1962455.52	2231984.46
2663258.59	3093338.67	3507927.15

1989	1990	1991
5389.61	5664.85	5948.09
2399.77	2615.97	2746.77
100133.22	104693.77	109928.46
356256.52	372487.80	391112.19
6181.68	6182.26	6491.37
175480.09	175498.81	184273.75
106314.91	110876.02	116419.82
531736.61	547986.61	575385.94
24044.75	26847.80	28190.19
21974.05	24537.56	25764.44
5798.14	6187.91	6497.31
42277.63	45123.51	47379.69
29842.90	33035.71	34687.50
64251.68	69661.07	73144.13
12058.29	12559.88	13187.87
3542.27	3689.71	3874.20
10065.80	11007.02	11557.37
23592.90	25799.59	27089.57
22124.08	23566.90	24745.24
27135.17	29489.31	30963.77
202080.76	216276.14	227089.94
39637.05	42424.82	44546.06
360362.65	383754.77	402942.51
662760.51	689561.81	724039.90
1416817.38	1551969.85	1679816.79
2491073.96	2733926.93	2963652.70
3907891.34	4285896.78	4643469.49

1992	1993	1994
6245.50	6557.77	6885.66
2884.10	3028.31	3179.72
115424.88	121196.12	127255.93
410667.80	431201.18	452761.24
6815.94	7156.73	7514.57
193487.44	203161.81	213319.90
122240.82	128352.86	134770.50
604155.23	634363.00	666081.15
29599.70	31079.68	32633.67
27052.66	28405.30	29825.56
6822.17	7163.28	7521.45
49748.67	52236.10	54847.91
36421.87	38242.96	40155.11
76801.33	80641.40	84673.47
13847.27	14539.63	15266.61
4067.91	4271.31	4484.87
12135.24	12742.00	13379.10
28444.05	29866.25	31359.57
25982.51	27281.63	28645.71
32511.96	34137.56	35844.44
238444.44	250366.66	262885.00
46773.36	49112.03	51567.63
423089.63	444244.12	466456.32
760241.89	798253.99	838166.69
1800753.08	1915152.27	2023367.72
3180960.87	3386522.65	3580972.99
4981713.95	5301674.92	5604340.71

1995	1996	1997
~~7229.94~~	~~7591.44~~	~~7971.01~~
3338.71	3505.65	3680.93
133618.72	140299.66	147314.64
475399.31	499169.27	524127.74
7890.30	8284.81	8699.06
223985.90	235185.19	246944.45
141509.02	148584.48	156013.70
699385.20	734354.46	771072.19
34265.35	35978.62	37777.55
31316.84	32882.68	34526.81
7897.52	8292.39	8707.01
57590.30	60469.82	63493.31
42162.87	44271.01	46484.56
88907.14	93352.50	98020.12
16029.94	16831.44	17673.01
4709.11	4944.57	5191.80
14048.05	14750.46	15487.98
32927.55	34573.92	36302.62
30078.00	31581.90	33160.99
37636.66	39518.49	41494.42
276029.25	289830.71	304322.24
54146.02	56853.32	59695.98
489779.14	514268.09	539981.50
880075.02	924078.77	970282.71
2125733.69	2222566.36	2314164.84
3764912.49	3938909.32	4103500.91
5890646.18	6161475.68	6417665.75

1998	1999
8369.56	8788.04
3864.97	4058.22
154680.38	162414.40
550334.12	577850.83
9134.01	9590.71
259291.67	272256.26
163814.38	172005.10
809625.80	850107.09
39666.43	41649.75
36253.16	38065.81
9142.37	9599.48
66667.97	70001.37
48808.79	51249.23
102921.13	108067.19
18556.66	19484.50
5451.39	5723.96
16262.38	17075.50
38117.75	40023.64
34819.04	36559.99
43569.14	45747.60
319538.36	335515.27
62680.78	65814.82
566980.57	595329.60
1018796.85	1069736.69
2400812.04	2482775.62
4259195.67	4406474.49
6660007.71	6889250.10

LINK C: NO-BUILD 1979-1999

		1980	1981	1982
		1783.62	2371.51	2959.40
		1070.82	1276.57	1482.32
Class 1				
Car	OC	14942.79	23793.61	31817.04
	TC	29915.68	74122.91	104522.38
Bus	OC	603.77	1021.94	1414.42
	TC	9512.77	25259.49	36732.65
Total	OC	15546.57	24815.55	33231.46
	TC	39428.44	99382.40	141255.03
Class 2				
Car	OC	10123.21	12554.95	14371.25
	TC	5544.22	10113.27	11702.71
Bus	OC	2312.61	2718.84	3000.99
	TC	10053.84	17814.83	19936.49
Total	OC	12435.83	15273.79	17372.24
	TC	15598.05	27928.10	31639.20
Class 3				
Car	OC	0.00	1718.07	3459.39
	TC	0.00	474.42	977.42
Bus	OC	2998.94	3654.39	4130.10
	TC	4257.79	8053.20	9358.92
Total	OC	2998.94	5372.46	7589.49
	TC	4257.79	8527.63	10336.34
Truck	OC	58224.87	75245.46	90305.16
	TC	5881.66	10821.49	13657.12
Total	OC	89206.20	120707.26	148498.34
	TC	65165.96	146659.62	196887.69
Discounted Totals				
	OC	89206.20	197951.48	318476.06
	TC	65165.96	197291.74	357090.20
Grand Total		154372.15	395243.22	675566.27

1983	1984	1985
3547.29	4135.10	4723.07
1688.07	1893.82	2099.57
39768.12	47693.71	55593.77
133797.88	163512.94	193700.12
1805.90	2197.67	2589.42
47971.45	59544.20	71497.89
41574.02	49891.38	58183.19
181769.33	223057.15	265198.00
16216.76	18101.17	20010.37
13283.28	15104.01	17204.71
3284.02	3570.89	3860.05
21917.19	24180.40	26771.85
19500.78	21672.06	23870.42
35200.46	39284.42	43976.56
5208.09	6965.55	8729.18
1479.71	1993.84	2521.99
4596.25	5060.53	5523.19
10497.56	11647.23	12808.15
9804.35	12026.08	14252.38
11977.27	13641.07	15330.14
105584.66	121040.14	136571.52
16705.98	20215.66	24253.80
176463.80	204629.66	232877.50
245653.03	296198.29	348758.51
447504.87	582300.77	720502.23
536709.58	731824.57	938795.77
984214.46	1314125.34	1659298.00

1986	1987	1988
4970.95	5218.82	5466.70
2386.69	2673.82	2960.94
58965.87	62151.70	65328.24
209556.31	221128.24	232429.99
2933.74	3268.97	3603.77
83170.32	92797.79	102301.89
61899.60	65420.66	68932.00
292726.63	313926.04	334731.88
20846.96	21492.00	22127.31
18989.32	19642.63	20223.27
4247.09	4610.24	4972.07
30882.96	33618.81	36257.36
25094.05	26102.24	27099.38
49872.28	53261.44	56480.63
8908.68	9064.76	9219.71
2614.72	2662.95	2708.47
5676.58	5822.59	5968.15
13295.95	13647.69	13988.88
14585.25	14887.34	15187.86
15910.68	16310.64	16697.36
154786.24	170898.35	186911.44
30223.61	33523.49	36664.63
256365.14	277308.59	298130.68
388733.20	417021.61	444574.49
857565.51	991133.52	1120500.33
1146628.41	1347490.38	1540403.03
2004193.92	2338623.90	2660903.36

1989	1990	1991
5714.57	5962.45	6260.57
3248.07	3535.19	3711.95
68504.78	71681.31	75265.38
243731.73	255033.47	267785.14
3938.56	4273.36	4487.03
111805.99	121310.09	127375.60
72443.34	75954.68	79752.41
355537.72	376343.56	395160.74
22762.61	23397.92	24567.82
20803.91	21384.55	22453.77
5333.91	5695.74	5980.52
38895.92	41534.47	43611.19
28096.52	29093.66	30548.34
59699.82	62919.02	66064.97
9374.66	9529.62	10006.10
2753.99	2799.51	2939.49
6113.72	6259.28	6572.24
14330.07	14671.27	15404.83
15488.38	15788.90	16578.34
17084.07	17470.78	18344.32
202924.53	218937.62	229884.50
39805.76	42946.90	45094.24
318952.77	339774.86	356763.60
472127.38	499680.26	524664.27
1245186.86	1364850.29	1478045.43
1724969.32	1900948.95	2067416.17
2970156.18	3265799.24	3545461.60

1992	1993	1994
6573.60	6902.28	7247.40
3897.55	4092.43	4297.05
79028.65	82980.08	87129.09
281174.40	295233.12	309994.78
4711.38	4946.95	5194.30
133744.38	140431.60	147453.18
83740.03	87927.03	92323.38
414918.78	435664.72	457447.95
25796.21	27086.02	28440.32
23576.46	24755.29	25993.05
6279.55	6593.53	6923.20
45791.75	48081.34	50485.41
32075.76	33679.55	35363.52
69368.22	72836.63	76478.46
10506.40	11031.72	11583.31
3086.46	3240.79	3402.83
6900.86	7245.90	7608.19
16175.07	16983.83	17833.02
17407.26	18277.62	19191.50
19261.54	20224.61	21235.84
241378.73	253447.67	266120.05
47348.96	49716.40	52202.22
374601.78	393331.87	412998.46
550897.49	578442.36	607364.48
1585121.91	1686410.47	1782223.98
2224885.16	2373842.32	2514747.73
3810007.07	4060252.79	4296971.71

1995	1996	1997
7609.77	7990.25	8389.77
4511.90	4737.49	4974.37
91485.54	96059.82	100862.81
325494.52	341769.24	358857.70
5454.01	5726.71	6013.05
154825.84	162567.13	170695.48
96939.55	101786.53	106875.86
480320.35	504336.37	529553.19
29862.34	31355.45	32923.23
27292.70	28657.34	30090.20
7269.36	7632.83	8014.47
53009.68	55660.16	58443.17
37131.70	38988.29	40937.70
80302.38	84317.50	88533.37
12162.47	12770.60	13409.13
3572.97	3751.62	3939.20
7988.60	8388.03	8807.44
18724.67	19660.90	20643.95
20151.08	21158.63	22216.56
22297.64	23412.52	24583.14
279426.05	293397.36	308067.22
54812.33	57552.95	60430.60
433648.39	455330.81	478097.35
637732.70	669619.34	703100.31
1872858.38	1958593.62	2039694.52
2648036.64	2774120.74	2893389.49
4520895.02	4732714.36	4933084.01

1998	1999
8809.25	9249.72
5223.09	5484.24
105905.95	111201.25
376800.59	395640.62
6313.70	6629.39
179230.26	188191.77
112219.65	117830.63
556030.85	583832.39
34569.39	36297.86
31594.71	33174.45
8415.20	8835.96
61365.33	64433.60
42984.59	45133.81
92960.04	97608.05
14079.58	14783.56
4136.16	4342.97
9247.81	9710.20
21676.14	22759.95
23327.39	24493.76
25812.30	27102.92
323470.58	339644.11
63452.13	66624.73
502002.21	527102.32
738255.32	775168.09
2116411.59	2188981.80
3006211.27	3112934.58
5122622.86	5301916.38

LINK A: BUILD - 1980-1999

1980	1981	1982
1777.38	2336.74	2896.10
924.10	966.45	1008.81
15908.83	25113.71	35322.14
10606.16	20502.50	34576.78
645.04	1444.67	2337.90
3638.93	9607.14	18114.48
16553.87	26558.39	37660.04
14245.09	30109.65	52691.27
10526.98	9771.03	9356.99
1862.67	2050.35	2284.42
2303.10	2393.85	2534.78
3416.00	4067.99	4934.78
12830.08	12164.88	11891.77
5278.67	6118.34	7219.20
0.00	1364.89	2800.45
0.00	96.94	235.33
3100.28	3491.75	3985.75
1489.01	1939.85	2563.02
3100.28	4856.64	6786.20
1489.01	2036.80	2798.35
62782.56	67628.97	73809.99
2143.91	2586.72	3158.60
95266.79	111208.88	130148.00
23156.68	40851.50	65867.42
95266.79	195454.97	301086.01
23156.68	59959.83	113419.30
118423.47	255414.80	414505.31

19 1982

1983	1984	1985
3455.46	4014.82	4846.3275
1051.16	1093.51	1201.505
47125.71	60499.41	49857.92072
54254.34	81018.09	82612.00555
3344.84	4454.86	3583.738172
30075.08	46441.18	46343.61117
50470.55	64954.28	53441.65889
84329.42	127459.27	128955.6167
9096.42	8838.73	6467.769952
2546.19	2815.29	2526.348756
2701.86	2874.09	2022.353557
6031.17	7371.10	6263.366172
11798.28	11712.82	8490.123509
8577.35	10186.39	8789.714928
4412.89	6223.80	5505.454674
431.11	700.94	754.5529598
4558.63	5178.70	4177.426537
3394.29	4470.31	4464.966641
8971.52	11402.49	9682.881211
3825.40	5171.25	5219.519601
81072.27	88996.65	63346.62333
3882.98	4783.77	4085.17992
152312.61	177066.24	134961.2869
100615.15	147600.68	147050.0312
412455.67	529094.69	601250.5034
186988.23	284217.37	362836.3252
599443.91	813312.06	964086.8286

1 19 1985

1986	1987	1988
5118.48	5390.6325	5662.785
1267.143333	1332.781667	1398.42
53358.32061	56891.24731	60444.96746
94520.24709	107693.7998	122208.3852
3676.593058	3764.96024	3848.940867
50871.58797	55711.66757	60869.64642
57034.91366	60656.20755	64293.90833
145391.8351	163405.4674	183078.0317
7722.968247	9013.577819	10335.1902
3251.672759	4080.459455	5021.039731
2166.518822	2309.38308	2450.949987
7047.233781	7893.366	8804.513666
9889.487069	11322.9609	12786.14018
10298.90654	11973.82546	13825.5534
5945.025838	6386.048958	6827.386908
863.5210288	983.5102303	1115.16227
4772.760275	5378.997575	5994.419249
5448.129276	6558.888796	7806.783329
10717.78611	11765.04653	12821.80616
6311.650305	7542.399026	8921.945599
66649.70369	69956.99144	73263.88678
4580.461556	5123.622091	5717.435882
144291.8905	153701.2064	163165.7414
166582.8535	188045.314	211542.9665
670749.9061	737444.9321	801230.4623
443072.3577	524670.202	607367.5878
1113822.264	1262115.134	1408598.05

19.

1988

1989	1990	1991
5934.9375	6207.09	6517.4445
1464.058333	1529.696667	1606.1815
64010.34143	67580.36016	72077.90214
138140.3815	155566.7989	178411.0861
3928.727391	4004.567039	4259.387088
66351.25334	72162.15678	82743.12666
67939.06882	71584.92719	76337.28923
204491.6349	227728.9557	261154.2128
11683.72025	13055.48465	13898.92845
6081.836299	7271.359467	8325.782247
2591.283247	2730.488892	2896.862423
9783.442524	10832.93302	12361.34078
14275.0035	15785.97355	16795.79087
15865.27882	18104.29248	20687.12303
7268.208278	7707.929649	8212.267768
1259.124254	1416.048493	1622.531871
6617.532412	7247.059507	7707.823737
9201.451133	10752.62613	12328.2564
13885.74069	14954.98916	15920.09151
10460.57539	12168.67462	13950.78827
76567.73905	79867.44624	84373.09422
6364.700516	7068.235975	8014.930691
172667.5521	182193.3361	193426.2658
237182.1896	265070.1588	303807.0548
862041.2941	919847.9055	975137.0286
690899.4736	775001.3385	861841.7972
1552940.768	1694849.244	1836978.826

19 1991

1992	1993	1994
6843.316725	7185.482561	7544.756689
1686.490575	1770.815104	1859.355859
76806.05992	81770.23281	85897.86053
204926.2005	235720.0766	248477.4635
4526.911225	4807.533096	5050.541829
95023.44442	109284.4962	115205.1551
81332.97114	86577.76591	90948.40236
299949.6449	345004.5727	363682.6186
14785.62493	15716.87577	16502.68619
9548.876682	10968.53706	11567.32689
3071.92489	3256.089936	3422.135104
14131.78327	16184.15832	17084.18609
17857.54982	18972.96571	19924.8213
23680.65995	27152.69538	28651.51299
8742.467769	9299.233322	9766.078082
1862.111607	2140.26452	2256.661294
8191.579927	8699.048006	9138.838832
14156.88208	16280.39238	17162.79618
16934.0477	17998.28133	18904.91691
16018.99369	18420.6569	19419.45748
89109.91051	94092.51496	98601.55612
9108.534553	10373.10522	10969.80839
205234.4792	217641.5279	228379.6967
348757.8331	400951.0302	422723.3974
1027987.833	1078479.541	1126211.89
951651.911	1044670.475	1133021.502
1979639.744	2123150.016	2259233.393

19 10 1994

1995	1996	1997
7921.994524	8318.09425	8733.998962
1952.323652	2049.939834	2152.436826
90185.11724	94688.34693	99418.89304
260935.9742	274023.2239	287771.6252
5303.575931	5569.444417	5848.823351
120989.778	127067.7214	133454.3377
95488.69317	100257.7913	105267.7164
381925.7522	401090.9453	421225.9629
17320.3857	18180.53783	19085.79564
12154.35615	12772.19083	13422.61522
3596.103843	3779.802209	3973.910551
17973.72599	18913.67263	19907.54159
20916.48954	21960.34004	23059.70619
30128.08214	31685.86346	33330.1568
10251.48655	10761.77595	11298.3969
2370.578768	2490.374119	2616.371787
9596.829096	10078.09659	10583.87619
18025.0957	18931.20834	19883.44195
19848.31564	20839.87254	21882.27309
20395.67447	21421.58246	22499.81373
103332.7404	108342.4214	113658.7132
11568.03857	12204.5284	12882.59197
239586.2388	251400.4254	263868.4089
444017.5474	466402.9196	489938.5254
1171324.111	1213969.823	1254294.768
1216626.545	1295743.693	1370617.165
2387950.656	2509713.516	2624911.932

10 199 1997

1998	1999
9170.698911	9629.233856
2260.058668	2373.061601
104388.7222	109610.4442
302215.3752	317390.572
6142.424903	6450.998379
140165.862	147219.4759
110531.1471	116061.4426
442381.2372	464610.0479
20038.99934	21043.17491
14107.54378	14829.03455
4179.156243	4396.311636
20959.19124	22072.86796
24218.15558	25439.48655
35066.73502	36901.90251
11862.89378	12456.90522
2748.917562	2888.380511
11115.46927	11674.24544
20884.23939	21936.18869
22978.36305	24131.15066
23633.15696	24824.5692
119312.5942	125337.7627
13605.94426	14378.76061
277040.2599	290969.8425
514687.0735	540715.2802
1292437.016	1328527.142
1441478.065	1508545.094
2733915.081	2837072.236

1789

LINK B BUILD 1979-1999

1980	1981	1982
1777.38	2279.64	2781.90
924.10	1046.27	1168.45
15908.83	23809.63	32410.80
10606.16	18958.76	30325.92
645.04	1373.25	2173.41
3638.93	8963.94	16249.94
16553.87	25182.87	34584.21
14245.09	27922.70	46575.86
10526.98	10115.04	9971.02
1862.67	2058.30	2279.62
2303.10	2461.31	2658.57
3416.00	4083.65	4911.22
12830.08	12576.34	12629.59
5278.67	6141.95	7190.84
0.00	1376.72	2803.22
0.00	95.70	227.23
3100.28	3402.32	3784.83
1489.01	1863.35	2364.52
3100.28	4779.04	6588.05
1489.01	1959.05	2591.74
62782.56	70299.43	78858.03
2143.91	2688.18	3372.90
95266.79	112837.69	132659.87
23156.68	38711.89	59731.35
95266.79	196922.36	304592.09
23156.68	58032.26	106511.56
118423.47	254954.62	411103.65

1983	1984	1985
3284.15	3786.41	4288.67
1290.62	1412.79	1534.97
42168.33	53133.68	65133.19
45644.12	65885.02	92050.44
3064.16	4041.91	5091.65
26148.59	39337.01	56514.07
45232.49	57175.59	70224.84
71792.71	105222.03	148564.51
9944.44	9910.62	9799.07
2507.82	2722.74	2903.14
2877.04	3100.54	3318.80
5903.82	7065.73	8400.58
12821.48	13011.16	13117.87
8411.65	9788.48	11303.71
4376.77	6129.34	8048.98
407.35	649.38	967.05
4231.25	4718.32	5225.93
3015.01	3837.75	4856.12
8608.01	10847.66	13274.91
3422.36	4487.13	5823.17
88452.69	98849.68	109782.23
4226.99	5280.12	6562.63
155114.67	179884.09	206399.85
87853.71	124777.76	172254.03
418010.60	536505.82	658994.09
170749.44	252944.41	355168.80
588760.04	789450.24	1014162.89

1986	1987	1988
4563.90	4839.14	5114.38
1751.17	1967.37	2183.57
70293.47	75550.40	80891.65
106208.10	122015.40	139587.17
5195.02	5290.47	5378.49
61646.54	67099.71	72871.89
75488.49	80840.87	86270.14
167854.64	189115.11	212459.06
12005.57	14256.71	16570.11
3787.79	4803.67	5965.01
3631.23	3946.44	4268.24
9499.57	10696.98	12003.28
15636.80	18203.16	20838.35
13287.35	15500.64	17968.28
8613.67	9166.66	9711.82
1087.50	1218.85	1361.82
6084.87	6961.63	7856.63
5955.97	7204.44	8615.24
14698.54	16128.29	17568.46
7043.47	8423.29	9977.06
121153.90	132952.59	145267.77
7837.41	9287.16	10928.09
226977.73	248124.91	269944.71
196022.87	222326.21	251332.49
780345.65	899857.10	1016993.26
459970.63	567055.91	676115.74
1240316.28	1466913.01	1693109.01

1989	1990	1991
-		
5389.61	5664.85	5948.09
2399.77	2615.97	2746.77
86307.34	91788.59	98021.22
159039.47	180489.48	206122.01
5459.72	5534.86	5896.81
78961.18	85365.47	97497.25
91767.05	97323.44	103918.02
238000.65	265854.95	303619.26
18960.38	21437.68	22812.39
7286.26	8782.11	9949.08
4599.82	4943.48	5261.04
13429.17	14985.55	16936.14
23560.19	26381.16	28073.42
20715.43	23767.66	26885.22
10253.68	10796.48	11521.29
1517.14	1685.53	1922.26
8770.25	9702.53	10335.57
10202.25	11979.53	13667.36
19023.93	20499.00	21856.85
11719.38	13665.06	15589.62
158156.10	171640.04	182601.98
12776.61	14849.35	16810.84
292507.27	315843.64	336450.28
283212.07	318137.03	362904.94
1131341.60	1242576.83	1349326.89
786830.35	898873.28	1014016.96
1918171.96	2141450.11	2363343.85

1992	1993	1994
6245.50	6557.77	6885.66
2884.10	3028.31	3179.72
104612.31	111571.21	118908.01
235823.61	270265.55	310231.21
6278.39	6680.20	7102.87
111555.40	127857.74	146775.18
110890.70	118251.41	126010.88
347379.00	398123.29	457006.38
24284.14	25858.55	27541.24
11296.56	12854.08	14656.09
5600.10	5961.85	6347.48
19185.87	21783.56	24786.11
29884.24	31820.40	33888.72
30482.44	34637.64	39442.20
12289.62	13102.94	13962.76
2196.42	2514.16	2882.69
11004.03	11709.13	12452.13
15622.32	17888.45	20517.13
23293.66	24812.07	26414.89
17818.74	20402.61	23399.82
194348.26	206925.69	220381.13
19075.00	21691.30	24717.45
358416.86	381809.56	406695.61
414755.18	474854.85	544565.86
1451777.06	1550098.46	1644449.74
1132570.92	1254852.81	1381189.27
2584347.98	2804951.28	3025639.02

1995	1996	1997
7229.94	7591.44	7971.01
3338.71	3505.65	3680.93
126497.63	132988.91	139830.21
353932.09	372345.06	391798.90
7540.46	7927.55	8335.02
167459.29	176150.69	185330.10
134038.09	140916.46	148165.22
521391.38	548495.74	577129.00
29317.56	30989.98	32777.63
16639.38	17699.77	18851.53
6754.90	7152.69	7576.49
28097.76	29990.62	32060.03
36072.46	38142.67	40354.11
44737.14	47690.40	50911.55
14855.86	15635.40	16459.54
3286.09	3463.46	3651.89
13223.45	13915.26	14644.79
23393.65	24643.37	25969.02
28079.30	29550.66	31104.33
26679.74	28106.83	29620.90
234605.15	248081.54	262498.83
28050.06	29867.03	31844.40
432795.00	456691.32	482122.50
620858.32	654160.00	689505.86
1734905.78	1820897.20	1902680.90
1510951.36	1634124.59	1751087.27
3245857.14	3455021.79	3653768.17

1998	1999
8369.56	8788.04
3864.97	4058.22
147038.94	154632.94
412365.86	434125.13
8763.86	9215.11
195030.89	205289.61
155802.81	163848.06
607396.75	639414.75
34686.15	36720.92
20105.64	21474.74
8027.46	8506.74
34328.54	36822.18
42713.62	45227.66
54434.18	58296.93
17330.49	18250.48
3852.30	4065.72
15413.85	16224.29
27376.63	28872.95
32744.34	34474.77
31228.93	32938.67
277903.29	294338.50
34001.88	36362.11
509164.05	537888.99
727061.74	767012.45
1980492.45	2054547.74
1862198.43	1967798.89
3842690.89	4022346.63

LINK C - BUILD 1979-99

1980	1981	1982
1783.62 1070.82	2371.51 1276.57	2959.40 1482.32
12183.41 8065.55	17270.96 13944.52	23039.54 22319.40
453.06 2545.08	727.68 4747.42	1037.19 7861.69
12636.47 10610.64	17998.64 18691.94	24076.73 30181.09
7953.37 1401.95	9085.95 1892.36	10519.99 2540.43
1691.64 2509.66	1922.57 3267.43	2201.17 4274.74
9645.01 3911.61	11008.52 5159.79	12721.16 6815.17
0.00 0.00	1205.50 84.24	2472.59 204.90
2180.51 1046.61	2557.14 1426.45	3018.10 1955.99
2180.51 1046.61	3762.64 1510.68	5490.69 2160.90
49730.29 1735.44	58647.79 2360.18	68748.32 3179.72
74192.27 17304.30	91417.60 27722.59	111,036.90 42336.88
74192.27 17304.30 91496.57	156550.47 42279.61 198830.08	246670.51 76641.17 323311.68

1983	1984	1985
3547.29	4135.18	4723.07
1688.07	1893.82	2099.57
29766.63	37375.64	45655.80
34028.86	49945.39	70970.23
1385.16	1765.62	2169.88
12199.86	18086.60	25857.39
31151.79	39141.26	47825.67
46228.71	68031.99	96827.62
12196.19	14021.87	15926.31
3376.89	4433.11	5741.08
2511.15	2836.25	3166.02
5572.92	7203.86	9209.96
14707.34	16858.12	19092.33
8949.81	11636.96	14951.04
3890.19	5471.99	7192.73
376.40	613.77	932.59
3545.81	4114.82	4704.31
2670.48	3606.16	4800.19
7436.00	9586.81	11897.04
3046.88	4219.93	5732.78
80090.79	92434.70	105519.73
4243.13	5601.03	7305.40
133385.92	158020.89	184334.77
62468.54	89489.91	124816.84
344201.15	448294.40	557688.12
122317.62	181267.40	255340.12
466518.77	629561.80	813028.24

1986	1987	1988
4970.95	5218.82	5466.70
2386.69	2673.82	2960.94
49058.42	52549.17	56129.64
80812.02	91705.24	103726.11
2494.23	2827.87	3169.92
31698.72	38301.51	45725.84
51552.65	55377.04	59299.56
112510.73	130006.75	149451.95
16504.38	17115.63	17773.79
6204.65	6708.37	7257.49
3487.15	3821.39	4169.94
10575.44	12108.72	13828.76
19991.53	20937.02	21943.73
16780.09	18817.08	21086.25
7447.63	7704.35	7963.13
1023.64	1121.92	1227.80
4894.77	5086.09	5278.97
5280.56	5800.48	6362.58
12342.40	12790.44	13242.10
6304.20	6922.41	7590.38
119050.76	133424.68	148655.63
8875.15	10667.46	12703.83
202937.34	222529.17	243141.03
144470.17	166413.70	190832.40
666186.71	773369.76	878875.09
332579.77	412734.33	495541.57
998766.48	1186104.09	1374416.66

1989	1990	1991
5714.57	5962.45	6260.57
3248.07	3535.19	3711.95
59794.93	63535.79	67854.74
116951.78	131460.33	150333.45
3519.43	3875.35	4128.05
54032.46	63282.82	72386.27
63314.36	67411.14	71982.79
170984.24	194743.15	222719.73
18483.89	19244.53	20560.27
7857.41	8513.64	9675.00
4532.76	4908.86	5234.26
15754.90	17906.80	20392.58
23016.65	24153.39	25794.53
23612.31	26420.44	30067.58
8223.62	8485.17	9061.77
1341.64	1463.80	1674.45
5473.66	5670.07	6039.92
6969.52	7624.01	8720.05
13697.29	14155.23	15101.69
8311.16	9087.81	10394.50
164695.01	181456.14	193854.72
15006.05	17596.22	20012.21
264723.30	287175.91	306733.73
217913.76	247847.62	283194.01
982361.98	1083500.88	1180822.37
580729.46	668017.55	757870.28
1563091.44	1751518.43	1938692.65

1992	1993	1994
6573.60	6902.28	7247.40
3897.55	4092.43	4297.05
72420.63	77239.32	82186.85
172214.63	197600.76	224474.90
4394.28	4674.41	4962.36
82941.74	95189.11	108143.96
76814.90	81913.73	87149.21
255156.37	292789.86	332618.86
21966.43	23465.89	25037.86
11017.90	12572.14	14252.22
5579.18	5944.24	6324.30
23269.58	26602.16	30178.58
27545.61	29410.13	31362.16
34287.48	39174.30	44430.80
9670.94	10313.45	10972.30
1918.71	2202.12	2501.86
6429.62	6839.74	7261.41
9990.86	11465.32	13025.36
16100.57	17153.19	18233.71
11909.57	13667.45	15527.23
207090.25	221188.78	235937.71
22806.81	26042.24	29530.19
327551.33	349665.83	372682.79
324160.22	371673.86	422107.08
1274449.92	1364493.85	1450954.33
850528.50	946239.82	1044166.48
2124978.42	2310733.67	2495120.81

1995	1996	1997
7609.77	7990.25	8389.77
4511.90	4737.49	4974.37
86539.52	91126.73	95958.42
237030.60	250437.62	264776.07
5222.16	5495.53	5783.07
114107.16	120461.85	127243.25
91761.68	96622.26	101741.49
351137.76	370899.47	392019.32
26553.22	28162.65	29868.93
15335.31	16534.73	17866.73
6687.83	7071.86	7477.11
32265.67	34554.15	37070.37
33241.05	35234.51	37346.04
47600.98	51088.87	54937.11
11548.53	12155.49	12794.51
2639.44	2785.99	2942.31
7642.37	8043.26	8464.96
13746.91	14516.33	15337.99
19190.90	20198.75	21259.47
16386.35	17302.31	18280.30
250029.68	264985.67	280832.12
31699.36	34093.23	36742.56
394223.31	417041.19	441179.12
446824.44	473383.89	501979.29
1533348.71	1611874.32	1686712.69
1137554.73	1226689.22	1311841.28
2670903.44	2838563.54	2998553.97

1998	1999
8809.25	9249.72
5223.09	5484.24
101044.86	106396.70
280136.33	296620.66
6085.40	6403.18
134491.00	142249.76
107130.26	112799.88
414627.33	438870.42
31674.78	33582.92
19350.14	21006.75
7904.31	8354.23
39844.75	42912.41
39579.09	41937.14
59194.89	63919.16
13466.98	14174.33
3109.30	3287.98
8908.38	9374.49
16216.83	17158.39
22375.36	23548.81
19326.13	20446.37
297595.06	315300.67
39682.91	42955.43
466679.77	493586.51
532831.26	566191.39
1758031.71	1825987.53
1393269.72	1471221.61
3151301.42	3297209.14

ANNEX

DEMAND ANALYSIS AND EVALUATION METHODOLOGY

FOR URBAN TRANSPORT COMPONENTS

for the Transportation and Land Sectors

of the Colon Urban Development Project

Draft prepared by Robert M. Sarly, Consultant, for the World Bank, Urban Operations Review & Support Unit.

April 1980

RMSarly:dm/bb/al
2/29/80

COLON URBAN DEVELOPMENT PROJECT

Demand Analysis and Evaluation Method
for Transport and Land Sectors

Context

1. Summary of Approach

In multi-sectoral urban projects, significant changes in the level and location of linked economic activities will result from direct project interventions as well as induced program impacts. In given circumstances, projections of future locational demands for residential and employment land cannot be readily made by extrapolating past trends. Structural changes, such as relative accessibilities, aggregate demand, supply of serviced land on the market, and overall location cost borne by the activity, will affect returns to investment throughout the urban economy and particularly in the Land and Transport sectors where locational preferences are most directly exercised.

Within the framework of an urban development project, analytic method is needed to identify future levels and locations of economic activity with sufficient confidence to serve as the basis of rudimentary cost-benefit evaluation. Any given method, especially one with an operational focus, will be a highly simplified application of basic non principles. The particular approach described herein is adapted from an operational tradition of Strategic Land Use-Transportation Analyses in which some quantitative detail is sacrificed for quickly determined strategic indicators of overall project impact in the urban area.

The method is based upon a conurbation of manual calibration, and manual and programal estimation. The program is written for use on a Texas Instrument TI59 hand-held programmable calculator, with use of attached paper tape printer. Discounted time and operating cost savings are automatically calculated for each link, year, mode, income group and (if

required) origin of trip. A complete run of a given configuration of transport inputs takes about four hours.

The entire study takes about two calendar months (3 mm) including Data assembly, input generation, manual calculation, programmable estimation, manual estimation, interpretation of results and reporting.

COLON URBAN PROJECT

JUSTIFICATION OF HIGHWAY COMPONENT: II

Summary of Results

1. The highway improvement is economically justified. From the perspective of intercity transport alone, the investment is already overdue, in that past "territorial" constraints on the expansion of the highway to meet growing demand in the region and between Cristobal Port and Panama City has resulted in near, or above, capacity levels of service on the highway. (See IRR, FURR, and increase in C/B ratio from 1973 to present below section E: Justification).

2. The integrated urban development project to revitalize the Colon sub-region proposes to increase and disperse economic activity and housing in the corridor between Manzanillo Island and the Cativa/Sabanitas suburbs. The resulting additional metropolitan travel demand in effect transforms the highway, which is the only transport spine in the sub-region, from an inter-city to a metropolitan transport artery. As such it is an indispensible component of the integrated urban development program (see below section C: Impact).

3. Demand for the road improvements to the Boyd-Roosevelt Highway between Cativa/Randolph Road junction and Manzanillo Island is a direct result of the implementation of the integrated urban project, and in particular of the employment and housing components in the Expanded Free Zone, Porto Escondido and industrial zones (5, 6, and 7 in the attached map). Indirectly additional travel demands will also be generated in Manzanillo Island and Cativa-Sabanitas (Zones 1 and 8), as a result of the urban project (see below section B: Context).

4. Reductions in the overall size, or delays in the implementation rate of the urban project would reduce overall demand for transport on the road, providing that both employment and housing were reduced in equal proportions. However, if employment in the new Free Zone sites is to develop in any event, as is currently planned, while the housing in Porto Escondido (Zone 6) is eliminated or reduced, then travel demand on the road would increase further, due to the increase in average consequent commuting distance (along the Boyd-Roosevelt corridor) between jobs and homes.

5. In the absence of both the proposed highway improvements and new housing, residential preferences, especially for low-income households would generate strong demands for locations in the proximity of employment resulting in illegal squatting conditions if affordable legal options were unavailable. The areas most likely to be affected would be the Expanded Free Zone industrial zone and Rainbow City (zones 5, 7, and 4), where land would be available, and to a lesser extent, Manzanillo Island (Zone 1) where services would be available.

6. At the other extreme, implementation of the integrated urban project, but without these road improvements, would undermine the effectiveness of the urban project as a whole. The growth of travel demand on the road would quickly create congestion and loss of efficiency to all road users. The disbenefits to the urban project directly attributable to the absence of the proposed road improvements, as shown in the attached memo, would represent a significant share of overall project benefits. Disbenefits to goods movement, which generate 10% of the trip volumes, represent 60% of the total operating cost savings achievable on the road by 1984. Bus travelers which amount to 50% of the trip volumes, would bear about 10% of the operating cost savings, while car travelers (40% of the total trips) would derive 40% of the total operating cost savings. The low- and middle-income travelers generate 25% and 35% of the trips respectively and would incur 6% and 10% of the respective total disbenefits.

7. In view of the above, implementation of the urban project in its current form including the proposed road improvements would appear to generate the minimum negative externalities for the transport sector in the provision of essential access to linked economic activities in Gran Colon.

COLON URBAN PROJECT

JUSTIFICATION OF HIGHWAY COMPONENT: II

A. Objectives

1. Implementation of the urban project is not required to justify going ahead with construction of the road: as shown below, the road is justified on the basis of regional demand. However, the road is required to ensure the urban project realizes its objectives, particularly:

(i) the objective of stimulating improvements in key sectors such as transport, and in the level of transport services in Colon, to reduce travel costs and improve standards of access;

(ii) the objective of avoiding the disbenefits of $18,027 million (present value) in additional travel expenditures on the unimproved road (1980-1999), that would be incurred by the Colon population were the urban project to go ahead without the road component; and

(iii) ensure that the imminent rise in the volumes of trips along the road caused directly by the housing and employment components of the project are satisfactorily served, so that bottlenecks do not arise that delay overall project implementation causing cost overruns and development imbalance.

B. Context

2. The existing two lane Boyd-Roosevelt Highway is the only access corridor between Colon (i.e., Manzanillo Island), the main housing and employment development areas of the urban project, the suburbs of Cativa and Sabanitas, and Panama City (and the rest of the Metropolitan Region). Upgrading of the highway as proposed in the urban project will be along its existing alignment. No alternative alignment is likely to develop in the foreseeable future.

3. The roadway widening part of the project comprises a doubling of the existing two lane highway which extends from 800 meters east of the refinery junction in Cativa to the Randolph Road junction for a distance of 6.8 kilometers. The one-way loop part of the project extends from Randolph Road junction to Manzanillo Island for a distance of 2.5 kilometers inbound and a return route through Rainbow City for a distance of about 2.8 kilometers outbound. There are about nine junctions all of which will be at grade. Lane width will be 3.65 meters and the existing one-way loop roads will be brought up to comparable service levels as the main highway by means of resurfacing and geometric design of junctions, storage lanes and slipways.

4. On the basis of the regional demand projections made in the 1973 technical and feasibility study of Boyd-Roosevelt, the expansion of the road from its current two lane capacity to four lanes was determined to be economically justified from regional demand alone. On the basis of 1973 cost estimates this produced a benefit-cost ratio in the range of 1.8. Regional travel volumes then were estimated to be over 6,000 average daily trips (ADT) in 1973, with projections of over 10,000 ADT by 1980.

5. Current travel volume estimates based upon survey data collected by the Ministry of Public Works (MOP) in 1979 show current volumes along the road to be about 10,000-12,000 ADT, growing at an average rate of about 5% p.a. Current peak hour volumes are 1,200 passenger car units (PCU), which prevail an average of 28 hours per week. This peak hour demand exceeds the assumed effective capacity of the road during 25% of the travel week.

C. Impact

6. Without an urban project previous trends of traffic growth within Colon, and between Colon and Panama City, suggest that demand would continue to grow at about 5% p.a. producing 1984 ADT of 12,000 and 1990 ADT of 16,000.

7. However, in view of the dual impact of the urban project on Colon the expected growth in traffic demand will be about 20% greater due to:

(a) the accelerated development of economic activities in Colon resulting from the urban project; and

(b) the increased dispersion of project activities within the Colon sub-region, whose inter-relationships will rely on effective sub-regional transport access.

8. The economic analysis of demand for travel on the Boyd-Roosevelt Road done for this project component has taken the above impacts into account. It has been constructed upon conservative assumptions of trip generation, trip distribution and modal split, trip assignment and travel cost. The method distinguishes nine origin and destination zones in the city, three income classes and three travel modes. It also distinguishes operating costs and time costs.

9. The results of this demand analysis show a rapid increase in the number of peak hour PCU's from about 1,350 in 1980 to 1,650 in 1981, 2,000 in 1982, 2,300 in 1983, 2,600 in 1984 and 3,900 in 1989.

D. Cost

10. The capital cost of the road component, based upon preliminary estimates prepared by MOP, is $5,772 million (base) plus physical and price contingencies for a gross of $8,700 million.

E. Justification

11. Assuming (conservatively) an actual capital cost of about $8.0 million (not including price contingencies), economic evaluation of the road project shows a benefit-cost ratio in excess of 2.25 and a net present value of $10.03 million, not including time cost savings.

12. When time cost savings are taken into account the benefit-cost ratio rises to 12.94, and the net present value increases to $95.50 million.

13. The first year rate of return is 110%, showing that the optimum time for initiating investment in the road is already past, and that further delay is not justified.

14. The internal rate of return (IRR) for the road is 39.75% not including time cost savings. When these are included the IRR is in excess of 100%.

15. Sensitivity tests on costs show that a 20% rise in costs reduces IRR to 34.65%, and that a 20% fall in expected benefits reduces IRR to 32.15%.

RMSarly:bb

COLON URBAN PROJECT

ROADWAY IMPROVEMENT: ORIGIN/DESTINATION TRIP VOLUMES

1979 - 1984

1	1979	1984
POP	75000	65000
EMP	8000	9500
MP OR	8100	7760
MP DE	6470	8940

2	1979	1984
POP	–	–
EMP	5000	5000
MP OR	500	500
MP DE	3840	4700

3	1979	1984
POP	–	–
EMP	3000	3500
MP OR	300	350
MP DE	2300	3210

4	1979	1984
POP	5000	5000
EMP	250	500
MP OR	855	1050
MP DE	215	617

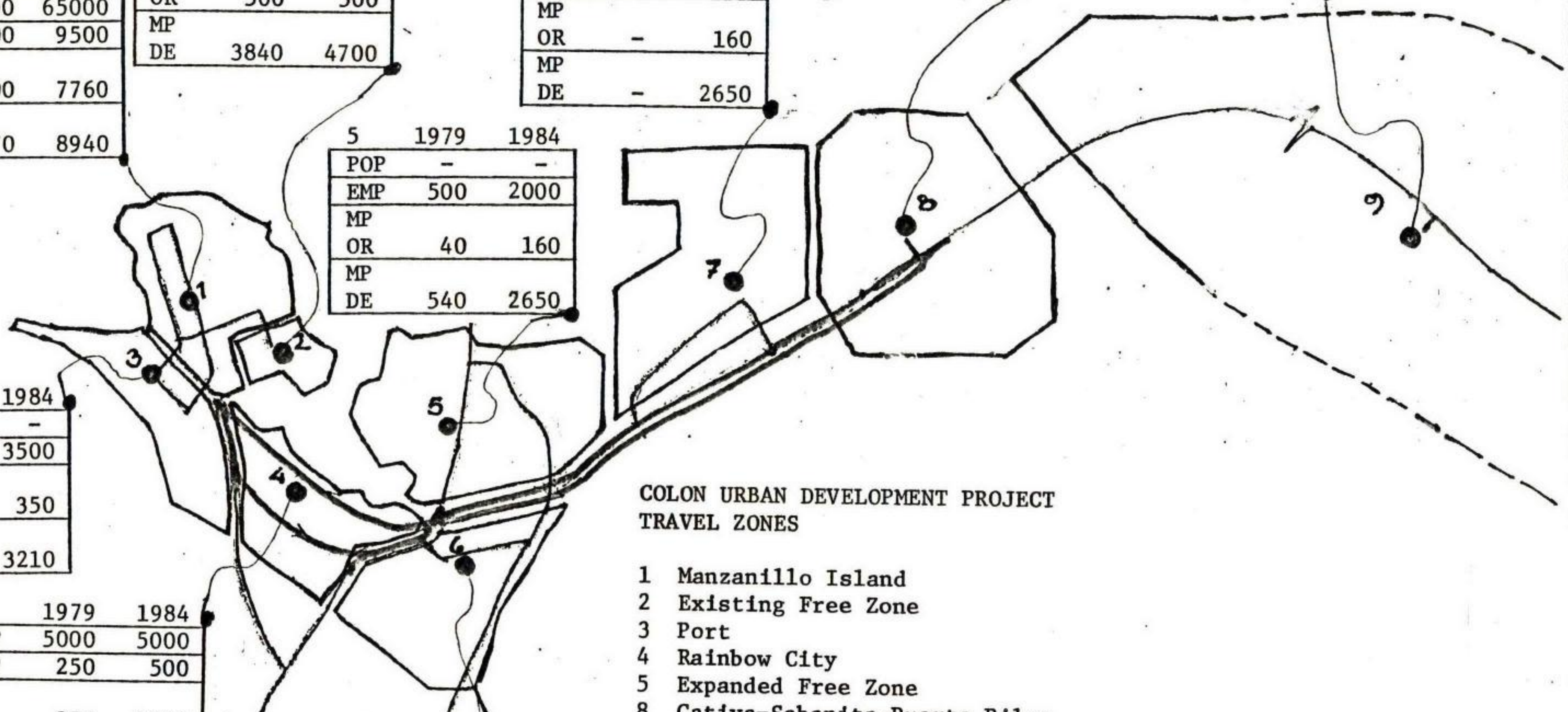
5	1979	1984
POP	–	–
EMP	500	2000
MP OR	40	160
MP DE	540	2650

6	1979	1984
POP	–	25000
EMP	–	250
MP OR	–	3015
MP DE	–	319

7	1979	1984
POP	–	–
EMP	–	2000
MP OR	–	160
MP DE	–	2650

8	1979	1984
POP	20000	25000
EMP	1500	2500
MP OR	2610	3400
MP DE	1290	2680

9	1979	1984
POP	–	–
EMP	–	–
MP OR	3025	9214
MP DE	745	1514



COLON URBAN DEVELOPMENT PROJECT
TRAVEL ZONES

1 Manzanillo Island
2 Existing Free Zone
3 Port
4 Rainbow City
5 Expanded Free Zone
8 Cativa-Sabanita-Puerto Pilon
9 Panama City Metropolitan Region

MPPE = Morning Peak Period Destinations
MPOR = Morning Peak Period Origins
include only vehicle trips (2 hours)

2. Introduction to the Demand Analysis

Amongst the objectives of transport sector intervention in the Colon Urban Development project is the provision of an efficient transport system to make linked economic activities in metropolitan Colon more accessible to the urban population. Since the impact of the overall project is multi-sectoral and complex it will not be possible to represent its derived benefit in a single measure such as a cost-benefit ratio, or internal rate of return. The estimate of the transport components' net worth, its benefits and costs (associated with road widening, traffic improvements, bus and train service provision, bus fleet expansion and vehicle maintenance) are therefore defined by the following evaluation measures:

1. time savings to bus travellers
2. operating cost savings to bus travellers
3. time savings to car travellers
4. operating cost savings to car travellers
5. time and operating cost savings to trucks
6. time savings to train travellers
7. levels of service for the public bus system and primary road network
8. travel expenditure share of household income
9. generalized travel share of location costs for households.

Each of the above terms is measured for nine separate geographic areas in the metropolitan region, and with respect to its incidence in three income classes. The areas are:

1. Manzanillo Island (excluding the Colon Free Zone)
2. Colon Free Zone
3. Cristobal Port
4. Rainbow City
5. New Commercial Zone (Coco Solito)
6. Puerto Escondido
7. New Industrial Area (Export Processing Zone)
8. Cativa - Sabantas - Puerto Pilon Suburbs
9. Rest of the Metropolitan Region and Panama City

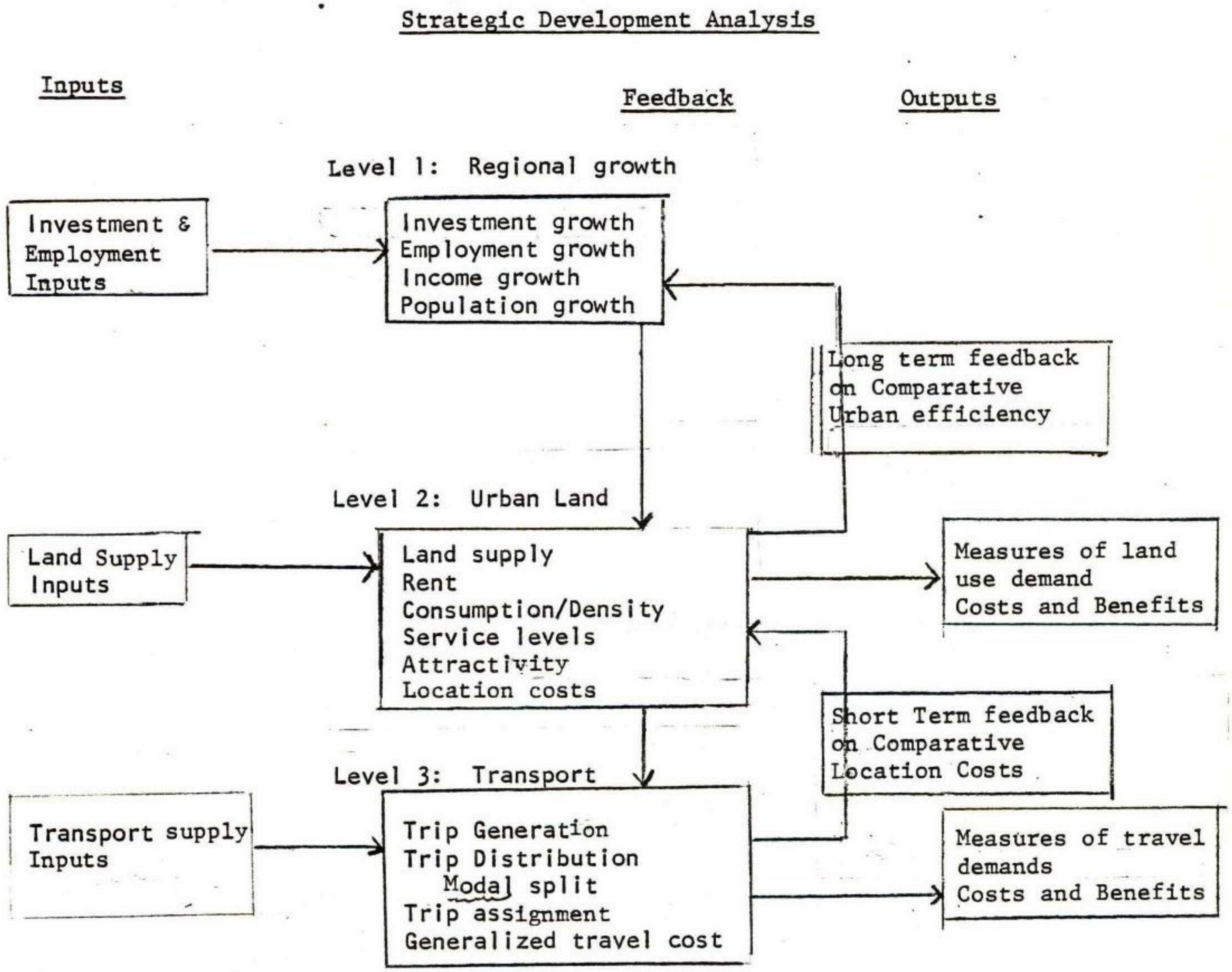
The three income classes are:

	Average HH income per month
1. Upper income (top 2 deciles)	\$1800/m
2. Middle income (from 4th to 8th decile)	\$425/m
3. Lower income (bottom 3 deciles)	\$125/m

3. Method in General

The method for estimating the above evaluation measures relies on an aggregate strategic analysis of transport and land use changes over the project period, and on their interaction. On the basis of these estimates are made of the generation, distribution, assignment and cost of household and business trips, for each income class and for every zone in the region. Travel cost forecasts serve as the basis for estimating locational demand in general, and in particular the values of land in different parts of the region. From these estimates, long-term implications for changes in the land use structure of the Metropolitan Region are determined.

Future levels of demand for transport facilities and services are taken as a function of the future urban spatial structure and the rate of growth of economic activity in the Colon Region. These are expressed logically in three levels of a strategic development analysis, as shown in the following diagram:



Each level of analysis starting with Regional growth provides the operating assumptions upon which the next level projections are made. The analysis is validated on the basis of existing conditions by calibrating the governing relationships linking the supply and demand of transport and land, from survey and field observation. These relationships then derive the projection of future demand levels in terms of changes in supply and the behavior of the urban economy under conditions of growth.

4. Method in Detail

The method is made operational in three phases:

1. Manual calibration of functional relationships governing the changing values of transport and land demands by mode, link, zone and income class.
2. Programmable estimation of travel benefits by mode, link, zone of origin, and income class
3. Manual estimation of location cost changes and imputed affect on the demand for land by income class, zones density and rent values.

4.1 Manual Calibration of Transport Demands

The governing relationships for the transport analysis are shown below:

Trip Generation and Distribution

(Equation 1) $T_i^{z^\circ} = P_\cdot^z \quad z$

(Equation 2) $T_j^{z^\circ} = P_\cdot^z \quad z$

T_i^{zo} = number of trips generated by an activity (residential/employment) z for purpose o from origin zone.

T_j^{zo} = number of trips generated by an activity (employment) of type z for purpose o to destination zone j.

P^z = Population (or number of employees) associated with that activity

α^z = Propensity for each unit of activity to generate a morning peak hour trip.

This function is used to discriminate trips by origin zone, i, destination zone j, car users and non-car users. It is used to generate estimates of existing conditions reflecting known overall flows of public and private traffic.

(Equation 3) $$T_{ij}^{mzo} = \frac{O_i^{mzo} D_j^{mzo}}{C_{ij}^{mb}} \circ B$$

T_{ij}^{mzo} = Total trips per mode m between zones i and j for activity type z and figure o.

O_i^{mzo} = Number of trip origins in Zone j, for mode m activity z, purpose o.

D_j^{zo} = Number of trip destinations in zone j for activity z, purpose o.

C_{ij}^{b} = Cost of travel between zone i and j.

b = Elasticity of demand for travel with respect to cost.

B = Normalizing factor = $1/\sum^{m} O_i D_i / C_{ij}$

<u>Trip Assignment & Costs</u>

Given the simplified structure of the transport network in metropolitan Colon, inter-zonal traffic is assigned directly to links. These links acquire traffic loads which generate congestion as a function of free flow link speeds and design capacities.

Travel costs are estimated in two parts:

1. Operating costs, measured in terms of average use, speed and distance, characteristic vehicle cost per kilometer at link speed.
2. The cost assumed in terms of real (i.e., congested) travel time elapsed per journey plus the (pedestrian) access time at either end of the (vehicular) journey.

(Equation 4) $$G_c = \sum^{j} C_i^{op} + \sum^{j} C_i^{t}$$

The cost of travel is aggregated for each income class and each mode for all trips made by households in a single origin zone to all other zones, This measure is taken to be the generalized cost of travel for the typical household in each origin zone. Truck trips are similarly aggregated by employment-origin zones for all trips.

The results of the transport analysis are fed back into the land analysis in terms of generalized travel costs per household. These values are then used to reestimate locational demand for land in different zones in terms of residential densities, land rent and numbers of households to be located in each zone.

The governing relationships for the land analysis are as follows:

4.2 Manual Calibration of Land Demands

Demand for Land

The first function determines the quantity of land consumed by each activity l^z given the unit rent of land, r_1 and the income of the activity w_i^z. The relationships amongst these factors (land consumption, rent and income) are governed by three parameters:

(a) constant coefficient, k^z

(b) price elasticity of demand, p^e, which is negative to reflect the reduction of land consumption that occurs with an increase in rents.

(c) income elasticity of demand i^e, which is positive to reflect the increase in land consumption that occurs with an increase in incomes.

The demand for land function is specified in the following form:

(Equation 5) $l_i^z = k^z r_i^{-pe} \cdot w^{z^{ie}}$ where:

l_i^z = land consumed by household group z in zone i.

r_i = rent of land per m^2 in zone i

w^z = income of activity z

p^e = price elasticity of demand for land

i^e = income elasticity of demand for land

k^z = constant scalar.

Cost of Location

The second function, determines the total cost for an activity, z, resulting from the selection of a location in zone i, C_i^z, as the sum of the cost of land rent $l_i^z \cdot r_i$ plus the cost of building rent $S_i^z \cdot b_i^z$ plus the transport cost associated with locating in the zone $A_i^z\ g_i^z$ plus the cost of providing the zone with infrastructure services $F_i^z \cdot O_i^z$. The transport cost is calculated as the weighted average of the cost of all trips made by that activity in that zone. This cost connects the land use sub-model with the transport sub-model. The function is specified in the following form:

(Equation 6) $C_i^z = l_i^z \cdot r_i + S_i^z \cdot b_i^z + A_i^z \cdot g_i^z + \sum^{Q} F_i^z \cdot c_i^z$

Where:

C_i^z = Cost of location for household group z at zone i.

$l_i^z \cdot r_i$ = Cost of ground rent for land consumed.

$S_i^z \cdot b_i^z$ = Cost of building rent.

Where: S = amount of built space per household.

b = unit cost of space.

$A_i^z \cdot g_i^z$ = Transport cost.= G_c

Where: A = accessibility index for HH

g = unit cost of transport

$\sum^{Q} F_i^z \cdot c_i^z$ = Cost of infrastructure for all services, Q

Where: F = standard of service.

c = unit cost of standard service.

Distribution of Activities

The third function, determines the distribution among all the zones of each activity in terms of the total number of the activity G^z, the amount of land available for development in zone i, L_i, the location cost of the activity C_i^z, and residual attraction W_i^z. The function is specified in the following form:

(Equation 7) $G_i^z = G^z . L_i . W_i^z . C_i^{z\ -1_z} B^z$

Where:

G_i^z = total number of households

G^z = total number of household group z

L_i = total land available in zone i.

W_i^z = residual attraction index for household group z in zone i.

C_i^z = location cost for household group z in zone i.

1_z = elasticity of demand for location with respect to cost.

B^z = normalizing factor

Budget Constraint

The following constraint must be respected to ensure land supply and located demand are in balance.

(Equation 8) $G_i^z . 1_i^z = L_i$

Cost Recovery

The cost of location function is the basis for estimating means for cost recovery in terms of a recovery rate by cost component for each activity, and for each location for all public capital investment projects, as follows:

(Equation 9)

$$RC_i^{*z} = T_1 l_i^z r_r + T_2 S_i^z \cdot b_i^z + T_3 A_i^z \cdot g_i^z + T_4 F_i^z \cdot c_i^z$$

where: R = cost recovery rate (aggregate),

T_1= land tax rate

T_2= building tax rate

T_3= public transit fares and road user charges

T_4= utilities user charges

In terms of this formulation, C^* may be thought of as the social cost of location since not all of C_i^{z*} may necessarily be charged to the locator. Nonetheless, all of C_i^{*z} is recovered as a result of the locators' choice of the i^{th} location on aggregate, though certain areas (target groups, project sited, etc.) may be cross-subsidized in order to ensure affordability.

The inclusion of C_i^{*z} in the function ensures that the social values created by project investments are reflected in land prices throughout the urban market area in proportion to their impacts for each activity group at each location, and are recovered without detriment to the benefit share of the targetted poverty groups.

Income Generation

The demand for land function for household activities is the basis for incorporating real income, w^* and not just wage income w. Income gains and social subsidies that may have been created in different locations in each of the cost categories as follows:

(Equation 10)

$$l_i^{*r} = \frac{K^z . w^{*z^{ie}}}{r_i^{pe}}$$

where: $w^{*z^{ie}} = \sum B^p - R \cdot C_i^{*z} + \sum^p b_i + w_i^{\,z}$

where: $\sum B^p$ = the sum of project capital costs per household

$R \cdot C_i^{*z}$ = total costs recovered per household

$\sum^p b_i^z$. = sum of income gains resulting from operating cost savings in each project.

w_i^z = wage income per household.

Difference between project costs and costs recovered measures the proportion of conferred benefit not directly recovered by tax, user charge (etc.,) or other methods. The function shows the effect of income gains changes in location and service levels. Also, the use of b_i^z ensures that locational preferences reflect the aggregate effect of income gains from constraints on the structure of demand, and in particular on land prices and location priorities for development.

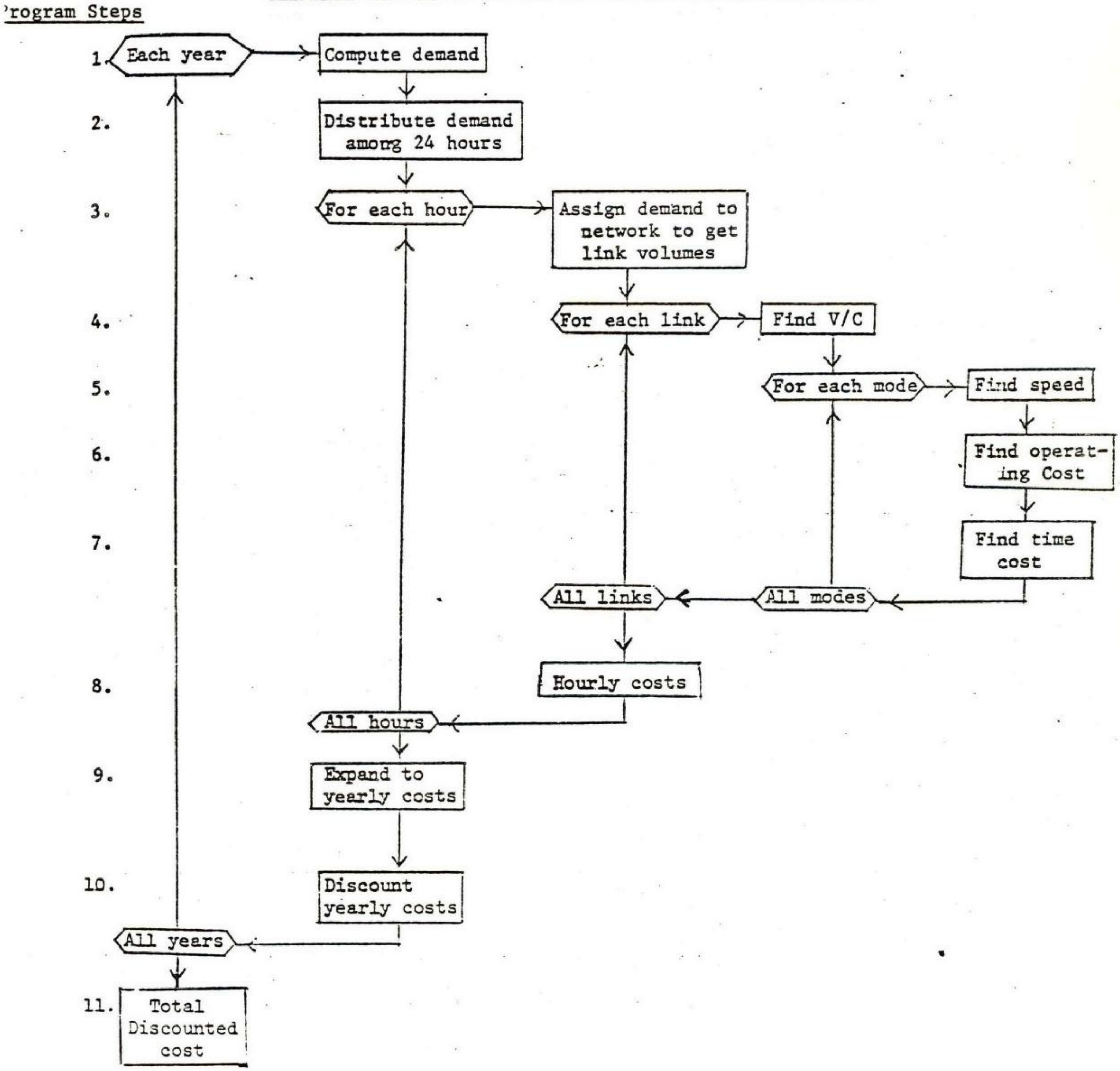
The income effects identified in the analysis are used to indicate aggregate changes in the levels of household demand by income group and location in the urban area. These indicators are viewed from the broad employment market perspective through disaggregated demand and income elasticities as the basis for examining consequent employment impact. This examination requires a separate formulation of a specific income-employment relationship that applies for a given urban system. This is not included in the above.

4.3 Programmable Estimation

A general sketch of the method for estimating transport benefits by means of a hand-held computer program is shown in the diagram below. Discussion follows this diagram, step-by-step.

Figure 1

Computing Operating and Time Costs of Each Alternative



Step 1: For Each Year, Compute Demand

Demand is used for an average weekday as representative of the whole year. Demand has two dimensions: O-D pair, and mode. Because of population and activity growth in different locations, demand between different O-D pairs varys in magnitude and growth. There is also a different demand for each mode of freight and passenger transport. All modes are aggregated into: truck (freight), auto, and bus (transit). Demand values are taken from the results of the manual algorithm.

Step 2: Distribute Demand Throughout the Day

Demand also has a temporal and a directional dimension. Usually demand is not predicted directly for an hour, however; it is predicted for the entire day and later distributed. For each direction there is a peaking profile, which gives the relative demand in each hour of the day. For convenience we may say there is a peaking profile of 48 hours, where the first 24 hours correspond to one direction (positive) and the last 24 to the other (negative) direction.

The most common assumption is that the daily peaking profile will be the same in every year for every O-D pair. This assumption can cause significant error when the network includes major radial and crosstown roads, each of which exhibit different peaking patterns. (The crosstown road has 2 peaks per rush hour while the radial has only

However, in the corridor problem with which we are dealing it is probably safe to assume each link of the same road will have the same peaking pattern. Different modes may have different peaking profiles, however. Thus the demand at an hour h is

where $D^{t,h}_{m,p} = D^{t}_{m,p} f^{h}_{m}$ (2)

f^h_m is the peaking factor for hour h and mode m, and the vector $\left\{f^h_m\right\}$, h = 1,..., H is called the peaking profile for mode m. Thus a peaking profile is assumed given for each mode. It is common to not analyze all 48 hours separately but rather to select a few representative hours, the results of which are expanded hours in the day which have similar flows. A peaking profile for peak direction travel in San Jose, Costa Rica is found in Attachment A.

Step 3: For Each Hour, Assign Demand to the Network to Get Link Volumes

This can be the most complex step of the urban transportation analysis procedure. However, our restricted problem definition makes this problem trivial. Each O-D pair has a unique path, covering a known set of links. To get link volumes one must aggregate over O-D pairs and modes. Links, like hourly flows, are assumed unidirectional and furthermore we assume a link is symmetric in its capacity. Thus the flow on link j in hour 10 is the flow in the positive direction on link j at 10 a.m., while the flow in hour 34 is the flow in the negative direction at 10 a.m.

To aggregate over modes (since they all share the same roadway), each mode is given a passenger car unit (PCU) equivalency. This PCU equivalency depends not only on vehicle size, but on vehicle performance as well; and since vehicle performance is differentially affected by link characteristics, particularly grade, there must be a PCU equivalency factor for each mode and link.

Link volumes must be measured ~~in~~ vehicles. For auto and truck this presents no problem, since demand is usually measured in vehicles, or if measured in passengers, a single

occupancy factor can convert demand into vehicles. However, when bus demand is measured in passengers, it is not so readily converted into vehicles since load factors can vary widely throughout the day. Since bus operations are usually centrally planned, bus volumes may be exogenously specified. In more complex networks rerouting is also a possibility. In the simple corridor analysis with which we are dealing, it is probably sufficient to assume that load factors on each route at each hour will be the same year-to-year, so that demand can be measured in vehicles in the base year and treated in the same way as cars and trucks.

Aggregating over O-D pairs is simple summation, so that the link volumes are:

$$V_a^{t,h} = \sum^{p} \sum^{m} D_{m,p}^{t,h} \; e_{m,a} \; \delta_{a,p} \qquad (3)$$

where

$V_a^{t,h}$ = volume (in PCU's) on link a in hour h and year t

$D_{m,p}^{t,h}$ = demand for mode m between O-D pair p in hour h and year t (measured in vehicles

$e_{m,a}$ = PCU equivalency factor for mode m on link a

$\delta_{a,p} = \begin{cases} 1 \text{ if link a is on the path between O-D pair p} \\ 0 \text{ otherwise} \end{cases}$

In addition we will later need modal link volumes, which are:

$$V_{m,a}^{t,h} = \sum^{p} D_{m,p}^{t,h} \; \delta_{a,p} \quad (3.1)$$

Step 4: For Each Link, Calculate the Volume/Capacity Ratio (V/C)

Since the volume has been determined in Step 3, all that is needed is the link capacities. These are given for both alternatives (no-build and build), and are the same at every hour in every year (barring the use of reversible lanes, peak hour exclusive lanes, etc.). Therefore, for any link, hour and year, for an alternative b (no-build or build,

$$(V/C)_a^{t,h,b} = V_a^{t,h} \div C_a^b \qquad (4)$$

where

C_a^b = capacity of link a in alternative b

$(V/C)_a^{t,h,b}$ = volume/capacity ratio in alternative b on link a at time h in year t

since each alternative is analyzed identically, we shall remove the superscript b and continue with the notation $(V/C)_a^{t,h}$, realizing that its value pertains to a particular alternative.

Step 5: For Each Mode, Find the Speed

The speed at which traffic flows on a link depends on the volume on the link and its capacity. All existing models (to my knowledge) give speed as a function of the volume/capacity ratio. Recognizing that volume and capacity affect speed not only by their ratio, often there is a family of speed-flow (speed vs. V/C) curves for roads of different capacities, e.g., 2-lane and 4-lane arterials.

Because of different vehicle and operating characteristics, the speeds of each mode will be affected differently by congestion. Therefore each mode will have its own speed-flow relations.

Therefore the speed of mode m on link a which is of type s will be

$$x_{m,a}^{t,h} = g_{m,s}\left[(V/C)_a^{t,h}\right] \qquad (5)$$

where

$g_{m,s}[\,*\,]$ is a particular speed-flow relation for mode m and road type s. Different functional forms exist for the functions $g_{m,s}$. In order to identify the appropriate curve to be used for a particular link (given that mode is known), there must be a pointer specific to each link indicating the correct curve. If all of the curves have the same functional form with a different parameter (e.g., minimum speed), the pointer may be simply the parameter and thus the functional form of the speed-flow curve needs to be stored only once. This pointer or parameter is called s_m. (It seems obvious that the speed of the bus and truck modes might be affected by grade. However most analyses consider the peak direction only, which is one direction half the day and the other direction the other half, so that average grade on every link is zero, and average speed is almost unaffected by grade. The same is true for operating cost, though it is known that it costs more to travel a distance on a hilly road with

an "average" grade of zero than on a flat road. Since we will usually be using models for speed and cost that ignore grade, the remainder of this paper shall ignore it, too. Furthermore, ignoring grade allows both directions of a link to be identical. This is a significant simplification, making flows to be direction abstract, and hence allowing analysis of flows in one hour to be expanded to hours with similar flows without regard to direction when less than 48 hours are analyzed.) Some examples of speed-flow functions are found in Attachment A.

Step 6: For Each Mode, Determine Operating Cost

Vehicle operating cost on a link is difficult to measure, and therefore difficult to model. It is affected by road characteristics (grade, curvature, pavement), vehicle characteristics (weight, engine type), and operating characteristics (speed, number of stops). Most models give operating cost in terms of one of the operating characteristics only (speed) aggregating different vehicle types (within the same mode) and averaging over road characteristics. If pavement is uniform over the road, there is no more than normal curvature for an urban road, and grades are not great, such approximations are acceptable. Under normal urban operating conditions a study found that 95% of the variation in fuel consumption among British cars could be explained by speed alone. Since other auto related costs are roughly proportional to fuel consumption, the simple speed-operating cost relation may be sufficient for autos.

Operating cost is usually computed by a function of this form:

$$OC^{t,h}_{m,a} = \beta_m + \frac{\alpha_m}{X^{t,h}_{m,a}} \cdot d_a \cdot V^{t,h}_{m,a} \qquad (6)$$

where

$OC^{t,h}_{m,a}$ = operating cost for mode m on link at time h in year t

α_m, β_m = parameters (per hour and per Km operating cost for mode m)

$X^{t,h}_{m,a}$ = speed of mode m on link a at time h in year t

d_a = length of link a

$V^{t,h}_{m,a}$ = volume of mode m on link a at time h in year t.

Since operating cost should include the labor cost of paid drivers such a function including a term in which distance is divided by speed (which yields time) is especially appropriate for bus and truck. Operating cost models estimated in a few cities are documented in Attachment A.

Step 7: For Each Mode, Determine Time Cost

The time each vehicle spends on a link is the link's distance divided by the vehicle's speed. The total passenger time is the vehicle time multiplied by vehicle occupancy (not including paid drivers). The total time cost is this total passenger time multiplied by the value of time.

Vehicle occupancy can vary not only by mode but also by link and by time of day, particularly on buses where loads may be 80 in the peak and 20 off-peak, and may increase steadily toward the city center. Value of time is generally taken to be fixed for all modes and all times, and invariant over the year.

Thus the passenger wait time cost is

$$TC^{t,h}_{m,a} = \frac{d_a}{X^{t,h}_{m,a}} \cdot W^{h}_{m,a} \cdot v \cdot V^{t,h}_{m,a} \qquad (8)$$

where

$TC^{t,h}_{m,a}$ = time cost for mode m on link a at time h in year t

d_a = length of link a

$X^{t,h}_{m,a}$ = speed of mode m on link a at time h in year t

$W^{h}_{m,a}$ = vehicle occupancy of mode m on link a at time h

v = value of time

$V^{t,h}_{m,a}$ = volume (of vehicles) of mode m on link a at time h in year t

Step 8: Aggregate Costs Over Modes and Links

Steps 4-7 must be repeated for every link and every mode as the flowchart in Figure 1 indicates, aggregating costs to yield hourly costs. Thus the operating and time costs for an hour h in year t are:

$$OC^{t,h} = \sum^{a} \sum^{m} OC^{t,h}_{m,a}$$
$$TC^{t,h} = \sum^{a} \sum^{m} TC^{t,h}_{m,a} \qquad (9)$$

Other meaningful aggregations should be taken as well, such as total costs for modes, for links, etc.

Step 9: Aggregate Costs Over Hours, Expanding to Yearly Costs

Steps 3-8 are repeated for each hour. To expand the predicted hourly costs to yearly costs one needs to know the number of hours in a year that hour represents. These annualization factors should insure that the daily demand (in Step 1) is properly expanded to annual demand. Different hours may have different annualization factors because they represent different numbers of weekday and weekend hours. Also some analyses may want to consider peak hours only in computing benefit.

The annual costs are then:

$$OC^{t} = \sum^{h} OC^{t,h} \; N_h$$
$$TC^{t} = \sum^{h} TC^{t,h} \; N_h \qquad (10)$$

where

N_h = number of hours in a year represented by hour h.

Step 10: Discount Yearly Costs

Either annual or continuous compounding may be used to discount the yearly costs to present values. For operating costs, these formulas are:

$$\overline{OC}^{t} = OC^{t} \, (1 + D)^{-t} \quad \text{(yearly compounding)}$$
$$\overline{OC}_{t} = OC^{t} \, e^{-Dt} \quad \text{(continuous compounding)} \qquad (11)$$

where

OC_t = discounted operating cost from year t

D = shadow discount rate

time costs are similarly discounted

Step 11: Aggregate Discounted Costs

This yields the present costs of the alternative being studied. The difference between the present cost of the no-build alternative and that of the build alternative is the present value of the build alternative. (When other discounted costs, such as construction, maintenance, etc., are subtracted this becomes net present value.) So the final equation for present operating costs (and similarly for time cost) is

$$OC = {}^{t}\ \overline{OC}^{t} \qquad (12)$$

The predicted costs thus obtained may be disaggregated and manipulated in any way to afford the analyst a closer look to see the benefits accruing to each link, or to each mode, or to find link specific benefit/cost ratios, internal rates of return, etc.

5. Solution Procedure

Within the above Analytic framework, the solution procedure provides a logical, yet simple sequence of analytic tasks. These tasks are listed below and elaborated in detail in the following sections.

5.1 Summary of Tasks

A. Strategic Forecasts of Travel Demands

1. Review land use conditions and developmental assumptions
2. Review test road network and bus system conditions and changes
3. Review traffic assignments and diversions

B. Future Demand Volumes

1. Estimate future auto/truck traffic volumes
2. Estimate future bus and bus passenger traffic volumes
3. Estimate future train passenger traffic volumes
4. Develop peak hour and peak direction factors
5. Estimate future peak hour, peak direction volumes for auto/truck, bus and bus passenger, train passengers.

C. Design Capacities

1. Develop lane capacity of auto/truck
2. Determine PCU equivalencies and passenger capacities for bus and mini-bus

D. Volume/Capacity Ratios

1. Compute V/C ratio for auto/trucks and for busses

E. Level of Service and Travel Speed

1. For auto/trucks and for busses, establish a LOS - V/C Speed table.
2. Determine LOS and travel speed, knowing V/C.

F. Travel Time, Stops, and Idling Time

1. Develop a "model" to relate LOS, travel time per km., stops per km., and idling time per km. for auto/trucks and busses.
2. Determine on a "per kilometre" basis, travel time, stops, idling time, and excess travel time (actual time minus 1.0 minute as derived from 60 kph base)

G. Time Costs and Vehicle Operating Costs

1. Determine value of driver's time and passengers' time per hour.
2. Determine for auto/truck and for bus, vehicle operating cost per km. for 60 kph base, and for additional costs due to stops and idling time.

H. Time Savings

1. For auto/truck drivers and for bus passengers, compute time savings during six peak hour, peak directions for each year (1979-1999). "Savings" are based on difference between "No Build" (Alternative 1) and "Build" (Alternative 2).
2. Compute present value of time savings.

I. Vehicle Operating Cost Savings

1. For auto/truck volumes and for bus volumes, compute operating cost savings by link during six peak hour, peak directions for each year (1979-1999). "Savings" are based on "No Build" (Alternative 1) and "Build" (Alternative 2).
2. Compute present value of vehicle operating cost savings.

J. Project Costs

1. Determine present value of project costs.

K. Economic Evaluation

1. Determine benefit-cost (B/C) ratio, "Benefits" refer to the sum of present values for time savings and vehicle operating cost savings.

2. Determine net present value (NPV).

3. Determine internal rate of return.

5.2 Input Requirements

A description of input requirements and assumptions used to calibrate the analysis to conditions in Colon in 1979 is given in the pages that follow.

Input Requirements

For a project with A links, M modes, a benefit horizon of T years, each of which has H hours, considering 2 alternatives.

Number of Items	Variable	
A x M	$V^{o,*}_{m,a}$	base year vehicular demand for mode m on link a
M or 1	r_m or r	demand growth rate (for mode m)
H x M or H	f^h_m or f^h	peaking factor (for mode m) in hour h
M	e_m	PCU equivalency factor for mode m
2A	c^b_a	capacity of link a under alternative b (no build or build)
2M	α_m, β_m	operating cost model parameters for mode m
A	d_a	length of link a
H x M or M	W^h_m or W_m	vehicle occupancy of mode m(in hour h)
1	v	value of time

H	N_h	yearly number of travel hours of type h
1	D	shadow discount rate
M	s_m	speed-flow curve parameter for mode m

plus a speed-flow function

c_B	bus fares
t_c	terminal times
C_{nr}	non-transport location costs
W	disaggregate attractivity indices
L	land availability
P	aggregate popular growth
E	aggregate employment growth

BENEFITS ON A SINGLE LINK: SINGLE HOUR EXPANDED

(Input Data Format)

Site: ______________________ Date: __________

Analyst: ______________________ Page: _____ of _____

Costs: ______________________

Enter		Press
(Initialize)		A
(Initialize)		B
Auto mode:		
growth factor (1.xx)	= 1. ______	R/S
PCU equivalency factor (1)	= 1 ______	R/S
speed-flow function parameter	= ______	R/S
per hour operating cost ($/hr)	= ______	R/S
per km operating cost ($/hr)	= ______	R/S
auto occupancy ______ x value of time ______ ($/hr)	= ______	R/S
Truck mode:		
growth factor (1.xx)	= 1. ______	R/S
PCU equivalency factor	= ______	R/S
speed-flow function parameter	= ______	R/S
per hour operating cost	= ______	R/S
per km operating cost	= ______	R/S
occupancy x value of time	= 0.0 ______	R/S

Enter		Press
Bus Mode		
growth factor (vehicular) (1.xx)	= 1. ______	R/S
PCU equivalency factor	= ______	R/S
speed-flow function parameter	= ______	R/S
per hour operating cost	= ______	R/S
per km operating cost	= ______	R/S
bus occupancy ______ x value of time ______	= ______	R/S
(Initialize)		C
Base year vehicular volumes (peak hour, peak direction)		
auto volume (veh/hr)	= ______	R/S
truck volume	= ______	R/S
bus volume	= ______	R/S
Link capacities (one direction)		
no build capacity (veh/hr)	= ______	R/S
build capacity	= ______	R/S
Link length (km)	= ______	R/S
Peak hour, peak direction yearly expansion factor (number of peak hours per year)	= ______	STO 11
First year discount factor (1.xx)	= ______	STO 13
Discount rate (1.xx)	= ______	STO 14
Number of years	= ______	STO 00
First Year in Benefit Horizon	= ______	STO 06

5.3 Regional Growth, Land and Transport Inputs for Colon Urban Development Project

Level 1: Regional Growth Inputs

The key regional growth assumptions underlying the projection of travel demands are described in the Project Appraisal Report and summarized in the tables below:

Employment Growth and Change 1979-1989

Based on "basic" employment-generating project investment and "non-basic" job-generation (assuming a multiplier of 1.8) distributed to spatial structure of the market and available land.

Urban Project Build

Year	Employment					
	1979		1984		1989	
Zone	Basic	Non-basic	Basic	Non-basic	Basic	Non-basic
1	500	7,500	500	9,000	500	11,000
2	5,000	-	5,000	-	5,000	-
3	3,000	-	3,500	-	4,000	-
4	-	250	-	500	-	1,300
5	500	-	2,000	-	3,000	-
6	-	-	-	250	-	500
7	-	-	2,000	-	5,000	-
8	1,000	500	1,000	1,500	1,000	2,000
9	-	-	-	-	-	-
Total	10,000	8,250	14,000	11,250	18,500	14,800

Urban Project No-Build

Year	Employment					
	1979		1984		1989	
Zone	Basic	Non-basic	Basic	Non-basic	Basic	Non-basic
1	500	7,500	500			
2	5,000	-	5,000			
3	3,000	-	3,000			
4	-	250	-			
5	500	-	1,000			
6	-	-	-			
7	-	-	-			
8	1,000	500	1,000			
9	-	-	-			
Total	10,000	8,250				

Population Growth and Change 1979-1989

Based upon a full labor participation rate of .33 and an unemployment rate (in formal sector activities) of 40% effective 1979 and reducing ___ to 7%-10% by 1989, distributed on the basis of observed existing densities and inputed changes on future locational cost/demand for housing. Income classes are defined in terms of average income levels which are taken to neither increase nor decline in real terms over the analysis period. Population growth arising from natural increase and net in-migration are not distinguished in the h household totals shown below; average household size is taken as 4.6 (existing 1979 average) throughout the period. (Households.)

Income	1979				1980				198			
Class	High	Medium	Low	Total	High	Medium	Low	Total	High	Medium	Low	Total
Zone												
1	2,600	8,300	4,100	15,000	2,500	8,000	2,500	13,000	2,500	8,000	2,500	13,000
4	800	200	-	1,000	800	200	-	1,000	800	200	-	1,000
6	-	-	-	-		3,000	2,000	5,000	-	3,000	2,000	5,000
8	800	2,000	1,200	4,000	1,000	2,500	1,500	5,000	1,500	3,500	2,000	7,000
Total	4,200	10,500	5,300	20,000	4,300	13,700	6,000	24,000	4,800	14,700	6,500	26,000

Level 2: Urban Land Inputs

The key land assumptions underlying the projection of land demands are summarized in the tables below:

Land Available for Residential Use

Based on surveyed land use patterns and observed net residential densities existing for 1979, with income classes separately estimated by zone.

INCOME CLASS

Year	1979							1984				1989			
	High		Middle		Low		Total	High	Middle	Low	Total	High	Middle	Low	Total
Zone															
1	78.0	300	83.0	100	12.3	30	173.3	75.0	80.0	77.5	162.5				
4	48.0	600	4.0	200	0.0		52.0	48.0	4.0		52.0				
6	–	–	–	–	–	–	–	–	75.0	15.0	90.0				
8	72.0	900	60.0	300	10.8	90	142.8	90.0	75.0	13.5	178.5				
Total	198.0		147.0		23.1		368.1	213.0	234.0	36.0	483.0				

Disaggretated Attractivity Indices.

Based upon existing and future demand by income class in proportion to class size in each residential zone, and a calibrated coefficient of attraction.

Income	1979						1984						1989					
Class	High	αH	Middle	αM	Low	αL	High	αH	Middle	αM	Low	αL	High	αH	Middle	αM	Low	αL
Zone																		
1	26		83		41		25		80		25		25		80		25	
4	8		2		0		8		2		0		8		2		0	
6	–		–		–		0		30		20		–		30		20	
8	8		20		12		10		25		15		15		35		20	

Non-transport Location Expenditure

Based upon an estimated proportion of average household income budgeted for land, housing and utilities costs, measured in terms of monthly household expenditures per square meter of residential land.

Income Class	1979 High	1979 Middle	1979 Low	1984 High	1984 Middle	1984 Low	1989 High	1989 Middle	1989 Low
Zone									
1	1.80	1.10	0.83						
4	0.90	0.53	-						
6	-	-	-						
8	0.60	0.35	0.28						

Level 3: Transport Inputs

The key transport assumptions underlying the projection of travel demands are summarized in the tables below:

Values of Travel Time

Income Class

	High	Middle	Low
Average HH income/month	\$1800	\$425	\$125
Average hourly income/traveler	\$8.72	\$225	\$0.73
Value of travel time rate	25%	25%	25%
VOT/minute of travel	0.036	0.009	0.003

Trip Rate by Mode (Morning Peak Period Only)
1979

Income class	High			Middle			Low		
Mode	Car	Bus	Walk	Car	Bus	Walk	Car	Bus	Walk
Zone									
1	0.6	0.2	0.2	0.2	0.3	0.3	0.1	0.3	0.3
4	0.7	0.2	0.1	0.2	0.4	0.2	-	-	-
6	-	-	-	0.2	0.4	0.2	0.1	0.3	0.3
8	0.7	0.2	0.1	0.2	0.4	0.2	0.0	0.5	0.2
9	.8	.2	-	0.2	.6	-	-	1.0	-

Year 1984/1989

Income class	High			Middle			Low		
Mode	Car	Bus	Walk	Car	Bus	Walk	Car	Bus	Walk
1	0.7	0.2	0.2	0.3	0.3	0.3	0.1	0.3	0.3
4	0.8	0.2	0.1	0.3	0.4	0.2	-	-	-
6	-	-	-	0.3	0.4	0.2	0.1	0.4	0.2
8	0.8	0.2	0.1	0.2	0.4	0.2	0.1	0.4	0.2
9	0.9	0.1	-	0.5	0.5	0.2	0.1	0.9	-

TRUCK TRIP RATE PER UNIT OF EMPLOYMENT

Zone	Truck Trips
1	0.08
2	0.10
3	0.10
4	0.06
5	0.08
6	0.06
7	0.08
8	0.06
9	-

INTERZONAL LINK DISTANCES

(Based upon shortest route distances between zone centroids along existing roads in kilometers).

	1	2	3	4	5	6	7	8
1	0.67	1.40	1.00	2.40	4.80	4.40	8.20	9.60
2	1.40	0.36	1.60	3.00	5.40	5.00	8.80	10.20
3	1.00	1.60	0.54	2.20	4.60	4.20	8.00	9.40
4	2.40	3.00	2.20	0.74	2.40	2.00	5.80	7.20
5	4.80	5.40	4.60	2.40	0.66	1.60	5.40	6.80
6	4.40	5.00	4.20	2.00	1.60	1.00	4.60	6.00
7	8.20	8.80	8.00	5.80	5.40	4.60	1.20	3.00
8	9.60	10.20	9.40	7.20	6.80	6.00	3.00	1.20

PCU EQUIVALENCY AND OCCUPANCY RATE

	PCU Equivalent	Occupancy
cars	1.0	1.6
busses	3.0	45.0
trucks	3.0	1.0

PEAK PERIOD EXPANSION FACTOR TO MONTHLY TOTALS

trucks	115.0
busses	92.0
cars	107.4

Expansion factors are based on the following considerations for the purpose of estimating benefits:

Auto: Peak (2 hour) volume is 1/7 of total daily

3 peak periods @ full benefit			=	3.00
2 " " " 2/3 "			=	1.33
1 " " " 1/3 "			=	0.33
1 " " " no "			=	0.00
				4.67
4.67 (daily)	X	23 (days per month)	=	115.0

Bus: Peak (2 hour) volume is 1/5 of total daily

3 peak periods @ full benefit			=	3.00
2 " " 1/2 "			=	1.00
				4.00
4.00 (daily)	X	23 (days per month)	=	92.0

Truck: peak (2 hour) volume is 1/8 of total daily

3 peak periods @ full benefit			=	3.00
2 " " 2/3 "			=	1.33
2 " " 1/2 "			=	0.67
1 " " 0 "			=	0.00
				5.00
5.00 (daily)	X	23 (days per month)	=	115.0

AUTOMOBILE OPERATING COST PER 1,600 KMS. (1979)

MPH	KPH	Gas	Oil	Tires	Maintenance	Depreciation	Interest	Total
10	16	49.11	2.39	1.02	7.00	45.00	36.00	140.52
15	24	51.01	2.23	1.22	8.00	41.00	28.50	131.96
20	32	45.82	1.92	1.63	8.50	36.00	22.50	116.37
25	40	43.47	1.82	2.14	8.85	34.50	19.00	109.78
30	48	41.24	1.77	2.65	9.50	32.50	16.50	104.16
35	56	43.22	1.71	3.26	9.85	30.50	15.00	103.54
40	64	43.45	1.71	3.82	10.60	29.00	13.50	102.08
45	72	46.70	1.66	4.54	11.00	27.50	13.00	104.40
50	80	48.67	1.61	5.30	11.50	26.50	12.00	105.58
55	88	53.04	1.50	6.17	12.25	26.00	11.50	110.46
60	96	57.14	1.58	7.19	13.00	25.00	11.00	114.89
65	104	62.96	1.77	8.36	13.75	24.50	10.50	121.84

Using linear regression a curve is determined to fit these data points, whose equation is:

$$C = 0.1046-0.001256x + 0.000009512x^2$$

where C = \$ cost per km for cars
x = speed in km/hour

For busses, based upon 1977 data, the ratio of bus to auto operating costs is given as 4.3. For trucks, based upon the same data source, the truck to auto operating cost ratio is given as 5.6. These values are taken as given.

ASSUMED LEVELS OF BUS FARES

Destination Zone / Origin Zone	1	2	3	4	5	6	7	8	9	Total
1.	.10	.10	.10	.10	.25	.20	.40	.50	1.25	
2	.10	.10	.10	.15	.25	.25	.45	.50	1.25	
3	.10	.10	.10	.10	.20	.20	.40	.50	1.25	
4	.10	.15	.10	.10	.10	.10	.30	.35	1.15	
5	.25	.25	.20	.10	.10	.10	.25	.35	1.00	
6	.20	.25	.20	.10	.10	.10	.25	.30	1.05	
7	.40	.45	.40	.30	.25	.25	.10	.15	.85	
8	.50	.50	.50	.35	.35	.30	.15	.10	.75	
9	1.25	1.25	1.25	1.15	1.00	1.05	.85	.75		

ASSUMED LEVELS OF TRIP TERMINAL TIME IN MINUTES

Origin Zone	Destination Zone	1	2	3	4	5	6	7	8	Note
	Cars	4	4	4	4	4	5	4	4	5 Min.
	Busses	9	9	9	9	9	15	9	9	Service Level
	Cars	4	4	4	3	4	6	4	4	10. Min.
	Busses	14	14	14	14	14	18	14	14	Service Level
	Cars	6	6	6	6	6	8	6	6	10 Min.
	Busses	18	18	18	18	18	22	18	18	Service Level
	Cars	4	4	4	4	4	6	4	4	10 Min.
	Busses	14	14	14	14	14	18	14	14	Service Level

LINK CAPACITY TABLE

	1	2	3	4	5	6	7	8
1		240	1,600	1,600	-	-	-	-
2	240		-	-	-	-	-	-
3	1,600	-		800	-	-	-	-
4	1,600	-	800		1,200	1,200	800	800
5	-	-	-	1,200		1,200	800	800
6	-	-	-	1,200	1,200		800	800
7	-	-	-	800	800	800		800
8	-	-	-	800	800	800	800	

REVISED OPERATING COST FOR TRUCK

At 40 km/h, car operating cost of \$ 0.07.

Truck operating cost is 5.6 times higher, or \$ 0.39

$$\$0.39 \frac{1}{\text{km}} \times \frac{40\text{km}}{\text{hr}} = \$15.59/\text{hrs}$$

The labor cost component is \$1/hr, so the reduced OC is 14.5%.

This corresponds to \$0.36/km, which is 5.2 times higher than auto.

So truck cost is [5.2 (auto cost/km) X distance + \$1 time]

6. OPERATING THE PROGRAM

6.1 BASIC USER INSTRUCTIONS FOR A T159 & PRINTER

1. To turn on the calculator, first plug in the printer and calculator. DO NOT turn on calculator and printer before plugging in the printer. To turn off the calculator, turn off both calculator and printer before unplugging the printer.

2. Algebraic operations -- The TI59 uses logic known as Algebraic Operating System. Algebraic operations are punched into the calculator going from left to right as they would be written out. For example, to perform the following calculation:

$$8 \div 3 = 2.67$$

you would push the following buttons:

1) $\boxed{8}$
2) $\boxed{\div}$
3) $\boxed{3}$
4) $\boxed{=}$

Where there are a complex series of calculations, the calculator follows certain rules about which ones are performed first. Alternatively, you can use parentheses to make the calculator perform operations in a particular order.

The order of operations performed by the T159 is:

1) Special single function keys (such as trig and log functions)
2) Powers and roots (Y^X and $\sqrt[x]{Y}$)
3) Multiplications and divisions
4) Additions and subtractions

Example

$$3 + 10 - 2 \times 14 \div 7 = 9$$

This is the same as

$$3 + 10 - (2 * 14 \div 7) = 9$$

If you do not wish the above interpretation to be followed you must use parentheses, for example:

$$(3 + 10 - 2) * 14 \div 7 = 22$$

2. <u>Special function and operation keys</u>

A) Every key can be used in 2 ways as indicated by 1) labels on the key and 2) gold labels above the key. To get the use of the gold label function, push the gold key marked $\boxed{\text{2nd}}$ before pushing the desired key.

B) The INV key will give you the use of inverse functions or operations for many of the keys. For example to compute e^2 push the following:

$\boxed{2}$

$\boxed{\text{INV}}$

$\boxed{\ln}$

4. <u>User Labels</u> -- User labels are names given by the programmer to different parts (or subroutines) of a pocket calculator program. By pushing a user label key, you are able to have the calculator perform a specific subroutine. The user labels are contained in the top row of the TI59 and consist of A,B,C,D,E, and A', B', C', D', E'.

5. <u>Memory Structure</u> -- The TI59 memory is divided into a section to hold a program and a section to hold data. When the TI59 is turned on, it contains 480 spaces for program instruction and 60 spaces for data.

You may re-partition memory if you need more data storage, or more program storage. Following are two commands useful in memory partitioning:

A. $\boxed{2nd}$ $\boxed{OP}$ $\boxed{1}$ $\boxed{6}$ will cause the calculator to display the current memory partition. Ordinarily the display will read 479.59 (program positions go from 000 to 479 and data registers go from 00 to 59).

B. $\boxed{X}$ $\boxed{2nd}$ $\boxed{OP}$ $\boxed{1}$ $\boxed{7}$ will cause the calculator to repartition memory so that there are 10X data registers. For example:

$\boxed{4}$ $\boxed{2nd}$ $\boxed{OP}$ $\boxed{1}$ $\boxed{7}$ would give a partition of 639.39 (or 640 program positions and 40 data registers).

6. <u>Reading a Card</u> -- In order to read a card the calculator must be properly partitional in the same manner as when the card was created. The calculator must also be told the proper place to store the data on the card. Each magnetic card has two sides (or banks). The calculator memory can hold 4 banks (or 2 cards) worth of information.

To read a card, first push the number of the memory bank into which this card will be read. The number will be 1, 2, 3 or 4. Usually the proper memory bank is indicated upon the card or in programmer user instructions. As an alternative, push 0 before reading the card. Then the card will be automatically read into the proper bank.

The second step in reading a card is to hold the yellow side up and insert the proper end (designated by the bank number on the card) into the card reader. Let the calculator process the card through (do not push the card once the calculator has hold of it) and then gently remove the card. The calculator will display the number of the memory bank into which the card read. If there is a misread or if you have pushed an improper bank number, the calculator display will flash. In this case you must start over.

7. Listing Memory

There are two commands which allow you to list memory. There are:

A. 2nd List

This command will print out the program memory. It is especially useful for checking that the current program has been properly read in. To stop the listing push R/S

B. INV 2nd List

This command will print out the contents of the data registers. To stop the listing push R/S .

Notes: Occasionally the listing does not start at the proper place (i.e. does not start at program location 000 or data register 00). To correct for this you press GTO and the proper memory address. For a program, the address would be 000, and for the data registers (under normal partitioning) the address would be 480. The calculator may flash when given the data register address, but this procedure works nontheless. Follow with the desired list command.

8. Run Stop and Reset

These are two useful commands. Reset RST will place the program counter at the beginning of a program which is at address 000. Thus reset may be used when you wish to start a program from the beginning.

Run/Stop R/S may be used to stop program execution, and it may be used to start program execution at the current location in the program. For example, a program may halt execution to wait for data. The user enters the data into the display and starts execution by pressing R/S.

9. Clears -- There are four clear commands with the T159 as follows:

CE -- clears the current display only

CLR -- clears the current math operation

2nd CP -- clears the program

2nd CMs -- clears the data registers

10. Store and Recall

Press STO and a two digit data register number to place the display in memory. For example, 1 STO 0 2 would place a 1 in register 2.

Press RCL and a two digit data register number to recall the contents of the data register onto the display. In the above example, RCL 0 2 would display a 1.

11. Printer commands -- The printer attached to the T 59 has a number of different operating modes. If none of its three buttons have been pushed, then the printer takes all its instructions from the calculator.

If the PRINT button is pushed, the printer will print out the current display on the calculator.

If the TRACE button is pushed, the printer will print out each step in the execution of a program. Trace is very useful for debugging.

The ADV or advance button merely advances the paper in the printer.

6.2 INSTRUCTIONS FOR COMPUTING BENEFITS TO ORIGIN ZONES [FIRST PROGRAM]

1. Fill in, for each mode, a matrix giving volume on each link, by income class within each origin zone, for each mode. (See Tables 1-3)
   Differentiate between volume inbound (+) and outbound (-).
2. Compute, for each link, the total volume in PCU's. This is given by

$$V^e = \sum_{\text{MODES } m} \left(\sum_{\text{INCOME CLASS } i} V_{mi} \right) \cdot PCU_m \div OCCUPANCY_m$$

   Note than inbound volume must be computed separately from outbound.
3. Table 4 summarizes the necessary link data. Fill in such a table, including length, V/C in each direction, and free-flow speed. If V/C or free-flow speed changes in the build alternative, mark that down.
4. Fill in, for each mode (bus and car) for each zone, a table headed "ORIGIN ZONE:" (See Tables 5-10) which contains all the data needed.
5. Fill in, for truck, a table for each origin zone (see Tables 11-16).
6. You are now ready to run the programs.
7. After turning on the printer and calculator, set the partition; Press 9 2nd Op 17 23.908
8. Enter side 2A of program UTB -2.2(A) after entering zero (0).
9. Enter the data on one of the bus or car tables. To enter the data, enter each number and then press the key indicated (A, B, or C). Where no key is indicated, press R/S. Enter data corresponding to the no-build alternative. If you make an error in entering data, see Step 19 below. Fill in the data for one origin zone and one mode completely.
10. Enter zero (0), and load card 1B of UTB-2.2(A).
11. If desired fix the output format by pressing 2nd Fix n where (n) is the number of digits desired after the decimal.

12. Press A and wait until costs are printed. These are the operating and time costs for each income class, and their sum over the income classes.

13. If there is a build alternative, enter data for it. You may re-enter all the data (beginning with number of links, as the values of time and model parameters don't change), or enter only those items that change. To do the latter, see 19 below. To do the former, do Steps 8-11. Before entering data you may want to change the format (as in Step 12).

   * Whatever you do, <u>be sure to enter the number of links</u>, even if it hasn't changed, by entering it and pressing <u>STO</u> <u>00</u>, or pressing C if card 1A is in memory.

14. Press B and wait. The same items as listed in Step 12 will be printed for the build alternative; so will the differences between no build and build.

15. Now select another mode-zone pair. It is best to do all the zones of a single mode together.

16. For each mode-zone pair, repeat Steps 8-15. Note: If values of time and modal parameters do not change, they need not be repeated.

   Also, you may want to undo the fixed display format by pressing INV 2nd Fix.

17. You are now ready to do the trucks. For each origin zone, perform Steps 8-15 again, with these changes:

   Use Program UTB-2.2(B), sides 1A and 1B instead of Program UTB-2.2(A),

   Because these are the income classes, the run time and output in Steps 12 and 14 will be shorter

   Output is operating cost not including labor, labor cost and their sum.

18. FINISHED!

19. <u>Error Recovery</u>

   1. You may list the contents of the data registers, beginning with register (m) by pressing (<u>m</u>) <u>INV</u> <u>2nd</u> list. Press R/S when you want it to stop listing.

   2. You may enter any number directly by entering it and pressing <u>STO</u> <u>ab</u>, where <u>ab</u> is the register it goes in. This also applies

to changes for the build alternative.

3. The contents of the data registers is given in the Table so marked for each program.

Figure 2

Detailed Output Table

Link \ Year	1	2		T	Total (discounted)
1	□	□	. . .	□	□
2	□	.		.	.
	.		.	.	.
A	□			□	□
Total	□	□	. . .	□	□

□ =

Alternative 1 (no build)

1. Peak hour V/C
2. Peak hour auto speed

Alternative 2 (build)

3. Peak hour V/C
4. Peak hour auto speed

not included in row and column totals

Mode 1 (auto)

Alternative 1 (no build)

5. Operating cost
6. Time cost

Alternative 2 (build)

7. Operating cost
8. Time cost

Difference (benefit of build alternative)

9. Operating cost
10. Time cost

Mode 2 (truck)

Alternative 1

11. Operating Cost
12. Time cost

Alternative 2

13. Operating cost

Figure 2 (continued)

14. Time cost

Difference

15. Operating cost

16. Time cost

Mode 3 (bus)

Alternative 1

17. Operating cost

18. Time cost

Alternative 2

19. Operating cost

20. Time cost

Difference

21. Operating cost

22. Time cost

Total (all modes)

Alternative 1

23. Operating cost

24. Time cost

Alternative 2

25. Operating cost

26. Time cost

Difference

27. Operating cost

28. Time cost

6.3 ESTIMATED 1979 TRAVEL BENEFITS BY ORIGIN ZONE

By mode, income class and zone of origin for conditions existing with no highway component as compared to those with the proposed highway component.

Summary:

Table 1:

SUMMARY GENERALIZED TRAVEL COST - YEAR: 1979

Zone:		High Income HH	Middle Income HH	Low Income HH	Employment	Total
1.	Car					
	Bus					
	Truck					
	Walk					
2.	Car					
	Bus					
	Truck					
	Walk					
3.	Car					
	Bus					
	Truck					
	Walk					
4.	Car					
	Bus					
	Truck					
	Walk					
5.	Car					
	Bus					
	Truck					
	Walk					
6.	Car					
	Bus					
	Truck					
	Walk					
7.	Car					
	Bus					
	Truck					
	Walk					
8.	Car					
	Bus					
	Truck					
	Walk					
9.	Car					
	Bus					
	Truck					
	Walk					
Total	Car					
	Bus					
	Truck					
	Walk					
Total						

Table 2: TRIP-ORIGIN - MORNING PEAK

Year 1979

Zone:		High Income HH	Middle Income HH	Low Income HH	Employment Places	Total
1.	Car	1,560	1,660	-		3,220
	Bus	520	2,490	1,230		4,240
	Truck	-	-	-	640	640
	Walk	520	2,490	1,230		4,240
2.	Car					
	Bus					
	Truck				500	500
	Walk					
3.	Car					
	Bus					
	Truck				300	300
	Walk					
4.	Car	560	40	-		600
	Bus	160	80	-		240
	Truck	-	-	-	15	15
	Walk	80	40	-		120
5.	Car					
	Bus					
	Truck				40	40
	Walk					
6.	Car	0	0	0		0
	Bus	0	0	0		0
	Truck	0	0	0	-	0
	Walk	0	0	0		0
7.	Car					
	Bus					
	Truck					
	Walk					
8.	Car	560	400	-		960
	Bus	160	800	600		1,560
	Truck	-	-	-	90	90
	Walk	80	400	240		720
9.	Car	+580	320	-		900
	Bus	+145	+480	+1,300		1,925
	Truck				200	200
	Walk	-	-	-		-
Total	Car	3,260	2,420	-		5,680
	Bus	985	3,850	3,130		7,965
	Truck	-	-	-	1,785	1,785
	Walk	680	2,930	1,470		5,080
Total		4,925	9,200	4,600	1,785	20,510

Table 3: TRIP DESTINATIONS - MORNING PEAK

Year: 1979

Zone:		High Income HH	Middle Income HH	Low Income HH	Employment Places	Total
1.	Car	485	1,465	-		1,950
	Bus	105	2,355	1,420		3,880
	Truck				640	640
	Walk	30	1,780	420		2,230
2.	Car	1,250	420	-		1,670
	Bus	420	625	625		1,670
	Truck				500	500
	Walk	330	635	535		1,500
3.	Car	750	250	-		1,000
	Bus	250	375	375		1,000
	Truck				300	300
	Walk	250	375	375		1,000
4.	Car	70	20	-		90
	Bus	20	40	50		110
	Truck				15	15
	Walk	10	20	20		50
5.	Car	130	70	-		200
	Bus	35	100	165		300
	Truck				40	40
	Walk	-	-	-	-	-
6.	Car					
	Bus					
	Truck					0
	Walk					
7.	Car					
	Bus					
	Truck					0
	Walk					
8.	Car	420	120	-		540
	Bus	120	240	300		660
	Truck				90	90
	Walk	60	120	120		300
9.	Car	155	75	-		230
	Bus	35	115	195		345
	Truck				200	200
	Walk	-	-	-		-
Total	Car	3,260	2,420	-		5,680
	Bus	985	3,850	3,130		7,965
	Truck	-	-	-	1,785	1,785
	Walk	680	2,930	1,470		5,080
Total		4,925	9,200	4,600	1,785	20,510

Table 4: O-D DISTRIBUTION OF CAR TRIPS

Year: 1979

Destination Zones

Origin Zone	1	2	3	4	5	6	7	8	9	TOTAL
1. H	283	649	400	23	39	0	0	82	74	1,560
M	1,043	288	169	14	51	0	0	40	52	1,660
L	0	0	0	0	0	0	0	0	0	0
TOTAL	1,326	937	569	37	90	0	0	112	126	3,220
2. H										
M										
L										
TOTAL										
3. H										
M										
L										
TOTAL										
4. H	43	198	134	25	39	0	0	64	27	560
M	22	9	8	0	0	0	0	0	1	40
L	0	0	0	0	0	0	0	0	0	0
TOTAL	95	207	142	25	39	0	0	64	28	600
5. H										
M										
L										
TOTAL										
6. H										
M										
L										
TOTAL										
7. H										
M										
L										
TOTAL										
8. H	43	171	82	9	29	0	0	199	27	560
M	205	69	40	0	10	0	0	65	11	400
L	0	0	0	0	0	0	0	0	0	0
TOTAL	248	240	122	9	39	0	0	264	38	960
9. H	86	222	134	13	23	0	0	75	27	580
M	195	54	33	3	9	0	0	15	11	320
L	0	0	0	0	0	0	0	0	0	0
TOTAL	281	276	167	16	32	0	0	90	38	900
H	485	1,250	750	40	130	0	0	420	155	3,260
M	1,465	420	250	20	70	0	0	120	75	2,420
L	0	0	0	0	0	0	0	0	0	0
GRAND TOTAL	1,950	1,670	1,000	90	200	0	0	540	230	5,680

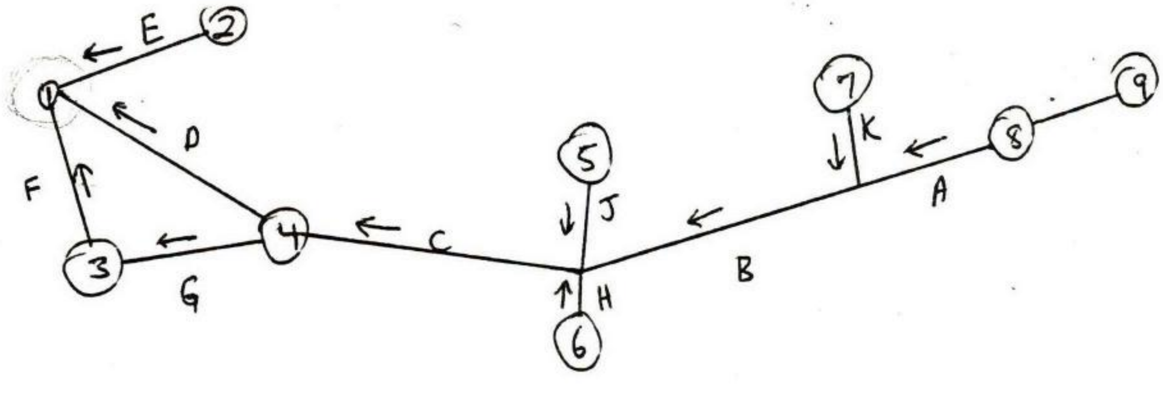
Table 5: O-D DISTRIBUTION OF BUS TRIPS
Year: 1979

Origin Zone	Destination Zone 1	2	3	4	5	6	7	8	9	TOTAL
1. H	72	241	139	2	20	0	0	28	18	520
M	1,624	388	250	24	62	0	0	64	78	2,490
L	628	270	149	15	52	0	0	40	76	1,230
TOTAL	2,324	899	538	41	134	0	0	132	172	4,240
2. H										
M										
L										
TOTAL										
3. H										
M										
L										
TOTAL										
4. H	11	61	37	8	5	0	0	31	6	160
M	44	16	8	0	0	0	0	10	2	80
L	0	0	0	0	0	0	0	0	0	0
TOTAL	55	77	45	8	5	0	0	41	8	240
5. H										
M										
L										
TOTAL										
6. H										
M										
L										
TOTAL										
7. H										
M										
L										
TOTAL										
8. H	7	52	37	0	7	0	0	44	7	160
M	393	143	70	11	26	0	0	136	21	800
L	202	95	71	15	45	0	0	136	36	600
TOTAL	602	290	178	26	78	0	0	316	64	1,560
9. H	15	66	37	3	3	0	0	17	4	145
M	294	78	47	5	12	0	0	30	14	480
L	590	260	155	20	68	0	0	124	83	1,300
TOTAL	899	404	239	28	83	0	0	171	101	1,925
TOTAL										
H	105	420	250	20	35	0	0	120	35	985
M	2,355	625	375	40	100	0	0	242	115	3,850
L	1,420	625	375	50	165	0	0	300	195	3,130
GRAND TOTAL	3,880	1,675	1,000	110	300	0	0	660	345	7,965

Table 6: O-D DISTRIBUTION OF TRUCK TRIPS
Year: 1979

Origin Zone	Destination 1	2	3	4	5	6	7	8	9	TOTAL
1. TOTAL	276	141	109	6	10	0	0	26	72	640
2. TOTAL	147	203	66	5	5	0	0	18	56	500
3. TOTAL	102	69	72	1	10	0	0	12	34	300
4. TOTAL	2	1	3	0	0	0	0	7	2	15
5. TOTAL	17	7	7	0	4	0	0	0	5	40
6. TOTAL	0	0	0	0	0	0	0	0	0	0
7. TOTAL	0	0	0	0	0	0	0	0	0	0
8. TOTAL	24	23	9	0	7	0	0	17	10	90
9. TOTAL	72	56	34	2	4	0	0	10	22	200
GRAND TOTAL	640	300	300	15	40	0	0	90	200	1,785

Table 7: NETWORK



Arrow points in inbound (+) direction.

Link	PCU's in (2 hrs)	PCU's out (2 hrs)	Capacity (No Build/Build)	V/C in (NB/B)	V/C out (NB/B)	Length	Car Free-flow speed (NB/B)
A						3.4	
B						3.4	80/100
AB	1777	924	800/2400	1.11/.37	.58/.19	6.8	80/100
C	1784	1064	1600	.56	.33	1.5	60
D	1603	864	1600	.50	.27	2.4	60
E	891	2036	1000	.45	1.02	1.4	60
F	519	912	1600	.16	.29	1.1	60
G	463	165	800	.29	.10	2.2	60
J	108	250	1200	.05	.10	0.9	60
H			1200			0.5	60
K			1200				60

Table 8:
Year: 1979
Mode: Car
Link Assignments

Origin Zone / Link		A	B	C	D	E	F	G	H	J	K
1.	H M L	(Same as B)	164^- 85 (0)	221^- 120	251^- 130	621^- 328	408^- 163	- -		57^- 35	
2.	H M L										
3.	H M L										
4.	H M L		90^- 41	128^- 1	271^+ 31	199^- 8	- -	132^+ 8		38^- 0	
5.	H M L										
6.	H M L		+809/-254								
8.	H M L		331^+ 331	302^+ 322	211^+ 282	169^- 76	- -	82^+ 40		29^- 9	
9.	H M L		478^+ 294	455^+ 287	308^+ 249	222^- 54	- -	134^+ 33		23^- 9	
TOTAL	H M L		+809/-254 +625/-86 +1434/-340	+757/-349 +609/-121 +1366/-470	+790/-251 +362/-130 +1352/-381	+0/-1211 +0/-466 +0/-1677	+0/-408 +0/-163 +0/-671	+348/-0 +81/-0 +429/-0		+0/-147 +0/-53 +0/-260	
GRAND TOTAL°											

Table 9:
Year: 1979
Mode: Bus
Link Assignments

Origin Zone / Link	A	B	C	D	E	F	G	H	J	K
1. H M L	(Same as B)	43 122 114	55 152 147	61 168 158	223 283 214	155 237 154	– – –		12 30 33	
2. H M L										
3. H M L										
4. H M L		35^{-} 10 0	42^{+} 10	74^{+} 62 0	58^{-} 16 0	– – –	37^{+} 8 0		7^{-} 0	
5. H M L										
[illegible] H M L										
[illegible] H M L		140^{+} 650 429	111^{+} 631 393	68^{+} 552 321	51^{-} 118 98	– – –	34^{+} 69 63		29^{-} 20 36	
9. H M L		122^{+} 433 1093	117^{+} 421 1025	77^{+} 369 850	62^{-} 78 260		37^{+} 47 155		5^{-} 12 68	
TOTAL H M L		262 1083 1522 +2867	228 1052 1418 +2698	219 983 1171 2373	0 0 0 0	0 0 0 0	108 124 218 +440		0 0 0 0	
GRAND TOTAL°		– 78 132 114	– 97 162 147	– 61 168 158	– 394 493 512	– 155 261 134	0 0 0		53 68 137	

Table 10:
Year: 1979

Mode: Truck

Link Assignments

Origin Zone / Link		A	B	C	D	E	F	G	H	J	K
1.	H M L	(Same as B)	98^-	108^-	114^-	141^-	109^-	-		10^-	
2.	H M L		74^-	79^-	84^-	297^+	66^-	-		5^-	
3.	H M L		46^-	56^-	-	69^-	171^+	57^-		10^-	
4.	H M L		6^-	6^-	3^+	1^-	-	3^+		0^-	
5.	H M L		5^-	28^+	24^+	7^-		4^+		33^+	
6.	H M L										
8.	H M L		63^+	56^+	47^+	23^-	-	9^+		7	
9.	H M L		168^+	166^+	128^+	56^-	-	34^+		2^-	
TOTAL	H M L		230	250	200	297	173	55		36	
GRAND TOTAL°			230	250	200	297	173	55		36	

Table 11:

YEAR: 1979

ORIGIN ZONE: 1

Input Data

MODE: Car

	Values of Time ($/hr)		
9	Class 1	2.18	(A)
10	Class 2	.56	
11	Class 3	.18	

	Mode:		
5	O.C. parameter	1	(B)
6	occupancy	1.6	
7	expansion factor	107.4	

0	Number of Links:	6	(C)

	Link: A-B outbound	
20	length (km)	5.5
21	V/C	0.587/.19
22	free-flow speed (km/h)	80/100
23	class 1 vol	164
24	class 2 vol	85
25	class 3 vol	0

	Link: C out	
26	length	1.5
27	V/C	.33
28	free-flow spd	60
29	class 1 vol	221
30	class 2 vol	120
31	class 3 vol	0

	Link: D out	
32	length	2.4
33	V/C	0.27
34	free-flow spd	60
35	class 1 vol	251
36	class 2 vol	130
37	class 3 vol	0

	Link: E out	
38	length	1.4
39	V/C	1.02
40	free-flow spd	60
41	class 1 vol	621
42	class 2 vol	328
43	class 3 vol	0

	Link: F out	
44	length	1.0
45	V/C	0.29
46	free-flow spd	60
47	class 1 vol	408
48	class 2 vol	163
49	class 3 vol	0

	Link: J out	
50	length	0.9
51	V/C	.10
52	free-flow spd	60
53	class 1 vol	57
54	class 2 vol	35
55	class 3 vol	0

	Link:	
56	length	
57	V/C	
58	free-flow spd	
59	class 1 vol	
60	class 2 vol	
61	class 3 vol	

	Link:	
62	length	
63	V/C	
64	free-flow spd	
65	class 1 vol	
66	class 2 vol	
67	class 3 vol	

	Link:	
68	length	
69	V/C	
70	free-flow spd	
71	class 1 vol	
72	class 2 vol	
73	class 3 vol	

YEAR: 1979

ORIGIN ZONE: 1

Input Data

MODE: Bus

	Values of Time ($/hr)		
9	Class 1	2.18	(A)
10	Class 2	.56	
11	Class 3	.18	

	Mode:		
5	O.C. parameter	4.3	(B)
6	occupancy	45	
7	expansion factor	92	

0	Number of Links:	6	(C)

	Link: A-B out	
20	length (km)	5.5
21	V/C	.58/.19
22	free-flow speed (km/h)	64/80
23	class 1 vol	43
24	class 2 vol	122
25	class 3 vol	114

	Link: C out	
26	length	1.5
27	V/C	.33
28	free-flow spd	42
29	class 1 vol	55
30	class 2 vol	152
31	class 3 vol	147

	Link: D out	
32	length	2.4
33	V/C	.27
34	free-flow spd	42
35	class 1 vol	61
36	class 2 vol	168
37	class 3 vol	158

	Link: E out	
38	length	1.4
39	V/C	1.02
40	free-flow spd	42
41	class 1 vol	223
42	class 2 vol	283
43	class 3 vol	214

	Link: F out	
44	length	1.0
45	V/C	.29
46	free-flow spd	42
47	class 1 vol	155
48	class 2 vol	237
49	class 3 vol	154

	Link: J oút	
50	length	0.9
51	V/C	.10
52	free-flow spd	42
53	class 1 vol	12
54	class 2 vol	30
55	class 3 vol	33

	Link:	
56	length	
57	V/C	
58	free-flow spd	
59	class 1 vol	
60	class 2 vol	
61	class 3 vol	

	Link:	
62	length	
63	V/C	
64	free-flow spd	
65	class 1 vol	
66	class 2 vol	
67	class 3 vol	

	Link:	
68	length	
69	V/C	
70	free-flow spd	
71	class 1 vol	
72	class 2 vol	
73	class 3 vol	

Year: 1979

Table 13:

BENEFITS TO RESIDENTS OF ORIGIN ZONE 1 Output Costs

		AUTO	BUS	$/Month
NO BUILD				
Income class 1	OC	15304.	652.	
	TC	24177.	9269.	
Income class 2	OC	7826.	1312.	
	TC	3209.	4137.	
Income class 3	OC	0.	1136.	
	TC	0.	1111.	
Total	OC	23131.	3100.	
	TC	27386.	14517.	
BUILD				
Income class 1	OC	15449.	635.	
	TC	21628.	8553.	
Income class 2	OC	7901.	1263.	
	TC	2870.	3615.	
Income class 3	OC	0.	1089.	
	TC	0.	955.	
Total	OC	23350.	2987.	
	TC	24498.	13123.	
DIFFERENCE				
Income class 1	OC	-145.	17.	
	TC	2549.	716.	
Income class 2	OC	-75.	50.	
	TC	339.	522.	
Income class 3	OC	0.	46.	
	TC	0.	157.	
Total	OC	-220.	113.	
	TC	2888.	1394.	

YEAR: 1979

Table 14: ORIGIN ZONE: 4 Input Data

MODE: Car

	Values of Time ($/hr)		
9	Class 1	2.18	(A)
10	Class 2	.56	
11	Class 3	.18	

	Mode:		
5	O.C. parameter	1	(B)
6	occupancy	1.6	
7	expansion factor	107.4	

0	Number of Links:	6	(C)

	Link: A-B out	
20	length (km)	5.5
21	V/C	0.58/.19
22	free-flow speed (km/h)	80/100
23	class 1 vol	90
24	class 2 vol	1
25	class 3 vol	0

	Link: C out	
26	length	1.5
27	V/C	0.33
28	free-flow spd	60
29	class 1 vol	128
30	class 2 vol	1
31	class 3 vol	0

	Link: D in	
32	length	2.4
33	V/C	.50
34	free-flow spd	60
35	class 1 vol	271
36	class 2 vol	31
37	class 3 vol	0

	Link: E out	
38	length	1.4
39	V/C	1.02
40	free-flow spd	60
41	class 1 vol	199
42	class 2 vol	8
43	class 3 vol	0

	Link: G in	
44	length	2.2
45	V/C	.29
46	free-flow spd	60
47	class 1 vol	133
48	class 2 vol	8
49	class 3 vol	0

	Link: I out	
50	length	0.9
51	V/C	.10
52	free-flow spd	60
53	class 1 vol	38
54	class 2 vol	0
55	class 3 vol	0

	Link:	
56	length	
57	V/C	
58	free-flow spd	
59	class 1 vol	
60	class 2 vol	
61	class 3 vol	

	Link:	
62	length	
63	V/C	
64	free-flow spd	
65	class 1 vol	
66	class 2 vol	
67	class 3 vol	

	Link:	
68	length	
69	V/C	
70	free-flow spd	
71	class 1 vol	
72	class 2 vol	
73	class 3 vol	

YEAR: 1979

Table 15: ORIGIN ZONE: 4

Input Data

MODE: Bus

	Values of Time ($/hr)		
9	Class 1		(A)
10	Class 2		
11	Class 3		

	Mode:		
5	O.C. parameter	4.3	(B)
6	occupancy	45	
7	expansion factor	92	

0	Number of Links:	6	(C)

	Link: A-B	
20	length (km)	5.5
21	V/C	.58/.19
22	free-flow speed (km/h)	64/80
23	class 1 vol	35
24	class 2 vol	10
25	class 3 vol	0

	Link: C out	
26	length	1.5
27	V/C	.33
28	free-flow spd	42
29	class 1 vol	42
30	class 2 vol	10
31	class 3 vol	0

	Link: D in	
32	length	2.4
33	V/C	.50
34	free-flow spd	42
35	class 1 vol	74
36	class 2 vol	62
37	class 3 vol	0

	Link: E out	
38	length	1.4
39	V/C	1.02
40	free-flow spd	42
41	class 1 vol	58
42	class 2 vol	16
43	class 3 vol	0

	Link: G in	
44	length	2.2
45	V/C	.29
46	free-flow spd	42
47	class 1 vol	37
48	class 2 vol	8
49	class 3 vol	0

	Link: J out	
50	length	0.9
51	V/C	.10
52	free-flow spd	42
53	class 1 vol	7
54	class 2 vol	0
55	class 3 vol	0

	Link:	
56	length	
57	V/C	
58	free-flow spd	
59	class 1 vol	
60	class 2 vol	
61	class 3 vol	

	Link:	
62	length	
63	V/C	
64	free-flow spd	
65	class 1 vol	
66	class 2 vol	
67	class 3 vol	

	Link:	
68	length	
69	V/C	
70	free-flow spd	
71	class 1 vol	
72	class 2 vol	
73	class 3 vol	

Year: 1979

Table 16: BENEFITS TO RESIDENTS OF ORIGIN ZONE 4 Output Costs

		AUTO	BUS	$/Month
NO BUILD				
Income class 1	OC	9248.	407.	
	TC	13248.	4852.	
Income class 2	OC	528.	176.	
	TC	192.	529.	
Income class 3	OC	0.	0.	
	TC	0.	0.	
Total	OC	9776.	584.	
	TC	13441.	5381.	
BUILD				
Income class 1	OC	9327.	391.	
	TC	11849.	4215.	
Income class 2	OC	529.	172.	
	TC	188.	483.	
Income class 3	OC	0.	0.	
	TC	0.	0.	
Total	OC	9856.	563.	
	TC	12038.	4698.	
DIFFERENCE				
Income class 1	OC	-79.	16.	
	TC	1399.	637.	
Income class 2	OC	-1.	5.	
	TC	4.	47.	
Income class 3	OC	0.	0.	
	TC	0.	0.	
Total	OC	-80.	20.	
	TC	1403.	683.	

YEAR: 1979

Table 17: ORIGIN ZONE: 8

Input Data

MODE: Car

	Values of Time ($/hr)		
9	Class 1	2.18	(A)
10	Class 2	.56	
11	Class 3	.18	

	Mode:		
5	O.C. parameter	1	(B)
6	occupancy	1.6	
7	expansion factor	107.4	

0 Number of Links: 6 (C)

	Link: AB in	
20	length (km)	5.5
21	V/C	1.11/.37
22	free-flow speed (km/h)	80/100
23	class 1 vol	331
24	class 2 vol	331
25	class 3 vol	0

	Link: C in	
26	length	1.5
27	V/C	.56
28	free-flow spd	60
29	class 1 vol	302
30	class 2 vol	322
31	class 3 vol	0

	Link: D in	
32	length	2.4
33	V/C	.50
34	free-flow spd	60
35	class 1 vol	211
36	class 2 vol	282
37	class 3 vol	0

	Link: E out	
38	length	1.4
39	V/C	1.02
40	free-flow spd	60
41	class 1 vol	169
42	class 2 vol	76
43	class 3 vol	0

	Link: G in	
44	length	2.2
45	V/C	.29
46	free-flow spd	60
47	class 1 vol	82
48	class 2 vol	40
49	class 3 vol	0

	Link: J out	
50	length	.9
51	V/C	.10
52	free-flow spd	60
53	class 1 vol	29
54	class 2 vol	9
55	class 3 vol	0

	Link:	
56	length	
57	V/C	
58	free-flow spd	
59	class 1 vol	
60	class 2 vol	
61	class 3 vol	

	Link:	
62	length	
63	V/C	
64	free-flow spd	
65	class 1 vol	
66	class 2 vol	
67	class 3 vol	

	Link:	
68	length	
69	V/C	
70	free-flow spd	
71	class 1 vol	
72	class 2 vol	
73	class 3 vol	

YEAR: 1979

Table 18: ORIGIN ZONE: 8 Input Data

MODE: BUS

	Values of Time ($/hr)		
9	Class 1		(A)
10	Class 2		
11	Class 3		
	Mode:		
5	O.C. parameter	4.3	(B)
6	occupancy	45	
7	expansion factor	92	
0	Number of Links:	6	(C)
	Link: AB+		
20	length (km)	5.5	
21	V/C	1.11/.37	
22	free-flow speed (km/h)	64/80	
23	class 1 vol	140	
24	class 2 vol	650	
25	class 3 vol	429	
	Link: C+		
26	length	1.5	
27	V/C	.56	
28	free-flow spd	40	
29	class 1 vol	111	
30	class 2 vol	631	
31	class 3 vol	393	
	Link: D+		
32	length	2.4	
33	V/C	.50	
34	free-flow spd	42	
35	class 1 vol	68	
36	class 2 vol	552	
37	class 3 vol	321	
	Link: F-		
38	length	1.4	
39	V/C	1.02	
40	free-flow spd	42	
41	class 1 vol	51	
42	class 2 vol	118	
43	class 3 vol	98	

	Link: G+	
44	length	2.2
45	V/C	.29
46	free-flow spd	42
47	class 1 vol	34
48	class 2 vol	69
49	class 3 vol	63
	Link: J-	
50	length	0.9
51	V/C	.10
52	free-flow spd	42
53	class 1 vol	21
54	class 2 vol	20
55	class 3 vol	36
	Link:	
56	length	
57	V/C	
58	free-flow spd	
59	class 1 vol	
60	class 2 vol	
61	class 3 vol	
	Link:	
62	length	
63	V/C	
64	free-flow spd	
65	class 1 vol	
66	class 2 vol	
67	class 3 vol	
	Link:	
68	length	
69	V/C	
70	free-flow spd	
71	class 1 vol	
72	class 2 vol	
73	class 3 vol	

Year: 1979

Table 19: BENEFITS TO RESIDENTS OF ORIGIN ZONE 8 Output Costs

		AUTO	BUS	$/Month
NO BUILD				
Income class 1	OC	17282.	948.	
	TC	34120.	15089.	
Income class 2	OC	16995.	4592.	
	TC	8464.	18290.	
Income class 3	OC	0.	2994.	
	TC	0.	3859.	
Total	OC	34277.	8534.	
	TC	42584.	37237.	
BUILD				
Income class 1	OC	14752.	779.	
	TC	16311.	7023.	
Income class 2	OC	14464.	3808.	
	TC	3889.	8670.	
Income class 3	OC	0.	2477.	
	TC	0.	1818.	
Total	OC	29216.	7064.	
	TC	20200.	17512.	
DIFFERENCE				
Income class 1	OC	2531.	169.	
	TC	17809.	8065.	
Income class 2	OC	2531.	784.	
	TC	4575.	9619.	
Income class 3	OC	0.	517.	
	TC	0.	2041.	
Total	OC	5061.	1470.	
	TC	22383.	19725.	

Year: 1979

Table 20: BENEFITS TO RESIDENTS OF ORIGIN ZONE 9 OUTPUT COSTS

	AUTO	BUS	$/Month
NO BUILD			
Income class 1			
OC			
TC			
Income class 2			
OC			
TC			
Income class 3			
OC			
TC			
Total			
OC			
TC			
BUILD			
Income class 1			
OC			
TC			
Income class 2			
OC			
TC			
Income class 3			
OC			
TC			
Total			
OC			
TC			
DIFFERENCE			
Income class 1			
OC			
TC			
Income class 2			
OC			
TC			
Income class 3			
OC			
TC			
Total			
OC			
TC			

Year: 1979

Table 21: BENEFITS TO RESIDENTS OF ORIGIN ZONE 9

		AUTO	BUS	
NO BUILD				
Income class 1	OC	21829.57	846.01	
	TC	43073.42	36065.39	
Income class 2	OC	14158.55	2935.36	
	TC	7053.11	11225.28	
Income class 3	OC	0.00	7365.38	No-Build
	TC	0.00	9154.68	
Total	OC	35988.13	11146.74	
	TC	50126.53	56445.36	
BUILD				
Income class 1	OC	18175.10	698.87	
	TC	17355.66	16721.07	
Income class 2	OC	11910.82	2413.16	
	TC	2989.76	4817.35	
Income class 3	OC	0.00	6047.22	Build w/loop
	TC	0.00	3955.50	
Total	OC	30085.92	9159.25	
	TC	20345.42	25493.92	
DIFFERENCE				
Income class 1	OC	3654.47	147.13	Difference w/loop
	TC	25717.76	19344.32	
Income class 2	OC	2247.73	522.20	
	TC	4063.35	6407.94	
Income class 3	OC	0.00	1318.16	
	TC	0.00	5199.18	
Total	OC	5902.20	1987.49	
	TC	29781.11	30951.44	

Build

Difference

OK

1759.52
6418.56

2660.47
37907.89

YEAR: 1979

Input Data

Table 22: ORIGIN ZONE: 1
MODE: Truck

Modal Parameters	
Labor cost ($/hr)	(B)
O.C parameter	
expansion factor	
Number of Links:	6 (C)

Link: AB-	
Length (km)	5.5
V/C	.58/.19
Free-flow speed (km/h)	80/100
Volume	98

Link: C-	
Length	1.5
V/C	.33
Free-flow speed	.60
Volume	108

Link: D-	
Length	2.4
V/C	.27
Free-flow speed	60
Volume	114

Link: E-	
Length	1.4
V/C	.1.02
Free-flow speed	60
Volume	141

Link: F-	
Length	1.0
V/C	.29
Free-flow speed	60
Volume	109

Link: J	
Length	0.9
V/C	.1
Free-flow speed	60
Volume	10

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Link:	
Length	
V/C	
Free-flow speed	
Volume	

YEAR: 1979

Input Data

Table 23: ORIGIN ZONE: 2
MODE: Truck

Modal Parameters	
Labor cost ($/hr)	1 (B)
O.C parameter	5.2
expansion factor	115

Number of Links: 6 (C)

Link: AB	
Length (km)	5.5
V/C	58/.19
Free-flow speed (km/h)	80/100
Volume	74

Link: C-	
Length	1.5
V/C	.33
Free-flow speed	60
Volume	79

Link: D-	
Length	2.4
V/C	.27
Free-flow speed	60
Volume	84

Link: E+	
Length	1.4
V/C	.45
Free-flow speed	60
Volume	297

Link: F-	
Length	1.0
V/C	.29
Free-flow speed	60
Volume	66

Link: J-	
Length	0.9
V/C	.10
Free-flow speed	60
Volume	5

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Link:	
Length	
V/C	
Free-flow speed	
Volume	

YEAR: 1979

Input Data

Table 24: ORIGIN ZONE: 3
MODE: Truck

Modal Parameters

Labor cost ($/hr)		(B)
O.C parameter		
expansion factor		

Number of Links: (C)

Link: AB-	
Length (km)	5.5
V/C	.58/.19
Free-flow speed (km/h)	80/100
Volume	46

Link: C-	
Length	1.5
V/C	.33
Free-flow speed	60
Volume	56

Link: E-	
Length	1.4
V/C	1.02
Free-flow speed	60
Volume	69

Link: F+	
Length	1.0
V/C	..16
Free-flow speed	60
Volume	171

Link: G-	
Length	2.2
V/C	.10
Free-flow speed	60
Volume	57

Link: J-	
Length	0.9
V/C	.1
Free-flow speed	60
Volume	10

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Link:	
Length	
V/C	
Free-flow speed	
Volume	

YEAR: 1979

Table 25: ORIGIN ZONE: 4
MODE: Truck

Input Data

Modal Parameters

Labor cost ($/hr)		(B)
O.C parameter		
expansion factor		

Number of Links: 5 (C)

Link: C-

Length (km)	1.5
V/C	.33
Free-flow speed (km/h)	60
Volume	6

Link: D+

Length	2.4
V/C	.5
Free-flow speed	60
Volume	3

Link: E-

Length	6.4
V/C	1.02
Free-flow speed	60
Volume	1

Link:

Length	
V/C	
Free-flow speed	
Volume	

Link: G+

Length	2.2
V/C	.29
Free-flow speed	60
Volume	3

Link:

Length	
V/C	
Free-flow speed	
Volume	

Link:

Length	
V/C	
Free-flow speed	
Volume	

Link:

Length	
V/C	
Free-flow speed	
Volume	

Link:

Length	
V/C	
Free-flow speed	
Volume	

YEAR: 1979

Input Data

Table 26: ORIGIN ZONE: 5
MODE:

Modal Parameters

Labor cost ($/hr)		(B)
O.C parameter		
expansion factor		

Number of Links: 6 (C)

Link: AB-

Length (km)	5.5
V/C	.58/.19
Free-flow speed (km/h)	80/100
Volume	5

Link: C+

Length	1.5
V/C	.56
Free-flow speed	60
Volume	28

Link: D+

Length	2.4
V/C	.5
Free-flow speed	60
Volume	24

Link: E-

Length	1.4
V/C	1.02
Free-flow speed	60
Volume	7

Link: G+

Length	2.2
V/C	.29
Free-flow speed	60
Volume	4

Link: J+

Length	.9
V/C	.05
Free-flow speed	60
Volume	33

Link:

Length	
V/C	
Free-flow speed	
Volume	

Link:

Length	
V/C	
Free-flow speed	
Volume	

Link:

Length	
V/C	
Free-flow speed	
Volume	

YEAR: 1979

Input Data

Table 27: ORIGIN ZONE: 8
MODE: Truck

Modal Parameters
- Labor cost ($/hr) ________ (B)
- O.C parameter ________
- expansion factor ________

Number of Links: 6 (C)

Link: AB+	
Length (km)	5.5
V/C	1.1/.37
Free-flow speed (km/h)	80/100
Volume	63

Link: C+	
Length	1.5
V/C	.56
Free-flow speed	60
Volume	56

Link: D+	
Length	2.4
V/C	.5
Free-flow speed	60
Volume	47

Link: E-	
Length	1.4
V/C	1.02
Free-flow speed	60
Volume	23

Link: G+	
Length	2.2
V/C	.29
Free-flow speed	60
Volume	9

Link: J-	
Length	.9
V/C	.1
Free-flow speed	60
Volume	7

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Link:	
Length	
V/C	
Free-flow speed	
Volume	

TRUCK COSTS FROM EACH ORIGIN ZONE

ZONE:	1	2	3
No-Build			
OC *	53,796	8,991	30,263
labor	4,113	3,128	2,176
Build			
OC *	54,566	9,573	30,624
labor	3,365	2,563	1,825
Difference			
OC *	-770	-582	-362
labor	748	565	351
total OC	-22	-17	-10

ZONE:	4	5	8
No-Build			
OC *	2,330	7,368	30,225
labor	155	539	21,541
Build			
OC *	2,377	7,407	25,987
labor	109	501	19,909
Difference			
OC *	-47	-39	4,239
labor	46	38	1,632
total OC	-1	-1	5,870

* Operating cost minus $1/hr labor cost.

Projected 1984 travel benefits by mode, income class, zone of origin for conditions assumed to prevail with no highway component as compared to those with the proposed highway component. Summary:

Year 1984

Table 29: SUMMARY GENERALIZED TRAVEL COST

ZONE:	High Income HH	Middle Income HH	Low Income HH	Employment	Total
1. Car					
bus					
truck					
walk					
2. Car					
bus					
truck					
walk					
3. Car					
bus					
truck					
walk					
4. Car					
bus					
truck					
walk					
5. Car					
bus					
truck					
walk					
6. Car					
bus					
truck					
walk					
7. Car					
bus					
truck					
walk					
8. Car					
bus					
truck					
walk					
9. Car					
bus					
truck					
walk					
Total: Car					
bus					
truck					
walk					
Total:					

Year 1984

Table 30: TRIP ORIGINS - MORNING PEAK HOUR

ZONE	HIGH INCOME HH	MIDDLE INCOME HH	LOW INCOME HH	EMPLOYMENT	TOTAL
1. Car	1.500	1,600	250		3,350
Bus	500	2,400	750		3,650
Truck				760	760
Walk	500	1,200	375		2,075
2. Car				500	
Bus					
Truck					
Walk					
3. Car					
Bus				350	350
Truck					
Walk					
4. Car	560	40	80		680
Bus	160	80	100		340
Truck				30	30
Walk	180	20			200
5. Car				160	160
Bus					
Truck					
Walk					
6. Car		600	200		800
Bus		1,200	1,000	15	2,200
Truck		300	200		500
Walk					
7. Car				160	160
Bus					
Truck					
Walk					
8. Car	700	500	100		1,300
Bus	200	1,000	750		1,950
Truck				150	150
Walk	100	250	150		500
9. Car	4,112	424	380		4,916
Bus	1,303	180	2,815		4,298
TrucK				0	
Walk	175	120	675		970
TOTAL Car	6,872	3,164	1,010		11,046
Bus	2,163	4,860	5,415		12,438
Truck				2,125	2,125
Bus	955	1,890	1,400		2,245

Table 31: TRIP DESTINATIONS - MORNING PEAK HOUR

ZONE	HIGH INCOME HH	MIDDLE INCOME HH	LOW INCOME HH	EMPLOYMENT	TOTAL
1. Car	2280	1140	500		3920
Bus	760	1710	1710		4180
Truck				460	460
Walk	380	570	570		1520
2. Car	1200	600	200		2000
Bus	400	900	900		2200
Truck				500	500
Walk	200	420	310		930
3. Car	840	340	140		1320
Bus	280	630	630		1540
Truck				350	350
Walk	200	420	310		930
4. Car	195	82	20		297
Bus	55	120	150		325
Truck				30	30
Walk	30	50	50		130
5. Car	780	330	80		1190
Bus	220	480	600		1300
Truck				160	160
Walk	40	80	80		200
6. Car	94	42	10		146
Bus	28	60	75		163
Truck				15	15
Walk	15	10	10		35
7. Car	780	330	80		1190
Bus	220	480	600		1300
Truck				160	160
Walk	40	80	80		200
8. Car	700	300	100		1100
Bus	200	480	750		1430
Truck				150	150
Walk	50	80	100		230
9. Car					
Bus					
Truck					
Walk					
TOTAL Car	6872	3164	1010		11046
Bus	2163	4860	5415		12438
Truck				2125	2125
Walk	955	1890	1400		4245
TOTAL	9990	9914	7825	2125	29854

Table 32: O-D DISTRIBUTION OF TRUCK TRIPS Year 1985

ORIGIN ZONES	1	2	3	4.	5	6	7	8	9	TOTAL
1. H	584	318	200	24	118	19	183	54	0	1500
M	673	336	200	19	148	16	92	116	0	1600
L	121	40	37	2	8	21	8	32	0	250
TOTAL	1378	694	437	45	274	37	283	202	0	3350
2. H										
M										
L										
TOTAL										
3. H										
M										
L										
TOTAL										
4. H	155	89	80	36	102	18	44	36	0	560
M	9	7	4	4	4	1	4	7	0	40
L	27	19	2	7	7	1	10	7	0	80
TOTAL	191	115	86	47	113	20	5	50	0	680
5. H										
M										
L										
TOTAL										
6. H										
M	170	103	66	28	94	9	93	38	0	600
L	65	41	35	4	27	1	18	9	0	200
TOTAL										
7. H										
M										
L										
TOTAL										
8. H	175	94	67	15	67	15	100	167	0	700
M	132	76	23	18	42	8	56	101	0	456
L	26	22	8	3	8	2	14	17	0	100
TOTAL	333	192	98	36	117	25	170	285	0	1,256
9. H	1356	699	493	120	493	45	453	453		4,112
M	156	81	47	13	42	5	42	38	0	424
L	141	78	53	9	30	4	30	35	0	380
TOTAL	1653	858	593	142	565	54	525	526	0	4,916
TOTAL H	2280	1200	840	195	780	67	780	700	0	6842
M	1140	600	340	82	330	42	330	300	0	3164
L	380	200	140	20	80	10	80	100	0	1010
TOTAL	3800	2000	1320	297	1190	119	1190	1100	0	11,016

Table 33: O-D DISTRIBUTION OF CAR TRIPS Year 1984

ORIGIN TOWNS	1	2	3	4	5	6	7	8	9	TOTAL
1. H	193	110	67	6	49	4	54	17	0	500
M	981	467	477	57	187	16	88	127	0	2400
L	354	134	114	20	47	7	4	40	0	750
TOTAL	1528	711	658	83	283	27	176	184	0	3650
2. H										
M										
L										
TOTAL										
3. H										
M										
L										
TOTAL										
4. H	59	27	25	8	17	8	8	8	0	160
M	24	16	8	4	8	4	8	8	0	80
L	31	15	15	8	8	7	8	8	0	100
TOTAL	114	58	48	20	33	19	24	24	0	340
5. H										
M										
L										
TOTAL										
6. H										
M	390	230	133	37	177	28	112	93	0	1200
L	282	159	96	21	168	23	138	103	0	990
TOTAL	672	389	229	58	345	51	250	196	0	2190
7. H										
M										
L										
TOTAL										
8. H	56	28	19	2	24	3	23	45	0	200
M	252	153	99	18	90	10	44	234	0	1000
L	160	114	67	17	67	10	110	205	0	750
TOTAL	468	295	185	37	181	23	277	484	0	1950
9. H	457	235	169	39	130	13	130	130	0	1303
M	63	34	23	4	18	2	18	18	0	180
L	873	478	338	84	310	28	310	394	0	2815
TOTAL	1393	747	530	127	458	43	458	542	0	4298
TOTAL H	760	400	380	55	220	28	220	200	0	2263
M	110	150	630	120	480	30	480	480	0	2480
L	110	700	630	150	100	75	750	750	0	3265
TOTAL	980	1250	1640	325	800	133	1450	1430	0	8008

Table 34: O-D DISTRIBUTION OF TRUCK TRIPS Year 1984

ORIGIN TOWNS	1	2	3	4	5	6	7	8	9	TOTAL
1. H M L										
TOTAL	354	154	140	12	43	0	28	29	0	760
2. H M L										
TOTAL	167	177	71	6	26	0	33	20	0	500
3. H M L										
TOTAL	115	68	73	6	26	6	36	20	0	350
4. H M L										
TOTAL	10	10	10	0	0	0	0	0	0	30
5. H M L										
TOTAL	31	28	23	0	38	9	14	17	0	160
6. H M L										
TOTAL	8	7	0	0	0	0	0	0	0	15
7. H M L										
TOTAL	36	30	14	6	16	0	30	28	0	160
8. H M L										
TOTAL	39	26	19	0	11	0	19	36	0	150
9. H M L										
TOTAL										
TOTAL H M L										
TOTAL	760	500	350	30	160	15	160	150		2125

Table 35: LINK ASSIGNMENTS

MODE: Car

YEAR: 1984

Link Origin Zone		A	B	C	D	E	F	G	H	I	J	K	TOTAL
1	H M L	79- 80	168- 223										
	H M L	35 5	113 11										
	H M L	0 6- 3	10 18- 7										
	H M L	538+ 387+	397+ 318										
	H M L	3687+ 21 470	3210+ 19 470										
6	H M L												
7	H M L												
In	H M L Total	4225+ 408 470 5103+	3607+ 337+ 470+ 4414										
OUT	H M L Total	114- 91- 3- 208-	381- 252- 7- 640-										

Table 36: LINK ASSIGNMENTS

YEAR: 1984

MODE: Bus

Link Origin Zone		A	B	C	D	E	F	G	H	I	J	K	TOTAL
1	H	22	72										
	M	132	387										
	L	0	0										
2	H	9	18										
	M	10	20										
	L	0	0										
3	H	0	0										
	M	8-	32-										
	L	12	18										
4	H	237+	210+										
	M	1020	960										
	L	940	820										
5	H	2085	1885										
	M	125	110										
	L	1470	1390										
6	H												
	M												
	L												
7	H												
	M												
	L												
In	H	2322+	2095+										
	M	1145	1070										
TOTAL	L	2410	2210										
		4375	4375										
In	H	31-	90-										
	M	150	439-										
	L	12	18-										
TOTAL		193	647										

Table 37: LINK ASSIGNMENTS

MODE: Truck

YEAR: 1984

Link Origin Zone		A	B	C	D	E	F	G	H	I	J	K	TOTAL
1	H M L	29-	57-										
2	H M L	20-	53-										
3	H M L	20-	56-										
4	H M L	0	0										
5	H M L	17-	3										
6	H M L	15-	30-										
7	H M L	28-	102+										
8 9	H M L	103+ 228+	84+ 190+										
TOTAL	H M L	129 331+	227 376+										

TABLE 38

YEAR 1984

LINK ASSIGNMENTS BY MODE CAR DCUS

ORIGIN/ZONE LINK	1	2	3	4	5	6	7	8	9	Total Passengers	Total PCU
1-1	3,350			113						3,350	
1-2	694					144		162	858	1,973	
1-3	437									437	
1-4	842									842	
2-1											
2-2											
*(2-5)											
3-1											
3-3											
3-4											
4-1				306		379		495	2,571	3,691	
4-3				86		101		98	593	878	
4-4				680						680	
4-5	274			113						387	
4-6	37			20						57	
4-7	283			58						341	
4-8	203			50						253	
*(5-2)											
5-4											
5-5											
5-6											
5-7											
5-8											
6-4						572				572	
6-5						121				121	
6-6						800				800	
6-7						110				110	
6-8						47				47	
7-4											
7-5											
7-6											
7-7											
7-8											
8-4								629	3,246	3,875	
8-5								117	565	682	
8-6								25	54	79	
8-7								170	525	695	
8-8								1,300		1,300	
8-9											
9-8									5,916	5,916	
9-9									5,916	5,916	

TABLE 39

YEAR 1984

LINK ASSIGNMENTS BY MODE BUS DCUS

ORIGIN/ZONE LINK	1	2	3	4	5	6	7	8	9	Total Passengers	Total PCU
1-1	3,650									3,650	
1-2	711			58		389		295	747	2,200	
1-3	658									658	
1-4	763									763	
2-1											
2-2											
*(2-5)											
3-1											
3-3											
3-4											
4-1				172		1,061		763	2,140	4,136	
4-3				48		229		185	520	982	
4-4				340						340	
4-5	283			23						316	
4-6	27			19						46	
4-7	176			24						200	
4-8	184			24						208	
*(5-2)											
5-4											
5-5											
5-6											
5-7											
5-8											
6-4						1,348				1,348	
6-5						345				345	
6-6						2,200				2,200	
6-7						250				250	
6-8						196				196	
7-4											
7-5											
7-6											
7-7											
7-8											
8-4								985	1,587	2,572	
8-5								181	458	639	
8-6								23	43	66	
8-7								274	458	732	
8-8								1,950		1,950	
8-9											
9-8									4,298	4,298	
9-9									4,298	4,298	

TABLE 40

YEAR 1984

LINK ASSIGNMENTS BY MODE TRUCK DCUS

ORIGIN/ZONE LINK	1	2	3	4	5	6	7	8	9	Total passengers	Total PCU
1-1	760									760	
1-2	154		68	10	28	7	30	26		323	
1-3	140	71								211	
1-4	112	85								197	
2-1		333								333	
2-2		500								500	
*(2-5)											
3-1			183							183	
3-3			350							350	
3-4			161							161	
4-1				20	59	15	66	65		225	
4-3				10	23		14	23		66	
4-4				30						30	
4-5	43	26	6							75	
4-6			26							26	
4-7	28	33	36							97	
4-8	29	20	20							69	
*(5-2)											
5-4					72					72	
5-5					160					160	
5-6					9					9	
5-7					14					14	
5-8					17					17	
6-4						15				15	
6-5											
6-6						15				15	
6-7											
6-8											
7-4							86			86	
7-5							16			16	
7-6											
7-7							160			160	
7-8							28			28	
8-4								84		84	
8-5								11		11	
8-6											
8-7								19		19	
8-8								150		150	
8-9											
9-8											
9-9											

REGISTER CONTENTS: UTB-2.1(A)

YEAR: 1984

FOR CAR & BUS

ORIGIN ZONE: 1

MODE: Bus

Values of Time ($/hr)

9	Class 1	2.18	(A)
10	Class 2	.56	
11	Class 3	.18	

Mode:

5	O.C. parameter	4.3	(B)
6	occupancy	45	
7	expansion factor	92	

0 Number of Links: 10 (C)

Link: A outbound

20	length (km)	2.1
21	V/C 1135/1600=	0.17/0.24
22	free-flow speed (km/h)	64/80
23	class 1 vol	22
24	class 2 vol	132
25	class 3 vol	0

Link: B outbound

26	length	3.4
27	V/C	
28	free-flow spd	68/80
29	class 1 vol	72
30	class 2 vol	387
31	class 3 vol	0

Link:

32	length	
33	V/C	
34	free-flow spd	
35	class 1 vol	
36	class 2 vol	
37	class 3 vol	

Link:

38	length	
39	V/C	
40	free-flow spd	
41	class 1 vol	
42	class 2 vol	
43	class 3 vol	

Link:

44	length	
45	V/C	
46	free-flow spd	
47	class 1 vol	
48	class 2 vol	
49	class 3 vol	

Link:

50	length	
51	V/C	
52	free-flow spd	
53	class 1 vol	
54	class 2 vol	
55	class 3 vol	

Link:

56	length	
57	V/C	
58	free-flow spd	
59	class 1 vol	
60	class 2 vol	
61	class 3 vol	

Link:

62	length	
63	V/C	
64	free-flow spd	
65	class 1 vol	
66	class 2 vol	
67	class 3 vol	

Link:

68	length	
69	V/C	
70	free-flow spd	
71	class 1 vol	
72	class 2 vol	
73	class 3 vol	

TRIP-ORIGINS - MORNING PEAK HOUR

ZONE	HIGH INCOME HH	MIDDLE INCOME HH	LOW INCOME HH	EMPLOYMENT	TOTAL
1. Car	2250	2100	350		4725
Bus	1000	3600	1500		6100
Truck				920	920
Walk	250	800	375		1425
2. Car					
Bus					
Truck				500	500
Walk					
3. Car					
Bus					
Truck				400	400
Walk					
4. Car	840	60			900
Bus	280	120			400
Truck				150	150
Walk	120	20			140
5. Car					
Bus					
Truck				240	240
Walk					
6. Car		750	300		1050
Bus		1800	1600		3400
Truck				30	30
Walk		225	300		525
7. Car					
Bus					
Truck				400	400
Walk					
8. Car	735	650	300		1685
Bus	375	1400	900		2675
Truck				180	180
Walk	75	260	100		435
9. Car	5175	350	410		5935
Bus	2325	225	2420		4970
Truck					
Walk	135	145	550		830
TOTAL Car	9000	3915	1385		14300
Bus	3980	7145	6420	2820	17545
Truck				2820	2820
Walk	580	1450	1325		3355
TOTAL	13560	12510	9130	2820	38020

TRIP DESTINATIONS - MORNING PEAK HOUR

ZONE	HIGH INCOME HH	MIDDLE INCOME HH	LOW INCOME HH	EMPLOYMENT	TOTAL
1. Car	2990	1035	460		4485
Bus	1380	2070	2070		5520
Truck				920	920
Walk	230	500	460		1190
2. Car	1300	600	200		2100
Bus	600	1000	900		2500
Truck				500	500
Walk	100	250	200		550
3. Car	1040	360	160		1560
Bus	480	900	630		2010
Truck				400	400
Walk	80	200	160		440
4. Car	725	400	100		1225
Bus	250	575	475		1300
Truck				150	150
Walk	50	100	75		225
5. Car	870	500	120		1490
Bus	300	600	540		1440
Truck				240	240
Walk	60	90	90		240
6. Car	115	80	15		210
Bus	50	150	115		315
Truck				30	30
Walk	5	40	20		65
7. Car	1150	700	150		2000
Bus	500	1250	1150		2900
Truck				400	400
Walk	25	150	200		375
8. Car	810	240	180		1230
Bus	420	600	540		1560
Truck				180	180
Walk	30	120	120		270
9. Car					
Bus					
Truck					
Walk					
TOTAL Car	9000	3915	1385		14300
Bus	3980	7145	1420		17545
Truck				2820	2820
Walk	1580	1450	1325		3355
TOTAL	13560	12510	9180	2820	38020

Year 1989

O-D DISTRIBUTION OF CAR TRIPS

ORIGIN ZONE	1	2	3	4.	5	6	7	8	9	TOTAL
1. H	873	343	280	136	201	20	281	116	0	2250
M	688	366	236	193	175	31	355	56	0	2100
L	168	73	48	24	21	4	18	19	0	375
TOTAL	1729	782	564	353	397	55	654	191	0	4725
2. H										
M										
L										
TOTAL										
3. H										
M										
L										
TOTAL										
4. H	248	146	131	129	86	9	69	23	0	840
M	11	7	7	7	7	7	7	7	0	60
L	0	0	0	0	0	0	0	0	0	0
TOTAL	259	153	138	136	93	16	76	30	0	900
5. H										
M										
L										
TOTAL										
6. H										
M	140	96	42	105	159	26	113	69	0	750
L	82	38	39	28	38	2	44	27	0	300
TOTAL	222	134	81	133	197	28	157	96	0	1050
7. H										
M										
L										
TOTAL										
8. H	163	86	48	46	68	34	128	165	0	735
M	95	78	43	61	113	9	164	87	0	650
L	74	32	24	19	24	3	43	81	0	300
TOTAL	332	196	115	126	205	46	335	333	0	1685
9. H	1707	125	621	444	508	52	672	466	0	5175
M	91	53	32	39	46	77	61	21	0	350
L	136	57	49	29	37	4	45	53	0	5135
TOTAL	1934	835	702	482	601	63	778	540		5935
TOTAL H	2990	1300	1040	725	870	115	1150	810	0	9000
M	1035	600	360	400	500	80	700	240		3915
L	460	300	160	100	120	75	150	180	0	1545
TOTAL	4485	2200	1560	1225	1490	270	2000	1230	0	14,460

O-D DISTRIBUTION OF BUS TRIPS Year 1989

ORIGIN ZONE	1	2	3	4.	5	6	7	8	9	TOTAL
1. H	401	169	135	60	63	11	94	67	0	1,000
M	1342	570	509	247	217	59	541	115	0	3,600
L	633	230	190	81	95	20	180	66	0	1,500
TOTAL	2376	969	834	393	375	90	815	248	0	6,100
2. H										
M										
L										
TOTAL										
3. H										
M										
L										
TOTAL										
4. H	93	42	34	34	27	8	25	17	0	280
M	32	16	16	16	8	8	16	8	0	120
L	0	0	0	0	0	0	0	0	0	0
TOTAL	125	58	50	50	35	16	41	25		4 0
5. H										
M										
L										
TOTAL										
6. H	0	0	0	0	0	0	0	0	0	0
M	372	229	210	201	210	73	292	239	0	1800
L	443	238	136	158	197	30	279	93	0	1600
TOTAL	815	467	346	359	407	103	571	332		3400
7. H										
M										
L										
TOTAL										
8. H	96	40	32	16	24	8	79	80	0	375
M	264	153	136	93	147	25	340	246	0	1400
L	220	93	62	51	65	17	231	161	0	900
TOTAL	580	286	230	160	236	50	650	487	0	2675
9. H	790	349	279	140	186	23	302	256	0	2325
M	64	32	29	18	18	5	41	18	0	225
L	774	339	242	169	194	48	460	194	0	2420
TOTAL	1528	720	550	32	398	76	803	468	0	4970
TOTAL H										
M										
L										
TOTAL										

O-D DISTRIBUTION OF TRUCK TRIPS

Year 1989

ORIGIN ZONE	1	2	3	4.	5	6	7	8	9	TOTAL
1. H M L										
TOTAL	381	149	120	40	86	6	75	63	0	920
2. H M L										
TOTAL	133	14	74	35	20	7	74	14	0	500
3. H M L										
TOTAL	149	60	97	14	21	0	44	15	0	400
4. H M L										
TOTAL	46	24	24	16	16	0	16	8	0	150
5. H M L										
TOTAL	71	35	27	18	48	0	27	14	0	240
6. H M L										
TOTAL	10	10	5	0	0	0	5	0	0	30
7. H M L										
TOTAL	92	51	34	17	30	17	121	38	0	400
8. H M L										
TOTAL	38	28	19	10	19	0	38	28	0	180
9. H M L										
TOTAL	120	100	60	5	8	2	10	20	0	325
TOTAL H M L										
TOTAL	920	500	400	150	240	30	400	180	0	3,145

Year 1989

LINK ASSIGNMENTS BY MODE CAR

ORIGIN ZONE	1	2	3	4	5	6	7	8	9	Total Passengers	Total FCU
LINK 1-1	4725									4725	
1-2	782			153		134		196	835	2100	
1-3	564									564	
1-4	1650									1650	
2-1											
2-2											
*(2-5)											
3-1											
3-3											
3-4											
4-1				312		356		528	2769	3965	
4-3				138		81		115	702	1036	
4-4				900						900	
4-5	397			93						490	
4-6	55			16						71	
4-7	654			76						730	
4-8	191			30						221	
*(5-2)											
5-4											
5-5											
5-6											
5-7											
5-8											
6-4						570				570	
6-5						197				197	
6-6						1050				1050	
6-7						151				151	
6-8						96				96	
7-4											
7-5											
7-6											
7-7											
7-8											
8-4								769	3973	4742	
8-5								205	601	806	
8-6								46	63	109	
8-7								335	778	1113	
8-8								1685		1685	
8-9											
9-8									5135	5135	
9-9									5135	5135	

Year 1989

LINK ASSIGNMENTS BY MODE

ORIGIN ZONE	1	2	3	4	5	6	7	8	9	Total Passengers	Total FCU
LINK 1-1	6100									6100	
1-2	969			58		467		286		1780	
1-3	834									834	
1-4	1927									1927	
2-1											
2-2											
*(2-5)											
3-1											
3-3											
3-4											
4-1				183		1282		866	2248	4579	
4-3				50		346		230	540	1166	
4-4				400						400	
4-5	375			35						410	
4-6	90			16						106	
4-7	815			41						856	
4-8	248			25						273	
*(5-2)											
5-4											
5-5											
5-6											
5-7											
5-8											
6-4						1987				1987	
6-5						407				407	
6-6						3400				3400	
6-7						571				571	
6-8						332				332	
7-4											
7-5											
7-6											
7-7											
7-8											
8-4								1256	3115	4371	
8-5								236	398	634	
8-6								50	76	126	
8-7								650	803	1453	
8-8								2675		2675	
8-9											
9-8									4970	4970	
9-9									4970	4970	

Year 1989

LINK ASSIGNMENTS BY MODE: TRUCK

ORIGIN ZONE	1	2	3	4	5	6	7	8	9	Total Passengers	Total FCU
LINK 1-1	920									920	
1-2	149		60	24	35	10	51			329	
1-3	120	74								194	
1-4	270	150								420	
2-1		357								357	
2-2		500								500	
2-5											
3-1			209							209	
3-3			400							400	
3-4			94							94	
4-1				70	106	20	143	66		405	
4-3				24	27	5	34	19		109	
4-4				150						150	
4-5	86	20	21	16						143	
4-6	6	7								13	
4-7	75	74	44	16						209	
4-8	63	14	15	8						100	
5-2											
5-4					157					157	
5-5					240					240	
5-6					0					0	
5-7					27					27	
5-8					14					14	
6-4						25				25	
6-5											
6-6						30				30	
6-7						5				5	
6-8											
7-4							194			194	
7-5							30			30	
7-6							17			17	
7-7							400			400	
7-8							38			38	
8-4								95		95	
8-5								19		19	
8-6								38		38	
8-7											
8-8								180		180	
8-9											
9-8											
9-9											

PROGRAMMING LAND DEMAND

A1) With <u>No</u> highway component

A2) With highway component

B1) With weak public transport component
B1A) Context A1
B1B) Context A2

B2) With strong public transport component
B2A) Context A1
B2B) Context A2

					$\frac{LW}{\sqrt{C}}$	$\frac{GLW}{\sqrt{c}}$	B		
1	83	83	6889	898 30	229.6	.75	7875	8300	79
4	4 8	2	8	4.7	1.702	.01	105	200	.02
8	60 48	20	1200	16.1	59.6	.24	2520	2000	.19
					305.8		10500	10500	

LOW MOVE

	L_i	W_i	$\frac{LW}{VC}$		$\frac{LW}{VC}$	$\frac{GLWD}{PC}$	Move	4.4 Sm
1	12.3	41	34	10	60	.70	3710	4100
4	/	0	/	/				/
8	10.8	12	130	6	22	.30	1590	1200
					72			5310

$$G_1^{z}\,2\;\frac{6^{2}\,L_1\,W_1^{z}}{C_1^{z}}\,B$$

Total loan cost/mm

	H	M	L
1 2	39.4 9.9 50 1404 1494	11.3 CAR 5.4 BUS 16 882 898	2.2 BUS 2 103 105
3 4 5 6	22.5 CAR 5.3 BUS 28 432 460	.72 .71 1 21 22	0
7 8 9	51.3 CAR 16.1 BUS 67 432 499	25.4 CAR 22.3 BUS 48 210 258	6.8 BUS 7 30 37

1989

1984 - 1989 Volume Increments
Links A & B

			LINK A			LINK B				
			1984	1989	Increment	1979	1984	1989	1984-89 Increment	1979-84 Increment
High	Auto	In	4223	5279	211.2	809	3603	4479	174.8	559.2
		Out	114	139	5	254	281	489	41.6	5.4
	Bus	In	2322	2364	8.4	262	2095	1983	22.4	366.6
		Out	31	84	10.6	78	90	203	22.6	2.4
Med.	Auto	In	418	892	94.5	625	357	667	62	53.6
		Out	91	132	8.2	86	252	607	71	33.2
	Bus	In	1245	1361	23.2	1083	1060	977	16.6	4.6
		Out	142	462	64	132	439	1211	154.4	61.4
Low	Auto	In	470	576	21.2	0	470	488	3.6	94
		Out	3	46	8.6	0	7	108	20.2	1.4
	Bus	In	2410	3965	311	1522	2210	3274	212.8	137.6
		Out	6	159	30.6	114	18	618	120	19.2
	Truck	In	342	417	15	230	387	576	37.8	31.4
		Out	342	417	15	230	387	576	37.8	31.4

Origin Zone: 4

Mode: Car

Values of Time ($/hr) (A)

class 1	2.18
class 2	.56
class 3	.18

Mode: (B)

O.C. parameter	1
occupancy	~~1.6~~
expansion factor	107.4

Number of Links: 9 (C)

Link: A Out

length (km)	2.1
V/C	.73/.24
free-flow speed (km/h)	80/100
class 1 vol	79
class 2 vol	86
class 3 vol	0

Link: B Out

length	3.4
V/C	.96/.32
free-flow spd	80/100
class 1 vol	168
class 2 vol	223
class 3 vol	0

Link: C Out

length	1.5
V/C	.62
free-flow spd	60
class 1 vol	363
class 2 vol	408
class 3 vol	0

Link: D Out

length	2.4
V/C	.49
free-flow spd	60
class 1 vol	402
class 2 vol	453
class 3 vol	0

Link: E Out

length	1.4
V/C	1.15
free-flow spd	60
class 1 vol	284
class 2 vol	231
class 3 vol	50

Link: F Out

length	1.0
V/C	.27
free-flow spd	60
class 1 vol	198
class 2 vol	231
class 3 vol	50

Link: H Out

length	0.5
V/C	.05
free-flow spd	60
class 1 vol	18
class 2 vol	16
class 3 vol	0

Link: J Out

length	0.9
V/C	.52
free-flow spd	60
class 1 vol	177
class 2 vol	169
class 3 vol	0

Link: K Out

length	0.5
V/C	.54
free-flow spd	60
class 1 vol	89
class 2 vol	73
class 3 vol	0

Year: 1984

Origin Zone: 4

Mode: Car

Values of Time ($/hr)

class 1		(A)
class 2		
class 3		

Mode:

O.C. parameter		(B)
occupancy		
expansion factor		

Number of Links: 9 (C)

Link: A Out

length (km)	2.1
V/C	.73/.24
free-flow speed (km/h)	80/100
class 1 vol	35
class 2 vol	5
class 3 vol	0

Link: B Out

length	3.4
V/C	.96/.32
free-flow spd	80/100
class 1 vol	113
class 2 vol	11
class 3 vol	0

Link: C Out

length	1.5
V/C	.62
free-flow spd	60
class 1 vol	200
class 2 vol	17
class 3 vol	0

Link: D In

length	2.4
V/C	1.02
free-flow spd	60
class 1 vol	246
class 2 vol	17
class 3 vol	0

Link: F Out

length	1.4
V/C	1.15
free-flow spd	60
class 1 vol	88
class 2 vol	6
class 3 vol	0

Link: G In

length	2.2
V/C	.59
free-flow spd	60
class 1 vol	79
class 2 vol	6
class 3 vol	0

Link: H Out

length	.5
V/C	.05
free-flow spd	60
class 1 vol	26
class 2 vol	0
class 3 vol	0

Link: J Out

length	.9
V/C	.52
free-flow spd	60
class 1 vol	61
class 2 vol	6
class 3 vol	0

Link: K Out

length	.5
V/C	.54
free-flow spd	60
class 1 vol	78
class 2 vol	6
class 3 vol	0

Year: 1984

Origin Zone: 6

Mode: Car

Values of Time ($/hr)

class 1		(A)
class 2		
class 3		

Mode:

O.C. parameter		(B)
occupancy		
expansion factor		

Number of Links: 9 (C)

Link: A Out

length (km)	2.1
V/C	.73/.24
free-flow speed (km/h)	80/100
class 1 vol	0
class 2 vol	6
class 3 vol	3

Link: B Out

length	3.4
V/C	.96/.32
free-flow spd	80/100
class 1 vol	0
class 2 vol	18
class 3 vol	7

Link: C In

length	1.5
V/C	1.25
free-flow spd	60
class 1 vol	0
class 2 vol	20
class 3 vol	8

Link: D In

length	2.4
V/C	1.02
free-flow spd	60
class 1 vol	0
class 2 vol	12
class 3 vol	4

Link: E Out

length	1.4
V/C	1.15
free-flow spd	60
class 1 vol	0
class 2 vol	3
class 3 vol	1

Link: G In

length	2.2
V/C	.59
free-flow spd	60
class 1 vol	0
class 2 vol	6
class 3 vol	3

Link: H In

length	.5
V/C	.04
free-flow spd	60
class 1 vol	0
class 2 vol	56
class 3 vol	19

Link: J Out

length	.9
V/C	.52
free-flow spd	60
class 1 vol	0
class 2 vol	16
class 3 vol	5

Link: K Out

length	.5
V/C	.54
free-flow spd	60
class 1 vol	0
class 2 vol	12
class 3 vol	4

Year: 1984

Origin Zone: 8

Mode: Car

Values of Time ($/hr) (A)

class 1	
class 2	
class 3	

Mode: (B)

O.C. parameter	
occupancy	
expansion factor	

Number of Links: 9 (C)

Link: A In

length (km)	2.1
V/C	1.5/.96
free-flow speed (km/h)	80/100
class 1 vol	536
class 2 vol	387
class 3 vol	0

Link: B In

length	3.4
V/C	1.5/.89
free-flow spd	395
class 1 vol	318
class 2 vol	0
class 3 vol	

Link: C In

length	1.5
V/C	1.25
free-flow spd	60
class 1 vol	317
class 2 vol	264
class 3 vol	0

Link: D In

length	2.4
V/C	1.02
free-flow spd	60
class 1 vol	235
class 2 vol	215
class 3 vol	0

Link: E Out

length	1.4
V/C	1.15
free-flow spd	60
class 1 vol	96
class 2 vol	77
class 3 vol	0

Link: G In

length	2.2
V/C	.59
free-flow spd	60
class 1 vol	69
class 2 vol	40
class 3 vol	0

Link: H Out

length	.5
V/C	.05
free-flow spd	60
class 1 vol	9
class 2 vol	11
class 3 vol	0

Link: J Out

length	1
V/C	.52
free-flow spd	60
class 1 vol	69
class 2 vol	43
class 3 vol	0

Link: K Out

length	5
V/C	.54
free-flow spd	60
class 1 vol	141
class 2 vol	69
class 3 vol	0

Origin Zone: 1

Mode: Bus

Values of Time ($/hr) (A)

class 1	
class 2	
class 3	

Mode: (B)

O.C. parameter	4.3
occupancy	45
expansion factor	92

Number of Links: 9 (C)

Link: A Out

length (km)	2.1
V/C	.73/.24
free-flow speed (km/h)	64/80
class 1 vol	72
class 2 vol	387
class 3 vol	0

Link: B Out

length	1.5
V/C	.96/.32
free-flow spd	64/80
class 1 vol	72
class 2 vol	387
class 3 vol	0

Link: C Out

length	1.5
V/C	.62
free-flow spd	42
class 1 vol	116
class 2 vol	738
class 3 vol	0

Link: D Out

length	2.4
V/C	.49
free-flow spd	42
class 1 vol	125
class 2 vol	819
class 3 vol	0

Link: E Out

length	1.4
V/C	1.15
free-flow spd	47
class 1 vol	109
class 2 vol	443
class 3 vol	194

Link: F Out

length	1.0
V/C	.29
free-flow spd	42
class 1 vol	67
class 2 vol	312
class 3 vol	133

Link: H Out

length	.5
V/C	.05
free-flow spd	02
class 1 vol	0
class 2 vol	36
class 3 vol	0

Link: J Out

length	.9
V/C	.52
free-flow spd	42
class 1 vol	44
class 2 vol	315
class 3 vol	0

Link: K Out

length	.5
V/C	.54
free-flow spd	42
class 1 vol	50
class 2 vol	255
class 3 vol	0

Year: 1984

Origin Zone: 41

Mode: Bus

Values of Time ($/hr)

class 1		(A)
class 2		
class 3		

Mode:

O.C. parameter		(B)
occupancy		
expansion factor		

Number of Links: 9 (C)

Link: A Out

length (km)	2.1
V/C	.73/.24
free-flow speed (km/h)	64/80
class 1 vol	9
class 2 vol	10
class 3 vol	0

Link: B Out

length	3.4
V/C	.96/.32
free-flow spd	64/80
class 1 vol	18
class 2 vol	20
class 3 vol	0

Link: C Out

length	1.5
V/C	.62
free-flow spd	42
class 1 vol	49
class 2 vol	30
class 3 vol	0

Link: D In

length	2.4
V/C	1.02
free-flow spd	42
class 1 vol	75
class 2 vol	40
class 3 vol	0

Link: E Out

length	1.4
V/C	1.15
free-flow spd	42
class 1 vol	27
class 2 vol	10
class 3 vol	0

Link: G In

length	2.2
V/C	.59
free-flow spd	47
class 1 vol	27
class 2 vol	10
class 3 vol	0

Link: H Out

length	.5
V/C	.05
free-flow spd	42
class 1 vol	9
class 2 vol	0
class 3 vol	0

Link: J Out

length	.9
V/C	.52
free-flow spd	42
class 1 vol	22
class 2 vol	10
class 3 vol	0

Link: K Out

length	.5
V/C	.54
free-flow spd	42
class 1 vol	9
class 2 vol	10
class 3 vol	0

Year: 1984

Origin Zone: 6

Mode: Bus

Values of Time ($/hr) (A)

class 1	
class 2	
class 3	

Mode: (B)

O.C. parameter	
occupancy	
expansion factor	

Number of Links: 9 (C)

Link: A Out

length (km)	2.1
V/C	.73/.24
free-flow speed (km/h)	64/80
class 1 vol	0
class 2 vol	8
class 3 vol	6

Link: B Out

length	3.4
V/C	.96/.32
free-flow spd	64/80
class 1 vol	0
class 2 vol	32
class 3 vol	18

Link: C In

length	1.5
V/C	1.25
free-flow spd	42
class 1 vol	0
class 2 vol	56
class 3 vol	20

Link: D In

length	2.4
V/C	1.02
free-flow spd	42
class 1 vol	0
class 2 vol	36
class 3 vol	12

Link: E Out

length	1.4
V/C	1.15
free-flow spd	42
class 1 vol	0
class 2 vol	8
class 3 vol	3

Link: G In

length	2.2
V/C	.59
free-flow spd	42
class 1 vol	0
class 2 vol	16
class 3 vol	6

Link: H In

length	.5
V/C	.04
free-flow spd	42
class 1 vol	0
class 2 vol	112
class 3 vol	54

Link: J Out

length	.9
V/C	.52
free-flow spd	42
class 1 vol	0
class 2 vol	26
class 3 vol	16

Link: K Out

length	.5
V/C	.54
free-flow spd	42
class 1 vol	0
class 2 vol	24
class 3 vol	12

Origin Zone: 8

Mode: Bus

Values of Time ($/hr) (A)
class 1 ______
class 2 ______
class 3 ______

Mode: (B)
O.C. parameter ______
occupancy ______
expansion factor ______

Number of Links: 9 (C)

Link: A In
length (km) 2.1
V/C 1.5/.96
free-flow speed (km/h) 64/80
class 1 vol 231
class 2 vol 1120
class 3 vol 940

Link: B In
length 3.4
V/C 1.5/.89
free-flow spd 64/80
class 1 vol 210
class 2 vol 160
class 3 vol 820

Link: C In
length 1.5
V/C 1.25
free-flow spd 42
class 1 vol 180
class 2 vol 800
class 3 vol 720

Link: D In
length 2.4
V/C 1.25
free-flow spd 42
class 1 vol 140
class 2 vol 630
class 3 vol 600

Link: E Out
length 1.4
V/C 1.15
free-flow spd 42
class 1 vol 50
class 2 vol 210
class 3 vol 200

Link: G In
length 2.2
V/C .54
free-flow spd 42
class 1 vol 30
class 2 vol 140
class 3 vol 100

Link: H Out
length .5
V/C .05
free-flow spd 42
class 1 vol 0
class 2 vol 20
class 3 vol 0

Link: J Out
length .9
V/C .52
free-flow spd 43
class 1 vol 30
class 2 vol 140
class 3 vol 100

Link: K Out
length .5
V/C .54
free-flow spd 42
class 1 vol 27
class 2 vol 160
class 3 vol 120

Year:1984

ORIGIN ZONE: 1
Mode: Truck

Modal Parameters

Labor cost ($/hr)	1	(B)
O.C. parameter	5.2	
expansion factor	115	
Number of Links:	8	(C)

Link: A Out

	length (km)	2.1
21	V/C	.73/.24
22	free-flow speed (km/h)	80/100
	volume	135

Link: B Out

	length	3.4
25	V/C	.96/.32
26	free-flow speed	80/100
	volume	135

Link: C Out

length	1.5
V/C	.62
free-flow speed	60
volume	178

Link: D Out

length	2.4
V/C	.49
free-flow speed	60
volume	190

Link: E Out

length	1.4
V/C	1.15
free-flow speed	60
volume	158

Link: F Out

length	1.0
V/C	29
free-flow speed	60
volume	140

Link: H Out

length	15
V/C	.05
free-flow speed	60
volume	0

Link: J Out

length	.9
V/C	.52
free-flow speed	60
volume	43

Link: K Out

length	.5
V/C	.54
free-flow speed	60
volume	28

Year: 1984

ORIGIN ZONE: 2
Mode: Truck

Modal Parameters
- Labor cost ($/hr) ______ (B)
- O.C. parameter ______
- expansion factor ______

Number of Links: ______ (C)

Link: ______
- length (km) ______
- V/C .73/.24
- free-flow speed (km/h) 85/100
- 23 volume 72

Link: ______
- length ______
- V/C .96/.32
- free-flow speed 80/100
- 27 volume 105

Link: ______
- length ______
- V/C ______
- free-flow speed ______
- 31 volume 131

Link: ______
- length ______
- V/C ______
- free-flow speed ______
- 35 volume 137

Link: ______
- length ______
- 37 V/C .56
- free-flow speed ______
- 31 volume 375

Link: ______
- length ______
- V/C ______
- free-flow speed ______
- 43 volume 71

Link: ______
- length ______
- V/C ______
- free-flow speed ______
- volume ______

Link: ______
- length ______
- V/C ______
- free-flow speed ______
- 47 volume 26

Link: ______
- length ______
- V/C ______
- free-flow speed ______
- 51 volume 33

Year: 1984

ORIGIN ZONE: 3
Mode: Truck

Modal Parameters

Labor cost (\$/hr)		(B)
O.C. parameter		
expansion factor		
Number of Links:	9	(C)

Link:	A Out
length (km)	2.1
V/C	.73/.24
free-flow speed (km/h)	80/100
volume	58

Link:	B Out
length	3.4
V/C	.96/.32
free-flow speed	80/100
volume	94

Link:	C Out
length	1.5
V/C	.62
free-flow speed	60
volume	126

Link:	E Out
length	1.4
V/C	1.15
free-flow speed	60
volume	68

Link:	Fin
length	1.0
V/C	.18
free-flow speed	60
volume	183

Link:	G Out
length	2.2
V/C	.25
free-flow speed	60
volume	132

Link:	H Out
length	.5
V/C	.05
free-flow speed	60
volume	6

Link:	J Out
length	.9
V/C	.52
free-flow speed	60
volume	26

Link:	K Out
length	.5
V/C	.54
free-flow speed	60
volume	36

Year: 1984

ORIGIN ZONE: 4
Mode: Truck

Modal Parameters

Labor cost ($/hr)		(B)
O.C. parameter		
expansion factor		
Number of Links:	3	(C)

Link: D In

length (km)	2.4
V/C	1.02
free-flow speed (km/h)	60
volume	20

Link: E Out

length	1.4
V/C	1.15
free-flow speed	60
volume	10

Link: G In

length	2.2
V/C	59
free-flow speed	60
volume	10

Link:

length	
V/C	
free-flow speed	
volume	

Link:

length	
V/C	
free-flow speed	
volume	

Link:

length	
V/C	
free-flow speed	
volume	

Link:

length	
V/C	
free-flow speed	
volume	

Link:

length	
V/C	
free-flow speed	
volume	

Link:

length	
V/C	
free-flow speed	
volume	

Year: 1984

ORIGIN ZONE: 5
Mode: Truck

Modal Parameters		
Labor cost ($/hr)		(B)
O.C. parameter		
expansion factor		
Number of Links:	9	(C)

Link: A Out	
length (km)	2.1
V/C	.73/.24
free-flow speed (km/h)	80/100
volume	39

Link: B Out	
length	3.4
V/C	.96/.32
free-flow speed	80/100
volume	53

Link: C In	
length	1.5
V/C	1.25
free-flow speed	60
volume	82

Link: D In	
length	2.4
V/C	1.02
free-flow speed	60
volume	59

Link: E Out	
length	1.4
V/C	1.15
free-flow speed	60
volume	28

Link: G In	
length	2.2
V/C	.59
free-flow speed	60
volume	23

Link: H Out	
length	.5
V/C	.05
free-flow speed	60
volume	9

Link: J In	
length	.9
V/C	.23
free-flow speed	60
volume	182

Link: K Out	
length	.5
V/C	.54
free-flow speed	60
volume	14

Year: 1984

ORIGIN ZONE: 6
Mode: Truck

Changes from Zone 5

Modal Parameters
Labor cost ($/hr) ______ (B)
O.C. parameter ______
expansion factor ______

Number of Links: 7 (C)

Link:
length (km) ______
V/C ______
free-flow speed (km/h) ______
volume 0

Link:
length ______
V/C ______
free-flow speed ______
volume 0

Link:
length ______
V/C ______
free-flow speed ______
volume 15

Link:
length ______
V/C ______
free-flow speed ______
volume 15

Link:
length ______
V/C ______
free-flow speed ______
volume 7

Link:
length ______
V/C ______
free-flow speed ______
volume 0

Link: H In
length ______
V/C .04
free-flow speed ______
volume 15

Link:
length ______
V/C ______
free-flow speed ______
volume ______

Link:
length ______
V/C ______
free-flow speed ______
volume ______

Year: 1984

ORIGIN ZONE: 7
Mode: Truck

Changes from Zone 5

Modal Parameters
- Labor cost ($/hr) ______ (B)
- O.C. parameter ______
- expansion factor ______

Number of Links: 9 (C)

Link:
- length (km) ______
- V/C .73/.24
- free-flow speed (km/h) 80/100
- volume 66

Link: B In
- length ______
- V/C 1.5/.89
- free-flow speed 80/100
- volume 102

Link:
- length ______
- V/C ______
- free-flow speed ______
- volume 86

Link:
- length ______
- V/C ______
- free-flow speed ______
- volume 66

Link:
- length ______
- V/C ______
- free-flow speed ______
- volume 30

Link:
- length ______
- V/C ______
- free-flow speed ______
- volume 14

Link:
- length ______
- V/C ______
- free-flow speed ______
- volume 0

Link:
- length ______
- V/C .52
- free-flow speed ______
- volume 16

Link:
- length ______
- V/C .25
- free-flow speed ______
- volume 198

Year: 1984

ORIGIN ZONE: 8
Mode: Truck

Changes from Zone 7

Modal Parameters		
Labor cost ($/hr)		(B)
O.C. parameter		
expansion factor		
Number of Links:	9	(C)

Link: A In	
length (km)	
V/C	1.5/.96
free-flow speed (km/h)	80/100
volume	114

Link: B In	
length	
V/C	1.5/.89
free-flow speed	80/100
volume	95

Link:	
length	
V/C	
free-flow speed	
volume	84

Link:	
length	
V/C	
free-flow speed	
volume	65

Link:	
length	
V/C	
free-flow speed	
volume	.26

Link:	
length	
V/C	
free-flow speed	
volume	19

Link:	
length	
V/C	
free-flow speed	
volume	0

Link:	
length	
V/C	
free-flow speed	
volume	11

Link:	
length	
V/C	.54
free-flow speed	
volume	19

Year: 1984

BENEFITS TO RESIDENTS OF ORIGIN ZONE 1

		AUTO	BUS
NO BUILD			
Income class 1	OC	15501.79	757.77
	TC	26508.26	11165.60
Income class 2	OC	17232.42	4317.18
	TC	7351.37	15500.10
Income class 3	OC	642.27	308.73
	TC	124.18	561.18
Total	OC	33376.47	5383.69
	TC	33983.81	27226.89
BUILD			
Income class 1	OC	14865.12	705.71
	TC	21635.33	9043.61
Income class 2	OC	16403.70	4033.77
	TC	5747.25	12536.17
Income class 3	OC	642.27	308.73
	TC	124.18	561.18
Total	OC	31911.08	5048.21
	TC	27506.75	22140.97
DIFFERENCE			
Income class 1	OC	636.67	52.06
	TC	4872.93	2122.00
Income class 2	OC	828.72	283.42
	TC	1604.12	2963.93
Income class 3	OC	0.00	0.00
	TC	0.00	0.00
Total	OC	1465.39	335.48
	TC	6477.06	5085.92

Year 1984

BENEFITS TO RESIDENTS OF ORIGIN ZONE 4

		AUTO	BUS
NO BUILD			
Income class 1	OC	9522.10	350.04
	TC	19656.22	6354.84
Income class 2	OC	777.92	211.92
	TC	400.14	946.12
Income class 3	OC	0.00	0.00
	TC	0.00	0.00
Total	OC	10300.02	561.96
	TC	20056.36	7300.96
BUILD			
Income class 1	OC	9105.81	336.11
	TC	16541.71	5790.64
Income class 2	OC	736.34	196.45
	TC	318.58	785.08
Income class 3	OC	0.00	0.00
	TC	0.00	0.00
Total	OC	9842.16	532.56
	TC	16860.29	6575.72
DIFFERENCE			
Income class 1	OC	416.29	13.93
	TC	3114.51	564.20
Income class 2	OC	41.57	15.48
	TC	81.56	161.04
Income class 3	OC	0.00	0.00
	TC	0.00	0.00
Total	OC	457.86	29.40
	TC	3196.07	725.24

Year 1984

BENEFITS TO RESIDENTS OF ORIGIN ZONE 6

		AUTO	BUS
NO BUILD			
Income class 1	OC	0.00	0.00
	TC	0.00	0.00
Income class 2	OC	1055.08	325.44
	TC	560.76	1581.57
Income class 3	OC	402.91	145.92
	TC	68.81	211.23
Total	OC	1457.99	471.36
	TC	629.57	1792.80
BUILD			
Income class 1	OC	0.00	0.00
	TC	0.00	0.00
Income class 2	OC	988.49	302.77
	TC	432.34	1343.70
Income class 3	OC	376.57	132.77
	TC	52.27	167.03
Total	OC	1365.06	435.54
	TC	484.60	1510.73
DIFFERENCE			
Income class 1	OC	0.00	0.00
	TC	0.00	0.00
Income class 2	OC	66.59	22.68
	TC	128.42	237.87
Income class 3	OC	26.34	13.15
	TC	16.55	44.20
Total	OC	92.93	35.82
	TC	144.97	282.07

Year 1984

BENEFITS TO RESIDENTS OF ORIGIN ZONE 8

		AUTO	BUS
NO BUILD			
Income class 1	OC	23756.66	1637.97
	TC	77277.15	44108.70
Income class 2	OC	18663.96	7507.09
	TC	15639.94	51844.24
Income class 3	OC	0.00	6519.95
	TC	0.00	14509.99
Total	OC	42420.63	15665.01
	TC	92917.09	110462.93
BUILD			
Income class 1	OC	20887.15	1475.81
	TC	41713.83	25365.74
Income class 2	OC	16454.43	6756.39
	TC	8619.70	29539.95
Income class 3	OC	0.00	5883.00
	TC	0.00	8429.37
Total	OC	37341.58	14115.20
	TC	50333.53	63335.06
DIFFERENCE			
Income class 1	OC	2869.51	162.16
	TC	35563.32	18742.96
Income class 2	OC	2209.54	750.70
	TC	7020.24	22304.29
Income class 3	OC	0.00	636.94
	TC	0.00	6080.63
Total	OC	5079.05	1549.81
	TC	42583.56	47127.88

Year 1984

TRUCK COSTS FROM EACH ORIGIN ZONE

Origin Zone:	1	2	3	4
No-Build				
OC *	82483.03	73860.69	54476.85	4229.52
labor	7834.72	6080.97	4706.83	554.65
Build				
OC *	77669.78	70182.93	51222.28	4229.52
labor	5719.15	4485.11	3306.68	554.65
Difference				
OC *	4813.25	3677.76	3254.57	0.00
labor	2115.56	1595.86	1400.15	0.00
Total OC	6928.81	5273.63	4654.72	0.00

Origin Zone:	5	6	7	8
No-Build				
OC	37543.85	3925.04	48609.66	54610.80
labor	4394.30	598.01	7464.02	9364.21
Build				
OC	35671.86	3925.04	44407.69	48762.77
labor	3577.03	598.01	4650.16	5377.30
Difference				
OC *	1871.99	0.00	4201.97	5848.03
labor	817.27	0.00	2813.86	3986.91
Total OC	2689.26	0.00	7015.83	9834.94

6.4 Instructions for computing benefits to a single link (Second Program)

BSL-2.3(A)

USER INSTRUCTIONS

	Enter	Press
1. Set partition.	7	2nd Op. 17
2. Enter data on Input Data Sheet into appropriate registers. This includes data this will probably not change during the analysis: modal characteristics, values of time, discount rate. It also includes data-specific to one link: modal volumes, volume increments (or growth rate), length, and capacity. To check that all the data is properly stored, press 0 INV 2nd list.		
3. Load program BSL-2.3(A) for liniar growth, or program BSL-2.3(B) for exponential growth. Load sides 1 and 2.	0 0	(load sides) (load side 2)
4. Initialize the accumulators of discounted costs.	0	STO 68 STO 69
5. Enter number of years for which costs should be computed with volume and growth data as given.	n_1	STO 00
6. Fix the display format to have 2 decimal places		2nd Fix 2
7. Computer costs for n_1 years	B	
8. To change the incremental volumes		

SINGLE LINK COST STREAM PROGRAM

BSL 2.3(A) INPUT DATA

Register			Link A			Link B			Link C	
			1979 NB	1981 NB	1981 Build	1979 NB	1981 NB	1981 Build	1979 NB	1984 NB
8	Auto	free-flow speed	80		100					
9		expansion factor	107.4							
10		OC parameter	1							
11		occupancy	1.6							
12	Bus	free-flow speed	64		80					
		expansion factor	92							
		OC parameter	4.3							
		occupancy	45							
16	Truck	free-flow speed	80		100					
		expansion factor	115							
		OC parameter	5.2							
		occupancy	1							
20	Class 1	auto volume in	809	2175.4					757	
21		" out	254	198					349	
22		bus volume in	262	1086					228	
23		" out	78	59.2					97	
24	Class 2	auto volume in	625	538.2					609	
25		" out	86	88					121	
26		bus " in	1083	1107.8					1052	
27		" out	132	139.2					162	
28	Class 3	auto volume in	0	188					0	
29		" out	0	1.2					0	
30		bus " in	1522	1877.2					1418	
31		" out	114	73.2					147	
32	Truck	volume in	230	270.4					250	503
		" out	230	270.4					250	503
34	Class 1	value of time	2.18							
35	Class 2	VOT	.56							
36	Class 3	VOT	.18							
37	Auto	PCU equivalency	1							
38	Bus	PCU "	3							
39	Truck	PCU "	3							

Yearly incremental volumes

Register			Link A 1979 NB	Link B 1979 NB	Link C 1979 NB
40	Class 1	Auto yiv in	683.2	559.2	489
		" out	-28	5.4	10
		Bus " in	412	366.6	169
		" out	- 9.4	2.4	16
44	Class 2	Auto yiv in	-43.4	-53.6	57
45		" out	1	33.2	58
46		Bus " in	12.4	-4.6	69
47		" out	3.6	61.4	62
48	Class 3	Auto yiv in	94	94	103
49		Auto " out	0.6	1.4	10
50		Bus " in	177.6	137.6	219
51		Bus " out	-20.4	-19.2	0
52	Truck	" in	20.2	31.4	50.6
53		" out	20.2	31.4	50.6

54 1 + discount rate	1.11				
55* first year discount factor	1	1.2321		1.2321	
56 link length (km)	3.4			3.4	
57 link capacity (PCV)	1600	4800	4800		4800
68 cumulative discounted total OC					
69 cumulative discounted total TC					

Supplementary Yearly incremental volumes for 1984	Link A	Link B	Link C
	1984	1984	1984
	NB	NB	NB
40 Class 1 Auto yiv in	211.2	174.8	135
41 " out	5	41.6	70
42 Bus " in	8.4	-22.4	138
43 " out	10.6	22.6	23
44 Class 2 Auto yiv in	94.5	62	-39
45 " out	8.2	71	80
46 Bus " in	23.2	-16.6	32
47 " out	64	154.4	142
48 Class 3 Auto yiv in	21.2	3.6	3
49 " out	8.6	20.2	17
50 Bus " in	311	212.8	10
51 Bus " out	30.6	120	60
52 Truck " in	15	37.8	58
53 " out	15	37.8	58

COMPUTING COSTS ON LINK A, 1981-2000

Link A No-Build

1. Load liniar growth program, BSL-2.3(A)

2. Enter data for Link A, 1981, No-Build. Store it on a magnetic card (press 3 2nd write and load side 3; 4 2nd write & load side)

3. a. Enter 0 STO 68 STO 69
   b. Enter 3 STO 00. Press 2nd Fix 2.
   c. Press B
      (costs for 1981, 1982, 1983 will be printed)
      (volumes will be updated to 1984)

4. a. Enter incremental volumes for the 1984-1989 interval, in registers 40-53.
   b. Enter 5 STO 00
   c. Press B
      (costs for 1984, 85, 86, 87, 88 will be printed)
      (volumes will be updated to 1989)

5. Load exponential growth program, BSL-2.3(B), sides 1 & 2.

6. a. Enter cumulative operating costs into register 68
      Enter cumulative time costs into register 69.
      (these costs were the first 2 of the last 3 numbers just printed)
   b. Enter growth factor: 1.05 STO 41
   c. Enter 12 STO 00
   d. Press B
      (Costs for 1989-2000 will be printed - takes 30 minutes)

Link A Build

7. If you have the Link A 1981 No-Build data on a card, load in (press 0, enter side 3; press 0, enter side 4.
   If not, the 1981 data may be entered manually.

8. Change the free-flow speeds (registers 8, 12, 16) and capacity (register 57) for build.

9. Proceed with Stpes 3-6.

DISCOUNTED COSTS ON SINGLE LINK INPUTS

BSL-2.3(A) CARD B

Register Content (Input Data)

```
*00 number of years
 01 counter
 02 counter
 03 pointer
 04 pointer
 05 pointer
 06 pointer
 07 pointer
 08 car     free-flow speed    )
 09         expansion factor   )
 10         operating cost     )
            parameter          )
 11         occupancy          )
 12 bus                        ) modal
 13                            ) char.
 14                            ) file
 15                            )
 16 truck                      )
 17                            )
 18                            )
 19                            )
 20 Class 1  car  volume in     )
 21                     out     )
 22          bus        in      )
 23                     out     )
 24 Class 2  car                )
 25                             ) car,
 26          bus                ) bus
 27                             ) vols.
 28 Class 3  car                )
 29                             )
 30          bus                )
 31                             )
 32 truck  volume in           ) truck
 33               out          )  vols.
 34 Class 1  VOT                )
 35       2                     ) VOT
 36       3                     )
 37 car PCV equivalency       )
 38 bus  "       "            ) PCU
 39 truck "      "            )
```

```
40 incremental class 1  car in    )
41  volumes                 out   )
42                      bus in    )
43                          out   )
44              class 2  car      )
45                                )
46                       bus      )
47                                )
48              class 3  car      )
49                                )
50                       bus      )
51                                )
52 truck incremental                )
    volume in                       )
53 truck incremental                )
    volume out                      )
54 1+ discount rate
55 discount factor for first year
56 length
57 capacity (for 2 hours)
```

LINK A
No-Build 1979-84

# of years	6 (6)	00
	0.	01
	0.	02
	0.	03
	0.	04
	0.	05
Modal Char's	0.	06
	0.	07
	80. free-flow spd	08
expansion factor	107.4	09
	1. ~~pa~~ operating cost param	10
occupancy	1.6	11
	64.	12
	92.	13
	4.3	14
bus	45.	15
	80.	16
	115.	17
truck	5.2	18
	1.	19
Class 1 car in	809.	20
out	254.	21
bus in	262.	22
out	78.	23
class 2 car in	625.	24
out	86.	25
bus in	1083. Volumes	26
out	132. (2 hour,	27
Class 3 Car in	0. pax)	28
out	0.	29
bus in	1522. 79	30
out	114. values	31
truck in	230. for	32
out	230. the	33
	2.18 link	34
Values of	0.56	35
time	0.18	36
PCU	1.	37
equiv.	3.	38
	3.	39
Class 1 car in	683.2	40
out	-28.	41
bus in	412.	42
out	-9.4 yearly	43
Class 2	-43.4 volume	44
	1. increments	45
	12.4 unique	46
	3.6 to each	47
class 3	94. link	48
	0.6	49
	177.6	50
	-20.4	51
truck in	20.2	52
out	20.2	53
	1.11 1 + discount rate ~~factor~~	54
1st year discount factor	1.	55
	2.1 length	56
	1600. capacity	57
	0. (2 hour)	58

LINK A
Build 1979-84

0.	00
0.	01
0.	02
0.	03
54.	04
34.	05
23.	06
40.	07
100.	08
107.4	09
1.	10
1.6	11
80.	12
92.	13
4.3	14
45.	15
100.	16
115.	17
5.2	18
1.	19
4908.2	20
86.	21
2734.	22
21.6	23
364.6	24
92.	25
1157.4	26
153.6	27
564.	28
3.6	29
2587.6	30
-8.4	31
351.2	32
351.2	33
2.18	34
0.56	35
0.18	36
1.	37
3.	38
3.	39
683.2	40
-28.	41
412.	42
-9.4	43
-43.4	44
1.	45
12.4	46
3.6	47
94.	48
0.6	49
177.6	50
-20.4	51
20.2	52
20.2	53
1.11	54
1.870414552	55
2.1	56
4800.	57

LINK A: NO-BUILD 1980-1999

1980	1981	1992
1777.38 924.10	2336.74 966.45	2896.10 1008.81
19599.96 39973.71	34787.47 110664.40	48982.30 167022.34
859.92 13779.42	2046.37 52844.60	3202.31 88441.27
20459.88 53753.13	36833.85 163509.00	52184.61 255463.61
13438.26 7421.34	13541.77 11074.65	12736.82 10813.01
3143.92 13685.11	3378.48 22187.36	3440.96 23603.70
16582.18 21106.45	16920.25 33262.01	16177.78 34416.71
0.00 0.00	1977.99 554.32	3980.86 1165.83
4264.12 6067.62	4986.85 10870.13	5470.89 12571.74
4264.12 6067.62	6964.84 11424.46	9451.75 13737.57
71370.39 6982.43	81565.14 11085.09	88951.56 12585.13
112676.57 87909.63	142284.08 219280.56	166765.70 316203.02
112676.57 87909.63 200586.20	240860.42 285459.69 526320.11	376211.20 542097.15 918308.36

1983	1984	1985
3455.46	4014.82	4846.33
1051.16	1093.51	1201.50
62971.22	76949.12	95488.31
217849.80	268632.01	335511.23
4348.10	5493.35	6687.93
121367.97	154278.06	188175.87
67319.32	82442.47	102176.25
339217.77	422910.06	523687.10
11856.55	10977.07	12257.97
10003.27	9195.05	10298.52
3488.02	3535.26	3804.32
23915.23	24230.39	25524.69
15344.57	14512.33	16062.29
33918.50	33425.44	35823.21
5971.67	7962.73	10546.47
1748.88	2332.03	3064.23
5929.51	6386.99	7794.93
13717.66	14860.38	18128.85
11901.18	14349.72	18341.40
15466.54	17192.41	21193.08
-		
96133.97	103402.73	116802.29
13656.89	14753.80	16878.63
190699.05	214707.25	253382.23
402259.70	488281.72	597582.02
515648.70	657083.02	792551.51
836225.98	1157872.27	1477364.02
1351874.68	1814955.29	2269915.53
	1157872.27	

	1986	1987	1988
	5118.48	5390.63	5662.78
	1267.14	1332.78	1398.42
	100064.23	104642.68	109223.18
	351687.53	367895.89	384138.15
	6738.62	6790.09	6842.27
	189225.39	190322.56	191471.27
	106802.85	111432.77	116065.46
	540912.91	558218.45	575609.42
	14422.92	16592.60	18766.51
	12218.69	14149.62	16092.06
	4031.03	4262.49	4498.32
	26566.89	27681.87	28875.63
	18453.95	20855.09	23264.83
	38785.58	41831.49	44967.68
	11144.57	11748.19	12357.07
	3215.71	3369.97	3527.24
	8749.05	9705.53	10664.19
	20267.73	22417.20	24578.19
	19893.62	21453.71	23021.26
	23483.44	25787.17	28105.43
	122931.18	129128.28	135381.29
	17924.05	19016.13	20157.53
	268081.61	282869.85	297732.83
	621105.97	644853.24	668840.06
	921675.27	1044419.99	1160811.13
	1776524.94	2056343.85	2317809.99
	2698200.21	3100763.83	3478621.12

1989	1990	1991
5934.94	6207.09	6517.44
1464.06	1529.70	1606.18
113805.33	118388.75	124357.28
400416.12	416731.64	437981.57
6895.11	6948.53	7299.68
192675.43	193939.01	203926.72
120700.44	125337.28	131656.96
593091.55	610670.65	641908.29
20944.16	23125.09	24329.15
18046.74	20014.42	21118.52
4738.15	4981.60	5251.71
30154.23	31523.82	33521.63
25682.31	28106.70	29580.86
48200.97	51538.24	54640.15
12970.88	13589.27	14287.35
3687.78	3851.82	4057.35
11624.88	12587.41	13224.49
26751.62	28938.42	30434.98
24595.76	26176.69	27511.84
30439.39	32790.24	34492.34
141679.23	148012.50	156691.80
21350.94	22599.06	24322.58
312657.75	327633.17	345441.46
693082.86	717598.20	755363.36
1270924.33	1374876.87	1473618.14
2561903.02	2789584.95	3005498.64
3832827.35	4164461.82	4479116.78

1992	1993	1994
6843.32	7185.48	7544.76
1686.49	1770.82	1859.36
130626.10	137209.89	144124.08
460363.36	483945.27	508800.89
7668.49	8055.82	8462.58
214462.62	225582.30	237324.52
138294.59	145265.71	152586.65
674825.98	709527.57	746125.41
25595.21	26926.07	28324.65
22295.18	23550.93	24893.13
5535.90	5834.74	6148.86
35690.09	38049.61	40623.62
31131.11	32760.82	34473.51
57985.26	61600.54	65516.74
15021.04	15791.99	16601.95
4275.34	4506.75	4752.70
13893.62	14596.38	15334.40
32014.70	33683.14	35446.36
28914.66	30388.37	31936.35
36290.04	38189.89	40199.06
165853.46	175513.19	185687.23
26231.90	28353.03	30716.08
364193.82	383928.09	404683.74
795333.18	837671.02	882557.29
1567403.24	1656472.57	1741053.23
3210308.27	3404643.61	3589101.92
4777711.51	5061116.18	5330155.15

1995	1996	1997
7921.99	8318.09	8734.00
1952.32	2049.94	2152.44
151384.84	159009.19	167014.98
535009.78	562658.16	591839.65
8889.70	9338.20	9809.12
249731.58	262849.76	276729.86
160274.54	168347.39	176824.10
784741.36	825507.92	868569.52
29794.00	31337.35	32958.10
26330.08	27871.14	29526.95
6478.87	6825.47	7189.36
43439.03	46526.84	49922.75
36272.87	38162.82	40147.45
69769.10	74397.98	79449.70
17452.73	18346.27	19284.56
5014.41	5293.24	5590.73
16109.38	16923.15	17777.59
37311.01	39284.39	41374.54
33562.12	35269.42	37062.15
42325.41	44577.63	46965.26
196392.65	207647.53	219471.20
33355.96	36313.13	39634.57
426502.19	449427.15	473504.91
930191.84	980796.66	1034619.05
1821360.26	1897597.77	1969959.82
3764249.79	3930624.90	4088737.63
5585610.06	5828222.67	6058697.45

1998	1999
9170.698911	9629.233856
2260.058668	2373.061601
175421.008	184247.0007
622656.2156	655219.1345
10303.55567	10822.67238
291427.7652	307005.1374
185724.5637	195069.6731
914083.9808	962224.2719
34659.8183	36446.30163
31309.57107	33232.72244
7571.299412	7972.098942
53667.9646	57810.08548
42231.11771	44418.40057
84977.53567	91042.80792
20269.74758	21304.06724
5908.601147	6248.804085
18674.70343	19616.58294
43590.3263	45941.58789
38944.45101	40920.65018
49498.92745	52190.39198
231884.4556	244909.6901
43374.80135	47597.18721
498784.5881	525318.4139
1091935.245	1153054.659
3	0
20~~8~~9517.974	21~~2~~4675.269
4239072.677	4382090.551
6~~2~~28590.651	65~~3~~6765.821
288	1984

1999

LINK B: NO-BUILD 1980-1989

1980	1981	1982
1777.38	2279.64	2781.90
924.10	1046.27	1168.45
19599.96	32641.85	45026.58
39973.71	98486.18	150731.79
859.92	1940.07	3006.44
13779.42	47594.91	81980.38
20459.88	34581.92	48033.02
53753.13	146081.09	232712.17
13438.26	13806.44	13449.59
7421.34	10623.17	10892.58
3143.92	3452.41	3627.37
13685.11	21288.99	23791.51
16582.18	17258.86	17076.96
21106.45	31912.15	34684.09
0.00	1979.28	4008.47
0.00	530.77	1169.30
4264.12	4859.26	5257.90
6067.62	10161.54	12070.43
4264.12	6838.54	9266.37
6067.62	10692.31	13239.73
71370.39	85821.00	98404.96
6982.43	11384.82	14161.31
112676.57	144500.31	172781.31
87909.63	200070.38	294797.30
112676.57	242857.03	383090.22
87909.63	268153.22	507417.32
200586.20	511010.25	890507.54

1983	1984	1985
3284.15	3786.41	4288.67
1290.62	1412.79	1534.97
57067.41	69108.20	81144.52
193671.70	236753.84	279986.28
4055.32	5104.08	6152.62
111771.57	141615.96	171517.16
61122.72	74212.28	87297.14
305443.26	378369.80	451503.44
12987.26	12560.55	12163.41
10216.85	9618.82	9108.82
3780.88	3941.74	4108.59
24378.45	25116.38	26025.69
16768.14	16502.30	16271.99
34595.31	34735.20	35134.51
6015.29	8023.70	10033.50
1755.09	2341.81	2929.61
5606.87	5952.70	6295.68
12959.03	13837.78	14704.71
11622.16	13976.39	16329.17
14714.12	16179.59	17634.32
110738.07	123339.20	136138.15
16201.95	18411.40	20808.81
200251.09	228030.18	256036.46
370954.64	447695.99	525081.08
529512.09	679722.63	831667.80
778656.15	1073567.37	1385177.43
1308168.24	1753290.00	2216845.24

1986	1987	1988
4563.90	4839.14	5114.38
1751.17	1967.37	2183.57
85873.61	90621.77	95377.19
297162.07	315484.41	335124.38
6157.62	6164.61	6172.80
171538.26	172140.30	173420.95
92031.23	96786.38	101550.00
468700.33	487624.71	508545.33
15057.08	18016.42	21017.73
11609.74	14538.36	17968.11
4511.15	4930.55	5360.90
28481.34	31894.47	36435.21
19568.23	22946.97	26378.62
40091.08	46432.83	54403.32
10504.87	11004.33	11524.14
3027.77	3158.20	3327.45
7214.81	8152.99	9104.69
16580.94	18659.73	20982.79
17719.68	19157.33	20628.83
19608.72	21817.92	24310.24
152713.34	169272.27	185737.73
24545.44	28876.71	33880.75
282032.46	308162.95	334295.18
552945.56	584752.18	621139.64
982453.88	1130883.15	1275942.69
1680804.71	1962455.52	2231984.46
2663258.59	3093338.67	3507927.15

1989	1990	1991
5389.61	5664.85	5948.09
2399.77	2615.97	2746.77
100133.22	104693.77	109928.46
356256.52	372487.80	391112.19
6181.68	6182.26	6491.37
175480.09	175498.81	184273.75
106314.91	110876.02	116419.82
531736.61	547986.61	575385.94
24044.75	26847.80	28190.19
21974.05	24537.56	25764.44
5798.14	6187.91	6497.31
42277.63	45123.51	47379.69
29842.90	33035.71	34687.50
64251.68	69661.07	73144.13
12058.29	12559.88	13187.87
3542.27	3689.71	3874.20
10065.80	11007.02	11557.37
23592.90	25799.59	27089.57
22124.08	23566.90	24745.24
27135.17	29489.31	30963.77
202080.76	216276.14	227089.94
39637.05	42424.82	44546.06
360362.65	383754.77	402942.51
662760.51	689561.81	724039.90
1416817.38	1551969.85	1679816.79
2491073.96	2733926.93	2963652.70
3907891.34	4285896.78	4643469.49

1992	1993	1994
6245.50	6557.77	6885.66
2884.10	3028.31	3179.72
115424.88	121196.12	127255.93
410667.80	431201.18	452761.24
6815.94	7156.73	7514.57
193487.44	203161.81	213319.90
122240.82	128352.86	134770.50
604155.23	634363.00	666081.15
29599.70	31079.68	32633.67
27052.66	28405.30	29825.56
6822.17	7163.28	7521.45
49748.67	52236.10	54847.91
36421.87	38242.96	40155.11
76801.33	80641.40	84673.47
13847.27	14539.63	15266.61
4067.91	4271.31	4484.87
12135.24	12742.00	13379.10
28444.05	29866.25	31359.57
25982.51	27281.63	28645.71
32511.96	34137.56	35844.44
238444.44	250366.66	262885.00
46773.36	49112.03	51567.63
423089.63	444244.12	466456.32
760241.89	798253.99	838166.69
1800753.08	1915152.27	2023367.72
3180960.87	3386522.65	3580972.99
4981713.95	5301674.92	5604340.71

1995	1996	1997
7229.94	7591.44	7971.01
3338.71	3505.65	3680.93
133618.72	140299.66	147314.64
475399.31	499169.27	524127.74
7890.30	8284.81	8699.06
223985.90	235185.19	246944.45
141509.02	148584.48	156013.70
699385.20	734354.46	771072.19
34265.35	35978.62	37777.55
31316.84	32882.68	34526.81
7897.52	8292.39	8707.01
57590.30	60469.82	63493.31
42162.87	44271.01	46484.56
88907.14	93352.50	98020.12
16029.94	16831.44	17673.01
4709.11	4944.57	5191.80
14048.05	14750.46	15487.98
32927.55	34573.92	36302.62
30078.00	31581.90	33160.99
37636.66	39518.49	41494.42
276029.25	289830.71	304322.24
54146.02	56853.32	59695.98
489779.14	514268.09	539981.50
880075.02	924078.77	970282.71
2125733.69	2222566.36	2314164.84
3764912.49	3938909.32	4103500.91
5890646.18	6161475.68	6417665.75

1998	1999
8369.56	8788.04
3864.97	4058.22
154680.38	162414.40
550334.12	577850.83
9134.01	9590.71
259291.67	272256.26
163814.38	172005.10
809625.80	850107.09
39666.43	41649.75
36253.16	38065.81
9142.37	9599.48
66667.97	70001.37
48808.79	51249.23
102921.13	108067.19
18556.66	19484.50
5451.39	5723.96
16262.38	17075.50
38117.75	40023.64
34819.04	36559.99
43569.14	45747.60
319538.36	335515.27
62680.78	65814.82
566980.57	595329.60
1018796.85	1069736.69
2400812.04	2482775.62
4259195.67	4406474.49
6660007.71	6889250.10

LINK C: NO-BUILD 1979-1999

		1980	1981	1982
		1783.62	2371.51	2959.40
		1070.82	1276.57	1482.32
Class 1				
Car	OC	14942.79	23793.61	31817.04
	TC	29915.68	74122.91	104522.38
Bus	OC	603.77	1021.94	1414.42
	TC	9512.77	25259.49	36732.65
Total	OC	15546.57	24815.55	33231.46
	TC	39428.44	99382.40	141255.03
Class 2				
Car	OC	10123.21	12554.95	14371.25
	TC	5544.22	10113.27	11702.71
Bus	OC	2312.61	2718.84	3000.99
	TC	10053.84	17814.83	19936.49
Total	OC	12435.83	15273.79	17372.24
	TC	15598.05	27928.10	31639.20
Class 3				
Car	OC	0.00	1718.07	3459.39
	TC	0.00	474.42	977.42
Bus	OC	2998.94	3654.39	4130.10
	TC	4257.79	8053.20	9358.92
Total	OC	2998.94	5372.46	7589.49
	TC	4257.79	8527.63	10336.34
Truck	OC	58224.87	75245.46	90305.16
	TC	5881.66	10821.49	13657.12
Total	OC	89206.20	120707.26	148498.34
	TC	65165.96	146659.62	196887.69
Discounted Totals				
	OC	89206.20	197951.48	318476.06
	TC	65165.96	197291.74	357090.20
Grand Total		154372.15	395243.22	675566.27

1983	1984	1985
3547.29	4135.10	4723.07
1688.07	1893.82	2099.57
39768.12	47693.71	55593.77
133797.88	163512.94	193700.12
1805.90	2197.67	2589.42
47971.45	59544.20	71497.89
41574.02	49891.38	58183.19
181769.33	223057.15	265198.00
16216.76	18101.17	20010.37
13283.28	15104.01	17204.71
3284.02	3570.89	3860.05
21917.19	24180.40	26771.85
19500.78	21672.06	23870.42
35200.46	39284.42	43976.56
5208.09	6965.55	8729.18
1479.71	1993.84	2521.99
4596.25	5060.53	5523.19
10497.56	11647.23	12808.15
9804.35	12026.08	14252.38
11977.27	13641.07	15330.14
105584.66	121040.14	136571.52
16705.98	20215.66	24253.80
176463.80	204629.66	232877.50
245653.03	296198.29	348758.51
447504.87	582300.77	720502.23
536709.58	731824.57	938795.77
984214.46	1314125.34	1659298.00

1986	1987	1988
4970.95	5218.82	5466.70
2386.69	2673.82	2960.94
58965.87	62151.70	65328.24
209556.31	221128.24	232429.99
2933.74	3268.97	3603.77
83170.32	92797.79	102301.89
61899.60	65420.66	68932.00
292726.63	313926.04	334731.88
20846.96	21492.00	22127.31
18989.32	19642.63	20223.27
4247.09	4610.24	4972.07
30882.96	33618.81	36257.36
25094.05	26102.24	27099.38
49872.28	53261.44	56480.63
8908.68	9064.76	9219.71
2614.72	2662.95	2708.47
5676.58	5822.59	5968.15
13295.95	13647.69	13988.88
14585.25	14887.34	15187.86
15910.68	16310.64	16697.36
154786.24	170898.35	186911.44
30223.61	33523.49	36664.63
256365.14	277308.59	298130.68
388733.20	417021.61	444574.49
857565.51	991133.52	1120500.33
1146628.41	1347490.38	1540403.03
2004193.92	2338623.90	2660903.36

1989	1990	1991
5714.57 3248.07	5962.45 3535.19	6260.57 3711.95
68504.78 243731.73	71681.31 255033.47	75265.38 267785.14
3938.56 111805.99	4273.36 121310.09	4487.03 127375.60
72443.34 355537.72	75954.68 376343.56	79752.41 395160.74
22762.61 20803.91	23397.92 21384.55	24567.82 22453.77
5333.91 38895.92	5695.74 41534.47	5980.52 43611.19
28096.52 59699.82	29093.66 62919.02	30548.34 66064.97
9374.66 2753.99	9529.62 2799.51	10006.10 2939.49
6113.72 14330.07	6259.28 14671.27	6572.24 15404.83
15488.38 17084.07	15788.90 17470.78	16578.34 18344.32
202924.53 39805.76	218937.62 42946.90	229884.50 45094.24
318952.77 472127.38	339774.86 499680.26	356763.60 524664.27
1245186.86 1724969.32 2970156.18	1364850.29 1900948.95 3265799.24	1478045.43 2067416.17 3545461.60

1992	1993	1994
6573.60	6902.28	7247.40
3897.55	4092.43	4297.05
79028.65	82980.08	87129.09
281174.40	295233.12	309994.78
4711.38	4946.95	5194.30
133744.38	140431.60	147453.18
83740.03	87927.03	92323.38
414918.78	435664.72	457447.95
25796.21	27086.02	28440.32
23576.46	24755.29	25993.05
6279.55	6593.53	6923.20
45791.75	48081.34	50485.41
32075.76	33679.55	35363.52
69368.22	72836.63	76478.46
10506.40	11031.72	11583.31
3086.46	3240.79	3402.83
6900.86	7245.90	7608.19
16175.07	16983.83	17833.02
17407.26	18277.62	19191.50
19261.54	20224.61	21235.84
241378.73	253447.67	266120.05
47348.96	49716.40	52202.22
374601.78	393331.87	412998.46
550897.49	578442.36	607364.48
1585121.91	1686410.47	1782223.98
2224885.16	2373842.32	2514747.73
3810007.07	4060252.79	4296971.71

1995	1996	1997
7609.77	7990.25	8389.77
4511.90	4737.49	4974.37
91485.54	96059.82	100862.81
325494.52	341769.24	358857.70
5454.01	5726.71	6013.05
154825.84	162567.13	170695.48
96939.55	101786.53	106875.86
480320.35	504336.37	529553.19
29862.34	31355.45	32923.23
27292.70	28657.34	30090.20
7269.36	7632.83	8014.47
53009.68	55660.16	58443.17
37131.70	38988.29	40937.70
80302.38	84317.50	88533.37
12162.47	12770.60	13409.13
3572.97	3751.62	3939.20
7988.60	8388.03	8807.44
18724.67	19660.90	20643.95
20151.08	21158.63	22216.56
22297.64	23412.52	24583.14
279426.05	293397.36	308067.22
54812.33	57552.95	60430.60
433648.39	455330.81	478097.35
637732.70	669619.34	703100.31
1872858.38	1958593.62	2039694.52
2648036.64	2774120.74	2893389.49
4520895.02	4732714.36	4933084.01

1998	1999
8809.25	9249.72
5223.09	5484.24
105905.95	111201.25
376800.59	395640.62
6313.70	6629.39
179230.26	188191.77
112219.65	117830.63
556030.85	583832.39
34569.39	36297.86
31594.71	33174.45
8415.20	8835.96
61365.33	64433.60
42984.59	45133.81
92960.04	97608.05
14079.58	14783.56
4136.16	4342.97
9247.81	9710.20
21676.14	22759.95
23327.39	24493.76
25812.30	27102.92
323470.58	339644.11
63452.13	66624.73
502002.21	527102.32
738255.32	775168.09
2116411.59	2188981.80
3006211.27	3112934.58
5122622.86	5301916.38

LINK A: BUILD - 1980-1999

1980	1981	1982
1777.38	2336.74	2896.10
924.10	966.45	1008.81
15908.83	25113.71	35322.14
10606.16	20502.50	34576.78
645.04	1444.67	2337.90
3638.93	9607.14	18114.48
16553.87	26558.39	37660.04
14245.09	30109.65	52691.27
10526.98	9771.03	9356.99
1862.67	2050.35	2284.42
2303.10	2393.85	2534.78
3416.00	4067.99	4934.78
12830.08	12164.88	11891.77
5278.67	6118.34	7219.20
0.00	1364.89	2800.45
0.00	96.94	235.33
3100.28	3491.75	3985.75
1489.01	1939.85	2563.02
3100.28	4856.64	6786.20
1489.01	2036.80	2798.35
62782.56	67628.97	73809.99
2143.91	2586.72	3158.60
95266.79	111208.88	130148.00
23156.68	40851.50	65867.42
95266.79	195454.97	301086.01
23156.68	59959.83	113419.30
118423.47	255414.80	414505.31

19 1982

1983	1984	1985
3455.46	4014.82	4846.3275
1051.16	1093.51	1201.505
47125.71	60499.41	49857.92072
54254.34	81018.09	82612.00555
3344.84	4454.86	3583.738172
30075.08	46441.18	46343.61117
50470.55	64954.28	53441.65889
84329.42	127459.27	128955.6167
9096.42	8838.73	6467.769952
2546.19	2815.29	2526.348756
2701.86	2874.09	2022.353557
6031.17	7371.10	6263.366172
11798.28	11712.82	8490.123509
8577.35	10186.39	8789.714928
4412.89	6223.80	5505.454674
431.11	700.94	754.5529598
4558.63	5178.70	4177.426537
3394.29	4470.31	4464.966641
8971.52	11402.49	9682.881211
3825.40	5171.25	5219.519601
81072.27	88996.65	63346.62333
3882.98	4783.77	4085.17992
152312.61	177066.24	134961.2869
100615.15	147600.68	147050.0312
412455.67	529094.69	601250.5034
186988.23	284217.37	362836.3252
599443.91	813312.06	964086.8286

1 19 1985

1986	1987	1988
5118.48	5390.6325	5662.785
1267.143333	1332.781667	1398.42
53358.32061	56891.24731	60444.96746
94520.24709	107693.7998	122208.3852
3676.593058	3764.96024	3848.940867
50871.58797	55711.66757	60869.64642
57034.91366	60656.20755	64293.90833
145391.8351	163405.4674	183078.0317
7722.968247	9013.577819	10335.1902
3251.672759	4080.459455	5021.039731
2166.518822	2309.38308	2450.949987
7047.233781	7893.366	8804.513666
9889.487069	11322.9609	12786.14018
10298.90654	11973.82546	13825.5534
5945.025838	6386.048958	6827.386908
863.5210288	983.5102303	1115.16227
4772.760275	5378.997575	5994.419249
5448.129276	6558.888796	7806.783329
10717.78611	11765.04653	12821.80616
6311.650305	7542.399026	8921.945599
66649.70369	69956.99144	73263.88678
4580.461556	5123.622091	5717.435882
144291.8905	153701.2064	163165.7414
166582.8535	188045.314	211542.9665
670749.9061	737444.9321	801230.4623
443072.3577	524670.202	607367.5878
1113822.264	19. 1262115.134	1408598.05

1588

1989	1990	1991
5934.9375	6207.09	6517.4445
1464.058333	1529.696667	1606.1815
64010.34143	67580.36016	72077.90214
138140.3815	155566.7989	178411.0861
3928.727391	4004.567039	4259.387088
66351.25334	72162.15678	82743.12666
67939.06882	71584.92719	76337.28923
204491.6349	227728.9557	261154.2128
11683.72025	13055.48465	13898.92845
6081.836299	7271.359467	8325.782247
2591.283247	2730.488892	2896.862423
9783.442524	10832.93302	12361.34078
14275.0035	15785.97355	16795.79087
15865.27882	18104.29248	20687.12303
7268.208278	7707.929649	8212.267768
1259.124254	1416.048493	1622.531871
6617.532412	7247.059507	7707.823737
9201.451133	10752.62613	12328.2564
13885.74069	14954.98916	15920.09151
10460.57539	12168.67462	13950.78827
76567.73905	79867.44624	84373.09422
6364.700516	7068.235975	8014.930691
172667.5521	182193.3361	193426.2658
237182.1896	265070.1588	303807.0548
862041.2941	919847.9055	975137.0286
690899.4736	775001.3385	861841.7972
1552940.768	1694849.244	1836978.826

19 1991

1992	1993	1994
6843.316725 1686.490575	7185.482561 1770.815104	7544.756689 1859.355859
76806.05992 204926.2005	81770.23281 235720.0766	85897.86053 248477.4635
4526.911225 95023.44442	4807.533096 109284.4962	5050.541829 115205.1551
81332.97114 299949.6449	86577.76591 345004.5727	90948.40236 363682.6186
14785.62493 9548.876682	15716.87577 10968.53706	16502.68619 11567.32689
3071.92489 14131.78327	3256.089936 16184.15832	3422.135104 17084.18609
17857.54982 23680.65995	18972.96571 27152.69538	19924.8213 28651.51299
8742.467769 1862.111607	9299.233322 2140.26452	9766.078082 2256.661294
8191.579927 14156.88208	8699.048006 16280.39238	9138.838832 17162.79618
16934.0477 16018.99369	17998.28133 18420.6569	18904.91691 19419.45748
89109.91051 9108.534553	94092.51496 10373.10522	98601.55612 10969.80839
205234.4792 348757.8331	217641.5279 400951.0302	228379.6967 422723.3974
1027987.833 951651.911 1979639.744	19 1078479.541 1044670.475 2123150.016	1126211.89 10 1133021.502 2259233.393 1994

1995	1996	1997
7921.994524	8318.09425	8733.998962
1952.323652	2049.939834	2152.436826
90185.11724	94688.34693	99418.89304
260935.9742	274023.2239	287771.6252
5303.575931	5569.444417	5848.823351
120989.778	127067.7214	133454.3377
95488.69317	100257.7913	105267.7164
381925.7522	401090.9453	421225.9629
17320.3857	18180.53783	19085.79564
12154.35615	12772.19083	13422.61522
3596.103843	3779.802209	3973.910551
17973.72599	18913.67263	19907.54159
20916.48954	21960.34004	23059.70619
30128.08214	31685.86346	33330.1568
10251.48655	10761.77595	11298.3969
2370.578768	2490.374119	2616.371787
9596.829096	10078.09659	10583.87619
18025.0957	18931.20834	19883.44195
19848.31564	20839.87254	21882.27309
20395.67447	21421.58246	22499.81373
103332.7404	108342.4214	113658.7132
11568.03857	12204.5284	12882.59197
239586.2388	251400.4254	263868.4089
444017.5474	466402.9196	489938.5254
1171324.111	1213969.823	1254294.768
1216626.545	1295743.693	1370617.165
2387950.656	2509713.516	2624911.932

19 199 1997

1998	1999
9170.698911	9629.233856
2260.058668	2373.061601
104388.7222	109610.4442
302215.3752	317390.572
6142.424903	6450.998379
140165.862	147219.4759
110531.1471	116061.4426
442381.2372	464610.0479
20038.99934	21043.17491
14107.54378	14829.03455
4179.156243	4396.311636
20959.19124	22072.86796
24218.15558	25439.48655
35066.73502	36901.90251
11862.89378	12456.90522
2748.917562	2888.380511
11115.46927	11674.24544
20884.23939	21936.18869
22978.36305	24131.15066
23633.15696	24824.5692
119312.5942	125337.7627
13605.94426	14378.76061
277040.2599	290969.8425
514687.0735	540715.2802
1292437.016	1328527.142
1441478.065	1508545.094
2733915.081	2837072.236

١٢ 1789

LINK B BUILD 1979-1999

1980	1981	1982
1777.38 924.10	2279.64 1046.27	2781.90 1168.45
15908.83 10606.16	23809.63 18958.76	32410.80 30325.92
645.04 3638.93	1373.25 8963.94	2173.41 16249.94
16553.87 14245.09	25182.87 27922.70	34584.21 46575.86
10526.98 1862.67	10115.04 2058.30	9971.02 2279.62
2303.10 3416.00	2461.31 4083.65	2658.57 4911.22
12830.08 5278.67	12576.34 6141.95	12629.59 7190.84
0.00 0.00	1376.72 95.70	2803.22 227.23
3100.28 1489.01	3402.32 1863.35	3784.83 2364.52
3100.28 1489.01	4779.04 1959.05	6588.05 2591.74
62782.56 2143.91	70299.43 2688.18	78858.03 3372.90
95266.79 23156.68	112837.69 38711.89	132659.87 59731.35
95266.79 23156.68 118423.47	196922.36 58032.26 254954.62	304592.09 106511.56 411103.65

1983	1984	1985
3284.15	3786.41	4288.67
1290.62	1412.79	1534.97
42168.33	53133.68	65133.19
45644.12	65885.02	92050.44
3064.16	4041.91	5091.65
26148.59	39337.01	56514.07
45232.49	57175.59	70224.84
71792.71	105222.03	148564.51
9944.44	9910.62	9799.07
2507.82	2722.74	2903.14
2877.04	3100.54	3318.80
5903.82	7065.73	8400.58
12821.48	13011.16	13117.87
8411.65	9788.48	11303.71
4376.77	6129.34	8048.98
407.35	649.38	967.05
4231.25	4718.32	5225.93
3015.01	3837.75	4856.12
8608.01	10847.66	13274.91
3422.36	4487.13	5823.17
88452.69	98849.68	109782.23
4226.99	5280.12	6562.63
155114.67	179884.09	206399.85
87853.71	124777.76	172254.03
418010.60	536505.82	658994.09
170749.44	252944.41	355168.80
588760.04	789450.24	1014162.89

1986	1987	1988
4563.90	4839.14	5114.38
1751.17	1967.37	2183.57
70293.47	75550.40	80891.65
106208.10	122015.40	139587.17
5195.02	5290.47	5378.49
61646.54	67099.71	72871.89
75488.49	80840.87	86270.14
167854.64	189115.11	212459.06
12005.57	14256.71	16570.11
3787.79	4803.67	5965.01
3631.23	3946.44	4268.24
9499.57	10696.98	12003.28
15636.80	18203.16	20838.35
13287.35	15500.64	17968.28
8613.67	9166.66	9711.82
1087.50	1218.85	1361.82
6084.87	6961.63	7856.63
5955.97	7204.44	8615.24
14698.54	16128.29	17568.46
7043.47	8423.29	9977.06
121153.90	132952.59	145267.77
7837.41	9287.16	10928.09
226977.73	248124.91	269944.71
196022.87	222326.21	251332.49
780345.65	899857.10	1016993.26
459970.63	567055.91	676115.74
1240316.28	1466913.01	1693109.01

1989	1990	1991
-		
5389.61	5664.85	5948.09
2399.77	2615.97	2746.77
86307.34	91788.59	98021.22
159039.47	180489.48	206122.01
5459.72	5534.86	5896.81
78961.18	85365.47	97497.25
91767.05	97323.44	103918.02
238000.65	265854.95	303619.26
18960.38	21437.68	22812.39
7286.26	8782.11	9949.08
4599.82	4943.48	5261.04
13429.17	14985.55	16936.14
23560.19	26381.16	28073.42
20715.43	23767.66	26885.22
10253.68	10796.48	11521.29
1517.14	1685.53	1922.26
8770.25	9702.53	10335.57
10202.25	11979.53	13667.36
19023.93	20499.00	21856.85
11719.38	13665.06	15589.62
158156.10	171640.04	182601.98
12776.61	14849.35	16810.84
292507.27	315843.64	336450.28
283212.07	318137.03	362904.94
1131341.60	1242576.83	1349326.89
786830.35	898873.28	1014016.96
1918171.96	2141450.11	2363343.85

1992	1993	1994
6245.50	6557.77	6885.66
2884.10	3028.31	3179.72
104612.31	111571.21	118908.01
235823.61	270265.55	310231.21
6278.39	6680.20	7102.87
111555.40	127857.74	146775.18
110890.70	118251.41	126010.88
347379.00	398123.29	457006.38
24284.14	25858.55	27541.24
11296.56	12854.08	14656.09
5600.10	5961.85	6347.48
19185.87	21783.56	24786.11
29884.24	31820.40	33888.72
30482.44	34637.64	39442.20
12289.62	13102.94	13962.76
2196.42	2514.16	2882.69
11004.03	11709.13	12452.13
15622.32	17888.45	20517.13
23293.66	24812.07	26414.89
17818.74	20402.61	23399.82
194348.26	206925.69	220381.13
19075.00	21691.30	24717.45
358416.86	381809.56	406695.61
414755.18	474854.85	544565.86
1451777.06	1550098.46	1644449.74
1132570.92	1254852.81	1381189.27
2584347.98	2804951.28	3025639.02

1995	1996	1997
7229.94	7591.44	7971.01
3338.71	3505.65	3680.93
126497.63	132988.91	139830.21
353932.09	372345.06	391798.90
7540.46	7927.55	8335.02
167459.29	176150.69	185330.10
134038.09	140916.46	148165.22
521391.38	548495.74	577129.00
29317.56	30989.98	32777.63
16639.38	17699.77	18851.53
6754.90	7152.69	7576.49
28097.76	29990.62	32060.03
36072.46	38142.67	40354.11
44737.14	47690.40	50911.55
14855.86	15635.40	16459.54
3286.09	3463.46	3651.89
13223.45	13915.26	14644.79
23393.65	24643.37	25969.02
28079.30	29550.66	31104.33
26679.74	28106.83	29620.90
234605.15	248081.54	262498.83
28050.06	29867.03	31844.40
432795.00	456691.32	482122.50
620858.32	654160.00	689505.86
1734905.78	1820897.20	1902680.90
1510951.36	1634124.59	1751087.27
3245857.14	3455021.79	3653768.17

1998	1999
8369.56	8788.04
3864.97	4058.22
147038.94	154632.94
412365.86	434125.13
8763.86	9215.11
195030.89	205289.61
155802.81	163848.06
607396.75	639414.75
34686.15	36720.92
20105.64	21474.74
8027.46	8506.74
34328.54	36822.18
42713.62	45227.66
54434.18	58296.93
17330.49	18250.48
3852.30	4065.72
15413.85	16224.29
27376.63	28872.95
32744.34	34474.77
31228.93	32938.67
277903.29	294338.50
34001.88	36362.11
509164.05	537888.99
727061.74	767012.45
1980492.45	2054547.74
1862198.43	1967798.89
3842690.89	4022346.63

LINK C - BUILD 1979-99

1980	1981	1982
1783.62	2371.51	2959.40
1070.82	1276.57	1482.32
12183.41	17270.96	23039.54
8065.55	13944.52	22319.40
453.06	727.68	1037.19
2545.08	4747.42	7861.69
12636.47	17998.64	24076.73
10610.64	18691.94	30181.09
7953.37	9085.95	10519.99
1401.95	1892.36	2540.43
1691.64	1922.57	2201.17
2509.66	3267.43	4274.74
9645.01	11008.52	12721.16
3911.61	5159.79	6815.17
0.00	1205.50	2472.59
0.00	84.24	204.90
2180.51	2557.14	3018.10
1046.61	1426.45	1955.99
2180.51	3762.64	5490.69
1046.61	1510.68	2160.90
49730.29	58647.79	68748.32
1735.44	2360.18	3179.72
74192.27	91417.60	111036.90
17304.30	27722.59	42336.88
74192.27	156550.47	246670.51
17304.30	42279.61	76641.17
91496.57	198830.08	323311.68

1983	1984	1985
3547.29	4135.18	4723.07
1688.07	1893.82	2099.57
29766.63	37375.64	45655.80
34028.86	49945.39	70970.23
1385.16	1765.62	2169.88
12199.86	18086.60	25857.39
31151.79	39141.26	47825.67
46228.71	68031.99	96827.62
12196.19	14021.87	15926.31
3376.89	4433.11	5741.08
2511.15	2836.25	3166.02
5572.92	7203.86	9209.96
14707.34	16858.12	19092.33
8949.81	11636.96	14951.04
3890.19	5471.99	7192.73
376.40	613.77	932.59
3545.81	4114.82	4704.31
2670.48	3606.16	4800.19
7436.00	9586.81	11897.04
3046.88	4219.93	5732.78
80090.79	92434.70	105519.73
4243.13	5601.03	7305.40
133385.92	158020.89	184334.77
62468.54	89489.91	124816.84
344201.15	448294.40	557688.12
122317.62	181267.40	255340.12
466518.77	629561.80	813028.24

1986	1987	1988
4970.95 2386.69	5218.82 2673.82	5466.70 2960.94
49058.42 80812.02	52549.17 91705.24	56129.64 103726.11
2494.23 31698.72	2827.87 38301.51	3169.92 45725.84
51552.65 112510.73	55377.04 130006.75	59299.56 149451.95
16504.38 6204.65	17115.63 6708.37	17773.79 7257.49
3487.15 10575.44	3821.39 12108.72	4169.94 13828.76
19991.53 16780.09	20937.02 18817.08	21943.73 21086.25
7447.63 1023.64	7704.35 1121.92	7963.13 1227.80
4894.77 5280.56	5086.09 5800.48	5278.97 6362.58
12342.40 6304.20	12790.44 6922.41	13242.10 7590.38
119050.76 8875.15	133424.68 10667.46	148655.63 12703.83
202937.34 144470.17	222529.17 166413.70	243141.03 190832.40
666186.71 332579.77 998766.48	773369.76 412734.33 1186104.09	878875.09 495541.57 1374416.66

1989	1990	1991
5714.57	5962.45	6260.57
3248.07	3535.19	3711.95
59794.93	63535.79	67854.74
116951.78	131460.33	150333.45
3519.43	3875.35	4128.05
54032.46	63282.82	72386.27
63314.36	67411.14	71982.79
170984.24	194743.15	222719.73
18483.89	19244.53	20560.27
7857.41	8513.64	9675.00
4532.76	4908.86	5234.26
15754.90	17906.80	20392.58
23016.65	24153.39	25794.53
23612.31	26420.44	30067.58
8223.62	8485.17	9061.77
1341.64	1463.80	1674.45
5473.66	5670.07	6039.92
6969.52	7624.01	8720.05
13697.29	14155.23	15101.69
8311.16	9087.81	10394.50
164695.01	181456.14	193854.72
15006.05	17596.22	20012.21
264723.30	287175.91	306733.73
217913.76	247847.62	283194.01
982361.98	1083500.88	1180822.37
580729.46	668017.55	757870.28
1563091.44	1751518.42	1938692.65

1992	1993	1994
6573.60	6902.28	7247.40
3897.55	4092.43	4297.05
72420.63	77239.32	82186.85
172214.63	197600.76	224474.90
4394.28	4674.41	4962.36
82941.74	95189.11	108143.96
76814.90	81913.73	87149.21
255156.37	292789.86	332618.86
21966.43	23465.89	25037.86
11017.90	12572.14	14252.22
5579.18	5944.24	6324.30
23269.58	26602.16	30178.58
27545.61	29410.13	31362.16
34287.48	39174.30	44430.80
9670.94	10313.45	10972.30
1918.71	2202.12	2501.86
6429.62	6839.74	7261.41
9990.86	11465.32	13025.36
16100.57	17153.19	18233.71
11909.57	13667.45	15527.23
207090.25	221188.78	235937.71
22806.81	26042.24	29530.19
327551.33	349665.83	372682.79
324160.22	371673.86	422107.08
1274449.92	1364493.85	1450954.33
850528.50	946239.82	1044166.48
2124978.42	2310733.67	2495120.81

1995	1996	1997
7609.77	7990.25	8389.77
4511.90	4737.49	4974.37
86539.52	91126.73	95958.42
237030.60	250437.62	264776.07
5222.16	5495.53	5783.07
114107.16	120461.85	127243.25
91761.68	96622.26	101741.49
351137.76	370899.47	392019.32
26553.22	28162.65	29868.93
15335.31	16534.73	17866.73
6687.83	7071.86	7477.11
32265.67	34554.15	37070.37
33241.05	35234.51	37346.04
47600.98	51088.87	54937.11
11548.53	12155.49	12794.51
2639.44	2785.99	2942.31
7642.37	8043.26	8464.96
13746.91	14516.33	15337.99
19190.90	20198.75	21259.47
16386.35	17302.31	18280.30
250029.68	264985.67	280832.12
31699.36	34093.23	36742.56
394223.31	417041.19	441179.12
446824.44	473383.89	501979.29
1533348.71	1611874.32	1686712.69
1137554.73	1226689.22	1311841.28
2670903.44	2838563.54	2998553.97

1998	1999
8809.25	9249.72
5223.09	5484.24
101044.86	106396.70
280136.33	296620.66
6085.40	6403.18
134491.00	142249.76
107130.26	112799.88
414627.33	438870.42
31674.78	33582.92
19350.14	21006.75
7904.31	8354.23
39844.75	42912.41
39579.09	41937.14
59194.89	63919.16
13466.98	14174.33
3109.30	3287.98
8908.38	9374.49
16216.83	17158.39
22375.36	23548.81
19326.13	20446.37
297595.06	315300.67
39682.91	42955.43
466679.77	493586.51
532831.26	566191.39
1758031.71	1825987.53
1393269.72	1471221.61
3151301.42	3297209.14

DEMAND ANALYSIS AND EVALUATION METHODOLOGY FOR URBAN TRANSPORT COMPONENTS

for the Transportation and Land Sectors of the Colon Urban Development Project

Draft prepared by Robert M. Sarly, Consultant, for the World Bank, Urban Operations Review & Support Unit.

April 1980

RMSarly:dm/bb/al
2/29/80

COLON URBAN DEVELOPMENT PROJECT

Demand Analysis and Evaluation Method
for Transport and Land Sectors

Context

1. Summary of Approach

In multi-sectoral urban projects, significant changes in the level and location of linked economic activities will result from direct project interventions as well as induced program impacts. In given circumstances, projections of future locational demands for residential and employment land cannot be readily made by extrapolating past trends. Structural changes, such as relative accessibilities, aggregate demand, supply of serviced land on the market, and overall location cost borne by the activity, will affect returns to investment throughout the urban economy and particularly in the Land and Transport sectors where locational preferences are most directly exercised.

Within the framework of an urban development project, analytic method is needed to identify future levels and locations of economic activity with sufficient confidence to serve as the basis of rudimentary cost-benefit evaluation. Any given method, especially one with an operational focus, will be a highly simplified application of basic non principles. The particular approach described herein is adapted from an operational tradition of Strategic Land Use-Transportation Analyses in which some quantitative detail is sacrificed for quickly determined strategic indicators of overall project impact in the urban area.

The method is based upon a conurbation of manual calibration, and manual and programal estimation. The program is written for use on a Texas Instrument TI59 hand-held programmable calculator, with use of attached paper tape printer. Discounted time and operating cost savings are automatically calculated for each link, year, mode, income group and (if

required) origin of trip. A complete run of a given configuration of transport inputs takes about four hours.

The entire study takes about two calendar months (3 mm) including Data assembly, input generation, manual calculation, programmable estimation, manual estimation, interpretation of results and reporting.

COLON URBAN PROJECT

JUSTIFICATION OF HIGHWAY COMPONENT: II

Summary of Results

1. The highway improvement is economically justified. From the perspective of intercity transport alone, the investment is already overdue, in that past "territorial" constraints on the expansion of the highway to meet growing demand in the region and between Cristobal Port and Panama City has resulted in near, or above, capacity levels of service on the highway. (See IRR, FURR, and increase in C/B ratio from 1973 to present below section E: Justification).

2. The integrated urban development project to revitalize the Colon sub-region proposes to increase and disperse economic activity and housing in the corridor between Manzanillo Island and the Cativa/ Sabanitas suburbs. The resulting additional metropolitan travel demand in effect transforms the highway, which is the only transport spine in the sub-region, from an inter-city to a metropolitan transport artery. As such it is an indispensible component of the integrated urban development program (see below section C: Impact).

3. Demand for the road improvements to the Boyd-Roosevelt Highway between Cativa/Randolph Road junction and Manzanillo Island is a direct result of the implementation of the integrated urban project, and in particular of the employment and housing components in the Expanded Free Zone, Porto Escondido and industrial zones (5, 6, and 7 in the attached map). Indirectly additional travel demands will also be generated in Manzanillo Island and Cativa-Sabanitas (Zones 1 and 8), as a result of the urban project (see below section B: Context).

4. Reductions in the overall size, or delays in the implementation rate of the urban project would reduce overall demand for transport on the road, providing that both employment and housing were reduced in equal proportions. However, if employment in the new Free Zone sites is to develop in any event, as is currently planned, while the housing in Porto Escondido (Zone 6) is eliminated or reduced, then travel demand on the road would increase further, due to the increase in average consequent commuting distance (along the Boyd-Roosevelt corridor) between jobs and homes.

5. In the absence of both the proposed highway improvements and new housing, residential preferences, especially for low-income households would generate strong demands for locations in the proximity of employment resulting in illegal squatting conditions if affordable legal options were unavailable. The areas most likely to be affected would be the Expanded Free Zone industrial zone and Rainbow City (zones 5, 7, and 4), where land would be available, and to a lesser extent, Manzanillo Island (Zone 1) where services would be available.

6. At the other extreme, implementation of the integrated urban project, but without these road improvements, would undermine the effectiveness of the urban project as a whole. The growth of travel demand on the road would quickly create congestion and loss of efficiency to all road users. The disbenefits to the urban project directly attributable to the absence of the proposed road improvements, as shown in the attached memo, would represent a significant share of overall project benefits. Disbenefits to goods movement, which generate 10% of the trip volumes, represent 60% of the total operating cost savings achievable on the road by 1984. Bus travelers which amount to 50% of the trip volumes, would bear about 10% of the operating cost savings, while car travelers (40% of the total trips) would derive 40% of the total operating cost savings. The low- and middle-income travelers generate 25% and 35% of the trips respectively and would incur 6% and 10% of the respective total disbenefits.

7. In view of the above, implementation of the urban project in its current form including the proposed road improvements would appear to generate the minimum negative externalities for the transport sector in the provision of essential access to linked economic activities in Gran Colon.

COLON URBAN PROJECT

JUSTIFICATION OF HIGHWAY COMPONENT: II

A. Objectives

1. Implementation of the urban project is not required to justify going ahead with construction of the road: as shown below, the road is justified on the basis of regional demand. However, the road is required to ensure the urban project realizes its objectives, particularly:

(i) the objective of stimulating improvements in key sectors such as transport, and in the level of transport services in Colon, to reduce travel costs and improve standards of access;

(ii) the objective of avoiding the disbenefits of $18,027 million (present value) in additional travel expenditures on the unimproved road (1980-1999), that would be incurred by the Colon population were the urban project to go ahead without the road component; and

(iii) ensure that the imminent rise in the volumes of trips along the road caused directly by the housing and employment components of the project are satisfactorily served, so that bottlenecks do not arise that delay overall project implementation causing cost overruns and development imbalance.

B. Context

2. The existing two lane Boyd-Roosevelt Highway is the only access corridor between Colon (i.e., Manzanillo Island), the main housing and employment development areas of the urban project, the suburbs of Cativa and Sabanitas, and Panama City (and the rest of the Metropolitan Region). Upgrading of the highway as proposed in the urban project will be along its existing alignment. No alternative alignment is likely to develop in the foreseeable future.

3. The roadway widening part of the project comprises a doubling of the existing two lane highway which extends from 800 meters east of the refinery junction in Cativa to the Randolph Road junction for a distance of 6.8 kilometers. The one-way loop part of the project extends from Randolph Road junction to Manzanillo Island for a distance of 2.5 kilometers inbound and a return route through Rainbow City for a distance of about 2.8 kilometers outbound. There are about nine junctions all of which will be at grade. Lane width will be 3.65 meters and the existing one-way loop roads will be brought up to comparable service levels as the main highway by means of resurfacing and geometric design of junctions, storage lanes and slipways.

4. On the basis of the regional demand projections made in the 1973 technical and feasibility study of Boyd-Roosevelt, the expansion of the road from its current two lane capacity to four lanes was determined to be economically justified from regional demand alone. On the basis of 1973 cost estimates this produced a benefit-cost ratio in the range of 1.8. Regional travel volumes then were estimated to be over 6,000 average daily trips (ADT) in 1973, with projections of over 10,000 ADT by 1980.

5. Current travel volume estimates based upon survey data collected by the Ministry of Public Works (MOP) in 1979 show current volumes along the road to be about 10,000-12,000 ADT, growing at an average rate of about 5% p.a. Current peak hour volumes are 1,200 passenger car units (PCU), which prevail an average of 28 hours per week. This peak hour demand exceeds the assumed effective capacity of the road during 25% of the travel week.

C. Impact

6. Without an urban project previous trends of traffic growth within Colon, and between Colon and Panama City, suggest that demand would continue to grow at about 5% p.a. producing 1984 ADT of 12,000 and 1990 ADT of 16,000.

7. However, in view of the dual impact of the urban project on Colon the expected growth in traffic demand will be about 20% greater due to:

(a) the accelerated development of economic activities in Colon resulting from the urban project; and

(b) the increased dispersion of project activities within the Colon sub-region, whose inter-relationships will rely on effective sub-regional transport access.

8. The economic analysis of demand for travel on the Boyd-Roosevelt Road done for this project component has taken the above impacts into account. It has been constructed upon conservative assumptions of trip generation, trip distribution and modal split, trip assignment and travel cost. The method distinguishes nine origin and destination zones in the city, three income classes and three travel modes. It also distinguishes operating costs and time costs.

9. The results of this demand analysis show a rapid increase in the number of peak hour PCU's from about 1,350 in 1980 to 1,650 in 1981, 2,000 in 1982, 2,300 in 1983, 2,600 in 1984 and 3,900 in 1989.

D. Cost

10. The capital cost of the road component, based upon preliminary estimates prepared by MOP, is $5,772 million (base) plus physical and price contingencies for a gross of $8,700 million.

E. Justification

11. Assuming (conservatively) an actual capital cost of about $8.0 million (not including price contingencies), economic evaluation of the road project shows a benefit-cost ratio in excess of 2.25 and a net present value of $10.03 million, not including time cost savings.

12. When time cost savings are taken into account the benefit-cost ratio rises to 12.94, and the net present value increases to $95.50 million.

13. The first year rate of return is 110%, showing that the optimum time for initiating investment in the road is already past, and that further delay is not justified.

14. The internal rate of return (IRR) for the road is 39.75% not including time cost savings. When these are included the IRR is in excess of 100%.

15. Sensitivity tests on costs show that a 20% rise in costs reduces IRR to 34.65%, and that a 20% fall in expected benefits reduces IRR to 32.15%.

RMSarly:bb

COLON URBAN PROJECT

ROADWAY IMPROVEMENT: ORIGIN/DESTINATION TRIP VOLUMES

1979 - 1984

1	1979	1984
POP	75000	65000
EMP	8000	9500
MP OR	8100	7760
MP DE	6470	8940

2	1979	1984
POP	–	–
EMP	5000	5000
MP OR	500	500
MP DE	3840	4700

3	1979	1984
POP	–	–
EMP	3000	3500
MP OR	300	350
MP DE	2300	3210

4	1979	1984
POP	5000	5000
EMP	250	500
MP OR	855	1050
MP DE	215	617

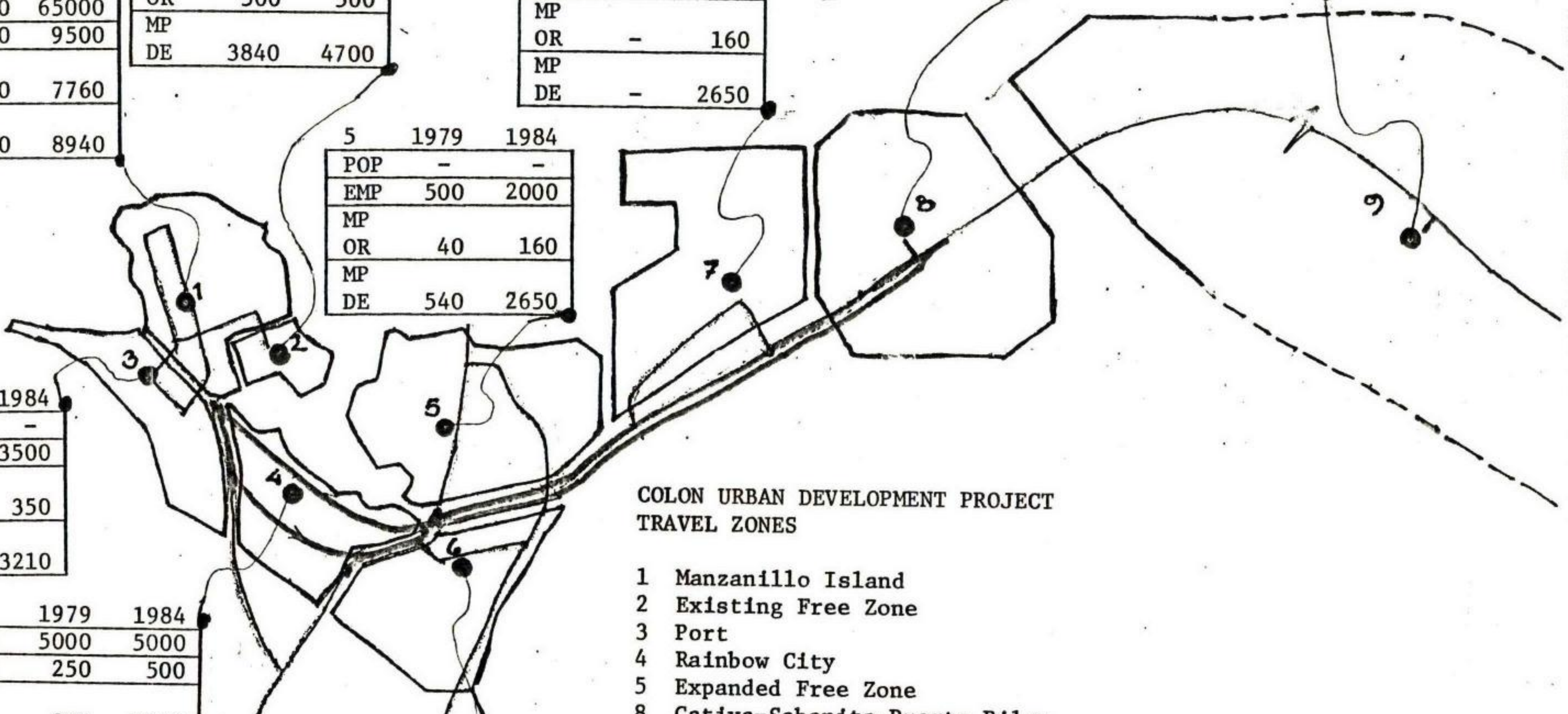
5	1979	1984
POP	–	–
EMP	500	2000
MP OR	40	160
MP DE	540	2650

6	1979	1984
POP	–	25000
EMP	–	250
MP OR	–	3015
MP DE	–	319

7	1979	1984
POP	–	–
EMP	–	2000
MP OR	–	160
MP DE	–	2650

8	1979	1984
POP	20000	25000
EMP	1500	2500
MP OR	2610	3400
MP DE	1290	2680

9	1979	1984
POP	–	–
EMP	–	–
MP OR	3025	9214
MP DE	745	1514



COLON URBAN DEVELOPMENT PROJECT
TRAVEL ZONES

1 Manzanillo Island
2 Existing Free Zone
3 Port
4 Rainbow City
5 Expanded Free Zone
8 Cativa-Sabanita-Puerto Pilon
9 Panama City Metropolitan Region

MPPE = Morning Peak Period Destinations
MPOR = Morning Peak Period Origins
include only vehicle trips (2 hours)

2. Introduction to the Demand Analysis

Amongst the objectives of transport sector intervention in the Colon Urban Development project is the provision of an efficient transport system to make linked economic activities in metropolitan Colon more accessible to the urban population. Since the impact of the overall project is multi-sectoral and complex it will not be possible to represent its derived benefit in a single measure such as a cost-benefit ratio, or internal rate of return. The estimate of the transport components' net worth, its benefits and costs (associated with road widening, traffic improvements, bus and train service provision, bus fleet expansion and vehicle maintenance) are therefore defined by the following evaluation measures:

1. time savings to bus travellers
2. operating cost savings to bus travellers
3. time savings to car travellers
4. operating cost savings to car travellers
5. time and operating cost savings to trucks
6. time savings to train travellers
7. levels of service for the public bus system and primary road network
8. travel expenditure share of household income
9. generalized travel share of location costs for households.

Each of the above terms is measured for nine separate geographic areas in the metropolitan region, and with respect to its incidence in three income classes. The areas are:

1. Manzanillo Island (excluding the Colon Free Zone)
2. Colon Free Zone
3. Cristobal Port
4. Rainbow City
5. New Commercial Zone (Coco Solito)
6. Puerto Escondido
7. New Industrial Area (Export Processing Zone)
8. Cativa - Sabantas - Puerto Pilon Suburbs
9. Rest of the Metropolitan Region and Panama City

The three income classes are:

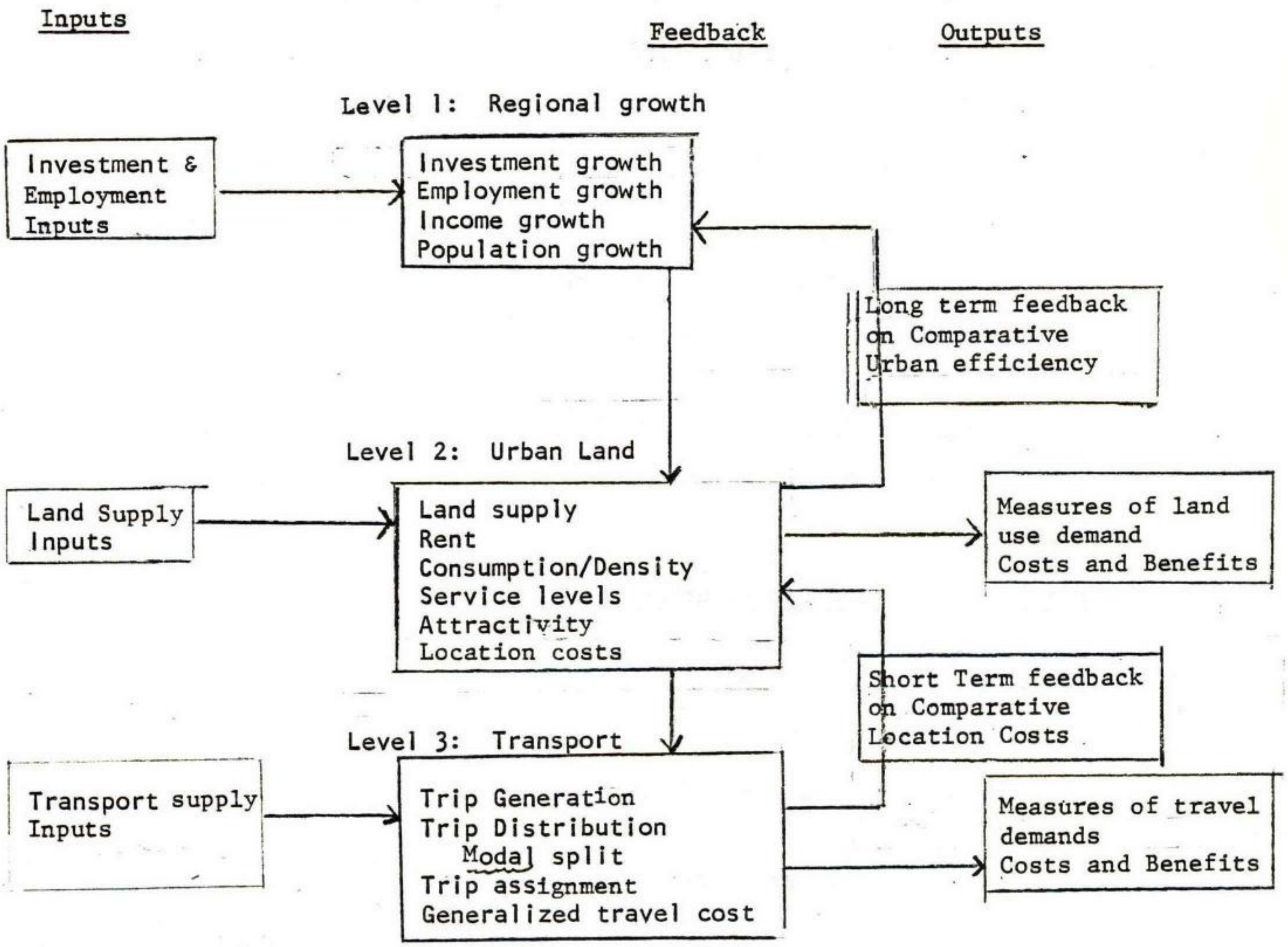
	Average HH income per month
1. Upper income (top 2 deciles)	\$1800/m
2. Middle income (from 4th to 8th decile)	\$425/m
3. Lower income (bottom 3 deciles)	\$125/m

3. Method in General

The method for estimating the above evaluation measures relies on an aggregate strategic analysis of transport and land use changes over the project period, and on their interaction. On the basis of these estimates are made of the generation, distribution, assignment and cost of household and business trips, for each income class and for every zone in the region. Travel cost forecasts serve as the basis for estimating locational demand in general, and in particular the values of land in different parts of the region. From these estimates, long-term implications for changes in the land use structure of the Metropolitan Region are determined.

Future levels of demand for transport facilities and services are taken as a function of the future urban spatial structure and the rate of growth of economic activity in the Colon Region. These are expressed logically in three levels of a strategic development analysis, as shown in the following diagram:

Strategic Development Analysis



Each level of analysis starting with Regional growth provides the operating assumptions upon which the next level projections are made. The analysis is validated on the basis of existing conditions by calibrating the governing relationships linking the supply and demand of transport and land, from survey and field observation. These relationships then derive the projection of future demand levels in terms of changes in supply and the behavior of the urban economy under conditions of growth.

4. Method in Detail

The method is made operational in three phases:

1. Manual calibration of functional relationships governing the changing values of transport and land demands by mode, link, zone and income class.
2. Programmable estimation of travel benefits by mode, link, zone of origin, and income class
3. Manual estimation of location cost changes and imputed affect on the demand for land by income class, zones density and rent values.

4.1 Manual Calibration of Transport Demands

The governing relationships for the transport analysis are shown below:

Trip Generation and Distribution

(Equation 1) $T_i^{z^\circ} = P_\cdot^z \quad z$

(Equation 2) $T_j^{z^\circ} = P_\cdot^z \quad z$

T_i^{zo} = number of trips generated by an activity (residential/employment) z for purpose o from origin zone.

T_j^{zo} = number of trips generated by an activity (employment) of type z for purpose o to destination zone j.

P^z = Population (or number of employees) associated with that activity

α^z = Propensity for each unit of activity to generate a morning peak hour trip.

This function is used to discriminate trips by origin zone, i, destination zone j, car users and non-car users. It is used to generate estimates of existing conditions reflecting known overall flows of public and private traffic.

(Equation 3) $$T_{ij}^{mzo} = \frac{O_i^{mzo} D_j^{mzo}}{C_{ij}^{mb}} \circ B$$

T_{ij}^{mzo} = Total trips per mode m between zones i and j for activity type z and figure o.

O_i^{mzo} = Number of$_1$ trip origins in Zone j, for mode m activity z, purpose o^1.

D_j^{zo} = Number of trip destinations in zone j for activity z, purpose o.

C_{ij}^{b} = Cost of travel between zone i and j.

b = Elasticity of demand for travel with respect to cost.

B = Normalizing factor = $1/\sum^{m} O_i D_i / C_{ij}$

Trip Assignment & Costs

Given the simplified structure of the transport network in metropolitan Colon, inter-zonal traffic is assigned directly to links. These links acquire traffic loads which generate congestion as a function of free flow link speeds and design capacities.

Travel costs are estimated in two parts:

1. Operating costs, measured in terms of average use, speed and distance, characteristic vehicle cost per kilometer at link speed.
2. The cost assumed in terms of real (i.e., congested) travel time elapsed per journey plus the (pedestrian) access time at either end of the (vehicular) journey.

(Equation 4) $$G_c = \sum^{j} C_i^{op} + \sum^{j} C_i^{t}$$

The cost of travel is aggregated for each income class and each mode for all trips made by households in a single origin zone to all other zones, This measure is taken to be the generalized cost of travel for the typical household in each origin zone. Truck trips are similarly aggregated by employment-origin zones for all trips.

The results of the transport analysis are fed back into the land analysis in terms of generalized travel costs per household. These values are then used to reestimate locational demand for land in different zones in terms of residential densities, land rent and numbers of households to be located in each zone.

The governing relationships for the land analysis are as follows:

4.2 Manual Calibration of Land Demands

Demand for Land

The first function determines the quantity of land consumed by each activity l^z given the unit rent of land, r_1 and the income of the activity w_i^z. The relationships amongst these factors (land consumption, rent and income) are governed by three parameters:

(a) constant coefficient, k^z

(b) price elasticity of demand, p^e, which is negative to reflect the reduction of land consumption that occurs with an increase in rents.

(c) income elasticity of demand i^e, which is positive to reflect the increase in land consumption that occurs with an increase in incomes.

The demand for land function is specified in the following form:

(Equation 5) $l_i^z = k^z r_i^{-pe} \cdot w^{z^{ie}}$ where:

l_i^z = land consumed by household group z in zone i.

r_i = rent of land per m^2 in zone i

w^z = income of activity z

p^e = price elasticity of demand for land

i^e = income elasticity of demand for land

k^z = constant scalar.

Cost of Location

The second function, determines the total cost for an activity, z, resulting from the selection of a location in zone i, C_i^z, as the sum of the cost of land rent $l_i^z \cdot r_i$ plus the cost of building rent $S_i^z \cdot b_i^z$ plus the transport cost associated with locating in the zone $A_i^z\ g_i^z$ plus the cost of providing the zone with infrastructure services $F_i^z \cdot O_i^z$. The transport cost is calculated as the weighted average of the cost of all trips made by that activity in that zone. This cost connects the land use sub-model with the transport sub-model. The function is specified in the following form:

(Equation 6) $$C_i^z = l_i^z \cdot r_i + S_i^z \cdot b_i^z + A_i^z \cdot g_i^z + \sum^{Q} F_i^z \cdot c_i^z$$

Where:

C_i^z = Cost of location for household group z at zone i.

$l_i^z \cdot r_i$ = Cost of ground rent for land consumed.

$S_i^z \cdot b_i^z$ = Cost of building rent.

Where: S = amount of built space per household.

b = unit cost of space.

$A_i^z \cdot g_i^z$ = Transport cost.= G_c

Where: A = accessibility index for HH

g = unit cost of transport

$\sum^{Q} F_i^z \cdot c_i^z$ = Cost of infrastructure for all services, Q

Where: F = standard of service.

c = unit cost of standard service.

Distribution of Activities

The third function, determines the distribution among all the zones of each activity in terms of the total number of the activity G^z, the amount of land available for development in zone i, L_i, the location cost of the activity C_i^z, and residual attraction W_i^z. The function is specified in the following form:

(Equation 7) $G_i^z = G^z.L_i.W_i^z.C_i^{z\ -1_z}B^z$

Where:

G_i^z = total number of households

G^z = total number of household group z

L_i = total land available in zone i.

W_i^z = residual attraction index for household group z in zone i.

C_i^z = location cost for household group z in zone i.

1_z = elasticity of demand for location with respect to cost.

B^z = normalizing factor

Budget Constraint

The following constraint must be respected to ensure land supply and located demand are in balance.

(Equation 8) $G_i^z \cdot 1_i^z = L_i$

Cost Recovery

The cost of location function is the basis for estimating means for cost recovery in terms of a recovery rate by cost component for each activity, and for each location for all public capital investment projects, as follows:

(Equation 9)

$$RC_i^{*z} = T_i l_i^z r_r + T_2 S_i^z \cdot b_i^z + T_3 A_i^z \cdot g_i^z + T_4 F_i^z \cdot c_i^z$$

where: R = cost recovery rate (aggregate),

T_i = land tax rate

T_2 = building tax rate

T_3 = public transit fares and road user charges

T_4 = utilities user charges

In terms of this formulation, C^* may be thought of as the social cost of location since not all of C_i^{z*} may necessarily be charged to the locator. Nonetheless, all of C_i^{*z} is recovered as a result of the locators' choice of the i^{th} location on aggregate, though certain areas (target groups, project sited, etc.) may be cross-subsidized in order to ensure affordability.

The inclusion of C_i^{*z} in the function ensures that the social values created by project investments are reflected in land prices throughout the urban market area in proportion to their impacts for each activity group at each location, and are recovered without detriment to the benefit share of the targetted poverty groups.

Income Generation

The demand for land function for household activities is the basis for incorporating real income, w^* and not just wage income w. Income gains and social subsidies that may have been created in different locations in each of the cost categories as follows:

(Equation 10)

$$l_i^{*r} = \frac{K^z \cdot w^{*z^{ie}}}{r_i^{pe}}$$

where: $w^{*z^{ie}} = \sum B^{p} - R \cdot C_i^{*z} + \sum {}^{p}b_i + w_i^{z}$

where: $\sum B^{p}$ = the sum of project capital costs per household

$R \cdot C_i^{*z}$ = total costs recovered per household

$\sum {}^{p}b_i^{z}$ = sum of income gains resulting from operating cost savings in each project.

w_i^{z} = wage income per household.

Difference between project costs and costs recovered measures the proportion of conferred benefit not directly recovered by tax, user charge (etc.,) or other methods. The function shows the effect of income gains changes in location and service levels. Also, the use of b_i^{z} ensures that locational preferences reflect the aggregate effect of income gains from constraints on the structure of demand, and in particular on land prices and location priorities for development.

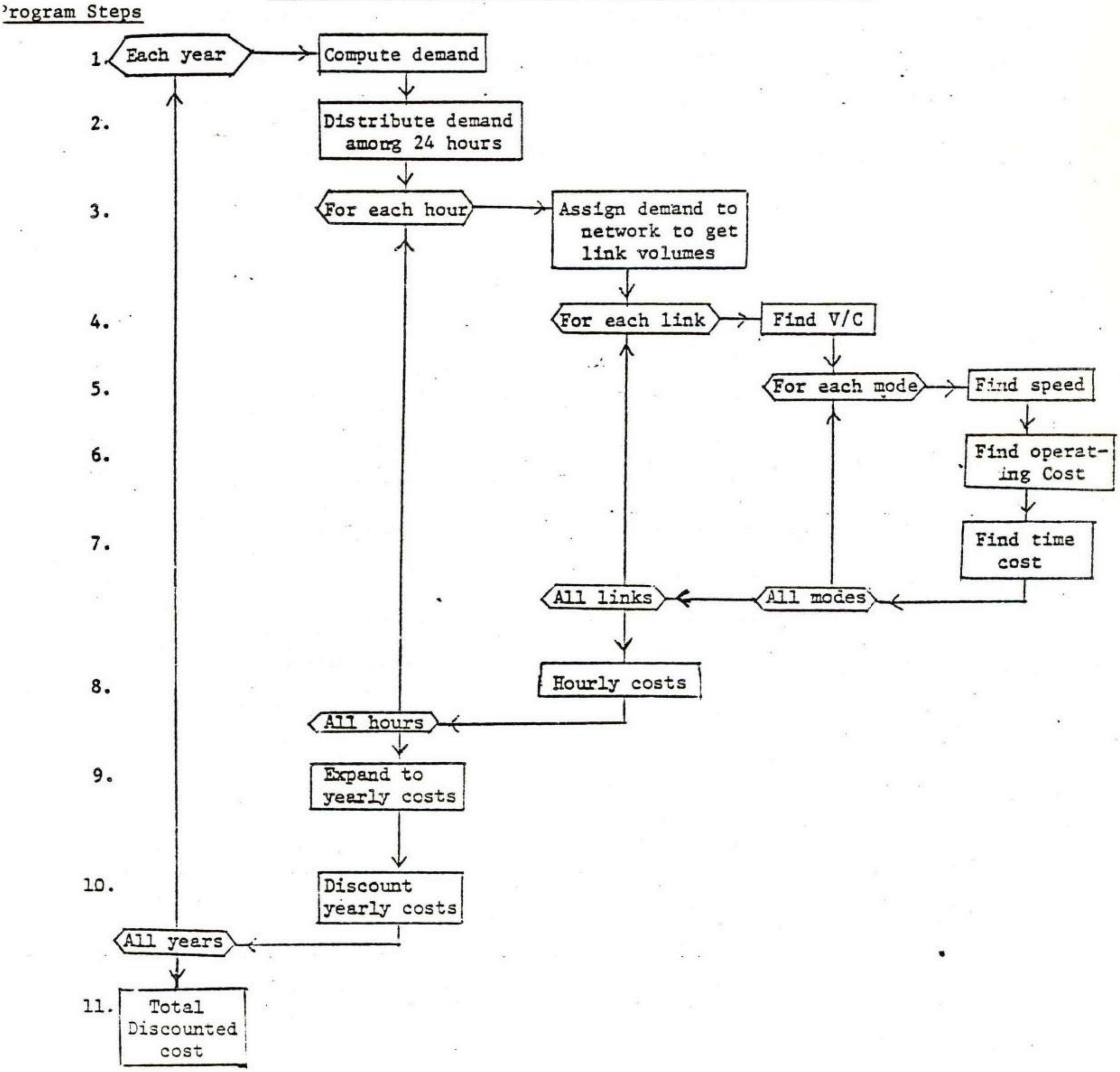
The income effects identified in the analysis are used to indicate aggregate changes in the levels of household demand by income group and location in the urban area. These indicators are viewed from the broad employment market perspective through disaggregated demand and income elasticities as the basis for examining consequent employment impact. This examination requires a separate formulation of a specific income-employment relationship that applies for a given urban system. This is not included in the above.

4.3 Programmable Estimation

A general sketch of the method for estimating transport benefits by means of a hand-held computer program is shown in the diagram below. Discussion follows this diagram, step-by-step.

Figure 1

Computing Operating and Time Costs of Each Alternative



Step 1: For Each Year, Compute Demand

Demand is used for an average weekday as representative of the whole year. Demand has two dimensions: O-D pair, and mode. Because of population and activity growth in different locations, demand between different O-D pairs varys in magnitude and growth. There is also a different demand for each mode of freight and passenger transport. All modes are aggregated into: truck (freight), auto, and bus (transit). Demand values are taken from the results of the manual algorithm.

Step 2: Distribute Demand Throughout the Day

Demand also has a temporal and a directional dimension. Usually demand is not predicted directly for an hour, however; it is predicted for the entire day and later distributed. For each direction there is a peaking profile, which gives the relative demand in each hour of the day. For convenience we may say there is a peaking profile of 48 hours, where the first 24 hours correspond to one direction (positive) and the last 24 to the other (negative) direction.

The most common assumption is that the daily peaking profile will be the same in every year for every O-D pair. This assumption can cause significant error when the network includes major radial and crosstown roads, each of which exhibit different peaking patterns. (The crosstown road has 2 peaks per rush hour while the radial has only

However, in the corridor problem with which we are dealing it is probably safe to assume each link of the same road will have the same peaking pattern. Different modes may have different peaking profiles, however. Thus the demand at an hour h is

where $$D^{t,h}_{m,p} = D^{t}_{m,p} f^{h}_{m} \qquad (2)$$

f^{h}_{m} is the peaking factor for hour h and mode m, and the vector $\left\{f^{h}_{m}\right\}$, h = 1,..., H is called the peaking profile for mode m. Thus a peaking profile is assumed given for each mode. It is common to not analyze all 48 hours separately but rather to select a few representative hours, the results of which are expanded hours in the day which have similar flows. A peaking profile for peak direction travel in San Jose, Costa Rica is found in Attachment A.

<u>Step 3: For Each Hour, Assign Demand to the Network to Get Link Volumes</u>

This can be the most complex step of the urban transportation analysis procedure. However, our restricted problem definition makes this problem trivial. Each O-D pair has a unique path, covering a known set of links. To get link volumes one must aggregate over O-D pairs and modes. Links, like hourly flows, are assumed unidirectional and furthermore we assume a link is symmetric in its capacity. Thus the flow on link j in hour 10 is the flow in the positive direction on link j at 10 a.m., while the flow in hour 34 is the flow in the negative direction at 10 a.m.

To aggregate over modes (since they all share the same roadway), each mode is given a passenger car unit (PCU) equivalency. This PCU equivalency depends not only on vehicle size, but on vehicle performance as well; and since vehicle performance is differentially affected by link characteristics, particularly grade, there must be a PCU equivalency factor for each mode and link.

Link volumes must be ~~in~~ measured in vehicles. For auto and truck this presents no problem, since demand is usually measured in vehicles, or if measured in passengers, a single

---

occupancy factor can convert demand into vehicles. However, when bus demand is measured in passengers, it is not so readily converted into vehicles since load factors can vary widely throughout the day. Since bus operations are usually centrally planned, bus volumes may be exogenously specified. In more complex networks rerouting is also a possibility. In the simple corridor analysis with which we are dealing, it is probably sufficient to assume that load factors on each route at each hour will be the same year-to-year, so that demand can be measured in vehicles in the base year and treated in the same way as cars and trucks.

Aggregating over O-D pairs is simple summation, so that the link volumes are:

$$V_a^{t,h} = \sum^{p} \sum^{m} D_{m,p}^{t,h} \; e_{m,a} \; \delta_{a,p} \qquad (3)$$

where

$V_a^{t,h}$ = volume (in PCU's) on link a in hour h and year t

$D_{m,p}^{t,h}$ = demand for mode m between O-D pair p in hour h and year t (measured in vehicles

$e_{m,a}$ = PCU equivalency factor for mode m on link a

$\delta_{a,p} = \begin{cases} 1 & \text{if link a is on the path between O-D pair p} \\ 0 & \text{otherwise} \end{cases}$

In addition we will later need modal link volumes, which are:

$$V_{m,a}^{t,h} = \sum^{p} D_{m,p}^{t,h} \; \delta_{a,p} \quad (3.1)$$

<u>Step 4: For Each Link, Calculate the Volume/Capacity Ratio (V/C)</u>

Since the volume has been determined in Step 3, all that is needed is the link capacities. These are given for both alternatives (no-build and build), and are the same at every hour in every year (barring the use of reversible lanes, peak hour exclusive lanes, etc.). Therefore, for any link, hour and year, for an alternative b (no-build or build,

$$(V/C)_a^{t,h,b} = V_a^{t,h} \div C_a^b \qquad (4)$$

where

C_a^b = capacity of link a in alternative b

$(V/C)_a^{t,h,b}$ = volume/capacity ratio in alternative b on link a at time h in year t

Since each alternative is analyzed identically, we shall remove the superscript b and continue with the notation $(V/C)_a^{t,h}$, realizing that its value pertains to a particular alternative.

Step 5: For Each Mode, Find the Speed

The speed at which traffic flows on a link depends on the volume on the link and its capacity. All existing models (to my knowledge) give speed as a function of the volume/capacity ratio. Recognizing that volume and capacity affect speed not only by their ratio, often there is a family of speed-flow (speed vs. V/C) curves for roads of different capacities, e.g., 2-lane and 4-lane arterials.

Because of different vehicle and operating characteristics, the speeds of each mode will be affected differently by congestion. Therefore each mode will have its own speed-flow relations.

Therefore the speed of mode m on link a which is of type s will be

$$x_{m,a}^{t,h} = g_{m,s}\left[(V/C)_a^{t,h} \right] \qquad (5)$$

where

$g_{m,s}[\ *\ ]$ is a particular speed-flow relation for mode m and road type s. Different functional forms exist for the functions $g_{m,s}$. In order to identify the appropriate curve to be used for a particular link (given that mode is known), there must be a pointer specific to each link indicating the correct curve. If all of the curves have the same functional form with a different parameter (e.g., minimum speed), the pointer may be simply the parameter and thus the functional form of the speed-flow curve needs to be stored only once. This pointer or parameter is called s_m. (It seems obvious that the speed of the bus and truck modes might be affected by grade. However most analyses consider the peak direction only, which is one direction half the day and the other direction the other half, so that average grade on every link is zero, and average speed is almost unaffected by grade. The same is true for operating cost, though it is known that it costs more to travel a distance on a hilly road with

an "average" grade of zero than on a flat road. Since we will usually be using models for speed and cost that ignore grade, the remainder of this paper shall ignore it, too. Furthermore, ignoring grade allows both directions of a link to be identical. This is a significant simplification, making flows to be direction abstract, and hence allowing analysis of flows in one hour to be expanded to hours with similar flows without regard to direction when less than 48 hours are analyzed.) Some examples of speed-flow functions are found in Attachment A.

Step 6: For Each Mode, Determine Operating Cost

Vehicle operating cost on a link is difficult to measure, and therefore difficult to model. It is affected by road characteristics (grade, curvature, pavement), vehicle characteristics (weight, engine type), and operating characteristics (speed, number of stops). Most models give operating cost in terms of one of the operating characteristics only (speed) aggregating different vehicle types (within the same mode) and averaging over road characteristics. If pavement is uniform over the road, there is no more than normal curvature for an urban road, and grades are not great, such approximations are acceptable. Under normal urban operating conditions a study found that 95% of the variation in fuel consumption among British cars could be explained by speed alone. Since other auto related costs are roughly proportional to fuel consumption, the simple speed-operating cost relation may be sufficient for autos.

Operating cost is usually computed by a function of this form:

$$OC^{t,h}_{m,a} = \beta_m + \frac{\alpha_m}{X^{t,h}_{m,a}} \cdot d_a \cdot V^{t,h}_{m,a} \qquad (6)$$

where

$OC^{t,h}_{m,a}$ = operating cost for mode m on link at time h in year t

α_m, β_m = parameters (per hour and per Km operating cost for mode m)

$X^{t,h}_{m,a}$ = speed of mode m on link a at time h in year t

d_a = length of link a

$V^{t,h}_{m,a}$ = volume of mode m on link a at time h in year t.

Since operating cost should include the labor cost of paid drivers such a function including a term in which distance is divided by speed (which yields time) is especially appropriate for bus and truck. Operating cost models estimated in a few cities are documented in Attachment A.

Step 7: For Each Mode, Determine Time Cost

The time each vehicle spends on a link is the link's distance divided by the vehicle's speed. The total passenger time is the vehicle time multiplied by vehicle occupancy (not including paid drivers). The total time cost is this total passenger time multiplied by the value of time.

Vehicle occupancy can vary not only by mode but also by link and by time of day, particularly on buses where loads may be 80 in the peak and 20 off-peak, and may increase steadily toward the city center. Value of time is generally taken to be fixed for all modes and all times, and invariant over the year.

Thus the passenger wait time cost is

$$TC^{t,h}_{m,a} = \frac{d_a}{X^{t,h}_{m,a}} \cdot W^{h}_{m,a} \cdot v \cdot V^{t,h}_{m,a} \qquad (8)$$

where

$TC^{t,h}_{m,a}$ = time cost for mode m on link a at time h in year t

d_a = length of link a

$X^{t,h}_{m,a}$ = speed of mode m on link a at time h in year t

$W^{h}_{m,a}$ = vehicle occupancy of mode m on link a at time h

v = value of time

$V^{t,h}_{m,a}$ = volume (of vehicles) of mode m on link a at time h in year t

Step 8: Aggregate Costs Over Modes and Links

Steps 4-7 must be repeated for every link and every mode as the flowchart in Figure 1 indicates, aggregating costs to yield hourly costs. Thus the operating and time costs for an hour h in year t are:

$$OC^{t,h} = \sum^{a} \sum^{m} OC^{t,h}_{m,a}$$
$$TC^{t,h} = \sum^{a} \sum^{m} TC^{t,h}_{m,a} \qquad (9)$$

Other meaningful aggregations should be taken as well, such as total costs for modes, for links, etc.

Step 9: Aggregate Costs Over Hours, Expanding to Yearly Costs

Steps 3-8 are repeated for each hour. To expand the predicted hourly costs to yearly costs one needs to know the number of hours in a year that hour represents. These annualization factors should insure that the daily demand (in Step 1) is properly expanded to annual demand. Different hours may have different annualization factors because they represent different numbers of weekday and weekend hours. Also some analyses may want to consider peak hours only in computing benefit.

The annual costs are then:

$$OC^{t} = \sum^{h} OC^{t,h} \; N_h$$
$$TC^{t} = \sum^{h} TC^{t,h} \; N_h \qquad (10)$$

where

N_h = number of hours in a year represented by hour h.

Step 10: Discount Yearly Costs

Either annual or continuous compounding may be used to discount the yearly costs to present values. For operating costs, these formulas are:

$$\overline{OC}^{t} = OC^{t} \; (1 + D)^{-t} \quad \text{(yearly compounding)}$$
$$\overline{OC}_{t} = OC^{t} \; e^{-Dt} \quad \text{(continuous compounding)} \qquad (11)$$

where

OC_t = discounted operating cost from year t

D = shadow discount rate

time costs are similarly discounted

Step 11: Aggregate Discounted Costs

This yields the present costs of the alternative being studied. The difference between the present cost of the no-build alternative and that of the build alternative is the present value of the build alternative. (When other discounted costs, such as construction, maintenance, etc., are subtracted this becomes net present value.) So the final equation for present operating costs (and similarly for time cost) is

$$OC = {}^{t}\ \overline{OC}^{t} \qquad (12)$$

The predicted costs thus obtained may be disaggregated and manipulated in any way to afford the analyst a closer look to see the benefits accruing to each link, or to each mode, or to find link specific benefit/cost ratios, internal rates of return, etc.

5. Solution Procedure

Within the above Analytic framework, the solution procedure provides a logical, yet simple sequence of analytic tasks. These tasks are listed below and elaborated in detail in the following sections.

5.1 Summary of Tasks

A. Strategic Forecasts of Travel Demands

1. Review land use conditions and developmental assumptions
2. Review test road network and bus system conditions and changes
3. Review traffic assignments and diversions

B. Future Demand Volumes

1. Estimate future auto/truck traffic volumes
2. Estimate future bus and bus passenger traffic volumes
3. Estimate future train passenger traffic volumes
4. Develop peak hour and peak direction factors
5. Estimate future peak hour, peak direction volumes for auto/truck, bus and bus passenger, train passengers.

C. Design Capacities

1. Develop lane capacity of auto/truck
2. Determine PCU equivalencies and passenger capacities for bus and mini-bus

D. Volume/Capacity Ratios

1. Compute V/C ratio for auto/trucks and for busses

E. Level of Service and Travel Speed

1. For auto/trucks and for busses, establish a LOS - V/C Speed table.
2. Determine LOS and travel speed, knowing V/C.

F. Travel Time, Stops, and Idling Time

1. Develop a "model" to relate LOS, travel time per km., stops per km., and idling time per km. for auto/trucks and busses.

2. Determine on a "per kilometre" basis, travel time, stops, idling time, and excess travel time (actual time minus 1.0 minute as derived from 60 kph base)

G. Time Costs and Vehicle Operating Costs

1. Determine value of driver's time and passengers' time per hour.

2. Determine for auto/truck and for bus, vehicle operating cost per km. for 60 kph base, and for additional costs due to stops and idling time.

H. Time Savings

1. For auto/truck drivers and for bus passengers, compute time savings during six peak hour, peak directions for each year (1979-1999). "Savings" are based on difference between "No Build" (Alternative 1) and "Build" (Alternative 2).

2. Compute present value of time savings.

I. Vehicle Operating Cost Savings

1. For auto/truck volumes and for bus volumes, compute operating cost savings by link during six peak hour, peak directions for each year (1979-1999). "Savings" are based on "No Build" (Alternative 1) and "Build" (Alternative 2).

2. Compute present value of vehicle operating cost savings.

J. Project Costs

1. Determine present value of project costs.

K. Economic Evaluation

1. Determine benefit-cost (B/C) ratio, "Benefits" refer to the sum of present values for time savings and vehicle operating cost savings.
2. Determine net present value (NPV).
3. Determine internal rate of return.

5.2 Input Requirements

A description of input requirements and assumptions used to calibrate the analysis to conditions in Colon in 1979 is given in the pages that follow.

Input Requirements

For a project with A links, M modes, a benefit horizon of T years, each of which has H hours, considering 2 alternatives.

Number of Items	Variable	
A x M	$V^{o,*}_{m,a}$	base year vehicular demand for mode m on link a
M or 1	r_m or r	demand growth rate (for mode m)
H x M or H	f^h_m or f^h	peaking factor (for mode m) in hour h
M	e_m	PCU equivalency factor for mode m
2A	C^b_a	capacity of link a under alternative b (no build or build)
2M	α_m, β_m	operating cost model parameters for mode m
A	d_a	length of link a
H x M or M	W^h_m or W_m	vehicle occupancy of mode m(in hour h)
1	v	value of time

H	N_h	yearly number of travel hours of type h
1	D	shadow discount rate
M	s_m	speed-flow curve parameter for mode m

plus a speed-flow function

c_B	bus fares
t_c	terminal times
C_{nr}	non-transport location costs
W	disaggregate attractivity indices
L	land availability
P	aggregate popular growth
E	aggregate employment growth

BENEFITS ON A SINGLE LINK: SINGLE HOUR EXPANDED

(Input Data Format)

Site: ______________________ Date: __________

Analyst: ____________________ Page: ______ of ______

Costs: ______________________

Enter		Press
(Initialize)		A
(Initialize)		B
Auto mode:		
growth factor (1.xx)	= 1.______	R/S
PCU equivalency factor (1)	= ___1___	R/S
speed-flow function parameter	= ______	R/S
per hour operating cost ($/hr)	= ______	R/S
per km operating cost ($/hr)	= ______	R/S
auto occupancy ______ x value of time ______ ($/hr)	= ______	R/S
Truck mode:		
growth factor (1.xx)	= 1.______	R/S
PCU equivalency factor	= ______	R/S
speed-flow function parameter	= ______	R/S
per hour operating cost	= ______	R/S
per km operating cost	= ______	R/S
occupancy x value of time	= 0.0______	R/S

Enter		Press
Bus Mode		
growth factor (vehicular) (1.xx)	= 1.______	R/S
PCU equivalency factor	= ______	R/S
speed-flow function parameter	= ______	R/S
per hour operating cost	= ______	R/S
per km operating cost	= ______	R/S
bus occupancy ______ x value of time ______	= ______	R/S
(Initialize)		C
Base year vehicular volumes (peak hour, peak direction)		
auto volume (veh/hr)	= ______	R/S
truck volume	= ______	R/S
bus volume	= ______	R/S
Link capacities (one direction)		
no build capacity (veh/hr)	= ______	R/S
build capacity	= ______	R/S
Link length (km)	= ______	R/S
Peak hour, peak direction yearly expansion factor (number of peak hours per year)	= ______	STO 11
First year discount factor (1.xx)	= ______	STO 13
Discount rate (1.xx)	= ______	STO 14
Number of years	= ______	STO 00
First Year in Benefit Horizon	= ______	STO 06

5.3 Regional Growth, Land and Transport Inputs for Colon Urban Development Project

Level 1: Regional Growth Inputs

The key regional growth assumptions underlying the projection of travel demands are described in the Project Appraisal Report and summarized in the tables below:

Employment Growth and Change 1979-1989

Based on "basic" employment-generating project investment and "non-basic" job-generation (assuming a multiplier of 1.8) distributed to spatial structure of the market and available land.

Urban Project Build

Year	Employment 1979		1984		1989	
Zone	Basic	Non-basic	Basic	Non-basic	Basic	Non-basic
1	500	7,500	500	9,000	500	11,000
2	5,000	-	5,000	-	5,000	-
3	3,000	-	3,500	-	4,000	-
4	-	250	-	500	-	1,300
5	500	-	2,000	-	3,000	-
6	-	-	-	250	-	500
7	-	-	2,000	-	5,000	-
8	1,000	500	1,000	1,500	1,000	2,000
9	-	-	-	-	-	-
Total	10,000	8,250	14,000	11,250	18,500	14,800

Urban Project No-Build

Year	Employment 1979		1984		1989	
Zone	Basic	Non-basic	Basic	Non-basic	Basic	Non-basic
1	500	7,500	500			
2	5,000	-	5,000			
3	3,000	-	3,000			
4	-	250	-			
5	500	-	1,000			
6	-	-	-			
7	-	-	-			
8	1,000	500	1,000			
9	-	-	-			
Total	10,000	8,250				

Population Growth and Change 1979-1989

Based upon a full labor participation rate of .33 and an unemployment rate (in formal sector activities) of 40% effective 1979 and reducing ___ to 7%-10% by 1989, distributed on the basis of observed existing densities and inpüted changes on future locational cost/demand for housing. Income classes are defined in terms of average income levels which are taken to neither increase nor decline in real terms over the analysis period. Population growth arising from natural increase and net in-migration are not distinguished in the h household totals shown below; average household size is taken as 4.6 (existing 1979 average) throughout the period. (Households.)

Income	1979				1980				198			
Class	High	Medium	Low	Total	High	Medium	Low	Total	High	Medium	Low	Total
Zone												
1	2,600	8,300	4,100	15,000	2,500	8,000	2,500	13,000	2,500	8,000	2,500	13,000
4	800	200	-	1,000	800	200	-	1,000	800	200	-	1,000
6	-	-	-	-		3,000	2,000	5,000	-	3,000	2,000	5,000
8	800	2,000	1,200	4,000	1,000	2,500	1,500	5,000	1,500	3,500	2,000	7,000
Total	4,200	10,500	5,300	20,000	4,300	13,700	6,000	24,000	4,800	14,700	6,500	26,000

Level 2: Urban Land Inputs

The key land assumptions underlying the projection of land demands are summarized in the tables below:

Land Available for Residential Use

Based on surveyed land use patterns and observed net residential densities existing for 1979, with income classes separately estimated by zone.

INCOME CLASS

Year	1979							1984				1989			
Zone	High		Middle		Low		Total	High	Middle	Low	Total	High	Middle	Low	Total
1	78.0	300	83.0	100	12.3	30	173.3	75.0	80.0	77.5	162.5				
4	48.0	600	4.0	200	0.0		52.0	48.0	4.0		52.0				
6	-	-	-	-	-	-	-	-	75.0	15.0	90.0				
8	72.0	900	60.0	300	10.8	90	142.8	90.0	75.0	13.5	178.5				
Total	198.0		147.0		23.1		368.1	213.0	234.0	36.0	483.0				

Disaggretated Attractivity Indices.

Based upon existing and future demand by income class in proportion to class size in each residential zone, and a calibrated coefficient of attraction.

Income Class	1979						1984						1989					
Zone	High	αH	Middle	αM	Low	αL	High	αH	Middle	αM	Low	αL	High	αH	Middle	αM	Low	αL
1	26		83		41		25		80		25		25		80		25	
4	8		2		0		8		2		0		8		2		0	
6	-		-		-		0		30		20		-		30		20	
8	8		20		12		10		25		15		15		35		20	

Non-transport Location Expenditure

Based upon an estimated proportion of average household income budgeted for land, housing and utilities costs, measured in terms of monthly household expenditures per square meter of residential land.

	1979			1984			1989		
Income Class	High	Middle	Low	High	Middle	Low	High	Middle	Low
Zone									
1	1.80	1.10	0.83						
4	0.90	0.53	-						
6	-	-	-						
8	0.60	0.35	0.28						

Level 3: Transport Inputs

The key transport assumptions underlying the projection of travel demands are summarized in the tables below:

Values of Travel Time

Income Class

	High	Middle	Low
Average HH income/month	$1800	$425	$125
Average hourly income/traveler	$8.72	$225	$0.73
Value of travel time rate	25%	25%	25%
VOT/minute of travel	0.036	0.009	0.003

Trip Rate by Mode (Morning Peak Period Only)
1979

Income class	High			Middle			Low		
Mode	Car	Bus	Walk	Car	Bus	Walk	Car	Bus	Walk
Zone									
1	0.6	0.2	0.2	0.2	0.3	0.3	0.1	0.3	0.3
4	0.7	0.2	0.1	0.2	0.4	0.2	-	-	-
6	-	-	-	0.2	0.4	0.2	0.1	0.3	0.3
8	0.7	0.2	0.1	0.2	0.4	0.2	0.0	0.5	0.2
9	.8	.2	-	0.2	.6	-	-	1.0	-

Year 1984/1989

Income class	High			Middle			Low		
Mode	Car	Bus	Walk	Car	Bus	Walk	Car	Bus	Walk
1	0.7	0.2	0.2	0.3	0.3	0.3	0.1	0.3	0.3
4	0.8	0.2	0.1	0.3	0.4	0.2	-	-	-
6	-	-	-	0.3	0.4	0.2	0.1	0.4	0.2
8	0.8	0.2	0.1	0.2	0.4	0.2	0.1	0.4	0.2
9	0.9	0.1	-	0.5	0.5	0.2	0.1	0.9	-

TRUCK TRIP RATE PER UNIT OF EMPLOYMENT

Zone	Truck Trips
1	0.08
2	0.10
3	0.10
4	0.06
5	0.08
6	0.06
7	0.08
8	0.06
9	-

INTERZONAL LINK DISTANCES

(Based upon shortest route distances between zone centroids along existing roads in kilometers).

	1	2	3	4	5	6	7	8
1	0.67	1.40	1.00	2.40	4.80	4.40	8.20	9.60
2	1.40	0.36	1.60	3.00	5.40	5.00	8.80	10.20
3	1.00	1.60	0.54	2.20	4.60	4.20	8.00	9.40
4	2.40	3.00	2.20	0.74	2.40	2.00	5.80	7.20
5	4.80	5.40	4.60	2.40	0.66	1.60	5.40	6.80
6	4.40	5.00	4.20	2.00	1.60	1.00	4.60	6.00
7	8.20	8.80	8.00	5.80	5.40	4.60	1.20	3.00
8	9.60	10.20	9.40	7.20	6.80	6.00	3.00	1.20

PCU EQUIVALENCY AND OCCUPANCY RATE

	PCU Equivalent	Occupancy
cars	1.0	1.6
busses	3.0	45.0
trucks	3.0	1.0

PEAK PERIOD EXPANSION FACTOR TO MONTHLY TOTALS

trucks	115.0
busses	92.0
cars	107.4

Expansion factors are based on the following considerations for the purpose of estimating benefits:

Auto: Peak (2 hour) volume is 1/7 of total daily

3 peak periods @ full benefit	=	3.00
2 " " " 2/3 "	=	1.33
1 " " " 1/3 "	=	0.33
1 " " " no "	=	0.00
		4.67
4.67 (daily) X 23 (days per month)	=	115.0

Bus: Peak (2 hour) volume is 1/5 of total daily

3 peak periods @ full benefit	=	3.00
2 " " 1/2 "	=	1.00
		4.00
4.00 (daily) X 23 (days per month)	=	92.0

Truck: peak (2 hour) volume is 1/8 of total daily

3 peak periods @ full benefit	=	3.00
2 " " 2/3 "	=	1.33
2 " " 1/2 "	=	0.67
1 " " 0 "	=	0.00
		5.00
5.00 (daily) X 23 (days per month)	=	115.0

AUTOMOBILE OPERATING COST PER 1,600 KMS. (1979)

MPH	KPH	Gas	Oil	Tires	Maintenance	Depreciation	Interest	Total
10	16	49.11	2.39	1.02	7.00	45.00	36.00	140.52
15	24	51.01	2.23	1.22	8.00	41.00	28.50	131.96
20	32	45.82	1.92	1.63	8.50	36.00	22.50	116.37
25	40	43.47	1.82	2.14	8.85	34.50	19.00	109.78
30	48	41.24	1.77	2.65	9.50	32.50	16.50	104.16
35	56	43.22	1.71	3.26	9.85	30.50	15.00	103.54
40	64	43.45	1.71	3.82	10.60	29.00	13.50	102.08
45	72	46.70	1.66	4.54	11.00	27.50	13.00	104.40
50	80	48.67	1.61	5.30	11.50	26.50	12.00	105.58
55	88	53.04	1.50	6.17	12.25	26.00	11.50	110.46
60	96	57.14	1.58	7.19	13.00	25.00	11.00	114.89
65	104	62.96	1.77	8.36	13.75	24.50	10.50	121.84

Using linear regression a curve is determined to fit these data points, whose equation is:

$$C = 0.1046 - 0.001256x + 0.000009512x^2$$

where C = \$ cost per km for cars
x = speed in km/hour

For busses, based upon 1977 data, the ratio of bus to auto operating costs is given as 4.3. For trucks, based upon the same data source, the truck to auto operating cost ratio is given as 5.6. These values are taken as given.

ASSUMED LEVELS OF BUS FARES

Destination Zone / Origin Zone	1	2	3	4	5	6	7	8	9	Total
1.	.10	.10	.10	.10	.25	.20	.40	.50	1.25	
2	.10	.10	.10	.15	.25	.25	.45	.50	1.25	
3	.10	.10	.10	.10	.20	.20	.40	.50	1.25	
4	.10	.15	.10	.10	.10	.10	.30	.35	1.15	
5	.25	.25	.20	.10	.10	.10	.25	.35	1.00	
6	.20	.25	.20	.10	.10	.10	.25	.30	1.05	
7	.40	.45	.40	.30	.25	.25	.10	.15	.85	
8	.50	.50	.50	.35	.35	.30	.15	.10	.75	
9	1.25	1.25	1.25	1.15	1.00	1.05	.85	.75		

ASSUMED LEVELS OF TRIP TERMINAL TIME IN MINUTES

Origin Zone	Destination Zone	1	2	3	4	5	6	7	8	Note
	Cars	4	4	4	4	4	5	4	4	5 Min.
	Busses	9	9	9	9	9	15	9	9	Service Level
	Cars	4	4	4	3	4	6	4	4	10. Min.
	Busses	14	14	14	14	14	18	14	14	Service Level
	Cars	6	6	6	6	6	8	6	6	10 Min.
	Busses	18	18	18	18	18	22	18	18	Service Level
	Cars	4	4	4	4	4	6	4	4	10 Min.
	Busses	14	14	14	14	14	18	14	14	Service Level

LINK CAPACITY TABLE

	1	2	3	4	5	6	7	8
1		240	1,600	1,600	-	-	-	-
2	240		-	-	-	-	-	-
3	1,600	-		800	-	-	-	-
4	1,600	-	800		1,200	1,200	800	800
5	-	-	-	1,200		1,200	800	800
6	-	-	-	1,200	1,200		800	800
7	-	-	-	800	800	800		800
8	-	-	-	800	800	800	800	

REVISED OPERATING COST FOR TRUCK

At 40 km/h, car operating cost of \$ 0.07.

Truck operating cost is 5.6 times higher, or \$ 0.39

$$\$0.39 \frac{1}{\text{km}} \times \frac{40\text{km}}{\text{hr}} = \$15.59/\text{hrs}$$

The labor cost component is \$1/hr, so the reduced OC is 14.5%. This corresponds to \$0.36/km, which is 5.2 times higher than auto.

So truck cost is [5.2 (auto cost/km) X distance + \$1 time]

6. OPERATING THE PROGRAM

6.1 BASIC USER INSTRUCTIONS FOR A T159 & PRINTER

1. To turn on the calculator, first plug in the printer and calculator. DO NOT turn on calculator and printer before plugging in the printer. To turn off the calculator, turn off both calculator and printer before unplugging the printer.

2. Algebraic operations -- The TI59 uses logic known as Algebraic Operating System. Algebraic operations are punched into the calculator going from left to right as they would be written out. For example, to perform the following calculation:

$$8 \div 3 = 2.67$$

you would push the following buttons:

1) $\boxed{8}$
2) $\boxed{\div}$
3) $\boxed{3}$
4) $\boxed{=}$

Where there are a complex series of calculations, the calculator follows certain rules about which ones are performed first. Alternatively, you can use parentheses to make the calculator perform operations in a particular order.

The order of operations performed by the T159 is:

1) Special single function keys (such as trig and log functions)
2) Powers and roots (Y^X and $\sqrt[x]{Y}$)
3) Multiplications and divisions
4) Additions and subtractions

Example

$$3 + 10 - 2 \times 14 \div 7; = 9$$

This is the same as

$$3 + 10 -(2 * 14 \div 7) = 9$$

If you do not wish the above interpretation to be followed you must use parentheses, for example:

$$(3 + 10 - .2) * 14 \div 7 = 22$$

2. <u>Special function and operation keys</u>

A) Every key can be used in 2 ways as indicated by 1) labels on the key and 2) gold labels above the key. To get the use of the gold label function, push the gold key marked $\boxed{\text{2nd}}$ before pushing the desired key.

B) The INV key will give you the use of inverse functions or operations for many of the keys. For example to compute e ^{2} push the following:

$\boxed{2}$

$\boxed{\text{INV}}$

$\boxed{\text{ln}}$

4. <u>User Labels</u> -- User labels are names given by the programmer to different parts (or subroutines) of a pocket calculator program. By pushing a user label key, you are able to have the calculator perform a specific subroutine. The user labels are contained inthe top row of the TI59 and consist of A,B,C,D,E, and A', B', C', D', E'.

5. <u>Memory Structure</u> -- The TI59 memory is divided into a section to hold a program and a section to hold data. When the TI59 is turned on, it contains 480 spaces for program instruction and 60 spaces for data.

You may re-partition memory if you need more data storage, or more program storage. Following are two commands useful in memory partitioning:

A. [2nd] [OP] [1] [6] will cause the calculator to display the current memory partition. Ordinarily the display will read 479.59 (program positions go from 000 to 479 and data registers go from 00 to 59).

B. [X] [2nd] [OP] [1] [7] will cause the calculator to repartition memory so that there are 10X data registers. For example:

[4] [2nd] [OP] [1] [7] would give a partition of 639.39 (or 640 program positions and 40 data registers).

6. Reading a Card -- In order to read a card the calculator must be properly partitional in the same manner as when the card was created. The calculator must also be told the proper place to store the data on the card. Each magnetic card has two sides (or banks). The calculator memory can hold 4 banks (or 2 cards) worth of information.

To read a card, first push the number of the memory bank into which this card will be read. The number will be 1, 2, 3 or 4. Usually the proper memory bank is indicated upon the card or in programmer user instructions. As an alternative, push 0 before reading the card. Then the card will be automatically read into the proper bank.

The second step in reading a card is to hold the yellow side up and insert the proper end (designated by the bank number on the card) into the card reader. Let the calculator process the card through (do not push the card once the calculator has hold of it) and then gently remove the card. The calculator will display the number of the memory bank into which the card read. If there is a misread or if you have pushed an improper bank number, the calculator display will flash. In this case you must start over.

7. Listing Memory

There are two commands which allow you to list memory. There are:

A. 2nd List

This command will print out the program memory. It is especially useful for checking that the current program has been properly read in. To stop the listing push R/S

B. INV 2nd List

This command will print out the contents of the data registers. To stop the listing push R/S .

Notes: Occasionally the listing does not start at the proper place (i.e. does not start at program location 000 or data register 00). To correct for this you press GTO and the proper memory address. For a program, the address would be 000, and for the data registers (under normal partitioning) the address would be 480. The calculator may flash when given the data register address, but this procedure works nontheless. Follow with the desired list command.

8. Run Stop and Reset

These are two useful commands. Reset RST will place the program counter at the beginning of a program which is at address 000. Thus reset may be used when you wish to start a program from the beginning.

Run/Stop R/S may be used to stop program execution, and it may be used to start program execution at the current location in the program. For example, a program may halt execution to wait for data. The user enters the data into the display and starts execution by pressing R/S.

9. Clears -- There are four clear commands with the T159 as follows:

CE -- clears the current display only

CLR -- clears the current math operation

2nd CP -- clears the program

2nd CMs -- clears the data registers

10. Store and Recall

Press STO and a two digit data register number to place the display in memory. For example, 1 STO 0 2 would place a 1 in register 2.

Press RCL and a two digit data register number to recall the contents of the data register onto the display. In the above example, RCL 0 2 would display a 1.

11. Printer commands -- The printer attached to the T 59 has a number of different operating modes. If none of its three buttons have been pushed, then the printer takes all its instructions from the calculator.

If the PRINT button is pushed, the printer will print out the current display on the calculator.

If the TRACE button is pushed, the printer will print out each step in the execution of a program. Trace is very useful for debugging.

The ADV or advance button merely advances the paper in the printer.

6.2 INSTRUCTIONS FOR COMPUTING BENEFITS TO ORIGIN ZONES [FIRST PROGRAM]

1. Fill in, for each mode, a matrix giving volume on each link, by income class within each origin zone, for each mode. (See Tables 1-3)
   Differentiate between volume inbound (+) and outbound (-).
2. Compute, for each link, the total volume in PCU's. This is given by

$$V^e = \sum_{\substack{\text{MODES} \\ m}} \Big(\sum_{\text{INCOME CLASS } i} V_{mi} \Big) \times PCU_m \div OCCUPANCY_m$$

   Note than inbound volume must be computed separately from outbound.
3. Table 4 summarizes the necessary link data. Fill in such a table, including length, V/C in each direction, and free-flow speed. If V/C or free-flow speed changes in the build alternative, mark that down.
4. Fill in, for each mode (bus and car) for each zone, a table headed "ORIGIN ZONE:" (See Tables 5-10) which contains all the data needed.
5. Fill in, for truck, a table for each origin zone (see Tables 11-16).
6. You are now ready to run the programs.
7. After turning on the printer and calculator, set the partition; Press 9 2nd Op 17 23.008
8. Enter side 2A of program UTB -2.2(A) after entering zero (0).
9. Enter the data on one of the bus or car tables. To enter the data, enter each number and then press the key indicated (A, B, or C). Where no key is indicated, press R/S. Enter data corresponding to the no-build alternative. If you make an error in entering data, see Step 19 below. Fill in the data for one origin zone and one mode completely.
10. Enter zero (0), and load card 1B of UTB-2.2(A).
11. If desired fix the output format by pressing 2nd Fix n where (n) is the number of digits desired after the decimal.

12. Press A and wait until costs are printed. These are the operating and time costs for each income class, and their sum over the income classes.

13. If there is a build alternative, enter data for it. You may re-enter all the data (beginning with number of links, as the values of time and model parameters don't change), or enter only those items that change. To do the latter, see 19 below. To do the former, do Steps 8-11. Before entering data you may want to change the format (as in Step 12).

* Whatever you do, <u>be sure to enter the number of links</u>, even if it hasn't changed, by entering it and pressing <u>STO</u> <u>00</u>, or pressing C if card 1A is in memory.

14. Press B and wait. The same items as listed in Step 12 will be printed for the build alternative; so will the differences between no build and build.

15. Now select another mode-zone pair. It is best to do all the zones of a single mode together.

16. For each mode-zone pair, repeat Steps 8-15. Note: If values of time and modal parameters do not change, they need not be repeated.

    Also, you may want to undo the fixed display format by pressing INV 2nd Fix.

17. You are now ready to do the trucks. For each origin zone, perform Steps 8-15 again, with these changes:

    Use Program UTB-2.2(B), sides 1A and 1B instead of Program UTB-2.2(A),

    Because these are the income classes, the run time and output in Steps 12 and 14 will be shorter

    Output is operating cost not including labor, labor cost and their sum.

18. FINISHED!

19. <u>Error Recovery</u>

    1. You may list the contents of the data registers, beginning with register (m) by pressing (<u>m</u>) <u>INV</u> <u>2nd</u> list. Press R/S when you want it to stop listing.

    2. You may enter any number directly by entering it and pressing <u>STO</u> <u>ab</u>, where <u>ab</u> is the register it goes in. This also applies

to changes for the build alternative.

3. The contents of the data registers is given in the Table so marked for each program.

Figure 2

Detailed Output Table

Link \ Year	1	2		T	Total (discounted)
1	□	□	. . .	□	□
2	□	.	.	.	.
	.		.	.	.
A	□			□	□
Total	□	□	. . .	□	□

□ =

Alternative 1 (no build)

1. Peak hour V/C
2. Peak hour auto speed

Alternative 2 (build)

3. Peak hour V/C
4. Peak hour auto speed

(items 1–4) not included in row and column totals

Mode 1 (auto)

Alternative 1 (no build)

5. Operating cost
6. Time cost

Alternative 2 (build)

7. Operating cost
8. Time cost

Difference (benefit of build alternative)

9. Operating cost
10. Time cost

Mode 2 (truck)

Alternative 1

11. Operating Cost
12. Time cost

Alternative 2

13. Operating cost

Figure 2 (continued)

14. Time cost

Difference

15. Operating cost
16. Time cost

Mode 3 (bus)

Alternative 1

17. Operating cost
18. Time cost

Alternative 2

19. Operating cost
20. Time cost

Difference

21. Operating cost
22. Time cost

Total (all modes)

Alternative 1

23. Operating cost
24. Time cost

Alternative 2

25. Operating cost
26. Time cost

Difference

27. Operating cost
28. Time cost

6.3 ESTIMATED 1979 TRAVEL BENEFITS BY ORIGIN ZONE

By mode, income class and zone of origin for conditions existing with no highway component as compared to those with the proposed highway component.

Summary:

Table 1:

SUMMARY GENERALIZED TRAVEL COST - YEAR: 1979

Zone:		High Income HH	Middle Income HH	Low Income HH	Employment	Total
1.	Car					
	Bus					
	Truck					
	Walk					
2.	Car					
	Bus					
	Truck					
	Walk					
3.	Car					
	Bus					
	Truck					
	Walk					
4.	Car					
	Bus					
	Truck					
	Walk					
5.	Car					
	Bus					
	Truck					
	Walk					
6.	Car					
	Bus					
	Truck					
	Walk					
7.	Car					
	Bus					
	Truck					
	Walk					
8.	Car					
	Bus					
	Truck					
	Walk					
9.	Car					
	Bus					
	Truck					
	Walk					
Total	Car					
	Bus					
	Truck					
	Walk					
Total						

Table 2: TRIP-ORIGIN - MORNING PEAK

Year 1979

Zone:		High Income HH	Middle Income HH	Low Income HH	Employment Places	Total
1.	Car	1,560	1,660	-		3,220
	Bus	520	2,490	1,230		4,240
	Truck	-	-	-	640	640
	Walk	520	2,490	1,230		4,240
2.	Car					
	Bus					
	Truck				500	500
	Walk					
3.	Car					
	Bus					
	Truck				300	300
	Walk					
4.	Car	560	40	-		600
	Bus	160	80	-		240
	Truck	-	-	-	15	15
	Walk	80	40	-		120
5.	Car					
	Bus					
	Truck				40	40
	Walk					
6.	Car	0	0	0		0
	Bus	0	0	0		0
	Truck	0	0	0	-	0
	Walk	0	0	0		0
7.	Car					
	Bus					
	Truck					
	Walk					
8.	Car	560	400	-		960
	Bus	160	800	600		1,560
	Truck	-	-	-	90	90
	Walk	80	400	240		720
9.	Car	+580	320	-		900
	Bus	+145	+480	+1,300		1,925
	Truck				200	200
	Walk	-	-	-		-
Total	Car	3,260	2,420	-		5,680
	Bus	985	3,850	3,130		7,965
	Truck	-	-	-	1,785	1,785
	Walk	680	2,930	1,470		5,080
Total		4,925	9,200	4,600	1,785	20,510

Table 3: TRIP DESTINATIONS - MORNING PEAK

Year: 1979

Zone:		High Income HH	Middle Income HH	Low Income HH	Employment Places	Total
1.	Car	485	1,465	-		1,950
	Bus	105	2,355	1,420		3,880
	Truck				640	640
	Walk	30	1,780	420		2,230
2.	Car	1,250	420	-		1,670
	Bus	420	625	625		1,670
	Truck				500	500
	Walk	330	635	535		1,500
3.	Car	750	250	-		1,000
	Bus	250	375	375		1,000
	Truck				300	300
	Walk	250	375	375		1,000
4.	Car	70	20	-		90
	Bus	20	40	50		110
	Truck				15	15
	Walk	10	20	20		50
5.	Car	130	70	-		200
	Bus	35	100	165		300
	Truck				40	40
	Walk	-	-	-	-	-
6.	Car					
	Bus					
	Truck					0
	Walk					
7.	Car					
	Bus					
	Truck					0
	Walk					
8.	Car	420	120	-		540
	Bus	120	240	300		660
	Truck				90	90
	Walk	60	120	120		300
9.	Car	155	75	-		230
	Bus	35	115	195		345
	Truck				200	200
	Walk	-	-	-		-
Total	Car	3,260	2,420	-		5,680
	Bus	985	3,850	3,130		7,965
	Truck	-	-	-	1,785	1,785
	Walk	680	2,930	1,470		5,080
Total		4,925	9,200	4,600	1,785	20,510

Table 4: O-D DISTRIBUTION OF CAR TRIPS

Year: 1979

Destination Zones

Origin Zone	1	2	3	4	5	6	7	8	9	TOTAL
1. H	283	649	400	23	39	0	0	82	74	1,560
M	1,043	288	169	14	51	0	0	40	52	1,660
L	0	0	0	0	0	0	0	0	0	0
TOTAL	1,326	937	569	37	90	0	0	112	126	3,220
2. H										
M										
L										
TOTAL										
3. H										
M										
L										
TOTAL										
4. H	43	198	134	25	39	0	0	64	27	560
M	22	9	8	0	0	0	0	0	1	40
L	0	0	0	0	0	0	0	0	0	0
TOTAL	95	207	142	25	39	0	0	64	28	600
5. H										
M										
L										
TOTAL										
6. H										
M										
L										
TOTAL										
7. H										
M										
L										
TOTAL										
8. H	43	171	82	9	29	0	0	199	27	560
M	205	69	40	0	10	0	0	65	11	400
L	0	0	0	0	0	0	0	0	0	0
TOTAL	248	240	122	9	39	0	0	264	38	960
9. H	86	222	134	13	23	0	0	75	27	580
M	195	54	33	3	9	0	0	15	11	320
L	0	0	0	0	0	0	0	0	0	0
TOTAL	281	276	167	16	32	0	0	90	38	900
H	485	1,250	750	40	130	0	0	420	155	3,260
M	1,465	420	250	20	70	0	0	120	75	2,420
L	0	0	0	0	0	0	0	0	0	0
GRAND TOTAL	1,950	1,670	1,000	90	200	0	0	540	230	5,680

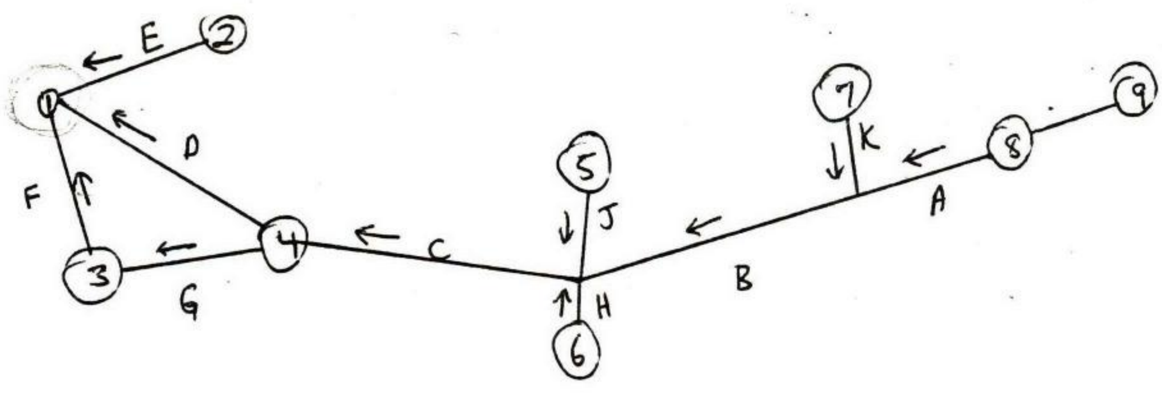
Table 5: O-D DISTRIBUTION OF BUS TRIPS
Year: 1979

Origin Zone	Destination Zone 1	2	3	4	5	6	7	8	9	TOTAL
1. H	72	241	139	2	20	0	0	28	18	520
M	1,624	388	250	24	62	0	0	64	78	2,490
L	628	270	149	15	52	0	0	40	76	1,230
TOTAL	2,324	899	538	41	134	0	0	132	172	4,240
2. H										
M										
L										
TOTAL										
3. H										
M										
L										
TOTAL										
4. H	11	61	37	8	5	0	0	31	6	160
M	44	16	8	0	0	0	0	10	2	80
L	0	0	0	0	0	0	0	0	0	0
TOTAL	55	77	45	8	5	0	0	41	8	240
5. H										
M										
L										
TOTAL										
6. H										
M										
L										
TOTAL										
7. H										
M										
L										
TOTAL										
8. H	7	52	37	0	7	0	0	44	7	160
M	393	143	70	11	26	0	0	136	21	800
L	202	95	71	15	45	0	0	136	36	600
TOTAL	602	290	178	26	78	0	0	316	64	1,560
9. H	15	66	37	3	3	0	0	17	4	145
M	294	78	47	5	12	0	0	30	14	480
L	590	260	155	20	68	0	0	124	83	1,300
TOTAL	899	404	239	28	83	0	0	171	101	1,925
TOTAL										
H	105	420	250	20	35	0	0	120	35	985
M	2,355	625	375	40	100	0	0	242	115	3,850
L	1,420	625	375	50	165	0	0	300	195	3,130
GRAND TOTAL	3,880	1,675	1,000	110	300	0	0	660	345	7,965

Table 6: O-D DISTRIBUTION OF TRUCK TRIPS
Year: 1979

Origin Zone	Destination 1	2	3	4	5	6	7	8	9	TOTAL
1. TOTAL	276	141	109	6	10	0	0	26	72	640
2. TOTAL	147	203	66	5	5	0	0	18	56	500
3. TOTAL	102	69	72	1	10	0	0	12	34	300
4. TOTAL	2	1	3	0	0	0	0	7	2	15
5. TOTAL	17	7	7	0	4	0	0	0	5	40
6. TOTAL	0	0	0	0	0	0	0	0	0	0
7. TOTAL	0	0	0	0	0	0	0	0	0	0
8. TOTAL	24	23	9	0	7	0	0	17	10	90
9. TOTAL	72	56	34	2	4	0	0	10	22	200
GRAND TOTAL	640	300	300	15	40	0	0	90	200	1,785

Table 7: NETWORK



Arrow points in inbound (+) direction.

Link	PCU's in (2 hrs)	PCU's out (2 hrs)	Capacity (No Build/Build)	V/C in (NB/B)	V/C out (NB/B)	Length	Car Free-flow speed (NB/B)
A						3.4	
B						3.4	80/100
AB	1777	924	800/2400	1.11/.37	.58/.19	6.8	80/100
C	1784	1064	1600	.56	.33	1.5	60
D	1603	864	1600	.50	.27	2.4	60
E	891	2036	1000	.45	1.02	1.4	60
F	519	912	1600	.16	.29	1.1	60
G	463	165	800	.29	.10	2.2	60
J	108	250	1200	.05	.10	0.9	60
H			1200			0.5	60
K			1200				60

Table 8: Year: 1979
Mode: Car
Link Assignments

Origin / Link		A	B	C	D	E	F	G	H	J	K
1.	H M L	(Same as B)	164^{-} 85 (0)	221^{-} 120	251^{-} 130	621^{-} 328	408^{-} 163	- -		57^{-} 35	
2.	H M L										
3.	H M L										
4.	H M L		90^{-} 41	128^{-} 1	271^{+} 31	199^{-} 8	- -	132^{+} 8		38^{-} 0	
5.	H M L										
6.	H M L		+809/-254								
8.	H M L		331^{+} 331	302^{+} 322	211^{+} 282	169^{-} 76	- -	82^{+} 40		29^{-} 9	
9.	H M L		478^{+} 294	455^{+} 287	308^{+} 249	222^{-} 54	- -	134^{+} 33		23^{-} 9	
TOTAL	H M L		+809/-254 +625/-86 +1434/-340	+757/-349 +609/-121 +1366/-470	+790/-251 +362/-130 +1352/-381	+0/-1211 +0/-466 +0/-1677	+0/-408 +0/-163 +0/-671	+348/-0 +81/-0 +429/-0		+0/-147 +0/-53 +0/-260	
GRAND TOTAL°											

Table 9:
Year: 1979
Mode: Bus
Link Assignments

Origin Zone / Link	A	B	C	D	E	F	G	H	J	K
1. H M L	(Same as B)	43 122 114	55 152 147	61 168 158	223 283 214	155 237 154	- - -		12 30 33	
2. H M L										
3. H M L										
4. H M L		35⁻ 10 0	42⁺ 10	74⁺ 62 0	58⁻ 16 0	- - -	37⁺ 8 0		7⁻ 0	
5. H M L										
[illegible] H M L										
8. H M L		140⁺ 650 429	111⁺ 631 393	68⁺ 552 321	51⁻ 118 98	- - -	34⁺ 69 63		29⁻ 20 36	
9. H M L		122⁺ 433 1093	117⁺ 421 1025	77⁺ 369 850	62⁻ 78 260		37⁺ 47 155		5⁻ 12 68	
TOTAL H M L		262 1083 1522 +2867	228 1052 1418 +2698	219 983 1171 2373	0 0 0 0	0 0 0 0	108 124 218 +440		0 0 0 0	
GRAND TOTAL°		- 78 132 114	- 97 162 147	- 61 168 158	- 394 493 512	- 155 261 134	0 0 0		53 68 137	

Table 10:
Year: 1979
Mode: Truck
Link Assignments

Origin Zone / Link	A	B	C	D	E	F	G	H	J	K
1. H M L	(Same as B)	98^-	108^-	114^-	141^-	109^-	–		10^-	
2. H M L		74^-	79^-	84^-	297^+	66^-	–		5^-	
3. H M L		46^-	56^-	–	69^-	171^+	57^-		10^-	
4. H M L		6^-	6^-	3^+	1^-	–	3^+		0^-	
5. H M L		5^-	28^+	24^+	7^-		4^+		33^+	
6. H M L										
8. H M L		63^+	56^+	47^+	23^-	–	9^+		7	
9. H M L		168^+	166^+	128^+	56^-	–	34^+		2^-	
TOTAL H M L		230	250	200	297	173	55		36	
GRAND TOTAL°		230	250	200	297	173	55		36	

Table 11: YEAR: 1979

ORIGIN ZONE: 1 Input Data

MODE: Car

	Values of Time ($/hr)		
9	Class 1	2.18	(A)
10	Class 2	.56	
11	Class 3	.18	

	Mode:		
5	O.C. parameter	1	(B)
6	occupancy	1.6	
7	expansion factor	107.4	

0 Number of Links: 6 (C)

	Link: A-B outbound	
20	length (km)	5.5
21	V/C	0.587/.19
22	free-flow speed (km/h)	80/100
23	class 1 vol	164
24	class 2 vol	85
25	class 3 vol	0

	Link: C out	
26	length	1.5
27	V/C	.33
28	free-flow spd	60
29	class 1 vol	221
30	class 2 vol	120
31	class 3 vol	0

	Link: D out	
32	length	2.4
33	V/C	0.27
34	free-flow spd	60
35	class 1 vol	251
36	class 2 vol	130
37	class 3 vol	0

	Link: E out	
38	length	1.4
39	V/C	1.02
40	free-flow spd	60
41	class 1 vol	621
42	class 2 vol	328
43	class 3 vol	0

	Link: F out	
44	length	1.0
45	V/C	0.29
46	free-flow spd	60
47	class 1 vol	408
48	class 2 vol	163
49	class 3 vol	0

	Link: J out	
50	length	0.9
51	V/C	.10
52	free-flow spd	60
53	class 1 vol	57
54	class 2 vol	35
55	class 3 vol	0

	Link:	
56	length	
57	V/C	
58	free-flow spd	
59	class 1 vol	
60	class 2 vol	
61	class 3 vol	

	Link:	
62	length	
63	V/C	
64	free-flow spd	
65	class 1 vol	
66	class 2 vol	
67	class 3 vol	

	Link:	
68	length	
69	V/C	
70	free-flow spd	
71	class 1 vol	
72	class 2 vol	
73	class 3 vol	

YEAR: 1979

ORIGIN ZONE: 1

Input Data

MODE: Bus

Values of Time ($/hr)

9	Class 1	2.18	(A)
10	Class 2	.56	
11	Class 3	.18	

Mode:

5	O.C. parameter	4.3	(B)
6	occupancy	45	
7	expansion factor	92	

0 Number of Links: 6 (C)

Link: A-B out

20	length (km)	5.5
21	V/C	.58/.19
22	free-flow speed (km/h)	64/80
23	class 1 vol	43
24	class 2 vol	122
25	class 3 vol	114

Link: C out

26	length	1.5
27	V/C	.33
28	free-flow spd	42
29	class 1 vol	55
30	class 2 vol	152
31	class 3 vol	147

Link: D out

32	length	2.4
33	V/C	.27
34	free-flow spd	42
35	class 1 vol	61
36	class 2 vol	168
37	class 3 vol	158

Link: E out

38	length	1.4
39	V/C	1.02
40	free-flow spd	42
41	class 1 vol	223
42	class 2 vol	283
43	class 3 vol	214

Link: F out

44	length	1.0
45	V/C	.29
46	free-flow spd	42
47	class 1 vol	155
48	class 2 vol	237
49	class 3 vol	154

Link: J oút

50	length	0.9
51	V/C	.10
52	free-flow spd	42
53	class 1 vol	12
54	class 2 vol	30
55	class 3 vol	33

Link:

56	length	
57	V/C	
58	free-flow spd	
59	class 1 vol	
60	class 2 vol	
61	class 3 vol	

Link:

62	length	
63	V/C	
64	free-flow spd	
65	class 1 vol	
66	class 2 vol	
67	class 3 vol	

Link:

68	length	
69	V/C	
70	free-flow spd	
71	class 1 vol	
72	class 2 vol	
73	class 3 vol	

Year: 1979

Table 13:

BENEFITS TO RESIDENTS OF ORIGIN ZONE 1 Output Costs

		AUTO	BUS	$/Month
NO BUILD				
Income class 1	OC	15304.	652.	
	TC	24177.	9269.	
Income class 2	OC	7826.	1312.	
	TC	3209.	4137.	
Income class 3	OC	0.	1136.	
	TC	0.	1111.	
Total	OC	23131.	3100.	
	TC	27386.	14517.	
BUILD				
Income class 1	OC	15449.	635.	
	TC	21628.	8553.	
Income class 2	OC	7901.	1263.	
	TC	2870.	3615.	
Income class 3	OC	0.	1089.	
	TC	0.	955.	
Total	OC	23350.	2987.	
	TC	24498.	13123.	
DIFFERENCE				
Income class 1	OC	-145.	17.	
	TC	2549.	716.	
Income class 2	OC	-75.	50.	
	TC	339.	522.	
Income class 3	OC	0.	46.	
	TC	0.	157.	
Total	OC	-220.	113.	
	TC	2888.	1394.	

YEAR: 1979

Table 14: ORIGIN ZONE: 4 Input Data

MODE: Car

	Values of Time ($/hr)		
9	Class 1	2.18	(A)
10	Class 2	.56	
11	Class 3	.18	
	Mode:		
5	O.C. parameter	1	(B)
6	occupancy	1.6	
7	expansion factor	107.4	
0	Number of Links:	6	(C)
	Link: A-B out		
20	length (km)	5.5	
21	V/C	0.58/.19	
22	free-flow speed (km/h)	80/100	
23	class 1 vol	90	
24	class 2 vol	1	
25	class 3 vol	0	
	Link: C out		
26	length	1.5	
27	V/C	0.33	
28	free-flow spd	60	
29	class 1 vol	128	
30	class 2 vol	1	
31	class 3 vol	0	
	Link: D in		
32	length	2.4	
33	V/C	.50	
34	free-flow spd	60	
35	class 1 vol	271	
36	class 2 vol	31	
37	class 3 vol	0	
	Link: E out		
38	length	1.4	
39	V/C	1.02	
40	free-flow spd	60	
41	class 1 vol	199	
42	class 2 vol	8	
43	class 3 vol	0	

	Link: G in	
44	length	2.2
45	V/C	.29
46	free-flow spd	60
47	class 1 vol	133
48	class 2 vol	8
49	class 3 vol	0
	Link: I out	
50	length	0.9
51	V/C	.10
52	free-flow spd	60
53	class 1 vol	38
54	class 2 vol	0
55	class 3 vol	0
	Link:	
56	length	
57	V/C	
58	free-flow spd	
59	class 1 vol	
60	class 2 vol	
61	class 3 vol	
	Link:	
62	length	
63	V/C	
64	free-flow spd	
65	class 1 vol	
66	class 2 vol	
67	class 3 vol	
	Link:	
68	length	
69	V/C	
70	free-flow spd	
71	class 1 vol	
72	class 2 vol	
73	class 3 vol	

YEAR: 1979

Table 15: ORIGIN ZONE: 4 — Input Data

MODE: Bus

Values of Time ($/hr)

9	Class 1		(A)
10	Class 2		
11	Class 3		

Mode:

5	O.C. parameter	4.3	(B)
6	occupancy	45	
7	expansion factor	92	

0	Number of Links:	6	(C)

Link: A-B

20	length (km)	5.5
21	V/C	.58/.19
22	free-flow speed (km/h)	64/80
23	class 1 vol	35
24	class 2 vol	10
25	class 3 vol	0

Link: C out

26	length	1.5
27	V/C	.33
28	free-flow spd	42
29	class 1 vol	42
30	class 2 vol	10
31	class 3 vol	0

Link: D in

32	length	2.4
33	V/C	.50
34	free-flow spd	42
35	class 1 vol	74
36	class 2 vol	62
37	class 3 vol	0

Link: E out

38	length	1.4
39	V/C	1.02
40	free-flow spd	42
41	class 1 vol	58
42	class 2 vol	16
43	class 3 vol	0

Link: G in

44	length	2.2
45	V/C	.29
46	free-flow spd	42
47	class 1 vol	37
48	class 2 vol	8
49	class 3 vol	0

Link: J out

50	length	0.9
51	V/C	.10
52	free-flow spd	42
53	class 1 vol	7
54	class 2 vol	0
55	class 3 vol	0

Link:

56	length	
57	V/C	
58	free-flow spd	
59	class 1 vol	
60	class 2 vol	
61	class 3 vol	

Link:

62	length	
63	V/C	
64	free-flow spd	
65	class 1 vol	
66	class 2 vol	
67	class 3 vol	

Link:

68	length	
69	V/C	
70	free-flow spd	
71	class 1 vol	
72	class 2 vol	
73	class 3 vol	

Year: 1979

Table 16: BENEFITS TO RESIDENTS OF ORIGIN ZONE 4

Output Costs

		AUTO	BUS	$/Month
NO BUILD				
Income class 1	OC	9248.	407.	
	TC	13248.	4852.	
Income class 2	OC	528.	176.	
	TC	192.	529.	
Income class 3	OC	0.	0.	
	TC	0.	0.	
Total	OC	9776.	584.	
	TC	13441.	5381.	
BUILD				
Income class 1	OC	9327.	391.	
	TC	11849.	4215.	
Income class 2	OC	529.	172.	
	TC	188.	483.	
Income class 3	OC	0.	0.	
	TC	0.	0.	
Total	OC	9856.	563.	
	TC	12038.	4698.	
DIFFERENCE				
Income class 1	OC	-79.	16.	
	TC	1399.	637.	
Income class 2	OC	-1.	5.	
	TC	4.	47.	
Income class 3	OC	0.	0.	
	TC	0.	0.	
Total	OC	-80.	20.	
	TC	1403.	683.	

YEAR: 1979

Table 17: ORIGIN ZONE: 8

Input Data

MODE: Car

Values of Time ($/hr)

9	Class 1	2.18	(A)
10	Class 2	.56	
11	Class 3	.18	

Mode:

5	O.C. parameter	1	(B)
6	occupancy	1.6	
7	expansion factor	107.4	

0	Number of Links:	6	(C)

Link: AB in

20	length (km)	5.5
21	V/C	1.11/.37
22	free-flow speed (km/h)	80/100
23	class 1 vol	331
24	class 2 vol	331
25	class 3 vol	0

Link: C in

26	length	1.5
27	V/C	.56
28	free-flow spd	60
29	class 1 vol	302
30	class 2 vol	322
31	class 3 vol	0

Link: D in

32	length	2.4
33	V/C	.50
34	free-flow spd	60
35	class 1 vol	211
36	class 2 vol	282
37	class 3 vol	0

Link: E out

38	length	1.4
39	V/C	1.02
40	free-flow spd	60
41	class 1 vol	169
42	class 2 vol	76
43	class 3 vol	0

Link: G in

44	length	2.2
45	V/C	.29
46	free-flow spd	60
47	class 1 vol	82
48	class 2 vol	40
49	class 3 vol	0

Link: J out

50	length	.9
51	V/C	.10
52	free-flow spd	60
53	class 1 vol	29
54	class 2 vol	9
55	class 3 vol	0

Link:

56	length	
57	V/C	
58	free-flow spd	
59	class 1 vol	
60	class 2 vol	
61	class 3 vol	

Link:

62	length	
63	V/C	
64	free-flow spd	
65	class 1 vol	
66	class 2 vol	
67	class 3 vol	

Link:

68	length	
69	V/C	
70	free-flow spd	
71	class 1 vol	
72	class 2 vol	
73	class 3 vol	

YEAR: 1979

Table 18: ORIGIN ZONE: 8 Input Data

MODE: BUS

	Values of Time ($/hr)		
9	Class 1		(A)
10	Class 2		
11	Class 3		

	Mode:		
5	O.C. parameter	4.3	(B)
6	occupancy	45	
7	expansion factor	92	

0	Number of Links:	6	(C)

	Link: AB+	
20	length (km)	5.5
21	V/C	1.11/.37
22	free-flow speed (km/h)	64/80
23	class 1 vol	140
24	class 2 vol	650
25	class 3 vol	429

	Link: C+	
26	length	1.5
27	V/C	.56
28	free-flow spd	40
29	class 1 vol	111
30	class 2 vol	631
31	class 3 vol	393

	Link: D+	
32	length	2.4
33	V/C	.50
34	free-flow spd	42
35	class 1 vol	68
36	class 2 vol	552
37	class 3 vol	321

	Link: F-	
38	length	1.4
39	V/C	1.02
40	free-flow spd	42
41	class 1 vol	51
42	class 2 vol	118
43	class 3 vol	98

	Link: G+	
44	length	2.2
45	V/C	.29
46	free-flow spd	42
47	class 1 vol	34
48	class 2 vol	69
49	class 3 vol	63

	Link: J-	
50	length	0.9
51	V/C	.10
52	free-flow spd	42
53	class 1 vol	21
54	class 2 vol	20
55	class 3 vol	36

	Link:	
56	length	
57	V/C	
58	free-flow spd	
59	class 1 vol	
60	class 2 vol	
61	class 3 vol	

	Link:	
62	length	
63	V/C	
64	free-flow spd	
65	class 1 vol	
66	class 2 vol	
67	class 3 vol	

	Link:	
68	length	
69	V/C	
70	free-flow spd	
71	class 1 vol	
72	class 2 vol	
73	class 3 vol	

Year: 1979

Table 19: BENEFITS TO RESIDENTS OF ORIGIN ZONE 8 Output Costs

		AUTO	BUS	$/Month
NO BUILD				
Income class 1	OC	17282.	948.	
	TC	34120.	15089.	
Income class 2	OC	16995.	4592.	
	TC	8464.	18290.	
Income class 3	OC	0.	2994.	
	TC	0.	3859.	
Total	OC	34277.	8534.	
	TC	42584.	37237.	
BUILD				
Income class 1	OC	14752.	779.	
	TC	16311.	7023.	
Income class 2	OC	14464.	3808.	
	TC	3889.	8670.	
Income class 3	OC	0.	2477.	
	TC	0.	1818.	
Total	OC	29216.	7064.	
	TC	20200.	17512.	
DIFFERENCE				
Income class 1	OC	2531.	169.	
	TC	17809.	8065.	
Income class 2	OC	2531.	784.	
	TC	4575.	9619.	
Income class 3	OC	0.	517.	
	TC	0.	2041.	
Total	OC	5061.	1470.	
	TC	22383.	19725.	

Table 20: BENEFITS TO RESIDENTS OF ORIGIN ZONE 9 OUTPUT COSTS

	AUTO	BUS	$/Month
NO BUILD			
Income class 1			
OC			
TC			
Income class 2			
OC			
TC			
Income class 3			
OC			
TC			
Total			
OC			
TC			
BUILD			
Income class 1			
OC			
TC			
Income class 2			
OC			
TC			
Income class 3			
OC			
TC			
Total			
OC			
TC			
DIFFERENCE			
Income class 1			
OC			
TC			
Income class 2			
OC			
TC			
Income class 3			
OC			
TC			
Total			
OC			
TC			

Year: 1979

Table 21: BENEFITS TO RESIDENTS OF ORIGIN ZONE 9

		AUTO	BUS
NO BUILD			
Income class 1	OC	21829.57	846.01
	TC	43073.42	36065.39
Income class 2	OC	14158.55	2935.36
	TC	7053.11	11225.28
Income class 3	OC	0.00	7365.38
	TC	0.00	9154.68
Total	OC	35988.13	11146.74
	TC	50126.53	56445.36
BUILD			
Income class 1	OC	18175.10	698.87
	TC	17355.66	16721.07
Income class 2	OC	11910.82	2413.16
	TC	2989.76	4817.35
Income class 3	OC	0.00	6047.22
	TC	0.00	3955.50
Total	OC	30085.92	9159.25
	TC	20345.42	25493.92
DIFFERENCE			
Income class 1	OC	3654.47	147.13
	TC	25717.76	19344.32
Income class 2	OC	2247.73	522.20
	TC	4063.35	6407.94
Income class 3	OC	0.00	1318.16
	TC	0.00	5199.18
Total	OC	5902.20	1987.49
	TC	29781.11	30951.44

Build

Difference

OK

No-Build

Build w/loop

Difference w/loop

1759.52
6418.56

2660.47
37907.89

YEAR: 1979

Input Data

Table 22: ORIGIN ZONE: 1
MODE: Truck

Modal Parameters	
Labor cost ($/hr)	(B)
O.C parameter	
expansion factor	

Number of Links:	6 (C)

Link: AB-	
Length (km)	5.5
V/C	.58/.19
Free-flow speed (km/h)	80/100
Volume	98

Link: C-	
Length	1.5
V/C	.33
Free-flow speed	.60
Volume	108

Link: D-	
Length	2.4
V/C	.27
Free-flow speed	60
Volume	114

Link: E-	
Length	1.4
V/C	.1.02
Free-flow speed	60
Volume	141

Link: F-	
Length	1.0
V/C	.29
Free-flow speed	60
Volume	109

Link: J	
Length	0.9
V/C	.1
Free-flow speed	60
Volume	10

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Link:	
Length	
V/C	
Free-flow speed	
Volume	

YEAR: 1979

Input Data

Table 23: ORIGIN ZONE: 2
MODE: Truck

Modal Parameters		
Labor cost ($/hr)	1	(B)
O.C parameter	5.2	
expansion factor	115	
Number of Links:	6	(C)

Link: AB	
Length (km)	5.5
V/C	58/.19
Free-flow speed (km/h)	80/100
Volume	74

Link: C-	
Length	1.5
V/C	.33
Free-flow speed	60
Volume	79

Link: D-	
Length	2.4
V/C	.27
Free-flow speed	60
Volume	84

Link: E+	
Length	1.4
V/C	.45
Free-flow speed	60
Volume	297

Link: F-	
Length	1.0
V/C	.29
Free-flow speed	60
Volume	66

Link: J-	
Length	0.9
V/C	.10
Free-flow speed	60
Volume	5

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Link:	
Length	
V/C	
Free-flow speed	
Volume	

YEAR:1979

Input Data

Table 24: ORIGIN ZONE: 3
MODE: Truck

Modal Parameters	
Labor cost ($/hr)	(B)
O.C parameter	
expansion factor	
Number of Links:	(C)

Link: AB-	
Length (km)	5.5
V/C	.58/.19
Free-flow speed (km/h)	80/100
Volume	46

Link: C-	
Length	1.5
V/C	.33
Free-flow speed	60
Volume	56

Link: E-	
Length	1.4
V/C	1.02
Free-flow speed	60
Volume	69

Link: F+	
Length	1.0
V/C	..16
Free-flow speed	60
Volume	171

Link: G-	
Length	2.2
V/C	.10
Free-flow speed	60
Volume	57

Link: J-	
Length	0.9
V/C	.1
Free-flow speed	60
Volume	10

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Link:	
Length	
V/C	
Free-flow speed	
Volume	

YEAR: 1979

Table 25: ORIGIN ZONE: 4 — MODE: Truck — Input Data

Modal Parameters

Labor cost ($/hr)		(B)
O.C parameter		
expansion factor		

Number of Links: 5 (C)

Link:	C-	D+	E-		G+				
Length (km)	1.5	2.4	6.4		2.2				
V/C	.33	.5	1.02		.29				
Free-flow speed (km/h)	60	60	60		60				
Volume	6	3	1		3				

YEAR: 1979

Input Data

Table 26: ORIGIN ZONE: 5
MODE:

Modal Parameters

Labor cost ($/hr)		(B)
O.C parameter		
expansion factor		

Number of Links: 6 (C)

Link: AB-	
Length (km)	5.5
V/C	.58/.19
Free-flow speed (km/h)	80/100
Volume	5

Link: C+	
Length	1.5
V/C	.56
Free-flow speed	60
Volume	28

Link: D+	
Length	2.4
V/C	.5
Free-flow speed	60
Volume	24

Link: E-	
Length	1.4
V/C	1.02
Free-flow speed	60
Volume	7

Link: G+	
Length	2.2
V/C	.29
Free-flow speed	60
Volume	4

Link: J+	
Length	.9
V/C	.05
Free-flow speed	60
Volume	33

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Link:	
Length	
V/C	
Free-flow speed	
Volume	

YEAR: 1979

Input Data

Table 27: ORIGIN ZONE: 8
MODE: Truck

Modal Parameters

Labor cost ($/hr)		(B)
O.C parameter		
expansion factor		

Number of Links: 6 (C)

Link:	AB+
Length (km)	5.5
V/C	1.1/.37
Free-flow speed (km/h)	80/100
Volume	63

Link:	C+
Length	1.5
V/C	.56
Free-flow speed	60
Volume	56

Link:	D+
Length	2.4
V/C	.5
Free-flow speed	60
Volume	47

Link:	E-
Length	1.4
V/C	1.02
Free-flow speed	60
Volume	23

Link:	G+
Length	2.2
V/C	.29
Free-flow speed	60
Volume	9

Link:	J-
Length	.9
V/C	.1
Free-flow speed	60
Volume	7

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Link:	
Length	
V/C	
Free-flow speed	
Volume	

TRUCK COSTS FROM EACH ORIGIN ZONE

ZONE:	1	2	3
No-Build			
OC *	53,796	8,991	30,263
labor	4,113	3,128	2,176
Build			
OC *	54,566	9,573	30,624
labor	3,365	2,563	1,825
Difference			
OC *	-770	-582	-362
labor	748	565	351
total OC	-22	-17	-10

ZONE:	4	5	8
No-Build			
OC *	2,330	7,368	30,225
labor	155	539	21,541
Build			
OC *	2,377	7,407	25,987
labor	109	501	19,909
Difference			
OC *	-47	-39	4,239
labor	46	38	1,632
total OC	-1	-1	5,870

* Operating cost minus $1/hr labor cost.

Projected 1984 travel benefits by mode, income class, zone of origin for conditions assumed to prevail with no highway component as compared to those with the proposed highway component. Summary:

Year 1984

Table 29: SUMMARY GENERALIZED TRAVEL COST

ZONE:		High Income HH	Middle Income HH	Low Income HH	Employment	Total
1.	Car					
	bus					
	truck					
	walk					
2.	Car					
	bus					
	truck					
	walk					
3.	Car					
	bus					
	truck					
	walk					
4.	Car					
	bus					
	truck					
	walk					
5.	Car					
	bus					
	truck					
	walk					
6.	Car					
	bus					
	truck					
	walk					
7.	Car					
	bus					
	truck					
	walk					
8.	Car					
	bus					
	truck					
	walk					
9.	Car					
	bus					
	truck					
	walk					
Total:	Car					
	bus					
	truck					
	walk					
Total:						

Year 1984

Table 30: TRIP ORIGINS - MORNING PEAK HOUR

ZONE	HIGH INCOME HH	MIDDLE INCOME HH	LOW INCOME HH	EMPLOYMENT	TOTAL
1. Car	1.500	1,600	250		3,350
Bus	500	2,400	750		3,650
Truck				760	760
Walk	500	1,200	375		2,075
2. Car				500	
Bus					
Truck					
Walk					
3. Car					
Bus				350	350
Truck					
Walk					
4. Car	560	40	80		680
Bus	160	80	100		340
Truck				30	30
Walk	180	20			200
5. Car				160	160
Bus					
Truck					
Walk					
6. Car		600	200		800
Bus		1,200	1,000	15	2,200
Truck		300	200		500
Walk					
7. Car				160	160
Bus					
Truck					
Walk					
8. Car	700	500	100		1,300
Bus	200	1,000	750		1,950
Truck				150	150
Walk	100	250	150		500
9. Car	4,112	424	380		4,916
Bus	1,303	180	2,815		4,298
TrucK				0	
Walk	175	120	675		970
TOTAL Car	6,872	3,164	1,010		11,046
Bus	2,163	4,860	5,415		12,438
Truck				2,125	2,125
Bus	955	1,890	1,400		2,245

Year 1984

Table 31: TRIP DESTINATIONS - MORNING PEAK HOUR

ZONE	HIGH INCOME HH	MIDDLE INCOME HH	LOW INCOME HH	EMPLOYMENT	TOTAL
1. Car	2280	1140	500		3920
Bus	760	1710	1710		4180
Truck				460	460
Walk	380	570	570		1520
2. Car	1200	600	200		2000
Bus	400	900	900		2200
Truck				500	500
Walk	200	420	310		930
3. Car	840	340	140		1320
Bus	280	630	630		1540
Truck				350	350
Walk	200	420	310		930
4. Car	195	82	20		297
Bus	55	120	150		325
Truck				30	30
Walk	30	50	50		130
5. Car	780	330	80		1190
Bus	220	480	600		1300
Truck				160	160
Walk	40	80	80		200
6. Car	94	42	10		146
Bus	28	60	75		163
Truck				15	15
Walk	15	10	10		35
7. Car	780	330	80		1190
Bus	220	480	600		1300
Truck				160	160
Walk	40	80	80		200
8. Car	700	300	100		1100
Bus	200	480	750		1430
Truck				150	150
Walk	50	80	100		230
9. Car					
Bus					
Truck					
Walk					
TOTAL Car	6872	3164	1010		11046
Bus	2163	4860	5415		12438
Truck				2125	2125
Walk	955	1890	1400		4245
TOTAL	9990	9914	7825	2125	29854

Table 32: O-D DISTRIBUTION OF TRUCK TRIPS Year 1985

ORIGIN ZONES	1	2	3	4.	5	6	7	8	9	TOTAL
1. H	584	318	200	24	118	19	183	54	0	1500
M	673	336	200	19	148	16	92	116	0	1600
L	121	40	37	2	8	21	8	32	0	250
TOTAL	1378	694	437	45	274	37	283	202	0	3350
2. H										
M										
L										
TOTAL										
3. H										
M										
L										
TOTAL										
4. H	155	89	80	36	102	18	44	36	0	560
M	9	7	4	4	4	1	4	7	0	40
L	27	19	2	7	7	1	10	7	0	80
TOTAL	191	115	86	47	113	20	5	50	0	680
5. H										
M										
L										
TOTAL										
6. H										
M	170	103	66	28	94	9	93	38	0	600
L	65	41	35	4	27	1	18	9	0	200
TOTAL										
7. H										
M										
L										
TOTAL										
8. H	175	94	67	15	67	15	100	167	0	700
M	132	76	23	18	42	8	56	101	0	456
L	26	22	8	3	8	2	14	17	0	100
TOTAL	333	192	98	36	117	25	170	285	0	1,256
9. H	1356	699	493	120	493	45	453	453		4,112
M	156	81	47	13	42	5	42	38	0	424
L	141	78	53	9	30	4	30	35	0	380
TOTAL	1653	858	593	142	565	54	525	526	0	4,916
TOTAL H	2280	1200	840	195	780	67	780	700	0	6842
M	1140	600	340	82	330	42	330	300	0	3164
L	380	200	140	20	80	10	80	100	0	1010
TOTAL	3800	2000	1320	297	1190	119	1190	1100	0	11,016

Table 33: O-D DISTRIBUTION OF CAR TRIPS Year 1984

ORIGIN TOWNS	1	2	3	4	5	6	7	8	9	TOTAL
1. H	193	110	67	6	49	4	54	17	0	500
M	981	467	477	57	187	16	88	127	0	2400
L	354	134	114	20	47	7	4	40	0	750
TOTAL	1528	711	658	83	283	27	176	184	0	3650
2. H										
M										
L										
TOTAL										
3. H										
M										
L										
TOTAL										
4. H	59	27	25	8	17	8	8	8	0	160
M	24	16	8	4	8	4	8	8	0	80
L	31	15	15	8	8	7	8	8	0	100
TOTAL	114	58	48	20	33	19	24	24	0	340
5. H										
M										
L										
TOTAL										
6. H										
M	390	230	133	37	177	28	112	93	0	1200
L	282	159	96	21	168	23	138	103	0	990
TOTAL	672	389	229	58	345	51	250	196	0	2190
7. H										
M										
L										
TOTAL										
8. H	56	28	19	2	24	3	23	45	0	200
M	252	153	99	18	90	10	44	234	0	1000
L	160	114	67	17	67	10	110	205	0	750
TOTAL	468	295	185	37	181	23	277	484	0	1950
9. H	457	235	169	39	130	13	130	130	0	1303
M	63	34	23	4	18	2	18	18	0	180
L	873	478	338	84	310	28	310	394	0	2815
TOTAL	1393	747	530	127	458	43	458	542	0	4298
TOTAL H	760	400	380	55	220	28	220	200	0	2263
M	110	150	630	120	480	30	480	480	0	2480
L	110	700	630	150	100	75	750	750	0	3265
TOTAL	980	1250	1640	325	800	133	1450	1430	0	8008

Table 34: O-D DISTRIBUTION OF TRUCK TRIPS Year 1984

ORIGIN TOWNS	1	2	3	4	5	6	7	8	9	TOTAL
1. H M L										
TOTAL	354	154	140	12	43	0	28	29	0	760
2. H M L										
TOTAL	167	177	71	6	26	0	33	20	0	500
3. H M L										
TOTAL	115	68	73	6	26	6	36	20	0	350
4. H M L										
TOTAL	10	10	10	0	0	0	0	0	0	30
5. H M L										
TOTAL	31	28	23	0	38	9	14	17	0	160
6. H M L										
TOTAL	8	7	0	0	0	0	0	0	0	15
7. H M L										
TOTAL	36	30	14	6	16	0	30	28	0	160
8. H M L										
TOTAL	39	26	19	0	11	0	19	36	0	150
9. H M L										
TOTAL										
TOTAL H M L										
TOTAL	760	500	350	30	160	15	160	150		2125

Table 35: LINK ASSIGNMENTS

MODE: Car

YEAR: 1984

Link Origin Zone		A	B	C	D	E	F	G	H	I	J	K	TOTAL
	H	79-	168-										
1	M	80	223										
	L												
	H	35	113										
	M	5	11										
	L												
	H	0	10										
	M	6-	18-										
	L	3	7										
	H	538+	397+										
	M	387+	318										
	L												
	H	3687+	3210+										
	M	21	19										
	L	470	470										
	H												
6	M												
	L												
	H												
7	M												
	L												
In	H	4225+	3607+										
	M	408	337+										
	L	470	470+										
	Total	5103+	4414										
	H	114-	381-										
OUT	M	91-	252-										
	L	3-	7-										
	Total	208-	640-										

Table 36: LINK ASSIGNMENTS

YEAR: 1984

MODE: Bus

Link Origin Zone		A	B	C	D	E	F	G	H	I	J	K	TOTAL
1	H	22	72										
	M	132	387										
	L	0	0										
2	H	9	18										
	M	10	20										
	L	0	0										
3	H	0	0										
	M	8-	32-										
	L	12	18										
4	H	237+	210+										
	M	1020	960										
	L	940	820										
5	H	2085	1885										
	M	125	110										
	L	1470	1390										
6	H												
	M												
	L												
7	H												
	M												
	L												
In	H	2322+	2095+										
	M	1145	1070										
TOTAL	L	2410	2210										
		4375	4375										
In	H	31-	90-										
	M	150	439-										
	L	12	18-										
TOTAL		193	647										

Table 37: LINK ASSIGNMENTS

YEAR: 1984

MODE: Truck

Link Origin Zone		A	B	C	D	E	F	G	H	I	J	K	TOTAL
1	H M L	29-	57-										
2	H M L	20-	53-										
3	H M L	20-	56-										
4	H M L	0	0										
5	H M L	17-	3										
6	H M L	15-	30-										
7	H M L	28-	102+										
8 9	H M L	103+ 228+	84+ 190+										
TOTAL	H M L	129 331+	227 376+										

TABLE 38

YEAR 1984

LINK ASSIGNMENTS BY MODE CAR DCUS

ORIGIN/ZONE LINK	1	2	3	4	5	6	7	8	9	Total Passengers	Total PCU
1-1	3,350			113						3,350	
1-2	694					144		162	858	1,973	
1-3	437									437	
1-4	842									842	
2-1											
2-2											
*(2-5)											
3-1											
3-3											
3-4											
4-1				306		379		495	2,571	3,691	
4-3				86		101		98	593	878	
4-4				680						680	
4-5	274			113						387	
4-6	37			20						57	
4-7	283			58						341	
4-8	203			50						253	
*(5-2)											
5-4											
5-5											
5-6											
5-7											
5-8											
6-4						572				572	
6-5						121				121	
6-6						800				800	
6-7						110				110	
6-8						47				47	
7-4											
7-5											
7-6											
7-7											
7-8											
8-4								629	3,246	3,875	
8-5								117	565	682	
8-6								25	54	79	
8-7								170	525	695	
8-8								1,300		1,300	
8-9											
9-8									5,916	5,916	
9-9									5,916	5,916	

TABLE 39

YEAR 1984

LINK ASSIGNMENTS BY MODE BUS DCUS

ORIGIN/ZONE LINK	1	2	3	4	5	6	7	8	9	Total Passengers	Total PCU
1-1	3,650									3,650	
1-2	711			58		389		295	747	2,200	
1-3	658									658	
1-4	763									763	
2-1											
2-2											
*(2-5)											
3-1											
3-3											
3-4											
4-1				172		1,061		763	2,140	4,136	
4-3				48		229		185	520	982	
4-4				340						340	
4-5	283			23						316	
4-6	27			19						46	
4-7	176			24						200	
4-8	184			24						208	
*(5-2)											
5-4											
5-5											
5-6											
5-7											
5-8											
6-4						1,348				1,348	
6-5						345				345	
6-6						2,200				2,200	
6-7						250				250	
6-8						196				196	
7-4											
7-5											
7-6											
7-7											
7-8											
8-4								985	1,587	2,572	
8-5								181	458	639	
8-6								23	43	66	
8-7								274	458	732	
8-8								1,950		1,950	
8-9											
9-8									4,298	4,298	
9-9									4,298	4,298	

TABLE 40

YEAR 1984

LINK ASSIGNMENTS BY MODE TRUCK DCUS

ORIGIN/ZONE LINK	1	2	3	4	5	6	7	8	9	Total passengers	Total PCU
1-1	760									760	
1-2	154		68	10	28	7	30	26		323	
1-3	140	71								211	
1-4	112	85								197	
2-1		333								333	
2-2		500								500	
*(2-5)											
3-1			183							183	
3-3			350							350	
3-4			161							161	
4-1				20	59	15	66	65		225	
4-3				10	23		14	23		66	
4-4				30						30	
4-5	43	26	6							75	
4-6			26							26	
4-7	28	33	36							97	
4-8	29	20	20							69	
*(5-2)											
5-4					72					72	
5-5					160					160	
5-6					9					9	
5-7					14					14	
5-8					17					17	
6-4						15				15	
6-5											
6-6						15				15	
6-7											
6-8											
7-4							86			86	
7-5							16			16	
7-6											
7-7							160			160	
7-8							28			28	
8-4								84		84	
8-5								11		11	
8-6											
8-7								19		19	
8-8								150		150	
8-9											
9-8											
9-9											

REGISTER CONTENTS: UTB-2.1(A)

FOR CAR & BUS

YEAR: 1984

ORIGIN ZONE: 1

MODE: Bus

Values of Time ($/hr)

9 Class 1 2.18 (A)
10 Class 2 .56
11 Class 3 .18

Mode:

5 O.C. parameter 4.3 (B)
6 occupancy 45
7 expansion factor 92

0 Number of Links: 10 (C)

Link: A outbound

20 length (km) 2.1
21 V/C 1135/1600=0.17/0.24
22 free-flow speed (km/h) 64/80
23 class 1 vol 22
24 class 2 vol 132
25 class 3 vol 0

Link: B outbound

26 length ~~3.4~~
27 V/C
28 free-flow spd 68/80
29 class 1 vol 72
30 class 2 vol 387
31 class 3 vol 0

Link:

32 length
33 V/C
34 free-flow spd
35 class 1 vol
36 class 2 vol
37 class 3 vol

Link:

38 length
39 V/C
40 free-flow spd
41 class 1 vol
42 class 2 vol
43 class 3 vol

Link:

44 length
45 V/C
46 free-flow spd
47 class 1 vol
48 class 2 vol
49 class 3 vol

Link:

50 length
51 V/C
52 free-flow spd
53 class 1 vol
54 class 2 vol
55 class 3 vol

Link:

56 length
57 V/C
58 free-flow spd
59 class 1 vol
60 class 2 vol
61 class 3 vol

Link:

62 length
63 V/C
64 free-flow spd
65 class 1 vol
66 class 2 vol
67 class 3 vol

Link:

68 length
69 V/C
70 free-flow spd
71 class 1 vol
72 class 2 vol
73 class 3 vol

Year 1989

TRIP-ORIGINS - MORNING PEAK HOUR

ZONE	HIGH INCOME HH	MIDDLE INCOME HH	LOW INCOME HH	EMPLOYMENT	TOTAL
1. Car	2250	2100	350		4725
Bus	1000	3600	1500		6100
Truck				920	920
Walk	250	800	375		1425
2. Car					
Bus					
Truck				500	500
Walk					
3. Car					
Bus					
Truck				400	400
Walk					
4. Car	840	60			900
Bus	280	120			400
Truck				150	150
Walk	120	20			140
5. Car					
Bus					
Truck				240	240
Walk					
6. Car		750	300		1050
Bus		1800	1600		3400
Truck				30	30
Walk		225	300		525
7. Car					
Bus					
Truck				400	400
Walk					
8. Car	735	650	300		1685
Bus	375	1400	900		2675
Truck				180	180
Walk	75	260	100		435
9. Car	5175	350	410		5935
Bus	2325	225	2420		4970
Truck					
Walk	135	145	550		830
TOTAL Car	9000	3915	1385		14300
Bus	3980	7145	6420	2820	17545
Truck				2820	2820
Walk	580	1450	1325		3355
TOTAL	13560	12510	9130	2820	38020

TRIP DESTINATIONS - MORNING PEAK HOUR

ZONE	HIGH INCOME HH	MIDDLE INCOME HH	LOW INCOME HH	EMPLOYMENT	TOTAL
1. Car	2990	1035	460		4485
Bus	1380	2070	2070		5520
Truck				920	920
Walk	230	500	460		1190
2. Car	1300	600	200		2100
Bus	600	1000	900		2500
Truck				500	500
Walk	100	250	200		550
3. Car	1040	360	160		1560
Bus	480	900	630		2010
Truck				400	400
Walk	80	200	160		440
4. Car	725	400	100		1225
Bus	250	575	475		1300
Truck				150	150
Walk	50	100	75		225
5. Car	870	500	120		1490
Bus	300	600	540		1440
Truck				240	240
Walk	60	90	90		240
6. Car	115	80	15		210
Bus	50	150	115		315
Truck				30	30
Walk	5	40	20		65
7. Car	1150	700	150		2000
Bus	500	1250	1150		2900
Truck				400	400
Walk	25	150	200		375
8. Car	810	240	180		1230
Bus	420	600	540		1560
Truck				180	180
Walk	30	120	120		270
9. Car					
Bus					
Truck					
Walk					
TOTAL Car	9000	3915	1385		14300
Bus	3980	7145	1420		17545
Truck				2820	2820
Walk	1580	1450	1325		3355
TOTAL	13560	12510	9180	2820	38020

Year 1989

O-D DISTRIBUTION OF CAR TRIPS

ORIGIN ZONE	1	2	3	4.	5	6	7	8	9	TOTAL
1. H	873	343	280	136	201	20	281	116	0	2250
M	688	366	236	193	175	31	355	56	0	2100
L	168	73	48	24	21	4	18	19	0	375
TOTAL	1729	782	564	353	397	55	654	191	0	4725
2. H										
M										
L										
TOTAL										
3. H										
M										
L										
TOTAL										
4. H	248	146	131	129	86	9	69	23	0	840
M	11	7	7	7	7	7	7	7	0	60
L	0	0	0	0	0	0	0	0	0	0
TOTAL	259	153	138	136	93	16	76	30	0	900
5. H										
M										
L										
TOTAL										
6. H										
M	140	96	42	105	159	26	113	69	0	750
L	82	38	39	28	38	2	44	27	0	300
TOTAL	222	134	81	133	197	28	157	96	0	1050
7. H										
M										
L										
TOTAL										
8. H	163	86	48	46	68	34	128	165	0	735
M	95	78	43	61	113	9	164	87	0	650
L	74	32	24	19	24	3	43	81	0	300
TOTAL	332	196	115	126	205	46	335	333	0	1685
9. H	1707	125	621	444	508	52	672	466	0	5175
M	91	53	32	39	46	77	61	21	0	350
L	136	57	49	29	37	4	45	53	0	5135
TOTAL	1934	835	702	482	601	63	778	540		5935
TOTAL H	2990	1300	1040	725	870	115	1150	810	0	9000
M	1035	600	360	400	500	80	700	240		3915
L	460	300	160	100	120	75	150	180	0	1545
TOTAL	4485	2200	1560	1225	1490	270	2000	1230	0	14,460

O-D DISTRIBUTION OF BUS TRIPS Year 1989

ORIGIN ZONE	1	2	3	4.	5	6	7	8	9	TOTAL
1. H	401	169	135	60	63	11	94	67	0	1,000
M	1342	570	509	247	217	59	541	115	0	3,600
L	633	230	190	81	95	20	180	66	0	1,500
TOTAL	2376	969	834	393	375	90	815	248	0	6,100
2. H										
M										
L										
TOTAL										
3. H										
M										
L										
TOTAL										
4. H	93	42	34	34	27	8	25	17	0	280
M	32	16	16	16	8	8	16	8	0	120
L	0	0	0	0	0	0	0	0	0	0
TOTAL	125	58	50	50	35	16	41	25		4 0
5. H										
M										
L										
TOTAL										
6. H	0	0	0	0	0	0	0	0	0	0
M	372	229	210	201	210	73	292	239	0	1800
L	443	238	136	158	197	30	279	93	0	1600
TOTAL	815	467	346	359	407	103	571	332		3400
7. H										
M										
L										
TOTAL										
8. H	96	40	32	16	24	8	79	80	0	375
M	264	153	136	93	147	25	340	246	0	1400
L	220	93	62	51	65	17	231	161	0	900
TOTAL	580	286	230	160	236	50	650	487	0	2675
9. H	790	349	279	140	186	23	302	256	0	2325
M	64	32	29	18	18	5	41	18	0	225
L	774	339	242	169	194	48	460	194	0	2420
TOTAL	1528	720	550	32	398	76	803	468	0	4970
TOTAL H										
M										
L										
TOTAL										

O-D DISTRIBUTION OF TRUCK TRIPS Year 1989

ORIGIN ZONE	1	2	3	4.	5	6	7	8	9	TOTAL
1. H M L										
TOTAL	381	149	120	40	86	6	75	63	0	920
2. H M L										
TOTAL	133	14	74	35	20	7	74	14	0	500
3. H M L										
TOTAL	149	60	97	14	21	0	44	15	0	400
4. H M L										
TOTAL	46	24	24	16	16	0	16	8	0	150
5. H M L										
TOTAL	71	35	27	18	48	0	27	14	0	240
6. H M L										
TOTAL	10	10	5	0	0	0	5	0	0	30
7. H M L										
TOTAL	92	51	34	17	30	17	121	38	0	400
8. H M L										
TOTAL	38	28	19	10	19	0	38	28	0	180
9. H M L										
TOTAL	120	100	60	5	8	2	10	20	0	325
TOTAL H M L										
TOTAL	920	500	400	150	240	30	400	180	0	3,145

LINK ASSIGNMENTS BY MODE CAR

ORIGIN ZONE	1	2	3	4	5	6	7	8	9	Total Passengers	Total FCU
LINK 1-1	4725									4725	
1-2	782			153		134		196	835	2100	
1-3	564									564	
1-4	1650									1650	
2-1											
2-2											
*(2-5)											
3-1											
3-3											
3-4											
4-1				312		356		528	2769	3965	
4-3				138		81		115	702	1036	
4-4				900						900	
4-5	397			93						490	
4-6	55			16						71	
4-7	654			76						730	
4-8	191			30						221	
*(5-2)											
5-4											
5-5											
5-6											
5-7											
5-8											
6-4						570				570	
6-5						197				197	
6-6						1050				1050	
6-7						151				151	
6-8						96				96	
7-4											
7-5											
7-6											
7-7											
7-8											
8-4								769	3973	4742	
8-5								205	601	806	
8-6								46	63	109	
8-7								335	778	1113	
8-8								1685		1685	
8-9											
9-8									5135	5135	
9-9									5135	5135	

Year 1989

LINK ASSIGNMENTS BY MODE

ORIGIN ZONE	1	2	3	4	5	6	7	8	9	Total Passengers	Total FCU
LINK 1-1	6100									6100	
1-2	969			58		467		286		1780	
1-3	834									834	
1-4	1927									1927	
2-1											
2-2											
*(2-5)											
3-1											
3-3											
3-4											
4-1				183		1282		866	2248	4579	
4-3				50		346		230	540	1166	
4-4				400						400	
4-5	375			35						410	
4-6	90			16						106	
4-7	815			41						856	
4-8	248			25						273	
*(5-2)											
5-4											
5-5											
5-6											
5-7											
5-8											
6-4						1987				1987	
6-5						407				407	
6-6						3400				3400	
6-7						571				571	
6-8						332				332	
7-4											
7-5											
7-6											
7-7											
7-8											
8-4								1256	3115	4371	
8-5								236	398	634	
8-6								50	76	126	
8-7								650	803	1453	
8-8								2675		2675	
8-9											
9-8									4970	4970	
9-9									4970	4970	

Year 1989

LINK ASSIGNMENTS BY MODE: TRUCK

ORIGIN ZONE	1	2	3	4	5	6	7	8	9	Total Passengers	Total FCU
LINK 1-1	920									920	
1-2	149		60	24	35	10	51			329	
1-3	120	74								194	
1-4	270	150								420	
2-1		357								357	
2-2		500								500	
2-5											
3-1			209							209	
3-3			400							400	
3-4			94							94	
4-1				70	106	20	143	66		405	
4-3				24	27	5	34	19		109	
4-4				150						150	
4-5	86	20	21	16						143	
4-6	6	7								13	
4-7	75	74	44	16						209	
4-8	63	14	15	8						100	
5-2											
5-4					157					157	
5-5					240					240	
5-6					0					0	
5-7					27					27	
5-8					14					14	
6-4						25				25	
6-5											
6-6						30				30	
6-7						5				5	
6-8											
7-4							194			194	
7-5							30			30	
7-6							17			17	
7-7							400			400	
7-8							38			38	
8-4								95		95	
8-5								19		19	
8-6								38		38	
8-7											
8-8								180		180	
8-9											
9-8											
9-9											

PROGRAMMING LAND DEMAND

A1) With No highway component

A2) With highway component

B1) With weak public transport component
B1A) Context A1
B1B) Context A2

B2) With strong public transport component
B2A) Context A1
B2B) Context A2

					$\frac{LW}{\sqrt{c}}$	$\frac{GLW}{\sqrt{c}}$	B		
1	83	83	6889	898 30	229.6	.75	7875	8300	79
4	4 8	2	8	4.7	1.702	.01	105	200	.02
8	60 48	20	1200	16.1	59.6	.24	2520	2000	.19
					305.8		10500	10500	

LOW MORE

	L_i	W_i	$\frac{LW}{\sqrt{c}}$		$\frac{LW}{\sqrt{c}}$	$\frac{GLWD}{\sqrt{c}}$	MORE	
1	~~[illegible]~~ 12.13	~~4~~	~~[illegible]~~ 54	10	60	.70	3710	~~4~~100
4	–	0	–	–				–
8	10.8	12	130	6	22	.30	1590	1200
					72			5300

- 98 -

$$G_1^z \, 2 \, \frac{G^2 \, L_1 \, W_1^z}{C_1^z} \, B$$

Total loan cost/mm

	H	M	L
1 2	39.4 9.9 50 1404 1494	11.3 CAR 5.4 BUS 16 882 898	2.2 BUS 2 103 105
3 4 5 6	22.5 CAR 5.3 BUS 28 432 460	.72 .71 1 21 22	0
7 8 9	51.3 CAR 16.1 BUS 67 432 499	25.4 CAR 22.3 BUS 48 210 258	6.8 BUS 7 30 37

1984 - 1989 Volume Increments
Links A & B

1989

			LINK A			LINK B				
			1984	1989	Increment	1979	1984	1989	1984-89 Increment	1979-84 Increment
High	Auto	In	4223	5279	211.2	809	3603	4479	174.8	559.2
		Out	114	139	5	254	281	489	41.6	5.4
	Bus	In	2322	2364	8.4	262	2095	1983	22.4	366.6
		Out	31	84	10.6	78	90	203	22.6	2.4
Med.	Auto	In	418	892	94.5	625	357	667	62	53.6
		Out	91	132	8.2	86	252	607	71	33.2
	Bus	In	1245	1361	23.2	1083	1060	977	16.6	4.6
		Out	142	462	64	132	439	1211	154.4	61.4
Low	Auto	In	470	576	21.2	0	470	488	3.6	94
		Out	3	46	8.6	0	7	108	20.2	1.4
	Bus	In	2410	3965	311	1522	2210	3274	212.8	137.6
		Out	6	159	30.6	114	18	618	120	19.2
	Truck	In	342	417	15	230	387	576	37.8	31.4
		Out	342	417	15	230	387	576	37.8	31.4

Year: 1984

Origin Zone: 4

Mode: Car

Values of Time ($/hr) (A)

class 1	2.18
class 2	.56
class 3	.18

Mode: (B)

O.C. parameter	1
occupancy	~~1.6~~
expansion factor	107.4

Number of Links: 9 (C)

Link: A Out

length (km)	2.1
V/C	.73/.24
free-flow speed (km/h)	80/100
class 1 vol	79
class 2 vol	86
class 3 vol	0

Link: B Out

length	3.4
V/C	.96/.32
free-flow spd	80/100
class 1 vol	168
class 2 vol	223
class 3 vol	0

Link: C Out

length	1.5
V/C	.62
free-flow spd	60
class 1 vol	363
class 2 vol	408
class 3 vol	0

Link: D Out

length	2.4
V/C	.49
free-flow spd	60
class 1 vol	402
class 2 vol	453
class 3 vol	0

Link: E Out

length	1.4
V/C	1.15
free-flow spd	60
class 1 vol	284
class 2 vol	231
class 3 vol	50

Link: F Out

length	1.0
V/C	.27
free-flow spd	60
class 1 vol	198
class 2 vol	231
class 3 vol	50

Link: H Out

length	0.5
V/C	.05
free-flow spd	60
class 1 vol	18
class 2 vol	16
class 3 vol	0

Link: J Out

length	0.9
V/C	.52
free-flow spd	60
class 1 vol	177
class 2 vol	169
class 3 vol	0

Link: K Out

length	0.5
V/C	.54
free-flow spd	60
class 1 vol	89
class 2 vol	73
class 3 vol	0

Year: 1984

Origin Zone: 4

Mode: Car

Values of Time ($/hr) (A)

class 1	
class 2	
class 3	

Mode: (B)

O.C. parameter	
occupancy	
expansion factor	

Number of Links: 9 (C)

Link: A Out

length (km)	2.1
V/C	.73/.24
free-flow speed (km/h)	80/100
class 1 vol	35
class 2 vol	5
class 3 vol	0

Link: B Out

length	3.4
V/C	.96/.32
free-flow spd	80/100
class 1 vol	113
class 2 vol	11
class 3 vol	0

Link: C Out

length	1.5
V/C	.62
free-flow spd	60
class 1 vol	200
class 2 vol	17
class 3 vol	0

Link: D In

length	2.4
V/C	1.02
free-flow spd	60
class 1 vol	246
class 2 vol	17
class 3 vol	0

Link: F Out

length	1.4
V/C	1.15
free-flow spd	60
class 1 vol	88
class 2 vol	6
class 3 vol	0

Link: G In

length	2.2
V/C	.59
free-flow spd	60
class 1 vol	79
class 2 vol	6
class 3 vol	0

Link: H Out

length	.5
V/C	.05
free-flow spd	60
class 1 vol	26
class 2 vol	0
class 3 vol	0

Link: J Out

length	.9
V/C	.52
free-flow spd	60
class 1 vol	61
class 2 vol	6
class 3 vol	0

Link: K Out

length	.5
V/C	.54
free-flow spd	60
class 1 vol	78
class 2 vol	6
class 3 vol	0

Origin Zone: 6

Mode: Car

Values of Time ($/hr)

class 1		(A)
class 2		
class 3		

Mode:

O.C. parameter		(B)
occupancy		
expansion factor		

Number of Links: 9 (C)

Link: A Out

length (km)	2.1
V/C	.73/.24
free-flow speed (km/h)	80/100
class 1 vol	0
class 2 vol	6
class 3 vol	3

Link: B Out

length	3.4
V/C	.96/.32
free-flow spd	80/100
class 1 vol	0
class 2 vol	18
class 3 vol	7

Link: C In

length	1.5
V/C	1.25
free-flow spd	60
class 1 vol	0
class 2 vol	20
class 3 vol	8

Link: D In

length	2.4
V/C	1.02
free-flow spd	60
class 1 vol	0
class 2 vol	12
class 3 vol	4

Link: E Out

length	1.4
V/C	1.15
free-flow spd	60
class 1 vol	0
class 2 vol	3
class 3 vol	1

Link: G In

length	2.2
V/C	.59
free-flow spd	60
class 1 vol	0
class 2 vol	6
class 3 vol	3

Link: H In

length	.5
V/C	.04
free-flow spd	60
class 1 vol	0
class 2 vol	56
class 3 vol	19

Link: J Out

length	.9
V/C	.52
free-flow spd	60
class 1 vol	0
class 2 vol	16
class 3 vol	5

Link: K Out

length	.5
V/C	.54
free-flow spd	60
class 1 vol	0
class 2 vol	12
class 3 vol	4

Origin Zone: 8

Mode: Car

Values of Time ($/hr)

class 1		(A)
class 2		
class 3		

Mode:

O.C. parameter		(B)
occupancy		
expansion factor		

Number of Links: 9 (C)

Link: A In

length (km)	2.1
V/C	1.5/.96
free-flow speed (km/h)	80/100
class 1 vol	536
class 2 vol	387
class 3 vol	0

Link: B In

length	3.4
V/C	1.5/.89
free-flow spd	395
class 1 vol	318
class 2 vol	0
class 3 vol	

Link: C In

length	1.5
V/C	1.25
free-flow spd	60
class 1 vol	317
class 2 vol	264
class 3 vol	0

Link: D In

length	2.4
V/C	1.02
free-flow spd	60
class 1 vol	235
class 2 vol	215
class 3 vol	0

Link: E Out

length	1.4
V/C	1.15
free-flow spd	60
class 1 vol	96
class 2 vol	77
class 3 vol	0

Link: G In

length	2.2
V/C	.59
free-flow spd	60
class 1 vol	69
class 2 vol	40
class 3 vol	0

Link: H Out

length	.5
V/C	.05
free-flow spd	60
class 1 vol	9
class 2 vol	11
class 3 vol	0

Link: J Out

length	1
V/C	.52
free-flow spd	60
class 1 vol	69
class 2 vol	43
class 3 vol	0

Link: K Out

length	5
V/C	.54
free-flow spd	60
class 1 vol	141
class 2 vol	69
class 3 vol	0

Year: 1984

Origin Zone: 1

Mode: Bus

Values of Time ($/hr)		
class 1		(A)
class 2		
class 3		

Mode:		
O.C. parameter	4.3	(B)
occupancy	45	
expansion factor	92	

Number of Links:	9	(C)

Link: A Out	
length (km)	2.1
V/C	.73/.24
free-flow speed (km/h)	64/80
class 1 vol	72
class 2 vol	387
class 3 vol	0

Link: B Out	
length	1.5
V/C	.96/.32
free-flow spd	64/80
class 1 vol	72
class 2 vol	387
class 3 vol	0

Link: C Out	
length	1.5
V/C	.62
free-flow spd	42
class 1 vol	116
class 2 vol	738
class 3 vol	0

Link: D Out	
length	2.4
V/C	.49
free-flow spd	42
class 1 vol	125
class 2 vol	819
class 3 vol	0

Link: E Out	
length	1.4
V/C	1.15
free-flow spd	47
class 1 vol	109
class 2 vol	443
class 3 vol	194

Link: F Out	
length	1.0
V/C	.29
free-flow spd	42
class 1 vol	67
class 2 vol	312
class 3 vol	133

Link: H Out	
length	.5
V/C	.05
free-flow spd	02
class 1 vol	0
class 2 vol	36
class 3 vol	0

Link: J Out	
length	.9
V/C	.52
free-flow spd	42
class 1 vol	44
class 2 vol	315
class 3 vol	0

Link: K Out	
length	.5
V/C	.54
free-flow spd	42
class 1 vol	50
class 2 vol	255
class 3 vol	0

Year: 1984

Origin Zone: 41

Mode: Bus

Values of Time ($/hr) (A)
- class 1 ____
- class 2 ____
- class 3 ____

Mode: (B)
- O.C. parameter ____
- occupancy ____
- expansion factor ____

Number of Links: 9 (C)

Link: A Out	
length (km)	2.1
V/C	.73/.24
free-flow speed (km/h)	64/80
class 1 vol	9
class 2 vol	10
class 3 vol	0

Link: B Out	
length	3.4
V/C	.96/.32
free-flow spd	64/80
class 1 vol	18
class 2 vol	20
class 3 vol	0

Link: C Out	
length	1.5
V/C	.62
free-flow spd	42
class 1 vol	49
class 2 vol	30
class 3 vol	0

Link: D In	
length	2.4
V/C	1.02
free-flow spd	42
class 1 vol	75
class 2 vol	40
class 3 vol	0

Link: E Out	
length	1.4
V/C	1.15
free-flow spd	42
class 1 vol	27
class 2 vol	10
class 3 vol	0

Link: G In	
length	2.2
V/C	.59
free-flow spd	47
class 1 vol	27
class 2 vol	10
class 3 vol	0

Link: H Out	
length	.5
V/C	.05
free-flow spd	42
class 1 vol	9
class 2 vol	0
class 3 vol	0

Link: J Out	
length	.9
V/C	.52
free-flow spd	42
class 1 vol	22
class 2 vol	10
class 3 vol	0

Link: K Out	
length	.5
V/C	.54
free-flow spd	42
class 1 vol	9
class 2 vol	10
class 3 vol	0

Year: 1984

Origin Zone: 6

Mode: Bus

Values of Time ($/hr) (A)

class 1	
class 2	
class 3	

Mode: (B)

O.C. parameter	
occupancy	
expansion factor	

Number of Links: 9 (C)

Link: A Out

length (km)	2.1
V/C	.73/.24
free-flow speed (km/h)	64/80
class 1 vol	0
class 2 vol	8
class 3 vol	6

Link: B Out

length	3.4
V/C	.96/.32
free-flow spd	64/80
class 1 vol	0
class 2 vol	32
class 3 vol	18

Link: C In

length	1.5
V/C	1.25
free-flow spd	42
class 1 vol	0
class 2 vol	56
class 3 vol	20

Link: D In

length	2.4
V/C	1.02
free-flow spd	42
class 1 vol	0
class 2 vol	36
class 3 vol	12

Link: E Out

length	1.4
V/C	1.15
free-flow spd	42
class 1 vol	0
class 2 vol	8
class 3 vol	3

Link: G In

length	2.2
V/C	.59
free-flow spd	42
class 1 vol	0
class 2 vol	16
class 3 vol	6

Link: H In

length	.5
V/C	.04
free-flow spd	42
class 1 vol	0
class 2 vol	112
class 3 vol	54

Link: J Out

length	.9
V/C	.52
free-flow spd	42
class 1 vol	0
class 2 vol	26
class 3 vol	16

Link: K Out

length	.5
V/C	.54
free-flow spd	42
class 1 vol	0
class 2 vol	24
class 3 vol	12

Origin Zone: 8

Mode: Bus

Values of Time ($/hr) (A)

class 1	
class 2	
class 3	

Mode: (B)

O.C. parameter	
occupancy	
expansion factor	

Number of Links: 9 (C)

Link: A In

length (km)	2.1
V/C	1.5/.96
free-flow speed (km/h)	64/80
class 1 vol	231
class 2 vol	1120
class 3 vol	940

Link: B In

length	3.4
V/C	1.5/.89
free-flow spd	64/80
class 1 vol	210
class 2 vol	160
class 3 vol	820

Link: C In

length	1.5
V/C	1.25
free-flow spd	42
class 1 vol	180
class 2 vol	800
class 3 vol	720

Link: D In

length	2.4
V/C	1.25
free-flow spd	42
class 1 vol	140
class 2 vol	630
class 3 vol	600

Link: E Out

length	1.4
V/C	1.15
free-flow spd	42
class 1 vol	50
class 2 vol	210
class 3 vol	200

Link: G In

length	2.2
V/C	.54
free-flow spd	42
class 1 vol	30
class 2 vol	140
class 3 vol	100

Link: H Out

length	.5
V/C	.05
free-flow spd	42
class 1 vol	0
class 2 vol	20
class 3 vol	0

Link: J Out

length	.9
V/C	.52
free-flow spd	43
class 1 vol	30
class 2 vol	140
class 3 vol	100

Link: K Out

length	.5
V/C	.54
free-flow spd	42
class 1 vol	27
class 2 vol	160
class 3 vol	120

Year:1984

ORIGIN ZONE: 1
Mode: Truck

Model Parameters

Labor cost ($/hr)	1	(B)
O.C. parameter	5.2	
expansion factor	115	

Number of Links: 8 (C)

Link: A Out

	length (km)	2.1
21	V/C	.73/.24
22	free-flow speed (km/h)	80/100
	volume	135

Link: B Out

	length	3.4
25	V/C	.96/.32
26	free-flow speed	80/100
	volume	135

Link: C Out

length	1.5
V/C	.62
free-flow speed	60
volume	178

Link: D Out

length	2.4
V/C	.49
free-flow speed	60
volume	190

Link: E Out

length	1.4
V/C	1.15
free-flow speed	60
volume	158

Link: F Out

length	1.0
V/C	29
free-flow speed	60
volume	140

Link: H Out

length	15
V/C	.05
free-flow speed	60
volume	0

Link: J Out

length	.9
V/C	.52
free-flow speed	60
volume	43

Link: K Out

length	.5
V/C	.54
free-flow speed	60
volume	28

Year: 1984

ORIGIN ZONE: 2
Mode: Truck

Modal Parameters
- Labor cost ($/hr) ______ (B)
- O.C. parameter ______
- expansion factor ______

Number of Links: ______ (C)

Link:	
length (km)	
V/C	.73/.24
free-flow speed (km/h)	85/100
23 volume	72

Link:	
length	
V/C	.96/.32
free-flow speed	80/100
27 volume	105

Link:	
length	
V/C	
free-flow speed	
31 volume	131

Link:	
length	
V/C	
free-flow speed	
35 volume	137

Link:	
length	
37 V/C	.56
free-flow speed	
31 volume	375

Link:	
length	
V/C	
free-flow speed	
43 volume	71

Link:	
length	
V/C	
free-flow speed	
volume	

Link:	
length	
V/C	
free-flow speed	
47 volume	26

Link:	
length	
V/C	
free-flow speed	
51 volume	33

Year: 1984

ORIGIN ZONE: 3
Mode: Truck

Modal Parameters

Labor cost ($/hr)		(B)
O.C. parameter		
expansion factor		
Number of Links:	9	(C)

Link:	A Out
length (km)	2.1
V/C	.73/.24
free-flow speed (km/h)	80/100
volume	58

Link:	B Out
length	3.4
V/C	.96/.32
free-flow speed	80/100
volume	94

Link:	C Out
length	1.5
V/C	.62
free-flow speed	60
volume	126

Link:	E Out
length	1.4
V/C	1.15
free-flow speed	60
volume	68

Link:	Fin
length	1.0
V/C	.18
free-flow speed	60
volume	183

Link:	G Out
length	2.2
V/C	.25
free-flow speed	60
volume	132

Link:	H Out
length	.5
V/C	.05
free-flow speed	60
volume	6

Link:	J Out
length	.9
V/C	.52
free-flow speed	60
volume	26

Link:	K Out
length	.5
V/C	.54
free-flow speed	60
volume	36

Year: 1984

ORIGIN ZONE: 4
Mode: Truck

Modal Parameters
- Labor cost ($/hr) ______ (B)
- O.C. parameter ______
- expansion factor ______

Number of Links: 3 (C)

Link: D In	
length (km)	2.4
V/C	1.02
free-flow speed (km/h)	60
volume	20

Link: E Out	
length	1.4
V/C	1.15
free-flow speed	60
volume	10

Link: G In	
length	2.2
V/C	59
free-flow speed	60
volume	10

Link:	
length	
V/C	
free-flow speed	
volume	

Link:	
length	
V/C	
free-flow speed	
volume	

Link:	
length	
V/C	
free-flow speed	
volume	

Link:	
length	
V/C	
free-flow speed	
volume	

Link:	
length	
V/C	
free-flow speed	
volume	

Link:	
length	
V/C	
free-flow speed	
volume	

Year: 1984

ORIGIN ZONE: 5
Mode: Truck

Modal Parameters		
Labor cost ($/hr)		(B)
O.C. parameter		
expansion factor		
Number of Links:	9	(C)

Link: A Out	
length (km)	2.1
V/C	.73/.24
free-flow speed (km/h)	80/100
volume	39

Link: B Out	
length	3.4
V/C	.96/.32
free-flow speed	80/100
volume	53

Link: C In	
length	1.5
V/C	1.25
free-flow speed	60
volume	82

Link: D In	
length	2.4
V/C	1.02
free-flow speed	60
volume	59

Link: E Out	
length	1.4
V/C	1.15
free-flow speed	60
volume	28

Link: G In	
length	2.2
V/C	.59
free-flow speed	60
volume	23

Link: H Out	
length	.5
V/C	.05
free-flow speed	60
volume	9

Link: J In	
length	.9
V/C	.23
free-flow speed	60
volume	182

Link: K Out	
length	.5
V/C	.54
free-flow speed	60
volume	14

Year: 1984

ORIGIN ZONE: 6
Mode: Truck

Changes from Zone 5

Modal Parameters
- Labor cost ($/hr) ______ (B)
- O.C. parameter ______
- expansion factor ______

Number of Links: 7 (C)

Link:
- length (km) ______
- V/C ______
- free-flow speed (km/h) ______
- volume 0

Link:
- length ______
- V/C ______
- free-flow speed ______
- volume 0

Link:
- length ______
- V/C ______
- free-flow speed ______
- volume 15

Link:
- length ______
- V/C ______
- free-flow speed ______
- volume 15

Link:
- length ______
- V/C ______
- free-flow speed ______
- volume 7

Link:
- length ______
- V/C ______
- free-flow speed ______
- volume 0

Link: H In
- length ______
- V/C .04
- free-flow speed ______
- volume 15

Link:
- length ______
- V/C ______
- free-flow speed ______
- volume ______

Link:
- length ______
- V/C ______
- free-flow speed ______
- volume ______

Year: 1984

ORIGIN ZONE: 7
Mode: Truck

Changes from Zone 5

Modal Parameters
- Labor cost ($/hr) ______ (B)
- O.C. parameter ______
- expansion factor ______

Number of Links: 9 (C)

Link:	
length (km)	
V/C	.73/.24
free-flow speed (km/h)	80/100
volume	66

Link: B In	
length	
V/C	1.5/.89
free-flow speed	80/100
volume	102

Link:	
length	
V/C	
free-flow speed	
volume	86

Link:	
length	
V/C	
free-flow speed	
volume	66

Link:	
length	
V/C	
free-flow speed	
volume	30

Link:	
length	
V/C	
free-flow speed	
volume	14

Link:	
length	
V/C	
free-flow speed	
volume	0

Link:	
length	
V/C	.52
free-flow speed	
volume	16

Link:	
length	
V/C	.25
free-flow speed	
volume	198

Year: 1984

ORIGIN ZONE: 8
Mode: Truck

Changes from Zone 7

Modal Parameters

Labor cost ($/hr)		(B)
O.C. parameter		
expansion factor		
Number of Links:	9	(C)

Link: A In

length (km)	
V/C	1.5/.96
free-flow speed (km/h)	80/100
volume	114

Link: B In

length	
V/C	1.5/.89
free-flow speed	80/100
volume	95

Link:

length	
V/C	
free-flow speed	
volume	84

Link:

length	
V/C	
free-flow speed	
volume	65

Link:

length	
V/C	
free-flow speed	
volume	.26

Link:

length	
V/C	
free-flow speed	
volume	19

Link:

length	
V/C	
free-flow speed	
volume	0

Link:

length	
V/C	
free-flow speed	
volume	11

Link:

length	
V/C	.54
free-flow speed	
volume	19

Year: 1984

BENEFITS TO RESIDENTS OF ORIGIN ZONE 1

		AUTO	BUS
NO BUILD			
Income class 1	OC	15501.79	757.77
	TC	26508.26	11165.60
Income class 2	OC	17232.42	4317.18
	TC	7351.37	15500.10
Income class 3	OC	642.27	308.73
	TC	124.18	561.18
Total	OC	33376.47	5383.69
	TC	33983.81	27226.89
BUILD			
Income class 1	OC	14865.12	705.71
	TC	21635.33	9043.61
Income class 2	OC	16403.70	4033.77
	TC	5747.25	12536.17
Income class 3	OC	642.27	308.73
	TC	124.18	561.18
Total	OC	31911.08	5048.21
	TC	27506.75	22140.97
DIFFERENCE			
Income class 1	OC	636.67	52.06
	TC	4872.93	2122.00
Income class 2	OC	828.72	283.42
	TC	1604.12	2963.93
Income class 3	OC	0.00	0.00
	TC	0.00	0.00
Total	OC	1465.39	335.48
	TC	6477.06	5085.92

Year 1984

BENEFITS TO RESIDENTS OF ORIGIN ZONE 4

		AUTO	BUS
NO BUILD			
Income class 1	CC	9522.10	350.04
	TC	19656.22	6354.84
Income class 2	CC	777.92	211.92
	TC	400.14	946.12
Income class 3	CC	0.00	0.00
	TC	0.00	0.00
Total	CC	10300.02	561.96
	TC	20056.36	7300.96
BUILD			
Income class 1	CC	9105.81	336.11
	TC	16541.71	5790.64
Income class 2	CC	736.34	196.45
	TC	318.58	785.08
Income class 3	CC	0.00	0.00
	TC	0.00	0.00
Total	CC	9842.16	532.56
	TC	16860.29	6575.72
DIFFERENCE			
Income class 1	CC	416.29	13.93
	TC	3114.51	564.20
Income class 2	CC	41.57	15.48
	TC	81.56	161.04
Income class 3	CC	0.00	0.00
	TC	0.00	0.00
Total	CC	457.86	29.40
	TC	3196.07	725.24

BENEFITS TO RESIDENTS OF ORIGIN ZONE 6

		AUTO	BUS
NO BUILD			
Income class 1	OC	0.00	0.00
	TC	0.00	0.00
Income class 2	OC	1055.08	325.44
	TC	560.76	1581.57
Income class 3	OC	402.91	145.92
	TC	68.81	211.23
Total	OC	1457.99	471.36
	TC	629.57	1792.80
BUILD			
Income class 1	OC	0.00	0.00
	TC	0.00	0.00
Income class 2	OC	988.49	302.77
	TC	432.34	1343.70
Income class 3	OC	376.57	132.77
	TC	52.27	167.03
Total	OC	1365.06	435.54
	TC	484.60	1510.73
DIFFERENCE			
Income class 1	OC	0.00	0.00
	TC	0.00	0.00
Income class 2	OC	66.59	22.68
	TC	128.42	237.87
Income class 3	OC	26.34	13.15
	TC	16.55	44.20
Total	OC	92.93	35.82
	TC	144.97	282.07

Year 1984

BENEFITS TO RESIDENTS OF ORIGIN ZONE 8

		AUTO	BUS
NO BUILD			
Income class 1	OC	23756.66	1637.97
	TC	77277.15	44108.70
Income class 2	OC	18663.96	7507.09
	TC	15639.94	51844.24
Income class 3	OC	0.00	6519.95
	TC	0.00	14509.99
Total	OC	42420.63	15665.01
	TC	92917.09	110462.93
BUILD			
Income class 1	OC	20887.15	1475.81
	TC	41713.83	25365.74
Income class 2	OC	16454.43	6756.39
	TC	8619.70	29539.95
Income class 3	OC	0.00	5883.00
	TC	0.00	8429.37
Total	OC	37341.58	14115.20
	TC	50333.53	63335.06
DIFFERENCE			
Income class 1	OC	2869.51	162.16
	TC	35563.32	18742.96
Income class 2	OC	2209.54	750.70
	TC	7020.24	22304.29
Income class 3	OC	0.00	636.94
	TC	0.00	6080.63
Total	OC	5079.05	1549.81
	TC	42583.56	47127.88

Year 1984

TRUCK COSTS FROM EACH ORIGIN ZONE

Origin Zone:	1	2	3	4
No-Build				
OC *	82483.03	73860.69	54476.85	4229.52
labor	7834.72	6080.97	4706.83	554.65
Build				
OC *	77669.78	70182.93	51222.28	4229.52
labor	5719.15	4485.11	3306.68	554.65
Difference				
OC *	4813.25	3677.76	3254.57	0.00
labor	2115.56	1595.86	1400.15	0.00
Total OC	6928.81	5273.63	4654.72	0.00

Origin Zone:	5	6	7	8
No-Build				
OC	37543.85	3925.04	48609.66	54610.80
labor	4394.30	598.01	7464.02	9364.21
Build				
OC	35671.86	3925.04	44407.69	48762.77
labor	3577.03	598.01	4650.16	5377.30
Difference				
OC *	1871.99	0.00	4201.97	5848.03
labor	817.27	0.00	2813.86	3986.91
Total OC	2689.26	0.00	7015.83	9834.94

6.4 Instructions for computing benefits to a single link (Second Program)

BSL-2.3(A)

USER INSTRUCTIONS

		Enter	Press
1.	Set partition.	7	2nd Op. 17
2.	Enter data on Input Data Sheet into appropriate registers. This includes data this will probably not change during the analysis: modal characteristics, values of time, discount rate. It also includes data-specific to one link: modal volumes, volume increments (or growth rate), length, and capacity. To check that all the data is properly stored, press 0 INV 2nd list.		
3.	Load program BSL-2.3(A) for liniar growth, or program BSL-2.3(B) for exponential growth. Load sides 1 and 2.	0 0	(load sides) (load side 2)
4.	Initialize the accumulators of discounted costs.	0	STO 68 STO 69
5.	Enter number of years for which costs should be computed with volume and growth data as given.	n_1	STO 00
6.	Fix the display format to have 2 decimal places		2nd Fix 2
7.	Computer costs for n_1 years	B	
8.	To change the incremental volumes		

SINGLE LINK COST STREAM PROGRAM

BSL 2.3(A) INPUT DATA

Register		Link A 1979 NB	Link A 1981 NB	Link A 1981 Build	Link B 1979 NB	Link B 1981 NB	Link B 1981 Build	Link C 1979 NB	Link C 1984 NB
8	Auto free-flow speed	80		100					
9	expansion factor	107.4							
10	OC parameter	1							
11	occupancy	1.6							
12	Bus free-flow speed	64		80					
	expansion factor	92							
	OC parameter	4.3							
	occupancy	45							
16	Truck free-flow speed	80		100					
	expansion factor	115							
	OC parameter	5.2							
	occupancy	1							
20	Class 1 auto volume in	809	2175.4					757	
21	" out	254	198					349	
22	bus volume in	262	1086					228	
23	" out	78	59.2					97	
24	Class 2 auto volume in	625	538.2					609	
25	" out	86	88					121	
26	bus " in	1083	1107.8					1052	
27	" out	132	139.2					162	
28	Class 3 auto volume in	0	188					0	
29	" out	0	1.2					0	
30	bus " in	1522	1877.2					1418	
31	" out	114	73.2					147	
32	Truck volume in	230	270.4					250	503
	" out	230	270.4					250	503
34	Class 1 value of time	2.18							
35	Class 2 VOT	.56							
36	Class 3 VOT	.18							
37	Auto PCU equivalency	1							
38	Bus PCU "	3							
39	Truck PCU "	3							

Yearly incremental volumes

Register		Link A	Link B	Link C
40	Class 1 Auto yiv in	683.2	559.2	489
	" out	-28	5.4	10
	Bus " in	412	366.6	169
	" out	- 9.4	2.4	16
44	Class 2 Auto yiv in	-43.4	-53.6	57
45	" out	1	33.2	58
46	Bus " in	12.4	-4.6	69
47	" out	3.6	61.4	62
48	Class 3 Auto yiv in	94	94	103
49	Auto " out	0.6	1.4	10
50	Bus " in	177.6	137.6	219
51	Bus " out	-20.4	-19.2	0
52	Truck " in	20.2	31.4	50.6
53	" out	20.2	31.4	50.6

54 1 + discount rate	1.11				
55* first year discount factor	1	1.2321		1.2321	
56 link length (km)	3.4			3.4	
57 link capacity (PCV)	1600	4800	4800		4800
68 cumulative discounted total OC					
69 cumulative discounted total TC					

Supplementary Yearly incremental volumes for 1984	Link A 1984 NB	Link B 1984 NB	Link C 1984 NB
40 Class 1 Auto yiv in	211.2	174.8	135
41 " out	5	41.6	70
42 Bus " in	8.4	-22.4	138
43 " out	10.6	22.6	23
44 Class 2 Auto yiv in	94.5	62	-39
45 " out	8.2	71	80
46 Bus " in	23.2	-16.6	32
47 " out	64	154.4	142
48 Class 3 Auto yiv in	21.2	3.6	3
49 " out	8.6	20.2	17
50 Bus " in	311	212.8	10
51 Bus " out	30.6	120	60
52 Truck " in	15	37.8	58
53 " out	15	37.8	58

COMPUTING COSTS ON LINK A, 1981-2000

Link A No-Build

1. Load liniar growth program, BSL-2.3(A)

2. Enter data for Link A, 1981, No-Build. Store it on a magnetic card (press 3 2nd write and load side 3; 4 2nd write & load side)

3. a. Enter 0 STO 68 STO 69
   b. Enter 3 STO 00. Press 2nd Fix 2.
   c. Press B
      (costs for 1981, 1982, 1983 will be printed)
      (volumes will be updated to 1984)

4. a. Enter incremental volumes for the 1984-1989 interval, in registers 40-53.
   b. Enter 5 STO 00
   c. Press B
      (costs for 1984, 85, 86, 87, 88 will be printed)
      (volumes will be updated to 1989)

5. Load exponential growth program, BSL-2.3(B), sides 1 & 2.

6. a. Enter cumulative operating costs into register 68
      Enter cumulative time costs into register 69.
      (these costs were the first 2 of the last 3 numbers just printed)
   b. Enter growth factor: 1.05 STO 41
   c. Enter 12 STO 00
   d. Press B
      (Costs for 1989-2000 will be printed - takes 30 minutes)

Link A Build

7. If you have the Link A 1981 No-Build data on a card, load in (press 0, enter side 3; press 0, enter side 4.
   If not, the 1981 data may be entered manually.

8. Change the free-flow speeds (registers 8, 12, 16) and capacity (register 57) for build.

9. Proceed with Stpes 3-6.

DISCOUNTED COSTS ON SINGLE LINK INPUTS

BSL-2.3(A) CARD B

Register Content (Input Data)

*00 number of years
01 counter
02 counter
03 pointer
04 pointer
05 pointer
06 pointer
07 pointer
08 <u>car</u> free-flow speed)
09 expansion factor)
10 operating cost)
parameter)
11 occupancy)
12 bus) modal
13) char.
14) file
15)
16 truck)
17)
18)
19)
20 Class 1 <u>car</u> volume in)
21 out)
22 <u>bus</u> in)
23 out)
24 Class 2 <u>car</u>)
25) car,
26 <u>bus</u>) bus
27) vols.
28 Class 3 <u>car</u>)
29)
30 <u>bus</u>)
31)
32 truck volume in) truck
33 out) vols.
34 Class 1 VOT)
35 2) VOT
36 3)
37 car PCV equivalency)
38 bus " ") PCU
39 truck " ")

40 incremental class 1 <u>car</u> in)
41 volumes out)
42 <u>bus</u> in)
43 out)
44 class 2 car)
45)
46 bus)
47)
48 class 3 car)
49)
50 bus)
51)
52 truck incremental)
volume in)
53 truck incremental)
volume out)
54 1+ discount rate
55 discount factor for first year
56 length
57 capacity (for 2 hours)

LINK A
No-Build 1979-84

# of years →	6 ← (6)	00	
	0.	01	
	0.	02	
	0.	03	
	0.	04	
	0.	05	
Modal	0.	06	
Char's	0.	07	
	80.	08	free-flow spd
expansion factor	107.4	09	
	1.	10	~~fcc~~ operating cost param
occupancy	1.6	11	
	64.	12	
	92.	13	
	4.3	14	
bus	45.	15	
	80.	16	
	115.	17	
truck	5.2	18	
	1.	19	
class 1 car in	809.	20	
out	254.	21	
bus in	262.	22	
out	78.	23	
class 2 car in	625.	24	
out	86.	25	
bus in	1083.	26	Volumes
out	132.	27	(2 hour,
class 3 car in	0.	28	pax)
out	0.	29	
bus in	1522.	30	79
out	114.	31	values
truck in	230.	32	for
out	230.	33	the
	2.18	34	LINK
Values of	0.56	35	
time	0.18	36	
PCU	1.	37	
equiv.	3.	38	
	3.	39	
Class 1 car in	683.2	40	
out	-28.	41	
bus in	412.	42	yearly
out	-9.4	43	volume
class 2	-43.4	44	increments
	1.	45	unique
	12.4	46	to each
	3.6	47	
class 3	94.	48	LINK
	0.6	49	
	177.6	50	
	-20.4	51	
truck in	20.2	52	
out	20.2	53	1 + discount
	1.11	54	rate ~~factor~~
1st year discount factor	1.	55	
	2.1	56	length
	1600.	57	capacity
	0.	58	(2 hour)

LINK A
Build 1979-84

0.	00
0.	01
0.	02
0.	03
54.	04
34.	05
23.	06
40.	07
100.	08
107.4	09
1.	10
1.6	11
80.	12
92.	13
4.3	14
45.	15
100.	16
115.	17
5.2	18
1.	19
4908.2	20
86.	21
2734.	22
21.6	23
364.6	24
92.	25
1157.4	26
153.6	27
564.	28
3.6	29
2587.6	30
-8.4	31
351.2	32
351.2	33
2.18	34
0.56	35
0.18	36
1.	37
3.	38
3.	39
683.2	40
-28.	41
412.	42
-9.4	43
-43.4	44
1.	45
12.4	46
3.6	47
94.	48
0.6	49
177.6	50
-20.4	51
20.2	52
20.2	53
1.11	54
1.870414552	55
2.1	56
4800.	57

LINK A: NO-BUILD 1980-1999

1980	1981	1992
1777.38 924.10	2336.74 966.45	2896.10 1008.81
19599.96 39973.71	34787.47 110664.40	48982.30 167022.34
859.92 13779.42	2046.37 52844.60	3202.31 88441.27
20459.88 53753.13	36833.85 163509.00	52184.61 255463.61
13438.26 7421.34	13541.77 11074.65	12736.82 10813.01
3143.92 13685.11	3378.48 22187.36	3440.96 23603.70
16582.18 21106.45	16920.25 33262.01	16177.78 34416.71
0.00 0.00	1977.99 554.32	3980.86 1165.83
4264.12 6067.62	4986.85 10870.13	5470.89 12571.74
4264.12 6067.62	6964.84 11424.46	9451.75 13737.57
71370.39 6982.43	81565.14 11085.09	88951.56 12585.13
112676.57 87909.63	142284.08 219280.56	166765.70 316203.02
112676.57 87909.63 200586.20	240860.42 285459.69 526320.11	376211.20 542097.15 918308.36

1983	1984	1985
3455.46	4014.82	4846.33
1051.16	1093.51	1201.50
62971.22	76949.12	95488.31
217849.80	268632.01	335511.23
4348.10	5493.35	6687.93
121367.97	154278.06	188175.87
67319.32	82442.47	102176.25
339217.77	422910.06	523687.10
11856.55	10977.07	12257.97
10003.27	9195.05	10298.52
3488.02	3535.26	3804.32
23915.23	24230.39	25524.69
15344.57	14512.33	16062.29
33918.50	33425.44	35823.21
5971.67	7962.73	10546.47
1748.88	2332.03	3064.23
5929.51	6386.99	7794.93
13717.66	14860.38	18128.85
11901.18	14349.72	18341.40
15466.54	17192.41	21193.08
96133.97	103402.73	116802.29
13656.89	14753.80	16878.63
190699.05	214707.25	253382.23
402259.70	488281.72	597582.02
515648.70	657083.02	792551.51
836225.98	1157872.27	1477364.02
1351874.68	1814955.29	2269915.53
	1157872.27	

1986	1987	1988
5118.48	5390.63	5662.78
1267.14	1332.78	1398.42
100064.23	104642.68	109223.18
351687.53	367895.89	384138.15
6738.62	6790.09	6842.27
189225.39	190322.56	191471.27
106802.85	111432.77	116065.46
540912.91	558218.45	575609.42
14422.92	16592.60	18766.51
12218.69	14149.62	16092.06
4031.03	4262.49	4498.32
26566.89	27681.87	28875.63
18453.95	20855.09	23264.83
38785.58	41831.49	44967.68
11144.57	11748.19	12357.07
3215.71	3369.97	3527.24
8749.05	9705.53	10664.19
20267.73	22417.20	24578.19
19893.62	21453.71	23021.26
23483.44	25787.17	28105.43
122931.18	129128.28	135381.29
17924.05	19016.13	20157.53
268081.61	282869.85	297732.83
621105.97	644853.24	668840.06
921675.27	1044419.99	1160811.13
1776524.94	2056343.85	2317809.99
2698200.21	3100763.83	3478621.12

1989	1990	1991
5934.94	6207.09	6517.44
1464.06	1529.70	1606.18
113805.33	118388.75	124357.28
400416.12	416731.64	437981.57
6895.11	6948.53	7299.68
192675.43	193939.01	203926.72
120700.44	125337.28	131656.96
593091.55	610670.65	641908.29
20944.16	23125.09	24329.15
18046.74	20014.42	21118.52
4738.15	4981.60	5251.71
30154.23	31523.82	33521.63
25682.31	28106.70	29580.86
48200.97	51538.24	54640.15
12970.88	13589.27	14287.35
3687.78	3851.82	4057.35
11624.88	12587.41	13224.49
26751.62	28938.42	30434.98
24595.76	26176.69	27511.84
30439.39	32790.24	34492.34
141679.23	148012.50	156691.80
21350.94	22599.06	24322.58
312657.75	327633.17	345441.46
693082.86	717598.20	755363.36
1270924.33	1374876.87	1473618.14
2561903.02	2789584.95	3005498.64
3832827.35	4164461.82	4479116.78

1992	1993	1994
6843.32	7185.48	7544.76
1686.49	1770.82	1859.36
130626.10	137209.89	144124.08
460363.36	483945.27	508800.89
7668.49	8055.82	8462.58
214462.62	225582.30	237324.52
138294.59	145265.71	152586.65
674825.98	709527.57	746125.41
25595.21	26926.07	28324.65
22295.18	23550.93	24893.13
5535.90	5834.74	6148.86
35690.09	38049.61	40623.62
31131.11	32760.82	34473.51
57985.26	61600.54	65516.74
15021.04	15791.99	16601.95
4275.34	4506.75	4752.70
13893.62	14596.38	15334.40
32014.70	33683.14	35446.36
28914.66	30388.37	31936.35
36290.04	38189.89	40199.06
165853.46	175513.19	185687.23
26231.90	28353.03	30716.08
364193.82	383928.09	404683.74
795333.18	837671.02	882557.29
1567403.24	1656472.57	1741053.23
3210308.27	3404643.61	3589101.92
4777711.51	5061116.18	5330155.15

1995	1996	1997
7921.99 1952.32	8318.09 2049.94	8734.00 2152.44
151384.84 535009.78	159009.19 562658.16	167014.98 591839.65
8889.70 249731.58	9338.20 262849.76	9809.12 276729.86
160274.54 784741.36	168347.39 825507.92	176824.10 868569.52
29794.00 26330.08	31337.35 27871.14	32958.10 29526.95
6478.87 43439.03	6825.47 46526.84	7189.36 49922.75
36272.87 69769.10	38162.82 74397.98	40147.45 79449.70
17452.73 5014.41	18346.27 5293.24	19284.56 5590.73
16109.38 37311.01	16923.15 39284.39	17777.59 41374.54
33562.12 42325.41	35269.42 44577.63	37062.15 46965.26
196392.65 33355.96	207647.53 36313.13	219471.20 39634.57
426502.19 930191.84	449427.15 980796.66	473504.91 1034619.05
1821360.26 3764249.79 5585610.06	1897597.77 3930624.90 5828222.67	1969959.82 4088737.63 6058697.45

1998	1999
9170.698911	9629.233856
2260.058668	2373.061601
175421.008	184247.0007
622656.2156	655219.1345
10303.55567	10822.67238
291427.7652	307005.1374
185724.5637	195069.6731
914083.9808	962224.2719
34659.8183	36446.30163
31309.57107	33232.72244
7571.299412	7972.098942
53667.9646	57810.08548
42231.11771	44418.40057
84977.53567	91042.80792
20269.74758	21304.06724
5908.601147	6248.804085
18674.70343	19616.58294
43590.3263	45941.58789
38944.45101	40920.65018
49498.92745	52190.39198
231884.4556	244909.6901
43374.80135	47597.18721
498784.5881	525318.4139
1091935.245	1153054.659
3	0
20~~6~~9517.974	21~~5~~4675.269
4239072.677	4382090.551
6~~22~~8590.651	65~~36~~6765.821
288	1484

1999

LINK B: NO-BUILD 1980-1989

1980	1981	1982
1777.38	2279.64	2781.90
924.10	1046.27	1168.45
19599.96	32641.85	45026.58
39973.71	98486.18	150731.79
859.92	1940.07	3006.44
13779.42	47594.91	81980.38
20459.88	34581.92	48033.02
53753.13	146081.09	232712.17
13438.26	13806.44	13449.59
7421.34	10623.17	10892.58
3143.92	3452.41	3627.37
13685.11	21288.99	23791.51
16582.18	17258.86	17076.96
21106.45	31912.15	34684.09
0.00	1979.28	4008.47
0.00	530.77	1169.30
4264.12	4859.26	5257.90
6067.62	10161.54	12070.43
4264.12	6838.54	9266.37
6067.62	10692.31	13239.73
71370.39	85821.00	98404.96
6982.43	11384.82	14161.31
112676.57	144500.31	172781.31
87909.63	200070.38	294797.30
112676.57	242857.03	383090.22
87909.63	268153.22	507417.32
200586.20	511010.25	890507.54

1983	1984	1985
3284.15	3786.41	4288.67
1290.62	1412.79	1534.97
57067.41	69108.20	81144.52
193671.70	236753.84	279986.28
4055.32	5104.08	6152.62
111771.57	141615.96	171517.16
61122.72	74212.28	87297.14
305443.26	378369.80	451503.44
12987.26	12560.55	12163.41
10216.85	9618.82	9108.82
3780.88	3941.74	4108.59
24378.45	25116.38	26025.69
16768.14	16502.30	16271.99
34595.31	34735.20	35134.51
6015.29	8023.70	10033.50
1755.09	2341.81	2929.61
5606.87	5952.70	6295.68
12959.03	13837.78	14704.71
11622.16	13976.39	16329.17
14714.12	16179.59	17634.32
110738.07	123339.20	136138.15
16201.95	18411.40	20808.81
200251.09	228030.18	256036.46
370954.64	447695.99	525081.08
529512.09	679722.63	831667.80
778656.15	1073567.37	1385177.43
1308168.24	1753290.00	2216845.24

1986	1987	1988
4563.90	4839.14	5114.38
1751.17	1967.37	2183.57
85873.61	90621.77	95377.19
297162.07	315484.41	335124.38
6157.62	6164.61	6172.80
171538.26	172140.30	173420.95
92031.23	96786.38	101550.00
468700.33	487624.71	508545.33
15057.08	18016.42	21017.73
11609.74	14538.36	17968.11
4511.15	4930.55	5360.90
28481.34	31894.47	36435.21
19568.23	22946.97	26378.62
40091.08	46432.83	54403.32
10504.87	11004.33	11524.14
3027.77	3158.20	3327.45
7214.81	8152.99	9104.69
16580.94	18659.73	20982.79
17719.68	19157.33	20628.83
19608.72	21817.92	24310.24
152713.34	169272.27	185737.73
24545.44	28876.71	33880.75
282032.46	308162.95	334295.18
552945.56	584752.18	621139.64
982453.88	1130883.15	1275942.69
1680804.71	1962455.52	2231984.46
2663258.59	3093338.67	3507927.15

1989	1990	1991
5389.61	5664.85	5948.09
2399.77	2615.97	2746.77
100133.22	104693.77	109928.46
356256.52	372487.80	391112.19
6181.68	6182.26	6491.37
175480.09	175498.81	184273.75
106314.91	110876.02	116419.82
531736.61	547986.61	575385.94
24044.75	26847.80	28190.19
21974.05	24537.56	25764.44
5798.14	6187.91	6497.31
42277.63	45123.51	47379.69
29842.90	33035.71	34687.50
64251.68	69661.07	73144.13
12058.29	12559.88	13187.87
3542.27	3689.71	3874.20
10065.80	11007.02	11557.37
23592.90	25799.59	27089.57
22124.08	23566.90	24745.24
27135.17	29489.31	30963.77
202080.76	216276.14	227089.94
39637.05	42424.82	44546.06
360362.65	383754.77	402942.51
662760.51	689561.81	724039.90
1416817.38	1551969.85	1679816.79
2491073.96	2733926.93	2963652.70
3907891.34	4285896.78	4643469.49

1992	1993	1994
6245.50	6557.77	6885.66
2884.10	3028.31	3179.72
115424.88	121196.12	127255.93
410667.80	431201.18	452761.24
6815.94	7156.73	7514.57
193487.44	203161.81	213319.90
122240.82	128352.86	134770.50
604155.23	634363.00	666081.15
29599.70	31079.68	32633.67
27052.66	28405.30	29825.56
6822.17	7163.28	7521.45
49748.67	52236.10	54847.91
36421.87	38242.96	40155.11
76801.33	80641.40	84673.47
13847.27	14539.63	15266.61
4067.91	4271.31	4484.87
12135.24	12742.00	13379.10
28444.05	29866.25	31359.57
25982.51	27281.63	28645.71
32511.96	34137.56	35844.44
238444.44	250366.66	262885.00
46773.36	49112.03	51567.63
423089.63	444244.12	466456.32
760241.89	798253.99	838166.69
1800753.08	1915152.27	2023367.72
3180960.87	3386522.65	3580972.99
4981713.95	5301674.92	5604340.71

1995	1996	1997
~~7229.94~~	7591.44	~~7971.01~~
3338.71	3505.65	3680.93
133618.72	140299.66	147314.64
475399.31	499169.27	524127.74
7890.30	8284.81	8699.06
223985.90	235185.19	246944.45
141509.02	148584.48	156013.70
699385.20	734354.46	771072.19
34265.35	35978.62	37777.55
31316.84	32882.68	34526.81
7897.52	8292.39	8707.01
57590.30	60469.82	63493.31
42162.87	44271.01	46484.56
88907.14	93352.50	98020.12
16029.94	16831.44	17673.01
4709.11	4944.57	5191.80
14048.05	14750.46	15487.98
32927.55	34573.92	36302.62
30078.00	31581.90	33160.99
37636.66	39518.49	41494.42
276029.25	289830.71	304322.24
54146.02	56853.32	59695.98
489779.14	514268.09	539981.50
880075.02	924078.77	970282.71
2125733.69	2222566.36	2314164.84
3764912.49	3938909.32	4103500.91
5890646.18	6161475.68	6417665.75

1998	1999
8369.56	8788.04
3864.97	4058.22
154680.38	162414.40
550334.12	577850.83
9134.01	9590.71
259291.67	272256.26
163814.38	172005.10
809625.80	850107.09
39666.43	41649.75
36253.16	38065.81
9142.37	9599.48
66667.97	70001.37
48808.79	51249.23
102921.13	108067.19
18556.66	19484.50
5451.39	5723.96
16262.38	17075.50
38117.75	40023.64
34819.04	36559.99
43569.14	45747.60
319538.36	335515.27
62680.78	65814.82
566980.57	595329.60
1018796.85	1069736.69
2400812.04	2482775.62
4259195.67	4406474.49
6660007.71	6889250.10

LINK C: NO-BUILD 1979-1999

		1980	1981	1982
		1783.62	2371.51	2959.40
		1070.82	1276.57	1482.32
<u>Class 1</u>				
Car	OC	14942.79	23793.61	31817.04
	TC	29915.68	74122.91	104522.38
Bus	OC	603.77	1021.94	1414.42
	TC	9512.77	25259.49	36732.65
Total	OC	15546.57	24815.55	33231.46
	TC	39428.44	99382.40	141255.03
<u>Class 2</u>				
Car	OC	10123.21	12554.95	14371.25
	TC	5544.22	10113.27	11702.71
Bus	OC	2312.61	2718.84	3000.99
	TC	10053.84	17814.83	19936.49
Total	OC	12435.83	15273.79	17372.24
	TC	15598.05	27928.10	31639.20
<u>Class 3</u>				
Car	OC	0.00	1718.07	3459.39
	TC	0.00	474.42	977.42
Bus	OC	2998.94	3654.39	4130.10
	TC	4257.79	8053.20	9358.92
Total	OC	2998.94	5372.46	7589.49
	TC	4257.79	8527.63	10336.34
Truck	OC	58224.87	75245.46	90305.16
	TC	5881.66	10821.49	13657.12
Total	OC	89206.20	120707.26	148498.34
	TC	65165.96	146659.62	196887.69
<u>Discounted Totals</u>				
	OC	89206.20	197951.48	318476.06
	TC	65165.96	197291.74	357090.20
Grand Total		154372.15	395243.22	675566.27

1983	1984	1985
3547.29	4135.10	4723.07
1688.07	1893.82	2099.57
39768.12	47693.71	55593.77
133797.88	163512.94	193700.12
1805.90	2197.67	2589.42
47971.45	59544.20	71497.89
41574.02	49891.38	58183.19
181769.33	223057.15	265198.00
16216.76	18101.17	20010.37
13283.28	15104.01	17204.71
3284.02	3570.89	3860.05
21917.19	24180.40	26771.85
19500.78	21672.06	23870.42
35200.46	39284.42	43976.56
5208.09	6965.55	8729.18
1479.71	1993.84	2521.99
4596.25	5060.53	5523.19
10497.56	11647.23	12808.15
9804.35	12026.08	14252.38
11977.27	13641.07	15330.14
105584.66	121040.14	136571.52
16705.98	20215.66	24253.80
176463.80	204629.66	232877.50
245653.03	296198.29	348758.51
447504.87	582300.77	720502.23
536709.58	731824.57	938795.77
984214.46	1314125.34	1659298.00

1986	1987	1988
4970.95 2386.69	5218.82 2673.82	5466.70 2960.94
58965.87 209556.31	62151.70 221128.24	65328.24 232429.99
2933.74 83170.32	3268.97 92797.79	3603.77 102301.89
61899.60 292726.63	65420.66 313926.04	68932.00 334731.88
20846.96 18989.32	21492.00 19642.63	22127.31 20223.27
4247.09 30882.96	4610.24 33618.81	4972.07 36257.36
25094.05 49872.28	26102.24 53261.44	27099.38 56480.63
8908.68 2614.72	9064.76 2662.95	9219.71 2708.47
5676.58 13295.95	5822.59 13647.69	5968.15 13988.88
14585.25 15910.68	14887.34 16310.64	15187.86 16697.36
154786.24 30223.61	170898.35 33523.49	186911.44 36664.63
256365.14 388733.20	277308.59 417021.61	298130.68 444574.49
857565.51 1146628.41 2004193.92	991133.52 1347490.38 2338623.90	1120500.33 1540403.03 2660903.36

1989	1990	1991
5714.57 3248.07	5962.45 3535.19	6260.57 3711.95
68504.78 243731.73	71681.31 255033.47	75265.38 267785.14
3938.56 111805.99	4273.36 121310.09	4487.03 127375.60
72443.34 355537.72	75954.68 376343.56	79752.41 395160.74
22762.61 20803.91	23397.92 21384.55	24567.82 22453.77
5333.91 38895.92	5695.74 41534.47	5980.52 43611.19
28096.52 59699.82	29093.66 62919.02	30548.34 66064.97
9374.66 2753.99	9529.62 2799.51	10006.10 2939.49
6113.72 14330.07	6259.28 14671.27	6572.24 15404.83
15488.38 17084.07	15788.90 17470.78	16578.34 18344.32
202924.53 39805.76	218937.62 42946.90	229884.50 45094.24
318952.77 472127.38	339774.86 499680.26	356763.60 524664.27
1245186.86 1724969.32 2970156.18	1364850.29 1900948.95 3265799.24	1478045.43 2067416.17 3545461.60

1992	1993	1994
6573.60	6902.28	7247.40
3897.55	4092.43	4297.05
79028.65	82980.08	87129.09
281174.40	295233.12	309994.78
4711.38	4946.95	5194.30
133744.38	140431.60	147453.18
83740.03	87927.03	92323.38
414918.78	435664.72	457447.95
25796.21	27086.02	28440.32
23576.46	24755.29	25993.05
6279.55	6593.53	6923.20
45791.75	48081.34	50485.41
32075.76	33679.55	35363.52
69368.22	72836.63	76478.46
10506.40	11031.72	11583.31
3086.46	3240.79	3402.83
6900.86	7245.90	7608.19
16175.07	16983.83	17833.02
17407.26	18277.62	19191.50
19261.54	20224.61	21235.84
241378.73	253447.67	266120.05
47348.96	49716.40	52202.22
374601.78	393331.87	412998.46
550897.49	578442.36	607364.48
1585121.91	1686410.47	1782223.98
2224885.16	2373842.32	2514747.73
3810007.07	4060252.79	4296971.71

1995	1996	1997
7609.77	7990.25	8389.77
4511.90	4737.49	4974.37
91485.54	96059.82	100862.81
325494.52	341769.24	358857.70
5454.01	5726.71	6013.05
154825.84	162567.13	170695.48
96939.55	101786.53	106875.86
480320.35	504336.37	529553.19
29862.34	31355.45	32923.23
27292.70	28657.34	30090.20
7269.36	7632.83	8014.47
53009.68	55660.16	58443.17
37131.70	38988.29	40937.70
80302.38	84317.50	88533.37
12162.47	12770.60	13409.13
3572.97	3751.62	3939.20
7988.60	8388.03	8807.44
18724.67	19660.90	20643.95
20151.08	21158.63	22216.56
22297.64	23412.52	24583.14
279426.05	293397.36	308067.22
54812.33	57552.95	60430.60
433648.39	455330.81	478097.35
637732.70	669619.34	703100.31
1872858.38	1958593.62	2039694.52
2648036.64	2774120.74	2893389.49
4520895.02	4732714.36	4933084.01

1998	1999
8809.25	9249.72
5223.09	5484.24
105905.95	111201.25
376800.59	395640.62
6313.70	6629.39
179230.26	188191.77
112219.65	117830.63
556030.85	583832.39
34569.39	36297.86
31594.71	33174.45
8415.20	8835.96
61365.33	64433.60
42984.59	45133.81
92960.04	97608.05
14079.58	14783.56
4136.16	4342.97
9247.81	9710.20
21676.14	22759.95
23327.39	24493.76
25812.30	27102.92
323470.58	339644.11
63452.13	66624.73
502002.21	527102.32
738255.32	775168.09
2116411.59	2188981.80
3006211.27	3112934.58
5122622.86	5301916.38

LINK A: BUILD - 1980-1999

1980	1981	1982
1777.38	2336.74	2896.10
924.10	966.45	1008.81
15908.83	25113.71	35322.14
10606.16	20502.50	34576.78
645.04	1444.67	2337.90
3638.93	9607.14	18114.48
16553.87	26558.39	37660.04
14245.09	30109.65	52691.27
10526.98	9771.03	9356.99
1862.67	2050.35	2284.42
2303.10	2393.85	2534.78
3416.00	4067.99	4934.78
12830.08	12164.88	11891.77
5278.67	6118.34	7219.20
0.00	1364.89	2800.45
0.00	96.94	235.33
3100.28	3491.75	3985.75
1489.01	1939.85	2563.02
3100.28	4856.64	6786.20
1489.01	2036.80	2798.35
62782.56	67628.97	73809.99
2143.91	2586.72	3158.60
95266.79	111208.88	130148.00
23156.68	40851.50	65867.42
95266.79	195454.97	301086.01
23156.68	59959.83	113419.30
118423.47	255414.80	414505.31

19 1982

1983	1984	1985
3455.46	4014.82	4846.3275
1051.16	1093.51	1201.505
47125.71	60499.41	49857.92072
54254.34	81018.09	82612.00555
3344.84	4454.86	3583.738172
30075.08	46441.18	46343.61117
50470.55	64954.28	53441.65889
84329.42	127459.27	128955.6167
9096.42	8838.73	6467.769952
2546.19	2815.29	2526.348756
2701.86	2874.09	2022.353557
6031.17	7371.10	6263.366172
11798.28	11712.82	8490.123509
8577.35	10186.39	8789.714928
4412.89	6223.80	5505.454674
431.11	700.94	754.5529598
4558.63	5178.70	4177.426537
3394.29	4470.31	4464.966641
8971.52	11402.49	9682.881211
3825.40	5171.25	5219.519601
81072.27	88996.65	63346.62333
3882.98	4783.77	4085.17992
152312.61	177066.24	134961.2869
100615.15	147600.68	147050.0312
412455.67	529094.69	601250.5034
186988.23	284217.37	362836.3252
599443.91	813312.06	964086.8286

1 19 1985

1986	1987	1988
5118.48	5390.6325	5662.785
1267.143333	1332.781667	1398.42
53358.32061	56891.24731	60444.96746
94520.24709	107693.7998	122208.3852
3676.593058	3764.96024	3848.940867
50871.58797	55711.66757	60869.64642
57034.91366	60656.20755	64293.90833
145391.8351	163405.4674	183078.0317
7722.968247	9013.577819	10335.1902
3251.672759	4080.459455	5021.039731
2166.518822	2309.38308	2450.949987
7047.233781	7893.366	8804.513666
9889.487069	11322.9609	12786.14018
10298.90654	11973.82546	13825.5534
5945.025838	6386.048958	6827.386908
863.5210288	983.5102303	1115.16227
4772.760275	5378.997575	5994.419249
5448.129276	6558.888796	7806.783329
10717.78611	11765.04653	12821.80616
6311.650305	7542.399026	8921.945599
66649.70369	69956.99144	73263.88678
4580.461556	5123.622091	5717.435882
144291.8905	153701.2064	163165.7414
166582.8535	188045.314	211542.9665
670749.9061	737444.9321	801230.4623
443072.3577	524670.202	607367.5878
1113822.264	19. 1262115.134	1408598.05 1588

1989	1990	1991
5934.9375	6207.09	6517.4445
1464.058333	1529.696667	1606.1815
64010.34143	67580.36016	72077.90214
138140.3815	155566.7989	178411.0861
3928.727391	4004.567039	4259.387088
66351.25334	72162.15678	82743.12666
67939.06882	71584.92719	76337.28923
204491.6349	227728.9557	261154.2128
11683.72025	13055.48465	13898.92845
6081.836299	7271.359467	8325.782247
2591.283247	2730.488892	2896.862423
9783.442524	10832.93302	12361.34078
14275.0035	15785.97355	16795.79087
15865.27882	18104.29248	20687.12303
7268.208278	7707.929649	8212.267768
1259.124254	1416.048493	1622.531871
6617.532412	7247.059507	7707.823737
9201.451133	10752.62613	12328.2564
13885.74069	14954.98916	15920.09151
10460.57539	12168.67462	13950.78827
76567.73905	79867.44624	84373.09422
6364.700516	7068.235975	8014.930691
172667.5521	182193.3361	193426.2658
237182.1896	265070.1588	303807.0548
862041.2941	919847.9055	975137.0286
690899.4736	775001.3385	861841.7972
1552940.768	1694849.244	1836978.826

19 1991

1992	1993	1994
6843.316725 1686.490575	7185.482561 1770.815104	7544.756689 1859.355859
76806.05992 204926.2005	81770.23281 235720.0766	85897.86053 248477.4635
4526.911225 95023.44442	4807.533096 109284.4962	5050.541829 115205.1551
81332.97114 299949.6449	86577.76591 345004.5727	90948.40236 363682.6186
14785.62493 9548.876682	15716.87577 10968.53706	16502.68619 11567.32689
3071.92489 14131.78327	3256.089936 16184.15832	3422.135104 17084.18609
17857.54982 23680.65995	18972.96571 27152.69538	19924.8213 28651.51299
8742.467769 1862.111607	9299.233322 2140.26452	9766.078082 2256.661294
8191.579927 14156.88208	8699.048006 16280.39238	9138.838832 17162.79618
16934.0477 16018.99369	17998.28133 18420.6569	18904.91691 19419.45748
89109.91051 9108.534553	94092.51496 10373.10522	98601.55612 10969.80839
205234.4792 348757.8331	217641.5279 400951.0302	228379.6967 422723.3974
1027987.833 951651.911 1979639.744	19 1078479.541 1044670.475 2123150.016	10 1126211.89 1133021.502 2259233.393 1994

1995	1996	1997
7921.994524 1952.323652	8318.09425 2049.939834	8733.998962 2152.436826
90185.11724 260935.9742	94688.34693 274023.2239	99418.89304 287771.6252
5303.575931 120989.778	5569.444417 127067.7214	5848.823351 133454.3377
95488.69317 381925.7522	100257.7913 401090.9453	105267.7164 421225.9629
17320.3857 12154.35615	18180.53783 12772.19083	19085.79564 13422.61522
3596.103843 17973.72599	3779.802209 18913.67263	3973.910551 19907.54159
20916.48954 30128.08214	21960.34004 31685.86346	23059.70619 33330.1568
10251.48655 2370.578768	10761.77595 2490.374119	11298.3969 2616.371787
9596.829096 18025.0957	10078.09659 18931.20834	10583.87619 19883.44195
19848.31564 20395.67447	20839.87254 21421.58246	21882.27309 22499.81373
103332.7404 11568.03857	108342.4214 12204.5284	113658.7132 12882.59197
239586.2388 444017.5474	251400.4254 466402.9196	263868.4089 489938.5254
1171324.111 1216626.545 2387950.656	10 1213969.823 1295743.693 2509713.516	199 1254294.768 1370617.165 2624911.932 1997

1998	1999
9170.698911	9629.233856
2260.058668	2373.061601
104388.7222	109610.4442
302215.3752	317390.572
6142.424903	6450.998379
140165.862	147219.4759
110531.1471	116061.4426
442381.2372	464610.0479
20038.99934	21043.17491
14107.54378	14829.03455
4179.156243	4396.311636
20959.19124	22072.86796
24218.15558	25439.48655
35066.73502	36901.90251
11862.89378	12456.90522
2748.917562	2888.380511
11115.46927	11674.24544
20884.23939	21936.18869
22978.36305	24131.15066
23633.15696	24824.5692
119312.5942	125337.7627
13605.94426	14378.76061
277040.2599	290969.8425
514687.0735	540715.2802
1292437.016	1328527.142
1441478.065	1508545.094
2733915.081	2837072.236

1989

LINK B BUILD 1979-1999

1980	1981	1982
1777.38 924.10	2279.64 1046.27	2781.90 1168.45
15908.83 10606.16	23809.63 18958.76	32410.80 30325.92
645.04 3638.93	1373.25 8963.94	2173.41 16249.94
16553.87 14245.09	25182.87 27922.70	34584.21 46575.86
10526.98 1862.67	10115.04 2058.30	9971.02 2279.62
2303.10 3416.00	2461.31 4083.65	2658.57 4911.22
12830.08 5278.67	12576.34 6141.95	12629.59 7190.84
0.00 0.00	1376.72 95.70	2803.22 227.23
3100.28 1489.01	3402.32 1863.35	3784.83 2364.52
3100.28 1489.01	4779.04 1959.05	6588.05 2591.74
62782.56 2143.91	70299.43 2688.18	78858.03 3372.90
95266.79 23156.68	112837.69 38711.89	132659.87 59731.35
95266.79 23156.68 118423.47	196922.36 58032.26 254954.62	304592.09 106511.56 411103.65

1983	1984	1985
3284.15	3786.41	4288.67
1290.62	1412.79	1534.97
42168.33	53133.68	65133.19
45644.12	65885.02	92050.44
3064.16	4041.91	5091.65
26148.59	39337.01	56514.07
45232.49	57175.59	70224.84
71792.71	105222.03	148564.51
9944.44	9910.62	9799.07
2507.82	2722.74	2903.14
2877.04	3100.54	3318.80
5903.82	7065.73	8400.58
12821.48	13011.16	13117.87
8411.65	9788.48	11303.71
4376.77	6129.34	8048.98
407.35	649.38	967.05
4231.25	4718.32	5225.93
3015.01	3837.75	4856.12
8608.01	10847.66	13274.91
3422.36	4487.13	5823.17
88452.69	98849.68	109782.23
4226.99	5280.12	6562.63
155114.67	179884.09	206399.85
87853.71	124777.76	172254.03
418010.60	536505.82	658994.09
170749.44	252944.41	355168.80
588760.04	789450.24	1014162.89

1986	1987	1988
4563.90 1751.17	4839.14 1967.37	5114.38 2183.57
70293.47 106208.10	75550.40 122015.40	80891.65 139587.17
5195.02 61646.54	5290.47 67099.71	5378.49 72871.89
75488.49 167854.64	80840.87 189115.11	86270.14 212459.06
12005.57 3787.79	14256.71 4803.67	16570.11 5965.01
3631.23 9499.57	3946.44 10696.98	4268.24 12003.28
15636.80 13287.35	18203.16 15500.64	20838.35 17968.28
8613.67 1087.50	9166.66 1218.85	9711.82 1361.82
6084.87 5955.97	6961.63 7204.44	7856.63 8615.24
14698.54 7043.47	16128.29 8423.29	17568.46 9977.06
121153.90 7837.41	132952.59 9287.16	145267.77 10928.09
226977.73 196022.87	248124.91 222326.21	269944.71 251332.49
780345.65 459970.63 1240316.28	899857.10 567055.91 1466913.01	1016993.26 676115.74 1693109.01

1989	1990	1991
5389.61	5664.85	5948.09
2399.77	2615.97	2746.77
86307.34	91788.59	98021.22
159039.47	180489.48	206122.01
5459.72	5534.86	5896.81
78961.18	85365.47	97497.25
91767.05	97323.44	103918.02
238000.65	265854.95	303619.26
18960.38	21437.68	22812.39
7286.26	8782.11	9949.08
4599.82	4943.48	5261.04
13429.17	14985.55	16936.14
23560.19	26381.16	28073.42
20715.43	23767.66	26885.22
10253.68	10796.48	11521.29
1517.14	1685.53	1922.26
8770.25	9702.53	10335.57
10202.25	11979.53	13667.36
19023.93	20499.00	21856.85
11719.38	13665.06	15589.62
158156.10	171640.04	182601.98
12776.61	14849.35	16810.84
292507.27	315843.64	336450.28
283212.07	318137.03	362904.94
1131341.60	1242576.83	1349326.89
786830.35	898873.28	1014016.96
1918171.96	2141450.11	2363343.85

1992	1993	1994
6245.50	6557.77	6885.66
2884.10	3028.31	3179.72
104612.31	111571.21	118908.01
235823.61	270265.55	310231.21
6278.39	6680.20	7102.87
111555.40	127857.74	146775.18
110890.70	118251.41	126010.88
347379.00	398123.29	457006.38
24284.14	25858.55	27541.24
11296.56	12854.08	14656.09
5600.10	5961.85	6347.48
19185.87	21783.56	24786.11
29884.24	31820.40	33888.72
30482.44	34637.64	39442.20
12289.62	13102.94	13962.76
2196.42	2514.16	2882.69
11004.03	11709.13	12452.13
15622.32	17888.45	20517.13
23293.66	24812.07	26414.89
17818.74	20402.61	23399.82
194348.26	206925.69	220381.13
19075.00	21691.30	24717.45
358416.86	381809.56	406695.61
414755.18	474854.85	544565.86
1451777.06	1550098.46	1644449.74
1132570.92	1254852.81	1381189.27
2584347.98	2804951.28	3025639.02

1995	1996	1997
7229.94	7591.44	7971.01
3338.71	3505.65	3680.93
126497.63	132988.91	139830.21
353932.09	372345.06	391798.90
7540.46	7927.55	8335.02
167459.29	176150.69	185330.10
134038.09	140916.46	148165.22
521391.38	548495.74	577129.00
29317.56	30989.98	32777.63
16639.38	17699.77	18851.53
6754.90	7152.69	7576.49
28097.76	29990.62	32060.03
36072.46	38142.67	40354.11
44737.14	47690.40	50911.55
14855.86	15635.40	16459.54
3286.09	3463.46	3651.89
13223.45	13915.26	14644.79
23393.65	24643.37	25969.02
28079.30	29550.66	31104.33
26679.74	28106.83	29620.90
234605.15	248081.54	262498.83
28050.06	29867.03	31844.40
432795.00	456691.32	482122.50
620858.32	654160.00	689505.86
1734905.78	1820897.20	1902680.90
1510951.36	1634124.59	1751087.27
3245857.14	3455021.79	3653768.17

1998	1999
8369.56	8788.04
3864.97	4058.22
147038.94	154632.94
412365.86	434125.13
8763.86	9215.11
195030.89	205289.61
155802.81	163848.06
607396.75	639414.75
34686.15	36720.92
20105.64	21474.74
8027.46	8506.74
34328.54	36822.18
42713.62	45227.66
54434.18	58296.93
17330.49	18250.48
3852.30	4065.72
15413.85	16224.29
27376.63	28872.95
32744.34	34474.77
31228.93	32938.67
277903.29	294338.50
34001.88	36362.11
509164.05	537888.99
727061.74	767012.45
1980492.45	2054547.74
1862198.43	1967798.89
3842690.89	4022346.63

LINK C - BUILD 1979-99

1980	1981	1982
1783.62 1070.82	2371.51 1276.57	2959.40 1482.32
12183.41 8065.55	17270.96 13944.52	23039.54 22319.40
453.06 2545.08	727.68 4747.42	1037.19 7861.69
12636.47 10610.64	17998.64 18691.94	24076.73 30181.09
7953.37 1401.95	9085.95 1892.36	10519.99 2540.43
1691.64 2509.66	1922.57 3267.43	2201.17 4274.74
9645.01 3911.61	11008.52 5159.79	12721.16 6815.17
0.00 0.00	1205.50 84.24	2472.59 204.90
2180.51 1046.61	2557.14 1426.45	3018.10 1955.99
2180.51 1046.61	3762.64 1510.68	5490.69 2160.90
49730.29 1735.44	58647.79 2360.18	68748.32 3179.72
74192.27 17304.30	91417.60 27722.59	111036.90 42336.88
74192.27 17304.30 91496.57	156550.47 42279.61 198830.08	246670.51 76641.17 323311.68

1983	1984	1985
3547.29	4135.18	4723.07
1688.07	1893.82	2099.57
29766.63	37375.64	45655.80
34028.86	49945.39	70970.23
1385.16	1765.62	2169.88
12199.86	18086.60	25857.39
31151.79	39141.26	47825.67
46228.71	68031.99	96827.62
12196.19	14021.87	15926.31
3376.89	4433.11	5741.08
2511.15	2836.25	3166.02
5572.92	7203.86	9209.96
14707.34	16858.12	19092.33
8949.81	11636.96	14951.04
3890.19	5471.99	7192.73
376.40	613.77	932.59
3545.81	4114.82	4704.31
2670.48	3606.16	4800.19
7436.00	9586.81	11897.04
3046.88	4219.93	5732.78
80090.79	92434.70	105519.73
4243.13	5601.03	7305.40
133385.92	158020.89	184334.77
62468.54	89489.91	124816.84
344201.15	448294.40	557688.12
122317.62	181267.40	255340.12
466518.77	629561.80	813028.24

1986	1987	1988
4970.95	5218.82	5466.70
2386.69	2673.82	2960.94
49058.42	52549.17	56129.64
80812.02	91705.24	103726.11
2494.23	2827.87	3169.92
31698.72	38301.51	45725.84
51552.65	55377.04	59299.56
112510.73	130006.75	149451.95
16504.38	17115.63	17773.79
6204.65	6708.37	7257.49
3487.15	3821.39	4169.94
10575.44	12108.72	13828.76
19991.53	20937.02	21943.73
16780.09	18817.08	21086.25
7447.63	7704.35	7963.13
1023.64	1121.92	1227.80
4894.77	5086.09	5278.97
5280.56	5800.48	6362.58
12342.40	12790.44	13242.10
6304.20	6922.41	7590.38
119050.76	133424.68	148655.63
8875.15	10667.46	12703.83
202937.34	222529.17	243141.03
144470.17	166413.70	190832.40
666186.71	773369.76	878875.09
332579.77	412734.33	495541.57
998766.48	1186104.09	1374416.66

1989	1990	1991
5714.57	5962.45	6260.57
3248.07	3535.19	3711.95
59794.93	63535.79	67854.74
116951.78	131460.33	150333.45
3519.43	3875.35	4128.05
54032.46	63282.82	72386.27
63314.36	67411.14	71982.79
170984.24	194743.15	222719.73
18483.89	19244.53	20560.27
7857.41	8513.64	9675.00
4532.76	4908.86	5234.26
15754.90	17906.80	20392.58
23016.65	24153.39	25794.53
23612.31	26420.44	30067.58
8223.62	8485.17	9061.77
1341.64	1463.80	1674.45
5473.66	5670.07	6039.92
6969.52	7624.01	8720.05
13697.29	14155.23	15101.69
8311.16	9087.81	10394.50
164695.01	181456.14	193854.72
15006.05	17596.22	20012.21
264723.30	287175.91	306733.73
217913.76	247847.62	283194.01
982361.98	1083500.88	1180822.37
580729.46	668017.55	757870.28
1563091.44	1751518.42	1938692.65

1992	1993	1994
6573.60	6902.28	7247.40
3897.55	4092.43	4297.05
72420.63	77239.32	82186.85
172214.63	197600.76	224474.90
4394.28	4674.41	4962.36
82941.74	95189.11	108143.96
76814.90	81913.73	87149.21
255156.37	292789.86	332618.86
21966.43	23465.89	25037.86
11017.90	12572.14	14252.22
5579.18	5944.24	6324.30
23269.58	26602.16	30178.58
27545.61	29410.13	31362.16
34287.48	39174.30	44430.80
9670.94	10313.45	10972.30
1918.71	2202.12	2501.86
6429.62	6839.74	7261.41
9990.86	11465.32	13025.36
16100.57	17153.19	18233.71
11909.57	13667.45	15527.23
207090.25	221188.78	235937.71
22806.81	26042.24	29530.19
327551.33	349665.83	372682.79
324160.22	371673.86	422107.08
1274449.92	1364493.85	1450954.33
850528.50	946239.82	1044166.48
2124978.42	2310733.67	2495120.81

1995	1996	1997
7609.77	7990.25	8389.77
4511.90	4737.49	4974.37
86539.52	91126.73	95958.42
237030.60	250437.62	264776.07
5222.16	5495.53	5783.07
114107.16	120461.85	127243.25
91761.68	96622.26	101741.49
351137.76	370899.47	392019.32
26553.22	28162.65	29868.93
15335.31	16534.73	17866.73
6687.83	7071.86	7477.11
32265.67	34554.15	37070.37
33241.05	35234.51	37346.04
47600.98	51088.87	54937.11
11548.53	12155.49	12794.51
2639.44	2785.99	2942.31
7642.37	8043.26	8464.96
13746.91	14516.33	15337.99
19190.90	20198.75	21259.47
16386.35	17302.31	18280.30
250029.68	264985.67	280832.12
31699.36	34093.23	36742.56
394223.31	417041.19	441179.12
446824.44	473383.89	501979.29
1533348.71	1611874.32	1686712.69
1137554.73	1226689.22	1311841.28
2670903.44	2838563.54	2998553.97

1998	1999
8809.25	9249.72
5223.09	5484.24
101044.86	106396.70
280136.33	296620.66
6085.40	6403.18
134491.00	142249.76
107130.26	112799.88
414627.33	438870.42
31674.78	33582.92
19350.14	21006.75
7904.31	8354.23
39844.75	42912.41
39579.09	41937.14
59194.89	63919.16
13466.98	14174.33
3109.30	3287.98
8908.38	9374.49
16216.83	17158.39
22375.36	23548.81
19326.13	20446.37
297595.06	315300.67
39682.91	42955.43
466679.77	493586.51
532831.26	566191.39
1758031.71	1825987.53
1393269.72	1471221.61
3151301.42	3297209.14

ANNEX

DEMAND ANALYSIS AND EVALUATION METHODOLOGY
FOR URBAN TRANSPORT COMPONENTS
for the Transportation and Land Sectors
of the Colon Urban Development Project

Draft prepared by Robert M. Sarly, Consultant, for the World Bank, Urban Operations Review & Support Unit.

April 1980

RMSarly:dm/bb/al
2/29/80

COLON URBAN DEVELOPMENT PROJECT

Demand Analysis and Evaluation Method
for Transport and Land Sectors

Context

1. Summary of Approach

In multi-sectoral urban projects, significant changes in the level and location of linked economic activities will result from direct project interventions as well as induced program impacts. In given circumstances, projections of future locational demands for residential and employment land cannot be readily made by extrapolating past trends. Structural changes, such as relative accessibilities, aggregate demand, supply of serviced land on the market, and overall location cost borne by the activity, will affect returns to investment throughout the urban economy and particularly in the Land and Transport sectors where locational preferences are most directly exercised.

Within the framework of an urban development project, analytic method is needed to identify future levels and locations of economic activity with sufficient confidence to serve as the basis of rudimentary cost-benefit evaluation. Any given method, especially one with an operational focus, will be a highly simplified application of basic non principles. The particular approach described herein is adapted from an operational tradition of Strategic Land Use-Transportation Analyses in which some quantitative detail is sacrificed for quickly determined strategic indicators of overall project impact in the urban area.

The method is based upon a conurbation of manual calibration, and manual and programal estimation. The program is written for use on a Texas Instrument TI59 hand-held programmable calculator, with use of attached paper tape printer. Discounted time and operating cost savings are automatically calculated for each link, year, mode, income group and (if

required) origin of trip. A complete run of a given configuration of transport inputs takes about four hours.

The entire study takes about two calendar months (3 mm) including Data assembly, input generation, manual calculation, programmable estimation, manual estimation, interpretation of results and reporting.

COLON URBAN PROJECT

JUSTIFICATION OF HIGHWAY COMPONENT: II

Summary of Results

1. The highway improvement is economically justified. From the perspective of intercity transport alone, the investment is already overdue, in that past "territorial" constraints on the expansion of the highway to meet growing demand in the region and between Cristobal Port and Panama City has resulted in near, or above, capacity levels of service on the highway. (See IRR, FURR, and increase in C/B ratio from 1973 to present below section E: Justification).

2. The integrated urban development project to revitalize the Colon sub-region proposes to increase and disperse economic activity and housing in the corridor between Manzanillo Island and the Cativa/ Sabanitas suburbs. The resulting additional metropolitan travel demand in effect transforms the highway, which is the only transport spine in the sub-region, from an inter-city to a metropolitan transport artery. As such it is an indispensible component of the integrated urban development program (see below section C: Impact).

3. Demand for the road improvements to the Boyd-Roosevelt Highway between Cativa/Randolph Road junction and Manzanillo Island is a direct result of the implementation of the integrated urban project, and in particular of the employment and housing components in the Expanded Free Zone, Porto Escondido and industrial zones (5, 6, and 7 in the attached map). Indirectly additional travel demands will also be generated in Manzanillo Island and Cativa-Sabanitas (Zones 1 and 8), as a result of the urban project (see below section B: Context).

4. Reductions in the overall size, or delays in the implementation rate of the urban project would reduce overall demand for transport on the road, providing that both employment and housing were reduced in equal proportions. However, if employment in the new Free Zone sites is to develop in any event, as is currently planned, while the housing in Porto Escondido (Zone 6) is eliminated or reduced, then travel demand on the road would increase further, due to the increase in average consequent commuting distance (along the Boyd-Roosevelt corridor) between jobs and homes.

5. In the absence of both the proposed highway improvements and new housing, residential preferences, especially for low-income households would generate strong demands for locations in the proximity of employment resulting in illegal squatting conditions if affordable legal options were unavailable. The areas most likely to be affected would be the Expanded Free Zone industrial zone and Rainbow City (zones 5, 7, and 4), where land would be available, and to a lesser extent, Manzanillo Island (Zone 1) where services would be available.

6. At the other extreme, implementation of the integrated urban project, but without these road improvements, would undermine the effectiveness of the urban project as a whole. The growth of travel demand on the road would quickly create congestion and loss of efficiency to all road users. The disbenefits to the urban project directly attributable to the absence of the proposed road improvements, as shown in the attached memo, would represent a significant share of overall project benefits. Disbenefits to goods movement, which generate 10% of the trip volumes, represent 60% of the total operating cost savings achievable on the road by 1984. Bus travelers which amount to 50% of the trip volumes, would bear about 10% of the operating cost savings, while car travelers (40% of the total trips) would derive 40% of the total operating cost savings. The low- and middle-income travelers generate 25% and 35% of the trips respectively and would incur 6% and 10% of the respective total disbenefits.

7. In view of the above, implementation of the urban project in its current form including the proposed road improvements would appear to generate the minimum negative externalities for the transport sector in the provision of essential access to linked economic activities in Gran Colon.

COLON URBAN PROJECT

JUSTIFICATION OF HIGHWAY COMPONENT: II

A. Objectives

1. Implementation of the urban project is not required to justify going ahead with construction of the road: as shown below, the road is justified on the basis of regional demand. However, the road is required to ensure the urban project realizes its objectives, particularly:

(i) the objective of stimulating improvements in key sectors such as transport, and in the level of transport services in Colon, to reduce travel costs and improve standards of access;

(ii) the objective of avoiding the disbenefits of $18,027 million (present value) in additional travel expenditures on the unimproved road (1980-1999), that would be incurred by the Colon population were the urban project to go ahead without the road component; and

(iii) ensure that the imminent rise in the volumes of trips along the road caused directly by the housing and employment components of the project are satisfactorily served, so that bottlenecks do not arise that delay overall project implementation causing cost overruns and development imbalance.

B. Context

2. The existing two lane Boyd-Roosevelt Highway is the only access corridor between Colon (i.e., Manzanillo Island), the main housing and employment development areas of the urban project, the suburbs of Cativa and Sabanitas, and Panama City (and the rest of the Metropolitan Region). Upgrading of the highway as proposed in the urban project will be along its existing alignment. No alternative alignment is likely to develop in the foreseeable future.

3. The roadway widening part of the project comprises a doubling of the existing two lane highway which extends from 800 meters east of the refinery junction in Cativa to the Randolph Road junction for a distance of 6.8 kilometers. The one-way loop part of the project extends from Randolph Road junction to Manzanillo Island for a distance of 2.5 kilometers inbound and a return route through Rainbow City for a distance of about 2.8 kilometers outbound. There are about nine junctions all of which will be at grade. Lane width will be 3.65 meters and the existing one-way loop roads will be brought up to comparable service levels as the main highway by means of resurfacing and geometric design of junctions, storage lanes and slipways.

4. On the basis of the regional demand projections made in the 1973 technical and feasibility study of Boyd-Roosevelt, the expansion of the road from its current two lane capacity to four lanes was determined to be economically justified from regional demand alone. On the basis of 1973 cost estimates this produced a benefit-cost ratio in the range of 1.8. Regional travel volumes then were estimated to be over 6,000 average daily trips (ADT) in 1973, with projections of over 10,000 ADT by 1980.

5. Current travel volume estimates based upon survey data collected by the Ministry of Public Works (MOP) in 1979 show current volumes along the road to be about 10,000-12,000 ADT, growing at an average rate of about 5% p.a. Current peak hour volumes are 1,200 passenger car units (PCU), which prevail an average of 28 hours per week. This peak hour demand exceeds the assumed effective capacity of the road during 25% of the travel week.

C. Impact

6. Without an urban project previous trends of traffic growth within Colon, and between Colon and Panama City, suggest that demand would continue to grow at about 5% p.a. producing 1984 ADT of 12,000 and 1990 ADT of 16,000.

7. However, in view of the dual impact of the urban project on Colon the expected growth in traffic demand will be about 20% greater due to:

(a) the accelerated development of economic activities in Colon resulting from the urban project; and

(b) the increased dispersion of project activities within the Colon sub-region, whose inter-relationships will rely on effective sub-regional transport access.

8. The economic analysis of demand for travel on the Boyd-Roosevelt Road done for this project component has taken the above impacts into account. It has been constructed upon conservative assumptions of trip generation, trip distribution and modal split, trip assignment and travel cost. The method distinguishes nine origin and destination zones in the city, three income classes and three travel modes. It also distinguishes operating costs and time costs.

9. The results of this demand analysis show a rapid increase in the number of peak hour PCU's from about 1,350 in 1980 to 1,650 in 1981, 2,000 in 1982, 2,300 in 1983, 2,600 in 1984 and 3,900 in 1989.

D. Cost

10. The capital cost of the road component, based upon preliminary estimates prepared by MOP, is $5,772 million (base) plus physical and price contingencies for a gross of $8,700 million.

E. Justification

11. Assuming (conservatively) an actual capital cost of about $8.0 million (not including price contingencies), economic evaluation of the road project shows a benefit-cost ratio in excess of 2.25 and a net present value of $10.03 million, not including time cost savings.

12. When time cost savings are taken into account the benefit-cost ratio rises to 12.94, and the net present value increases to $95.50 million.

13. The first year rate of return is 110%, showing that the optimum time for initiating investment in the road is already past, and that further delay is not justified.

14. The internal rate of return (IRR) for the road is 39.75% not including time cost savings. When these are included the IRR is in excess of 100%.

15. Sensitivity tests on costs show that a 20% rise in costs reduces IRR to 34.65%, and that a 20% fall in expected benefits reduces IRR to 32.15%.

RMSarly:bb

COLON URBAN PROJECT

ROADWAY IMPROVEMENT: ORIGIN/DESTINATION TRIP VOLUMES

1979 - 1984

1	1979	1984
POP	75000	65000
EMP	8000	9500
MP OR	8100	7760
MP DE	6470	8940

2	1979	1984
POP	-	-
EMP	5000	5000
MP OR	500	500
MP DE	3840	4700

3	1979	1984
POP	-	-
EMP	3000	3500
MP OR	300	350
MP DE	2300	3210

4	1979	1984
POP	5000	5000
EMP	250	500
MP OR	855	1050
MP DE	215	617

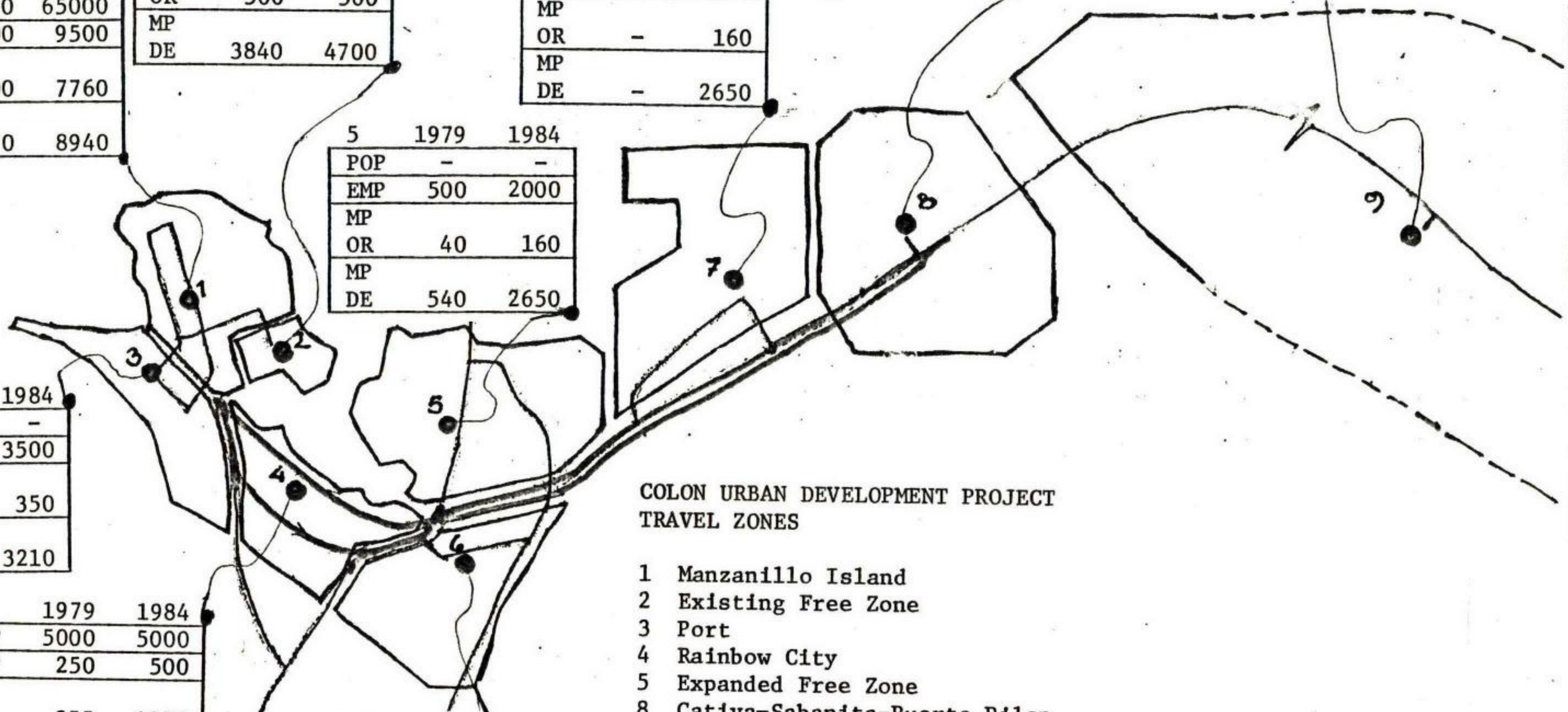
5	1979	1984
POP	-	-
EMP	500	2000
MP OR	40	160
MP DE	540	2650

6	1979	1984
POP	-	25000
EMP	-	250
MP OR	-	3015
MP DE	-	319

7	1979	1984
POP	-	-
EMP	-	2000
MP OR	-	160
MP DE	-	2650

8	1979	1984
POP	20000	25000
EMP	1500	2500
MP OR	2610	3400
MP DE	1290	2680

9	1979	1984
POP	-	-
EMP	-	-
MP OR	3025	9214
MP DE	745	1514



COLON URBAN DEVELOPMENT PROJECT
TRAVEL ZONES

1 Manzanillo Island
2 Existing Free Zone
3 Port
4 Rainbow City
5 Expanded Free Zone
8 Cativa-Sabanita-Puerto Pilon
9 Panama City Metropolitan Region

MPPE = Morning Peak Period Destinations
MPOR = Morning Peak Period Origins
include only vehicle trips (2 hours)

2. Introduction to the Demand Analysis

Amongst the objectives of transport sector intervention in the Colon Urban Development project is the provision of an efficient transport system to make linked economic activities in metropolitan Colon more accessible to the urban population. Since the impact of the overall project is multi-sectoral and complex it will not be possible to represent its derived benefit in a single measure such as a cost-benefit ratio, or internal rate of return. The estimate of the transport components' net worth, its benefits and costs (associated with road widening, traffic improvements, bus and train service provision, bus fleet expansion and vehicle maintenance) are therefore defined by the following evaluation measures:

1. time savings to bus travellers
2. operating cost savings to bus travellers
3. time savings to car travellers
4. operating cost savings to car travellers
5. time and operating cost savings to trucks
6. time savings to train travellers
7. levels of service for the public bus system and primary road network
8. travel expenditure share of household income
9. generalized travel share of location costs for households.

Each of the above terms is measured for nine separate geographic areas in the metropolitan region, and with respect to its incidence in three income classes. The areas are:

1. Manzanillo Island (excluding the Colon Free Zone)
2. Colon Free Zone
3. Cristobal Port
4. Rainbow City
5. New Commercial Zone (Coco Solito)
6. Puerto Escondido
7. New Industrial Area (Export Processing Zone)
8. Cativa - Sabantas - Puerto Pilon Suburbs
9. Rest of the Metropolitan Region and Panama City

The three income classes are:

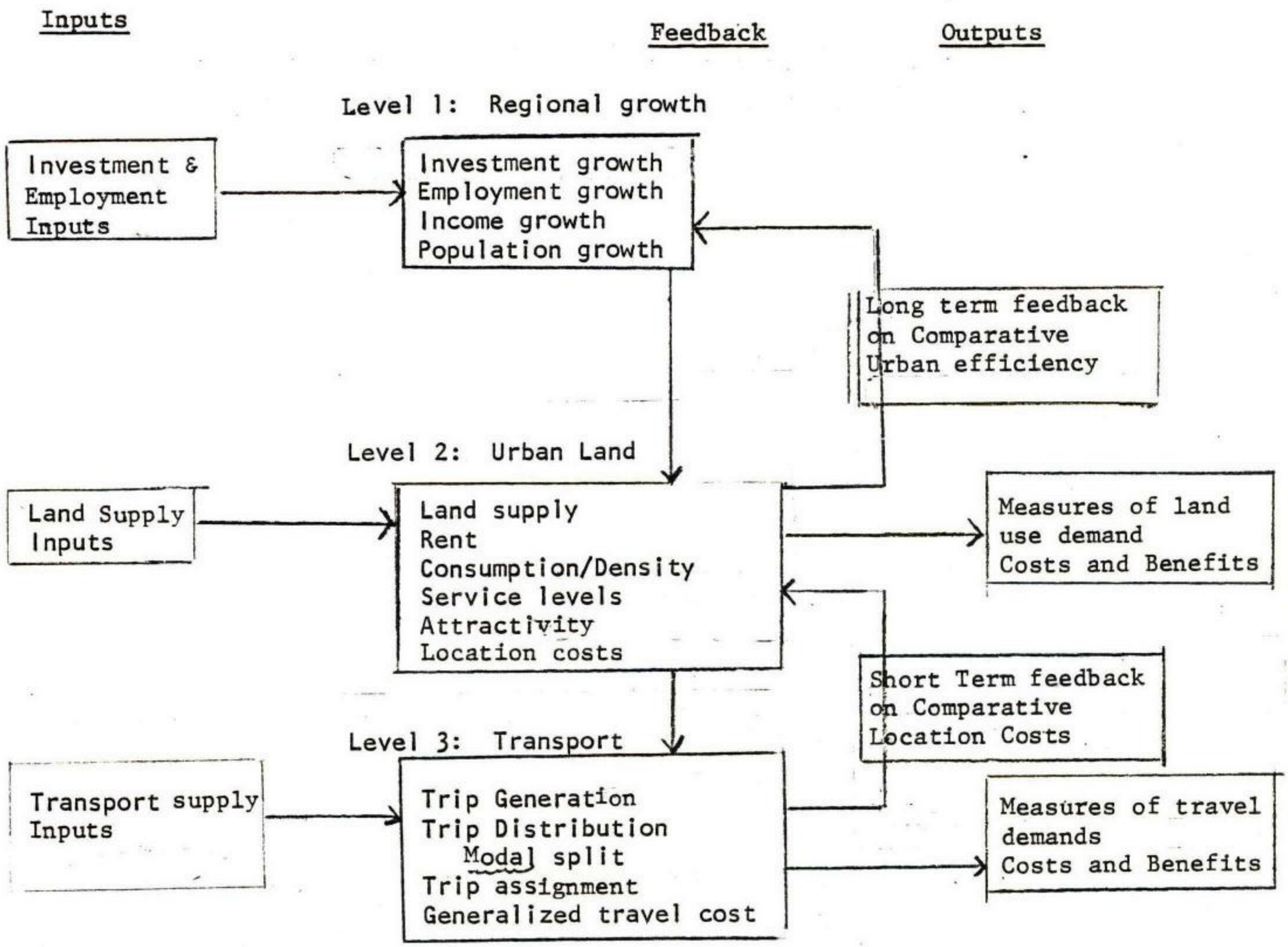
	Average HH income per month
1. Upper income (top 2 deciles)	$1800/m
2. Middle income (from 4th to 8th decile)	$425/m
3. Lower income (bottom 3 deciles)	$125/m

3. Method in General

The method for estimating the above evaluation measures relies on an aggregate strategic analysis of transport and land use changes over the project period, and on their interaction. On the basis of these estimates are made of the generation, distribution, assignment and cost of household and business trips, for each income class and for every zone in the region. Travel cost forecasts serve as the basis for estimating locational demand in general, and in particular the values of land in different parts of the region. From these estimates, long-term implications for changes in the land use structure of the Metropolitan Region are determined.

Future levels of demand for transport facilities and services are taken as a function of the future urban spatial structure and the rate of growth of economic activity in the Colon Region. These are expressed logically in three levels of a strategic development analysis, as shown in the following diagram:

Strategic Development Analysis



Each level of analysis starting with Regional growth provides the operating assumptions upon which the next level projections are made. The analysis is validated on the basis of existing conditions by calibrating the governing relationships linking the supply and demand of transport and land, from survey and field observation. These relationships then derive the projection of future demand levels in terms of changes in supply and the behavior of the urban economy under conditions of growth.

4. Method in Detail

The method is made operational in three phases:

1. Manual calibration of functional relationships governing the changing values of transport and land demands by mode, link, zone and income class.
2. Programmable estimation of travel benefits by mode, link, zone of origin, and income class
3. Manual estimation of location cost changes and imputed affect on the demand for land by income class, zones density and rent values.

4.1 Manual Calibration of Transport Demands

The governing relationships for the transport analysis are shown below:

Trip Generation and Distribution

(Equation 1) $T_i^{z^\circ} = P_\cdot^z \; ^z$

(Equation 2) $T_j^{z^\circ} = P_\cdot^z \; ^z$

T_i^{zo} = number of trips generated by an activity (residential/ employment) z for purpose o from origin zone.

T_j^{zo} = number of trips generated by an activity (employment) of type z for purpose o to destination zone j.

P^z = Population (or number of employees) associated with that activity

α^z = Propensity for each unit of activity to generate a morning peak hour trip.

This function is used to discriminate trips by origin zone, i, destination zone j, car users and non-car users. It is used to generate estimates of existing conditions reflecting known overall flows of public and private traffic.

(Equation 3) $$T_{ij}^{mzo} = \frac{O_i^{mzo} D_j^{mzo}}{C_{ij}^{mb}} \circ B$$

T_{ij}^{mzo} = Total trips per mode m between zones i and j for activity type z and figure o.

O_i^{mzo} = Number of $_1$trip origins in Zone j, for mode m activity z, purpose o^1.

D_j^{zo} = Number of trip destinations in zone j for activity z, purpose o.

C_{ij}^{b} = Cost of travel between zone i and j.

b = Elasticity of demand for travel with respect to cost.

B = Normalizing factor = $1/\sum^{m} O_i D_i / C_{ij}$

Trip Assignment & Costs

Given the simplified structure of the transport network in metropolitan Colon, inter-zonal traffic is assigned directly to links. These links acquire traffic loads which generate congestion as a function of free flow link speeds and design capacities.

Travel costs are estimated in two parts:

1. Operating costs, measured in terms of average use, speed and distance, characteristic vehicle cost per kilometer at link speed.
2. The cost assumed in terms of real (i.e., congested) travel time elapsed per journey plus the (pedestrian) access time at either end of the (vehicular) journey.

(Equation 4) $$G_c = \sum^{j} C_i^{op} + \sum^{j} C_i^{t}$$

The cost of travel is aggregated for each income class and each mode for all trips made by households in a single origin zone to all other zones, This measure is taken to be the generalized cost of travel for the typical household in each origin zone. Truck trips are similarly aggregated by employment-origin zones for all trips.

The results of the transport analysis are fed back into the land analysis in terms of generalized travel costs per household. These values are then used to reestimate locational demand for land in different zones in terms of residential densities, land rent and numbers of households to be located in each zone.

The governing relationships for the land analysis are as follows:

4.2 Manual Calibration of Land Demands

Demand for Land

The first function determines the quantity of land consumed by each activity l^z given the unit rent of land, r_1 and the income of the activity w_i^z. The relationships amongst these factors (land consumption, rent and income) are governed by three parameters:

(a) constant coefficient, k^z

(b) price elasticity of demand, p^e, which is negative to reflect the reduction of land consumption that occurs with an increase in rents.

(c) income elasticity of demand i^e, which is positive to reflect the increase in land consumption that occurs with an increase in incomes.

The demand for land function is specified in the following form:

(Equation 5) $l_i^z = k^z r_i^{-pe} \cdot w^{z^{ie}}$ where:

l_i^z = land consumed by household group z in zone i.

r_i = rent of land per m^2 in zone i

w^z = income of activity z

p^e = price elasticity of demand for land

i^e = income elasticity of demand for land

k^z = constant scalar.

Cost of Location

The second function, determines the total cost for an activity, z, resulting from the selection of a location in zone i, C_i^z, as the sum of the cost of land rent $l_i^z \cdot r_i$ plus the cost of building rent $S_i^z \cdot b_i^z$ plus the transport cost associated with locating in the zone $A_i^z\ g_i^z$ plus the cost of providing the zone with infrastructure services $F_i^z \cdot O_i^z$. The transport cost is calculated as the weighted average of the cost of all trips made by that activity in that zone. This cost connects the land use sub-model with the transport sub-model. The function is specified in the following form:

(Equation 6) $$C_i^z = l_i^z \cdot r_i + S_i^z \cdot b_i^z + A_i^z \cdot g_i^z + \sum^Q F_i^z \cdot c_i^z$$

Where:

C_i^z = Cost of location for household group z at zone i.

$l_i^z \cdot r_i$ = Cost of ground rent for land consumed.

$S_i^z \cdot b_i^z$ = Cost of building rent.

Where: S = amount of built space per household.

b = unit cost of space.

$A_i^z \cdot g_i^z$ = Transport cost.= G_c

Where: A = accessibility index for HH

g = unit cost of transport

$\sum^Q F_i^z \cdot c_i^z$ = Cost of infrastructure for all services, Q

Where: F = standard of service.

c = unit cost of standard service.

Distribution of Activities

The third function, determines the distribution among all the zones of each activity in terms of the total number of the activity G^z, the amount of land available for development in zone i, L_i, the location cost of the activity C_i^z, and residual attraction W_i^z. The function is specified in the following form:

(Equation 7) $G_i^z = G^z . L_i . W_i^z . {C_i^z}^{-1_z} B^z$

Where:

G_i^z = total number of households

G^z = total number of household group z

L_i = total land available in zone i.

W_i^z = residual attraction index for household group z in zone i.

C_i^z = location cost for household group z in zone i.

1_z = elasticity of demand for location with respect to cost.

B^z = normalizing factor

Budget Constraint

The following constraint must be respected to ensure land supply and located demand are in balance.

(Equation 8) $G_i^z . 1_i^z = L_i$

Cost Recovery

The cost of location function is the basis for estimating means for cost recovery in terms of a recovery rate by cost component for each activity, and for each location for all public capital investment projects, as follows:

(Equation 9)

$$RC_i^{*z} = T_i l_i^z r_r + T_2 S_i^z \cdot b_i^z + T_3 A_i^z \cdot g_i^z + T_4 F_i^z \cdot c_i^z$$

where: R = cost recovery rate (aggregate),

T_i= land tax rate

T_2= building tax rate

T_3= public transit fares and road user charges

T_4= utilities user charges

In terms of this formulation, C^* may be thought of as the social cost of location since not all of C_i^{z*} may necessarily be charged to the locator. Nonetheless, all of C_i^{*z} is recovered as a result of the locators' choice of the i^{th} location on aggregate, though certain areas (target groups, project sited, etc.) may be cross-subsidized in order to ensure affordability.

The inclusion of C_i^{*z} in the function ensures that the social values created by project investments are reflected in land prices throughout the urban market area in proportion to their impacts for each activity group at each location, and are recovered without detriment to the benefit share of the targetted poverty groups.

Income Generation

The demand for land function for household activities is the basis for incorporating real income, w^* and not just wage income w. Income gains and social subsidies that may have been created in different locations in each of the cost categories as follows:

(Equation 10)

$$l_i^{*r} = \frac{K^z \cdot w^{*z^{ie}}}{r_i^{pe}}$$

where: $w^{*z^{ie}} = \sum B^p - R \cdot C_i^{*z} + \sum^p b_i + w_i^z$

where: $\sum B^p$ = the sum of project capital costs per household

$R \cdot C_i^{*z}$ = total costs recovered per household

$\sum^p b_i^z$ = sum of income gains resulting from operating cost savings in each project.

w_i^z = wage income per household.

Difference between project costs and costs recovered measures the proportion of conferred benefit not directly recovered by tax, user charge (etc.,) or other methods. The function shows the effect of income gains changes in location and service levels. Also, the use of b_i^z ensures that locational preferences reflect the aggregate effect of income gains from constraints on the structure of demand, and in particular on land prices and location priorities for development.

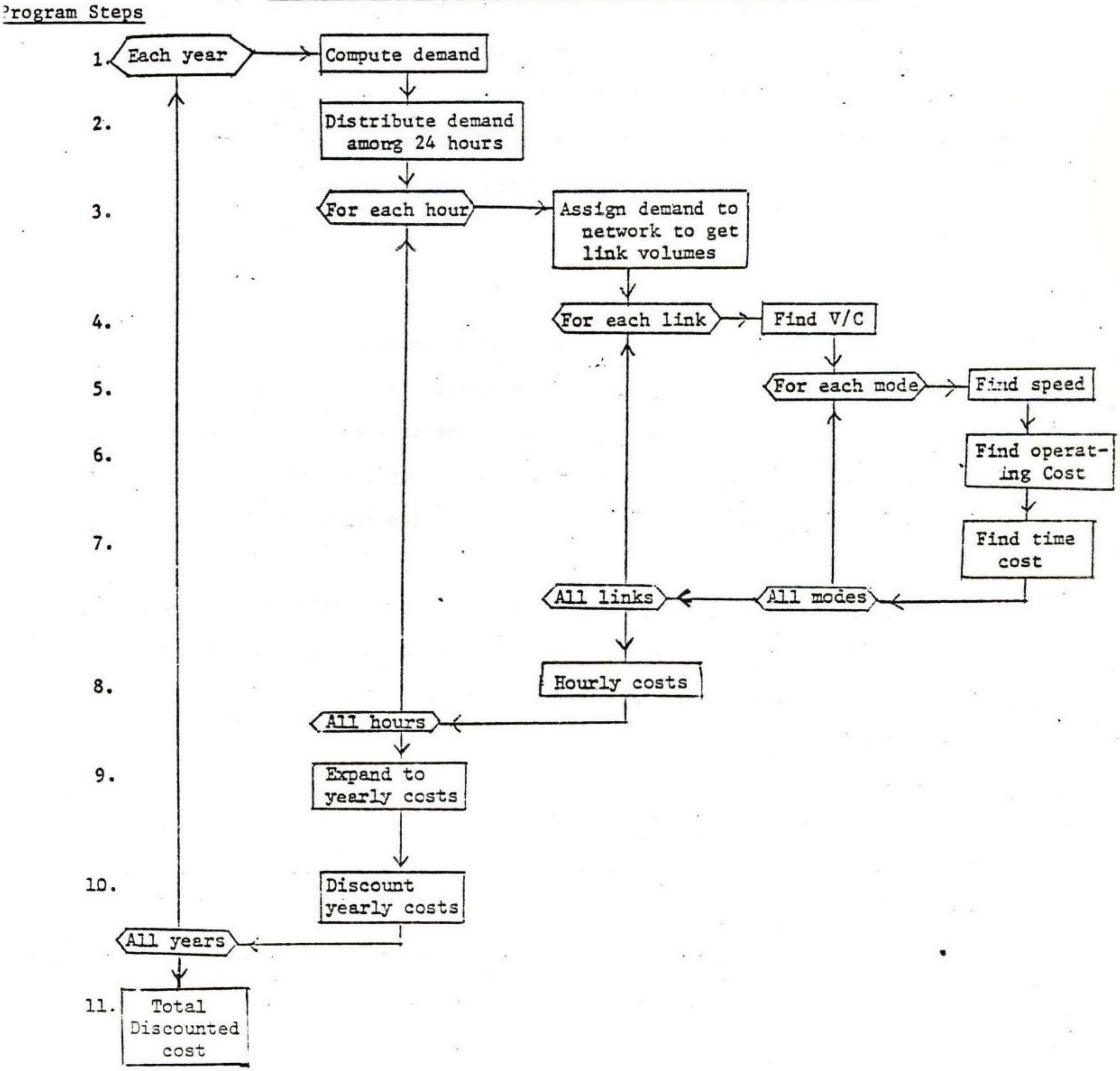
The income effects identified in the analysis are used to indicate aggregate changes in the levels of household demand by income group and location in the urban area. These indicators are viewed from the broad employment market perspective through disaggregated demand and income elasticities as the basis for examining consequent employment impact. This examination requires a separate formulation of a specific income-employment relationship that applies for a given urban system. This is not included in the above.

4.3 Programmable Estimation

A general sketch of the method for estimating transport benefits by means of a hand-held computer program is shown in the diagram below. Discussion follows this diagram, step-by-step.

Figure 1

Computing Operating and Time Costs of Each Alternative



Step 1: For Each Year, Compute Demand

Demand is used for an average weekday as representative of the whole year. Demand has two dimensions: O-D pair, and mode. Because of population and activity growth in different locations, demand between different O-D pairs varys in magnitude and growth. There is also a different demand for each mode of freight and passenger transport. All modes are aggregated into: truck (freight), auto, and bus (transit). Demand values are taken from the results of the manual algorithm.

Step 2: Distribute Demand Throughout the Day

Demand also has a temporal and a directional dimension. Usually demand is not predicted directly for an hour, however; it is predicted for the entire day and later distributed. For each direction there is a peaking profile, which gives the relative demand in each hour of the day. For convenience we may say there is a peaking profile of 48 hours, where the first 24 hours correspond to one direction (positive) and the last 24 to the other (negative) direction.

The most common assumption is that the daily peaking profile will be the same in every year for every O-D pair. This assumption can cause significant error when the network includes major radial and crosstown roads, each of which exhibit different peaking patterns. (The crosstown road has 2 peaks per rush hour while the radial has only

However, in the corridor problem with which we are dealing it is probably safe to assume each link of the same road will have the same peaking pattern. Different modes may have different peaking profiles, however. Thus the demand at an hour h is

where $D^{t,h}_{m,p} = D^{t}_{m,p} f^{h}_{m}$ (2)

f^h_m is the peaking factor for hour h and mode m, and the vector $\left\{f^h_m\right\}$, h = 1,..., H is called the peaking profile for mode m. Thus a peaking profile is assumed given for each mode. It is common to not analyze all 48 hours separately but rather to select a few representative hours, the results of which are expanded hours in the day which have similar flows. A peaking profile for peak direction travel in San Jose, Costa Rica is found in Attachment A.

Step 3: For Each Hour, Assign Demand to the Network to Get Link Volumes

This can be the most complex step of the urban transportation analysis procedure. However, our restricted problem definition makes this problem trivial. Each O-D pair has a unique path, covering a known set of links. To get link volumes one must aggregate over O-D pairs and modes. Links, like hourly flows, are assumed unidirectional and furthermore we assume a link is symmetric in its capacity. Thus the flow on link j in hour 10 is the flow in the positive direction on link j at 10 a.m., while the flow in hour 34 is the flow in the negative direction at 10 a.m.

To aggregate over modes (since they all share the same roadway), each mode is given a passenger car unit (PCU) equivalency. This PCU equivalency depends not only on vehicle size, but on vehicle performance as well; and since vehicle performance is differentially affected by link characteristics, particularly grade, there must be a PCU equivalency factor for each mode and link.

Link volumes must be measured ~~in~~ vehicles. For auto and truck this presents no problem, since demand is usually measured in vehicles, or if measured in passengers, a single

---

occupancy factor can convert demand into vehicles. However, when bus demand is measured in passengers, it is not so readily converted into vehicles since load factors can vary widely throughout the day. Since bus operations are usually centrally planned, bus volumes may be exogenously specified. In more complex networks rerouting is also a possibility. In the simple corridor analysis with which we are dealing, it is probably sufficient to assume that load factors on each route at each hour will be the same year-to-year, so that demand can be measured in vehicles in the base year and treated in the same way as cars and trucks.

Aggregating over O-D pairs is simple summation, so that the link volumes are:

$$V_a^{t,h} = \sum^{p} \sum^{m} D_{m,p}^{t,h} \; e_{m,a} \; \delta_{a,p} \qquad (3)$$

where

$V_a^{t,h}$ = volume (in PCU's) on link a in hour h and year t

$D_{m,p}^{t,h}$ = demand for mode m between O-D pair p in hour h and year t (measured in vehicles

$e_{m,a}$ = PCU equivalency factor for mode m on link a

$\delta_{a,p} = \begin{cases} 1 \text{ if link a is on the path between O-D pair p} \\ 0 \text{ otherwise} \end{cases}$

In addition we will later need modal link volumes, which are:

$$V_{m,a}^{t,h} = \sum^{p} D_{m,p}^{t,h} \; \delta_{a,p} \quad (3.1)$$

Step 4: For Each Link, Calculate the Volume/Capacity Ratio (V/C)

Since the volume has been determined in Step 3, all that is needed is the link capacities. These are given for both alternatives (no-build and build), and are the same at every hour in every year (barring the use of reversible lanes, peak hour exclusive lanes, etc.). Therefore, for any link, hour and year, for an alternative b (no-build or build,

$$(V/C)_a^{t,h,b} = V_a^{t,h} \div C_a^b \qquad (4)$$

where

C_a^b = capacity of link a in alternative b

$(V/C)_a^{t,h,b}$ = volume/capacity ratio in alternative b on link a at time h in year t

since each alternative is analyzed identically, we shall remove the superscript b and continue with the notation $(V/C)_a^{t,h}$, realizing that its value pertains to a particular alternative.

Step 5: For Each Mode, Find the Speed

The speed at which traffic flows on a link depends on the volume on the link and its capacity. All existing models (to my knowledge) give speed as a function of the volume/capacity ratio. Recognizing that volume and capacity affect speed not only by their ratio, often there is a family of speed-flow (speed vs. V/C) curves for roads of different capacities, e.g., 2-lane and 4-lane arterials.

Because of different vehicle and operating characteristics, the speeds of each mode will be affected differently by congestion. Therefore each mode will have its own speed-flow relations.

Therefore the speed of mode m on link a which is of type s will be

$$x_{m,a}^{t,h} = g_{m,s}\left[(V/C)_a^{t,h} \right] \qquad (5)$$

where

$g_{m,s}[\ *\ ]$ is a particular speed-flow relation for mode m and road type s. Different functional forms exist for the functions $g_{m,s}$. In order to identify the appropriate curve to be used for a particular link (given that mode is known), there must be a pointer specific to each link indicating the correct curve. If all of the curves have the same functional form with a different parameter (e.g., minimum speed), the pointer may be simply the parameter and thus the functional form of the speed-flow curve needs to be stored only once. This pointer or parameter is called s_m. (It seems obvious that the speed of the bus and truck modes might be affected by grade. However most analyses consider the peak direction only, which is one direction half the day and the other direction the other half, so that average grade on every link is zero, and average speed is almost unaffected by grade. The same is true for operating cost, though it is known that it costs more to travel a distance on a hilly road with

an "average" grade of zero than on a flat road. Since we will usually be using models for speed and cost that ignore grade, the remainder of this paper shall ignore it, too. Furthermore, ignoring grade allows both directions of a link to be identical. This is a significant simplification, making flows to be direction abstract, and hence allowing analysis of flows in one hour to be expanded to hours with similar flows without regard to direction when less than 48 hours are analyzed.) Some examples of speed-flow functions are found in Attachment A.

Step 6: For Each Mode, Determine Operating Cost

Vehicle operating cost on a link is difficult to measure, and therefore difficult to model. It is affected by road characteristics (grade, curvature, pavement), vehicle characteristics (weight, engine type), and operating characteristics (speed, number of stops). Most models give operating cost in terms of one of the operating characteristics only (speed) aggregating different vehicle types (within the same mode) and averaging over road characteristics. If pavement is uniform over the road, there is no more than normal curvature for an urban road, and grades are not great, such approximations are acceptable. Under normal urban operating conditions a study found that 95% of the variation in fuel consumption among British cars could be explained by speed alone. Since other auto related costs are roughly proportional to fuel consumption, the simple speed-operating cost relation may be sufficient for autos.

Operating cost is usually computed by a function of this form:

$$OC^{t,h}_{m,a} = \beta_m + \frac{\alpha_m}{X^{t,h}_{m,a}} \cdot d_a \cdot V^{t,h}_{m,a} \qquad (6)$$

where

$OC^{t,h}_{m,a}$ = operating cost for mode m on link at time h in year t

α_m, β_m = parameters (per hour and per Km operating cost for mode m)

$X^{t,h}_{m,a}$ = speed of mode m on link a at time h in year t

d_a = length of link a

$V^{t,h}_{m,a}$ = volume of mode m on link a at time h in year t.

Since operating cost should include the labor cost of paid drivers such a function including a term in which distance is divided by speed (which yields time) is especially appropriate for bus and truck. Operating cost models estimated in a few cities are documented in Attachment A.

Step 7: For Each Mode, Determine Time Cost

The time each vehicle spends on a link is the link's distance divided by the vehicle's speed. The total passenger time is the vehicle time multiplied by vehicle occupancy (not including paid drivers). The total time cost is this total passenger time multiplied by the value of time.

Vehicle occupancy can vary not only by mode but also by link and by time of day, particularly on buses where loads may be 80 in the peak and 20 off-peak, and may increase steadily toward the city center. Value of time is generally taken to be fixed for all modes and all times, and invariant over the year.

Thus the passenger wait time cost is

$$TC^{t,h}_{m,a} = \frac{d_a}{X^{t,h}_{m,a}} \cdot W^{h}_{m,a} \cdot v \cdot V^{t,h}_{m,a} \qquad (8)$$

where

$TC^{t,h}_{m,a}$ = time cost for mode m on link a at time h in year t

d_a = length of link a

$X^{t,h}_{m,a}$ = speed of mode m on link a at time h in year t

$W^{h}_{m,a}$ = vehicle occupancy of mode m on link a at time h

v = value of time

$V^{t,h}_{m,a}$ = volume (of vehicles) of mode m on link a at time h in year t

Step 8: Aggregate Costs Over Modes and Links

Steps 4-7 must be repeated for every link and every mode as the flowchart in Figure 1 indicates, aggregating costs to yield hourly costs. Thus the operating and time costs for an hour h in year t are:

$$OC^{t,h} = \sum^{a} \sum^{m} OC^{t,h}_{m,a}$$
$$TC^{t,h} = \sum^{a} \sum^{m} TC^{t,h}_{m,a} \qquad (9)$$

Other meaningful aggregations should be taken as well, such as total costs for modes, for links, etc.

Step 9: Aggregate Costs Over Hours, Expanding to Yearly Costs

Steps 3-8 are repeated for each hour. To expand the predicted hourly costs to yearly costs one needs to know the number of hours in a year that hour represents. These annualization factors should insure that the daily demand (in Step 1) is properly expanded to annual demand. Different hours may have different annualization factors because they represent different numbers of weekday and weekend hours. Also some analyses may want to consider peak hours only in computing benefit.

The annual costs are then:

$$OC^{t} = \sum^{h} OC^{t,h} \; N_h$$
$$TC^{t} = \sum^{h} TC^{t,h} \; N_h \qquad (10)$$

where

N_h = number of hours in a year represented by hour h.

Step 10: Discount Yearly Costs

Either annual or continuous compounding may be used to discount the yearly costs to present values. For operating costs, these formulas are:

$$\overline{OC}^{t} = OC^{t} \; (1 + D)^{-t} \quad \text{(yearly compounding)}$$
$$\overline{OC}_{t} = OC^{t} \; e^{-Dt} \quad \text{(continuous compounding)} \qquad (11)$$

where

OC_t = discounted operating cost from year t

D = shadow discount rate

time costs are similarly discounted

Step 11: Aggregate Discounted Costs

This yields the present costs of the alternative being studied. The difference between the present cost of the no-build alternative and that of the build alternative is the present value of the build alternative. (When other discounted costs, such as construction, maintenance, etc., are subtracted this becomes net present value.) So the final equation for present operating costs (and similarly for time cost) is

$$OC = {}^{t}\ \overline{OC}^{t} \qquad (12)$$

The predicted costs thus obtained may be disaggregated and manipulated in any way to afford the analyst a closer look to see the benefits accruing to each link, or to each mode, or to find link specific benefit/cost ratios, internal rates of return, etc.

5. Solution Procedure

Within the above Analytic framework, the solution procedure provides a logical, yet simple sequence of analytic tasks. These tasks are listed below and elaborated in detail in the following sections.

5.1 Summary of Tasks

A. Strategic Forecasts of Travel Demands

1. Review land use conditions and developmental assumptions
2. Review test road network and bus system conditions and changes
3. Review traffic assignments and diversions

B. Future Demand Volumes

1. Estimate future auto/truck traffic volumes
2. Estimate future bus and bus passenger traffic volumes
3. Estimate future train passenger traffic volumes
4. Develop peak hour and peak direction factors
5. Estimate future peak hour, peak direction volumes for auto/truck, bus and bus passenger, train passengers.

C. Design Capacities

1. Develop lane capacity of auto/truck
2. Determine PCU equivalencies and passenger capacities for bus and mini-bus

D. Volume/Capacity Ratios

1. Compute V/C ratio for auto/trucks and for busses

E. Level of Service and Travel Speed

1. For auto/trucks and for busses, establish a LOS - V/C Speed table.
2. Determine LOS and travel speed, knowing V/C.

F. Travel Time, Stops, and Idling Time

1. Develop a "model" to relate LOS, travel time per km., stops per km., and idling time per km. for auto/trucks and busses.
2. Determine on a "per kilometre" basis, travel time, stops, idling time, and excess travel time (actual time minus 1.0 minute as derived from 60 kph base)

G. Time Costs and Vehicle Operating Costs

1. Determine value of driver's time and passengers' time per hour.
2. Determine for auto/truck and for bus, vehicle operating cost per km. for 60 kph base, and for additional costs due to stops and idling time.

H. Time Savings

1. For auto/truck drivers and for bus passengers, compute time savings during six peak hour, peak directions for each year (1979-1999). "Savings" are based on difference between "No Build" (Alternative 1) and "Build" (Alternative 2).
2. Compute present value of time savings.

I. Vehicle Operating Cost Savings

1. For auto/truck volumes and for bus volumes, compute operating cost savings by link during six peak hour, peak directions for each year (1979-1999). "Savings" are based on "No Build" (Alternative 1) and "Build" (Alternative 2).
2. Compute present value of vehicle operating cost savings.

J. Project Costs

1. Determine present value of project costs.

K. Economic Evaluation

1. Determine benefit-cost (B/C) ratio, "Benefits" refer to the sum of present values for time savings and vehicle operating cost savings.

2. Determine net present value (NPV).

3. Determine internal rate of return.

5.2 Input Requirements

A description of input requirements and assumptions used to calibrate the analysis to conditions in Colon in 1979 is given in the pages that follow.

Input Requirements

For a project with A links, M modes, a benefit horizon of T years, each of which has H hours, considering 2 alternatives.

Number of Items	Variable	
A x M	$V^{o,*}_{m,a}$	base year vehicular demand for mode m on link a
M or 1	r_m or r	demand growth rate (for mode m)
H x M or H	f^h_m or f^h	peaking factor (for mode m) in hour h
M	e_m	PCU equivalency factor for mode m
2A	c^b_a	capacity of link a under alternative b (no build or build)
2M	α_m, β_m	operating cost model parameters for mode m
A	d_a	length of link a
H x M or M	W^h_m or W_m	vehicle occupancy of mode m(in hour h)
1	v	value of time

H	N_h	yearly number of travel hours of type h
1	D	shadow discount rate
M	s_m	speed-flow curve parameter for mode m

plus a speed-flow function

c_B	bus fares
t_c	terminal times
C_{nr}	non-transport location costs
W	disaggregate attractivity indices
L	land availability
P	aggregate popular growth
E	aggregate employment growth

BENEFITS ON A SINGLE LINK: SINGLE HOUR EXPANDED

(Input Data Format)

Site: ____________________ Date: __________

Analyst: ____________________ Page: _____ of _____

Costs: ____________________

Enter		Press
(Initialize)		A
(Initialize)		B
Auto mode:		
growth factor (1.xx)	= 1.______	R/S
PCU equivalency factor (1)	= 1	R/S
speed-flow function parameter	= ______	R/S
per hour operating cost ($/hr)	= ______	R/S
per km operating cost ($/hr)	= ______	R/S
auto occupancy ______ x value of time ______ ($/hr)	= ______	R/S
Truck mode:		
growth factor (1.xx)	= 1.______	R/S
PCU equivalency factor	= ______	R/S
speed-flow function parameter	= ______	R/S
per hour operating cost	= ______	R/S
per km operating cost	= ______	R/S
occupancy x value of time	= 0.0	R/S

Enter		Press
Bus Mode		
growth factor (vehicular) (1.xx)	= 1.______	R/S
PCU equivalency factor	= ______	R/S
speed-flow function parameter	= ______	R/S
per hour operating cost	= ______	R/S
per km operating cost	= ______	R/S
bus occupancy ______ x value of time ______	= ______	R/S
(Initialize)		C
Base year vehicular volumes (peak hour, peak direction)		
auto volume (veh/hr)	= ______	R/S
truck volume	= ______	R/S
bus volume	= ______	R/S
Link capacities (one direction)		
no build capacity (veh/hr)	= ______	R/S
build capacity	= ______	R/S
Link length (km)	= ______	R/S
Peak hour, peak direction yearly expansion factor (number of peak hours per year)	= ______	STO 11
First year discount factor (1.xx)	= ______	STO 13
Discount rate (1.xx)	= ______	STO 14
Number of years	= ______	STO 00
First Year in Benefit Horizon	= ______	STO 06

5.3 Regional Growth, Land and Transport Inputs for Colon Urban Development Project

Level 1: Regional Growth Inputs

The key regional growth assumptions underlying the projection of travel demands are described in the Project Appraisal Report and summarized in the tables below:

Employment Growth and Change 1979-1989

Based on "basic" employment-generating project investment and "non-basic" job-generation (assuming a multiplier of 1.8) distributed to spatial structure of the market and available land.

Urban Project Build

Year	Employment					
	1979		1984		1989	
Zone	Basic	Non-basic	Basic	Non-basic	Basic	Non-basic
1	500	7,500	500	9,000	500	11,000
2	5,000	-	5,000	-	5,000	-
3	3,000	-	3,500	-	4,000	-
4	-	250	-	500	-	1,300
5	500	-	2,000	-	3,000	-
6	-	-	-	250	-	500
7	-	-	2,000	-	5,000	-
8	1,000	500	1,000	1,500	1,000	2,000
9	-	-	-	-	-	-
Total	10,000	8,250	14,000	11,250	18,500	14,800

Urban Project No-Build

Year	Employment					
	1979		1984		1989	
Zone	Basic	Non-basic	Basic	Non-basic	Basic	Non-basic
1	500	7,500	500			
2	5,000	-	5,000			
3	3,000	-	3,000			
4	-	250	-			
5	500	-	1,000			
6	-	-	-			
7	-	-	-			
8	1,000	500	1,000			
9	-	-	-			
Total	10,000	8,250				

Population Growth and Change 1979-1989

Based upon a full labor participation rate of .33 and an unemployment rate (in formal sector activities) of 40% effective 1979 and reducing ___ to 7%-10% by 1989, distributed on the basis of observed existing densities and inputed changes on future locational cost/demand for housing. Income classes are defined in terms of average income levels which are taken to neither increase nor decline in real terms over the analysis period. Population growth arising from natural increase and net in-migration are not distinguished in the h household totals shown below; average household size is taken as 4.6 (existing 1979 average) throughout the period. (Households.)

Income	1979				1980				198			
Class	High	Medium	Low	Total	High	Medium	Low	Total	High	Medium	Low	Total
Zone												
1	2,600	8,300	4,100	15,000	2,500	8,000	2,500	13,000	2,500	8,000	2,500	13,000
4	800	200	-	1,000	800	200	-	1,000	800	200	-	1,000
6	-	-	-	-		3,000	2,000	5,000	-	3,000	2,000	5,000
8	800	2,000	1,200	4,000	1,000	2,500	1,500	5,000	1,500	3,500	2,000	7,000
Total	4,200	10,500	5,300	20,000	4,300	13,700	6,000	24,000	4,800	14,700	6,500	26,000

Level 2: Urban Land Inputs

The key land assumptions underlying the projection of land demands are summarized in the tables below:

Land Available for Residential Use

Based on surveyed land use patterns and observed net residential densities existing for 1979, with income classes separately estimated by zone.

INCOME CLASS

Year	1979							1984				1989			
Zone	High		Middle		Low		Total	High	Middle	Low	Total	High	Middle	Low	Total
1	78.0	300	83.0	100	12.3	30	173.3	75.0	80.0	77.5	162.5				
4	48.0	600	4.0	200	0.0		52.0	48.0	4.0		52.0				
6	-	-	-	-	-	-	-	-	75.0	15.0	90.0				
8	72.0	900	60.0	300	10.8	90	142.8	90.0	75.0	13.5	178.5				
Total	198.0		147.0		23.1		368.1	213.0	234.0	36.0	483.0				

Disaggregated Attractivity Indices.

Based upon existing and future demand by income class in proportion to class size in each residential zone, and a calibrated coefficient of attraction.

Income Class	1979						1984						1989					
Zone	High	αH	Middle	αM	Low	αL	High	αH	Middle	αM	Low	αL	High	αH	Middle	αM	Low	αL
1	26		83		41		25		80		25		25		80		25	
4	8		2		0		8		2		0		8		2		0	
6	-		-		-		0		30		20		-		30		20	
8	8		20		12		10		25		15		15		35		20	

Non-transport Location Expenditure

Based upon an estimated proportion of average household income budgeted for land, housing and utilities costs, measured in terms of monthly household expenditures per square meter of residential land.

	1979			1984			1989		
Income Class	High	Middle	Low	High	Middle	Low	High	Middle	Low
Zone									
1	1.80	1.10	0.83						
4	0.90	0.53	-						
6	-	-	-						
8	0.60	0.35	0.28						

Level 3: Transport Inputs

The key transport assumptions underlying the projection of travel demands are summarized in the tables below:

Values of Travel Time

Income Class

	High	Middle	Low
Average HH income/month	\$1800	\$425	\$125
Average hourly income/traveler	\$8.72	\$225	\$0.73
Value of travel time rate	25%	25%	25%
VOT/minute of travel	0.036	0.009	0.003

Trip Rate by Mode (Morning Peak Period Only)
1979

Income class	High			Middle			Low		
Mode	Car	Bus	Walk	Car	Bus	Walk	Car	Bus	Walk
Zone									
1	0.6	0.2	0.2	0.2	0.3	0.3	0.1	0.3	0.3
4	0.7	0.2	0.1	0.2	0.4	0.2	-	-	-
6	-	-	-	0.2	0.4	0.2	0.1	0.3	0.3
8	0.7	0.2	0.1	0.2	0.4	0.2	0.0	0.5	0.2
9	.8	.2	-	0.2	.6	-	-	1.0	-

Year 1984/1989

Income class	High			Middle			Low		
Mode	Car	Bus	Walk	Car	Bus	Walk	Car	Bus	Walk
1	0.7	0.2	0.2	0.3	0.3	0.3	0.1	0.3	0.3
4	0.8	0.2	0.1	0.3	0.4	0.2	-	-	-
6	-	-	-	0.3	0.4	0.2	0.1	0.4	0.2
8	0.8	0.2	0.1	0.2	0.4	0.2	0.1	0.4	0.2
9	0.9	0.1	-	0.5	0.5	0.2	0.1	0.9	-

TRUCK TRIP RATE PER UNIT OF EMPLOYMENT

Zone	Truck Trips
1	0.08
2	0.10
3	0.10
4	0.06
5	0.08
6	0.06
7	0.08
8	0.06
9	-

INTERZONAL LINK DISTANCES

(Based upon shortest route distances between zone centroids along existing roads in kilometers).

	1	2	3	4	5	6	7	8
1	0.67	1.40	1.00	2.40	4.80	4.40	8.20	9.60
2	1.40	0.36	1.60	3.00	5.40	5.00	8.80	10.20
3	1.00	1.60	0.54	2.20	4.60	4.20	8.00	9.40
4	2.40	3.00	2.20	0.74	2.40	2.00	5.80	7.20
5	4.80	5.40	4.60	2.40	0.66	1.60	5.40	6.80
6	4.40	5.00	4.20	2.00	1.60	1.00	4.60	6.00
7	8.20	8.80	8.00	5.80	5.40	4.60	1.20	3.00
8	9.60	10.20	9.40	7.20	6.80	6.00	3.00	1.20

PCU EQUIVALENCY AND OCCUPANCY RATE

	PCU Equivalent	Occupancy
cars	1.0	1.6
busses	3.0	45.0
trucks	3.0	1.0

PEAK PERIOD EXPANSION FACTOR TO MONTHLY TOTALS

trucks	115.0
busses	92.0
cars	107.4

Expansion factors are based on the following considerations for the purpose of estimating benefits:

Auto: Peak (2 hour) volume is 1/7 of total daily

3	peak	periods	@	full	benefit	=	3.00
2	"	"	"	2/3	"	=	1.33
1	"	"	"	1/3	"	=	0.33
1	"	"	"	no	"	=	0.00
							4.67

4.67 (daily) X 23 (days per month) = 115.0

Bus: Peak (2 hour) volume is 1/5 of total daily

3	peak	periods	@	full	benefit	=	3.00
2		"	"	1/2	"	=	1.00
							4.00

4.00 (daily) X 23 (days per month) = 92.0

Truck: peak (2 hour) volume is 1/8 of total daily

3	peak	periods	@	full	benefit	=	3.00
2		"	"	2/3	"	=	1.33
2		"	"	1/2	"	=	0.67
1		"	"	0	"	=	0.00
							5.00

5.00 (daily) X 23 (days per month) = 115.0

AUTOMOBILE OPERATING COST PER 1,600 KMS. (1979)

MPH	KPH	Gas	Oil	Tires	Maintenance	Depreciation	Interest	Total
10	16	49.11	2.39	1.02	7.00	45.00	36.00	140.52
15	24	51.01	2.23	1.22	8.00	41.00	28.50	131.96
20	32	45.82	1.92	1.63	8.50	36.00	22.50	116.37
25	40	43.47	1.82	2.14	8.85	34.50	19.00	109.78
30	48	41.24	1.77	2.65	9.50	32.50	16.50	104.16
35	56	43.22	1.71	3.26	9.85	30.50	15.00	103.54
40	64	43.45	1.71	3.82	10.60	29.00	13.50	102.08
45	72	46.70	1.66	4.54	11.00	27.50	13.00	104.40
50	80	48.67	1.61	5.30	11.50	26.50	12.00	105.58
55	88	53.04	1.50	6.17	12.25	26.00	11.50	110.46
60	96	57.14	1.58	7.19	13.00	25.00	11.00	114.89
65	104	62.96	1.77	8.36	13.75	24.50	10.50	121.84

Using linear regression a curve is determined to fit these data points, whose equation is:

$$C = 0.1046-0.001256x + 0.000009512x^2$$

where C = \$ cost per km for cars
x = speed in km/hour

For busses, based upon 1977 data, the ratio of bus to auto operating costs is given as 4.3. For trucks, based upon the same data source, the truck to auto operating cost ratio is given as 5.6. These values are taken as given.

ASSUMED LEVELS OF BUS FARES

Destination Zone / Origin Zone	1	2	3	4	5	6	7	8	9	Total
1.	.10	.10	.10	.10	.25	.20	.40	.50	1.25	
2	.10	.10	.10	.15	.25	.25	.45	.50	1.25	
3	.10	.10	.10	.10	.20	.20	.40	.50	1.25	
4	.10	.15	.10	.10	.10	.10	.30	.35	1.15	
5	.25	.25	.20	.10	.10	.10	.25	.35	1.00	
6	.20	.25	.20	.10	.10	.10	.25	.30	1.05	
7	.40	.45	.40	.30	.25	.25	.10	.15	.85	
8	.50	.50	.50	.35	.35	.30	.15	.10	.75	
9	1.25	1.25	1.25	1.15	1.00	1.05	.85	.75		

ASSUMED LEVELS OF TRIP TERMINAL TIME IN MINUTES

Origin Zone	Destination Zone	1	2	3	4	5	6	7	8	Note
	Cars	4	4	4	4	4	5	4	4	5 Min.
	Busses	9	9	9	9	9	15	9	9	Service Level
	Cars	4	4	4	3	4	6	4	4	10. Min.
	Busses	14	14	14	14	14	18	14	14	Service Level
	Cars	6	6	6	6	6	8	6	6	10 Min.
	Busses	18	18	18	18	18	22	18	18	Service Level
	Cars	4	4	4	4	4	6	4	4	10 Min.
	Busses	14	14	14	14	14	18	14	14	Service Level

LINK CAPACITY TABLE

	1	2	3	4	5	6	7	8
1		240	1,600	1,600	-	-	-	-
2	240		-	-	-	-	-	-
3	1,600	-		800	-	-	-	-
4	1,600	-	800		1,200	1,200	800	800
5	-	-	-	1,200		1,200	800	800
6	-	-	-	1,200	1,200		800	800
7	-	-	-	800	800	800		800
8	-	-	-	800	800	800	800	

REVISED OPERATING COST FOR TRUCK

At 40 km/h, car operating cost of \$ 0.07.

Truck operating cost is 5.6 times higher, or \$ 0.39

$$\$0.39 \frac{1}{\text{km}} \quad X \quad \frac{40\text{km}}{\text{hr}} \quad = \quad \$15.59/\text{hrs}$$

The labor cost component is \$1/hr, so the reduced OC is 14.5%. This corresponds to \$0.36/km, which is 5.2 times higher than auto.

So truck cost is [5.2 (auto cost/km) X distance + \$1 time]

6. OPERATING THE PROGRAM

6.1 BASIC USER INSTRUCTIONS FOR A T159 & PRINTER

1. To turn on the calculator, first plug in the printer and calculator. DO NOT turn on calculator and printer before plugging in the printer. To turn off the calculator, turn off both calculator and printer before unplugging the printer.

2. Algebraic operations -- The TI59 uses logic known as Algebraic Operating System. Algebraic operations are punched into the calculator going from left to right as they would be written out. For example, to perform the following calculation:

$$8 \div 3 = 2.67$$

you would push the following buttons:

1) $\boxed{8}$
2) $\boxed{\div}$
3) $\boxed{3}$
4) $\boxed{=}$

Where there are a complex series of calculations, the calculator follows certain rules about which ones are performed first. Alternatively, you can use parentheses to make the calculator perform operations in a particular order.

The order of operations performed by the T159 is:

1) Special single function keys (such as trig and log functions)
2) Powers and roots (Y^X and $\sqrt[x]{Y}$)
3) Multiplications and divisions
4) Additions and subtractions

Example

$$3 + 10 - 2 \times 14 \div 7 = 9$$

This is the same as

$$3 + 10 - (2 * 14 \div 7) = 9$$

If you do not wish the above interpretation to be followed you must use parentheses, for example:

$$(3 + 10 - 2) * 14 \div 7 = 22$$

2. Special function and operation keys

A) Every key can be used in 2 ways as indicated by 1) labels on the key and 2) gold labels above the key. To get the use of the gold label function, push the gold key marked $\boxed{\text{2nd}}$ before pushing the desired key.

B) The INV key will give you the use of inverse functions or operations for many of the keys. For example to compute e ^{2} push the following:

$\boxed{2}$

$\boxed{\text{INV}}$

$\boxed{\ln}$

4. User Labels -- User labels are names given by the programmer to different parts (or subroutines) of a pocket calculator program. By pushing a user label key, you are able to have the calculator perform a specific subroutine. The user labels are contained inthe top row of the TI59 and consist of A,B,C,D,E, and A', B', C', D', E'.

5. Memory Structure -- The TI59 memory is divided into a section to hold a program and a section to hold data. When the TI59 is turned on, it contains 480 spaces for program instruction and 60 spaces for data.

You may re-partition memory if you need more data storage, or more program storage. Following are two commands useful in memory partitioning:

A. $\boxed{2nd}$ $\boxed{OP}$ $\boxed{1}$ $\boxed{6}$ will cause the calculator to display the current memory partition. Ordinarily the display will read 479.59 (program positions go from 000 to 479 and data registers go from 00 to 59).

B. $\boxed{X}$ $\boxed{2nd}$ $\boxed{OP}$ $\boxed{1}$ $\boxed{7}$ will cause the calculator to repartition memory so that there are 10X data registers. For example:

$\boxed{4}$ $\boxed{2nd}$ $\boxed{OP}$ $\boxed{1}$ $\boxed{7}$ would give a partition of 639.39 (or 640 program positions and 40 data registers).

6. Reading a Card -- In order to read a card the calculator must be properly partitional in the same manner as when the card was created. The calculator must also be told the proper place to store the data on the card. Each magnetic card has two sides (or banks). The calculator memory can hold 4 banks (or 2 cards) worth of information.

To read a card, first push the number of the memory bank into which this card will be read. The number will be 1, 2, 3 or 4. Usually the proper memory bank is indicated upon the card or in programmer user instructions. As an alternative, push 0 before reading the card. Then the card will be automatically read into the proper bank.

The second step in reading a card is to hold the yellow side up and insert the proper end (designated by the bank number on the card) into the card reader. Let the calculator process the card through (do not push the card once the calculator has hold of it) and then gently remove the card. The calculator will display the number of the memory bank into which the card read. If there is a misread or if you have pushed an improper bank number, the calculator display will flash. In this case you must start over.

7. Listing Memory

There are two commands which allow you to list memory. There are:

A. [2nd] [List]

This command will print out the program memory. It is especially useful for checking that the current program has been properly read in. To stop the listing push [R/S]

B. [INV] [2nd] [List]

This command will print out the contents of the data registers. To stop the listing push [R/S] .

Notes: Occasionally the listing does not start at the proper place (i.e. does not start at program location 000 or data register 00). To correct for this you press [GTO] and the proper memory address. For a program, the address would be 000, and for the data registers (under normal partitioning) the address would be 480. The calculator may flash when given the data register address, but this procedure works nontheless. Follow with the desired list command.

8. Run Stop and Reset

These are two useful commands. Reset [RST] will place the program counter at the beginning of a program which is at address 000. Thus reset may be used when you wish to start a program from the beginning.

Run/Stop [R/S] may be used to stop program execution, and it may be used to start program execution at the current location in the program. For example, a program may halt execution to wait for data. The user enters the data into the display and starts execution by pressing [R/S].

9. Clears -- There are four clear commands with the T159 as follows:

CE -- clears the current display only

CLR -- clears the current math operation

2nd CP -- clears the program

2nd CMs -- clears the data registers

10. Store and Recall

Press STO and a two digit data register number to place the display in memory. For example, 1 STO 0 2 would place a 1 in register 2.

Press RCL and a two digit data register number to recall the contents of the data register onto the display. In the above example, RCL 0 2 would display a 1.

11. Printer commands -- The printer attached to the T 59 has a number of different operating modes. If none of its three buttons have been pushed, then the printer takes all its instructions from the calculator.

If the PRINT button is pushed, the printer will print out the current display on the calculator.

If the TRACE button is pushed, the printer will print out each step in the execution of a program. Trace is very useful for debugging.

The ADV or advance button merely advances the paper in the printer.

6.2 INSTRUCTIONS FOR COMPUTING BENEFITS TO ORIGIN ZONES [FIRST PROGRAM]

1. Fill in, for each mode, a matrix giving volume on each link, by income class within each origin zone, for each mode. (See Tables 1-3)
   Differentiate between volume inbound (+) and outbound (-).
2. Compute, for each link, the total volume in PCU's. This is given by

$$V^e = \sum_{\substack{\text{MODES} \\ m}} \Big(\sum_{\substack{\text{INCOME} \\ \text{CLASS } i}} V_{mi} \Big) \times PCU_m \div OCCUPANCY_m$$

   Note than inbound volume must be computed separately from outbound.
3. Table 4 summarizes the necessary link data. Fill in such a table, including length, V/C in each direction, and free-flow speed. If V/C or free-flow speed changes in the build alternative, mark that down.
4. Fill in, for each mode (bus and car) for each zone, a table headed "ORIGIN ZONE:" (See Tables 5-10) which contains all the data needed.
5. Fill in, for truck, a table for each origin zone (see Tables 11-16).
6. You are now ready to run the programs.
7. After turning on the printer and calculator, set the partition; Press <u>9</u> <u>2nd</u> <u>Op</u> <u>17</u>   23.[illegible]
8. Enter side 2A of program UTB -2.2(A) after entering zero (<u>0</u>).
9. Enter the data on one of the bus or car tables. To enter the data, enter each number and then press the key indicated (A, B, or C). Where no key is indicated, press R/S. Enter data corresponding to the no-build alternative. <u>If you make an error in entering data</u>, see Step 19 below. Fill in the data for one origin zone and one mode completely.
10. Enter zero (0), and load card 1B of UTB-2.2(A).
11. If desired fix the output format by pressing <u>2nd</u> <u>Fix</u> <u>n</u> where (n) is the number of digits desired after the decimal.

12. Press A and wait until costs are printed. These are the operating and time costs for each income class, and their sum over the income classes.

13. If there is a build alternative, enter data for it. You may re-enter all the data (beginning with number of links, as the values of time and model parameters don't change), or enter only those items that change. To do the latter, see 19 below. To do the former, do Steps 8-11. Before entering data you may want to change the format (as in Step 12).

   * Whatever you do, <u>be sure to enter the number of links</u>, even if it hasn't changed, by entering it and pressing <u>STO</u> <u>00</u>, or pressing C if card 1A is in memory.

14. Press B and wait. The same items as listed in Step 12 will be printed for the build alternative; so will the differences between no build and build.

15. Now select another mode-zone pair. It is best to do all the zones of a single mode together.

16. For each mode-zone pair, repeat Steps 8-15. Note: If values of time and modal parameters do not change, they need not be repeated.

    Also, you may want to undo the fixed display format by pressing INV 2nd Fix.

17. You are now ready to do the trucks. For each origin zone, perform Steps 8-15 again, with these changes:

    Use Program UTB-2.2(B), sides 1A and 1B instead of Program UTB-2.2(A),

    Because these are the income classes, the run time and output in Steps 12 and 14 will be shorter

    Output is operating cost not including labor, labor cost and their sum.

18. FINISHED!

19. <u>Error Recovery</u>

    1. You may list the contents of the data registers, beginning with register (m) by pressing (<u>m</u>) <u>INV</u> <u>2nd</u> list. Press R/S when you want it to stop listing.

    2. You may enter any number directly by entering it and pressing <u>STO</u> <u>ab</u>, where <u>ab</u> is the register it goes in. This also applies

to changes for the build alternative.

3. The contents of the data registers is given in the Table so marked for each program.

Figure 2

Detailed Output Table

Link \ Year	1	2		T	Total (discounted)
1	□	□	. . .	□	□
2	□	.	.	.	.
⋮	⋮		.	.	.
A	□			□	□
Total	□	□	. . .	□	□

□ =

Alternative 1 (no build)

1. Peak hour V/C
2. Peak hour auto speed

Alternative 2 (build)

3. Peak hour V/C
4. Peak hour auto speed

not included in row and column totals

Mode 1 (auto)

Alternative 1 (no build)

5. Operating cost
6. Time cost

Alternative 2 (build)

7. Operating cost
8. Time cost

Difference (benefit of build alternative)

9. Operating cost
10. Time cost

Mode 2 (truck)

Alternative 1

11. Operating Cost
12. Time cost

Alternative 2

13. Operating cost

Figure 2 (continued)

14. Time cost

Difference

15. Operating cost

16. Time cost

Mode 3 (bus)

Alternative 1

17. Operating cost

18. Time cost

Alternative 2

19. Operating cost

20. Time cost

Difference

21. Operating cost

22. Time cost

Total (all modes)

Alternative 1

23. Operating cost

24. Time cost

Alternative 2

25. Operating cost

26. Time cost

Difference

27. Operating cost

28. Time cost

6.3 ESTIMATED 1979 TRAVEL BENEFITS BY ORIGIN ZONE

By mode, income class and zone of origin for conditions existing with no highway component as compared to those with the proposed highway component.

Summary:

Table 1:

SUMMARY GENERALIZED TRAVEL COST - YEAR: 1979 .

Zone:		High Income HH	Middle Income HH	Low Income HH	Employment	Total
1.	Car					
	Bus					
	Truck					
	Walk					
2.	Car					
	Bus					
	Truck					
	Walk					
3.	Car					
	Bus					
	Truck					
	Walk					
4.	Car					
	Bus					
	Truck					
	Walk					
5.	Car					
	Bus					
	Truck					
	Walk					
6.	Car					
	Bus					
	Truck					
	Walk					
7.	Car					
	Bus					
	Truck					
	Walk					
8.	Car					
	Bus					
	Truck					
	Walk					
9.	Car					
	Bus					
	Truck					
	Walk					
Total	Car					
	Bus					
	Truck					
	Walk					
Total						

Table 2: TRIP-ORIGIN - MORNING PEAK

Year 1979

Zone:		High Income HH	Middle Income HH	Low Income HH	Employment Places	Total
1.	Car	1,560	1,660	-		3,220
	Bus	520	2,490	1,230		4,240
	Truck	-	-	-	640	640
	Walk	520	2,490	1,230		4,240
2.	Car					
	Bus					
	Truck				500	500
	Walk					
3.	Car					
	Bus					
	Truck				300	300
	Walk					
4.	Car	560	40	-		600
	Bus	160	80	-		240
	Truck	-	-	-	15	15
	Walk	80	40	-		120
5.	Car					
	Bus					
	Truck				40	40
	Walk					
6.	Car	0	0	0		0
	Bus	0	0	0		0
	Truck	0	0	0	-	0
	Walk	0	0	0		0
7.	Car					
	Bus					
	Truck					
	Walk					
8.	Car	560	400	-		960
	Bus	160	800	600		1,560
	Truck	-	-	-	90	90
	Walk	80	400	240		720
9.	Car	+580	320	-		900
	Bus	+145	+480	+1,300		1,925
	Truck				200	200
	Walk	-	-	-		-
Total	Car	3,260	2,420	-		5,680
	Bus	985	3,850	3,130		7,965
	Truck	-	-	-	1,785	1,785
	Walk	680	2,930	1,470		5,080
Total		4,925	9,200	4,600	1,785	20,510

Table 3: TRIP DESTINATIONS - MORNING PEAK

Year: 1979

Zone:		High Income HH	Middle Income HH	Low Income HH	Employment Places	Total
1.	Car	485	1,465	-		1,950
	Bus	105	2,355	1,420		3,880
	Truck				640	640
	Walk	30	1,780	420		2,230
2.	Car	1,250	420	-		1,670
	Bus	420	625	625		1,670
	Truck				500	500
	Walk	330	635	535		1,500
3.	Car	750	250	-		1,000
	Bus	250	375	375		1,000
	Truck				300	300
	Walk	250	375	375		1,000
4.	Car	70	20	-		90
	Bus	20	40	50		110
	Truck				15	15
	Walk	10	20	20		50
5.	Car	130	70	-		200
	Bus	35	100	165		300
	Truck				40	40
	Walk	-	-	-	-	-
6.	Car					
	Bus					
	Truck					0
	Walk					
7.	Car					
	Bus					
	Truck					0
	Walk					
8.	Car	420	120	-		540
	Bus	120	240	300		660
	Truck				90	90
	Walk	60	120	120		300
9.	Car	155	75	-		230
	Bus	35	115	195		345
	Truck				200	200
	Walk	-	-	-		-
Total	Car	3,260	2,420	-		5,680
	Bus	985	3,850	3,130		7,965
	Truck	-	-	-	1,785	1,785
	Walk	680	2,930	1,470		5,080
Total		4,925	9,200	4,600	1,785	20,510

Table 4: O-D DISTRIBUTION OF CAR TRIPS

Year: 1979

Origin Zone	Destination Zones 1	2	3	4	5	6	7	8	9	TOTAL
1. H	283	649	400	23	39	0	0	82	74	1,560
M	1,043	288	169	14	51	0	0	40	52	1,660
L	0	0	0	0	0	0	0	0	0	0
TOTAL	1,326	937	569	37	90	0	0	112	126	3,220
2. H										
M										
L										
TOTAL										
3. H										
M										
L										
TOTAL										
4. H	43	198	134	25	39	0	0	64	27	560
M	22	9	8	0	0	0	0	0	1	40
L	0	0	0	0	0	0	0	0	0	0
TOTAL	95	207	142	25	39	0	0	64	28	600
5. H										
M										
L										
TOTAL										
6. H										
M										
L										
TOTAL										
7. H										
M										
L										
TOTAL										
8. H	43	171	82	9	29	0	0	199	27	560
M	205	69	40	0	10	0	0	65	11	400
L	0	0	0	0	0	0	0	0	0	0
TOTAL	248	240	122	9	39	0	0	264	38	960
9. H	86	222	134	13	23	0	0	75	27	580
M	195	54	33	3	9	0	0	15	11	320
L	0	0	0	0	0	0	0	0	0	0
TOTAL	281	276	167	16	32	0	0	90	38	900
H	485	1,250	750	40	130	0	0	420	155	3,260
M	1,465	420	250	20	70	0	0	120	75	2,420
L	0	0	0	0	0	0	0	0	0	0
GRAND TOTAL	1,950	1,670	1,000	90	200	0	0	540	230	5,680

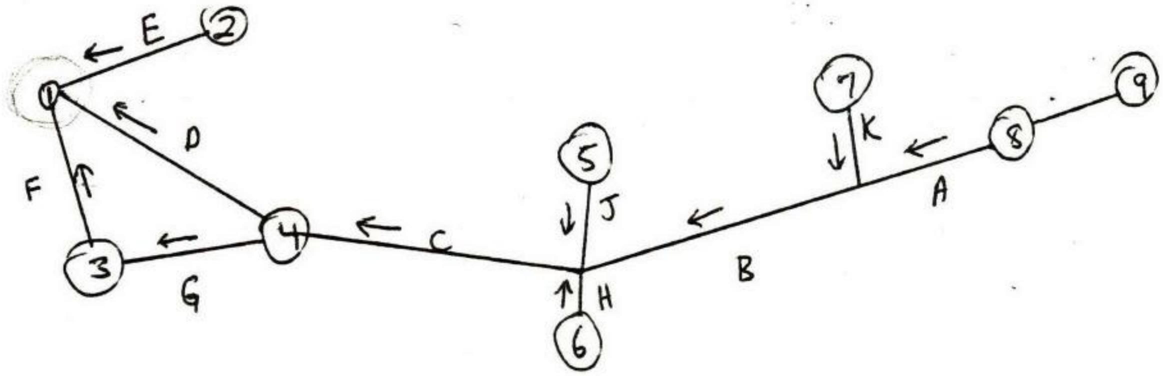
Table 5: O-D DISTRIBUTION OF BUS TRIPS
Year: 1979

Origin Zone	Destination Zone 1	2	3	4	5	6	7	8	9	TOTAL
1. H	72	241	139	2	20	0	0	28	18	520
M	1,624	388	250	24	62	0	0	64	78	2,490
L	628	270	149	15	52	0	0	40	76	1,230
TOTAL	2,324	899	538	41	134	0	0	132	172	4,240
2. H										
M										
L										
TOTAL										
3. H										
M										
L										
TOTAL										
4. H	11	61	37	8	5	0	0	31	6	160
M	44	16	8	0	0	0	0	10	2	80
L	0	0	0	0	0	0	0	0	0	0
TOTAL	55	77	45	8	5	0	0	41	8	240
5. H										
M										
L										
TOTAL										
6. H										
M										
L										
TOTAL										
7. H										
M										
L										
TOTAL										
8. H	7	52	37	0	7	0	0	44	7	160
M	393	143	70	11	26	0	0	136	21	800
L	202	95	71	15	45	0	0	136	36	600
TOTAL	602	290	178	26	78	0	0	316	64	1,560
9. H	15	66	37	3	3	0	0	17	4	145
M	294	78	47	5	12	0	0	30	14	480
L	590	260	155	20	68	0	0	124	83	1,300
TOTAL	899	404	239	28	83	0	0	171	101	1,925
TOTAL										
H	105	420	250	20	35	0	0	120	35	985
M	2,355	625	375	40	100	0	0	242	115	3,850
L	1,420	625	375	50	165	0	0	300	195	3,130
GRAND TOTAL	3,880	1,675	1,000	110	300	0	0	660	345	7,965

Table 6: O-D DISTRIBUTION OF TRUCK TRIPS
Year: 1979

Origin Zone	Destination 1	2	3	4	5	6	7	8	9	TOTAL
1. TOTAL	276	141	109	6	10	0	0	26	72	640
2. TOTAL	147	203	66	5	5	0	0	18	56	500
3. TOTAL	102	69	72	1	10	0	0	12	34	300
4. TOTAL	2	1	3	0	0	0	0	7	2	15
5. TOTAL	17	7	7	0	4	0	0	0	5	40
6. TOTAL	0	0	0	0	0	0	0	0	0	0
7. TOTAL	0	0	0	0	0	0	0	0	0	0
8. TOTAL	24	23	9	0	7	0	0	17	10	90
9. TOTAL	72	56	34	2	4	0	0	10	22	200
GRAND TOTAL	640	300	300	15	40	0	0	90	200	1,785

Table 7: NETWORK



Arrow points in inbound (+) direction.

Link	PCU's in (2 hrs)	PCU's out (2 hrs)	Capacity (No Build/Build)	V/C in (NB/B)	V/C out (NB/B)	Length	Car Free-flow speed (NB/B)
A						3.4	
B						3.4	80/100
AB	1777	924	800/2400	1.11/.37	.58/.19	6.8	80/100
C	1784	1064	1600	.56	.33	1.5	60
D	1603	864	1600	.50	.27	2.4	60
E	891	2036	1000	.45	1.02	1.4	60
F	519	912	1600	.16	.29	1.1	60
G	463	165	800	.29	.10	2.2	60
J	108	250	1200	.05	.10	0.9	60
H			1200			0.5	60
K			1200				60

Table 8:
Year: 1979
Mode: Car
Link Assignments

Origin Zone / Link	A	B	C	D	E	F	G	H	J	K
1. H M L	(Same as B)	164^{-} 85 (0)	221^{-} 120	251^{-} 130	621^{-} 328	408^{-} 163	– –		57^{-} 35	
2. H M L										
3. H M L										
4. H M L		90^{-} 41	128^{-} 1	271^{+} 31	199^{-} 8	– –	132^{+} 8		38^{-} 0	
5. H M L										
6. H M L		+809/-254								
8. H M L		331^{+} 331	302^{+} 322	211^{+} 282	169^{-} 76	– –	82^{+} 40		29^{-} 9	
9. H M L		478^{+} 294	455^{+} 287	308^{+} 249	222^{-} 54	– –	134^{+} 33		23^{-} 9	
TOTAL H M L		+809/-254 +625/-86 +1434/-340	+757/-349 +609/-121 +1366/-470	+790/-251 +362/-130 +1352/-381	+0/-1211 +0/-466 +0/-1677	+0/-408 +0/-163 +0/-671	+348/-0 +81/-0 +429/-0		+0/-147 +0/-53 +0/-260	
GRAND TOTAL°										

Table 9:
Year: 1979
Mode: Bus
Link Assignments

Origin Zone	Link	A	B	C	D	E	F	G	H	J	K
1.	H	(Same as B)	43	55	61	223	155	-		12	
	M		122	152	168	283	237	-		30	
	L		114	147	158	214	154	-		33	
2.	H										
	M										
	L										
3.	H										
	M										
	L										
4.	H		35^{-}	42^{-}	74^{+}	58^{-}	-	37^{+}		7^{-}	
	M		10	10	62	16	-	8		0	
	L		0		0	0	-	0			
5.	H										
	M										
	L										
6.	H										
	M										
	L										
8.	H		140^{+}	111^{+}	68^{+}	51^{-}	-	34^{+}		29^{-}	
	M		650	631	552	118	-	69		20	
	L		429	393	321	98	-	63		36	
9.	H		122^{+}	117^{+}	77^{+}	62^{-}		37^{+}		5^{-}	
	M		433	421	369	78		47		12	
	L		1093	1025	850	260		155		68	
TOTAL			262	228	219	0	0	108		0	
	H		1083	1052	983	0	0	124		0	
	M		1522	1418	1171	0	0	218		0	
	L		+2867	+2698	2373	0	0	+440		0	
GRAND TOTAL°			- 78	- 97	- 61	- 394	- 155	0		53	
			132	162	168	493	261	0		68	
			114	147	158	512	134	0		137	

Table 10:
Year: 1979
Mode: Truck
Link Assignments

Origin Zone / Link	A	B	C	D	E	F	G	H	J	K
1. H M L	(Same as B)	98^{-}	108^{-}	114^{-}	141^{-}	109^{-}	-		10^{-}	
2. H M L		74^{-}	79^{-}	84^{-}	297^{+}	66^{-}	-		5^{-}	
3. H M L		46^{-}	56^{-}	-	69^{-}	171^{+}	57^{-}		10^{-}	
4. H M L		6^{-}	6^{-}	3^{+}	1^{-}	-	3^{+}		0^{-}	
5. H M L		5^{-}	28^{+}	24^{+}	7^{-}		4^{+}		33^{+}	
6. H M L										
8. H M L		63^{+}	56^{+}	47^{+}	23^{-}	-	9^{+}		7	
9. H M L		168^{+}	166^{+}	128^{+}	56^{-}	-	34^{+}		2^{-}	
TOTAL H M L		230	250	200	297	173	55		36	
GRAND TOTAL°		230	250	200	297	173	55		36	

Table 11: YEAR: 1979

ORIGIN ZONE: 1 Input Data

MODE: Car

	Values of Time ($/hr)		
9	Class 1	2.18	(A)
10	Class 2	.56	
11	Class 3	.18	
	Mode:		
5	O.C. parameter	1	(B)
6	occupancy	1.6	
7	expansion factor	107.4	
0	Number of Links:	6	(C)

	Link: A-B outbound	
20	length (km)	5.5
21	V/C	0.58/.19
22	free-flow speed (km/h)	80/100
23	class 1 vol	164
24	class 2 vol	85
25	class 3 vol	0
	Link: C out	
26	length	1.5
27	V/C	.33
28	free-flow spd	60
29	class 1 vol	221
30	class 2 vol	120
31	class 3 vol	0
	Link: D out	
32	length	2.4
33	V/C	0.27
34	free-flow spd	60
35	class 1 vol	251
36	class 2 vol	130
37	class 3 vol	0
	Link: E out	
38	length	1.4
39	V/C	1.02
40	free-flow spd	60
41	class 1 vol	621
42	class 2 vol	328
43	class 3 vol	0
	Link: F out	
44	length	1.0
45	V/C	0.29
46	free-flow spd	60
47	class 1 vol	408
48	class 2 vol	163
49	class 3 vol	0
	Link: J out	
50	length	0.9
51	V/C	.10
52	free-flow spd	60
53	class 1 vol	57
54	class 2 vol	35
55	class 3 vol	0
	Link:	
56	length	
57	V/C	
58	free-flow spd	
59	class 1 vol	
60	class 2 vol	
61	class 3 vol	
	Link:	
62	length	
63	V/C	
64	free-flow spd	
65	class 1 vol	
66	class 2 vol	
67	class 3 vol	
	Link:	
68	length	
69	V/C	
70	free-flow spd	
71	class 1 vol	
72	class 2 vol	
73	class 3 vol	

YEAR: 1979

ORIGIN ZONE: 1

Input Data

MODE: Bus

	Values of Time ($/hr)		
9	Class 1	2.18	(A)
10	Class 2	.56	
11	Class 3	.18	

	Mode:		
5	O.C. parameter	4.3	(B)
6	occupancy	45	
7	expansion factor	92	

0	Number of Links:	6	(C)

	Link: A-B out	
20	length (km)	5.5
21	V/C	.58/.19
22	free-flow speed (km/h)	64/80
23	class 1 vol	43
24	class 2 vol	122
25	class 3 vol	114

	Link: C out	
26	length	1.5
27	V/C	.33
28	free-flow spd	42
29	class 1 vol	55
30	class 2 vol	152
31	class 3 vol	147

	Link: D out	
32	length	2.4
33	V/C	.27
34	free-flow spd	42
35	class 1 vol	61
36	class 2 vol	168
37	class 3 vol	158

	Link: E out	
38	length	1.4
39	V/C	1.02
40	free-flow spd	42
41	class 1 vol	223
42	class 2 vol	283
43	class 3 vol	214

	Link: F out	
44	length	1.0
45	V/C	.29
46	free-flow spd	42
47	class 1 vol	155
48	class 2 vol	237
49	class 3 vol	154

	Link: J out	
50	length	0.9
51	V/C	.10
52	free-flow spd	42
53	class 1 vol	12
54	class 2 vol	30
55	class 3 vol	33

	Link:	
56	length	
57	V/C	
58	free-flow spd	
59	class 1 vol	
60	class 2 vol	
61	class 3 vol	

	Link:	
62	length	
63	V/C	
64	free-flow spd	
65	class 1 vol	
66	class 2 vol	
67	class 3 vol	

	Link:	
68	length	
69	V/C	
70	free-flow spd	
71	class 1 vol	
72	class 2 vol	
73	class 3 vol	

Year: 1979

Table 13:

BENEFITS TO RESIDENTS OF ORIGIN ZONE 1 Output Costs

		AUTO	BUS	$/Month
NO BUILD				
Income class 1	OC	15304.	652.	
	TC	24177.	9269.	
Income class 2	OC	7826.	1312.	
	TC	3209.	4137.	
Income class 3	OC	0.	1136.	
	TC	0.	1111.	
Total	OC	23131.	3100.	
	TC	27386.	14517.	
BUILD				
Income class 1	OC	15449.	635.	
	TC	21628.	8553.	
Income class 2	OC	7901.	1263.	
	TC	2870.	3615.	
Income class 3	OC	0.	1089.	
	TC	0.	955.	
Total	OC	23350.	2987.	
	TC	24498.	13123.	
DIFFERENCE				
Income class 1	OC	-145.	17.	
	TC	2549.	716.	
Income class 2	OC	-75.	50.	
	TC	339.	522.	
Income class 3	OC	0.	46.	
	TC	0.	157.	
Total	OC	-220.	113.	
	TC	2888.	1394.	

YEAR: 1979

Table 14: ORIGIN ZONE: 4 Input Data

MODE: Car

	Values of Time ($/hr)		
9	Class 1	2.18	(A)
10	Class 2	.56	
11	Class 3	.18	
	Mode:		
5	O.C. parameter	1	(B)
6	occupancy	1.6	
7	expansion factor	107.4	
0	Number of Links:	6	(C)
	Link: A-B out		
20	length (km)	5.5	
21	V/C	0.58/.19	
22	free-flow speed (km/h)	80/100	
23	class 1 vol	90	
24	class 2 vol	1	
25	class 3 vol	0	
	Link: C out		
26	length	1.5	
27	V/C	0.33	
28	free-flow spd	60	
29	class 1 vol	128	
30	class 2 vol	1	
31	class 3 vol	0	
	Link: D in		
32	length	2.4	
33	V/C	.50	
34	free-flow spd	60	
35	class 1 vol	271	
36	class 2 vol	31	
37	class 3 vol	0	
	Link: E out		
38	length	1.4	
39	V/C	1.02	
40	free-flow spd	60	
41	class 1 vol	199	
42	class 2 vol	8	
43	class 3 vol	0	
	Link: G in		
44	length	2.2	
45	V/C	.29	
46	free-flow spd	60	
47	class 1 vol	133	
48	class 2 vol	8	
49	class 3 vol	0	
	Link: I out		
50	length	0.9	
51	V/C	.10	
52	free-flow spd	60	
53	class 1 vol	38	
54	class 2 vol	0	
55	class 3 vol	0	
	Link:		
56	length		
57	V/C		
58	free-flow spd		
59	class 1 vol		
60	class 2 vol		
61	class 3 vol		
	Link:		
62	length		
63	V/C		
64	free-flow spd		
65	class 1 vol		
66	class 2 vol		
67	class 3 vol		
	Link:		
68	length		
69	V/C		
70	free-flow spd		
71	class 1 vol		
72	class 2 vol		
73	class 3 vol		

YEAR: 1979

Table 15: ORIGIN ZONE: 4

Input Data

MODE: Bus

	Values of Time ($/hr)		
9	Class 1		(A)
10	Class 2		
11	Class 3		

	Mode:		
5	O.C. parameter	4.3	(B)
6	occupancy	45	
7	expansion factor	92	

0	Number of Links:	6	(C)

	Link: A-B	
20	length (km)	5.5
21	V/C	.58/.19
22	free-flow speed (km/h)	64/80
23	class 1 vol	35
24	class 2 vol	10
25	class 3 vol	0

	Link: C out	
26	length	1.5
27	V/C	.33
28	free-flow spd	42
29	class 1 vol	42
30	class 2 vol	10
31	class 3 vol	0

	Link: D in	
32	length	2.4
33	V/C	.50
34	free-flow spd	42
35	class 1 vol	74
36	class 2 vol	62
37	class 3 vol	0

	Link: E out	
38	length	1.4
39	V/C	1.02
40	free-flow spd	42
41	class 1 vol	58
42	class 2 vol	16
43	class 3 vol	0

	Link: G in	
44	length	2.2
45	V/C	.29
46	free-flow spd	42
47	class 1 vol	37
48	class 2 vol	8
49	class 3 vol	0

	Link: J out	
50	length	0.9
51	V/C	.10
52	free-flow spd	42
53	class 1 vol	7
54	class 2 vol	0
55	class 3 vol	0

	Link:	
56	length	
57	V/C	
58	free-flow spd	
59	class 1 vol	
60	class 2 vol	
61	class 3 vol	

	Link:	
62	length	
63	V/C	
64	free-flow spd	
65	class 1 vol	
66	class 2 vol	
67	class 3 vol	

	Link:	
68	length	
69	V/C	
70	free-flow spd	
71	class 1 vol	
72	class 2 vol	
73	class 3 vol	

Year: 1979

Table 16: BENEFITS TO RESIDENTS OF ORIGIN ZONE 4 Output Costs

		AUTO	BUS
			$/Month
NO BUILD			
Income class 1	OC	9248.	407.
	TC	13248.	4852.
Income class 2	OC	528.	176.
	TC	192.	529.
Income class 3	OC	0.	0.
	TC	0.	0.
Total	OC	9776.	584.
	TC	13441.	5381.
BUILD			
Income class 1	OC	9327.	391.
	TC	11849.	4215.
Income class 2	OC	529.	172.
	TC	188.	483.
Income class 3	OC	0.	0.
	TC	0.	0.
Total	OC	9856.	563.
	TC	12038.	4698.
DIFFERENCE			
Income class 1	OC	-79.	16.
	TC	1399.	637.
Income class 2	OC	-1.	5.
	TC	4.	47.
Income class 3	OC	0.	0.
	TC	0.	0.
Total	OC	-80.	20.
	TC	1403.	683.

YEAR: 1979

Table 17: ORIGIN ZONE: 8

Input Data

MODE: Car

	Values of Time ($/hr)		
9	Class 1	2.18	(A)
10	Class 2	.56	
11	Class 3	.18	

	Mode:		
5	O.C. parameter	1	(B)
6	occupancy	1.6	
7	expansion factor	107.4	

0	Number of Links:	6	(C)

	Link: AB in	
20	length (km)	5.5
21	V/C	1.11/.37
22	free-flow speed (km/h)	80/100
23	class 1 vol	331
24	class 2 vol	331
25	class 3 vol	0

	Link: C in	
26	length	1.5
27	V/C	.56
28	free-flow spd	60
29	class 1 vol	302
30	class 2 vol	322
31	class 3 vol	0

	Link: D in	
32	length	2.4
33	V/C	.50
34	free-flow spd	60
35	class 1 vol	211
36	class 2 vol	282
37	class 3 vol	0

	Link: E out	
38	length	1.4
39	V/C	1.02
40	free-flow spd	60
41	class 1 vol	169
42	class 2 vol	76
43	class 3 vol	0

	Link: G in	
44	length	2.2
45	V/C	.29
46	free-flow spd	60
47	class 1 vol	82
48	class 2 vol	40
49	class 3 vol	0

	Link: J out	
50	length	.9
51	V/C	.10
52	free-flow spd	60
53	class 1 vol	29
54	class 2 vol	9
55	class 3 vol	0

	Link:	
56	length	
57	V/C	
58	free-flow spd	
59	class 1 vol	
60	class 2 vol	
61	class 3 vol	

	Link:	
62	length	
63	V/C	
64	free-flow spd	
65	class 1 vol	
66	class 2 vol	
67	class 3 vol	

	Link:	
68	length	
69	V/C	
70	free-flow spd	
71	class 1 vol	
72	class 2 vol	
73	class 3 vol	

YEAR: 1979

Table 18: ORIGIN ZONE: 8 Input Data

MODE: BUS

	Values of Time ($/hr)		
9	Class 1		(A)
10	Class 2		
11	Class 3		

	Mode:		
5	O.C. parameter	4.3	(B)
6	occupancy	45	
7	expansion factor	92	

0	Number of Links:	6	(C)

	Link: AB+	
20	length (km)	5.5
21	V/C	1.11/.37
22	free-flow speed (km/h)	64/80
23	class 1 vol	140
24	class 2 vol	650
25	class 3 vol	429

	Link: C+	
26	length	1.5
27	V/C	.56
28	free-flow spd	40
29	class 1 vol	111
30	class 2 vol	631
31	class 3 vol	393

	Link: D+	
32	length	2.4
33	V/C	.50
34	free-flow spd	42
35	class 1 vol	68
36	class 2 vol	552
37	class 3 vol	321

	Link: F-	
38	length	1.4
39	V/C	1.02
40	free-flow spd	42
41	class 1 vol	51
42	class 2 vol	118
43	class 3 vol	98

	Link: G+	
44	length	2.2
45	V/C	.29
46	free-flow spd	42
47	class 1 vol	34
48	class 2 vol	69
49	class 3 vol	63

	Link: J-	
50	length	0.9
51	V/C	.10
52	free-flow spd	42
53	class 1 vol	21
54	class 2 vol	20
55	class 3 vol	36

	Link:	
56	length	
57	V/C	
58	free-flow spd	
59	class 1 vol	
60	class 2 vol	
61	class 3 vol	

	Link:	
62	length	
63	V/C	
64	free-flow spd	
65	class 1 vol	
66	class 2 vol	
67	class 3 vol	

	Link:	
68	length	
69	V/C	
70	free-flow spd	
71	class 1 vol	
72	class 2 vol	
73	class 3 vol	

Year: 1979

Table 19: BENEFITS TO RESIDENTS OF ORIGIN ZONE 8 Output Costs

	AUTO	BUS	$/Month
NO BUILD			
Income class 1			
OC	17282.	948.	
TC	34120.	15089.	
Income class 2			
OC	16995.	4592.	
TC	8464.	18290.	
Income class 3			
OC	0.	2994.	
TC	0.	3859.	
Total			
OC	34277.	8534.	
TC	42584.	37237.	
BUILD			
Income class 1			
OC	14752.	779.	
TC	16311.	7023.	
Income class 2			
OC	14464.	3808.	
TC	3889.	8670.	
Income class 3			
OC	0.	2477.	
TC	0.	1818.	
Total			
OC	29216.	7064.	
TC	20200.	17512.	
DIFFERENCE			
Income class 1			
OC	2531.	169.	
TC	17809.	8065.	
Income class 2			
OC	2531.	784.	
TC	4575.	9619.	
Income class 3			
OC	0.	517.	
TC	0.	2041.	
Total			
OC	5061.	1470.	
TC	22383.	19725.	

Year: 1979

Table 20: BENEFITS TO RESIDENTS OF ORIGIN ZONE 9 OUTPUT COSTS

	AUTO	BUS	$/Month
NO BUILD			
Income class 1			
OC			
TC			
Income class 2			
OC			
TC			
Income class 3			
OC			
TC			
Total			
OC			
TC			
BUILD			
Income class 1			
OC			
TC			
Income class 2			
OC			
TC			
Income class 3			
OC			
TC			
Total			
OC			
TC			
DIFFERENCE			
Income class 1			
OC			
TC			
Income class 2			
OC			
TC			
Income class 3			
OC			
TC			
Total			
OC			
TC			

Year: 1979

Table 21: BENEFITS TO RESIDENTS OF ORIGIN ZONE 9

		AUTO	BUS	
NO BUILD				
Income class 1	OC	21829.57	846.01	
	TC	43073.42	36065.39	
Income class 2	OC	14158.55	2935.36	
	TC	7053.11	11225.38	
Income class 3	OC	0.00	7365.38	No-Build
	TC	0.00	9154.68	
Total	OC	35988.13	11146.74	
	TC	50126.53	56445.36	
BUILD				
Income class 1	OC	18175.10	698.87	
	TC	17355.66	16721.07	
Income class 2	OC	11910.82	2413.16	
	TC	2989.76	4817.35	
Income class 3	OC	0.00	6047.22	Build w/loop
	TC	0.00	3955.50	
Total	OC	30085.92	9159.25	
	TC	20345.42	25493.92	
DIFFERENCE				
Income class 1	OC	3654.47	147.13	Difference w/loop
	TC	25717.76	19344.32	
Income class 2	OC	2247.73	522.20	
	TC	4063.35	6407.94	
Income class 3	OC	0.00	1318.16	
	TC	0.00	5199.18	
Total	OC	5902.20	1987.49	
	TC	29781.11	30951.44	
				1759.52
				6418.56
				2660.47
				37907.89

Build

Difference

OK

YEAR: 1979

Input Data

Table 22: ORIGIN ZONE: 1
MODE: Truck

Modal Parameters	
Labor cost ($/hr)	(B)
O.C parameter	
expansion factor	
Number of Links:	6 (C)

Link: AB-	
Length (km)	5.5
V/C	.58/.19
Free-flow speed (km/h)	80/100
Volume	98

Link: C-	
Length	1.5
V/C	.33
Free-flow speed	.60
Volume	108

Link: D-	
Length	2.4
V/C	.27
Free-flow speed	60
Volume	114

Link: E-	
Length	1.4
V/C	.1.02
Free-flow speed	60
Volume	141

Link: F-	
Length	1.0
V/C	.29
Free-flow speed	60
Volume	109

Link: J	
Length	0.9
V/C	.1
Free-flow speed	60
Volume	10

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Link:	
Length	
V/C	
Free-flow speed	
Volume	

YEAR: 1979

Input Data

Table 23: ORIGIN ZONE: 2
MODE: Truck

Modal Parameters		
Labor cost ($/hr)	1	(B)
O.C parameter	5.2	
expansion factor	115	

Number of Links:	6	(C)

Link: AB	
Length (km)	5.5
V/C	58/.19
Free-flow speed (km/h)	80/100
Volume	74

Link: C-	
Length	1.5
V/C	.33
Free-flow speed	60
Volume	79

Link: D-	
Length	2.4
V/C	.27
Free-flow speed	60
Volume	84

Link: E+	
Length	1.4
V/C	.45
Free-flow speed	60
Volume	297

Link: F-	
Length	1.0
V/C	.29
Free-flow speed	60
Volume	66

Link: J-	
Length	0.9
V/C	.10
Free-flow speed	60
Volume	5

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Link:	
Length	
V/C	
Free-flow speed	
Volume	

YEAR:1979

Input Data

Table 24: ORIGIN ZONE: 3
MODE: Truck

Modal Parameters

Labor cost ($/hr)		(B)
O.C parameter		
expansion factor		

Number of Links: (C)

Link: AB-

Length (km)	5.5
V/C	.58/.19
Free-flow speed (km/h)	80/100
Volume	46

Link: C-

Length	1.5
V/C	.33
Free-flow speed	60
Volume	56

Link: E-

Length	1.4
V/C	1.02
Free-flow speed	60
Volume	69

Link: F+

Length	1.0
V/C	..16
Free-flow speed	60
Volume	171

Link: G-

Length	2.2
V/C	.10
Free-flow speed	60
Volume	57

Link: J-

Length	0.9
V/C	.1
Free-flow speed	60
Volume	10

Link:

Length	
V/C	
Free-flow speed	
Volume	

Link:

Length	
V/C	
Free-flow speed	
Volume	

Link:

Length	
V/C	
Free-flow speed	
Volume	

YEAR: 1979

Table 25: ORIGIN ZONE: 4 — MODE: Truck — Input Data

Modal Parameters

Labor cost ($/hr)		(B)
O.C parameter		
expansion factor		

Number of Links: 5 (C)

Link: C-

Length (km)	1.5
V/C	.33
Free-flow speed (km/h)	60
Volume	6

Link: D+

Length	2.4
V/C	.5
Free-flow speed	60
Volume	3

Link: E-

Length	6.4
V/C	1.02
Free-flow speed	60
Volume	1

Link:

Length	
V/C	
Free-flow speed	
Volume	

Link: G+

Length	2.2
V/C	.29
Free-flow speed	60
Volume	3

Link:

Length	
V/C	
Free-flow speed	
Volume	

Link:

Length	
V/C	
Free-flow speed	
Volume	

Link:

Length	
V/C	
Free-flow speed	
Volume	

Link:

Length	
V/C	
Free-flow speed	
Volume	

YEAR: 1979

Input Data

Table 26: ORIGIN ZONE: 5
MODE:

Modal Parameters

Labor cost ($/hr)		(B)
O.C parameter		
expansion factor		

Number of Links: 6 (C)

Link: AB-

Length (km)	5.5
V/C	.58/.19
Free-flow speed (km/h)	80/100
Volume	5

Link: C+

Length	1.5
V/C	.56
Free-flow speed	60
Volume	28

Link: D+

Length	2.4
V/C	.5
Free-flow speed	60
Volume	24

Link: E-

Length	1.4
V/C	1.02
Free-flow speed	60
Volume	7

Link: G+

Length	2.2
V/C	.29
Free-flow speed	60
Volume	4

Link: J+

Length	.9
V/C	.05
Free-flow speed	60
Volume	33

Link:

Length	
V/C	
Free-flow speed	
Volume	

Link:

Length	
V/C	
Free-flow speed	
Volume	

Link:

Length	
V/C	
Free-flow speed	
Volume	

YEAR: 1979

Input Data

Table 27: ORIGIN ZONE: 8
MODE: Truck

Modal Parameters
Labor cost ($/hr) ________ (B)
O.C parameter ________
expansion factor ________

Number of Links: 6 (C)

Link:	AB+
Length (km)	5.5
V/C	1.1/.37
Free-flow speed (km/h)	80/100
Volume	63

Link:	C+
Length	1.5
V/C	.56
Free-flow speed	60
Volume	56

Link:	D+
Length	2.4
V/C	.5
Free-flow speed	60
Volume	47

Link:	E-
Length	1.4
V/C	.1.02
Free-flow speed	60
Volume	23

Link:	G+
Length	2.2
V/C	.29
Free-flow speed	60
Volume	9

Link:	J-
Length	.9
V/C	.1
Free-flow speed	60
Volume	7

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Link:	
Length	
V/C	
Free-flow speed	
Volume	

Link:	
Length	
V/C	
Free-flow speed	
Volume	

TRUCK COSTS FROM EACH ORIGIN ZONE

ZONE:	1	2	3
No-Build			
OC *	53,796	8,991	30,263
labor	4,113	3,128	2,176
Build			
OC *	54,566	9,573	30,624
labor	3,365	2,563	1,825
Difference			
OC *	-770	-582	-362
labor	748	565	351
total OC	-22	-17	-10

ZONE:	4	5	8
No-Build			
OC *	2,330	7,368	30,225
labor	155	539	21,541
Build			
OC *	2,377	7,407	25,987
labor	109	501	19,909
Difference			
OC *	-47	-39	4,239
labor	46	38	1,632
total OC	-1	-1	5,870

---

* Operating cost minus $1/hr labor cost.

Projected 1984 travel benefits by mode, income class, zone of origin for conditions assumed to prevail with no highway component as compared to those with the proposed highway component. Summary:

Year 1984

Table 29: SUMMARY GENERALIZED TRAVEL COST

ZONE:		High Income HH	Middle Income HH	Low Income HH	Employment	Total
1.	Car					
	bus					
	truck					
	walk					
2.	Car					
	bus					
	truck					
	walk					
3.	Car					
	bus					
	truck					
	walk					
4.	Car					
	bus					
	truck					
	walk					
5.	Car					
	bus					
	truck					
	walk					
6.	Car					
	bus					
	truck					
	walk					
7.	Car					
	bus					
	truck					
	walk					
8.	Car					
	bus					
	truck					
	walk					
9.	Car					
	bus					
	truck					
	walk					
Total:	Car					
	bus					
	truck					
	walk					
Total:						

Year 1984

Table 30: TRIP ORIGINS - MORNING PEAK HOUR

ZONE		HIGH INCOME HH	MIDDLE INCOME HH	LOW INCOME HH	EMPLOYMENT	TOTAL
1.	Car	1.500	1,600	250		3,350
	Bus	500	2,400	750		3,650
	Truck				760	760
	Walk	500	1,200	375		2,075
2.	Car				500	
	Bus					
	Truck					
	Walk					
3.	Car					
	Bus				350	350
	Truck					
	Walk					
4.	Car	560	40	80		680
	Bus	160	80	100		340
	Truck				30	30
	Walk	180	20			200
5.	Car				160	160
	Bus					
	Truck					
	Walk					
6.	Car		600	200		800
	Bus		1,200	1,000	15	2,200
	Truck		300	200		500
	Walk					
7.	Car				160	160
	Bus					
	Truck					
	Walk					
8.	Car	700	500	100		1,300
	Bus	200	1,000	750		1,950
	Truck				150	150
	Walk	100	250	150		500
9.	Car	4,112	424	380		4,916
	Bus	1,303	180	2,815		4,298
	Truck				0	
	Walk	175	120	675		970
TOTAL	Car	6,872	3,164	1,010		11,046
	Bus	2,163	4,860	5,415		12,438
	Truck				2,125	2,125
	Bus	955	1,890	1,400		2,245

Table 31: TRIP DESTINATIONS - MORNING PEAK HOUR

ZONE	HIGH INCOME HH	MIDDLE INCOME HH	LOW INCOME HH	EMPLOYMENT	TOTAL
1. Car	2280	1140	500		3920
Bus	760	1710	1710		4180
Truck				460	460
Walk	380	570	570		1520
2. Car	1200	600	200		2000
Bus	400	900	900		2200
Truck				500	500
Walk	200	420	310		930
3. Car	840	340	140		1320
Bus	280	630	630		1540
Truck				350	350
Walk	200	420	310		930
4. Car	195	82	20		297
Bus	55	120	150		325
Truck				30	30
Walk	30	50	50		130
5. Car	780	330	80		1190
Bus	220	480	600		1300
Truck				160	160
Walk	40	80	80		200
6. Car	94	42	10		146
Bus	28	60	75		163
Truck				15	15
Walk	15	10	10		35
7. Car	780	330	80		1190
Bus	220	480	600		1300
Truck				160	160
Walk	40	80	80		200
8. Car	700	300	100		1100
Bus	200	480	750		1430
Truck				150	150
Walk	50	80	100		230
9. Car					
Bus					
Truck					
Walk					
TOTAL Car	6872	3164	1010		11046
Bus	2163	4860	5415		12438
Truck				2125	2125
Walk	955	1890	1400		4245
TOTAL	9990	9914	7825	2125	29854

Table 32: O-D DISTRIBUTION OF TRUCK TRIPS Year 1985

ORIGIN ZONES	1	2	3	4.	5	6	7	8	9	TOTAL
1. H	584	318	200	24	118	19	183	54	0	1500
M	673	336	200	19	148	16	92	116	0	1600
L	121	40	37	2	8	21	8	32	0	250
TOTAL	1378	694	437	45	274	37	283	202	0	3350
2. H										
M										
L										
TOTAL										
3. H										
M										
L										
TOTAL										
4. H	155	89	80	36	102	18	44	36	0	560
M	9	7	4	4	4	1	4	7	0	40
L	27	19	2	7	7	1	10	7	0	80
TOTAL	191	115	86	47	113	20	5	50	0	680
5. H										
M										
L										
TOTAL										
6. H										
M	170	103	66	28	94	9	93	38	0	600
L	65	41	35	4	27	1	18	9	0	200
TOTAL										
7. H										
M										
L										
TOTAL										
8. H	175	94	67	15	67	15	100	167	0	700
M	132	76	23	18	42	8	56	101	0	456
L	26	22	8	3	8	2	14	17	0	100
TOTAL	333	192	98	36	117	25	170	285	0	1,256
9. H	1356	699	493	120	493	45	453	453		4,112
M	156	81	47	13	42	5	42	38	0	424
L	141	78	53	9	30	4	30	35	0	380
TOTAL	1653	858	593	142	565	54	525	526	0	4,916
TOTAL H	2280	1200	840	195	780	67	780	700	0	6842
M	1140	600	340	82	330	42	330	300	0	3164
L	380	200	140	20	80	10	80	100	0	1010
TOTAL	3800	2000	1320	297	1190	119	1190	1100	0	11,016

Table 33: O-D DISTRIBUTION OF CAR TRIPS Year 1984

ORIGIN TOWNS	1	2	3	4	5	6	7	8	9	TOTAL
1. H	193	110	67	6	49	4	54	17	0	500
M	981	467	477	57	187	16	88	127	0	2400
L	354	134	114	20	47	7	4	40	0	750
TOTAL	1528	711	658	83	283	27	176	184	0	3650
2. H										
M										
L										
TOTAL										
3. H										
M										
L										
TOTAL										
4. H	59	27	25	8	17	8	8	8	0	160
M	24	16	8	4	8	4	8	8	0	80
L	31	15	15	8	8	7	8	8	0	100
TOTAL	114	58	48	20	33	19	24	24	0	340
5. H										
M										
L										
TOTAL										
6. H										
M	390	230	133	37	177	28	112	93	0	1200
L	282	159	96	21	168	23	138	103	0	990
TOTAL	672	389	229	58	345	51	250	196	0	2190
7. H										
M										
L										
TOTAL										
8. H	56	28	19	2	24	3	23	45	0	200
M	252	153	99	18	90	10	44	234	0	1000
L	160	114	67	17	67	10	110	205	0	750
TOTAL	468	295	185	37	181	23	277	484	0	1950
9. H	457	235	169	39	130	13	130	130	0	1303
M	63	34	23	4	18	2	18	18	0	180
L	873	478	338	84	310	28	310	394	0	2815
TOTAL	1393	747	530	127	458	43	458	542	0	4298
TOTAL H	760	400	380	55	220	28	220	200	0	2263
M	110	150	630	120	480	30	480	480	0	2480
L	110	700	630	150	100	75	750	750	0	3265
TOTAL	980	1250	1640	325	800	133	1450	1430	0	8008

Table 34: O-D DISTRIBUTION OF TRUCK TRIPS Year 1984

ORIGIN TOWNS	1	2	3	4	5	6	7	8	9	TOTAL
1. H										
M										
L										
TOTAL	354	154	140	12	43	0	28	29	0	760
2. H										
M										
L										
TOTAL	167	177	71	6	26	0	33	20	0	500
3. H										
M										
L										
TOTAL	115	68	73	6	26	6	36	20	0	350
4. H										
M										
L										
TOTAL	10	10	10	0	0	0	0	0	0	30
5. H										
M										
L										
TOTAL	31	28	23	0	38	9	14	17	0	160
6. H										
M										
L										
TOTAL	8	7	0	0	0	0	0	0	0	15
7. H										
M										
L										
TOTAL	36	30	14	6	16	0	30	28	0	160
8. H										
M										
L										
TOTAL	39	26	19	0	11	0	19	36	0	150
9. H										
M										
L										
TOTAL										
TOTAL H										
M										
L										
TOTAL	760	500	350	30	160	15	160	150		2125

Table 35: LINK ASSIGNMENTS

YEAR: 1984

MODE: Car

Link Origin Zone		A	B	C	D	E	F	G	H	I	J	K	TOTAL
1	H	79-	168-										
	M	80	223										
	L												
	H	35	113										
	M	5	11										
	L												
	H	0	10										
	M	6-	18-										
	L	3	7										
	H	538+	397+										
	M	387+	318										
	L												
	H	3687+	3210+										
	M	21	19										
	L	470	470										
6	H												
	M												
	L												
7	H												
	M												
	L												
In	H	4225+	3607+										
	M	408	337+										
	L	470	470+										
	Total	5103+	4414										
OUT	H	114-	381-										
	M	91-	252-										
	L	3-	7-										
	Total	208-	640-										

Table 36: LINK ASSIGNMENTS

YEAR: 1984

MODE: Bus

Link Origin Zone		A	B	C	D	E	F	G	H	I	J	K	TOTAL
1	H	22	72										
	M	132	387										
	L	0	0										
2	H	9	18										
	M	10	20										
	L	0	0										
3	H	0	0										
	M	8-	32-										
	L	12	18										
4	H	237+	210+										
	M	1020	960										
	L	940	820										
5	H	2085	1885										
	M	125	110										
	L	1470	1390										
6	H												
	M												
	L												
7	H												
	M												
	L												
In	H	2322+	2095+										
	M	1145	1070										
TOTAL	L	2410	2210										
		4375	4375										
In	H	31-	90-										
	M	150	439-										
	L	12	18-										
TOTAL		193	647										

Table 37: LINK ASSIGNMENTS

MODE: Truck

YEAR: 1984

Link Origin Zone		A	B	C	D	E	F	G	H	I	J	K	TOTAL
1	H M L	29-	57-										
2	H M L	20-	53-										
3	H M L	20-	56-										
4	H M L	0	0										
5	H M L	17-	3										
6	H M L	15-	30-										
7	H M L	28-	102+										
8 9	H M L	103+ 228+	84+ 190+										
TOTAL	H M L	129 331+	227 376+										

TABLE 38

YEAR 1984

LINK ASSIGNMENTS BY MODE CAR DCUS

ORIGIN/ZONE LINK	1	2	3	4	5	6	7	8	9	Total Passengers	Total PCU
1-1	3,350			113						3,350	
1-2	694					144		162	858	1,973	
1-3	437									437	
1-4	842									842	
2-1											
2-2											
*(2-5)											
3-1											
3-3											
3-4											
4-1				306		379		495	2,571	3,691	
4-3				86		101		98	593	878	
4-4				680						680	
4-5	274			113						387	
4-6	37			20						57	
4-7	283			58						341	
4-8	203			50						253	
*(5-2)											
5-4											
5-5											
5-6											
5-7											
5-8											
6-4						572				572	
6-5						121				121	
6-6						800				800	
6-7						110				110	
6-8						47				47	
7-4											
7-5											
7-6											
7-7											
7-8											
8-4								629	3,246	3,875	
8-5								117	565	682	
8-6								25	54	79	
8-7								170	525	695	
8-8								1,300		1,300	
8-9											
9-8									5,916	5,916	
9-9									5,916	5,916	

TABLE 39

YEAR 1984

LINK ASSIGNMENTS BY MODE BUS DCUS

ORIGIN/ZONE LINK	1	2	3	4	5	6	7	8	9	Total Passengers	Total PCU
1-1	3,650									3,650	
1-2	711			58		389		295	747	2,200	
1-3	658									658	
1-4	763									763	
2-1											
2-2											
*(2-5)											
3-1											
3-3											
3-4											
4-1				172		1,061		763	2,140	4,136	
4-3				48		229		185	520	982	
4-4				340						340	
4-5	283			23						316	
4-6	27			19						46	
4-7	176			24						200	
4-8	184			24						208	
*(5-2)											
5-4											
5-5											
5-6											
5-7											
5-8											
6-4						1,348				1,348	
6-5						345				345	
6-6						2,200				2,200	
6-7						250				250	
6-8						196				196	
7-4											
7-5											
7-6											
7-7											
7-8											
8-4								985	1,587	2,572	
8-5								181	458	639	
8-6								23	43	66	
8-7								274	458	732	
8-8								1,950		1,950	
8-9											
9-8									4,298	4,298	
9-9									4,298	4,298	

TABLE 40

YEAR 1984

LINK ASSIGNMENTS BY MODE TRUCK DCUS

ORIGIN/ZONE LINK	1	2	3	4	5	6	7	8	9	Total passengers	Total PCU
1-1	760									760	
1-2	154		68	10	28	7	30	26		323	
1-3	140	71								211	
1-4	112	85								197	
2-1		333								333	
2-2		500								500	
*(2-5)											
3-1			183							183	
3-3			350							350	
3-4			161							161	
4-1				20	59	15	66	65		225	
4-3				10	23		14	23		66	
4-4				30						30	
4-5	43	26	6							75	
4-6			26							26	
4-7	28	33	36							97	
4-8	29	20	20							69	
*(5-2)											
5-4					72					72	
5-5					160					160	
5-6					9					9	
5-7					14					14	
5-8					17					17	
6-4						15				15	
6-5											
6-6						15				15	
6-7											
6-8											
7-4							86			86	
7-5							16			16	
7-6											
7-7							160			160	
7-8							28			28	
8-4								84		84	
8-5								11		11	
8-6											
8-7								19		19	
8-8								150		150	
8-9											
9-8											
9-9											

REGISTER CONTENTS: UTB-2.1(A)

YEAR: 1984

FOR CAR & BUS

ORIGIN ZONE: 1

MODE: Bus

Values of Time ($/hr)

9	Class 1	2.18	(A)
10	Class 2	.56	
11	Class 3	.18	

Mode:

5	O.C. parameter	4.3	(B)
6	occupancy	45	
7	expansion factor	92	

0	Number of Links:	10	(C)

Link: A outbound

20	length (km)	2.1
21	V/C	1135/1600=0.17/0.24
22	free-flow speed (km/h)	64/80
23	class 1 vol	22
24	class 2 vol	132
25	class 3 vol	0

Link: B outbound

26	length	3.4
27	V/C	
28	free-flow spd	68/80
29	class 1 vol	72
30	class 2 vol	387
31	class 3 vol	0

Link:

32	length	
33	V/C	
34	free-flow spd	
35	class 1 vol	
36	class 2 vol	
37	class 3 vol	

Link:

38	length	
39	V/C	
40	free-flow spd	
41	class 1 vol	
42	class 2 vol	
43	class 3 vol	

Link:

44	length	
45	V/C	
46	free-flow spd	
47	class 1 vol	
48	class 2 vol	
49	class 3 vol	

Link:

50	length	
51	V/C	
52	free-flow spd	
53	class 1 vol	
54	class 2 vol	
55	class 3 vol	

Link:

56	length	
57	V/C	
58	free-flow spd	
59	class 1 vol	
60	class 2 vol	
61	class 3 vol	

Link:

62	length	
63	V/C	
64	free-flow spd	
65	class 1 vol	
66	class 2 vol	
67	class 3 vol	

Link:

68	length	
69	V/C	
70	free-flow spd	
71	class 1 vol	
72	class 2 vol	
73	class 3 vol	

TRIP-ORIGINS - MORNING PEAK HOUR

ZONE	HIGH INCOME HH	MIDDLE INCOME HH	LOW INCOME HH	EMPLOYMENT	TOTAL
1. Car	2250	2100	350		4725
Bus	1000	3600	1500		6100
Truck				920	920
Walk	250	800	375		1425
2. Car					
Bus					
Truck				500	500
Walk					
3. Car					
Bus					
Truck				400	400
Walk					
4. Car	840	60			900
Bus	280	120			400
Truck				150	150
Walk	120	20			140
5. Car					
Bus					
Truck				240	240
Walk					
6. Car		750	300		1050
Bus		1800	1600		3400
Truck				30	30
Walk		225	300		525
7. Car					
Bus					
Truck				400	400
Walk					
8. Car	735	650	300		1685
Bus	375	1400	900		2675
Truck				180	180
Walk	75	260	100		435
9. Car	5175	350	410		5935
Bus	2325	225	2420		4970
Truck					
Walk	135	145	550		830
TOTAL Car	9000	3915	1385		14300
Bus	3980	7145	6420	2820	17545
Truck				2820	2820
Walk	580	1450	1325		3355
TOTAL	13560	12510	9130	2820	38020

TRIP DESTINATIONS - MORNING PEAK HOUR

ZONE	HIGH INCOME HH	MIDDLE INCOME HH	LOW INCOME HH	EMPLOYMENT	TOTAL
1. Car	2990	1035	460		4485
Bus	1380	2070	2070		5520
Truck				920	920
Walk	230	500	460		1190
2. Car	1300	600	200		2100
Bus	600	1000	900		2500
Truck				500	500
Walk	100	250	200		550
3. Car	1040	360	160		1560
Bus	480	900	630		2010
Truck				400	400
Walk	80	200	160		440
4. Car	725	400	100		1225
Bus	250	575	475		1300
Truck				150	150
Walk	50	100	75		225
5. Car	870	500	120		1490
Bus	300	600	540		1440
Truck				240	240
Walk	60	90	90		240
6. Car	115	80	15		210
Bus	50	150	115		315
Truck				30	30
Walk	5	40	20		65
7. Car	1150	700	150		2000
Bus	500	1250	1150		2900
Truck				400	400
Walk	25	150	200		375
8. Car	810	240	180		1230
Bus	420	600	540		1560
Truck				180	180
Walk	30	120	120		270
9. Car					
Bus					
Truck					
Walk					
TOTAL Car	9000	3915	1385		14300
Bus	3980	7145	1420		17545
Truck				2820	2820
Walk	1580	1450	1325		3355
TOTAL	13560	12510	9180	2820	38020

Year 1[illegible]

O-D DISTRIBUTION OF CAR TRIPS

ORIGIN ZONE	1	2	3	4.	5	6	7	8	9	TOTAL
1. H	873	343	280	136	201	20	281	116	0	2250
M	688	366	236	193	175	31	355	56	0	2100
L	168	73	48	24	21	4	18	19	0	375
TOTAL	1729	782	564	353	397	55	654	191	0	4725
2. H										
M										
L										
TOTAL										
3. H										
M										
L										
TOTAL										
4. H	248	146	131	129	86	9	69	23	0	840
M	11	7	7	7	7	7	7	7	0	60
L	0	0	0	0	0	0	0	0	0	0
TOTAL	259	153	138	136	93	16	76	30	0	900
5. H										
M										
L										
TOTAL										
6. H										
M	140	96	42	105	159	26	113	69	0	750
L	82	38	39	28	38	2	44	27	0	300
TOTAL	222	134	81	133	197	28	157	96	0	1050
7. H										
M										
L										
TOTAL										
8. H	163	86	48	46	68	34	128	165	0	735
M	95	78	43	61	113	9	164	87	0	650
L	74	32	24	19	24	3	43	81	0	300
TOTAL	332	196	115	126	205	46	335	333	0	1685
9. H	1707	125	621	444	508	52	672	466	0	5175
M	91	53	32	39	46	77	61	21	0	350
L	136	57	49	29	37	4	45	53	0	5135
TOTAL	1934	835	702	482	601	63	778	540		5935
TOTAL H	2990	1300	1040	725	870	115	1150	810	0	9000
M	1035	600	360	400	500	80	700	240		3915
L	460	300	160	100	120	75	150	180	0	1545
TOTAL	4485	2200	1560	1225	1490	270	2000	1230	0	14,460

O-D DISTRIBUTION OF BUS TRIPS

Year 1989

ORIGIN ZONE	1	2	3	4.	5	6	7	8	9	TOTAL
1. H	401	169	135	60	63	11	94	67	0	1,000
M	1342	570	509	247	217	59	541	115	0	3,600
L	633	230	190	81	95	20	180	66	0	1,500
TOTAL	2376	969	834	393	375	90	815	248	0	6,100
2. H										
M										
L										
TOTAL										
3. H										
M										
L										
TOTAL										
4. H	93	42	34	34	27	8	25	17	0	280
M	32	16	16	16	8	8	16	8	0	120
L	0	0	0	0	0	0	0	0	0	0
TOTAL	125	58	50	50	35	16	41	25		4 0
5. H										
M										
L										
TOTAL										
6. H	0	0	0	0	0	0	0	0	0	0
M	372	229	210	201	210	73	292	239	0	1800
L	443	238	136	158	197	30	279	93	0	1600
TOTAL	815	467	346	359	407	103	571	332		3400
7. H										
M										
L										
TOTAL										
8. H	96	40	32	16	24	8	79	80	0	375
M	264	153	136	93	147	25	340	246	0	1400
L	220	93	62	51	65	17	231	161	0	900
TOTAL	580	286	230	160	236	50	650	487	0	2675
9. H	790	349	279	140	186	23	302	256	0	2325
M	64	32	29	18	18	5	41	18	0	225
L	774	339	242	169	194	48	460	194	0	2420
TOTAL	1528	720	550	32	398	76	803	468	0	4970
TOTAL H										
M										
L										
TOTAL										

O-D DISTRIBUTION OF TRUCK TRIPS Year 1989

ORIGIN ZONE	1	2	3	4.	5	6	7	8	9	TOTAL
1. H M L										
TOTAL	381	149	120	40	86	6	75	63	0	920
2. H M L										
TOTAL	133	14	74	35	20	7	74	14	0	500
3. H M L										
TOTAL	149	60	97	14	21	0	44	15	0	400
4. H M L										
TOTAL	46	24	24	16	16	0	16	8	0	150
5. H M L										
TOTAL	71	35	27	18	48	0	27	14	0	240
6. H M L										
TOTAL	10	10	5	0	0	0	5	0	0	30
7. H M L										
TOTAL	92	51	34	17	30	17	121	38	0	400
8. H M L										
TOTAL	38	28	19	10	19	0	38	28	0	180
9. H M L										
TOTAL	120	100	60	5	8	2	10	20	0	325
TOTAL H M L										
TOTAL	920	500	400	150	240	30	400	180	0	3,145

LINK ASSIGNMENTS BY MODE CAR

ORIGIN ZONE	1	2	3	4	5	6	7	8	9	Total Passengers	Total FCU
LINK 1-1	4725									4725	
1-2	782			153		134		196	835	2100	
1-3	564									564	
1-4	1650									1650	
2-1											
2-2											
*(2-5)											
3-1											
3-3											
3-4											
4-1				312		356		528	2769	3965	
4-3				138		81		115	702	1036	
4-4				900						900	
4-5	397			93						490	
4-6	55			16						71	
4-7	654			76						730	
4-8	191			30						221	
*(5-2)											
5-4											
5-5											
5-6											
5-7											
5-8											
6-4						570				570	
6-5						197				197	
6-6						1050				1050	
6-7						151				151	
6-8						96				96	
7-4											
7-5											
7-6											
7-7											
7-8											
8-4								769	3973	4742	
8-5								205	601	806	
8-6								46	63	109	
8-7								335	778	1113	
8-8								1685		1685	
8-9											
9-8									5135	5135	
9-9									5135	5135	

Year 1989

LINK ASSIGNMENTS BY MODE

ORIGIN ZONE	1	2	3	4	5	6	7	8	9	Total Passengers	Total FCU
LINK 1-1	6100									6100	
1-2	969			58		467		286		1780	
1-3	834									834	
1-4	1927									1927 7	
2-1											
2-2											
*(2-5)											
3-1											
3-3											
3-4											
4-1				183		1282		866	2248	4579	
4-3				50		346		230	540	1166	
4-4				400						400	
4-5	375			35						410	
4-6	90			16						106	
4-7	815			41						856	
4-8	248			25						273	
*(5-2)											
5-4											
5-5											
5-6											
5-7											
5-8											
6-4						1987				1987	
6-5						407				407	
6-6						3400				3400	
6-7						571				571	
6-8						332				332	
7-4											
7-5											
7-6											
7-7											
7-8											
8-4								1256	3115	4371	
8-5								236	398	634	
8-6								50	76	126	
8-7								650	803	1453	
8-8								2675		2675	
8-9											
9-8									4970	4970	
9-9									4970	4970	

Year 1989

LINK ASSIGNMENTS BY MODE: TRUCK

ORIGIN ZONE	1	2	3	4	5	6	7	8	9	Total Passengers	Total FCU
LINK 1-1	920									920	
1-2	149		60	24	35	10	51			329	
1-3	120	74								194	
1-4	270	150								420	
2-1		357								357	
2-2		500								500	
2-5											
3-1			209							209	
3-3			400							400	
3-4			94							94	
4-1				70	106	20	143	66		405	
4-3				24	27	5	34	19		109	
4-4				150						150	
4-5	86	20	21	16						143	
4-6	6	7								13	
4-7	75	74	44	16						209	
4-8	63	14	15	8						100	
5-2											
5-4					157					157	
5-5					240					240	
5-6					0					0	
5-7					27					27	
5-8					14					14	
6-4						25				25	
6-5											
6-6						30				30	
6-7						5				5	
6-8											
7-4							194			194	
7-5							30			30	
7-6							17			17	
7-7							400			400	
7-8							38			38	
8-4								95		95	
8-5								19		19	
8-6								38		38	
8-7											
8-8								180		180	
8-9											
9-8											
9-9											

PROGRAMMING LAND DEMAND

A1) With <u>No</u> highway component

A2) With highway component

B1) With weak public transport component
B1A) Context A1
B1B) Context A2

B2) With strong public transport component
B2A) Context A1
B2B) Context A2

					$\frac{LW}{\sqrt{C}}$	$\frac{GLW}{\sqrt{c}}$	B		
1	83	83	6889	898 30	229.6	.75	7875	8300	79
4	4 8	2	8	4.7	1.702	.01	105	200	.02
8	60 48	20	1200	16.1	59.6	.24	2520	2000	.19
					305.8		10500	10500	

LOW MOVE

	L_i	VD_1	LW/VC		LW/VC	GLWD/VC	Mwac	4.4
1	12.3	41	4	10	60	.70	3710	4100
4	/	0	/	/				—
8	10.8	12	130	6	22	.30	1590	1200
					72			5300

$$G_1^z 2 \quad \frac{6^2 L_1 W_1^z}{C_1^z} B$$

Total loan cost/mm

	H	M	L
1 2	39.4 9.9 50 1404 1494	11.3 CAR 5.4 BUS 16 882 898	2.2 BUS 2 103 105
3 4 5 6	22.5 CAR 5.3 BUS 28 432 460	.72 .71 1 21 22	0
7 8 9	51.3 CAR 16.1 BUS 67 432 499	25.4 CAR 22.3 BUS 48 210 258	6.8 BUS 7 30 37

1984 - 1989 Volume Increments
Links A & B

1989

			LINK A 1984	LINK A 1989	LINK A Increment	LINK B 1979	LINK B 1984	LINK B 1989	LINK B 1984-89 Increment	LINK B 1979-84 Increment
High	Auto	In	4223	5279	211.2	809	3603	4479	174.8	559.2
		Out	114	139	5	254	281	489	41.6	5.4
	Bus	In	2322	2364	8.4	262	2095	1983	22.4	366.6
		Out	31	84	10.6	78	90	203	22.6	2.4
Med.	Auto	In	418	892	94.5	625	357	667	62	53.6
		Out	91	132	8.2	86	252	607	71	33.2
	Bus	In	1245	1361	23.2	1083	1060	977	16.6	4.6
		Out	142	462	64	132	439	1211	154.4	61.4
Low	Auto	In	470	576	21.2	0	470	488	3.6	94
		Out	3	46	8.6	0	7	108	20.2	1.4
	Bus	In	2410	3965	311	1522	2210	3274	212.8	137.6
		Out	6	159	30.6	114	18	618	120	19.2
	Truck	In	342	417	15	230	387	576	37.8	31.4
		Out	342	417	15	230	387	576	37.8	31.4

Year: 1984

Origin Zone: 4

Mode: Car

Values of Time ($/hr)

class 1	2.18	(A)
class 2	.56	
class 3	.18	

Mode:

O.C. parameter	1	(B)
occupancy	~~1.6~~	
expansion factor	107.4	

Number of Links: 9 (C)

Link: A Out

length (km)	2.1
V/C	.73/.24
free-flow speed (km/h)	80/100
class 1 vol	79
class 2 vol	86
class 3 vol	0

Link: B Out

length	3.4
V/C	.96/.32
free-flow spd	80/100
class 1 vol	168
class 2 vol	223
class 3 vol	0

Link: C Out

length	1.5
V/C	.62
free-flow spd	60
class 1 vol	363
class 2 vol	408
class 3 vol	0

Link: D Out

length	2.4
V/C	.49
free-flow spd	60
class 1 vol	402
class 2 vol	453
class 3 vol	0

Link: E Out

length	1.4
V/C	1.15
free-flow spd	60
class 1 vol	284
class 2 vol	231
class 3 vol	50

Link: F Out

length	1.0
V/C	.27
free-flow spd	60
class 1 vol	198
class 2 vol	231
class 3 vol	50

Link: H Out

length	0.5
V/C	.05
free-flow spd	60
class 1 vol	18
class 2 vol	16
class 3 vol	0

Link: J Out

length	o.9
V/C	.52
free-flow spd	60
class 1 vol	177
class 2 vol	169
class 3 vol	0

Link: K Out

length	0.5
V/C	.54
free-flow spd	60
class 1 vol	89
class 2 vol	73
class 3 vol	0

Year: 1984

Origin Zone: 4

Mode: Car

Values of Time ($/hr)

class 1		(A)
class 2		
class 3		

Mode:

O.C. parameter		(B)
occupancy		
expansion factor		

Number of Links: 9 (C)

Link: A Out

length (km)	2.1
V/C	.73/.24
free-flow speed (km/h)	80/100
class 1 vol	35
class 2 vol	5
class 3 vol	0

Link: B Out

length	3.4
V/C	.96/.32
free-flow spd	80/100
class 1 vol	113
class 2 vol	11
class 3 vol	0

Link: C Out

length	1.5
V/C	.62
free-flow spd	60
class 1 vol	200
class 2 vol	17
class 3 vol	0

Link: D In

length	2.4
V/C	1.02
free-flow spd	60
class 1 vol	246
class 2 vol	17
class 3 vol	0

Link: F Out

length	1.4
V/C	1.15
free-flow spd	60
class 1 vol	88
class 2 vol	6
class 3 vol	0

Link: G In

length	2.2
V/C	.59
free-flow spd	60
class 1 vol	79
class 2 vol	6
class 3 vol	0

Link: H Out

length	.5
V/C	.05
free-flow spd	60
class 1 vol	26
class 2 vol	0
class 3 vol	0

Link: J Out

length	.9
V/C	.52
free-flow spd	60
class 1 vol	61
class 2 vol	6
class 3 vol	0

Link: K Out

length	.5
V/C	.54
free-flow spd	60
class 1 vol	78
class 2 vol	6
class 3 vol	0

Year: 1984

Origin Zone: 6

Mode: Car

Values of Time ($/hr)

class 1		(A)
class 2		
class 3		

Mode:

O.C. parameter		(B)
occupancy		
expansion factor		

Number of Links: 9 (C)

Link: A Out

length (km)	2.1
V/C	.73/.24
free-flow speed (km/h)	80/100
class 1 vol	0
class 2 vol	6
class 3 vol	3

Link: B Out

length	3.4
V/C	.96/.32
free-flow spd	80/100
class 1 vol	0
class 2 vol	18
class 3 vol	7

Link: C In

length	1.5
V/C	1.25
free-flow spd	60
class 1 vol	0
class 2 vol	20
class 3 vol	8

Link: D In

length	2.4
V/C	1.02
free-flow spd	60
class 1 vol	0
class 2 vol	12
class 3 vol	4

Link: E Out

length	1.4
V/C	1.15
free-flow spd	60
class 1 vol	0
class 2 vol	3
class 3 vol	1

Link: G In

length	2.2
V/C	.59
free-flow spd	60
class 1 vol	0
class 2 vol	6
class 3 vol	3

Link: H In

length	.5
V/C	.04
free-flow spd	60
class 1 vol	0
class 2 vol	56
class 3 vol	19

Link: J Out

length	.9
V/C	.52
free-flow spd	60
class 1 vol	0
class 2 vol	16
class 3 vol	5

Link: K Out

length	.5
V/C	.54
free-flow spd	60
class 1 vol	0
class 2 vol	12
class 3 vol	4

Origin Zone: 8

Mode: Car

Values of Time ($/hr) (A)

class 1	
class 2	
class 3	

Mode: (B)

O.C. parameter	
occupancy	
expansion factor	

Number of Links: 9 (C)

Link: A In

length (km)	2.1
V/C	1.5/.96
free-flow speed (km/h)	80/100
class 1 vol	536
class 2 vol	387
class 3 vol	0

Link: B In

length	3.4
V/C	1.5/.89
free-flow spd	395
class 1 vol	318
class 2 vol	0
class 3 vol	

Link: C In

length	1.5
V/C	1.25
free-flow spd	60
class 1 vol	317
class 2 vol	264
class 3 vol	0

Link: D In

length	2.4
V/C	1.02
free-flow spd	60
class 1 vol	235
class 2 vol	215
class 3 vol	0

Link: E Out

length	1.4
V/C	1.15
free-flow spd	60
class 1 vol	96
class 2 vol	77
class 3 vol	0

Link: G In

length	2.2
V/C	.59
free-flow spd	60
class 1 vol	69
class 2 vol	40
class 3 vol	0

Link: H Out

length	.5
V/C	.05
free-flow spd	60
class 1 vol	9
class 2 vol	11
class 3 vol	0

Link: J Out

length	.1
V/C	.52
free-flow spd	60
class 1 vol	69
class 2 vol	43
class 3 vol	0

Link: K Out

length	.5
V/C	.54
free-flow spd	60
class 1 vol	141
class 2 vol	69
class 3 vol	0

Year: 1984

Origin Zone: 1

Mode: Bus

Values of Time ($/hr)

class 1		(A)
class 2		
class 3		

Mode:

O.C. parameter	4.3	(B)
occupancy	45	
expansion factor	92	

Number of Links:	9	(C)

Link: A Out

length (km)	2.1
V/C	.73/.24
free-flow speed (km/h)	64/80
class 1 vol	72
class 2 vol	387
class 3 vol	0

Link: B Out

length	1.5
V/C	.96/.32
free-flow spd	64/80
class 1 vol	72
class 2 vol	387
class 3 vol	0

Link: C Out

length	1.5
V/C	.62
free-flow spd	42
class 1 vol	116
class 2 vol	738
class 3 vol	0

Link: D Out

length	2.4
V/C	.49
free-flow spd	42
class 1 vol	125
class 2 vol	819
class 3 vol	0

Link: E Out

length	1.4
V/C	1.15
free-flow spd	47
class 1 vol	109
class 2 vol	443
class 3 vol	194

Link: F Out

length	1.0
V/C	.29
free-flow spd	42
class 1 vol	67
class 2 vol	312
class 3 vol	133

Link: H Out

length	.5
V/C	.05
free-flow spd	02
class 1 vol	0
class 2 vol	36
class 3 vol	0

Link: J Out

length	.9
V/C	.52
free-flow spd	42
class 1 vol	44
class 2 vol	315
class 3 vol	0

Link: K Out

length	.5
V/C	.54
free-flow spd	42
class 1 vol	50
class 2 vol	255
class 3 vol	0

Year: 1984

Origin Zone: 41

Mode: Bus

Values of Time ($/hr) (A)
class 1 ____
class 2 ____
class 3 ____

Mode: (B)
O.C. parameter ____
occupancy ____
expansion factor ____

Number of Links: 9 (C)

Link: A Out	
length (km)	2.1
V/C	.73/.24
free-flow speed (km/h)	64/80
class 1 vol	9
class 2 vol	10
class 3 vol	0

Link: B Out	
length	3.4
V/C	.96/.32
free-flow spd	64/80
class 1 vol	18
class 2 vol	20
class 3 vol	0

Link: C Out	
length	1.5
V/C	.62
free-flow spd	42
class 1 vol	49
class 2 vol	30
class 3 vol	0

Link: D In	
length	2.4
V/C	1.02
free-flow spd	42
class 1 vol	75
class 2 vol	40
class 3 vol	0

Link: E Out	
length	1.4
V/C	1.15
free-flow spd	42
class 1 vol	27
class 2 vol	10
class 3 vol	0

Link: G In	
length	2.2
V/C	.59
free-flow spd	47
class 1 vol	27
class 2 vol	10
class 3 vol	0

Link: H Out	
length	.5
V/C	.05
free-flow spd	42
class 1 vol	9
class 2 vol	0
class 3 vol	0

Link: J Out	
length	.9
V/C	.52
free-flow spd	42
class 1 vol	22
class 2 vol	10
class 3 vol	0

Link: K Out	
length	.5
V/C	.54
free-flow spd	42
class 1 vol	9
class 2 vol	10
class 3 vol	0

Year: 1984

Origin Zone: 6

Mode: Bus

Values of Time ($/hr) (A)

class 1	
class 2	
class 3	

Mode: (B)

O.C. parameter	
occupancy	
expansion factor	

Number of Links: 9 (C)

Link: A Out

length (km)	2.1
V/C	.73/.24
free-flow speed (km/h)	64/80
class 1 vol	0
class 2 vol	8
class 3 vol	6

Link: B Out

length	3.4
V/C	.96/.32
free-flow spd	64/80
class 1 vol	0
class 2 vol	32
class 3 vol	18

Link: C In

length	1.5
V/C	1.25
free-flow spd	42
class 1 vol	0
class 2 vol	56
class 3 vol	20

Link: D In

length	2.4
V/C	1.02
free-flow spd	42
class 1 vol	0
class 2 vol	36
class 3 vol	12

Link: E Out

length	1.4
V/C	1.15
free-flow spd	42
class 1 vol	0
class 2 vol	8
class 3 vol	3

Link: G In

length	2.2
V/C	.59
free-flow spd	42
class 1 vol	0
class 2 vol	16
class 3 vol	6

Link: H In

length	.5
V/C	.04
free-flow spd	42
class 1 vol	0
class 2 vol	112
class 3 vol	54

Link: J Out

length	.9
V/C	.52
free-flow spd	42
class 1 vol	0
class 2 vol	26
class 3 vol	16

Link: K Out

length	.5
V/C	.54
free-flow spd	42
class 1 vol	0
class 2 vol	24
class 3 vol	12

Origin Zone: 8

Mode: Bus

Values of Time ($/hr) (A)

class 1	
class 2	
class 3	

Mode: (B)

O.C. parameter	
occupancy	
expansion factor	

Number of Links: 9 (C)

Link: A In

length (km)	2.1
V/C	1.5/.96
free-flow speed (km/h)	64/80
class 1 vol	231
class 2 vol	1120
class 3 vol	940

Link: B In

length	3.4
V/C	1.5/.89
free-flow spd	64/80
class 1 vol	210
class 2 vol	160
class 3 vol	820

Link: C In

length	1.5
V/C	1.25
free-flow spd	42
class 1 vol	180
class 2 vol	800
class 3 vol	720

Link: D In

length	2.4
V/C	1.25
free-flow spd	42
class 1 vol	140
class 2 vol	630
class 3 vol	600

Link: E Out

length	1.4
V/C	1.15
free-flow spd	42
class 1 vol	50
class 2 vol	210
class 3 vol	200

Link: G In

length	2.2
V/C	.54
free-flow spd	42
class 1 vol	30
class 2 vol	140
class 3 vol	100

Link: H Out

length	.5
V/C	.05
free-flow spd	42
class 1 vol	0
class 2 vol	20
class 3 vol	0

Link: J Out

length	.9
V/C	.52
free-flow spd	43
class 1 vol	30
class 2 vol	140
class 3 vol	100

Link: K Out

length	.5
V/C	.54
free-flow spd	42
class 1 vol	27
class 2 vol	160
class 3 vol	120

Year:1984

ORIGIN ZONE: 1
Mode: Truck

Modal Parameters

labor cost ($/hr)	1	(B)
O.C. parameter	5.2	
expansion factor	115	
Number of Links:	8	(C)

Link: A Out

	length (km)	2.1
.21	V/C	.73/.24
22	free-flow speed (km/h)	80/100
	volume	135

Link: B Out

	length	3.4
25	V/C	.96/.32
26	free-flow speed	80/100
	volume	135

Link: C Out

length	1.5
V/C	.62
free-flow speed	60
volume	178

Link: D Out

length	2.4
V/C	.49
free-flow speed	60
volume	190

Link: E Out

length	1.4
V/C	1.15
free-flow speed	60
volume	158

Link: F Out

length	1.0
V/C	29
free-flow speed	60
volume	140

Link: H Out

length	15
V/C	.05
free-flow speed	60
volume	0

Link: J Out

length	.9
V/C	.52
free-flow speed	60
volume	43

Link: K Out

length	.5
V/C	.54
free-flow speed	60
volume	~~28~~

Year: 1984

ORIGIN ZONE: 2
Mode: Truck

Modal Parameters
Labor cost ($/hr) ______ (B)
O.C. parameter ______
expansion factor ______

Number of Links: ______ (C)

Link: ______
length (km) ______
V/C .73/.24
free-flow speed (km/h) 85/100
23 volume 72

Link: ______
length ______
V/C .96/.32
free-flow speed 80/100
27 volume 105

Link: ______
length ______
V/C ______
free-flow speed ______
31 volume 131

Link: ______
length ______
V/C ______
free-flow speed ______
35 volume 137

Link: ______
length ______
37 V/C .56
free-flow speed ______
31 volume 375

Link: ______
length ______
V/C ______
free-flow speed ______
43 volume 71

Link: ______
length ______
V/C ______
free-flow speed ______
volume ______

Link: ______
length ______
V/C ______
free-flow speed ______
47 volume 26

Link: ______
length ______
V/C ______
free-flow speed ______
51 volume 33

Year: 1984

ORIGIN ZONE: 3
Mode: Truck

Modal Parameters		
Labor cost ($/hr)		(B)
O.C. parameter		
expansion factor		
Number of Links:	9	(C)

Link:	A Out
length (km)	2.1
V/C	.73/.24
free-flow speed (km/h)	80/100
volume	58

Link:	B Out
length	3.4
V/C	.96/.32
free-flow speed	80/100
volume	94

Link:	C Out
length	1.5
V/C	.62
free-flow speed	60
volume	126

Link:	E Out
length	1.4
V/C	1.15
free-flow speed	60
volume	68

Link:	Fin
length	1.0
V/C	.18
free-flow speed	60
volume	183

Link:	G Out
length	2.2
V/C	.25
free-flow speed	60
volume	132

Link:	H Out
length	.5
V/C	.05
free-flow speed	60
volume	6

Link:	J Out
length	.9
V/C	.52
free-flow speed	60
volume	26

Link:	K Out
length	.5
V/C	.54
free-flow speed	60
volume	36

Year: 1984

ORIGIN ZONE: 4
Mode: Truck

Modal Parameters

Labor cost ($/hr)		(B)
O.C. parameter		
expansion factor		
Number of Links:	3	(C)

Link: D In

length (km)	2.4
V/C	1.02
free-flow speed (km/h)	60
volume	20

Link: E Out

length	1.4
V/C	1.15
free-flow speed	60
volume	10

Link: G In

length	2.2
V/C	.59
free-flow speed	60
volume	10

Link:

length	
V/C	
free-flow speed	
volume	

Link:

length	
V/C	
free-flow speed	
volume	

Link:

length	
V/C	
free-flow speed	
volume	

Link:

length	
V/C	
free-flow speed	
volume	

Link:

length	
V/C	
free-flow speed	
volume	

Link:

length	
V/C	
free-flow speed	
volume	

Year: 1984

ORIGIN ZONE: 5
Mode: Truck

Modal Parameters

Labor cost ($/hr)		(B)
O.C. parameter		
expansion factor		

Number of Links: 9 (C)

Link: A Out

length (km)	2.1
V/C	.73/.24
free-flow speed (km/h)	80/100
volume	39

Link: B Out

length	3.4
V/C	.96/.32
free-flow speed	80/100
volume	53

Link: C In

length	1.5
V/C	1.25
free-flow speed	60
volume	82

Link: D In

length	2.4
V/C	1.02
free-flow speed	60
volume	59

Link: E Out

length	1.4
V/C	1.15
free-flow speed	60
volume	28

Link: G In

length	2.2
V/C	.59
free-flow speed	60
volume	23

Link: H Out

length	.5
V/C	.05
free-flow speed	60
volume	9

Link: J In

length	.9
V/C	.23
free-flow speed	60
volume	182

Link: K Out

length	.5
V/C	.54
free-flow speed	60
volume	14

Year: 1984

ORIGIN ZONE: 6
Mode: Truck

Changes from Zone 5

Modal Parameters
- Labor cost ($/hr) ______ (B)
- O.C. parameter ______
- expansion factor ______

Number of Links: 7 (C)

Link: ______
- length (km) ______
- V/C ______
- free-flow speed (km/h) ______
- volume 0

Link: ______
- length ______
- V/C ______
- free-flow speed ______
- volume 0

Link: ______
- length ______
- V/C ______
- free-flow speed ______
- volume 15

Link: ______
- length ______
- V/C ______
- free-flow speed ______
- volume 15

Link: ______
- length ______
- V/C ______
- free-flow speed ______
- volume 7

Link: ______
- length ______
- V/C ______
- free-flow speed ______
- volume 0

Link: H In
- length ______
- V/C .04
- free-flow speed ______
- volume 15

Link: ______
- length ______
- V/C ______
- free-flow speed ______
- volume ______

Link: ______
- length ______
- V/C ______
- free-flow speed ______
- volume ______

Year: 1984

ORIGIN ZONE: 7
Mode: Truck

Changes from Zone 5

Modal Parameters
- Labor cost ($/hr) ______ (B)
- O.C. parameter ______
- expansion factor ______

Number of Links: 9 (C)

Link:
- length (km) ______
- V/C .73/.24
- free-flow speed (km/h) 80/100
- volume 66

Link: B In
- length ______
- V/C 1.5/.89
- free-flow speed 80/100
- volume 102

Link:
- length ______
- V/C ______
- free-flow speed ______
- volume 86

Link:
- length ______
- V/C ______
- free-flow speed ______
- volume 66

Link:
- length ______
- V/C ______
- free-flow speed ______
- volume 30

Link:
- length ______
- V/C ______
- free-flow speed ______
- volume 14

Link:
- length ______
- V/C ______
- free-flow speed ______
- volume 0

Link:
- length ______
- V/C .52
- free-flow speed ______
- volume 16

Link:
- length ______
- V/C .25
- free-flow speed ______
- volume 198

Year: 1984

ORIGIN ZONE: 8
Mode: Truck

Changes from Zone 7

Modal Parameters

Labor cost ($/hr)		(B)
O.C. parameter		
expansion factor		
Number of Links:	9	(C)

Link: A In

length (km)	
V/C	1.5/.96
free-flow speed (km/h)	80/100
volume	114

Link: B In

length	
V/C	1.5/.89
free-flow speed	80/100
volume	95

Link:

length	
V/C	
free-flow speed	
volume	84

Link:

length	
V/C	
free-flow speed	
volume	65

Link:

length	
V/C	
free-flow speed	
volume	.26

Link:

length	
V/C	
free-flow speed	
volume	19

Link:

length	
V/C	
free-flow speed	
volume	0

Link:

length	
V/C	
free-flow speed	
volume	11

Link:

length	
V/C	.54
free-flow speed	
volume	19

Year: 1984

BENEFITS TO RESIDENTS OF ORIGIN ZONE 1

		AUTO	BUS
NO BUILD			
Income class 1	OC	15501.79	757.77
	TC	26508.26	11165.60
Income class 2	OC	17232.42	4317.18
	TC	7351.37	15500.10
Income class 3	OC	642.27	308.73
	TC	124.18	561.18
Total	OC	33376.47	5383.69
	TC	33983.81	27226.89
BUILD			
Income class 1	OC	14865.12	705.71
	TC	21635.33	9043.61
Income class 2	OC	16403.70	4033.77
	TC	5747.25	12536.17
Income class 3	OC	642.27	308.73
	TC	124.18	561.18
Total	OC	31911.08	5048.21
	TC	27506.75	22140.97
DIFFERENCE			
Income class 1	OC	636.67	52.06
	TC	4872.93	2122.00
Income class 2	OC	828.72	283.42
	TC	1604.12	2963.93
Income class 3	OC	0.00	0.00
	TC	0.00	0.00
Total	OC	1465.39	335.48
	TC	6477.06	5085.92

Year <u>1984</u>

BENEFITS TO RESIDENTS OF ORIGIN ZONE 4

		AUTO	BUS
NO BUILD			
Income class 1	CC	9522.10	350.04
	TC	19656.22	6354.84
Income class 2	CC	777.92	211.92
	TC	400.14	946.12
Income class 3	CC	0.00	0.00
	TC	0.00	0.00
Total	CC	10300.02	561.96
	TC	20056.36	7300.96
BUILD			
Income class 1	CC	9105.81	336.11
	TC	16541.71	5790.64
Income class 2	CC	736.34	196.45
	TC	318.58	785.08
Income class 3	CC	0.00	0.00
	TC	0.00	0.00
Total	CC	9842.16	532.56
	TC	16860.29	6575.72
DIFFERENCE			
Income class 1	CC	416.29	13.93
	TC	3114.51	564.20
Income class 2	CC	41.57	15.48
	TC	81.56	161.04
Income class 3	CC	0.00	0.00
	TC	0.00	0.00
Total	CC	457.86	29.40
	TC	3196.07	725.24

Year 1984

BENEFITS TO RESIDENTS OF ORIGIN ZONE 6

		AUTO	BUS
NO BUILD			
Income class 1	OC	0.00	0.00
	TC	0.00	0.00
Income class 2	OC	1055.08	325.44
	TC	560.76	1581.57
Income class 3	OC	402.91	145.92
	TC	68.81	211.23
Total	OC	1457.99	471.36
	TC	629.57	1792.80
BUILD			
Income class 1	OC	0.00	0.00
	TC	0.00	0.00
Income class 2	OC	988.49	302.77
	TC	432.34	1343.70
Income class 3	OC	376.57	132.77
	TC	52.27	167.03
Total	OC	1365.06	435.54
	TC	484.60	1510.73
DIFFERENCE			
Income class 1	OC	0.00	0.00
	TC	0.00	0.00
Income class 2	OC	66.59	22.68
	TC	128.42	237.87
Income class 3	OC	26.34	13.15
	TC	16.55	44.20
Total	OC	92.93	35.82
	TC	144.97	282.07

Year 1984

BENEFITS TO RESIDENTS OF ORIGIN ZONE 8

		AUTO	BUS
NO BUILD			
Income class 1	CC	23756.66	1637.97
	TC	77277.15	44108.70
Income class 2	CC	18663.96	7507.09
	TC	15639.94	51844.24
Income class 3	CC	0.00	6519.95
	TC	0.00	14509.99
Total	CC	42420.63	15665.01
	TC	92917.09	110462.93
BUILD			
Income class 1	CC	20887.15	1475.81
	TC	41713.83	25365.74
Income class 2	CC	16454.43	6756.39
	TC	8619.70	29539.95
Income class 3	CC	0.00	5883.00
	TC	0.00	8429.37
Total	CC	37341.58	14115.20
	TC	50333.53	63335.06
DIFFERENCE			
Income class 1	CC	2869.51	162.16
	TC	35563.32	18742.96
Income class 2	CC	2209.54	750.70
	TC	7020.24	22304.29
Income class 3	CC	0.00	636.94
	TC	0.00	6080.63
Total	CC	5079.05	1549.81
	TC	42583.56	47127.88

Year 1984

TRUCK COSTS FROM EACH ORIGIN ZONE

Origin Zone:	1	2	3	4
No-Build				
OC *	82483.03	73860.69	54476.85	4229.52
labor	7834.72	6080.97	4706.83	554.65
Build				
OC *	77669.78	70182.93	51222.28	4229.52
labor	5719.15	4485.11	3306.68	554.65
Difference				
OC *	4813.25	3677.76	3254.57	0.00
labor	2115.56	1595.86	1400.15	0.00
Total OC	6928.81	5273.63	4654.72	0.00

Origin Zone:	5	6	7	8
No-Build				
OC	37543.85	3925.04	48609.66	54610.80
labor	4394.30	598.01	7464.02	9364.21
Build				
OC	35671.86	3925.04	44407.69	48762.77
labor	3577.03	598.01	4650.16	5377.30
Difference				
OC *	1871.99	0.00	4201.97	5848.03
labor	817.27	0.00	2813.86	3986.91
Total OC	2689.26	0.00	7015.83	9834.94

6.4 Instructions for computing benefits to a single link (Second Program)

BSL-2.3(A)

USER INSTRUCTIONS

		Enter	Press
1.	Set partition.	7	2nd Op. 17
2.	Enter data on Input Data Sheet into appropriate registers. This includes data this will probably not change during the analysis: modal characteristics, values of time, discount rate. It also includes data-specific to one link: modal volumes, volume increments (or growth rate), length, and capacity. To check that all the data is properly stored, press 0 INV 2nd list.		
3.	Load program BSL-2.3(A) for liniar growth, or program BSL-2.3(B) for exponential growth. Load sides 1 and 2.	0 0	(load sides) (load side 2)
4.	Initialize the accumulators of discounted costs.	0	STO 68 STO 69
5.	Enter number of years for which costs should be computed with volume and growth data as given.	n_1	STO 00
6.	Fix the display format to have 2 decimal places		2nd Fix 2
7.	Computer costs for n_1 years	B	
8.	To change the incremental volumes		

SINGLE LINK COST STREAM PROGRAM

BSL 2.3(A) INPUT DATA

Register		Link A 1979 NB	Link A 1981 NB	Link A 1981 Build	Link B 1979 NB	Link B 1981 NB	Link B 1981 Build	Link C 1979 NB	Link C 1984 NB
8	Auto free-flow speed	80		100					
9	expansion factor	107.4							
10	OC parameter	1							
11	occupancy	1.6							
12	Bus free-flow speed	64		80					
	expansion factor	92							
	OC parameter	4.3							
	occupancy	45							
16	Truck free-flow speed	80		100					
	expansion factor	115							
	OC parameter	5.2							
	occupancy	1							
20	Class 1 auto volume in	809	2175.4					757	
21	" out	254	198					349	
22	bus volume in	262	1086					228	
23	" out	78	59.2					97	
24	Class 2 auto volume in	625	538.2					609	
25	" out	86	88					121	
26	bus " in	1083	1107.8					1052	
27	" out	132	139.2					162	
28	Class 3 auto volume in	0	188					0	
29	" out	0	1.2					0	
30	bus " in	1522	1877.2					1418	
31	" out	114	73.2					147	
32	Truck volume in	230	270.4					250	503
	" out	230	270.4					250	503
34	Class 1 value of time	2.18							
35	Class 2 VOT	.56							
36	Class 3 VOT	.18							
37	Auto PCU equivalency	1							
38	Bus PCU "	3							
39	Truck PCU "	3							

Yearly incremental volumes

Register		Link A 1979 NB	Link A 1981 NB	Link A 1981 Build	Link B 1979 NB	Link B 1981 NB	Link B 1981 Build	Link C 1979 NB	Link C 1984 NB
40	Class 1 Auto yiv in	683.2			559.2			489	
	" out	-28			5.4			10	
	Bus " in	412			366.6			169	
	" out	- 9.4			2.4			16	
44	Class 2 Auto yiv in	-43.4			-53.6			57	
45	" out	1			33.2			58	
46	Bus " in	12.4			-4.6			69	
47	" out	3.6			61.4			62	
48	Class 3 Auto yiv in	94			94			103	
49	Auto " out	0.6			1.4			10	
50	Bus " in	177.6			137.6			219	
51	Bus " out	-20.4			-19.2			0	
52	Truck " in	20.2			31.4			50.6	
53	" out	20.2			31.4			50.6	

54 1 + discount rate	1.11				
55* first year discount factor	1	1.2321		1.2321	
56 link length (km)	3.4			3.4	
57 link capacity (PCV)	1600	4800	4800		4800
68 cumulative discounted total OC					
69 cumulative discounted total TC					

Supplementary Yearly incremental volumes for 1984	Link A 1984 NB	Link B 1984 NB	Link C 1984 NB
40 Class 1 Auto yiv in	211.2	174.8	135
41 " out	5	41.6	70
42 Bus " in	8.4	-22.4	138
43 " out	10.6	22.6	23
44 Class 2 Auto yiv in	94.5	62	-39
45 " out	8.2	71	80
46 Bus " in	23.2	-16.6	32
47 " out	64	154.4	142
48 Class 3 Auto yiv in	21.2	3.6	3
49 " out	8.6	20.2	17
50 Bus " in	311	212.8	10
51 Bus " out	30.6	120	60
52 Truck " in	15	37.8	58
53 " out	15	37.8	58

COMPUTING COSTS ON LINK A, 1981-2000

Link A No-Build

1. Load liniar growth program, BSL-2.3(A)

2. Enter data for Link A, 1981, No-Build. Store it on a magnetic card (press 3 2nd write and load side 3; 4 2nd write & load side)

3. a. Enter 0 STO 68 STO 69
   b. Enter 3 STO 00. Press 2nd Fix 2.
   c. Press B
      (costs for 1981, 1982, 1983 will be printed)
      (volumes will be updated to 1984)

4. a. Enter incremental volumes for the 1984-1989 interval, in registers 40-53.
   b. Enter 5 STO 00
   c. Press B
      (costs for 1984, 85, 86, 87, 88 will be printed)
      (volumes will be updated to 1989)

5. Load exponential growth program, BSL-2.3(B), sides 1 & 2.

6. a. Enter cumulative operating costs into register 68
      Enter cumulative time costs into register 69.
      (these costs were the first 2 of the last 3 numbers just printed)
   b. Enter growth factor: 1.05 STO 41
   c. Enter 12 STO 00
   d. Press B
      (Costs for 1989-2000 will be printed - takes 30 minutes)

Link A Build

7. If you have the Link A 1981 No-Build data on a card, load in (press 0, enter side 3; press 0, enter side 4.
   If not, the 1981 data may be entered manually.

8. Change the free-flow speeds (registers 8, 12, 16) and capacity (register 57) for build.

9. Proceed with Stpes 3-6.

DISCOUNTED COSTS ON SINGLE LINK INPUTS

BSL-2.3(A) CARD B

Register Content (Input Data)

Register	Content	
*00	number of years	
01	counter	
02	counter	
03	pointer	
04	pointer	
05	pointer	
06	pointer	
07	pointer	
08	car free-flow speed	)
09	expansion factor	)
10	operating cost parameter	)
11	occupancy	)
12	bus	) modal
13		) char.
14		) file
15		)
16	truck	)
17		)
18		)
19		)
20	Class 1 car volume in	)
21	out	)
22	bus in	)
23	out	)
24	Class 2 car	)
25		) car,
26	bus	) bus
27		) vols.
28	Class 3 car	)
29		)
30	bus	)
31		)
32	truck volume in	) truck
33	out	) vols.
34	Class 1 VOT	)
35	2	) VOT
36	3	)
37	car PCV equivalency	)
38	bus " "	) PCU
39	truck " "	)

Register	Content	
40	incremental class 1 car in	)
41	volumes out	)
42	bus in	)
43	out	)
44	class 2 car	)
45		)
46	bus	)
47		)
48	class 3 car	)
49		)
50	bus	)
51		)
52	truck incremental volume in	)
53	truck incremental volume out	)
54	1+ discount rate	
55	discount factor for first year	
56	length	
57	capacity (for 2 hours)	

LINK A
No-Build 1979-84

# of years →	~~2.~~ 6 ← (6)	00	
	0.	01	
	0.	02	
	0.	03	
	0.	04	
	0.	05	
Modal Char's	0.	06	
	0.	07	
	80.	08	Free-flow spd
expansion factor	107.4	09	
	1.	10	~~ct~~ operating cost param
occupancy	1.6	11	
	64.	12	
	92.	13	
bus	4.3	14	
	45.	15	
	80.	16	
	115.	17	
truck	5.2	18	
	1.	19	
class 1 car in	809.	20	
out	254.	21	
bus in	262.	22	
out	78.	23	
class 2 car in	625.	24	
out	86.	25	
bus in	1083.	26	Volumes
out	132.	27	(2 hour,
class 3 car in	0.	28	pax)
out	0.	29	
bus in	1522.	30	79
out	114.	31	values
truck in	230.	32	for
out	230.	33	the
	2.18	34	LINK
Values of	0.56	35	
time	0.18	36	
PCU	1.	37	
equiv.	3.	38	
	3.	39	
Class 1 car in	683.2	40	
out	-28.	41	
bus in	412.	42	yearly
out	-9.4	43	volume
class 2	-43.4	44	increments
	1.	45	while
	12.4	46	to
	3.6	47	enter
class 3	94.	48	LINK
	0.6	49	
	177.6	50	
	-20.4	51	
truck in	20.2	52	
out	20.2	53	1 +
	1.11	54	discount rate~~factor~~
1st year discount factor	1.	55	
	2.1	56	length
	1600.	57	capacity
	0.	58	(2 hour)

LINK A
Build 1979-84

0.	00
0.	01
0.	02
0.	03
54.	04
34.	05
23.	06
40.	07
100.	08
107.4	09
1.	10
1.6	11
80.	12
92.	13
4.3	14
45.	15
100.	16
115.	17
5.2	18
1.	19
4908.2	20
86.	21
2734.	22
21.6	23
364.6	24
92.	25
1157.4	26
153.6	27
564.	28
3.6	29
2587.6	30
-8.4	31
351.2	32
351.2	33
2.18	34
0.56	35
0.18	36
1.	37
3.	38
3.	39
683.2	40
-28.	41
412.	42
-9.4	43
-43.4	44
1.	45
12.4	46
3.6	47
94.	48
0.6	49
177.6	50
-20.4	51
20.2	52
20.2	53
1.11	54
1.870414552	55
2.1	56
4800.	57

LINK A: NO-BUILD 1980-1999

1980	1981	1992
1777.38 924.10	2336.74 966.45	2896.10 1008.81
19599.96 39973.71	34787.47 110664.40	48982.30 167022.34
859.92 13779.42	2046.37 52844.60	3202.31 88441.27
20459.88 53753.13	36833.85 163509.00	52184.61 255463.61
13438.26 7421.34	13541.77 11074.65	12736.82 10813.01
3143.92 13685.11	3378.48 22187.36	3440.96 23603.70
16582.18 21106.45	16920.25 33262.01	16177.78 34416.71
0.00 0.00	1977.99 554.32	3980.86 1165.83
4264.12 6067.62	4986.85 10870.13	5470.89 12571.74
4264.12 6067.62	6964.84 11424.46	9451.75 13737.57
71370.39 6982.43	81565.14 11085.09	88951.56 12585.13
112676.57 87909.63	142284.08 219280.56	166765.70 316203.02
112676.57 87909.63 200586.20	240860.42 285459.69 526320.11	376211.20 542097.15 918308.36

1983	1984	1985
3455.46	4014.82	4846.33
1051.16	1093.51	1201.50
62971.22	76949.12	95488.31
217849.80	268632.01	335511.23
4348.10	5493.35	6687.93
121367.97	154278.06	188175.87
67319.32	82442.47	102176.25
339217.77	422910.06	523687.10
11856.55	10977.07	12257.97
10003.27	9195.05	10298.52
3488.02	3535.26	3804.32
23915.23	24230.39	25524.69
15344.57	14512.33	16062.29
33918.50	33425.44	35823.21
5971.67	7962.73	10546.47
1748.88	2332.03	3064.23
5929.51	6386.99	7794.93
13717.66	14860.38	18128.85
11901.18	14349.72	18341.40
15466.54	17192.41	21193.08
96133.97	103402.73	116802.29
13656.89	14753.80	16878.63
190699.05	214707.25	253382.23
402259.70	488281.72	597582.02
515648.70	657083.02	792551.51
836225.98	1157872.27	1477364.02
1351874.68	1814955.29	2269915.53
	1157872.27	

1986	1987	1988
5118.48	5390.63	5662.78
1267.14	1332.78	1398.42
100064.23	104642.68	109223.18
351687.53	357895.89	384138.15
6738.62	6790.09	6842.27
189225.39	190322.56	191471.27
106802.85	111432.77	116065.46
540912.91	558218.45	575609.42
14422.92	16592.60	18766.51
12218.69	14149.62	16092.06
4031.03	4262.49	4498.32
26566.89	27681.87	28875.63
18453.95	20855.09	23264.83
38785.58	41831.49	44967.68
11144.57	11748.19	12357.07
3215.71	3369.97	3527.24
8749.05	9705.53	10664.19
20267.73	22417.20	24578.19
19893.62	21453.71	23021.26
23483.44	25787.17	28105.43
122931.18	129128.28	135381.29
17924.05	19016.13	20157.53
268081.61	282869.85	297732.83
621105.97	644853.24	668840.06
921675.27	1044419.99	1160811.13
1776524.94	2056343.85	2317809.99
2698200.21	3100763.83	3478621.12

1989	1990	1991
5934.94	6207.09	6517.44
1464.06	1529.70	1606.18
113805.33	118388.75	124357.28
400416.12	416731.64	437981.57
6895.11	6948.53	7299.68
192675.43	193939.01	203926.72
120700.44	125337.28	131656.96
593091.55	610670.65	641908.29
20944.16	23125.09	24329.15
18046.74	20014.42	21118.52
4738.15	4981.60	5251.71
30154.23	31523.82	33521.63
25682.31	28106.70	29580.86
48200.97	51538.24	54640.15
12970.88	13589.27	14287.35
3687.78	3851.82	4057.35
11624.88	12587.41	13224.49
26751.62	28938.42	30434.98
24595.76	26176.69	27511.84
30439.39	32790.24	34492.34
141679.23	148012.50	156691.80
21350.94	22599.06	24322.58
312657.75	327633.17	345441.46
693082.86	717598.20	755363.36
1270924.33	1374876.87	1473618.14
2561903.02	2789584.95	3005498.64
3832827.35	4164461.82	4479116.78

1992	1993	1994
6843.32	7185.48	7544.76
1686.49	1770.82	1859.36
130626.10	137209.89	144124.08
460363.36	483945.27	508800.89
7668.49	8055.82	8462.58
214462.62	225582.30	237324.52
138294.59	145265.71	152586.65
674825.98	709527.57	746125.41
25595.21	26926.07	28324.65
22295.18	23550.93	24893.13
5535.90	5834.74	6148.86
35690.09	38049.61	40623.62
31131.11	32760.82	34473.51
57985.26	61600.54	65516.74
15021.04	15791.99	16601.95
4275.34	4506.75	4752.70
13893.62	14596.38	15334.40
32014.70	33683.14	35446.36
28914.66	30388.37	31936.35
36290.04	38189.89	40199.06
165853.46	175513.19	185687.23
26231.90	28353.03	30716.08
364193.82	383928.09	404683.74
795333.18	837671.02	882557.29
1567403.24	1656472.57	1741053.23
3210308.27	3404643.61	3589101.92
4777711.51	5061116.18	5330155.15

1995	1996	1997
7921.99	8318.09	8734.00
~~1952.32~~	2049.94	2152.44
151384.84	159009.19	167014.98
535009.78	562658.16	591839.65
8889.70	9338.20	9809.12
249731.58	262849.76	276729.86
160274.54	168347.39	176824.10
784741.36	825507.92	868569.52
29794.00	31337.35	32958.10
26330.08	27871.14	29526.95
6478.87	6825.47	7189.36
43439.03	46526.84	49922.75
36272.87	38162.82	40147.45
69769.10	74397.98	79449.70
17452.73	18346.27	19284.56
5014.41	5293.24	5590.73
16109.38	16923.15	17777.59
37311.01	39284.39	41374.54
33562.12	35269.42	37062.15
42325.41	44577.63	46965.26
196392.65	207647.53	219471.20
33355.96	36313.13	39634.57
426502.19	449427.15	473504.91
930191.84	980796.66	1034619.05
1821360.26	1897597.77	1969959.82
3764249.79	3930624.90	4088737.63
5585610.06	5828222.67	6058697.45

1998	1999
9170.698911	9629.233856
2260.058668	2373.061601
175421.008	184247.0007
622656.2156	655219.1345
10303.55567	10822.67238
291427.7652	307005.1374
185724.5637	195069.6731
914083.9808	962224.2719
34659.8183	36446.30163
31309.57107	33232.72244
7571.299412	7972.098942
53667.9646	57810.08548
42231.11771	44418.40057
84977.53567	91042.80792
20269.74758	21304.06724
5908.601147	6248.804085
18674.70343	19616.58294
43590.3263	45941.58789
38944.45101	40920.65018
49498.92745	52190.39198
231884.4556	244909.6901
43374.80135	47597.18721
498784.5881	525318.4139
1091935.245	1153054.659
3	0
2089517.974	2184675.269
4239072.677	4382090.551
6328590.651	6566765.821
288	1988

1999

LINK B: NO-BUILD 1980-1989

1980	1981	1982
1777.38	2279.64	2781.90
924.10	1046.27	1168.45
19599.96	32641.85	45026.58
39973.71	98486.18	150731.79
859.92	1940.07	3006.44
13779.42	47594.91	81980.38
20459.88	34581.92	48033.02
53753.13	146081.09	232712.17
13438.26	13806.44	13449.59
7421.34	10623.17	10892.58
3143.92	3452.41	3627.37
13685.11	21288.99	23791.51
16582.18	17258.86	17076.96
21106.45	31912.15	34684.09
0.00	1979.28	4008.47
0.00	530.77	1169.30
4264.12	4859.26	5257.90
6067.62	10161.54	12070.43
4264.12	6838.54	9266.37
6067.62	10692.31	13239.73
71370.39	85821.00	98404.96
6982.43	11384.82	14161.31
112676.57	144500.31	172781.31
87909.63	200070.38	294797.30
112676.57	242857.03	383090.22
87909.63	268153.22	507417.32
200586.20	511010.25	890507.54

1983	1984	1985
3284.15	3786.41	4288.67
1290.62	1412.79	1534.97
57067.41	69108.20	81144.52
193671.70	236753.84	279986.28
4055.32	5104.08	6152.62
111771.57	141615.96	171517.16
61122.72	74212.28	87297.14
305443.26	378369.80	451503.44
12987.26	12560.55	12163.41
10216.85	9618.82	9108.82
3780.88	3941.74	4108.59
24378.45	25116.38	26025.69
16768.14	16502.30	16271.99
34595.31	34735.20	35134.51
6015.29	8023.70	10033.50
1755.09	2341.81	2929.61
5606.87	5952.70	6295.68
12959.03	13837.78	14704.71
11622.16	13976.39	16329.17
14714.12	16179.59	17634.32
110738.07	123339.20	136138.15
16201.95	18411.40	20808.81
200251.09	228030.18	256036.46
370954.64	447695.99	525081.08
529512.09	679722.63	831667.80
778656.15	1073567.37	1385177.43
1308168.24	1753290.00	2216845.24

1986	1987	1988
4563.90	4839.14	5114.38
1751.17	1967.37	2183.57
85873.61	90621.77	95377.19
297162.07	315484.41	335124.38
6157.62	6164.61	6172.80
171538.26	172140.30	173420.95
92031.23	96786.38	101550.00
468700.33	487624.71	508545.33
15057.08	18016.42	21017.73
11609.74	14538.36	17968.11
4511.15	4930.55	5360.90
28481.34	31894.47	36435.21
19568.23	22946.97	26378.62
40091.08	46432.83	54403.32
10504.87	11004.33	11524.14
3027.77	3158.20	3327.45
7214.81	8152.99	9104.69
16580.94	18659.73	20982.79
17719.68	19157.33	20628.83
19608.72	21817.92	24310.24
152713.34	169272.27	185737.73
24545.44	28876.71	33880.75
282032.46	308162.95	334295.18
552945.56	584752.18	621139.64
982453.88	1130883.15	1275942.69
1680804.71	1962455.52	2231984.46
2663258.59	3093338.67	3507927.15

1989	1990	1991
5389.61	5664.85	5948.09
2399.77	2615.97	2746.77
100133.22	104693.77	109928.46
356256.52	372487.80	391112.19
6181.68	6182.26	6491.37
175480.09	175498.81	184273.75
106314.91	110876.02	116419.82
531736.61	547986.61	575385.94
24044.75	26847.80	28190.19
21974.05	24537.56	25764.44
5798.14	6187.91	6497.31
42277.63	45123.51	47379.69
29842.90	33035.71	34687.50
64251.68	69661.07	73144.13
12058.29	12559.88	13187.87
3542.27	3689.71	3874.20
10065.80	11007.02	11557.37
23592.90	25799.59	27089.57
22124.08	23566.90	24745.24
27135.17	29489.31	30963.77
202080.76	216276.14	227089.94
39637.05	42424.82	44546.06
360362.65	383754.77	402942.51
662760.51	689561.81	724039.90
1416817.38	1551969.85	1679816.79
2491073.96	2733926.93	2963652.70
3907891.34	4285896.78	4643469.49

1992	1993	1994
6245.50	6557.77	6885.66
2884.10	3028.31	3179.72
115424.88	121196.12	127255.93
410667.80	431201.18	452761.24
6815.94	7156.73	7514.57
193487.44	203161.81	213319.90
122240.82	128352.86	134770.50
604155.23	634363.00	666081.15
29599.70	31079.68	32633.67
27052.66	28405.30	29825.56
6822.17	7163.28	7521.45
49748.67	52236.10	54847.91
36421.87	38242.96	40155.11
76801.33	80641.40	84673.47
13847.27	14539.63	15266.61
4067.91	4271.31	4484.87
12135.24	12742.00	13379.10
28444.05	29866.25	31359.57
25982.51	27281.63	28645.71
32511.96	34137.56	35844.44
238444.44	250366.66	262885.00
46773.36	49112.03	51567.63
423089.63	444244.12	466456.32
760241.89	798253.99	838166.69
1800753.08	1915152.27	2023367.72
3180960.87	3386522.65	3580972.99
4981713.95	5301674.92	5604340.71

1995	1996	1997
~~7229.94~~	7591.44	~~7971.01~~
3338.71	3505.65	3680.93
133618.72	140299.66	147314.64
475399.31	499169.27	524127.74
7890.30	8284.81	8699.06
223985.90	235185.19	246944.45
141509.02	148584.48	156013.70
699385.20	734354.46	771072.19
34265.35	35978.62	37777.55
31316.84	32882.68	34526.81
7897.52	8292.39	8707.01
57590.30	60469.82	63493.31
42162.87	44271.01	46484.56
88907.14	93352.50	98020.12
16029.94	16831.44	17673.01
4709.11	4944.57	5191.80
14048.05	14750.46	15487.98
32927.55	34573.92	36302.62
30078.00	31581.90	33160.99
37636.66	39518.49	41494.42
276029.25	289830.71	304322.24
54146.02	56853.32	59695.98
489779.14	514268.09	539981.50
880075.02	924078.77	970282.71
2125733.69	2222566.36	2314164.84
3764912.49	3938909.32	4103500.91
5890646.18	6161475.68	6417665.75

1998	1999
8369.56	8788.04
3864.97	4058.22
154680.38	162414.40
550334.12	577850.83
9134.01	9590.71
259291.67	272256.26
163814.38	172005.10
809625.80	850107.09
39666.43	41649.75
36253.16	38065.81
9142.37	9599.48
66667.97	70001.37
48808.79	51249.23
102921.13	108067.19
18556.66	19484.50
5451.39	5723.96
16262.38	17075.50
38117.75	40023.64
34819.04	36559.99
43569.14	45747.60
319538.36	335515.27
62680.78	65814.82
566980.57	595329.60
1018796.85	1069736.69
2400812.04	2482775.62
4259195.67	4406474.49
6660007.71	6889250.10

LINK C: NO-BUILD 1979-1999

		1980	1981	1982
		1783.62	2371.51	2959.40
		1070.82	1276.57	1482.32
Class 1				
Car	OC	14942.79	23793.61	31817.04
	TC	29915.68	74122.91	104522.38
Bus	OC	603.77	1021.94	1414.42
	TC	9512.77	25259.49	36732.65
Total	OC	15546.57	24815.55	33231.46
	TC	39428.44	99382.40	141255.03
Class 2				
Car	OC	10123.21	12554.95	14371.25
	TC	5544.22	10113.27	11702.71
Bus	OC	2312.61	2718.84	3000.99
	TC	10053.84	17814.83	19936.49
Total	OC	12435.83	15273.79	17372.24
	TC	15598.05	27928.10	31639.20
Class 3				
Car	OC	0.00	1718.07	3459.39
	TC	0.00	474.42	977.42
Bus	OC	2998.94	3654.39	4130.10
	TC	4257.79	8053.20	9358.92
Total	OC	2998.94	5372.46	7589.49
	TC	4257.79	8527.63	10336.34
Truck	OC	58224.87	75245.46	90305.16
	TC	5881.66	10821.49	13657.12
Total	OC	89206.20	120707.26	148498.34
	TC	65165.96	146659.62	196887.69
Discounted Totals				
	OC	89206.20	197951.48	318476.06
	TC	65165.96	197291.74	357090.20
Grand Total		154372.15	395243.22	675566.27

1983	1984	1985
3547.29	4135.10	4723.07
1688.07	1893.82	2099.57
39768.12	47693.71	55593.77
133797.88	163512.94	193700.12
1805.90	2197.67	2589.42
47971.45	59544.20	71497.89
41574.02	49891.38	58183.19
181769.33	223057.15	265198.00
16216.76	18101.17	20010.37
13283.28	15104.01	17204.71
3284.02	3570.89	3860.05
21917.19	24180.40	26771.85
19500.78	21672.06	23870.42
35200.46	39284.42	43976.56
5208.09	6965.55	8729.18
1479.71	1993.84	2521.99
4596.25	5060.53	5523.19
10497.56	11647.23	12808.15
9804.35	12026.08	14252.38
11977.27	13641.07	15330.14
105584.66	121040.14	136571.52
16705.98	20215.66	24253.80
176463.80	204629.66	232877.50
245653.03	296198.29	348758.51
447504.87	582300.77	720502.23
536709.58	731824.57	938795.77
984214.46	1314125.34	1659298.00

1986	1987	1988
4970.95 2386.69	5218.82 2673.82	5466.70 2960.94
58965.87 209556.31	62151.70 221128.24	65328.24 232429.99
2933.74 83170.32	3268.97 92797.79	3603.77 102301.89
61899.60 292726.63	65420.66 313926.04	68932.00 334731.88
20846.96 18989.32	21492.00 19642.63	22127.31 20223.27
4247.09 30882.96	4610.24 33618.81	4972.07 36257.36
25094.05 49872.28	26102.24 53261.44	27099.38 56480.63
8908.68 2614.72	9064.76 2662.95	9219.71 2708.47
5676.58 13295.95	5822.59 13647.69	5968.15 13988.88
14585.25 15910.68	14887.34 16310.64	15187.86 16697.36
154786.24 30223.61	170898.35 33523.49	186911.44 36664.63
256365.14 388733.20	277308.59 417021.61	298130.68 444574.49
857565.51 1146628.41 2004193.92	991133.52 1347490.38 2338623.90	1120500.33 1540403.03 2660903.36

1989	1990	1991
5714.57	5962.45	6260.57
3248.07	3535.19	3711.95
68504.78	71681.31	75265.38
243731.73	255033.47	267785.14
3938.56	4273.36	4487.03
111805.99	121310.09	127375.60
72443.34	75954.68	79752.41
355537.72	376343.56	395160.74
22762.61	23397.92	24567.82
20803.91	21384.55	22453.77
5333.91	5695.74	5980.52
38895.92	41534.47	43611.19
28096.52	29093.66	30548.34
59699.82	62919.02	66064.97
9374.66	9529.62	10006.10
2753.99	2799.51	2939.49
6113.72	6259.28	6572.24
14330.07	14671.27	15404.83
15488.38	15788.90	16578.34
17084.07	17470.78	18344.32
202924.53	218937.62	229884.50
39805.76	42946.90	45094.24
318952.77	339774.86	356763.60
472127.38	499680.26	524664.27
1245186.86	1364850.29	1478045.43
1724969.32	1900948.95	2067416.17
2970156.18	3265799.24	3545461.60

1992	1993	1994
6573.60	6902.28	7247.40
3897.55	4092.43	4297.05
79028.65	82980.08	87129.09
281174.40	295233.12	309994.78
4711.38	4946.95	5194.30
133744.38	140431.60	147453.18
83740.03	87927.03	92323.38
414918.78	435664.72	457447.95
25796.21	27086.02	28440.32
23576.46	24755.29	25993.05
6279.55	6593.53	6923.20
45791.75	48081.34	50485.41
32075.76	33679.55	35363.52
69368.22	72836.63	76478.46
10506.40	11031.72	11583.31
3086.46	3240.79	3402.83
6900.86	7245.90	7608.19
16175.07	16983.83	17833.02
17407.26	18277.62	19191.50
19261.54	20224.61	21235.84
241378.73	253447.67	266120.05
47348.96	49716.40	52202.22
374601.78	393331.87	412998.46
550897.49	578442.36	607364.48
1585121.91	1686410.47	1782223.98
2224885.16	2373842.32	2514747.73
3810007.07	4060252.79	4296971.71

1995	1996	1997
7609.77	7990.25	8389.77
4511.90	4737.49	4974.37
91485.54	96059.82	100862.81
325494.52	341769.24	358857.70
5454.01	5726.71	6013.05
154825.84	162567.13	170695.48
96939.55	101786.53	106875.86
480320.35	504336.37	529553.19
29862.34	31355.45	32923.23
27292.70	28657.34	30090.20
7269.36	7632.83	8014.47
53009.68	55660.16	58443.17
37131.70	38988.29	40937.70
80302.38	84317.50	88533.37
12162.47	12770.60	13409.13
3572.97	3751.62	3939.20
7988.60	8388.03	8807.44
18724.67	19660.90	20643.95
20151.08	21158.63	22216.56
22297.64	23412.52	24583.14
279426.05	293397.36	308067.22
54812.33	57552.95	60430.60
433648.39	455330.81	478097.35
637732.70	669619.34	703100.31
1872858.38	1958593.62	2039694.52
2648036.64	2774120.74	2893389.49
4520895.02	4732714.36	4933084.01

1998	1999
8809.25	9249.72
5223.09	5484.24
105905.95	111201.25
376800.59	395640.62
6313.70	6629.39
179230.26	188191.77
112219.65	117830.63
556030.85	583832.39
34569.39	36297.86
31594.71	33174.45
8415.20	8835.96
61365.33	64433.60
42984.59	45133.81
92960.04	97608.05
14079.58	14783.56
4136.16	4342.97
9247.81	9710.20
21676.14	22759.95
23327.39	24493.76
25812.30	27102.92
323470.58	339644.11
63452.13	66624.73
502002.21	527102.32
738255.32	775168.09
2116411.59	2188981.80
3006211.27	3112934.58
5122622.86	5301916.38

LINK A: BUILD - 1980-1999

1980	1981	1982
1777.38	2336.74	2896.10
924.10	966.45	1008.81
15908.83	25113.71	35322.14
10606.16	20502.50	34576.78
645.04	1444.67	2337.90
3638.93	9607.14	18114.48
16553.87	26558.39	37660.04
14245.09	30109.65	52691.27
10526.98	9771.03	9356.99
1862.67	2050.35	2284.42
2303.10	2393.85	2534.78
3416.00	4067.99	4934.78
12830.08	12164.88	11891.77
5278.67	6118.34	7219.20
0.00	1364.89	2800.45
0.00	96.94	235.33
3100.28	3491.75	3985.75
1489.01	1939.85	2563.02
3100.28	4856.64	6786.20
1489.01	2036.80	2798.35
62782.56	67628.97	73809.99
2143.91	2586.72	3158.60
95266.79	111208.88	130148.00
23156.68	40851.50	65867.42
95266.79	195454.97	301086.01
23156.68	59959.83	113419.30
118423.47	255414.80	414505.31

19 1982

1983	1984	1985
3455.46	4014.82	4846.3275
1051.16	1093.51	1201.505
47125.71	60499.41	49857.92072
54254.34	81018.09	82612.00555
3344.84	4454.86	3583.738172
30075.08	46441.18	46343.61117
50470.55	64954.28	53441.65889
84329.42	127459.27	128955.6167
9096.42	8838.73	6467.769952
2546.19	2815.29	2526.348756
2701.86	2874.09	2022.353557
6031.17	7371.10	6263.366172
11798.28	11712.82	8490.123509
8577.35	10186.39	8789.714928
4412.89	6223.80	5505.454674
431.11	700.94	754.5529598
4558.63	5178.70	4177.426537
3394.29	4470.31	4464.966641
8971.52	11402.49	9682.881211
3825.40	5171.25	5219.519601
81072.27	88996.65	63346.62333
3882.98	4783.77	4085.17992
152312.61	177066.24	134961.2869
100615.15	147600.68	147050.0312
412455.67	529094.69	601250.5034
186988.23	284217.37	362836.3252
599443.91	813312.06	964086.8286

1 19 1985

1986	1987	1988
5118.48	5390.6325	5662.785
1267.143333	1332.781667	1398.42
53358.32061	56891.24731	60444.96746
94520.24709	107693.7998	122208.3852
3676.593058	3764.96024	3848.940867
50871.58797	55711.66757	60869.64642
57034.91366	60656.20755	64293.90833
145391.8351	163405.4674	183078.0317
7722.968247	9013.577819	10335.1902
3251.672759	4080.459455	5021.039731
2166.518822	2309.38308	2450.949987
7047.233781	7893.366	8804.513666
9889.487069	11322.9609	12786.14018
10298.90654	11973.82546	13825.5534
5945.025838	6386.048958	6827.386908
863.5210288	983.5102303	1115.16227
4772.760275	5378.997575	5994.419249
5448.129276	6558.888796	7806.783329
10717.78611	11765.04653	12821.80616
6311.650305	7542.399026	8921.945599
66649.70369	69956.99144	73263.88678
4580.461556	5123.622091	5717.435882
144291.8905	153701.2064	163165.7414
166582.8535	188045.314	211542.9665
670749.9061	737444.9321	801230.4623
443072.3577	524670.202	607367.5878
1113822.264	19. 1262115.134	1408598.05

1588

1989	1990	1991
5934.9375	6207.09	6517.4445
1464.058333	1529.696667	1606.1815
64010.34143	67580.36016	72077.90214
138140.3815	155566.7989	178411.0861
3928.727391	4004.567039	4259.387088
66351.25334	72162.15678	82743.12666
67939.06882	71584.92719	76337.28923
204491.6349	227728.9557	261154.2128
11683.72025	13055.48465	13898.92845
6081.836299	7271.359467	8325.782247
2591.283247	2730.488892	2896.862423
9783.442524	10832.93302	12361.34078
14275.0035	15785.97355	16795.79087
15865.27882	18104.29248	20687.12303
7268.208278	7707.929649	8212.267768
1259.124254	1416.048493	1622.531871
6617.532412	7247.059507	7707.823737
9201.451133	10752.62613	12328.2564
13885.74069	14954.98916	15920.09151
10460.57539	12168.67462	13950.78827
76567.73905	79867.44624	84373.09422
6364.700516	7068.235975	8014.930691
172667.5521	182193.3361	193426.2658
237182.1896	265070.1588	303807.0548
862041.2941	919847.9055	975137.0286
690899.4736	775001.3385	861841.7972
1552940.768	1694849.244	1836978.826

19 1991

1992	1993	1994
6843.316725	7185.482561	7544.756689
1686.490575	1770.815104	1859.355859
76806.05992	81770.23281	85897.86053
204926.2005	235720.0766	248477.4635
4526.911225	4807.533096	5050.541829
95023.44442	109284.4962	115205.1551
81332.97114	86577.76591	90948.40236
299949.6449	345004.5727	363682.6186
14785.62493	15716.87577	16502.68619
9548.876682	10968.53706	11567.32689
3071.92489	3256.089936	3422.135104
14131.78327	16184.15832	17084.18609
17857.54982	18972.96571	19924.8213
23680.65995	27152.69538	28651.51299
8742.467769	9299.233322	9766.078082
1862.111607	2140.26452	2256.661294
8191.579927	8699.048006	9138.838832
14156.88208	16280.39238	17162.79618
16934.0477	17998.28133	18904.91691
16018.99369	18420.6569	19419.45748
89109.91051	94092.51496	98601.55612
9108.534553	10373.10522	10969.80839
205234.4792	217641.5279	228379.6967
348757.8331	400951.0302	422723.3974
1027987.833	1078479.541	1126211.89
951651.911	1044670.475	1133021.502
1979639.744	2123150.016	2259233.393

19 10 1994

1995	1996	1997
7921.994524	8318.09425	8733.998962
1952.323652	2049.939834	2152.436826
90185.11724	94688.34693	99418.89304
260935.9742	274023.2239	287771.6252
5303.575931	5569.444417	5848.823351
120989.778	127067.7214	133454.3377
95488.69317	100257.7913	105267.7164
381925.7522	401090.9453	421225.9629
17320.3857	18180.53783	19085.79564
12154.35615	12772.19083	13422.61522
3596.103843	3779.802209	3973.910551
17973.72599	18913.67263	19907.54159
20916.48954	21960.34004	23059.70619
30128.08214	31685.86346	33330.1568
10251.48655	10761.77595	11298.3969
2370.578768	2490.374119	2616.371787
9596.829096	10078.09659	10583.87619
18025.0957	18931.20834	19883.44195
19848.31564	20839.87254	21882.27309
20395.67447	21421.58246	22499.81373
103332.7404	108342.4214	113658.7132
11568.03857	12204.5284	12882.59197
239586.2388	251400.4254	263868.4089
444017.5474	466402.9196	489938.5254
1171324.111	1213969.823	1254294.768
1216626.545	1295743.693	1370617.165
2387950.656	2509713.516	2624911.932

10 199 1997

1998	1999
9170.698911	9629.233856
2260.058668	2373.061601
104388.7222	109610.4442
302215.3752	317390.572
6142.424903	6450.998379
140165.862	147219.4759
110531.1471	116061.4426
442381.2372	464610.0479
20038.99934	21043.17491
14107.54378	14829.03455
4179.156243	4396.311636
20959.19124	22072.86796
24218.15558	25439.48655
35066.73502	36901.90251
11862.89378	12456.90522
2748.917562	2888.380511
11115.46927	11674.24544
20884.23939	21936.18869
22978.36305	24131.15066
23633.15696	24824.5692
119312.5942	125337.7627
13605.94426	14378.76061
277040.2599	290969.8425
514687.0735	540715.2802
1292437.016	1328527.142
1441478.065	1508545.094
2733915.081	2837072.236

1989

LINK B BUILD 1979-1999

1980	1981	1982
1777.38	2279.64	2781.90
924.10	1046.27	1168.45
15908.83	23809.63	32410.80
10606.16	18958.76	30325.92
645.04	1373.25	2173.41
3638.93	8963.94	16249.94
16553.87	25182.87	34584.21
14245.09	27922.70	46575.86
10526.98	10115.04	9971.02
1862.67	2058.30	2279.62
2303.10	2461.31	2658.57
3416.00	4083.65	4911.22
12830.08	12576.34	12629.59
5278.67	6141.95	7190.84
0.00	1376.72	2803.22
0.00	95.70	227.23
3100.28	3402.32	3784.83
1489.01	1863.35	2364.52
3100.28	4779.04	6588.05
1489.01	1959.05	2591.74
62782.56	70299.43	78858.03
2143.91	2688.18	3372.90
95266.79	112837.69	132659.87
23156.68	38711.89	59731.35
95266.79	196922.36	304592.09
23156.68	58032.26	106511.56
118423.47	254954.62	411103.65

1983	1984	1985
~~3284.15~~	3786.41	4288.67
1290.62	1412.79	1534.97
42168.33	53133.68	65133.19
45644.12	65885.02	92050.44
3064.16	4041.91	5091.65
26148.59	39337.01	56514.07
45232.49	57175.59	70224.84
71792.71	105222.03	148564.51
9944.44	9910.62	9799.07
2507.82	2722.74	2903.14
2877.04	3100.54	3318.80
5903.82	7065.73	8400.58
12821.48	13011.16	13117.87
8411.65	9788.48	11303.71
4376.77	6129.34	8048.98
407.35	649.38	967.05
4231.25	4718.32	5225.93
3015.01	3837.75	4856.12
8608.01	10847.66	13274.91
3422.36	4487.13	5823.17
88452.69	98849.68	109782.23
4226.99	5280.12	6562.63
155114.67	179884.09	206399.85
87853.71	124777.76	172254.03
418010.60	536505.82	658994.09
170749.44	252944.41	355168.80
588760.04	789450.24	1014162.89

1986	1987	1988
4563.90 1751.17	4839.14 1967.37	5114.38 2183.57
70293.47 106208.10	75550.40 122015.40	80891.65 139587.17
5195.02 61646.54	5290.47 67099.71	5378.49 72871.89
75488.49 167854.64	80840.87 189115.11	86270.14 212459.06
12005.57 3787.79	14256.71 4803.67	16570.11 5965.01
3631.23 9499.57	3946.44 10696.98	4268.24 12003.28
15636.80 13287.35	18203.16 15500.64	20838.35 17968.28
8613.67 1087.50	9166.66 1218.85	9711.82 1361.82
6084.87 5955.97	6961.63 7204.44	7856.63 8615.24
14698.54 7043.47	16128.29 8423.29	17568.46 9977.06
121153.90 7837.41	132952.59 9287.16	145267.77 10928.09
226977.73 196022.87	248124.91 222326.21	269944.71 251332.49
780345.65 459970.63 1240316.28	899857.10 567055.91 1466913.01	1016993.26 676115.74 1693109.01

1989	1990	1991
-		
5389.61	5664.85	5948.09
2399.77	2615.97	2746.77
86307.34	91788.59	98021.22
159039.47	180489.48	206122.01
5459.72	5534.86	5896.81
78961.18	85365.47	97497.25
91767.05	97323.44	103918.02
238000.65	265854.95	303619.26
18960.38	21437.68	22812.39
7286.26	8782.11	9949.08
4599.82	4943.48	5261.04
13429.17	14985.55	16936.14
23560.19	26381.16	28073.42
20715.43	23767.66	26885.22
10253.68	10796.48	11521.29
1517.14	1685.53	1922.26
8770.25	9702.53	10335.57
10202.25	11979.53	13667.36
19023.93	20499.00	21856.85
11719.38	13665.06	15589.62
158156.10	171640.04	182601.98
12776.61	14849.35	16810.84
292507.27	315843.64	336450.28
283212.07	318137.03	362904.94
1131341.60	1242576.83	1349326.89
786830.35	898873.28	1014016.96
1918171.96	2141450.11	2363343.85

1992	1993	1994
6245.50	6557.77	6885.66
2884.10	3028.31	3179.72
104612.31	111571.21	118908.01
235823.61	270265.55	310231.21
6278.39	6680.20	7102.87
111555.40	127857.74	146775.18
110890.70	118251.41	126010.88
347379.00	398123.29	457006.38
24284.14	25858.55	27541.24
11296.56	12854.08	14656.09
5600.10	5961.85	6347.48
19185.87	21783.56	24786.11
29884.24	31820.40	33888.72
30482.44	34637.64	39442.20
12289.62	13102.94	13962.76
2196.42	2514.16	2882.69
11004.03	11709.13	12452.13
15622.32	17888.45	20517.13
23293.66	24812.07	26414.89
17818.74	20402.61	23399.82
194348.26	206925.69	220381.13
19075.00	21691.30	24717.45
358416.86	381809.56	406695.61
414755.18	474854.85	544565.86
1451777.06	1550098.46	1644449.74
1132570.92	1254852.81	1381189.27
2584347.98	2804951.28	3025639.02

1995	1996	1997
7229.94	7591.44	7971.01
3338.71	3505.65	3680.93
126497.63	132988.91	139830.21
353932.09	372345.06	391798.90
7540.46	7927.55	8335.02
167459.29	176150.69	185330.10
134038.09	140916.46	148165.22
521391.38	548495.74	577129.00
29317.56	30989.98	32777.63
16639.38	17699.77	18851.53
6754.90	7152.69	7576.49
28097.76	29990.62	32060.03
36072.46	38142.67	40354.11
44737.14	47690.40	50911.55
14855.86	15635.40	16459.54
3286.09	3463.46	3651.89
13223.45	13915.26	14644.79
23393.65	24643.37	25969.02
28079.30	29550.66	31104.33
26679.74	28106.83	29620.90
234605.15	248081.54	262498.83
28050.06	29867.03	31844.40
432795.00	456691.32	482122.50
620858.32	654160.00	689505.86
1734905.78	1820897.20	1902680.90
1510951.36	1634124.59	1751087.27
3245857.14	3455021.79	3653768.17

1998	1999
8369.56	8788.04
3864.97	4058.22
147038.94	154632.94
412365.86	434125.13
8763.86	9215.11
195030.89	205289.61
155802.81	163848.06
607396.75	639414.75
34686.15	36720.92
20105.64	21474.74
8027.46	8506.74
34328.54	36822.18
42713.62	45227.66
54434.18	58296.93
17330.49	18250.48
3852.30	4065.72
15413.85	16224.29
27376.63	28872.95
32744.34	34474.77
31228.93	32938.67
277903.29	294338.50
34001.88	36362.11
509164.05	537888.99
727061.74	767012.45
1980492.45	2054547.74
1862198.43	1967798.89
3842690.89	4022346.63

LINK C - BUILD 1979-99

1980	1981	1982
1783.62 1070.82	2371.51 1276.57	2959.40 1482.32
12183.41 8065.55	17270.96 13944.52	23039.54 22319.40
453.06 2545.08	727.68 4747.42	1037.19 7861.69
12636.47 10610.64	17998.64 18691.94	24076.73 30181.09
7953.37 1401.95	9085.95 1892.36	10519.99 2540.43
1691.64 2509.66	1922.57 3267.43	2201.17 4274.74
9645.01 3911.61	11008.52 5159.79	12721.16 6815.17
0.00 0.00	1205.50 84.24	2472.59 204.90
2180.51 1046.61	2557.14 1426.45	3018.10 1955.99
2180.51 1046.61	3762.64 1510.68	5490.69 2160.90
49730.29 1735.44	58647.79 2360.18	68748.32 3179.72
74192.27 17304.30	91417.60 27722.59	111036.90 42336.88
74192.27 17304.30 91496.57	156550.47 42279.61 198830.08	246670.51 76641.17 323311.68

1983	1984	1985
3547.29	4135.18	4723.07
1688.07	1893.82	2099.57
29766.63	37375.64	45655.80
34028.86	49945.39	70970.23
1385.16	1765.62	2169.88
12199.86	18086.60	25857.39
31151.79	39141.26	47825.67
46228.71	68031.99	96827.62
12196.19	14021.87	15926.31
3376.89	4433.11	5741.08
2511.15	2836.25	3166.02
5572.92	7203.86	9209.96
14707.34	16858.12	19092.33
8949.81	11636.96	14951.04
3890.19	5471.99	7192.73
376.40	613.77	932.59
3545.81	4114.82	4704.31
2670.48	3606.16	4800.19
7436.00	9586.81	11897.04
3046.88	4219.93	5732.78
80090.79	92434.70	105519.73
4243.13	5601.03	7305.40
133385.92	158020.89	184334.77
62468.54	89489.91	124816.84
344201.15	448294.40	557688.12
122317.62	181267.40	255340.12
466518.77	629561.80	813028.24

1986	1987	1988
4970.95	5218.82	5466.70
2386.69	2673.82	2960.94
49058.42	52549.17	56129.64
80812.02	91705.24	103726.11
2494.23	2827.87	3169.92
31698.72	38301.51	45725.84
51552.65	55377.04	59299.56
112510.73	130006.75	149451.95
16504.38	17115.63	17773.79
6204.65	6708.37	7257.49
3487.15	3821.39	4169.94
10575.44	12108.72	13828.76
19991.53	20937.02	21943.73
16780.09	18817.08	21086.25
7447.63	7704.35	7963.13
1023.64	1121.92	1227.80
4894.77	5086.09	5278.97
5280.56	5800.48	6362.58
12342.40	12790.44	13242.10
6304.20	6922.41	7590.38
119050.76	133424.68	148655.63
8875.15	10667.46	12703.83
202937.34	222529.17	243141.03
144470.17	166413.70	190832.40
666186.71	773369.76	878875.09
332579.77	412734.33	495541.57
998766.48	1186104.09	1374416.66

1989	1990	1991
5714.57	5962.45	6260.57
3248.07	3535.19	3711.95
59794.93	63535.79	67854.74
116951.78	131460.33	150333.45
3519.43	3875.35	4128.05
54032.46	63282.82	72386.27
63314.36	67411.14	71982.79
170984.24	194743.15	222719.73
18483.89	19244.53	20560.27
7857.41	8513.64	9675.00
4532.76	4908.86	5234.26
15754.90	17906.80	20392.58
23016.65	24153.39	25794.53
23612.31	26420.44	30067.58
8223.62	8485.17	9061.77
1341.64	1463.80	1674.45
5473.66	5670.07	6039.92
6969.52	7624.01	8720.05
13697.29	14155.23	15101.69
8311.16	9087.81	10394.50
164695.01	181456.14	193854.72
15006.05	17596.22	20012.21
264723.30	287175.91	306733.73
217913.76	247847.62	283194.01
982361.98	1083500.88	1180822.37
580729.46	668017.55	757870.28
1563091.44	1751518.42	1938692.65

1992	1993	1994
6573.60	6902.28	7247.40
3897.55	4092.43	4297.05
72420.63	77239.32	82186.85
172214.63	197600.76	224474.90
4394.28	4674.41	4962.36
82941.74	95189.11	108143.96
76814.90	81913.73	87149.21
255156.37	292789.86	332618.86
21966.43	23465.89	25037.86
11017.90	12572.14	14252.22
5579.18	5944.24	6324.30
23269.58	26602.16	30178.58
27545.61	29410.13	31362.16
34287.48	39174.30	44430.80
9670.94	10313.45	10972.30
1918.71	2202.12	2501.86
6429.62	6839.74	7261.41
9990.86	11465.32	13025.36
16100.57	17153.19	18233.71
11909.57	13667.45	15527.23
207090.25	221188.78	235937.71
22806.81	26042.24	29530.19
327551.33	349665.83	372682.79
324160.22	371673.86	422107.08
1274449.92	1364493.85	1450954.33
850528.50	946239.82	1044166.48
2124978.42	2310733.67	2495120.81

1995	1996	1997
7609.77	7990.25	8389.77
4511.90	4737.49	4974.37
86539.52	91126.73	95958.42
237030.60	250437.62	264776.07
5222.16	5495.53	5783.07
114107.16	120461.85	127243.25
91761.68	96622.26	101741.49
351137.76	370899.47	392019.32
26553.22	28162.65	29868.93
15335.31	16534.73	17866.73
6687.83	7071.86	7477.11
32265.67	34554.15	37070.37
33241.05	35234.51	37346.04
47600.98	51088.87	54937.11
11548.53	12155.49	12794.51
2639.44	2785.99	2942.31
7642.37	8043.26	8464.96
13746.91	14516.33	15337.99
19190.90	20198.75	21259.47
16386.35	17302.31	18280.30
250029.68	264985.67	280832.12
31699.36	34093.23	36742.56
394223.31	417041.19	441179.12
446824.44	473383.89	501979.29
1533348.71	1611874.32	1686712.69
1137554.73	1226689.22	1311841.28
2670903.44	2838563.54	2998553.97

1998	1999
8809.25	9249.72
5223.09	5484.24
101044.86	106396.70
280136.33	296620.66
6085.40	6403.18
134491.00	142249.76
107130.26	112799.88
414627.33	438870.42
31674.78	33582.92
19350.14	21006.75
7904.31	8354.23
39844.75	42912.41
39579.09	41937.14
59194.89	63919.16
13466.98	14174.33
3109.30	3287.98
8908.38	9374.49
16216.83	17158.39
22375.36	23548.81
19326.13	20446.37
297595.06	315300.67
39682.91	42955.43
466679.77	493586.51
532831.26	566191.39
1758031.71	1825987.53
1393269.72	1471221.61
3151301.42	3297209.14