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جمهورية مصر العربية

ARAB REPUBLIC OF EGYPT

وزارة النقل والمواصلات
والنقل البحرى

MINISTRY OF TRANSPORT AND COMMUNICATION
AND MARINE TRANSPORT

هيئة الطرق والكبارى

ROADS AND BRIDGES AUTHORITY

دراسة الجدوى لمشروع طريق القاهرة - أسيوط

CAIRO-ASSUIT HIGHWAY FEASIBILITY STUDY

FINAL REPORT

Appendix Volume 6

TRAFFIC FORECASTS

بواسطة
ويلبر سميث وشركاه
المجموعة الإستشارية المصرية
القاهرة - جمهورية مصر العربية

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U.S.A.I.D. Project Number 263-0181
Funded under U.S.A.I.D. Grant Number 263-0101
And
MINISTRY OF TRANSPORT AND COMMUNICATION

January 1987

FORWARD

This sixth volume of appendices presents the traffic forecasts for the Study for the two years 1990 and 2000. Appendices describe the assumptions made in the forecasts, and describe the function and operation of the computer Traffic Model.

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ALTERNATIVE ROAD NETWORKS

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Appendix 6A

ALTERNATIVE ROAD NETWORKS

Each alternative road system evaluated by the Study required a detailed description of road characteristics in terms of distances, travel speeds and road traffic capacity. The descriptions, termed coded networks, were prepared in the format required for computer analysis. This chapter describes the function of the networks and the assumptions made in coding them.

Function and Format of the Coded Networks

As described in Appendix 5D, the whole of Egypt was sub-divided into 64 traffic zones for the purpose of the socio-economic analyses. Population and other socio-economic measures were allocated to each traffic zone in order to describe the geographical distribution of population and wealth across the Nation.

These same traffic zones were used to code the origins and destinations of traffic movements identified in the Roadside Interview Survey. By this means zone-to-zone trip tables, termed matrices, were assembled showing the complete pattern of traffic movements passing through the the Cairo-Assuit corridor. Thus it was possible to identify that on an average day in the survey period (1985/1986), 27 large trucks with trailers travelled from the Port of Alexandria (Zone 6) to Assuit (Zone 49), and similarly for every other combination of zone pair and vehicle type. Likewise, the forecasting process (described in Chapter 7) defines traffic patterns for the forecast years 1990 and 2000 in terms of zone-to-zone matrices of traffic movements by vehicle type.

What was required, therefore, was a way of relating the matrices of zone-to-zone movements to volumes of traffic on the road system. This was the function of the coded road networks. The coded road network described all the road sections in the Nation which connected each of the 64 traffic zones to, and within, the Cairo-Assuit corridor. The road sections were divided into links by node numbers which represented road junctions, locations where road characteristics change, or locations where the traffic to and from a zone was assumed to join and leave the road system. A typical section of a road network is shown in Figure 6A-1.

Each road link in a network was defined by the node numbers at each end of the link, and was described by such parameters as length and traffic speed. Special computer programs could then be used to determine shortest routes through the network considering either time, distance or travel cost. In Base Year, there was little choice of route in the corridor, except between Cairo and Beni Suef. However, traffic on the future road systems evaluated by this Study could have a choice between the existing West Bank Highway, the East Bank Highway between Cairo and Minia, and the new Expressway between Cairo and Assuit. The identification of choice of route by drivers was, therefore, an important part of the traffic forecasting and evaluation process, and the detailed description of the road network was a crucial element in this process.

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Network Data Coded

The traffic modelling and forecasting process described in Appendix 6B was based on a detailed assessment of vehicle operating costs on each link of the network, as provided by the LNKCOST computer program. An essential input to LNKCOST was an accurate description of the characteristics of each link in the road network, with particular emphasis on traffic capacity and operating speed. Hence the detailed data coded for each link of the road network was aimed primarily at supplying information to the LNKCOST program for use in calculating vehicle operating costs.

The following items of data were coded for each link in the network:

Length
Class
Jurisdiction
Car speed
Traffic Capacity
Local Traffic

Each data item is discussed below.

Length - The length of the link was coded to the nearest tenth of a kilometer.

Class - This was an intermediate code used to identify certain detailed characteristics of the link, and to assist in coding jurisdiction, traffic speed and traffic capacity in a uniform manner. It was a 2-digit code where the first digit represented road type as follows:

1 = Divided highway
2 = 2-lane road with shoulder
3 = 2-lane road without shoulder

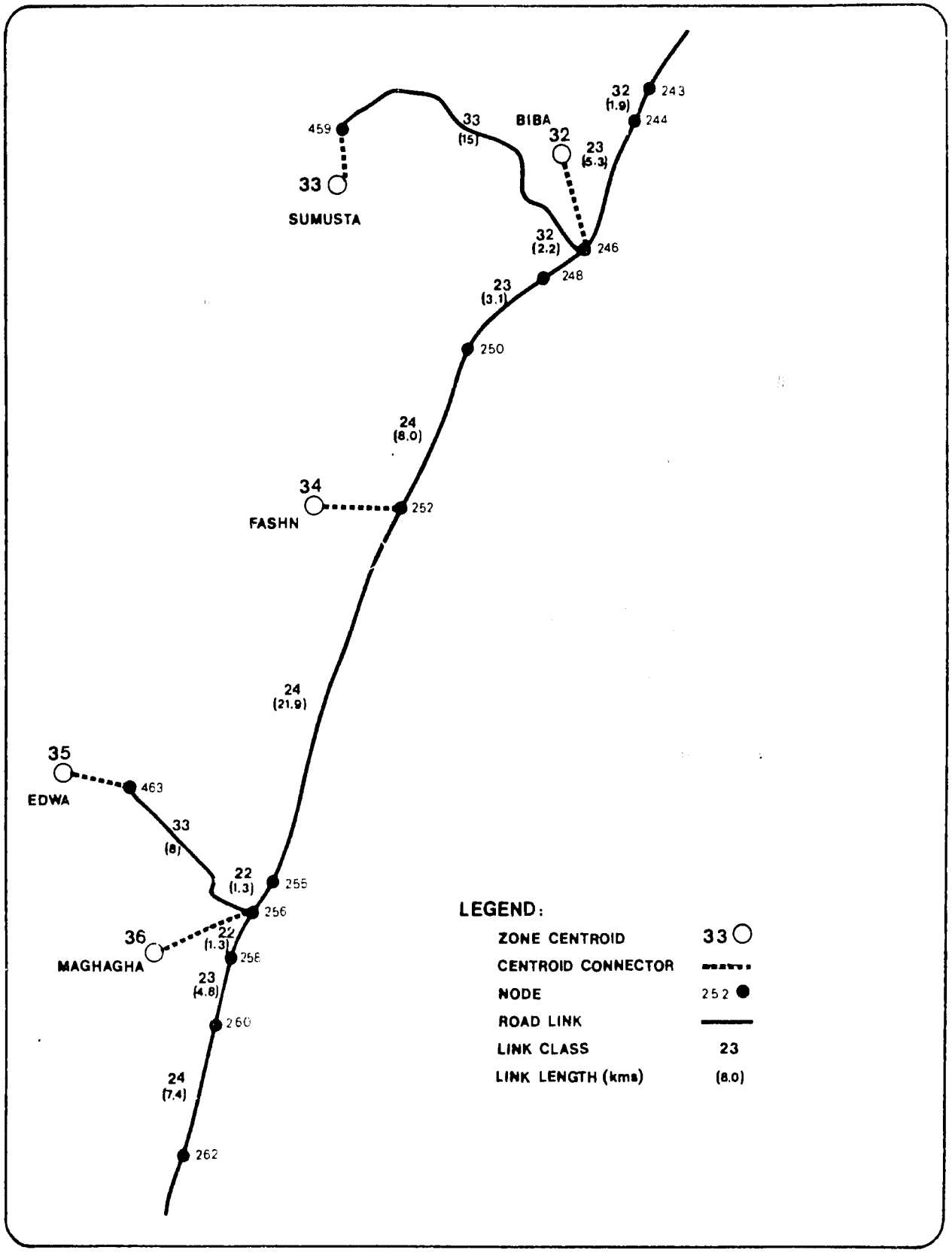
The second digit represented the type of development alongside the road link, as follows:

1 = Urban
2 = Light urban/heavy village
3 = Light village
4 = Open Country

Urban represented city centers and also the centers of major towns such as Beni Suef or Minia.

Light Urban/Heavy Village represented sections outside urban centers where the dwellings and commercial developments of the village or town fronted onto the road, with consequent interference to traffic.

Light Village represented areas where the road passed through settled areas which generated some local movements on the main



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TYPICAL SECTION OF NETWORK

Figure 6A-1

road, but where the main road traffic had clear priority and suffered only slight interference.

Open Country represented sections of road with no adjacent buildings.

Putting the two codes together, a link class 24, for example, represented a 2-lane road passing through Open Country.

Generally, a passage through one of the towns on the main West Bank Road would traverse all types of development from Open Country through Light Village and Light Urban to a short central Urban section, and then back through the classes to Open Country again. Along the links between towns, several different developments would be encountered. In order to reduce the number of links in the network, sections of road with the same development class were grouped together to form one link. Such consolidation was made separately for the lengths of route between between Governorate or Markaz capital, or between important road junctions.

Jurisdiction - Jurisdiction is a code used in the modelling process to distinguish between different types or locations of links. The jurisdictions used are given in Table 6A-1.

Table 6A-1

ROAD NETWORK JURISDICTION CODES

CODE	JURISDICTION
0	Centroid Connectors
1	Rural 2-lane roads
2	Rural multi-lane roads
3	Urban 2-lane roads
4	Urban multi-lane roads
5	Cairo roads (all multi-lane)
6	Cairo-Assuit Expressway
7	East Bank Desert Highway
8	Expressway access roads
9	Road toll links

The uses of most of these codes are obvious, but some explanation is required for centroid connectors and toll links.

The centroid of a traffic zone is a point representing the geographical center of gravity of the population and other socio-economic activities of the zone. Centroid connectors (Jurisdiction 0) were links which connected zones centroids to the road network. It was assumed that all traffic to and from a zone entered and left the road network via the centroid connector. Most zones had just one connector, but in some special cases two were provided. Toll links (Jurisdiction 9) were used to represent the toll stations located on some roads.

The relationships between link class and link jurisdiction are shown in Table 6A-2.

Car Speed - Free flow car speeds were coded, representing the speed of car traffic under conditions of no congestion. Speeds were coded in kilometers per hour. The speeds used for each link class are also shown in Table 6A-2.

Traffic Capacity - The traffic models dealing with capacity and congestion used by the Study required link traffic capacity to be defined in terms of possible capacity in passenger car units per hour. Possible capacity was defined in the 1950 edition of the Highway Capacity Manual as the "maximum number of vehicles that can pass a given point on a lane or a roadway during one hour, under prevailing roadway and traffic conditions". The 1965 edition of the manual replaced the previous range of terms for capacity with a single term -- capacity -- which corresponds to the definition of possible capacity given above.

It should be noted that traffic conditions at possible capacity are not good, being characterized as Level of Service E by the Highway Capacity Manual. Traffic flow is unstable and there are stoppages of momentary duration. Any higher volume of traffic attempting to use the road leads to Level of Service F where forced flow occurs, and queues of traffic back up along the highway.

Therefore the choice of possible capacity was not a recommendation for design of new roads or meant to indicate the Study assessment of volumes which would be acceptable in the Cairo-Assuit Corridor. It was simply a measure of capacity required for modelling purposes.

Under ideal conditions of alignment, possible capacity can reach 2000 passenger car units (pcus) per lane (one-way) on a multilane highway, or 2000 pcus per carriageway (two-way) on a 2-lane road. Many sections of roads in the Open Country class in the Cairo-Assuit Corridor attained these ideal conditions; grades were completely flat, and the road had very little horizontal curvature being characterized by long straight stretches alongside the canal. With shoulders constructed, road conditions could be said to be ideal in these circumstances. The situation was quite different in the many towns and villages through which the road passed, and in the sections with no shoulders. Table 6A-2 shows the possible capacities assumed for each link class.

Local Traffic - The tables of zone-to-zone trip matrices which defined current and future traffic movements through the corridor road system, did not account for purely local movements of traffic made entirely within a zone. Yet these movements were important since they took up a proportion of road capacity which was therefore unavailable to the main traffic movements.

Some indications of local traffic were found from Roadside Interview Stations which were not located exactly on zone boundaries. Other indications were available from the Journey Time Survey which maintained a

Table 6A-2

LINK CLASSIFICATIONS, JURISDICTIONS, SPEEDS AND CAPACITIES

CLASS	DESCRIPTION	JURIS-DICTION	FREE FLOW SPEED (kph)	TRAFFIC CAPACITY (PCU/hr 2-way)
	4-lane			
11	Urban	4	60	4400
12	Light Urban/Heavy Village	4	65	5700
13	Light Village	2	95	7200
14	Open Country	2	100	8000
	2-lane, with shoulders			
21	Urban	3	50	1100
22	Light Urban/Heavy Village	3	55	1450
23	Light Village	1	85	1800
24	Open Country	1	90	2000
	2-lane, no shoulder			
31	Urban	3	40	1000
32	Light Urban/Heavy village	3	55	1350
33	Light Village	1	85	1650
34	Open Country	1	90	1800

continuous count of traffic moving in the opposite direction to the survey car. However, none of these data provided a clear estimate of local traffic for every link. It was decided, therefore, to define local traffic as a percentage of the zone-to-zone traffic on a link, the percentage depending on the link class defined above. After testing different assumptions against the count data available, the percentages set out in Table 6A-3 were adopted:

Table 6A-3

LOCAL TRAFFIC AS A PERCENTAGE OF INTER-ZONAL TRAFFIC

DEVELOPMENT	PERCENT ASSUMED
Urban	+ 40 percent
Light Urban	+ 30 percent
Light Village	+ 25 percent
Open Country	+ 20 percent

It should be noted that the Open Country classification indicates intensely cultivated agricultural land, and considerable local activity was associated with this.

Where good data on local traffic volumes were available, this was used in place of the percentages given above. In particular, road links passing through desert were coded with little or no local traffic, and links near Cairo were coded with substantially higher volumes of local traffic deduced from other traffic counts. For links completely outside the Cairo-Assuit Corridor, total traffic estimates were obtained from available traffic counts and the relatively small portions of traffic associated with the corridor deducted from these values. In these cases, of course, "local traffic" was not really the correct term since it made up the majority of traffic on the link, but the term was retained for simplicity of reference.

In the special case of Greater Cairo, only a nominal network was coded, sufficient to show the main routes through the City for traffic between the Corridor and the North. Each route was coded with a capacity of 6000 pcus per hour possible traffic capacity, and sufficient local traffic was coded (allowing for some traffic from the Corridor) to represent congested conditions. In the Central area, a ratio of Average Daily Traffic to Hourly Capacity (ADT/C ratio) of 18 was assumed; an ADT/C ratio of 12 was assumed for remaining links in Greater Cairo. These values were kept constant for all future networks, on the assumption that the road facilities of Greater Cairo would always remain under strong traffic pressure, even with the construction of the Helwan Autostrade and Cairo Ring Road.

Access to Zones

The road networks contained all road links between zones, but did not represent the length of travel within a zone involved in leaving and arriving. Clearly, distances and road conditions for this element depended on the nature of the zone, in particular on the size of urban population (if any). Assumptions made on distances, travel speeds and congestion factor (used to factor costs on the zone centroid connector) are set out in Table 6A-4 below:

Table 6A-4

ASSUMED ZONAL ACCESS PARAMETERS

URBAN POPULATION (thous)	DISTANCE (kms)	CAR SPEED (kph)	CONGESTION FACTOR
0	5	50	1.0
10	1	25	1.3
50	2	25	1.5
200	3	25	1.6
500	4	25	1.8
1,000	5	25	1.9
5,000	7	25	2.0

Network Coverage

It is common in transport studies to differentiate between internal and external transport links; that is to say, links located entirely within the study area or corridor (internal) and links located outside (external). The external road links are often treated in a nominal manner, if at all,

An investment which improves road capacity in the corridor will naturally have most impact on traffic entirely within the corridor. At the same time, however, it will also influence movements of traffic which start or end their journey elsewhere, the impact of corridor investments on such traffic depending on the proportion of the movements within the corridor. For example, a Cairo to Sohag movement would be greatly influenced by the presence of an Expressway between Cairo and Assuit, while an Alexandria to Beni Suef movement would be influenced less.

The decision was taken, therefore, not to differentiate between internal and external links, but to code all road links in the network with the same type of information -- distance, car speed, local traffic and capacity. The link costing model, described in Appendix 6B, could therefore treats all links equally and no distinctions were necessary for internal and external traffic.

Of course, internal corridor links were treated in finer detail,

generally being from 1 to 5 kilometers long, and with small variations in link characteristics and type of local development coded. Also, the proportion of traffic classed as local was relatively small within the corridor.

The external road links were generally much longer (up to 99 kilometers) and average link conditions were coded rather than specifying every detail. In particular, local traffic (the difference between total traffic and volume on the link recorded in the Study trip matrices) represented almost all the traffic on the link.

The Coded Networks

Five basic coded networks were prepared for the Study, as follows:

Base Year Network
Committed Network
Overlay Network
Expressway Network
Improved Network

The Base Year Network described the existing road conditions and was used to establish reference travel times and costs for comparison with estimated future conditions.

The Committed Network represented the likely future road system with the addition of only those current projects which were actually in construction or definitely funded. It also assumed the current maintenance practice for road surface improvement, which allows roads to deteriorate to a poor quality of surface before rehabilitation.

The Overlay Network consisted of the Committed Network, but with a program of more frequent road surface overlays. Thus the configuration of the network in terms of links and nodes was identical to the Committed Network, but a better quality of road surface was assumed. Estimates of the additional costs of more frequent overlaying were made for the evaluation phase. This network was the principal reference network against which the performance of the other networks containing new highway investments could be compared.

The Expressway Network consisted of the Overlay Network with the addition of the new Cairo-Assuit Highway for which preliminary designs were being prepared by this Study. The term 'Expressway' referred to the possible final layout of the Highway with divided carriageways, and grade separated intersections. The evaluation stage decided by what year such a configuration could be justified, and use of the term Expressway to describe the network containing the new Highway should not be taken as a pre-judgement on the initial construction recommendations.

The Improved Network was the alternative to the Expressway Network, and consisted of the Overlay Network (Committed Network plus improved overlay policy) together with improvements to the alignment of the existing West Bank Highway. In fact, two distinct networks were prepared assuming a

staging of improvements. In the first stage, two-lane bypasses were assumed for all towns along the West Bank Highway which currently did not have one. This was known initially as the Bypass Network. In the second stage, the entire West Bank Highway, including the new bypasses, was assumed to be widened to four lanes. This was known initially as the Widen Network. Early computer tests showed that the Bypass Network had little beneficial effects for the year 2000, and it was assumed that there was little possibility of achieving the 4-lane widening by 1990. Therefore, both networks were referred to subsequently as the Improved Network, which contained 2-lane bypasses for 1990 and bypasses plus widening to 4-lanes for 2000.

Each network is described in more detail in the following sections.

Base Year Network

This network represented the road system at the time of the traffic surveys undertaken by this Study in December 1985/January 1986. The roads included in the network are shown in Figure 6A-2.

The principal road in the Cairo-Assuit corridor was the main West Bank Highway running all the way from Cairo to Assuit. Conditions varied considerably along the route, and Table 6A-5 summarizes distances by link class.

The new bridge across the Nile River at Beni Suef was included in the Base Network, together with the East Bank Highway from Beni Suef to Helwan. Although some sections of the Autostrade were open at the time of the surveys, they did not make up coherent sections of route and so this road was excluded from the network. The main opening of the Autostrade took place in April and May 1986, long after the surveys were completed.

The Committed Network

The Committed Network was derived the Base Year network, and contained all those improvements to the road system which were either underway or definitely programmed to be completed by the end of 1990, the first test year. Figure 6A-3 shows all the improvements included in the Committed Network.

The principal improvements were as follows:

i) Completion of the road rehabilitation program on the main West Bank highway, including construction of shoulders on links which do not yet have them. Hence all links of classification 33 and 34 were modified to 23 and 24 respectively. (see Table 6A-2)

ii) Completion of the road rehabilitation program on the East Bank Highway from Helwan to Beni Suef, adding shoulders where necessary.

iii) Completion of the extension of the East Bank Highway from Beni Suef to Minia, and the new bridge at Minia expected to open in 1987.

Table 6A-5

EXISTING WEST BANK HIGHWAY LINK CLASSES

CLASS	DESCRIPTION	DISTANCE (kms)
	4-lane	
11	Urban	12.7
13	Light Village	15.4
14	Open Country	31.8
	2-lane, with shoulders	
22	Light Urban/Heavy Village	17.9
23	Light Village	12.1
24	Open Country	37.6
	2-lane, no shoulder	
31	Urban	1.1
32	Light Urban/Heavy village	12.9
33	Light Village	72.8
34	Open Country	150.2
	TOTAL DISTANCE	364.5 kms

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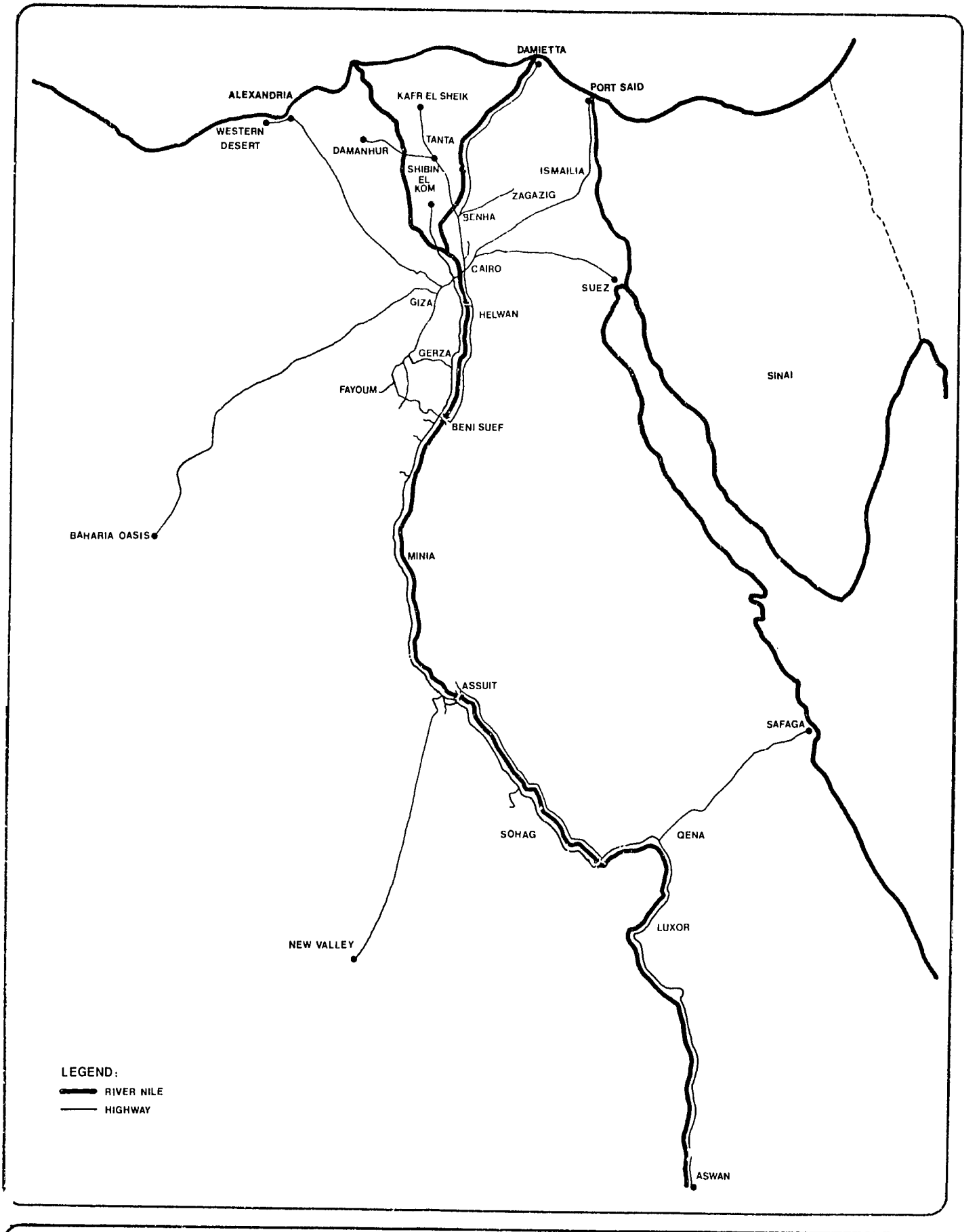

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BASE YEAR ROAD NETWORK

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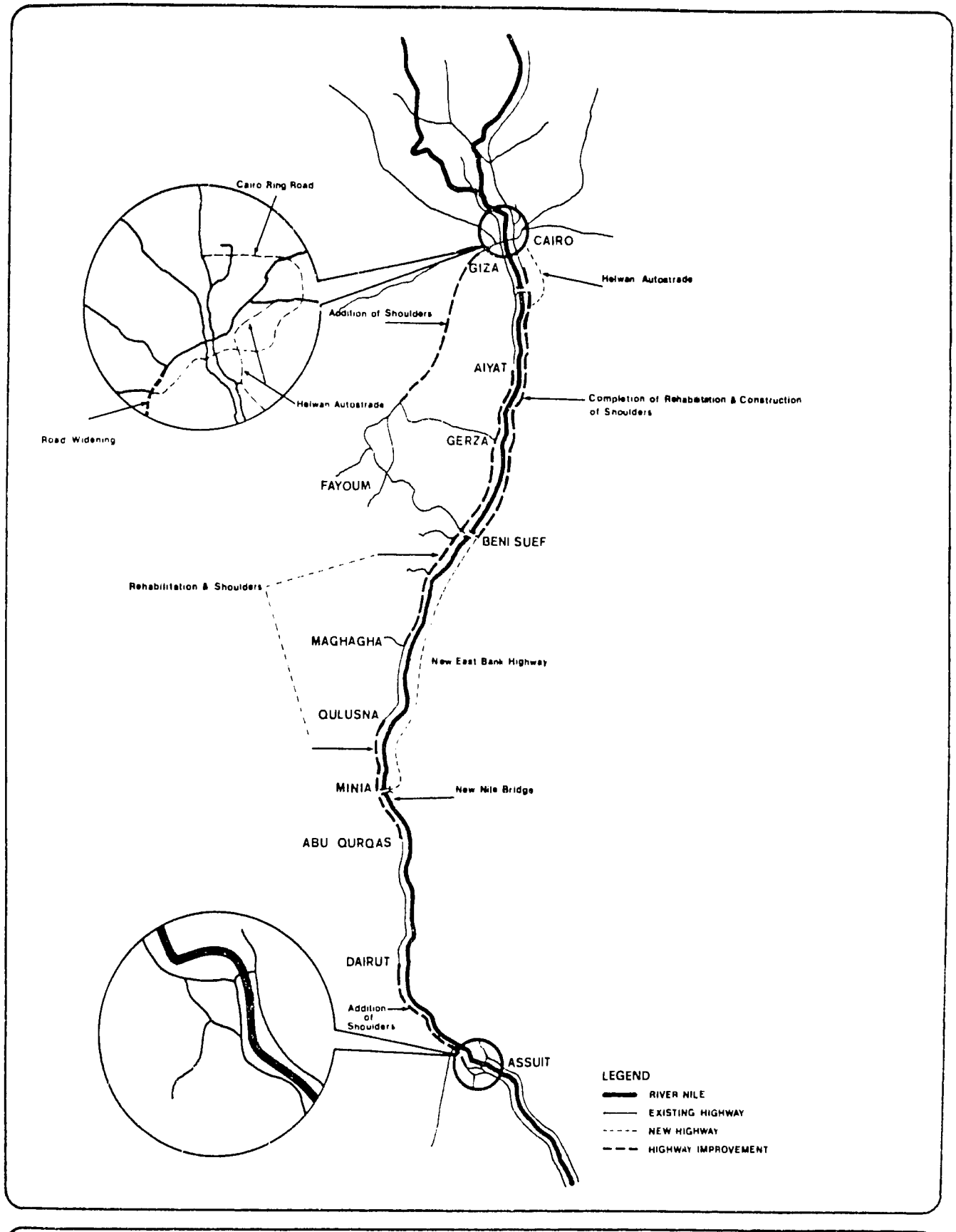
Figure GA-2



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COMMITTED NETWORK
(Additions to Base Year)

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Figure 6A 3

iv) Completion of the Autostrade from Helwan to the Suez Road, including intersections with the existing roads.

v) Widening of the Fayoum Desert Road between the junction with the Alexandria Desert Road and the Dahshour Road.

vi) Addition of shoulders to the remainder of the Fayoum Desert Road.

In addition to these changes, it was also assumed that the Cairo Ring Road would be completed from the junction of the Fayoum Desert Road with the Western Desert Road, round the South, East and Northern sides of Cairo to link into the Alexandria Agricultural Road, together with intersections with appropriate routes including the Helwan Autostrade. It was accepted that the Cairo Ring Road faced problems of financing and construction, such that the road as included in the Committed Network might not be completed by 1990, the first forecast year. However, the road was of such significance that its omission in one forecast year and addition in another would confuse results. In particular, the 1990 forecasts will be used in the Evaluation Phase of the Study to estimate traffic for each of the intermediate years between the two forecast years 1990 and 2000, and omission of the Cairo Ring Road for 1990 would obscure this process.

Speeds and capacities were coded according to Table 6A-2, with the exception of the Autostrade and Cairo Ring Road which were coded with a speed of 80 kph and capacity of 6600 pcus per hour, with the Autostrade south of the Ring Road coded at 100 kph and 12,000 pcus per hour.

The Overlay Network

As noted above, the Overlay Network contained exactly the same configuration of roads as the Committed Network, but assumed a more intense maintenance and overlay policy.

The Expressway Network

The Expressway Network was defined as the Committed Network with the addition of the new Cairo-Assuit highway under engineering investigation by this Study, including all access roads. The additional roads included in the network are shown in Figure 6A-4.

The new highway was 343 kilometers long from the junction with the New Valley Road north of Assuit to the junction with the Fayoum Desert Road 2 kilometers south of the Dahshour Road junction. The total length from the center of Assuit to the Cairo Ring Road was 372 kilometers.

Two versions of the Expressway Network were coded, one assuming 4-lane construction with a capacity of 8000 PCUs per hour and a free-flow speed of 110 kph, and the other assuming 2-lane construction with a capacity of 2000 PCUs per hour and a free-flow speed of 100 kph.

Access roads linking the new highway to communities along the Corridor

were assumed at 13 locations, approximately one for each Governorate and Markaz capital. This gave an average of an access to the new highway every 20 to 30 kilometers. The access roads were assumed to be class 24 (2-lane road with shoulder in open country), with appropriate speeds and capacities.

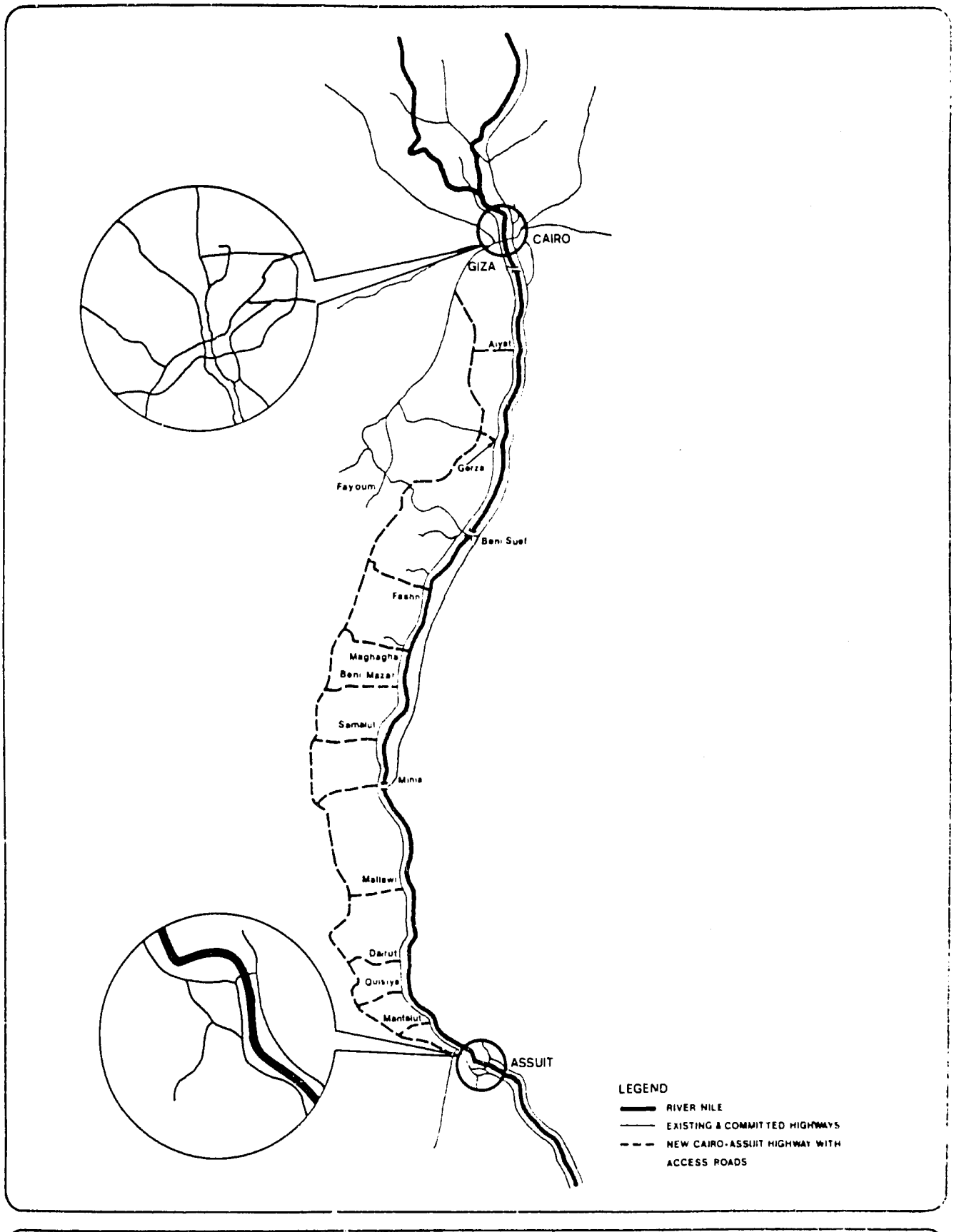
In order to comply with the requirement that little agricultural land be taken for building new roads, all the access roads were located on the alignment of existing roads in the agricultural area. Some of these existing roads were well aligned and provided a direct link between the old and the new highway. In other cases, alignments were rather tortuous and considerable distance was added to the access roads. Table 6A-6 identifies the locations of all access roads, together with the length measured from the existing West Bank Highway to the new road. In cases of particularly difficult alignments, a distance is also given for a well aligned connection crossing agricultural land directly. However, the computer tests and costing assumed only use of the existing roads. Only at Abu Qurquas was it impossible to provide an access road using existing routes, so this access road was omitted.

The Improved Network

As an alternative to the Expressway Network, a network was developed which concentrated investments on the existing West Bank Highway. Two versions of the network were developed, one for 1990 and one for 2000.

The 1990 Improved Network included 2-lane bypasses around the major cities and towns along the West Bank Highway. Based on an inspection of the route, it was concluded that bypasses could usefully be provided at 14 locations in addition to the three towns which already had bypasses: Aiyat, Fashn and Dairut. The locations of the new bypasses are shown on the map in Figure 6A-5, and are listed in Table 6A-7. It can be seen that the bypasses add nearly 16 kilometers, or 4 percent, to the distance from Cairo to Assuit.

The 2000 Improved Network included the bypasses of the 1990 Improve Network, but assumed in addition that the existing highway and the bypasses would be widened to 4-lane construction from south of Aiyat (where the current 4-lane construction ends) all the way to Assuit.



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EXPRESSWAY NETWORK
(Additions to Committed / Overlay)

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Figure 4.4.4

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Table 6A-6

LOCATIONS AND LENGTHS OF ACCESS ROADS IN THE EXPRESSWAY NETWORK
(kilometers)

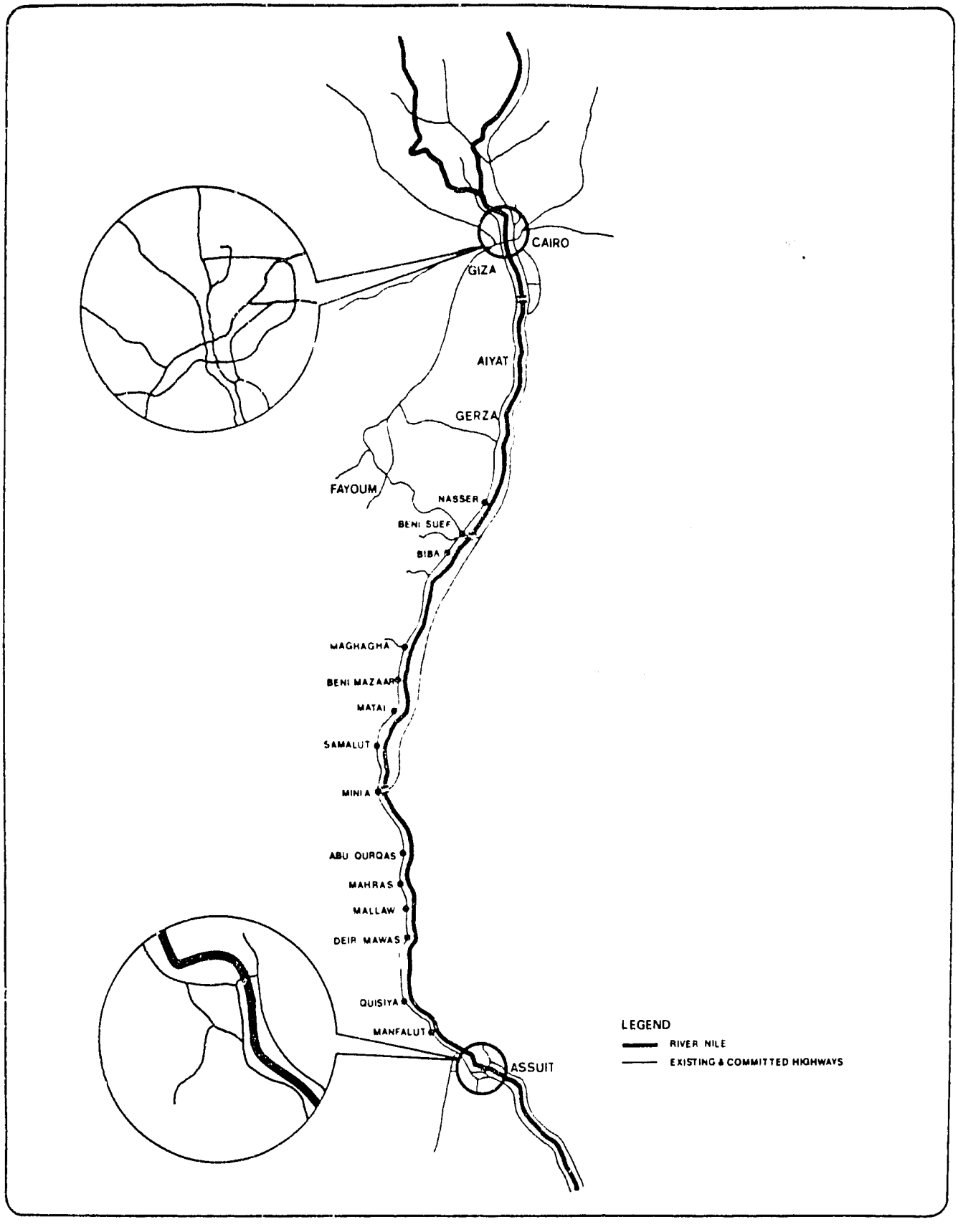
LOCATION	ACCESS ROAD ASSUMED	SHORTER ACCESS ROAD
	(kms)	(kms)
Aiyat	15.2	-
Gerza/Tamiya	6.2	-
Beni Suef/Fayoum	Existing Fayoum-Beni Suef Road	
Fashn	21.6	16.7
Maghagha	24.6	21.6
Beni Mazaar	21.2	20.3
Samalut	16.6	--
Minia	16.3	14.2
Abu Qurqas	(1)	14.0
Mallawi	15.1	12.0
Dairut	13.8	10.6
Quisiya	11.9	--
Manfalut	10.4	8.2
New Valley Road	8.0	0.0

(1) No existing road could be adapted as an access road.

Table 6A-7

LOCATIONS AND LENGTHS PROPOSED FOR WEST BANK HIGHWAY BYPASSES

LOCATION	LENGTH ALONG BYPASS (kms)	LENGTH SAVED ON EXIST ROAD (kms)
Nasser (Bush)	5.2	3.6
Beni Suef	3.2	3.4
Biba	4.9	4.8
Maghagha	5.3	4.8
Beni Mazaar	6.0	4.9
Matai	4.5	3.8
Samalut	8.5	4.8
Minia	12.2	11.0
Abu Qurqas	4.1	3.8
Mahras	2.8	2.5
Mallawi	9.4	6.4
Deir Mawas	4.2	4.4
Quisiya	7.6	4.3
Manfalut	4.3	3.8
Total	82.2	66.3



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BYPASSES INCLUDED IN THE IMPROVED NETWORK

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Figure 6A 5

Appendix 6B

THE TRAFFIC MODEL

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Appendix 6B

THE TRAFFIC MODEL

This Appendix describes the Traffic Model used to estimate future year traffic flows on alternative road networks and the resulting benefits in terms of operating cost and time savings.

Overview of the Traffic Model

The overall modelling process can be viewed in four stages as follows:

- forecasting future year trip matrices;
- preparation of future networks;
- running the main traffic model; and,
- calculating operating cost and time savings.

Each process is summarized below, with more detail provided later in this Appendix.

Future Trip Matrices - Initial estimates of zone-to-zone travel demand in the years 1990 and 2000 were based on the growth in base year trips, as a function of projected zonal GDP. As discussed later the initial future year trip matrices were subject to adjustment by the main forecasting model in response to increases or decreases in operating costs in comparison to the base year. This subject is discussed in more detail in the section on Generation/Degeneration of Traffic.

Preparation of Future Networks - Before running the main Traffic Model it was necessary to prepare a file of link data describing each future year road network. This was done by editing the description of the Base Year network, to reflect improvements to existing roads and the creation of new roads. Four principle future year networks were prepared, as follows:

- COMMITTED, representing the existing road network plus all committed improvements and additions.

- OVERLAY, similar physical characteristics as the Committed network, but with an assumed higher standard of maintenance.

- IMPROVED, same as Overlay, except that Bypasses were added around fourteen towns along the existing Cairo-Assuit road, and the highway was widened to 4-lane standard.

- EXPRESSWAY, as the Committed with the addition of the proposed.

Three of these four networks were used for both the 1990 and year 2000 runs of the main Traffic Model. However, the Improved Network contained just 2-lane Bypasses for 1990, with widening to 4-lane included for 2000 only.

The Main Traffic Model - The objectives of this model were to estimate future year traffic flows and resulting operating costs and travel times by vehicle type, for each alternative road network considered. With four networks and two future years being evaluated, the main series of tests consisted of eight model runs.

The model consisted of a number of individual components and was cyclic in nature. It is shown in schematic form in Figure 6B-1.

The model began by building paths along the principle alternative routes through the study corridor. In the Expressway networks, three sets of paths were built, namely:

A - paths using the EAST BANK road
B - paths using the EXISTING Cairo-Assuit Road on the West Bank
C - paths using the EXPRESSWAY

In the Committed, Overlay and Improved networks it was only necessary to consider paths A and B.

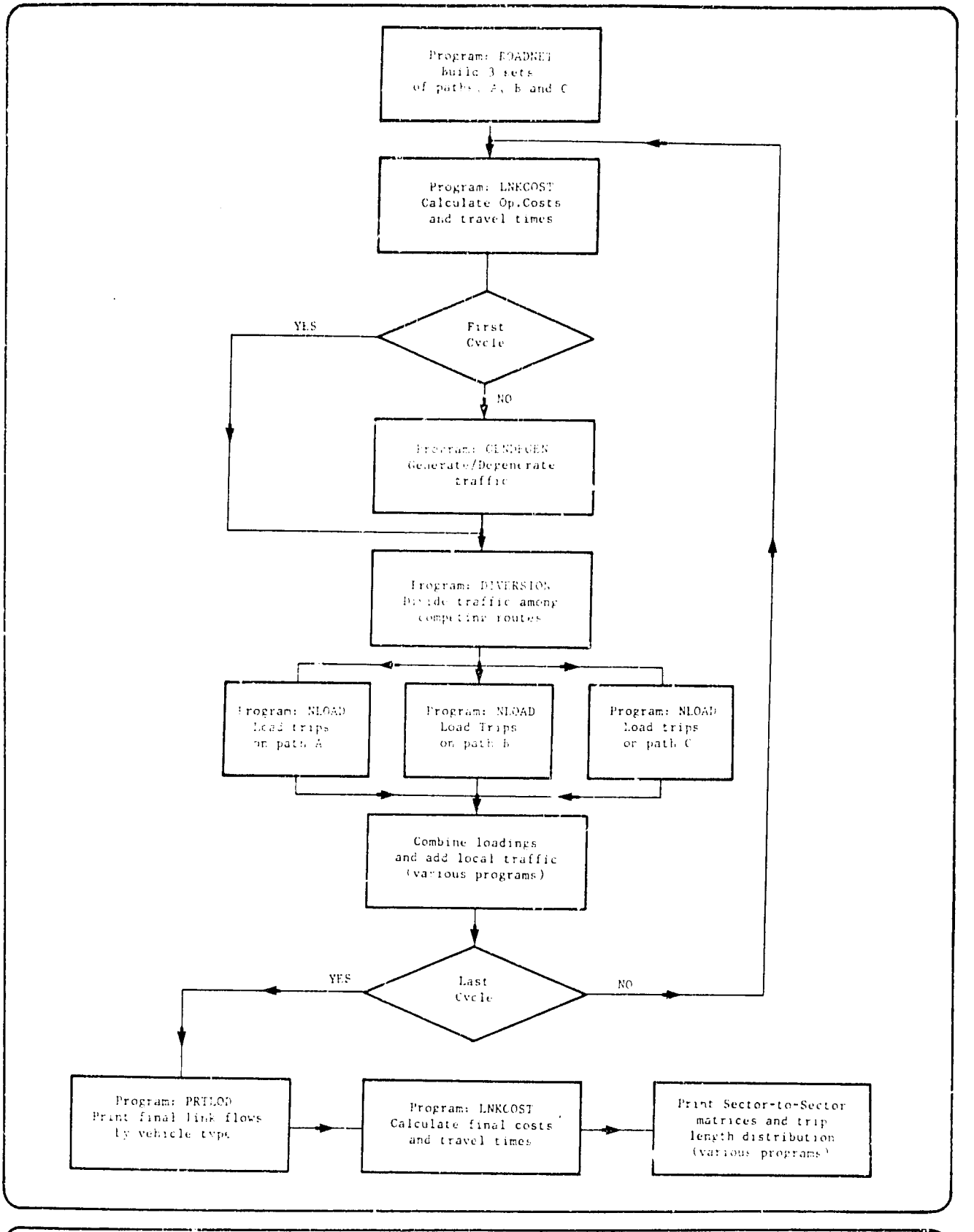
The model then entered the cyclic portion of the process, which involved the following functions:

1. Calculation of zone-to-zone operating costs and travel times for each of the sets of paths A, B and C. In the first cycle these calculations were based on an assumed volume to capacity ratio for each link, but for subsequent cycles link flows were taken from the traffic assignments made at the end of the previous cycle.

2. Generation or Degeneration of trip matrices in accordance with the change in operating costs for each zone-to-zone movement and vehicle type. An increase in costs resulted in a degeneration (reduction) in traffic, while a decrease in costs generated additional traffic. This function was omitted in the first cycle. In the second cycle the cost comparison was between the latest cost estimate (made in Cycle 2) and Base Year operating costs. In subsequent cycles the comparison was between the latest costs (made in the current cycle) and the previous cycle's costs.

3. Allocation of trips to the alternative sets of paths A, B and C. This process is known as Diversion as it essentially estimates the amount of traffic which will be diverted from existing roads by the construction of a new or improved alternative. The allocation of traffic among the 3 alternative paths was performed for each zone-to-zone movement and vehicle type, by comparing the costs (Financial Perceived costs) of using each path.

4. Loading trip matrices to the sets of paths A, B and C and combining these assignments to provide new flow estimates for each link, by vehicle type and total PCUs. These functions were provided by a number of standard transportation modelling programs. The resulting disk files were in a form suitable for



Cairo – Assuit Highway Feasibility Study

THE TRAFFIC MODEL

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Egyptian Consultants Consortium

FIGURE 6B-1

input to the link costing process in the next cycle, and in the case of the final cycle they provided the necessary input to print the final traffic volumes.

As the model was developed and tested it was found that three cycles were sufficient to provide stable results, as indicated by the small amount of traffic generated or degenerated in the third cycle (typically less than one percent).

Following completion of the third cycle the model printed final traffic flows, computed final operating costs (Economic, Financial Perceived and Foreign Exchange costs) and travel times, provided Sector-to-Sector printouts of the final trip matrices and calculated trip length distributions by vehicle type.

Cost and Time Benefits - In addition to estimates of traffic flow in the future year road network, one of the Traffic Model principal outputs was a set of zone-to-zone cost and travel time matrices. For each of the paths A, B and C the following four matrices were output;

- Economic operating costs
- Financial perceived operating costs
- Foreign exchange operating costs
- Travel time (in minutes)

The cost and time benefits associated with a particular network and year of operation were determined by comparing the total operating costs and time consumed in the network with an alternative network.

The detailed equations used to calculate cost and time benefits are given later in this Appendix, as are details of each of the steps in the Traffic Model summarized above. The results obtained when using this model are documented elsewhere in this Report.

Forecasting Future Trip Matrices

The base year trip matrices were expanded to the future years of 1990 and 2000 by the FRATAR technique, named after its originator Thomas J. Fratar. In this technique future year trips are expanded according to zonal production (origin) growth factors and attraction (destination) growth factors.

Summary of FRATAR Method - The method of expanding trip matrices in the FRATAR program may be expressed as follows:

$$T(i-j) = P(i) * \frac{F(j) * V(i-j)}{\sum_{j=1}^{n} F(j)*(Vi-j)}$$

and

$$P(i) = E(i) * \sum_{j=1}^{n} V(i-j)$$

where T(i-j) Factored trips from productions in zone i to attractions in zone j.

P(i) = Total of factored productions for zone i.

E(i) = Production growth factor for zone i.

F(j) = Attraction growth factor for zone j.

V(i-j) = Initial trip volumes from production in zone i to attraction in zone j.

After the first iteration the program balances the sums of expanded productions and the expanded attractions to either of the two sums as required. Five iterations are used to balance the sum of all arriving trips in each zone to the desired number of expanded attractions.

Zonal Growth Factors - Separate zonal growth factors were used for each of the nine vehicle types being modelled. For a particular vehicle type the growth factor represented the projected increase in vehicle trips as a function of the projected increase in zonal GDP. This growth factor was used as both the production growth factor and the attraction growth factor in the FRATAR equations given above.

Trip Matrices Input to FRATAR - The trip matrices prepared for Base Year Calibration were used as the basis for the trip matrices input to FRATAR. The only adjustments made to the matrices were for Combination and Articulated truck movements involving Gasoline/Diesel fuel and Cement.

In the future it is anticipated that some distribution of Gasoline/Diesel fuel from the Cairo region will be accomplished by pipeline rather than road transport. Such movements were, therefore, removed from the base year trip matrices before input to FRATAR. This resulted in the deletion of 8 articulated truck movements and 22 combination truck movements (per day).

The development of cement production facilities in Assuit will significantly affect the pattern of long distance cement movements in the study corridor. To reflect this development, cement movements into the corridor from Alexandria and Helwan were replaced by movements originating in Assuit. This adjustment affected a total of 15 articulated truck movements and 104 combination truck movements.

Summary of Future Year Trip Matrices - Following expansion of the trip matrices by FRATAR, the 1990 and 2000 matrices were made square or symmetrical, so that the number of trips from origin i to destination j equals the number from origin j to destination i. The matrices were

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further checked and adjusted where necessary to ensure a consistent rate of growth in trips between different regions or sectors of the country.

The resulting trip matrices contained a total of 98,280 inter-zonal vehicle movements in 1990, compared to 78,333 in the Base Year. This represents an overall increase of 25 percent. The trip matrices for the year 2000 increased by 135 percent in comparison to the Base Year, to 184,000 inter-zonal movements.

The number of movements in the initial 1990 and 2000 trip matrices are shown by Vehicle Type in Table 6B-1. The initial number of trips assumed in the Low and High Volume Sensitivity tests are also shown. As mentioned earlier in the Overview of the Traffic Model, the trip matrices described above were used as an input to the main Traffic Model, and were then adjusted (increased or decreased) by the model as a function of the change in travel costs and times. Thus the final projection of future year traffic movements was dependent upon the road network available to the user.

Building of Road Network Paths

For each of the four alternative road networks considered in the main series of tests, a source file of data was prepared. This data described each section of the road (link) in terms of its physical and traffic related characteristics, such as length, free-flow speed and capacity.

Checking of Network Descriptions - This data was read by a conventional transportation modelling road network analysis program, named ROADNET. After checking for logical inconsistencies in the data, this program constructed and printed optimum paths from selected zones to all points in the network. These selected paths were manually checked and plotted on maps to detect other errors in the link data. The program was instructed to consider minimum time as the criteria for building paths.

The program was run three times for the EXPRESSWAY network. In the first run, the program was instructed to build paths making use of the East Bank road, to the extent possible. To encourage the path building process to make use of the East Bank road the travel time on it was effectively divided by ten and the Expressway links were banned. The paths resulting from this run (Paths A) are referred to as the EAST BANK paths.

In the second run the East Bank road and the Expressway links were banned and the path builder was encouraged to make use of the Existing West Bank Road between Cairo and Assuit. These paths (B) are known as the EXISTING ROAD paths. Finally a third set of paths (C-EXPRESSWAY) were constructed with the East Bank Road banned and artificially low travel times on the Expressway.

For networks not involving the Expressway it was only necessary to build two sets of paths (A and B). A batch file was constructed to build selected paths for each of the 2 or 3 alternative principal routes through the study corridor, as described above. This Batch file was named BUILDNET.

Table 6B-1

FUTURE YEAR TRIP MATRICES
INPUT TO THE TRAFFIC MODEL

VEHICLE TYPE	BASE YEAR	YEAR 1990	YEAR 2000	2000 LOW(1)	2000 HIGH(2)
1. Car, Purpose = Work	7,118	9,681	20,589	15,532	25,873
2. Car, Purpose = Other	5,437	7,389	15,603	11,782	19,609
3. Taxi - car	15,133	17,099	24,199	21,946	27,947
4. Taxi - van	15,206	20,307	44,397	32,553	57,829
5. Pickup truck	18,719	23,589	43,661	36,129	55,083
6. Bus, microbus	3,965	4,803	8,563	7,080	10,329
7. Single truck	10,480	12,516	21,901	18,109	26,397
8. Combination truck	1,730	2,035	3,576	2,972	4,317
9. Articulated truck	725	861	1,513	1,255	1,809
Total	78,333	98,280	184,002	147,358	229,193
% Increase from Base Year	-	25.5%	134.9%	88.1%	192.6%

(1) Trip matrices used in Sensitivity Tests to determine effect of lower growth in traffic.
(2) Trip matrices used in Sensitivity Tests to determine effect of higher growth in traffic.

Factoring Local Traffic - After building selected paths, the final process in Batch file BUILDNET was to factor up local traffic volumes. These volumes (in PCUs) represented local intra-zonal trips which could not be modelled by the main Traffic Model. The factors used to grow local traffic from Base Year values are shown in Table 6B-2.

The estimated volume of local traffic in the base year was included in the source file of network data. Program ROADNET appended this information to the network description file, thus making it available to other programs. A program was specially written for this Study to read in the network description file, factor the local traffic volume according to the link jurisdiction code and output a revised network description file. This program was called LOCALTRF.

Building All Paths - As shown in Figure 6B-1, the first step of the main Traffic Model is to build paths for every zone, rather than for selected zones as done for checking purposes. Once again, three sets of paths were constructed for the Expressway networks and two sets for the Committed, Overlay and Improved networks.

Following the building of paths, the Traffic Model enters its cyclic phase, which begins with the calculation of link operating costs and travel times.

Calculation of Operating Costs

Operating costs and travel times were calculated for each vehicle type along each link in the road network. These costs and times were summed along the paths connecting all zone pairs to provide matrices of zone-to-zone costs and times by vehicle type. These matrices were used by later phases of the Traffic Model, such as the Generation/Degeneration process and Diversion, as well as the subsequent stage of calculating operating cost savings by comparing networks.

A program, named LNKCOST, was written for this project to perform these calculations.

Summary of the Link Costing Process - The calculation of operating costs and travel times on a link was based upon the following characteristics:

- link jurisdiction;
- free-flow speed;
- link length;
- capacity (PCUs per hour); and,
- daily traffic volume (in PCUs)

With the exception of centroid connector and toll links, which are discussed later, the basic costing process was common to all types of link.

The costing methodology was based upon that developed for the Highway Investment Analysis Package (HIAP)(Reference 7).

Table 6B-2

GROWTH FACTORS FOR LOCAL TRAFFIC

LINK JURISDICTION	GROWTH FACTORS			
	1990	2000	LOW(1)	HIGH(2)
0- Centroid connectors	1.0	1.0	1.0	1.0
1- Rural 2-lane	1.1	1.5	1.3	1.8
2- Rural multi-lane	1.2	2.2	1.8	2.6
3- Urban 2-lane	1.1	1.5	1.3	1.8
4- Urban multi-lane	1.2	2.2	1.8	2.6
5- Cairo roads	1.0	1.0	1.0	1.0
6- Expressway	1.2	2.2	1.8	2.6
7- East Bank Desert Road	1.2	2.2	1.8	2.6
8- New Access roads	1.2	2.2	1.8	2.6
9- Toll links	1.0	1.0	1.0	1.0

(1) Factors used in Sensitivity Tests to determine effect of lower growth in traffic.

(2) Factors used in Sensitivity Tests to determine effect of higher growth in traffic.

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Costs were calculated for each of six segments of the day, in the following steps:

1. calculate speed.
2. calculate number of speed change cycles.
3. determine time spent idling.
4. sum time components.
5. sum operating cost components.
6. factor costs by pavement condition.

The average costs and time values for the link are then calculated from the values for all segments of the day, weighted by the fraction of the ADT in each segment.

Daily Traffic Distribution - HIAP divides the 24-hour day into six segments. The duration of each segment and the fraction of the ADT occuring in it was determined by the ADT/Capacity ratio for the link, and tables of Daily Traffic Distributions by type of road (Tables A-4, A-5 and A-6 of the HIAP Technical Manual). An example of a Daily Traffic Distribution table is given in Table 6B-3, showing values for rural facilities, which are covered by Jurisdictions 1, 2 and 6-8 in this Study.

HIAP road types were associated with the system of link jurisdiction codes used in this Study (See Appendix 6-A), as follows:

HIAP	2 lane, rural	-	jurisdiction 1, 7 and 8
HIAP	multi-lane,rural	-	jurisdiction 2
HIAP	freeway, rural	-	jurisdiction 6
HIAP	2 lane, small urban	-	jurisdiction 3
HIAP	multilane, small urban	-	jurisdiction 4
HIAP	multilane, large urban	-	jurisdiction 5

The Volume/Capcacity(V/C) ratio for the current segment of the day was determined, as follows:

$$\text{V/C Ratio} = \frac{\text{ADT * Fration of ADT in Segment}}{\text{duration of segment * capacity}}$$

Speed Flow Curves - For each segment of the day a car speed was calculated dependent upon the type of link, the link free-flow speed and the V/C ratio for the current segment. The equations for the speed/flow relationships used to determine car speed are shown in Table 6B-4. These curves were selected from 50 illustrated in the HIAP Technical Manual as being representative of the road conditions encountered in the study area.

Speeds for vehicle types 6 and 7 (Buses and Single trucks) and for types 8 and 9 (Combination and Articulated trucks) were derived from car speeds using the following HIAP equations:

$$S(\text{bus}) = S(\text{truck}) = 0.961 * S(\text{car}) - 0.00115 * S(\text{car})^2$$
$$S(\text{combo}) = S(\text{artic}) = 0.943 * S(\text{car}) - 0.00059 * S(\text{car})^2$$

Table 6B-3

DAILY TRAFFIC DISTRIBUTION RURAL FACILITY

ADT/C RATIO RANGE	JURISDICTION 1 and 7, 8						JURISDICTION 2						JURISDICTION 6					
	FRACTION OF ADT / DURATION (IN HOURS)																	
	2-Lane Highway						Multilane Highway Ex. Freeway						Freeway					
	V/C Segment						V/C Segment						V/C Segment					
	1	2	3	4	5	6	1	2	3	4	5	6	1	2	3	4	5	6
0-1	.16/5.3	.16/5.3	.18/4.0	.18/4.0	.16/2.7	.16/2.7	.16/5.3	.16/5.3	.18/4.0	.18/4.0	.16/2.7	.16/2.7	.17/5.2	.17/5.2	.17/5.2	.17/3.5	.17/2.6	.15/2.3
1-2	.01/1.6	.05/2.6	.09/3.5	.05/1.6	.30/5.9	.50/8.8	.16/7.1	.16/4.1	.18/4.0	.18/3.5	.16/3.2	.16/2.2	.06/4.7	.17/5.3	.25/5.6	.38/6.6	.08/1.1	.06/0.7
2-3	.01/2.5	.03/2.5	.08/3.3	.15/4.2	.16/3.1	.57/8.4	.08/6.6	.07/2.5	.08/2.0	.62/11.0	.07/0.9	.08/0.9	.06/4.9	.26/8.0	.32/6.0	.22/3.4	.08/1.0	.06/0.6
3-4	.01/3.3	.03/2.5	.06/2.8	.12/3.3	.34/5.9	.44/6.1	.05/5.7	.08/3.1	.19/4.3	.51/8.8	.09/1.2	.08/0.9	.06/5.1	.13/4.4	.37/7.9	.26/4.4	.11/1.4	.07/0.7
4-5	.01/2.3	.02/1.8	.06/3.1	.14/4.0	.34/6.5	.43/6.3	.04/4.7	.08/3.4	.09/2.5	.47/8.8	.20/3.2	.12/1.4	.04/4.3	.09/3.9	.13/3.5	.56/10.1	.09/1.1	.09/0.9
5-6	.01/2.7	.02/2.1	.06/2.9	.15/4.0	.42/7.4	.34/4.7	.05/4.8	.07/2.9	.11/3.0	.57/10.6	.09/1.4	.11/1.3	.07/5.5	.08/3.1	.27/6.1	.37/6.7	.11/1.5	.10/1.0
6-7	.01/3.1	.03/2.7	.05/2.4	.14/3.7	.39/6.8	.38/5.3	.05/4.8	.06/2.7	.19/4.7	.51/9.4	.10/1.4	.09/1.0	.05/4.8	.06/2.9	.45/9.7	.27/4.6	.08/1.0	.09/1.0
7-8	.01/3.5	.03/3.0	.06/2.6	.13/3.2	.48/7.9	.29/3.8	.04/4.3	.08/3.4	.14/3.6	.53/10.0	.10/1.5	.11/1.3	.06/6.2	.06/2.3	.19/4.4	.44/8.0	.15/2.0	.10/1.1
8-9	.01/2.8	.03/2.8	.06/2.7	.13/3.4	.45/7.9	.32/4.4	.05/4.8	.06/2.6	.15/3.9	.49/9.3	.14/2.1	.11/1.3	.05/5.7	.08/3.1	.14/3.4	.45/8.2	.16/2.2	.12/1.3
9-10	.01/3.0	.03/3.0	.05/2.2	.12/3.1	.40/7.2	.39/5.5	.04/3.9	.08/3.6	.13/3.5	.50/9.7	.13/2.0	.12/1.4	.05/6.4	.06/2.5	.12/3.1	.44/7.8	.18/2.5	.15/1.7
10-11	.01/3.3	.03/3.2	.06/2.6	.13/3.0	.52/8.8	.25/3.1	.05/4.8	.08/3.3	.17/4.2	.45/8.5	.14/2.0	.11/1.2	.04/6.1	.08/4.1	.14/3.1	.35/5.9	.22/3.0	.17/1.8
11-12	.01/3.5	.03/2.9	.07/3.0	.13/2.9	.51/8.7	.25/3.0	.06/5.2	.13/4.2	.48/9.8	.21/3.4	.05/0.6	.07/0.8	.05/6.0	.06/2.5	.14/3.5	.37/6.9	.19/2.8	.19/2.2
12-13	.02/5.6	.05/3.3	.07/2.2	.48/8.2	.34/4.3	.04/0.4	.06/4.8	.11/4.0	.35/7.7	.31/5.4	.05/0.7	.12/1.4	.08/6.7	.25/6.3	.38/7.2	.14/1.9	.04/0.5	.11/1.4
13-14	.02/4.9	.04/2.7	.06/2.2	.30/5.8	.45/6.9	.13/1.5	.06/5.5	.08/3.0	.25/5.8	.38/6.8	.05/0.7	.18/2.3	.07/7.1	.18/4.8	.39/7.3	.11/1.6	.02/0.3	.23/2.6
14-15	.02/5.2	.03/2.4	.06/2.3	.16/3.2	.52/8.3	.21/2.6	.05/5.3	.07/2.4	.18/4.5	.39/7.3	.07/1.1	.24/3.3	.06/5.9	.13/4.2	.35/7.2	.13/2.7	.03/0.5	.30/4.1
15-16	.02/5.5	.03/2.4	.05/2.0	.10/2.2	.51/8.1	.29/3.8	.04/4.7	.06/2.9	.13/3.4	.36/6.9	.10/1.6	.31/4.4	.05/5.3	.10/3.5	.28/6.1	.17/3.1	.08/0.5	.37/5.3
16-17	.02/5.7	.03/2.4	.04/1.6	.08/1.9	.44/7.1	.39/5.3	.04/4.7	.05/2.4	.10/2.9	.28/5.6	.14/2.4	.39/6.0	.05/5.3	.08/2.9	.19/4.4	.21/4.0	.03/0.5	.44/6.9
17-18	.02/5.9	.03/2.5	.04/1.7	.06/1.5	.31/5.0	.54/7.5	.03/4.0	.06/3.1	.06/1.8	.18/3.8	.17/3.1	.50/8.2	.04/4.5	.07/2.8	.14/3.5	.18/3.5	.06/1.1	.51/8.6

Source: Data developed by FHWA for HUIS from automatic traffic recorder data supplied by several States, 1971. (The duration values are transformations of the HUIS data performed by ECI Systems, Inc.)

NOTE: This is a reproduction of the HIAP Manual, Table A-4.

Table 6B-4

SPEED FLOW CURVES

Link speeds (MPH) cars are given by the following curves, where FF is the free-flow speed (MPH) and V/C is the link Volume to Capacity ratio:

1. Expressway (Jurisdiction 6).

Speed = FF-26*V/C	for V/C < 0.95
= 26+(K-26)*(1-V/C)/0.05	for 0.95 < V/C < 1.0
= 16	for V/C > 1.0

where K = FF-24.7

2. Rural multilane (Jurisdiction 2)

Speed = FF-29*V/C	for V/C < 1.0
= 15	for V/C > 1.0

3. Rural 2-lane (Jurisdiction 1, 7, 8)

Speed = FF-(FF-26)*V/C	for V/C < 1.0
= 13	for V/C > 1.0

4. Urban Multilane (Jurisdiction 4, 5)

Speed = FF	for V/C < 0.80
= 20+(FF-20)*(1-V/C)/0.20	for 0.80 < V/C < 1.0
= 10	for V/C > 1.0

5. Urban 2-lane (Jurisdiction 3)

Speed = FF-7*V/C	for V/C < 0.75
= 18+(K-18)*(1-V/C)/0.25	for 0.75 < V/C < 1.0
= 9	for V/C > 1.0

where K = FF-5.25

Note, that the speed/flow curves and the above equations are appropriate for speeds in miles per hour. Results were converted to kilometers per hour (kph) at the end of the HIAP based computations.

No adjustments to speed were made for curves and grades, but an adjustment was made for road condition. Speeds were multiplied by a factor of 0.95 on all roads in the Base Year and Committed Road Networks. A factor of 0.97 was used in the Overlay, Improved and Expressway networks, except for the Expressway links themselves which had a factor of 1.0. The adjusted speed is referred to as SA(car) in the equations which follow.

Speed Change Cycles - The number of speed changes (per mile) for cars, not involving stops, SCH(car), is determined in HIAP as follows:

$$SCH(car) = A * LOG \text{ of } SA(car) + B$$

where A and B are HIAP constants shown in Table 6B-5.

It can be seen that this equation for the number of speed changes is only dependent upon speed. Specifically it is not related to the degree of congestion or Volume/Capacity (V/C) ratio. The HIAP equation results in a high number of speed changes being estimated for travel along clear open roads. For example, consider a car travelling at a speed of 110 kph on a clear multi-lane roadway. The HIAP equation results in an estimate of 2.93 speed changes per kilometer (almost one and a half speed change cycles). This implies, at 110 kph, a complete speed change cycle every 22 seconds. HIAP equations on the magnitude of the speed change are described shortly, but in the above example the average speed change cycle would involve a fall in speed to 95 kph.

The HIAP estimate of the frequency of speed changes appeared unrealistically high, so its effect was dampened by including a term involving the link's V/C ratio, as follows:

$$SCH(car) = (A * LOG \text{ of } SA(car) + B) * (V/C \text{ ratio})^{0.5}$$

The revised equation resulted in the same value as HIAP at a V/C ratio of 1.0, but reduced this to 71 percent of this value at a V/C ratio of 0.5 and to 32 percent at a V/C ratio of 0.1.

The number of speed changes involving stops for all vehicle types, STP, was given by:

$$STP = 10^{D} * SCH(car)^{C}$$

where C and D are shown in Table 6B-5.

Table 6B-5

CONSTANTS FOR SPEED CHANGE CYCLE EQUATIONS

CONSTANT IDENTIFICATION	LINK JURISDICTION CODE 1, 7, 8	2	6	3	4, 5
A	-7.40	-7.40	-7.40	-20.50	-20.50
B	18.70	19.50	18.30	41.50	40.00
C	0.61	0.61	0.61	1.58	1.58
D	-1.41	-1.41	-2.79	-0.85	-0.85
E (car)	1.00	1.00	1.00	1.00	1.00
E (bus, truck)	1.00	0.70	0.38	1.00	0.70
E (combo, artic)	1.00	0.91	0.75	1.00	0.91
F	0.092	0.036	0.036	0.078	0.014
G	14.50	12.20	12.20	9.90	10.80

SOURCE: Table 2-7, HIAP Technical Manual

The number of speed change cycles for cars SCC(car) was then found by dividing SCH(car) and STP by two. Speed change cycles (per mile) for other vehicle types were calculated as follows:

SCC(bus) = SCC(truck)= 0.5 * E * SCH(car) + 0.00191 * (SCH(car)+STP)

SCC(combo) = SCC(artic)= 0.5 * E * SCH(car) + 0.00954 * (SCH(car)+STP)

The magnitude of the speed change cycles is calculated in HIAP as a function of car speed, but the results are applied to all vehicle types. The change in speed, DELTA(car), is calculated from the following equation:

DELTA(car) = MINIMUM OF (SA(car), -F* SA(car) + G)

where F and G are constants by link type, shown in Table 6B-5.

The lower speed, LS(car), reached in a speed change cycle is given by:

LS(car) = 0 for a stop cycle

= SA(car) - DELTA(car) for all other speed change cycles.

Link Time - The time spent on each link is the sum of the running time and the excess time due to speed change cyles.

The running time is computed from the adjusted speed for the vehicle type being processed and the link length. The excess time due to speed change cycles is determined from tables shown in Annex 6B-1, as a function of vehicle type, adjusted running speed (SA) and speed reduced to (LS). These tables were derived from corresponding HIAP tables for four sizes of vehicles, which related to study vehicle types as follows:

HIAP 4 KIP	-	car and taxi (types 1, 2 and 3)
HIAP 5 KIP	-	taxi-van and pick-up truck (types 4 and 5)
HIAP 40 KIP	-	bus and single truck (types 6 and 7)
HIAP 50 KIP	-	combination and articulated truck (types 8 and 9)

HIAP cost equations also require the fraction of the time on the link spent idling, even though this idling time is considered to be included in the excess time due to speed changes.

The fraction of time spent idling was determined by Table 6B-6, except for rural 2-lane roads (jurisdiction codes 1, 7 and 8). For these roads a value of 0.017 was used in the following three cases:

1. Car speed, SA(car) is less than or equal to 80 kph (50 mph)
2. SA(car) is between 81 and 105 kph and V/C ratio exceeds 0.24
3. SA(car) is above 105 kph and V/C ratio is greater than 0.34.

In any other circumstances the fraction of time spent idling on 2-lane rural roads was taken as 0.003. This logic was based upon Table 2-10 of the HIAP Technical Manual, assuming a passing sight distance of at least 500 meters for between 70 to 90 percent of the link length.

Table 6B-6

FRACTION OF TIME SPENT IDLING

LINK TYPE	FRACTION OF TIME IDLING V/C <= 0.9	V/C > 0.9
2. Rural multi-lane	0.014	0.014
3. Urban 2-lane	0.560	0.188
4. Small Urban multi-lane	0.075	0.239
5. Large Urban multi-lane	0.075	0.239
6 Expressway	0.004	0.004

SOURCE: Table 2-9, HIAP Technical Manual.

Operating Costs - Operating costs were calculated by vehicle type as the sum of four components, namely:

- running cost;
- excess cost of speed changes
- excess cost of stop cycles; and,
- idling cost.

Operating costs were looked up in tables, shown in Annex 6B-2 to this Appendix, as a function of vehicle type and speed(SA). Three types of table were used during the main series of test runs, as follows:

- Economic costs;
- Foreign exchange costs;
- Financial perceived costs.

The Financial Perceived costs were used in the main Traffic Model, while operating costs based on Economic and Foreign Exchange costs were only calculated once for each alternative network, using the final traffic assignments - to provide input to benefit calculations. It should be noted that these operating costs include driver costs, except for cars.

The excess cost of speed change and stop cycles was determined from tables developed by Texas Research and Development Foundation (TRDF) (Reference 8). These tables are also shown in Annex 6B-3, as a function of vehicle type, speed (SA) and speed reduced to (LS). These tables express the excess cost in terms of the fraction of the operating costs at the initial speed (SA). The tables of excess costs were derived from TRDF tables for four types of vehicles as follows:

TRDF medium automobile	-	car and taxi (types 1,2 and 3)
TRDF pickup truck	-	taxi and pickup truck (types 4 and 5)
TRDF 3A SU truck	-	bus and single truck (types 6 and 7)
TRDF 3-S2 semi	-	combination and articulated truck(types 8 and 9)

Idling costs were determined from the tables referred to above, as a fraction of operating costs at 8 kph.

The running cost, excess cost of speed change cycles and excess cost of stop cycles were then factored according to vehicle type and pavement condition. The factors used are shown in Table 6B-7. The resulting costs were combined with the idling cost (unaffected by pavement condition) to arrive at the total operating cost for the link (by vehicle type and segment of the day).

Centroid Connectors - Centroid connectors are links in the road network which combine the assumed center of activity of the traffic zone to physical road network links. An operating cost figure was estimated for these links, as a function of year (Base Year, 1990 or 2000), distance, speed and a congestion factor. The values used for these parameters are shown in Table 6B-8.

Table 6B-7

OPERATING COST FACTORS FOR PAVEMENT CONDITION

VEHICLE TYPE	LEVEL OF MAINTENANCE		
	LOW	HIGH	EXPRESSWAY
1. Car, Purpose = Work	1.24	1.16	1.08
2. Car, Purpose = Other	1.24	1.16	1.08
3. Taxi - car	1.26	1.18	1.09
4. Taxi - van	1.24	1.16	1.08
5. Pick-up truck	1.16	1.10	1.05
6. Bus, microbus	1.16	1.11	1.06
7. Single truck	1.09	1.06	1.03
8. Combination truck	1.11	1.07	1.04
9. Articulated truck	1.08	1.05	1.03

Table 6B-8

ZONE CENTROID LINK COST PARAMETERS

Zone	YEAR 1985			YEAR 1990			YEAR 2000		
	Dist (kms)	Speed (kph)	Cong. Factor	Dist (kms)	Speed (kph)	Cong. Factor	Dist (kms)	Speed (kph)	Cong. Factor
1	2	25	1.5	3	25	1.6	3	25	1.6
2	3	25	1.6	3	25	1.6	4	25	1.8
3	3	25	1.6	3	25	1.6	4	25	1.8
4	3	25	1.6	3	25	1.6	4	25	1.8
5	4	25	1.8	4	25	1.8	5	25	1.9
6	5	25	1.9	5	25	1.9	5	25	1.9
7	2	25	1.5	2	25	1.5	2	25	1.5
8	3	25	1.6	3	25	1.6	4	25	1.8
9	4	25	1.8	5	25	1.9	5	25	1.9
10	4	25	1.8	5	25	1.9	5	25	1.9
11	3	25	1.6	4	25	1.8	4	25	1.8
12	4	25	1.8	4	25	1.8	5	25	1.9
13	4	25	1.8	5	25	1.9	5	25	1.9
14	2	25	1.5	3	25	1.6	3	25	1.6
15	7	25	2.0	7	25	2.0	7	25	2.0
16	4	25	1.8	5	25	1.9	5	25	1.9
17	4	25	1.8	4	25	1.8	4	25	1.8
18	1	25	1.3	1	25	1.3	1	25	1.3
19	5	25	1.9	5	25	1.9	5	25	1.9
20	2	25	1.5	2	25	1.5	2	25	1.5
21	1	25	1.3	1	25	1.3	1	25	1.3
22	1	25	1.3	1	25	1.3	1	25	1.3
23	1	25	1.3	1	25	1.3	1	25	1.3
24	3	25	1.6	3	25	1.6	3	25	1.6
25	1	25	1.3	1	25	1.3	1	25	1.3
26	2	25	1.5	2	25	1.5	2	25	1.5
27	1	25	1.3	1	25	1.3	1	25	1.3
28	1	25	1.3	1	25	1.3	2	25	1.5
29	2	25	1.5	2	25	1.5	2	25	1.5
30	2	25	1.5	2	25	1.5	3	25	1.6
31	1	25	1.3	1	25	1.3	1	25	1.3
32	1	25	1.3	1	25	1.3	2	25	1.5
33	1	25	1.3	1	25	1.3	1	25	1.3
34	1	25	1.3	1	25	1.3	2	25	1.5
35	5	50	1.0	1	25	1.3	1	25	1.3
36	2	25	1.5	2	25	1.5	2	25	1.5
37	1	25	1.3	2	25	1.5	2	25	1.5
38	1	25	1.3	1	25	1.3	1	25	1.3
39	2	25	1.5	2	25	1.5	2	25	1.5
40	2	25	1.5	3	25	1.6	3	25	1.6
41	1	25	1.3	2	25	1.5	2	25	1.5
42	2	25	1.5	2	25	1.5	2	25	1.5
43	1	25	1.3	1	25	1.3	1	25	1.3

Table 6B-8 (Cont'd)

ZONE CENTROID LINK COST PARAMETERS

Zone	YEAR 1985			YEAR 1990			YEAR 2000		
	Dist (kms)	Speed (kph)	Cong. Factor	Dist (kms)	Speed (kph)	Cong. Factor	Dist (kms)	Speed (kph)	Cong. Factor
44	1	25	1.3	1	25	1.3	2	25	1.5
45	1	25	1.3	1	25	1.3	2	25	1.5
46	2	25	1.5	2	25	1.5	2	25	1.5
47	2	25	1.5	2	25	1.5	2	25	1.5
48	5	50	1.0	5	50	1.0	5	50	1.0
49	3	25	1.6	3	25	1.6	4	25	1.8
50	5	50	1.0	5	50	1.0	5	50	1.0
51	1	25	1.3	1	25	1.3	2	25	1.5
52	1	25	1.3	1	25	1.3	1	25	1.3
53	1	25	1.3	1	25	1.3	1	25	1.3
54	1	25	1.3	1	25	1.3	1	25	1.3
55	1	25	1.3	1	25	1.3	1	25	1.3
56	3	25	1.6	3	25	1.6	3	25	1.6
57	2	25	1.5	2	25	1.5	2	25	1.5
58	1	25	1.3	1	25	1.3	1	25	1.3
59	2	25	1.5	2	25	1.5	2	25	1.5
60	3	25	1.6	4	25	1.8	4	25	1.8
61	3	25	1.6	3	25	1.6	4	25	1.8
62	2	25	1.5	2	25	1.5	2	25	1.5
63	2	25	1.5	2	25	1.5	2	25	1.5
64	3	25	1.6	3	25	1.6	3	25	1.6

The zone centroid operating cost was determined by looking up the operating cost tables for the speed indicated and multiplying the result by the distance and congestion factor for the zone.

Toll Links - During the main series of tests, the only links classified as Toll links in the four networks under consideration (Committed, Overlay, Improved and Expressway) were those on the Giza-Alexandria Desert Highway. Zero length links of jurisdiction code 9 were included in the network to represent the collection of tolls for using this Highway. The cost of travel on the toll links was, therefore, set equal to the current toll rates, namely, cars and taxis LE 1.0, pickups and buses LE 2.0, single trucks LE 3.0 and combination and articulated trucks LE 5.0.

During Sensitivity Tests to assess the effect of tolls on Expressway traffic volumes, toll links on the Expressway were also allocated toll costs by vehicle type.

Final Outputs of the Link Costing Process - As mentioned previously, the operating costs and times calculated for each of the six segments of the day, were combined by weighting with the fraction of the ADT in each segment, to arrive at an average cost and time for the link. Separate values were obtained for each of the nine vehicle types being modelled.

Costs and times along each zone-to-zone path were then combined to produce operating cost and travel time matrices for all possible zone-to-zone movements. This was repeated for each of the 2 or 3 sets of paths built at the start of the model run (paths A, B and C for the Expressway network and paths A and B for other networks).

Generation/Degeneration of Traffic

The future year trip matrices input to the Traffic Model were considered as initial estimates only. The actual number of trips is likely to be influenced by the degree of congestion and costs of travel in the road network available. In other words the future year trip matrices are themselves a function of the road network being considered.

A lowering of congestion and travel costs would be expected to increase travel activity over and above that anticipated due to increases in zonal GDP. On the other hand an increase in congestion and costs is likely to suppress to some extent the growth in travel otherwise expected.

The Generation/Degeneration Program - A computer program, named GENDEGEN, was specially written to perform this function within the Traffic Model. The program was run twice during the course of operating the Traffic Model for a particular network.

During Cycle 2 of the model GENDEGEN compared costs and times computed by the latest run of LNKCOST with corresponding zone-to-zone costs and times in the Base Year. As a result of this comparison trips for this zone-to-zone movement in the initial future year matrix were either increased or decreased. A new set of future year trip matrices, one per

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vehicle type, were therefore generated and used during the remainder of Cycle 2.

In Cycle 3, GENDEGEN compared costs and times from the Cycle 3 run of LNKCOST with those from Cycle 2, to increase or decrease the future year trip matrices generated in Cycle 2. The resulting Cycle 3 trip matrices were found to differ from those of the previous cycle by less than one percent in total trips, indicating that the matrices were in balance with the road network being modelling. The matrices resulting from GENDEGEN in Cycle 3 were, therefore, considered the final future year trip matrices for that particular network.

Zone-by-Zone Comparison of Costs - The calculations necessary to generate or degenerate traffic were performed for each zone-to-zone movement and for each vehicle type.

From the costs and time matrices generated by the latest LNKCOST run, the zone-to-zone cost was computed for each of the 2 or 3 sets of paths available in the network (A, B and C). These "current" costs may be indicated by CC(A), CC(B) and CC(C). For all vehicle types except Car-Work and Car-Other, the cost was simply equal to the LNKCOST Operating Cost. For car trips the value of time was added to the Operating Cost, using the time matrices from LNKCOST and a value of time as follows:

VEHICLE TYPE	AVERAGE OCCUPANCY	VALUE OF PERSON TIME (LE per hr)	VEHICLE TIME VALUE (LE per hr)
Car, Work	2.55	1.42	3.62
Car, Other	2.55	0.57	1.45

It should be noted that the Financial Perceived costs used by LNKCOST do not include driver or passenger time for the two car vehicle types.

Program GENDEGEN determined the minimum of CC(A), CC(B) and CC(C), and compared this with the previous cost, denoted by PC(X). When the comparison was with Base Year in Cycle 2, the previous cost was simply taken from the Base Year cost and time matrices, as Base Year costs were computed for only a single set of paths (corresponding to set B, utilizing the existing Cairo-Assuit West Bank Road). In Cycle 3 the previous cost was computed from cost and time matrices generated by LNKCOST in Cycle 2, for the path X, determined to have minimum costs in Cycle 3.

The trip generation or degeneration factor applied to this zone-to-zone movement, F(i,j) was then computed as:

$$F(i,j) = (CC(x) \ / \ PC(x))^{E}$$

where CC (x) is the current cost by the minimum cost path
PC(x) is the previous cost
E is the Elasticity Factor.

The Elasticity factor controlled the sensitivity with which trips were generated or degenerated due to cost changes. The Elasticity values used for each vehicle type were as follows:

VEHICLE TYPE	ELASTICITY
1. Car, Purpose = Work	0.70
2. Car, Purpose = Other	1.00
3. Taxi, car	0.60
4. Taxi, van	0.60
5. Pick-up truck	0.40
6. Bus, microbus	0.60
7. Single truck	0.20
8. Combination truck	0.20
9. Articulated truck	0.20

Output of the GENDEGEN Process - The final product of the GENDEGEN program was a revised set of future year trip matrices, by vehicle type. These matrices were passed to the next step in the Traffic Model which allocated trips amongst the alternative paths available in the network being modelled.

Diversion of Traffic

Following creation of revised future year trip matrices by GENDEGEN, the trips for each zone-to-zone movement were divided amongst the 2 or 3 sets of paths available in the network being modelled. This process, known as Diversion, was performed by a program called DVERSION.

Summary of Diversion Process - Trips were divided between the available paths (A, B and C) on the basis of the zone-to-zone cost by each path. In general terms, the lower the cost of a particular path compared to the alternatives, the greater the proportion of trips allocated to that path.

The Diversion process generally resulted in some trips being allocated to each of the available paths-unless the cost along a particular path was more than 75 percent above the alternative. The spreading of trips among available paths which resulted from this process is considered a more realistic and stable model of route choice than assignment processes in which all trips for a zone-to-zone movement are assigned to the lowest cost path, regardless of the size of the cost difference.

Diversion of trips between three alternative paths was undertaken in two steps. Firstly, trips were divided into those which will use the Existing West Bank Road and those which will use either of the other alternatives (East Bank Road or Expressway). This allocation was based upon a comparison of the zone-to-zone cost using the Existing West Bank Road (Path B) and the minimum of the costs for the East Bank Road and Expressway paths (paths A and C).

Those trips not allocated to the Existing West Bank Road were then divided between the East Bank Road and the Expressway, by a comparison of zone-to-zone costs for these two paths.

Detailed Zone-to-Zone Cost Comparisons - Diversion of trips between available paths was undertaken for each zone-to-zone movement and for each of the nine vehicle types. As in the case of program GENDEGEN the cost was taken to be the zone-to-zone operating cost calculated by the most recent run of LNKCOST, except for car trips where the cost of time was also included.

Let the current cost by the three alternative paths be denoted by CC(A), CC(B) and CC(C), for paths A, B and C respectively. To determine the number of trips which will remain on the Existing West Bank Road (path B) the ratio of its cost to the lower of path A and C costs was computed as follows:

Ratio = (Minimum of CC(A), CC(C)) / CC(B)

This ratio was converted to a trip percentage by use of the Diversion Curve shown in Figure 6B-2. As an example, if the value of Ratio is 1.0, corresponding to equal costs along the alternative paths, then the trip percentages would be 50 percent for path B and 50 percent for paths A and C. However, if Ratio (B) equals 0.90, corresponding to higher costs on the Existing West Bank Road than the cheaper of the alternatives (A or C) then the trip percentages would be 37 percent for path B and 63 percent for paths A and C.

To reflect route choice considerations, such as convenience or comfort, which were not reflected in operating costs, the percentage diversion obtained from the curve was adjusted by 5 percent in favour of the desert routes (paths A and C). Hence in the above example, 32 percent of trips would be allocated to the Existing West Bank Road (path B) and 68 percent would be available for paths A and C.

The division of trips between the East Bank Road (A) and the Expressway (C) was performed in a similar manner, with the ratio of costs along these paths being calculated as:

Ratio = CC(C) / CC(A)

After a percentage was obtained from the Diversion Curve, this was adjusted by 5 percent in favour of the Expressway paths to reflect the greater comfort expected to be experienced on this road. Supposing the ratio of costs CC(C) to CC(A) is also 0.90, implying lower costs on path C (Expressway), then 32 percent of the available trips would be allocated to the East Bank Road paths and 68 percent to the Expressway. However, in the example being considered only 68 percent of the total trips are available to either path. As a percentage of total trips, 22 percent (0.68 * 0.32) would be allocated to the East Bank Road path and 46 percent (0.68 * 0.68) to the Expressway. The other 32 percent had already been allocated to the Existing West Bank Road paths.

The results of the above example may be summarized as follows, if the zone-to-zone costs on the Existing West Bank Road is taken as an arbitrary figure of 100 units of cost:

Path	Zone-to-Zone Cost	% Trips Allocated
A	100	22
B	100	32
C	90	46

This example illustrates how the two step diversion process favours the choice of using the Existing West Bank Road, in that costs on paths A and B are assumed equal but more traffic is allocated to path B. However, this is deliberate in that it is considered likely that the actual route choice will be decided upon by consideration of two questions:

1. Shall the most direct route be taken (Existing West Bank Road) or a longer, but less congested route?

2. If a longer, less congested route, is preferred, then shall the East Bank Road or the Expressway be used?

Only if a deliberate decision is made not to use the most direct route will the East Bank Road or Expressway be considered, thus giving rise to the expected tendency to choose the Existing West Bank route more frequently than the less direct alternatives, when perceived costs are similar.

Assignment of Traffic to Paths

The Diversion process resulted in a trip matrix being available for each vehicle type and set of paths (A, B and C). These matrices were processed by three standard Road Transportation Modelling programs to "assign" these matrices to the road network. By combining this "loaded" network with local traffic volumes, a file containing revised daily PCU totals for each road link was produced for input to LNKCOST in the next cycle.

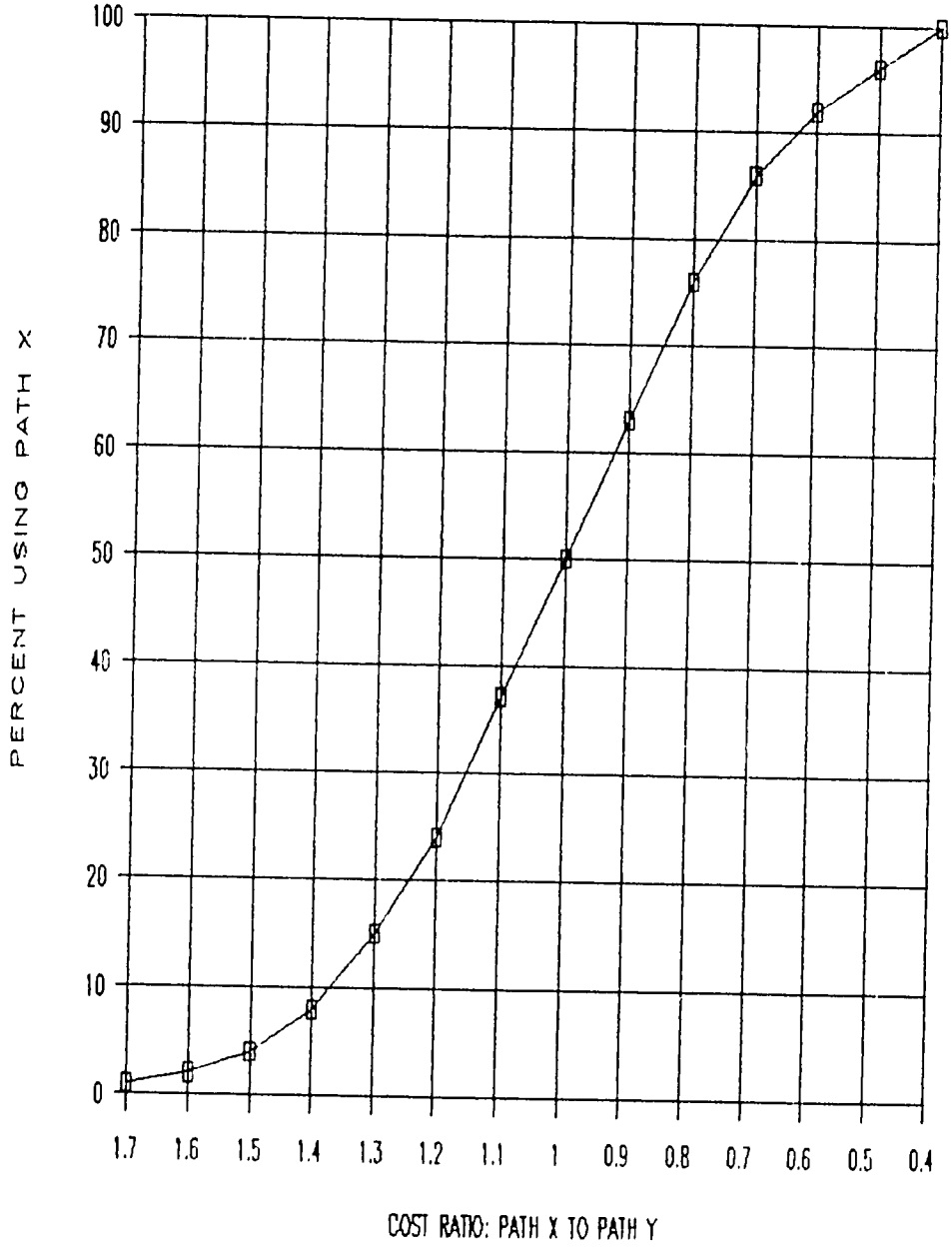
The three standard programs used to process trip matrices were:

1. Program MATR03 - converts vehicle trip matrices to PCU trip matrices.

2. Program NLOAD - assigns the PCU matrix for path X to those paths.

3. Program ADDLOD - combines the loaded networks for path sets A, B and C and local traffic into one file.

The process of assigning traffic to network paths concluded the cyclic portion of the Traffic Model.



Cairo – Assuit Highway Feasibility Study

Wilbur Smith and Associates
Egyptian Consultants Consortium

TRAFFIC MODEL DIVERSION CURVE

Figure 6B-2

Final Model Processes

Upon completion of the third cycle of the Traffic Model, four final processes were performed, as follows:

1. Printing of the final traffic assignment
2. Calculation of final operating costs and times
3. Printing of sector-to-sector vehicle movements
4. Calculation of average trip lengths by vehicle type.

Each process is described briefly below.

Printing of Final Traffic Assignment - A printed traffic assignment was provided which detailed individual link volumes by vehicle type, total PCUs and V/C ratio. Various summaries were available, such as vehicle-kilometers and vehicle-hours by link jurisdiction and vehicle type. Links with V/C ratios exceeding a user specified threshold were also listed in descending order of V/C ratio.

The printed assignment was provided by program PRTLOD, a standard program in the Consultant's Road Transportation Modelling package.

Final Operating Costs and Times - Using the final PCU link volumes as input, program LNKCOST was used to calculate final operating costs and link travel times. The program was run three times at this point with the following objectives:

1. to produce final matrices of Financial Perceived operating costs and matrices of zone-to-zone travel times.
2. to produce matrices of Economic operating costs.
3. to produce matrices of Foreign Exchange operating costs.

The matrices referred to above were used in calculating the benefits attributable to a network in comparison to an alternative.

Sector-to-Sector Vehicle Movements - To summarize the final future year trip matrices resulting from each model run, sector-to-sector movements were printed by vehicle type. The sectors defined for this purpose corresponded to the following sets of analysis zones:

SECTOR	ANALYSIS ZONES
1. Northern Ports	2, 3, 6, 64
2. Greater Cairo	13, 15-17, 19
3. Rest of Northern Egypt	1, 4-5, 7-12, 14, 22
4. Giza (in Corridor)	18, 20, 21
5. Fayoum	23-27
6. Beni Suef	28-34
7. Minia	35-43
8. Assuit (in Corridor)	44-49
9. Rest of Assuit	50-55
10. Rest of Upper Egypt, Red Sea, New Valley	56-63

Sector-to-Sector information was provided by the program named MATR02.

Average Trip Lengths - The average trip lengths by vehicle type, resulting from the final future year trip matrices, were also computed and reported. These were provided by program TRIPSUM. The calculation of average trip lengths was the final process in the main Traffic Model.

Operating Cost and Time Benefits

The benefits attributable to a particular network in comparison to an alternative were determined by a program named COSTEVAL. This program calculated savings in operating costs and time. The network for which benefits were being calculated is referred to as the TEST network, while the alternative with which it was compared is labelled the BASE network, in the discussion which follows.

COSTEVAL required as input the final future year trip matrices and the Economic cost, Financial Perceived cost and time matrices from the final runs of LNKCOST in the Traffic Model - for both the TEST network and the BASE case network with which it was being compared.

Benefit Calculations - Benefits were calculated for each zone-to-zone movement and for each vehicle type.

Benefits due to operating cost savings may be expressed in general terms as:

Cost Benefits (CB) = Total Economic cost of travel in BASE case
+ Cost of previous activities displaced by generated traffic.
- Total Economic cost of travel in TEST case.

This may be expressed mathematically as:

$$CB = Q * EC + 1/2*(Q' - Q) * (FC + FC') - Q' * EC'$$

Where Q = number of trips in BASE case
EC = zone-to-zone Economic cost in BASE case
FC = zone-to-zone Perceived Financial cost in BASE case
Q' = number of trips in TEST case
EC' = zone-to-zone Economic cost in TEST case
FC' = zone-to-zone Perceived Financial cost in BASE case

The term Q times EC was computed by summing the products of Trips and Economic costs for each set of paths (A and B) in the BASE case network. The term Q' times EC' was found similarly, summing over paths A, B and C when the TEST case involved an Expressway network, or paths A and B otherwise.

In the central term of the Cost Benefits equation, Q was taken as the sum of trips over all available sets of paths in the BASE case and Q' as the corresponding sum in the TEST case. The zone-to-zone Financial Cost in the Base case (FC) was taken as the average Perceived Financial Cost

for paths A and B. Finally, the Financial Cost in the TEST case (FC') was taken as the minimum of the zone-to-zone Perceived Financial costs for paths A, B and C.

For time benefits, the classic form of the consumer surplus benefit equation was used, as follows:

Time benefits = 1/2 * (Q + Q') * (C - C')

where Q = number of trips in BASE case
C = time cost in BASE case
Q' = number of trips in TEST case
C' = time cost in BASE case.

Once again Q and Q' were determined by summing trips over the available paths A, B and C. C was determined by summing the products of zone-to-zone travel times and a value of time, for each available path. The value of time used in benefit calculations for each vehicle type is shown in Table 6B-9.

Operating cost and time benefits were summed over all zone-to-zone movements and summarized by vehicle type, while retaining separate sub-totals, for through trips, trips internal to the study corridor and trips with either origin or destination (but not both) in the corridor. Large and small benefits as well as positive and negative benefits were also summarized separately.

Running the Traffic Model

As indicated previously the Traffic Model used to determine future year traffic flows and operating costs did not consist of a single program, but was comprised of a variety of programs executed in sequence.

The main Model in fact made use of 12 different programs, as follows:

1. ROADNET - Build Road Network and Minimum Paths
2. LNKCOST - Calculate Link Operating Costs
3. GENDEGEN - Generate or Degenerate Trips
4. DVERSION - Division of Trips between 2 or 3 sets of Paths
5. MATRO3 - Add, Subtract and Factor Complete Matrices
6. NLOAD - Load Trips onto Road Network Paths
7. ADDLOD - Add and Manipulate Loaded Networks
8. LOCALTRF - Local Road Traffic Loading Program
9. PRTLOD - Print Link Loadings and Summaries
10. MATRO2 - Print Sector to Sector Movements
11. ROADSKIM - Build Road Network Skim Matrices
12. TRIPSUM - Trip Matrix Summary Program

During the course of a model run each of these programs was executed a number of times. The modelling of the Expressway network involved a total of 72 program executions, while 53 were required for the Committed, Overlay and Improved networks. In addition a utility program (CPRINT) was run 20 times to provide the necessary printer control characters to print at 17 characters per inch. This utility was run once for each of the 20 separate print files generated by the model.

Table 6B-9

VALUE OF TIME FOR BENEFIT CALCULATIONS

VEHICLE TYPE	VEHICLE TIME VALUE PER HOUR (LE)
1. Car, Purpose = Work	3.620
2. Car, Purpose = Other	1.450
3. Taxi - Car	2.590
4. Taxi - Van	4.810
5. Pickup Truck	0.000
6. Bus, Microbus	4.580
7. Single Truck	0.018
8. Combination Truck	0.074
9. Articulated Truck	0.058

To simplify running of the model a Batch file of DOS commands was created to automatically request each of the model components to execute in sequence. This Batch file, named ASSUIT, is shown in Annex 6B-4 to this Appendix. It is called into action by typing:

ASSUIT %1 %2

where %1 is a 2-character code for the network, and %2 is a 2-character code for the level of tolls on the Expressway

Valid codes for the network were:

C9	-	Committed 1990 network
C2	-	Committed 2000 network
09	-	Overlay 1990 network
02	-	Overlay 2000 network
B9	-	Bypass 1990 network } (version of the Improved Network)
B2	-	Bypass 2000 network }
E9	-	Expressway 1990 network
E2	-	Expressway 2000 network
EL	-	Expressway 2000 network with Low Sensitivity Test
EH	-	Expressway 2000 network with High Sensitivity Test
OL	-	Overlay 2000 network with Low Sensitivity Test
OH	-	Overlay 2000 network with High Sensitivity Test
W2	-	Widen West Bank Road 2000 network (Improved Network)
S9	-	Expressway 1990 network ending near Beni Suef
S2	-	Expressway 2000 network ending near Beni Suef
M2	-	Expressway 2000 network ending near Minia.

Codes used to define the level of tolls on the Expressway were as follows:

NO	-	no tolls
TC	-	current rates (as used on Giza - Alexandria Desert Highway)
TL	-	low rate of tolls
TM	-	medium rate of tolls
TH	-	high rate of tolls
TV	-	very high rate of tolls

Four other smaller Batch files were also used in connection with running the model, namely:

BUILDNET %1	-	used program ROADNET to build selected paths for network checking purposes and LOCALTRF to factor local traffic to future year values, for network %1.
DUMPLST %1	-	to copy all print files created during a model run for network %1 to 5 diskettes for archive purposes.
EVALFILE %1	-	to copy all files which would subsequently be required by program COSTEVAL following a model run for network %1, to diskette (up to 5 diskettes were required depending on the network).

EVALUATE %1 %2 - run program COSTEVAL to determine the benefits attributable to network %1 in comparison to network %2.

These four Batch files are also shown in Annex 6B-4 to this Appendix.

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EXCESS HOURS CONSUMED PER 1000 SPEED CHANGE CYCLES
CAR AND TAXI (HIAP 4 KIP)

INITIAL RUNNING SPEED	SPEED REDUCED TO AND RETURNED FROM, KPH													
	STOP	8	16	24	32	40	48	56	64	72	80	88	96	104
kph														
8	1.02													
16	1.51	0.62												
24	2.00	1.12	0.46											
32	2.49	1.62	0.93	0.35										
40	2.98	2.11	1.40	0.80	0.28									
48	3.46	2.60	1.87	.24	0.70	0.23								
56	3.94	3.09	2.34	1.69	1.11	0.60	0.19							
64	4.42	3.58	2.81	2.13	1.52	0.97	0.51	0.16						
72	4.90	4.06	3.28	2.57	1.93	1.34	0.83	0.42	0.13					
80	5.37	4.54	3.75	3.01	2.34	1.71	1.15	0.68	0.35	0.11				
88	5.84	5.02	4.21	3.45	2.74	2.08	1.47	0.94	0.57	0.28	0.09			
96	6.31	5.50	4.67	3.88	3.14	2.44	1.78	1.20	0.78	0.45	0.21	0.07		
104	6.78	5.97	5.13	4.31	3.54	2.80	2.09	1.45	0.99	0.62	0.36	0.18	0.05	
112	7.25	6.44	5.58	4.74	3.94	3.16	2.40	1.70	1.19	0.78	0.50	0.30	0.16	0.04

EXCESS HOURS CONSUMED PER 1000 SPEED CHANGE CYCLES
TAXI VAN AND PICKUP (HIAP 5 KIP)

INITIAL RUNNING SPEED	SPEED REDUCED TO AND RETURNED FROM, KPH													
	STOP	8	16	24	32	40	48	56	64	72	80	88	96	104
kph														
8	0.73													
16	1.12	0.58												
24	1.52	0.98	0.47											
32	1.93	1.37	0.86	0.41										
40	2.36	1.77	1.24	0.76	0.35									
48	2.81	2.20	1.63	1.13	0.68	0.30								
56	3.28	2.64	2.05	1.52	1.04	0.62	0.27							
64	3.78	3.11	2.50	1.93	1.42	0.96	0.57	0.25						
72	4.30	3.62	2.96	2.36	1.81	1.32	0.89	0.53	0.24					
80	4.87	4.16	3.48	2.84	2.26	1.73	1.26	0.84	0.49	0.22				
88	5.48	4.75	4.04	3.37	2.74	2.16	1.64	1.18	0.79	0.47	0.22			
96	6.15	5.40	4.67	3.96	3.28	2.65	2.07	1.56	1.11	0.73	0.43	0.21		
104	6.90	6.15	5.40	4.67	3.97	3.30	2.67	2.10	1.57	1.12	0.72	0.41	0.21	
112	7.75	6.99	6.23	5.45	4.73	4.01	3.25	2.66	2.04	1.57	1.06	0.70	0.38	0.20

EXCESS HOURS CONSUMED PER 1000 SPEED CHANGE CYCLES
BUS AND SINGLE TRUCK (HIAP 40 KIP)

INITIAL RUNNING SPEED	SPEED REDUCED TO AND RETURNED FROM, KPH													
	STOP	8	16	24	32	40	48	56	64	72	80	88	96	10
kph														
8	0.67													
16	1.47	0.61												
24	2.30	1.34	0.55											
32	3.19	2.08	1.19	0.50										
40	4.16	2.97	1.95	1.12	0.47									
48	5.22	3.98	2.85	1.88	1.07	0.44								
56	6.41	5.14	3.94	2.84	1.68	1.07	0.44							
64	7.76	6.48	5.24	4.05	2.96	1.98	1.16	0.49						
72	9.35	8.07	6.80	5.57	4.37	3.25	2.21	1.31	0.57					
80	11.34	10.02	8.70	7.40	6.12	4.88	3.72	2.64	1.66	0.78				
88	13.94	12.52	11.12	9.74	8.38	7.05	5.76	4.50	3.30	2.14	1.04			
96	17.47	15.87	14.29	12.73	11.18	9.67	8.18	6.73	5.30	3.91	2.56	1.25		
104	20.90	19.30	17.60	15.80	13.80	12.20	10.60	8.80	7.20	5.70	4.00	2.20	0.60	
112	24.40	22.60	20.80	18.70	16.40	14.80	13.20	11.00	9.10	7.60	5.60	3.70	1.80	0.

EXCESS HOURS CONSUMED PER 1000 SPEED CHANGE CYCLES
COMBINATION AND ARTICULATED TRUCKS (HIAP 50 KIP)

INITIAL RUNNING SPEED	SPEED REDUCED TO AND RETURNED FROM, KPH													
	STOP	8	16	24	32	40	48	56	64	72	80	88	96	104
kph														
8	1.10													
16	2.27	0.95												
24	3.48	1.96	0.81											
32	4.76	3.05	1.71	0.69										
40	6.10	4.25	2.72	1.49	0.60									
48	7.56	5.59	3.90	2.45	1.36	0.54								
56	9.19	7.12	5.29	3.66	2.35	1.31	0.52							
64	11.09	8.94	6.99	5.20	3.66	2.40	1.36	0.58						
72	13.39	11.20	9.12	7.19	5.45	3.95	2.65	1.58	0.71					
80	16.37	14.13	11.95	9.88	7.95	6.19	4.60	3.18	1.95	0.89				
88	20.72	18.33	15.98	13.71	11.53	9.45	7.48	5.66	3.98	2.48	1.15			
96	27.94	24.99	22.10	19.28	16.55	13.93	11.44	9.10	6.92	4.92	3.10	1.46		
104	36.00	32.00	27.60	24.80	21.60	18.80	15.30	12.50	10.00	7.20	5.20	3.20	1.30	
112	44.00	38.60	33.20	30.50	26.60	23.30	19.20	15.80	12.90	9.80	7.00	4.90	2.90	0.80

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COSTS PER 1000 KILOMETERS BY SPEED (All costs in LE) (financial)

****

(excluding time cost) Roughness = 2000 mm/km

TOTAL OPERATING COSTS

SPEED (KPH)	CAR	TAXI-C	TAXI-V	PICK-U	BUS	TRK-S	TRK-C	TRK-A
5	101.0	310.3	382.6	314.7	584.5	452.4	863.0	1128.9
10	81.3	207.2	262.0	221.7	424.1	350.8	649.4	809.6
15	74.8	173.0	222.1	190.8	370.7	317.0	578.3	703.3
20	71.7	156.0	202.5	175.6	344.0	300.2	542.8	650.2
25	70.5	146.5	195.0	168.6	334.3	293.5	531.6	641.6
30	71.6	142.4	190.5	165.5	328.1	289.5	524.8	637.4
35	72.7	139.7	187.9	163.7	323.9	286.8	520.6	635.4
40	73.8	137.9	186.5	162.7	320.9	285.0	517.8	634.7
45	75.0	136.8	185.8	162.2	318.7	283.8	515.9	634.7
50	76.1	136.0	185.8	162.1	317.0	282.9	514.7	635.1
55	77.2	135.6	186.2	162.4	315.8	282.3	513.9	635.8
60	78.4	135.5	187.0	162.9	314.8	282.0	513.5	636.7
65	79.5	135.5	188.1	163.5	314.0	281.7	513.4	637.7
70	80.7	135.7	189.5	164.4	313.4	281.6	513.4	638.8
75	81.9	136.1	191.1	165.4	313.0	281.6	513.6	640.0
80	83.1	136.6	193.0	166.5	312.7	281.7	514.0	641.2
85	84.3	137.2	195.1	167.8	312.5	281.8	514.5	642.4
90	85.5	137.9	197.4	169.2	312.3	282.0	515.1	643.7
95	86.8	138.7	200.0	170.7	312.3	282.2	515.8	645.0
100	88.1	139.6	202.7	172.4	312.3	282.6	516.6	646.4
105	89.4	140.6	205.5	174.1	312.3	282.9	517.5	647.7
110	90.8	141.7	208.6	176.0	312.4	283.3	518.4	649.1
115	92.2	142.8	211.8	177.9	312.6	283.7	519.4	650.5
120	93.7	144.0	215.2	180.0	312.8	284.2	520.5	652.0

COSTS PER 1000 KILOMETERS BY SPEED (All costs in LE) (economic)

****

(excluding time cost) Roughness = 2000 mm/km

TOTAL OPERATING COSTS

SPEED (KPH)	CAR	TAXI-C	TAXI-V	PICK-U	BUS	TRK-S	TRK-C	TRK-A
5	106.1	275.7	351.5	301.6	612.3	492.4	1033.8	1321.0
10	85.2	183.9	239.1	211.8	444.6	377.6	789.5	960.9
15	78.4	153.4	202.0	182.1	389.0	339.7	708.8	841.6
20	75.1	138.3	183.7	167.5	361.5	321.1	669.3	782.6
25	73.8	129.8	176.1	160.6	351.1	313.5	655.8	771.9
30	74.9	125.7	171.6	157.4	344.7	309.2	648.4	767.1
35	76.1	123.0	168.9	155.5	340.7	306.7	644.3	765.4
40	77.3	121.2	167.4	154.5	338.1	305.3	642.5	765.6
45	78.5	120.0	166.7	154.0	336.5	304.8	642.2	767.0
50	79.7	119.3	166.7	153.9	335.6	304.9	643.0	769.4
55	80.9	118.9	167.1	154.1	335.2	305.5	644.8	772.3
60	82.2	118.7	167.9	154.6	335.3	306.4	647.3	775.9
65	83.4	118.7	169.1	155.3	335.8	307.7	650.5	779.9
70	84.6	119.0	170.5	156.2	336.6	309.3	654.2	784.3
75	85.8	119.3	172.2	157.2	337.6	311.2	658.5	789.0
80	87.1	119.8	174.2	158.4	338.9	313.3	663.3	794.2
85	88.4	120.5	176.4	159.7	340.5	315.6	668.5	799.6
90	89.7	121.2	178.8	161.2	342.2	318.1	674.2	805.4
95	91.0	122.0	181.5	162.8	344.1	320.9	680.3	811.5
100	92.4	123.0	184.3	164.5	346.2	323.8	686.9	817.9
105	93.8	124.0	187.3	166.3	348.5	326.9	693.8	824.6
110	95.3	125.1	190.6	168.3	350.9	330.2	701.2	831.6
115	96.8	126.3	194.0	170.3	353.5	333.7	708.9	838.9
120	98.3	127.6	197.6	172.5	356.3	337.4	717.0	846.5

COSTS PER 1000 KILOMETERS BY SPEED (All costs in LE) (for exch)

****

(excluding time cost) Roughness = 2000 mm/km

TOTAL OPERATING COSTS

SPEED (KPH)	CAR	TAXI-C	TAXI-V	PICK-U	BUS	TRK-S	TRK-C	TRK-A
5	40.1	40.3	52.1	34.1	62.6	43.6	132.3	424.3
10	32.8	26.5	36.2	24.3	46.4	33.4	95.8	288.0
15	30.4	21.9	31.0	21.0	41.0	30.0	83.7	242.6
20	29.2	19.6	28.3	19.4	38.3	28.4	77.6	219.8
25	28.8	18.4	28.3	19.0	38.0	28.4	76.8	219.8
30	29.7	18.4	28.4	19.2	37.8	28.5	76.5	220.6
35	30.6	18.4	28.5	19.4	37.7	28.7	76.4	221.7
40	31.3	18.5	28.7	19.6	37.6	28.8	76.3	222.9
45	31.9	18.5	28.8	19.7	37.6	29.0	76.4	224.1
50	32.5	18.6	28.9	19.9	37.6	29.1	76.5	225.2
55	33.0	18.6	29.1	20.0	37.6	29.2	76.6	226.3
60	33.5	18.7	29.2	20.2	37.6	29.3	76.7	227.3
65	33.9	18.8	29.3	20.3	37.6	29.4	76.8	228.2
70	34.3	18.8	29.4	20.4	37.6	29.5	76.8	229.1
75	34.6	18.9	29.5	20.5	37.6	29.6	76.9	229.9
80	34.9	18.9	29.6	20.6	37.6	29.7	77.0	230.6
85	35.2	19.0	29.6	20.6	37.7	29.8	77.1	231.3
90	35.4	19.0	29.7	20.7	37.7	29.9	77.2	231.9
95	35.7	19.0	29.8	20.8	37.7	29.9	77.3	232.5
100	35.9	19.1	29.8	20.9	37.7	30.0	77.4	233.0
105	36.1	19.1	29.9	20.9	37.7	30.1	77.4	233.5
110	36.3	19.2	30.0	21.0	37.7	30.1	77.5	234.0
115	36.5	19.2	30.0	21.0	37.7	30.2	77.6	234.5
120	36.7	19.2	30.1	21.1	37.8	30.2	77.6	234.9

COSTS PER 1000 KILOMETERS BY SPEED (All costs in LE) (fin perc)

****

(excluding time cost) Roughness = 2000 mm/km

TOTAL OPERATING COSTS

SPEED (KPH)	CAR	TAXI-C	TAXI-V	PICK-U	BUS	TRK-S	TRK-C	TRK-A
5	38.0	279.3	344.3	314.7	526.0	407.1	776.7	1016.0
10	28.9	186.5	235.8	221.7	381.7	315.7	584.4	728.7
15	26.0	155.7	199.9	190.8	333.6	285.3	520.4	633.0
20	24.7	140.4	182.3	175.6	309.6	270.2	488.5	585.2
25	24.0	131.9	175.5	168.6	300.9	264.2	478.4	577.4
30	23.7	128.2	171.5	165.5	295.3	260.5	472.4	573.6
35	23.6	125.7	169.1	163.7	291.5	258.1	468.5	571.9
40	23.7	124.1	167.8	162.7	288.8	256.5	466.0	571.2
45	23.9	123.1	167.2	162.2	286.8	255.4	464.3	571.2
50	24.2	122.4	167.2	162.1	285.3	254.6	463.2	571.6
55	24.6	122.1	167.6	162.4	284.2	254.1	462.5	572.3
60	25.1	121.9	168.3	162.9	283.3	253.8	462.2	573.1
65	25.6	122.0	169.3	163.5	282.6	253.5	462.0	574.0
70	26.2	122.2	170.5	164.4	282.1	253.4	462.1	575.0
75	26.9	122.5	172.0	165.4	281.7	253.4	462.3	576.0
80	27.6	122.9	173.7	166.5	281.4	253.5	462.6	577.1
85	28.5	123.5	175.6	167.8	281.2	253.6	463.1	578.2
90	29.3	124.1	177.7	169.2	281.1	253.8	463.6	579.3
95	30.2	124.8	180.0	170.7	281.0	254.0	464.2	580.5
100	31.2	125.7	182.4	172.4	281.0	254.3	464.9	581.7
105	32.3	126.5	185.0	174.1	281.1	254.6	465.7	582.9
110	33.4	127.5	187.7	176.0	281.2	255.0	466.6	584.2
115	34.5	128.5	190.7	177.9	281.3	255.3	467.5	585.5
120	35.7	129.6	193.7	180.0	281.5	255.8	468.5	586.8

EXCESS COST OF 1000 SPEED CHANGE CYCLES (FRACTION OF FREE FLOW COST PER 1000 KMS AT INITIAL
CAR AND TAXI (HIAP 4 KIP)

INIT RUN SPD	STOP	8	16	24	32	40	48	56	64	72	80	88	96	104
	SPEED REDUCED TO AND RETURNED FROM, KPH													
kph	0.3682 = IDLING COST PER HOUR AS FRACTION OF HOURLY COST AT 8 KPH													
8	0.012													
16	0.027	0.014												
24	0.048	0.034	0.017											
32	0.078	0.061	0.044	0.024										
40	0.108	0.090	0.073	0.051	0.028									
48	0.142	0.125	0.106	0.085	0.061	0.032								
56	0.187	0.169	0.151	0.128	0.101	0.072	0.040							
64	0.229	0.211	0.193	0.171	0.145	0.116	0.083	0.043						
72	0.272	0.254	0.233	0.211	0.186	0.157	0.126	0.087	0.046					
80	0.315	0.298	0.280	0.257	0.232	0.205	0.174	0.136	0.095	0.050				
88	0.346	0.330	0.313	0.295	0.268	0.241	0.213	0.177	0.138	0.096	0.049			
96	0.382	0.367	0.351	0.333	0.310	0.284	0.257	0.221	0.184	0.144	0.099	0.052		
104	0.423	0.408	0.392	0.375	0.353	0.328	0.301	0.270	0.233	0.195	0.153	0.107	0.058	
112	0.471	0.455	0.442	0.425	0.405	0.381	0.357	0.325	0.292	0.256	0.217	0.172	0.126	0.072

EXCESS COST OF 1000 SPEED CHANGE CYCLES (FRACTION OF FREE FLOW COST PER 1000 KMS AT INITIAL
TAXI VAN AND PICKUP (HIAP 5 KIP)

INIT RUNNING SPEED	STOP	8	16	24	32	40	48	56	64	72	80	88	96	104
	SPEED REDUCED TO AND RETURNED FROM, KPH													
kph	0.3905 = IDLING COST PER HOUR AS FRACTION OF HOURLY COST AT 8 KPH													
8	0.014													
16	0.033	0.017												
24	0.061	0.042	0.023											
32	0.101	0.081	0.058	0.031										
40	0.136	0.116	0.093	0.068	0.035									
48	0.175	0.154	0.132	0.107	0.074	0.039								
56	0.220	0.200	0.177	0.153	0.121	0.086	0.046							
64	0.264	0.245	0.222	0.198	0.169	0.134	0.095	0.050						
72	0.303	0.284	0.263	0.239	0.210	0.178	0.142	0.098	0.052					
80	0.342	0.325	0.303	0.281	0.255	0.222	0.188	0.146	0.101	0.053				
88	0.388	0.371	0.353	0.331	0.303	0.274	0.239	0.200	0.156	0.109	0.058			
96	0.439	0.424	0.405	0.385	0.360	0.330	0.296	0.260	0.217	0.172	0.124	0.068		
104	0.471	0.456	0.439	0.421	0.398	0.372	0.343	0.309	0.268	0.229	0.185	0.135	0.074	
112	0.529	0.516	0.502	0.484	0.463	0.441	0.413	0.382	0.348	0.311	0.272	0.225	0.168	0.102

EXCESS COST OF 1000 SPEED CHANGE CYCLES (FRACTION OF FREE FLOW COST PER 1000 KMS AT INITIAL
BUS AND SINGLE TRUCK (HIAP 40 KIP)

INIT RUNNING SPEED	STOP	SPEED REDUCED TO AND RETURNED FROM, KPH 8	16	24	32	40	48	56	64	72	80	88	96	104
kph	0.2223 = IDLING COST PER HOUR AS FRACTION OF HOURLY COST AT 8 KPH													
8	0.017													
16	0.046	0.026												
24	0.091	0.069	0.039											
32	0.155	0.130	0.098	0.055										
40	0.236	0.210	0.177	0.131	0.072									
48	0.342	0.315	0.279	0.231	0.169	0.093								
56	0.447	0.418	0.382	0.333	0.270	0.191	0.095							
64	0.564	0.531	0.497	0.451	0.384	0.305	0.208	0.112						
72	0.698	0.669	0.631	0.580	0.521	0.440	0.342	0.245	0.131					
80	0.840	0.810	0.773	0.722	0.655	0.584	0.487	0.389	0.276	0.146				
88	0.968	0.944	0.907	0.862	0.792	0.718	0.624	0.529	0.418	0.293	0.150			
96	1.099	1.079	1.039	0.994	0.930	0.854	0.766	0.670	0.569	0.441	0.300	0.154		
104	1.209	1.182	1.151	1.101	1.044	0.967	0.882	0.794	0.691	0.572	0.441	0.300	0.153	
112	1.319	1.296	1.259	1.219	1.163	1.093	0.785	0.919	0.819	0.704	0.578	0.444	0.300	0.153

EXCESS COST OF 1000 SPEED CHANGE CYCLES (FRACTION OF FREE FLOW COST PER 1000 KMS AT INITIAL
COMBINATION AND ARTICULATED TRUCKS (HIAP 50 KIP)

INIT RUNNING SPEED	STOP	SPEED REDUCED TO AND RETURNED FROM, KPH 8	16	24	32	40	48	56	64	72	80	88	96	104
kph	0.2427 = IDLING COST PER HOUR AS FRACTION OF HOURLY COST AT 8 KPH													
5	0.027													
10	0.081	0.046												
15	0.176	0.134	0.078											
20	0.346	0.292	0.222	0.126										
25	0.505	0.452	0.380	0.283	0.153									
30	0.682	0.631	0.560	0.460	0.332	0.179								
35	0.842	0.791	0.720	0.622	0.501	0.344	0.167							
40	1.013	0.963	0.894	0.802	0.669	0.527	0.351	0.187						
45	1.214	1.164	1.100	1.005	0.877	0.732	0.559	0.396	0.210					
50	1.397	1.353	1.287	1.199	1.075	0.934	0.767	0.613	0.428	0.223				
55	1.566	1.524	1.456	1.368	1.254	1.119	0.958	0.806	0.633	0.435	0.224			
60	1.739	1.698	1.633	1.551	1.433	1.306	1.147	1.004	0.837	0.649	0.441	0.224		
65	1.897	1.858	1.800	1.713	1.612	1.479	1.330	1.189	1.037	0.853	0.657	0.446	0.230	
70	2.032	1.991	1.935	1.857	1.760	1.637	1.496	1.358	1.209	1.034	0.845	0.647	0.447	0.226

```
REM
REM Start of the Traffic Model for the Cairo-Assuit Highway Feas. Study
REM
CD \N%1
CLS
IF %1==T1 GOTO STRT
IF %1==C9 GOTO COP9
IF %1==C2 GOTO COP2
IF %1==E9 GOTO COP9
IF %1==E2 GOTO COP2
IF %1==B9 GOTO COP9
IF %1==B2 GOTO COP2
IF %1==O9 GOTO COP9
IF %1==O2 GOTO COP2
IF %1==W2 GOTO COP2
IF %1==S9 GOTO COP9
IF %1==S2 GOTO COP2
IF %1==M2 GOTO COP2
IF %1==EL GOTO COPL
IF %1==EH GOTO COPH
IF %1==OL GOTO COPL
IF %1==OH GOTO COPH
REM
REM Invalid Network Code ..... Cannot proceed, sorry.
REM
GOTO PROB
:COP9
COPY \MATRIX\TRIPS90.TRP \N%1\MATINIT.TRP
COPY \FILES\ZNCST90.PRN \FILES\ZONECOST.PRN
GOTO STRT
:COP2
COPY \MATRIX\TRIPS20.TRP \N%1\MATINIT.TRP
COPY \FILES\ZNCST20.PRN \FILES\ZONECOST.PRN
GOTO STRT
:COPL
COPY \MATRIX\TRIPS2L.TRP \N%1\MATINIT.TRP
COPY \FILES\ZNCST20.PRN \FILES\ZONECOST.PRN
GOTO STRT
:COPH
COPY \MATRIX\TRIPS2H.TRP \N%1\MATINIT.TRP
COPY \FILES\ZNCST20.PRN \FILES\ZONECOST.PRN
:STRT
COPY \FILES\SKIMS\CST86.SKI \N%1\CST86.SKI
COPY \FILES\SKIMS\TIM86.SKI \N%1\TIM86.SKI
COPY \FILES\BYTOLLS.DAT \FILES\TOLLCOST.DAT
IF %2==TC COPY \FILES\TCURRENT.PRN \FILES\TOLLCOST.DAT
IF %2==TL COPY \FILES\TLOW.PRN \FILES\TOLLCOST.DAT
IF %2==TM COPY \FILES\TMEDIUM.PRN \FILES\TOLLCOST.DAT
IF %2==TH COPY \FILES\THIGH.PRN \FILES\TOLLCOST.DAT
IF %2==TV COPY \FILES\TVHIGH.PRN \FILES\TOLLCOST.DAT
CLS
REM Building the First set of paths          Network ... %1, Tolls %2
ROADNET (\SCREENS\RNXXPA.CON
CLS
REM Building the Second set of paths         Network ... %1, Tolls %2
```

```
 56  ROADNET (\SCREENS\RNXXPB.CON
 57  COPY RNXXPA.PRN+RNXXPB.PRN RN%1PATH.PRN
 58  IF %1==E9 GOTO LAB1
 59  IF %1==E2 GOTO LAB1
 60  IF %1==EL GOTO LAB1
 61  IF %1==EH GOTO LAB1
 62  IF %1==S9 GOTO LAB1
 63  IF %1==S2 GOTO LAB1
 64  IF %1==M2 GOTO LAB1
 65  IF %1==T1 GOTO LAB1
 66  GOTO SKP1
 67  :LAB1
 68  CLS
 69  REM Building the Third set of paths          Network ... %1, Tolls %2
 70  ROADNET (\SCREENS\RNXXPC.CON
 71  COPY RNXXPA.PRN+RNXXPB.PRN+RNXXPC.PRN RN%1PATH.PRN
 72  ERASE RNXXPC.PRN
 73  :SKP1
 74  ERASE RNXXPA.PRN
 75  ERASE RNXXPB.PRN
 76  CD\PRINTER
 77  CPRINT \N%1\RN%1PATH.PRN \N%1\OUTPUT\RN%1PATH.LST -H17 -P1 -FF
 78  ERASE \N%1\RN%1PATH.PRN
 79  BEEP /R2
 80  REM
 81  REM Start of Cycle 1
 82  REM
 83  CD \N%1
 84  CLS
 85  REM Run Link Costing Program                 Network ... %1, Cycle 1
 86  LNKCOST (\SCREENS\LCXXG1.CON
 87  CD\PRINTER
 88  CPRINT \N%1\LCXXG1.PRN \N%1\OUTPUT\LC%1G1.LST -H17 -P1 -FF
 89  ERASE \N%1\LCXXG1.PRN
 90  BEEP /R2
 91  CD \N%1
 92  CLS
 93  REM Run the Diversion Program                Network ... %1, Cycle 1
 94  DVERSION (\SCREENS\DVXXG1.CON
 95  CD\PRINTER
 96  CPRINT \N%1\DVXXG1.PRN \N%1\OUTPUT\DV%1G1.LST -H17 -P1 -FF
 97  ERASE \N%1\DVXXG1.PRN
 98  BEEP /R2
 99  CD \N%1
100  CLS
101  REM Calc PCU matrix for Path A (veh 1 to 6)   Network ... %1, Cycle 1
102  MATR03 (\SCREENS\M3XX6AG1.CON
103  CLS
104  REM Calc PCU matrix for Path A (veh 1 to 9)   Network ... %1, Cycle 1
105  MATR03 (\SCREENS\M3XX9AG1.CON
106  CLS
107  REM Load Path A trips (sequential load file)  Network ... %1, Cycle 1
108  NLOAD (\SCREENS\NLXXSAG1.CON
109  CLS
110  REM Add Path A trips to local traffic         Network ... %1, Cycle 1
```

```
111  ADDLOD (\SCREENS\ALXXSAG1.CON
112  CLS
113  REM Calc PCU matrix for Path B (veh 1 to 6)    Network ... %1, Cycle 1
114  MATR03 (\SCREENS\M3XX6BG1.CON
115  CLS
116  REM Calc PCU matrix for Path B (veh 1 to 9)    Network ... %1, Cycle 1
117  MATR03 (\SCREENS\M3XX9BG1.CON
118  CLS
119  REM Load Path B trips (sequential load file)   Network ... %1, Cycle 1
120  NLOAD (\SCREENS\NLXXSBG1.CON
121  CLS
122  REM Add Path B trips to Path A + local traf.   Network ... %1, Cycle 1
123  ADDLOD (\SCREENS\ALXXSBG1.CON
124  COPY M3XX6AG1.PRN+M3XX9AG1.PRN+NLXXSAG1.PRN+ALXXSAG1.PRN TEMP1.PRN
125  COPY M3XX6BG1.PRN+M3XX9BG1.PRN+NLXXSBG1.PRN+ALXXSBG1.PRN TEMP2.PRN
126  COPY TEMP1.PRN+TEMP2.PRN M3%1SQG1.PRN
127  ERASE M3XX6AG1.PRN
128  ERASE M3XX9AG1.PRN
129  ERASE NLXXSAG1.PRN
130  ERASE ALXXSAG1.PRN
131  ERASE M3XX6BG1.PRN
132  ERASE M3XX9BG1.PRN
133  ERASE NLXXSBG1.PRN
134  ERASE ALXXSBG1.PRN
135  IF %1==E9 GOTO LAB3
136  IF %1==E2 GOTO LAB3
137  IF %1==EL GOTO LAB3
138  IF %1==EH GOTO LAB3
139  IF %1==S9 GOTO LAB3
140  IF %1==S2 GOTO LAB3
141  IF %1==M2 GOTO LAB3
142  IF %1==T1 GOTO LAB3
143  IF EXIST NETENDG1.DES ERASE NETENDG1.DES
144  REN NETLABG1.DES NETENDG1.DES
145  GOTO SKP3
146  :LAB3
147  CLS
148  REM Calc PCU matrix for Path C (veh 1 to 6)    Network ... %1, Cycle 1
149  MATR03 (\SCREENS\M3XX6CG1.CON
150  CLS
151  REM Calc PCU matrix for Path C (veh 1 to 9)    Network ... %1, Cycle 1
152  MATR03 (\SCREENS\M3XX9CG1.CON
153  CLS
154  REM Load Path C trips (sequential load file)   Network ... %1, Cycle 1
155  NLOAD (\SCREENS\NLXXSCG1.CON
156  CLS
157  REM Add Path C to Paths A, B + local traf.     Network ... %1, Cycle 1
158  ADDLOD (\SCREENS\ALXXSCG1.CON
159  COPY M3XX6CG1.PRN+M3XX9CG1.PRN+NLXXSCG1.PRN+ALXXSCG1.PRN TEMP3.PRN
160  COPY TEMP1.PRN+TEMP2.PRN+TEMP3.PRN M3%1SQG1.PRN
161  ERASE M3XX6CG1.PRN
162  ERASE M3XX9CG1.PRN
163  ERASE NLXXSCG1.PRN
164  ERASE ALXXSCG1.PRN
165  IF EXIST NETENDG1.DES ERASE NETENDG1.DES
```

```
166  REN NETLABC1.DES NETENDG1.DES
167  :SKP3
168  ERASE TEMP1.PRN
169  ERASE TEMP2.PRN
170  IF EXIST TEMP3.PRN ERASE TEMP3.PRN
171  CD\PRINTER
172  CPRINT \N%1\M3%1SQG1.PRN \N%1\OUTPUT\M3%1SQG1.LST -H17 -P1 -FF
173  ERASE \N%1\M3%1SQG1.PRN
174  BEEP /R2
175  REM
176  REM Start of Cycle 2
177  REM
178  :CYC2
179  CD \N%1
180  CLS
181  REM Run Link Costing Program                    Network ... %1, Cycle 2
182  LNKCOST (\SCREENS\LCXXG2.CON
183  CD\PRINTER
184  CPRINT \N%1\LCXXG2.PRN \N%1\OUTPUT\LC%1G2.LST -H17 -P1 -FF
185  ERASE \N%1\LCXXG2.PRN
186  BEEP /R2
187  CD \N%1
188  CLS
189  REM Run Generation - Degeneration Program       Network ... %1, Cycle 2
190  GENDEGEN (\SCREENS\GDXXG2.CON
191  CD\PRINTER
192  CPRINT \N%1\GDXXG2.PRN \N%1\OUTPUT\GD%1G2.LST -H17 -P1 -FF
193  ERASE \N%1\GDXXG2.PRN
194  BEEP /R2
195  CD \N%1
196  CLS
197  REM Run the Diversion Program                   Network ... %1, Cycle 2
198  DVERSION (\SCREENS\DVXXG2.CON
199  CD\PRINTER
200  CPRINT \N%1\DVXXG2.PRN \N%1\OUTPUT\DV%1G2.LST -H17 -P1 -FF
201  ERASE \N%1\DVXXG2.PRN
202  BEEP /R2
203  CD \N%1
204  CLS
205  REM Calc PCU matrix for Path A (veh 1 to 6)     Network ... %1, Cycle 2
206  MATR03 (\SCREENS\M3XX6AG2.CON
207  CLS
208  REM Calc PCU matrix for Path A (veh 1 to 9)     Network ... %1, Cycle 2
209  MATR03 (\SCREENS\M3XX9AG2.CON
210  CLS
211  REM Load Path A trips (sequential load file)    Network ... %1, Cycle 2
212  NLOAD (\SCREENS\NLXXSAG2.CON
213  CLS
214  REM Add Path A trips to local traffic           Network ... %1, Cycle 2
215  ADDLOD (\SCREENS\ALXXSAG2.CON
216  CLS
217  REM Calc PCU matrix for Path B (veh 1 to 6)     Network ... %1, Cycle 2
218  MATR03 (\SCREENS\M3XX6BG2.CON
219  CLS
220  REM Calc PCU matrix for Path B (veh 1 to 9)     Network ... %1, Cycle 2
```

```
221 MATRO3 (\SCREENS\M3XX9BG2.CON
222 CLS
223 REM Load Path B trips (sequential load file)   Network ... %1, Cycle 2
224 NLOAD (\SCREENS\NLXXSBG2.CON
225 CLS
226 REM Add Path B trips to Path A + local traf.   Network ... %1, Cycle 2
227 ADDLOD (\SCREENS\ALXXSBG2.CON
228 COPY M3XX6AG2.PRN+M3XX9AG2.PRN+NLXXSAG2.PRN+ALXXSAG2.PRN TEMP1.PRN
229 COPY M3XX6BG2.PRN+M3XX9BG2.PRN+NLXXSBG2.PRN+ALXXSBG2.PRN TEMP2.PRN
230 COPY TEMP1.PRN+TEMP2.PRN M3%1SQG2.PRN
231 ERASE M3XX6AG2.PRN
232 ERASE M3XX9AG2.PRN
233 ERASE NLXXSAG2.PRN
234 ERASE ALXXSAG2.PRN
235 ERASE M3XX6BG2.PRN
236 ERASE M3XX9BG2.PRN
237 ERASE NLXXSBG2.PRN
238 ERASE ALXXSBG2.PRN
239 IF %1==E9 GOTO LAB6
240 IF %1==E2 GOTO LAB6
241 IF %1==EL GOTO LAB6
242 IF %1==EH GOTO LAB6
243 IF %1==S9 GOTO LAB6
244 IF %1==S2 GOTO LAB6
245 IF %1==M2 GOTO LAB6
246 IF %1==T1 GOTO LAB6
247 IF EXIST NETENDG2.DES ERASE NETENDG2.DES
248 REN NETLABG2.DES NETENDG2.DES
249 GOTO SKP6
250 :LAB6
251 CLS
252 REM Calc PCU matrix for Path C (veh 1 to 6)    Network ... %1, Cycle 2
253 MATRO3 (\SCREENS\M3XX6CG2.CON
254 CLS
255 REM Calc PCU matrix for Path C (veh 1 to 9)    Network ... %1, Cycle 2
256 MATRO3 (\SCREENS\M3XX9CG2.CON
257 CLS
258 REM Load Path C trips (sequential load file)   Network ... %1, Cycle 2
259 NLOAD (\SCREENS\NLXXSCG2.CON
260 CLS
261 REM Add Path C to Paths A, B + local traf.     Network ... %1, Cycle 2
262 ADDLOD (\SCREENS\ALXXSCG2.CON
263 COPY M3XX6CG2.PRN+M3XX9CG2.PRN+NLXXSCG2.PRN+ALXXSCG2.PRN TEMP3.PRN
264 COPY TEMP1.PRN+TEMP2.PRN+TEMP3.PRN M3%1SQG2.PRN
265 ERASE M3XX6CG2.PRN
266 ERASE M3XX9CG2.PRN
267 ERASE NLXXSCG2.PRN
268 ERASE ALXXSCG2.PRN
269 IF EXIST NETENDG2.DES ERASE NETENDG2.DES
270 REN NETLABC2.DES NETENDG2.DES
271 :SKP6
272 CD\PRINTER
273 CPRINT \N%1\M3%1SQG2.PRN \N%1\OUTPUT\M3%1SQG2.LST -H17 -P1 -FF
274 ERASE \N%1\M3%1SQG2.PRN
275 BEEP /R2
```

```
276  CD \N%1
277  IF NOT %1==T1 ERASE \N%1\MATINIT.TRP
278  IF NOT %1==T1 ERASE \N%1\CST86.SKI
279  IF NOT %1==T1 ERASE \N%1\TIM86.SKI
280  ERASE \N%1\DUMMY.DES
281  ERASE \N%1\CSTPAG1.SKI
282  ERASE \N%1\TIMPAG1.SKI
283  ERASE \N%1\MATPAG1.TRP
284  ERASE \N%1\PCU6AG1.TRP
285  ERASE \N%1\PCU9AG1.TRP
286  ERASE \N%1\NLXXSAG1.LOD
287  ERASE \N%1\NETLTAG1.DES
288  ERASE \N%1\CSTPBG1.SKI
289  ERASE \N%1\TIMPBG1.SKI
290  ERASE \N%1\MATPBG1.TRP
291  ERASE \N%1\PCU6BG1.TRP
292  ERASE \N%1\PCU9BG1.TRP
293  ERASE \N%1\NLXXSBG1.LOD
294  ERASE \N%1\NETENDG1.DES
295  IF %1==E9 GOTO LAB7
296  IF %1==E2 GOTO LAB7
297  IF %1==EL GOTO LAB7
298  IF %1==EH GOTO LAB7
299  IF %1==S9 GOTO LAB7
300  IF %1==S2 GOTO LAB7
301  IF %1==M2 GOTO LAB7
302  IF %1==T1 GOTO LAB7
303  GOTO SKP7
304  :LAB7
305  ERASE \N%1\CSTPCC1.SKI
306  ERASE \N%1\TIMPCG1.SKI
307  ERASE \N%1\MATPCG1.TRP
308  ERASE \N%1\PCU6CG1.TRP
309  ERASE \N%1\PCU9CG1.TRP
310  ERASE \N%1\NLXXSCG1.LOD
311  ERASE \N%1\NETLABC1.DES
312  :SKP7
313  :CYC3
314  REM
315  REM Start of Cycle 3
316  REM
317  CD \N%1
318  CLS
319  REM Run Link Costing Program                    Network ... %1, Cycle 3
320  LNKCOST (\SCREENS\LCXXG3.CON
321  CD\PRINTER
322  CPRINT \N%1\LCXXG3.PRN \N%1\OUTPUT\LC%1G3.LST -H17 -P1 -FF
323  ERASE \N%1\LCXXG3.PRN
324  BEEP /R2
325  CD \N%1
326  CLS
327  REM Run Generation - Degeneration Program       Network ... %1, Cycle 3
328  GENDEGEN (\SCREENS\GDXXG3.CON
329  CD\PRINTER
330  CPRINT \N%1\GDXXG3.PRN \N%1\OUTPUT\GD%1G3.LST -H17 -P1 -FF
```

```
331  ERASE \N%1\GDXXG3.PRN
332  BEEP /R2
333  CD \N%1
334  CLS
335  REM Run the Diversion Program                Network ... %1, Cycle 3
336  DVERSION (\SCREENS\DVXXG3.CON
337  CD\PRINTER
338  CPRINT \N%1\DVXXG3.PRN \N%1\OUTPUT\DV%1G3.LST -H17 -P1 -FF
339  ERASE \N%1\DVXXG3.PRN
340  BEEP /R2
341  CD \N%1
342  CLS
343  REM Calc PCU matrix for Path A (veh 1 to 6)    Network ... %1, Cycle 3
344  MATR03 (\SCREENS\M3XX6AG3.CON
345  CLS
346  REM Calc PCU matrix for Path A (veh 1 to 9)    Network ... %1, Cycle 3
347  MATR03 (\SCREENS\M3XX9AG3.CON
348  CLS
349  REM Load Path A trips (sequential load file)   Network ... %1, Cycle 3
350  NLOAD (\SCREENS\NLXXSAG3.CON
351  CLS
352  REM Add Path A trips to local traffic          Network ... %1, Cycle 3
353  ADDLOD (\SCREENS\ALXXSAG3.CON
354  CLS
355  REM Calc PCU matrix for Path B (veh 1 to 6)    Network ... %1, Cycle 3
356  MATR03 (\SCREENS\M3XX6BG3.CON
357  CLS
358  REM Calc PCU matrix for Path B (veh 1 to 9)    Network ... %1, Cycle 3
359  MATR03 (\SCREENS\M3XX9BG3.CON
360  CLS
361  REM Load Path B trips (sequential load file)   Network ... %1, Cycle 3
362  NLOAD (\SCREENS\NLXXSBG3.CON
363  CLS
364  REM Add Path B trips to Path A + local traf.   Network ... %1, Cycle 3
365  ADDLOD (\SCREENS\ALXXSBG3.CON
366  COPY M3XX6AG3.PRN+M3XX9AG3.PRN+NLXXSAG3.PRN+ALXXSAG3.PRN TEMP1.PRN
367  COPY M3XX6BG3.PRN+M3XX9BG3.PRN+NLXXSBG3.PRN+ALXXSBG3.PRN TEMP2.PRN
368  COPY TEMP1.PRN+TEMP2.PRN M3%1SQG3.PRN
369  ERASE M3XX6AG3.PRN
370  ERASE M3XX9AG3.PRN
371  ERASE NLXXSAG3.PRN
372  ERASE ALXXSAG3.PRN
373  ERASE M3XX6BG3.PRN
374  ERASE M3XX9BG3.PRN
375  ERASE NLXXSBG3.PRN
376  ERASE ALXXSBG3.PRN
377  IF %1==E9 GOTO LAB9
378  IF %1==E2 GOTO LAB9
379  IF %1==EL GOTO LAB9
380  IF %1==EH GOTO LAB9
381  IF %1==S9 GOTO LAB9
382  IF %1==S2 GOTO LAB9
383  IF %1==M2 GOTO LAB9
384  IF %1==T1 GOTO LAB9
385  IF EXIST NETENDG3.DES ERASE NETENDG3.DES
```

```
386  REN NETLABC3.DES NETENDC3.DES
387  GOTO SKP9
388  :LAB9
389  CLS
390  REM Calc PCU matrix for Path C (veh 1 to 6)    Network ... %1, Cycle 3
391  MATR03 (\SCREENS\M3XX6CC3.CON
392  CLS
393  REM Calc PCU matrix for Path C (veh 1 to 9)    Network ... %1, Cycle 3
394  MATR03 (\SCREENS\M3XX9CC3.CON
395  CLS
396  REM Load Path C trips (sequential load file)   Network ... %1, Cycle 3
397  NLOAD (\SCREENS\NLXXSCC3.CON
398  CLS
399  REM Add Path C to Paths A, B + local traf.     Network ... %1, Cycle 3
400  ADDLOD (\SCREENS\ALXXSCC3.CON
401  COPY M3XX6CC3.PRN+M3XX9CC3.PRN+NLXXSCC3.PRN+ALXXSCC3.PRN TEMP3.PRN
402  COPY TEMP1.PRN+TEMP2.PRN+TEMP3.PRN M3%1SQC3.PRN
403  ERASE M3XX6CC3.PRN
404  ERASE M3XX9CC3.PRN
405  ERASE NLXXSCC3.PRN
406  ERASE ALXXSCC3.PRN
407  IF EXIST NETENDC3.DES ERASE NETENDC3.DES
408  REN NETLABC3.DES NETENDC3.DES
409  :SKP9
410  CD\PRINTER
411  CPRINT \N%1\M3%1SQC3.PRN \N%1\OUTPUT\M3%1SQC3.LST -H17 -P1 -FF
412  ERASE \N%1\M3%1SQC3.PRN
413  BEEP /R2
414  CD \N%1
415  ERASE \N%1\CSTPAC2.SKI
416  ERASE \N%1\TIMPAC2.SKI
417  ERASE \N%1\MATPAC2.TRP
418  ERASE \N%1\CSTPBC2.SKI
419  ERASE \N%1\TIMPBC2.SKI
420  ERASE \N%1\MATPBC2.TRP
421  ERASE \N%1\PCU6AC2.TRP
422  ERASE \N%1\PCU9AC2.TRP
423  ERASE \N%1\NLXXSAC2.LOD
424  ERASE \N%1\NETLTAC2.DES
425  ERASE \N%1\PCU6BC2.TRP
426  ERASE \N%1\PCU9BC2.TRP
427  ERASE \N%1\NLXXSBC2.LOD
428  ERASE \N%1\NETENDC2.DES
429  IF %1==E9 GOTO LAB97
430  IF %1==E2 GOTO LAB97
431  IF %1==EL GOTO LAB97
432  IF %1==EH GOTO LAB97
433  IF %1==S9 GOTO LAB97
434  IF %1==S2 GOTO LAB97
435  IF %1==M2 GOTO LAB97
436  IF %1==T1 GOTO LAB97
437  GOTO SKP97
438  :LAB97
439  ERASE \N%1\CSTPCC2.SKI
440  ERASE \N%1\TIMPCC2.SKI
```

```
441  ERASE \N%1\MATPCG2.TRP
442  ERASE \N%1\PCU6CG2.TRP
443  ERASE \N%1\PCU9CG2.TRP
444  ERASE \N%1\NLXXSCG2.LOD
445  ERASE \N%1\NETLABC2.DES
446  :SKP97
447  COPY MATPAG3.TRP MATPA.TRP
448  COPY MATPBG3.TRP MATPB.TRP
449  COPY PCU6AG3.TRP PCUPA.TRP
450  COPY PCU6BG3.TRP PCUPB.TRP
451  IF %1==C9 GOTO PRNT
452  IF %1==C2 GOTO PRNT
453  IF %1==B9 GOTO PRNT
454  IF %1==B2 GOTO PRNT
455  IF %1==O9 GOTO PRNT
456  IF %1==O2 GOTO PRNT
457  IF %1==W2 GOTO PRNT
458  IF %1==OL GOTO PRNT
459  IF %1==OH GOTO PRNT
460  COPY MATPCG3.TRP MATPC.TRP
461  COPY PCU6CG3.TRP PCUPC.TRP
462  GOTO PRNT
463  REM
464  REM End of Cycle 3 - Start Final Model Processes
465  REM
466  :PRNT
467  CLS
468  REM Load Path A to DA file (veh 1-6)          Network ... %1
469  NLOAD (\SCREENS\NLXXDA6.CON
470  CLS
471  REM Load Path A to DA file (veh 7-9)          Network ... %1
472  NLOAD (\SCREENS\NLXXDA3.CON
473  CLS
474  REM Load Path A to DA file (veh 1-9)          Network ... %1
475  NLOAD (\SCREENS\NLXXDA9.CON
476  CLS
477  REM Load Local Traffic to DA file (veh 1-9)   Network ... %1
478  LOCALTRF (\SCREENS\LTXXDA.CON
479  COPY NLXXDA6.PRN+NLXXDA3.PRN+NLXXDA9.PRN+LTXXDA.PRN TEMP1.PRN
480  ERASE NLXXDA6.PRN
481  ERASE NLXXDA3.PRN
482  ERASE NLXXDA9.PRN
483  ERASE LTXXDA.PRN
484  CLS
485  REM Load Path B to DA file (veh 1-6)          Network ... %1
486  NLOAD (\SCREENS\NLXXDB6.CON
487  CLS
488  REM Load Path B to DA file (veh 7-9)          Network ... %1
489  NLOAD (\SCREENS\NLXXDB3.CON
490  CLS
491  REM Load Path B to DA file (veh 1-9)          Network ... %1
492  NLOAD (\SCREENS\NLXXDB9.CON
493  COPY NLXXDB6.PRN+NLXXDB3.PRN+NLXXDB9.PRN TEMP2.PRN
494  ERASE NLXXDB6.PRN
495  ERASE NLXXDB3.PRN
```

```
496  ERASE NLXXDB9.PRN
497  COPY TEMP1.PRN+TEMP2.PRN NLXXDA.PRN
498  IF %1==E9 GOTO LAB5
499  IF %1==E2 GOTO LAB5
500  IF %1==EL GOTO LAB5
501  IF %1==EH GOTO LAB5
502  IF %1==S9 GOTO LAB5
503  IF %1==S2 GOTO LAB5
504  IF %1==M2 GOTO LAB5
505  IF %1==T1 GOTO LAB5
506  GOTO SKP75
507  :LAB5
508  CLS
509  REM Load Path C to DA file (veh 1-6)          Network ... %1
510  NLOAD (\SCREENS\NLXXDC6.CON
511  CLS
512  REM Load Path C to DA file (veh 7-9)          Network ... %1
513  NLOAD (\SCREENS\NLXXDC3.CON
514  CLS
515  REM Load Path C to DA file (veh 1-9)          Network ... %1
516  NLOAD (\SCREENS\NLXXDC9.CON
517  COPY NLXXDC6.PRN+NLXXDC3.PRN+NLXXDC9.PRN TEMP3.PRN
518  ERASE NLXXDC6.PRN
519  ERASE NLXXDC3.PRN
520  ERASE NLXXDC9.PRN
521  COPY TEMP1.PRN+TEMP2.PRN+TEMP3.PRN NLXXDA.PRN
522  ERASE TEMP3.PRN
523  :SKP75
524  ERASE TEMP1.PRN
525  ERASE TEMP2.PRN
526  CLS
527  REM Print DA Loading (vehicle types 1-6)      Network ... %1
528  PRTLOD (\SCREENS\PLXX6.CON
529  CLS
530  REM Print DA Loading (vehicle types 1-9)      Network ... %1
531  PRTLOD (\SCREENS\PLXX9.CON
532  COPY PLXX6.PRN+PLXX9.PRN PL%1.PRN
533  ERASE PLXX6.PRN
534  ERASE PLXX9.PRN
535  CD\PRINTER
536  CPRINT \N%1\PL%1.PRN \N%1\OUTPUT\PL%1.LST -H17 -P1 -FF -QD -V6
537  ERASE \N%1\PL%1.PRN
538  CPRINT \N%1\NLXXDA.PRN \N%1\OUTPUT\NLXXDA.LST -H17 -P1 -FF -QD -V6
539  ERASE \N%1\NLXXDA.PRN
540  ERASE \N%1\PCUPA.TRP
541  ERASE \N%1\PCUPB.TRP
542  CD \N%1
543  IF EXIST PCUPC.TRP ERASE PCUPC.TRP
544  CLS
545  REM Run Link Costing Program                  Network ... %1, Cycle 4
546  LNKCOST (\SCREENS\LCXXG4.CON
547  CD\PRINTER
548  CPRINT \N%1\LCXXG4.PRN \N%1\OUTPUT\LC%1G4.LST -H17 -P1 -FF
549  ERASE \N%1\LCXXG4.PRN
550  BEEP /R2
```


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```
551  CD \N%1
552  CLS
553  REM Run Link Costing Prog, for Economic Costs  Network ... %1, Cycle 4
554  LNKCOST (\SCREENS\LCXXG4E.CON
555  CD\PRINTER
556  CPRINT \N%1\LCXXG4E.PRN \N%1\OUTPUT\LC%1G4E.LST -H17 -P1 -FF
557  ERASE \N%1\LCXXG4E.PRN
558  BEEP /R2
559  CD \N%1
560  CLS
561  REM Run Link Costing Prog, for F.Exch. Costs   Network ... %1, Cycle 4
562  LNKCOST (\SCREENS\LCXXG4X.CON
563  CD\PRINTER
564  CPRINT \N%1\LCXXG4X.PRN \N%1\OUTPUT\LC%1G4X.LST -H17 -P1 -FF
565  ERASE \N%1\LCXXG4X.PRN
566  BEEP /R2
567  CD \N%1
568  CLS
569  REM Sector print of Final Mats for Paths A     Network ... %1
570  MATRO2 (\SCREENS\M2XXPA.CON
571  CLS
572  REM Sector print of Final Mats for Paths B     Network ... %1
573  MATRO2 (\SCREENS\M2XXPB.CON
574  COPY M2XXPA.PRN+M2XXPB.PRN M2%1.PRN
575  IF %1==E9 GOTO LAB12
576  IF %1==E2 GOTO LAB12
577  IF %1==EL GOTO LAB12
578  IF %1==EH GOTO LAB12
579  IF %1==S9 GOTO LAB12
580  IF %1==S2 GOTO LAB12
581  IF %1==M2 GOTO LAB12
582  IF %1==T1 GOTO LAB12
583  GOTO SKP12
584  :LAB12
585  CLS
586  REM Sector print of Final Mats for Paths C     Network ... %1
587  MATRO2 (\SCREENS\M2XXPC.CON
588  COPY M2XXPA.PRN+M2XXPB.PRN+M2XXPC.PRN M2%1.PRN
589  ERASE M2XXPC.PRN
590  :SKP12
591  ERASE M2XXPA.PRN
592  ERASE M2XXPB.PRN
593  CD\PRINTER
594  CPRINT \N%1\M2%1.PRN \N%1\OUTPUT\M2%1.LST -H17 -P1 -FF
595  ERASE \N%1\M2%1.PRN
596  BEEP /R2
597  CD \N%1
598  CLS
599  REM Sector print of Final Mats for ALL Paths   Network ... %1
600  MATRO2 (\SCREENS\M2XXALL.CON
601  CD\PRINTER
602  CPRINT \N%1\M2XXALL.PRN \N%1\OUTPUT\M2%1ALL.LST -H17 -P1 -FF
603  ERASE \N%1\M2XXALL.PRN
604  BEEP /R2
605  CD \N%1
```

```
606  CLS
607  REM Distance Skims for Paths A                Network ... %1
608  ROADSKIM (\SCREENS\RSXXDPA.CON
609  CLS
610  REM Distance Skims for Paths B                Network ... %1
611  ROADSKIM (\SCREENS\RSXXDPB.CON
612  COPY RSXXDPA.PRN+RSXXDPB.PRN TEMP1.PRN
613  IF %1==E9 GOTO LAB14
614  IF %1==E2 GOTO LAB14
615  IF %1==EL GOTO LAB14
616  IF %1==EH GOTO LAB14
617  IF %1==S9 GOTO LAB14
618  IF %1==S2 GOTO LAB14
619  IF %1==M2 GOTO LAB14
620  IF %1==T1 GOTO LAB14
621  GOTO SKP14
622  :LAB14
623  CLS
624  REM Distance Skims for Paths C                Network ... %1
625  ROADSKIM (\SCREENS\RSXXDPC.CON
626  COPY RSXXDPA.PRN+RSXXDPB.PRN+RSXXDPC.PRN TEMP1.PRN
627  ERASE RSXXDPC.PRN
628  :SKP14
629  ERASE RSXXDPA.PRN
630  ERASE RSXXDPB.PRN
631  CD \N%1
632  CLS
633  REM Trip Length Distribution for Paths A      Network ... %1
634  TRIPSUM (\SCREENS\TSXXDPA.CON
635  CLS
636  REM Trip Length Distribution for Paths B      Network ... %1
637  TRIPSUM (\SCREENS\TSXXDPB.CON
638  COPY TSXXDPA.PRN+TSXXDPB.PRN TEMP2.PRN
639  IF %1==E9 GOTO LAB16
640  IF %1==E2 GOTO LAB16
641  IF %1==EL GOTO LAB16
642  IF %1==EH GOTO LAB16
643  IF %1==S9 GOTO LAB16
644  IF %1==S2 GOTO LAB16
645  IF %1==M2 GOTO LAB16
646  IF %1==T1 GOTO LAB16
647  GOTO SKP16
648  :LAB16
649  CLS
650  REM Trip Length Distribution for Paths C      Network ... %1
651  TRIPSUM (\SCREENS\TSXXDPC.CON
652  COPY TSXXDPA.PRN+TSXXDPB.PRN+TSXXDPC.PRN TEMP2.PRN
653  ERASE TSXXDPC.PRN
654  :SKP16
655  ERASE TSXXDPA.PRN
656  ERASE TSXXDPB.PRN
657  COPY TEMP1.PRN+TEMP2.PRN TS%1.PRN
658  ERASE TEMP1.PRN
659  ERASE TEMP2.PRN
660  CD\PRINTER
```

```
CPRINT \N%1\TS%1.PRN \N%1\OUTPUT\TS%1.LST -H17 -P1 -FF
ERASE \N%1\TS%1.PRN
BEEP /R2
CD \N%1\OUTPUT
DIR *.LST
BEEP /R3
GOTO END
:PROB
REM     Problem encountered
:END
```

```
CD \N%1\OUTPUT
CLS
REM     Load Diskette 1 of 5 for Network %1 LIST Files
PAUSE
COPY RN%1PATH.LST A: /V
COPY LC%1G1.LST A: /V
COPY DV%1G1.LST A: /V
COPY M3%1SQG1.LST A: /V
COPY LC%1G2.LST A: /V
COPY GD%1G2.LST A: /V
COPY DV%1G2.LST A: /V
COPY M3%1SQG2.LST A: /V
COPY LC%1G3.LST A: /V
PAUSE
DIR A: )PRN:
CLS
REM     Load Diskette 2 of 5 for Network %1 LIST Files
PAUSE
COPY PL%1.LST A: /V
PAUSE
DIR A: )PRN:
CLS
REM     Load Diskette 3 of 5 for Network %1 LIST Files
PAUSE
COPY GD%1G3.LST A: /V
COPY DV%1G3.LST A: /V
COPY M3%1SQG3.LST A: /V
COPY NLXXDA.LST A: /V
COPY LC%1G4.LST A: /V
PAUSE
DIR A: )PRN:
CLS
REM     Load Diskette 4 of 5 for Network %1 LIST Files
PAUSE
COPY LC%1G4E.LST A: /V
COPY LC%1G4X.LST A: /V
COPY M2%1.LST A: /V
COPY M2%1ALL.LST A: /V
PAUSE
DIR A: )PRN:
CLS
REM     Load Diskette 5 of 5 for Network %1 LIST Files
PAUSE
COPY TS%1.LST A: /V
PAUSE
DIR A: )PRN:
REM     Dump of LIST Files for Network %1 now complete
```

```
 1  CD \N%1
 2  IF %1==E9 GOTO LAB1
 3  IF %1==E2 GOTO LAB1
 4  IF %1==EL GOTO LAB1
 5  IF %1==EH GOTO LAB1
 6  IF %1==M9 GOTO LAB1
 7  IF %1==M2 GOTO LAB1
 8  IF %1==S9 GOTO LAB1
 9  IF %1==S2 GOTO LAB1
10  CLS
11  REM     Load Diskette 1 of 3 for Network %1 Files for Cost Evaluation
12  PAUSE
13  COPY MATP?.TRP A: /V
14  COPY MATG3.TRP A: /V
15  COPY NETENDG3.DES A: /V
16  COPY RNXXP?.TRE A: /V
17  COPY PCU9?G3.TRP A: /V
18  COPY DSTP?.SKI A: /V
19  DIR A: )PRN:
20  REM     Load Diskette 2 of 3 for Network %1 Files for Cost Evaluation
21  PAUSE
22  COPY CSTPAG4.SKI A: /V
23  COPY TIMPAG4.SKI A: /V
24  COPY CSTPAG4E.SKI A: /V
25  COPY CSTPAG4X.SKI A: /V
26  DIR A: )PRN:
27  REM     Load Diskette 3 of 3 for Network %1 Files for Cost Evaluation
28  PAUSE
29  COPY CSTPBG4.SKI A: /V
30  COPY TIMPBG4.SKI A: /V
31  COPY CSTPBG4E.SKI A: /V
32  COPY CSTPBG4X.SKI A: /V
33  DIR A: )PRN:
34  GOTO END
35  :LAB1
36  CLS
37  REM     Load Diskette 1 of 5 for Network %1 Files for Cost Evaluation
38  PAUSE
39  COPY MATP?.TRP A: /V
40  COPY MATG3.TRP A: /V
41  DIR A: )PRN:
42  REM     Load Diskette 2 of 5 for Network %1 Files for Cost Evaluation
43  PAUSE
44  COPY NETENDG3.DES A: /V
45  COPY RNXXP?.TRE A: /V
46  COPY PCU9?G3.TRP A: /V
47  COPY DSTP?.SKI A: /V
48  DIR A: )PRN:
49  REM     Load Diskette 3 of 5 for Network %1 Files for Cost Evaluation
50  PAUSE
51  COPY CSTPAG4.SKI A: /V
52  COPY TIMPAG4.SKI A: /V
53  COPY CSTPAG4E.SKI A: /V
54  COPY CSTPAG4X.SKI A: /V
55  DIR A: )PRN:
```

```
56 REM     Load Diskette 4 of 5 for Network %1 Files for Cost Evaluation
57 PAUSE
58 COPY CSTPBG4.SKI A: /V
59 COPY TIMPBG4.SKI A: /V
60 COPY CSTPBG4E.SKI A: /V
61 COPY CSTPBG4X.SKI A: /V
62 DIR A: )PRN:
63 REM     Load Diskette 5 of 5 for Network %1 Files for Cost Evaluation
64 PAUSE
65 COPY CSTPCG4.SKI A: /V
66 COPY TIMPCG4.SKI A: /V
67 COPY CSTPCG4E.SKI A: /V
68 COPY CSTPCG4X.SKI A: /V
69 DIR A: )PRN:
70 PAUSE
71 :END
72 REM     Dump of Network %1 Files for Cost Evaluation now complete
```

```
 1  CD \N%1
 2  CLS
 3  REM     Build selected trees for Paths A         Network ... %1
 4  ROADNET (\SCREENS\RN%1SPA.CON
 5  CLS
 6  REM     Build selected trees for Paths B         Network ... %1
 7  ROADNET (\SCREENS\RN%1SPB.CON
 8  COPY RN%1SPA.PRN+RN%1SPB.PRN RN%1SP.PRN
 9  IF %1==C9 GOTO SKP1
10  IF %1==C2 GOTO SKP1
11  IF %1==B9 GOTO SKP1
12  IF %1==B2 GOTO SKP1
13  IF %1==09 GOTO SKP1
14  IF %1==02 GOTO SKP1
15  IF %1==W2 GOTO SKP1
16  CLS
17  REM     Build selected trees for Paths C         Network ... %1
18  ROADNET (\SCREENS\RN%1SPC.CON
19  COPY RN%1SPA.PRN+RN%1SPB.PRN+RN%1SPC.PRN RN%1SP.PRN
20  ERASE RN%1SPC.PRN
21  :SKP1
22  ERASE RN%1SPA.PRN
23  ERASE RN%1SPB.PRN
24  CLS
25  REM     Factor the Local Traffic                 Network ... %1
26  LOCALTRF (\SCREENS\LTXXFAC.CON
27  ERASE DUMMY.SLD
28  COPY RN%1SP.PRN+LTXXFAC.PRN BUILDNET.PRN
29  ERASE RN%1SP.PRN
30  ERASE LTXXFAC.PRN
31  CD \PRINTER
32  CPRINT \N%1\BUILDNET.PRN \N%1\OUTPUT\BUILDNET.LST -H17 -P1 -FF
33  ERASE \N%1\BUILDNET.PRN
34  CD \N%1\OUTPUT
35  DIR *.*
36  BEEP /R2
```

```
CD\N%1
CLS
REM     Evaluate Network %1 with respect to %2
COSTEVAL {\SCREENS\EV%1%2.CON
CD\PRINTER
CPRINT \N%1\EV%1%2.PRN \N%1\OUTPUT\EV%1%2.LST -H17 -P1 -FF
ERASE \N%1\EV%1%2.PRN
CD\N%1\OUTPUT
DIR *.*
BEEP /R3
```


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Appendix 6C

HIGHWAY TRAFFIC FORECASTS

This Appendix presents the traffic forecasts for each of the two forecast years 1990 and 2000. The underlying assumptions in the forecasting process and an outline of the modelling approach are also described in this appendix; a more detailed description of the Traffic Model used in is presented in Appendix 6B to this report.

Approach to Traffic Forecasting

There were considered to be three main determinants of highway traffic growth; the overall growth of the national economy, the development of other modes of transport, and the degree of congestion on the road system.

Growth in the Economy - The growth of the economy was measured by the projected increase in Gross Domestic Product (GDP) for each traffic zone. Projections of GDP were discussed and presented in Appendix 5D.

Other Modes - Developments in other modes of transport were discussed in Appendix 2E where it was concluded that, with the single exception of petroleum product pipelines, there were no likely developments in other modes of transport in the Cairo-Assuit corridor which were likely to have a significant affect on the growth in road traffic. This is contrary to Government policy, and probably to good economic planning, which would indicate a growing use of waterways and railways for long distance freight transport. Sensitivity tests were used to examine the effect of alternative assumptions.

Congestion - Increased congestion on the road system, by making the costs of transport higher, tends to slow the growth rate in traffic. Since the level of congestion depends, amongst other things, on the transport system in place, congestion effects had to be measured separately for each transport network. This was the main function of the computer Traffic Model.

The approach of the Study, therefore, was to make initial forecasts of zone to zone road transport movements for each forecast year 1990 and 2000, based on the projected growth in the national economy, and adjusted to developments in other modes. These initial forecasts were then input to the Traffic Model which determined, separately for each network evaluated, the effects of congestion on growth in road traffic, and on the distribution of traffic between the available routes.

Vehicle Growth Rates

Although growth in the economy controls overall growth in traffic, individual vehicle types can be expected to grow at significantly different rates. For example, as national wealth increases a higher proportion of the population can be expected to choose more comfortable, although more expensive, modes of transport, leading to a switch from buses to taxis or private cars. Therefore, an important step in preparing

the initial forecasts of traffic was to determine the growth rate for each vehicle type relative to the growth in the economy. Growth for each vehicle type is discussed below.

Truck Growth Rates

The ENTS study (Reference 1) observed that growth in total freight transport, considering all modes, in the years up to 1983 was greater than the growth in Gross Domestic Product (GDP). However, ENTS forecast that growth in freight transport would slow to a lower level than the growth in GDP, and that road freight transport would grow at an even lower rate. Moreover, they expected that the growth rates in the Cairo-Assuit corridor to be at a lower rate than the rest of Egypt. This is summarized in Table 6C-1 below:

Table 6C-1

ENTS FORECAST FREIGHT GROWTH 1983-1987
(annual percent growth over period)

REGION	GDP	TOTAL FREIGHT	ROAD FREIGHT
Egypt	8.0%	6.5%	6.2%
Cairo-Assuit		5.5	4.9

The evidence for actual growth in road freight in the Cairo-Assuit Corridor was a little contradictory, as shown in Table 6C-2 (derived from Appendix 2E).

Table 6C-2

ACTUAL ROAD FREIGHT GROWTH IN CAIRO ASSUIT CORRIDOR
(million tons per year)

CLASS	ENTS 83	CAS 85	ANNUAL GROWTH
O&D in corridor	13.82	16.02	7.6%
Total in corridor	18.53	18.95	1.1%

This table indicates that road freight traffic with origins and destinations in the corridor grew more rapidly than expected, even though the economy grew at only 5.7 percent annually compared with ENTS expectation of 8.0 percent. However, the remaining (through) traffic was lower than expected, so that overall growth was low. It is possible that ENTS overestimated through traffic in 1983 and that this explains the discrepancy. Certainly the road traffic counts of cargo carrying vehicles (See Appendix 2A) indicate an annual growth rate of 5.9 percent, just above the growth in observed GDP.

It was concluded that forecasts of growth in truck traffic for this Study should be at the same rate as the growth in GDP.

Private Car Growth Rates

ENTS assumed for the period 1983-1987 that growth rate in car traffic would be 14.7 percent annually, compared with the expected GDP growth rate of 8 percent. Technically, they assumed an elasticity of demand for car transport with respect to GDP of about 1.8.

Actual car traffic in the corridor in the period 1983-1985 grew by about 10.7 percent annually compared with an estimated 5.7 percent annual growth in GDP. This indicates that the ENTS assumption on elasticity was about right.

This Study assumed that growth in car traffic would slow relative to the growth in GDP. This should be expected as the car ownership base of the Nation increases, and with both car and fuel prices likely to rise in future years to remove subsidies and reduce imports. Assuming future elasticities of 1.6 and 1.3 for 1985-1990 and 1990-2000 respectively, the growth rates shown in Table 6C-3 were estimated:

Table 6C-3

ASSUMED ANNUAL GROWTH RATES IN PRIVATE CAR TRAFFIC

	ANNUAL GDP GROWTH	ASSUMED ELASTICITY	ANNUAL TRAFFIC GROWTH
1985-1990	4.0 percent	1.6	6.5 percent
1990-2000	6.0	1.3	8.0

Taxi Growth Rates

Taxi traffic growth from 1983 to 1985 was about 7.2 percent annually. Growth in taxi passengers, however, was almost certainly significantly higher with the increasing use of the higher capacity taxi-vans. Therefore, elasticity of demand for taxi passenger travel with respect to growth in GDP was perhaps approaching the level for private cars. Future elasticities were assumed at 1.5 and 1.25 for 1985-1990 and 1990-2000 respectively.

The roadside interview survey conducted by this Study showed an equal number of taxi cars to taxi vans (incl taxi pickups). This was a much higher proportion of taxi vans than expected by ENTS, and indicated a more rapid conversion to taxi vans, at least in Upper Egypt. While taxi vans had a higher occupancy than taxi cars, their average trip length was much less; 30 km for taxi vans compared with 73 kms for taxi cars.

Assuming the above elasticities of demand for taxi demand (in passenger-kms), and that the proportion of taxi-cars of total taxis would drop to one third by the year 2000 (compared with one half now), annual growth rates in taxi traffic were estimated as set in Table 6C-4.

Table 6C-4

ASSUMED GROWTH RATES IN TAXI TRAFFIC

	TAXI CARS	TAXI VANS
1985-1990	2.5 percent	6.0 percent
1990-2000	3.5	7.5

Pickup Growth Rates

Trends in growth in pickup traffic were obscured by changes in character of this vehicle. The class of vehicle currently known as a pickup includes larger vehicles than before, and covers a range of functions from semi-private car to light truck.

Overall growth in the corridor in pickup traffic had been at a higher rate than GDP approaching, as far as can be determined, the growth rate of private cars. Growth on the main West Bank highway, however, was considerably lower. Considering the changing nature of the pickup, caused by the high duties on the traditional imported pickups and the heavier type of vehicle manufactured locally, it was thought likely that the growth rate would slow down in the future, although remaining above the truck growth rate. Accordingly, elasticities of demand for pickup traffic with respect to growth in GDP of 1.2 and 1.1 were selected for the years 1985-1990 and 1990-2000 respectively. These give annual growth rates for pickup traffic of 5.0 percent and 6.5 percent respectively for the two periods.

Bus Growth Rates

ENTS assumed a low growth rate in bus traffic with respect to growth in the economy, with an elasticity of demand of 0.75 with respect to growth in GDP. The evidence as reported in Appendix 2E, was that growth in bus passengers (excluding micobuses) had been higher at about 8 percent per year. Road traffic growth indicated 9 percent per year in the corridor as a whole, but with lower growth on the main West Bank Highway (see Appendix 2A).

This Study agreed with ENTS that bus growth in the future was likely to be slower than for other modes of road passenger transport. However, it was thought that a slightly higher growth rate could be assumed than ENTS, with an elasticity with respect to growth in GDP of 1.0. Hence bus traffic was assumed by this Study to grow in the future at the same rate as GDP.

Summary of Vehicle Growth Rates

Vehicle growth rates were related to growth in the economy as measured by GDP. With assumed GDP annual growth rates of 4 percent and 6 percent for the years 1985-1990 and 1990-2000 respectively, the annual growth rates set out in Table 6C-5 were selected:

Table 6C-5

TRAFFIC ANNUAL GROWTH RATES TO 1990 AND 2000

VEHICLE TYPE	1985-1990	1990-2000
Private car	6.5 percent	8.0 percent
Taxi-car	2.5	3.5
Taxi-van	6.4	8.2
Pickup	5.0	6.5
Bus	4.0	6.0
Truck	4.0	6.0

These were the starting point for forecasting traffic growth in the corridor. The initial forecasts of traffic varied by traffic zone according to the particular growth in GDP of the zone, and all initial forecasts were modified in the computer Traffic Model according to the degree of congestion detected on the road system.

Forecasting Methodology

This section presents a brief outline of the methodology followed in forecasting traffic. A detailed description of the Traffic Model is presented in Appendix 6B.

The traffic forecasting procedure involved three separate main stages, as follows:

1. Preparation of initial forecasts of traffic based on expected national and zonal economic growth, and the likely growth in vehicles relative to economic growth. This stage was undertaken once only for each forecast year for the main tests, but alternative estimates were prepared for the sensitivity tests.

2. Assessment of the degree of congestion on the road system resulting from the initial traffic forecasts, and the likely impact that this would have on transport costs.

3. Adjustment of the initial forecasts to take account of the changes in traffic congestion and transport costs. If congestion increased, the initial traffic forecasts were reduced, and vice versa.

Stages 2 and 3 were undertaken separately for each network examined.

The two stages were linked together in the Traffic Model with the results of stage 3 automatically providing a new starting point for stage 2. Thus a cycle of iterative calculations were made until the modified traffic forecasts produced in stage 3 were in balance with traffic congestion detected in stage 2. With the completion of cost files required for the evaluation phase, the Traffic Model could take as long as 12 hours to run for a single transport network.

Model Stage 1 - Initial Traffic Forecasts

The starting point for estimating initial traffic forecasts was a set of tables (matrices) of zone-to-zone travel movements by each vehicle type in Base Year (1985/86). These were derived from the Roadside Interview Survey for each of the nine Study vehicle types.

Adjustments were made to the interview survey matrices to add estimates for short trips in the corridor which did not pass through survey stations. These Base Year adjusted matrices were then used to calibrate the transport network computer program, so that computer estimates of traffic volumes and traffic speeds on each part of the road system were in agreement with observed volumes and speeds.

Before forecasting future traffic, further adjustments were made to the vehicle movement matrices to reflect two future changes expected in the Cairo-Assuit corridor. First, all long distance supply movements by road petroleum tankers were removed -- these movements were expected to be replaced by the new Cairo-Assuit petroleum product pipeline under construction. Secondly, all long distance supplies of cement by road to the corridor from Greater Cairo and Lower Egypt were replaced by similar supplies from Assuit. This reflected the expected opening of the new cement plant in Assuit.

Production of the initial matrices - one for each of the nine vehicle types for each of the two forecast years 1990 and 2000 - were made using the Fratar process. This technique "grows" the traffic from each traffic zone according to the overall growth rate selected for each vehicle type, modified by the relative increase in economic activity of the zone, measured by growth in zonal Gross Domestic Product (GDP).

Growth in local traffic, which was link specific (see Appendix 6A), was estimated by factoring the local traffic volume according to link jurisdiction. For most jurisdictions, the factor approximated to the overall growth in GDP -- 1.2 to 1990 and 2.2 to 2000. For two-lane rural and urban roads (jurisdictions 1 and 3 respectively) which predominated in the corridor, however, lower growth rates of 1.1 and 1.5 respectively were selected, on the basis that as congestion grew, and as the local roads improved, more of the local traffic would move off the main highway and would not contribute to congestion there. Local traffic on roads in Greater Cairo was not grown at all, since the traffic and capacities had been fixed in Base Year to give a fixed, and high, level of congestion for traffic passing through the center of the City. For the Cairo Ring Road and the Helwan Autostrade, normal growth factors of 1.2 and 2.2 were applied.

Model Stage 2 - Analysis of Congestion

For each network tested, the Traffic Model was used to assess the degree of congestion on each road link in the network, and then to estimate transport costs on the link under these congested conditions.

The first step was to allocate (or assign) traffic to each link of the network. Many zone-to-zone traffic movements had a choice of route. The selection of route for minor alternatives was made on the basis of minimum time. However, some major route choices were available: in particular, between the existing East Bank and West Bank Highways. The choice between these two routes was made using the diversion technique which divides traffic between the two routes according to the ratio of the transport cost by each alternative, considering the financial perceived costs discussed in Appendix 5E. For networks containing the new Cairo-Assuit Highway, a third major choice of route was available, and so a two-part diversion procedure was developed. This first divided traffic between the existing West Bank Highway and the desert routes (East Bank Highway and the new highway), slightly favoring the desert routes. It then further split the desert route traffic between the two available roads, in this case slightly favoring the new highway.

The second step was to assess the cost of using each link of the network for each vehicle type, taking full account of any congestion on the link. This was done using a specially developed program LNKCOST, based on the relationships set out in the US Department of Transportation Highway Investment Analysis Package (HIAP) computer model (Reference 7). Congestion was determined by relating the total traffic volume to the traffic capacity of the link.

LNKCOST first estimated travel speeds in relation to congestion level and road surface condition. The total cost of travel on a road section was then built up in stages, starting with the free-flow vehicle operating cost for the calculated speed, and then adding additional costs for speed-change cycles as vehicles slow down and speed up in congested traffic conditions. Travel time estimates along each link were calculated in the same way, starting with free flow travel time, and then adding the "excess" time for speed-change cycles and idling.

It was necessary to recognize that traffic volumes vary throughout the day and so does the level of congestion. Therefore, the above calculations were performed separately for each of six segments of the day, covering operating conditions ranging from very light traffic, as could be expected in the hours after midnight, to the heaviest traffic volumes which could be expected in the peak period of the day. The final link costs with congestion taken into account were estimated by taking an average of costs in each of the six periods of the day, weighted by the number of vehicles in each of the time periods.

Some modifications were made to costs, principally to reflect expected road surface conditions using the surface condition factors presented in Appendix 5E. It was assumed that all roads in the Committed Network were

in "fair" condition and that all roads in other networks would benefit from a more intensive road repair and overlay program and would be in "good" condition. It was assumed that the new Cairo-Assuit Highway would be built and maintained to high standards and would be in "very good" condition.

Model Stage 3 - Modified Traffic Forecasts

At the conclusion of the Stage 2 Model, an analysis was made of the cost of travel between each pair of zones in the system (64 zones and therefore over 2000 two-way pairs of movements). Using a new program written specially for this Study, GENDEGEN, a comparison was made with Base Year costs to determine whether costs had fallen or risen. This was done separately for each vehicle type. A rise in costs could be due to increased congestion, and a fall in costs could be due to reduced congestion, perhaps due to the inclusion of a new route which was not present in Base Year for that movement.

On the basis of the change in costs detected, GENDEGEN either generated new traffic if costs had decreased, or reduced traffic if costs had risen. This was done on the basis of a selected elasticity of demand for each vehicle type. Elasticity of demand is a measure of how much demand for transport changes in response to changes in transport costs. Elasticities of demand for each of the nine vehicle types were selected based on experience as follows:

Car-work	0.7
Car-other	1.0
Taxi car	0.6
Taxi van	0.6
Pickup	0.4
Bus	0.6
Truck single	0.2
Truck comb	0.2
Truck artic	0.2

Demand for car-other trips was considered perfectly elastic, indicating that, for example, a doubling of transport costs would half the number of trips, or that halfing transport costs would double the number of trips. Demand for transport by the other vehicle types was considered less elastic, with trucks being the least responsive. For example, the elasticity of demand selected for trucks meant that a doubling of transport costs would result in a 15 percent decrease in demand for truck transport. This is because the price to the consumer of goods transported by trucks is only partly determined by transport costs. Hence even if congestion increases, most of the goods must still be delivered. Similarly, most work and business trips must still be made, and thus a rise in costs due to congestion would be unlikely to result in a proportionate drop in travel, although some reduction would be experienced.

Model Iteration

After the Traffic Model had completed stages 2 and 3 for the first

time, the modified matrices from Stage 3 were processed again by both the Stage 2 and Stage 3 models. On the second pass through GENDEGEN, zone to zone transport costs were compared the costs after the previous cycle through the model in order to modify the matrices once more. In every case, this second modification was of much lower magnitude and in the opposite direction to the first - that is to say, if costs had previously risen leading to de-generation of trips, costs now declined (relative to the previous cycle) leading to the generation of trips. At this point, the model was said to have converged. All that remained was to prepare a set of link costs based on the final movement patterns ready for the evaluation stage of the Study.

Traffic Forecasts

Traffic forecasts were prepared for each of the two forecast years, 1990 and 2000, and for each of the four test networks described in detail in Appendix 6A -- Committed, Overlay, Improved and Expressway. In summary, these networks represented the following:

Committed - The existing road system, together with those roads funded to be completed in the next four years, plus the Cairo Ring Road and Helwan Autostrade.

Overlay - The Committed Network with an improved maintenance policy, particularly a more intensive pavement overlay program.

Improved - The Overlay Network, plus improvements to the existing West Bank Highway consisting of the addition of 14 bypasses by 1990 and widening to 4-lane standard by the year 2000.

Expressway - The Overlay Network, plus the new 4-lane West Bank Desert Highway for which a preliminary engineering design has been prepared by this Study.

The forecasts are presented in Table 6C-6, summarizing total trips, average journey length, total vehicle-kilometers and growth in vehicle kilometers, by all vehicle types and for both forecast years.

The 1985/86 Base Year situation is included in Table 6C-6, as are the initial forecasts for each year which represent the traffic forecasts prior to taking account of congestion on the road system. Results for all four test networks represent final network conditions fully reflecting the effects of traffic congestion.

Initial Traffic Forecasts

The initial forecasts, before congestion effects were analyzed by the Traffic Model, showed a growth in the number of movements in the corridor, combined with a slight increase in journey length. The increase in

Table 6C-6

TRAFFIC FORECASTS: 1990 AND 2000
(24 hour AADT)

VEHICLE	BASE YEAR	1990 INITIAL	1990 MAIN TESTS (1) Com	Over	Impr	Expr	2000 INITIAL	2000 MAIN TESTS (1) Com	Over	Impr	Expr
Total Movements in Corridor (thousands)											
1. Car work	7.1	9.7	9.5	9.8	9.8	9.9	20.6	16.6	16.8	18.9	18.0
2. Car other	5.4	7.4	7.2	7.6	7.5	7.7	15.6	12.5	12.8	14.4	13.8
3. Taxi car	15.1	17.1	17.0	17.5	17.5	17.6	24.2	22.9	23.6	23.8	23.9
4. Taxi van	15.0	20.3	20.1	20.8	20.6	20.8	44.4	41.8	43.1	43.3	43.3
5. Pickup	18.7	23.6	23.5	23.8	23.7	23.9	43.7	42.3	43.0	43.3	43.2
6. Bus	4.0	4.8	4.7	4.9	4.8	4.9	8.6	8.1	8.2	8.4	8.3
7. Truck single	10.5	12.5	12.5	12.6	12.5	12.6	21.9	21.5	21.6	21.8	21.7
8. Truck comb	1.7	2.0	2.0	2.0	2.0	2.1	3.6	3.5	3.5	3.6	3.6
9. Truck artic	0.7	0.9	0.9	0.9	0.9	0.9	1.5	1.5	1.5	1.5	1.5
ALL VEHICLES	78.3	98.3	97.4	99.8	99.4	100.4	184.0	170.7	174.3	179.0	177.4
FACTOR	1.00	1.26	1.24	1.27	1.27	1.28	2.35	2.18	2.23	2.29	2.27
Average Journey Length (Kilometers)											
1. Car work	49	50	52	52	52	57	52	55	55	50	63
2. Car other	57	59	59	59	60	62	62	65	65	61	71
3. Taxi car	67	70	69	69	70	74	76	76	76	76	81
4. Taxi van	30	31	31	31	31	33	33	33	33	34	35
5. Pickup	70	71	70	70	72	75	74	74	74	74	78
6. Bus	65	67	68	68	69	73	71	74	74	72	79
7. Truck single	73	75	75	75	76	80	76	77	77	74	82
8. Truck comb	204	203	213	214	216	221	206	220	219	209	227
9. Truck artic	215	217	226	225	225	234	218	228	230	219	238
ALL VEHICLES	63.3	63.9	64.1	64.0	64.9	68.2	64.7	66.5	66.3	64.8	70.7
FACTOR	1.00	1.01	1.01	1.01	1.03	1.08	1.02	1.05	1.05	1.02	1.12
Total Vehicle-kilometers (thousands)											
1. Car work	349	484	495	507	507	563	1,071	915	925	945	1,141
2. Car other	310	436	426	446	451	480	967	814	835	878	980
3. Taxi car	1,014	1,197	1,172	1,210	1,222	1,297	1,839	1,739	1,797	1,809	1,942
4. Taxi van	451	630	624	644	640	684	1,465	1,379	1,421	1,472	1,510
5. Pickup	1,310	1,675	1,642	1,669	1,709	1,787	3,231	3,131	3,184	3,204	3,364
6. Bus	258	322	322	330	333	357	608	597	610	605	658
7. Truck single	765	939	937	942	953	1,014	1,664	1,656	1,663	1,613	1,772
8. Truck comb	348	413	434	438	443	459	737	774	776	752	817
9. Truck artic	154	187	196	196	196	206	330	339	346	329	360
ALL VEHICLES	4,959	6,282	6,247	6,383	6,453	6,848	11,912	11,344	11,556	11,608	12,545
FACTOR	1.00	1.27	1.26	1.29	1.30	1.38	2.40	2.29	2.33	2.34	2.53

Source: Study estimates

(1) Key to the Test Networks:
Com = Committed, Over = Overlay,
Impr = Improved, Expr = Expressway

journey length was brought about by forecast stronger economic growth outside the corridor increasing the forecast proportion of longer distance movements to and from the corridor. The overall result was that vehicle kilometers were forecast to increase by 1.25 times to 1990 and by 2.4 times to the year 2000, compared with Base Year. This represented an average annual growth rate of nearly 5 percent to 1990 and 6.5 percent from 1990 to 2000.

Growth rates were quite different by vehicle type, with the strongest growth shown in taxi vans. This was consistent with the assumption that taxi vans were expected to take an increasing proportion of total ta traffic, leading to a decline in the use of taxi cars. Accordingly, taxi car growth was the lowest of all vehicles. Private car growth was also strong, and growth in pickups was above average. (The assumptions on vehicle growth rates were set out earlier in this Appendix.)

These traffic growth rates were lower than had been experienced in the years immediately prior to the Study, and reflected the expected lower future growth rates in the National Economy. A case could certainly be made for traffic growth rates higher than reported here based on past traffic growth rates. However, a strong case could also be made for lower traffic growth, on the basis that the reduction in National economic growth could be much sharper in the late 1980s than assumed by this Study, and by assuming a greater role for waterway and railroad transport, both of which have opportunities for increasing their share of transport in the corridor. Hence the traffic forecasts presented here represented a middle ground, suitable for project identification and evaluation. Sensitivity tests were made to assess the affect of different growth rate assumptions on Study recommendations.

Test Network Forecasts

For both 1990 and 2000, the Committed Network showed a decline in traffic from the initial forecasts; in other words, a slower traffic growth rate. This was because the forecast increase in traffic on the network was greater than the increase in traffic capacity from Base Year, hence increasing traffic congestion which had the effect of slowing traffic growth. The reduction in traffic was slight in 1990 - about 1 percent - but the reduction was much more significant for 2000 representing about 7 percent of all movements.

For 1990, the Overlay, the Improved and the Expressway networks showed an increase in total journeys compared with the Initial Forecast, which indicated that sufficient new road capacity had been introduced into the networks to off-set the congestion effects of increased traffic. By 2000, however, all three networks showed a decline in the number of movements compared with the Initial Forecast for that year, which indicated increased congestion on the corridor road system, despite extensive road investments underway or committed at the time of this Study.

Average Journey Length - On all networks, including the Committed, average journey lengths increased from the initial forecasts for each year, due to the presence of new long distance roads in the corridor. All

networks included the extension to the existing East Bank Highway from Beni Suef to Minia, under construction at the time of this Study. The Expressway Network, of course, included the new Cairo-Assuit Highway and this had a dramatic effect on journey lengths, increasing the average by over 12 percent from 1985 to 2000.

The reason for this effect is that the costs of long distance journeys were much reduced by being able to bypass the existing congested routes, so these movements tended to grow faster than average. On the other hand, short distance journeys which could not conceivably use either the new East Bank or West Bank Highways suffered the increasing congestion on the existing roads, and growth rates were slower than average. Hence, average journey lengths increased due to more long journeys combined with fewer short journeys.

The Improved Network for 2000 showed the lowest increase in average journey length compared with the Initial Forecast, essentially because the main investment included in the network for this year -- widening the existing West Bank Highway to 4-lanes -- would bring about a significant reduction in costs for short distance journeys, thus increasing the relative proportion of such journeys and therefore reducing average journey lengths.

Vehicle-Kilometers - The measure of vehicle-kilometers, which combines number of journeys with length of journey, indicated more clearly the changes in movement patterns.

The Committed Network showed a decline from initial forecast levels, confirming that increased congestion would slow traffic growth as a whole in the absence of further new projects.

The other three networks -- Overlay, Improved and Expressway -- showed an increase in vehicle kilometers compared with the Initial Forecast for 1990, indicating that the road investments included in the networks would reduce transport costs, thus increasing traffic overall.

By the year 2000, only the Expressway Network showed an increase in vehicle-kilometers compared with the Initial Forecast, indicating that only this network provided sufficient new capacity to off-set the congestion effects of traffic growth. However, this increase in vehicle kilometers combined with a decrease in the number of journeys (compared with the initial forecast), clearly showed the role of the Expressway in promoting long distance journeys without providing significant help to the short distance movements.

In contrast to the Expressway Network, the Improved Network showed a slight decline in both vehicle-kilometers and the total number of journeys compared with the Initial Forecasts. This indicates that additional capacity had been added to almost offset congestion by traffic growth, and with a more even spread of benefits to all movements in the corridor.

Forecast Highway Traffic Volumes

Forecast traffic volumes are discussed below for each test network.

Committed Network - Forecast volumes on the Committed Network are shown in Figure 6C-1. The Committed Network volumes reflected the general increase in trip making to the two forecast years, with traffic volumes more than doubling by the year 2000. The main difference from Base Year, apart from the increase in traffic, was the use made of the East Bank Highway.

The traffic surveys, from which the Base Year traffic volumes were derived, were made in December 1985 and January 1986, only a few months after the new bridge at Beni Suef was opened. At that time, the Autostrade around Helwan was only partly opened, and major road works were in progress on the East Bank south of the Maraziq Bridge. Little long distance traffic was observed on the East Bank Highway at the two interview stations operated during the survey. It can be concluded that little transfer of traffic from the West Bank Highway had taken place by the time of the surveys, due partly to lack of knowledge of the route on the part of drivers, and partly to the poor road conditions at the northern end of the Highway. Since the surveys and the opening of the Autostrade, East Bank traffic volumes were observed to increase significantly.

This trend was confirmed in the Committed Network traffic forecasts which also included a major extension to the East Bank Highway, taking it as far south as Minia, two thirds of the total distance along the corridor. Therefore, the Committed Network showed 1990 traffic volumes on the West Bank Highway between Cairo and Minia lower than Base Year due to diversion to the East Bank Highway. By 2000, however, volumes on the West Bank Highway were forecast to be significantly higher on all sections, and volumes on the East Bank Highway were expected to be at, or above, the Base Year West Bank Highway volumes.

Overlay Network - Overlay Network forecast traffic volumes, shown in Figure 6C-2, were very similar to those for the Committed Network; slightly higher in both 1990 and 2000 due to the improved surface which reduced costs and thus increased the number of journeys slightly.

Improved Network - Forecast volumes on the Improved Network are shown in Figure 6C-3. For 1990, the Improved Network consisted of the Committed Network with the addition of 14 2-lane bypasses, as detailed in Appendix 6A. Hence the network offered a good 2-lane road with shoulders all the way from Cairo to Assuit, avoiding all passages through the towns and cities along the route. However, it is apparent from the traffic volumes that this improvement made little difference to the forecast traffic flows. In fact, forecast traffic decreased slightly from the Overlay Network, indicating that the benefits to traffic of being able to bypass congested town centers, was offset by the increased length of highway along the Bypass alignments. Overall, the bypasses would add 16 kms to the length of the existing Cairo-Assuit Highway. Of course, there would be other advantages to the bypasses, but these are hard to measure directly since they take the form of a substantial improvement in living conditions for

the inhabitants of the town living alongside the existing route.

The year 2000 forecasts showed the Improved Network was substantially better in traffic impact through the widening of the entire route between Aiyat (46kms south of Cairo) to Assuit, including the 1990 bypasses. Not surprisingly, traffic volumes on the existing West Bank Highway under this alternative were the highest of all the network alternatives, ranging between 5 and 15 percent above the volumes recorded on the other networks.

Expressway Network - Forecast volumes on the Expressway Network are shown in Figure 6C-4. Volumes on the new Cairo-Assuit Highway for 2000 ranged from about 22,000 PCUs per day between Giza and Beni Suef to about 8,000 PCUs per day near Assuit. Volumes in 1990 were at about half this level. The average PCU factor was about 2 (2.1 on the new highway and 1.9 on the existing highway) so the PCU volumes can be divided by two to arrive at an approximate daily vehicle count.

Traffic volumes on the existing West Bank Highway were reduced by the new road, but not greatly. This was because much of the long distance traffic on the sections from Cairo to Minia had already been taken by the new East Bank Highway. South of Minia, where there was no East Bank Highway, the new road relieved the existing road of about 6-7,000 PCUs per day, with some additional traffic on the new road due to traffic generation.

In the section north of Beni Suef, the new road appeared to draw its traffic evenly from the existing East Bank and West Bank Highways and from the Fayoum Desert Road. At the boundary between Giza and Fayoum/Beni Suef, the three West Bank roads were forecast to have more or less equal traffic volumes by the year 2000 at about 20,000 PCUs per day, while the East Bank Highway was reduced to about 9,000 PCUs per day.

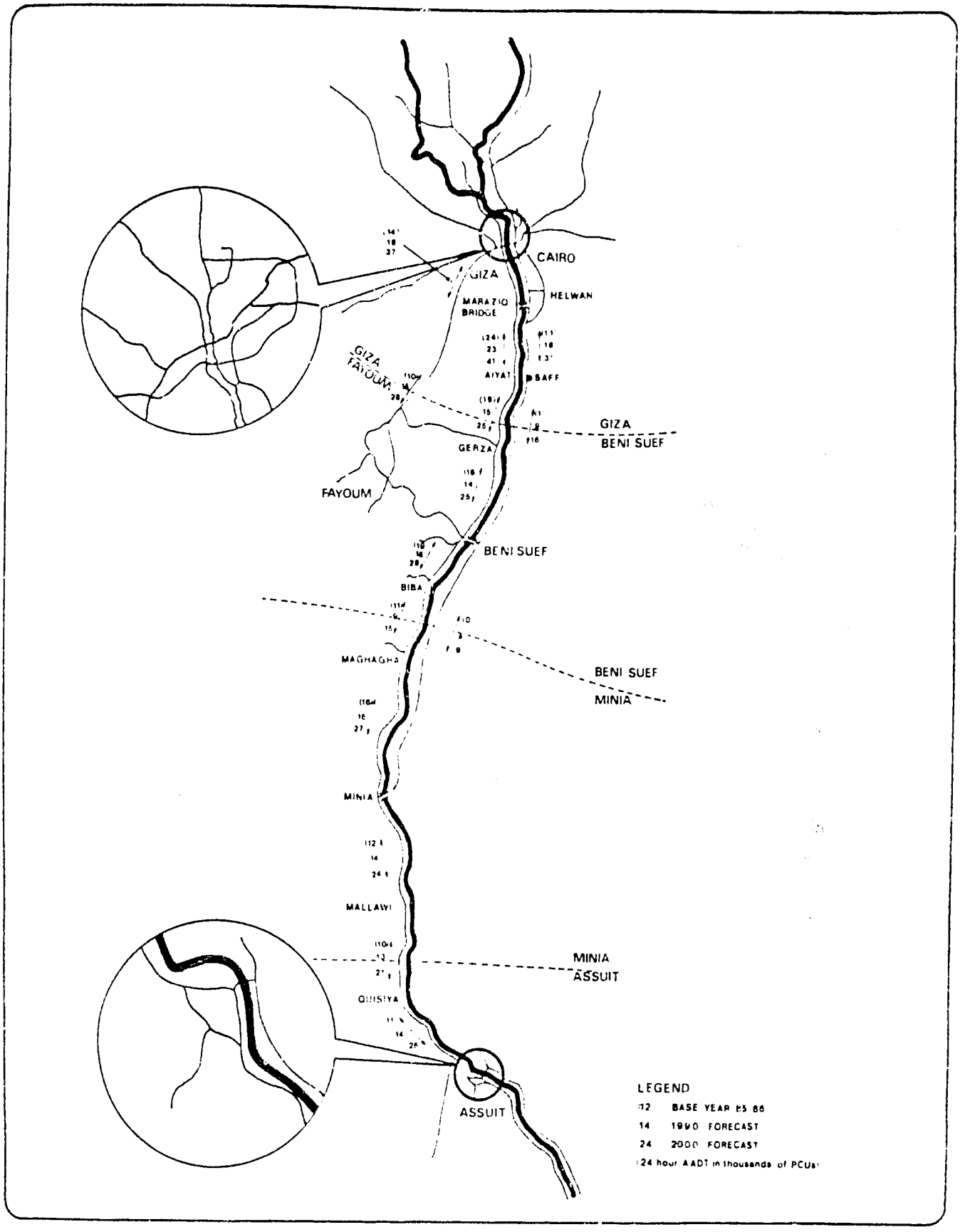
South of Beni Suef, the new road had more impact on the East Bank Highway, more than halfing the volumes on that road for both 1990 and 2000.

Forecast Traffic volumes at the entrances and on the access roads to the new highway are shown in Table 6C-7. Some 55 percent of all traffic (60 percent of trucks) entered a left via the northern and southern entrances. Of the remainder, about half was connected with Governorate capitals. Truck traffic used the non-Governorate capital access roads more heavily than other traffic.

Volumes on the new Cairo-Assuit Highway reported here were not particularly high for an expressway, and south of Beni Suef they did not support 4-lane construction in the early stages of the project. The next section looks at why traffic volumes were so low.

Candidate Traffic for the New Cairo-Assuit Highway

Referring to the analysis of surveyed corridor traffic reported in Appendix 2B, it was concluded that the Governorates in the corridor were very self-contained, with the bulk of all movements taking place entirely



Cairo – Assuit Highway Feasibility Study

FORECAST TRAFFIC
COMMITTED NETWORK

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Figure 6C-1

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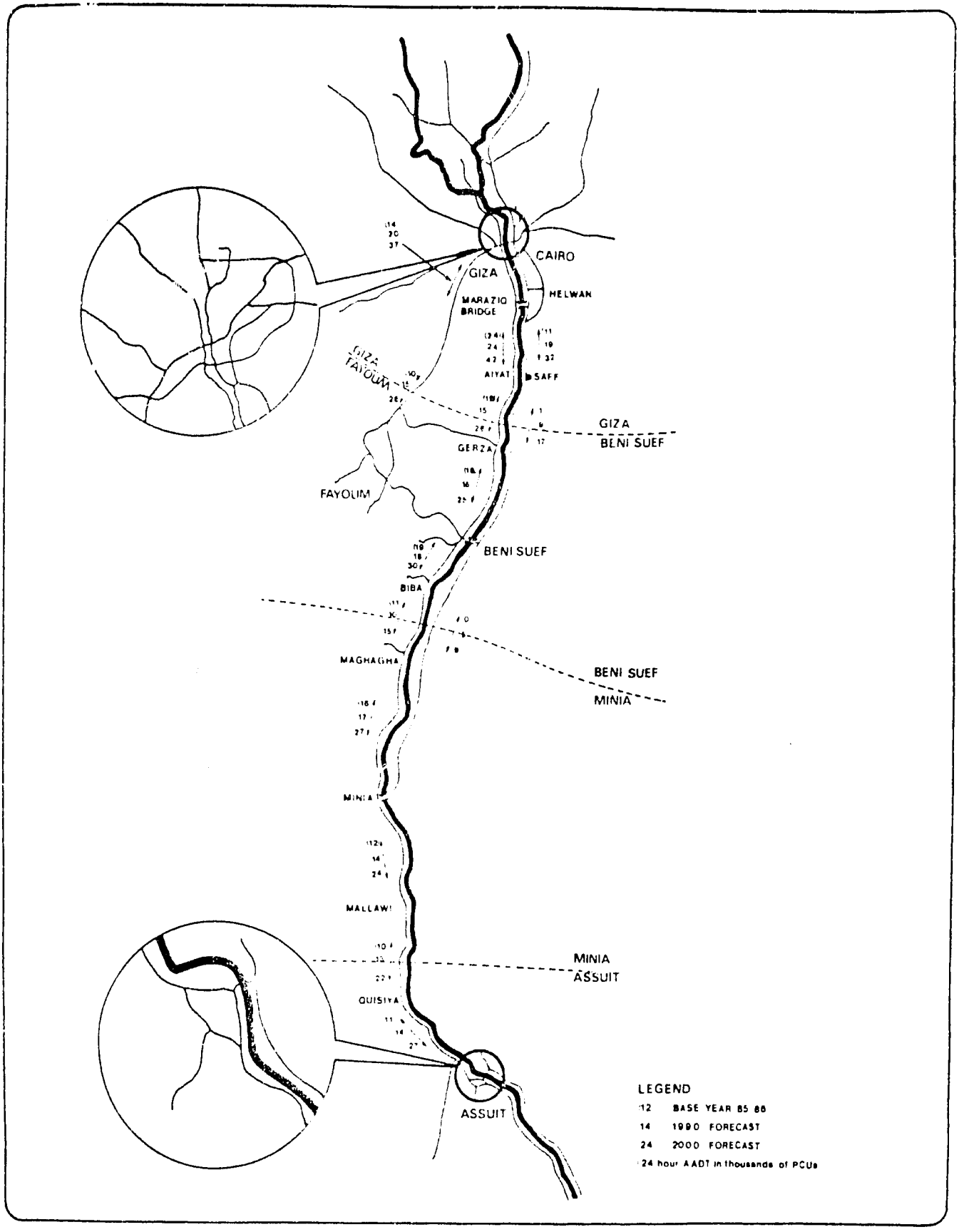

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FORECAST TRAFFIC OVERLAY NETWORK

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Figure 6C-2

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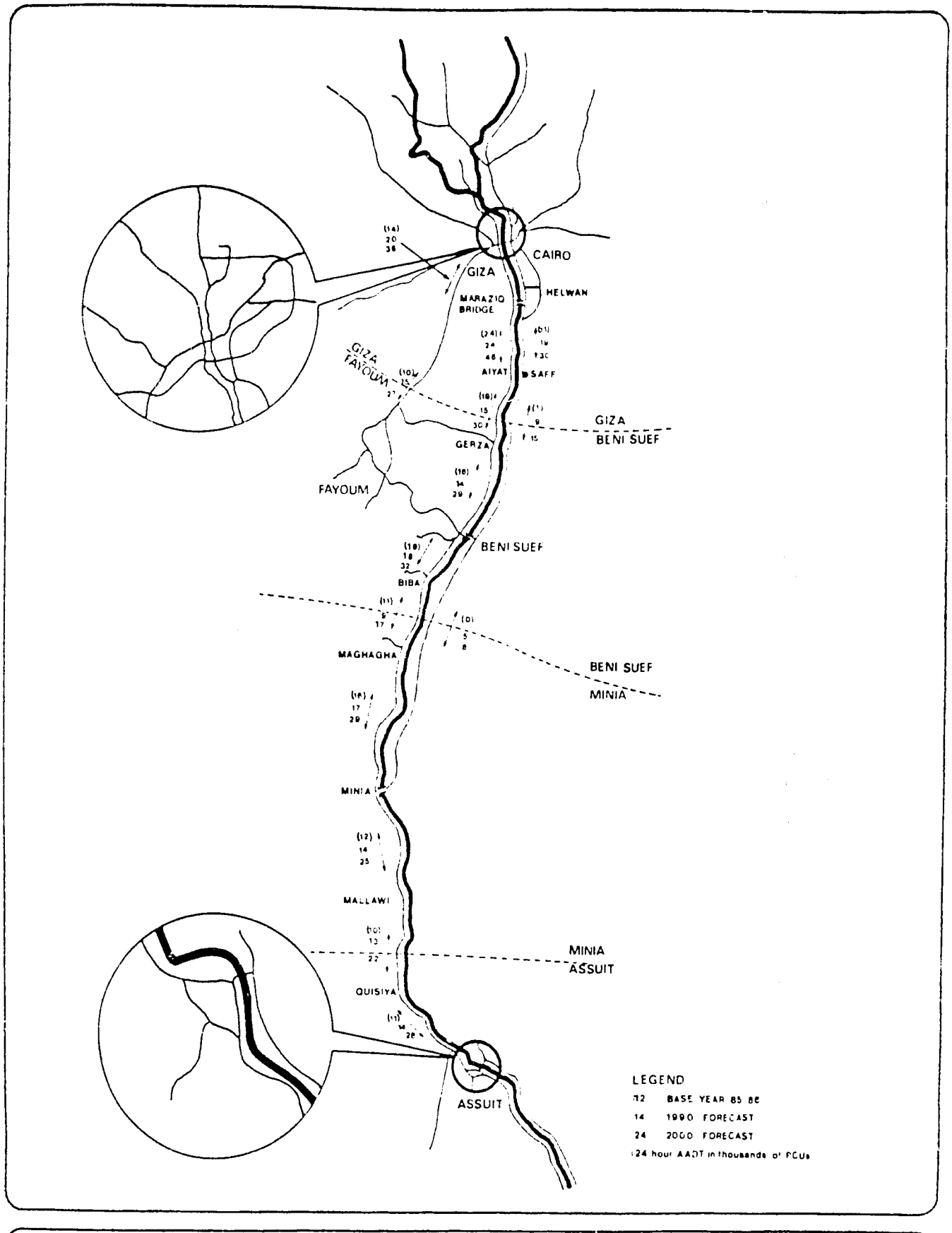

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FORECAST TRAFFIC
IMPROVED NETWORK

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Figure 6C 3

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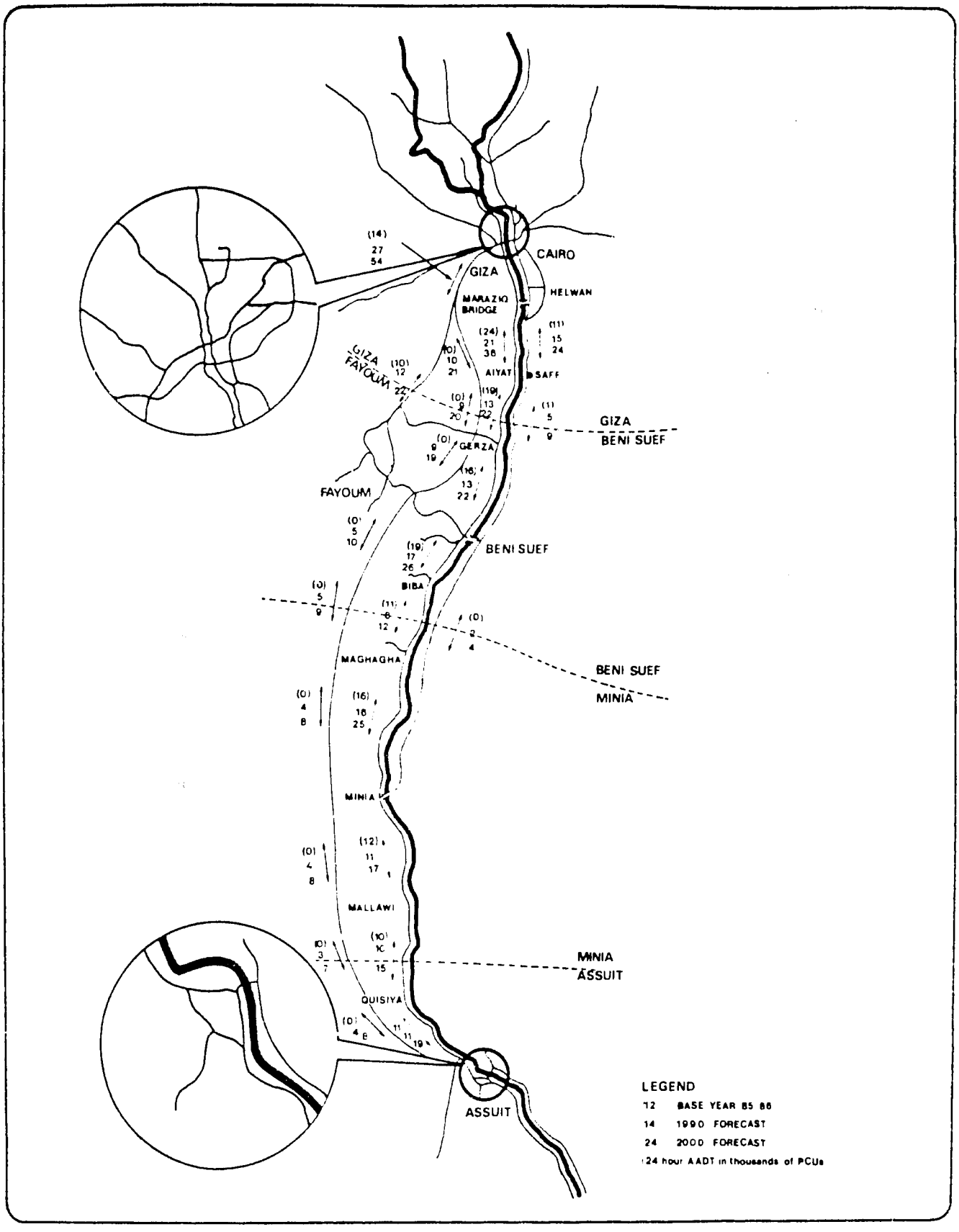

Cairo – Assuit Highway Feasibility Study

FORECAST TRAFFIC
EXPRESSWAY NETWORK

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Figure 6C - 4

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Table 6C-7

2000 ACCESS VOLUMES TO THE NEW CAIRO-ASSUIT HIGHWAY
(4-lane expressway)

ACCESS POINT	VEHICLES PER DAY			PERCENTS		
	Trucks	Other	Total	Trucks	Other	Total
Fayoum Desert Road (1)	2,556	8,902	11,458	39.8	40.3	40.2
Aiyat	388	809	1,197	6.0	3.7	4.2
Gerza	319	998	1,317	5.0	4.5	4.6
BS-Fayoum Road (2)	573	3,927	4,500	8.9	17.8	15.8
Fashn	65	259	324	1.0	1.2	1.1
Maghagha	89	350	439	1.4	1.6	1.5
Beni Mazar	105	382	487	1.6	1.7	1.7
Samalut	94	276	370	1.5	1.3	1.3
Minia (2)	508	1,606	2,114	7.9	7.3	7.4
Mallawi	234	763	997	3.6	3.5	3.5
Dairut	108	497	605	1.7	2.3	2.1
Quisiya	57	371	428	0.9	1.7	1.5
Manfalut	13	6	19	0.2	0.0	0.1
New Valley Road (1)	1,309	2,926	4,235	20.4	13.3	14.9
	6,418	22,072	28,490	100.0	100.0	100.0
Northern and Southern entrances	3,865	11,828	15,693	60.2%	53.6%	55.1%
Governorate Capitals	1,081	5,533	6,614	16.8%	25.1%	23.2%
Other	1,472	4,711	6,183	22.9%	21.3%	21.7%

(1) Entrance to new highway
(2) Governorate Capital

within each Governorate. In fact, the volume of movements entirely within Governorates represented almost 50 percent of all movements in the corridor, considering all internal and external movements together. Most of these intra-Governorate movements would not be attracted to the new highway, since the extra journey length of perhaps 30 kms along the access roads to and from the Expressway, offsets the advantages such a route would give. It must be remembered that the average journey length of all vehicles, including very long distance journeys, was only 71 kms in the Expressway Network, and therefore the length of the average intra-Governorate journey was very much less.

Movements between Governorates in the Corridor represented only about 7 to 8 percent of all trips, and the great majority of these were to the adjoining Governorate. For example, few journeys were observed (or were forecast) between Assuit and Fayoum, or between Minia and Giza (that part in the corridor). Inter-Governorate movements could use the Expressway, but north of Minia, the East Bank Highway also provides a competitive route, at least for the main inter-Governorate Capital movements.

The analysis in Appendix 2B also showed that most external movements to and from the Cairo-Assuit Corridor were associated with Greater Cairo and the North. There were strong movements into Giza and Fayoum, and the movements to Beni Suef, Minia and Assuit were substantial. As could be expected, the strongest movements were between the closer Governorates, with volumes tailing off as they went further south down the corridor. External movements to and from the North represented 25 percent of all traffic in the corridor. Only one third of this (about 9 percent of all corridor traffic) was truly long distance passing beyond Fayoum and Giza, but this 9 percent represented strong candidates for using the new highway. However, the new East Bank Highway would also be in competition for this traffic, and so not all would find its way onto the new highway.

It was observed that there was very little interaction between the South and the rest of the corridor, and hence the external movements between the corridor and the South were likely to contribute little to the new highway.

Through movements passing along the corridor without intermediate stops were significant in Base Year, although representing only about 2 percent of all traffic in the corridor. They were forecast to increase from 2,500 PCUs per day in 1985/86 to 5,500 by the year 2000, and were strong candidates for using the new highway.

It was concluded that only a small proportion of the Corridor traffic was likely to be attracted to a new West Bank Desert Highway, consisting of the following main movements (as a percentage of all 2000 traffic):

Through traffic	1.9 percent
External traffic between Cairo and points in the corridor south of Fayoum	9.0
Inter-governorate traffic in the corridor	7.5
	18.4 percent

A further 9.0 percent, representing external movements between Fayoum and the North, were candidates, but only for the northern section of the Expressway. Some of this traffic would be shared with the other roads in this part of the corridor, in particular, the East Bank Highway and the Fayoum Desert Road (for the North-Fayoum movements), either because they represent more efficient routes for certain movements, or because the costs by new highway and the alternatives would be so similar that the traffic would divide between the two. Lastly, some traffic would always stick to the existing road, no matter how attractive the new highway, either because of dislike of expressway travel, or because of a need or desire to stop frequently in towns and villages. Locations of favorite stopping places for truck drivers are mainly on the existing road, and such popular venues are an impediment for traffic to transfer to the more efficient route. The diversion procedure used in Traffic Modelling reflected all this.

Overall, then, it was considered that the traffic assignments to the new Cairo-Assuit Highway were reasonable having regard to the nature of movements in the corridor, and to the likely behavior of drivers when faced with alternative routes.

Congestion

As traffic builds up on the road system, so congestion increases. It is useful to compare travel times on the different networks in order to appreciate the relative effects of congestion.

Table 6C-8 shows the time in hours to travel from the center of Cairo to the center of Assuit for selected vehicles on each of the different networks presented here.

Table 6C-8

TRAVEL TIMES CAIRO TO ASSUIT
(hours, city center to city center)

NETWORK	YEAR	PRIVATE CAR	PICKUP	BUS	LARGE TRUCK
Base Year	1985	7.0	7.0	7.8	8.1
Committed	1990	6.4	6.4	7.1	7.3
Overlay	1990	6.2	6.3	7.0	7.2
Improved	1990	6.1	6.2	6.9	7.0
Expressway	1990	4.8	5.3	5.6	5.5
Committed	2000	9.6	9.6	10.5	11.0
Overlay	2000	9.5	9.5	10.5	10.9
Improved	2000	5.9	5.9	6.6	6.9
Expressway	2000	5.9	5.7	6.5	6.3

These times were for movements between Cairo and Assuit which could be expected to use the least congested roads suitable for long distance movements. For the Committed Network, this meant the East Bank Highway completed up to Beni Suef and under construction at the time of this Study up to Minia. Use of this route in 1990 enabled all vehicle types to reduce travel times from those observed in the 1985 Base Year, to the extent of half an hour or more. Note that the Base Year travel times assumed travel on the West Bank Highway since the East Bank Highway to Beni Suef had only been opened a short time and most drivers did not take advantage of it.

The other 1990 networks showed reduced travel times compared with the Committed reflecting the degree of investment included in the network. The Overlay Network showed only slightly reduced times as a result of the better road surface. The Improved Network showed a greater reduction due to the avoidance of congested areas, and because traffic volumes were lighter in this network compared with the Overlay Network. The largest time reductions come with the Expressway Network which cut over 1.5 hour from the total travel time on the Committed Network, and nearly 2.5 hours from travel times in the Base Year.

The results for the Year 2000 are more dramatic. The Committed Network, with a doubling of traffic from 1990 but with no new investment in infrastructure, showed an increase in travel times compared with Base Year of between 2.5 and 3 hours. Thus a journey from the center of Cairo to the center of Assuit which took 7 hours in Base Year, could take nearly

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10 hours by the Year 2000 if no more road improvements are made other than those already committed.

The 2000 Overlay, as expected, made little impact on these travel times, but both the Improved and the Expressway Networks had a substantial impact, both cutting the Committed Network times by a third. Times on the Improved Network and the Expressway Network were similar -- both were lower than Base Year with the Expressway Network showing slightly the shortest time.

Congested Links by Network

Figures 6C-5 to 6C-7 show the congested road links on the Committed, Improved and Expressway Networks respectively under conditions of 2000 traffic forecasts. Traffic volumes above practical capacity (about 70 to 80 percent of possible capacity) indicate poor driving conditions with slow traffic during substantial periods of the day. Volumes above possible capacity indicate very difficult driving conditions for most of the day with reasonable conditions only during the evening and at night.

In the Committed Network, most sections of the existing West Bank Highway, together with the Fayoum Desert Road into Sinnuris and the East Bank Highway from Helwan to Saff, were above practical capacity and several sections, mostly in towns along the route, were above possible capacity. The most congested portion of the Network was the East Bank Highway between Helwan and Saff. Traffic was attracted to this route because of the much easier conditions south of Saff.

The Improved Network showed almost complete relief to the West Bank Highway, and took some traffic off the East Bank Highway giving relief to the Helwan-Saff section. The Fayoum Desert Road had little relief in this Network.

The Expressway Network showed significant relief to the existing West Bank Highway compared to the Committed Network, but still left a high proportion of the route over practical capacity. Relief was given to the East Bank Highway but still left the Helwan-Saff section above practical capacity. Good relief was given to the Fayoum Desert Road, although still leaving the section within the Fayoum Oasis around Sinnuris at around possible capacity.

Sensitivity and Staging Tests

After the main tests were completed, a series of sensitivity and staging tests were undertaken. They were all completed with versions of the Expressway Network. Summaries of the number of trips, average trip length and total vehicle-kilometers are presented in Table 6C-9.

This additional model testing program started with sensitivity tests for 2000 traffic and then proceeded to the staging tests for a 4-lane highway for the year 2000 and then to staging tests for a 2-lane highway for both 1990 and 2000. They are discussed below in that order.

Table 6C-9

TRAFFIC FORECASTS FOR EXPRESSWAY SENSITIVITY AND STAGING TESTS
(24 hour AADT)

VEHICLE	BASE YEAR	2000 EXPRESSWAY SENSITIVITY (4-LANE)			2000 EXPRESSWAY STAGING					1990 EXPRESSWAY STAGING			
					4-lane			2-lane			2-lane		
		Main Test	Low Grwth	High Grwth	Main Test	Giza-Minia	Giza-Ben Sf	Giza -Ass't	Ben Sf -Ass't	Main Test 4-lane	Giza -Ass't	Ben Sf -Ass't	Minia -Ass't
Total Movements in Corridor (thousands)													
Car work	7.1	18.0	14.6	21.2	18.0	17.5	17.2	17.8	17.1	9.9	9.9	9.8	9.7
Car Other	5.4	13.8	11.0	16.2	13.8	13.3	13.0	13.7	13.1	7.7	7.7	7.6	7.5
Taxi car	15.1	23.9	20.5	27.3	23.9	23.8	23.7	23.9	23.7	17.6	17.6	17.6	17.6
Taxi van	15.0	43.3	29.8	55.9	43.3	43.2	43.1	43.3	43.2	20.8	20.8	20.8	20.8
Pickup	18.7	43.2	35.9	54.2	43.2	43.1	43.1	43.2	43.1	23.9	23.9	23.9	23.8
Bus	4.0	8.3	6.1	9.9	8.3	8.3	8.3	8.3	8.3	4.9	4.9	4.9	4.8
Truck single	10.5	21.7	17.2	26.1	21.7	21.6	21.6	21.7	21.7	12.6	12.6	12.6	12.6
Truck comb	1.7	3.6	2.8	4.3	3.6	3.6	3.6	3.6	3.6	2.1	2.1	2.1	2.1
Truck artic	0.7	1.5	1.2	1.8	1.5	1.5	1.5	1.5	1.5	0.9	0.9	0.9	0.9
ALL VEHICLES	78.3	177.4	139.0	216.9	177.4	175.9	174.9	177.0	175.2	100.4	100.4	99.9	99.8
FACTOR	1.00	2.27	1.78	2.77	2.27	2.25	2.23	2.26	2.24	1.28	1.28	1.28	1.27
Average Journey Length (kilometers)													
Car work	49	63	61	65	63	62	64	62	62	57	56	54	54
Car Other	57	71	68	74	71	70	72	71	70	62	62	61	61
Taxi car	67	81	81	82	81	81	80	81	80	74	73	71	70
Taxi van	30	35	35	35	35	34	34	35	34	33	33	32	32
Pickup	70	78	78	78	78	78	78	78	75	75	75	73	73
Bus	65	79	78	79	79	78	77	79	77	73	73	71	70
Truck single	73	82	81	82	82	81	80	82	80	80	80	79	79
Truck comb	204	227	227	228	227	224	223	221	224	221	218	217	223
Truck artic	215	238	239	238	238	240	238	234	236	234	236	241	242
ALL VEHICLES	63.3	70.7	71.2	70.7	70.7	69.9	70.1	70.4	69.3	68.2	67.9	66.5	66.3
FACTOR	1.00	1.12	1.12	1.12	1.12	1.10	1.11	1.11	1.09	1.08	1.07	1.05	1.05
Total Vehicle-kilometers (thousands)													
Car work	349	1,141	884	1,382	1,141	1,088	1,100	1,101	1,056	563	553	530	529
Car Other	310	980	750	1,195	980	929	931	975	924	480	479	460	457
Taxi car	1,014	1,942	1,656	2,235	1,942	1,915	1,901	1,942	1,895	1,297	1,292	1,254	1,227
Taxi van	451	1,510	1,041	1,950	1,510	1,474	1,471	1,511	1,486	684	684	674	658
Pickup	1,310	3,364	2,781	4,233	3,364	3,344	3,347	3,363	3,251	1,787	1,787	1,738	1,731
Bus	258	658	476	785	658	643	638	654	637	357	356	342	341
Truck single	765	1,772	1,387	2,139	1,772	1,743	1,723	1,771	1,730	1,014	1,009	993	988
Truck comb	348	817	636	988	817	800	791	793	803	459	451	447	460
Truck artic	154	360	282	430	360	364	358	354	356	206	207	210	210
ALL VEHICLES	4,959	12,545	9,894	15,337	12,545	12,302	12,258	12,462	12,137	6,848	6,818	6,648	6,611
FACTOR	1.00	2.53	2.00	3.09	2.53	2.48	2.47	2.51	2.45	1.38	1.37	1.34	1.33

Source: Study estimates

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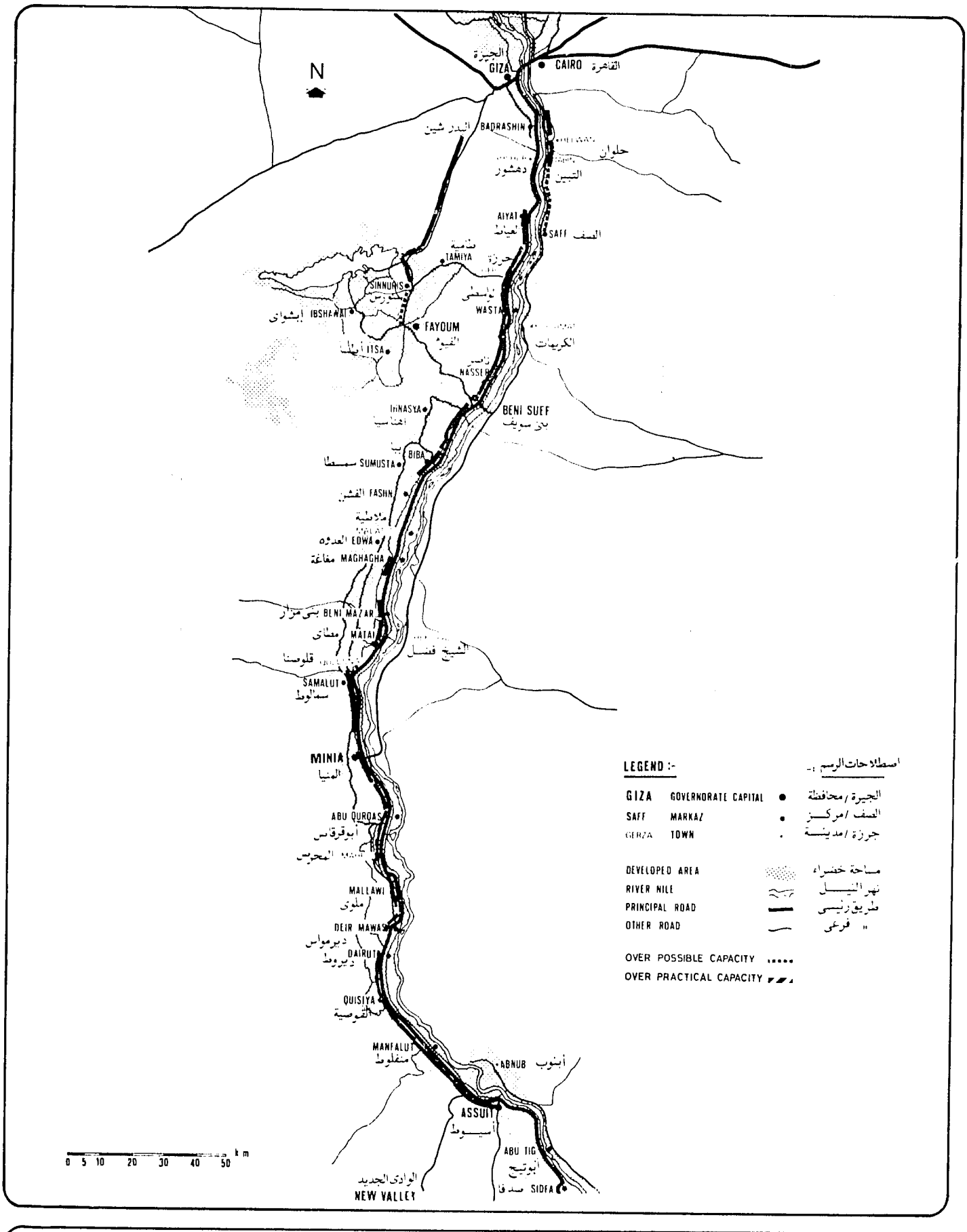

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CONGESTION ON THE 2000 COMMITTED NETWORK

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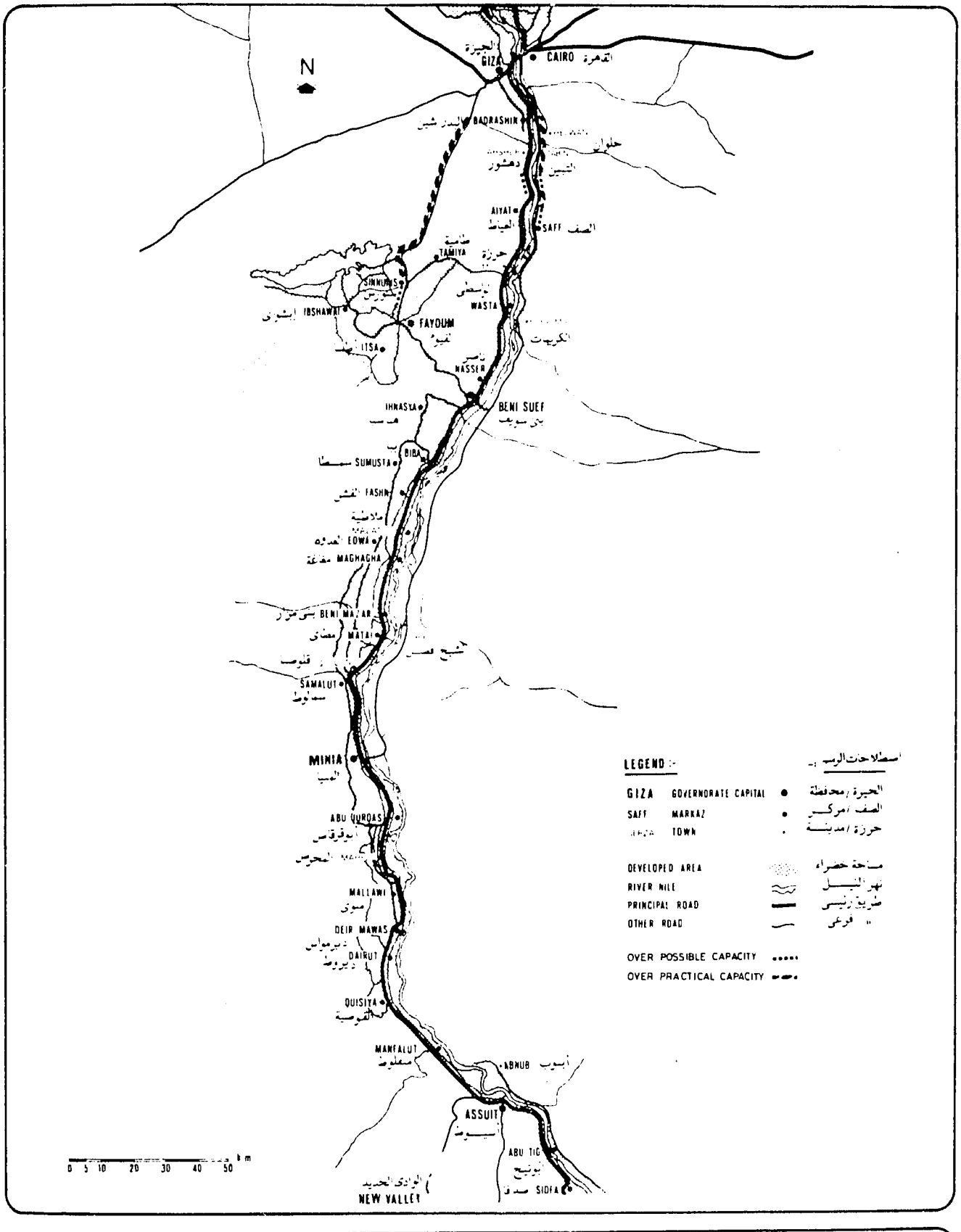
Figure 6C-5



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CONGESTION ON THE 2000 IMPROVED NETWORK

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6C-6

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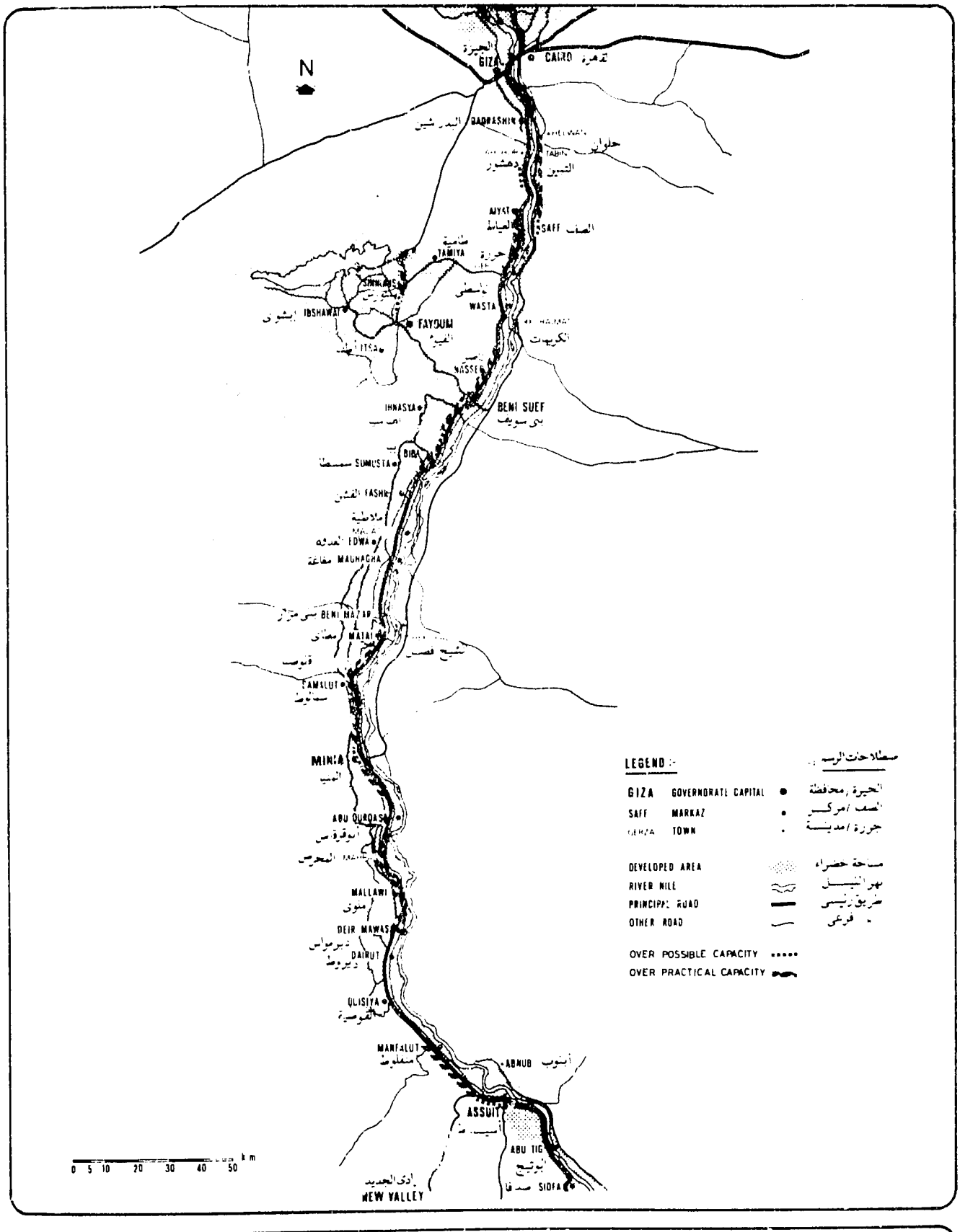

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CONGESTION ON THE 2000 EXPRESSWAY NETWORK

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Figure 6C-7

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Sensitivity Tests - Two sensitivity tests were undertaken for the 4-lane Expressway Network, one assuming low economic growth between 1990 and 2000 (4 percent per year) and the other assuming high growth (8 percent per year), compared with 6 percent per year assumed in the main test. In addition, the low sensitivity test assumed that subsidies on fuel would be removed and that transport tariffs would be raised to better match economic operating costs. This had the effect of increasing all vehicle operating costs, but with particular impact on truck costs which rose between 25 percent (single truck) and 40 percent (combination truck).

The low sensitivity test showed a 22 percent reduction in the number of journeys, while the high sensitivity test showed a 22 percent increase, each compared with the main test. Trip lengths were almost unchanged, so changes in vehicle-kilometers reflected the change in number of journeys.

Figure 6C-8 shows the traffic volumes recorded in the sensitivity tests compared with the main test. Growth rates were even through the corridor so that link volumes reflected changes in trip making noted above.

4-Lane Expressway Staging Tests - In addition to the main test, two staging tests were undertaken for a 4-lane expressway for the year 2000, both assuming construction starting from Giza. The first considered the highway terminating at Minia, while the second terminated the expressway at Beni Suef. The forecast traffic volumes are shown in Figure 6C-9.

The Beni Suef alternative showed a reduction in expressway traffic of about 20 percent in the only section of the expressway open (Giza-Beni Suef), and showed higher volumes on the existing West Bank Highway south of Beni Suef. Comparison with the Committed Network earlier (Figure 6C-1) shows that the volumes between Beni Suef and Minia on the existing West Bank Highway increased with this partial Expressway Network, which is explained by the reduction in journey costs of the partial expressway attracting more traffic into the corridor. Volumes south of Minia were just above the Committed Network forecast level.

The Minia alternative showed a similar pattern with expressway traffic reduced from the full expressway, although only by about 5 to 10 percent at the northern end.

2-Lane Expressway Staging Tests - Observing that on traffic grounds, a 4-lane expressway appeared not to be justified, alternative networks with a 2-lane highway were devised. These should be considered as a staging of the full expressway, with construction and design allowing for later expansion when traffic increased.

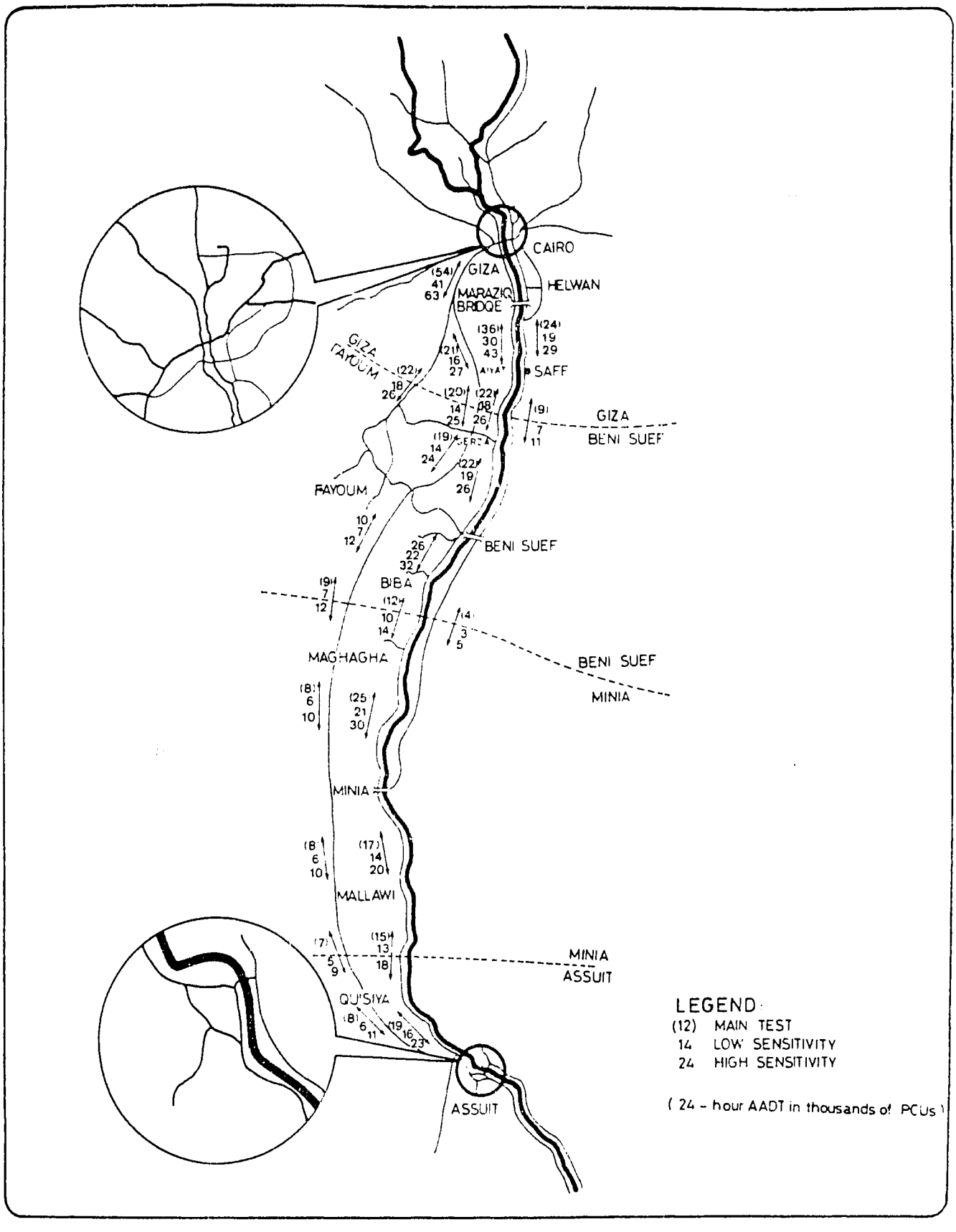
The traffic forecasts for the 2-lane highway for 1990 and 2000 are shown in Figure 6C-10, one set for the full route from Giza to Assuit, and the second set assuming construction from Beni Suef to Assuit only.

The tests on a full length 2-lane highway showed only slight reductions in traffic compared with the full 4-lane expressway tests (see Figure 6C-4). Volumes for 1990 were almost unchanged and the 2000

forecasts showed a reduction of about 5-10 percent. This indicated that the major reduction in capacity going from a 4-lane to a 2-lane highway had little effect at these low forecast traffic volumes.

The partial network from Beni Suef to Assuit showed a 20 percent reduction in volume immediately south of Beni Suef, but almost unchanged volumes between Minia and Assuit.

A further test was made of a 2-lane highway for 1990, this time considering construction from Minia to Assuit only. The results showed at 25 percent reduction in volumes compared with the full 2-lane highway, but on what was already forecast to be a very lightly trafficked section of the road.



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2000 TRAFFIC FORECASTS FOR THE 4- LANE EXPRESSWAY SENSITIVITY TESTS

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Figure 6C - 8

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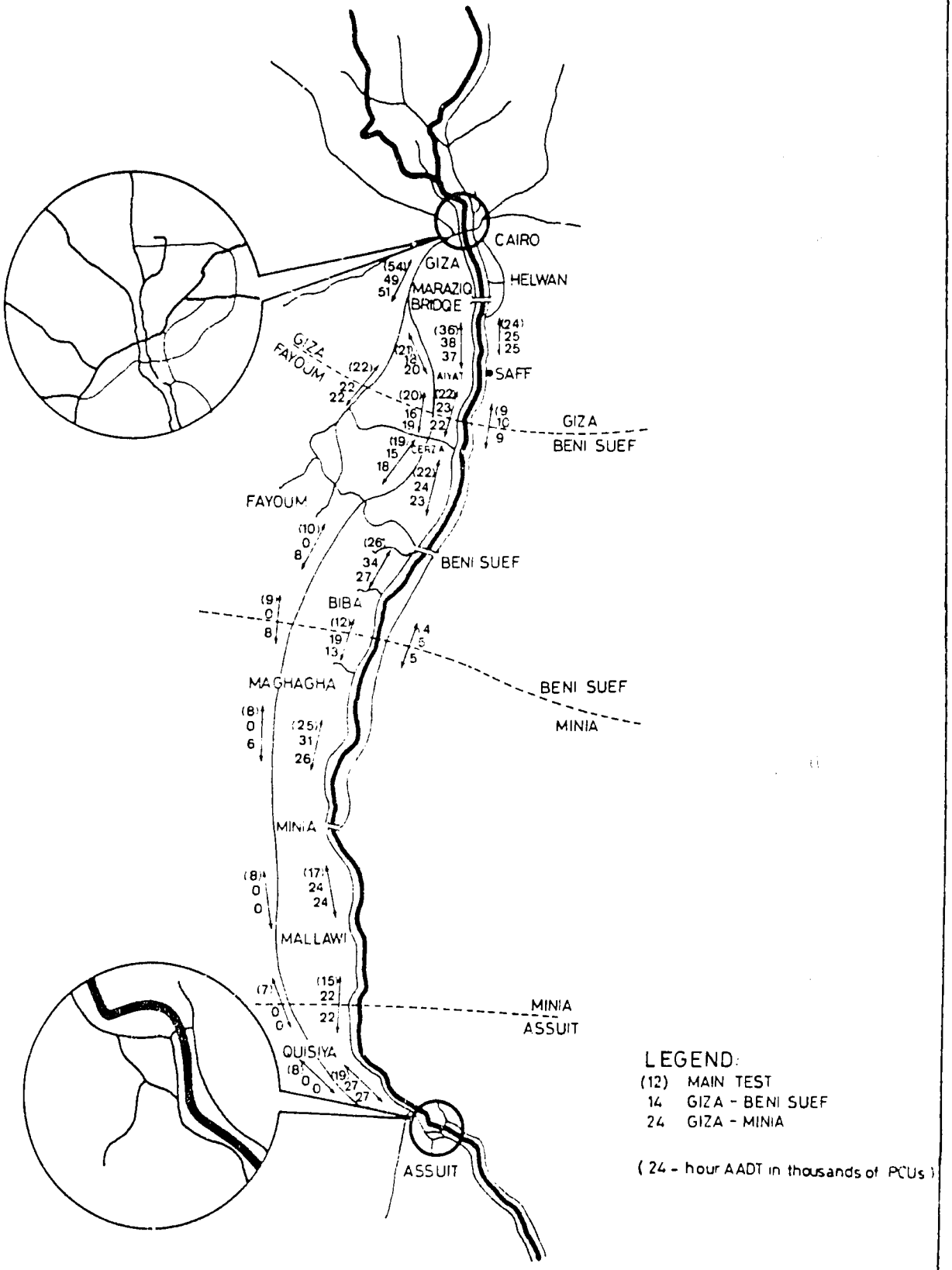

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2000 TRAFFIC FORECASTS FOR THE 4- LANE EXPRESSWAY STAGING TESTS

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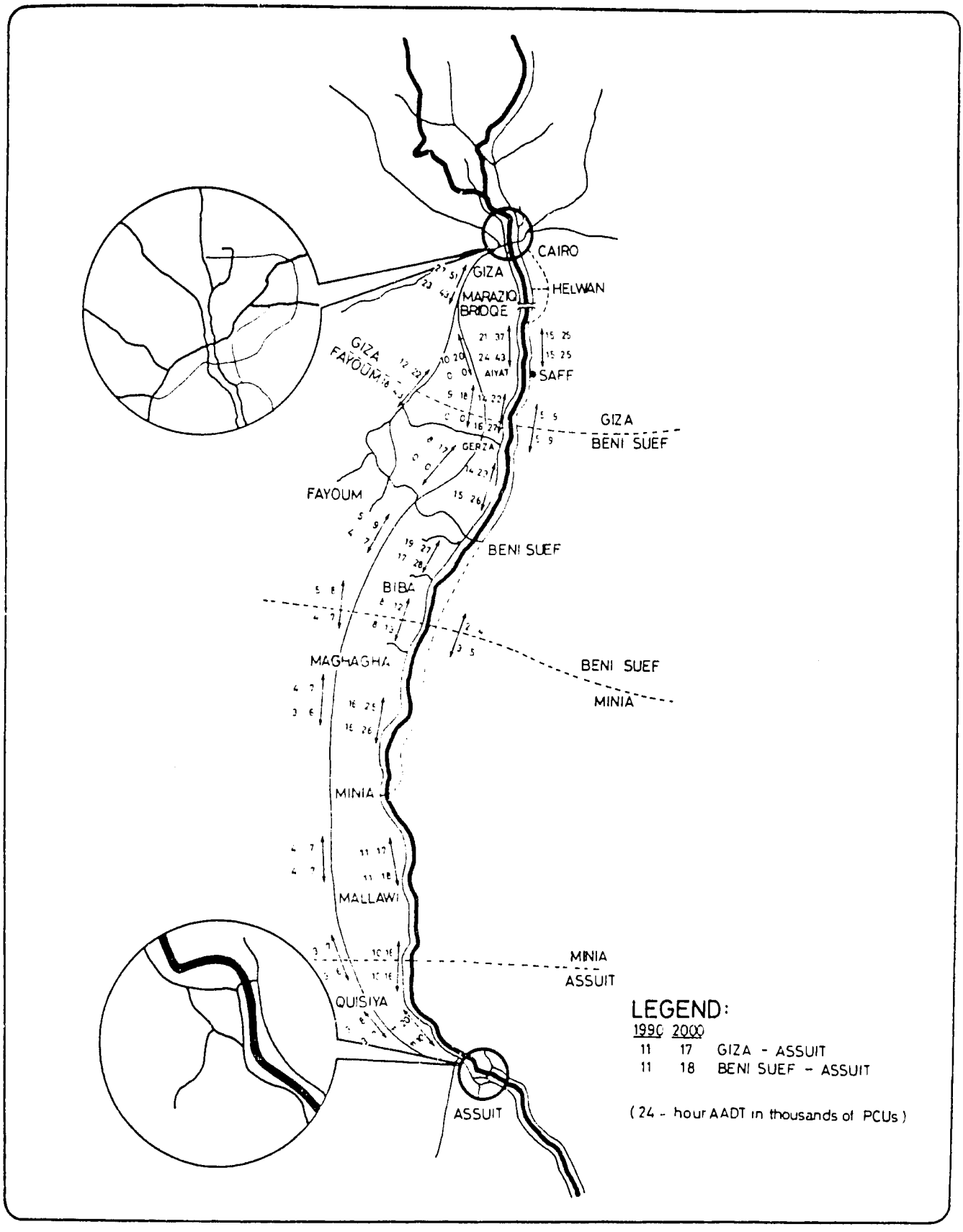
Figure 6C - 9



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TRAFFIC FORECASTS FOR THE
2- LANE EXPRESSWAY STAGING TESTS

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Figure 6C - 10